CITY OF BONITA SPRINGS
STORMWATER MASTER PLAN UPDATE
Phase II

Prepared for

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1 Executive Summary

This report presents the results of the Phase II Stormwater Master Plan development for the City of Bonita Springs (the City). Phase II of this study addresses the water quality concerns in the basin encompassing the City, particularly the Total Maximum Daily Load (TMDL) for total nitrogen (TN) for the freshwater section of the Imperial River. In accordance with the Identification of Impaired Surface Waters Rule (IWR), the Imperial River has been verified as impaired for dissolved oxygen (DO) by the Florida Department of Environmental Protection (FDEP). The DO impairment of the Imperial River has been shown to be correlated to high TN loadings in the river. This phase of the analysis addresses the TN loading in the freshwater section of the Imperial River and examines the use of Best Management Practices (BMPs) to reduce the TN loading in the Imperial River. These BMP alternatives may be suggested for inclusion in the Basin Management Action Plan (BMAP).

A total of sixteen potential BMP sites were evaluated using the FDEP *Stormwater Applicant's Handbook* and a calibrated HSPF model. Potential sites for BMPs were selected based upon the availability of land, proximity to the receiving water, current land use, lack of structures, and lack of BMPs within the contributing area. Potential BMP locations were primarily selected within areas contributing to the freshwater section of the Imperial River, since BMP implementation in these areas would improve the water quality and reduce impairment in this critical section of the river.

The sixteen BMP projects were scored and ranked using six pre-determined criteria including land availability, site location within the watershed, TN removal efficiency, cost effectiveness, existing land use and BMPs, and public interest and sensitivity. Using this prioritization system, eight of the sixteen potential BMP sites were recommended as part of the City Capital Improvement Projects (CIP) program. Table 1-1, below, shows the priority ranking of each BMP site along with other pertinent information. The location of each BMP site can be seen in Figures 7-1 through 7-17 in Section 7 of this report.

An implementation schedule for the first 5-year cycle is proposed for the recommended BMP projects. As potential BMP sites are identified in the future as feasible for water quality improvement projects, the CIP program can be expanded as needed by the City.

In addition, for the top three ranked BMP projects, up to four alternatives were developed for each location. The alternatives for each BMP project were then compared with respect to effectiveness in providing TN loading reduction, implementation cost, maintenance requirements, permitability, and public acceptance.

In conclusion, this report provides the City with an established point to begin addressing surface water quality concerns within its limits. A strong commitment of resources and staff will be required to participate in the on-going BMAP development process and undertake the implementation of structural BMPs, non-structural BMPs, and other activities in order to meet the established TMDL in the Imperial River.

Table 1-1 Potential BMP Site Summary

Rank	Site ID	Land Ownership	Basin in HSPF Model	TMDL Watershed	Structural BMP Type	Annual TN Loading Reduction (lb/yr)	Preliminary Cost
1	4	City	Leitner Creek	Yes	Wet Detention Pond	458	$130,000
2	5	City/Private	Leitner Creek	Yes	Dry Retention Pond & Baffle Box	2,622	$560,000
3	1	City	Imperial Low	Yes	Dry Retention Pond & Baffle Box	243	$200,000
4	14	City	Imperial Middle	Yes	Baffle Box	43	$75,000
5	6	City	Leitner Creek	Yes	Wet Detention Pond	118	$65,000
6	10	Lee County	Oak Creek	No	Dry Retention Pond & Baffle Box	99	$130,000
7	8	HOA/Utility Corridor	Imperial Middle	Yes	Dry Retention Pond & Baffle Box	152	$180,000
8	2	Private	Imperial Middle	Yes	Dry Retention Pond & Baffle Box	164	$370,000
9	15	City	Leitner Creek	Yes	Dry Retention Pond & Baffle Box	241	$220,000
10	12	Private	Imperial Middle	Yes	Dry Retention Pond	398	$310,000
11	3	FDEP	Imperial Kehl	Yes	Constructed Wetland & Baffle Box	336	$400,000
12	16	Lee County	Imperial Middle	Yes	Dry Retention Pond	81	$120,000
13	7	Private	Imperial Middle	Yes	Wet Detention Pond & Baffle Box	51	$430,000
14	11	Private	Oak Creek	No	Dry Retention Pond & Baffle Box	303	$700,000
15	9	City	Imperial Upper	Yes	Constructed Wetland	40	$120,000
16	13	City	Rosemary Canal	No	Wet Detention Pond & Baffle Box	34	$150,000

1.1 Potential BMPs

This section provides a brief description for each of the structural BMP alternatives that could be utilized to improve water quality and natural systems for the freshwater section of the Imperial River watershed within the City jurisdiction.

1.1.1 Potential BMP Site 1 – Felts Avenue at Ragsdale Street

Potential BMP Site 1 is located in the eastern portion of the Imperial Low HSPF basin, however, it is still considered in the freshwater section of the Imperial River watershed per the FDEP TMDL program. It is represented by six City-owned parcels that are approximately 2 acres in total and bounded by Felts Avenue to the west, Shriver Avenue to the east, Ragsdale Street to the north and Abernathy Street to the south. The contributing area, approximately 49 acres in size, was delineated to the south and southeast of the site. No major water quality BMP, e.g., stormwater ponds, exists in the contributing area. It was assumed that a dry pond could be as deep as 2 ft to provide a 3.1 ac-ft treatment volume. The TN removal efficiency of the dry retention pond at this depth is estimated at 82.15%, which is equal to 243 lb/yr in TN reduction. The preliminary cost is estimated at $200,000 for the proposed BMPs, including both design and construction costs.

1.1.2 Potential BMP Site 2 – Imperial Parkway at Dean Street

Potential BMP Site 2 is located in the center portion of the Imperial Middle HSPF basin, just south of the Imperial River at Imperial Parkway. The site is located on a 5-acre privately-owned parcel at the northwest corner of the intersection of Imperial Parkway and Dean Street. The site consists of 1.6-acres of open land at the southeast corner of the parcel. This site is surrounded by densely populated residential areas. The contributing area is approximately 38 acres in size and extends to the south and southwest of the site. No water quality BMP exists in the contributing area. It is assumed that a dry pond could be dredged as deep as 2 ft in order to provide a 2.1 ac-ft treatment volume. The TN removal efficiency is then estimated at 86.85%, per FDEP Handbook method. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide 19% of TN removal efficiency alone. These BMPs result in an estimated 164 lb/yr of TN removal. The preliminary cost is estimated at $370,000, which covers design and construction fees as well as a land acquisition cost of $150,000.

1.1.3 Potential BMP Site 3 – Bonita Grande Drive at Kehl Canal

Potential BMP Site 3 is located in the western portion of the Imperial Kehl HSPF basin, just north of the Kehl Canal at Bonita Grande Drive. The site contains 2.9-acres of open land in the FDEP-owned parcel (9 acres in size). The SFWMD Kehl Canal control structure is located at the south end of the same parcel. The contributing area is approximately 1,500 acres in size and extends to the north of the site. The majority of the contributing area is within the City limits, which is dominated by mining, agriculture lands and wetlands. It is assumed that the constructed wetland could have a 2 ft difference between the control elevation and normal pool in order to provide a 4 ac-ft treatment volume. TN removal efficiency of the constructed wetland is then estimated at 3.57%. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment and will provide 3.8% of TN removal efficiency. These BMPs result in an estimated 336 lb/yr of TN removal. The preliminary cost is estimated at $400,000, which includes both design and construction fees.

1.1.4 Potential BMP Site 4 – Leitner Creek – Bypass Canal

Potential BMP Site 4 is located in the southern portion of the Imperial Kehl HSPF basin, about ¼ mile south of the Imperial Parkway at Leitner Creek. The site is within the City-owned ROW of the Leitner Creek Bypass Canal, which is about 1,250 ft in length and 50 ft in width. Based on the 2010 aerial imagery and 2004 land use map, this site and the Bypass Canal are surrounded by densely populated residential areas. The contributing area to the north is approximately 1,624 acres in size. The majority of the contributing area is dominated by agriculture and residential areas. It is assumed that the weir structure will raise the upstream water level by 2 ft and hence provide a 3.27 ac-ft treatment volume. The TN removal efficiency of this structural BMP is estimated at 4.77%, which is equivalent to 458 lb/yr of annual TN removal. The preliminary cost is estimated at $130,000, which includes both design and construction fees.

1.1.5 Potential BMP Site 5 – E. Terry Street at Leitner Creek - North

Potential BMP Site 5 is located in the southern portion of the HSPF basin Leitner Creek, located north of E. Terry Street at Leitner Creek. As part of the two City-owned parcels totaling 16.5-acre in size, the site contains a 12-acre open land curbed by the Leitner Creek to the southeast. This open land is surrounded by densely populated residential areas. Prior to a land acquisition by the City in 2001 for a roadway project, a mobile home park was located on the eastern half of the site. It was assumed that a dry pond could be dredged as deep as 2 ft to provide a 17.3 ac-ft treatment volume. The TN removal efficiency is then estimated at 21.24%. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, which will provide 9.5% of TN removal efficiency. These BMPs result in an estimated 2622 lb/yr of TN removal. The preliminary cost is estimated at $560,000, which covers design and construction fees as well as a drainage easement cost of $75,000.

1.1.6 Potential BMP Site 6 – Leitner Creek – Old Course

Potential BMP Site 6 is located in the southern portion of the Leitner Creek HSPF basin, and encompasses the old course of Leitner Creek which has been re-routed by the new Bypass Canal to the east. The site is a 1.55-acre ROW owned by the City, about 1,350 ft in length and 50 ft in width. This site is surrounded by densely populated residential areas and the contributing area is approximately 34 acres in size. Multiple ditch blocks are recommended to be constructed at various locations in the old course to create additional storage volume for water quality treatment. It is assumed that the ditch blocks will create a series of wet detention ponds with 2 ft depth and hence provide a 2.2 ac-ft treatment volume in total. The TN removal efficiency of this structural BMP is estimated at 30.8%, which is equivalent to 118 lb/yr of annual TN removal. The preliminary cost is estimated at $65,000, which includes both design and construction fees.

1.1.7 Potential BMP Site 7 – E. Terry Street at Morton Avenue

Potential BMP Site 7 is located in the northern portion of the Imperial Middle HSPF basin. The site is comprised of five privately-owned parcels approximately 1.2 acres in size located at the northwest corner of the intersection of E. Terry Street and Morton Avenue. This site is surrounded by densely populated residential areas to the north and east and transportation system to the west and south. The contributing area is approximately 38 acres in size was delineated to the north of the site, and is dominated by residential areas. It is assumed that the wet pond could have a 2 ft difference between the control elevation and normal pool in order to provide a 1.5 ac-ft treatment volume. The TN removal efficiency is estimated at 35.76%. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide an extra 19% in TN removal efficiency. These BMPs result in an estimated 51 lb/yr of TN removal. The preliminary cost is estimated at $430,000, which covers design and construction fees as well as a land acquisition cost of $165,000.

1.1.8 Potential BMP Site 8 – FPL Corridor near Imperial River

Potential BMP Site 8 is located in the center portion of the Imperial Middle HSPF basin, just north of the Imperial River in the Florida Power & Line Company (FPL) corridor. The site is identified as the ROW of the Imperial Bonita Estates Home Owner Association (HOA). Per City staff, the HOA is responsible for the roadway and drainage system operation and maintenance within their corporation limits. The site is a 1.8-acre open land at the southeast corner of the HOA RO. This site is surrounded by densely populated residential areas, and the contributing area of approximately 24 acres in size was delineated to the north of the site. No water quality BMP exists in the contributing area. It is assumed that the dry pond could be dredged as deep as 2 ft in order to provide a 1.5 ac-ft treatment volume. The TN removal efficiency is then estimated at 77.55%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide an extra 19% in TN removal efficiency. These BMPs result in an estimated 152 lb/yr of TN removal. The preliminary cost is estimated at $180,000, which covers design and construction fees as well as a drainage easement fee of $25,000.

1.1.9 Potential BMP Site 9 – Kent Road at Imperial River

Potential BMP Site 9 is located in the center portion of the Imperial Upper HSPF basin, north of Kehl Canal and east of I-75. The 19.5-ac site encompasses a City-owned ROW of the old course of the Imperial River and an 18.6-ac parcel that was granted by SFWMD in 2009. The site is bounded by Kehl Canal to the south and another City-owned parcel (a.k.a., Bonita Nature Place) to the north, a Lee County-owned parcel to the east, and a FDEP-owned parcel to the west. This site is surrounded by wetlands to the east, west and north and a major canal (Kehl Canal) to the south. The contributing area of approximately 163 acres in size was delineated to the north of the site, and contains a stormwater pond at the Youth Organization Recreational Center located at the southwest corner of E. Terry Street and Kent Road. It is assumed that the weir structure will raise the upstream water level to 10 ft-NGVD and hence provide a 2.05 ac-ft treatment volume for water quality improvement. The TN removal efficiency of this structural BMP is estimated at 14.82%, which is equivalent to 40 lb/yr of annual TN removal. The preliminary cost is estimated at $120,000, which covers both design and construction fees.

1.1.10 Potential BMP Site 10 – Imperial Parkway at Meadow Lane

Potential BMP Site 10 is located in the center portion of the Oak Creek HSPF basin, where a FDEP TMDL program has not been currently established. The site encompasses part of the County-owned ROW of Imperial Parkway, located just south of Oak Creek, as well as two County-owned parcels (0.5 acre in size) located east of Imperial Parkway between Meadow Lane and Sunray Drive. This site is surrounded by densely populated residential areas, and the contributing area, approximately 37 acres in size, was delineated to the east of the site. It is assumed that the dry pond could only be dredged as deep as 1 foot in to provide a 0.31 ac-ft treatment volume. The TN removal efficiency is then estimated at 24.31%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide an extra 19% in TN removal efficiency. These BMPs result in an estimated 99 lb/yr of TN removal. The preliminary cost is estimated at $130,000, which covers both design and construction fees.

1.1.11 Potential BMP Site 11 – Bonita Beach Road at Oak Creek

Potential BMP Site 11 is located in the center portion of the Oak Creek HSPF basin, where a FDEP TMDL program has not been currently established. The site encompasses part of the City-owned ROW of Matheson Avenue as well as one privately-owned parcel (2.2 acre in size), both located between Oak Creek and Bonita Beach Road. This site is surrounded by densely populated residential areas. The contributing area, approximately 97 acres in size, was delineated to the north of the site. It is assumed that the dry pond could be dredged as deep as 2 ft to provide a 1.8 ac-ft treatment volume. The TN removal efficiency is estimated at 30.1%. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide an extra 19% in TN removal efficiency. These BMPs result in an estimated 303 lb/yr of TN removal. The preliminary cost is estimated at $700,000, which covers design and construction fees, as well as a land acquisition cost of $500,000.

1.1.12 Potential BMP Site 12 – Imperial Parkway at Imperial River

Potential BMP Site 12 is located in the center portion of the Imperial Middle HSPF basin, just north of the Imperial River at Imperial Parkway. The site is represented by a 4.3-acre privately-owned parcel. This site is surrounded by densely populated residential areas. The contributing area of approximately 92 acres in size was delineated to the north the site. It is assumed that the dry pond could be dredged as deep as 2 ft in order to provide a 4.4 ac-ft treatment volume. The dry pond will be linked with the existing drainage system of the Imperial Parkway. The TN removal efficiency is estimated at 78.4%, which is equivalent to 398 lb/yr of annual TN removal. The preliminary cost is estimated at $310,000, which covers design and construction fees as well as a land acquisition cost of $150,000.

1.1.13 Potential BMP Site 13 – W. Terry Street Palm Street

Potential BMP Site 13 is located in the southern portion of the Rosemary Canal HSPF basin, where a FDEP TMDL program has not been currently established. The site is a 0.5-acre City-owned open land located at the northwest corner of W. Terry Street and Palm Street. This site is surrounded by densely populated residential areas. The contributing area of approximately 10.7 acres in size was delineated to the north of the site. It is assumed that the wet pond could have a 2 ft difference between the control elevation and normal pool in order to provide a 0.6 ac-ft treatment volume. TN removal efficiency of the wet detention pond is estimated at 34.17%. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment and will provide an extra 19% in TN removal efficiency. These BMPs result in an estimated 34 lb/yr of TN removal. The preliminary cost is estimated at $150,000, which includes both design and construction fees.

1.1.14 Potential BMP Site 14 – Murat Circle at Imperial River

Potential BMP Site 14 is located in the center portion of the Imperial Middle HSPF basin, about 1/2 mile downstream of the Imperial River bridge at Imperial Parkway. The site is located in the north end of the City-owned ROW of Murat Circle, adjacent to the Imperial River. This site is surrounded by densely populated residential areas. The contributing area, approximately 47 acres in size, was delineated to the south of the site. A Suntree Baffle Box could be incorporated into the existing drainage system at this location. The Baffle Box will have a 19% TN removal efficiency, which is equivalent to 43 lb/yr of annual TN removal. The preliminary cost is estimated at $75,000, which covers both design and construction fees.

1.1.15 Potential BMP Site 15 – E. Terry Street at Leitner Creek - South

Potential BMP Site 15 is located in the southern portion of the Leitner Creek HSPF basin, located north of E. Terry Street at Leitner Creek. As part of the two City-owned parcels totaling 16.5-acre in size, the site contains a 2.5-acre open land curbed by Leitner Creek to the northwest. This open land is surrounded by densely populated residential areas, and was a mobile home park prior to 2001. The contributing area to the east is approximately 31 acres in size. Assuming that the dry pond could be dredged as deep as 2 ft to provide a 3.8 ac-ft treatment volume, the TN removal efficiency is estimated at 85%. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, which will provide extra 19% in TN removal efficiency. These BMPs result in an estimated 241 lb/yr of TN removal. The preliminary cost is estimated at $220,000, which covers both design and construction fees.

1.1.16 Potential BMP Site 16 – Dean Street at Imperial River

Potential BMP Site 16 is located in the center portion of the Imperial Middle HSPF basin, about 1/3 mile upstream the Imperial River bridge at Imperial Parkway. The site is represented by two County-owned parcels approximately 2.4-acre in size, located at the east end of Dean Street and immediate south of the Imperial River. This site is surrounded by commercial and residential areas. The contributing area of approximately 18 acres in size was delineated to the north of the site. About half of the contributing area is a high density residential area without any water quality BMPs. It is assumed that the dry pond could be dredged as deep as 1.5 ft in order to provide a 0.96 ac-ft treatment volume. The TN removal efficiency is estimated at 83.5%, which is equivalent to 81 lb/yr of annual TN removal. The preliminary cost is estimated at $120,000, which covers both design and construction fees.

2 Introduction

2.1 Background

In March of 2010, INTERA, Inc. (INTERA) and its sub-consultant Engineering & Applied Science, Inc. (EAS) were authorized by the City of Bonita Springs, FL (City) to prepare an update of the existing Stormwater Master Plan. This resulted in the City of Bonita Springs Stormwater Master Plan Update Phase I (INTERA, 2010). Phase I of the Master Plan update included an evaluation of water quantity alternative simulations in flood-prone areas, however did not address water quality issues within the City. In February 2011, the water quality component of the Stormwater Master Plan (Phase II) began and included the following tasks:

- Water Quality Data Collection and Assessment
- Basin Assessment and Model Conceptualization
- Model Construction and Calibration
- Simulation of Potential Best Management Practices (BMPs)
- Evaluation and Recommendation of BMPs

Each of these tasks was performed at the direction of the City and the South Florida Water Management District (SFWMD). This report documents the activities that were accomplished to complete these tasks.

2.2 Purpose and Objectives

The purpose of this project is to develop recommendations for a Basin Management Action Plan (BMAP) to address the water quality concerns defined by the Total Maximum Daily Load (TMDL) developed by the Florida Department of Environmental Protection (FDEP). A TMDL was established by the FDEP as a result of documented decreases in dissolved oxygen (DO) in the freshwater section of the Imperial River (FDEP, 2008). The decrease in DO was attributed to an increase in nutrients, namely nitrogen. According to the Identification of Impaired Surface Waters Rule (IWR), the freshwater section of the Imperial River has been verified to be impaired for DO.

A TMDL has been developed for the freshwater section of the Imperial River (Water Body ID 3258E) in order to ensure that the river will meet acceptable water quality standards and maintain its designation as a Class III water. A TMDL is the sum of all point source and non-point source loads plus an allowable margin of safety which accounts for uncertainty. A TN loading reduction of 24.87% was needed in order to ascertain results in DO improvements. This is based on the reduction in TN concentration to 0.74mg/L, which will capture the anthropogenic effects of TN and result in improved DO.

After the adoption of the TMDL in the freshwater section of the Imperial River, a BMAP for its implementation must be developed. Phase II examines various structural and non-structural BMPs that will be incorporated into the on-going BMAP development to address the TMDL mandated by the FDEP for the City of Bonita Springs.

2.3 Section References

Florida Department of Environmental Protection. (2008), *TMDL Report, Dissolved Oxygen for Imperial River, WBID 3258E*. Florida Department of Environmental Protection, South District.

Florida Department of Environmental Protection. (2010), *Stormwater Quality Applicant's Handbook.*

INTERA (2010). *City of Bonita Springs Stormwater Master Plan, Phase I.* Final Report Submitted to the City of Bonita Springs and the South Florida Water Management District.

3 Existing Information

The following information was collected as part of the background study for Phase II of the Stormwater Master Plan (SMP) update. Copies of these documents (where applicable) are included on the enclosed DVD. This compilation of files is included as a source of information and is included on an "as is" basis with no expressed warranty implied.

3.1 Water Quality Reports

"Basin Status Report: Everglades West Coast"
Florida Department of Environmental Protection, November 2001

"Water Quality Assessment Report: Everglades West Coast"
Florida Department of Environmental Protection, September 2003

"Evaluation of Current Stormwater Design Criteria within the State of Florida"
Florida Department of Environmental Protection, June 2007

"TMDL Report: Dissolved Oxygen TMDL for Imperial River, WBID 3258E"
Florida Department of Environmental Protection, August 2008

"Stormwater Quality Applicant's Handbook"
Florida Department of Environmental Protection, March 2010 -Draft

"City of Bonita Springs October 2009 – September 2010 Surface Water Quality Assessment Report"
Johnson Engineering, 2011

3.2 BMAP Meeting Documents

All of the documents presented at the FDEP Basin Management Action Plan (BMAP) meetings was also reviewed and are included on the enclosed DVD. These files contain information regarding TN loading and the five year reduction amounts for the City.

3.3 NPDES Permitting

Runoff from rainfall events is typically transported through Municipal Separate Storm Sewer Systems (MS4s) and eventually discharged into local water bodies. An MS4 is a conveyance system that is owned by a public entity, designed to collect and convey stormwater, not a combined sewer, and not part of a waste water treatment plant. To prevent pollutants that can be harmful to the receiving water body from draining into an MS4, operators must obtain a National Pollution Discharge Elimination System (NPDES) permit and develop a stormwater management program.

The City of Bonita Springs currently holds an NPDES permit (effective May 19, 2003) for MS4 discharge to waters of the state. As a condition of this permit, a storm water management plan (SWMP) must be implemented and include pollution prevention measures, treatment and removal techniques, stormwater monitoring, and other means to control the quality of the stormwater discharged from the MS4 owned and operated by the City.

One such pollution prevention measure enacted by the City is the adoption of City Ordinance No. 08-23, a landscape management ordinance. This ordinance regulates landscape practices including the application and use of fertilizers containing nitrogen and phosphorous and provides for the registration of landscapers and landscape businesses. While this ordinance regulates the use of fertilizer, it does not regulate the sale of fertilizer.

On September 11, 2008, the City submitted a reapplication of the NPDES MS4 permit (FLS000035-003). This permit is expected to be issued in October 2011.

3.4 Existing Water Quality Data Collection Program

In 2006, Johnson Engineering was authorized by the City of Bonita Springs to implement a water quality monitoring program to characterize water quality of the surface water entering the City of Bonita Springs and within the City of Bonita Springs. A total of 9 active stations were monitored for water quality from October 2009 through September 2010 for various water quality parameters.

In addition, Johnson Engineering analyzed water quality data for 8 water quality sampling locations monitored by Lee County. Water quality data, for Lee County water quality sampling locations as well as Johnson Engineering water quality sampling locations, was obtained from Johnson Engineering.

4 Existing Facilities

According to the Florida Department of Environmental Protection's (FDEP) September 2010 Basin Management Action Plan meeting, "Pounds reduced will be subtracted from the total allocation for those projects completed January 1, 2000 and later." (FDEP 2010) In essence, this means that projects completed after January 1, 2000 are eligible to receive credit for TMDL pollutant load reduction. The Felts Avenue project is one such project which is currently planned for water quality enhancement to meet TMDL target established for the freshwater section of the Imperial River.

4.1 Felts Ave Water Quality Enhancement

Urban stormwater runoff is directly discharged into the Imperial River via the Felts Avenue outfall swale. This results in increased nitrogen and phosphorous loadings to the Imperial River due to plant material and fertilizers. The planned water quality enhancement project involves the construction of a dry detention area on a 1.2-acre site located at the northeast corner Felts Avenue and Wilson Street in Bonita Springs (Forge Engineering, 2010). Along with the construction of a dry retention area, a baffle box will be installed upstream of the dry retention area in order to reduce detritus and provide the pre-treatment in the proposed treatment train. The second component of the treatment train is a dry retention pond with a total storage depth of 1.5-feet, capable of treating 0.30 inches of runoff for the 36.6 acre contributing area (Agnoli, 2011). When calculated in accordance with the March 2010 Draft DEP Stormwater Handbook for Zone 4, the proposed BMPs in series are expected to achieve a 70% TN removal and a 69% Total Phosphorous (TP) removal (Agnoli, 2011).

4.2 Section References

Agnoli, Barber and Brundage, Inc, (2011). *Felts Avenue Water Quality Enhancement.* Report submitted to the City of Bonita Springs.

FDEP 2010). *Basin Management Action Plan meeting*. FDEP presentation.

Forge Engineering, Inc. (2010). *Felts Avenue Water Quality Project Limited Hydrogeological Evaluation*. Prepared for Agnoli, Barber and Brundage, Inc. Project 135-026.01

5 Water Quality Models

5.1 Overview

The water quality models and methodology utilized for the evaluation of BMPs for the City of Bonita Springs are discussed in this section. Two modeling strategies were selected. The standard design methodology utilizes the FDEP Stormwater Quality Applicant's Handbook (2010). This methodology is accepted from the regulatory agency for the design of stormwater facilities. An alternate method was also selected utilizing a readily available numerical model HSPF. The alternate method is capable of simulating more complex systems and can be used for the evaluation of complex stormwater systems.

Each BMP alternative was evaluated using the methodology described in the FDEP Stormwater Quality Applicant's Handbook (2010), which is the current standard-of-practice in Florida. The FDEP Handbook method has been widely used for many water quality improvement projects since the FDEP and all water management Districts initiated the new statewide stormwater quality rules. This method has been utilized in the BMP design of the Felts Avenue Water Quality Enhancement project for the City of Bonita Springs, which involves a dry retention pond and a baffle box for nutrient removal, including TN and total phosphorus (TP).

In addition to using the FDEP method for water quality analysis, A Hydrologic Simulation Program-FORTRAN (HSPF) model was created to estimate total nitrogen (TN) loadings in the Imperial/Spring watersheds. The model was developed to determine the effectiveness of various Best Management Practices (BMPs) at removing TN to meet TMDL requirements. HSPF was developed by the United States Environmental Protection Agency (USEPA) and has been applied to many TMDL projects around the country. This software was selected because it is a comprehensive program that can simulate both hydrologic/hydraulic and water quality parameters and because it has been proven to be very successful in modeling point and non-point sources of nutrient loadings. It is also well documented, tested, and recognized by the USEPA and United States Geological Society (USGS) as an effective program to model water quality.

The City of Bonita Springs HSPF model was created in order to aid in the development of a Basin Management Action Plan (BMAP) for reducing TN loading to the freshwater section of the Imperial River. With the model calibrated, it was possible to determine areas that are significant sources of TN loadings to the Imperial River. Once these areas were established, different planning options and BMP alterations were modeled to estimate the impacts of each alternative and ensure that the desired water quality improvement goals were achieved.

5.2 HSPF Model

The HSPF model of the City of Bonita Springs was conceptualized and calibrated using the best available data for boundary conditions, flow targets, and water quality targets. The HSPF model is a continuous simulation that represents seasonal wet and dry conditions. The calibration adequately replicated the observed hydrologic and water quality response to observed climatic conditions. The calibrated model was then utilized for the simulation of potential BMPs.

5.2.1 Conceptualization

HSPF simulates runoff quantities based on the Stanford Watershed Model. A continuous record of evapotranspiration and precipitation along with calculated storages and losses to inactive groundwater is utilized in order to calculate the water balance according to the following formula:

$$R = P - ET - IG - \Delta S$$

Where:

R=Runoff
P=Precipitation
ET= Evapotranspiration
IG=Inactive Groundwater
ΔS=Change in Storage

This water balance is calculated for different areas called segments. Segments are areas within each subbasin that have uniform properties such as land use, soil type, and topography. The model uses different input parameters for each segment in order to calculate a particular variable (e.g. flow, sediment, and nutrient concentration) at one point in space, called a node. In HSPF, land segments are broken down into pervious and impervious land (PERLAND and IMPLAND). For pervious land segments, the user must input parameters for infiltration, soil storage, losses to deep groundwater sources, and exponents used in equations that describe the partitioning and migration of water from groundwater flow to surface water flow. The impervious land segments do not use these parameters due to the fact that water is not infiltrating and is controlled by surface water flow processes. Parameters that are needed in both PERLAND and IMPLAND segments include overland flow distance, slope, and Manning’s n. With these variables, travel time for overland flow is calculated.

Streams, lakes, and wetlands are also represented as segments. These segments are called reach/reservoirs (RCHRES) in HSPF. In order to simulate the movement of water in these segments flow tables (FTABLES) must be developed. These tables describe the relationship between runoff and the volume of water stored in the reach.

Once the output for each node is calculated, HSPF utilizes the information stored in the Schematic and Mass-Link blocks to connect different land/reach segments and simulate the movement of runoff and water quality constituents in river channels and storage areas.

5.2.2 Data Sources

Input data for the HSPF model was gathered from several sources. The following sections will discuss key datasets that were used, where they were obtained, and how that data was utilized.

5.2.2.1 Basins

Basins were originally delineated for the City of Bonita Springs Stormwater Master Plan Update Phase I project to determine land areas that contribute flow to stormwater infrastructure. Preliminary high-resolution watersheds were developed using standard raster-based delineation techniques and the ArcGIS Spatial Analyst extension. Digital Elevation Models (DEMs) with 5-foot by 5-foot resolution provided by the South Florida Water Management District (the District or SFWMD) on April 9, 2010 were utilized to develop the watersheds. These watersheds were manually modified to provide a better match to the observed field conditions collected for the City of Bonita Springs Stormwater Master Plan Update Phase I. The final watersheds served as the basins utilized in the ICPR model. The developed ICPR basins were then further generalized to develop 9 basins for use in the HSPF model. Figure 5-1 shows the 9 HSPF basins that were used in the model. These basins were defined so that outlets were created near gauging stations for calibration purposes.

5.2.2.2 Land Use Land Cover

To determine land use area in each basin, the 2004 Florida Land Use and Cover Classification System (FLUCCS) map was used. This data was downloaded from the DISTRICT and represents the best description of land use for the modeled simulation period.. This intersected GIS coverage of the land use and basin boundaries was utilized to define the model segmentation. The model simulates the 9 basins, each divided into 6 generalized land use conditions. This model conceptualization avoids parameter lumping by not combining areas with starkly different hydrologic response.

5.2.2.3 Stream Data

Hydrography data was obtained from the National Hydrography Dataset (NHD) provided by USGS. This data was used in calculating reach lengths and was also used in conjunction with the DEM data in order to calculate reach slopes. These parameters were then used in the model to calculate the flow routing from each basin.

USGS streamflow data was also downloaded from the USGS website. Two gauges located within the basin boundaries were used as calibration stations. USGS gauge # 02291500 is located on the Imperial River near Exit# 116 on I-75, and USGS gauge # 02291524 is located on Spring Creek near Old US 41. Daily average flow data was obtained for each of these gauges for the entire simulation period. The location of the gauging stations and NHD streams are shown in Figure 5-2.

5.2.2.4 Water Quality Monitoring Data

In 2006, Johnson Engineering was authorized by the City of Bonita Springs to implement a water quality monitoring program to characterize the water quality of surface water entering the City of Bonita Springs and within the City of Bonita Springs. A total of 9 active stations (named "CBS#") were monitored for water quality from October 2009 through September 2010 for various water quality parameters. In addition, Johnson Engineering analyzed water quality data at 8 water quality sampling locations monitored by Lee County. Water quality data, for both Lee County water quality sampling locations as well as Johnson Engineering water quality sampling locations, was obtained from Johnson Engineering and included in the water quality modeling efforts. Figure 5-2 shows the Lee County and City of Bonita Springs (sampled by Johnson Engineering) sampling locations. This data was used to calibrate the water quality portion of the HSPF model.

5.2.2.5 Evapotranspiration Data

Unlike the event based ICPR model developed for Phase I, the HSPF model is a continuous simulation model utilized to simulate the entire hydrologic cycle. This includes significant water budget terms, including precipitation, upper zone storage, lower zone soil storage (vadose zone storage), evapotranspiration, and basin outflow.

The utilization of HSPF requires the inclusion of ET fluxes as they become significant water budget term. DBHYDRO, the SFWMD environmental database, was used to obtain daily evapotranspiration potential data. ET records from several weather stations were examined for potential use in the HSPF modeling efforts. Of the stations examined, only Station FPWX had a complete ET record set for the entire simulation period. Information for this station is provided below in Table 5-1.

Table 5-1 Selected Evapotranspiration Station

Dbkey:	OH520
Data Type:	POTENTIAL EVAPOTRANSPIRATION, (MM)
Frequency:	DAILY
Start Date:	1-Jan-01
End Date:	30-Apr-11
Station:	**FPWX**
Station Description:	FLINT PEN STRAND WEATHER STATION
Agency:	DISTRICT
Latitude:	419436.348
Longitude:	763584.203
Coordinate System:	NAD 1983-State Plane Florida East

5.2.2.6 NEXRAD Precipitation

Next-Generation Radar (NEXRAD) precipitation data was obtained from the District. It consisted of 15-minute data recorded for 540 2km x 2km grid cells from January 1, 2002 through December 31, 2010. A GIS shapefile of the precipitation grids was also provided by the District. These grids were used with the ArcGIS intersect tool in order to determine grid cell areas for each basin. With these areas known, the area-weighted average precipitation for each basin was calculated. The calculated yearly precipitation for each basin is listed below in Table 5-2.

Table 5-2 NEXRAD Yearly Precipitation by HSPF Basin

	Basin (Precipitation in inches)								
Year	1	2	3	4	5	6	7	8	9
2002	49.2	50.7	47.3	51.3	46.7	49.9	51.7	49.4	46.3
2003	60.5	58.2	53.6	60.2	61.2	57.4	65.3	53.9	51.2
2004	58.4	54.9	53	57.4	57.3	55.4	61.1	55	53.3
2005	64.3	63.9	62.4	63.4	61.6	65.1	64.9	65.4	63.8
2006	51.5	47	43.5	49.4	49.8	50.3	51.6	46.1	43.7
2007	40.5	38.1	33.7	38.9	41.4	38.4	43.9	33.4	30.2
2008	60.3	62.4	55.8	60.6	70.1	62.4	66.5	61.9	60.4
2009	50.1	53.7	46	51.7	53.1	54.3	56.7	53.2	46.5
2010	56.3	57.8	53.4	56.6	55.6	57.5	57.6	54.7	51.4

5.2.2.7 Irrigation

Water use for irrigation by golf courses in Florida is significant. According to a recent economic study, total water use for irrigation by golf courses in Florida was estimated at 172 billion gallons in Year 2000. The average water use per golf course in Florida was estimated at 133 million gallons per year (Haydu and Hodges, 2002). Hence, water use for irrigation by golf courses can't be neglected in the modeling efforts.

A golf course GIS coverage was provided by the City of Bonita Springs Public Works Division. From this coverage, 17 golf courses were identified as being located in the project vicinity. Monthly water use volumes for golf courses were provided by the District Water Use Division. Golf courses that have permitted water use with the District are required to report monthly pumpage volumes to the District to ensure that permit requirements are met.

Out of the 17 golf courses in the project vicinity, 6 golf courses had pumping data recorded in the District database and were used to estimate daily irrigation time series for use in the HSPF model. Pumpage consumption from the District included data from January 1, 2000 until May 1, 2011. The assumption was made that the golf course monthly water use was used primarily for irrigation. Using the estimated golf courses areas, the golf course water use monthly volume (provided in million gallons per minute) were estimated in inches per month over each golf course area (excluding water hazard areas).

Next, monthly time series from the identified 6 golf courses were averaged and converted into daily time series. When converting from monthly time series to daily time series, it was assumed that the golf courses were irrigated twice a week: on Monday and Thursday. This ensured a uniform distribution of monthly irrigation volumes in the model and eliminated high peaks in the runoff associated with the application of irrigation rates. The average flux calculated using this method was applied to all irrigated lands.

5.2.2.8 WWTPs

Point source loads from Waste Water Treatment Plants (WWTPs) were included in the HSPF model. According to Florida Department of Environmental Protection's (FDEP) website, there are six domestic WWTPs that were active within the project vicinity and simulated timeframe. These plants are shown in Table 5-3 below and in Figure 5-3 at the end of the section.

The FDEP was contacted to obtain available information with regards to effluent flow rate (provided in million gallons per day, or MGD) and Total Nitrogen (TN) effluent concentration (mg/L) for these plants. Only two of the plants had recorded measurements for TN, while all six plants had recorded effluent flow rates. At this time, the four plants without TN concentration data have been excluded in the model; however, the addition of these point sources to the model could be easily achieved if new data is obtained.

Additionally, because the data obtained was periodic, it was assumed that the loading from these point sources was a constant rate (calculated from the average flow rate and TN concentration).

Table 5-3 WWTPs located within HSPF model boundary

FACILITY ID	NAME	HSPF Basin	Avg. Flow Rate (MGD)	*Avg. TN Conc. (mg/L)
FLA012343	Bonita Springs Utilities East	4	1.0217	NR
FLA014443	Bonita Springs Water Reclamation (West)	9	2.3220	<0.02
FLA014467	Glades Haven Park, FKA: Jones Mobile Village WWTF	7	0.0159	3.00
FLA014477	Citrus Park North	2	0.0874	6.55
FLA014541	Hunters Ridge WWTP	1	0.0457	NR
FLA014584	Morton Grove Apartments	4	0.0277	NR

*NR = No values reported.

5.2.3 Model Construction

The basins used in the HSPF model are based on the watersheds developed for the ICPR model created during Phase I of this project. The smaller ICPR basins were aggregated to represent each of the major reaches flowing into the Imperial River (Oak Creek, Leitner Creek, and Rosemary Canal). They were also aggregated to create watersheds that could be used for calibration purposes (these basin boundaries were based on the location of USGS stream gauges and water quality measurement locations). This grouping resulted in the creation of 9 basins, as shown in Figure 5-1. Seven of these basins discharge to the Imperial River and two drain to Spring Creek. Table 5-4 displays the ID number and description of each of the basins.

Table 5-4. Basin IDs and Descriptions

Basin ID	Basin Name
1	Oak Creek
2	Leitner Creek
3	Imperial Lower
4	Imperial Middle
5	Imperial Kehl
6	Rosemary Canal
7	Imperial Upper
8	Spring Upper
9	Spring Lower

In HSPF, the physical environment is represented using segments, nodes, and elements. In the City of Bonita Springs HSPF model, segments are based on the Florida Land Use and Cover Classification System (FLUCCS). The 2004 land use data with FLUCCS codes was obtained from the District and then generalized into six different categories: Forested, Grass/Pasture, Irrigated Lands, Mining/Other, Urban, and Wetlands. Table 5-5 shows the different land use categories utilized in the model. Table 5-10 at the end of the section shows the relationship between each of the FLUCCS codes and these generalized categories.

Table 5-5. HSPF Land Use Categories

Category #	Category Description
1	Forested
2	Grass/Pasture
3	Irrigated Lands
4	Mining/Other
5	Urban
6	Wetlands

Since these land use types will have very different infiltration capacities and runoff potential, it is important to separate these land use types in the HSPF simulation. For example, agricultural lands have high evapotranspiration potential, little to no impervious area, and high storage capacity; and conversely, urbanized areas are characterized by low evapotranspiration potential, higher impervious area, and low storage.

Individual land use areas in each basin were combined in order to represent the different segments in the model. For example, FLUCCS codes 5000s and 6000s (water and wetlands) were extracted from the dataset for each basin in order to create the RCHRES segment for each basin. These segments provide storage capacity for each basin and provide storage attenuation during rainfall events. The total storage attenuation area for each basin is shown in Table 5-6. As shown in the table, Basin 5, which includes the Corkscrew Swamp area, contains the largest area of water and wetlands. Conversely, Basin 8, which represents Upper Spring Creek and is heavily urbanized, has the least amount of available storage in wetlands and open water.

A similar procedure was executed for the PERLND and IMPLND segments. For land use categories 1 through 4, it was assumed that all areas were pervious. Category 5 contained urbanized land uses, and hence, both pervious and impervious areas were present in Table 5-6.

To determine appropriate values for the area of each segment, ArcGIS was used to clip the land use dataset to the basin boundaries. Areas for each land use were calculated. Category 5 is represented using both PERLND and IMPLND segments in HSPF. To calculate the amount of impervious land in each basin, the urban land use was divided into a pervious portion and an impervious portion based on literature values. This percentage was then multiplied by the urban land use and summed by basin to get the IMPLND area. The pervious land area was then calculated by multiplying each urban land use area by one minus the impervious fraction. To get the total PERLND and IMPLND area, each HSPF land use category was then summed by basin. Figure 5-4 shows each of the FLUCCS land use areas after conversion to the new HSPF categories. The area for each segment in HSPF is displayed in Table 5-6.

Table 5-6. Land Use Area by HSPF Basin

	Basin Number (Area in Acres)								
	1	2	3	4	5	6	7	8	9
Forested	24	24	70	82	2,649	120	64	-	88
Grass/Pasture	99	163	63	115	6,150	785	151	121	115
Irrigated Lands	362	668	173	57	4,865	10	495	115	869
Mining/Other	-	13	-	-	1,947	-	0	-	-
Urban-Perv.	491	578	1,249	675	705	299	683	414	1,936
Urban-Inperv.	430	366	1,018	416	287	223	345	166	1,188
Wetland (Storage Attenuation)	463	86	484	141	23,104	1,240	490	79	1,403
Total:	**1,869**	**1,898**	**3,057**	**1,485**	**39,707**	**2,676**	**2,228**	**895**	**5,598**

The land use dataset was also used with ArcGIS in order to determine physical parameters used for each land segment. Overland slope was determined using a 1/3 arc-second DEM downloaded from the USGS with the land use data by calculating the average slope in each land use polygon.

5.2.4 Calibration

5.2.4.1 Hydrology & Hydraulics

In order to calibrate the HSPF model, flow data from two USGS streamflow gauges were used. The first site, USGS gauge # 02291500, is located on the Imperial River near Exit# 116 on I-75. The second site, USGS gauge # 02291524, is located on Spring Creek near Old US 41. Flow is recorded every 15 minutes at both gauges. The locations of the flow calibration stations and the modeled basins are presented in Figure 5-2.

Since only two gauges are present in the project vicinity, a systematic approach was used to develop the parameters for each of the basins that did not have a gauging station for calibration. Model parameters were changed based on the original land use categories, thereby making the calibration systematic. Parameters were adjusted based on the more detailed land use categories and then calculated for each basin segment based on an aerially weighted average. By doing this, the calibration that is developed at the two gauging stations can serve as a proxy for the calibration of the entire watershed.

The calibration period extended from January 1, 2002 through September 30, 2010. During the calibration process, modifications to the HSPF parameters were made in order to more closely match the observed USGS flow hydrographs. Initial values for parameters that had no known data sources were estimated using Basins Technical Note 6 (USEPA, 2000).

The results of the calibration can be seen in Figures 5-5 through 5-10. Figures 5-5 through 5-7 show observed versus simulated discharge, cumulative volume, and flow duration at USGS gauge # 02291500 (Imperial River). Figures 5-8 through 5-10 show the similar plots for USGS gauge # 02291524 (Spring Creek). Calibration statistics are shown in Table 5-7.

