SATELLITE BEACH

STORMWATER QUALITY MASTERPLAN

FINAL

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Satellite Beach

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1.0 EXECUTIVE SUMMARY

The City of Satellite Beach (City) is located on the east side of the Banana River Lagoon (BRL), between Indian Harbour Beach on the south and Brevard County on the north. The decline of water quality and ecosystems of the BRL has been documented by local, state, and federal agencies, leading to the BRL being placed on EPA's Verified List of Impaired Waters. In order to address pollution problems in the BRL, the Florida Department of Environmental Protection (FDEP) established a Total Maximum Daily Load (TMDL) for the Indian River Lagoon and Banana River in 2009 to reduce pollutant loadings of Total Nitrogen (TN) and Total Phosphorus (TP). The FDEP TMDL was based on a Pollutant Load Reduction Goal (PLRG) developed by the St Johns River Water Management District (SJRWMD) with the goal of restoring seagrasses to historic high levels. To implement the TMDL program, FDEP is currently going through the Basin Management Action Plan (BMAP) process.

The City discharges runoff from its stormwater systems to the Banana River under National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) Permit No. FLR04E074. Accordingly, TMDLs set by FDEP will affect stormwater management practices within the City. Enforcement of these pollutant reductions goals will be through the NPDES MS4 permit.

In order to address TMDL compliance issues, Satellite Beach undertook this study with the project team of Quentin L. Hampton and Associates (QLH) and Stormwater Solutions to quantify stormwater pollutant loadings, compare the pollutant loadings to TMDL allocations, and propose stormwater retrofit projects and measures necessary to comply with TMDL and BMAP mandates.

1.1 Findings

The BMAP allocation for the City is an annual 75.3% reduction of TN and 79.2% reduction of TP from the City's stormwater runoff over a 15-year period. Compliance to these allocations is split into three equal five-year cycles. The City is expected to commit to implementation of stormwater treatment projects and policies that will result in reducing TN by 3,500 lb/yr and TP by 650 lb/yr for only the first five-year cycle. A compliance program with three types of components has been developed for implementation by Satellite Beach in the first five-year cycle.

1.1.1 PLSM Model Refinements

The first component of the City's TMDL compliance plan consists of refining the Pollutant Load Screening Model (PLSM) provided by FDEP for calculating existing and proposed pollutant loadings. The PLSM model uses the variables of existing treatment system presence, soils type, land use, runoff coefficient, and annual rainfall. An analysis of FDEP's PLSM model revealed potential deficiencies in the Geographical Information System (GIS) coverages of land use, runoff coefficient, and existing Environmental Resource Permits (ERP) treatment areas. These coverages reflect the year 2000 conditions, which have changed over the last 10 years. **Stormwater Solutions recommends the City undertake a GIS coverage update. Refining the coverages will allow a more accurate determination of existing load allocations and existing BMP credits for the City. Specifically, Stormwater Solutions recommends a thorough review and update of land uses not reflected in the year 2000 coverage and identification of private stormwater treatment systems constructed after 2000.**

An inconsistency in the PLSM model appears to exist where the Banana River (Land Use 5400) does not have pollutant loads assigned to the waterbody, but the Grand Canal and residential canals (Land Use 5100) do have pollutant loads that increase the City's required pollutant reductions. **Stormwater Solutions recommends that FDEP be requested to revise the PLSM model be adjusted to use the same pollutant loadings for Land Use Codes 5100 and 5400.**

Stormwater runoff volumes calculated in the PLSM model use the variable called a runoff coefficient (RO) that predicts the amount of rainfall that infiltrates into the ground. An RO is determined by the land use and soil type in a drainage basin. Another potential flaw in the PLSM model is in the use of RO factors that are not accurate for the large amounts of open or undeveloped land at Sansom Island. **Stormwater Solutions recommends that the City undertake a study to develop Delivery Ratio factors that more accurately calculate RO factors and runoff volumes at Sansom Island.**

1.1.2 Nonstructural BMPs

FDEP offers TMDL reduction credits for so called “soft” or nonstructural BMPs such as educational program implementation and maintenance practices. Credits are available for sediment removal through a street sweeping program. Credits are based on measurement of actual pounds of sediment removed. The City currently has a street sweeping program in place that collects approximately 180 cubic yards of sediment per year. **Stormwater Solutions recommends the City continue their street sweeping program and develop an accurate documentation method for tracking masses of sediment removed and convert the masses to pounds of TN and TP removed.** The calculated TN and TP masses should be applied toward the City’s annual load allocation.

A maximum of 6% credit is available for a combination of public education measures. The City currently undertakes several of these measures as part of required activities for their MS4 permit. Maximum educational program credits can be achieved by implementing the following categories of programs.

1. Participation in the Florida Yards and Neighborhoods Program
2. Revising ordinances pertaining to landscaping, irrigation, fertilizer, and pet waste management
3. Public service announcements over the television
4. Websites with stormwater pollution control information
5. Informational pamphlets
6. Inspection and call in programs for illicit discharges

Most of these programs have been initiated and can be completed to FDEP’s specifications with moderate effort. The Florida Yards and Neighborhoods program will be implemented by the Agricultural Extension Service. The details of the program are not finalized, but appear to be difficult to comply with. At this point participation in this program is not recommended until the City can fully understand the implications of this program. Implementation of the other five public education components can result in 3% credits. **Stormwater Solutions recommends that the City implement and properly document a public education program with the above components except for the Florida Yards and Neighborhoods Program.**

1.1.3 Structural BMPs

After careful analysis of the City's stormwater system, a listing of 30 potential structural retrofit projects was developed that could be feasibly implemented. See Table 2. Types of projects selected were dry retention ponds, wet detention ponds, exfiltration trenches, inlet traps, and floating vegetated islands. The construction costs for this ultimate build out plan were estimated to be $8,485,113.

At this point FDEP is only requiring the City to commit to implementing BMPs that will meet the first five-year cycle reductions, not the full 15 year reductions. **Based upon the previously constructed retrofit projects and recommended nonstructural BMPs and model adjustments, the City would be able to meet the first five-year allocations with no further structural BMPs.** TMDL credits from the Cassia and North Basin projects would count toward the second five year allocations. See Table 1. FDEP is currently revisiting BMAP allocations and the baseline numbers and allocations may change in March 2011.

Table 1 - TMDL Implementation Plan

	TN (lb/yr)	TP (lb/yr)
FDEP Required 5 Year Reduction	3,500	650
FDEP Required 10 Year Reduction	7,000	1,300
FDEP Required 15 Year Reduction	10,501	1,949
Proposed Nonstructural and Scheduled Structural Reductions		
Reduction from GIS Treatment Area Updates	1,296	461
Reduction from GIS EMC changes for Land Use 5100	310	26
Reduction from Proposed Runoff Coefficient Study	77	5
Reduction from Proposed Public Education Programs (3%)	419	77
Reduction from Street Sweeping	578	202
Reduction from Existing BMPs	1,211	234
Reduction from Proposed North Basin BMPs	325	79
Reduction from Proposed Cassia BMPs.	61	13
Subtotal	**4,277**	**1,097**
Remaining 5 Year Reductions Required	0	0
Remaining 10 Year Reductions Required	2,723	203
Remaining 15 Year Reductions Required	6,224	852
Recommended Structural Reductions from Table 2	3,586	1,448
Projected Remaining 10 Year Reductions	0	0
Projected Remaining 15 Year Reductions	2,638	0

1.2 Summary

The project team performed an assessment of the TMDL program. An analysis of FDEP pollutant load allocations, the PLSM model, and the City's stormwater system revealed a number of measures that could be instituted by the City to reduce TMDL pollutant loadings. A combination of model corrections, nonstructural BMPs, and construction of two retrofit projects already on the books would achieve compliance with the TMDL allocations for the first five-year cycle. Construction of the projects listed in Table 2 would provide sufficient credits for the second five-year cycle. Based upon today's technology, additional TMDL reductions for the third cycle would come at great cost in land acquisition and difficult construction. At this point there are no recommendations for meeting the third five-year cycle reductions. BMAP allocations and required reductions are not set in stone. Future reassessments of BRL health may reduce those allocations or new low cost BMPs may become prevalent. This BMAP process is evolving and there will be several rounds of modifications to the mandates. FDEP would like for the City to at least buy into the program by committing to projects and measures to meet the first five-year allocations. **Based upon Table 1 the City will be able to meet these first five year reductions by committing to clean up GIS coverages, implement public education programs, perform a study by Dr. Harvey Harper to redefine runoff characteristics for Sansom Island, and submitting credits for BMPs previously constructed by the City and for the Cassia and North Basin.**

In order to reduce costs for implementing various program components, the City should pursue participation and partnerships with other municipalities in order to achieve cost sharing of regional stormwater retrofit projects, public education programs, and possibly maintenance operations such as street sweeping or BMP cleaning.

Construction of some of the recommended projects will have permitting difficulty because they are located in Waters of the State where stormwater treatment is prohibited. **The City should pursue legislative change to allow pollutant treatment in Waters of the State for purposes of TMDL compliance.**

The City may wish to pursue regulatory changes at State and Federal levels. This option would have a greater chance for success if the City joined with other municipalities or the Florida Stormwater Association to seek regulatory relief.

