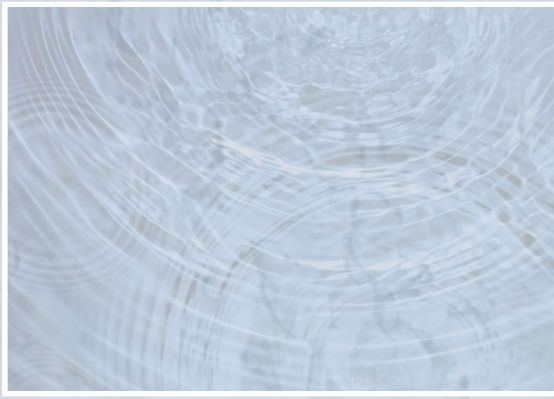
Stormwater Master Plan



August 30, 2013

Facility Plan

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EXECUTIVE SUMMARY

Chen Moore and Associates (CMA) were retained by the City of Pompano Beach in July 2011 to prepare a Stormwater Master Plan for the entire City limits. The purpose of the Stormwater Master Plan was to identify any deficiencies in the existing stormwater management system and to recommend system improvements to alleviate flooding problems within public right of way areas throughout the study area, and address regulatory compliance issues. The Stormwater Master Plan assessed the performance of existing stormwater management system, summarized the results of the stormwater model for the existing conditions, prioritized the drainage basins in need of stormwater improvements, analyzed various alternatives for proposed improvements to the stormwater management system in each priority basin, and provided an estimated cost to construct the recommended upgrades to the stormwater management system. Within the Stormwater Master Plan, CMA provided recommendations for improvements to the stormwater management system that will reduce the flooding issues currently encountered within various right-of-way areas during or after rainfall events. The Stormwater Master Plan was accepted and adopted by the City Commission on July 9th, 2013.

CMA used all available information on the existing conditions within the City limits and on the existing stormwater management system to create a hydraulic and hydrologic stormwater model of the existing conditions, which allowed CMA to conduct an analysis of the performance of the existing stormwater management system; to better identify any deficiencies with the existing stormwater management system; and to analyze various system improvement alternatives. The stormwater model was used to prioritize the drainage basins throughout the City which are most in need of stormwater improvements. The analysis with the stormwater model is defined in detail within the complete Stormwater Master Plan Report, which is included within Appendix C. The limits of these priority drainage basins are displayed on Figure A - Priority Study Areas on the following page.

For each priority drainage basin, CMA has developed various system improvement alternatives for areas throughout the City in need of stormwater improvements based on our analysis of the existing conditions. The goal of these system improvement alternatives is to meet level of service criteria for flood control of the public right of way areas along with providing additional water quality benefits. These various system improvement alternatives which were considered for these areas include the installation of exfiltration trench systems, the interconnection with the adjacent existing stormwater systems, the upsizing of existing stormwater pipes, the construction of retention areas, the installation of stormwater pump stations, the implementation of backflow prevention devices at existing outfalls, the installation of drainage wells, and the regrading of roadway swale areas. Each of these potential system improvement alternatives were evaluated in multiple configurations within each area to determine which would be the most effective at alleviating the existing flooding within the public right of way areas. For comparison purposes, CMA used the stormwater model to analyze the effectiveness of these system improvement alternatives at improving the performance to the existing stormwater management system within each area of the City. Each system improvement alternative was compared based on its ability to reduce the peak flood stage within the study area and to reduce the flood duration within the study area. The conceptual layout and preliminary cost estimate each system improvement alternative for each priority drainage basin along with the selection methodology for the recommended improvements is summarized within this Facility Plan Report. The detailed information on our analysis with the stormwater model is defined within the complete Stormwater Master Plan Report, which is included within Appendix C.

The purpose of this Facility Plan Report is to summarize the various alternatives within each priority drainage basin, to compare the effectiveness and feasibility of each system improvement alternative, and to define the impacts of the recommended alternative for each priority drainage basin. Within the following sections of this Facility Plan Report, the recommended stormwater improvements are presented based on the order of the prioritization for the drainage basins within the City.

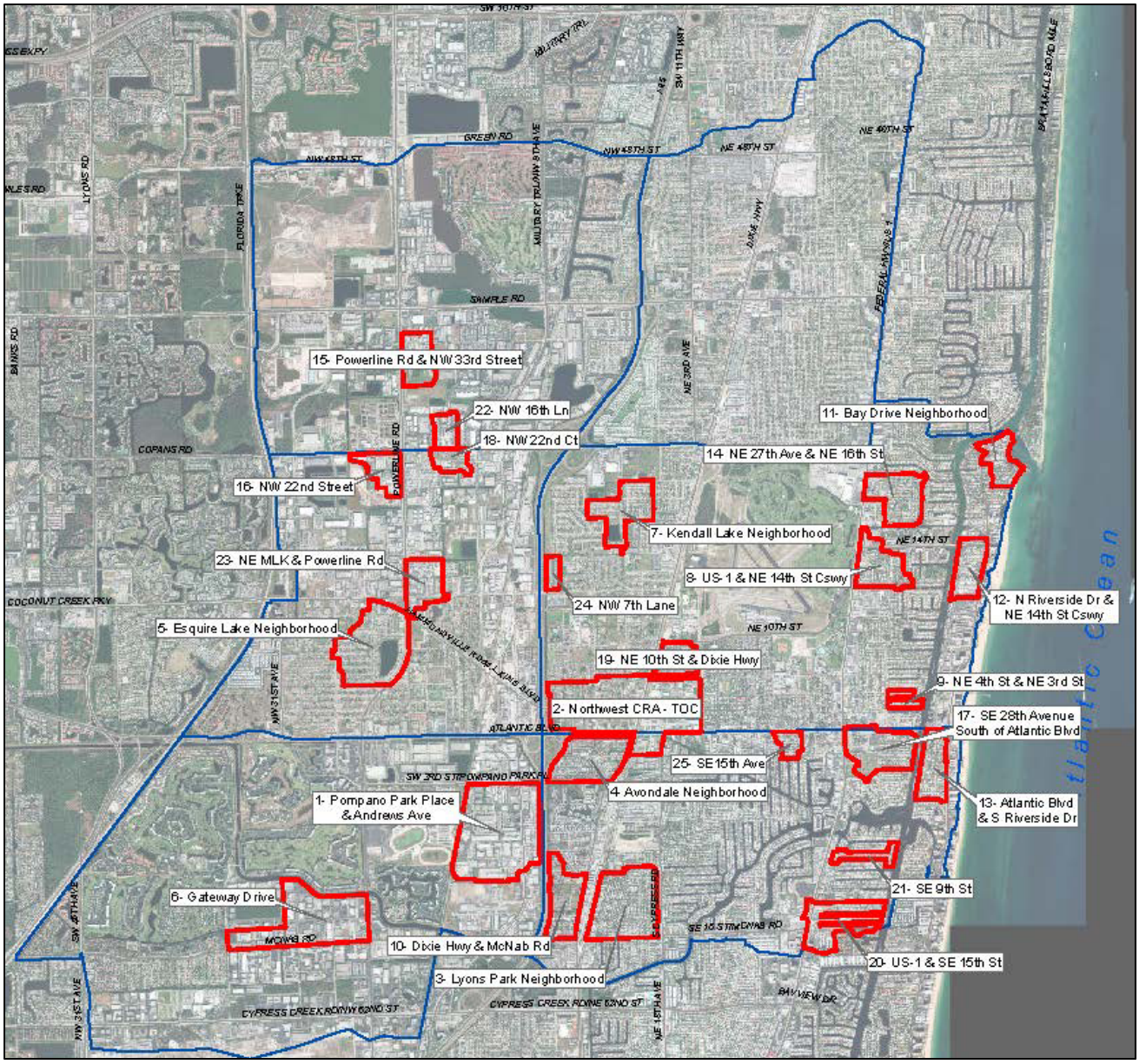

Figure A – Priority Study Areas

SECTION A – STORMWATER IMPROVEMENT PROJECTS

1 POMPANO PARK PLACE AND ANDREWS AVENUE

This study area is located on the west side of the I-95, east of Andrews Avenue and south of Pompano Park Place. This study area mainly consists of industrial and commercial properties with high amounts of impervious ground surface. The majority of these commercial properties have their own on-site drainage system or along the private roadways. Some properties located at the center of the study area discharge to two large lakes at SW 6th Street and Andrews Avenue, which overflow through a control structure into the Andrews Avenue stormwater system. A majority of the remaining properties discharge directly to the Andrews Avenue stormwater system, which outfalls through an 84-inch pipe into the SFWMD C-14 Canal.

Alternative 1: Pipe Size Upgrades

Alternative 1 includes upgrading the pipe sizes along Andrews Avenue from the connection with the lakes at SW 6th Street south to the existing outfall near McNab Road in order to increase transmission capacity. The existing drainage pipes to be removed and upsized include 5,675 linear feet of pipe. The diameter of existing pipe to be removed ranges from 42-inch to 84-inch. Alternative 1 also interconnects this stormwater system with the existing stormwater system east of I-95. Under Alternative 1, the proposed improvements include 6,125 linear feet of pipe replacement. The proposed pipe diameters range from 42-inch RCP to 96-inch RCP at the outfall location. The estimated design and construction costs for this pipe size upgrades alternative are approximately $3,602,000.

Alternative 2: Exfiltration Trench

Alternative 2 includes the installation of new exfiltration trench within available right-of-way areas throughout the study area in order to provide additional storage and infiltration capacity to the existing stormwater system. Under Alternative 2, the installation of exfiltration trench was proposed throughout the study area along available public roadways with a ground elevation greater than +5.0 feet NAVD, which results in a maximum potential installation of 7,344 linear feet of exfiltration trench. The estimated design and construction costs for this exfiltration trench alternative are approximately $2,950,000.

Alternative 3: Pump Station + Additional Dry Retention Storage

Alternative 3 includes the construction of a pump station at the south end of SW 14th Avenue in order to pump stormwater runoff to new dry retention area(s) throughout the study area in order to provide additional storage volume for stormwater runoff. The pump station would transmit all collected stormwater runoff into a new retention area(s) at a location to be determined by the City in the future. Under this analysis, the proposed storage retention area(s) would encompasses a total area of 1.00 acres. The estimated design and construction costs for this pump station alternative are approximately $3,088,000.

Alternative Comparison

Refer to the Table 1-1 below for a comparison of the various system improvement alternatives. Based on our analysis with the stormwater model, only Alternative 1 can significantly reduce the peak flood stages and the flood duration within the study area. However, Alternative 1 should be eliminated from consideration since the existing downstream piping in need of upsizing is located within the right-of-way of Andrews Avenue, which is the responsibility of Broward County, not the City of Pompano Beach.

Alternative 3 should also be eliminated from consideration since using private property in this study area for stormwater retention is not feasible from a cost standpoint.

Table 1-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.22	7.87	$3,602,000
Alternative 2	0.02	0.6	$2,950,000
Alternative 3	0.00	1.37	$3,088,000

Recommended Alternative

Based on the ownership of existing drainage facilities within the study area, the extensive existing underground utilities within public right of way areas, and the lack of available property for stormwater storage, a scaled back version of Alternative 2 is the recommended option for improving the stormwater system within this study area. Although Alternative 2 does not provide enough additional flood protection to meet the level of service criteria for all public roadways within the study area, Alternative 2 does provide limited benefits which alleviate the localized flooding problems within the areas with historical flooding and public complaints. Instead of the installation of new exfiltration trench throughout all City right of way areas, CMA recommends the installation of exfiltration trench in targeted City right-of-ways which address isolated flooding problem locations within the study area. The recommended stormwater improvements for this study area include the installation of new exfiltration trench along SW 9th Terrace and along SW 16th Terrace to address localized flooding problems in this area. A conceptual layout of the recommended system improvements for this design alternative is displayed in Figure 1-1 below. The estimated design and construction costs for this recommended alternative are approximately $396,000. The detailed preliminary cost estimate of each alternative and the recommended alternative is displayed in Table 1-2 at the end of this section.

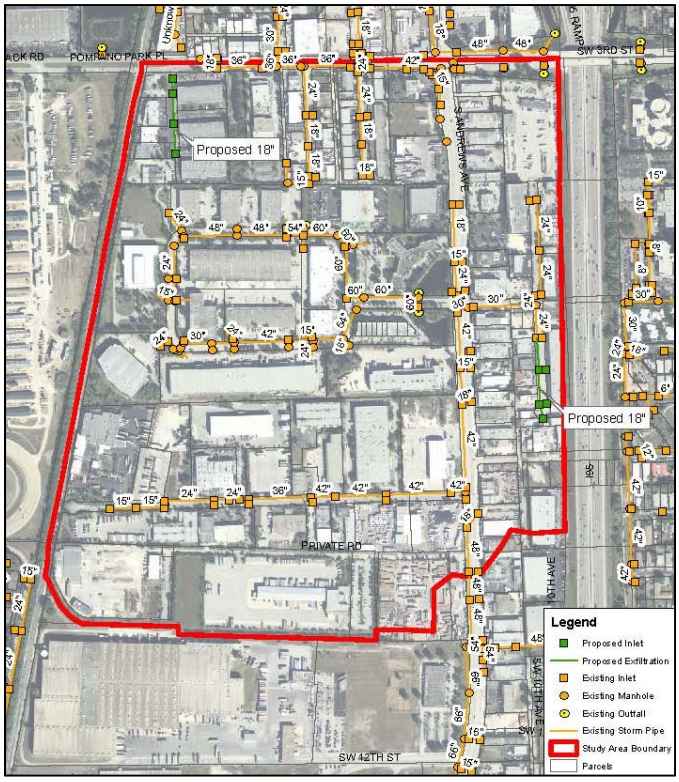

Figure 1-1 Pompano Park Place & Andrews Avenue Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will improve the water quality of the stormwater discharge into the SFWMD C-14 Canal since a portion of the stormwater runoff would be diverted from the downstream outfalls into the new exfiltration trench, which will result in a net reduction in peak discharge and a net improvements in the water quality of the stormwater runoff flowing into the receiving waters via the existing outfalls.
- Groundwater: This alternative will allow stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within this drainage basin, which will reduce the peak flood stage within the drainage basin during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way. A portion of stormwater runoff will be diverted from discharging into the receiving waters into the new exfiltration trench.

Biological

- Aquatic: This alternative will enhance the water quality of the stormwater discharge into the SFWMD C-14 Canal over the existing conditions since a portion of the stormwater runoff would be diverted from the downstream outfalls into the new exfiltration trenches, which will result in a net improvement within the receiving waters of the SFWMD C-14 Canal.

- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area. All construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use. All construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities. All construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features. All construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study, the area surrounding the Pompano Park Place and Andrews Avenue study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Pompano Park Place and Andrews Avenue study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 1-2 Pompano Park Place & Andrews Avenue Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Recommended Alternative
Remove Existing Pipe	$113,500	-	$6,000	-
Replace Existing Drainage Structure	$100,000	-	-	-
Install Catch Basin	-	$315,000	-	$40,500
Upgrade Existing Outfall	$5,000	-	-	-
15" RCP Drainage Pipe	-	-	-	$4,500
18" DIP Pressure Pipe	-	-	$91,000	-
18" RCP Drainage Pipe	-	-	$68,900	-
18" RCP Drainage Pipe with Exfiltration	-	$882,000	-	$117,000
42" RCP Drainage Pipe	$47,000	-	-	-
54" RCP Drainage Pipe	$173,600	-	-	-
60" RCP Drainage Pipe	$200,000	-	-	-
72" RCP Drainage Pipe	$231,600	-	-	-
90" RCP Drainage Pipe	$390,000	-	-	-
96" RCP Drainage Pipe	$479,500	-	-	-
Wet Well & Pump Station	-	-	$600,000	-
Water Control Structure	-	-	$5,000	-
Soil Removal & Construct Dry Retention	-	-	$85,450	-
Sod Restoration of Retention Area	-	-	$19,360	-
Purchase Property for Retention Area	-	-	$1,100,000	-
Pavement Restoration	$598,889	$718,667	$29,333	$95,333
Subtotal	$2,339,089	$1,915,667	$2,005,043	$257,333
Mobilization (10%)	$233,909	$191,567	$200,504	$25,733
Construction Contingency (20%)	$514,600	$421,447	$441,110	$56,613
Design and Permitting (15%)	$385,950	$316,085	$330,832	$42,460
Construction Administration (5%)	$128,650	$105,362	$110,277	$14,153
TOTAL COST	**$3,602,197**	**$2,950,127**	**$3,087,766**	**$396,293**

2 NORTHWEST CRA

The study area for the Northwest CRA TOC Neighborhood has general boundaries of NW 6th Street on the north, West Atlantic Boulevard on the south, I-95 on the west, and NE 5th Street on the east. This study area is also located directly within the WBID basin for the Old Pompano Canal and is considered to have an impact on water quality within this impaired waterbody. The flooding problems within the NW CRA TOC Neighborhood are created primarily by a combination the topography within the study area and the lack of extensive existing stormwater infrastructure. The existing drainage system within the NW CRA TOC Neighborhood consists of gravity pipes, ranging from 15-inches to 72-inches in diameter, collecting stormwater runoff from the public right of way areas and discharging to the Old Pompano Canal.

Recommended Alternative - Exfiltration Trench

CMA has investigated various system improvement alternatives for the implementation of a master stormwater management system for the entire TOC study area. The system improvement alternatives considered as feasible for the TOC Area include the construction of exfiltration trench which are interconnected with the existing stormwater management system. The replacement of existing outfalls with larger diameter pipe or the installation of stormwater pumps stations were not considered as a feasible system improvement alternative since neither provides the additional water quality storage volume required for the reduction of pollutant loading within stormwater runoff. The installation of larger outfall pipes or stormwater pump stations would likely increase the peak discharge into the Pompano Canal, which would likely not be allowed due to regulatory restrictions. The installation of gravity drainage wells is not an option due to the lack of brackish groundwater at the bottom of the surficial aquifer below the TOC Area since the boundary of this brackish groundwater is located just east of Dixie Highway. The installation of Class V drainage wells is not allowed outside of this zone by the regulatory agencies.

The recommended stormwater improvements include the installation of exfiltration trench along the streets with localized flooding issues, which include NW 9th Avenue, NW 7th Avenue, NW 4th Avenue, and NW 2nd Street. The proposed construction includes a total of 3,600 LF of 24-inch exfiltration pipe, which will be interconnected with the existing drainage system. The purpose of this system improvement alternative is to alleviate the existing flooding issues at the low elevations areas which are not served by the existing drainage system. The estimated design and construction costs for this alternative are approximately $1,982,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 2-1 below and a preliminary cost estimate summarized in Table 2-1 at the end of this section.

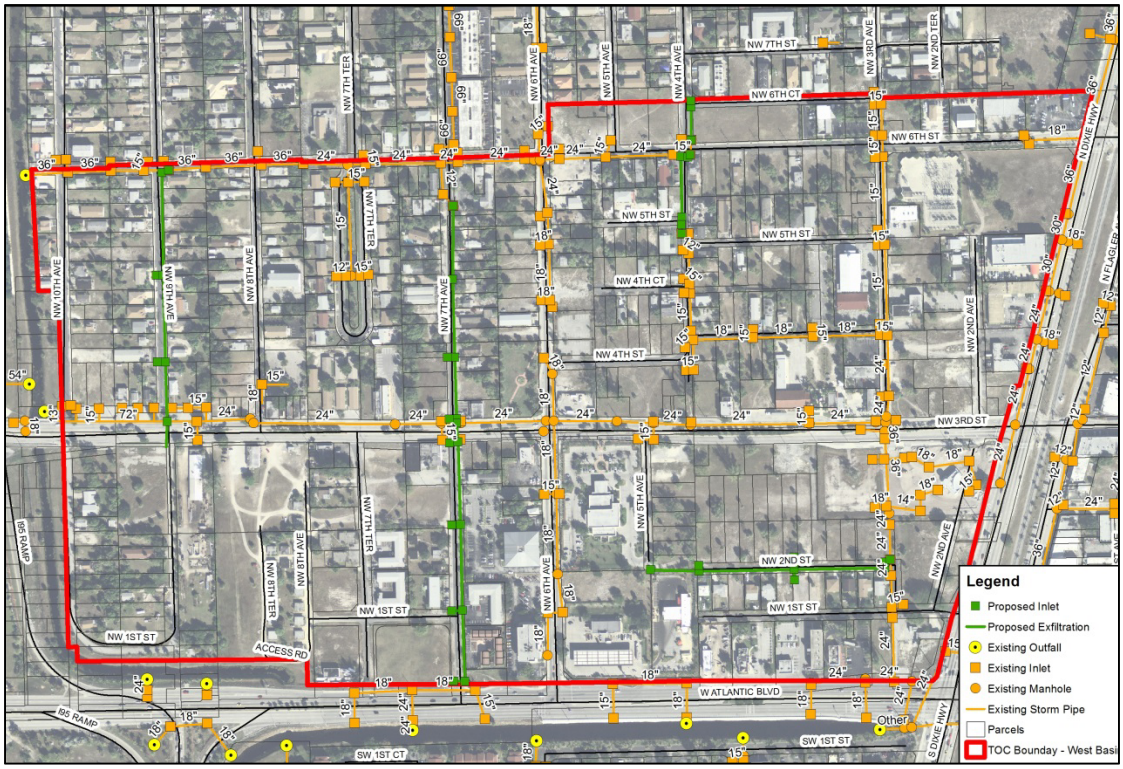

Figure 2-1 CRA TOC Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the Old Pompano Canal since some of the stormwater runoff would be diverted into the new exfiltration trenches, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system over the existing conditions since some of the stormwater runoff would be diverted from the downstream outfalls to new exfiltration trench, which will result in a net improvement within the receiving waters.

- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, the area surrounding the CRA TOC Neighborhood will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the CRA TOC Neighborhood study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 2-1 Pompano CRA TOC Preliminary Cost Comparison

Item	Recommended Alternative
Install Drainage Structure	$156,000
Connect to Existing Drainage Structure	$40,000
24" RCP Drainage Pipe	$48,160
24" RCP Exfiltration Trench	$504,000
Swale Regrading	$33,600
Pavement Restoration	$505,200
Subtotal	$1,286,960
Mobilization (10%)	$128,696
Construction Contingency (20%)	$283,131
Design and Permitting (15%)	$212,348
Construction Administration (5%)	$70,783
TOTAL COST	**$1,981,918**

3 LYONS PARK NEIGHBORHOOD

The Lyons Park Neighborhood is located west of South Cypress Road, north of McNab Road, east of South Flagler Avenue and south of Southwest 8th Street. This study area is a residential neighborhood with chiefly single family homes, which is served by an existing stormwater collection system. The existing stormwater management system consists of four independent systems which are interconnected with other stormwater systems outside of the neighborhood. The Lyons Park neighborhood has low-lying streets surrounded by higher ground on all sides, which leads to stormwater runoff flowing into the neighborhood from the perimeter. The stormwater runoff within the Lyons Park neighborhood is eventually discharged via multiple positive outfalls located to the south of West McNab Road and to the east of South Cypress Road all eventually leading into the SFWMD C-14 Canal.