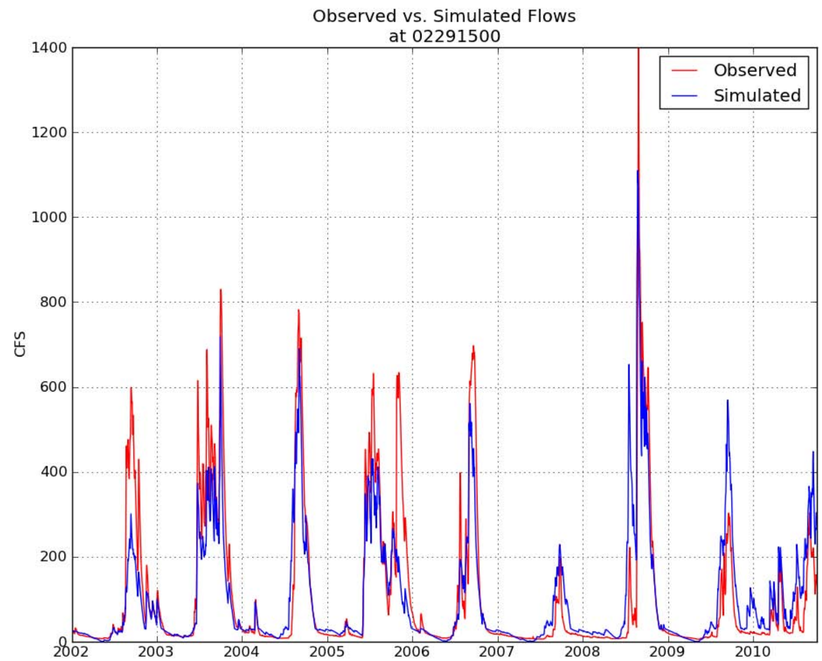

Figure 5-5. USGS 02291500 (Imperial River) Observed vs. Simulated Flows

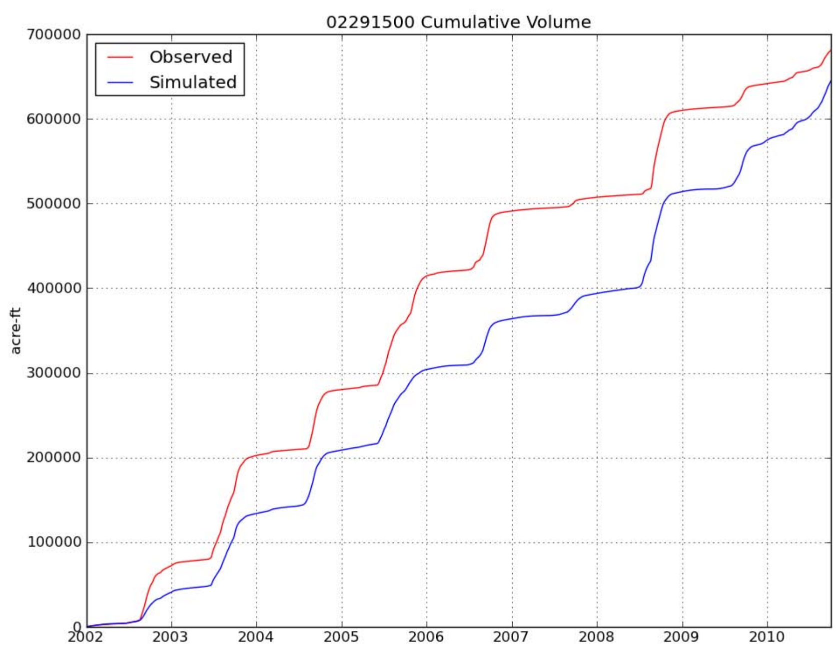

Figure 5-6. USGS 02291500 (Imperial River) Observed vs. Simulated Cumulative Volume

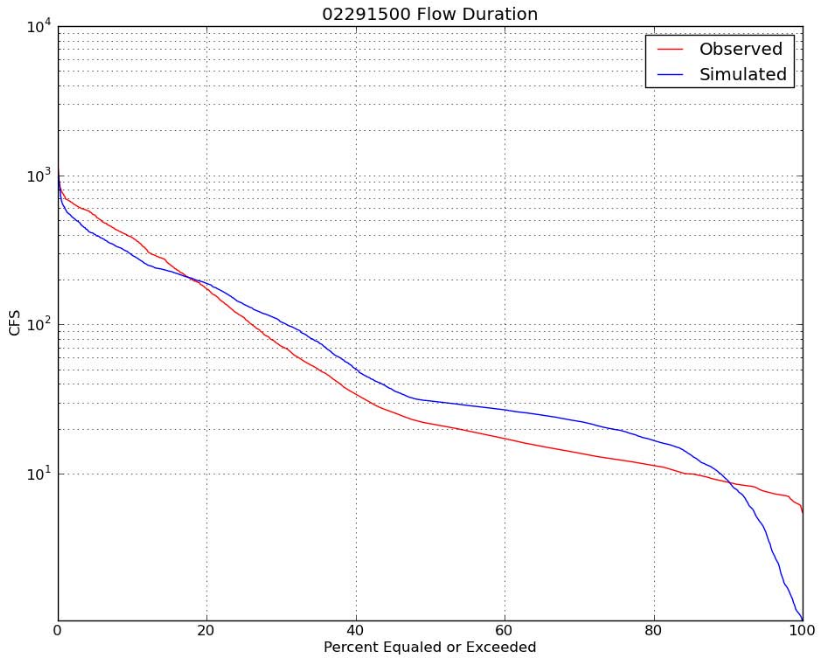

Figure 5-7. USGS 02291500 (Imperial River) Flow Duration Plot

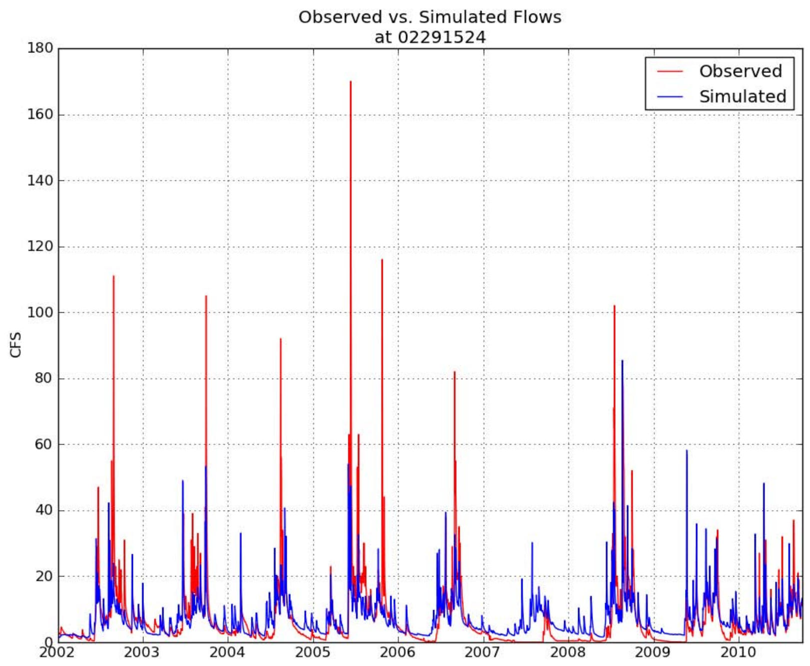

Figure 5-8. USGS 02291524 (Spring Creek) Observed vs. Simulated Flows

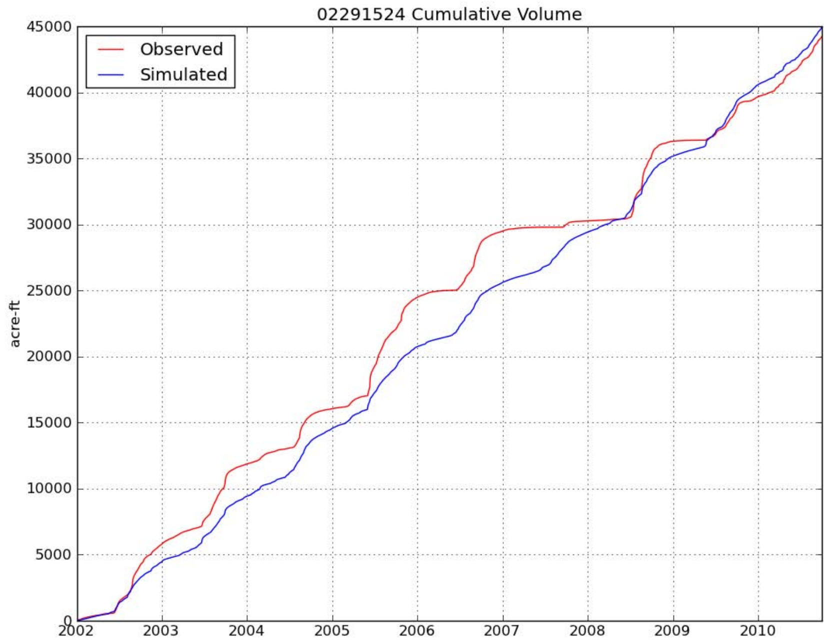

Figure 5-9. USGS 02291524 (Spring Creek) Observed vs. Simulated Cumulative Volume

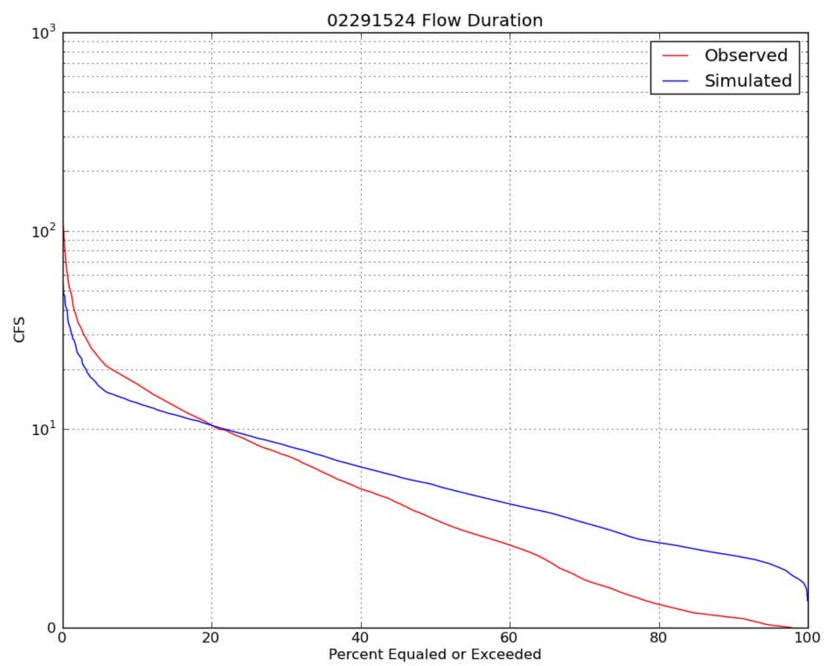

Figure 5-10. USGS 02291524 (Spring Creek) Flow Duration Plot

Table 5-7. Model Calibration Statistics

	USGS Gauge		
	02291500 (Imperial)	02291524 (Spring)	Units
Simulated Cumulative Volume	644,684	44,904	acre-ft
Observed Cumulative Volume	680,906	44,214	acre-ft
Simulated 10% Highest Flows	441.6	20.4	cfs
Observed 10% Highest Flows	557.3	29.5	cfs
Simulated 50% Lowest Flows	18.0	3.2	cfs
Observed 50% Lowest Flows	12.9	1.4	cfs
Simulated Mean Flow	101.7	7.1	cfs
Observed Mean Flow	107.4	7.0	cfs
Mean Flow Error	-5.3%	1.6%	

5.2.4.2 Water Quality

After the hydrology portion of the model was calibrated, the water quality calibration was performed. To calibrate the model, measured TN concentration data was obtained from Lee County and Johnson Engineering. The locations of these water quality measurement locations are shown in Figure 5-2. The 9 water quality sampling locations used in calibration are also listed below in Table 5-8.

Table 5-8. Calibration Water Quality Sampling Locations

Basin ID	Station ID
1	IMPRGR41
2	IMPRGR51
3	IMPRGR30
4	CBS11
5	KEHLGR
6	CBS9
7	IMPRGR80
8	48-25GR
9	48-10GR

In HSPF, there are several modules for modeling nutrients. For this application, data was input into the PQUAL, GQUAL, and Mass-Links sections to simulate the wash-off and transport of TN within the watershed. The surface water concentration of TN in runoff from different land uses was based on Event Mean Concentration (EMC) data found in the 2010 FDEP draft report, *Stormwater Quality Applicant's Handbook*. EMC data from this report was used to assign runoff concentration to each of the different FLUCCS land codes. Table 5-9 below lists the EMC data obtained from the FDEP report, and Table 5-10 at the end of this section shows the relationship between FLUCCS codes and the land use categories listed in the FDEP report. Since an EMC for Undeveloped/Rangeland/

Forest land uses was not given in the FDEP report, an EMC value for this land use was obtained from an additional FDEP publication (Harper and Baker, 2007).

Table 5-9. EMC Data from FDEP Reports

Land Use	TN (mg/L)
Low-Density Residential	1.50
Single-Family	1.85
Multi-Family	1.91
Low-Intensity Commercial	0.93
High-Intensity Commercial	2.48
Light Industrial	1.14
Highway	1.37
Pasture	2.48
Citrus	2.31
Row Crops	2.47
General Agriculture	2.42
Undeveloped / Rangeland / Forest**	1.15
Mining / Extractive	1.18

** Value from Harper and Baker (2007).

These values were used to compute an aerially weighted average for each of the HSPF generalized land use types. The computed concentrations were then input in the MASS-LINKS block of the model through the use of a multiplying factor that converted the runoff from each PERLND segment to a TN loading.

HSPF also includes an input for the TN concentration in interflow and baseflow in the PQUAL section of the PERLND block. Initial values for interflow and baseflow concentrations were selected to be half of the surface water values. During calibration, the numbers entered in the MASS-LINKS section for the surface water concentration were held constant while the values of the interflow and baseflow concentrations adjusted. In order to calibrate the model, the interflow and baseflow concentrations values were lowered even further until the average simulated concentration approached the measured concentration. During calibration, the ratio of one land use's concentration to another's was held constant. Each land use category was divided by the same amount in order to preserve these ratios.

Information entered in the GQUAL section of the RCHRES block included: initial TN concentration for each reach, decay exponents, and monthly water temperature. The initial concentration for each basin reach was input as the average concentration from the measured data. The decay rate exponent was obtained from Bowie et al. (1985), and average monthly water temperatures were calculated from measurements at USGS gauge # 022929176. These parameters were needed to simulate the decay of TN as it is being transported through the watershed and is broken down and absorbed.

The results of the water quality calibration are shown in Figure 5-11. Table 5-11 shows the observed versus simulated average TN concentrations for the model simulation period. In most cases, the simulated average concentration and the observed average concentration agree favorably. Station IMPRGR30 had the largest difference between the observed and simulated average TN concentrations. This is likely due to the tidal influence at this station, which is not accounted for in the HSPF model.

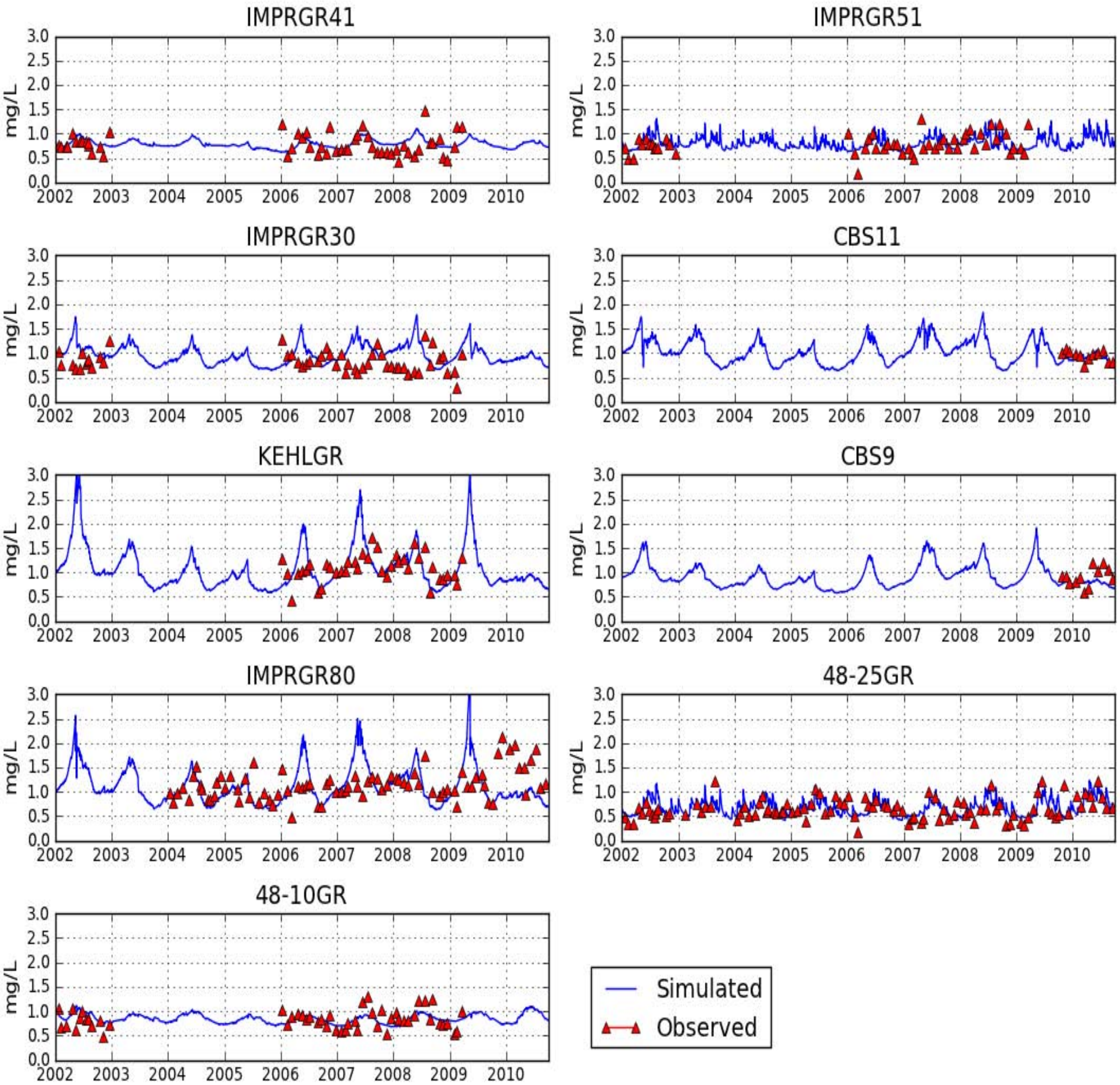

Figure 5-11. Water Quality Calibration Plots for TN

Table 5-11. Water Quality Calibration Statistics

HSPF Basin	Station ID	Observations #	Observed Average (mg/L)	Simulated Average (mg/L)
1	IMPRGR41	54	0.79	0.79
2	IMPRGR51	53	0.79	0.80
3	IMPRGR30	52	0.84	0.96
4	CBS11	12	0.95	1.02
5	KEHLGR	39	1.10	1.07
6	CBS9	12	0.91	0.90
7	IMPRGR80	82	1.16	1.12
8	48-25GR	102	0.66	0.67
9	48-10GR	53	0.84	0.85

Table 5-12 shows the yearly average TN loading from each basin during the model simulation period. Basin 5 (which represents the Imperial River upstream of the Kehl Canal structure) has the largest yearly average TN loading, while Basin 8 (which represents Upper Spring Creek) has the lowest yearly average TN loading.

Table 5-12. Yearly Average TN loading by Basin

HSPF Basin	Average TN Loading (lb/yr)
1	11,850
2	18,984
3	21,029
4	10,423
5	141,366
6	10,440
7	27,934
8	10,347
9	58,018

5.2.5 BMP Modeling

The BMPRAC module in HSPF allows for the simulation of Best Management Practices (BMPs). This module utilizes user-supplied removal fractions and multiplies them by the influent quantity for a specific BMP. The result of this calculation is the removed and effluent quantities. The removal fraction was input in the HSPF model for the 16 proposed BMPs based on the analysis presented in the FDEP's *Stormwater Quality Applicant's Handbook* (FDEP, 2010). This analysis along with a more detailed description of each of the BMPs is described further in Sections 7 and 8 of this report. The HSPF schematic block was also modified to route contributing drainage area flows into each BMP.

The contributing drainage area for each potential BMP site was delineated by examining the subbasin and network maps developed for the ICPR model in the City of Bonita Springs SMP Update Phase I. The contributing areas for each BMP site are presented in Section 7 in Figures 7-2 through 7-17.

Using the contributing area in conjunction with the 2004 land use map, areas for each PERLND, IMPLND, and RCHRES segment that drained to the specific BMP were calculated. The SCHEMATIC block in the HSPF model was altered to allow the flow from these segments to enter the BMP prior to being discharged to the reach. Table 5-13 shows the area of each HSPF land use category that drains to each BMP.

Table 5-13. BMP Contributing Drainage Areas

BMP Site ID	HSPF Land Use Categories (Area in Acres)							
	Forested	Grass/ Pasture	Irrigated Lands	Mining/ Other	Urban	Impervious	Wetland	Total
1	-	-	-	-	28	21	-	49
2	-	-	-	-	26	12	-	38
3	116	51	94	864	16	4	355	1,500
4	19	152	668	13	417	269	86	1,624
5	23	158	668	13	433	281	86	1,662
6	1	-	-	-	19	14	-	34
7	13	-	-	-	11	3	-	26
8	-	-	-	-	12	12	-	24
9	15	19	-	-	25	9	95	163
10	-	0	-	-	26	11	-	37
11	-	2	12	-	20	44	20	97
12	7	-	-	-	59	23	3	92
13	-	-	-	-	7	3	-	11
14	-	-	-	-	33	14	-	47
15	-	5	-	-	17	9	-	31
16	-	4	-	-	10	5	-	18

The results from the BMP simulations are shown below in Table 5-14. As shown in the tables, the TN removal (lb/yr) is highly dependent on the removal fraction and contributing drainage area. Additionally, BMPs with similar drainage areas (BMP4 and BMP5) can have widely varying TN removals (lb/yr) depending on the TN removal fraction. The estimated values of the mean annual TN removal are also listed in Table 7-1 for each BMP site.

Table 5-14. Average BMP TN Removal

BMP Site ID	HSPF Basin	TN Removal Efficiency (%)	TN Removal (lb/yr)
1	3	85.5	356
2	4	89.3	262
3	5	6.6	323
4	2	4.7	702
5	2	26.7	4,037
6	2	30.8	110
7	4	47.9	49
8	4	81.8	207
9	7	14.8	116
10	1	38.6	118
11	1	43.3	412
12	4	78.3	470
13	6	46.6	45
14	4	19.0	67
15	2	87.4	236
16	4	83.4	103

Table 5-15 shows the simulated annual TN loading for each basin during the simulation period for the existing conditions with no BMP implementation.

Table 5-15. Simulated Annual TN Loading by Basin Without BMP Implementation

	Basin Number (Loading in lb/yr)								
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2002	9,720	17,881	18,813	9,829	99,288	11,110	22,622	9,277	48,698
2003	13,525	20,020	23,751	11,846	185,190	11,874	30,682	10,258	58,718
2004	12,410	17,785	21,690	10,574	136,580	9,801	27,770	10,531	61,622
2005	13,883	21,656	26,877	11,909	164,340	12,494	32,829	12,505	73,393
2006	11,807	17,381	18,688	9,705	114,860	9,261	26,737	9,394	53,004
2007	8,531	13,573	13,077	6,931	73,058	4,724	21,213	6,699	36,780
2008	13,876	23,033	24,643	12,336	232,780	13,986	32,110	12,793	72,209
2009	11,050	20,544	20,695	10,253	124,830	10,272	29,506	11,321	59,719
Mean	**11,850**	**18,984**	**21,029**	**10,423**	**141,366**	**10,440**	**27,934**	**10,347**	**58,018**

5.2.6 Limitations

The HSPF model is a versatile and complex model that has many different input parameters and input data sources. This complexity yields a very flexible code that is applicable for watersheds ranging in both size and geographic location.. However, the added complexity means the model construction and data requirement costs are more extensive than simplistic event-based models. As with any modeling strategy, the HSPF model has limitations in the simulation of both hydrologic and water quality processes. Complex models require more calibration in order to gain confidence in their predictive capabilities. Without adequate calibration, uncertainty in the predictions can be high. For this model, the data to constrain the calibration was the largest limitation. Ideally, additional calibration data would help gain confidence in the model predictions. Nevertheless, the best available data was utilized in the construction of the Bonita Springs model.

5.3 FDEP Handbook Method

5.3.1 Method Overview

The current standard-of-practice for the evaluation of BMPs in Florida is the March 2010 edition of the FDEP's *Stormwater Quality Applicant's Handbook*. The methodology presented in this handbook involves the use the rational method and an annual average runoff methodology to estimate BMP nutrition removal efficiency.

The rational runoff coefficient method is described in the FDEP Handbook to estimate the site-specific annual runoff volume collected from the contributing area. The runoff coefficient is calculated based on the non-directly connected impervious area (non-DCIA) curve number and DCIA percentage of the contributing area. Table 5-16 summarizes the curve number for pervious area by land use and soil type, which was originally documented in the TR-55 report (USDA, 1986). The watershed-specified DCIA and NDCIA percentage values for each developed land use type were estimated for this study area, as listed in Table 5-16. Given the curve number of pervious area, DCIA and NDCIA, the Non-DCIA curve number could be calculated using area-weighted method. Using the corresponding table provided in the FDEP Handbook, similar to Table 5-17, the mean annual runoff coefficient could be interpolated. Note that the City of Bonita Springs is located in the Meteorological Zone No. 4. Table 5-18 lists the runoff coefficient values by land use and soil type.

The annual rainfall for the City of Bonita Springs was estimated as 52.5 in/yr based on the Rainfall Isopleth Map in the FDEP Handbook. For a given area with same land use and soil type, the mean annual runoff volume could be calculated by multiplying the corresponding runoff coefficient, size of the area and annual rainfall (52.5 in/yr).

For a given BMP site, the contributing area may be divided into multiple sub-areas with the same land use and soil type. By aggregating the runoff volume from these sub-areas, the total annual runoff volume for the contributing area could be calculated. Similarly, by aggregating the multiplication of the annual runoff volume and the TN EMC value of each sub-area, the annual TN loading could be calculated for the contributing area. The TN EMC values for all land use types are listed in Table 5-10.

The estimated annual runoff volume and annual TN loading are summarized in Table 5-19 for all potential BMP sites.

Among the structural BMPs described in Section 6, dry retention systems and wet detention systems are the two most common BMP options in land development and regional water quality improvement projects throughout Florida. Therefore, these two systems are recommended for most of the potential BMP sites listed in Section 7. The estimation of TN removal efficiency for dry retention and wet detention systems are briefly discussed below.

For a dry retention pond, the TN removal efficiency is based on the retention depth over the contributing area. First, based on the evaluation of the soil and groundwater conditions, the treatment volume could be estimated for a given pond site. The retention depth is then calculated by dividing the pond treatment volume by the size of contributing area. Finally, using the corresponding tables provided in FDEP Handbook, similar to Table 5-20 in the end of this section, the TN removal efficiency can be interpolated for a dry retention pond.

For a wet detention pond, the TN removal efficiency is defined as a function of the residence time and appears to peak at approximately 45% at a very long residence time. First, the treatment volume of a wet pond is estimated based on the evaluation of the soil and groundwater conditions at a given site. Then the residence time can be calculated by dividing the treatment volume by the mean annual runoff volume that has been calculated for all potential BMP sites as listed in Table 5-19. An equation suggested in the FDEP Handbook defines the relationship between residence time and removal efficiency for TN in a wet detention pond, see below:

$$\textit{TN Removal Efficiency} = 43.75 * \textit{Residence Time} / (4.38 + \textit{Residence Time})$$

To enhance the total system performance of a dry retention system or a wet detention system, some amount of pre-treatment or post-treatment is usually provided, such as roadside swales and a manufactured baffle box. In this study, the Suntree Baffle Box is selected for stormwater pre-treatment in most of the potential BMP sites. Based on the study reports provided by the manufacturer - Suntree Technologies, Inc., the Baffle Box can provide an average 38% in TN removal in mass. Assuming a safety factor of 2.0, a 19% of TN removal efficiency is used for the Suntree Baffle Box in this study.

In some cases, due to the limited capacity of the BMP treatment system, it is assumed that only part of the runoff volume from the contributing area will be treated. The TN removal efficiencies listed in the BMPs discussion in Section 7 (Table 7-2) has accounted for this factor in the calculation.

To determine the overall TN removal efficiency of a BMP treatment train with two BMP components, e.g., a dry pond plus a baffle box, the following equation could be used:

$$Overall\ Efficiency = Eff_1 + (1-Eff_1) * Eff_2$$

Given the existing mean annual TN loading and overall TN removal efficiency, the mean annual TN loading reduction could be evaluated, as listed in Table 7-2 for each BMP site.

5.3.2 Method Limitations

The FDEP Handbook method is suitable for BMP design of small scale (defined by contributing area of 100 acres) land development projects. Twelve of the sixteen potential BMP sites have a contributing area of less than 100 acres. Additionally, in determining the annual runoff volume, the FDEP method does not account for the exchange between surface water and groundwater and the lateral flow between basins or watersheds. For example, in the Site 4 BMP Evaluation (Leitner Creek - Bypass Canal) with a contributing drainage area of over 1,500 acres, the estimated annual runoff volume by the FDEP Handbook method might be under-estimated given the noticeable lateral flows from adjacent basins and extensive numbers of pump stations. In the final design phase for this BMP project, a more detailed watershed model might be needed in better estimation of the runoff volume and hence the TN removal efficiency and TN loading reduction.

5.4 Section References

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5.5 Additional Table & Figure Descriptions

Table #	Description
5-10	Relationship between FLUCCS codes, HSPF LU Categories, & EMCs
5-16	Lookup Table of Curve Number & DCIA
5-17	Mean Annual Runoff Coefficients as a Function of DCIA Percentage and Non-DCIA Curve Number (Zone 4)
5-18	Lookup Table of Mean Annual Runoff Coefficient
5-19	Summary of Annual Runoff Volume and TN Loading for Potential BMP Sites
5-20	Dry Retention System Mean Annual TN Removal Efficiencies as a Function of DCIA and Non-DCIA Curve Number (Zone 4)

Figure #	Description
5-1	HSPF Basins
5-2	Water Quality and Streamflow Data
5-3	Waste Water Treatment Plant Locations
5-4	HSPF Land Use Segments

Table 5-10. Relationship between FLUCCS codes, HSPF LU Categories, & EMCs

FLUCCS Code	FDEP Land Use Category	HSPF Land Use	TN EMC (mg/L)
1110	Low-Density Residential	5	1.5
1120	Low-Density Residential	5	1.5
1130	Low-Density Residential	5	1.5
1180	Low-Density Residential	5	1.5
1190	Low-Density Residential	5	1.5
1210	Single-Family	5	1.85
1220	Single-Family	5	1.85
1290	Single-Family	5	1.85
1310	Multi-Family	5	1.91
1320	Multi-Family	5	1.91
1330	Multi-Family	5	1.91
1340	Multi-Family	5	1.91
1350	Multi-Family	5	1.91
1390	Multi-Family	5	1.91
1400	Low-Intensity Commercial	5	0.93
1411	Low-Intensity Commercial	5	0.93
1423	Low-Intensity Commercial	5	0.93
1490	Low-Intensity Commercial	5	0.93
1550	Light Industrial	5	1.14
1610	Mining/ Extractive	4	1.18
1630	Mining/ Extractive	4	1.18
1660	Mining/ Extractive	4	1.18
1700	Low-Density Residential	5	1.5
1710	Low-Density Residential	5	1.5
1800	Single-Family	3	1.85
1820	Single-Family	3	1.85
1830	Single-Family	3	1.85
1840	Single-Family	3	1.85
1850	Single-Family	3	1.85
1900	Undeveloped / Rangeland / Forest	2	1.15
1920	Undeveloped / Rangeland / Forest	2	1.15
2110	Pasture	2	2.48
2120	Pasture	2	2.48
2130	Pasture	2	2.48
2140	Row Crops	3	2.47
2150	Pasture	2	2.48

Table 5-10. (Continued)
Relationship between FLUCCS codes, HSPF LU Categories, & EMCs

FLUCCS Code	FDEP Land Use Category	HSPF Land Use	TN EMC (mg/L)
2210	Citrus	3	2.31
2220	Citrus	3	2.31
2410	General Agriculture	3	2.42
2430	General Agriculture	3	2.42
2500	General Agriculture	4	2.42
2610	Row Crops	2	2.47
3100	Undeveloped / Rangeland / Forest	2	1.15
3200	Undeveloped / Rangeland / Forest	2	1.15
3210	Undeveloped / Rangeland / Forest	2	1.15
3300	Undeveloped / Rangeland / Forest	2	1.15
4110	Undeveloped / Rangeland / Forest	1	1.15
4120	Undeveloped / Rangeland / Forest	1	1.15
4130	Undeveloped / Rangeland / Forest	1	1.15
4200	Undeveloped / Rangeland / Forest	1	1.15
4220	Undeveloped / Rangeland / Forest	1	1.15
4240	Undeveloped / Rangeland / Forest	1	1.15
4340	Undeveloped / Rangeland / Forest	1	1.15
4370	Undeveloped / Rangeland / Forest	1	1.15
7400	Mining/ Extractive	4	1.18
8140	Highway	5	1.37
8200	Light Industrial	5	1.14
8320	Light Industrial	5	1.14
8330	Light Industrial	5	1.14
8340	Light Industrial	5	1.14

Table 5-16. Lookup Table of Curve Number & DCIA

FLUCCS Code	Description	CN_PERV/Soil Hydro Group					NDCIA (%)	DCIA (%)	PERV (%)
		A	B	C	D	W			
1100	Residential, low density	39	61	74	80	100	5	15	80
1110	Low Density: Fixed Single Family Units	39	61	74	80	100	5	15	80
1130	Low Density: Mixed Units, Fixed and Mobile Home U	39	61	74	80	100	5	15	80
1180	Rural Residential	39	61	74	80	100	5	15	80
1200	Residential, medium density	39	61	74	80	100	5	25	70
1300	Residential, high density	39	61	74	80	100	10	55	35
1400	Commercial and services	39	61	74	80	100	10	75	15
1500	Industrial	39	61	74	80	100	5	67	28
1600	Extractive	39	61	74	80	100	65	0	35
1660	Holding pond	39	61	74	80	100	65	0	35
1700	Institutional	39	61	74	80	100	5	55	40
1800	Recreational	39	61	74	80	100	8	2	90
1820	Golf courses	39	61	74	80	100	10	0	90
1900	Open land (Urban)	39	61	74	80	100	0	0	100
2100	Cropland and pastureland	49	69	79	84	100	0	0	100
2110	Improved pastures	49	69	79	84	100	0	0	100
2120	Unimproved pastures	49	69	79	84	100	0	0	100
2130	Woodland pastures	49	69	79	84	100	0	0	100
2140	Cropland and pastureland	49	69	79	84	100	0	0	100
2200	Tree crops	44	65	77	82	100	0	0	100
2210	Citrus groves	44	65	77	82	100	0	0	100
2300	Feeding operations	73	83	89	92	100	0	0	100
2400	Nurseries and vineyards	57	73	82	86	100	0	0	100
2500	Specialty farms	59	74	82	86	100	0	0	100
2550	Aquaculture	59	74	82	86	100	0	0	100
2600	Other open land (Rural)	30	58	71	78	100	0	0	100
2610	Fallow Cropland	30	58	71	78	100	0	0	100
3100	Rangeland	63	71	81	89	100	0	0	100
3200	Shrub and brushland	35	56	70	77	100	0	0	100
3210	Palmetto Prairies	35	56	70	77	100	0	0	100
3300	Mixed rangeland	49	69	79	84	100	0	0	100
4100	Upland coniferous forests	45	66	77	83	100	0	0	100
4110	Upland coniferous forests	57	73	82	86	100	0	0	100
4120	Upland coniferous forests	43	65	76	82	100	0	0	100

Table 5-16. (Continued)
Lookup Table of Curve Number & DCIA

FLUCCS Code	Description	CN_PERV/Soil Hydro Group					NDCIA (%)	DCIA (%)	PERV (%)
		A	B	C	D	W			
4200	Upland hardwood forests	36	60	73	79	100	0	0	100
4220	Brazilian Pepper	36	60	73	79	100	0	0	100
4340	Mixed coniferous/hardwood	36	60	73	79	100	0	0	100
4400	Tree plantations	36	60	73	79	100	0	0	100
5100	Streams and waterways	100	100	100	100	100	0	0	100
5200	Lakes	100	100	100	100	100	0	0	100
5300	Reservoirs	100	100	100	100	100	0	0	100
5400	Bays and estuaries	100	100	100	100	100	0	0	100
6100	Wetland hardwood forests	98	98	98	98	98	0	0	100
6110	Bay swamps	98	98	98	98	98	0	0	100
6120	Mangrove swamps	98	98	98	98	98	0	0	100
6150	Stream and lake swamps	98	98	98	98	98	0	0	100
6170	Mixed wetland hardwoods	98	98	98	98	98	0	0	100
6172	Mixed Shrubs	98	98	98	98	98	0	0	100
6200	Wetland coniferous forests	98	98	98	98	98	0	0	100
6210	Cypress	98	98	98	98	98	0	0	100
6215	Cypress - Domes/Heads	98	98	98	98	98	0	0	100
6250	Wet Pinelands Hydric Pine	98	98	98	98	98	0	0	100
6300	Wetland forested mixed	98	98	98	98	98	0	0	100
6400	Vegetated non-forested wetlands	98	98	98	98	98	0	0	100
6410	Freshwater marshes	98	98	98	98	98	0	0	100
6411	Freshwater Marshes – Sawgrass	98	98	98	98	98	0	0	100
6420	Saltwater marshes	98	98	98	98	98	0	0	100
6430	Saltwater marshes	98	98	98	98	98	0	0	100
6440	Emergent aquatic vegetation	98	98	98	98	98	0	0	100
6500	Non-vegetated	98	98	98	98	98	0	0	100
6510	Tidal flats	98	98	98	98	98	0	0	100
6520	Tidal flats	98	98	98	98	98	0	0	100
6530	Intermittent ponds	98	98	98	98	98	0	0	100
7100	Beaches	77	86	91	94	100	0	0	100
7400	Disturbed land	77	86	91	94	100	0	0	100
8100	Transportation	39	61	74	80	100	5	67	28
8200	Communications	39	61	74	80	100	5	67	28
8300	Utilities	39	61	74	80	100	5	67	28

Table 5-17. Mean Annual Runoff Coefficients as a Function of DCIA Percentage and Non-DCIA Curve Number (Zone 4)

NDCIA CN	Percent DCIA																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	0.004	0.045	0.086	0.127	0.168	0.209	0.250	0.291	0.332	0.373	0.414	0.455	0.496	0.536	0.577	0.618	0.659	0.700	0.741	0.782	0.823
35	0.007	0.048	0.089	0.129	0.170	0.211	0.252	0.293	0.333	0.374	0.415	0.456	0.497	0.537	0.578	0.619	0.660	0.701	0.741	0.782	0.823
40	0.011	0.051	0.092	0.133	0.173	0.214	0.254	0.295	0.336	0.376	0.417	0.458	0.498	0.539	0.579	0.620	0.661	0.701	0.742	0.782	0.823
45	0.016	0.056	0.096	0.137	0.177	0.217	0.258	0.298	0.339	0.379	0.419	0.460	0.500	0.540	0.581	0.621	0.662	0.702	0.742	0.783	0.823
50	0.022	0.062	0.102	0.142	0.182	0.222	0.262	0.302	0.342	0.382	0.423	0.463	0.503	0.543	0.583	0.623	0.663	0.703	0.743	0.783	0.823
55	0.030	0.070	0.109	0.149	0.189	0.228	0.268	0.308	0.347	0.387	0.427	0.466	0.506	0.546	0.585	0.625	0.664	0.704	0.744	0.783	0.823
60	0.040	0.080	0.119	0.158	0.197	0.236	0.275	0.314	0.353	0.393	0.432	0.471	0.510	0.549	0.588	0.627	0.667	0.706	0.745	0.784	0.823
65	0.054	0.092	0.131	0.169	0.208	0.246	0.285	0.323	0.362	0.400	0.438	0.477	0.515	0.554	0.592	0.631	0.669	0.708	0.746	0.785	0.823
70	0.071	0.109	0.147	0.184	0.222	0.259	0.297	0.335	0.372	0.410	0.447	0.485	0.522	0.560	0.598	0.635	0.673	0.710	0.748	0.785	0.823
75	0.096	0.132	0.168	0.205	0.241	0.277	0.314	0.350	0.387	0.423	0.459	0.496	0.532	0.568	0.605	0.641	0.678	0.714	0.750	0.787	0.823
80	0.130	0.165	0.199	0.234	0.268	0.303	0.338	0.372	0.407	0.442	0.476	0.511	0.546	0.580	0.615	0.650	0.684	0.719	0.754	0.788	0.823
85	0.182	0.214	0.246	0.278	0.310	0.342	0.374	0.406	0.438	0.470	0.502	0.534	0.566	0.599	0.631	0.663	0.695	0.727	0.759	0.791	0.823
90	0.266	0.294	0.322	0.350	0.378	0.406	0.433	0.461	0.489	0.517	0.545	0.573	0.600	0.628	0.656	0.684	0.712	0.740	0.767	0.795	0.823
95	0.429	0.449	0.469	0.488	0.508	0.528	0.547	0.567	0.587	0.606	0.626	0.646	0.665	0.685	0.705	0.725	0.744	0.764	0.784	0.803	0.823
98	0.616	0.626	0.636	0.647	0.657	0.667	0.678	0.688	0.699	0.709	0.719	0.730	0.740	0.750	0.761	0.771	0.782	0.792	0.802	0.813	0.823

Data Source: FDEP Stormwater Quality Applicant's Handbook (March 2010 Draft)

Table 5-18. Lookup Table of Mean Annual Runoff Coefficient

FLUCCS Code	Description	Runoff Coefficient by Soil Hydro Group				
		A	B	C	D	W
1100	Residential, low density	0.135	0.165	0.207	0.243	0.823
1110	Low Density: Fixed Single Family Units	0.135	0.165	0.207	0.243	0.823
1130	Low Density: Mixed Units, Fixed and Mobile Home U	0.135	0.165	0.207	0.243	0.823
1180	Rural Residential	0.135	0.165	0.207	0.243	0.823
1200	Residential, medium density	0.216	0.245	0.280	0.312	0.823
1300	Residential, high density	0.464	0.484	0.509	0.529	0.823
1400	Commercial and services	0.629	0.642	0.659	0.672	0.823
1500	Industrial	0.558	0.571	0.589	0.604	0.823
1600	Extractive	0.112	0.183	0.259	0.321	0.823
1660	Holding pond	0.112	0.183	0.259	0.321	0.823
1700	Institutional	0.460	0.477	0.501	0.520	0.823
1800	Recreational	0.031	0.067	0.117	0.159	0.823
1820	Golf courses	0.016	0.053	0.106	0.149	0.823
1900	Open land (Urban)	0.010	0.043	0.091	0.130	0.823
2100	Cropland and pastureland	0.021	0.068	0.123	0.172	0.823
2110	Improved pastures	0.021	0.068	0.123	0.172	0.823
2120	Unimproved pastures	0.021	0.068	0.123	0.172	0.823
2130	Woodland pastures	0.021	0.068	0.123	0.172	0.823
2140	Cropland and pastureland	0.021	0.068	0.123	0.172	0.823
2200	Tree crops	0.015	0.054	0.110	0.151	0.823
2210	Citrus groves	0.015	0.054	0.110	0.151	0.823
2300	Feeding operations	0.086	0.161	0.249	0.331	0.823
2400	Nurseries and vineyards	0.034	0.086	0.151	0.199	0.823
2500	Specialty farms	0.038	0.091	0.151	0.199	0.823
2550	Aquaculture	0.038	0.091	0.151	0.199	0.823
2600	Other open land (Rural)	0.004	0.036	0.076	0.116	0.823
2610	Fallow Cropland	0.004	0.036	0.076	0.116	0.823
3100	Rangeland	0.048	0.076	0.140	0.249	0.823
3200	Shrub and brushland	0.007	0.032	0.071	0.110	0.823
3210	Palmetto Prairies	0.007	0.032	0.071	0.110	0.823
3300	Mixed rangeland	0.021	0.068	0.123	0.172	0.823
4100	Upland coniferous forests	0.016	0.057	0.110	0.161	0.823
4110	Upland coniferous forests	0.034	0.086	0.151	0.199	0.823
4120	Upland coniferous forests	0.014	0.054	0.103	0.151	0.823

Table 5-18. (Continued)
Lookup Table of Mean Annual Runoff Coefficient

FLUCCS Code	Description	Runoff Coefficient by Soil Hydro Group				
		A	B	C	D	W
4200	Upland hardwood forests	0.008	0.040	0.086	0.123	0.823
4220	Brazilian Pepper	0.008	0.040	0.086	0.123	0.823
4340	Mixed coniferous/hardwood	0.008	0.040	0.086	0.123	0.823
4400	Tree plantations	0.008	0.040	0.086	0.123	0.823
5100	Streams and waterways	0.823	0.823	0.823	0.823	0.823
5200	Lakes	0.823	0.823	0.823	0.823	0.823
5300	Reservoirs	0.823	0.823	0.823	0.823	0.823
5400	Bays and estuaries	0.823	0.823	0.823	0.823	0.823
6100	Wetland hardwood forests	0.616	0.616	0.616	0.616	0.823
6110	Bay swamps	0.616	0.616	0.616	0.616	0.823
6120	Mangrove swamps	0.616	0.616	0.616	0.616	0.823
6150	Stream and lake swamps	0.616	0.616	0.616	0.616	0.823
6170	Mixed wetland hardwoods	0.616	0.616	0.616	0.616	0.823
6172	Mixed Shrubs	0.616	0.616	0.616	0.616	0.823
6200	Wetland coniferous forests	0.616	0.616	0.616	0.616	0.823
6210	Cypress	0.616	0.616	0.616	0.616	0.823
6215	Cypress - Domes/Heads	0.616	0.616	0.616	0.616	0.823
6250	Wet Pinelands Hydric Pine	0.616	0.616	0.616	0.616	0.823
6300	Wetland forested mixed	0.616	0.616	0.616	0.616	0.823
6400	Vegetated non-forested wetlands	0.616	0.616	0.616	0.616	0.823
6410	Freshwater marshes	0.616	0.616	0.616	0.616	0.823
6411	Freshwater Marshes – Sawgrass	0.616	0.616	0.616	0.616	0.823
6420	Saltwater marshes	0.616	0.616	0.616	0.616	0.823
6430	Saltwater marshes	0.616	0.616	0.616	0.616	0.823
6440	Emergent aquatic vegetation	0.616	0.616	0.616	0.616	0.823
6500	Non-vegetated	0.616	0.616	0.616	0.616	0.823
6510	Tidal flats	0.616	0.616	0.616	0.616	0.823
6520	Tidal flats	0.616	0.616	0.616	0.616	0.823
6530	Intermittent ponds	0.616	0.616	0.616	0.616	0.823
7100	Beaches	0.110	0.199	0.299	0.396	0.823
7400	Disturbed land	0.110	0.199	0.299	0.396	0.823
8100	Transportation	0.558	0.571	0.589	0.604	0.823
8200	Communications	0.558	0.571	0.589	0.604	0.823
8300	Utilities	0.558	0.571	0.589	0.604	0.823

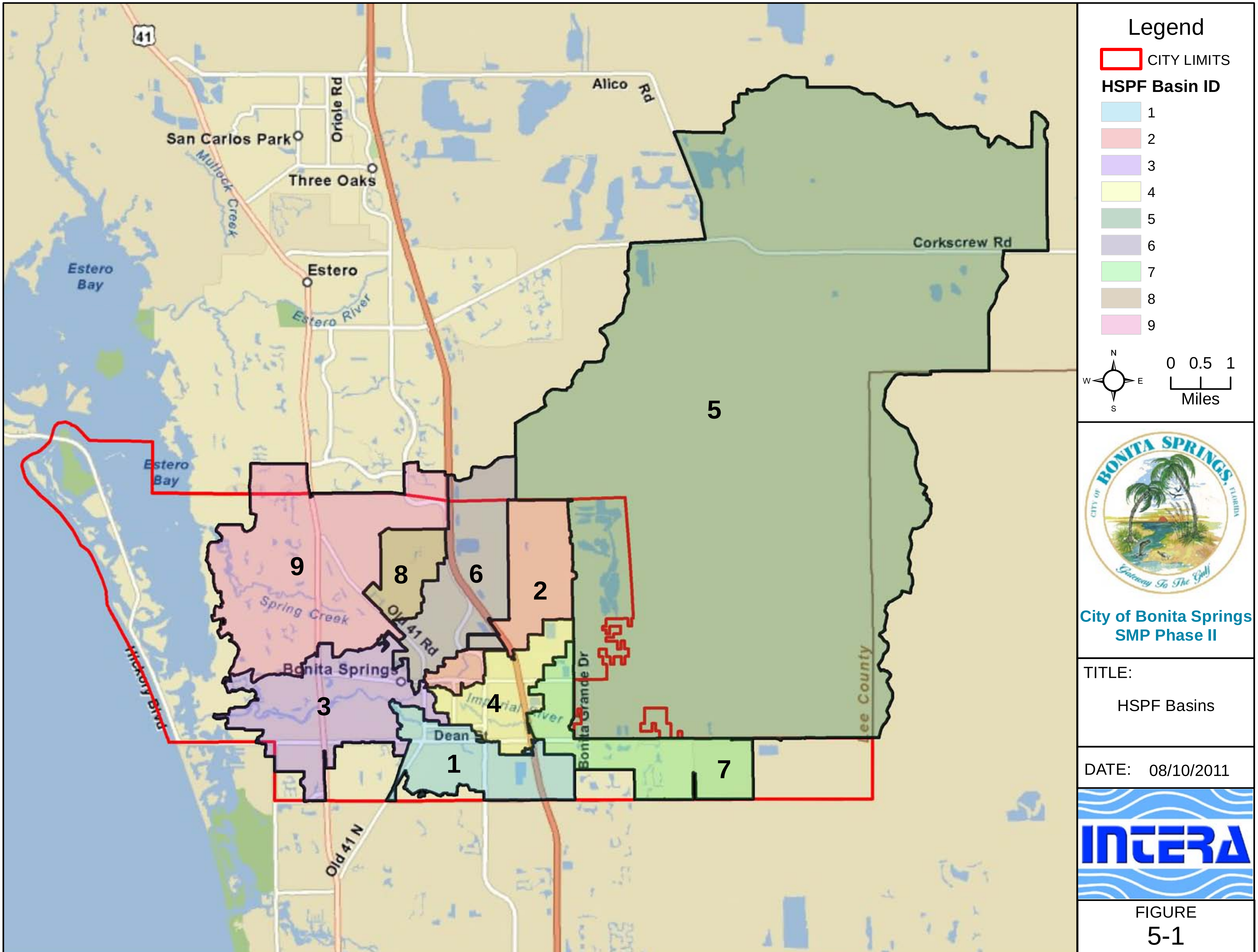
Table 5-19.
Summary of Annual Runoff Volume and TN Loading for Potential BMP Sites