Table 2 - Recommended Structural BMPs

Project No.	BMP Type	TN Removal (lb/yr)	TP Removal (lb/yr)	Estimated Costs	Cost per pound TN Removed	Cost per pound TP Removed
9B* Elwood Ave	Beemats	52.85	5.10	$ 5,160	$ 97.64	$ 1,012.16
21 Desoto Park	Beemats	218.50	20.11	$ 26,325	$ 120.48	$ 1,308.77
7B* Roosevelt and S. Patrick	Beemats	435.99	81.19	$ 55,224	$ 126.66	$ 680.22
36 Jamaica Pond	Beemats	286.77	41.23	$ 42,120	$ 146.88	$ 1,021.69
31 City Hall	Beemats	71.34	13.15	$ 10,530	$ 147.61	$ 800.82
11 South Base Housing	Beemats	451.13	108.51	$ 126,360	$ 280.10	$ 1,164.48
1B* Post Office	Beemats	147.42	23.91	$ 58,968	$ 400.00	$ 2,466.37
3B* Jackson and S. Patrick	Beemats	29.31	4.42	$ 13,104	$ 447.11	$ 2,962.47
17B* Library 2	Beemats	93.41	8.82	$ 47,385	$ 507.30	$ 5,372.28
8B* Cinnamon	Beemats	6.06	0.58	$ 5,160	$ 851.47	$ 8,921.77
9A Elwood Pond	Wet Det.	65.16	23.35	$ 61,927	$ 950.43	$ 2,651.81
17A Library 2	Wet Det.	265.20	70.53	$ 304,236	$ 1,147.20	$ 4,313.80
4B* Jackson	Beemats	4.76	0.59	$ 5,616	$ 1,179.64	$ 9,552.96
15 South Ditch	Swale	71.62	10.94	$ 93,852	$ 1,310.36	$ 8,581.28
1A Post Office	Wet Det.	349.96	161.09	$ 532,883	$ 1,522.70	$ 3,307.93
34 Tortoise Island	Beemats	22.36	3.24	$ 52,650	$ 2,354.65	$ 16,260.04
16B* Library 1	Beemats	14.07	0.86	$ 34,749	$ 2,469.77	$ 40,523.59
6 Publix	Dry Pond	76.91	19.75	$ 204,059	$ 2,653.24	$ 10,332.65
22-27 Cassia	Exfiltration, Baffle Box	386.00	92.00	$ 1,124,588	$ 2,913.44	$ 12,223.78
16A Library 1	Wet Det.	51.31	13.09	$ 213,800	$ 4,166.72	$ 16,329.92
30 North Outfall	Exfiltration Baffle Box	270.79	70.56	$ 1,131,930	$ 4,180.08	$ 16,043.23
7A Roosevelt and S. Patrick	Wet Det.	625.48	221.67	$ 2,619,410	$ 4,187.86	$ 11,816.45
13 Palm	Exfiltration	28.49	6.36	$ 138,038	$ 4,845.68	$ 21,719.58
35 Lansing Island	Beemats	27.17	1.62	$ 152,685	$ 5,620.03	$ 94,483.29
5 Lincoln	Exfiltration	33.27	6.69	$ 200,813	$ 6,035.09	$ 29,996.03
12 Elwood	Exfiltration	13.92	1.96	$ 106,920	$ 7,682.24	$ 54,656.43
14 Palmetto	Exfiltration	34.78	7.76	$ 271,350	$ 7,801.37	$ 34,967.73
3A Jackson and S. Patrick	Wet Det.	54.95	24.84	$ 457,340	$ 8,322.37	$ 18,409.36
8A Cinnamon	Wet Det.	20.12	6.02	$ 208,670	$ 10,370.60	$ 34,652.39
4A Jackson	Wet Det.	16.10	6.42	$ 184,424	$ 11,457.65	$ 28,709.37
Totals		4,209.08	1,049.93	$ 8,485,113		

* This project can not be implemented until the associated wet detention pond is constructed

2.0 BACKGROUND

Satellite Beach has strong environmental awareness and concern for the Banana River Lagoon. Over the last 60 years the health of the BRL has markedly declined, as noted by the losses of critical seagrass beds and once-productive fisheries. The principal cause of the degradation of the BRL has been identified as nutrients in polluted stormwater runoff that stimulates algae growth and reduces seagrass coverage.

The FDEP is implementing the TMDL program for impaired waters throughout Florida. A TMDL is the maximum amount of pollutants, expressed in pounds per year, which a water body can assimilate without degrading or violating Florida's water quality standards. Criteria for identifying those water bodies subject to having a TMDL set, the methods to be used to set TMDL's, methods to establish TMDLs, and schedules for implementing TMDL's are described in the Florida Watershed Restoration Act of 1999 (Subsection 403.067[4]F.S.) and the Impaired Waters Rule (IWR) (Chapter 62-303, F.A.C.).

In response to TMDL regulations, the City has assembled a project team to perform a TMDL assessment and make recommendations for implementation measures that would bring the City into compliance with these regulations.

2.1 Study Objectives

The study objectives for the Satellite Beach Masterplan are as follows:

- To provide a synopsis of the TMDL and BMAP program and its impacts upon the City's planning and budgetary programs;
- To evaluate the State's TMDL process;
- To perform a current pollutant loading analysis of the City's drainage basins;
- To inventory and evaluate the City's efforts to date to provide structural and nonstructural Best Management Practices (BMPs) to reduce stormwater pollution;
- To identify BMPs or practices the City may undertake to meet load reduction mandates;
- To perform a proposed conditions pollutant loading analysis of the City's drainage basins based upon the recommended retrofit projects; and

- To develop a TMDL documentation package to be used in the development of a BMAP, which will be used to provide a detailed plan for achieving protection and improvements of water quality in the BRL.

2.2 Sources of data collection

The available stormwater data from local. State, and federal agencies have been researched, compiled, and presented in this report. The listing of materials used in the development of this report are presented below.

Maps:

- Existing Stormwater System Maps (QLH) 2010
- GIS coverages for Soils, Land Use and Cover (FDEP 2010 based on SJRWMD 2000)
- Roads and county boundaries (SJRWMD or TIGER 2000-2010)
- Imagery as 1' resolution orthophotography (Brevard County, 2009)
- Cassia Blvd Phase 1 and 2 Plans (QLH) 2010

Reports and Information

- "Satellite Beach Stormwater Masterplan" (Outlaw and Rice) 2001
- Environmental Resource Permits for Jackson Street, Desoto Street, Desoto Pond
- "Satellite Beach Soils Report" (Outlaw and Rice) 2001

3.0 REGULATORY FRAMEWORK

The TMDL Program was established by federal and state legislation and implemented by state regulatory policies as discussed below.

3.1 Clean Water Act

Congress enacted the Clean Water Act in 1972 with the goal of restoring and maintaining the "chemical, physical, and biological integrity of the nation's waters" (33 U.S.C. § 1251[a]). Section 305(b) of the Clean Water Act requires states to provide a biennial report to the U.S. Environmental Protection Agency (EPA) assessing water quality. The 305(b) assessment report provides information on the physical, chemical, biological, and cultural features of each river basin in Florida. This initial assessment provides a common factual basis for identifying information sources and major issues, and for determining the future changes, strategies, and actions needed to preserve, protect, and/or restore water quality.

Understanding the multiple factors affecting water quality in each basin allows for the site specific development of scientific methodology for assessing water quality and an accurate depiction of which areas have the greatest impairment or are vulnerable to contamination. Section 303(d) of the Clean Water Act requires states to provide a list of surface waters that do not meet applicable water quality standards to EPA. States are then tasked with adding these waters to their planning list for TMDL development.. If the water body meets criteria for identifying impaired water bodies, a TMDL is developed. A pollution limit is next allocated to each pollutant source in an individual water bodies. Those waterbodies that do not meet water quality standards for its designated uses are defined as *impaired*, according to Section 305(b).

3.2 Florida's Impaired Surface Water Rule

Section 303(d) of the Clean Water Act and Chapter 403.067, Florida Statutes, describe impaired waters as those waterbodies or waterbody segments that do not meet applicable water quality standards. "Impairment" is a broad term that includes designated uses, water quality criteria, the Florida anti-degradation policy, and narrative nutrient criteria. The state's Identification of Impaired Surface Waters Rule (Section 62-303, Florida Administrative Code) (IWR) was developed in cooperation with a Technical Advisory Committee and adopted by the Florida Environmental Regulatory Commission on April 26, 2001. It provides a scientific methodology for evaluating water quality data in order to identify impaired waters, and it establishes specific criteria for impairment based on chemical parameters, the interpretation of narrative nutrient criteria, biological impairment, fish consumption advisories, and ecological impairment. Waters that are identified as impaired through the IWR are prioritized for TMDL development and implementation.

Determining impairment in individual waterbodies takes place in two phases. First, Florida is divided into five areas called groups containing a number of hydrologic basins. The FDEP evaluates the existing water quality data in each basin, using the methodology prescribed in the IWR to determine whether waters are potentially impaired. Waters found to be potentially impaired are included on a *Planning List* for further assessment. As required by Subsection 403.067(2), Florida Statutes, the Planning List is not used to administer or implement any regulatory program and is submitted to the EPA for informational purposes only.

The second phase is to assess waters on the Planning List under Chapter 403.067(3), Florida Statutes, as part of FDEP's watershed management approach (described in the following section). The FDEP carries out additional data gathering and strategic monitoring for water bodies on the planning list, to determine if a waterbody is, in fact, impaired and if the impairment is anthropogenic or natural. The criteria for the Verified List are more stringent than those for the Planning List. An Assessment Report is produced containing the results of this updated evaluation and a Draft Verified List of impaired waters is made available for public comment. Waterbodies which are not removed based on information obtained during the public comment period become part of an official and final Verified List. In accordance with the Florida Watershed Restoration Act, the Verified List is adopted by Secretarial Order. Once adopted, the list is submitted to the EPA for approval as part of the state's Section 303(d) list of impaired waters.

The FDEP is required to develop TMDLs for waters on the Verified List under Subsection 403.067(4), Florida Statutes. A watershed management plan, called BMAP, which provides a list of necessary actions for all parties who are stakeholders in the TMDL to reduce the amount of pollutants causing impairment, must also be produced and implemented.

3.3 The Florida Watershed Restoration Act

The Florida Watershed Restoration Act of 1999 contains the following major provisions:

- Establishes that the 303(d) list submitted to the EPA in 1998 is for planning purposes only;
- Requires the FDEP to adopt 303(d) listing criteria (i.e., the methodology used to define impaired waters) by rule;
- Requires the FDEP to verify identified impairment from planning lists, and then establish basin-specific Verified Lists;
- FDEP must evaluate whether proposed pollution control programs are sufficient to meet water quality standards, list the specific pollutant(s) and concentration(s) causing impairment, and adopt the basin-specific 303(d) list by Secretarial Order;
- Requires the FDEP's Secretary to adopt TMDL allocations by rule. The legislation requires the FDEP to establish "reasonable and equitable" allocations of TMDLs, but does not mandate how allocations will be made among individual sources;
- Requires that TMDL allocations consider:
  - existing treatment levels and management practices;
  - the differing impacts that pollutant sources may have;
  - the availability of treatment technologies;
  - best management practices (BMPs), or other pollutant reduction measures that might be implemented;
  - the feasibility, costs, and benefits of achieving the allocation;
  - reasonable time frames for implementation; and
  - the extent that non-attainment is caused by pollution from outside Florida, discharges that have ceased, or alteration to a waterbody.
- Authorizes the FDEP to develop basin plans to implement TMDLs, coordinating with the water management districts, the Florida Department of Agriculture and Consumer Services (DACS), the Soil and Water Conservation Districts, regulated parties, and environmental groups in assessing waterbodies for impairment, collecting data for TMDLs, developing TMDLs, and conducting at least one public meeting in the watershed;
- Implementation is voluntary if not covered by regulatory programs; and

- Authorizes the FDEP and DACS to develop interim measures and BMPs to address nonpoint sources. While BMPs may be adopted by rule, they are voluntary if they are not a requirement of a regulatory program.