Since the Lyons Park neighborhood is served by an existing drainage system, various pipe upgrades to this existing system are evaluated with the stormwater model to optimize the pipe sizing of the stormwater system. Additional system improvement alternative, such as drainage wells, pump stations, storage/retention areas, and/or a combination of these alternatives, were also analyzed with the stormwater model to compare the effectiveness in reducing the peak flood stage and flood duration. The installation of exfiltration trench was eliminated from consideration as system improvement alternative due to low surface elevations throughout the study area which would limit the effectiveness of this option. The analysis of each system improvement alternative is summarized below:

Alternative 1: Pipe Size Upgrades

The stormwater model was used to conduct multiple simulations of various scenarios of upsizing the drainage pipe throughout the study area. The purpose of the pipe upgrades is to increase the transmission capacity of the existing system. Under Alternative 1, the existing pipe would be upsized along the primary routes to the existing outfalls, which include upgrading along South Cypress Road to 42-inch diameter and along Flagler Avenue to 48-inch diameter. The estimated design and construction costs for the pipe size upgrades under Alternative 1 are $4,766,000.

Alternative 2: Drainage Wells

Under Alternative 2, the stormwater model was used to iteratively estimate the impact of installing a variable number of stormwater drainage wells throughout the Lyons Park neighborhood. The purpose of is to create additional discharge capacity via new drainage wells. The locations of proposed drainage wells were targeted to optimize the flooding reduction within the low lying problem areas of the Lyons Park neighborhood. In order to maximize the reductions in flooding, 25 drainage wells have been considered under Alternative 2. The estimated design and construction costs for the improvements under Alternative 2 are $3,659,000.

Alternative 3: Pump Stations

Alternative 3 includes the proposed construction of a stormwater pump station along with associated drainage pipe upgrades in various configurations. The purpose is to provide additional discharge capacity to the existing system, especially during high tide. Due to the layout of the existing drainage system along with the large size of the Lyons Park neighborhood, the construction of a single pump station would not be capable of servicing the entire neighborhood. Three system configurations were developed and analyzed to determine the best options for reducing the peak flood stage and the flooding duration within the Lyons Park neighborhood. The results of our analysis with the stormwater model are summarized below for the three layout options for Alternative 3.

Alternative 3-1: Pump Station Layout 1

Under this layout option, the proposed construction includes two new pump stations at existing outfalls in order to provide additional hydraulic head on the downstream end of the system to increase the discharge capacity of the system. This additional discharge capacity from the stormwater pump stations will draw down the flooding within the upstream areas of the Lyons Park neighborhood quicker than the existing conditions. Pipe improvements to the existing stormwater system are also proposed to efficiently transmit stormwater runoff to the proposed pump stations in order to maximize the pump operational capacity. The estimated design and construction costs for pump station Alternative 3 – Layout 1 are approximately $3,980,000.

Alternative 3-2: Pump Station Layout 2

Under this layout option, the proposed construction includes two new pump stations near the problem area of Lyons Park in order to increase the discharge capacity of the stormwater system. This additional discharge capacity from the stormwater pump stations will draw down the flooding within the problem areas of the Lyons Park neighborhood quicker than the existing conditions. Under this layout option, the proposed pump stations are located within the west service area approximately 500 feet north of the intersection of West McNab Road and South Flagler Avenue and within the east service area on the southeast corner of SW 12th Street and SW 1st Avenue. Pipe improvements to the existing stormwater system are also proposed to efficiently transmit stormwater runoff to the proposed pump stations in order to maximize the pump operational capacity and to reduce the possibility of creating flooding issues downstream of the proposed pump station. The estimated design and construction costs for this pump station alternative (Layout 2) are approximately $5,107,000.

Alternative 3-3: Pump Station Layout 3

Under this layout option, the proposed construction includes three new pump stations within the problem areas of Lyons Park in order to increase the discharge capacity of the stormwater system. Under this layout option, the proposed pump stations are located within the west service area, north of SW 12th Street along SW 4th Avenue and within the east service area on the southeast corner of SW 12th Street and SW 1st Avenue and at the intersection of SW 14th Street and SW 1st Terrace. Pipe improvements to the existing stormwater system are also proposed to efficiently transmit stormwater runoff to the proposed pump stations in order to maximize the pump operational capacity and to reduce the possibility of creating flooding issues downstream of the proposed pump station. The estimated design and construction costs for this pump station alternative (layout 3) are $6,674,000.

Alternative Comparison

Refer to the Table 3-1 below for a comparison of the various system improvement alternatives for the Lyons Park Neighborhood. Based on our analysis with the stormwater model, multiple system improvement alternatives (Alternative 1, Alternative 2, and Alternative 3-3) can be considered to be a slightly effective option for reducing the peak flood stage and reducing the flood duration within the Lyons Park Neighborhood. The estimated reduction in flood duration from Alternative 3-1 and 3-2 is relatively minimal when compared to the other alternatives, so these alternatives are eliminated from consideration. Alternative 3-3 can also be eliminated as it is not feasible from a cost standpoint.

Table 3-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.17	18.24	$4,766,000
Alternative 2	0.20	18.16	$3,659,000
Alternative 3-1	0.01	4.86	$3,980,000
Alternative 3-2	0.19	15.26	$5,107,000
Alternative 3-3	0.37	20.44	$6,674,000

Recommended Alternative

Due to various constructability concerns and regulatory limitations, the recommended stormwater improvement project incorporates elements of Alternative 1 which increase the discharge capacity of the existing stormwater system from the Lyons Park neighborhood by upsizing the primary pipe connections to the existing outfalls. Due to the residential nature of the Lyons Park neighborhood, the regrading of all existing grass swale areas along the neighborhood roadways will provide additional storage volume for stormwater runoff, which would provide a significant reduction in flooding throughout the neighborhood roadways. The estimated design and construction costs for this recommended alternative are approximately $2,434,000. For the recommended stormwater improvements for this study area, CMA has prepared the conceptual layout displayed in Figure 3-1 below and a detailed preliminary cost estimate of each alternative and the recommended alternative in Table 3-2 at the end of this section.

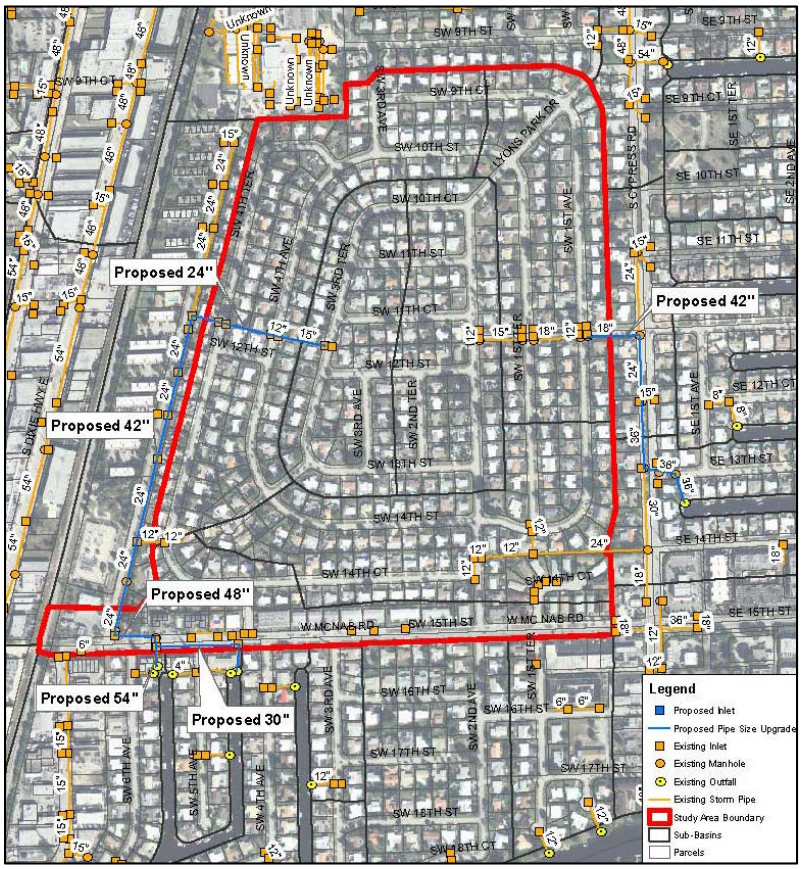

Figure 3-1 Lyons Park Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will improve the water quality of the stormwater discharge into the SFWMD C-14 Canal since a portion of the stormwater runoff would be diverted from the downstream outfalls into the new exfiltration trench, which will result in a net reduction in peak discharge and a net improvements in the water quality of the stormwater runoff flowing into the receiving waters via the existing outfalls.
- Groundwater: This alternative will not have an impact on the ground water.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within this drainage basin, which will reduce the peak flood stage within the drainage basin during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way. There will not be an increase in the discharge of stormwater runoff into the receiving waters.

Biological

- Aquatic: This alternative will enhance the water quality of the stormwater runoff since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement to the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area. All construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, Lyons Park neighborhood will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Lyons Park neighborhood does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 3-2 Lyons Park Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3-1	Alternative 3-2	Alternative 3-3	Recommended Alternative
Remove Existing Pipe	$120,540	-	$22,700	$53,200	$84,600	$81,500
Replace Existing Drainage Structure	$165,000	-	$25,000	$90,000	$110,000	$100,000
Install Catch Basin	$18,000	-	-	$13,500	$18,000	-
Upgrade Existing Outfall	$15,000	-	-	-	-	$10,000
21" RCP Drainage Pipe	-	-	$25,270	-	-	-
24" RCP Drainage Pipe	$45,750	$217,500	$18,000	$205,875	$138,750	$46,650
24" DIP Pressure Pipe	-	-	$10,350	$17,775	$7,350	-
30" RCP Drainage Pipe	$29,414	-	-	-	$131,670	$38,500
30" DIP Pressure Pipe	-	-	$9,856	$45,276	$42,735	-
36" RCP Drainage Pipe	$227,440	-	$10,080	$78,800	$173,360	-
42" RCP Drainage Pipe	$211,500	-	-	-	-	$233,200
48" RCP Drainage Pipe	$109,625	-	-	-	$20,625	$30,875
54" RCP Drainage Pipe	$195,300	-	-	-	-	$58,125
Wet Well & Pump Station	-	-	$1,200,000	$1,200,000	$1,800,000	-
Drainage Well	-	$1,875,000	-	-	-	-
Swale Regrading	$1,166,667	-	$1,166,667	$1,166,667	$1,166,667	$583,333
Pavement Restoration	$790,729	$283,556	$97,093	$445,378	$639,956	$398,542
Subtotal	$3,094,965	$2,376,056	$2,585,016	$3,316,470	$4,333,712	$1,580,726
Mobilization (10%)	$309,496	$237,606	$258,502	$331,647	$433,371	$158,073
Construction Contingency (20%)	$680,892	$522,732	$568,704	$729,623	$953,417	$347,760
Design and Permitting (15%)	$510,669	$392,049	$426,528	$547,218	$715,063	$260,820
Construction Admin. (5%)	$170,223	$130,683	$142,176	$182,406	$238,354	$86,940
TOTAL COST	**$4,766,245**	**$3,659,126**	**$3,980,925**	**$5,107,364**	**$6,673,917**	**$2,434,317**

4 AVONDALE NEIGHBORHOOD

The Avondale Neighborhood is bound by I-95 to the west, SW 3rd Street to the south, Dixie Highway to the east and Atlantic Boulevard to the north. The Avondale Neighborhood typically experiences significant flooding throughout the area during heavy rainfall events. The flooding problems within the Avondale Neighborhood are created primarily by the topography within the study area. In general, these roadways which form the perimeter around the study area have a relatively higher ground surface elevation compared to the majority of the study area. This ground surface topography allows stormwater runoff to flow into the study area from these perimeter roadways and also tends to trap any stormwater runoff within the study area.

The existing drainage system within the Avondale Neighborhood consists of gravity pipes collecting stormwater runoff from the public right of way areas to eventually discharge to the SFWMD G16 Canal via positive outfalls. Although there are existing stormwater facilities within the Avondale Neighborhood, it does not provide an adequate level of service to the right-of-way areas within the study area. In order to alleviate the existing flooding problems within the Avondale Neighborhood, stormwater improvements will need to be implemented to enhance the performance of the existing stormwater management system within the study area.

Alternative 1: Exfiltration Trench

Alternative 1 includes the installation of new exfiltration trench within available right-of-way areas throughout the study area in order to provide additional storage and infiltration capacity to the existing stormwater system. For this potential system improvement alternative, the proposed construction would include the installation of exfiltration trench which extends into areas of the Avondale Neighborhood that are not currently served by the existing system. The goal of this alternative is to intercept stormwater runoff before it reaches the problems area and to provide additional storage and infiltration capacity within the study area. Under Alternative 1, the proposed construction would include approximately 4,900 linear feet of exfiltration trench, which would be aligned along streets in the Avondale Neighborhood, which do not currently have existing drainage infrastructure. The estimated implementation cost for design and construction of this system improvement alternative would be approximately $2,300,000.

Alternative 2: Stormwater Pump Station

This alternative includes the construction of a new stormwater pump station located within the problem area of the Avondale Neighborhood, which would discharge stormwater runoff directly into the SFWMD G16 Canal. The proposed pump station would be located at the northwest corner of SW 2nd Court and SW 4th Avenue. The proposed construction would also include the installation of a new transmission main from the new pump station to the outfall location at the SFWMD G16 Canal. This proposed modification to the existing system would help transmit any additional stormwater runoff not handled by the existing system and minimize the risk of flooding within the existing system downstream of these proposed improvements. The purpose of these proposed system modifications reduce the influence of elevated water levels in SFWMD G16 Canal on the performance of the existing stormwater system, which completely relies on gravity discharge. The estimated implementation cost for design and construction of this system improvement alternative would be approximately $3,064,000.

Alternative 3: Stormwater Pump Station + Stormwater Retention Area

This alternative includes the construction of a new stormwater pump station that will discharge stormwater runoff directly into a new stormwater retention area(s). The proposed construction would also include the installation of a new transmission main from the new pump station to the outfall location at

the new stormwater retention area. A weir-type control structure would be installed within the stormwater retention area to allow collected stormwater runoff to be connected back to the existing stormwater system for drawdown and overflow purposes. Under Alternative 3, the proposed stormwater retention area was assumed to encompass a total area of 0.81 acres at a location to be investigated by the City. This system improvement alternative attenuates the stormwater runoff within the retention in order to delay the discharge through the existing drainage system into the SFWMD G16 Canal until the canals levels are favorable to gravity discharge. The estimated implementation cost for design and construction of this system improvement alternative would be approximately $3,237,000.

Alternative 4: Composite (Alternative 2 + Alternative 3)

Under this system improvement alternative, the components of the proposed improvement under Alternative 2 and Alternative 3 will be merged for the purpose of maximizing the advantages of each alternative. For this potential system improvement alternative, the proposed construction would include two pump stations, one pump station with an 18-inch pressure pipe discharging to the retention area and one pump station with a 30-inch pressure pipe discharging to the G16 Canal. The estimated implementation cost for design and construction of this system improvement alternative would be approximately $4,514,000.

Alternative Comparison

Refer to the Table 4-1 below for a comparison of the various system improvement alternatives for the Avondale Neighborhood. Based on our analysis of the various system improvement alternatives with the stormwater model, Alternative 2 with the stormwater pumping to the SFWMD G16 Canal is the most effective option for reducing the peak flood stage and reducing the flood duration within the Avondale Neighborhood. Although Alternative 2 does not provide enough additional flood protection to meet the level of service criteria for the public roadways, this alternative does provide significant benefits which alleviate the flooding problems within the study area.

Table 4-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0	1.3	$2,300,000
Alternative 2	1.25	12.0	$3,064,000
Alternative 3	1.12	7.6	$3,237,000
Alternative 4	1.35	10.1	$4,514,000

Recommended Alternative

Due to the relatively low existing elevations within the area and regulatory limitations, the recommended Phase 1 option for a stormwater improvement project for this study area incorporates Alternative 2, along with elements of Alternative 4, which increase the discharge capacity of the existing stormwater system from the Avondale neighborhood. The recommended stormwater improvements include the construction of a new stormwater pump station, which pumps into potential dry retention area(s) throughout the study area, which allow for the overflow into the SFWMD G16 Canal. These areas are currently conceptual in location to provide opportunities for the City to review existing land prices or to utilize existing City owned property. One such option would be to include a provision for overflow storage during significant events in Avondale Park, providing temporary relief to minimize flood stages prior to discharge into the

SFWMD G-16 canal. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout in Figure 4-1 below. The estimated design and construction costs for this recommended alternative are approximately $2,488,000. A detailed preliminary cost estimate of each alternative and the recommended alternative are provided in Table 4-2 at the end of this section.

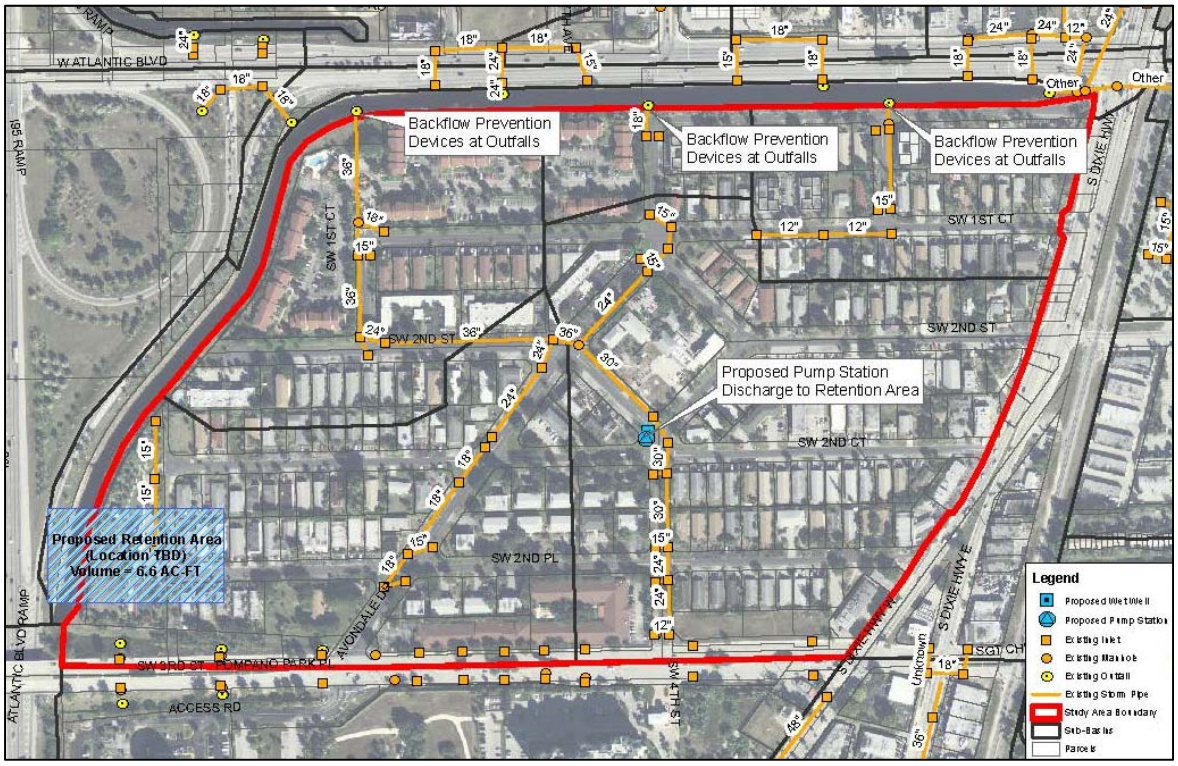

Figure 4-1 Avondale Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the SFWMD G16 canal since stormwater runoff would be diverted into a retention areas first for water quality treatment, which will result in a net improvement in water quality within the receiving waters.
- Groundwater: This alternative will allow stormwater runoff to infiltrate via the proposed retention areas into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an adverse impact on air quality since the proposed stormwater pump station will use electrical power.
- Noise: This alternative does not have an adverse impact on noise since the proposed stormwater pump will be enclosed within a concrete structure which is designed to limit noise from reaching public areas.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge due to the treatment within the proposed dry retention areas, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative will require additional power consumption in order to operate the proposed stormwater pump station.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, Avondale neighborhood will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Avondale neighborhood does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 4-2 Avondale Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Recommended Alternative
Remove Existing Pipe	$18,000	$13,700	$1,000	$4,000	-
Replace Existing Drainage Structure	$3,500	$20,000	$500	$2,500	-
Install Catch Basin	$157,500	-	-	-	-
18" DIP Pressure Pipe	-	-	$71,148	$3,696	-
24" RCP Drainage Pipe with Exfiltration	$688,800	-	-	-	-
30" DIP Pressure Pipe	-	$127,820	-	$127,820	$138,600
36" RCP Drainage Pipe	-	$44,000	$4,400	$6,050	-
15" Backflow Prevention Devices at Outfall	$40,000	$40,000	$40,000	$40,000	$40,000
18" Backflow Prevention Devices at Outfall	$45,000	$45,000	$45,000	$45,000	$45,000
36" Backflow Prevention Devices at Outfall	$60,000	$55,000	$60,000	$60,000	$55,000
Wet Well & Pump Station	-	$600,000	$600,000	$1,200,000	$600,000
Water Control Structure	-	-	$5,000	$5,000	-
Soil Removal & Construct Dry Retention	-	-	$51,500	$51,500	$100,000
Sod Restoration of Retention Area	-	-	$11,228	$11,228	$20,000
Purchase Property for Retention Area	-	-	$240,000	$240,000	-
Swale Regrading	-	$882,000	$882,000	$882,000	$441,000
Pavement Restoration	$481,067	$162,311	$90,347	$252,658	$176,000
Subtotal	$1,493,867	$1,989,831	$2,102,123	$2,931,452	$1,615,600
Mobilization (10%)	$149,387	$198,983	$210,212	$293,145	$161,560
Construction Contingency (20%)	$328,651	$437,763	$462,467	$644,919	$355,432
Design and Permitting (15%)	$246,488	$328,322	$346,850	$483,690	$266,574
Construction Administration (5%)	$82,163	$109,441	$115,617	$161,230	$88,858
TOTAL COST	**$2,300,555**	**$3,064,340**	**$3,237,269**	**$4,514,436**	**$2,488,024**

5 ESQUIRE LAKE NEIGHBORHOOD

The study area for the Esquire Lake Neighborhood is located on the west side of the Powerline Road, south of Martin Luther King Boulevard. This residential neighborhood contains a lake towards the east side, which collects runoff from all local roadways through gravity stormwater pipes ranging from 12 inches to 36 inches. The lake has a weir type control structure that overflows to the system on Powerline Road. System improvement alternatives investigated for this study area include pipe size upgrades and exfiltration trenches. Drainage wells are not a feasible option since the study area is located too far west.

Alternative 1: Pipe Size Upgrades

The stormwater model was used to conduct several simulations of various proposed pipe size upgrades at specific locations within the existing stormwater system. The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. Under Alternative 1, the existing 12-inch pipe at NW 23rd Terrace and NW 9th Street will be upsized to a 30-inch RCP pipe and the existing 36-inch pipe will be upsized to a 42-inch, which includes a total pipe replacement of 960 linear feet. The estimated design and construction costs for this pipe size upgrade alternative are approximately $909,000.

Alternative 2: Exfiltration Trench

The purpose of this system improvement alternative is to intercept stormwater runoff before it reaches the existing outfalls and to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 2, the installation of proposed exfiltration trench includes a total of 7,416 linear feet. The estimated design and construction costs for this exfiltration trench alternative are approximately $3,008,000.

Alternative Comparison

Refer to Table 5-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, both system improvement alternatives provide flood control benefits to the study area. Alternative 2 should be implemented for this study area since it provides the best potential flood control benefits.

Table 5-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.70	3.2	$909,000
Alternative 2	0.44	10.5	$3,008,000

Recommended Alternative

CMA recommends elements of Alternative 2 which includes the installation of exfiltration trench in targeted City right-of-ways which will intercept stormwater runoff before it flows into Esquire Lake and will provide additional storage and infiltration capacity for stormwater runoff. The recommended stormwater improvements for this study area include the installation of new exfiltration trench along select City roadways to collect stormwater runoff from these areas. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $1,656,000.