Site ID	Contributing Area (ac)	Annual Runoff Volume (ac-ft/yr)	Annual TN Loading (lb/yr)
1	48.92	68.85	283.69
2	38.35	37.71	183.43
3	1,500.07	2399.29	5029.60
4	1,624.19	2218.58	9608.29
5	1,661.67	2261.86	9820.65
6	33.72	75.80	382.99
7	26.19	27.08	107.17
8	24.24	42.99	186.31
9	163.04	329.77	270.38
10	37.24	50.98	254.88
11	96.77	241.51	699.61
12	91.88	117.14	507.38
13	10.68	14.53	72.77
14	47.18	44.59	224.31
15	31.24	55.08	275.33
16	18.38	20.42	97.43

Table 5-20. Dry Retention System Mean Annual TN Removal Efficiencies as a Function of DCIA and Non-DCIA Curve Number (Zone 4)

Mean Annual Mass Removal Efficiencies (%) for 0.50-inches of Retention for Zone 4

NDCIA	Percent DCIA																	
CN	0-15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	92.1	88.8	84.8	80.5	76.3	72.4	68.6	65.2	62.0	59.1	56.4	53.9	51.7	49.5	47.6	45.8	44.1	42.6
35	90.7	87.7	84.0	79.9	75.9	72.0	68.4	65.0	61.9	59.0	56.3	53.9	51.6	49.5	47.6	45.8	44.1	42.6
40	88.9	86.4	82.9	79.1	75.3	71.5	68.0	64.7	61.6	58.8	56.2	53.8	51.5	49.4	47.5	45.7	44.1	42.6
45	86.8	84.7	81.6	78.1	74.5	70.9	67.5	64.3	61.3	58.6	56.0	53.6	51.4	49.4	47.5	45.7	44.1	42.6
50	84.3	82.7	80.1	76.9	73.5	70.2	66.9	63.9	61.0	58.3	55.8	53.5	51.3	49.3	47.4	45.7	44.1	42.6
55	81.4	80.4	78.2	75.4	72.3	69.2	66.2	63.3	60.5	57.9	55.5	53.2	51.1	49.2	47.3	45.6	44.0	42.6
60	78.1	77.6	75.9	73.6	70.9	68.0	65.2	62.5	59.9	57.4	55.1	53.0	50.9	49.0	47.2	45.6	44.0	42.6
65	74.5	74.5	73.3	71.4	69.1	66.6	64.1	61.6	59.2	56.9	54.7	52.6	50.6	48.8	47.1	45.5	44.0	42.6
70	70.8	70.8	70.2	68.9	67.0	64.9	62.7	60.5	58.3	56.1	54.1	52.1	50.3	48.6	46.9	45.4	43.9	42.6
75	66.7	66.7	66.6	65.7	64.4	62.7	60.9	59.0	57.1	55.2	53.3	51.5	49.8	48.2	46.7	45.2	43.8	42.6
80	62.4	62.4	62.4	61.9	61.1	59.9	58.6	57.1	55.5	53.9	52.3	50.7	49.2	47.8	46.4	45.0	43.8	42.6
85	57.7	57.7	57.7	57.6	57.1	56.4	55.5	54.5	53.3	52.1	50.8	49.6	48.3	47.1	45.9	44.7	43.6	42.6
90	52.8	52.8	52.8	52.8	52.6	52.2	51.7	51.1	50.3	49.6	48.7	47.9	47.0	46.1	45.2	44.3	43.4	42.6
95	47.6	47.6	47.6	47.6	47.5	47.3	47.1	46.8	46.5	46.2	45.8	45.4	44.9	44.5	44.0	43.5	43.0	42.6
98	44.8	44.8	44.7	44.7	44.6	44.5	44.3	44.2	44.1	44.0	43.8	43.6	43.5	43.3	43.1	42.9	42.7	42.6



City of Bonita Springs
SMP Phase II

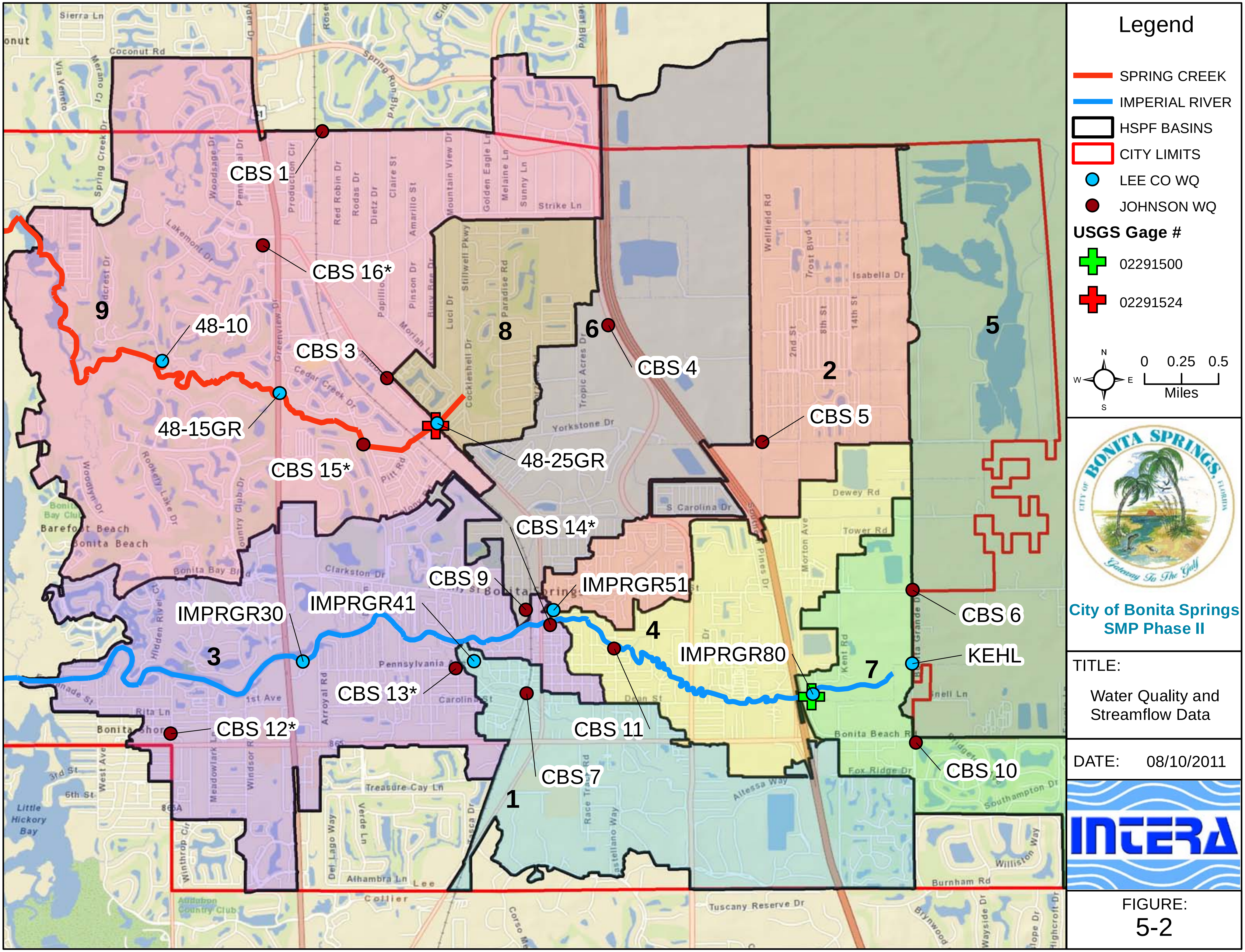
TITLE:

HSPF Basins

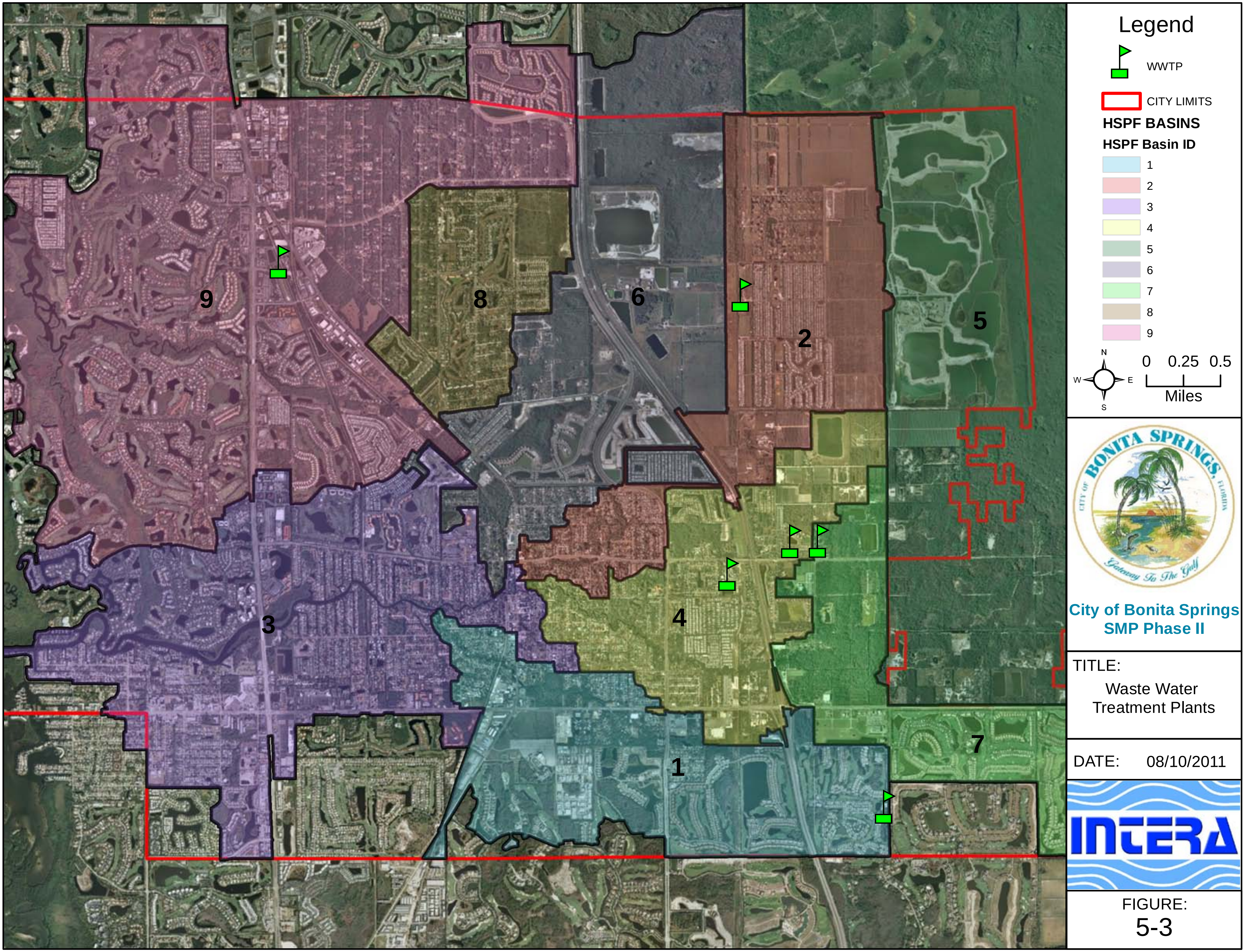
DATE: 08/10/2011

INTERA

FIGURE
5-1



Legend
SPRING CREEK
IMPERIAL RIVER
HSPF BASINS
CITY LIMITS
LEE CO WQ
JOHNSON WQ
USGS Gage #
02291500
02291524
0 0.25 0.5
Miles
N
S
E
W
1
2
3
4
5
6
7
8
9
CBS 1
CBS 16*
CBS 3
CBS 15*
CBS 4
CBS 5
CBS 14*
CBS 9
CBS 6
CBS 13*
CBS 12*
CBS 11
CBS 7
CBS 10
48-10
48-15GR
48-25GR
IMPRGR30
IMPRGR41
IMPRGR51
IMPRGR80
KEHL
BONITA SPRINGS
City of Bonita Springs
SMP Phase II
TITLE:
Water Quality and
Streamflow Data
DATE: 08/10/2011
INTERA
FIGURE:
5-2



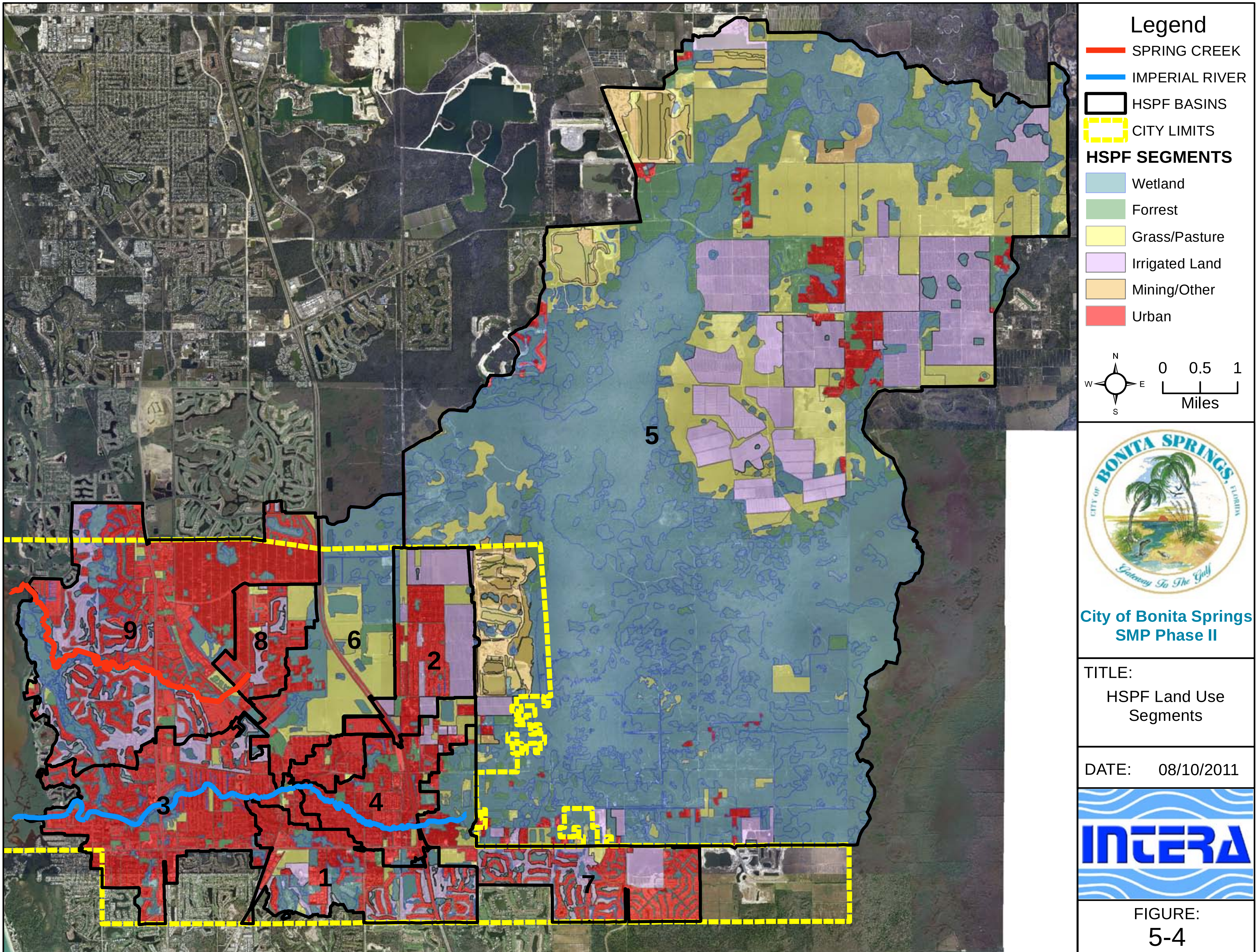
City of Bonita Springs
SMP Phase II

TITLE:
Waste Water Treatment Plants

DATE: 08/10/2011

INTERA

FIGURE:
5-3


Legend
SPRING CREEK
IMPERIAL RIVER
HSPF BASINS
CITY LIMITS
HSPF SEGMENTS
Wetland
Forrest
Grass/Pasture
Irrigated Land
Mining/Other
Urban
N
W
E
S
0
0.5
1
Miles
1
2
3
4
5
6
7
8
9
CITY OF BONITA SPRINGS FLORIDA
Gateway To The Gulf
City of Bonita Springs
SMP Phase II
TITLE:
HSPF Land Use Segments
DATE: 08/10/2011
INTERA
FIGURE:
5-4

6 Water Quality Issue and Solutions

6.1 Existing Water Quality Conditions

Like many Florida cities, much of the original drainage system of the City of Bonita Springs was constructed during the early part of the last century with little consideration to water quality impacts. In virtually all cases, construction design criteria used did not include any stormwater quality treatment considerations. As such, the vast majority of the City's existing stormwater infrastructure was designed for flood protection. The primary goal of this project is to modernize the City's existing situation to address the current regulatory focus on water quality within the City jurisdiction.

6.2 Best Management Practice Solutions

A stormwater best management practice (BMP) is a structural control or non-strutural preventative measure that is used for a given set of circumstances to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner. BMPs can be engineered and constructed systems ("structural BMPs") to improve the quality and/or control the quantity of runoff. Examples of structural BMPs include retention/detention ponds, constructed wetlands, and diversion structures or weirs, which are designed to limit the amount of stormwater runoff discharge and thus reduce the amounts of pollutants in the runoff. Non-structural BMPs reduce the source of pollution through regulation of practices including fertilizer application and land use.

No single BMP will address all stormwater scenarios; each type has certain limitations based on drainage area served, available land space, cost, and pollutant removal efficiency, as well as a variety of site-specific factors such as soil types, slopes, and depth to groundwater table.

In existing urbanized areas, BMPs can be implemented to address a range of water quantity and water quality considerations. For new urban development, BMPs should be designed and implemented so that the post-development peak discharge rate, volume, and pollutant loadings to receiving waters are the same or less than pre-development values. To meet these goals, multiple BMPs can be implemented to address three main factors: flow control, pollutant removal, and pollutant source reductions.

6.2.1 Non-Structural BMPs

Non-structural BMPs include prevention practices designed to improve water quality by reducing the accumulation and generation of potential pollutants at or near their source. They do not require construction of a facility, but instead provide for the development of pollution control programs that include, but are not limited to prevention, education, and regulation. These programs may consist of the following elements:

- Regulations, Ordinances, and Guidelines
- Conservation, recycling, and source controls
- Maintenance and operational procedures
- Educational and outreach programs

Most non-structural BMP options are applicable for use in residential, commercial, industrial, agricultural, and nursery operations in newly developed or existing watersheds. They can be used to complement structural BMPs in developing areas; however they may be the only option for existing developments.

Regulations, Ordinances, and Guidelines

Action plans and regulations encourage or mandate management practices that prevent, reduce, or treat stormwater runoff. For example, setbacks can be required from waterways, minimum allowable impervious areas within a site can be established, and criteria for treating runoff can be mandated. Plans for stormwater runoff control should be submitted to the appropriate agencies for review and approval. The planning process gives the public an opportunity to participate in the decision making process regarding stormwater quality for existing and future land uses within their area. Existing federal, state, local, and site specific requirements provide the basis for building regulatory programs.

Ordinances and Regulatory Programs: Federal agencies are tasked with establishing nationwide programs to address stormwater pollution. The State of Florida has generally established regulations by adopting the appropriate Code of Federal Regulations title into the Florida Statutes and the Florida Administrative Code. Water management districts function under these codes and require permits for the construction and operation of water management systems, water usage, or water quality monitoring plans.

Local governments play an important role in establishing regulatory programs that provide opportunities to meet specific local objectives. Regulatory measures must comply with state and federal mandates and should address such issues as hazardous materials codes, zoning, land development and land use regulations, water shortage and conservation policies, and controls on types of flow allowed to drain into sanitary municipal storm sewer systems.

Ordinances are laws or rules issued by a local government under legal authority granted by statutes. They can include findings of fact, objectives or purposes, definitions, permitting requirements, variances, performance/design standards, and enforcement policies.

Low Impact Development: The applications of Low Impact Development (LID) principles are key management actions being advanced and utilized by stakeholders to offset the effects of future growth. LID is an approach to land development that uses various land planning and design practices and technologies to simultaneously protect natural resource systems and reduce infrastructure costs. Key LID principles include the following:

- Incorporation of small-scale stormwater treatment systems integrated at the lot level
- Increased infiltration
- Reduction of impervious surfaces
- Preservation/protection of environmentally sensitive features
- Use of multiple strategies (i.e., treatment train)

Innovative stormwater management strategies are a significant component of LID. The basic concept is to manage runoff at the source with decentralized techniques that replicate a site's predevelopment hydrology. These design techniques infiltrate, filter, store, evaporate, and detain runoff close to its source. LID is a versatile approach that can be applied to new development, urban retrofits, and redevelopment/revitalization projects. Key components that are elements of LID design are as follows:

- Site design (clustering, decreasing impervious surfaces, disconnected impervious areas)
- Swales and filter strips
- Pervious pavements
- Green roofs
- Bioretention areas (i.e., rain gardens)
- Florida-Friendly Landscaping (including local Florida Yards & Neighborhoods workshops and outreach programs)
- Buffers
- Education and public outreach

<u>Conservation, Recycling, and Source Controls</u>

Conservation Plan: All water users, including domestic, utility, commercial, agricultural, and recreational, have an opportunity and responsibility to conserve water to reduce or eliminate the amount of water potentially requiring stormwater runoff treatment. Promotion of conservation practices is essential in all communities. A good water conservation plan should include a framework for the following components:

- Appropriate lawn irrigation
- Xeriscape landscape component
- Low volume plumbing fixtures
- Conservation-oriented rate structures by utilities
- Leak detection programs
- Public education for conservation

Using Reclaimed Water: Recycling water involves treating and disinfecting wastewater for other innovative and beneficial uses such as the irrigation, groundwater recharge, manufacturing processes, wetlands, fire protection, aesthetic enhancement for landscape feature, dust control and others.

Source Control Measures: These measures address management, storage, and/or disposal practices of contaminants on the typical urban landscape. They may reduce or eliminate pollutants deposited on land surfaces that may eventually come in contact with stormwater and be transported to receiving waters. Water quality benefits may be derived from addressing the following:

- Erosion and sediment control during construction
- Collection and proper disposal of animal waste
- Collection and proper disposal of solid waste
- Proper disposal and composting of yard waste
- Proper disposal and recycling of unused toxic waste materials
- Proper storage, disposal, and recycling of unused automotive fluids and prevention of fluid leaks
- Modified use of chemicals such as fertilizer, pesticides, and herbicides
- Safe storage, handling, and disposal of hazardous household products

Maintenance and Operational Procedures

Non-structural maintenance and operational procedures can be used to prevent or reduce the need for more costly structural treatment controls. To ensure the proper operation of stormwater BMP systems, periodic maintenance tasks are required. The efficiency of an entire system relies on the proper upkeep of all BMP components. Non-structural maintenance operations may consist of the following:

- Turf and landscape management
- Street cleaning
- Catch basin cleaning
- Road maintenance
- Canal/ditch maintenance
- Modification of structural operations

Turf and Landscape Management: Lawns and grasses planted for aesthetic and recreational use, surface stabilization, and erosion control require routine maintenance that includes irrigation, mowing, fertilization, targeted pest management, aeration, and/or dethatching. Mowing should be performed at optimal times, such as when no significant rainfall events are predicted.

Municipal "no dumping" ordinances should be enacted to prevent the disposal of cuttings and clippings in or near drainage facilities. Composting is a good disposal alternative, and the installation of a yard waste composting facility is a viable management tool. Turf and landscape management procedures should be consistent with vegetation use, growing season, and the amount of rainfall.

Street Cleaning: Routine street cleaning removes accumulated depositions of solids that may otherwise be transported as contaminants within the first flush of stormwater. Efficiency depends upon sweeping frequency which appears to be more effective in areas with distinct wet and dry seasons. Sweeping practices should increase just prior to the rainy season. Mechanical broom sweepers, vacuum sweepers, and street flushers are typically used for cleaning and are very effective in removing larger particles (>50 microns) and associated pollutants (i.e., solids and heavy metals). Parked cars can be an obstacle to effective sweeping and therefore parking regulations may be required. Costs for purchasing equipment and implementing a program can be significant.

Catch Basin Cleaning: Accumulated sediments should be removed from catch basins on a regular basis to prevent clogging. Basins should be cleaned before the sump is 40 percent full. Maintenance schedules should be targeted to those areas with the highest pollutant loading. Capital costs may be high, as communities with numerous basins will need to procure mechanical cleaners such as educators, vacuums, or bucket loaders.

Road Maintenance: Deteriorating roadway surfaces can contribute to contamination of stormwater. Potholes and worn pavement should be promptly repaired to reduce sediment loading. Minimizing the size of the impervious area is the most effective method to reduce stormwater pollution from roadways. Aggressive maintenance programs are more cost effective than complete roadway replacements.

Canal/Ditch Maintenance: Ditches that carry heavy flow concentrations should be periodically checked for collapsed or blocked flowways, or degradation of flowway lining materials. The channel bottom should be dredged if a buildup of sediment occurs. Illegally dumped items should be removed to reduce possible pollutants and achieve aesthetic enhancement. “No littering” signs can be posted with a call-in number to report dumping in progress. Also, if water quality will not be compromised, the characteristics of the channel can be modified to improve hydraulics.

Modification of Structural Operations: Schedules for structural operations can be modified to optimize water quality objectives. Activities such as diverting low quality water away from critical habitat areas; increasing the detention times or reducing the discharge orifice size in existing ponds; storing water for future use during drought periods; recharging the ground water table; and mixing clean water with degraded water to enhance quality are all examples of modifying operations to achieve these priorities. Successful operations will reduce risk, increase water supply reliability, and enhance water quality.

Educational and Outreach Programs

Public education is a BMP that can be implemented to meet the individual needs and interests of each segment of the community. Outreach programs should be integrated into a community's stormwater management plan to educate employees, the public, and businesses about the importance of protecting stormwater from the improper use, storage, and disposal of pollutants. Often people are not aware of the cumulative effects of pollution generating activities. Once a pollutant has been linked with a particular community, support for volunteer efforts and public education campaigns can be made through the local civic association.

Public and private funding partnerships may be needed to ensure participation and encourage development of information and infrastructure improvements. Public information can be expensive to develop and distribute and must be periodically updated and redistributed. A specific course of action must be defined and the associated cost to implement a solution determined for each problem. The initiation of a well-coordinated comprehensive campaign will be more effective at reaching audiences rather than a series of separate actions that may seem unrelated.

The public should be educated regarding their relationship they have with the watershed in the area where they live. Programs informing citizens of practices that reduce sources of potential pollutants in runoff will encourage them to become part of the solution. They must receive repeated messages about how their behavior affects the health of their watershed to encourage behavior modification. The effectiveness of a program can be assessed by estimating how many people will hear the message, change their behavior, and to what degree their behavior changes. A public education plan should consist of several kinds of activities that may include the following:

- Public surveys to assess use of toxic materials, disposal practices, and overall environmental awareness
- Frequent and consistent campaign messages using a mission statement, logo, and tag line
- Campaign products such as door hangers, pamphlets, guidebooks, signs, press releases, or classroom/library displays
- Public outreach activities such as having a field day where a local water quality expert comes to a community to demonstrate ways of reducing pollution
- Neighborhood projects, such as the following:
    - Identifying storm drains with stenciling to discourage dumping
    - Distributing toxics checklist of household hazardous waste
    - Producing displays and exhibits for school programs
    - Distributing free seedlings for erosion control
    - Creating volunteer opportunities such as water quality monitoring
    - Conducting awards ceremonies for specific neighborhood projects

6.2.2 Structural BMPs

Structural BMPs are used to treat stormwater at either the point of generation or the point of discharge to either the storm sewer system or to receiving waters. Generally, application of a single BMP will be insufficient to adequately address all aspects of a particular set of stormwater circumstances. As such, the system designers must employ a series of BMPs commonly referred to as a “treatment train” to accomplish the design objective.

There are a wide variety of structural BMPs in use for stormwater management. Structural BMPs include engineered and constructed systems that are designed to provide for water quantity and/or water quality control of stormwater runoff. It is important to understand the distinction between BMP types, in particular, the terms “retention” and detention” are frequently used interchangeably, although they have distinct meanings.

Detention is defined as providing temporary storage of a runoff volume prior to discharge. Retention, conversely, is defined as providing complete storage of runoff without discharge by means other than evaporation or infiltration. With the strict interpretation of this definition, retention practices would be limited to those practices that only infiltrate or evaporate runoff. However, retention is also commonly misused to describe a practice that primarily retains a runoff volume in a permanent pool until it is displaced in part or in total by the next storm event. Structural BMPs can been grouped and defined as follows:

- Infiltration systems which capture defined volumes of runoff and infiltrate into the ground.
- Detention systems which capture defined volumes of runoff and temporarily detain that volume prior to release by surface discharge.
- Retention systems which capture a defined volume of runoff and retain that volume until it evaporates, infiltrates or is displaced in part or in total by the next runoff event.
- Constructed wetland systems which incorporate elements of both retention and detention systems. Treatment in these systems is primarily provided by aquatic vegetation that is incorporated in the design to treat runoff by bio-assimilation.
- Filtration systems which use a combination of filtration media such as sand, organic materials, carbon, or membrane technology to remove pollutants found in stormwater runoff.
- Vegetated systems (biofilters) which include such systems as grassed swales and vegetated filter strips designed to convey and treat runoff.
- Miscellaneous and vendor-supplied systems which include a variety of proprietary mechanical systems that capture various solids in runoff. These systems include catch basin inserts, hydrodynamic devices and other filtration devices.

Infiltration Systems

Infiltration systems include infiltration basins, pervious pavement systems, and infiltration trenches or wells. An infiltration BMP is designed to capture a specific volume of runoff, retain it, and infiltrate that volume into the ground water regime. Infiltration of stormwater has a number of advantages and disadvantages. The primary advantage of infiltration is water quality treatment by reducing the volume of runoff contributing to discharge runoff. However, this tends to be a limited fraction of the overall reducing runoff volume. Infiltration systems should be designed to capture a specific volume of stormwater runoff and infiltrate that volume into the ground over a period of time.

Infiltration provides secondary benefits by increasing recharge to the underlying surficial aquifer thus raising the ambient water table and providing increased baseflow to nearby streams. Pollutant removal occurs as water percolates through the adjacent soil and filters pollutants. Microorganisms in the soil also provide degradation to organic pollutants that are contained in the infiltrated stormwater. Although the water quality aspect of infiltration systems is limited, infiltration of runoff mitigates and generally mimics the pre-urbanized characteristics of an area by eliminating discharge from numerous small events, and by returning that rainfall volume back into the groundwater column.

Although infiltration of stormwater has many benefits, there are limitations. First, infiltration may not be appropriate in the vicinity of areas where groundwater is a primary source of drinking water supply due to the potential for contaminant migration. This is especially true of runoff from commercial or industrial areas where the potential for contamination by organic compounds or heavy metals is present. The performance of infiltration BMPs is limited in areas with poorly permeable soils. Infiltration BMPs can experience reduced infiltrative capacity and even clogging due to excessive sediment accumulation. A dedicated maintenance program is required to maintain the infiltrative capacity of the system. Care must also be taken during construction to limit compaction of the soil layers underlying the BMP. Excessive compaction due to construction equipment will reduce infiltrative capacity of the system. Excessive sediment generation during construction and site grading/stabilization may cause premature clogging of the system if not addressed prior to operating the system. Infiltration systems should not be placed into service until disturbed areas have been stabilized by vegetation or grasses.

Infiltration Basins: Infiltration basins, such as **dry detention** areas, are designed to capture a specific stormwater runoff volume, hold this volume and infiltrate it into the ground over a period of time. Infiltration basins are usually placed off-line and designed to intercept a certain volume of runoff, with any excess volume bypassing the system. The basin should include the planting of aquatic vegetation, to assist in preventing the migration of pollutants. Also, the roots of the vegetation increase the permeability of the soils, thereby increasing the systems infiltration efficiency. Infiltration basins are typically not designed to retain a permanent pool volume; their primary treatment function is provided by converting surface water runoff to infiltrated groundwater. Pollutants are removed through mechanisms such as filtration, adsorption, and biological conversion as the water percolates through the underlying soil.

Infiltration basins should be designed to restore the treatment volume within 72 hours to prevent mosquito breeding and potential odor problems associated with standing water and to ensure that the basin is ready to receive runoff from the next storm. In addition to removing pollutants, infiltration basins are useful to help restore or maintain redevelopment hydrology before increasing the ambient water table, and increasing stream base flow.

Pervious Pavement Systems: Pervious pavement is an infiltration system where stormwater runoff is infiltrated into the ground through a permeable layer of pavement or other stabilized permeable surface. These systems can include pervious asphalt, pervious concrete, pervious aggregate/binder products, pervious paver systems, and modular paver systems.

Pervious pavement can be used in many applications where traditional paved surfaces are called for and can greatly reduce the amount of runoff and associated pollutants discharging from these areas. Pervious pavement systems are suitable for a limited number of applications and typically should only be used in areas that are not exposed to high volumes of traffic or heavy equipment. They are particularly useful for driveways, secondary streets, residential areas, and low turnover and overflow parking areas in commercial and industrial areas.

Pervious pavement is not effective in areas subject to high amounts of sediment due to the tendency of the pores to clog. To prevent clogging and subsequent loss of percolation, pervious pavement requires periodic maintenance by vacuuming or jet-washing to remove sediment from the pores. Paved areas should be clearly marked to indicate that a pervious pavement system is in use and to limit use by heavy equipment, reduce traffic volume, and to prevent resurfacing with non-pervious pavement.

Studies of properly maintained pervious concrete systems used in Florida indicate the system has performed well. Many of the documented failures are attributed to lack of proper erosion and sediment controls during construction or lack of contractor experience with installation of pervious pavement systems. When properly designed and maintained, pervious pavement systems can be a very effective means of reducing urban stormwater runoff.

Infiltration Trenches and Wells: An infiltration trench or well is a gravel-filled trench or vertical well designed to infiltrate stormwater into the ground water column. A volume of stormwater runoff is diverted into a designed trench or well where it infiltrates into the surrounding soil. Typically infiltration trenches and wells can only capture a limited amount of runoff and therefore may be designed to capture the “first flush” of runoff from a relatively small area. For this reason, these systems are frequently used in combination with another BMP such as a detention basin to control peak stormwater flows. Infiltration trenches and wells can be used as initial treatment to remove suspended solids, particulates, bacteria, organics, and soluble metals and nutrients through the mechanisms of filtration, absorption, and microbial decomposition. They are also useful in providing groundwater recharge and to increase base flow levels in nearby streams. As with any infiltration practice, the possibility for groundwater contamination due to buildup may exist.

<u>Detention Systems</u>

Detention systems are BMPs designed to intercept a volume of stormwater runoff and temporarily impound the water for gradual release to the receiving stream or storm sewer system. Detention systems are designed to completely discharge the treatment volume between storm events, and therefore provide primarily water quantity benefits as opposed to water quality treatment. However, detention basins do provide settling of particulate matter, and a limited amount of infiltration but a large portion of settled material can be re-suspended by subsequent runoff events and infiltration is limited by the reduced detention times. Detention facilities should be considered mainly as practices used to reduce the peak stages and discharge rates to receiving streams in order to reduce downstream flooding and to provide some degree of channel protection. There are several types of detention facilities used to manage stormwater runoff, including wet and dry detention basins, and underground chambers.

Dry/Wet Detention Systems: Detention systems are of two types, wet or dry and are designed to intercept a volume of stormwater, temporarily impounding the water, and releasing it over time at a design rate after the storm event. The main purpose of a detention system is quantity control by reducing the peak flow rate of stormwater discharges. Wet systems are designed to retain permanent pool volumes below a design water level (control elevation) between runoff events. Dry detention system are not designed to retain a permanent pool below the control elevation and have a bottom elevation at least 1.0 foot above the wet season water table. Both systems are designed to empty in a time period of less than 72 hours. The treatment ability of detention system is usually limited to the removal of suspended solids and associated contaminants by gravity settling. The efficiency can be increased by incorporating various elements such as forebay or separate settling chambers for the accumulation of coarse sediment, facilitating periodic cleaning to prevent re-suspension by subsequent storm events.

Detention systems can assist in limiting downstream scour and subsequent loss of aquatic habitat by reducing the impact of peak flow rates and reducing the energy of stormwater discharges to the receiving stream. Treatment efficiency can be further enhanced by including the plantings of various hydrophyotic plants to increase pollutant assimilation.

Underground Chambers: Underground detention chambers such as vaults, pipes and tanks are designed to provide temporary storage of stormwater runoff. Significant water quality improvements should not be expected with this BMP without a significant infiltration component. Infiltration in underground chambers would be difficult to maintain given the high water table. They should mainly be used for providing storage to limit downstream impacts due to high peak flow rates. Like detention basins, underground detention systems are designed to drain between runoff events so that storage capacity is available for subsequent runoff events. Underground chambers can be utilized in series with other treatment systems to obtain both detention as well as treatment.

Retention Systems: Retention systems are designed to capture a defined volume of runoff and retain that volume until it is displaced in part or in total by the next runoff event. Retention ponds, when properly designed and maintained, can be extremely effective BMPs, providing both water quality improvements and quantity control, as well as providing aesthetic value and aquatic and terrestrial habitat for a variety of plants and animals. The volume available for storage, termed the water quality volume, is provided above the permanent pool level of the system. Discharge from these systems is limited to evaporation, infiltration, or displacement. The main pollutant removal mechanisms in retention systems are sedimentation and bio assimilation. By retaining a permanent pool of water, retention systems can benefit from the added biological and biochemical pollutant removal mechanisms provided by aquatic plants and microorganisms, mimicking a natural pond or lake ecosystem. Also, sediments that accumulate in the pond are less likely to be re-suspended and washed out due to the presence of a permanent pool of water and then relative depth of the system. In addition to sedimentation, other pollutant removal mechanisms in retention systems include filtration of suspended solids by vegetation, infiltration, biological uptake of nutrients by aquatic plants and algae, volatilization of organic compounds, uptake of metals by plant tissue, and biological conversion of organic compounds. Retention basins that incorporate an aquatic bench around the perimeter of the pond with planted aquatic vegetation can have increased pollutant removal efficiency. This littoral zone can aid in pollutant removal efficiency by incorporating mechanisms found in wetland systems.

Constructed Wetland Systems

Constructed wetland systems also referred to as filter marshes or Stormwater Treatment Areas (STA), incorporate the natural functions of native wetlands to aid in pollutant removal from stormwater. Constructed wetlands provide for quantity control of stormwater by providing storage volume of ponded water above the permanent pool elevation. As a living system, constructed wetland systems have limits to their applicability in that a water balance must be performed to assess the limits of the systems' hydroperiod to sustain the aquatic vegetation between runoff events and during the dry season. Additionally, a sediment forebay or some other pre-treatment provision should be incorporated into the wetland system design to allow for the removal of coarse sediments and floating debris that can degrade the performance of the system.

Constructed wetlands are particularly appropriate where groundwater levels are historically close to the land surface.

Depending upon regulatory considerations, stormwater runoff maybe routed to natural wetlands after pre-treatment in a constructed wetland system. Natural wetlands that receive treated stormwater runoff should be evaluated to determine if the runoff will cause degradation of the wetland, and if so, additional measures should be taken to protect the wetland from further degradation. As noted, regulatory authorities should be consulted early in the design process of the constructed wetland systems to avoid undue complications.

Wetland Treatment Areas and Wetland Channels: Wetland treatment areas and channels are any of a number of designed systems that incorporate mechanisms of natural wetland systems to improve water quality and provide quantity control. A wetland channel is designed to develop dense wetland vegetation to slowly convey storm flows to a rate of less than two (2) feet per second. Wetland treatment areas may be designed with or without an open water (permanent pool) component. Wetland treatment areas with open water are similar to retention ponds, except that a significant portion, usually 50 percent or more, of the permanent pool volume is covered by emergent wetland vegetation.

Wetland treatment areas without open water are typically inundated during peak runoff events, but maintain a shallow pool. Wetland treatment areas of this type, also known as filter marshes, support a variety of hydrophilic vegetation adapted to saturated soil conditions and tolerant of periodic inundation by runoff. Pollutant removal in wetlands can occur through a number of mechanisms including sedimentation, filtration, volatilization, adsorption, absorption, microbial decomposition, and plant uptake. In addition, wetlands can provide for significant amount of water storage during runoff events, thus supplying water quantity control as well.

Filtration Systems

A filtration system is a device that uses a media such as sand, gravel, peat, or compost to remove a fraction of the pollutant constituents found in stormwater runoff by filtration through the media. Filters are primarily a water quality control device designed to remove particulate pollutants. Limited quantity control can be included by providing additional storage volume in a pond or basin, by providing vertical storage volume above the filter bed, or for example by allowing water to temporarily pond in parking lots or other areas before being discharged through the filter. Media filters are commonly used to treat runoff from small sites such as parking lots and small developments, in areas with high pollution potential such as industrial areas, or in highly urbanized areas where land availability or costs preclude the use of other BMP types. Filters should be placed off-line i.e., a portion of the runoff volume, called the water quality volume or first flush, is diverted to the BMP, while any flows in excess of this volume are bypassed.

Media filters should incorporate the use of a forebay or pre-treatment chamber to remove a portion of the particulates solids before filtration. This helps to extend the life of the filter and prevent clogging of the filter media by removing a portion of the coarse sediment. Also, care must be taken to prevent construction site sediments and debris such as fines washed off of newly paved areas from entering the filter, as these can cause premature clogging of the filter.

Surface Sand Filter: The surface sand filter was developed in Florida in 1981 for sites that could not infiltrate runoff or were too small for effective use of detention systems.

The surface sand filter system usually incorporates two basins. Runoff first enters a sedimentation basin where coarse particles are removed by gravity settling. This sedimentation basin can be either wet or dry. Water then flows through a control device such as a weir or inlet into the filter basin. The filter bed consists of sand with a gravel bed and a perforated pipe under-drain system to capture the treated water. The surface of the filter bed should be planted with grass or other appropriate vegetation. Additional storage volume can be provided above the filter bed to increase the volume of water that can be temporarily ponded in the system before filtration. This two-basin configuration can help to limit premature clogging of the filter bed by first removing excess sediment loading.

Biofiltration/Bioretention Systems: Bioretention systems are designed to mimic the functions of a natural forested ecosystem for treating stormwater runoff. Bioretention systems are a variation of a surface sand filter, where the sand filtration media is replaced with a planted soil bed. Stormwater flows into a bioretention area, first ponds on the surface and infiltrates into the soil bed. Pollutants are removed by a number of processes including adsorption, filtration, volatilization, ion exchange, and decomposition. Treated water is allowed to infiltrate into the surrounding soil, or is collected by an under-drain system and discharged to a second treatment element or directly to the receiving waters. When water is allowed to infiltrate into the surrounding soil, bioretention systems can be an excellent source of groundwater recharge. Several components of a bioretention system include:

Grass Buffer Strips. Runoff enters the bioretention area as sheet flow through a grass buffer strips. These buffers reduce the velocity of the runoff, filter particulates, and promote assimilation and uptake of pollutants. Grass strips are typically directly connected to impervious areas.

Ponding Area. The ponding area provides for surface storage of stormwater runoff before it filters through a soil bed. The ponding area allows for discharges by evaporation and uptake by the system vegetation as well as promoting settling of sediment from the runoff.

Organic Mulch Layer. The organic mulch layer has several functions, which include protecting the soil bed from erosion, retaining moisture in the plant root zone, providing a medium for biological growth and decomposition of organic matter, and providing some filtration of pollutants.

Planting Soil Bed. The planting soil bed provides water and nutrients to support plant life in the bioretention system. Stormwater filters through the planting soil bed where pollutants are removed by the mechanisms of filtration, plant uptake, adsorption, and biological degradation.

Sand Bed. The sand bed underlies the planting soil bed and allows water to freely drain from the planting soil bed through the sand bed and into the surrounding soil. The sand bed also provides additional filtration and allows for aeration of the planting soil bed.

Plantings. Plantings are an important component of a bioretention system. Plants remove water though evapotranspiration and remove pollutants and nutrient through uptake. The plant species selected are designed to replicate a forested ecosystem and to survive stresses such as frequent periods of inundation during runoff events and drying during inter-event periods.

In addition to providing for treatment of stormwater, bioretention facilities, when properly maintained, can be aesthetically pleasing. Bioretention facilities can be placed in areas such as parking lot islands, in landscaped areas around buildings, the perimeter of parking lots, and in other open spaces. Since local regulations frequently require site plans to incorporate a certain percentage of open landscaped area, additional land requirements for bioretention facilities are often not required. The layout of bioretention facilities can be flexible, and the selection of plant species can provide for a wide variety of landscape designs. However, it is important that these systems be designed by registered individuals with experience in designing bioretention systems. Bioretention facilities can be adapted easily for use on individual residential lots. Prince George's County, MD has developed the concept of "rain gardens" which are small bioretention systems for use in single or multi-lot residential areas. They provide an easily maintainable, aesthetically pleasing, and effective means of controlling runoff from residential areas. By placing a series of bioretention areas throughout a residential area, the volume of stormwater runoff produced and requiring subsequent management can be significantly reduced.

Vegetated Systems (Biofilters)

Vegetated systems such as grass filter strips and vegetated swales are used to convey and provide initial stormwater treatment. These BMPs are commonly referred to as biofilters, since the grasses and vegetation "filter" the stormwater as it flows. Open channel vegetated systems are alternatives to traditional curb-and-gutter and storm sewer conveyance systems. By conveying stormwater runoff in vegetated systems, some degree of treatment, storage, and infiltration can be provided before discharge to subsequent treatment BMP's. This can help to reduce the overall volume of stormwater runoff that is generated from a particular drainage area.

Grass Filter Strips: Grass filter strips are densely vegetated and uniformly graded areas that intercept sheet runoff from impervious surfaces such as parking lots, highways, and rooftops. Grass filter strips are frequently planted with turf grasses, however alternatives that adopt any natural vegetated form such as meadows or small forest may be used. Grass filter strips can either accept sheet flow directly from impervious surfaces, or concentrated flow can be distributed along the width of the strip using a gravel trench or other level spreader. Grass filter strips primarily intended to trap sediments, to partially infiltrate this runoff and to reduce the velocity of the runoff. Grass filter strips are frequently used as a "pre-treatment" system before stormwater being treated by other BMPs such as filters or bioretention systems. Grass filter strips can also be used in combination with riparian buffers in treating sheet flows and in stabilizing drainage channel banks and stream banks. Grass filter strips should be irrigated to maintain a dense stand of vegetation and to prevent export of unconfined soil during the dry season.

Vegetated Swales: Vegetated swales are broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. Vegetated swales are designed to slowly convey stormwater runoff trapping pollutants, promoting infiltration and reducing flow velocities. Vegetated swales can be either wet or dry. Dry swales are used in areas where standing water is not desired, such as in residential areas. Wet swales can be used where standing water does not create a nuisance problem and where the groundwater level is close enough to the surface to maintain the permanent pool in inter-event periods. Wet swales provide the added benefit of being able to include a range of wetland vegetation to aid in pollutant removal.

Miscellaneous and Vendor-Supplied Systems

There is a wide variety of proprietary mechanical devices that are available for urban stormwater management. Many of these systems are fabricated systems and incorporate some combination of filtration media, hydrodynamic sediment removal, oil and grease removal, or screening to remove pollutants from stormwater. Their use has varied applicability and is circumstance dependant. These systems may consist of the following:

Water Quality Inlets: Water quality inlets rely on settling to remove pollutants before discharging water to the storm sewer or other collection system. They are also designed to trap floating trash and debris. When inlets are coupled with oil/grit separators and/or hydrocarbon absorbents, hydrocarbon loadings from high traffic/parking areas may be reduced. However, experience has shown that pollutant-removal effectiveness is limited, and the devices should be used only when coupled with extensive clean-out. Maintenance must include proper disposal of trapped coarse-grained sediments and hydrocarbons. Clean-out and disposal costs may be significant.

Catch basins are water quality inlets in their simplest form. They are single chambered inlets with a lowered bottom to provide 2 to 4 feet of additional space between the outlet pipe for collection of sediment at the bottom of the structure.