4.0 THE TOTAL MAXIMUM DAILY LOAD PROCESS

4.1 The Watershed Management Approach

The FDEP statewide approach to water resource management, called the Watershed Management Approach is the framework for implementing TMDLs as required by the federal and state governments. The approach does not focus on individual sources of pollution. Instead, each basin is assessed as an entire functioning system. Aquatic resources are evaluated from a basin-wide perspective that considers the cumulative effects of anthropogenic activities. Water resources are managed on the basis of natural boundaries, such as river basins, rather than political or regulatory boundaries. Federal, state, regional, tribal, and local governments identify watersheds not meeting clean water or other natural resource goals and work cooperatively to focus their efforts to implement effective strategies to restore water quality.

The watershed management approach is not new, nor does it compete with or replace existing programs. Rather than relying on single solutions to water resource issues, it is intended to improve the health of surface water and ground water resources by strengthening coordination among such activities as monitoring, stormwater management, wastewater treatment, wetland restoration, land acquisition, and public involvement. By promoting the management of entire natural systems and addressing the cumulative effects of long-term human activities on a watershed basis, this approach is intended to protect and enhance the ecological structure, function, and integrity of Florida's watersheds. It provides a framework for setting priorities, focusing the FDEP's assets on protecting and restoring water quality, and aims to increase cooperation among state, regional, local, and federal interests.

4.2 The Watershed Management Cycle

To implement the watershed management cycle, the state has been divided into five hydrologic groups based on 52 major hydrologic drainage basins. Figure 1 shows the five basin groups for implementing the TMDL cycle. The basin rotation schedule for TMDL development and implementation will take nine years to complete one full cycle of the state and will repeat itself every five years. There are five phases that must be completed for each cycle. The watershed management cycle is an iterative process.

- ***Phase 1: Preliminary Watershed Evaluation***

For each impaired watershed a Basin Status Report is developed, containing a Planning List of potentially impaired waters that may require the establishment of TMDLs. The report characterizes each basin's hydrologic, ecological, and socioeconomic setting as well as historical, current, and proposed watershed management issues and activities. It also contains a preliminary evaluation of major water quality parameters, water quality issues by planning unit, an evaluation of ecological resources, and basin-wide pollutant loading trends related to land uses. At the end of Phase 1, a Strategic Monitoring Plan is developed to provide sufficient data to determine if a specific waterbody should be included on the draft verified list or removed from the planning list.

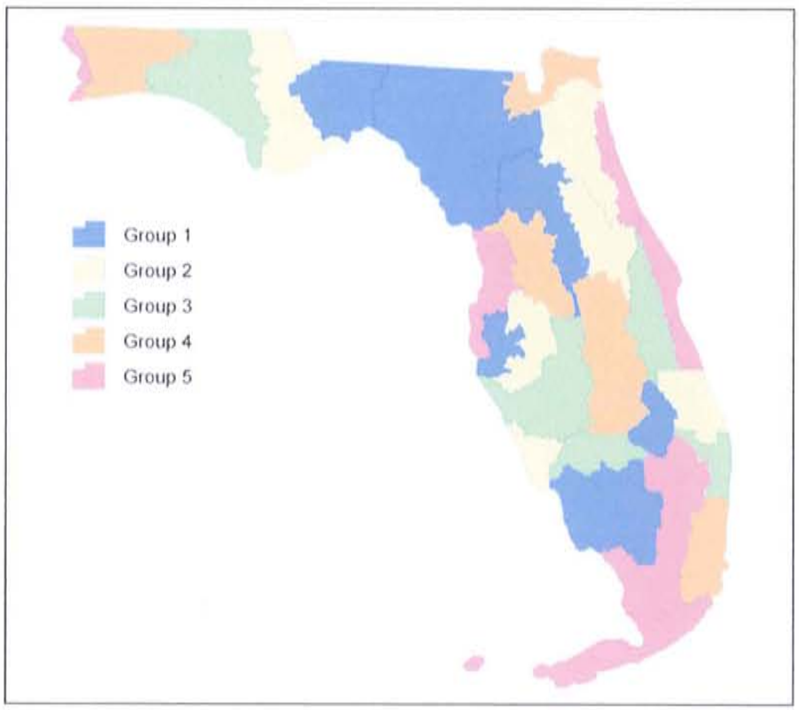


Figure 1 - FDEP Basin Groups

- ***Phase 2: Strategic Monitoring and Assessment***

Additional data for each planning list waterbody is collected through strategic monitoring and uploaded to STORET, an acronym for STORage and RETrieval database. STORET is the states currently used database for the storage of biological, chemical, and physical data for ground and surface waters. The data is used to verify whether potentially impaired waters in each basin are impaired and to calibrate and verify predictive models for TMDL development. At the end of Phase 2, an Assessment Report is produced for each basin that contains a Draft Verified List of impaired waters. The report also provides an updated and more thorough evaluation of water quality, associated biological resources, and current management plans. The FDEP will adopt Verified List through a Secretarial Order and submit it to the EPA as the state's Section 303(d) list of impaired waters.

- ***Phase 3: Development and Adoption of TMDLs***

Watershed quality restoration targets, called TMDLs, for priority-impaired waters in the basin will be developed and adopted by rule. Because TMDLs cannot be developed for all listed waters during a single watershed management cycle due to fiscal and technical limitations, waterbodies will be prioritized using the criteria in the Identification of Impaired Surface Waters Rule, Section 62-303, Florida Administrative Code.

- ***Phase 4: Development of Basin Management Action Plan***

A Basin Management Action Plan will be developed for each of the 52 major hydrologic drainage basins that specifies how pollutant loadings from point and nonpoint sources of pollution loading will be allocated among stakeholders and reduced, in order to meet TMDL requirements. Each basin stakeholder is allowed to participate in the BMAP development process. The plans will include regulatory and non-regulatory (i.e., voluntary), structural and nonstructural strategies. Existing management plans developed by other agencies such as water management districts, will be used where feasible. Data needs and future studies required to increase the accuracy of the basin TMDL are also identified for inclusion in the next TMDL cycle. The involvement and support of affected stakeholders in this phase will be especially critical.

- ***Phase 5: Implementation of Basin Management Action Plan***

Implementation of the activities specified in the Basin Management Action Plan will begin a schedule contained in the plan. This includes beginning retrofit and restoration projects, carrying out rule development as needed, securing funding, informing stakeholders and the public of the plan, and monitoring and evaluating the implementation of the plan. One of the key components of the BMAP is that effectiveness of management activities (TMDL implementation) will be monitored in successive five year cycles. Monitoring conducted in Phase 2 of subsequent cycles will be focused on evaluating whether water quality objectives are being met and whether individual waters are no longer impaired and can be removed from the Verified list. The FDEP also will track the implementation of scheduled restoration activities, whether required or voluntary, to ensure continued progress towards meeting the TMDLs.

5.0 POLLUTANT LOAD REDUCTION GOALS

Prior to FDEP's TMDL program, the SJRWMD undertook a program known as the Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) between 1991-1996 to establish Pollutant Load Reduction Goals. The SJRWMD PLRGs identified maximum levels of stormwater pollutants that could be discharged to the Lagoon without impairing its waters.

"The Indian River/Banana River Lagoon PLRGs set maximum loading targets for TN, TP, and TSS as a function of seagrass depth limits in the lagoon. The logic behind this approach is that an excess of those pollutants will diminish water transparency and attenuate light penetration, in turn reducing seagrass coverage. Seagrasses have an important role in the ecology of estuaries such as Indian River Lagoon. Seagrasses stabilize sediments, improve water clarity, and provide food and shelter to various marine organisms. In addition, seagrass is a conspicuous floral feature of this waterbody, and Florida's nutrient criterion requires preventing an imbalance in natural populations of aquatic flora. Thus, maintaining healthy seagrass is consistent with the overall goal of meeting water quality standards and maintaining the designated use of the waterbody.

As part of the PLRG analysis, maximum seagrass depths were determined from the union of mapped seagrass extent spatial layers, which were available for 1943, 1986, 1989, 1992, 1994, 1996, and 1999 (Steward et al, 2005). Full restoration seagrass conditions are the median depth of the furthest extent of seagrass coverage achieved during this period. The TMDL value for the Indian River Lagoon is equivalent to the mean annual loads of TN and TP that achieve the target seagrass depth of -10% from full restoration conditions. The seagrass depth targets for the sub-lagoons are represented by a range of values, since seagrass depth targets were developed for each segment within them (Steward et al., 2005).

The nonpoint fraction of the nutrient loading estimates to which the seagrass depths are correlated were generated using the Pollutant Load Screening Model (PLSM) and the Hydrologic Simulation Program- Fortran (HSPF). PLSM is a GIS-based watershed model that can estimate annual runoff and pollutant loads from spatial data (Adamus and Bergman, 1993, 1995). HSPF is a system of models commonly used to simulate the effects of changes in land use and point or nonpoint source treatments on watershed hydrology and associated water quality (Bicknell et al., 2001). Load predictions were made for four time periods where both seagrass depths and pollutant loading could be estimated: 1942-43, 1995-96, 1998-99, and 2000-01. The results for 2000 were used to represent current loads." (EPA, 2007)

Much of the extensive work for the PLRGs was adopted by FDEP as best available data for their IRL TMDL. FDEP also used the PLSM model as the basis for calculating loading allocations.

6.0 INDIAN RIVER LAGOON TMDL

6.1 Background

The Indian River Lagoon system is considered to contain the most diverse estuarine ecology in North America, but it exists in a delicate imbalance. The Lagoon is threatened by stormwater runoff, disruptions in freshwater inflows, and other factors related to urbanization and land development. Like elsewhere in Florida, the watershed of the IRL is changing over time. Increases in population, land use changes, and alterations of natural drainage patterns have resulted in impacts to water quality and the ecological health of the IRL system and its watersheds.