For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 5-1 below and a preliminary cost estimate summarized in Table 5-2 at the end of this section.

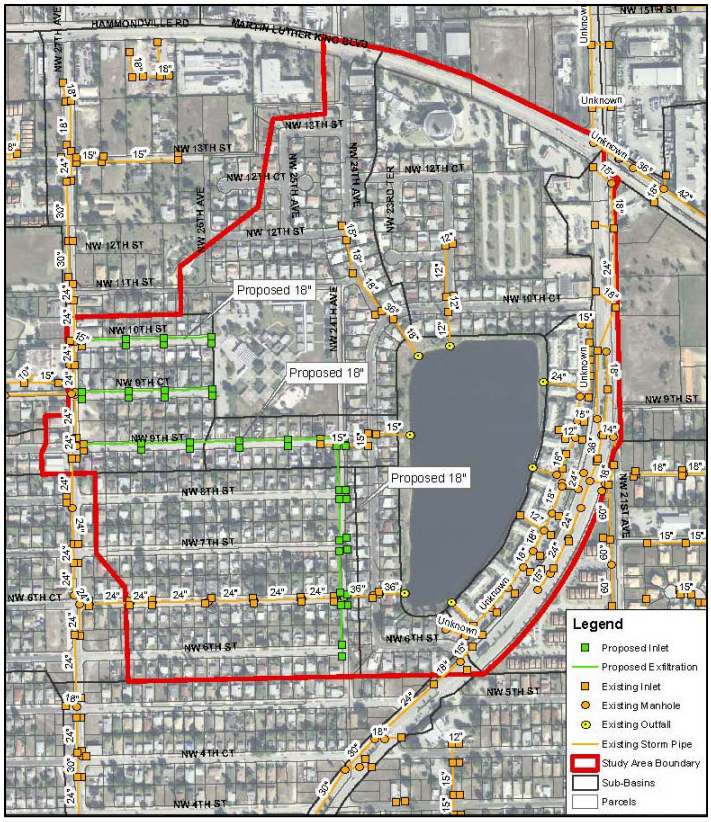

Figure 5-1 Esquire Lake Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the lake since some of the stormwater runoff would be diverted into the new exfiltration trenches, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system over the existing conditions since some of the stormwater runoff would be diverted from the downstream outfalls to new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, the area surrounding the Esquire Lake Neighborhood will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Esquire Lake Neighborhood study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 5-2 Esquire Lake Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Recommended Alternative
Remove Existing Pipe	$19,200	-	-
Replace Existing Drainage Structure	$30,000	-	$25,000
Install Catch Basin	-	$337,500	$184,500
Upgrade Existing Outfall	$10,000	-	-
15" RCP Drainage Pipe	-	-	$46,000
18" RCP Drainage Pipe with Exfiltration	-	$890,400	$408,000
30" RCP Drainage Pipe	$16,940	-	-
42" RCP Drainage Pipe	$74,000	-	-
Swale Regrading throughout study area	$346,267	-	$79,333
Pavement Restoration	$93,867	$725,511	$332,444
Subtotal	$590,273	$1,953,411	$1,075,278
Mobilization (10%)	$59,027	$195,341	$107,528
Construction Contingency (20%)	$129,860	$429,750	$236,561
Design and Permitting (15%)	$97,395	$322,313	$177,421
Construction Administration (5%)	$32,465	$107,438	$59,140
TOTAL COST	**$909,021**	**$3,008,253**	**$1,655,928**

6 GATEWAY DRIVE

The Gateway Drive study area is a commercial and industrial neighborhood bounded by West McNab Road to the south, by Powerline Road to the east, by SW 36th Avenue to the west and by SFWMD C-14 Canal to north. Due to the commercial nature of the study area, the public right-of-way areas have a high percentage of impervious ground coverage, which limits the infiltration of stormwater runoff into the ground surface. The public roadways within the study area have a limited existing stormwater system which discharges into a stormwater pond with an overflow connection to the SFWMD C-14 Canal. According to the topography, the private properties within the study area typically have a higher elevation than the adjacent public right-of-way areas, which causes stormwater runoff to collect on these low lying roadways. The stormwater model was used to evaluate the effectiveness of various system improvement alternatives on reducing the flooding problems within the study area. The system improvement alternative for this study area included various configurations of proposed exfiltration trench and new connections with existing stormwater systems. The system improvement alternatives which were evaluated with the stormwater model are summarized below.

Alternative 1: Exfiltration Trench

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 5,780 LF of exfiltration trench aligned inside the study area along Gateway Drive, SW 26th Avenue, SW 27th Avenue and SW 30th Avenue. The estimated design and construction costs for this exfiltration trench alternative are approximately $2,486,000.

Alternative 2: Exfiltration Trench with Positive Outfall to Canal

Under Alternative 2, the proposed improvements defined under Alternative 1 were modified to include the installation of a new drainage connection between the proposed exfiltration system and the existing drainage canal between SW 30th Avenue and SW 31st Avenue. In addition to the 5,780 linear feet of exfiltration trench in Alternative 1, Alternative 2 includes an additional 200 linear feet of 24-inch pipe to connect to the drainage canal. The estimated design and construction costs for this exfiltration trench alternative are $2,547,000.

Alternative 3: Exfiltration Trench – with Positive Outfall to Lake

Under Alternative 3, the proposed improvements defined under Alternative 1 were modified to include the installation of a new drainage connection between the proposed exfiltration system and the existing stormwater pond. In addition to the proposed 5,780 linear feet of exfiltration trench under Alternative 1, Alternative 3 includes an additional 400 linear feet of 24-inch drainage pipe to connect with the stormwater pond. The estimated design and construction costs for this exfiltration trench alternative are approximately $2,423,000.

Alternative Comparison

Refer to the Table 6-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, all system improvement alternatives provide minimal reductions in the peak flood stages and variable reductions in the expected flood duration within the study area. Alternative 2 should be implemented for this study area since it provides the highest reduction in expected flood duration amongst the system improvement alternatives. Although Alternative 2 does not provide enough additional flood protection to meet the level of service criteria for

all public roadways within the study area, Alternative 2 does provide significant benefits which alleviate the flooding problems within the study area.

Table 6-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.01	0.9	$2,486,000
Alternative 2	0.03	12.9	$2,547,000
Alternative 3	0.03	7.6	$2,423,000

Recommended Alternative

CMA recommends Alternative 2 which includes the installation of exfiltration trench within the study area which will provide additional storage and infiltration capacity for stormwater runoff. The recommended stormwater improvements for this study area include the installation of new exfiltration trench along Gateway Drive, SW 27th Avenue, SW 29th Avenue, and SW 30th Avenue to collect stormwater runoff from these areas. The proposed improvements will be interconnected with the existing canal via a new control structure to allow for an overflow connection. As feasible, any grass swale areas along these roadways should also be regraded to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $3,524,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 6-1 below and a preliminary cost estimate summarized in Table 6-2 at the end of this section.

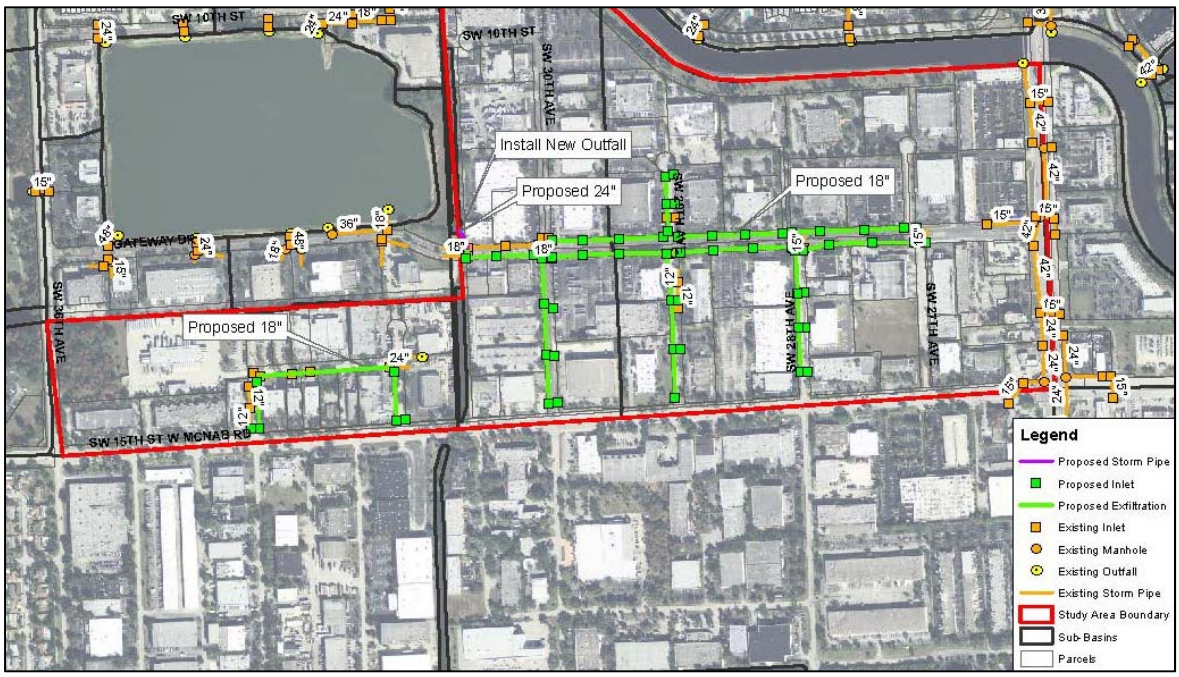

Figure 6-1 Gateway Drive Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the canal since some of the stormwater runoff would be diverted into the new exfiltration trench, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system over the existing conditions since stormwater runoff would be diverted from the downstream outfalls to new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.

- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, the area surrounding the Gateway Drive will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Gateway Drive study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 6-2 Gateway Drive Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Recommended Alternative
Remove Existing Pipe	-	-	-	$13,500
Replace Existing Drainage Structure	-	-	-	$25,000
Install Catch Basin	$355,500	$355,500	$237,000	$265,500
Install New Outfall	-	$10,000	$10,000	$10,000
15" RCP Drainage Pipe	-	-	-	$26,000
18" RCP Drainage Pipe with Exfiltration	$693,600	$693,600	$693,600	$966,000
24" RCP Drainage Pipe	-	$12,750	$29,400	$7,500
Swale Regrading	-	-	-	$187,833
Pavement Restoration	$565,156	$581,778	$603,484	$787,111
Subtotal	$1,614,256	$1,653,628	$1,573,484	$2,288,444
Mobilization (10%)	$161,426	$165,363	$157,348	$228,844
Construction Contingency (20%)	$355,136	$363,798	$346,167	$503,458
Design and Permitting (15%)	$266,352	$272,849	$259,625	$377,593
Construction Administration (5%)	$88,784	$90,950	$86,542	$125,864
TOTAL COST	**$2,485,954**	**$2,546,587**	**$2,423,166**	**$3,524,204**

7 KENDALL LAKE NEIGHBORHOOD

The Kendall Lake Neighborhood is a residential neighborhood bounded by NW 21st Street on the north, by NW 16th Street on the south, NW 5th Way on the west and NW 1st Avenue on the east. The study area consists of all single family developments. The existing stormwater system is composed of two independent systems. The existing stormwater system in the northeast portion of the study area is a closed exfiltration trench system in the low lying areas. The existing stormwater system in the western portion of the study area includes a drainage pipe network which discharges via three outfalls into Kendall Lake, which does not have an overflow connection and has been observed with a very high water level. Due to the relatively high ground surface elevation of the study area, the system improvement alternative which was investigated for this area consists of expanding the exfiltration trench system and expanding the lake. Upsizing the outfall pipes or installing a pump station within the study area was not considered as a feasible alternative since Kendall Lake is already near capacity. The installation of drainage wells is also not allowed at this study area since it is located west of the brackish aquifer boundary.

Alternative 1: Exfiltration Trench

The stormwater model was used to conduct several simulations of the installation of proposed exfiltration trench within the study area not currently served by the existing stormwater system. The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 4,872 LF of exfiltration trench throughout the eastern portion of the study area, due to the higher ground elevations. The installation of additional exfiltration systems within the east side of the study area will intercept a portion of the stormwater runoff flowing to the east side of the study area and reduce the flow into Kendall Lake. The estimated design and construction costs for this exfiltration trench alternative are $2,223,000.

Alternative 2: Exfiltration Trench and Expanded Lake

The purpose of this system improvement alternative is to provide additional storage in the adjacent existing lake. There is a vacant property owned by the City of Pompano Beach located to the west of the existing lake with an area of approximately 20 acres. This alternative utilizes a portion of this vacant property to excavate a lake that will be interconnected to the existing lake and will be used to reduce the peak stages in the existing lake. The lake expansion alternative will be combined with the proposed exfiltration trench descried in Alternative 1. The estimated design and construction costs for this exfiltration trench and lake expansion alternative are $2,341,000.

Alternative Comparison

Refer to the Table 7-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, both system improvement alternatives provide similar limited flood control benefits for reducing the peak flood stages and reducing the expected flood duration within the study area. The goal of the alternative is to alleviate the overflow possibility of Kendall Lake, which has been observed to reach capacity during heavy rainfall events. Under both alternatives, a portion of the stormwater runoff generated within the study area will be diverted into the proposed exfiltration trench and thereby reduce the total flow into Kendall Lake. The expansion of the existing lake will further reduce the possibility of Kendall Lake overtopping during a heavy storm event, therefore Alternative 2 should be implemented in this study area.

Table 7-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.33	9.5	$2,223,000
Alternative 2	0.33	9.6	$2,341,000

Recommended Alternative

CMA recommends Alternative 2 which includes the installation of new exfiltration trench along City roadways throughout the study area to collect stormwater runoff from these areas and the excavation of a new expanded lake to the west of the existing Kendall Lake, which is connected via a new control structure. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $2,721,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 7-1 below and a preliminary cost estimate summarized in Table 7-2 at the end of this section.

Figure 7-1 Kendall Lake Neighborhood Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the lake since some of the stormwater runoff would be diverted into the new exfiltration trench, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed exfiltration and lake expansion, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system over the existing conditions since stormwater runoff would be diverted from the lake outfalls to new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties as well as provided additional lake surface area which will improve the aesthetics of the neighborhood.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, the area surrounding the Kendall Lake Neighborhood will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Kendall Lake Neighborhood does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 7-2 Kendall Lake Neighborhood Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Recommended Alternative
Replace Existing Drainage Structure	-	-	$40,000
Install Catch Basin	$382,500	$382,500	$234,000
Install Overflow Structure	-	$10,000	$10,000
15" RCP Drainage Pipe	-	-	$41,500
18" RCP Drainage Pipe with Exfiltration	$584,520	$584,520	$684,000
Soil Removal & Construct Dry Retention	-	$55,000	$55,000
Sod Restoration of Retention Area	-	$12,000	$12,000
Swale Regrading	-	-	$133,000
Pavement Restoration	$476,276	$476,276	$557,333
Subtotal	$1,443,296	$1,520,296	$1,766,833
Mobilization (10%)	$144,330	$152,030	$176,683
Construction Contingency (20%)	$317,525	$334,465	$388,703
Design and Permitting (15%)	$238,144	$250,849	$291,528
Construction Administration (5%)	$79,381	$83,616	$97,176
TOTAL COST	**$2,222,675**	**$2,341,255**	**$2,720,923**

8 US-1 AND NE 14TH STREET CAUSEWAY AREA

This study area is generally located southeast of the intersection of US Highway 1 and NE 14th Street Causeway. This study area consists chiefly of residential properties along with commercial properties located along US-1 and NE 14th Street. The existing drainage system within the study area includes a few separate systems, such as the FDOT drainage system along US-1 and NE 14th Street Causeway and various independent City systems within the neighborhood. These independent City drainage systems are located in the east side of the study area that discharges via existing outfall pipes into the tidally influenced canal system, which is directly connected to the Intracoastal Waterway. One 15-inch outfall is located towards the east end of the study area along NE 27th Terrace. Another 24-inch is located on the southeast of the study area along NE 12th Street. According to the model results, the worst flooding problems appear to be located along NE 26th Avenue and NE 23rd Avenue. Several system improvement alternatives were evaluated for this study area, which include pipe size upgrades, pump station and drainage wells to address the existing flooding problems. The installation of exfiltration trench is not a feasible option for this study area due to the low ground surface elevation and was not included in the analysis of potential alternatives.

Alternative 1: Pipe Size Upgrades (Option 1)

The stormwater model was used to conduct several simulations of potential pipe size upgrades to the existing stormwater system. The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. The proposed construction consist of installing a new 18-inch pipe and replace an existing 12-inch pipe with an 18-inch pipe to discharge to the outfall. The estimated design and construction costs for this pipe size upgrades alternative are approximately $1,438,000.

Alternative 2: Pipe Size Upgrades (Option 2)

Similar to Alternative #1, the proposed construction under Alternative 2 consisted of installing new pipe connections and pipe size upgrades. Alternative #2 includes the installation of a new 18-inch pipe along NE 23rd Avenue and NE 12th Street, replacing an existing 24-inch pipe with a 36-inch pipe along NE 14th Street Causeway and replacing an existing 12-inch pipe with a 15-inch pipe towards the outfall. The estimated design and construction costs for this pipe size upgrades alternative are approximately $1,626,000.

Alternative 3: Pipe Size Upgrades (Option 3)

Alterative 3 includes all proposed improvements defined for Alternative #2 along with additional pipe installation. In addition to the pipe upgrades, the proposed construction will include the installation of additional drainage pipes that will interconnect the problem areas to the existing outfalls in the southern portion of the study area. Alternative 3 will provide additional conveyance capacity to transmit stormwater runoff from the problem area to the existing outfalls on the south side of the study area. Alternative 3 includes the installation of additional 18-inch pipe throughout the study area. The estimated design and construction costs for this pipe size upgrades alternative are approximately $2,193,000.

Alternative 4: Pump Station

The stormwater model was used to conduct several simulations of a potential pump station within the study area. The purpose of this system improvement alternative is to increase the conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. The proposed construction under Alternative 4 consists of the installation of a pump station adjacent to the existing

outfall. The proposed construction also includes new pipe upgrades to adequately convey stormwater runoff to the pump station. The estimated design and construction costs for this pump station alternative are approximately $2,199,000.

Alternative 5: Drainage Wells

The stormwater model was used to conduct several simulations of the installation of proposed drainage wells within problem areas of the study area. The purpose of this system improvement alternative is to intercept stormwater runoff before it reaches the existing outfalls and to provide additional discharge capacity at the problem area to alleviate the existing flooding issues quicker. The expected construction includes a total of three drainage wells along NE 23rd Avenue within the study area. The estimated design and construction costs for this drainage well alternative are approximately $633,000.

Alternative Comparison

Refer to the Table 8-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, all system improvement alternatives provide similar limited flood control benefits for reducing the peak flood stages and reducing the expected flood duration within the study area. Alternative 3 should likely be eliminated from consideration since it provides the least flood control benefits to the study area. Alternative 5 should likely be eliminated from consideration since the flood control benefits effect only a limited portion of the study area. Alternative 2 should be implemented instead of Alternative 1 as it provides additional flood control benefits and should be implemented instead of Alternative 4 since it provides similar flood control benefits but is significantly more cost effective. Although Alternative 2 does not provide enough additional flood protection to meet the level of service criteria for all public roadways within the study area, Alternative 2 does provide significant benefits which alleviate the flooding problems within the study area.

Table 8-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.05	2.7	$1,438,000
Alternative 2	0.08	3.2	$1,626,000
Alternative 3	0.07	0.9	$2,193,000
Alternative 4	0.11	3.4	$2,199,000
Alternative 5	0.00	1.1	$633,000

Recommended Alternative

Due to various constructability concerns, the recommended stormwater improvement project incorporates elements of Alternative 2, including the installation of new drainage along NE 13th Street to interconnect the existing stormwater systems along with the replacement of the existing 12-inch pipe with new 15-inch pipe to increase the transmission capacity to the existing outfall. Due to the low elevation of the study area, the proposed improvements also include the installation of a backflow prevention device at the 15-inch outfall to reduce the negative impact of tidal fluctuation. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $909,000. CMA has

prepared a conceptual layout displayed in Figure 8-1 below and a cost estimate summarized in Table 8-2 at the end of this section.

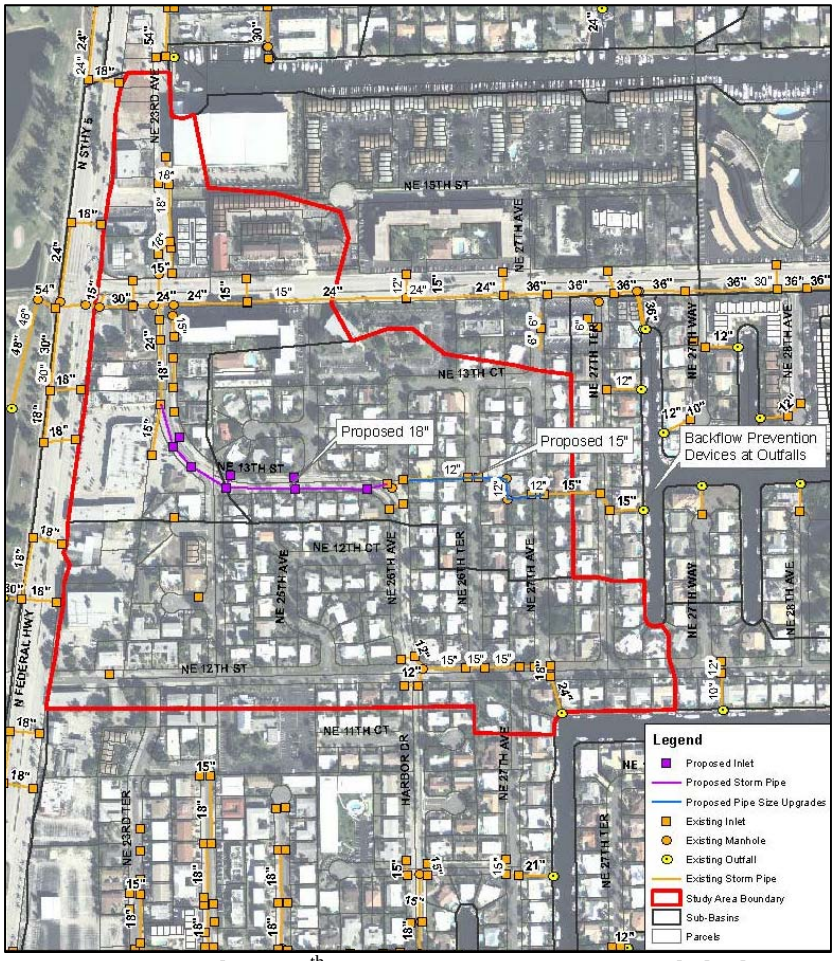

Figure 8-1 US-1 and NE 14th Street Causeway Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance water quality of stormwater discharge into the South Lake over the existing conditions since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will not have an impact on the groundwater.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.

- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of the stormwater discharge via the existing outfalls since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken within this study area, the US-1 and NE 14th Street Causeway study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the US-1 and NE 14th Street Causeway study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 8-2 US-1 and NE 14th Street Causeway Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Recommended Alternative
Remove Existing Pipe	$20,000	$33,700	$33,700	$11,440	-	$10,500
Replace Existing Drainage Structure	$60,000	$50,000	$50,000	$50,000	-	$45,000
Install Catch Basin	$27,000	$27,000	$67,500	$9,000	-	$36,000
Upgrade Existing Outfall	$5,000	-	-	$5,000	-	-
15” RCP Drainage Pipe	-	$24,000	$24,000	-	-	$26,250
18" RCP Drainage Pipe	$117,000	$54,405	$185,250	-	$20,800	$65,650
18" DIP Pressure Pipe	-	-	-	$7,150	-	-
24" RCP Drainage Pipe	-	-	-	$93,675	-	-
36” RCP Drainage Pipe	-	$96,400	$96,400	-	-	-
15" Backflow Prevention Devices at Outfall	-	$40,000	$40,000	$40,000	$40,000	$40,000
18” Backflow Prevention Devices at Outfall	$45,000	-	-	$45,000	$50,000	-
24” Backflow Prevention Devices at Outfall	$50,000	$50,000	$50,000	-	-	-
Wet Well & Pump Station	-	-	-	$600,000	-	-
Drainage Well	-	-	-	-	$300,000	-
Swale Regrading	$434,000	$434,000	$434,000	$434,000	-	$217,000
Pavement Restoration	$176,000	$246,596	$443,422	$132,880	$391	$150,089
Subtotal	$934,000	$1,056,101	$1,424,272	$1,428,145	$411,191	$590,489
Mobilization (10%)	$93,400	$105,610	$142,427	$142,815	$41,119	$59,049
Construction Contingency (20%)	$205,480	$232,342	$313,340	$314,192	$90,462	$129,908
Design and Permitting (15%)	$154,110	$174,257	$235,005	$235,644	$67,847	$97,431
Construction Administration (5%)	$51,370	$58,086	$78,335	$78,548	$22,616	$32,477
TOTAL COST	**$1,438,360**	**$1,626,395**	**$2,193,379**	**$2,199,343**	**$633,234**	**$909,353**

9 NE 4TH STREET AND NE 3RD STREET

This study area includes NE 4th Street and NE 3rd Street to the east of Harbor Drive immediately adjacent to the Intracoastal Waterway. This residential neighborhood includes two separate areas surrounded by the finger canals off the Intracoastal Waterway. The public right-of-way areas within this neighborhood do not have an existing drainage system to address any flooding issues since these roadways are hydraulically isolated from adjacent areas with existing drainage infrastructure, such as Harbor Drive. During rainfall events, stormwater runoff from this neighborhood will collect in right-of-way areas where it can only slowly infiltrate into the ground surface from pervious swale areas adjacent to the roadway.

According to the model results, both NE 4th Street and NE 3rd Street experience significant flooding depth of greater than 2 inches at the eastern limits near the cul-de-sacs due to the low lying elevations. The stormwater model was used to evaluate effectiveness of various system improvement alternatives, such as exfiltration trench or pump station, in reducing the existing flooding problems. The interconnection of the study area to the existing stormwater system along Harbor Drive was not a feasible option since it actually could worsen the flooding problem when stormwater runoff flows into the study area via the interconnection from higher areas located to the west. The system improvement alternatives which were evaluated with the stormwater model are summarized below.

Alternative 1: Exfiltration Trench

The stormwater model was used to conduct several simulations of the installation of proposed exfiltration trench within the study area not currently served by the existing stormwater system. The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 5,882 LF of exfiltration trench. The proposed exfiltration trenches were aligned inside the study area along NE 3rd Street and NE 4th Street as well as outside the study area along NE 1st Street, NE 2nd Street, NE 23rd Avenue, NE 24th Avenue, NE 25th Avenue and NE 28th Avenue. The estimated design and construction costs for this exfiltration trench alternative are approximately $2,561,000.

Alternative 2: Pump Station

The stormwater model was used to conduct several simulations of various proposed pump station within the study area. The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. The proposed construction under Alternative 2 includes the installation of one pump stations near the existing outfall at Harbor Drive and NE 2nd Street, an 18-inch discharge pipe to the outfall location and a flap gate at the point of discharge. The estimated design and construction costs for this pump station alternative are approximately $1,089,000.

Alternative Comparison

Refer to Table 9-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, Alternative 1 can be considered to be the most effective option for reducing the peak flood stages and reducing the expected flood duration within the study area. Although Alternative 1 will not completely eliminate the flooding within the study area, it will reduce the duration of flooding within the low lying area. Additional local improvements which provide additional storage volume for stormwater runoff should be considered along NE 3rd Street and NE 4th Street, such as regraded swales or subsurface soil storage.

Table 9-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.36	17.1	$2,561,000
Alternative 2	0.0	2.5	$1,089,000

Recommended Alternative

CMA recommends elements of Alternative 1 including the installation of exfiltration trench along NE 4th Street and NE 3rd Street to provide additional infiltration capacity for stormwater runoff. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $949,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 9-1 below and a preliminary cost estimate summarized in Table 9-2 at the end of this section.

Figure 9-1 NE 4th Street & NE 3rd Street Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the canal since some of the stormwater runoff would be diverted into the new exfiltration trench, which will result in a net improvement within the receiving waters.

- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed exfiltration, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system since some of the stormwater runoff would be diverted from the canal outfalls to new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties which will improve the aesthetics of the neighborhood.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the area surrounding the NE 4th Street and NE 3rd Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within this study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 9-2 NE 4th Street and NE 3rd Street Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Recommended Alternative
Replace Existing Drainage Structure	-	$5,000	$5,000
Install Catch Basin	$382,500	-	$103,500
Upgrade Existing Outfall	-	$5,000	-
15" RCP Drainage Pipe	-	-	$20,750
18" RCP Drainage Pipe with Exfiltration	$705,600	-	$242,400
18" DIP Pressure Pipe	-	$1,250	-
Wet Well & Pump Station	-	$600,000	-
Swale Regrading	-	$93,333	$47,133
Pavement Restoration	$574,933	$2,444	$197,511
Subtotal	$1,663,033	$707,028	$616,294
Mobilization (10%)	$166,303	$70,703	$61,629
Construction Contingency (20%)	$365,867	$155,546	$135,585
Design and Permitting (15%)	$274,401	$116,660	$101,689
Construction Administration (5%)	$91,467	$38,887	$33,896
TOTAL COST	**$2,561,071**	**$1,088,823**	**$949,093**

10 DIXIE HIGHWAY AND WEST MCNAB ROAD

This study area is bounded by Interstate-95 on the west, by SW 9th Street on the north, by Dixie Highway on the east, and by West McNab Road on the south. This study area consists of mixture of residential and commercial properties. A portion of this study area consists of a large development project, which is currently under construction and bounded by SW 13th Court to the south and SW 10th Street to the north. This development project will implement on-site stormwater improvements, which will provide adequate flood control for the property. The remainder of this study area to the south of this development has existing City drainage facilities. There is also an existing FDOT drainage system, which only serves the right of way for Dixie Highway. Based on the results of the stormwater model, many roadways and properties throughout the study area display flooding greater than two inches.

After discussions with City staff, the existing stormwater system used to be discharge via an outfall into FDOT drainage system along east of Interstate 95. During regrading work within the FDOT right of way, the contractor had plugged the existing outfall pipe, which created additional flooding problems throughout the study area. Since there is extensive existing stormwater infrastructure along both SW 13th Court and SW 14th Court, a system improvement alternative for this study area would include the reconnection of the existing outfall pipe to FDOT system.

Recommended Alternative: Pipe Connections

The recommended alternative for this study area includes the reconnection of this existing outfall pipe. The installation of exfiltration trench was eliminated from consideration as system improvement alternative due to low surface elevations throughout the study area which would limit the effectiveness of this option. The installation of gravity drainage wells is not an option due to the lack of brackish groundwater at the bottom of the surficial aquifer below the TOC Area since the boundary of this brackish groundwater is located just east of Dixie Highway. Dry retention areas were not considered an option due to the limited amount of right-of-way in this study area. The installation of a pump station was not a feasible option for this study area and was not consider during the analysis of potential alternatives.

The stormwater model was used to conduct a simulation of the installation of a proposed connection of the system within the study area to that of the Interstate 95 system. The proposed construction includes a 36-inch drainage pipe connection to the Interstate 95 drainage system. The estimated design and construction costs for this pipe connection alternative are approximately $52,000. This alternative provides a reduction in the peak flood stage and a significant reduction in the flood duration within the study area. CMA has prepared a conceptual layout displayed in Figure 10-1 below and a preliminary cost estimate summarized in Table 10-1 at the end of this section.

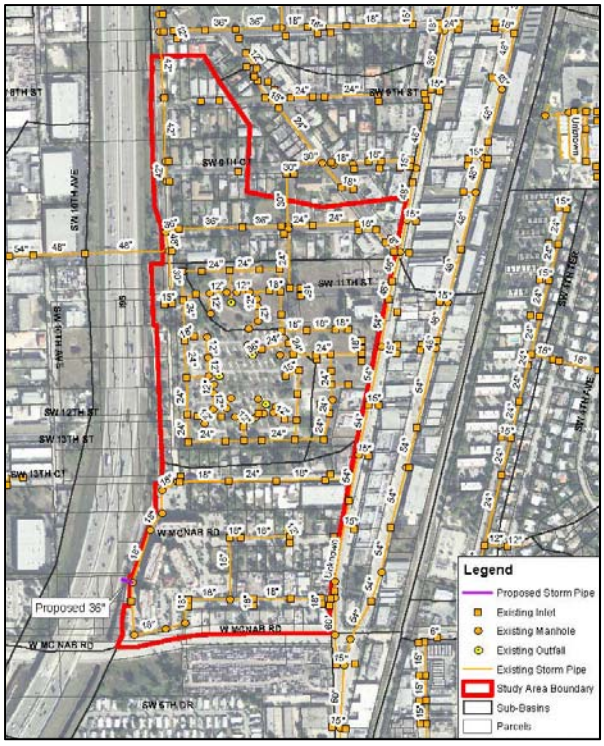

Figure 10-1 Dixie Highway and West McNab Road Recommended Improvements

Environmental Effects

Physical

- Surface Water: This alternative will not have an impact on the surface waters, since the existing or proposed improvements do not directly connect to any surface water body.
- Groundwater: This alternative will not have an impact on the groundwater.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge over the existing conditions since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving stormwater system.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the Dixie Highway and West McNab Road study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Dixie Highway and West McNab Road study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 10-1 Dixie Highway and West McNab Road Preliminary Cost Comparison

Item	**Recommended Alternative**
Replace Existing Drainage Structure	$5,000
Install New Outfall	$10,000
36" RCP Drainage Pipe	$9,000
Pavement Restoration	$9,778
Subtotal	$33,778
Mobilization (10%)	$3,378
Construction Contingency (20%)	$7,431
Design and Permitting (15%)	$5,573
Construction Administration (5%)	$1,858
TOTAL COST	**$52,018**

11 BAY DRIVE NEIGHBORHOOD

This study area consists of a residential neighborhood, which is bounded by Robbins Road to the south, by North Riverside Drive to the north, by A1A to the west and Bay Drive to the east. The existing stormwater system within the study area consists of the FDOT system along US A1A and a City system along Bay Drive with an existing outfall discharging directly to the Hillsboro Inlet. The City has received extensive complaints from residents in this area about flooding within the neighborhood roadways. According to the model results, Bay Drive and areas along Beacon Street, Dover Drive and Spring Street displays flooding with depths greater than 2.0 inches. The high flood depths are expected in these areas as the elevations range from 2.0 to 3.0 NAVD.

Recommended Alternative: Pipe Connections

A system improvement alternative was not modeled for this study area since the typical ground surface elevations are too low to be able to implement any major improvements, such as drainage wells or exfiltration trench, and there is not adequate access to a positive outfall location. Due to the very low ground surface elevations within the study areas, a system improvement alternative to be considered for this study areas would be an extension of the existing stormwater system to ensure the drainage inlets are located within the low lying right-of-way area not currently served by the existing system.

The recommended alternative includes the installation of new drainage pipe and catch basin inlets within low lying portions of Bay Drive, Beacon Street, Dover Road, Spring Street, Leigh Road, and Barton Road. The proposed construction includes a total of 3,460 LF of 15-inch and 18-inch RCP pipe, which will be interconnected with the existing drainage system. The purpose of this system improvement alternative is to alleviate the existing flooding issues at the low elevations areas which are not served by the existing drainage system. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this alternative are approximately $1,210,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 11-1 below and a preliminary cost estimate summarized in Table 11-1 at the end of this section.

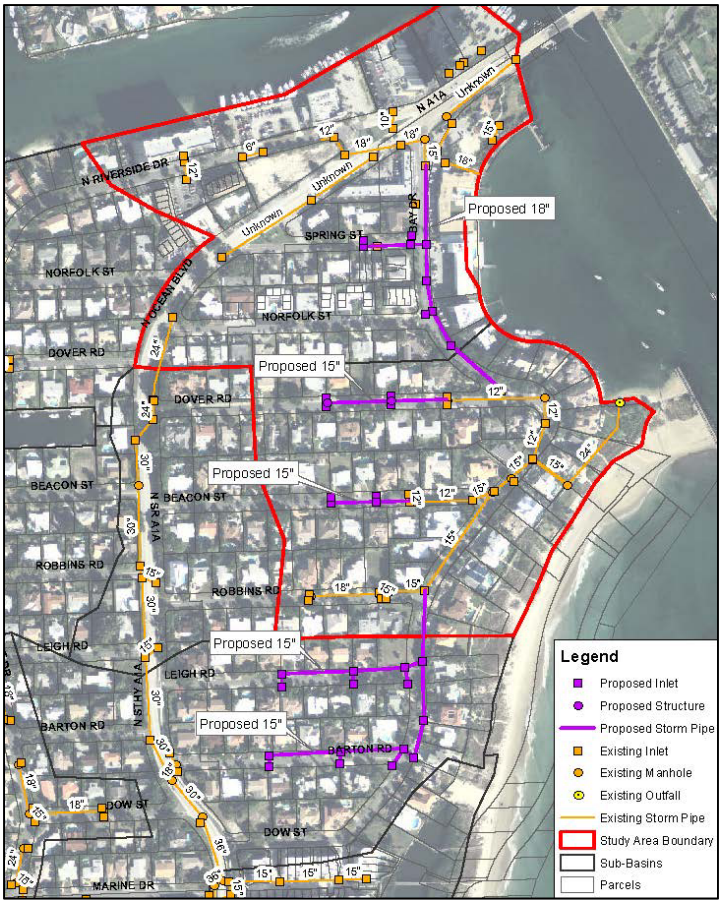

Figure 11-1 Bay Drive Neighborhood Recommended Improvements

Environmental Effects

Physical

- Surface Water: This alternative will enhance water quality of stormwater discharge into the Intracoastal Waterway since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will not have an impact on the ground water.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge over the existing conditions since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the Bay Drive neighborhood will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the Bay Drive neighborhood does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 11-1 Bay Drive Neighborhood Preliminary Cost Comparison

Item	Recommended Alternative
Install Drainage Structure	$153,000
Replace Existing Drainage Structure	$25,000
15" RCP Drainage Pipe	$120,500
18" RCP Drainage Pipe	$68,250
Swale Regrading	$80,733
Pavement Restoration	$338,311
Subtotal	$785,794
Mobilization (10%)	$78,579
Construction Contingency (20%)	$172,875
Design and Permitting (15%)	$129,656
Construction Administration (5%)	$43,219
TOTAL COST	**$1,210,123**

12 NORTH RIVERSIDE DRIVE & NE 14TH STREET CAUSEWAY

This study area is primarily located along North Riverside Drive between NE 14th Street Causeway and NE 8th Street. This neighborhood is a mixture of single family homes, multi-family residential complex and commercial properties. The existing stormwater system within the study area consists of the FDOT system along US A1A and a City system along North Riverside Drive with three existing outfalls discharging directly to the Intracoastal Waterway. The ground surface elevation along the centerline of North Riverside Drive is as low as 1.3 feet NAVD at some locations. Due to the very low elevation of the study area, the flooding problems within the study area are directly influenced by the tidal fluctuations within the Intracoastal Waterway. Based on our analysis with the stormwater model, North Riverside Drive experiences significant flooding of greater than 2 inches throughout the entire length of the study area. The system improvement alternatives investigated within this study area include pipe size upgrades and pump stations. Exfiltration trench was not considered as a potential system improvement alternative for this study area due to the very low ground surface elevation which would eliminate the effectiveness of either option.

Alternative 1: Pipe Size Upgrades

The stormwater model was used to conduct several simulations of various proposed pipe size upgrades at specific locations within the existing stormwater system. The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. Alternative 1 included the replacement of the existing City outfall pipes which discharge into the Intracoastal Waterway with a larger diameter pipe. Under Alternative 1, the existing 18-inch pipe will be replaced with a 36-inch pipe at NE 12th Street which includes a total pipe replacement of 200 linear feet. The two existing 15-inch outfall pipes at NE 11th Street will remain in place since it is a private system. The estimated design and construction costs for this pipe size upgrade alternative are approximately $402,000.

Alternative 2: Pump Station

The stormwater model was used to conduct several simulations of various proposed pump stations within the study area. The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. The proposed construction under Alternative 2 includes the installation of one pump station near the existing outfall, an 18-inch discharge pipe and a new flap gate for backflow prevention. The estimated design and construction costs for this pump station alternative are approximately $1,298,000.

Alternative 3: Pumped Drainage Well

The proposed construction under Alternative 3 includes the installation of one pumped drainage well near the existing outfall, an 18-inch discharge pipe and a new flap gate for backflow prevention. The estimated design and construction costs for this alternative are approximately $813,000.

Alternative 4: Pumped Drainage Well and Pipe Size Upgrades

The proposed construction under Alternative 4 includes the installation of one pumped drainage well with the same characteristics from Alternative 3 and the installation of pipe size upgrades with the same characteristics as noted in Alternative 1. The estimated design and construction costs for this alternative are approximately $979,000.

Alternative Comparison

Refer to Table 12-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, Alternative 4 provides significantly better flood control benefits to the study area in regards to the reduction of both peak flood stages and expected flood duration than all other alternatives. Alternative 4 should be implemented for this study area since it provides better flood control benefits which alleviate the flooding problems within the study area.

Table 12-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.22	5.6	$402,000
Alternative 2	0.06	1.9	$1,299,000
Alternative 3	0.05	2.2	$813,000
Alternative 4	0.32	5.7	$976,000

Recommended Alternative

The recommended stormwater improvements for this study area include the installation of a new pumped drainage well and the replacement of one existing outfall pipe with 36-inch diameter pipe. The proposed upsized outfall pipe is intended to reduce flooding within North Riverside Drive during low tide periods within the Intracoastal Waterway. Due to the extremely low ground surface elevations along North Riverside Drive, the proposed upsized outfall pipe will not assist with the gravity discharge during high tide periods within the Intracoastal Waterway. The installation of the pumped drainage well is intended to reduce flooding within North Riverside Drive during high tide periods within the Intracoastal Waterway. Due to the negative impacts of high tide on the performance of the stormwater system in this study area, the proposed improvements also include the installation of backflow prevention devices at this outfall from North Riverside Drive. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $980,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 12-1 and a preliminary cost estimate summarized in Table 12-2 at the end of this section.

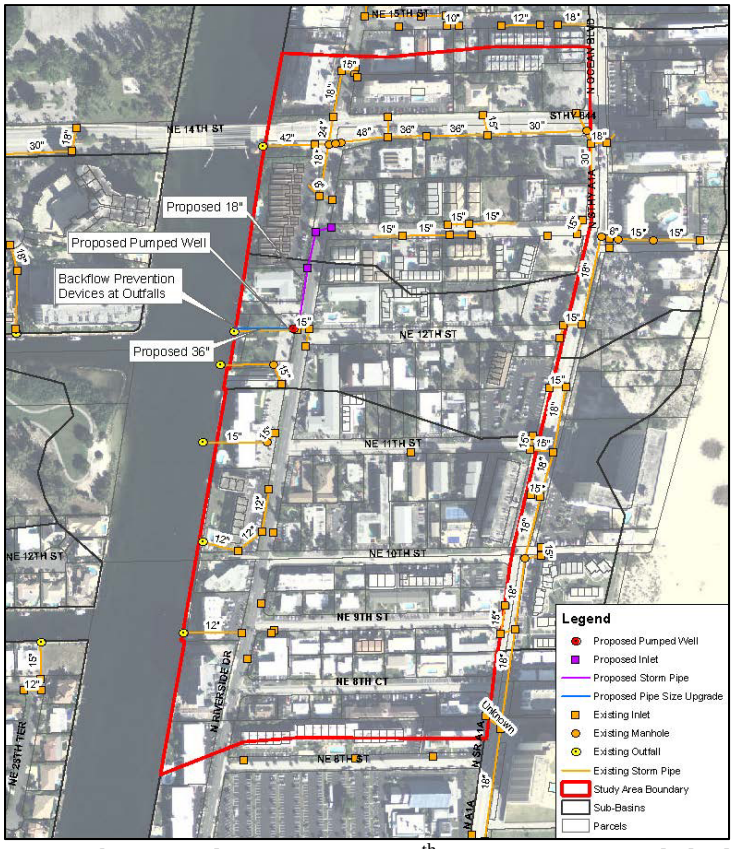

Figure 12-1 North Riverside Drive & NE 14th Street Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will enhance water quality of stormwater discharge into the Intracoastal Canal since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will not have an impact on the ground water.
- Air Quality: This alternative does not have an adverse impact on air quality since the proposed stormwater pump station will use electrical power.
- Noise: This alternative does not have an adverse impact on noise since the proposed stormwater pump will be enclosed within a concrete structure which is designed to limit noise from reaching public areas.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of the stormwater discharge since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.

- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative will require additional power consumption in order to operate the proposed stormwater pumped drainage well.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, North Riverside Drive and NE 14th Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 12-2 North Riverside Drive & NE 14th Street Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Recommended Alternative
Remove Existing Pipe	$4,000	$4,000	$4,000	$4,000	$4,000
Replace Existing Drainage Structure	$5,000	$5,000	-	$5,000	$5,000
Install Catch Basin	-	-	-	$13,500	$13,500
Upgrade Existing Outfall	$5,000	$5,000	-	$5,000	$5,000
18" RCP Drainage Pipe	-	-	$13,000	$23,725	$23,725
18" DIP Pressure Pipe	-	$13,000	-	-	-
36" RCP Drainage Pipe	$16,000	-	-	$16,000	$18,000
18" Backflow Prevention Devices at Outfall	-	$45,000	$40,000	-	-
36" Backflow Prevention Devices at Outfall	$60,000	-	-	$60,000	$60,000
Drainage Well	-	$600,000	-	-	-
Install Pumped Drainage Well	-	-	$300,000	$300,000	$300,000
Swale Regrading	$151,667	$151,667	$151,667	$151,667	$151,667
Pavement Restoration	$19,556	$19,556	$19,556	$55,244	$55,244
Subtotal	$261,222	$843,222	$528,222	$634,136	$636,136
Mobilization (10%)	$26,122	$84,322	$52,822	$63,414	$63,614
Construction Contingency (20%)	$57,469	$185,509	$116,209	$139,510	$139,950
Design and Permitting (15%)	$43,102	$139,132	$87,157	$104,632	$104,962
Construction Administration (5%)	$14,367	$46,377	$29,052	$34,877	$34,987
TOTAL COST	**$402,282**	**$1,298,562**	**$813,462**	**$976,570**	**$979,650**

13 ATLANTIC BOULEVARD AND SOUTH RIVERSIDE DRIVE

This study area is located on the east side of the Intracoastal Waterway chiefly along Riverside Drive. The project area extends along Riverside Drive from the intersection with Atlantic Boulevard on the northern limits to the intersection of SE 10th Street on the southern limits. Based on our analysis, heavy flooding can be expected at the north side of South Riverside Drive between SE 2nd Street to Atlantic Boulevard, which is very low lying. Due to the very low elevation of the study area, the expected flooding is also tidally influenced since backflow from the Intracoastal Waterway can occur via the existing outfall pipes.