Some water quality inlets include two chambers. The first provides effective removal of coarse particles and helps prevent premature clogging of the filter media. A second chamber contains a sand filter to provide additional removal of finer suspended solids by filtration.

Sediment Separation: Sediment separation devices include sumps, baffle boxes, oil/grit separators, and sediment basins to capture trash, sediments, and floating debris. They are efficient only within specific ranges of volume and discharge rates. Control units usually have a forebay to pretreat discharges by separating heavy grit and floating debris before it enters the separator. Separation processes use gravity, vortex flow, centrifugal force, and even direct filtration. Further treatment may be accomplished by adding chemicals such as alum. After separation, the sediment is collected and transported or pumped to a waste treatment facility. These devices may have a high initial investment cost.

Chemical Treatment: Chemical processes include coagulation coupled with solids separation to remove pollutants. Iron, aluminum metal salts, and alum are used to coagulate compounds, then polymers are added to enhance flocculation and induce settling. The resulting settled floc and solids would need to be disposed and may need dewatering prior to disposal.

Chemical processes offer the advantage of low land requirements, flexibility, reliability, decreased detention time requirements, and the ability to enhance water quality to levels substantially lower than could be achieved using other methods alone. The drawbacks are high capital, operations and maintenance costs, and solid waste management requirements.

6.3 Operations & Maintenance Considerations

All of the systems discussed herein require a dedicated long term commitment to operation and maintenance. Most municipal operation and maintenance programs for stormwater facilities are frequently implemented in response to citizen complaints concerning flooding. Replacements or upgrades to the existing system capacity are normally dependent upon the degree, severity, and/or frequency of the occurrence(s). Existing system improvements can only be addressed through the capital improvement programming process. A comprehensive maintenance program including street sweeping, culvert and inlet maintenance, channel mowing and cleaning, will constitute a reduction in citizen complaints.

6.4 Urbanized vs. Developing Area

6.4.1 Core Urban Areas

Given the State and Federal mandates related to water quality improvements such as the FDEP TMDL program, this study has focused on water quality issues in the freshwater section of the Imperial River watershed within the City jurisdiction, which is generally bounded by I-75 to the east, Old US 41 to the west, Bonita Beach Road to the south, and Terry Street to the north. These areas were predominately developed in the pre-regulatory years prior to 1980. As such, the land use development pattern did not incorporate stormwater management practices that are currently required by the state Environmental Resource Permitting process and regulations of SFWMD. As such, much of the runoff from this area is described as uncontrolled and untreated with direct discharge to the primary conveyance channels and the Imperial River.

Given the intensity of the development within this area, many of the traditional structural and non-structural BMP alternatives can be difficult and costly. Therefore, special effort to incorporate appropriate BMPs into the existing stormwater infrastructure using available public-owned lands will be required to achieve any improvements to the existing water quality situation.

Plans for implementing structural and non-structural BMPs in existing developed areas should incorporate the following actions:

- Identification of priority pollutant reduction opportunities
- Protection of natural areas that help control runoff
- Ecological restoration to clean up degraded water bodies

6.4.2 Developing and Annexation Areas

The freshwater section of the Imperial River watershed within the City jurisdiction that is generally located east of I-75, west of Old US 41, south of Bonita Beach Road and north of Terry Street, has mostly been or will be developed under the current ERP provisions of

SFWMD or FDEP. As such, these areas should provide for adequate flood protection and water quality treatment for those lands. However, the greater emphasis on water quality improvement and mitigation by state and federal agencies and the ultimate responsibility on local government for the quantity and quality of stormwater discharging from its corporate limits will require the City to be proactively involved in the planning, design, permitting, and operation of systems within its corporate limits.

6.5 Section References

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Harper, H.H. and Baker, D.M. (2007). *Evaluation of Current Stormwater Design Criteria within the State of Florida*. Orlando, FL: Florida Department of Environmental Protection

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7 Site Analysis of BMP Projects

7.1 Overview

This section describes a series of structural BMP alternatives that could potentially be utilized to improve water quality and natural systems for the freshwater section of the Imperial River watershed within the City jurisdiction. A series of analyses were performed to strategically locate the potential BMP sites for water quality and natural system improvement. This section also describes the methodology used to identify and prioritize these potential BMP projects. The existing water quality conditions were simulated using the HSPF model as described in previous sections. To address the total nitrogen (TN) reduction goals established in the FDEP TMDL program for the freshwater section of the Imperial River watershed, a total of sixteen sites have been identified for potential BMP projects.

For each of the BMPs, the TN removal was estimated using the FDEP Handbook methodology as well as the HSPF model. The results for both analyses are presented in this section. It should be noted that differences in the methodologies will yield significantly different results. The FDEP Handbook methodology is based on mean annual loadings and assumed curve numbers derived from land use and soil type data. The HSPF model, conversely, is a continuous hydrologic simulation model calibrated with average daily flow and instantaneous water quality measurements. The HSPF model results describe the behavior of the BMP over the entire hydrologic regime and represent the physical processes in detail. For potential BMP sites with less than 100 acres of contributing area, the FDEP Handbook method is the current standard-of-practice in Florida. Twelve of the sixteen BMP Sites presented have contributing areas of less than 100 acres.

After the TN removal was estimated for each BMP, the sixteen potential BMP sites were prioritized using six evaluation categories, including land availability, TN removal efficiency, cost and others factors. Eight of these BMP sites are recommended as part of the City's on-going CIP program.

7.2 Identification of Potential BMP Sites

The City has been intensively developed since 1980's, particularly in the core urban areas of the City limits. Many of the traditional structural and non-structural BMP alternatives may not be economically feasible. Therefore, special efforts have to be taken to incorporate appropriate BMPs into the existing stormwater infrastructures using available lands within the watershed.

The first step of the BMP site selection is to locate available or vacant lands that could potentially serve as stormwater treatment locations. It is more appropriate to select parcels that are owned by the government rather than private entities, because the land acquisition process is not only lengthy, but also very costly. A 2004 land use map, 2010 aerial imagery and the most recent Lee County parcel GIS layer were used to identify the most suitable sites within the watershed. As presented in Figure 7-1, the public owned parcels could be further categorized into the lands owned by the City and the lands owned by state/county agencies.

Secondly, in order to treat stormwater effectively, it is beneficial to locate BMPs in close proximity to a major stream network or having fairly large surface runoff contributing area. The subbasin and network maps developed for the ICPR model in Phase I of the City of Bonita Springs Stormwater Master Plan (SMP) Update were used to identify the contributing areas for the potential BMP sites.

Third, in order to utilize the BMPs with more efficiency in TN removal (such as dry retention ponds), it is more reasonable to select parcels that have lower seasonal high ground water tables (SHGWT) to provide enough infiltration and retention storage volume for stormwater treatment.

Fourth, given the fact that the TMDL nutrient removal goal for TN was only established in the freshwater section of the Imperial River watershed, the parcels located within this area should be considered with a higher priority level. The extent of the Imperial River watershed (freshwater only) modeled in the current FDEP TMDL model is presented in Figure 7-1, which is similar to the assembly of the HSPF basins: Leitner Creek, Imperial Middle, Imperial Upper and Imperial Kehl. To address the water quality issues in the areas that have no TMDL goal established, several sites located within the Oak Creek and Rosemary Canal basins were also considered in the site identification, prioritization and final recommendation stages.

A field visit was performed on August 10, 2011 to further observe and confirm the existing land use, vegetation, topography, buildings/structures and drainage system of the potential BMP sites as well as the surrounding areas. A total of sixteen potential BMP sites were identified and digitized in ArcGIS; their approximate locations are illustrated in Figure 7-1 and overlaid with public-owned parcel boundaries, HSPF basin boundaries, the FDEP Imperial River watershed boundary and 2010 aerial imagery. The sixteen BMP site locations and their respective contributing areas are shown individually in Figures 7-2 through 7-17.

The following sections discuss the sixteen potential BMP sites. Each section includes descriptions of the size of project site, land ownership/availability, land use/cover and soil type, contributing area, proximity to the receiving water, structural BMP type, TN removal efficiency, annual TN removal in pounds, and a preliminary cost estimate of recommended BMPs. Tables 7-1 and 7-2 are included at the end of this section to summarize the contents of these sections and allow for easier comparison of the potential BMP sites.

7.2.1 Potential BMP Site 1 – Felts Avenue at Ragsdale Street

Potential BMP Site 1 is located in the eastern portion of the Imperial Low HSPF basin, however, it is still considered in the freshwater section of the Imperial River watershed per the FDEP TMDL program, as shown in Figure 7-1. It is represented by six City-owned parcels approximately 2 acres bounded by Felts Avenue to the west, Shriver Avenue to the east, Ragsdale Street to the north and Abernathy Street to the south (Figure 7-2).

Based on the 2010 aerial imagery and 2004 land use map, this open land is surrounded by densely populated residential and commercial areas, which is also part of the core urban area.

Based on the ICPR subbasin map prepared in the City's SMP Phase I project, the contributing area, approximately 49 acres in size, was delineated to the south and southeast of the site, as presented in Figure 7-2. No major water quality BMP, e.g., stormwater ponds, exists in the contributing area.

Field inspection has confirmed that the site is fairly flat in topography and currently used as a temporary staging area for City construction vehicles/equipment and the public as well. A small forested area was found at the northwest corner along with other scattered trees (oaks, pines, etc.) in the remaining portion of the site, as shown in Figure 7-18. Similar to the surrounding areas, the site is generally drained through a series of catch basins and pipes along the roadways and no natural wetlands or man-made ponds were found. Stormwater is collected by the pipes and catch basins and discharges to the main drainage ditch/swale along the west side of Felts Avenue, which drains to the Imperial River ultimately, about ¼ miles north of the site.

Based on the results of screen analysis and field observation, this site is an ideal location for a structural BMP, such as a retention pond, given its size, governmental ownership, lack of structures/buildings, land use/cover and lack of BMPs in the contributing area.

Generally, this site is located at the highland portion of the watershed with a well-defined drainage system. The soil is classified as a hydro group "C" soil, which is characterized by a relatively high SHGWT. Given that this local residential area is well drained, a dry retention pond might be a feasible option for this site so that a higher TN removal efficiency could be achieved.

Figure 7-18. Potential Site Location, BMP 1

Using the methodology documented in the FDEP Stormwater Applicant's Handbook (FDEP Handbook), dated in March 2010, the TN removal efficiency and annual TN reduction that results from a dry retention pond can be estimated given the pond treatment volume and runoff volume. The runoff volume is calculated based on the curve number, pervious/impervious land percentage of the contributing area, and average annual rainfall depth. The FDEP Handbook method is described in Section 5.3.

It was assumed that the dry pond could be as deep as 2 ft to provide a 3.1 ac-ft treatment volume. The TN removal efficiency of the dry retention pond at this depth is estimated at 82.15%.

To eliminate the plant material, silt, trash and other large items into the dry retention pond and downstream receiving water, a Nutrient Separating Baffle Box (Baffle Box) manufactured by Suntree Technologies, Inc. (Suntree) is proposed to provide some amount of stormwater pre-treatment. The Suntree Baffle Box will provide 19% TN removal efficiency alone.

Combining both the dry pond and Suntree Baffle Box together, the overall TN removal efficiency is estimated at 85.54%, which is equivalent to 243 lb/yr of annual TN removal based on the FDEP Handbook methodology. Although the baffle box does not leverage the overall TN removal efficiency significantly, it will improve the treatment system by eliminating sediment accumulation in the dry pond bottom, and hence reduce the cost related to the operation and maintenance of the treatment train.

To confirm the BMP performance on a long-term basis, the previously calibrated HSPF model was simulated with the proposed BMPs and the average annual TN removal was estimated at 356 lb/yr. To be conservative, the TN removal calculated from the HSPF model is for reference purposes only and may not be used in the design and permitting of BMP projects. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-19.

The preliminary cost is estimated at $200,000 for the proposed BMPs, including both design and construction costs.

In addition to the dry pond discussed above, other structural BMPs, such as wet detention pond and constructed wetlands, may be considered at this site. For example, a wet pond system appears more publicly acceptable by providing more aesthetic landscape and educational opportunities than a dry pond. In terms of technical perspectives including TN removal efficiency and cost effectiveness, the dry pond system proposed in the preliminary engineering analysis may be the best choice to meet the TMDL goal established for the City.

It is recommended that an alternative analysis with multiple structural BMPs should be performed during the engineering design and permitting phases, in order to select the best BMP design alternative which is most cost effective and can meet multiple design criteria as well as various expectations from the City and other interested parties.

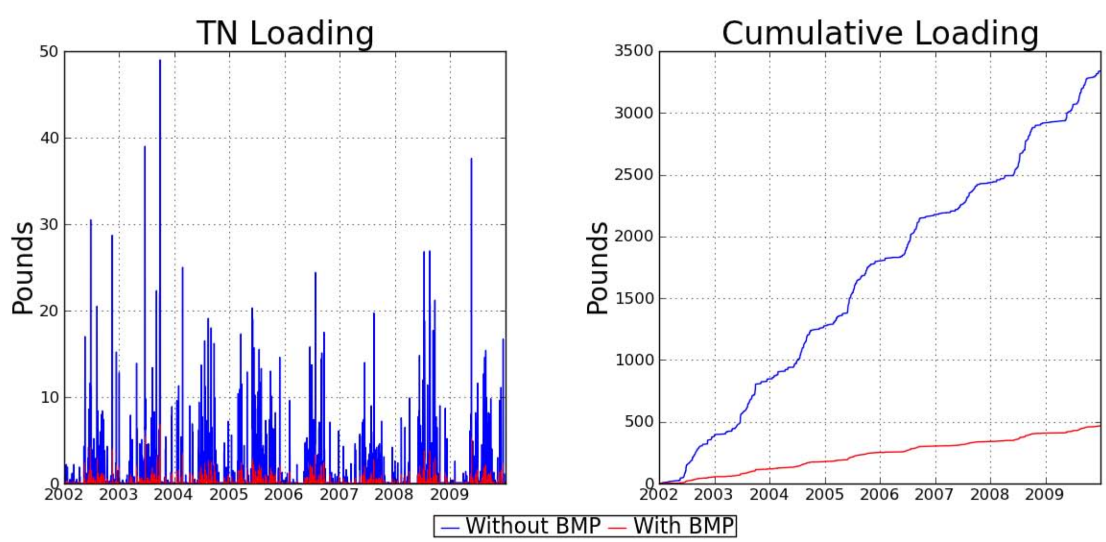


Figure 7-19. HSPF Simulated TN Removal, BMP 1

7.2.2 Potential BMP Site 2 – Imperial Parkway at Dean Street

Potential BMP Site 2 is located in the center portion of the Imperial Middle HSPF basin, just south of the Imperial River at Imperial Parkway (Figure 7-1). The site is located on a 5-acre privately-owned parcel at the northwest corner of the intersection of Imperial Parkway and Dean Street (Figure 7-3). The site consists of 1.6-acres of open land at the southeast corner of the parcel.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area is approximately 38 acres in size and extends to the south and southwest of the site, as presented in Figure 7-3. No water quality BMP exists in the contributing area.

Field inspection has confirmed that the site is fairly flat with a mild slope towards the Imperial River and is currently planted with many palm and oak trees. As shown in Figure 7-20, no existing drainage structure was found during the field visit. The contributing area south of Dean Street is generally drained through a series of catch basins and closed pipes along the west side of Imperial Parkway and ultimately drains to the Imperial River; while stormwater runoff discharges through roadside swales or overland flow discharge directly to the Imperial River from the contributing area north of Dean Street. No natural wetland or man-made pond was observed in the vicinity.

Figure7-20. Potential Site Location, BMP 2

If the land owner is willing to trade a part of the parcel or the entire parcel with the City, this site is a good candidate for a structural BMP, given its size, lack of structures/buildings, proximity to the receiving water, and lack of BMPs in the contributing area.

The site is located at the highland portion of the watershed and the soil is classified as hydro group "A" soil, which is characterized by a lower SHGWT. Therefore, a dry retention pond is recommended to achieve a higher TN removal efficiency.

It is assumed that the dry pond could be dredged as deep as 2 ft in order to provide a 2.1 ac-ft treatment volume. The TN removal efficiency is then estimated at 86.85%, per FDEP Handbook method. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide 19% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 89.35%, which is equivalent to 164 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 262 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-21.

The preliminary cost is estimated at $370,000, which covers design and construction fees as well as a land acquisition cost of $150,000.

Other structural BMPs, such as wet detention pond and constructed wetland, may be considered at this site as well. For example, a wet pond system can provide more aesthetic landscape and educational opportunities than a dry pond system, although it is not as efficient as the dry pond system in TN removal.

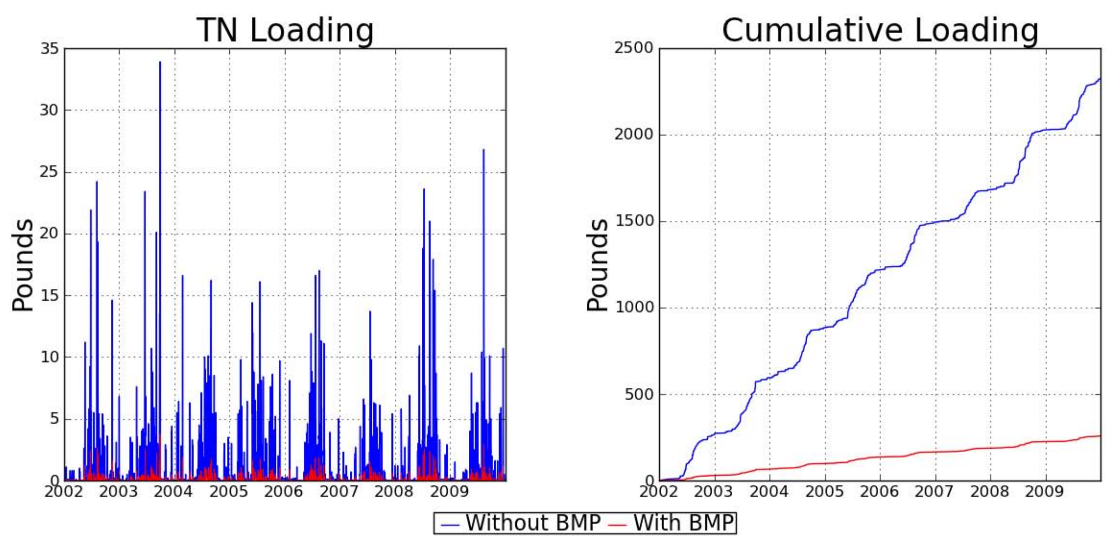


Figure 7-21. HSPF Simulated TN Removal, BMP 2

7.2.3 Potential BMP Site 3 – Bonita Grande Drive at Kehl Canal

Potential BMP Site 3 is located in the western portion of the Imperial Kehl HSPF basin, just north of the Kehl Canal at Bonita Grande Drive (Figure 7-1). The site contains 2.9-acres of open land in the FDEP-owned parcel (9 acres in size), as shown in Figure 7-4. The SFWMD Kehl Canal control structure is located at the south end of the same parcel.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by natural wetlands in its immediate vicinity.

Per the ICPR subbasin map, the contributing area is approximately 1,500 acres in size and extends to the north of the site, as presented in Figure 7-4. The majority of the contributing area is within the City limits, which is dominated by mining, agriculture lands and wetlands.

Field inspection has confirmed that this open land is fairly flat and bounded by natural wetlands to the east and north and by roadways to the south and west. As shown in Figure 7-22, drainage ditches were found along both sides of Bonita Grande Drive, which could also assist in draining the site to the Imperial River.

Figure7-22. Potential Site Location, BMP 3

Provided a land grant could be given by FDEP to the City for water quality improvement purposes, this site would be considered a good candidate for a structural BMP given its size, lack of structures/buildings, proximity to the receiving water, and lack of BMPs in the contributing area.

The site is surrounded by natural wetlands and the soil is classified as hydro group "D" soil, which is characterized by a higher expected SHGWT. Therefore, a wet detention pond or a constructed wetland could be considered at this site.

Nevertheless, this FDEP-owned open land is restricted to everglades watershed restoration purpose per the grant agreement dated June 10, 1999 between US Department of the Interior and SFWMD. A wet detention pond for stormwater treatment might not be a feasible option at this site. Therefore, a freshwater wetland similar to the adjacent wetland areas could be constructed to restore the historic land cover, and the stormwater from upstream contributing area could be routed through the constructed wetland area for water quality treatment given that the wetland will not be downgraded.

It is assumed that the constructed wetland could have a 2 ft difference between the control elevation and normal pool in order to provide a 4 ac-ft treatment volume. It is also assumed that only 20% of the runoff volume from the contributing area will be diverted to the proposed wetland for water quality treatment, given the relatively small size of the treatment volume compared to its contributing area. TN removal efficiency of the constructed wetland is then estimated at 3.57%, using the method described in the FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment and will provide a 3.8% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 6.69%, which is equivalent to 336 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 323 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-23.

The preliminary cost is estimated at $400,000, which includes both design and construction fees.

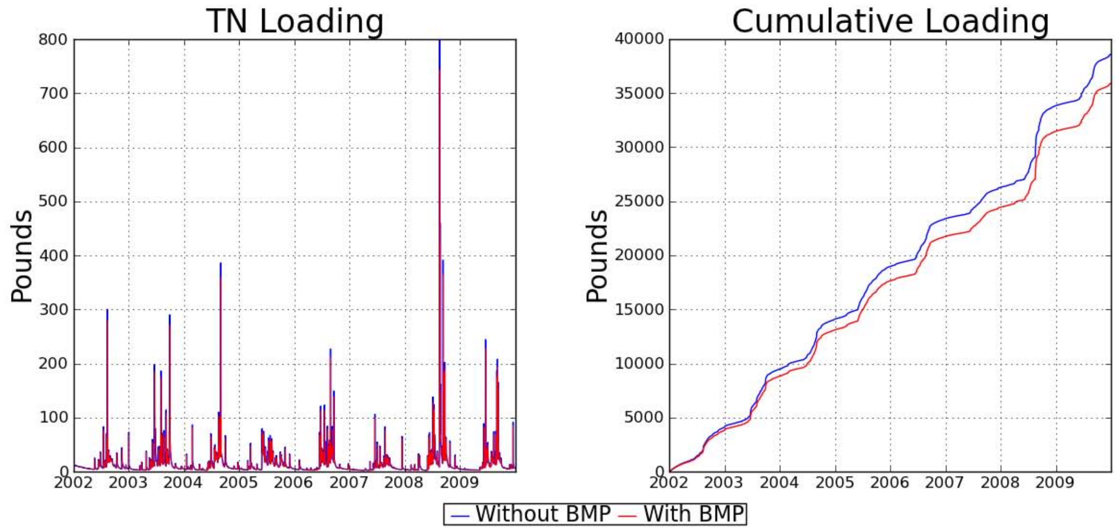


Figure 7-23. HSPF Simulated TN Removal, BMP 3

7.2.4 Potential BMP Site 4 – Leitner Creek – Bypass Canal

Potential BMP Site 4 is located in the southern portion of the Imperial Kehl HSPF basin, about ¼ mile south of the Imperial Parkway at Leitner Creek (Figure 7-1). The site is within the City-owned ROW of the Leitner Creek Bypass Canal, which is about 1,250 ft in length and 50 ft in width, as shown in Figure 7-5. Based on the 2010 aerial imagery and 2004 land use map, this site and the Bypass Canal are surrounded by densely populated residential areas.

Per the ICPR subbasin map, the contributing area to the north is approximately 1,624 acres in size, as presented in Figure 7-5. The majority of the contributing area is dominated by agriculture and residential areas, e.g., Citrus Park Mobile Home Village.

Field inspection has confirmed that the Bypass Canal is well maintained from Wagon Trail to its south end where it joins the old course of the Leitner Creek. No sediment or erosion problems were observed. As shown in Figure 7-24, the water in the canal was not flowing during the site visit and some algae were noticed in the south half of the canal, which may indicate a high nutrient level in the water body.

Figure7-24. Potential Site Location, BMP 4

This site should be considered as an ideal location for a structural BMP, given its location, governmental ownership, land use/cover and lack of BMPs in the large contributing area.

A concrete weir structure is recommended to be constructed at the south end of the Bypass Canal, just upstream where the canal joins the old course of the Leitner Creek. This structure will create a wet detention pond in the upstream canal, and hence provide water quality treatment. A detailed stormwater model is required to simulate various design storm events for both existing and proposed conditions in order to verify that the BMP project will not cause any adverse impact (such as flooding) to the upstream properties as required by the ERP permit application to SFWMD.

It is assumed that the weir structure will raise the upstream water level by 2 ft and hence provide a 3.27 ac-ft treatment volume. Using the method described in the FDEP Handbook, the TN removal efficiency of this structural BMP is estimated at 4.77%, which is equivalent to 458 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 702 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-25.

The preliminary cost is estimated at $130,000, which includes both design and construction fees.

There is a vacant lot with an assessed property value of approximately $30,000 located just west of the proposed weir structure. It is an option that the City could obtain this vacant land for construction of the weir structure and accessing the site for operation and maintenance.

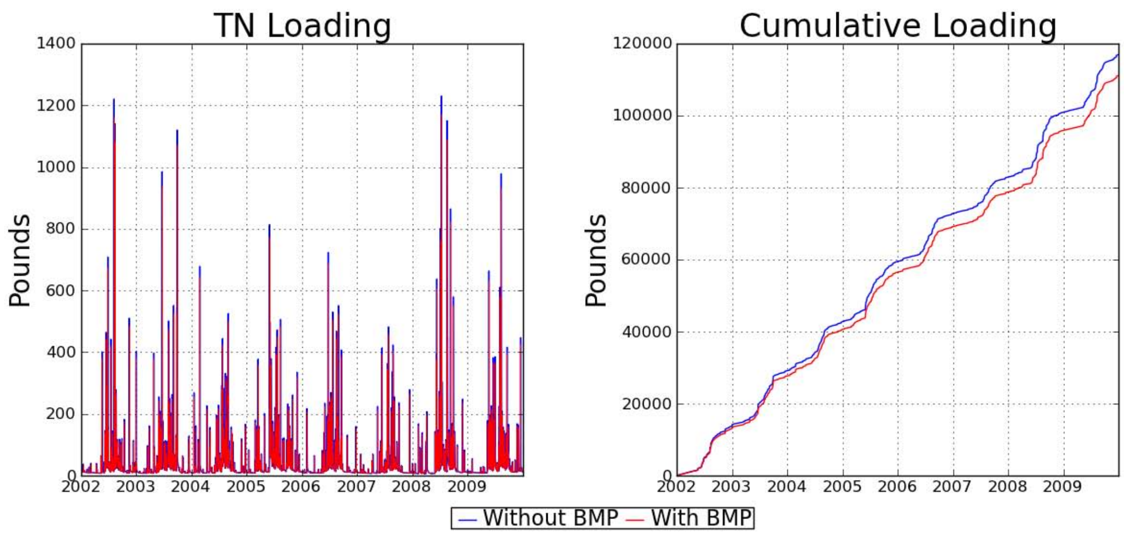


Figure 7-25. HSPF Simulated TN Removal, BMP 4

7.2.5 Potential BMP Site 5 – E. Terry Street at Leitner Creek - North

Potential BMP Site 5 is located in the southern portion of the HSPF basin Leitner Creek, located north of E. Terry Street at Leitner Creek (Figure 7-1). As part of the two City-owned parcels totaling 16.5-acre in size, the site contains a 12-acre open land curbed by the Leitner Creek to the southeast, as shown in Figure 7-6.

Based on the 2010 aerial imagery and 2004 land use map, this open land is surrounded by densely populated residential areas. Prior to a land acquisition by the City in 2001 for a roadway project, a mobile home park was located on the eastern half of the site. As mentioned by the City staff, the City Council will discuss the future development at these two parcels on the strategic planning session in later October of 2011.

Per the ICPR subbasin map, the contributing area to the north is approximately 1,662 acres in size, as presented in Figure 7-6. The majority of the contributing area is dominated by agriculture and residential areas, e.g., Citrus Park Mobile Home Village.

Field inspection has confirmed that the site is fairly flat in topography and currently vacant without noticeable activities. As shown in Figure 7-26, small forested areas were observed along the northern parcel boundary and Leitner Creek. No drainage structure was found on the site. Off-site runoff is drained through perimeter swales/ditches prior to discharging into Leitner Creek. No natural wetland or man-made pond was found in the field.

Figure7-26. Potential Site Location, BMP 5

This site is considered an ideal location for a structural BMP, given its size, governmental ownership, lack of structures/buildings, proximity to the receiving water, land use/cover and lack of BMPs in the contributing area.

Generally, the site is located in the highland portion of the watershed and is dominated by a hydro group “A” soil, which is characterized by a low SHGWT. Therefore, a dry retention pond is recommended to achieve a higher TN removal efficiency.

It is also assumed that only 50% of the runoff volume from the contributing area will be diverted to the proposed BMPs for water quality treatment, given the relatively small size of the pond compared to its contributing area. A head structure will be installed at the south end of the Leitner Creek Bypass Canal in order to divert half of the runoff into this potential BMP site. To construct a drainage ditch from the head structure to the site, a drainage easement or ROW should be obtained from the private property between the head structure and the BMP site.

It was assumed that the dry pond could be dredged as deep as 2 ft to provide a 17.3 ac-ft treatment volume. The TN removal efficiency is then estimated at 21.24%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, which will provide a 9.5% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 26.7%, which is equivalent to 2,622 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 4,037 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-27.

The preliminary cost is estimated at $560,000, which covers design and construction fees as well as a drainage easement cost of $75,000.

There are many other structural BMPs, such as wet detention pond, filter marsh and rain garden, which could be more publicly acceptable by providing more aesthetic landscape and educational opportunities than a dry pond. In terms of technical perspectives, such as TN removal efficiency and cost effectiveness, the dry pond option used in the preliminary engineering analysis may be the best choice to meet the TMDL goal established for the City; however, alternative analysis using different structural BMPs should be performed during the engineering design and permitting phases with considerations of various design criteria as well as expectations from the public, City and other interested parties.

In addition, the preliminary engineering analysis is based upon the assumption that the City is willing to utilize the land exclusively for stormwater treatment purposes. See detailed discussion in Section 9, where four BMP alternatives are proposed in different scenarios of structural BMPs selection and land availability.

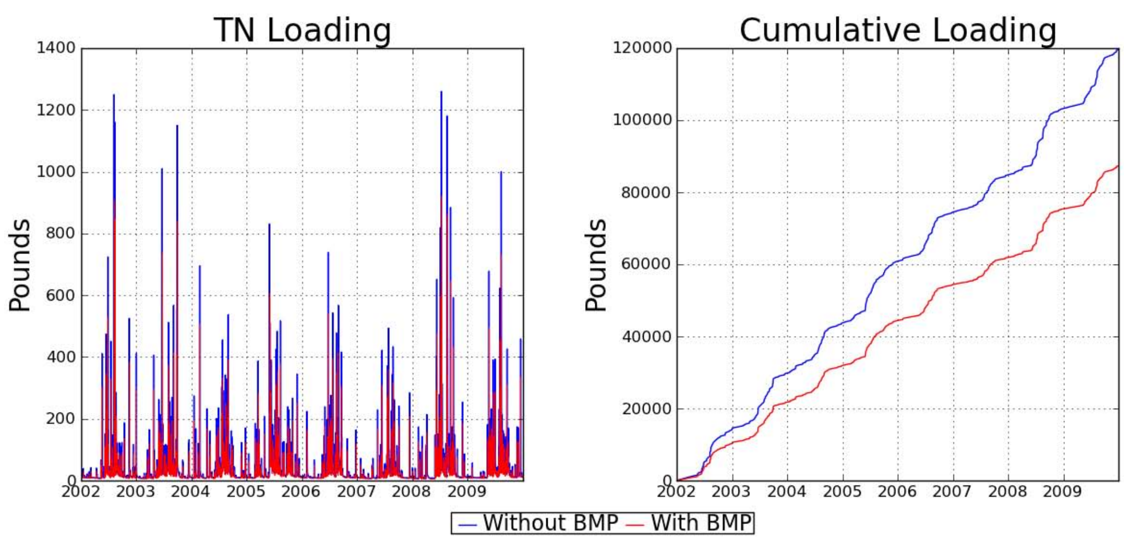


Figure 7-27. HSPF Simulated TN Removal, BMP 5

7.2.6 Potential BMP Site 6 – Leitner Creek – Old Course

Potential BMP Site 6 is located in the southern portion of the Leitner Creek HSPF basin, and encompasses the old course of Leitner Creek which has been re-routed by the new Bypass Canal to the east (Figure 7-1). The site is a 1.55-acre ROW owned by the City, about 1,350 ft in length and 50 ft in width, as shown in Figure 7-7.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area is approximately 34 acres in size, as presented in Figure 7-7.

Field inspection has confirmed that the site is mostly covered with cypress trees and other typical wetland vegetation. As shown in Figure 7-28, there were multiple elliptical pipes found under Wagon Trail and Torchfire Trial and a box culvert at the south end. No standing water was observed during the site visit, indicating that the site has been well drained as most of river flow is diverted by the Bypass Canal to the east.

Figure7-28. Potential Site Location, BMP 6

This site should be considered as a good location for a structural BMP given its location, governmental ownership, and land use/cover in the contributing area. Since the old course of the creek is part of a highly forested wetland area, only few structural BMPs, including wet detention pond, are feasible to be implemented at this site.

Multiple ditch bocks are recommended to be constructed at various locations in the old course to create additional storage volume for water quality treatment. It is assumed that the ditch blocks will create a series of wet detention ponds with 2 ft depth and hence provide a 2.2 ac-ft treatment volume in total. Using the method described in the FDEP Handbook, the TN removal efficiency of this structural BMP is estimated at 30.8%, which is equivalent to 118 lb/yr of annual TN removal.

For reference only, the average annual TN removal is estimated at 110 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-29.

The preliminary cost is estimated at $65,000, which includes both design and construction fees.

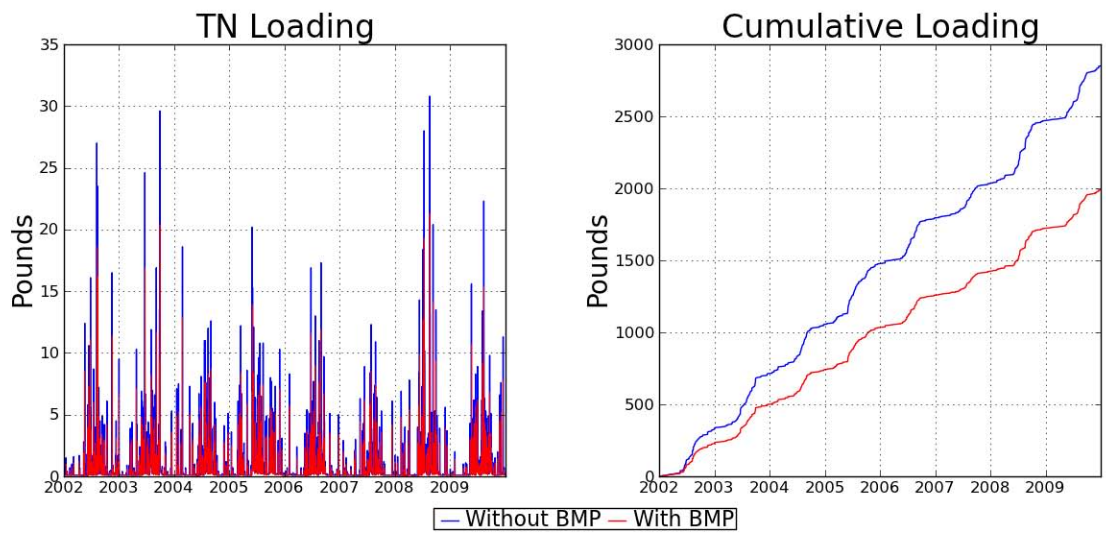


Figure 7-29. HSPF Simulated TN Removal, BMP 6

7.2.7 Potential BMP Site 7 – E. Terry Street at Morton Avenue

Potential BMP Site 7 is located in the northern portion of the Imperial Middle HSPF basin (Figure 7-1). The site is comprised of five privately-owned parcels approximately 1.2 acres in size located at the northwest corner of the intersection of E. Terry Street and Morton Avenue, as shown in Figure 7-8.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas to the north and east and transportation system to the west and south. Per the ICPR subbasin map, the contributing area of approximately 38 acres in size was delineated to the north of the site, as presented in Figure 7-8, and is dominated by residential areas. No water quality BMP exists in the contributing area.

Field inspection has confirmed that the site is fairly flat with a mild slope towards Sun Village Lane to the west. As shown in Figure 7-30, a two-story building is located in the eastern portion of the site near Morton Avenue. This site is scattered with palm, pine and oak trees along its border. No existing drainage structure was found on site. The drainage system of the contributing area consists of series roadside ditches and pipes along Morton Avenue and E. Terry Street, which drain stormwater westward into the drainage ditch located in the I-75 ROW.

Figure7-30. Potential Site Location, BMP 7

Provided the land owner is willing to sell the parcels to the City, this site is a fairly good candidate site for a structural BMP, given its size, location, and lack of BMPs in the contributing area.

The site is located at the highland portion of the watershed and the soil is classified as hydro group “D” soil, which indicates a high SHGWT is expected. Therefore, a wet detention pond is recommended at this site. Other structural BMPs may be considered at this site, such as constructed wetland and surface sand filter. During the engineering design and permitting phases, alternative analysis using different structural BMPs should be performed with considerations of various design criteria as well as expectations from the public, City and other interested parties.

It is assumed that the wet pond could have a 2 ft difference between the control elevation and normal pool in order to provide a 1.5 ac-ft treatment volume. The TN removal efficiency is estimated at 35.76%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide a 19% TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 48%, which is equivalent to 51.4 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 49 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-31.

The preliminary cost is estimated at $430,000, which covers design and construction fees as well as a land acquisition cost of $165,000.

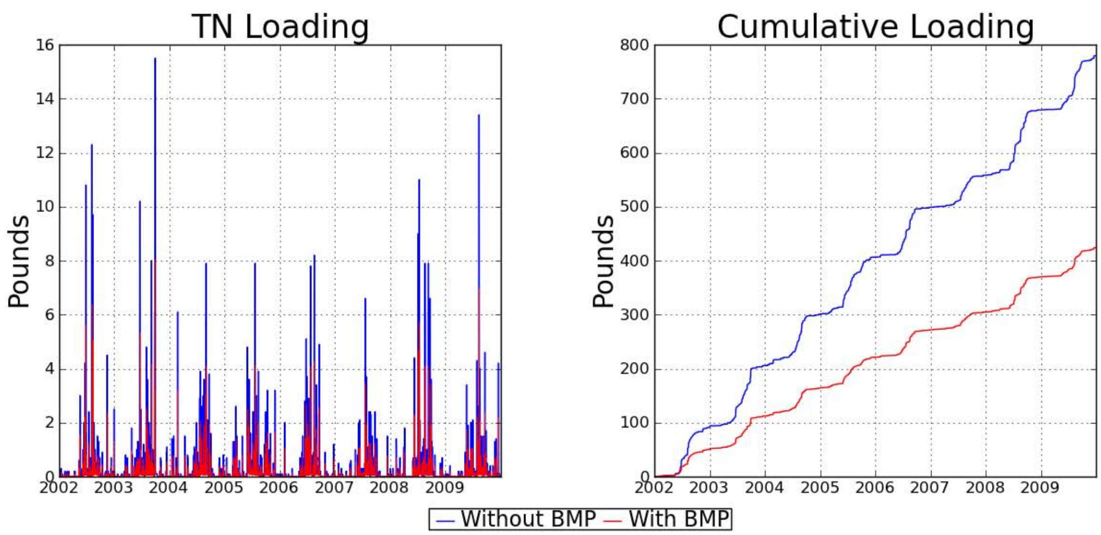


Figure 7-31. HSPF Simulated TN Removal, BMP 7

7.2.8 Potential BMP Site 8 – FPL Corridor near Imperial River

Potential BMP Site 8 is located in the center portion of the Imperial Middle HSPF basin, just north of the Imperial River in the Florida Power & Line Company (FPL) corridor (Figure 7-1). The site is identified as the ROW of the Imperial Bonita Estates Home Owner Association (HOA). Per City staff, the HOA is responsible for the roadway and drainage system operation and maintenance within their corporation limits. The site is a 1.8-acre open land at the southeast corner of the HOA ROW, as shown in Figure 7-9.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas.

Per the ICPR subbasin map, the contributing area of approximately 24 acres in size was delineated to the north of the site, as presented in Figure 7-9. No water quality BMP exists in the contributing area.

Field inspection has confirmed that this open land is fairly flat with a mild slope towards the Imperial River to the south. As shown in Figure 7-32, no drainage structure was found within this site except for a drainage ditch lying along the western fence, which is generally used to drain the off-site contributing area to the north.

Figure7-32. Potential Site Location, BMP 8

Provided the HOA and FPL would allow the City to utilize this open land for water quality improvements, this site will be an ideal candidate for a structural BMP, given its size, lack of structures/buildings, proximity to the receiving water, and lack of BMPs in the contributing area.

The soil found on site is classified as hydro group “A” soil, which indicates a lower SHGWT is expected. Therefore, a dry retention pond is recommended to achieve a higher TN removal efficiency.

Other structural BMPs may be considered at this site, such as constructed wetland and wet detention pond, which seem more publicly acceptable by providing more aesthetic landscape and educational opportunities than a dry pond. During the engineering design and permitting phases, alternative analysis using different structural BMPs should be performed with considerations of various design criteria as well as expectations from the public, City and other interested parties.

It is assumed that the dry pond could be dredged as deep as 2 ft in order to provide a 1.5 ac-ft treatment volume. The TN removal efficiency is then estimated at 77.55%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide a 19% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 81.8%, which is equivalent to 152 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 207 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-33.

The preliminary cost is estimated at $180,000, which covers design and construction fees as well as a drainage easement fee of $25,000.

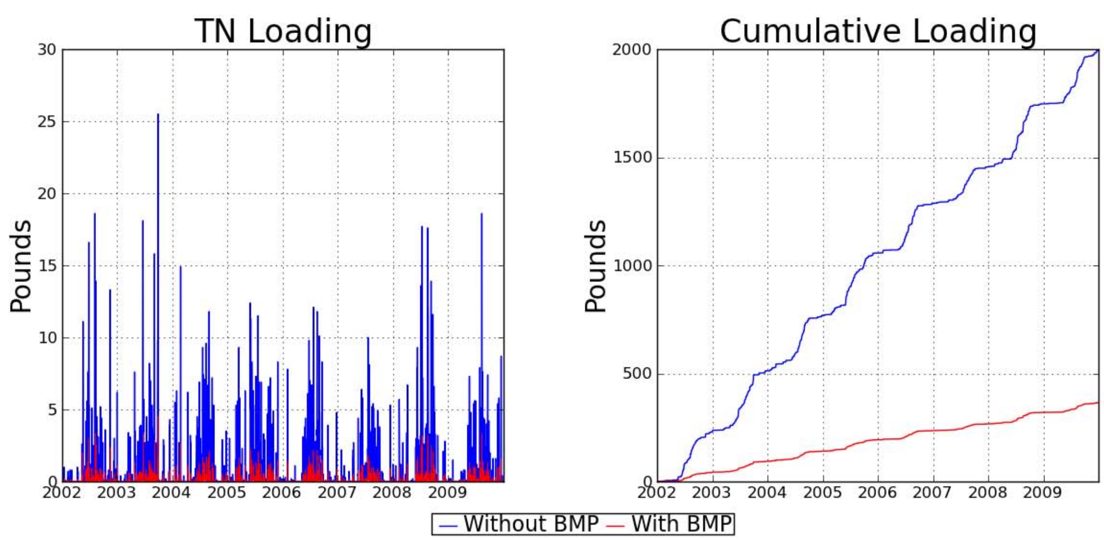


Figure 7-33. HSPF Simulated TN Removal, BMP 8

7.2.9 Potential BMP Site 9 – Kent Road at Imperial River

Potential BMP Site 9 is located in the center portion of the Imperial Upper HSPF basin, north of Kehl Canal and east of I-75 (Figure 7-1). The 19.5-ac site encompasses a City-owned ROW of the old course of the Imperial River and an 18.6-ac parcel that was granted by SFWMD in 2009. The site is bounded by Kehl Canal to the south and another City-owned parcel (a.k.a., Bonita Nature Place) to the north, a Lee County-owned parcel to the east, and a FDEP-owned parcel to the west, as shown in Figure 7-10.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by wetlands to the east, west and north and a major canal (Kehl Canal) to the south. Per the ICPR subbasin map, the contributing area of approximately 163 acres in size was delineated to the north of the site, as presented in Figure 7-10. A stormwater pond was found in the Youth Organization Recreational Center located at the southwest corner of E. Terry Street and Kent Road.

Field inspection has confirmed that the site is fairly flat with a mild slope towards the old course of the Imperial River located at the north portion of the site. As shown in Figure 7-34, dense trees were observed within the site. Standing water was observed in low area of the old course of the Imperial River. The contributing area is generally drained through the drainage ditch along both sides of Kent Road, which ultimately joins the old course of the Imperial River.

Figure7-34. Potential Site Location, BMP 9

This site is a good candidate for a structural BMP, given its size, land ownership, lack of structures/buildings, and proximity to the receiving water.

Nevertheless, it was noticed that this property was granted by SFWMD with some restrictions applied, i.e., the property shall be restricted for conservation, education and passive recreational purposes. Therefore, the BMPs with potential benefits in conservation and restoration of the highland and wetland habitats, such as constructed wetland, are recommended in order to be in compliance with the agreement between SFWMD and the City.

In the preliminary BMP design, a concrete weir structure is recommended to be constructed at the west end of the old course, just downstream where the drainage ditches of Kent Road join the old course of the Imperial River. This structure will create a wetland area in the upstream portions, and hence restore the historic highland/wetland habitats in the old course of the Imperial River prior to the dredging of Kehl Canal.

A detailed stormwater model is required to simulate various design storm events for both existing and proposed conditions in order to verify that the proposed BMP will not cause any adverse impact (such as flooding) to the upstream properties as required by the ERP permit application to SFWMD.

It is assumed that the weir structure will raise the upstream water level to 10 ft-NGVD and hence provide a 2.05 ac-ft treatment volume for water quality improvement. Using the method described in the FDEP Handbook, the TN removal efficiency of this structural BMP is estimated at 14.82%, which is equivalent to 40 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 116 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-35.

The preliminary cost is estimated at $120,000, which covers both design and construction fees.

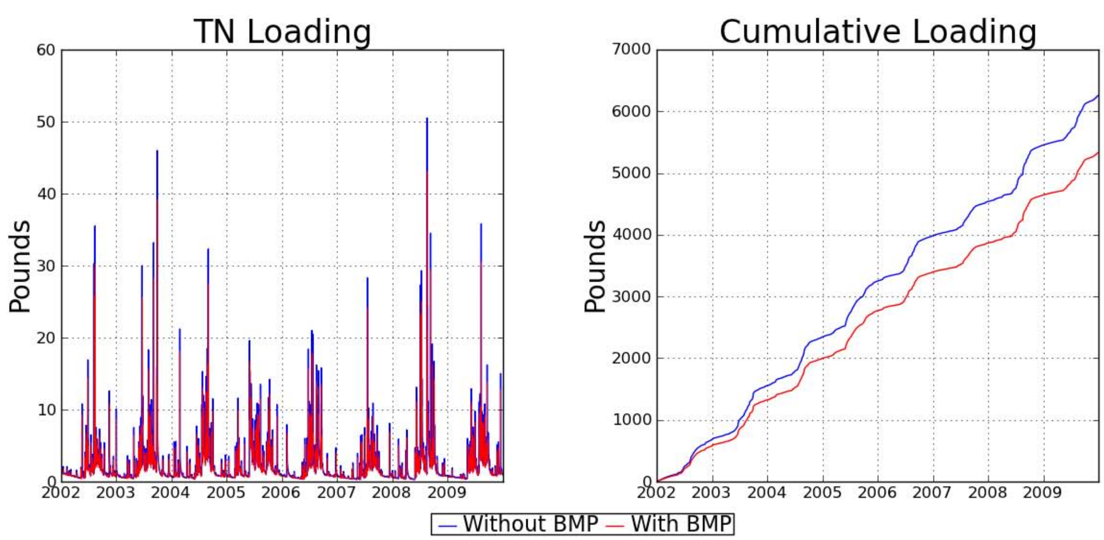


Figure 7-35. HSPF Simulated TN Removal, BMP 9

7.2.10 Potential BMP Site 10 – Imperial Parkway at Meadow Lane

Potential BMP Site 10 is located in the center portion of the Oak Creek HSPF basin, where a FDEP TMDL program has not been currently established (Figure 7-1). The site encompasses part of the County-owned ROW of Imperial Parkway, located just south of Oak Creek, as well as two County-owned parcels (0.5 acre in size) located east of Imperial Parkway between Meadow Lane and Sunray Drive, as shown in Figure 7-11.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area, approximately 37 acres in size, was delineated to the east of the site, as presented in Figure 7-11.