Satellite Beach lies in the Indian River Lagoon Basin, a FDEP Group 5 basin. The Indian River Lagoon Basin assessment area extends northward from the Indian River/St. Lucie county boundary to just north of Ponce Inlet in Daytona Beach. The Indian River Lagoon assessment unit is subdivided into planning units. The City lies in the Banana River Lagoon Planning Unit as shown in Figure 2. The Planning Units are further subdivided into Waterbody Identification (WBID) numbers as shown in Figure 3. The City lies in WBID 3057A.

Impaired WBIDs addressed in this TMDL fall within these Banana River and North and Central Indian River sub-lagoons. Distinct lagoon segments were delineated based on natural or constructed breakpoints and tributary drainages within the lagoons to reflect distinct physiographic, hydrologic, biologic, and water quality characteristics. Within the Banana River Lagoon and North and Central Indian River Lagoon there are 28 distinct segments that were aggregated to 15 final lagoon segments.

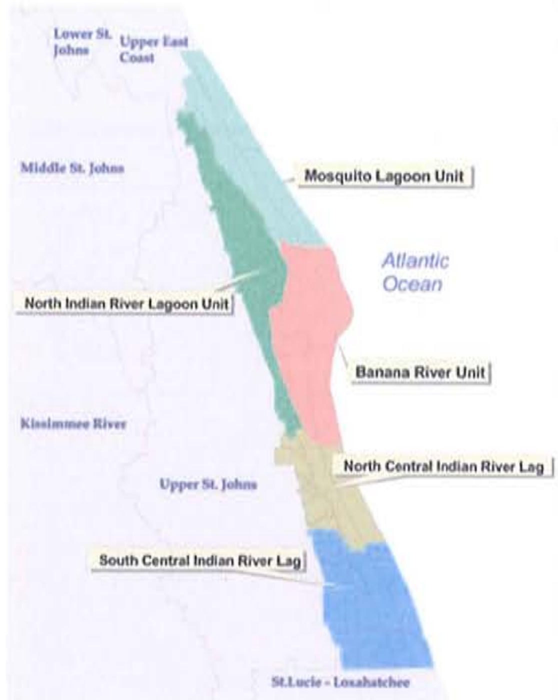


Figure 2 - Indian River Lagoon Planning Units

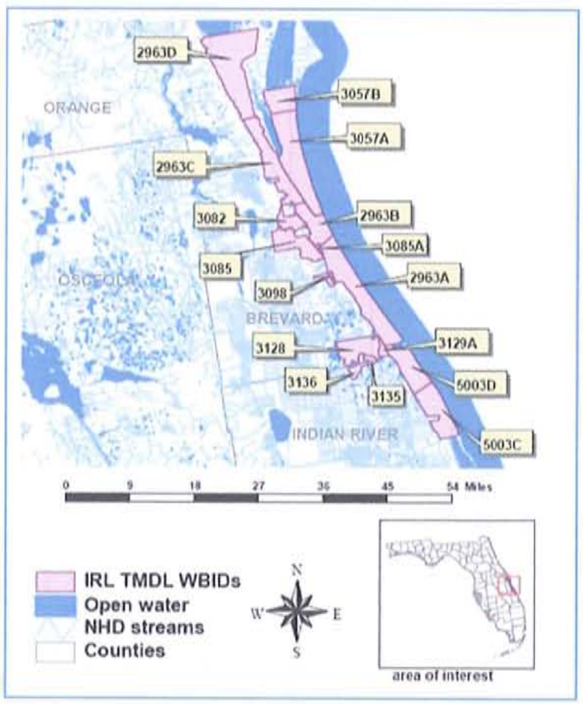


Figure 3 - IRL WBIDs and Land Areas Contributing to Each Lagoon Segment

6.2 Banana River Lagoon Impairment Status

In the 2009 Group 5 Revised Final Verified List of Impaired Waters, WBID 3057C was listed as impaired for nutrients, dissolved oxygen, and mercury. See Table 3. Mercury is being addressed by FDEP with a statewide mercury TMDL focused on atmospheric emissions from landfill and recycling operations, so it is not being address in the IRL and BRL TMDL. Dissolved Oxygen (DO) is a parameter that is related to nutrient loadings. Therefore it is assumed in the TMDL and modeling efforts and BMP design that reducing TN and TP will correct DO impairments. TN and TP are used as surrogates for DO. In this report, the pollutants modeled are TN and TP.

6.3 Expression and Allocation of the TMDL

"The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:" (EPA, 2007)

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

While WLAs were significant sources of pollution in many areas of Florida, and accordingly had TMDL allocations, in the early 1990s point sources were required for the most part to stop discharging to the IRL. There are a few small remaining WLA dischargers in the IRL, but their contribution to the overall pollutant loads is less than 5% of the overall load. FDEP also investigated pollutant loadings from atmospheric deposition. They concluded that the atmospheric loads were again not significant, difficult to measure, and difficult to regulate. Therefore, FDEP has determined that all TMDL load reductions must be borne by nonpoint sources (LAs).

"The TMDLs for Indian River Lagoon are based upon the results of a Pollutant Load Reduction Goal study (PLRG) conducted by the SJRWMD. The PLRGs for Indian River Lagoon were determined as average annual loads for each sub-lagoon. These loads were then distributed among individual segments. The TMDLs and their components are presented for each of the three sub-lagoons. The TMDLs are expressed as daily and annual loads of TN and TP and are calculated to achieve the narrative nutrient criteria. The TMDLs are intended to be implemented on an annual basis. Achieving the narrative nutrient criteria is expected to also result in achieving appropriate D.O. and chlorophyll regimes as these impairments are a direct result of symptoms associated with cultural eutrophication caused by nutrient enrichment."

FDEP will enforce the BRL TMDL through a Secretarial Order and through NPDES MS4 permits.. "The LA for MS4s are expressed in terms of percent reductions and calculated pound reductions from nonpoint sources as a whole. Given the available data, it is not possible to estimate loadings coming exclusively from the MS4 areas. Although the aggregate LAs for stormwater discharges are expressed in numeric form, i.e. percent reduction, based on the information available today, it is infeasible to calculate numeric LAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by these TMDLs often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow. These TMDLs assume for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges." (EPA, 2007)

Table 3 - Indian River Verified List of Impaired Water Bodies

OGC Case Number	Planning Unit	WBID	Water Segment Name	Waterbody Type	Waterbody Class[1]	1998 303(d) Parameters of Concern	Parameters Assessed Using the Impaired Waters Rule (IWR)	Concentration Causing Impairment[2]	Priority for TMDL Development[3]	Comments (# of Exceedances/ # of Samples) PP=Planning Period VP=Verified Period[4]
09-1196	Banana River Unit	3044A	NEWFOUND HARBOR	ESTUARY	3M	Dissolved Oxygen	Dissolved Oxygen	< 5.0 mg/L	High	PP = 208 / 2013 Not Impaired; VP = 154 / 1217 Impaired. DO met verification threshold and TN was identified as the causative pollutant. 144 TN measurements, median 1.45 mg/L. 214 TP measurements, median 0.04 mg/L. No BOD data.
09-1197	Banana River Unit	3044A	NEWFOUND HARBOR	ESTUARY	3M	Nutrients	Nutrients (Other Information)	TN = 1.46 mg/L TP =0.04 mg/L	High	Listed as impaired for nutrients based on "other information" indicating an imbalance in flora or fauna, pursuant to Rule 62-303.450(2), F.A.C. Based on information provided by the SJRWMD, the distribution of seagrass in the WBID has decreased due to elevated nutrients.
09-1198	Banana River Unit	3044A	NEWFOUND HARBOR	ESTUARY	3M		Mercury (in Fish Tissue)	Exceeds DOH threshold (>0.43 mg/kg)	High	Data verified to be within the last 7.5 years. Confirmed recent data for coastal fish advisory for King Mackerel and Bull Shark. 87 King Mackerel samples. Hg mean concentration was 0.67 mg/Kg: 28 Bull Shark samples. Hg mean concentration was 1.85 mg/Kg..
09-1199	Banana River Unit	3044B	SYKES CREEK/BARGE CANAL	ESTUARY	3M		Mercury (in Fish Tissue)	Exceeds DOH threshold (>0.43 mg/kg)	High	Data verified to be within the last 7.5 years. Confirmed recent data for coastal fish advisory for King Mackerel and Bull Shark. 87 King Mackerel samples. Hg mean concentration was 0.67 mg/Kg: 28 Bull Shark samples. Hg mean concentration was 1.85 mg/Kg..
09-1200	Banana River Unit	3057A	BANANA RIVER BELOW 520 CSWY	ESTUARY	3M	Dissolved Oxygen	Dissolved Oxygen	< 5.0 mg/L	High	PP = 579 / 6181 Impaired; VP = 497 / 4070 Impaired. DO met IWR verification threshold and TN was identified as the causative pollutant. 374 TN measurements, median 1.34 mg/L. 382 TP measurements, median 0.05 mg/L. No BOD data. EPA finalized nutrient and DO TMDLs in March of 2007 based on SJRWMD's PLRG.
09-1201	Banana River Unit	3057A	BANANA RIVER BELOW 520 CSWY	ESTUARY	3M	Nutrients	Nutrients (Other Information)	TN = 1.34 mg/L TP =0.06 mg/L	High	Listed as impaired for nutrients based on "other information" indicating an imbalance in flora or fauna, pursuant to Rule 62-303.450(2), F.A.C. Based on information provided by the SJRWMD, the distribution of seagrass in the WBID has decreased due to elevated nutrients. EPA finalized nutrient and DO TMDLs in March of 2007 based on SJRWMD's PLRG.
09-1202	Banana River Unit	3057A	BANANA RIVER BELOW 520 CSWY	ESTUARY	3M		Mercury (in Fish Tissue)	Exceeds DOH threshold (>0.43 mg/kg)	High	Data verified to be within the last 7.5 years. Confirmed recent data for coastal fish advisory for King Mackerel and Bull Shark. 87 King Mackerel samples. Hg mean concentration was 0.67 mg/Kg: 28 Bull Shark samples. Hg mean concentration was 1.85 mg/Kg..
09-1203	Banana River Unit	3057B	BANANA RIVER ABOVE 520 CSWY	ESTUARY	3M	Dissolved Oxygen	Dissolved Oxygen	< 5.0 mg/L	High	PP = 235 / 2242, Not impaired; VP = 182 / 1305, Impaired. DO met the IWR verification threshold, and TN was identified as the causative pollutant. 160 TN measurements, median 1.54 mg/L. 676 TP measurements, median 0.04 mg/L. No BOD measurements. EPA finalized nutrient and DO TMDLs in March of 2007 based on SJRWMD's PLRG.