The City has received resident complaints on the north Side of South Riverside Drive, just north of SE 2nd Street. Site photographs have been provided which show extensive flooding along South Riverside Drive between SE 2nd Street and Atlantic Boulevard as well throughout the vacant property to the west of Riverside Drive. Various system improvement alternatives to the existing stormwater system were investigated for this study area, which include upgrading the pipe sizes, installing a pump station that discharges to the Intracoastal Waterway through an existing outfall, and installing a pump station with a stormwater retention area. Please note that the installation of exfiltration trench was not considered as a system improvement alternative since the very low elevation of the study area would limit the effectiveness of these options.

Alternative 1: Pipe Size Upgrades

The proposed improvements under Alternative 1 include upgrading the pipe sizes at specific locations increase the conveyance capacity of the stormwater system, which could increase the discharge rate to alleviate the flooding problems within the study area. For this study area, all existing outfalls pipes were analyzed to receive pipe size upgrades. Alternative 1 includes the removal of existing pipes (1,530 linear feet) with diameters between 12 inches and 21 inches. Under Alternative 1, the proposed pipe sizes include 310 linear feet of 24 inch RCP and 1,220 linear feet of 30 inch RCP. The estimated design and construction costs for Alternative 1 are approximately $1,900,000.

Alternative 2: Pump Station

The proposed construction under Alternative 2 includes the installation of two pump stations adjacent to existing outfalls in order to provide additional hydraulic head on the downstream end of the system to increase the system discharge capacity to alleviate the flooding, especially during high tide conditions. In addition to the two new pump stations, the gravity outfall pipe will be upsized to a 24-inch discharge pipe and a flap gate will be installed at the point of discharge. The estimated design and construction costs for this pump station alternative are approximately $2,927,000.

Alternative 3/4: Pump Station and Storage

The proposed construction under Alternative 3 includes the installation of a pump station, which connects to potential stormwater retention area(s) at an undetermined location within the study area. The proposed stormwater retention area was assumed encompasses a total area of 1.0 acres. Overflow from this stormwater retention area would need to be connected back to the existing system through a weir-type control structure. The weir elevation within the control structure was assumed at +7.5 feet NAVD, which would provide a total storage volume of 1.93 acre-feet. The stormwater model was used to analyze Alternative 3 with the existing stormwater pipe remaining in place and Alternative 4 with increasing the existing pipe diameters to 30 inch RCP. The estimated design and construction costs for this pump station and storage alternative are approximately $4,375,000 for alternative 3 and $4,493,000 for alternative 4.

Alternative 5: Pumped Drainage Well

The proposed construction under Alternative 5 includes the installation of three pumped drainage well near the existing outfalls on South Riverside Drive with flap gates to be installed at the existing outfalls. The estimated design and construction costs for this pump station alternative are approximately $2,128,000.

Alternative 6: Pumped Drainage Well and Pipe Size Upgrades

The proposed construction under Alternative 6 includes the installation of three pumped drainage wells with the same characteristics of Alternative 5 and the installation of upsized outfall pipes with same characteristics as noted in Alternative 1. The estimated design and construction costs for this alternative are approximately $2,873,000.

Alternative Comparison

Refer to Table 13-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, all system improvement alternatives can be considered to be an effective option for reducing the peak flood stages and reducing the expected flood duration within the study area. However, Alternative 3 and Alternative 4 should likely be eliminated from consideration since using valuable private property in this study area for stormwater retention is not feasible from a cost standpoint. Alternative 1 provides similar flood control benefits as Alternative 2 and is significantly more cost effective, yet does not assist with discharge capacity during high tides. Alternative 6 should be implemented for this study area since it provides flood control throughout the study area and supplemental discharge capacity during high tide periods within the Intracoastal Waterway.

Table 13-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.13	1.72	$1,900,000
Alternative 2	0.21	1.25	$2,927,000
Alternative 3	0.22	1.24	$4,375,000
Alternative 4	0.65	1.91	$4,493,000
Alternative 5	0.12	0.90	$2,128,000
Alternative 6	0.13	1.90	$2,873,000

Recommended Alternative

The recommended stormwater improvements for this study area include the replacement of six existing outfall pipes with 24-inch or 30-inch diameter pipe, which will significantly reduce flooding within South Riverside Drive during low tide within the Intracoastal Waterway. Due to the extremely low ground surface elevations along South Riverside Drive, the upsized outfall pipes will not assist with the gravity discharge during high tide within the Intracoastal Waterway. The installation of the pumped drainage wells are intended to reduce flooding within North Riverside Drive during high tide periods within the Intracoastal Waterway. Due to the negative impacts of high tide on the performance of the stormwater system in this study area, the proposed improvements include the installation of backflow prevention devices at all six existing outfalls from South Riverside Drive. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated

design and construction costs for this recommended alternative are approximately $2,873,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout, displayed in Figure 13-1 below and a preliminary cost estimate summarized in Table 13-2 at the end of this section.

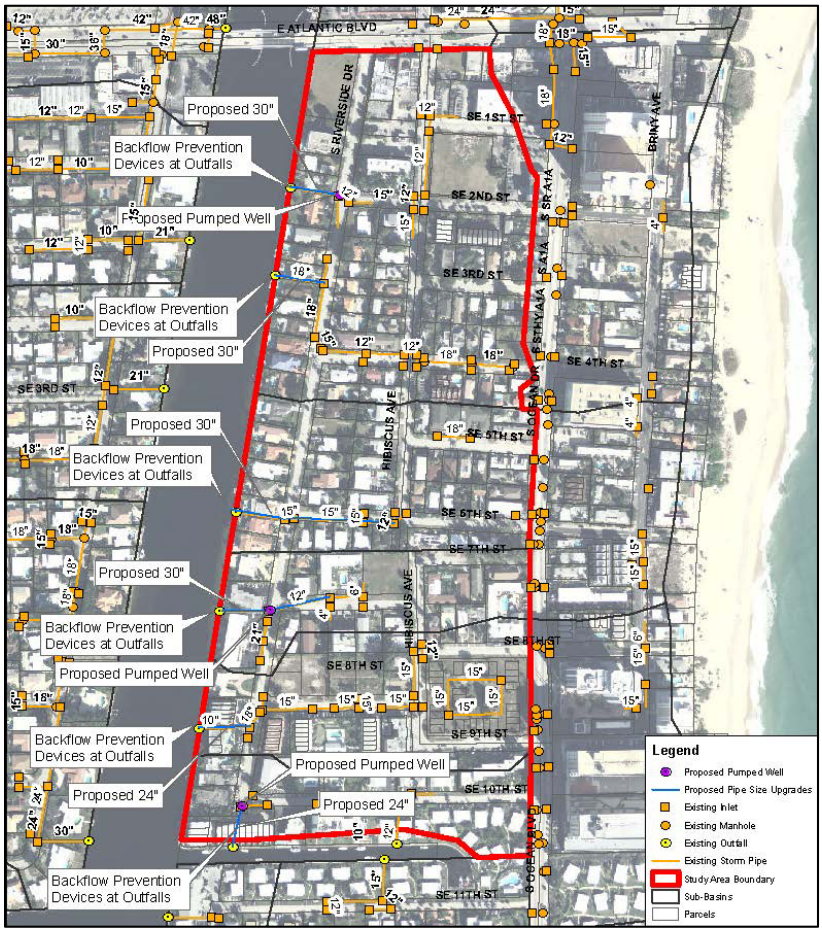

Figure 13-1 Atlantic Blvd and South Riverside Drive Recommended Alternative

<u>Environmental Effects</u>

Physical

- Surface Water: This alternative will enhance water quality of stormwater discharge into the Intracoastal Canal over the existing conditions since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will not have an impact on the ground water.
- Air Quality: This alternative does not have an adverse impact on air quality since the proposed stormwater pump station will use electrical power.
- Noise: This alternative does not have an adverse impact on noise since the proposed stormwater pump will be enclosed within a concrete structure which is designed to limit noise from reaching public areas.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.

- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge over the existing conditions since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative will require additional power consumption in order to operate the proposed stormwater pumped drainage well.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, Atlantic Boulevard and South Riverside Drive study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 13-2 Atlantic Blvd and South Riverside Drive Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6 (Recommended)
Remove Existing Pipe	$30,600	$5,600	-	$3,400	$24,000	$30,600
Replace Existing Drainage Structure	$50,000	-	$2,000	$2,000	-	$50,000
Upgrade Existing Outfall	$30,000	$10,000	-	$5,000	-	$30,000
12" RCP Drainage Pipe	-	-	$1,500	$1,500	-	-
18" RCP Drainage Pipe	-	-	-	-	$72,000	-
18" DIP Pressure Pipe	-	-	$39,000	$39,000	-	-
24" RCP Drainage Pipe	$23,250	-	-	-	-	$23,250
24" DIP Pressure Pipe	-	$21,000	-	-	-	-
30" RCP Drainage Pipe	$93,940	-	-	$13,090	-	$93,940
24" Backflow Prevention Devices at Outfall	$100,000	$100,000	-	-	-	$100,000
30" Backflow Prevention Devices at Outfall	$220,000	-	-	$55,000	-	$220,000
Water Control Structure	-	-	$5,000	$5,000	-	-
Wet Well & Pump Station	-	$1,200,000	$600,000	$600,000	-	-
Install Pumped Drainage Well	-	-	-	-	$900,000	$900,000
Soil Removal & Construct Dry Retention	-	-	$40,000	$40,000	-	-
Sod Restoration of Retention Area	-	-	$15,600	$15,600	-	-
Purchase Property for Retention Area	-	-	$1,540,000	$1,540,000	-	-
Swale Regrading	$536,667	$536,667	$536,667	$536,667	$268,333	$268,333
Pavement Restoration	$149,600	$27,378	$61,600	$61,600	$117,333	$149,600
Subtotal	$1,234,057	$1,900,644	$2,841,367	$2,917,857	$1,381,667	$1,865,723
Mobilization (10%)	$123,406	$190,064	$284,137	$291,786	$138,167	$186,572
Construction Contingency (20%)	$271,492	$418,142	$625,101	$641,928	$303,967	$410,459
Design and Permitting (15%)	$203,619	$313,606	$468,826	$481,446	$227,975	$307,844
Construction Administration (5%)	$67,873	$104,535	$156,275	$160,482	$75,992	$102,615
TOTAL COST	$1,900,447	$2,926,992	$4,375,705	$4,493,499	$2,127,767	$2,873,214

14 NE 27TH AVENUE AND NE 16TH STREET

This study area is bounded by US-1 on the west, NE 22nd Street on the north, NE 28th Avenue on the east, and NE 16th Street on the south. This study area consists of primarily single family residential properties with a limited existing drainage system serving the roadways. The existing drainage system within the study area consists of two independent drainage systems that collect stormwater runoff from the public right-of-way and discharges via existing 24-inch outfalls into tidal canals, which are directly connected to the Intracoastal Waterway. An existing outfall is located at the north end along NE 22nd Court while the other existing outfall is located at the south side end of NE 16th Street. According to the topography, stormwater runoff can be expected to flow from the north to the south along NE 27th Avenue before collecting in low lying areas in the right-of-way. The lowest elevations within the study area directly correlate to the flooding problems. The stormwater model was used to evaluate effectiveness of various system improvement alternatives, such as exfiltration trenches, drainage wells, or pump stations, in reducing the existing flooding problems.

Alternative 1: Exfiltration Trench

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 8,022 LF of exfiltration trench, which were aligned along right-of-way areas with ground surface elevations greater than +5.0 feet NAVD. The estimated design and construction costs for this exfiltration trench alternative are approximately $3,390,000.

Alternative 2: Pipe Size Upgrades

The proposed improvements under Alternative 2 include upgrading the pipe size at the outfall to increase the conveyance capacity of the stormwater system, which could increase the discharge rate to alleviate the flooding problems within the study area. Alternative 2 includes replacing the existing 12-inch pipe and 24-inch pipe with approximately 600 linear feet of new 36-inch RCP. The estimated design and construction costs for Alternative 2 are approximately $338,000.

Alternative 3: Pump Station

The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. The proposed construction under Alternative 3 includes the installation of one pump station near the existing outfall, installing a 24-inch discharge pipe to the outfall location and installing a flap gate at the point of discharge. The estimated design and construction costs for this pump station alternative are approximately $2,198,000.

Alternative 4: Drainage Wells

The stormwater model was used to conduct several simulations of the installation of proposed drainage wells within problem areas of the study area. The purpose of this system improvement alternative is to intercept stormwater runoff before it reaches the existing outfalls and to provide additional discharge capacity at the problem area to alleviate the existing flooding issues quicker. The expected construction includes a total of seven drainage wells along NE 16th Street and NE 17th Street within the study area. The estimated design and construction costs for this drainage well alternative are approximately $1,098,000.

Alternative 5: Exfiltration Trench & Pipe Size Upgrades

This alternative combines the exfiltration trench of alternative 1 and pipe size upgrades of alternative 2. Under Alternative 1, the proposed construction includes a total of 5,600 LF of exfiltration trench, which were aligned along right-of-way areas with ground surface elevations greater than +5.0 feet NAVD. The proposed improvements under Alternative 2 include replacing the existing 12-inch pipe and 24-inch pipe with approximately 600 linear feet of new 36-inch RCP. The estimated design and construction costs for Alternative 5 are approximately $2,487,000.

Alternative Comparison

Refer to the Table 14-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, all system improvement alternatives provide similar flood control benefits to the study area, which are limited. Based on the model results, Alternative 5 is slightly more effective than all of the other alternatives at providing additional flood control to the study area. Alternative 5 has the less potential concern that could arise during the detailed design phase which could restrict the complete implementation. Alternative 5 should be implemented for this study area since it provides the best potential flood control benefits. Although Alternative 5 does not provide enough additional flood protection to meet the level of service criteria for all public roadways within the study area, Alternative 5 does provide significant benefits which alleviate the flooding problems within the study area.

Table 14-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.13	1.3	$3,390,000
Alternative 2	0.49	5.2	$338,000
Alternative 3	0.08	1.2	$2,198,000
Alternative 4	0.18	2.9	$1,098,000
Alternative 5	0.72	5.7	$2,487,000

Recommended Alternative

CMA recommends the installation of exfiltration trench within City right-of-ways throughout the study area which provide additional storage and infiltration capacity for stormwater runoff. The recommended stormwater improvements for this study area include the installation of new exfiltration trench along NE 18th Street, NE 19th Street, NE 21st Street, NE 22nd Street and NE 27th Avenue to collect stormwater runoff from these areas. The proposed exfiltration system should be interconnected to existing drainage systems, which will allow drawdown via the existing outfalls. The recommended stormwater improvements also include upsizing the existing 24-inch outfall to a 36-inch outfall. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $2,572,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 14-1 below and a preliminary cost estimate summarized in Table 14-2 at the end of this section.

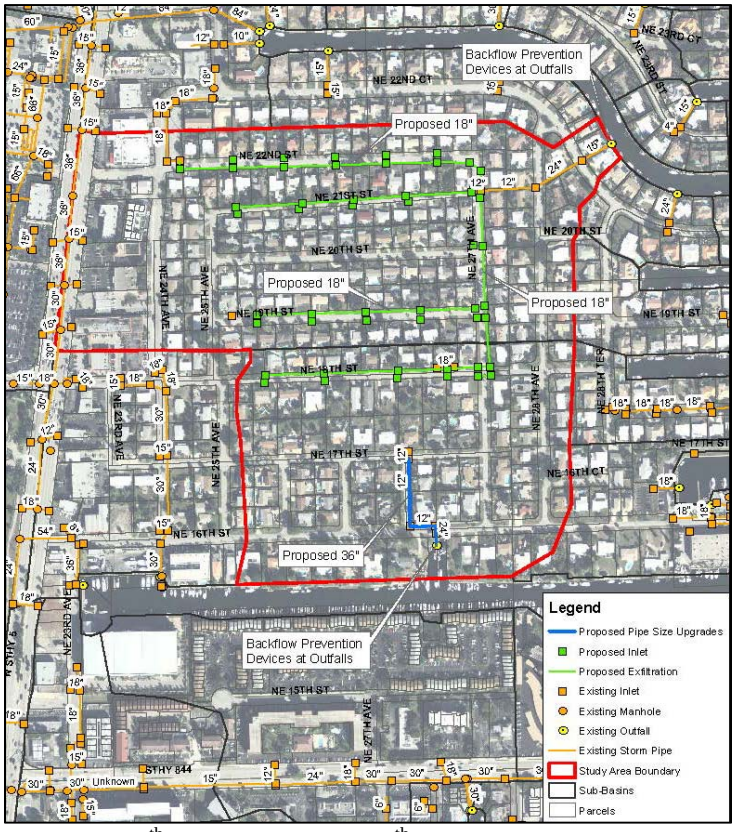

Figure 14-1 NE 27th Avenue and NE 16th Street Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the canal since some of the stormwater runoff would be diverted into the new exfiltration trench and the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed exfiltration, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system over the existing conditions since some of the stormwater runoff would be diverted from the canal outfalls to new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties which will improve the aesthetics of the neighborhood.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the area surrounding the NE 27th Avenue and NE 16th Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within this study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 14-2 NE 27th Avenue and NE 16th Street Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Recommended Alternative
Remove Existing Pipe	-	$12,000	-	-	$12,000	$9,400
Replace Existing Drainage Structure	-	$27,000	$10,000	-	$27,000	$25,000
Install Catch Basin	$405,000	-	-	-	$229,500	$220,500
Upgrade Existing Outfall	-	-	$5,000	-	$5,000	$5,000
15" RCP Drainage Pipe	-	-	-	-	-	$28,250
18" RCP Drainage Pipe with Exfiltration	$962,400	-	-	-	$672,000	$612,000
24" RCP Drainage Pipe	-	-	-	$60,000	-	-
24" DIP Pressure Pipe	-	-	$15,000	-	-	-
36" RCP Drainage Pipe	-	$72,000	-	-	$72,000	$42,300
24" Backflow Prevention Devices at Outfall	$50,000	-	$50,000	$50,000	-	$50,000
36" Backflow Prevention Devices at Outfall	-	$50,000	-	-	$50,000	$60,000
Drainage Well	-	-	-	$525,000	-	-
Wet Well & Pump Station	-	-	$600,000	-	-	-
Swale Regrading	-	-	$728,000	-	-	$119,000
Pavement Restoration	$784,178	$58,667	$19,556	$78,222	$547,556	$498,667
Subtotal	$2,201,578	$219,667	$1,427,556	$713,222	$1,615,056	$1,670,117
Mobilization (10%)	$220,158	$21,967	$142,756	$71,322	$161,506	$167,012
Construction Contingency (20%)	$484,347	$48,327	$314,062	$156,909	$355,312	$367,426
Design and Permitting (15%)	$363,260	$36,245	$235,547	$117,682	$266,484	$275,569
Construction Administration (5%)	$121,087	$12,082	$78,516	$39,227	$88,828	$91,856
TOTAL COST	$3,390,430	$338,287	$2,198,436	$1,098,362	$2,487,186	$2,571,980

15 POWERLINE ROAD AND NW 33RD STREET

This study area is bounded by Powerline Road on the west, NW 33rd Court on the north, NW 18th Terrace on the east and NW 31st Street on the south. This study area consists mainly of industrial and commercial properties. The study area has a limited amount of public roadways, which include NW 33rd Court, NW 33rd Street, NW 18th Terrace and NW 32nd Street. These public right-of-way areas have a significant impervious surface coverage, which prevents the infiltration of stormwater runoff into the ground surface after rainfall events. Based on the results of the stormwater model, NW 33rd Street displays flooding greater than two inches towards the west side of the road along with adjacent private properties towards the south of the study area.

Recommended Alternative: Exfiltration Trench

The only feasible system improvement alternative for this study area includes the installation of exfiltration trench within the public right-of-way areas due to the relatively high elevation. The installation of gravity drainage wells is not an option due to the lack of brackish groundwater at the bottom of the surficial aquifer below the TOC Area since the boundary of this brackish groundwater is located just east of Dixie Highway. Dry retention areas were not considered an option due to the limited amount of right-of-way in this study area. The installation of a pump station was not a feasible option for this study area and was not considered during the analysis of potential alternatives.

The stormwater model was used to conduct several simulations of the installation of proposed exfiltration trench within the study area, which is not currently served by an existing stormwater system. The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 3,330 LF of exfiltration trench t along NW 33rd Court, NW 33rd Street, NW 18th Terrace and NW 32nd Street. The installation of additional exfiltration systems within the study area will help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $1,480,000. CMA has prepared a conceptual layout displayed in Figure 15-1 below and a preliminary cost estimate summarized in Table 15-1 at the end of this section.

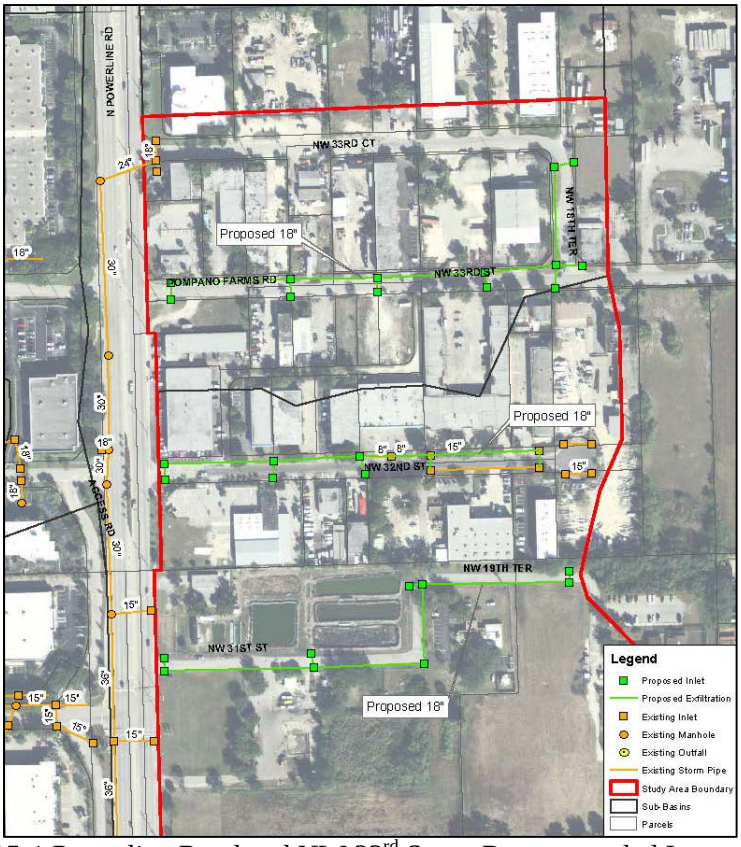

Figure 15-1 Powerline Road and NW 33rd Street Recommended Improvements

Environmental Effects

Physical

- Surface Water: This alternative will not have an impact on the surface waters, since the existing or proposed improvements do not directly connect to any surface water body.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will not have an impact on the aquatic areas, since the existing or proposed improvements do not directly connect to any surface water body.

- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the area surrounding the Powerline Road and NW 33rd Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 15-1 Powerline Road and NW 33rd Street Preliminary Cost Comparison

Item	Recommended Alternative
Remove Existing Pipe	$7,600
Replace Existing Drainage Structure	$20,000
Install Catch Basin	$126,000
15" RCP Drainage Pipe	$24,000
18" RCP Drainage Pipe with Exfiltration	$390,000
Swale Regrading	$75,833
Pavement Restoration	$317,778
Subtotal	$961,211
Mobilization (10%)	$96,121
Construction Contingency (20%)	$211,466
Design and Permitting (15%)	$158,600
Construction Administration (5%)	$52,867
TOTAL COST	**$1,480,265**

16 NW 22ND STREET

This study area is an isolated right-of-way area with heavy flooding problems just south of Copans Road and just west of Powerline Road. This study area mainly consists of industrial and commercial properties, with only one City roadway (NW 22nd Street) with significant impervious ground coverage, which can limit the infiltration of stormwater runoff into the ground surface. The remainder of the study area includes multiple private roadways and driveways which also have flooding problems. The public right-of-way area for NW 22nd Street has an existing stormwater system which consists of exfiltration trench along the south side of the roadway. According to the topography, the lowest elevations within the study area, beside the stormwater retention areas located on private property, are located along NW 22nd Street where stormwater runoff typically collects from the entire study area. Based on the results of the stormwater model, all public right-of-way areas within the study area display flooding greater than two inches. The system improvement alternatives that were investigated for this study area consist of expanding exfiltration trench system within NW 22nd Street.

Recommended Alternative: Exfiltration Trench

The only feasible system improvement alternative for this study area includes the installation of exfiltration trench within the public right-of-way areas due to the relatively high elevation. The installation of gravity drainage wells is not an option due to the lack of brackish groundwater at the bottom of the surficial aquifer below the TOC Area since the boundary of this brackish groundwater is located just east of Dixie Highway. Dry retention areas were not considered an option due to the limited amount of right-of-way in this study area. The installation of a pump station was not a feasible option for this study area and was not considered during the analysis of potential alternatives.

The stormwater model was used to conduct a simulation of the installation of additional exfiltration trench along the north side NW 22nd Street within the study area. The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 800 LF of exfiltration trench along NW 22nd Street, which will be interconnected with the existing drainage system. The installation of additional exfiltration systems within the study area will help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $350,000. CMA has prepared a conceptual layout displayed in Figure 16-1 below and a preliminary cost estimate summarized in Table 16-1 at the end of this section.

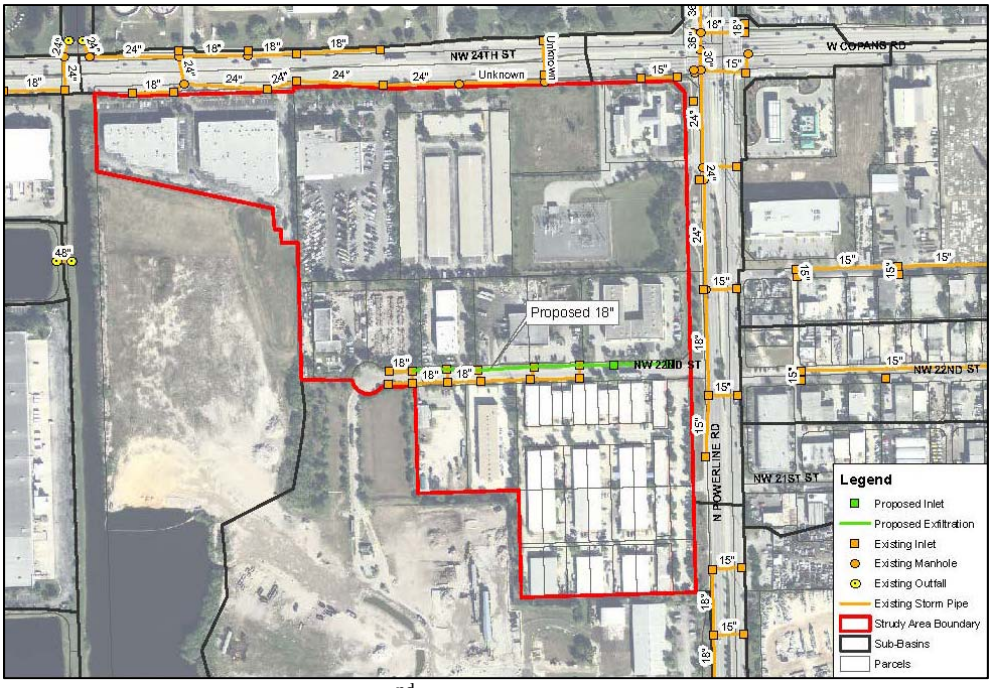

Figure 16-1 NW 22nd Street Recommended Alternatives

Environmental Effects

Physical

- Surface Water: This alternative will not have an impact on the surface waters, since the existing or proposed improvements do not directly connect to any surface water body.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will not have an impact on the aquatic areas, since the existing or proposed improvements do not directly connect to any surface water body.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the area surrounding the NW 22nd Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 16-1 NW 22nd Street Preliminary Cost Comparison

Item	**Recommended Alternative**
Replace Existing Drainage Structure	$25,000
Install Catch Basin	$9,000
18" RCP Drainage Pipe with Exfiltration	$96,000
Swale Regrading	$18,667
Pavement Restoration	$78,222
Subtotal	$226,889
Mobilization (10%)	$22,689
Construction Contingency (20%)	$49,916
Design and Permitting (15%)	$37,437
Construction Administration (5%)	$12,479
TOTAL COST	**$349,409**

17 SE 28TH AVENUE SOUTH OF ATLANTIC BOULEVARD

This study area is located along SE 28th Avenue between SE 1st Court and SE 4th Street, which is immediately west of the Intracoastal Waterway. The existing drainage system in this study area includes two existing 21-inch RCP conduits, which discharge directly to the Intracoastal Waterway. According the existing conditions stormwater model, the flood depth within the study area is estimated to be approximately 0.8 feet and 1.0 feet above the lowest roadway elevations within each sub-basin. Due to the direct connection to the Intracoastal Waterway, the performance of the existing stormwater system is tidally influenced, which will limit the discharge capacity of the existing outfalls during high tide conditions. For the evaluation of this study area with the stormwater model, several potential system improvement alternatives were considered to improve the performance of the existing drainage system, including pipe size upgrades, exfiltration trenches, and drainage wells.

Alternative 1: Pipe Size Upgrades

According to the results of the existing conditions stormwater model results, pipe size improvements of the existing outfalls will provide additional discharge capacity which should alleviate some flooding within the study area. Alternative 1 was limited to replacing these two existing 21-inch outfall pipes with a larger diameter, either 30-inch or 36-inch. The estimated design and construction costs for this pipe size upgrade alternative are approximately $756,000.

Alternative 2: Exfiltration Trenches

Under Alternative 2, the proposed construction includes the installation of exfiltration trenches in order to minimize the major source of overland flow into the project area. These proposed exfiltration trenches are only proposed along public roadways in the study area with ground surface elevations greater than +5.0 feet NAVD to ensure adequate storage and infiltration capacity. The proposed construction includes about 810 linear feet of exfiltration trench. The estimated design and construction costs for this exfiltration trench alternative are approximately $499,000.

Alternative 3: Drainage Wells

Under Alternative 3, the proposed construction includes the installation of three drainage wells in order to minimize the major source of overland flow into the project area. The three drainage wells are located near the intersection of SE 2nd Street and SE 24th Avenue. The estimated design and construction costs for this drainage well alternative are approximately $580,000.

Alternative 4: Pipe Size Upgrades and Drainage Wells

Alternative 4 merges the proposed improvements from Alternative 1 and Alternative 3 in order to obtain the benefits from each option. Proposed Improvements include three drainage wells and upgrading the two discharge pipes to 36-inch. Alternative 4 was evaluated since it minimizes overland flow into the study area from adjacent sub-basins along with increasing the discharge capacity via the outfalls. The estimated design and construction costs for this alternative are approximately $1,130,000.

Alternative Comparison

Refer to the Table 17-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, multiple system improvement alternatives (Alternative 1 and Alternative 4) can be considered to be an effective option for reducing the peak flood stages and reducing the expected flood duration within the study area. Although these alternatives do

provide significant benefits which alleviate the flooding problems within the study area, both alternatives have been eliminated from consideration by the City since the two existing 21-inch outfall pipe were recently rehabilitated at a significant cost. The City prefers to not replace these outfall pipes since the service life has been significantly extended by the pipe lining rehabilitation.

Table 17-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.39	2.03	$756,000
Alternative 2	0.08	0.23	$499,000
Alternative 3	0.11	4.6	$580,000
Alternative 4	0.51	6.4	$1,130,000

Recommended Alternative

In order to provide additional flood relief to this study area, CMA recommends the installation of backflow prevention devices at the two existing 21-inch outfalls to prevent high tides from impacting flood control in low lying areas, such as SE 28th Avenue. All grass swale areas within the study area should also be regraded to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $585,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed n Figure 17-1 below and a preliminary cost estimate summarized in Table 17-2 at the end of this section.

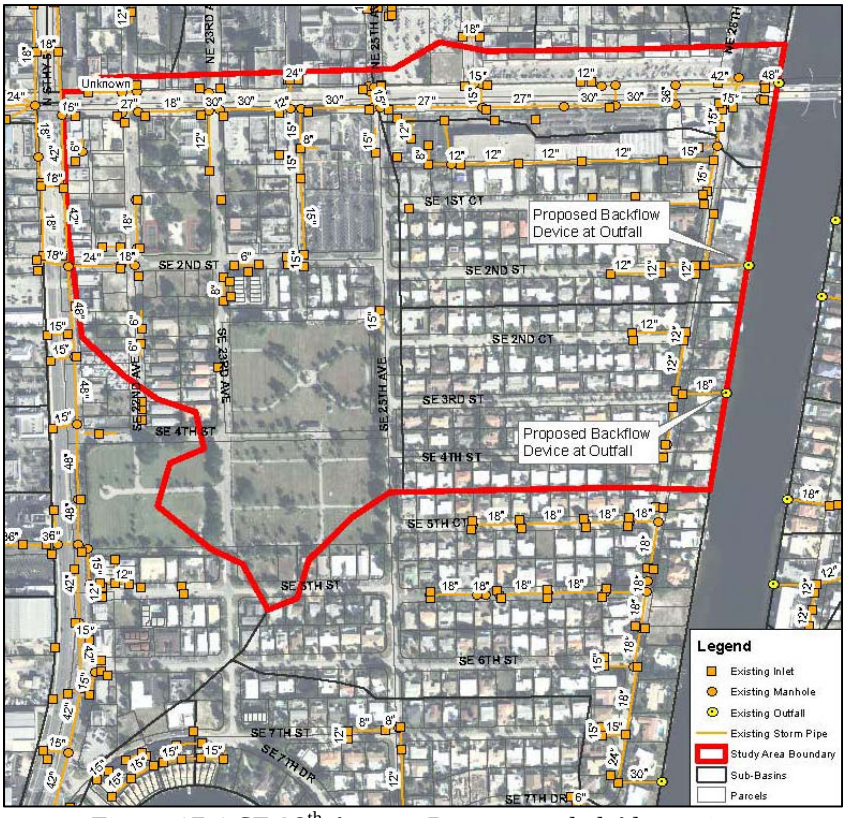

Figure 17-1 SE 28th Avenue Recommended Alternatives

Environmental Effects

Physical

- Surface Water: This alternative will enhance water quality of stormwater discharge into the Intracoastal over the existing conditions since the proposed stormwater improvements will include the installation of new swales, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed swale areas into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge over the existing conditions since the proposed swales will provide additional water quality treatment, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur within the public right of way.

No Action

- If no action is taken in this study area, the SE 28th Avenue study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the SE 28th Avenue study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 17-2 SE 28th Avenue Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Recommended Alternative
Remove Existing Pipe	$7,000	-	-	$7,000	-
Install Catch Basin	-	$49,500	-	-	-
Upgrade Existing Outfall	$10,000	-	-	$10,000	-
18" RCP Drainage Pipe with Exfiltration	-	$96,000	-	-	-
24" RCP Drainage Pipe	-	-	$22,500	$22,500	-
36" RCP Drainage Pipe	$28,000	-	-	$28,000	-
21" Backflow Prevention Devices at Outfall	-	$100,000	$100,000	-	$100,000
36" Backflow Prevention Devices at Outfall	$120,000	-	-	$120,000	-
Drainage Well	-	-	$225,000	$225,000	-
Swale Regrading	$291,667	-	-	$291,667	$280,000
Pavement Restoration	$34,222	$78,222	$29,333	$29,333	-
Subtotal	$490,889	$323,722	$376,833	$733,500	$380,000
Mobilization (10%)	$49,089	$32,372	$37,683	$73,350	$38,000
Construction Contingency (20%)	$107,996	$71,219	$82,903	$161,370	$83,600
Design and Permitting (15%)	$80,997	$53,414	$62,178	$121,028	$62,700
Construction Administration (5%)	$26,999	$17,805	$20,726	$40,343	$20,900
TOTAL COST	**$755,969**	**$498,532**	**$580,323**	**$1,129,590**	**$585,200**

18 NW 22ND COURT

This study area is an isolated right-of-way area with heavy flooding problems just south of Copans Road and just east of Powerline Road. This study area mainly consists of industrial and commercial properties, with only two City roadways (NW 22nd Court and NW 18th Avenue) with significant impervious ground coverage, which can limit the infiltration of stormwater runoff into the ground surface. The problem area is located along NW 22nd Court between NW 18th Avenue and NW 15th Avenue. According to the topography, the lowest elevations within the study area are located along NW 22nd Court where stormwater runoff collects from the entire study area. According to the model results, all public right-of-way areas within the study area display flooding greater than two inches. The system improvement alternatives that were investigated for this study area consist of upsizing the existing pipes and installing additional exfiltration trench.

Alternative 1: Pipe Size Upgrades

The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. Alternative 1 included the replacement of the existing pipes which discharge into the adjacent drainage canal with larger diameter pipe. Under Alternative 1, the existing 18-inch pipe will be replaced with a 24-inch pipe along NW 18th Avenue, which includes a total pipe replacement of 400 linear feet. The estimated design and construction costs for this pipe size upgrades alternative are approximately $138,000.

Alternative 2: Exfiltration Trench

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 2, the proposed construction includes a total of 3,843 LF of exfiltration trench along NW 22nd Court and NW 23rd Street. The installation of additional exfiltration systems within the study area will help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $1,470,000.

Alternative Comparison

Refer to the Table 18-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, Alternative 2 is slightly more effective at reducing the peak flood stages and expected flood duration within the study area. Alternative 2 should be implemented for this study area since it provides the better potential flood control benefits to the study area.

Table 18-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.03	3.5	$138,000
Alternative 2	0.05	12.9	$1,470,000

Recommended Alternative

CMA recommends the installation of exfiltration trench along NW 22nd Court and NW 23rd Street to provide additional storage and infiltration capacity for stormwater runoff. As feasible, any grass swale areas within the construction area should also be regraded to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $1,012,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 18-1 below and a preliminary cost estimate summarized in Table 18-2 at the end of this section.

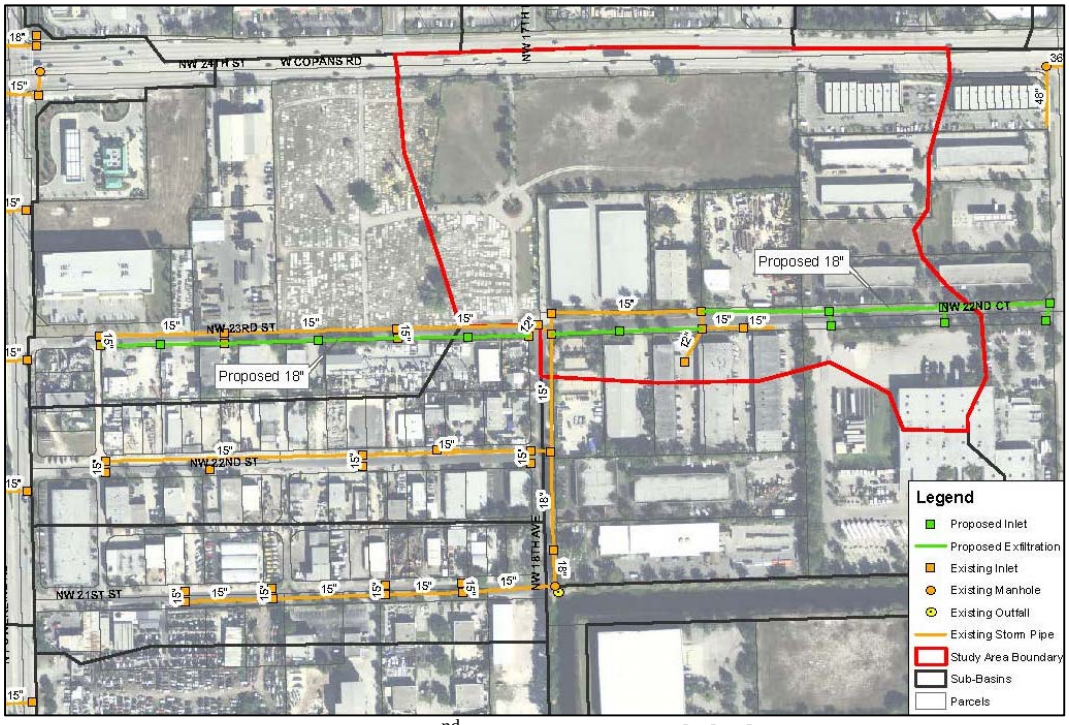

Figure 18-1 NW 22nd Court Recommended Alternative

Environmental Effects

A summary of the environmental assessment for this alternative is defined below:

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the canal since some of the stormwater runoff would be diverted into the new exfiltration trench, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.

- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge from the existing drainage system since some of the stormwater runoff would be diverted from the downstream outfalls into new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

Table 18-2 NW 22nd Court Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Recommended Alternative
Replace Existing Drainage Structure	$20,000	-	$35,000
Remove Existing Pipe	$7,200	-	-
Install Catch Basin	-	$117,000	$45,000
15" RCP Drainage Pipe	-	-	$6,000
18" RCP Drainage Pipe with Exfiltration	-	$461,400	$284,400
24" RCP Drainage Pipe	$27,000	-	-
Swale Regrading	-	-	$55,300
Pavement Restoration	$35,200	$375,956	$231,733
Subtotal	$89,400	$954,356	$657,433
Mobilization (10%)	$8,940	$95,436	$65,743
Construction Contingency (20%)	$19,668	$209,958	$144,635
Design and Permitting (15%)	$14,751	$157,469	$108,477
Construction Administration (5%)	$4,917	$52,490	$36,159
TOTAL COST	**$137,676**	**$1,469,708**	**$1,012,447**

19 NE 10TH STREET & DIXIE HIGHWAY

This study area is a single family residential neighborhood bounded by NE 10th Street to the north, by Dixie Highway to the west, by NE 6th Street to the south and by NE 5th Avenue to the east. According to the topography, the central portion of the study area is a lower elevation than the perimeter which leads to the collection of stormwater runoff in these low lying areas. According to the model results, limited flooding can be expected within low lying areas of NE 9th Street, NE 7th Street, and NE 3rd Avenue. The only feasible system improvement alternative for this study area includes the installation of exfiltration trench within the public right–of-way areas due to the relatively high elevation, which averages 16.0 feet NAVD. The higher elevation will allow for additional storage and infiltration capacity within the exfiltration system. Drainage wells were not considered since the saltwater intrusion barrier does not extend to this study area. The construction of new dry retention areas were also not analyzed due to the lack of available property within this study area. Due to the lack of existing drainage infrastructure within the study area, upsizing any existing drainage system either within or near the study area was also not an option.

Alternative 1: Exfiltration Trench - Option 1

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 2,685 LF of exfiltration trench within the study area. The installation of additional exfiltration systems within the study area will help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $1,193,000.

Alternative 2: Exfiltration Trench - Option 2

In an effort to increase the level of service provided under Alternative 1, Alternative 2 included an interconnection of the proposed exfiltration system with existing drainage systems located nearby. Alternative 2 includes the construction of 2,010 linear feet of exfiltration trench in addition to the 2,685 linear feet of exfiltration trench defined under Alternative 1. Alternative 2 will provide a connection to the existing stormwater system on NE 2nd Street. The estimated design and construction costs for this exfiltration trench alternative are approximately $2,064,000.

Alternative Comparison

Refer to Table 19-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, both system improvement alternatives can be considered to an effective option for reducing the peak flood stages and reducing the expected flood duration within the study area. Alternative 1 should be implemented for this study area since it provides similar flood control benefits as Alternative 2 but is more cost effective.

Table 19-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.19	33.3	$1,193,000
Alternative 2	0.22	34.6	$2,064,000

Recommended Alternative

CMA recommends the installation of exfiltration trench within City right-of-ways throughout the study area which provide additional storage and infiltration capacity for stormwater runoff. The recommended stormwater improvements for this study area include the installation of new exfiltration trench along NE 3rd Avenue, NE 7th Street, NE 8th Street and NE 9th Street to collect stormwater runoff from these areas. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $1,348,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 19-1 below and a preliminary cost estimate summarized in Table 19-2 at the end of this section.

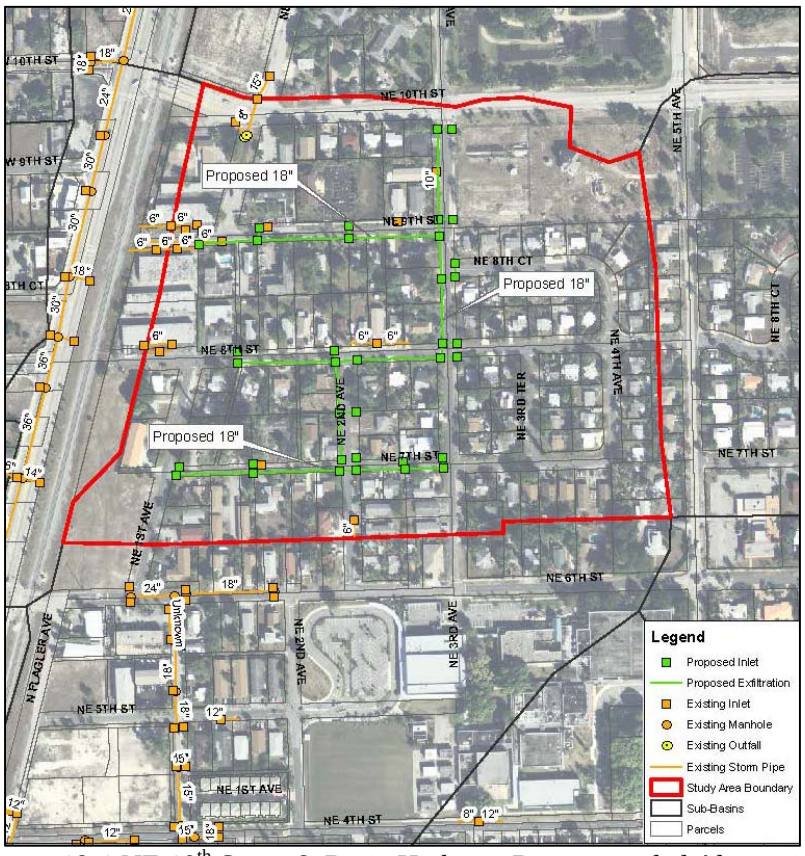

Figure 19-1 NE 10th Street & Dixie Highway Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will not have an impact on the surface waters, since the existing or proposed improvements do not directly connect to any surface water body.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.

- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative does not have an impact to the aquatic feature, since the existing or proposed improvements do not directly connect to any surface water body.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

Table 19-2 NE 10th Street & Dixie Highway Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Recommended Alternative
Replace Existing Drainage Structure	-	$50,000	-
Remove Existing Pipe	-	$40,000	-
Install Catch Basin	$189,000	$189,000	$166,500
15" RCP Drainage Pipe	-	-	$33,500
18" RCP Drainage Pipe with Exfiltration	$322,800	$322,800	$336,000
24" RCP Drainage Pipe with Exfiltration	-	$280,000	-
Swale Regrading	-	-	$65,333
Pavement Restoration	$263,022	$458,578	$273,778
Subtotal	$774,822	$1,340,378	$875,111
Mobilization (10%)	$77,482	$134,038	$87,511
Construction Contingency (20%)	$170,461	$294,883	$192,524
Design and Permitting (15%)	$127,846	$221,162	$144,393
Construction Administration (5%)	$42,615	$73,721	$48,131
TOTAL COST	**$1,193,226**	**$2,064,182**	**$1,347,671**

20 US-1 AND SE 15TH STREET

This study area is a residential neighborhood located between US-1 and the Intracoastal Waterway along SE 13th Street, SE 13th Court, SE 14th Street and SE 15th Street. The ground surface elevations within this study area are very low, which creates some the flooding problems. The existing stormwater system includes recently installed exfiltration system, approximately 7,000 linear feet, without a positive outfall into the Intracoastal Waterway. The storage and infiltration capacity of the existing exfiltration system is limited due to the low elevations within these right-of-way areas. However, there are some roadways in the study area, such as SE 23rd Avenue, SE 24th Avenue and SE 24th Terrace, which are without existing drainage facilities. According to the results of the stormwater model, the estimated flooding depth is greater than 1 inch throughout the entire study area.

Recommended Alternative: Exfiltration Trench

The only feasible system improvement alternative for this study area is expanding the exfiltration trench system within the public right-of-way areas which are not currently served by drainage infrastructure. The installation of a new positive outfall is not possible due to regulatory restrictions. The installation of the drainage well would not have an impact to the low ground surface elevation in relation to the water table depth, which would limit the discharge capacity. Dry retention areas were not considered an option due to the limited available of right-of-way in this study area. The installation of a pump station was not a feasible option for this study area and was not considered during the analysis of potential alternatives.

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. The proposed construction includes a total of 1,730 LF of exfiltration trench along SE 23rd Avenue, SE 24th Avenue, and SE 24th Terrace. The installation of additional exfiltration systems within the study area will help draw down any flooding after rainfall events. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this exfiltration trench alternative are approximately $1,185,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 20-1 below and a preliminary cost estimate summarized in Table 20-1 at the end of this section.

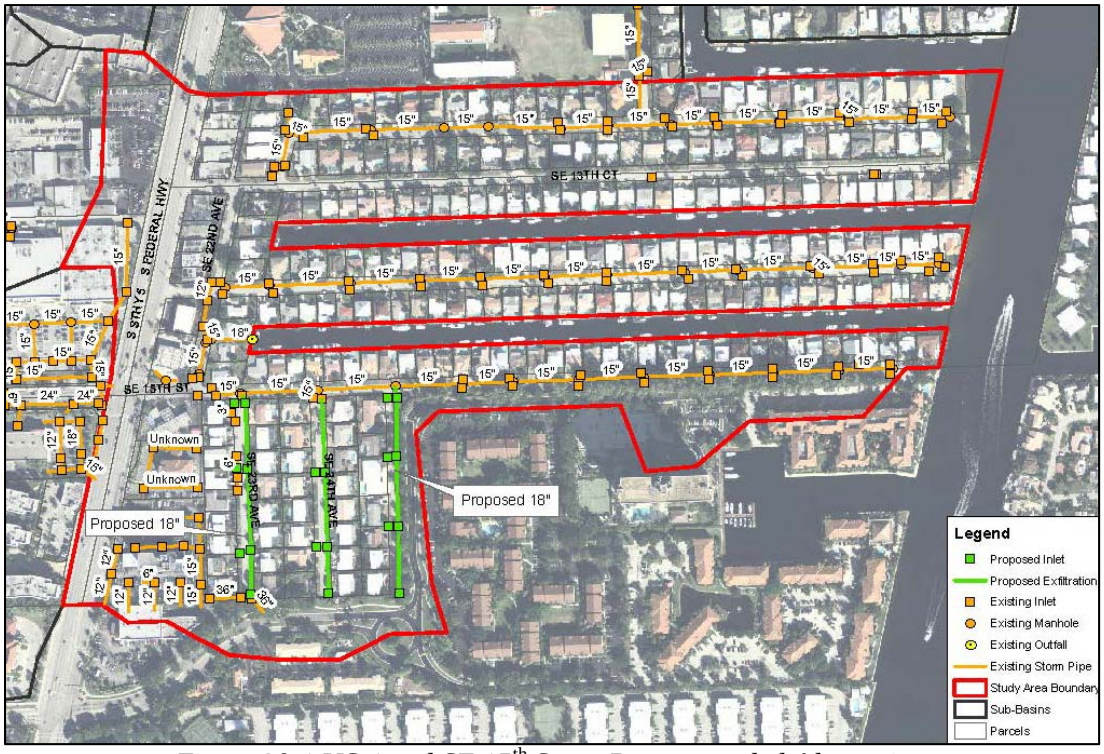

Figure 20-1 US-1 and SE 15th Street Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the canal since some of the stormwater runoff would be diverted into the new exfiltration trench, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative does not have an impact to the aquatic features since some of the stormwater runoff would be diverted into the new exfiltration trench, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, US-1 and SE 15th Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 20-1 NE 10th Street & Dixie Highway Preliminary Cost Comparison

Item	**Recommended Alternative**
Replace Existing Drainage Structure	$15,000
Install Catch Basin	$85,500
15" RCP Drainage Pipe	$13,000
18" RCP Drainage Pipe with Exfiltration	$232,800
Swale Regrading	$233,333
Pavement Restoration	$189,689
Subtotal	$769,322
Mobilization (10%)	$76,932
Construction Contingency (20%)	$169,251
Design and Permitting (15%)	$126,938
Construction Administration (5%)	$42,313
TOTAL COST	**$1,184,756**

21 SE 9TH STREET

This study area is along SE 9th Street to the east of SE 22nd Avenue, which is surrounded by the Intracoastal Waterway. This residential neighborhood has a closed exfiltration trench system of 1,500 linear feet of 18-inch without a positive outfall at the eastern end of the right–of-way. There is also an isolated inlet structure at the western end of the right-of-way that discharges via a 15-inch outfall pipe into the Intracoastal Waterway. Due to a small ridge midway along SE 9th Street, these two stormwater systems are hydraulically isolated from each other, which can lead to flooding during heavy rainfall events. The performance of the existing outfall is also limited by tidal influences due to the very low elevation of the study area. Based on the results of the stormwater model, SE 9th Street experiences significant flooding of greater than 1 inch towards the east and west side of the study area in the low lying area of the right-of-way. The system improvement alternatives investigated within this study area include new pipe connections, additional exfiltration trench and a pump station.

Alternative 1: New Pipe Connections

Due to the isolation of the two separate systems in this study area, the purpose of Alternative 1 is to interconnect the existing stormwater system to equalize the flooding within the study area and to provide a more consistent discharge capacity throughout the study area. Under Alternative 1, the proposed construction includes the installation of new 18-inch pipe to connect the existing exfiltration trench system to the east with the existing 15-inch outfall to the west. The proposed construction also includes the installation of 18-inch pipe along SE 22nd Avenue to interconnect the existing outfalls. Alternative 1 includes the installation of approximately 2,400 linear feet of 18-inch RCP. The estimated design and construction costs for this new gravity pipe alternative are approximately $1,133,000.

Alternative 2: Exfiltration Trench

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 2, the proposed construction includes a total of 5,035 LF of exfiltration trench. SE 9th Street has lower ground surface elevations which can cause additional exfiltration trench to be ineffective. Therefore, the proposed exfiltration trench under Alternative 2 is located outside of the study area along SE 10th Street, SE 10th Court, SE 11th Street and SE 12th Street. The installation of these additional exfiltration systems will help intercept stormwater runoff before it reaches SE 9th Street and help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $2,063,000.

Alternative 3: Pump Station

The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. The proposed construction under Alternative 3 includes the installation of one pump station at the western end of SE 9th Street, the installation of a new 18-inch discharge pipe from the pump station to the west along SE 21st Terrace into the outfall and new flap gates at the outfalls. The estimated design and construction costs for this pump station alternative are approximately $1,515,000.

Alternative Comparison

Refer to the Table 21-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, all system improvement alternatives provide limited flood control benefits to the study area. Alternative 1 is slightly more effective at reducing the expected flood duration within the study area and is the only option which addresses the flooding

within the eastern portion of SE 9th Street. Although Alternative 1 will not completely eliminate the flooding along SE 9th Street, it will reduce the duration of flooding along SE 9th Street. Additional local improvements which provide additional storage volume for stormwater runoff should be considered along SE 9th Street, such as regraded swales or subsurface soil storage.

Table 21-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.04	22.7	$1,133,000
Alternative 2	0.00	0	$2,063,000
Alternative 3	0.15	0	$1,515,000

Recommended Alternative

CMA recommends Alternative 1 which includes the installation of drainage pipe which will interconnect the existing closed exfiltration system on the eastern end of SE 9th Street with the existing 15-inch outfall at the western end of SE 9th Street. The proposed construction will allow the existing outfall to draw down the flooding within the lower eastern portion of SE 9th Street, which is hydraulically isolated under the existing conditions. Due to the very low ground surface elevations along SE 9th Street, backflow prevention devices will also need to be installed on the existing outfall to reduce the impact of high tide on flooding. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff. The estimated design and construction costs for this recommended alternative are approximately $377,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 21-1 below and a preliminary cost estimate summarized Table 21-2 at the end of this section.

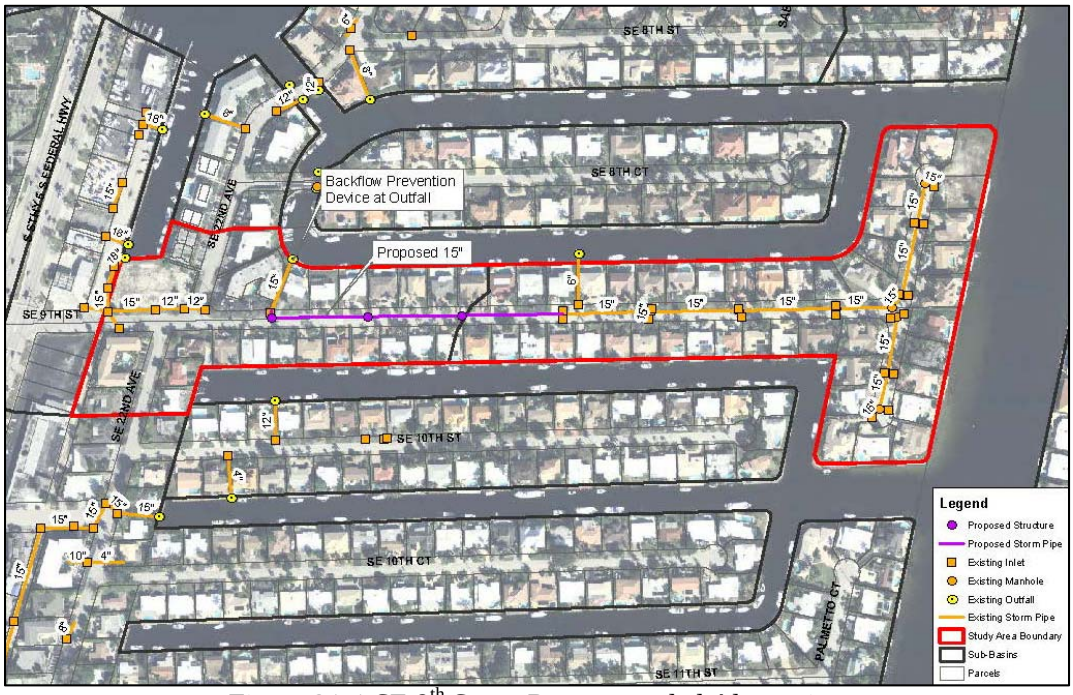

Figure 21-1 SE 9th Street Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will enhance the water quality of the stormwater discharge into the canal since some of the stormwater runoff would be diverted into the new swale areas, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed swale areas into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge over the existing conditions since some of the stormwater runoff would be diverted into the new swale areas, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, SE 9th Street study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 21-2 SE 9th Street Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3	Recommended Alternative
Replace Existing Drainage Structure	$35,000	-	$15,000	$10,000
Install Drainage Structure	$9,000	$243,000	-	$13,500
Upgrade Existing Outfall	-	-	$5,000	-
15" RCP Drainage Pipe	-	-	-	$40,000
18" RCP Drainage Pipe	$156,000	-	$63,750	-
18" RCP Drainage Pipe with Exfiltration	-	$604,200	-	-
18" DIP Pressure Pipe	-	-	$33,475	-
12" Backflow prevention devices at outfall	$40,000	-	-	-
15" Backflow prevention devices at outfall	$80,000	-	-	$40,000
18" Backflow prevention devices at outfall	-	-	$90,000	-
30" Backflow prevention devices at outfall	$55,000	-	-	-
Wet Well & Pump Station	-	-	$600,000	-
Swale Regrading	$126,000	-	$126,000	$63,000
Pavement Restoration	$234,667	$492,311	$50,356	$78,222
Subtotal	$735,667	$1,339,511	$983,581	$244,722
Mobilization (10%)	$73,567	$133,951	$98,358	$24,472
Construction Contingency (20%)	$161,847	$294,692	$216,388	$53,839
Design and Permitting (15%)	$121,385	$221,019	$162,291	$40,379
Construction Administration (5%)	$40,462	$73,673	$54,097	$13,460
TOTAL COST	**$1,132,927**	**$2,062,847**	**$1,514,714**	**$376,872**

22 NW 16TH LANE

This study area is an isolated right-of-way area with heavy flooding problem just north of Copans Road between Powerline Road and Andrews Avenue. This study area mainly consists of industrial and commercial properties with only one City roadway (NW 16th Lane) with significant impervious ground coverage, which can limit the infiltration of stormwater runoff into the ground surface. As shown in the City Stormwater Atlas, there is existing drainage facilities located along NW 16th Lane according to City staff, which does not provide adequate flood protection to the right of way areas based on past observations during rainfall events. According to the model results, the majority of NW 16th Lane displays flooding greater than two inches. Due to the lower ground surface elevations relative to the surrounding areas, NW 16th Lane has collects stormwater runoff which flows from surrounding private property.

Recommended Alternative: Exfiltration Trench

The system improvement alternative that was investigated for this study area consists of replacing the existing drainage infrastructure along NW 16th Lane with new additional exfiltration trench. The installation of gravity drainage wells is not an option due to the lack of brackish groundwater at the bottom of the surficial aquifer below the TOC Area since the boundary of this brackish groundwater is located just east of Dixie Highway. Dry retention areas were not considered an option due to the limited amount of right-of-way in this study area. The installation of a pump station was not a feasible option for this study area and was not considered during the analysis of potential alternatives.

The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 910 LF of exfiltration trench along NW 16th Lane. The installation of new exfiltration systems within the study area will help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $436,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 22-1 below and a preliminary cost estimate summarized in Table 22-1 at the end of this section.

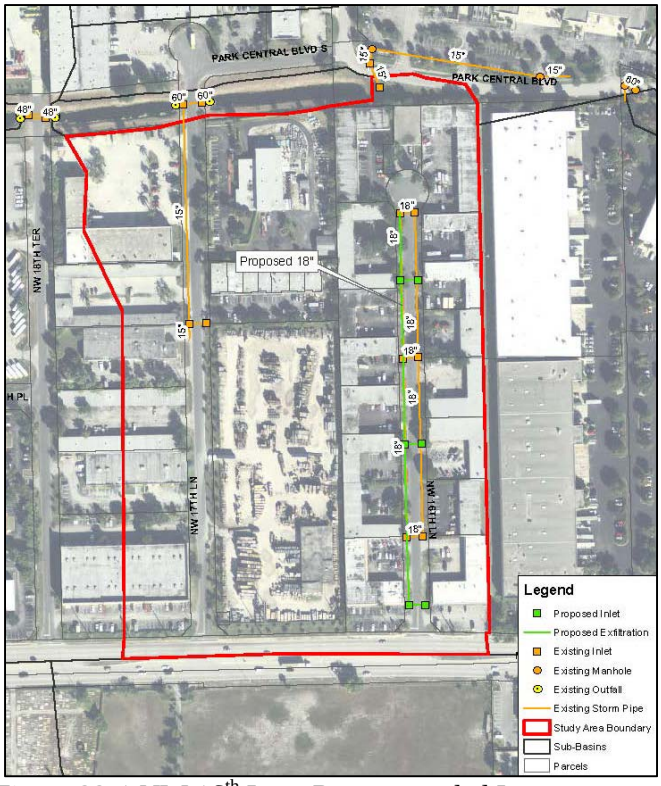

Figure 22-1 NW 16th Lane Recommended Improvements

Environmental Effects

Physical

- Surface Water: This alternative will not have an impact on the surface waters, since the existing or proposed improvements do not directly connect to any surface water body.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed exfiltration trench into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative does not have an impact to the aquatic feature, since the existing or proposed improvements do not directly connect to any surface water body.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, NW 16th Lane study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 22-1 NW 16th Lane Highway Preliminary Cost Comparison

Item	**Recommended Alternative**
Replace Existing Drainage Structure	$15,000
Remove Existing Pipe	$16,000
Install Catch Basin	$27,000
15" RCP Drainage Pipe	$5,750
18" RCP Drainage Pipe with Exfiltration	$109,200
Swale Regrading	$21,233
Pavement Restoration	$88,978
Subtotal	$283,161
Mobilization (10%)	$28,316
Construction Contingency (20%)	$62,295
Design and Permitting (15%)	$46,722
Construction Administration (5%)	$15,574
TOTAL COST	**$436,068**

23 NW 7TH TERRACE

This study area is an isolated section of right-of-way along NW 7th Terrace and NW 7th Lane immediately east of I-95. This study area mainly consists of single family residential properties. The public right-of-way area for NW 7th Terrace and NW 7th Lane has an existing stormwater system which ranges from 15 inch to 24 inch pipe and discharges into a stormwater retention pond at north side of the study area. According to the topography, the north side of the study area has a much lower elevation than the south side. According to the model results, both NW 7th Terrace and NW 7th Lane display flooding towards the north side of the study area. The installation of drainage wells and stormwater pumps stations were not feasible options for this study area are were not considered during the analysis of alternatives. The system improvement alternatives that were investigated for this study area consist of expanding exfiltration trench system along NW 7th Terrace and NW 7th Lane and expanding the existing retention area.

Alternative 1: Exfiltration Trench

The stormwater model was used to conduct a simulation of the installation of additional exfiltration trench along NW 7th Terrace and NW 7th Lane within the study area. The purpose of this system improvement alternative is to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 2,165 LF of exfiltration trench, which will be interconnected with the existing drainage system. The installation of additional exfiltration systems within the study area will help draw down any flooding after rainfall events. The estimated design and construction costs for this exfiltration trench alternative are approximately $828,000.

Alternative 2: Expand Retention Area

The purpose of this system improvement alternative is to provide additional storage to alleviate the existing flooding issues quicker. Under Alternative 2, the proposed construction includes a total of 0.34 AC of additional retention area, which is interconnected with the existing drainage system. The estimated design and construction costs for this retention alternative are approximately $93,000.

Alternative Comparison

Refer to Table 23-1 below for a comparison of the various system improvement alternatives for this study area. Alternative 1 does not provide enough additional flood protection to meet the level of service criteria for public roadways within this study area. Due to the presence of existing stormwater pipe along with other underground utilities within the right-of-way, the installation of parallel exfiltration trench within the right of way would be difficult to implement due to likely conflicts with other underground utilities. Under Alternative 2, the expansion of the existing retention area will provide some additional benefits which will alleviate the existing flooding problems within the study area. Alternative 2 should be implemented to provide additional flood control benefits to the right of way areas of NW 7 Terrace and NW 7th Lane.

Table 23-1 – Alternative Comparison

Alternative	Peak Flood Stage Reduction (feet)	Flood Duration Reduction (hours)	Implementation Costs ($)
Alternative 1	0.18	3.9	$828,000
Alternative 2	0.14	0	$93,000

Recommended Alternative

CMA recommends Alternative 2, the expansion of the existing retention area in the northwest corner of the study area, which will provide additional storage capacity for stormwater runoff. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 23-1 below and a preliminary cost estimate summarized in Table 23-2 at the end of this section.

Figure 23-1 NW 7th Terrace Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will not have an impact on the surface waters, since the existing or proposed improvements do not directly connect to any surface water body.
- Groundwater: This alternative will allow more stormwater runoff to infiltrate via the proposed expanded retention area into the groundwater, which will enhance the recharging of the aquifer in the area.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative does not have an impact to the aquatic feature, since the existing or proposed improvements do not directly connect to any surface water body.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

Table 23-2 NW 7th Terrace Preliminary Cost Comparison

Item	Alternative 1	Alternative 2 (Recommended)
Install Catch Basin	$66,000	-
18" RCP Drainage Pipe with Exfiltration	$259,800	-
Soil Removal & Expand Retention Area	-	$50,000
Sod Restoration of Retention Area	-	$10,400
Pavement Restoration	$211,689	-
Subtotal	$537,489	$60,400
Mobilization (10%)	$53,749	$6,040
Construction Contingency (20%)	$118,248	$13,288
Design and Permitting (15%)	$88,686	$9,966
Construction Administration (5%)	$29,562	$3,322
TOTAL COST	**$827,733**	**$93,016**

24 SE 15TH AVENUE

This study area is a single family residential neighborhood located immediately south of East Atlantic Boulevard along SE 15th Street. The existing drainage system within the study consists of a small pipe network that collects stormwater runoff along SE 15th Avenue between SE 2nd Street and SE 3rd Street and discharges via an existing 18-inch outfall pipe between SE 14th Avenue and SE 15th Avenue into a tidal canal. According to the topography, stormwater runoff typically flows south along SE 15th Avenue from a higher elevation toward SE 3rd Street, which has the lowest elevation in the study area. The roadways on the southern portion of the study area, specifically along SE 3rd Street, display an expected flooding depth between 0.5 and 1.0 feet. Alternatives analyzed for this project area included exfiltration trenches and a pump station. Drainage wells were not analyzed due to the elevations and minimum head available within the low lying problem areas along SE 3rd Street. The construction of new dry retention areas were also not analyzed due to the lack of available property within this study area.

Alternative 1: Exfiltration Trench

The stormwater model was used to conduct several simulations of the installation of proposed exfiltration trench within the study area, which are not currently served by an existing stormwater system on the north side where the ground elevation is greater than +5.0 feet NAVD. The purpose of this system improvement alternative is to intercept stormwater runoff before it flows south toward the problem areas and to provide additional storage and infiltration capacity to alleviate the existing flooding issues quicker. Under Alternative 1, the proposed construction includes a total of 1,120 LF of exfiltration trench along SE 1st Street and SE 15th Avenue. The estimated design and construction costs for this exfiltration trench alternative are approximately $556,000.

Alternative 2: Pump Station

The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker, especially within the low lying areas along SE 3rd Street. The proposed construction under Alternative 2 includes the installation of one pump station near the existing outfall from SE 3rd Street, a 30-inch discharge pipe and a flap gate at the point of discharge. The estimated design and construction costs for this pump station alternative are approximately $1,295,000.