Field inspection has confirmed that the site is fairly flat. One power pole and several trees were observed in the southern portion of the site. As shown in Figure 7-36, no man-made pond or natural wetland was observed. The contributing area is generally drained through small swales and pipes to the major drainage system along east side of Imperial Parkway, which ultimately joins Oak Creek to the north.

Figure7-36. Potential Site Location, BMP 10

This site is a good candidate for a structural BMP given its location, land ownership, lack of structures/buildings, proximity to the receiving water, and land use/cover and lack of BMPs in the contributing area.

The soil found on the open land portion of the site is classified as a hydro group "D" soil, indicating a higher SHGWT is expected. However, given that this local residential area has been well drained, a dry retention pond might be a feasible option for this site so that a higher TN removal efficiency could be achieved.

Other structural BMPs, such as wet detention pond and constructed wetland, may be considered at this site as well. For example, a wet pond system can provide more aesthetic landscape than a dry pond system, although it is not as efficient as the dry pond system in TN removal.

It is assumed that the dry pond could only be dredged as deep as 1 foot in to provide a 0.31 ac-ft treatment volume. The TN removal efficiency is then estimated at 24.31%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide a 19% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 38.7%, which is equivalent to 99 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 118 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-37.

The preliminary cost is estimated at $130,000, which covers both design and construction fees.

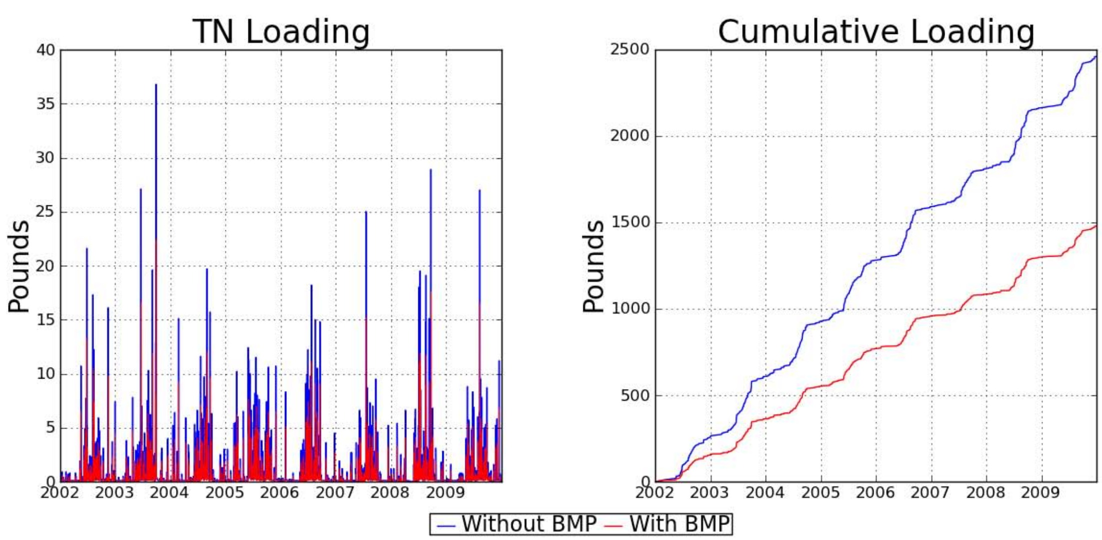


Figure 7-37. HSPF Simulated TN Removal, BMP 10

7.2.11 Potential BMP Site 11 – Bonita Beach Road at Oak Creek

Potential BMP Site 11 is located in the center portion of the Oak Creek HSPF basin, where a FDEP TMDL program has not been currently established (Figure 7-1). The site encompasses part of the City-owned ROW of Matheson Avenue as well as one privately-owned parcel (2.2 acre in size), both located between Oak Creek and Bonita Beach Road, as shown in Figure 7-12.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area, approximately 97 acres in size, was delineated to the north of the site, as presented in Figure 7-12.

Field inspection has confirmed that the site is fairly flat with a mild slope towards Oak Creek. As shown in Figure 7- 38, a heavily vegetated area was found along Oak Creek. No man-made pond or natural wetland was observed. The contributing area is generally drained through small swales, ponds and pipes to the drainage ditch along the east boundary of Pine Haven Condo, which is connected with Oak Creek through a 54" RCP pipe found under Bonita Beach Road and in the ROW of Matheson Avenue.

Figure7-38. Potential Site Location, BMP 11

If the cost of the land acquisition becomes affordable, this site will be a good candidate for a structural BMP, given its size, lack of structures/buildings, proximity to the receiving water, and land use/cover and lack of BMPs in the contributing area.

The soil found on the open land portion of the site is classified as hydro group "D" soil, indicating a higher SHGWT is expected. However, given that the site is adjacent to Oak Creek, a dry retention pond might be a feasible option for this site so that a higher TN removal efficiency could be achieved.

Other structural BMPs may be considered during the design and permitting phases. For example, a filter marsh can provide more aesthetic landscape than a dry pond system, although it is not as efficient as the dry pond system in TN removal.

It is assumed that the dry pond could be dredged as deep as 2 ft to provide a 1.8 ac-ft treatment volume. The TN removal efficiency is estimated at 30.1%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, and it will provide a 19% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 43.4%, which is equivalent to 303 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 412 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-39.

The preliminary cost is estimated at $700,000, which covers design and construction fees, as well as a land acquisition cost of $500,000. To avoid the high land acquisition cost, the dry pond option could be omitted, leaving the Baffle Box option in the existing ROW. In this case, the annual TN removal will be reduced to 133 lb/yr with a much lower design/construction cost of $120,000.

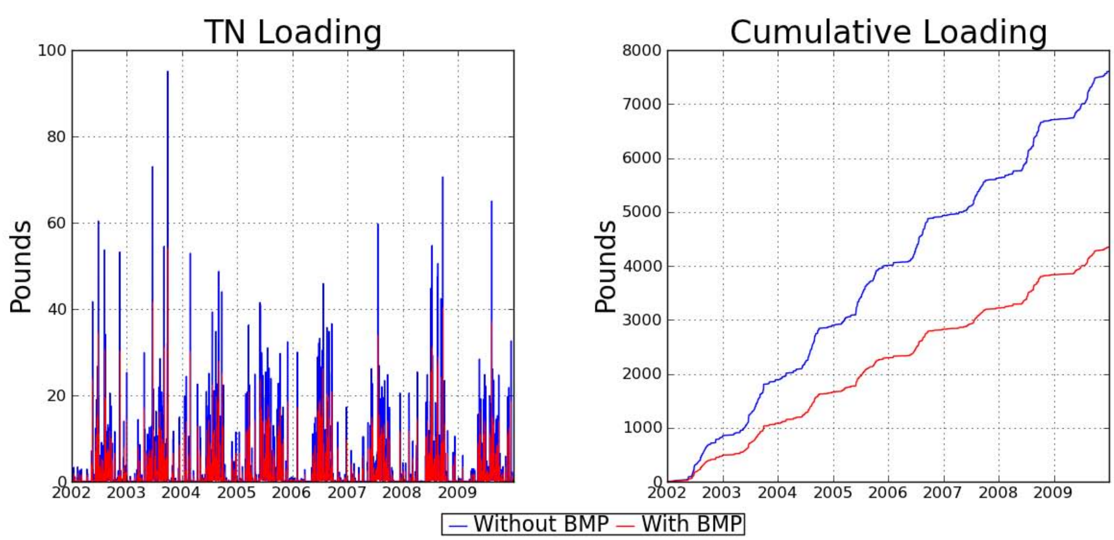


Figure 7-39. HSPF Simulated TN Removal, BMP 11

7.2.12 Potential BMP Site 12 – Imperial Parkway at Imperial River

Potential BMP Site 12 is located in the center portion of the Imperial Middle HSPF basin, just north of the Imperial River at Imperial Parkway (Figure 7-1). The site is represented by a 4.3-acre privately-owned parcel, as shown in Figure 7-13.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area of approximately 92 acres in size was delineated to the north the site, as presented in Figure 7-13. Existing water quality BMPs, such as stormwater pond, were found in most of the developed area of the contributing area.

Field inspection has confirmed that the site is fairly flat with a mild slope towards the Imperial River. One mobile home and the associated storage shed are located in the central part of the site, immediately adjacent to its eastern property fence. This site is scattered with palm, pine and oak trees. As shown in Figure 7-40, no natural wetland, man-made pond or drainage structure was found within the site during the field visit. There is a catch basin found outside of the site, near the northwest corner of the parcel, which may be used to drain the parcel into the existing Imperial Parkway drainage system.

Figure7-40. Potential Site Location, BMP 12

If the land owner is willing to sell the parcel to the City, this site will be a good candidate for a structural BMP, given its size, lack of structures/buildings, and proximity to the receiving water.

The soil found on site is classified as hydro group “A” soil, indicating a lower SHGWT is expected. Therefore, a dry retention pond is recommended to achieve a higher TN removal efficiency.

Other structural BMPs may be considered during the design and permitting phases. For example, a wet detention pond or a filter marsh can provide more aesthetic landscape and educational opportunities than a dry pond system, although they are not as efficient as the dry pond system in TN removal.

It is assumed that the dry pond could be dredged as deep as 2 ft in order to provide a 4.4 ac-ft treatment volume. The dry pond will be linked with the existing drainage system of the Imperial Parkway. The TN removal efficiency is estimated at 78.4%, which is equivalent to 398 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 470 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-41.

The preliminary cost is estimated at $310,000, which covers design and construction fees as well as a land acquisition cost of $150,000.

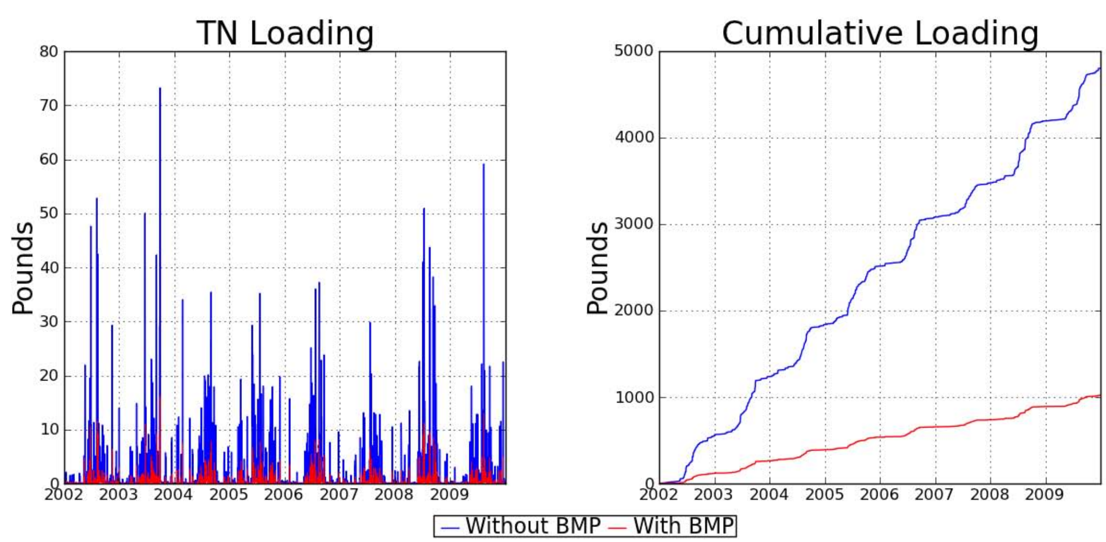


Figure 7-41. HSPF Simulated TN Removal, BMP 12

7.2.13 Potential BMP Site 13 – W. Terry Street Palm Street

Potential BMP Site 13 is located in the southern portion of the Rosemary Canal HSPF basin, where a FDEP TMDL program has not been currently established (Figure 7-1). The site is a 0.5-acre City-owned open land located at the northwest corner of W. Terry Street and Palm Street, as shown in Figure 7-14.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area of approximately 10.7 acres in size was delineated to the north of the site, as presented in Figure 7-14.

Field inspection has confirmed that this open land is fairly flat. Various pine and oak trees were found in the southern and central portions of the site. As shown in Figure 7-42, no man-made pond or natural wetland was observed. The contributing area is generally drained through small swales and pipes to the major drainage system along north side of W. Terry Street, which ultimately joins the Rosemary Canal to the east.

Figure7-42. Potential Site Location, BMP 13

This site is a good candidate for a structural BMP, given its size, lack of structures/buildings, proximity to the receiving water, land use/cover and lack of BMPs in the contributing area.

The soil found on site is classified as hydro group "D" soil, indicating a higher SHGWT is expected. Therefore, a wet detention pond is recommended at this site. Other structural BMPs may be considered at this site, such as constructed wetland and surface sand filter.

It is assumed that the wet pond could have a 2 ft difference between the control elevation and normal pool in order to provide a 0.6 ac-ft treatment volume. TN removal efficiency of the wet detention pond is estimated at 34.17%, using the method described in the FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment and will provide a 19% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 46.7%, which is equivalent to 34 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 45 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-43.

The preliminary cost is estimated at $150,000, which includes both design and construction fees.

Despite the appeal of this location for possible BMP implementation, per City staff, this site has been slated as a stormwater treatment pond site for the proposed W. Terry Street widening project; hence it might not be feasible to construct the proposed BMPs as described above.

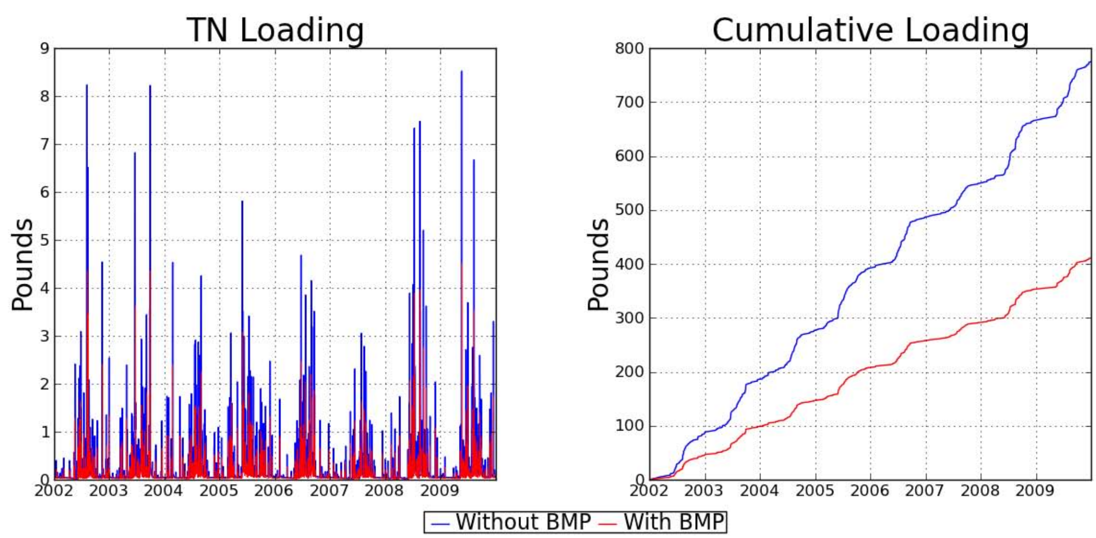


Figure 7-43. HSPF Simulated TN Removal, BMP 13

7.2.14 Potential BMP Site 14 – Murat Circle at Imperial River

Potential BMP Site 14 is located in the center portion of the Imperial Middle HSPF basin, about 1/2 mile downstream of the Imperial River bridge at Imperial Parkway (Figure 7-1). The site is located in the north end of the City-owned ROW of Murat Circle, adjacent to the Imperial River, as shown in Figure 7-15.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by densely populated residential areas. Per the ICPR subbasin map, the contributing area, approximately 47 acres in size, was delineated to the south of the site, as presented in Figure 7-15.

Field inspection has confirmed that Murat Circle is a paved roadway and the roadway and drainage system are currently maintained by the City. The existing drainage system consists of a series of pipes and catch basins to collect the stormwater from the contributing area to the south, and ultimately discharge to the Imperial River. A boat ramp and a wood boardwalk, both privately-owned, were found at the north end of the roadway, as shown in Figure 7-44.

Figure7-44. Potential Site Location, BMP 14

This site is a good candidate for a structural BMP, given the land ownership, proximity to the receiving water, and land use/cover and lack of BMPs in the contributing area. Due to the space limitations within the existing ROW, a baffle box is considered as the most feasible and cost efficient BMP option in this site.

Baffle boxes or other vendor-supplied water quality inlets and sediment separation devices could be used for the water quality improvements project in similar core urban areas where the land acquisition is either unfeasible or unaffordable.

A Suntree Baffle Box will be incorporated into the existing drainage system at the immediate upstream of its discharge point. The Baffle Box will provide a 19% TN removal efficiency, which is equivalent to 43 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 67 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-45.

The preliminary cost is estimated at $75,000, which covers both design and construction fees.

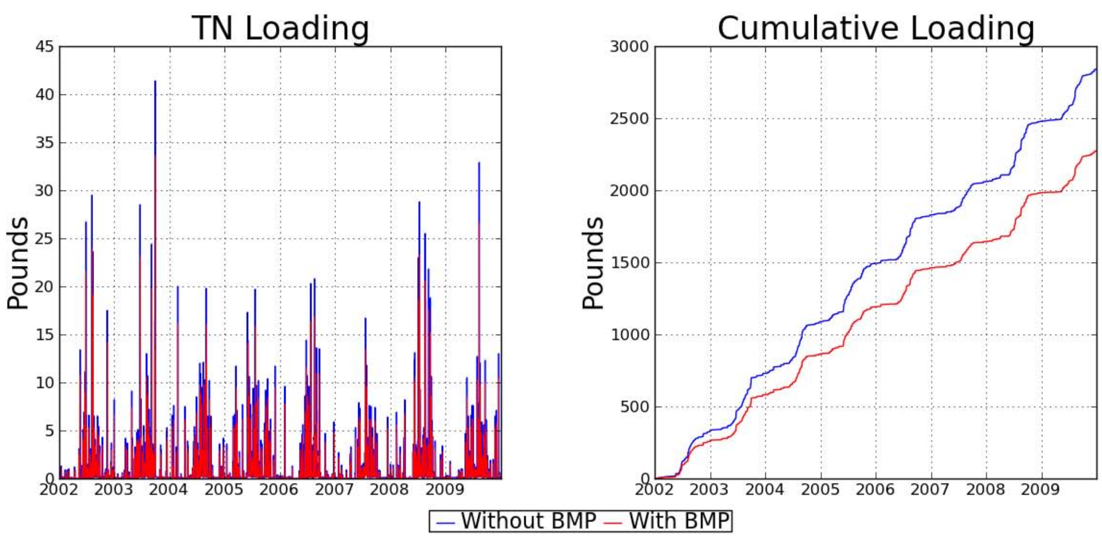


Figure 7-45. HSPF Simulated TN Removal, BMP 14

7.2.15 Potential BMP Site 15 – E. Terry Street at Leitner Creek - South

Potential BMP Site 15 is located in the southern portion of the Leitner Creek HSPF basin, located north of E. Terry Street at Leitner Creek (Figure 7-1). As part of the two City-owned parcels totaling 16.5-acre in size, the site contains a 2.5-acre open land curbed by Leitner Creek to the northwest, as shown in Figure 7-16. As described previously, potential BMP Site 5 contains the remaining and majority of the two parcels.

Based on the 2010 aerial imagery and 2004 land use map, this open land is surrounded by densely populated residential areas. This site was a mobile home park prior to 2001. Per the ICPR subbasin map, the contributing area to the east is approximately 31 acres in size, as presented in Figure 7-16. The majority of the contributing area is dominated by residential areas.

Field inspection has confirmed that the site is fairly flat with a mild slope towards the creek. Forested areas were observed along the east boundary and Leitner Creek. No natural wetland, man-made pond, or other drainage structures was found in the site, as shown in Figure 7-46. The off-site runoff is generally drained through the drainage ditches/pipes within E. Terry Street ROW prior to discharging into Leitner Creek.

Figure7-46. Potential Site Location, BMP 15

This site should be considered as an ideal location for a structural BMP, given its size, governmental ownership, lack of structures/buildings, proximity to the receiving water, land use/cover and lack of BMPs in the contributing area.

The soil found in the site is classified as a hydro group “D” soil, indicating a higher SHGWT is expected. However, given that this local residential area has been well drained, a dry retention pond might be a feasible option for this site.

Other structural BMPs may be considered during the design and permitting phases. For example, a wet detention pond or a filter marsh can provide more aesthetic landscape and educational opportunities than a dry pond system, although they are not as efficient as the dry pond system in TN removal.

Assuming that the dry pond could be dredged as deep as 2 ft to provide a 3.8 ac-ft treatment volume, the TN removal efficiency is estimated at 85%, using the method described in FDEP Handbook. In addition, a Suntree Baffle Box is proposed for stormwater pre-treatment, which will provide a 19% of TN removal efficiency alone.

Combining both BMP components, the overall TN removal efficiency is estimated at 87.4%, which is equivalent to 241 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 236 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-47.

The preliminary cost is estimated at $220,000, which covers both design and construction fees.

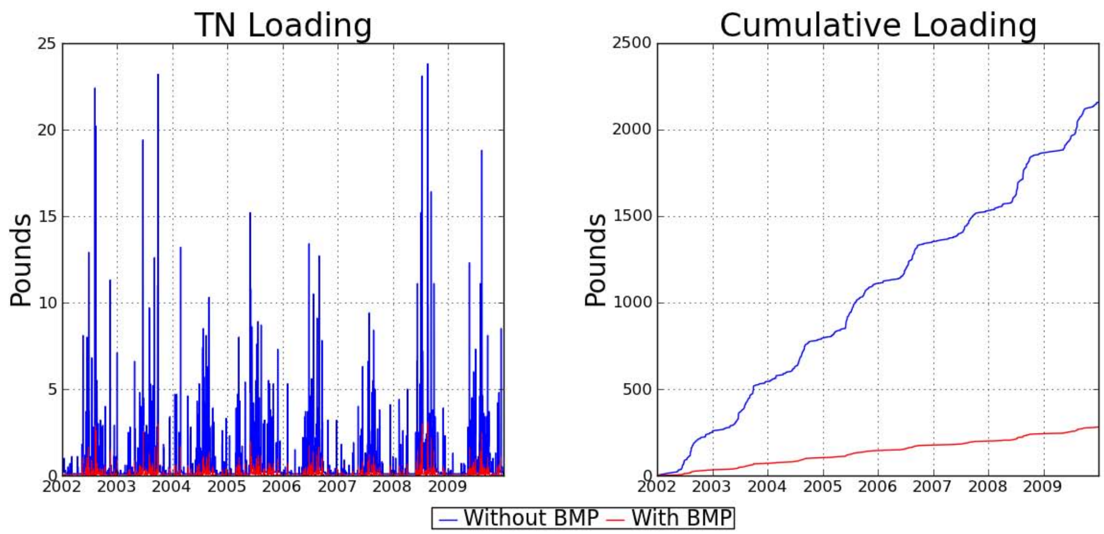


Figure 7-47. HSPF Simulated TN Removal, BMP 15

7.2.16 Potential BMP Site 16 – Dean Street at Imperial River

Potential BMP Site 16 is located in the center portion of the Imperial Middle HSPF basin, about 1/3 mile upstream the Imperial River bridge at Imperial Parkway (Figure 7-1). The site is represented by two County-owned parcels approximately 2.4-acre in size, located at the east end of Dean Street and immediate south of the Imperial River, as shown in Figure 7-17.

Based on the 2010 aerial imagery and 2004 land use map, this site is surrounded by commercial and residential areas. Per the ICPR subbasin map, the contributing area of approximately 18 acres in size was delineated to the north of the site, as presented in Figure 7-17. About half of the contributing area is a high density residential area without any water quality BMP.

Field inspection has confirmed that this vacant land is fairly flat with a mild slope towards the Imperial River to the north. No natural wetland, man-made pond or drainage structure was found within this site. The majority of the site is heavily vegetated with large oak trees, pine trees and others, as shown in Figure 7-48. This site, as the lowest point in its contributing area, receives surface runoff through natural swales or overland flow.

Figure7-48. Potential Site Location, BMP 16

This site will be a good candidate for a structural BMP, given its size, lack of structures/buildings, proximity to the receiving water, and lack of BMPs in the contributing area. Few years ago, the City staff initiated an investigation of developing a water quality treatment area at these two County-owned parcels; however, the local residents did not support the idea of converting the natural wooded area into a man-made pond at that time.

The soil found on site is classified as hydro group "A" soil, indicating a lower SHGWT is expected. Therefore, a dry retention pond is recommended to achieve higher TN removal efficiency.

Other structural BMPs may be considered during the design and permitting phases. For example, a wet detention pond or a filter marsh can provide more aesthetic landscape and educational opportunities than a dry pond system, although they are not as efficient as the dry pond system in TN removal.

It is assumed that the dry pond could be dredged as deep as 1.5 ft in order to provide a 0.96 ac-ft treatment volume. The TN removal efficiency is estimated at 83.5%, using the method described in FDEP Handbook, which is equivalent to 81 lb/yr of annual TN removal. For reference only, the average annual TN removal is estimated at 103 lb/yr using the HSPF model. A comparison of the TN loading with and without the BMP is shown both daily and cumulatively in Figure 7-49.

The preliminary cost is estimated at $120,000, which covers both design and construction fees.

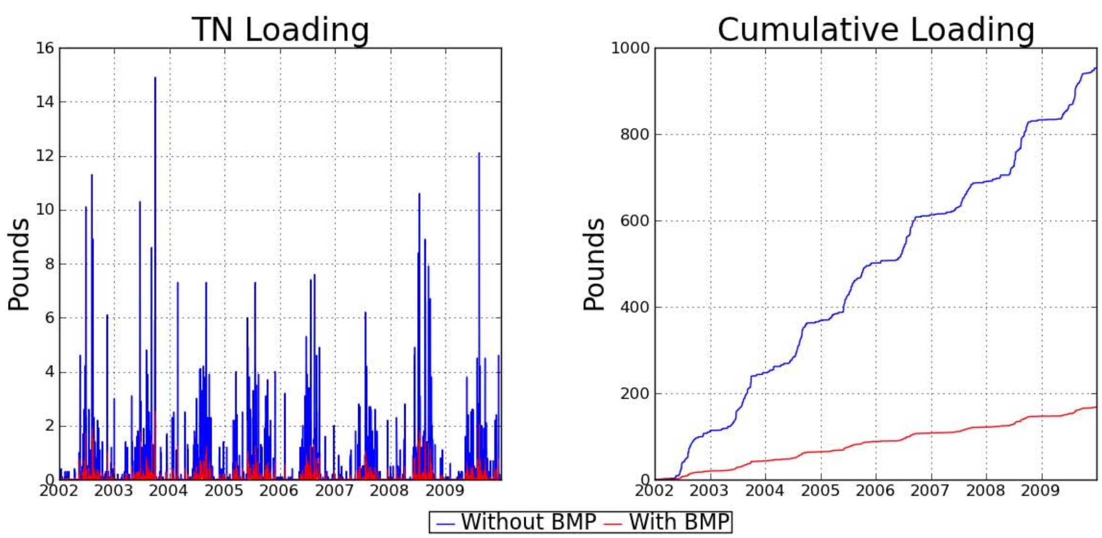


Figure 7-49. HSPF Simulated TN Removal, BMP 1

A summary of each BMP, including land ownership, basin name, contributing area, TN removal efficiency, annual TN loading reduction, and preliminary cost estimate, is shown in Table 7-1. The estimated TN removal efficiency and annual TN load reduction for each BMP components in the treatment train is summarized in Table 7-2.

7.3 Section References

Florida Department of Environmental Protection. (2010), *Stormwater Quality Applicant's Handbook.*

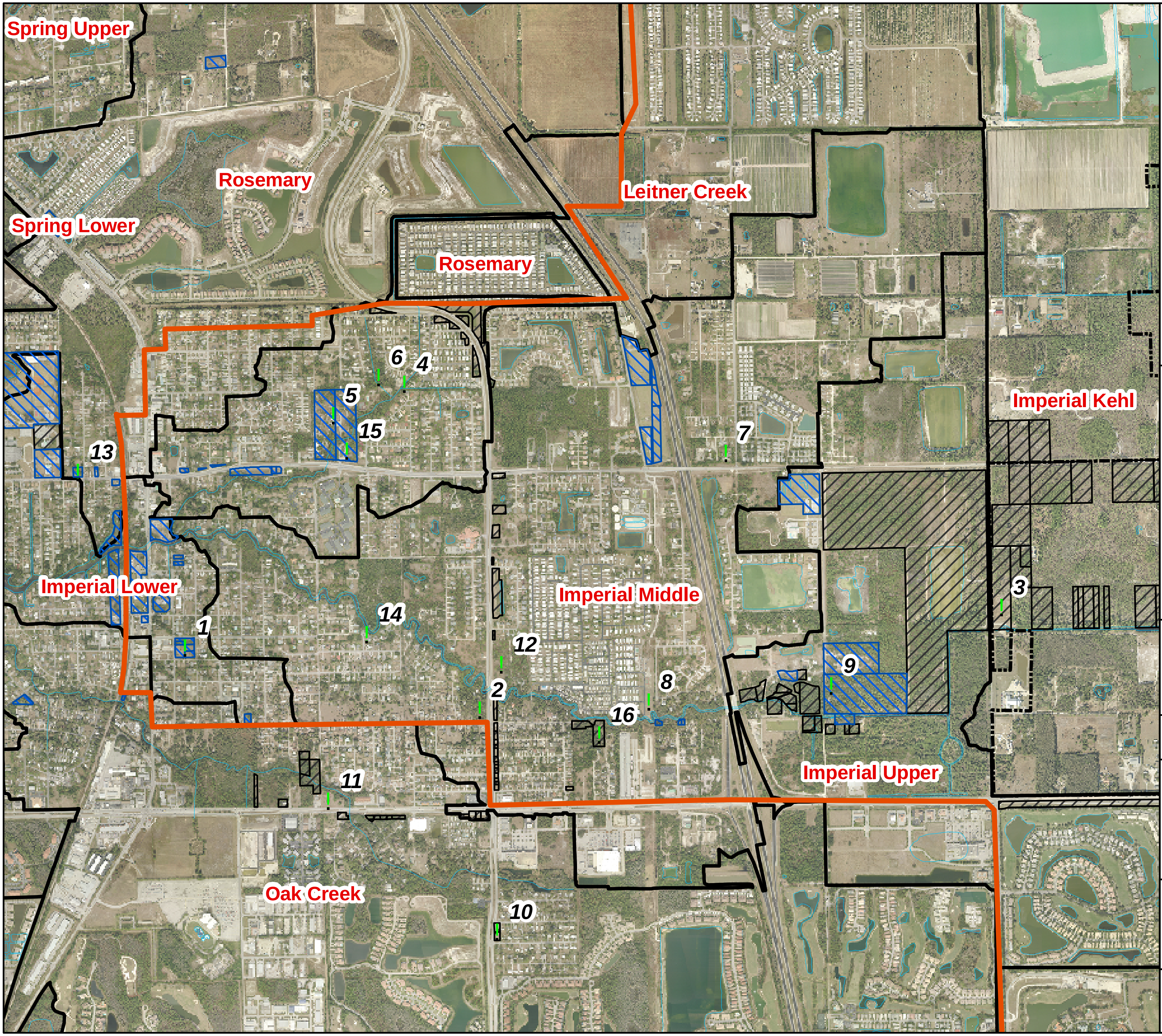
Harper, H.H. and Baker, D.M. (2007). *Evaluation of Current Stormwater Design Criteria within the State of Florida*. Orlando, FL: Florida Department of Environmental Protection

7.4 Additional Figure and Table Descriptions

The figures and tables discussed in this section are summarized below:

Figure #	Description
7-1	Potential BMP Sites
7-2	Potential BMP Site 1 – Felts Avenue at Ragsdale Street
7-3	Potential BMP Site 2 – Imperial Parkway at Dean Street
7-4	Potential BMP Site 3 – Bonita Grande Drive at Kehl Canal
7-5	Potential BMP Site 4 – Leitner Creek - Bypass Canal
7-6	Potential BMP Site 5 – E. Terry Street at Leitner Creek - North
7-7	Potential BMP Site 6 – Leitner Creek - Old Course
7-8	Potential BMP Site 7 – E. Terry Street at Morton Avenue
7-9	Potential BMP Site 8 – FPL Corridor near Imperial River
7-10	Potential BMP Site 9 – Kent Road at Imperial River
7-11	Potential BMP Site 10 – Imperial Parkway at Meadow Lane
7-12	Potential BMP Site 11 – Bonita Beach Road at Oak Creek
7-13	Potential BMP Site 12 – Imperial Parkway at Imperial River
7-14	Potential BMP Site 13 – W. Terry Street at Palm Street
7-15	Potential BMP Site 14 – Murat Circle at Imperial River
7-16	Potential BMP Site 15 – E. Terry Street at Leitner Creek – South
7-17	Potential BMP Site 16 – Dean Street at Imperial River

Table #	Description
7-1	Summary of Potential BMP Sites
7-2	Summary of TN Removal Efficiency and TN Loading Reduction for Potential BMP Sites



Legend

- Potential BMP Sites
- Parcel - City Owned
- Parcel - State/County
- Basin_HSPF
- FDEP_Imperial
- CityLimits

2

1 in equals 2,000 feet

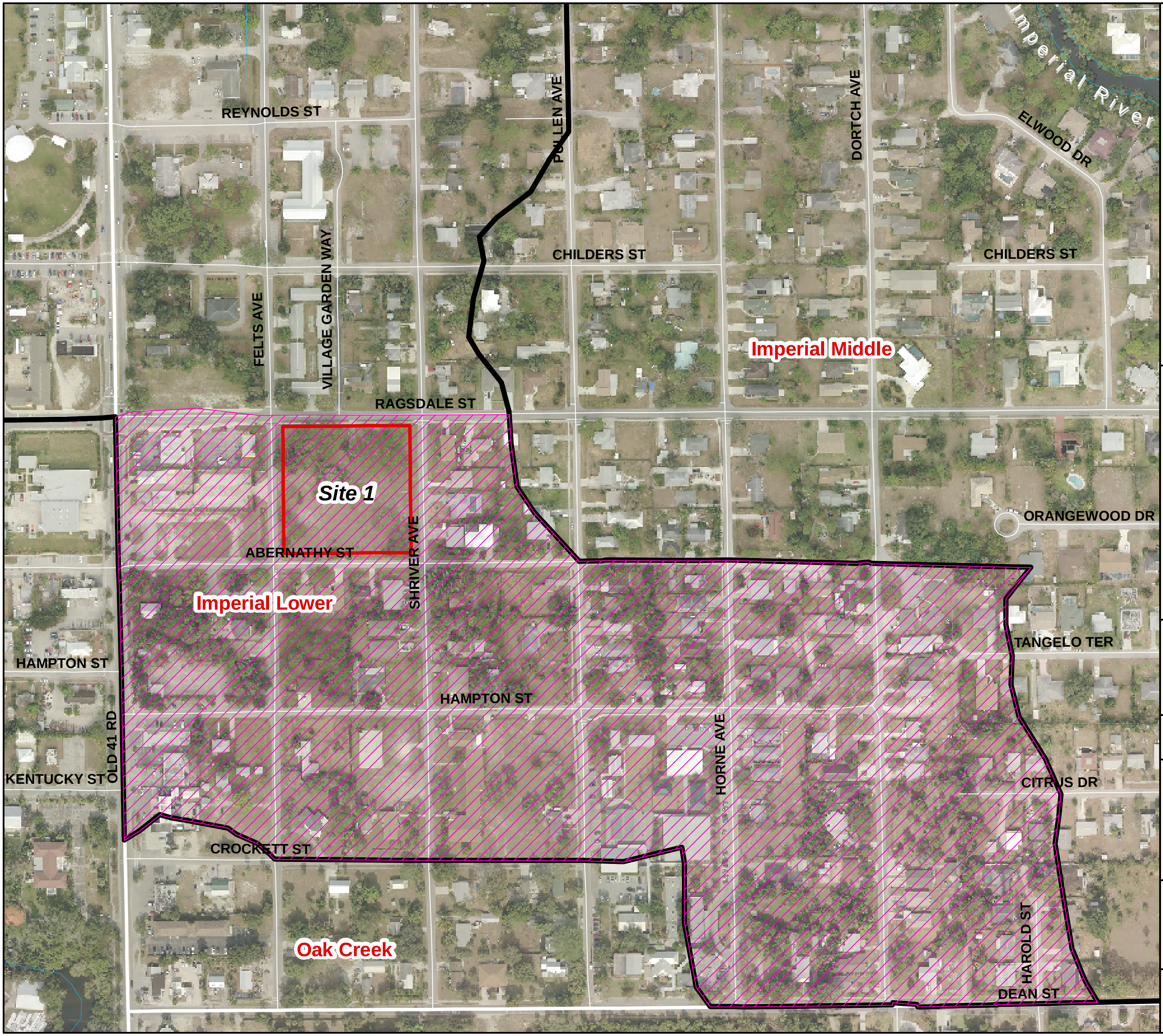
City of Bonita Springs
SMP Phase II

TITLE:

Potential BMP Sites

DATE: 10/10/2011

FIGURE:
7-1



Legend

BMP Site
Contributing Area
Basin_HSPF

2

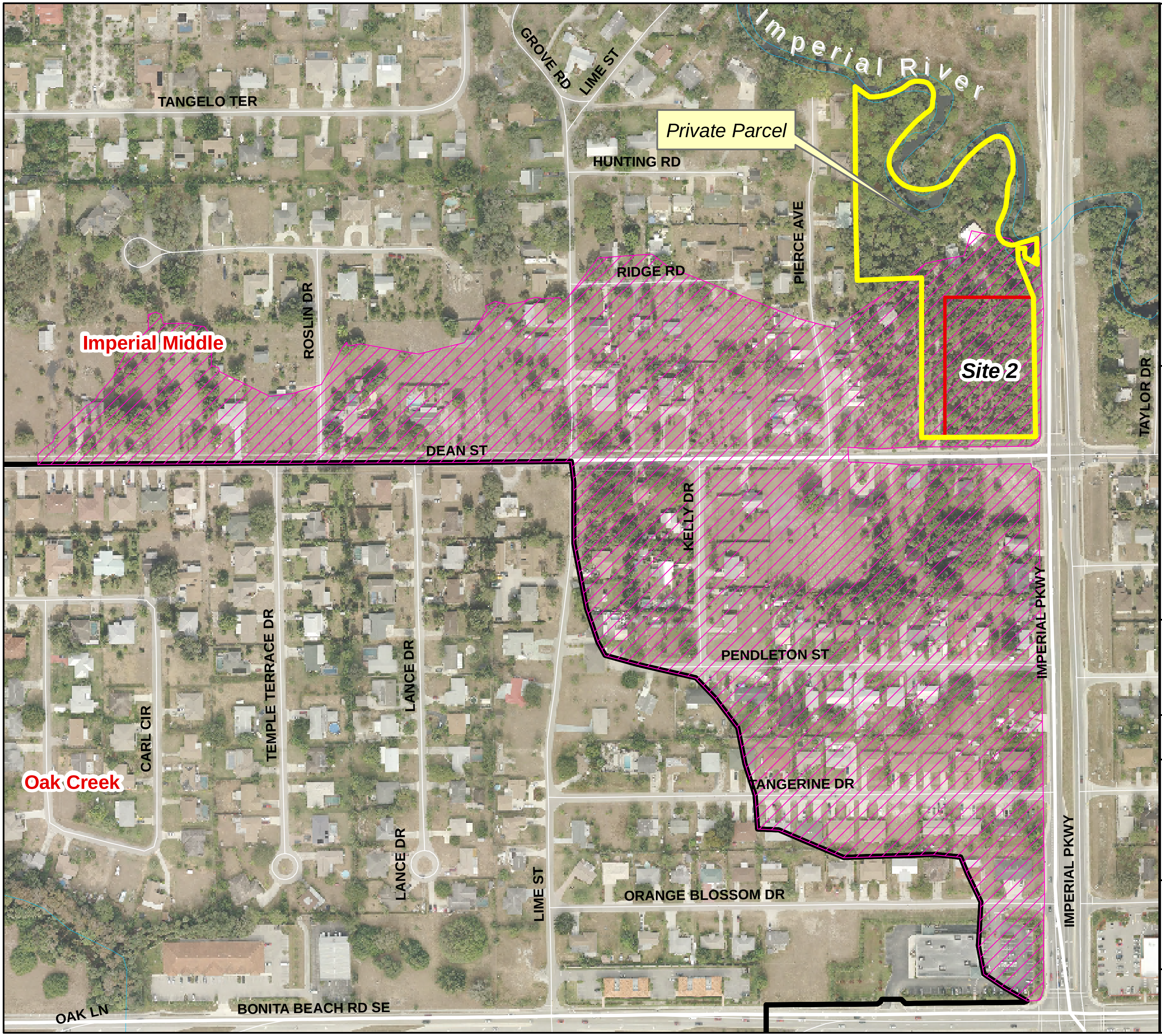
1 in equals 300 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 1: Felts Avenue at Ragsdale Street

DATE: 10/10/2011

FIGURE:
7-2



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 300 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 2: Imperial Parkway at Dean Street

DATE: 10/10/2011

INTERA

FIGURE:
7-3

Legend

- BMP Site
- Contributing Area
- Basin_HSPF
- CityLimits

2

1 in equals 200 feet

City of Bonita Springs
SMP Phase II

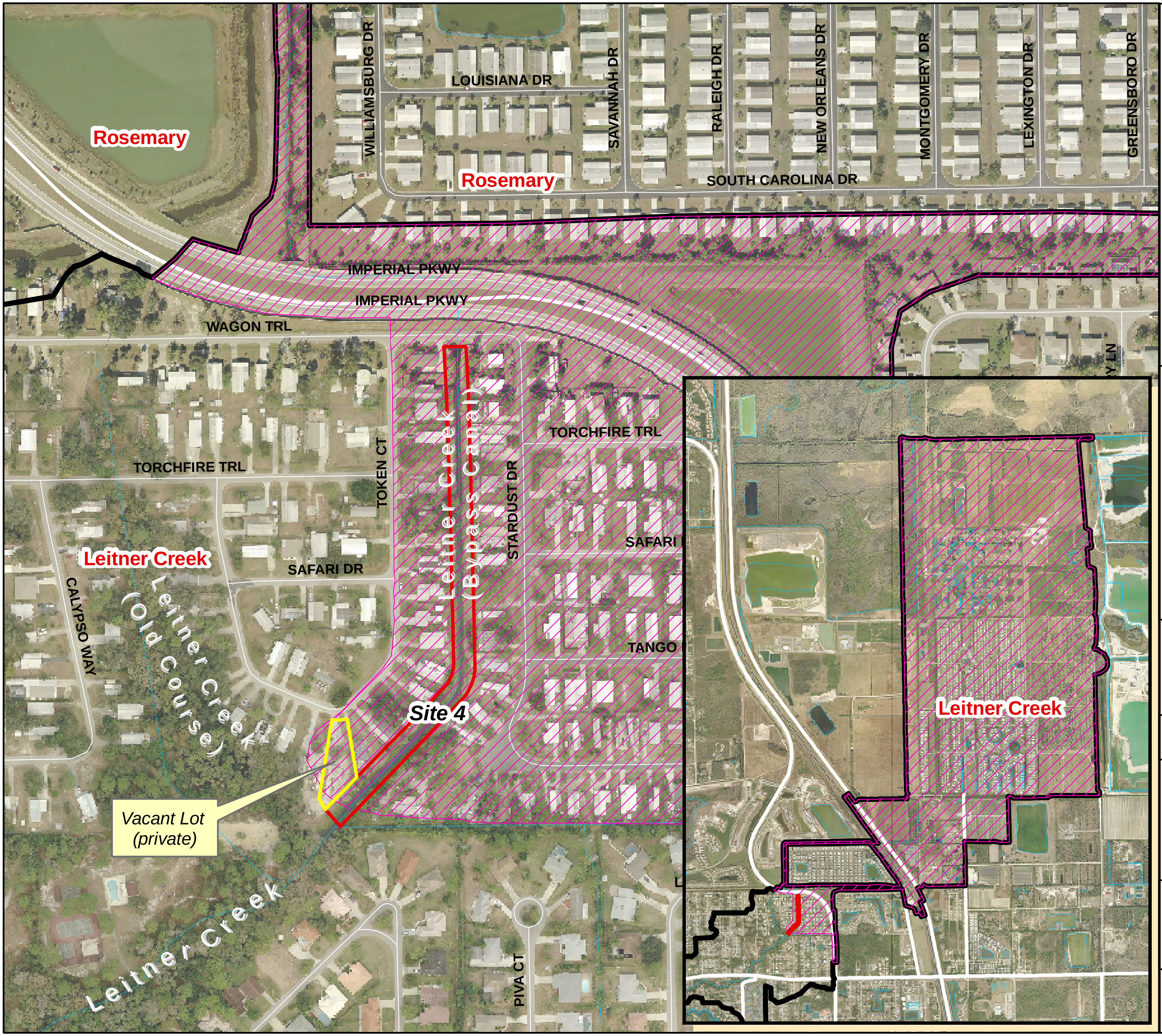
TITLE:

Potential BMP Site 3: Bonita Grande Drive at Kehl Canal

DATE: 10/10/2011

INTERA

FIGURE:
7-4



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 300 feet

City of Bonita Springs
SMP Phase II

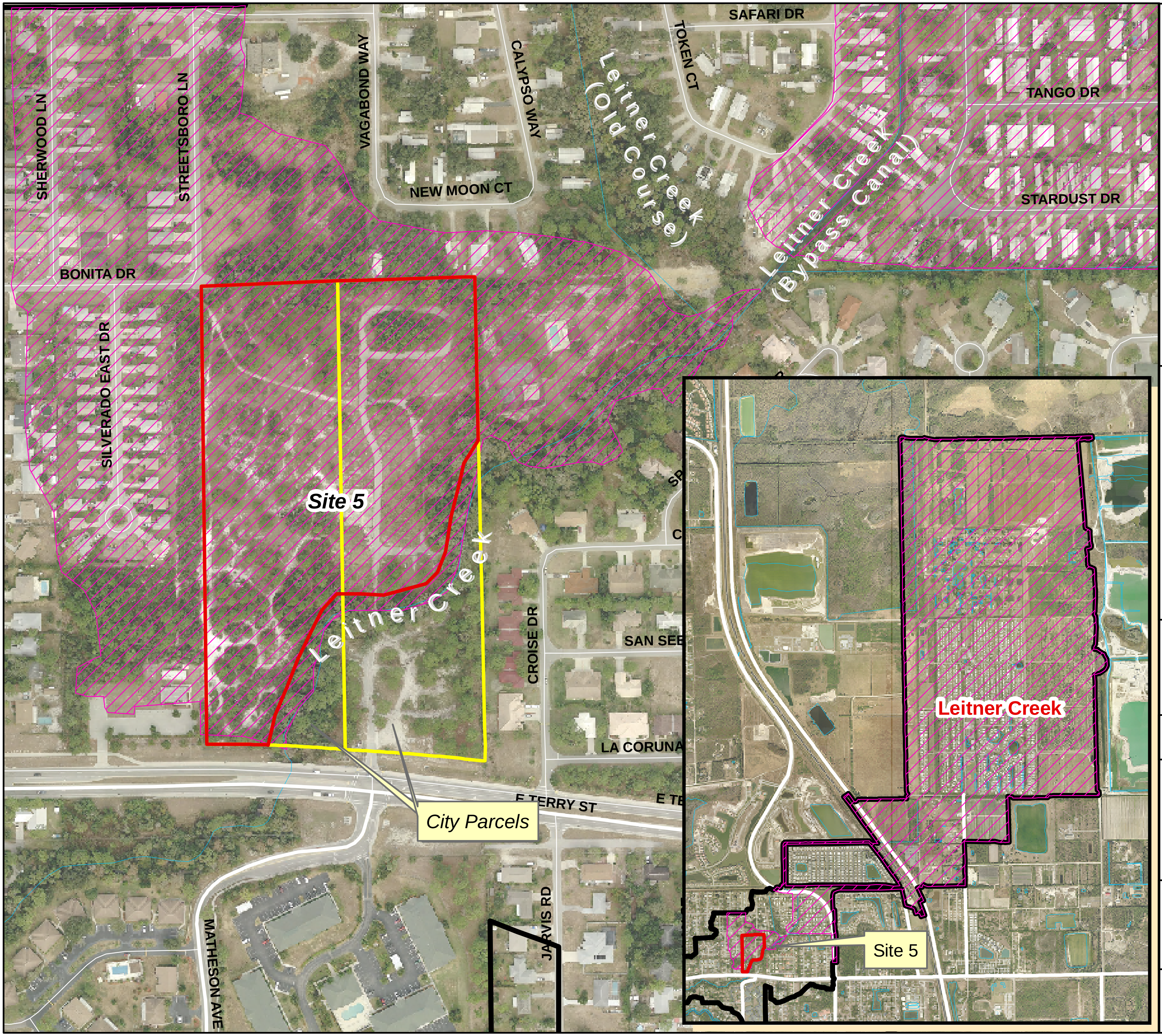
TITLE:
Potential BMP Site 4: Leitner Creek - Bypass Canal