FDEP 2009

6.4 TMDL FOR IRL AND BRL

The Indian River Lagoon Basin is in Phase 4 of FDEP TMDL development cycle, with development of BMAPs currently being undertaken. Final details of the BMAP will change beyond the time frame of this study, but the general process described will be followed. On March 18, 2009 the State adopted the "TMDL Report – Nutrient and Dissolved Oxygen TMDLs for the Indian River Lagoon and Banana River Lagoon." The TMDL assigned a basin wide percent reduction of TN and TP to achieve the seagrass depth targets. Required nutrient reductions for each WBID in the IRL are shown in Table 4. The City lies in WBID 3057A.

The TMDL did not specify detailed allocations to individual nonpoint sources (outfalls) or stakeholders, only nonpoint sources as a whole. Through the BMAP process, detailed allocations will be made to the appropriate stakeholders. **Overall load reductions for WBIDs 3057A are 59% for TN and 64% for TP.**

One of the final steps in the BMAP process is to develop an implementation plan with local stakeholders. The BMAP will include the following:

- Appropriate allocations among the affected parties,
- A description of the load reduction activities to be undertaken,
- Estimated load reductions associated with each activity to be undertaken,
- Timetables for project implementation and completion,
- Funding mechanisms that may be utilized,
- Any applicable signed agreement,
- Local ordinances defining actions to be taken or prohibited,
- Local water quality standards, permits, or load limitation agreements, and
- Monitoring and follow-up measures.

The implementation plan is expected to be completed by December 2011. After that time communities will start a five year cycle of implementation of retrofit project projects, monitoring the Banana River to determine effectiveness of BMPs at improving sea grass coverage, adjusting TMDL allocations, and developing another five year plan of retrofit projects. Five year cycles will continue until the BRL is no longer listed as an impaired water.

Table 4 - Required Percent Reductions of TN and TP Loads, by WBID, to Achieve Restoration Targets
(Excluding Atmospheric Deposition)

	TN			TP		
WBID	**Existing Nonpoint Load (lbs/yr)**	**LA (lbs/yr)**	**% Reduction**	**Existing Nonpoint Load (lbs/yr)**	**LA (lbs/yr)**	**% Reductio n**
2963F	134,968	88,322	35%	13,901	7,307	47%
2963E	146,598	95,932	35%	24,812	13,042	47%
2963D	115,901	73,882	36%	18,618	8,752	53%
2963B+2963C	178,946	114,459	36%	36,176	18,886	48%
5003D+2963A	1299,715	577,183	56%	210,596	109,055	48%
5003B+5003C	496,348	217,877	56%	98,411	50,857	48%
3057C	127,782	41,614	67%	20,660	5,874	72%
3057A+3057B	115,122	47,539	59%	24,597	8,916	64%
3044A	46,213	15,489	66%	9,724	2,907	70%

7.0 POLLUTANT LOADING ASSESSMENT

7.1 Assessment Methodology

FDEP has adopted a TMDL for TN and TP in the main stem of the IRL and BRL. Due to the large extent of the basin, FDEP has determined the best approach to develop the TMDL implementation plan is to split the basin into three subbasins: (1) BRL; (2) North IRL; and (3) Central IRL. A separate BMAP will be developed for each subbasin. The City is in the BRL subbasin.

The steps to calculate each entity's allocation for the BMAP are through a Geographic Information System (GIS) based process, which uses the input data to the TMDL model to account for the loads from each jurisdiction. The PLSM shapefile for the BRL with year 2000 data will be used as the base map. This shapefile contains the land use/land cover codes associated with the year 2000 **(not current)** land use, runoff coefficients (ROs), event mean concentration (EMCs), and the 30-year average rainfall. From the BRL shapefile, a custom coverage was created for each stakeholder by clipping the base file with the entity's jurisdictional boundary. The TMDL jurisdictional boundary for the City excluded all FDOT roads and right-of-ways (based on information provided by FDOT), agricultural areas (based on 2000 land use land cover), and any other areas occupied by other cities or unincorporated. See Figure 4.

In the next five-year cycle, the year 2000 GIS coverages can be updated to more current coverages (potentially 2008 or 2012 land use land cover data). When the PLSM model is rerun with more updated coverages, reductions to calculated loadings can be applied toward BMAP allocations as BMP credits.

7.1 Calculations

The shapefiles and associated model data will be used to calculate the BRL basin's 2000 loading and each entity's 2000 loading. Then, using the overall load generating acres in the basin, a target load per acre will be calculated using the target load for the BRL basin from the TMDL. The allowable load for each entity will be calculated by multiplying its total load

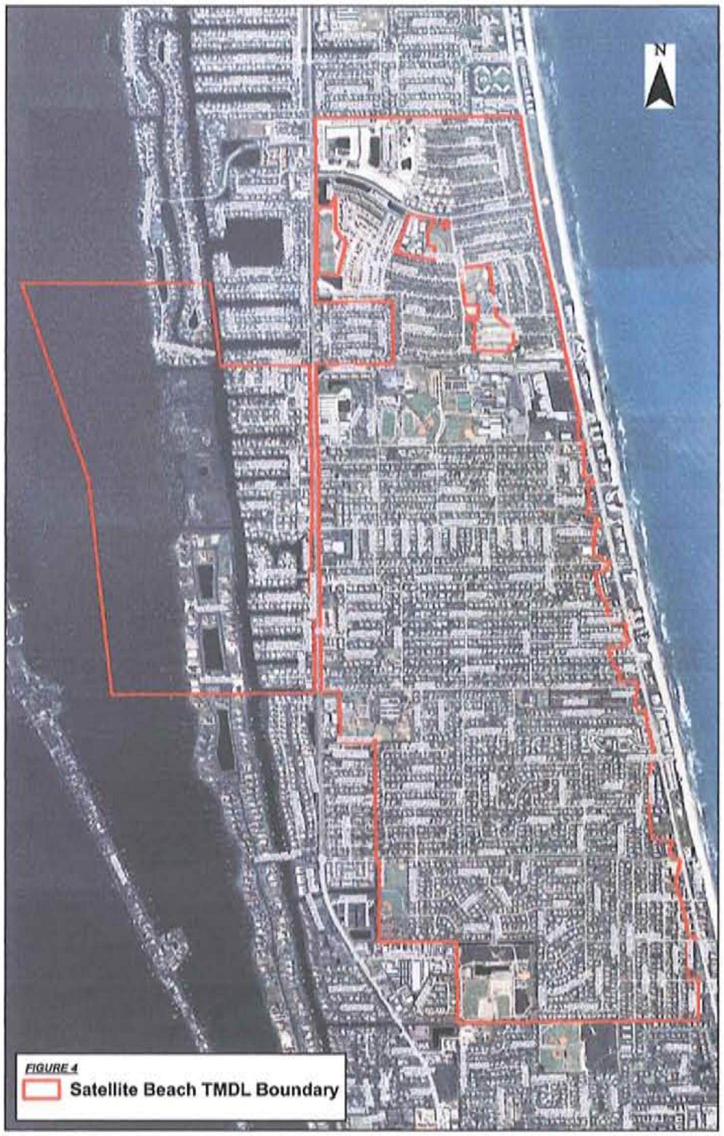


Figure 4 - TMDL Jurisdictional Boundary

generating acres by the target load per acre. The required reduction for each entity is then the entity's 2000 loading minus its allowable load. The reduction will be expressed in lb/year. Rather than each entity undertaking the effort and expense to develop the load allocation model for their jurisdiction, FDEP will expand their PLSM model to calculate the load reductions for each entity. FDEP will provide all modeling necessary to calculate initial load allocations and credits given for individual retrofit measures. FDEP has developed a list of removal efficiencies that will be used for structural and non-structural BMPs. The entities will use this list (Table 5) for developing their list of long term retrofit measures. Individual projects and associated data will be used by FDEP for developing three five-year increment PLSM models for each entity.

Table 5 - BMP Efficiencies for Banana River Lagoon BMAP

BMP	TP % Reduction	TN % Reduction
Retention BMPs (basin, exfiltration, etc.)	Appendix F-Statewide Stormwater Rule (SSR), based on DCIA, non-DCIA CN, and Rainfall Zone	Appendix F-SSR, based on DCIA, non-DCIA CN, and Rainfall Zone
Wet Detention Ponds	Annual Residence Time, Figure 13.2 SSR	Annual Residence Time, Figure 13.3 SSR
Dry Detention	10	10
Treatment Trains	Use BMP Treatment Train (TT) equation: BMP TT Efficiency = $Eff_1 +((1-EFF_1)*Eff_2)$	Use BMP Treatment Train (TT) equation: BMP TT Efficiency = $Eff_1 +((1-EFF_1)*Eff_2)$
Baffle Box	2.3	0.5
Nutrient Baffle Box	15.5	19.05
Catch Basin Inserts, inlet filters	Evaluated on case by case basis	Evaluated on case by case basis
Grass Swales with swale blocks or raised culverts	Use retention BMPs above	Use retention BMPs above
Grass swales without swale blocks or raised culverts	50% of value for grass swales with swale blocks or raised culverts	50% of value for grass swales with swale blocks or raised culverts
Alum Injection	90	50
Provisional BMPs	**TP % Reduction**	**TN % Reduction**
Street Sweeping	Pounds material removed x concentration from FSA study	Pounds material removed x concentration from FSA study
Stormceptor	13	2
CDS Unit	10	NA
Public Education	1-6, depending on program	1-6, depending on program

7.2 Implementation Schedule

FDEP recognizes that load reductions will be achieved through long-term, expensive stormwater retrofit projects. Recognizing the fiscal limitations of local entities in today's economy, FDEP will establish a phased implementation schedule over the next 15 years. Entities will be given three five-year intervals in which to schedule projects to achieve load reductions. At the end of each five years, the entities will be required to have implemented measures that will achieve one third of the overall pollutant reduction. While FDEP will not require any specific funding levels to achieve these goals; each entity will be expected to plan for and expend whatever funding is necessary to meet the load reductions. The entities will have the ability to choose whatever projects are appropriate in their jurisdiction to achieve required reductions.