Alternative 3: Pipe Size Upgrades

The purpose of this system improvement alternative is to increase conveyance capacity of the stormwater management system to alleviate the existing flooding issues quicker. Alternative 3 includes the replacement of the existing outfall pipes from SE 3rd Street, which discharge into the adjacent drainage canal with larger diameter pipe. Under Alternative 3, the existing 12-inch and 15-inch pipe will all be replaced with 24-inch pipe, which includes a total pipe replacement of 480 linear feet. The estimated design and construction costs for this pipe size upgrades alternative are approximately $394,000.

Alternative Comparison

Refer to Table 24-1 below for a comparison of the various system improvement alternatives for this study area. Based on our analysis with the stormwater model, none of the system improvement alternatives provide significant flood control benefits to the study area. Alternative 3 should be implemented for this study area since it reduces the peak flood stage and flood duration more than the other alternatives.

Table 24-1 – Alternative Comparison			
Alternative	**Peak Flood Stage Reduction (feet)**	**Flood Duration Reduction (hours)**	**Implementation Costs ($)**
Alternative 1	0.03	0.3	$556,000
Alternative 2	0.09	1.3	$1,295,000
Alternative 3	0.09	1.4	$394,000

Recommended Alternative

CMA recommends the replacement of existing outfall pipes with larger diameter pipe, which will increase the discharge capacity into the adjacent canal during heavy rainfall events. The recommended stormwater improvements for this study area include the replacement of the existing outfall pipes from SE 3rd Street, which discharge into the adjacent drainage canal with larger diameter pipe. The swale areas should also be regraded throughout the study area to provide additional storage volume for stormwater runoff for flooding attenuation and water quality treatment purposes. The estimated design and construction costs for this recommended alternative are approximately $394,000. For the recommended stormwater improvements for this study area, CMA has prepared a conceptual layout displayed in Figure 24-1 below and a preliminary cost estimate summarized in Table 24-2 at the end of this section.

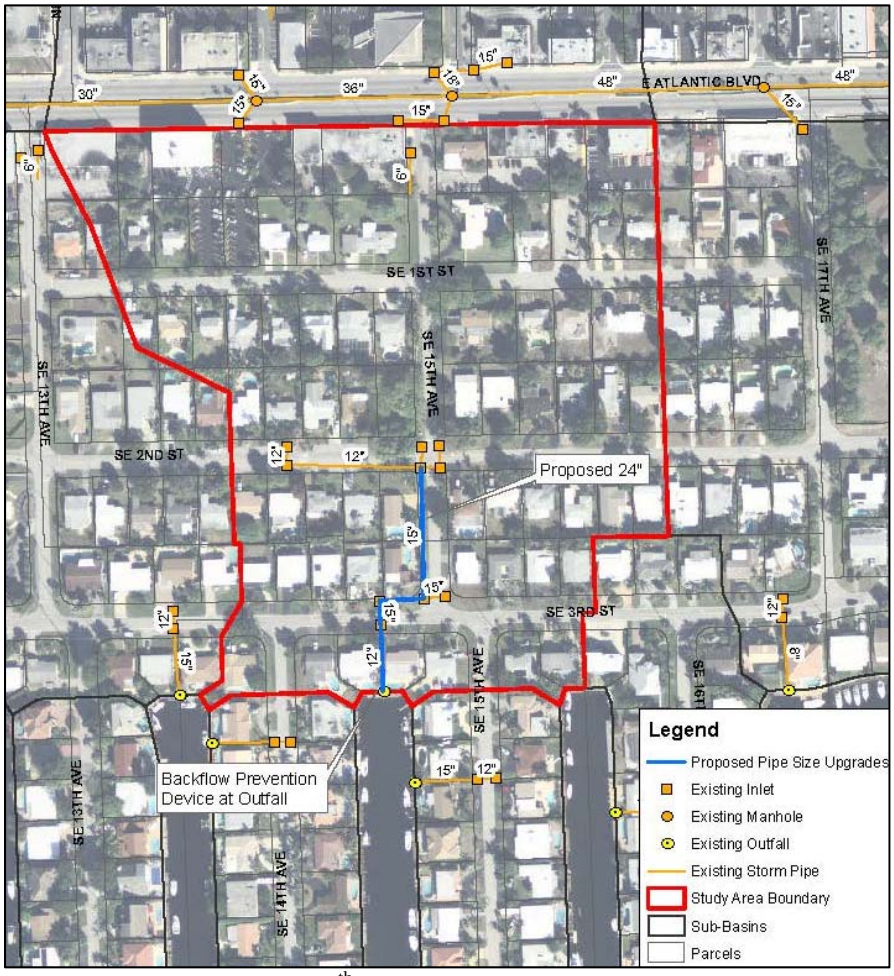

Figure 24-1 SE 15th Avenue Recommended Alternative

Environmental Effects

Physical

- Surface Water: This alternative will enhance water quality of stormwater discharge into the canal since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Groundwater: This alternative will not have an impact on the ground water.
- Air Quality: This alternative does not have an impact on air quality since there will not be any permanent equipment which generates any air pollution.
- Noise: This alternative does not have an impact on noise since there will not be any permanent mechanical equipment which generates any noise.
- Flood Plains: This alternative will provide additional flood protection within the service area of the proposed stormwater improvements, which will reduce the peak flood stage within the study area during and after rainfall events.
- Wetlands: This alternative does not have an adverse impact on any existing wetlands or undisturbed natural areas since all construction will occur in existing roadway areas within the public right of way.

Biological

- Aquatic: This alternative will enhance the water quality of stormwater discharge over the existing conditions since the proposed stormwater improvements will need to meet current regulatory requirements for implementation, which will result in a net improvement within the receiving waters.
- Terrestrial: This alternative does not have an adverse impact on any flora, fauna, threatened or endangered plant or animal species in the areas surrounding this study area since all construction will occur in existing roadway areas within the public right of way.

Socio-economic

- Economy: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the potential for future flood insurance claims from residential properties surrounding the study area.
- Land Use: This alternative does not impact the existing land use since all construction will occur in existing roadway areas within the public right of way.
- Public Health: This alternative will reduce the extent of flooding issues during heavy rainfall events which will reduce the duration of standing water within the public right-of-way and adjacent private properties. This alternative will not have an adverse effect on minority or low income communities.
- Transportation: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better accessibility via the public right-of-way to private properties.
- Community Facilities: This alternative does not impact any community facilities since all construction will occur in existing roadway areas within the public right of way.
- Energy: This alternative does not impact any energy consumption in this study area since there will not be any permanent mechanical equipment which consumes energy.

Cultural

- Aesthetics: This alternative will reduce the extent of flooding issues during heavy rainfall events which will allow for better aesthetics during the rainy season within the public right-of-way and adjacent private properties.
- Architectural/Historical: This alternative does not impact any architectural or historical features since all construction will occur in existing roadway areas within the public right of way.

No Action

- If no action is taken in this study area, the SE 15th Avenue study area will continue to face extensive flooding of the right-of-way areas and adjacent private properties during heavy rainfall events. Based on the stormwater model, the existing stormwater management system within the SE 15th Avenue study area does not provide adequate flood protection and does not meet level of service criteria. It is not a feasible option for the City to take no action on this alternative.

Table 24-2 SE 15th Avenue Preliminary Cost Comparison

Item	Alternative 1	Alternative 2	Alternative 3 (Recommended)
Replace Existing Drainage Structure	-	$5,000	$20,000
Removal of Existing Pipe	-	-	$9,600
Install Drainage Structure	$72,000	-	-
Upgrade Existing Outfall	-	$5,000	-
18" RCP Drainage Pipe with Exfiltration	$134,400	-	-
24" RCP Drainage Pipe	-	-	$36,000
30" DIP Pressure Pipe	-	$7,700	-
18" Backflow prevention devices at outfall	$45,000	-	-
24" Backflow prevention devices at outfall	-	-	$50,000
30" Backflow prevention devices at outfall	-	$55,000	-
Wet Well & Pump Station	-	$600,000	-
Swale Regrading	-	$158,667	$93,333
Pavement Restoration	$109,511	$9,778	$46,933
Subtotal	$360,911	$841,144	$255,867
Mobilization (10%)	$36,091	$84,114	$25,587
Construction Contingency (20%)	$79,400	$185,052	$56,291
Design and Permitting (15%)	$59,550	$138,789	$42,218
Construction Administration (5%)	$19,850	$46,263	$14,073
TOTAL COST	**$555,803**	**$1,295,362**	**$394,035**

SECTION B - PUBLIC PARTICIPATION PROCESS

All flooding complaints submitted by the general public to the City were taken into account within this basin prioritization formula. The City maintains a database which tracks all flooding complaints received from the general public, which was provided to CMA for incorporation into the basin prioritization formula. The additional feedback on flooding problems was received from the public during two public outreach events conducted during the development of this Stormwater Master Plan. These public outreach events assisted with gathering input from residents, business owners and stakeholders on any observed flooding within the City limits. The first event was a public outreach meeting held on May 14th 2012, from 4:00pm to 7:00pm. The second public outreach event was held at the City's Health and Financial Wellness Fair on August 8th and August 9th 2012. At these public outreach meetings, residents completed a questionnaire to describe any past flooding that has occurred within their neighborhood. This questionnaire was also available to any residents unable to attend the meetings but wishing to provide feedback to the City on past flooding within their neighborhood. Notices for these meetings were distributed on the City website and through a press release. Copies of these notices are included in Appendix B.

CMA compiled all flooding complaint information and completed questionnaires, which is included in the Complete Stormwater Master Plan, which is included within Appendix C. Through September 11, 2012, the City has received a total of 84 flooding complaints from residents within the database. The location of the drainage complaints that have been recorded by the City are displayed on Figure 2-15 Resident Complaints and FEMA Repetitive Losses within Section 2 of the Stormwater Master Plan Report enclosed as Appendix C. All complaints received through September 11, 2012 are included in this prioritization formula.

The Pompano Beach Stormwater Master Plan was adopted by the City of Pompano Beach on July 9, 2013. In preparation of the adoption of the Stormwater Master Plan, CMA and the Utilities Director meet with each City Commissioner individually to present the Stormwater Master Plan and each recommended alternative. On July 9th 2013, CMA prepared a presentation for the public during the commission meeting which presented the overall results of the Stormwater Master Plan and the recommended alternative for each study area.

SECTION C - FINANCIAL FEASIBILITY

The City of Pompano Beach has developed a plan to fund the proposed stormwater CIP improvements recommended within this Stormwater Master Plan along with the additional manpower and equipment needed to adequately operate and maintain the stormwater management system. The City is in the process of adopting an increase in the Stormwater Utility Fee in order to accomplish the goals defined within the Stormwater Master Plan. The stormwater management program was created by City Ordinance 97-78 on July 22, 1997 to implement the functional requirements of the stormwater management system and imposes a Stormwater Utility Fee. The City established the Stormwater Utility Fee to provide a dedicated funding source to address the City's stormwater management needs. The funding from this Stormwater Utility Fee is utilized to maintain the City's existing stormwater management system and to construct stormwater improvements to address flooding issues. These fees provide annual revenues to the enterprise fund for the stormwater management program.

The Stormwater Utility Fee is a monthly fee billed to each property within the City. The Stormwater Utility Fee is based on the number of dwelling units or the amount of impervious ground surface depending on the property type. For residential properties, the stormwater utility fee is based on the number and type of dwelling units. For non-residential properties, the stormwater utility fee is based on the amount of impervious ground surface located within the individual parcel. Based on this information, every parcel within the City is assigned a value defined as an Equivalent Residential Unit (ERU). There are currently 67,222 ERUs defined within the City. The Stormwater Utility Fee for each parcel shall be calculated based on the number of ERUs assigned to each property multiplied by the rate per ERU established by the City. The Stormwater Utility Fee was established at $3.00 per ERU per month when the stormwater management program was created by the City ordinance in 1997. The Stormwater Utility Fee has remained unchanged since that time (16 years ago).

In order to implement the recommendations within the adopted Stormwater Master Plan, the Stormwater Utility Fee needs to be adjusted to generate sufficient funding to accomplish the City's goals. CMA worked together with City staff from the Utility Department and Finance Department along with Raftelis Financial Consultants to identify the best option for the adjustment of the Stormwater Utility Fee. The team developed multiple scenarios for adjusting the Stormwater Utility Fee by using various assumptions related to the project construction schedules, funding sources and loan terms. Each set of assumptions was used to generate an adjustment schedule for the minimum Stormwater Utility Fee needed each fiscal year in order to implement the recommendations from the Stormwater Master Plan. The assumptions were refined until the most feasible and realistic options were identified. At this time, the City is proceeding with the best set of conservative assumptions based on currently available data. If these assumptions become inaccurate at some point during the 10 year timeframe, modifications to the implementation schedule could become necessary to ensure adequate funding continues to be available to implement all of the recommendations within the Stormwater Master Plan.

Based on these assumptions, the recommended adjustment schedule for the Stormwater Utility Fee was developed for the purpose of implementing the goals defined within the Stormwater Master Plan within the next 10 years. The recommended adjustment schedule is an annual 7.0% increase in the Stormwater Utility Fee starting in Fiscal Year 2014 and ending in Fiscal Year 2023. These adjusted Stormwater Utility Fees will be in place prior to seeking any type of financing since the marketplace will demand a defined revenue source for any offering via the SRF Program, public revenue bond or bank loan. Once the adjustment schedule for the Stormwater Utility Fee is adopted by the City Commission in September 2013, the City will be able to proceed with obtaining the initial round of funding for implementation of the recommended stormwater improvement projects. The adjustment schedule to the Stormwater Utility Fee is summarized within Table C below.

Table C: Stormwater Utility Fee Recommended Adjustment Schedule	
Fiscal Year	**Monthly Fee per ERU**
Existing	$3.00
FY 2014	$3.21
FY 2015	$3.43
FY 2016	$3.68
FY 2017	$3.93
FY 2018	$4.21
FY 2019	$4.50
FY 2020	$4.82
FY 2021	$5.15
FY 2022	$5.52
FY 2023	$5.90

For comparison purposes, the recommended adjustment schedule for the Stormwater Utility Fee is also displayed within Figure C below with the current average Stormwater Utility Fees for municipalities within the State of Florida, the South Florida region and Broward County. As displayed within Figure C, the proposed stormwater utility would not match the regional averages until later in the 10 year adjustment schedule.

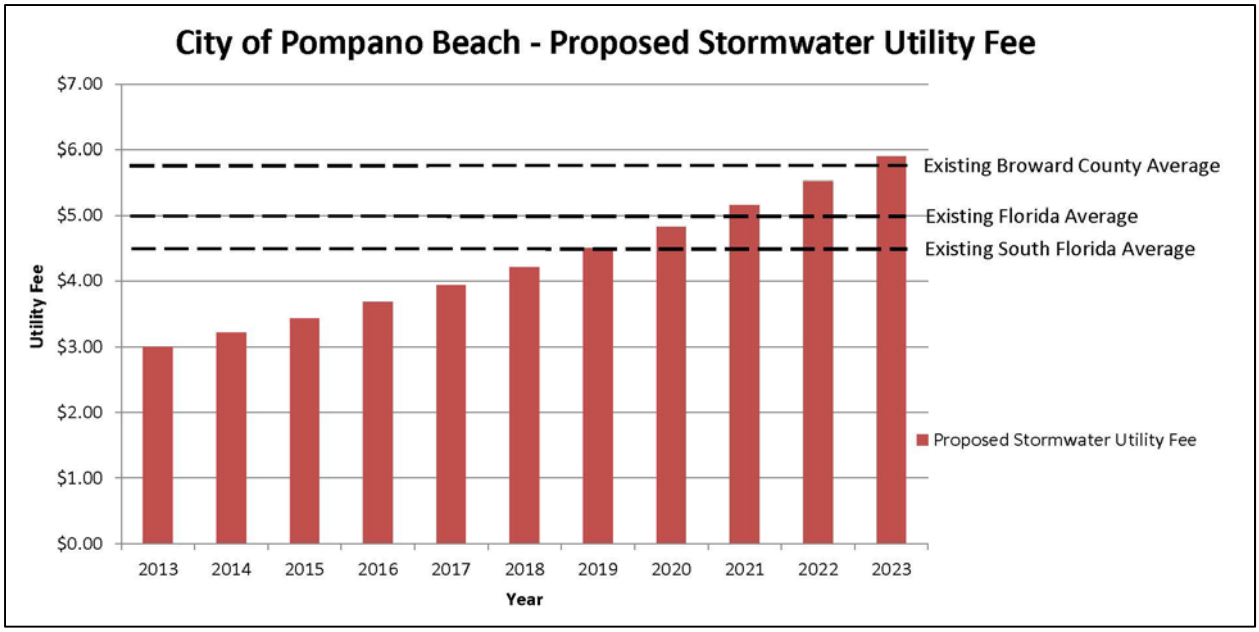

Figure C: Proposed Stormwater Utility Fee

SECTION D - SCHEDULE

The City of Pompano Beach has developed a schedule for the proposed stormwater CIP improvements recommended within this Facility Plan. This schedule includes phases for the design and permitting phase and the bidding and construction phase for each proposed CIP project. The schedule for the these projects is recommended to be implemented over the next 10 years, starting in Fiscal Year 2014 and ending in Fiscal Year 2023. This proposed implementation schedule for each project is presented in Table D and Figure D below.

Table D: Proposed Project Implementation Schedule

No.	Project Name	Design/Permitting	Bidding/Construction
1	Pompano Park Place & Andrews Avenue	FY2014	FY2015
2	Northwest CRA - TOC	FY2014-FY2015	FY2015-FY2023
3	Lyons Park Neighborhood	FY2014-FY2015	FY2016-FY2018
4	Avondale Neighborhood	FY2014	FY2015-FY2016
5	Esquire Lake Neighborhood	FY2014	FY2015-FY2016
6	Gateway Drive	FY2016	FY2017-FY2018
7	Kendall Lake Neighborhood	FY2016	FY2017-FY2018
8	US-1 & NE 14th Street Causeway	FY2018	FY2019
9	NE 4th Street & NE 3rd Street	FY2018	FY2019
10	Dixie Highway & McNab Road	FY2018	FY2019
11	Bay Drive Neighborhood	FY2018	FY2019
12	N Riverside Drive & NE 14th Street Causeway	FY2019	FY2020
13	Atlantic Blvd & South Riverside Drive	FY2019	FY2020-FY2021
14	NE 27th Avenue & NE 16th Street	FY2019	FY2020-FY2021
15	Powerline Road & NW 33rd Street	FY2021	FY2022
16	NW 22nd Street	FY2020	FY2021
17	SE 28th Avenue South of Atlantic Boulevard	FY2021	FY2022
18	NW 22nd Court	FY2021	FY2022
19	NE 10th Street & Dixie Highway	FY2022	FY2023
20	US-1 & SE 15th Street	FY2022	FY2023
21	SE 9th Street	FY2022	FY2023
22	NW 16th Lane	FY2022	FY2023
23	NW 7th Terrace	FY2022	FY2023
24	SE 15th Avenue	FY2022	FY2023

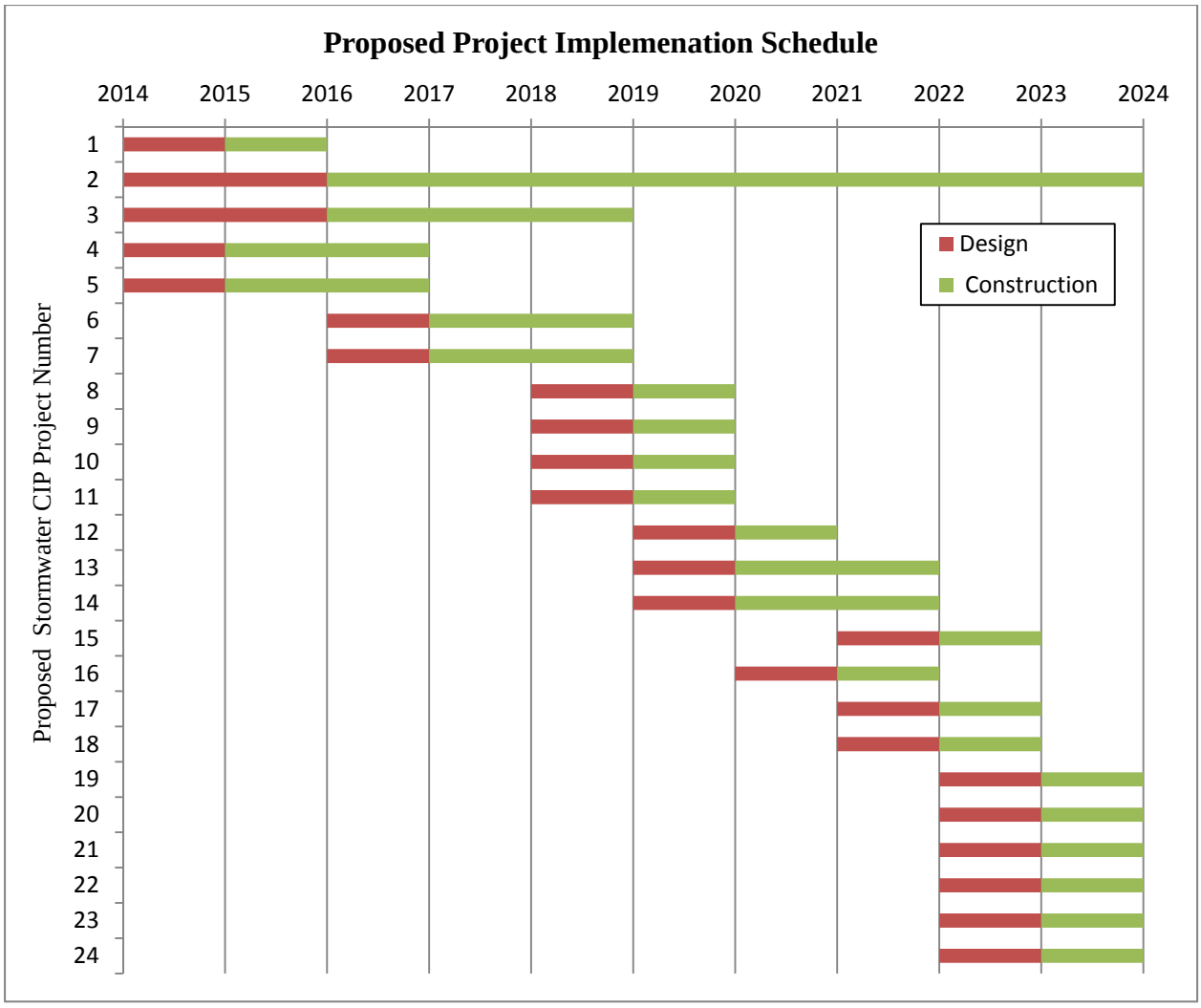

Figure D: Proposed Project Implementation Schedule

SECTION E - ADOPTING RESOLUTION

The City of Pompano Beach passed and adopted the Pompano Beach Stormwater Master Plan on July 9, 2013 at the City of Pompano Beach Commission Meeting. As previously noted, CMA prepared a presentation for the public during the commission meeting which presented the overall results of the Stormwater Master Plan and the recommended alternative for each study area. CMA received a copy of Resolution No. 2013-305, dated July 25th 2013, with the following resolution. A copy of the commission meeting agenda and resolution are included in Appendix A attached to this report.

> RESOLUTION NO. 2013-305
> A RESOLUTION OF THE CITY COMMISSION OF THE CITY OF POMPANO BEACH, FLORIDA, ACCEPTING THE SOTRMWATER MASTER PLAN PREPARED BY CHEN MOORE AND ASSOCIATES PROVIDING A COMPREHENSIVE STUDY PERTINENT TO THE CITY'S DRAINAGE LIMITATIONS AND PROBLEMS; PROVIDING FOR CONFLICTS; PROVIDING AN EFFECTIVE DATE.