DATE: 10/10/2011

INTERA

EAS

FIGURE:
7-5



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

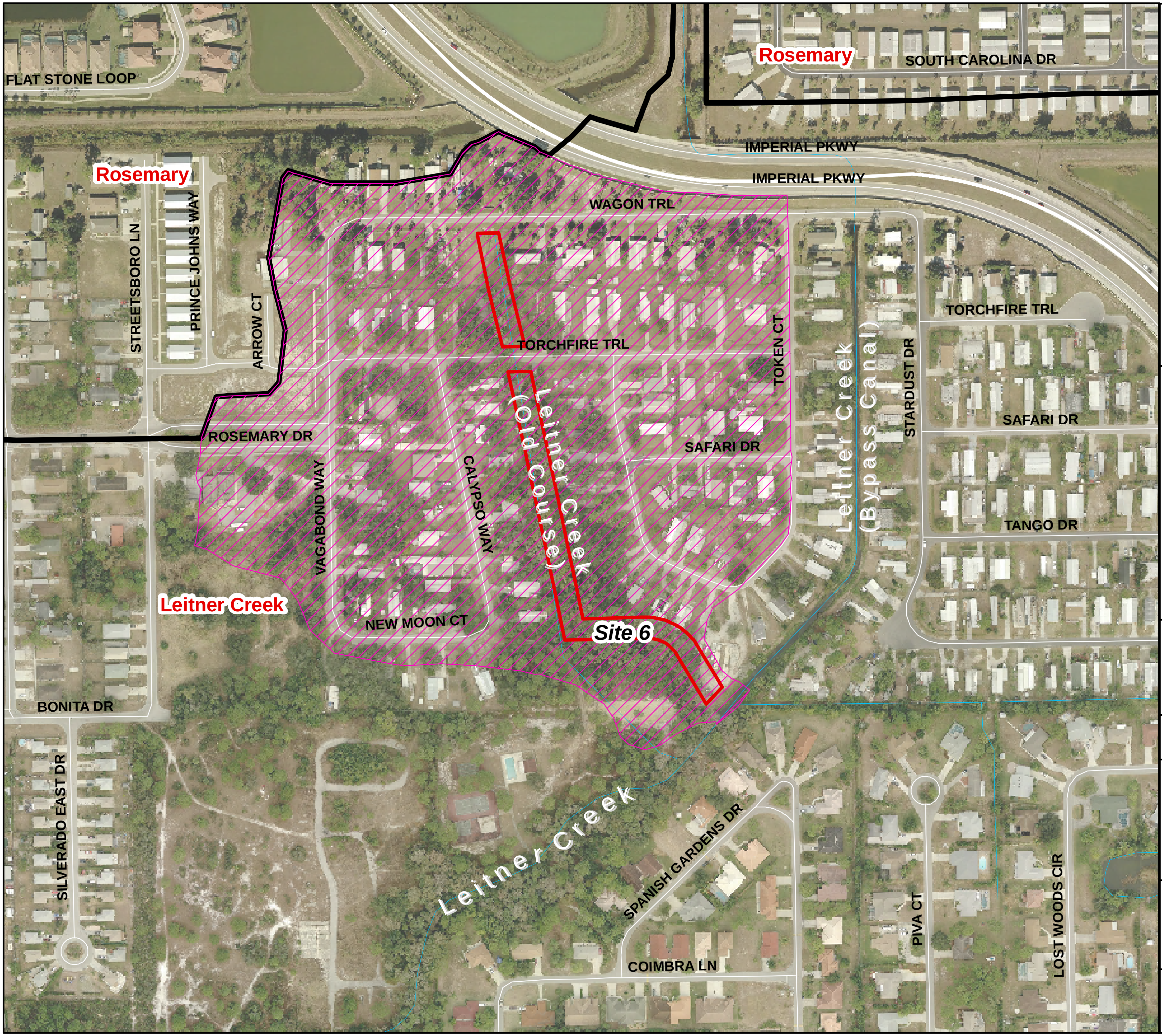
1 in equals 300 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 5:
E. Terry Street at
Leitner Creek - North

DATE: 10/10/2011

FIGURE:
7-6



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 300 feet

City of Bonita Springs
SMP Phase II

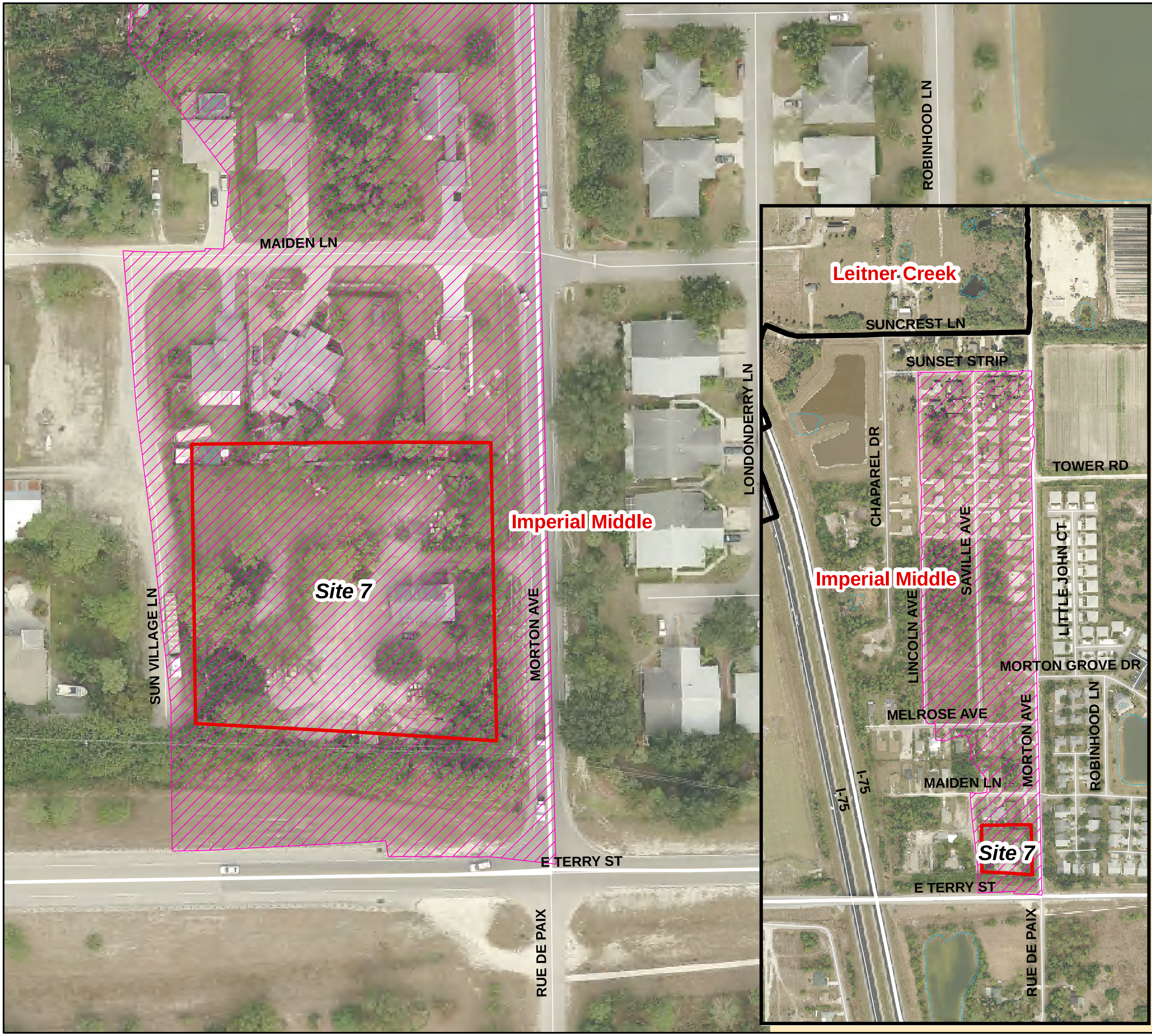
TITLE:

Potential BMP Site 6: Leitner Creek - Old Course

DATE: 10/10/2011

FIGURE:

7-7



Legend

BMP Site
Contributing Area
Basin_HSPF

2

1 in equals 100 feet

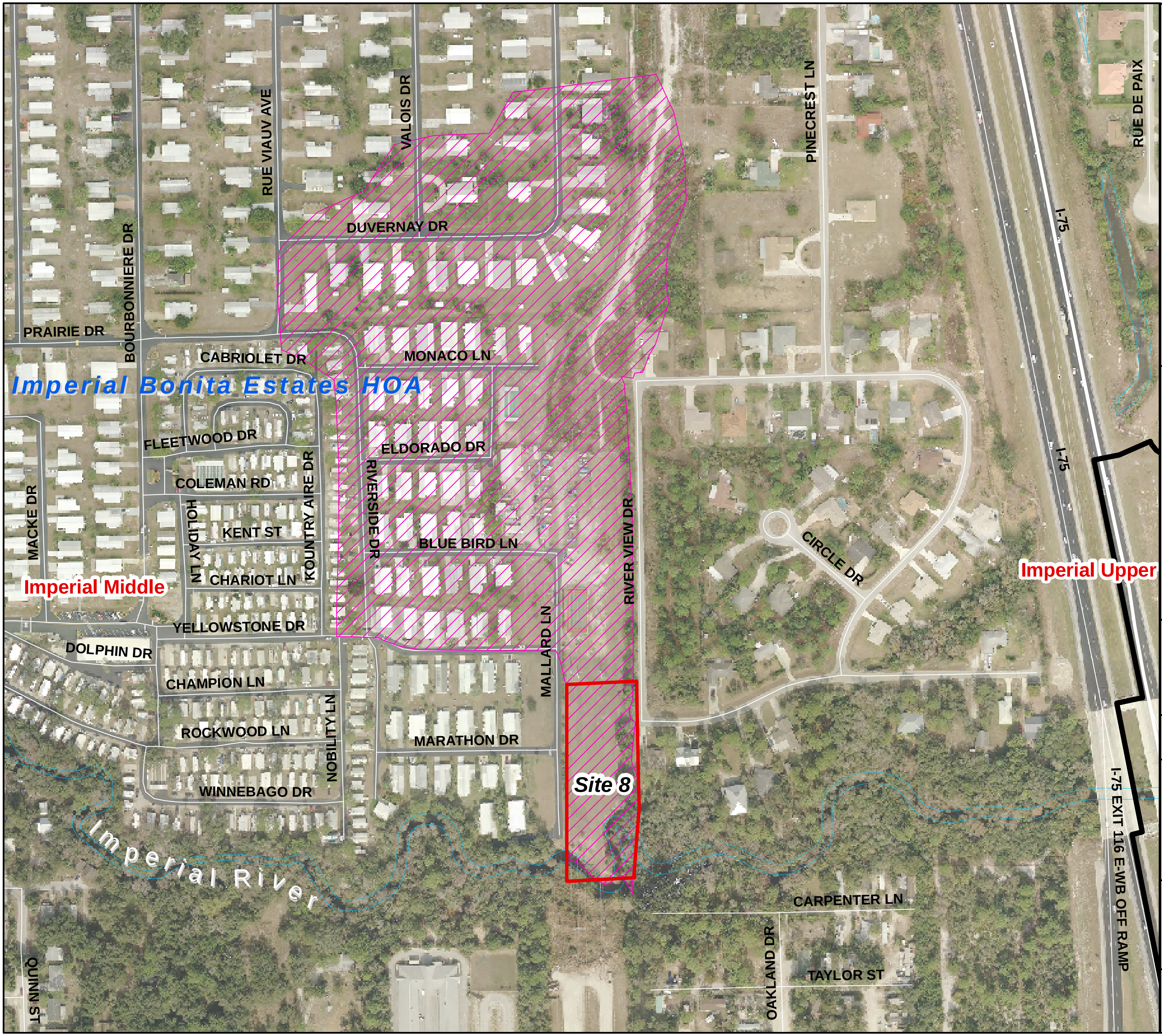
City of Bonita Springs
SMP Phase II

TITLE:

Potential BMP Site 7:
E. Terry Street at
Morton Avenue

DATE: 10/10/2011

FIGURE:
7-8



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

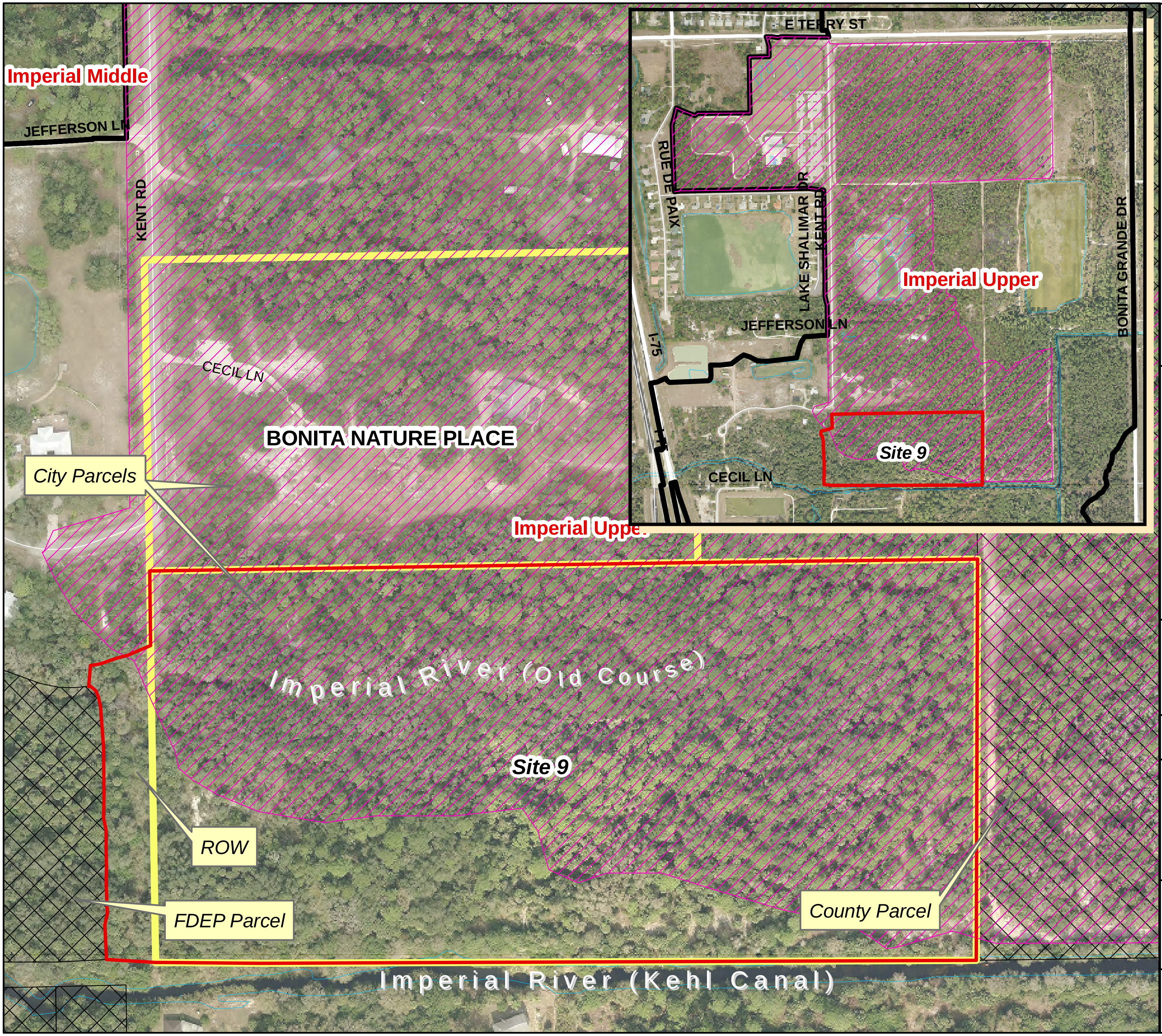
1 in equals 300 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 8: FPL Corridor near Imperial River

DATE: 10/10/2011

FIGURE:
7-9



Legend

- BMP Site
- Contributing Area
- Parcel - City Owned
- Parcel - State/County
- Basin_HSPF

2

1 in equals 200 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 9: Kent Road at Imperial River

DATE: 10/10/2011

INTERA

EAS

FIGURE:
7-10

Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 200 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 10: Imperial Parkway at Meadow Lane

DATE: 10/10/2011

FIGURE:
7-11

Legend

BMP Site

Contributing Area

Basin_HSPF

2

1 in equals 200 feet

City of Bonita Springs
SMP Phase II

TITLE:

Potential BMP Site 11: Bonita Beach Road at Oak Creek

DATE: 10/10/2011

INTERA

EAS

FIGURE:

7-12

Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 200 feet

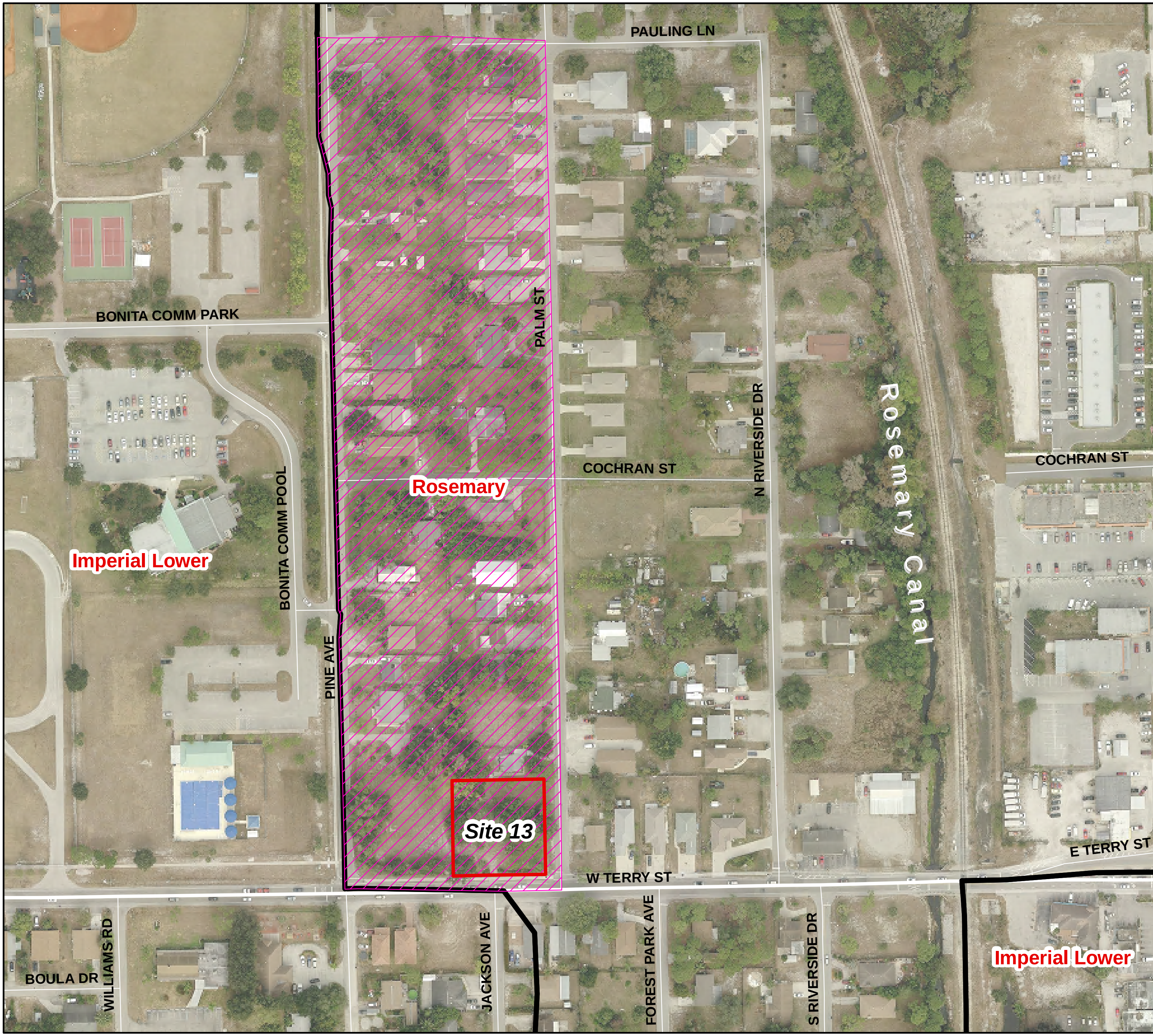
City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 12: Imperial Parkway at Imperial River

DATE: 10/10/2011

INTERA

FIGURE:
7-13



Legend

BMP Site
Contributing Area
Basin_HSPF

2

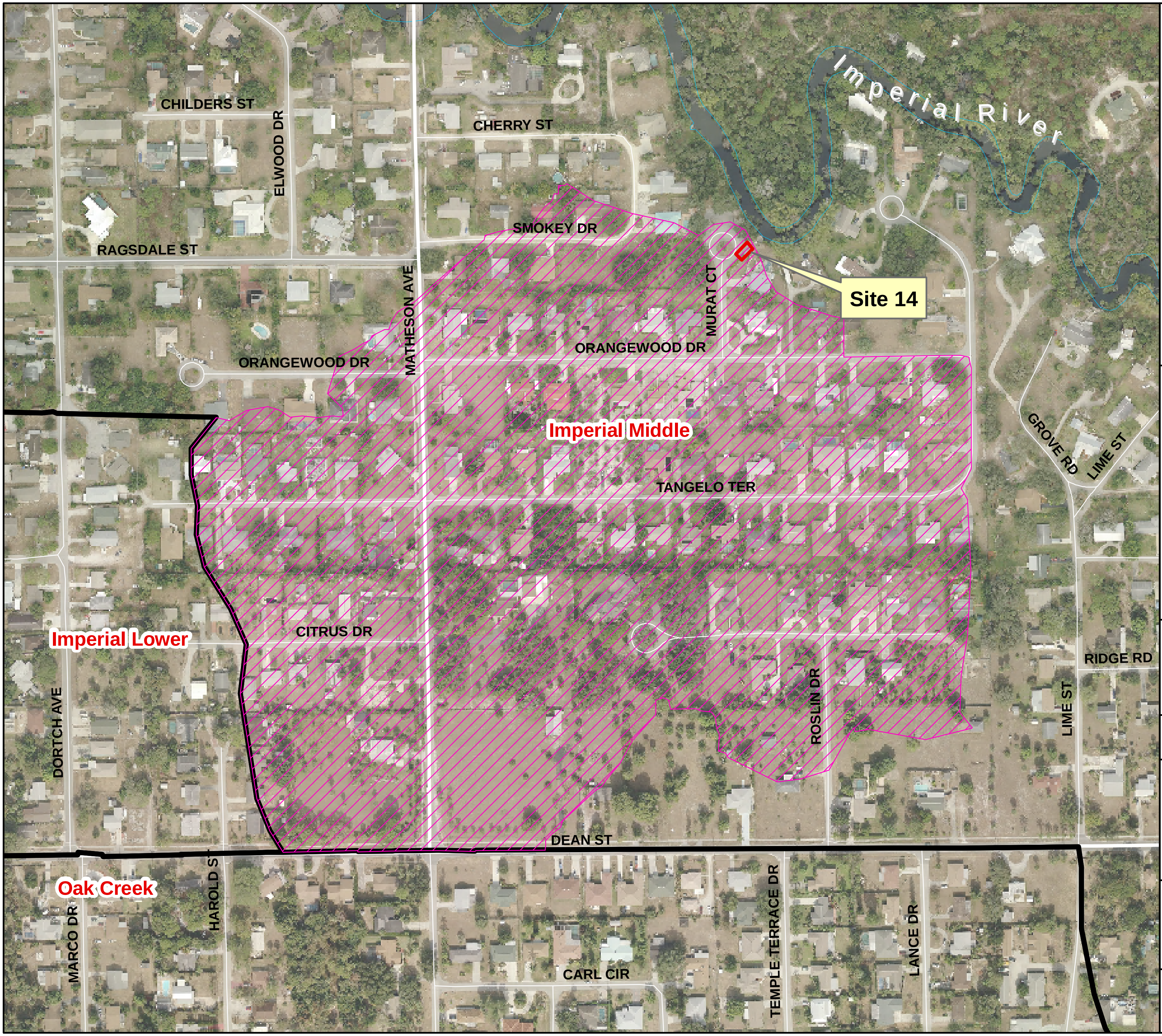
1 in equals 200 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 13: W. Terry Street at Palm Street

DATE: 10/10/2011

FIGURE:
7-14



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 300 feet

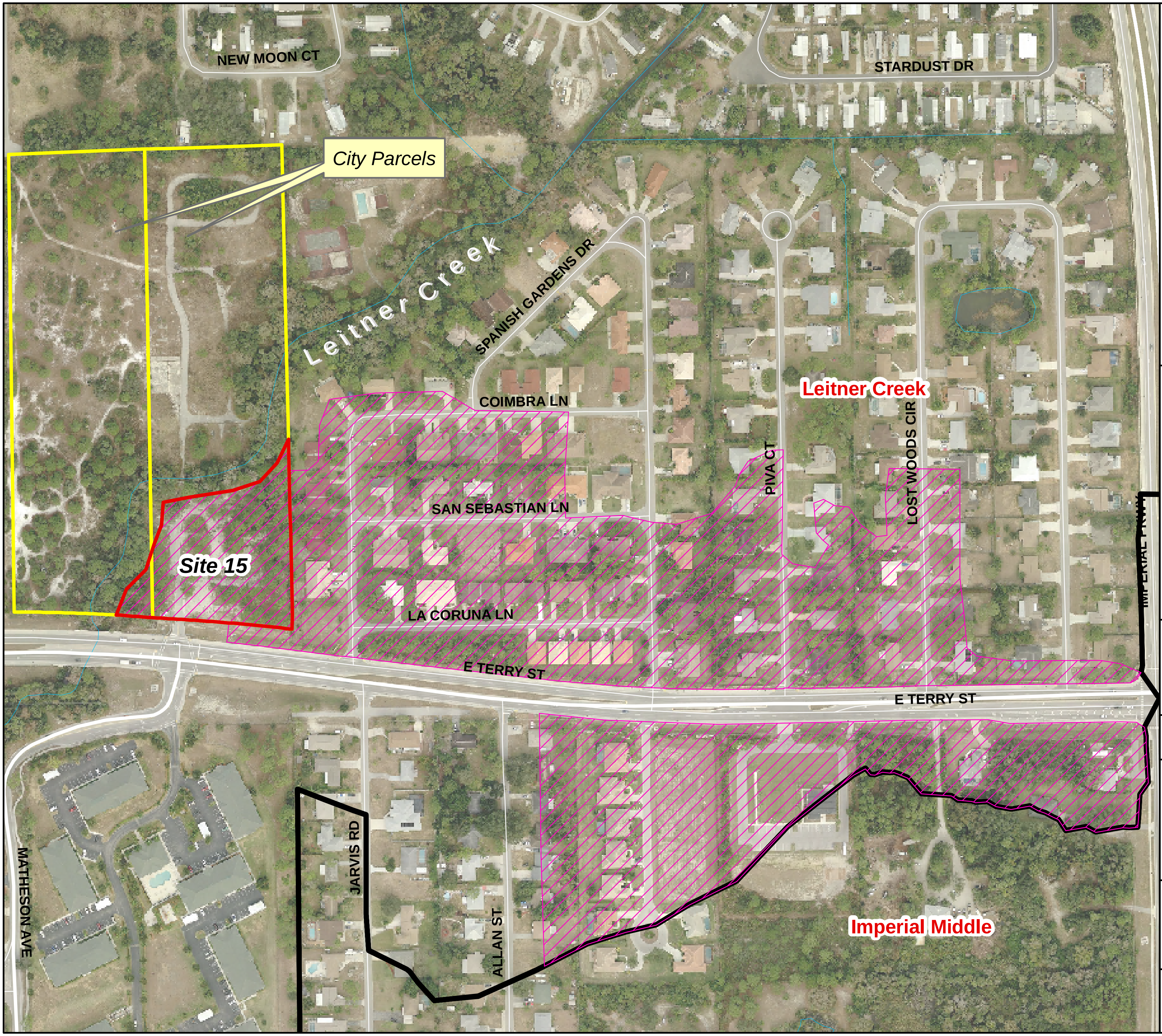
City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 14: Murat Circle at Imperial River

DATE: 10/10/2011

INTERA

FIGURE:
7-15



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

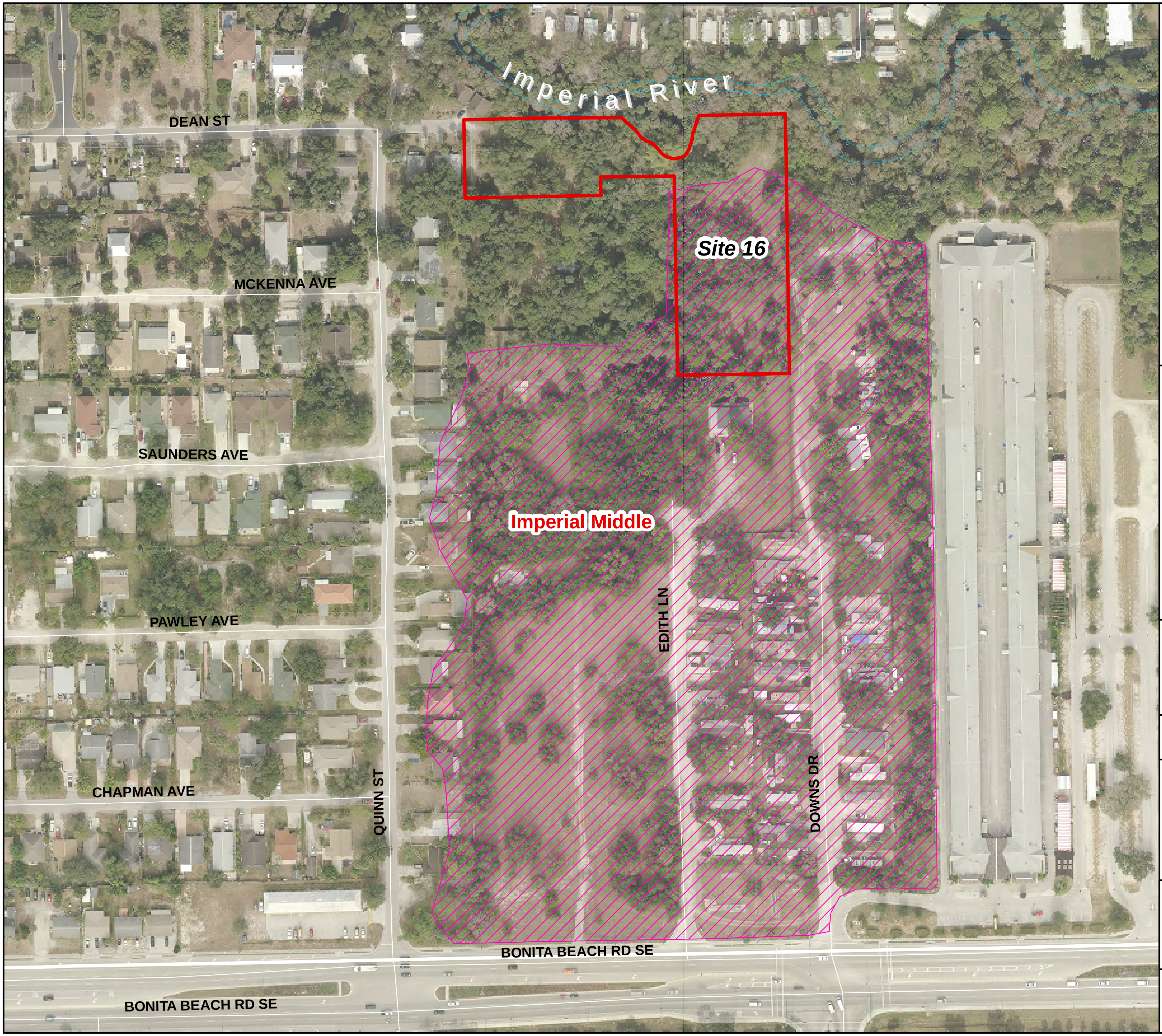
1 in equals 300 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 15: E. Terry Street at Leitner Creek - South

DATE: 10/10/2011

FIGURE:
7-16



Legend

- BMP Site
- Contributing Area
- Basin_HSPF

2

1 in equals 200 feet

City of Bonita Springs
SMP Phase II

TITLE:
Potential BMP Site 16: Dean Street at Imperial River

DATE: 10/10/2011

INTERA

FIGURE:
7-17

Table 7-1. Summary of Potential BMP Sites

Site ID	Site Location	Land Ownership	Site Area (ac)	Contrib-uting Area (ac)	Basin in HSPF Model	TMDL Watershed	Structural BMP Type	TN Removal Effic. (%)	Annual TN Loading Reduction (lb/yr)	Avg. Annual TN Removal in HSPF (lb/yr)	Preliminary Cost
1	Felts Avenue at Ragsdale Street	City	2.07	48.92	Imperial Low	Yes	Dry Retention Pond & Baffle Box	85.54	243	356	$200,000
2	Imperial Parkway at Dean Street	Private	1.60	38.35	Imperial Middle	Yes	Dry Retention Pond & Baffle Box	89.35	164	262	$370,000
3	Bonita Grande Drive at Kehl Canal	FDEP	2.93	1,500.07	Imperial Kehl	Yes	Constructed Wetland & Baffle Box	6.69	336	323	$400,000
4	Leitner Creek - Bypass Canal	City	1.45	1,624.19	Leitner Creek	Yes	Wet Detention Pond	4.77	458	702	$130,000
5	E. Terry Street at Leitner Creek - North	City/Private	12.16	1,661.67	Leitner Creek	Yes	Dry Retention Pond & Baffle Box	26.70	2,622	4,037	$560,000
6	Leitner Creek - Old Course	City	1.55	33.72	Leitner Creek	Yes	Wet Detention Pond	30.84	118	110	$65,000
7	E. Terry Street at Morton Avenue	Private	1.23	26.19	Imperial Middle	Yes	Wet Detention Pond & Baffle Box	47.96	51	49	$430,000
8	FPL Corridor near Imperial River	HOA/Utility Corridor	1.78	24.24	Imperial Middle	Yes	Dry Retention Pond & Baffle Box	81.82	152	207	$180,000
9	Kent Road at Imperial River	City	19.48	163.04	Imperial Upper	Yes	Constructed Wetland	14.82	40	116	$120,000
10	Imperial Parkway at Meadow Lane	Lee County	0.59	37.24	Oak Creek	No	Dry Retention Pond & Baffle Box	38.69	99	118	$130,000
11	Bonita Beach Road at Oak Creek	Private	2.50	96.77	Oak Creek	No	Dry Retention Pond & Baffle Box	43.38	303	412	$700,000
12	Imperial Parkway at Imperial River	Private	4.32	91.88	Imperial Middle	Yes	Dry Retention Pond	78.35	398	470	$310,000
13	W. Terry Street at Palm Street	City	0.50	10.68	Rosemary Canal	No	Wet Detention Pond & Baffle Box	46.68	34	45	$150,000
14	Murat Circle at Imperial River	City	0.02	47.18	Imperial Middle	Yes	Baffle Box	19.00	43	67	$75,000
15	E. Terry Street at Leitner Creek - South	City	2.51	31.24	Leitner Creek	Yes	Dry Retention Pond & Baffle Box	87.42	241	236	$220,000
16	Dean Street at Imperial River	Lee County	2.39	18.38	Imperial Middle	Yes	Dry Retention Pond	83.47	81	103	$120,000

Table 7-2. Summary of TN Removal Efficiency and TN Loading Reduction for Potential BMP Sites

Site ID	TN Removal Efficiency for Dry/Wet Pond (%)	TN Removal Efficiency for Baffle Box (%)	Overall TN Removal Efficiency (%)	Existing Annual TN Loading (lb/yr)	Annual TN Loading Reduction (lb/yr)
1	82.15	19	85.54	283.69	242.66
2	86.85	19	89.35	183.43	163.89
3	3.57	3.8	6.69	5,029.60	336.48
4	4.77	-	4.77	9,608.29	458.32
5	21.24	9.5	26.70	9,820.65	2,622.11
6	30.84	-	30.84	382.99	118.12
7	35.76	19	47.96	107.17	51.40
8	77.55	19	81.82	186.31	152.44
9	14.82	-	14.82	270.38	40.07
10	24.31	19	38.69	254.88	98.61
11	30.10	19	43.38	699.61	303.49
12	78.35	-	78.35	507.38	397.54
13	34.17	19	46.68	72.77	33.97
14	-	19	19	224.31	42.62
15	85.01	16.06	87.42	275.33	240.69
16	83.47	-	83.47	97.43	81.33

8 Prioritization of BMP Sites

8.1 Prioritization Scheme

The potential BMP sites are generally ranked in an order that indicates their relative importance to one another. Based on the review and assessment of collected data as described previously, it is possible to evaluate the priority ranking for the sixteen potential BMP sites listed in Table 7-1.

The methodology of prioritization is divided into six (6) evaluation categories as follows:

1. Land Availability
2. Site Location in Watershed
3. TN Removal Efficiency
4. Cost Efficiency
5. Existing Land Use and BMPs
6. Public Interest/Sensitivity (Optional)

Category 1 – Land Availability. This category offers higher point values to projects that are located in the government-owned properties, which are vacant and not preserved for other projects, such as parking lot and natural place. The maximum point value in this category is 25.

Category 2 – Site Location in Watershed. This category offers a higher point value for projects that are located in the freshwater section of the Imperial River watershed where a FDEP TMDL program has been established. The maximum point value in this category is 15.

Category 3 – TN Removal Efficiency. This category offers a higher point value for projects that have higher TN removal per acre of project site. The maximum point value in this category is 20.

Category 4 – Cost Efficiency. This category offers a higher point value for projects that have lower project cost per pound of annual TN removal. The maximum point value in this category is 20.

Category 5 – Existing Land Use and BMPs. This category offers a higher point value for projects that receive surface runoff from the contributing area having higher TN pollutant loads and having no existing BMP for stormwater treatment. The maximum point value in this category is 10.

Category 6 – Public Interest/Sensitivity (optional). This category accounts for public sentiment regarding the potential environmental/economic benefits or loss to the local neighborhood because of the proposed BMP projects.

For the five of the sixteen potential BMP sites – (1) Felts Avenue at Ragsdale Street, (8) FPL Corridor near Imperial River, (10) Imperial Parkway at Meadow Lane, (11) Bonita Beach Road at Oak Creek, and (14) Murat Circle at Imperial River, the proposed BMPs are located within the City's core urban area where no adequate stormwater treatment system exists. The local neighborhood is more likely to be receptive to the proposed BMPs. Therefore, 10 extra points were awarded to each of these five potential BMP sites, as listed in Category 6 of Table 8-2.

For the potential BMP sites – (4) Leitner Creek - Bypass Canal and (6) Leitner Creek - Old Course, the proposed BMPs are located in the old course or bypass canal of the Leitner Creek. It is a challenge to obtain an ERP permit from SFWMD in terms of avoiding potential flooding hazard to the upstream residential areas, and the local residents may also raise objections against the proposed weir structures for the same reason. For the potential BMP site (9) Kent Road at Imperial River, the property was given by SFWMD and is restricted in conservation, education and passive recreational purpose. While for the potential BMP (16) Dean Street at Imperial River, the proposed BMPs is to convert the natural forested areas adjacent to the Imperial River into stormwater treatment areas. It is not likely this BMP would gain the public support like other BMPs. Therefore, no extra point was awarded to these four potential BMP sites, as listed in Category 6 of Table 8-2.

For the remaining seven potential BMP sites, the proposed BMPs will not result in potential flooding risk to the local neighborhood; however, these sites are either located in the privately-owned properties, e.g., Site 7, or part of the public-owned lands where the City may have a potential plan to develop other projects that are more receptive to the public, e.g., Sites 5 and 15. Therefore, 5 extra points were awarded to these seven potential BMP sites, as listed in Category 6 of Table 8-2.

Upon evaluating the number of points awarded for Categories 1 through 6 in Table 8-1 the priority ranking is summarized in Table 8-2 for the sixteen potential BMP sites.

8.2 Recommended BMP Projects

Based upon the preliminary analysis in Section 7 and the priority ranking list provided in Table 8-2, the BMP projects are recommended in eight of the sixteen potential BMP sites. The selected eight potential BMP sites are as follows:

1. Potential BMP Site 4 – Leitner Creek - Bypass Canal
2. Potential BMP Site 5 – E. Terry Street at Leitner Creek - North
3. Potential BMP Site 1 – Felts Avenue at Ragsdale Street
4. Potential BMP Site 14 – Murat Circle at Imperial River

5. Potential BMP Site 6 – Leitner Creek - Old Course
6. Potential BMP Site 10 – Imperial Parkway at Meadow Lane
7. Potential BMP Site 8 – FPL Corridor near Imperial River
8. Potential BMP Site 2 – Imperial Parkway at Dean Street

8.3 Tables Descriptions

The tables discussed in this section are summarized below:

Table #	Description
8-1	Prioritization Methodology for Ranking BMP Sites
8-2	Summary of BMP Site Priority Ranking List

Table 8-1. Prioritization Methodology for Ranking BMP Sites

1. LAND AVAILABILITY	
Points Awarded	Description
0	Project site is located in privately-owned property, which has major structure found on site or the assessed property value is not in an affordable range.
5	Project site is located in public-owned property (including the City and other agencies). The property has been preserved for other projects that may also provide some stormwater treatment volume for the upstream contributing area.
10	Project site is located in privately-owned property, which is vacant and the assessed property value is in an affordable range.
15	Project site is located in public-owned property other than the City, such as Lee County and other state agencies. The property is not preserved for other projects.
20	Project site is located in the City-owned property. The property is currently used for other purposes, such as a temporary parking lot, or there is a potential to be used for other projects.
25	Project site is located in the City-owned property, which is vacant and ready for construction activities. The property is not preserved for other projects.
2. SITE LOCATION IN WATERSHED	
Points Awarded	Description
0	Project site is located in the watershed without FDEP TMDL Target established and is located west of Old US 41.
5	Project site is located in the watershed without FDEP TMDL Target established and is located east of Old US 41.
10	Project site is located in the freshwater section of the Imperial River watershed with FDEP TMDL Target established and is used to treat stormwater from the City jurisdiction and others.
15	Project site is located in the freshwater section of the Imperial River watershed with FDEP TMDL Target established and is used to treat stormwater from the City jurisdiction.
3. TN REMOVAL EFFICIENCY	
Points Awarded	Annual TN removal in pound per acre of Project Site
0	< 50 lb/ac
5	50 lb/ac - 100 lb/ac
10	100 lb/ac - 150 lb/ac
15	150 lb/ac - 200 lb/ac
20	> 200 lb/ac

Table 8-1. (Continued)
Prioritization Methodology for Ranking BMP Sites

4. COST EFFICIENCY	
Points Awarded	Project Cost per pound of Annual TN removal
0	> $1,500/lb
5	$1,000/lb - $1,500/lb
10	$500/lb - $1,000/lb
15	$250/lb - $500/lb
20	< $250/lb
5. EXISTING LAND USE AND BMPs	
Points Awarded	Description
0	Project site is receiving stormwater from highly developed areas (residential and agricultural) and treated by BMPs, or receiving stormwater from undeveloped areas.
5	Project site is receiving stormwater from highly developed areas (residential and agricultural) and partially treated by BMPs, or receiving stormwater from partially developed areas.
10	Project site is receiving stormwater from highly developed areas (residential and agricultural) with limited or without BMPs.
6. PUBLIC INTEREST/SENSITIVITY (OPTIONAL)	
Points Awarded	Description
0-10	Subjective, based upon intangible or other miscellaneous factors known by City staff, City Council, City Manager, or City Engineer. Such factors should be specified if any credit is awarded.

Table 8-2. Summary of BMP Site Priority Ranking List

Priority Ranking	Project Description[3]	Prioritization Ranking Category[1]						Total Points Awarded[2]
		1 (25)	2 (15)	3 (20)	4 (25)	5 (10)	6 (10)	
1	(4) Leitner Creek - Bypass Canal	25	15	20	15	10	0	85
2	(5) E. Terry Street at Leitner Creek - North	5	15	20	20	10	5	75
3	(1) Felts Avenue at Ragsdale Street	20	15	10	10	5	10	70
4	(14) Murat Circle at Imperial River	25	15	10	0	10	10	70
5	(6) Leitner Creek - Old Course	25	15	5	10	5	0	60
6	(10) Imperial Parkway at Meadow Lane	15	5	15	5	10	10	60
7	(8) FPL Corridor near Imperial River	10	15	5	5	10	10	55
8	(2) Imperial Parkway at Dean Street	10	15	10	0	10	5	50
9	(15) E. Terry Street at Leitner Creek - South	5	15	5	10	5	5	45
10	(12) Imperial Parkway at Imperial River	10	15	5	10	0	5	45
11	(3) Bonita Grande Drive at Kehl Canal	5	10	10	5	5	5	40
12	(16) Dean Street at Imperial River	15	15	0	5	5	0	40
13	(7) E. Terry Street at Morton Avenue	10	15	0	0	10	5	40
14	(11) Bonita Beach Road at Oak Creek	0	5	10	0	5	10	30
15	(9) Kent Road at Imperial River	5	15	0	0	5	0	25
16	(13) W. Terry Street at Palm Street	5	0	5	0	10	5	25

Notes:

1. Table 8-1 sets forth the basis for the number of points awarded under Categories 1 through 6.
2. Total points awarded after summing point values in Categories 1 through 6.
3. Numbers in parenthesis preceding each project is the BMP Site ID established in Table 7-1

9 Alternatives Analysis of Selected BMP Sites

9.1 Overview

After data collection and field inspection were completed, a preliminary site analysis was performed for each of the sixteen potential BMP sites. A conceptual BMP design and a preliminary engineer's cost estimate were completed and provided in Table 7-1. The sixteen potential BMP sites were then ranked using the prioritization methodology presented in Section 8 of this report.

Eight of the sixteen potential BMP sites were recommended as part of the City Capital Improvement Projects (CIP) program. As future potential BMP sites are identified feasible for water quality improvements projects, the CIP program can be expanded as needed by the City to implement additional projects once the funding is made available.