7.3 Monitoring

Every five-years of the BMAP cycle FDEP is required to re-evaluate the environmental health of the BRL in terms of seagrass and nutrient indicators to determine what progress is being achieved by entities through their load reduction programs. During the re-evaluation process the entities will also have the opportunity to update the land uses, runoff coefficients, soils, and other coverages used by FDEP for the PLSM model. Based upon the findings of the environmental evaluations and spatial variable updates, FDEP may adjust the load allocations as needed to achieve desired long-term improvements.

As part of the monitoring program for the BRL, the City may wish to implement additional monitoring of the runoff and pollutant loading conditions in the City. *Beginning in 2012 the City will probably required to perform a certain level of outfall monitoring as part of NPDES MS4 permit changes.* Such data could be used to enhance the PLSM model and provide additional accuracy to FDEP's pollutant load allocations.

8.0 EXISTING CONDITIONS EVALUATION

8.1 Background

Satellite Beach is located in Sections 2,3, and 10-14 Township 26 South, Range 37 East on the barrier island of Brevard County, Florida at longitude -80.607878, latitude 28.24412. The general site location map is shown on Figure 5 - Location Map. Although the BRL is called a river, it is a complex saline estuary with a minor tidal influence from the south.

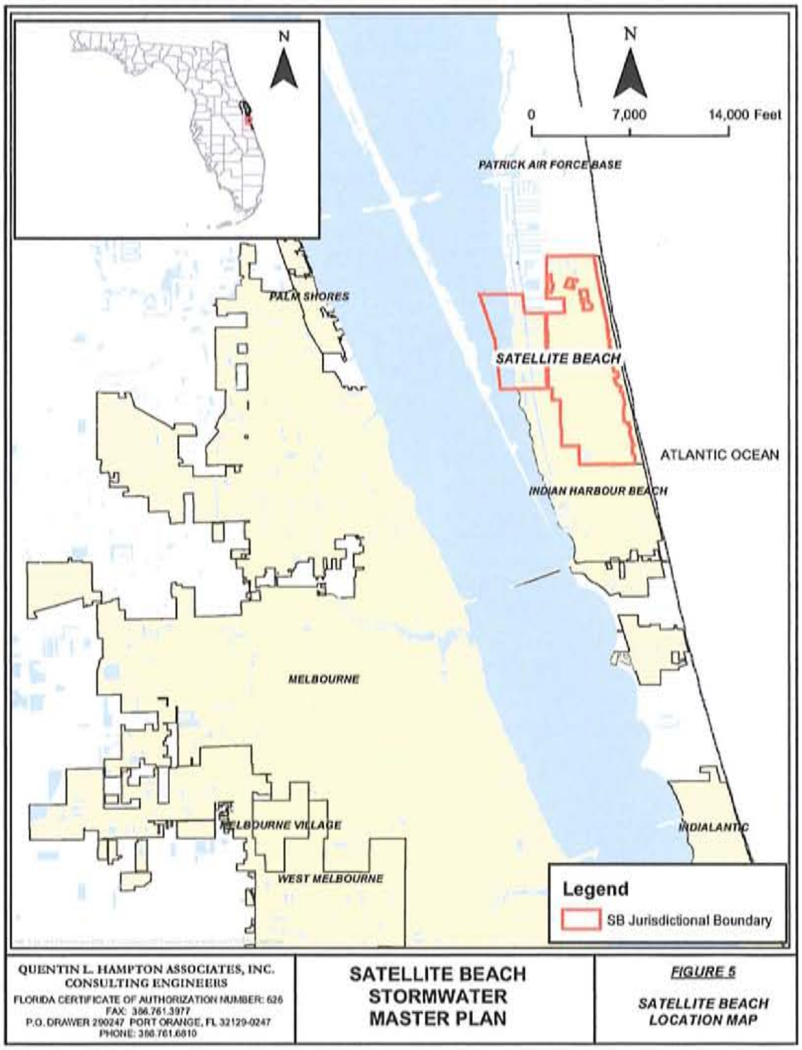


Figure 5 - Location Map

The City is bounded by the Banana River on the West, Brevard County on the north, the Atlantic Ocean on the east, and Indian Harbour Beach on the south. S.R. Highway A1A runs along a natural beach ridge approximately 15 feet above sea level, with water east of the road draining to the Atlantic Ocean and water west of the road draining to the Banana River. The land elevation gently slopes from S.R. A1A westward to the BRL. FDOT owns the land encompassing S.R. A1A and S.R. 513 and is responsible for TMDL allocations for this area. The current BMAPing process only addresses land that drains to the BRL. Land owned by FDOT and properties draining to the Atlantic Ocean are excluded from this report unless otherwise noted. Although the City annexed the South Base Housing area, there are four small outparcels remaining in this area (now Pelican Coast subdivision) that remain in Air Force possession. TMDL load allocations for these four areas are Air Force responsibility.

The soils in the City are predominantly Type C moderately well drained sands. There are also areas of well drained Type A beach sands along the eastern side of the City. Figure 6 shows soil classifications that were used in this report. These classifications were obtained from SJRWMD GIS coverages. Ground water elevations are at about elevation 6.0 near S.R. A1A, sloping to elevation 0.0 at the Banana River.

8.2 Land Use Description

The land use in the City is predominantly single family, with commercial and high density residential uses along S.R. A1A and S.R. 513. There are 3 schools along the north border and two parks near the south side of the City. See Figure 7 for land use maps used in this report.

8.3 Existing Stormwater System

The City's stormwater conveyance system has been constructed over the years principally for purposes of flood attenuation. Most of the infrastructure was installed prior to current design standards and does not meet today's level of service in many areas. Many pipes are small and run through yards where maintenance is difficult. Low elevations on the west side of town force most pipe outfalls below sea level, limiting the effective hydraulic gradient and conveyance capacity. There are few detention ponds to store and attenuate flood volumes. S.R. 513 acts as a dam, limiting flows to the western canals. The existing pipes and utilities along S.R. 513 make it difficult to install larger relief storm drains. For most outfalls the best hope for an improved flood level of service is through upstream flood attenuation with retention or detention BMPs.

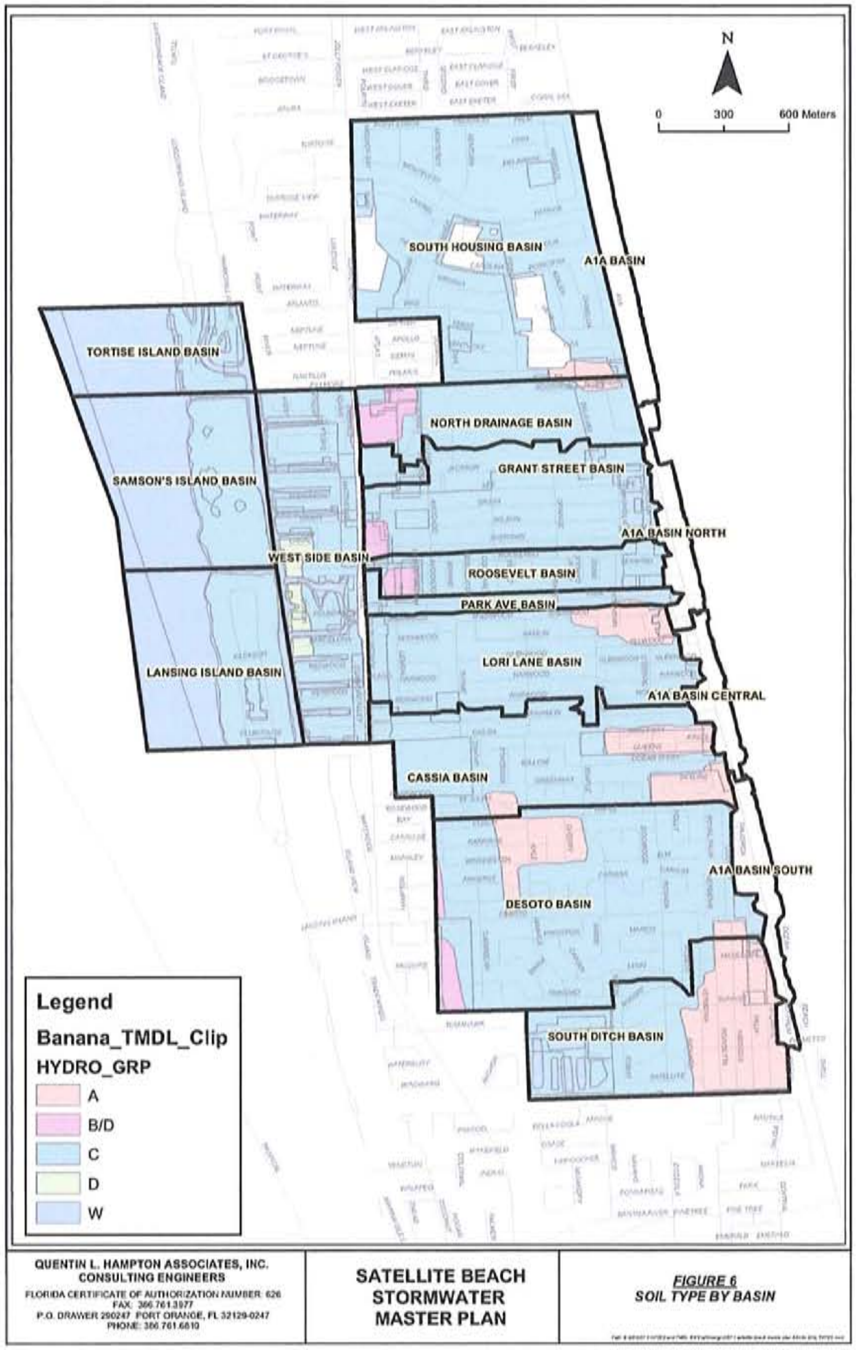


Figure 6 - Satellite Beach Soils Types by PLSM Model

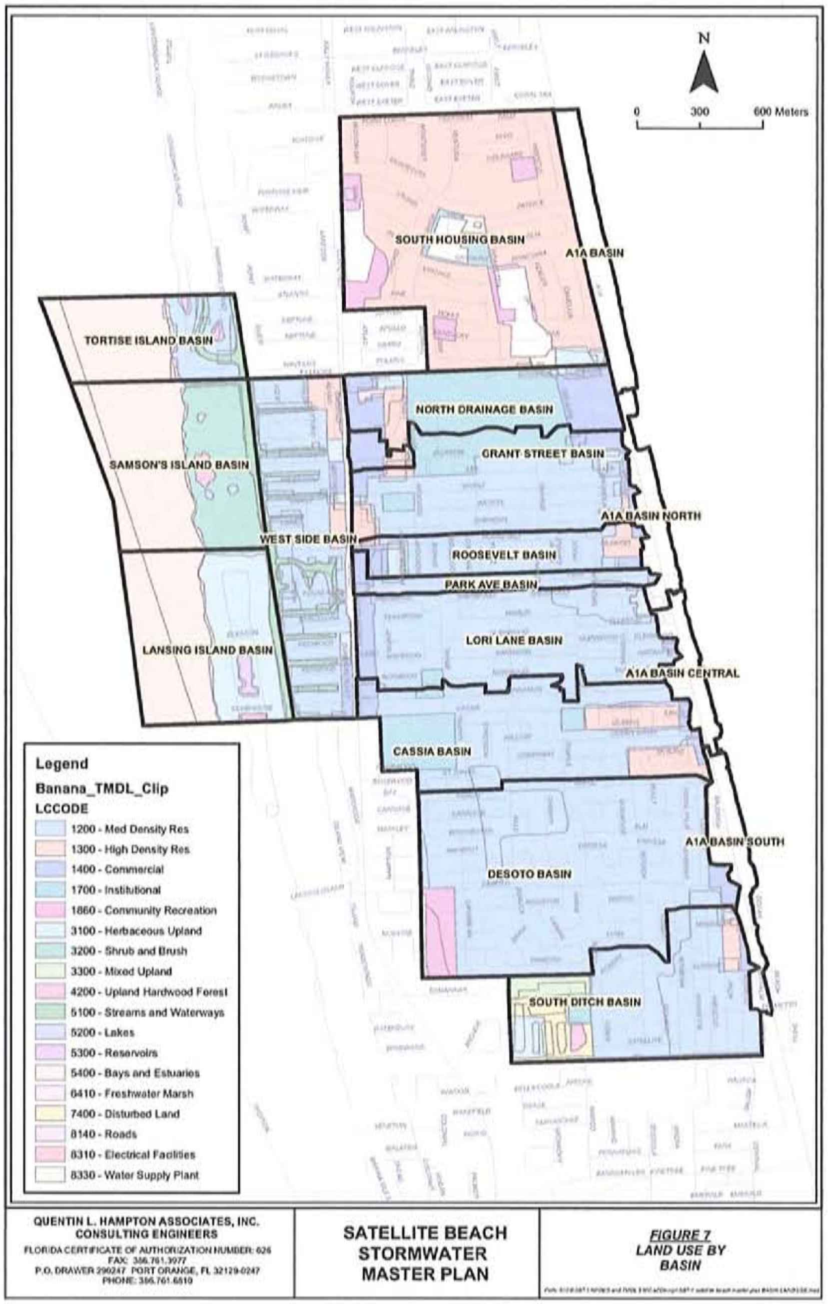


Figure 7 - PLSM Model Land Uses for Satellite Beach

Appendix 2 shows Node Diagrams with the hydraulic connectivity of the existing stormdrain system's pipe and ditches.

For the last 15 years the City has undertaken a number of stormwater retrofit projects to progressively address water quality concerns, most noticeably in the De Soto and Jackson Basins where extensive exfiltration, baffle box, and pond BMPs have been installed. The City is currently undergoing construction of another treatment train of BMPs in the Cassia Basin and will soon start another major project of exfiltration piping in the North drainage basin.

8.4 Calculation of Existing Pollution Loading

8.4.1 PLSM Model:

"PLSM is a GIS-based stormwater runoff model that was originally developed as a tool to assist watershed planning in the SJRWMD. Although PLSM is considered a screening level model useful for identifying potential stormwater runoff problems resulting from current and future land use patterns, the SJRWMD assessed its reliability in estimating annual nutrient loads to determine PLRGs for Indian River Lagoon (Steward and Green, 2006). Because it has only modest input requirements, PLSM has the advantage of being relatively easy to set up and run for different watersheds. PLSM is suitable for large watersheds with numerous pollutant sources, varied soils, and diverse land uses that have changed over time, such as the Indian River Lagoon watershed. Pollutant loads are expressed as the average annual load per acre and can be aggregated together or broken out to the level of individual drainage basins and/or lagoon segments, as necessary. PLSM generates pollutant loads from multiple spatially distributed inputs such as land use, soil types, hydrologic boundaries, rainfall, runoff coefficients, EMCs, and BMPs. By altering these variables, estimates of historic, current, and future loads of TN, TP, and TSS can be calculated. PLSM was calibrated to four different catchments of the Indian River Lagoon and the results for runoff volume, TN, TP, and TSS compared against the predictions of other watershed models. The SJRWMD study concluded that PLSM loads were comparable to more complex models that had been developed and calibrated for their respective watersheds." (Green and Stewart, 2003)

8.4.2 PLSM Set Up

"The input requirements for PLSM include spatial data for the watershed, such as land uses, soil types, drainage boundaries and annual rainfall, as well as data to characterize the quantity and quality of runoff. Runoff coefficients are used to predict the volumetric ratio of runoff generated from a given amount of rainfall. Event Mean Concentrations (EMCs) are used to represent the average concentration of a pollutant in runoff derived from a particular land use in the watershed. The land use data used in the Indian River Lagoon PLSM model were taken from Florida Land Use Cover Classification System (FLUCCS) land use coverages derived from photo-interpretation of aerial photographs (1943, 1989, 1994, and 1999). The data were reviewed and refined by ground-truthing and anecdotal reports from land appraisers and managers (Green and Steward, 2003). In some cases the land uses were re-classified by FDEP to improve the accuracy of the dataset. Soils data came from the Soil Survey Geographic Database (SSURGO) developed by the Natural Resource Conservation Service. SSURGO provides spatial distributions for different soil types, and some of the characteristics for each soil, such as its hydrologic properties. Drainage boundaries were determined from USGS 7.5 minute quadrangle maps at 5-foot contours intervals, aerial photogrammetric mapping, and on-file drainage maps or plans obtained from local governments and water control districts. Prior to March 2000, annual rainfall volumes were taken from established National Weather Service Stations and were supplemented with data from the WMD's hydrological/meteorological network. Following March 2000, rainfall data were derived from Doppler Radar. Runoff coefficients and EMCs were compiled from literature values for studies conducted within Florida. Where possible, values were taken from studies conducted within the region, and were supplemented with field data collected within the Indian River Lagoon basin." (Green and Stewart, 2003)

While the planning unit and associated drainage basins were developed on a large scale basis, for purposes of the PLSM model the basins were subdivided into large numbers of small grids (subsets of sub basins) having common characteristics of land use and soil type. Pollutant loads were calculated for each grid using the methodology discussed below.

8.4.3 Annual Rainfall

Most hydrodynamic stormwater models are based upon single rainfall events such as a 10 or 25 year storm, which work well for predicting peak rainfall for sizing of conveyance structures or ponds. However, the perspective for a pollutant model is different. Pollutant loads vary widely with rainfall intensity and duration, making a single event model inappropriate for pollutant load calculations. To normalize the variability of rainfall events, average annual rainfall is used in the PLSM model and pollutants are calculated on a mass annual basis.

Based upon a rain gauge station at Patrick Air Force Base, the PLSM model used an average annual rainfall of 46.66 inches in the Satellite Beach area.

8.4.4 Runoff Coefficients

Runoff coefficients are a major variable the PLSM model. While a runoff coefficient is typically called a "C" factor in other sources, it abbreviated as RO in the PLSM model. An RO is a variable that is used to calculate the percentage of rainfall that is not percolated into the ground. RO values used in the PLSM model are a function of land use and soil type. For example, an RO values of 0.60 indicates that 40% of the rainfall for a given area percolates and the other 60% results in runoff.

Runoff coefficients have historically been developed for use in single event rain event models such as the rational formula or the Soil and Water Conservation District's TR-55 for Small and Urban Watersheds. The coefficients were based upon the amount of soil percolation during single large event storms. However, the relationship between storm intensity and the volume of rainfall percolated into the soil is not linear. Ninety percent of storms in Florida are one inch or less of rainfall. With highly permeable soils the percentage of rainfall volume percolated into the ground is higher for small storms than for large storms, meaning the runoff coefficients typically used in engineering manuals and PLSM for open land could be unrealistically high in areas of Type A or B soils. Lower RO values would result in lower runoff volumes and lower pollutant loading estimates. Accurate estimates of RO values are crucial to accurate calculation of pollutant loadings. Runoff coefficients in the PLSM model for the City are shown in Table 6.

8.4.5 Runoff Volume Calculation

Annual rainfall runoff volume for each grid area in the PLSM model was calculated with the formula:

$$Volume_G = \sum[RD \times RO_G \times DA_G]$$

Where:

$Volume_G$ = Volume of rainfall runoff for each grid (ac-ft)

RD = Annual rainfall depth (inches)

RO_G = Grid Runoff Coefficient

DA_G = Grid drainage area (ac)