For the top three ranked BMP projects listed in Table 8-2, additional alternatives are developed in the following sections. These BMP projects include:

1. Leitner Creek – Bypass Canal (Potential BMP Site 4)
2. E. Terry Street at Leitner Creek – North (Potential BMP Site 5)
3. Felts Avenue at Ragsdale Street (Potential BMP Site 1)

The alternatives for each BMP project were then compared with respect to effectiveness in providing TN loading reduction, implementing cost, maintenance requirements, permittability, and public acceptance.

As part of the BMP alternative analysis in the following sections, the methodology provided in the FDEP Handbook will be the primary method in evaluating the TN removal of the proposed BMPs. The HSPF model utilized in the BMP site analysis in Section 7 only provided a reference for the average TN loading reduction and will not be discussed in the alternative analysis in this section.

Should the City decide to undertake the final engineering design for any of the alternatives presented below, the BMP design will be refined with the use of additional field data collection, such as topographic survey and geotechnical investigation. The BMP design should also meet the permit requirements of USACE, SFWMD and FDEP, in which a detailed stormwater model is required to simulate both the existing and proposed conditions to demonstrate no adverse impacts to the local neighborhood.

9.2 Leitner Creek - Bypass Canal

Potential BMP site 4 is located in the southern part of the Leitner Creek watershed and can be seen in Figure 7-1. The 1.45-acre site is part of City-owned ROW for the Leitner Creek Bypass Canal (Figure 7-5).

Based upon the preliminary site analysis and prioritization described in Sections 7 and 8, this site is ranked as the No. 1 choice for a structural BMP given: land availability, site size and location, TN removal efficiency, cost effectiveness, existing land use and BMPs in its contributing area and other considerations.

A weir structure was proposed in the preliminary BMP design for BMP Site 4 in Section 7.2.4. A wet detention pond created by the weir structure will provide a 4.77% reduction in TN, which is equivalent to 458 lb/yr in mean annual TN loading reduction.

The weir structure at this site is similar to the head structure proposed for Potential BMP Site 5 (E. Terry Street at Leitner Creek – North) in Alternatives No. 1 & 2 at the same location. In both of the BMP designs, the water level in the upstream channel will be raised by the structure. The main difference is that the weir structure in this BMP will create a wet detention pond with a certain treatment volume, which will be released by an outfall structure within a given period, e.g., 72-hour. However in BMP Site 5, the head structure raises the river water level permanently so that portion of the flow will be diverted to the dry retention pond, which has an extremely high TN removal efficiency.

Two alternatives were developed at this location with different structure designs and the corresponding detention volumes. These alternatives are discussed in the following sections.

9.2.1 Alternative No. 1 – Fixed Weir Structure

Alternative 1 is basically the preliminary BMP design discussed in Section 7.2.4. A conceptual sketch of this BMP's design components is presented in Figure 9-1 and listed below:

- Install a fixed weir structure to create a wet detention area with a 2-ft storage depth. A conceptual sketch of the weir structure is presented in Figure 9-1 and the weir invert elevation is selected at 7 ft-NGVD.
- Install a modified Type E DBI as the outfall structure at upstream of the weir structure. The control elevation is set at 5 ft-NGVD.
- Construct a MES at downstream of the weir structure and associated 24" RCP.

The fixed weir structure will create an on-line wet detention pond with a 2-ft storage depth or a 3.27 ac-ft of treatment volume. Using the FDEP Handbook method, the TN removal efficiency of the proposed wet detention pond is estimated at 4.77%, which is equivalent to a 458 lb/yr of annual TN loading reduction.

During the engineering design and permit phases, a detailed stormwater model is required to demonstrate that the proposed fixed weir structure will not adversely impact the existing drainage system in terms of flood protection. In addition, the outfall structure, a modified Type E DBI or similar structure should be designed to recover the treatment volume within the required period of time.

The analysis results are summarized in Table 9-1. The preliminary engineering cost estimate for Alternative No. 1 is $130,000 and a detailed cost breakdown is presented in Table 9-4.

9.2.2 Alternative No. 2 – Water Control Structure

To improve the TN removal efficiency of the wet detention pond, a water control structure with a higher invert elevation was designed to replace the fixed weir structure in Alternative No. 1. A conceptual sketch of the BMP design components for this alternative is presented in Figure 9-2 and listed below:

- Install a water control structure to create a wet detention area with a 4-ft storage depth. A conceptual sketch of the proposed structure is presented in Figure 9-2. The weir structure has an invert elevation of 9 ft-NGVD.
- Construct a 48” x 48” sluice gate in the middle segment of the concrete weir structure. The sluice gate is operated with an electric motor actuator. The sill elevation of the gateway is 5 ft-NGVD with sidewalls extending to 15 ft-NGVD.
- Install a 24” wide walkway with handrail to access the platform of the motor actuator.
- Install a modified Type E DBI as the outfall structure upstream of the weir structure. The control elevation of this structure is set at 5 ft-NGVD.
- Construct a MES at downstream of the weir structure and associated 24” RCP.

The water control structure consists of a fixed concrete weir and a sluice gate closure structure. During big storm events or other emergency conditions, the sluice gate will be lifted to release flood volume to the downstream creek. During normal conditions when the sluice gate is closed, a modified Type E DBI will serve as the outfall structure and should be capable of recovering the treatment volume within the required period of time.

The on-line wet detention area for this alternative has a 9.81 ac-ft of treatment volume. The TN removal efficiency is estimated at 12.31%, which is equivalent to a 1,183 lb/yr of annual TN loading reduction.

During the engineering design and permit phases, a detailed regional stormwater model is required to demonstrate that the proposed water control structure will not adversely impact the existing drainage system in terms of flood protection. An operation mechanism of the sluice gate should be well-defined and permitted by SFWMD.

There is a vacant lot adjacent to the proposed water control structure, as shown in Figure 9-2. This vacant lot will provide an ideal accessing point for future maintenance and operation of the water control structure and could be used as a staging area for construction of the structure. Therefore, it is highly recommended the vacant lot be obtained as part of this BMP alternative.

The analysis results are summarized in Table 9-1. The preliminary engineering cost estimate for Alternative No. 2 is $270,000 and a detailed cost breakdown is presented in Table 9-5.

As shown in Table 9-1, Alternative No. 2 appears more cost effective than Alternative No. 1, because project cost is decreased from $284 to $228 per pound of annual TN removal. However, the processing time and cost of land acquisition as well as the operation and maintenance of the water control structure should be given adequate considerations during the design and permit phases.

9.3 E. Terry Street at Leitner Creek - North

Potential BMP Site 5 is located in the southern part of the Leitner Creek watershed and is shown in Figure 7-1. This BMP site is located on a 12-acre City-owned open land and is adjacent to Leitner Creek. Based upon the preliminary site analysis and prioritization described in Sections 7 and 8, this site was ranked as the No. 2 choice for a structural BMP given the considerations of the land availability, size and location, TN removal efficiency, cost effectiveness, existing land use and BMPs in its contributing area and others.

There were two BMP components (a dry pond and a baffle box) in a treatment train that were used as part of the preliminary BMP design in Section 7.2.5. It was estimated in the preliminary design that a total of 2,622 lb/yr of TN would be removed by this BMP.

Being one of the few publicly-owned lands located in the City core urban area, the site is also the only one that is large enough for a regional stormwater treatment area. In addition, this site offers the highest cost effectiveness among all sixteen potential BMP sites, which is estimated at $214 for every pound of annual TN loading reduction.

During the site analysis it was discovered that the City Council is still debating on what to do with this site. The public and City Council's interests may outweigh the benefits that would be achieved from this BMP site. However, there may be an opportunity to combine the wishes of the City and local citizens and still construct a BMP at this location.

Four alternatives were developed based on the assumption of land availability and the choice of possible structural BMP options. These alternatives are discussed in the following sections.

9.3.1 Alternative No. 1 – Dry Retention Pond

A conceptual sketch of the BMP design components is presented in Figure 9-3 and listed below:

- Construct a head structure at the south end of the Leitner Creek Bypass Canal.
- Install a 400-ft 36” RCP & a mitered end section (MES) to divert flow westward to the pond system.
- Regrade the existing drainage ditch from the west end of 36” RCP to the Leitner Creek.
- Add a Type H ditch bottom inlet (DBI) and associated 36” RCP & MES. Modify this DBI to drain excess water to the downstream ditch when water stage reaches the storage depth of the pond.
- Add a Type E DBI in the pond and associated 24” RCP to link the Type H DBI in the ditch.
- Dredge a dry retention pond with a 2-ft storage depth and a side slope of 4:1.

In this alternative, the 12.2-ac site is assumed to be fully utilized for the stormwater treatment system. Based upon the assessment of the soil and groundwater conditions, the dry pond could provide a 2 ft storage depth or a 17.3 ac-ft treatment volume. To maintain a base flow in favor of ecological system in the downstream creek, it is assumed that up to 50% of the runoff volume will be diverted into the site for stormwater treatment.

The dry pond will treat 0.25” of the diverted 50% runoff of the 1,662-ac contributing area. Using the FDEP Handbook method, the TN removal efficiency is estimated at 21.24% for the entire contributing area and the annual TN loading reduction is approximately 2,086 lb/yr.

As the proposed 36” RCP and a portion of the ditch regrading are located in a private-owned property between the head structure and the pond, a drainage easement or ROW is required for this BMP project.

The analysis results are summarized in Table 9-2. The preliminary engineering cost estimate for Alternative No. 1 is $520,000 and a detailed cost breakdown is presented in Table 9-6.

9.3.2 Alternative No. 2 – Dry Retention Pond & Baffle Box

Alternative No. 2 is considered an enhancement of Alternative No. 1 by adding a baffle box to the treatment train for stormwater pre-treatment. This alternative is essentially the same as the preliminary BMP design described in Section 7.2.5. A conceptual sketch of the BMP design components is presented in Figure 9-4 and listed below:

- Construct a head structure at the south end of the Leitner Creek Bypass Canal.

- Install a 400-ft 36" RCP & a mitered end section (MES) to divert flow westward to the pond system.
- Regrade the existing drainage ditch from the west end of 36" RCP to the Leitner Creek.
- Add a Suntree Baffle Box and associated 36" RCP & MES. Modify this baffle box to drain excess water to the downstream ditch when water stage reaches the storage depth of the pond.
- Add a Type E DBI in the pond and associated 24" RCP to link the baffle box.
- Dredge a dry retention pond with a 2-ft storage depth and a side slope of 4:1.

The dry retention pond will treat 0.25" of the diverted 50% runoff of the 1,662-ac contributing area. The TN removal efficiency of the pond is estimated at 21.24%. The baffle box will provide a 9.5% of TN removal efficiency alone. The overall TN removal efficiency is estimated at 26.7%, which is equivalent to 2,622 lb/yr of annual TN loading reduction.

A drainage easement or ROW is required for the 36" RCP and a portion of the ditch regrading in a private-owned property between the head structure and the pond.

The analysis results are summarized in Table 9-2. The preliminary engineering cost estimate for Alternative No. 2 is $560,000 and a detailed cost breakdown is presented in Table 9-7.

Compared to Alternative No. 1, the addition of a baffle box in this alternative will increase the annual TN loading reduction from 2,086 lb/yr to 2,622 lb/yr. The associated additional cost with this alternative is estimated at around $40,000 or 7.4 % of the total cost of Alternative No.1.

9.3.3 Alternative No. 3 – Small Dry Retention Pond & Baffle Box

For the two alternatives above it was assumed that the entire site could be utilized for the proposed BMP project. Alternative No. 3, however, uses a smaller dry retention pond provided that only a portion of the land is available. In addition, to avoid land acquisition costs, the site layout was modified by repositioning the head structure from the Leitner Creek Bypass Canal (Figure 9-3) to just south of the proposed pond (Figure 9-5).

A conceptual sketch of the BMP design components is presented in Figure 9-5 and listed below:

- Construct a head structure about 500 ft upstream of the bridge at E. Terry Street.
- Install a Suntree Baffle Box and associated 36" RCP & MES. Modify this baffle box to drain excess water back to the creek when water stage reaches the storage depth of the dry pond.
- Dredge a dry retention pond with a 2-ft storage depth and a side slope of 4:1.
- Add a Type E DBI in the pond and associated 24" RCP to link the baffle box.

- Construct a perimeter drainage ditch along north side of the City property to drain the runoff around the proposed dry pond.
- Regrade the existing drainage ditch along east side of the City property.

Compared to the two previous alternatives, repositioning of the head structure will result in a larger upstream contributing area to the proposed stormwater treatment system. The BMP design was recalculated using the updated contributing area, which is approximately 1,729 acres in size.

Assuming only 30% of runoff volume will be diverted to the baffle box and dry pond system, the small dry retention pond will treat 0.13" of the diverted runoff from the contributing area. The TN removal efficiency of the pond is estimated to be 8.6% and the baffle box will provide a 5.7% of TN removal efficiency alone. The overall TN removal efficiency is estimated at 12.67%, which is equivalent to 1,331 lb/yr of annual TN loading reduction.

The analysis results are summarized in Table 9-2. The preliminary engineering cost estimate for Alternative No. 3 is $320,000 and a detailed cost breakdown is presented in Table 9-8.

9.3.4 Alternative No. 4 – Filter Marsh & Wet Detention Pond

For the three alternatives above, an off-line dry retention pond was selected as the main BMP component due to its high TN removal efficiency. In Alternative No. 4, however, a vegetated filter marsh is proposed to provide water quality improvements. A small wet detention pond is also included to provide stormwater pre-treatment by settling large debris and sediment. The vegetated filter marsh and wet pond system can provide an aesthetic landscape than the dry retention pond proposed in the first three alternatives.

The layout of this alternative is similar to Alternative No. 3 by positioning the treatment components in the eastern portion of the City-owned land. A head structure (diversion weir) will be installed in the creek in order to direct flow into the wet pond for pre-treatment by way of two drainage pipes. During the low flow conditions, the creek flow will be diverted to the wet pond and filter marsh system for treatment; during the high flow or big storm events, however, high flow portions will be discharged to the downstream creek by way of the head structure once the water level exceeds the weir crest elevation.

Flow from the wet pond will be conveyed to the filter marsh for stormwater treatment. Two outlet control structures will be used to discharged the treated flow back to the creek at downstream of the diversion weir. These control structures will be used to maintain water levels in the treatment train to sustain a favorable hydroperiod for the aquatic vegetation planted in the filter marsh system.

A conceptual sketch of the BMP design components is presented in Figure 9-6 and listed below:

- Install a head structure (diversion weir) about 600 ft upstream of the bridge at E. Terry Street.
- Dredge a wet detention pond with an 8-ft depth and side slopes of 4:1 above normal pool elevation and 2:1 for permanent pool.
- Install two 36” RCPs to direct flow from the creek to the wet detention pond.
- Construct a vegetated filter marsh with a 2-ft storage depth and a side slope of 5:1. Preserve the highland forested area in the central portion of the filter marsh.
- Install two 36” RCPs to link the wet detention pond and the filter marsh.
- Add two Type E DBIs at the south end of the filter marsh and associated 36” RCPs to discharge treated stormwater back to the creek.
- Construct a perimeter drainage ditch along north side of the City property to drain the runoff around the proposed dry pond.
- Regrade the existing drainage ditch along east side of the City property.

Similar to Alternative No. 3, the upstream contributing area for this BMP site is estimated at approximately 1,729 acres. The filter marsh and wet detention pond could provide a 2 ft storage depth or a 4.48 ac-ft treatment volume. The TN removal efficiency of the proposed treatment train is estimated to be 5.87%, which is equivalent to 617 lb/yr of annual TN loading reduction.

The analysis results are summarized in Table 9-2. The preliminary engineering cost estimate for Alternative No. 4 is $380,000 and a detailed cost breakdown is presented in Table 9-9. Compared to Alternative No. 3, project cost for this alternative is increased by $60,000; however, the TN removal efficiency is lowered about 50% due to the using of the filter marsh and wet pond system. This alternative seems less cost effective than other three alternatives discussed above.

Nevertheless, this alternative could provide some benefits that the dry pond option does not offer, including: 1) maintaining and restoring the existing highland and wetland habitats, 2) creating an aesthetic landscape, and 3) providing opportunities for public education by converting the BMP site to be a passive park or a nature place.

As discussed for all four alternatives above, a head structure will be constructed in Leitner Creek to divert a portion of flow into the stormwater treatment area. During the engineering design and permit phases, a detailed stormwater model should be developed to demonstrate that the head structure will not adversely impact the existing drainage system in terms of flood protection. The head structure should be designed with an appropriate operation mechanism for flood protection, for example, a gated spillway might be equipped to release the storage volume prior to and during big storm events.

Also, baseflow is usually desired to maintain a normal hydroperiod in the creek/wetland areas for ecological system protection. Therefore, the percentage of flow diverted to the BMP system should be re-evaluated during the design and permit phases, particularly for the first three alternatives.

9.4 Felts Avenue at Ragsdale Street

The Felts Avenue at Ragsdale Street site is located in the eastern portion of the HSPF basin Imperial Low and is identified as Potential BMP Site 1. This site is a 2-acre publicly-owned land in the City's urban core (Figure 7-2).

Based upon the site analysis and prioritization results, this site is ranked as the third choice for a structural BMP given: land availability, size and location, TN removal efficiency, cost effectiveness, existing land use and BMPs in its contributing area and other considerations.

There are two components (a dry pond and a baffle box) in the treatment train of the preliminary BMP design in Section 7.2.1. It was estimated in this preliminary design that a total of 243 lb/yr of TN would be removed by this BMP.

Four alternatives were developed at this location, based on the assumption of possible site availability and feasible structural BMP options. These alternatives are discussed in the following sections.

9.4.1 Alternative No. 1 – Dry Retention Pond

A conceptual sketch of the BMP design components is presented in Figure 9-7 and listed below:

- Dredge a dry retention pond with a 2-ft storage depth and a side slope of 4:1.
- Install a Type D DBI and associated 18" RCP & MES in the drainage ditch west of Felts Avenue and south of Ragsdale Street
- Install a Type C DBI in the pond and associated 18" RCP or equivalent across Felts Avenue to connect the new Type D DBI in the ditch.
- Modify the existing Type D DBI located at the northwest corner of the intersection of Felts Avenue and Ragsdale Street to drain excess water to the downstream ditch when water level reaches the storage depth of the dry pond.

In this alternative, the 2-ac site is assumed to be fully available for the stormwater treatment system. Given that the local neighborhood has been well drained for decades, it is assumed that the groundwater table has been lowered and hence a dry retention pond becomes a feasible option at this site.

The dry pond will provide a 2-ft storage depth or a 3.1 ac-ft treatment volume. The dry pond will treat 0.76" of runoff of the 49-ac contributing area. Using the FDEP Handbook method, the TN removal efficiency is estimated at 82.15% and the annual TN loading reduction is approximately 233 lb/yr.

The analysis results are summarized in Table 9-3. The preliminary engineering cost estimate for Alternative No. 1 is $150,000 and a detailed cost breakdown is presented in Table 9-10.

9.4.2 Alternative No. 2 – Dry Retention Pond & Baffle Box

Alternative No. 2 enhances the previous alternative by adding a baffle box for stormwater pre-treatment. This alternative is essentially the same as the preliminary BMP design described in Section 7.2.1.

A conceptual sketch of the BMP design components is presented in Figure 9-8 and listed below:

- Dredge a dry retention pond with a 2-ft storage depth and a side slope of 4:1
- Install a Suntree Baffle Box and associated 18" RCP & MES in the drainage ditch west of Felts Avenue and south of Ragsdale Street. Manufacture the baffle box to drain excess water to the downstream ditch when water level reaches the storage depth of the dry pond.
- Install a Type C DBI in the pond and associated 18" RCP or equivalent across Felts Avenue to connect the baffle box in the ditch to the west.

The dry retention pond, the same pond in Alternative No. 1, will treat 0.76" of runoff of the 49-ac contributing area. The TN removal efficiency of the pond is estimated at 82.15%. The baffle box will provide a 19% TN removal efficiency alone. The overall TN removal efficiency is estimated at 85.54%, which is equivalent to 243 lb/yr of annual TN loading reduction.

The analysis results are summarized in Table 9-3. The preliminary engineering cost estimate for Alternative No. 2 is $200,000 and a detailed cost breakdown is presented in Table 9-11.

Compared to Alternative No. 1, the addition of the baffle box in this alternative provides a slight improvement of the TN removal efficiency by 3.4% or 10 lb/yr of annual TN loading reduction; however, the total project cost is increased by $50,000, which is approximately 33% of the total cost of Alternative No. 1. Alternative No. 2 appears less cost effective and the cost of maintenance and operation related to the baffle box should be given some considerations as well.

9.4.3 Alternative No. 3 – Small Dry Retention Pond & Baffle Box

To retain a portion of the land for other projects (e.g., a parking lot), a small dry retention pond is proposed for Alternative No. 3. Despite the pond size being smaller, this alternative is identical to Alternative No. 2 having both a dry pond and a baffle box in the treatment train. A conceptual sketch of the BMP design components is presented in Figure 9-9 and listed below:

- Dredge a dry retention pond in the western half of the site, with a 2-ft storage depth and a side slope of 4:1.
- Install a Suntree Baffle Box and associated 18" RCP & MES in the drainage ditch west of Felts Avenue and south of Ragsdale Street. Manufacture this baffle box to drain excess water to the downstream ditch when water level reaches the storage depth of the dry pond.
- Install a Type C DBI in the pond and associated 18" RCP or equivalent across Felts Avenue to connect the baffle box in the ditch.

The small dry retention pond has a 1.55 ac-ft treatment volume and is capable of treating 0.38" of runoff from the 49-ac contributing area. The TN removal efficiency of the pond is estimated at 63.16%, and the baffle box will provide a 19% of TN removal efficiency alone. The overall TN removal efficiency is estimated at 70.16%, which is equivalent to 199 lb/yr of annual TN loading reduction.

The analysis results are summarized in Table 9-3. The preliminary engineering cost estimate for Alternative No. 3 is $170,000 and a detailed cost breakdown is presented in Table 9-12.

9.4.4 Alternative No. 4 – Wet Detention Pond

For the three alternatives above, an off-line dry retention pond was selected as the main BMP component due to its high TN removal efficiency. In this alternative, a wet detention pond is proposed to provide water quality improvements. As an important component of the wet detention pond, two littoral zones are designed at where the inflow pipes enter the wet pond for pre-treatment and nutrient removal. A wet detention pond can provide a more aesthetic landscape and is more publicly acceptable than a dry retention pond.

A conceptual sketch of the BMP design components is presented in Figure 9-10 and listed below:

- Dredge a wet detention pond with an 8-ft depth and side slopes of 4:1 above normal pool elevation and 2:1 for permanent pool.
- Construct two planted littoral zones with a side slope of 6:1.
- The highland forested area at the northwest corner of the site will be preserved.
- Install a concrete ditch block in the drainage ditch west of Felts Ave. and install an 18" RCP to direct flow from the ditch to the wet pond.
- Modify the existing Type C DBI at the south side of Ragsdale St. to divert the flow to the wet pond, and install an 18" RCP to link the inlet and the wet pond.
- Add a Type C DBI at the northwest corner of the wet pond and associated 18" RCP to discharge treated stormwater back to the drainage ditch to the west.
- Construct perimeter chain-link fences and gates along the wet pond berm.

The wet detention pond system could provide a 2.68 ac-ft treatment volume. The TN removal efficiency is estimated to be 33.3%, which is equivalent to 94 lb/yr of annual TN loading reduction.

The analysis results are summarized in Table 9-3. The preliminary engineering cost estimate for Alternative No. 4 is $250,000 and a detailed cost breakdown is presented in Table 9-13. Compared to other alternatives, this alternative has the highest project cost; however, the TN removal efficiency is the lowest among all four alternatives proposed. This alternative has the least cost effectiveness with a unit project cost of $2,600 or more per pound of TN removal.

On the other hand, this alternative could provide a more aesthetic landscape to the local neighborhood and has a potential in providing opportunities for public education.

The final TN removal efficiency offered by this BMP might be dramatically changed given more detailed modeling/design efforts, selection of BMP options, and field data collection, including geotechnical investigation and topography survey, during the engineering design and permit phases. For example, the treatment volume of the dry/wet pond might be changed if the geotechnical investigation does not support the soil and groundwater conditions originally assumed in this BMP alternative analysis.

9.5 Figure & Tables Descriptions

The figures and tables discussed in this section are summarized below:

Figure #	Description
9-1	Leitner Creek – Bypass Canal – Alternative No. 1
9-2	Leitner Creek – Bypass Canal – Alternative No. 2
9-3	E. Terry Street at Leitner Creek – North – Alternative No. 1
9-4	E. Terry Street at Leitner Creek – North – Alternative No. 2
9-5	E. Terry Street at Leitner Creek – North – Alternative No. 3
9-6	E. Terry Street at Leitner Creek – North – Alternative No. 4
9-7	Felts Avenue at Ragsdale Street – Alternative No. 1
9-8	Felts Avenue at Ragsdale Street – Alternative No. 2
9-9	Felts Avenue at Ragsdale Street – Alternative No. 3
9-10	Felts Avenue at Ragsdale Street – Alternative No. 4

Table #	Description
9-1	Summary of BMP Alternatives Analysis - Leitner Creek – Bypass Canal
9-2	Summary of BMP Alternatives Analysis - E. Terry Street at Leitner Creek – North
9-3	Summary of BMP Alternatives Analysis - Felts Avenue at Ragsdale Street

Table #	Description
9-4	Cost Estimate of Leitner Creek - Bypass Canal - Alternative No. 1
9-5	Cost Estimate of Leitner Creek - Bypass Canal - Alternative No. 2
9-6	Cost Estimate of E. Terry Street at Leitner Creek - North - Alternative No. 1
9-7	Cost Estimate of E. Terry Street at Leitner Creek - North - Alternative No. 2
9-8	Cost Estimate of E. Terry Street at Leitner Creek - North - Alternative No. 3
9-9	Cost Estimate of E. Terry Street at Leitner Creek - North - Alternative No. 4
9-10	Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 1
9-11	Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 2
9-12	Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 3
9-13	Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 4

Legend

Existing Drainage System:

- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 100 feet

City of Bonita Springs SMP Phase II

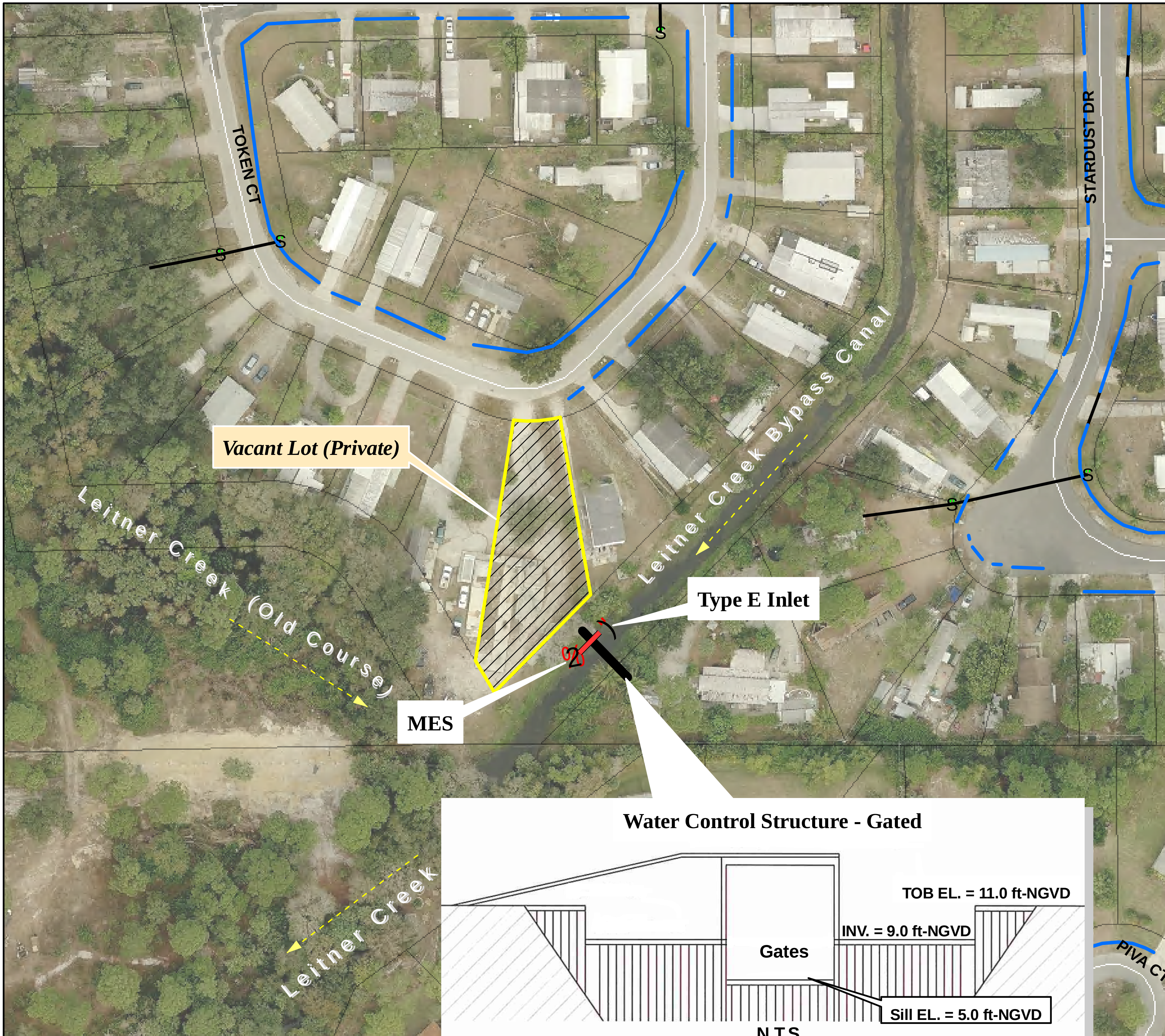
TITLE:

Leitner Creek - Bypass Canal Alternative No. 1

DATE: 10/10/2011

FIGURE:

9-1



Legend

Existing Drainage System:

- EndStructures
- S Inlet
- Conveyances
- DrainPipes

2

1 in equals 100 feet

City of Bonita Springs
SMP Phase II

TITLE:

Leitner Creek - Bypass Canal Alternative No. 2

DATE: 10/10/2011

INTERA

FIGURE:
9-2

Legend

Existing Drainage System:

- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 200 feet

City of Bonita Springs SMP Phase II

TITLE:

E. Terry Street at Leitner Creek - North Alternative No. 1

DATE: 10/10/2011

FIGURE: 9-3

Legend

Existing Drainage System:
- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 200 feet

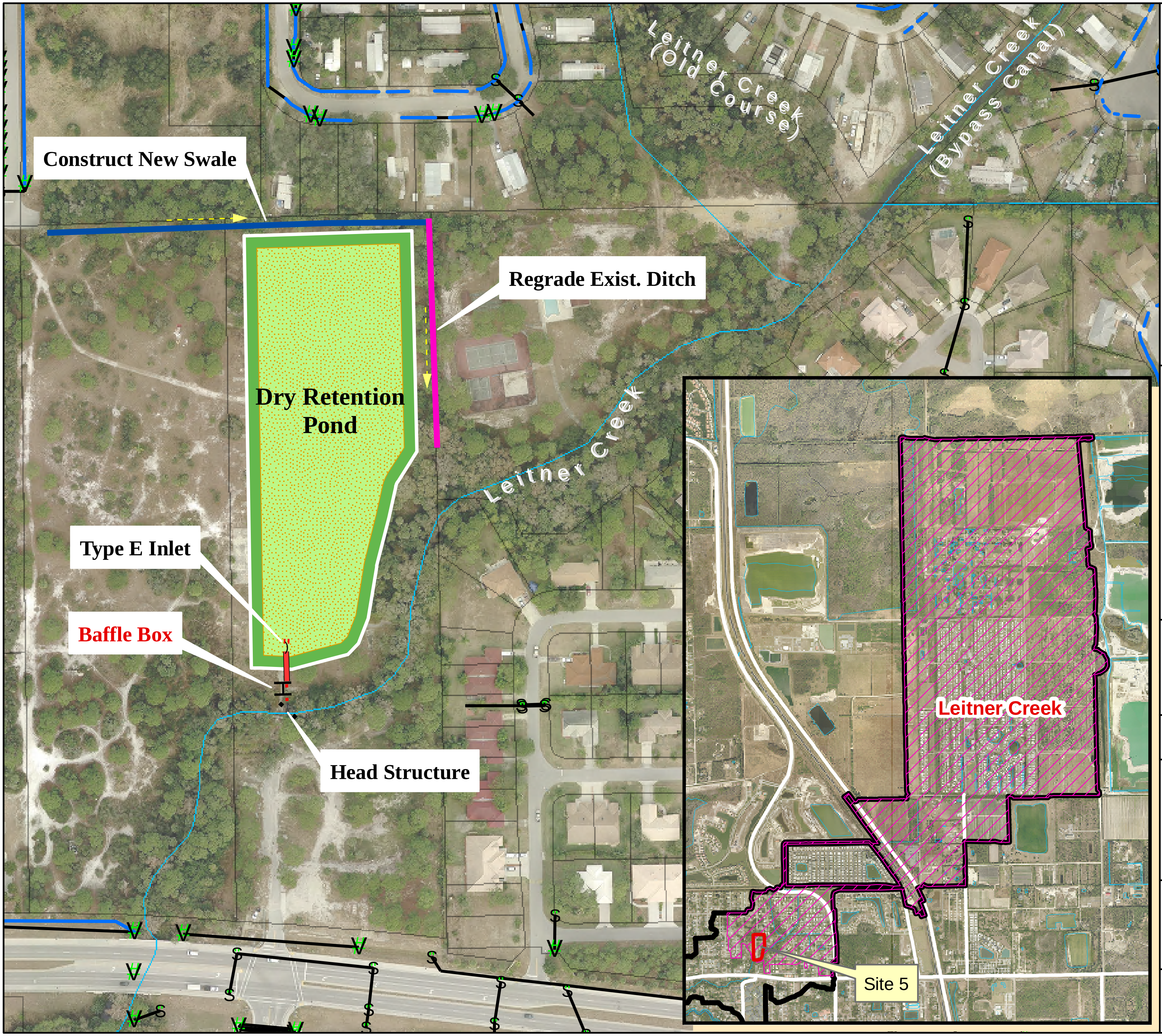
City of Bonita Springs
SMP Phase II

TITLE:

E. Terry Street at
Leitner Creek - North
Alternative No. 2

DATE: 10/10/2011

FIGURE:
9-4



Legend

Existing Drainage System:

- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 200 feet

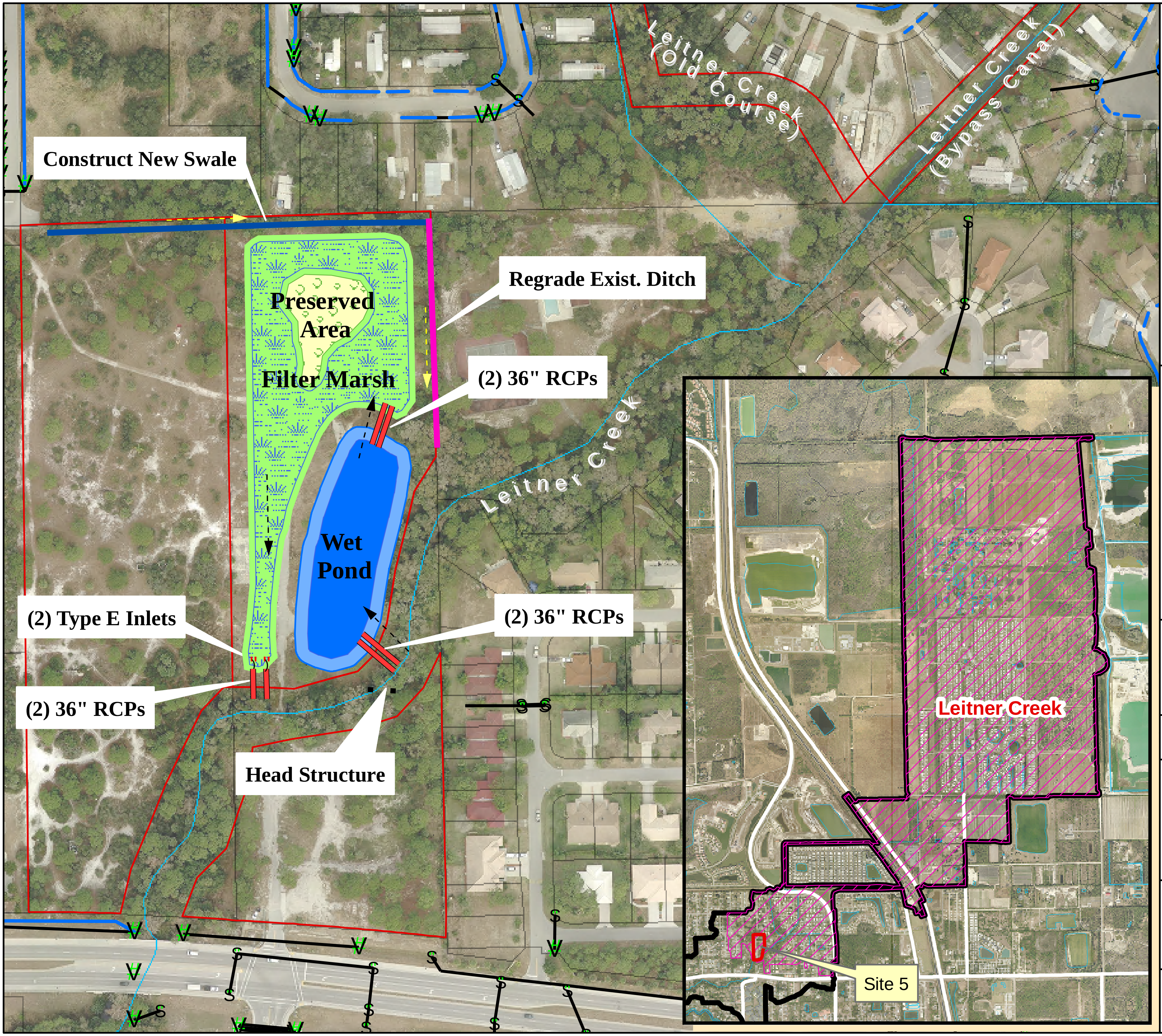
City of Bonita Springs
SMP Phase II

TITLE:

E. Terry Street at
Leitner Creek - North
Alternative No. 3

DATE: 10/10/2011

FIGURE:
9-5



Legend

Existing Drainage System:

- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 200 feet

City of Bonita Springs
SMP Phase II

TITLE:

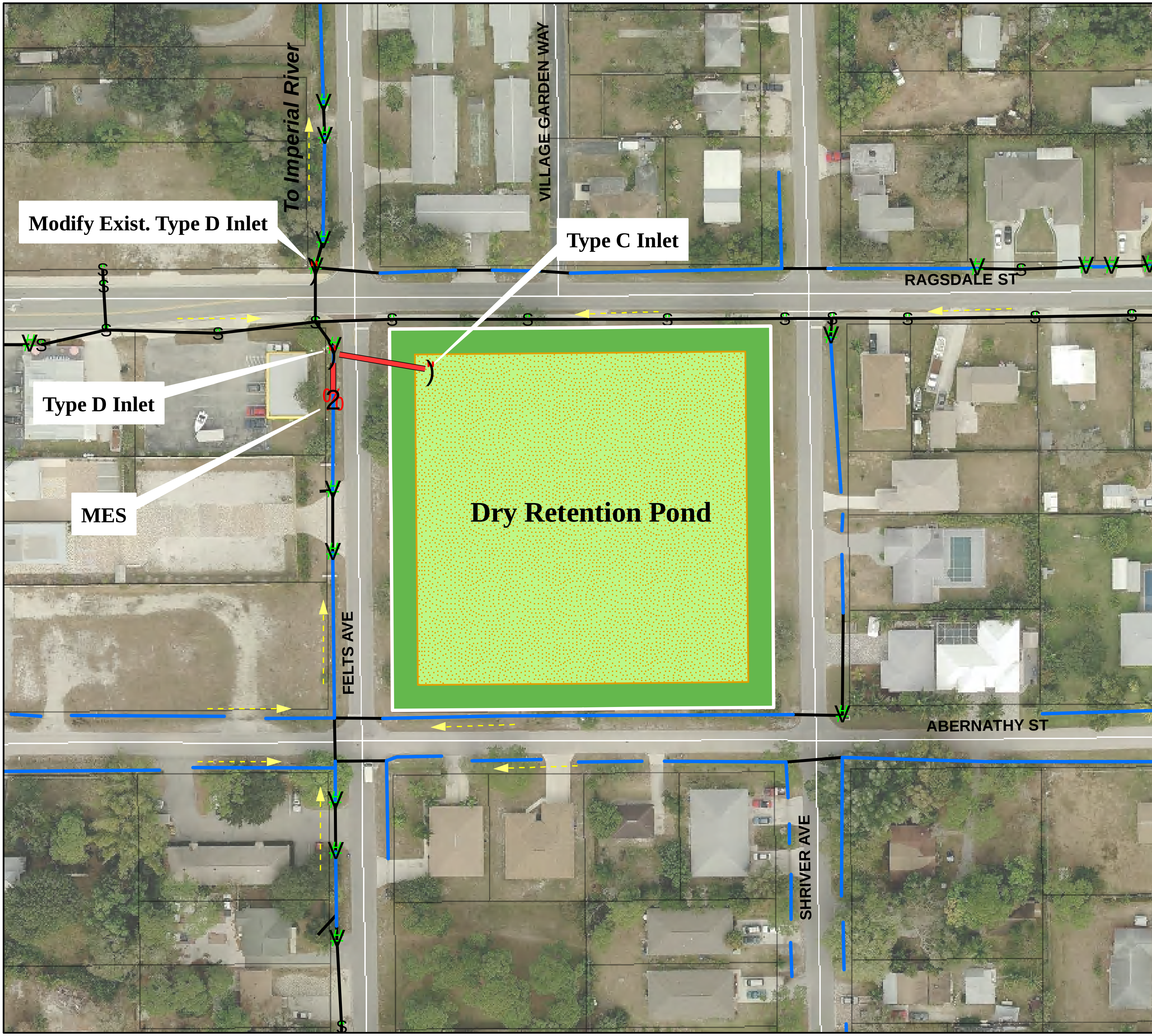
E. Terry Street at
Leitner Creek - North
Alternative No. 4

DATE: 10/10/2011

INTERA

EAS

FIGURE:
9-6



Legend

Existing Drainage System:

- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 100 feet

City of Bonita Springs
SMP Phase II

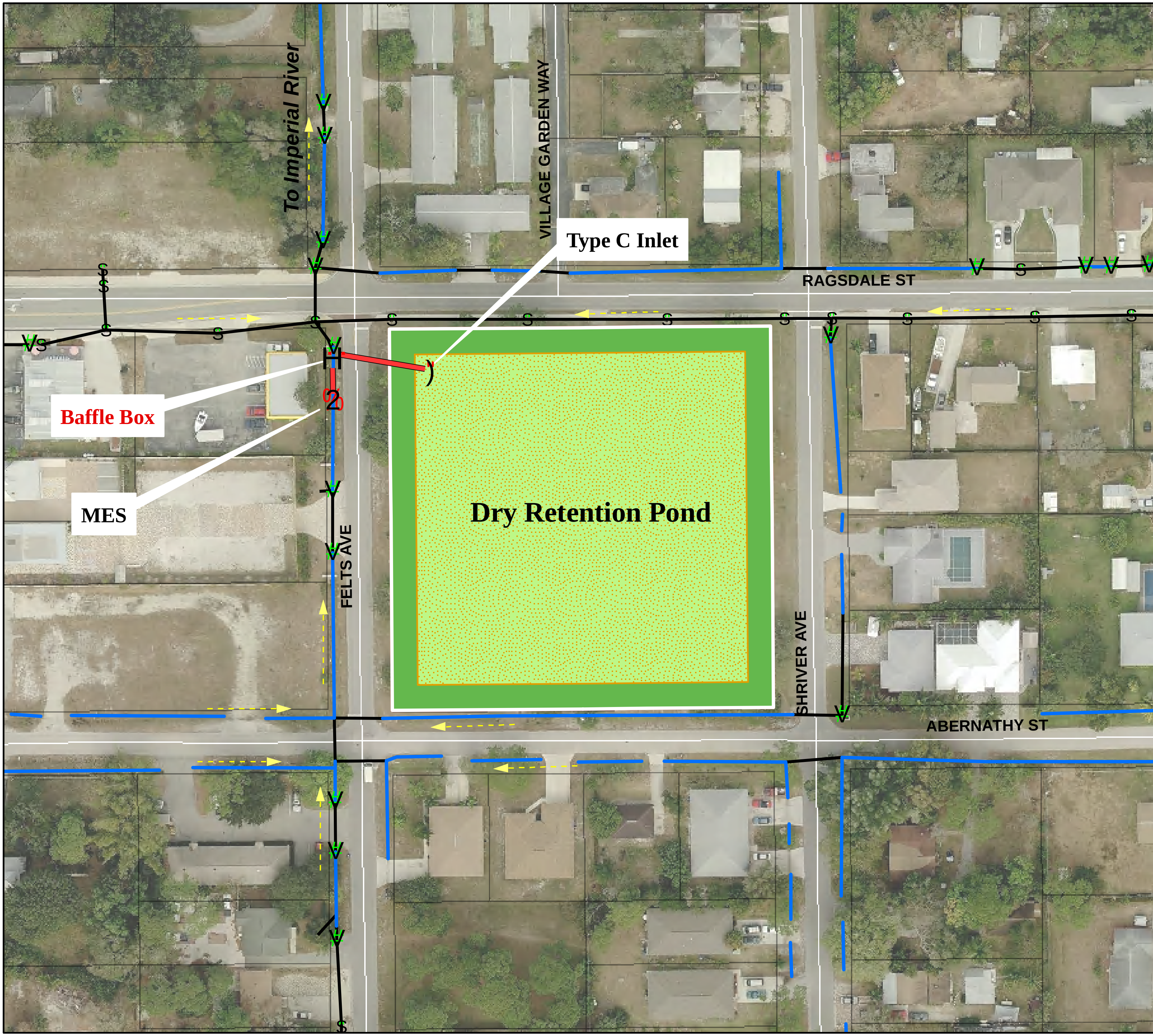
TITLE:

Felts Avenue at Ragsdale Street Alternative No. 1

DATE: 10/10/2011

INTERA

FIGURE:
9-7



Legend

Existing Drainage System:

- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 100 feet

City of Bonita Springs
SMP Phase II

TITLE:

Felts Avenue at
Ragsdale Street
Alternative No. 2

DATE: 10/10/2011

INTERA

FIGURE:
9-8

Legend

Existing Drainage System:
- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 100 feet

City of Bonita Springs
SMP Phase II

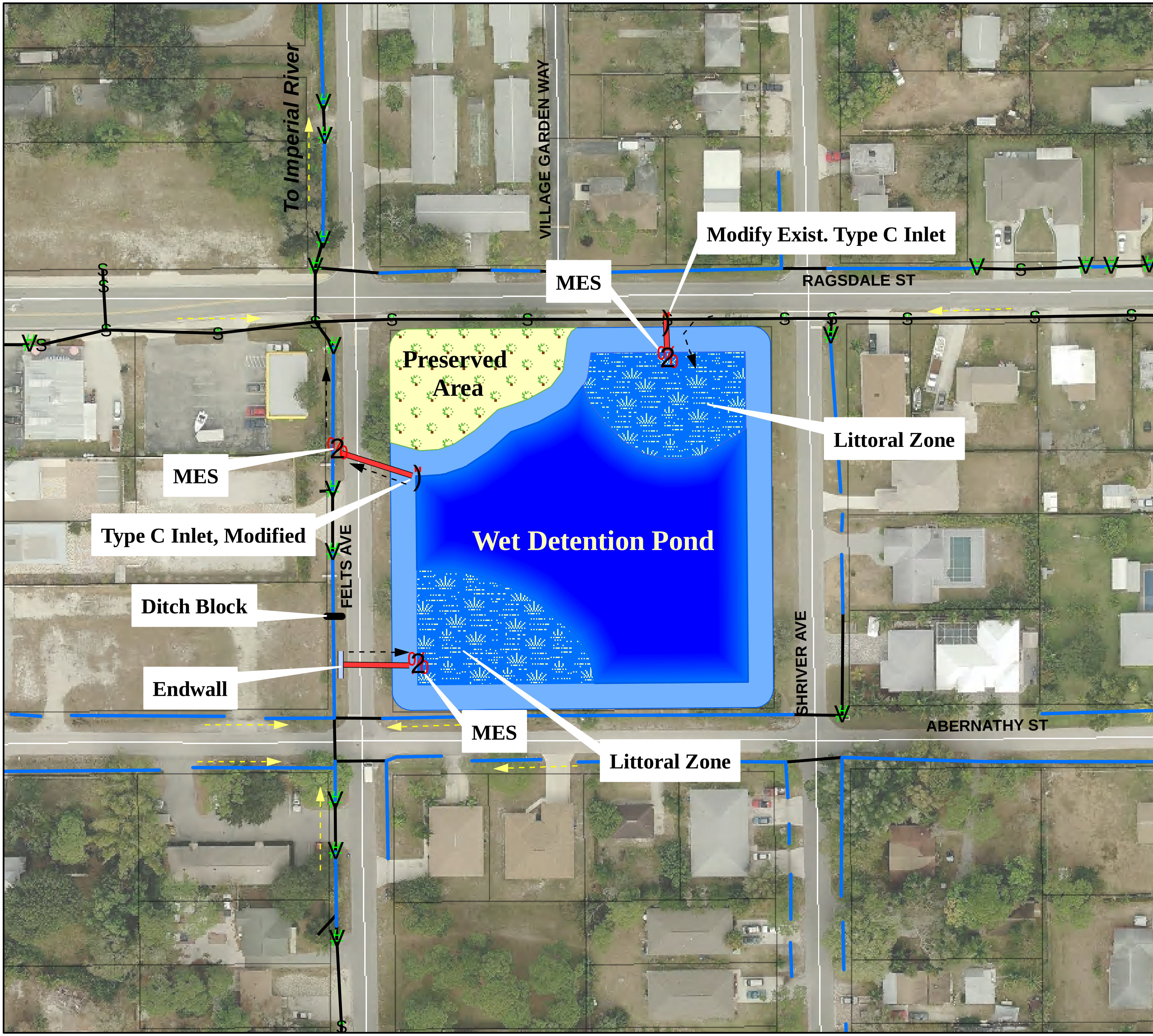
TITLE:

Felts Avenue at Ragsdale Street Alternative No. 3

DATE: 10/10/2011

INTERA

FIGURE:
9-9



Legend

Existing Drainage System:
- EndStructures
- Inlet
- Conveyances
- DrainPipes

2

1 in equals 100 feet

City of Bonita Springs
SMP Phase II

TITLE:

Felts Avenue at Ragsdale Street Alternative No. 4

DATE: 10/10/2011

INTERA

FIGURE:
9-10

Table 9-1.Summary of BMP Alternatives Analysis - Leitner Creek - Bypass Canal

ID	Description	Site Area (ac)	Contributing Area (ac)	Pond Treat-ment Volume (ac-ft)	TN Removal Eff. (%)	Annual TN Removal (lb/yr)	Preliminary Cost[1]	Project Cost per lb. of Annual TN Removal ($/lb/yr)	Land Ownership	Comments
1	Fixed Weir Structure	1.45	1,624.2	3.27	4.77	458	$ 130,000	$ 283.65	City	• Favorable alternative • Low maintenance cost • No land acquisition required • Low TN removal eff. • Low cost effectiveness
2	Water Control Structure (Weir & Gate)	1.72	1,624.2	9.81	12.31	1,183	$ 270,000	$ 228.28	City & Private	• High TN removal eff. • High cost effectiveness • Land acquisition required • Potential permit issue • High maintenance cost.

[1] Detailed break-down of the preliminary engineering cost estimate is included in Tables 9-4 thru 9-5.

Table 9-2. Summary of BMP Alternatives Analysis - E. Terry Street at Leitner Creek – North

ID	Description	Site Area (ac)	Contributing Area (ac)	Pond Treat-ment Volume (ac-ft)	TN Removal Eff. (%)			Annual TN Removal (lb/yr)	Preliminary Cost[1]	Project Cost per lb. of Annual TN Removal ($/lb/yr)	Land Own-ership	Comments
					Pond/ Marsh	Baffle Box	Over all					
1	Dry Retention Pond	12.16	1,661.7	17.30	21.24	-	21.24	2,086	$ 520,000	$ 249.29	City & Private	• Land acquisition required • Low TN removal eff. • Low cost effectiveness
2	Dry Retention Pond & Baffle Box	12.16	1,661.7	17.30	21.24	9.50	26.70	2,622	$ 560,000	$ 213.57	City & Private	• Most favorable alternative • High TN removal eff. • Land acquisition • Most cost effective with baffle box
3	Small Dry Retention Pond & Baffle Box	4.98	1,729.3	5.77	8.60	5.70	12.67	1,331	$ 340,000	$ 255.49	City	• Good alternative when the site is partially available • Retain land for other City projects • No land acquisition • Low total cost • Low TN removal eff. • Permit issue for head structure in the creek
4	Filter Marsh & Wet Detention Pond	4.98	1,729.3	4.48	5.87	-	5.87	617	$ 380,000	$ 616.33	City	• More aesthetic • Retain land for other City projects • No land acquisition • Low total cost • Low TN removal eff. • Permit issue for head structure in the creek

[1] Detailed break-down of the preliminary engineering cost estimate is included in Tables 9-6 thru 9-9.

Table 9-3. Summary of BMP Alternatives Analysis - Felts Avenue at Ragsdale Street

ID	Description	Site Area (ac)	Contributing Area (ac)	Pond Treat-ment Volume (ac-ft)	TN Removal Eff. (%)			Annual TN Removal (lb/yr)	Preliminary Cost[1]	Project Cost per lb. of Annual TN Removal ($/lb/yr)	Comments
					Pond	Baffle Box	Overall				
1	Dry Retention Pond	2.07	48.9	3.10	82.15	-	82.15	233	$ 150,000	$ 643.68	• Most favorable alternative • Low TN removal eff. • Low total cost • High cost effectiveness
2	Dry Retention Pond & Baffle Box	2.07	48.9	3.10	82.15	19.00	85.54	243	$ 200,000	$ 824.18	• High TN removal eff. • Low cost effectiveness with baffle box • High maintenance cost
3	Small Dry Retention Pond & Baffle Box	1.17	48.9	1.55	63.16	19.00	70.16	199	$ 170,000	$ 854.11	• Good when the site is partially available. • Retain land for other City projects • Better public acceptance • Low TN removal eff. • Low cost effectiveness with baffle box • High maintenance cost
4	Wet Detention Pond	2.07	48.9	2.68	33.30	-	33.30	94	$ 250,000	$ 2,646.42	• More aesthetic option • Low TN removal eff. • High total cost • Low cost effectiveness • High maintenance cost

[1] Detailed break-down of the preliminary engineering cost estimate is included in Tables 9-10 thru 9-13.

Table 9-4. Cost Estimate of Leitner Creek - Bypass Canal - Alternative No. 1

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
104-12	STAKED TURBIDITY BARRIER	LF	$ 12	200	$ 2,400
110-1-1	CLEARING AND GRUBBING	AC	$ 5,000	0.2	$ 1,000
400-4-4	CONCRETE CLASS IV, SUPER STRUCTURE	CY	$ 1,200	8	$ 9,600
425-1-559	INLETS, DT BOT, TYPE E, MODIFY	EA	$ 4,000	1	$ 4,000
430-175-124	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24"S/CD	LF	$ 50.00	50	$ 2,500
430-982-129	MITERED END SECTION, OPTIONAL, ROUND, 24" CD	EA	$ 1,000	1	$ 1,000
455-133-3	SHEET PILING STEEL, F&I PERMANENT	SF	$ 30	300	$ 9,000
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	250	$ 500
	CONSTRUCTION SUBTOTAL				$ 40,000
	CONTINGENCY			20%	$ 8,000
	CONSTRUCTION TOTAL				$ 48,000
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 80,000
	RIGHT OF WAY (City of Bonita Springs)				$ -
				TOTAL	$ 128,000
				USE	**$ 130,000**

Table 9-5. Cost Estimate of Leitner Creek - Bypass Canal - Alternative No. 2

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
104-12	STAKED TURBIDITY BARRIER	LF	$ 12	200	$ 2,400
110-1-1	CLEARING AND GRUBBING	AC	$ 5,000	0.5	$ 2,500
400-4-4	CONCRETE CLASS IV, SUPER STRUCTURE	CY	$ 1,200	8	$ 9,600
425-1-559	INLETS, DT BOT, TYPE E, MODIFY	EA	$ 4,000	1	$ 4,000
430-175-124	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24"S/CD	LF	$ 50	50	$ 2,500
430-982-129	MITERED END SECTION, OPTIONAL, ROUND, 24" CD	EA	$ 1,000	1	$ 1,000
455-133-3	SHEET PILING STEEL, F&I PERMANENT	SF	$ 30	300	$ 9,000
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	1,000	$ 2,000
	SLUICE GATE CLOSURE STRUCTURE				
	F&I TIMBER FRICTION PILES TO 20' DEEP	LF	$ 50	120	$ 6,000
	FORM AND POUR CONCRETE PILE CAP/FOOTING	CY	$ 1,200	10	$ 12,000
	FORM AND POUR RETAINING WALL & EMBEDED SHEETING	CY	$ 1,200	3	$ 3,600
	BACKFILL AND RESTORE	LS	$ 4,000	1	$ 4,000
	F&I UTILITY POLES WITH ELECTRIC SERVICE	EA	$ 5,000	1	$ 5,000
	F&I SLUICE GATE - 48" X 48" W/ ELEC. OPERATOR	EA	$ 40,000	1	$ 40,000
	24" ACCESS WALKWAY AND HANDRAIL	LF	$ 100	30	$ 3,000
	CONSTRUCTION SUBTOTAL				$ 116,600
	CONTINGENCY			20%	$ 23,320
	CONSTRUCTION TOTAL				$ 139,920
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 100,000
	RIGHT OF WAY (Private-owned Property, 0.27-ac Vacant Lot)				$ 30,000
				TOTAL	$ 269,920
				USE	**$ 270,000**

Table 9-6.
Cost Estimate of E. Terry Street at Leitner Creek - North - Alternative No. 1

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	4,500	$ 6,075
104-12	STAKED TURBIDITY BARRIER	LF	$ 12	180	$ 2,160
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	13	$ 26,000
120-1	REGULAR EXCAVATION	CY	$ 5	36,000	$ 180,000
400-4-4	CONCRETE CLASS IV, SUPER STRUCTURE	CY	$ 600	16	$ 9,600
425-1-551	INLETS, DT BOT, TYPE E, <10'	EA	$ 2,500	1	$ 2,500
425-1-589	INLETS, DT BOT, TYPE H, MODIFY	EA	$ 8,000	1	$ 8,000
430-175-124	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24"S/CD	LF	$ 50	60	$ 3,000
430-175-136	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 36"S/CD	LF	$ 80	460	$ 36,800
430-982-138	MITERED END SECTION, OPTIONAL, ROUND, 36" CD	EA	$ 2,500	2	$ 5,000
455-133-3	SHEET PILING STEEL, F&I PERMANENT	SF	$ 30	700	$ 21,000
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	20,000	$ 40,000
	CONSTRUCTION SUBTOTAL				$ 350,135
	CONTINGENCY			20%	$ 70,027
	CONSTRUCTION TOTAL				$ 420,162
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 100,000
	RIGHT OF WAY (City of Bonita Springs, Property # 11)				$ -
	DRAINAGE EASEMENT (50'X785'=0.9 ac)				$ 75,000
				TOTAL	$ 520,162
				USE	**$ 520,000**

Table 9-7.
Cost Estimate of E. Terry Street at Leitner Creek - North – Alternative No. 2

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	4,500	$ 6,075
104-12	STAKED TURBIDITY BARRIER	LF	$ 12	180	$ 2,160
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	13	$ 26,000
120-1	REGULAR EXCAVATION	CY	$ 5	36,000	$ 180,000
400-4-4	CONCRETE CLASS IV, SUPER STRUCTURE	CY	$ 600	16	$ 9,600
425-1-551	INLETS, DT BOT, TYPE E, <10'	EA	$ 2,500	1	$ 2,500
430-175-124	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24"S/CD	LF	$ 50	60	$ 3,000
430-175-136	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 36"S/CD	LF	$ 80	460	$ 36,800
430-982-138	MITERED END SECTION, OPTIONAL, ROUND, 36" CD	EA	$ 2,500	2	$ 5,000
455-133-3	SHEET PILING STEEL, F&I PERMANENT	SF	$ 30	700	$ 21,000
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	20,000	$ 40,000
	SUNTREE BAFFLE BOX	EA	$ 40,000	1	$ 40,000
	CONSTRUCTION SUBTOTAL				$ 382,135
	CONTINGENCY			20%	$ 76,427
	CONSTRUCTION TOTAL				$ 458,562
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 100,000
	RIGHT OF WAY (City of Bonita Springs, Property # 11)				$ -
	DRAINAGE EASEMENT (50'X785'=0.9 ac)				$ 75,000
				TOTAL	$ 558,562
				USE	**$ 560,000**

Table 9-8.
Cost Estimate of E. Terry Street at Leitner Creek - North – Alternative No. 3

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	4,500	$ 6,075
104-12	STAKED TURBIDITY BARRIER	LF	$ 12	180	$ 2,160
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	13	$ 26,000
120-1	REGULAR EXCAVATION	CY	$ 5	13,000	$ 65,000
400-4-4	CONCRETE CLASS IV, SUPER STRUCTURE	CY	$ 600	16	$ 9,600
425-1-551	INLETS, DT BOT, TYPE E, <10'	EA	$ 2,500	1	$ 2,500
430-175-124	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24"S/CD	LF	$ 50	60	$ 3,000
430-175-136	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 36"S/CD	LF	$ 80	40	$ 3,200
430-982-138	MITERED END SECTION, OPTIONAL, ROUND, 36" CD	EA	$ 2,500	2	$ 5,000
455-133-3	SHEET PILING STEEL, F&I PERMANENT	SF	$ 30	700	$ 21,000
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	7,600	$ 15,200
	SUNTREE BAFFLE BOX	EA	$ 40,000	1	$ 40,000
	CONSTRUCTION SUBTOTAL				$ 208,735
	CONTINGENCY			20%	$ 41,747
	CONSTRUCTION TOTAL				$ 250,482
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 90,000
	RIGHT OF WAY (City of Bonita Springs, Property # 11)				$ -
				TOTAL	$ 340,482
				USE	**$ 340,000**

Table 9-9.
Cost Estimate of E. Terry Street at Leitner Creek - North – Alternative No. 4

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 15,000	1	$ 15,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	4,500	$ 6,075
104-12	STAKED TURBIDITY BARRIER	LF	$ 12	180	$ 2,160
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	5	$ 10,000
120-1	REGULAR EXCAVATION	CY	$ 5	14,500	$ 72,500
400-1-2	CONCRETE CLASS I, ENDWALLS	CY	$ 700	12	$ 8,400
400-4-4	CONCRETE CLASS IV, SUPER STRUCTURE	CY	$ 600	16	$ 9,600
425-1-551	INLETS, DT BOT, TYPE E, <10'	EA	$ 2,500	2	$ 5,000
430-175-136	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 36"S/CD	LF	$ 80	410	$ 32,800
430-982-138	MITERED END SECTION, OPTIONAL, ROUND, 36" CD	EA	$ 2,500	6	$ 15,000
455-133-3	SHEET PILING STEEL, F&I PERMANENT	SF	$ 30	700	$ 21,000
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	10,700	$ 21,400
	PLANTING IN FILTER MARSH	LS	$ 15,000	1	$ 15,000
	CONSTRUCTION SUBTOTAL				$ 233,935
	CONTINGENCY			20%	$ 46,787
	CONSTRUCTION TOTAL				$ 280,722
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 100,000
	RIGHT OF WAY (City of Bonita Springs, Property # 11)				$ -
				TOTAL	$ 380,722
				USE	**$ 380,000**

Table 9-10. Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 1

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
102-1	MAINTENANCE OF TRAFFIC	LS	$ 2,000	1	$ 2,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	1,500	$ 2,025
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	2	$ 4,000
120-1	REGULAR EXCAVATION	CY	$ 5	6,260	$ 31,300
425-1-521	INLETS, DT BOT, TYPE C, <10'	EA	$ 2,000	1	$ 2,000
425-1-541	INLETS, DT BOT, TYPE D, <10'	EA	$ 2,500	1	$ 2,500
425-1-545	INLETS, DT BOT, TYPE D, PARTIAL	EA	$ 2,000	1	$ 2,000
430-175-218	PIPE CULVERT, OPTIONAL MATERIAL, OTHER SHAPE - ELIP/ARCH, 18"S/CD	LF	$ 50	100	$ 5,000
430-982-625	MITERED END SECTION, OPTIONAL - OTHER, 18" CD	EA	$ 800	1	$ 800
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	4,600	$ 9,200
	CONSTRUCTION SUBTOTAL				$ 70,825
	CONTINGENCY			20%	$ 14,165
	CONSTRUCTION TOTAL				$ 84,990
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 60,000
	RIGHT OF WAY (City of Bonita Springs)				$ -
				TOTAL	$ 144,990
				USE	**$ 150,000**

Table 9-11. Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 2

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
102-1	MAINTENANCE OF TRAFFIC	LS	$ 2,000	1	$ 2,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	1,500	$ 2,025
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	2	$ 4,000
120-1	REGULAR EXCAVATION	CY	$ 5	6,260	$ 31,300
425-1-521	INLETS, DT BOT, TYPE C, <10'	EA	$ 2,000	1	$ 2,000
430-175-218	PIPE CULVERT, OPTIONAL MATERIAL, OTHER SHAPE - ELIP/ARCH, 18"S/CD	LF	$ 50	100	$ 5,000
430-982-625	MITERED END SECTION, OPTIONAL - OTHER, 18" CD	EA	$ 800	1	$ 800
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	4,600	$ 9,200
	SUNTREE BAFFLE BOX	EA	$ 30,000	1	$ 30,000
	CONSTRUCTION SUBTOTAL				$ 96,325
	CONTINGENCY			20%	$ 19,265
	CONSTRUCTION TOTAL				$ 115,590
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 80,000
	RIGHT OF WAY (City of Bonita Springs)				$ -
				TOTAL	$ 195,590
				USE	**$ 200,000**

Table 9-12. Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 3

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 10,000	1	$ 10,000
102-1	MAINTENANCE OF TRAFFIC	LS	$ 2,000	1	$ 2,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	1,100	$ 1,485
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	1.2	$ 2,400
120-1	REGULAR EXCAVATION	CY	$ 5	3,130	$ 15,650
425-1-521	INLETS, DT BOT, TYPE C, <10'	EA	$ 2,000	1	$ 2,000
430-175-218	PIPE CULVERT, OPTIONAL MATERIAL, OTHER SHAPE - ELIP/ARCH, 18"S/CD	LF	$ 50	100	$ 5,000
430-982-625	MITERED END SECTION, OPTIONAL - OTHER, 18" CD	EA	$ 800	1	$ 800
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	3,500	$ 7,000
	SUNTREE BAFFLE BOX	EA	$ 30,000	1	$ 30,000
	CONSTRUCTION SUBTOTAL				$ 76,335
	CONTINGENCY			20%	$ 15,267
	CONSTRUCTION TOTAL				$ 91,602
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 75,000
	RIGHT OF WAY (City of Bonita Springs)				$ -
				TOTAL	$ 166,602
				USE	**$ 170,000**

Table 9-13. Cost Estimate of Felts Avenue at Ragsdale Street - Alternative No. 4

Item #	Description	Unit	Unit Cost	Quantity	Cost
101-1	MOBILIZATION	LS	$ 15,000	1	$ 10,000
102-1	MAINTENANCE OF TRAFFIC	LS	$ 2,000	1	$ 2,000
104-13-1	STAKED SILT FENCE (TYPE III)	LF	$ 1.35	1,500	$ 2,025
110-1-1	CLEARING AND GRUBBING	AC	$ 2,000	2	$ 4,000
120-1	REGULAR EXCAVATION	CY	$ 4	21,600	$ 86,400
400-1-2	CONCRETE CLASS I, ENDWALLS	CY	$ 700	3	$ 2,100
425-1-525	INLETS, DT BOT, TYPE C, PARTIAL	EA	$ 2,000	1	$ 2,000
425-1-529	INLETS, DT BOT, TYPE C, MODIFY	EA	$ 2,200	1	$ 2,200
430-175-218	PIPE CULVERT, OPTIONAL MATERIAL, OTHER SHAPE - ELIP/ARCH, 18"S/CD	LF	$ 50	150	$ 7,500
430-982-625	MITERED END SECTION, OPTIONAL - OTHER, 18" CD	EA	$ 800	3	$ 2,400
550-10-222	FENCING, TYPE B, 5.1-6.0, W/ VINYL COATING	LF	$ 12	1,200	$ 14,400
550-60-212	FENCE GATE, TYPE B, SINGLE, 6.1-12.0' OPENING	EA	$ 1,200	2	$ 2,400
570-1-2	PERFORMANCE TURF, SOD (BAHIA)	SY	$ 2	5,000	$ 10,000
	CONSTRUCTION SUBTOTAL				$ 152,625
	CONTINGENCY			20%	$ 30,525
	CONSTRUCTION TOTAL				$ 183,150
	ENGINEER FEES (INCLUDING SURVEY/GEOTECHNICAL)				$ 65,000
	RIGHT OF WAY (City of Bonita Springs)				$ -
				TOTAL	$ 248,150
				USE	**$ 250,000**

10 Funding Analysis

10.1 Overview

Funding sources for stormwater projects traditionally come from general revenue funds. During the past few years the entire country has faced new economic hardships which have resulted in many programs being altered and in some cases eliminated. Local governments have experienced new pressures finding sources of funding for projects. Many agencies are finding new limitations that make the search for new funding sources a great deal more challenging.

Since 1984 the State of Florida has gone through several large scale changes in policy regarding stormwater and pollution control. Most recently, in 2009, new regulations for monitoring Total Maximum Daily Loads (TMDL) in stormwater have become policy. Each new change in regulation adds complexities and costs to new stormwater management projects. With oversight from both State and Federal agencies, local governments are held more accountable and must be compliant with current policy and regulation.

With the increased focus at the State and Federal level, supplemental funding sources are being made available to the local governments to share the costs of new projects. Customary funding sources such as property taxes (millage rates), one cent gas tax referendums, and bonding are now being supplemented with Federal grant program cost sharing (historically recognized as Joint Party Agreements-JPAs).

Since these programs are continuously changing, it is entirely possible that a single project may have more than one source as a funding option. All funding sources may not necessarily be suitable for specific projects. Careful evaluation by legal teams, agency staff, and public endorsement should be conducted before choosing a funding source. Operating costs, direct capital costs, and cost benefits may be factors in choosing or declining funding options. Projects can also meet criteria for funding sources through demonstrations of secondary impacts. For example, if a project is addressing flooding concerns, the flooding could generate risk to water quality to adjacent lands or ecosystems making flooding projects eligible for water quality funding.

10.2 Local Funding Sources – City of Bonita Springs

10.2.1 Ad Valorem

Funds collected through Ad Valorem are taxes assessed on property ownership for all non-exempt real estate and personal property. The funds collected through Ad Valorem are the primary sources of revenue for the City. Revenues collected through property taxes are determined by a millage rate, and are collected from individual property owners. The millage rate is determined by a ratio calculated from comparing the total taxable property value with the deficit in the projected City budget.

For the fiscal year 2011/2012, the projected Ad Valorem revenue is expected to be $5,490,000. The revenue from this funding source represents 31% of the City's general fund revenue stream. The City of Bonita Springs Public Works forecasted budget for this timeframe is approximately $2,703,800, which includes the implementation of stormwater CIP projects as recommended in the existing SMP and approved by the city council.

10.2.2 Municipal Services Benefit Taxing Unit (MSBU/MSTU)

Several of Lee County's stormwater projects are paid for by "Taxing Authorities". For example a Municipal Services Taxing Unit (MSTU) or Municipal Services Benefit Unit (MSBU) is a Taxing Authority which has its own budget that is typically approved at a public hearing.

In the City of Bonita Springs there are specific geographic areas determined by ordinance that define specific areas of improvement. The benefits are structured to improve public infrastructure such as roads, sidewalks, drainage, and lighting. The revenue source collection method determines whether it is a MSBU and MSTU.

A MSBU is authorized by Florida Statutes as a special assessment district providing improvements and/or services to a specific geographic area. The MSBU is financed by an assessment specific to those properties receiving the benefit. The revenue funds services performed by the MSBU come from non-ad valorem assessments (not tied to property values).

A MSTU is authorized by the State constitution and Florida Statues as a taxing district. The MSTU performs as a legal financial mechanism for providing specific services based on geographic locations. The MSTU can impose ad valorem taxes to fund improvement projects.

City staff was contacted to discuss the City's use of MSBU's or MSTU's. It was confirmed that the City would consider the option of implementing MSBU/MSTU funding to assist CIP projects for those demonstrating benefit requirements. However, the benefit must be justified and documented before implementation for a specific region or project. For example, a stormwater quality improvement project may also involve extensive drainage system retrofitting components that may be eligible for a MSBU/MSTU funding which provides flood protection benefit to a specific local district.

Although this remains an option, the City does not pursue this funding frequently, because the benefit must be justified and documented before implementation and proving "benefit" could be challenging. For example, areas that drain to each BMP site should not be taxed for the project, if the whole city benefits. Also, making the entire city a MSBU/MSTU would likely be challenged by gated communities. The City does not pursue this funding frequently and other funding sources would likely be preferred.

10.2.3 Private Community Funding

Many local community and residential developments collect private funding through home owner association fees and/or CDD dues. Revenues collected from home owners through these sources can be allocated for flooding improvements within that community. The associations are independent from each other and will have varying quantities of available revenue for use within each community.

10.3 State Funding Sources

10.3.1 Clean Water Act Section 319 (h)

The Clean Water Act (CWA) was established in 1987 to address non-point source pollution. CWA Section 319 is an opportunity for federal funding that is administered through the office of Florida Department of Environmental Protection (FDEP). Under this section, states, territories and tribes have funding options for the following:

- Technical assistance
- Financial assistance
- Education
- Training
- Technology transfer
- Example projects
- Regulatory programs

Projects that are eligible for Section 319 funding must meet the criteria for mitigating nonpoint source pollution. Applications must be submitted to the Environmental Protection Agency for review and approval of funding.

This funding source was confirmed through the designated person for the Florida program at EPA. It is an active program and used by many agencies at the District level to fund projects demonstrating need and benefit. The designated person for the Florida program can provide assistance in all questions, appropriate forms, and required documentation for eligibility of Clean Water Act 319 funding.

Website information: http://www.epa.gove/owow_keep/NPS/cwact.html

10.3.2 Community Budget Issue Request (CBIR)

The Florida legislature created the Surface Water Improvement and Management (SWIM) program to address non-point pollution sources. The program is intended to improve water quality, specifically under the provisions of the Florida Watershed Restoration Act of 1999. Lower Charlotte Harbor is listed as a priority water management system by the SFWMD. The City of Bonita Springs is therefore in position to participate in Community Budget Issue Requests (CBIRs) for projects qualifying for restoration funding.

A water quality benefit must be demonstrated and the project should be “dirt ready”, meaning ready to go. Local participation is typically expected to be about 50% and completed permits are recommended.

The SFWMD convenes each August to prioritize each City and county’s project requests. The SFWMD continuously evaluates criteria in effort to achieve consistency of project requirements and selection processes. Projects with multiple component benefits score the highest and get a higher priority. For example a project having a water quality benefit, a flood mitigation component, and recreational components may have an advantage over a single component water quality project.

SFWMD subdivides its jurisdiction into regions to manage CBIR funding and project eligibility. The City of Bonita Springs falls under the jurisdiction of the SFWMD Central District. A district staff was designated to oversee projects requesting CBIR funding for the Central District and they can be contacted for information regarding the application process, forms, and required documentation.

10.3.3 TMDL Water Quality Restoration Grants

The FDEP receives documentary stamp funding for the implementation of projects to reduce urban non-point source pollution discharged to impaired waters. These funds are restricted to projects that reduce pollutant loadings to water bodies on the state’s verified list of impaired waters or to water bodies with an EPA/FDEP proposed or adopted TMDL. These funds primarily are used for stormwater retrofitting projects undertaken by local governments. Typically, FDEP will provide up to $1,000,000 in grant funding for these water quality improvement projects. All projects will require a minimum of 50% matching funds.

The TMDL Water Quality Restoration Grant funds primarily are for projects that are ready for construction within the next six to ten months. Land acquisition, design, and permitting should be completed or nearing completion. While the department will not fund these preliminary project elements, the cost of these elements are eligible as matching funds. Most projects will require storm event monitoring to document the project's effectiveness in removing pollutants and all data will be entered into the Florida BMP Database.

Projects will be selected for funding based on the following six categories:

1. Impairment status of the receiving water body
2. Estimated load reduction of the pollutants of concern
3. Percentage of local matching funds

4. Cost effectiveness based on the cost per pound of Total Nitrogen and/or Total Phosphorus removed per acre treated
5. Inclusion of a robust educational component
6. Whether the local government sponsor has implemented of a dedicated funding source for stormwater management, such as a stormwater utility fee.

Website information: http://www.dep.state.fl.us/water/watersheds/tmdl_grant.htm

10.4 Federal Funding Sources

10.4.1 Florida Forever Act

The Florida Forever Act legislation was passed in 1999 to provide funding for restoration projects. The projects are typically larger in size and dollar value and must meet criteria set forth by FDEP Office of Environmental Services Division of State Lands. Projects in pursuit of qualifying for this funding are projects that:

- Enhance the coordination and completion of land acquisition projects
- Protect bio-diversity at the species, natural community and landscape levels
- Protect, restore, and maintain the quality and functions of land, water, and wetland systems of the state
- Ensure sufficient quantities of water are available to meet current and future needs of natural systems
- Increase natural resource based public recreation or educational opportunities
- Preserve archaeological sites
- Increase the amount of forestland available for sustainable management of natural resources
- Increase the amount of open space available for urban areas

The Florida Forever Act is a funding source provided at the federal level through grants managed by the FDEP in Tallahassee. The proctor for this program was contacted with regards to this funding program including the procedures set forth at the state and federal levels. The key focus of the funding was to target restoration of Florida conservation areas. The projects are typically larger in nature in terms of acreage. The 2010 funding cycle had provisions for $19M in project funds, which is the smallest amount of annual funding available in recent years.

Website information: http://www.dep.state.fl.us/lands/links.htm

10.4.2 Community Development Block Grant Program

The Community Development Block Grant Program is a federal program targeted to provide funding for community development, including housing projects. Congress created the program in 1974 by passing the Housing and Community Development Act, Title I. The program is federally funded and administered at the state level through the Florida Department of Community Affairs (DCA). The objectives of the program at the national level are:

- Projects that provide benefit to low and moderate income community areas
- Prevent and/or reduce slums or blighted areas
- Specifically target urgent community development needs

The program is an excellent opportunity for projects that are in smaller communities (population less than 200,000), in cities that cannot afford projects affecting housing or low income areas, or under the jurisdiction of local governments who do not have the staff to complete projects without assistance.

Eligibility is classified into three categories:

1. Low-Moderate National Objective – where a minimum of 51% of the beneficiaries income is below 80% of the area's median income.
2. Slum-Blight National Objective – the area or community must meet the requirements set forth by local and state definitions as a slum or blighted area.
3. Urgent Needs National Objective – the project must mitigate existing conditions that pose a serious and immediate threat to local residents.

Candidates who receive grants are required to maintain records and documentation to fulfill eligibility requirements.

The proctor for this program was contacted to discuss the Block Grant program. It was noticed that the program remains completely funded and all projects are considered. The goal of the program is to provide funding for projects that are found in geographic regions considered to be slums and/or blighted areas. Applications for projects located in these areas can be made through the Division of Housing, and must be accompanied by documentation showing that the project meets the requirements of this grant program.

Website information: http://www.floridajobs.org/community-planning-and-development/assistance-for-governments-and-organizations/small-cities-community-development-block-grant-program.html

10.4.3 Federal Emergency Management Agency (DHS/FEMA)

The Federal Emergency Management Agency has developed a Hazard Mitigation Grant Program (HMGP). The HMGP is setup to assist communities to fund projects that mitigate threats resulting from natural and man-made hazards. HMGP funds can be used for projects that will help reduce or eliminate the losses and threats associated with future disasters. Projects applications must clearly demonstrate a long-term solution to a potential threat, such as, the elevation of a building to reduce the risk of flood damages in lieu of buying sandbags and pumps to combat the flood. Also, a project's cost benefit must demonstrate that the potential savings due to project implementation are greater than the cost of implementing the project. Funds can be used for projects on either public or private-owned property or to purchase property that in danger of continuous damage. The following list provides some examples of suitable projects:

- Acquiring property for sale resulting in the demolition or clearing of infrastructure, resulting in usable open space
- Retrofitting infrastructure to defend against flooding, wind, fire, or other hazards
- Elevating structures to reduce flood risks
- Vegetative management programs
- Flood projects that are not repetitive flood projects of other Federal agencies
- Local flood projects; i.e. construction of levees, floodwalls, or other stormwater management infrastructure
- Post disaster activities to retrofit or reconstruct existing buildings

FEMA was contacted regarding this grant program to determine requirements, documentation, forms, and procedures. A representative was designated to oversee the FEMA program funding for the State of Florida. It was noticed that the program was funded in 2010 and will also be funding projects in 2011. Projects demonstrating eligibility for this grant money are automatically funded. The funding targets infrastructure upgrades that mitigate potential threats to public safety and both public and private-owned property resulting from storms and natural disasters. The FEMA representative reviews application packages and can provide assistance in answering questions regarding application procedures.

Website information: http://www.fema.gov/government/grant/hmgp/

10.4.4 Charlotte Harbor National Estuary Program (CHNEP)

The Charlotte Harbor National Estuary Program (NEP) awards three types of grants. Micro-grant applications are accepted throughout the year but Public Outreach Grants and Research and Restoration Partner Grants are only available once a year. Florida residents, organizations, businesses, government agencies, schools, colleges and universities may apply for grants to support projects that occur within the Program study area. The Program has awarded outreach, research and restoration projects throughout the greater Charlotte Harbor watershed since 1996.

Guidance for Public Outreach Grants: Outreach projects, which are most often funded as public outreach grants, help multiply the number of people who are aware of the importance of estuaries and the protection of watersheds. In 2010 the maximum award was increased from $3,000 to $5,000.

Guidance for Research and Restoration Partner Grants: The research and restoration projects, which are most often funded as research and restoration partner projects, directly benefit the natural resources in the watershed, increase technical knowledge and often include an educational aspect. R&R grants provide up to $20,000 per participating partner and require a 50% match. CHNEP will NOT be seeking research and restoration partner proposals. These grants currently are not available. The website below will be updated when research and restoration partner grants will next be available.

Website information: http://www.chnep.org/Grants/Grants.htm

11 Final Recommendation

11.1 Recommended Capital Improvements

The primary objective of this study was to outline and evaluate alternative BMPs for inclusion in a Basin Management Action Plan (BMAP) to address the water quality concerns defined by the FDEP TMDL program. Based upon the preliminary analysis of the potential BMP sites in Sections 7 & 8, eight of the sixteen potential BMP sites are recommended. Upon approval of the Stormwater Master Plan Phase II by the City, these recommended BMPs could be implemented into the City's Capital Improvement Plan (CIP).

The recommended CIP projects are illustrated in Figures 11-1A & 11-1B and listed below by HSPF basins:

Imperial Lower

Felts Avenue at Ragsdale Street

Imperial Middle

Murat Circle at Imperial River

FPL Corridor near Imperial River

Imperial Parkway at Dean Street

Leitner Creek

Leitner Creek - Bypass Canal

Leitner Creek - Old Course

E. Terry Street at Leitner Creek - North

Oak Creek

Imperial Pkwy at Meadow Lane

In order to gain higher points when applying for FDEP TMDL restoration grants, the recommended BMPs can be incorporated into the on-going Basin Management Action Plan (BMAP) for the freshwater Imperial River TMDL. The most recent BMAP meeting was held in March 2011 between FDEP and the associated stakeholders including SFWMD, Lee County, and the City of Bonita Springs. As outlined in the action list of the meeting agenda, a list of BMP projects is to be finalized prior to next the BMAP meeting and should be prioritized for the first 5-year phase.

The CIP/BMP project "Imperial Pkwy at Meadow Lane" is located in HSPF basin "Oak Creek", which is not part of the freshwater section of the Imperial River watershed. Therefore, this CIP project is not eligible for the current FDEP BMAP program and will not be eligible until the TMDL program is established for the saltwater section of the Imperial River watershed.

11.2 Proposed Implementation Schedule

An implementation schedule for the first 5-year phase is proposed for the recommended CIP/BMP projects listed in the previous section. The majority of these CIP projects could be eligible for cost sharing or matching funds from other State or Federal sources as outlined in Section 10.

Fiscal Year 2012 – 2013 (Year 1)

E. Terry Street at Leitner Creek – North (50% Cost Share)	$87,500
Leitner Creek - Bypass Canal (50% Cost Share)	$65,000
Leitner Creek - Old Course	$65,000
	$217,500

Fiscal Year 2013 – 2014 (Year 2)

E. Terry Street at Leitner Creek – North (50% Cost Share)	$192,500
	$192,500

Fiscal Year 2014 – 2015 (Year 3)

Felts Avenue at Ragsdale Street (50% Cost Share)	$100,000
Murat Circle at Imperial River	$75,000
	$175,000

Fiscal Year 2015 – 2016 (Year 4)

FPL Corridor near Imperial River (50% Cost Share)	$90,000
Imperial Pkwy at Meadow Lane (50% Cost Share)	$65,000
	$155,000

Fiscal Year 2016 – 2017 (Year 5)

Imperial Parkway at Dean Street (50% Cost Share)	$185,000
	$185,000

The proposed schedule can be adjusted according to budget and other funding availabilities or constrains. As outlined above, these CIP projects have a total estimated budget of $925,000, which has an average annual expenditure of $185,000 for five years.

The typical process for the City to approve and implement recommendations for capital improvement projects begins with establishing the financial budget, usually in the late spring. The staff develops and submits their respective drafts by the middle of the summer. Approval of the financial budget drafts are finalized by the City Council in August and September. The budget year will then begin fiscally on October 1st and run until the following September 30th.

The annual financial budget report will identify the funding for approved CIP projects and Maintenance and Operation (M&O) and Repair and Replacement (R&R) costs. The annual report will include a projection for 5 additional years that will identify the CIP projects and planned sources of funding.

The annual report will also include CIP projects that are targeted for the next 5-10 year timeframe, but does not identify funding sources for these CIP projects. Each year the CIP projects are can be re-examined by the City staff to update their priorities and the City Council will then make the necessary adjustment to the CIP projects during the budget process.

The City has adopted the Stormwater Master Plan (SMP) Phase I. The following steps are recommended for implementation of the SMP Phase II:

1. City Council acceptance of the updated SMP Phase II.
2. Integrate the SMP Phase II into the City's Financial Program.
3. Pursue funding from other State and Federal sources to reduce the burden on the City's general fund.
4. Initiate funding for the top three CIP projects among the current eight identified CIP projects as part of the City's 5-year timeframe Financial Program.
5. Implementation of an updated O&M and R&R Program by the City's Public Works staff, primarily the Maintenance Coordinator.

11.3 Funding Mechanisms

As discussed above, the City would require approximately 4 to 6 months to put in place a financial program; 8 months for engineering design and permitting of the top three CIP projects; and 6 to 8 months for the construction and final certification. The timeframe is approximately 2 years before these top three CIP projects are completed. It is at this time, the City may begin implementing the remaining identified CIP projects once funding is made available.

It is strongly recommended that the City designate a staff member as a single point of contact for tracking and coordinating funding programs in furtherance of the City's interests. The major responsibilities of the designated staff member might include the following:

- Prepare and submit applications for cooperative funding through the SFWMD Community Budget Issue Request (CBIR), the FDEP Section 319 Grant and TMDL Water Quality Restoration Grant for the recommended CIP projects, and other State and Federal funding programs.
- Implement local sources of funding, such as Ad Valorem taxes and bonds, for construction and maintenance of the proposed CIP projects. It is essential in the scoring of grant applications, such as the FDEP Section 319 Grant, that a local government has implemented of a dedicated funding source for the implementation, operation, and maintenance for such facilities.

11.4 NPDES Permit

The City of Bonita Springs currently holds an NPDES permit for MS4 discharge to waters of the state. As a condition of this permit, a storm water management plan (SWMP) must be implemented and include pollution prevention measures, treatment and removal techniques, stormwater monitoring, and other means to control the quality of the stormwater discharged from the MS4 owned and operated by the City.

11.4.1 Regulatory Permit Inventory and Database

As part of the Stormwater Master Plan Phase I, a stormwater infrastructure inventory geodatabase in ArcGIS format was developed. It is recommended that the City use this GIS geodatabase to assist in development, implementation, and management of the on-going stormwater facility operation and maintenance program to the desired level, or as may be required by SFWMD permits, and to meet the current and further requirements of the NPDES permit.

11.4.2 Outreach and Education

Continue the public outreach and education program that focuses on issues of stormwater pollution prevention, as required by the current and future NDPES permit. In furtherance of this matter, the City may consider applying for cooperative grants from the Charlotte Harbor Nation Estuary Program (CHNEP).

11.4.3 Code of Ordinance

One such pollution prevention measure enacted by the City is the adoption of City Ordinance No. 08-23, a landscape management ordinance. While this ordinance regulates the use of fertilizer, it does not regulate the sale of fertilizer. It is recommended that a summer retail sales restriction of fertilizers be supplemented in the existing City ordinance.

Given the current lack of research on this subject, the most common sense approach would suggest that fewer nutrients placed on lawns and impervious surfaces during summer months would lead to fewer opportunities for nutrient runoff and, therefore, be beneficial to the surface waters of the City during those months of increased rainfall activity. From a regulatory/enforcement perspective, the prohibition of sales is more readily enforceable than is the prohibition of application. In Florida, Pinellas County is the only local government that has adopted a similar retail sales restriction in 2010.

The proposed rule could be stated as:

> *"Effective xxxx, 2012, no person shall sell, at retail, any lawn or landscape fertilizer, liquid or granular, within the City of Bonita Springs that contains any amount of nitrogen or phosphorous during the restricted season from June 1-September 30, unless otherwise provided for in this rule."*

It is also recommended that the City coordinate with Lee County and other four municipalities within the County: City of Cape Coral, City of Fort Myers, Town of Myers Beach, and City of Sanibel so that the retail sale restriction rule could be adopted for all six governments in order to adequately address urban fertilizer contributions to nonpoint source nutrient loading.

11.4.4 TMDL Consideration

A TMDL has been established for the freshwater section of the Imperial in order to ensure that the river will meet acceptable water quality standards. Per the most recent FDEP TMDL modeling efforts, a TN loading reduction of 26.5% was needed in order to improve levels of dissolved oxygen in the river. The first 5-year TN loading reduction was estimated at 3,301 lb/yr for the City of Bonita Springs.

Assumed that the BMAP for the freshwater section of the Imperial River will be adopted within two years of NPDES permit issuance, the City shall continue to participate in the BMAP process as required. Prior to the next BMAP meeting, the implementation schedule and priorities should be assigned to programs and projects, including the recommend BMPs, which have the greatest potential for achieving the goals and objective of the BMAP.

It is strongly recommended that the City designate a staff member as a single point of contact for tracking and coordinating NPDES permit as well as TMDL program in furtherance of the City's interests.

11.5 Figure & Tables Descriptions

The figures and tables discussed in this section are summarized below:

Figure #	Description
11-1A	Recommended BMP/CIP Projects
11-1B	Recommended BMP/CIP Projects

Legend

- Roadway
- BMPSite_Polygon
- Basin_HSPF

2

1 in equals 800 feet

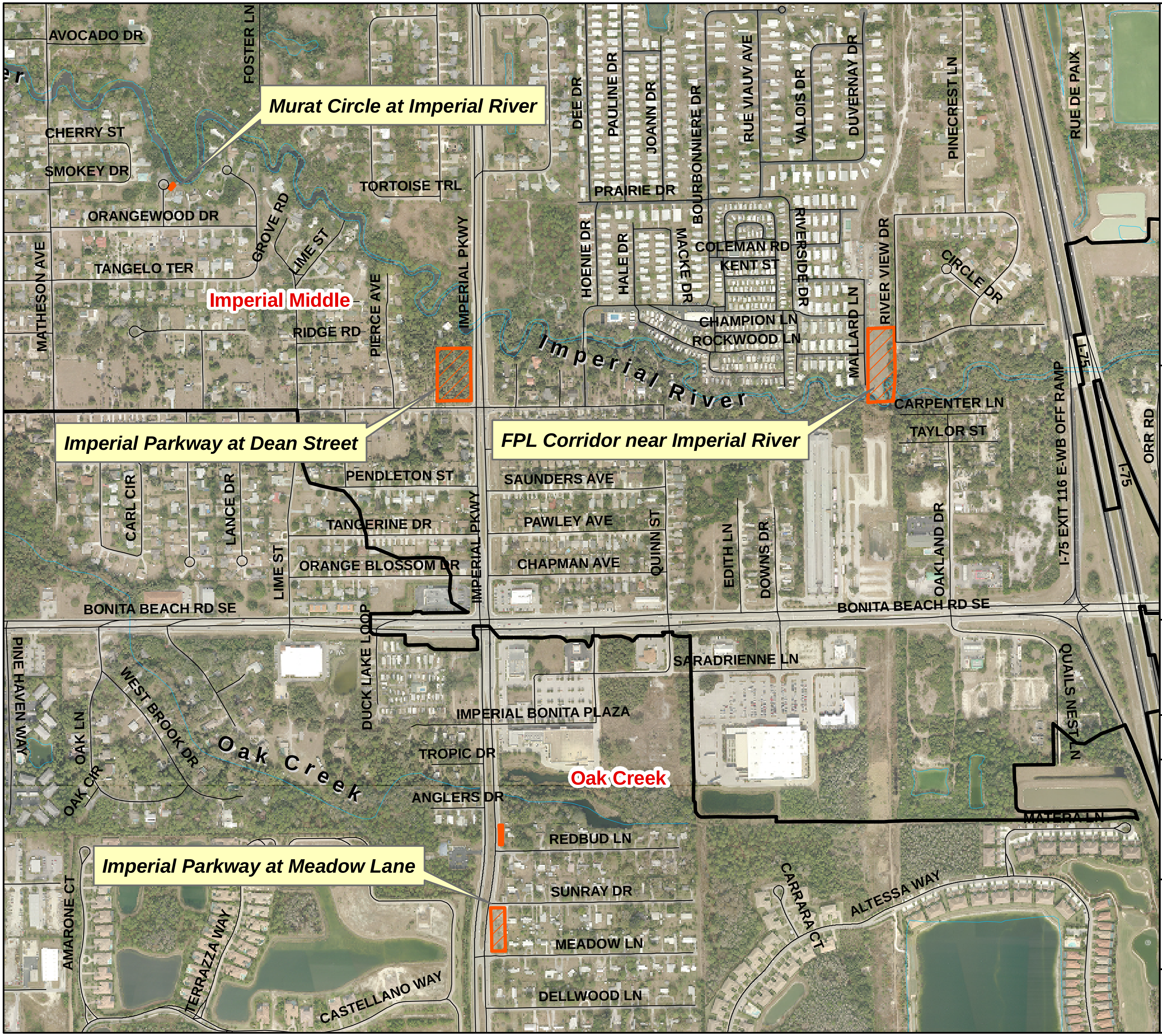
City of Bonita Springs
SMP Phase II

TITLE:
Recommended
BMP/CIP Projects

DATE: 10/10/2011

INTERA

FIGURE:
11-1A



Legend

- Roadway
- BMPSite_Polygon
- Basin_HSPF

2

1 in equals 800 feet

City of Bonita Springs
SMP Phase II

TITLE:
Recommended BMP/CIP Projects

DATE: 10/10/2011

INTERA

FIGURE:
11-1B