Table 6 - Runoff Coefficients and Land Uses in the PLSM Model

RUNOFF COEFFICIENTS								
		Soil Type						
FLUCCS	Definition	A	B/D	C	C/D	D	U	W
1100	Residential, low density	0.174	0.342	0.286		0.342		0.258
1190	Residential, low density, under construction	0.160	0.223	0.202			0.223	0.258
1200	Residential, medium density	0.220	0.304	0.389		0.473	0.347	0.347
1300	Residential, high density	0.631	0.662	0.692	0.692	0.733	0.677	0.677
1390	Residential, high density, under construction		0.223	0.202		0.223		0.677
1400	Commercial and services	0.886	0.887	0.888		0.900	0.890	0.890
1460	Tourist services	0.886					0.890	
1510	Food processing		0.793					0.809
1550	Other light industry	0.544	0.577	0.609			0.593	0.593
1600	Extractive	0.220	0.304					0.347
1700	Institutional	0.696	0.741	0.786	0.786	0.856	0.770	0.770
1730	Military	0.680	0.724	0.768			0.752	0.752
1750	Governmental	0.680	0.724	0.768	0.768	0.836	0.752	0.752
1800	Recreational	0.127	0.183	0.182		0.210	0.169	0.169
1820	Golf Course	0.182	0.222	0.258		0.298	0.240	0.240
1840	Marinas and fish camps		0.319	0.407		0.494	0.363	0.363
1860	Community recreational facilities	0.127	0.183	0.182			0.169	0.169
1890	Other recreational	0.499	0.543			0.637		
2110	Improved pasture	0.251	0.405					
2150	Field crops		0.411					
2200	Tree crops	0.251				0.302		
2210	Citrus	0.251	0.268	0.285	0.285	0.302		0.277
2240		0.251	0.268	0.285				
2500	Specialty farms			0.454			0.429	
3100	Herbaceous (Dry Prairie)	0.100	0.411	0.300	0.411	0.411	0.252	0.252
3200	Upland Shrub and Brushland	0.060	0.400	0.287	0.400	0.400	0.231	0.231
3300	Mixed rangeland	0.060	0.400	0.287	0.400	0.400	0.231	0.231
4100	Upland Coniferous Forest		0.413		0.413	0.413		
4110	Pine flatwood	0.102	0.413	0.309	0.413	0.413	0.258	0.258
4130	Sand pine	0.102		0.309		0.413		
4200	Upland Hardwood Forest	0.102	0.413	0.309		0.413	0.258	0.258
4210	Xeric oak	0.102	0.413	0.309		0.413	0.258	0.258
4340	Hardwood - Conifer Mixed	0.102	0.413	0.309	0.413	0.413	0.258	0.258
4370	Australian Pine	0.102	0.413	0.309		0.413	0.258	0.258
4430	Forest Regeneration Areas		0.413	0.309	0.413	0.413		
5100	Streams and Waterways	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5200	Lakes	0.500		0.500		0.500		0.500
5300	Reservoirs	0.500	0.500	0.500	0.500	0.500	0.500	0.500
5340	Reservoirs, <10 acres	0.500	0.500	0.500	0.500	0.500	0.500	0.500
5400	Bays and estuaries	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5430	Enclosed salt water ponds within salt marsh	1.000	1.000	1.000		1.000		1.000
6120	Mangrove Swamp	0.191	0.303	0.266	0.303	0.303	0.247	0.247
6170	Mixed wetland hardwood	0.191	0.303	0.266	0.303	0.303	0.247	0.247
6181		0.124	0.303	0.266	0.303	0.303	0.152	0.152
6182			0.303		0.303	0.303		0.152
6210	Cypress		0.303		0.303	0.303		
6300	Wetland Forested Mixed	0.191	0.303	0.266	0.303	0.303	0.247	0.247
6410	Freshwater Marshes / Graminoid Prairie - Ma	0.191	0.303	0.266	0.303	0.303	0.247	0.247
6420	Saltwater Marshes / Halophytic Herbaceous I	0.191	0.303	0.266	0.303	0.303	0.247	0.247
6430	Wet prairie	0.191	0.303	0.266	0.303	0.303	0.247	
6440	Emergent aquatic vegetation		0.303	0.266		0.303		0.247
6460		0.191	0.303	0.266	0.303	0.303	0.247	0.247
6500	Non-Vegetated Wetlands			0.266		0.303		0.247
7100	Beaches	0.102		0.309		0.413	0.258	0.258
7200	Sand other than beaches			0.309				0.258
7400	Disturbed land	0.160	0.223	0.202		0.223		0.191
7410	Rural land in transition (no indicators of new	0.151	0.234	0.234		0.276	0.255	0.255
7430	Spoil area	0.169	0.169	0.169		0.169	0.169	0.169
8110	Airports	0.326	0.399	0.473		0.546	0.436	0.436
8120	Railroads and railyards	0.200	0.250	0.300		0.350	0.275	0.275
8140	Roads and highways	0.630	0.703	0.777	0.777	0.850	0.740	0.740
8150	Port Facilities	0.630		0.777		0.850	0.740	0.740
8180	Auto parking facilities						0.890	0.890
8200	Communication						0.169	0.169
8310	Electrical power facilities		0.793	0.825				
8320	Electrical Power Transmission Lines	0.127	0.210	0.182		0.210	0.169	0.169
8330	Water Supply Plants - Including Pumping Stat	0.174		0.286			0.258	0.258
8340	Sewage Treatment			0.286			0.258	0.258

8.4.6 Event Mean Concentrations (EMCs)

EMCs were used as an expression of the assumed runoff pollutant concentrations for TN and TP, expressed in mg/L of rainfall runoff. EMCs were a function of land use. FDEP acknowledged that properties with stormwater treatment systems would have cleaner discharges than untreated properties. Rather than arduously tracking all types of BMPs permitted development in the IRL, FDEP assumed that any permitted system reduced pollutant loads by a fixed rate regardless of the type of treatment system used. Therefore, all properties developed after 1988 and before 2000 were given concentration reduction factors of 30% for TN and 50% for TP. Table 7 shows the EMC values used in the PLSM model.

8.4.7 Pollutant Load Calculation

Pollutant loadings were calculated for each grid value and summed for each basin based upon the equation:

$$Load_{parameter} = Volume_G \times Concentration_{Parameter}$$

Where:

$Load_{parameter}$	=	Pollutant load for each parameter (lb/yr)
$Volume_G$	=	Runoff volume for each grid (ac-ft)
$Concentration_{parameter}$	=	EMC for each parameter in each grid

8.4.8 Pollutant load allocations

On July 1, 2010 FDEP issued BMAP load allocations for Banana River Lagoon stakeholders based upon the PLSM calculations detailed above. The existing base line BRL loadings for the City were 13,952 lbs of TN/yr and 2,462 lbs of TP/yr. **Required TN reductions over a 15 year period were 75.3%, 10,501 lb/yr. TP reductions were 79.2%, 1,949 lb/yr.** Table 8 provides a summary for the pollutant load allocations for the BRL entities. FDEP requires the City to implement load reductions in three five-year cycles. In each five-year cycle the load reduction will be **3,500 lb/yr for TN and 650 lb/yr for TP.**

Table 7 - EMCs Used in the PLSM Model

EVENT MEAN CONCENTRATIONS (mg/L)			
LCCODE	Definition	TN	TP
1100	Residential, Low Density <Less than two dwelling units per acre>	1.850	0.220
1190	-Low Density Under Construction	1.380	0.080
1200	Residential, Medium Density <Twofive dwelling units per acre>	2.230	0.316
1300	Residential, High Density	2.100	0.516
1390	-High Density Under Construction	1.380	0.080
1400	Commercial and Services	1.930	0.497
1460	-Oil and Gas Storage <Except those areas associated with industrial use or m	1.930	0.497
1510	-Food Processing	1.790	0.310
1550	-Other Light Industrial	1.550	0.150
1600	Extractive	1.180	0.150
1700	Institutional	1.800	0.478
1730	-Military	1.800	0.478
1750	-Governmental	1.800	0.478
1800	Recreational	1.250	0.080
1840	-Marinas and Fish Camps	1.580	0.150
1860	-Community Recreational Facilities	1.580	0.100
1890	-Other Recreational	1.580	0.220
2110	-Improved Pastures	2.800	0.576
2200	Tree Crops	1.920	0.506
2210	-Citrus Groves	1.920	0.506
2240	-Abandoned Groves	1.490	0.280
3100	Herbaceous (Dry Prairie)	1.200	0.064
3200	Shrub and Brushland	1.200	0.064
3300	Mixed Rangeland	1.200	0.064
4100	Upland Coniferous Forests	0.700	0.090
4110	-Pine Flatwoods	0.700	0.090
4130	-Sand Pine	0.700	0.090
4200	Upland Hardwood Forests	0.700	0.090
4210	-Xeric Oak	0.700	0.090
4340	-Hardwood - Coniferous Mixed	0.700	0.090
4370	-Australian Pines	0.700	0.090
4430	-Forest Regeneration Areas	0.700	0.090
5100	Streams and Waterways	0.600	0.050
5200	Lakes	0.600	0.110
5300	Reservoirs	0.600	0.135
5340	-Reservoirs less than 10 acres (4 hectares) which are dominant features	0.600	0.135
5400	Bays and Estuaries	0.000	0.000
6120	-Mangrove Swamps	0.000	0.000
6150	-Streams and Lake Swamps (Bottomland)	0.000	0.000
6170	-Mixed Wetland Hardwoods	0.000	0.000
6210	-Cypress	0.000	0.000
6300	Wetland Forested Mixed	0.000	0.000
6410	-Freshwater Marshes	0.000	0.000
6420	-Saltwater Marshes	0.000	0.000
6430	-Wet Prairies	0.000	0.000
6440	-Emergent Aquatic Vegetation	0.000	0.000
6460	-Treeless Hydric Savanna	0.000	0.000
6500	NonVegetated	0.000	0.000
7100	Beaches Other Than Swimming Beaches	1.250	0.053
7200	Sand Other Than Beaches	1.250	0.053
7400	Disturbed Land	1.380	0.109
7410	-Rural land in transition without positive indicators of intended activity	1.510	0.115
7430	-Spoil Areas	1.250	0.202
8110	-Airports	1.150	0.150
8120	-Railroads	1.250	0.053
8140	-Roads and Highways	1.180	0.480
8140	-Roads and Highways	1.200	0.480

Table 8 - Banana River Lagoon BMAP Required Reductions

Required TN Reductions for the BRL BMAP

Entity	Area (acres)	TN Target (lbs/acre)	TN Target (lbs)	Base Load (lbs)	Required Reduction (lbs)	Required Reduction (%)	BMAP 1 Required Reduction (lbs)
Brevard County	10,470	2.32	24,283	75,489	51,206	67.8%	17,068.7
Cape Canaveral	856	2.32	1,985	8,945	6,960	77.8%	2,320.2
Cape Canaveral AFS	13,795	2.32	31,994	53,007	21,013	39.6%	7,004.4
Cocoa Beach	1,857	2.32	4,307	18,759	14,452	77.0%	4,817.5
FDOT 5	386	2.32	895	3,741	2,846	76.1%	948.5
Indian Harbour Beach	1,251	2.32	2,901	11,908	9,007	75.6%	3,002.4
Kennedy Space Center	18,540	2.88	53,324	70,816	17,492	24.7%	5,830.7
Patrick AFB	2,134	2.32	4,948	28,994	24,046	82.9%	8,015.3
Satellite Beach	1,488	2.32	3,451	13,952	10,501	75.3%	3,500.3
de minimus	609	-	2,954	2,954	0	0.0%	0.0
Total	**51,385**	-	**128,087**	**288,565**	**157,524**	**54.6%**	**52,508.0**

Required TP Reductions for the BRL BMAP

Entity	Area (acres)	TP Target (lbs/acre)	TP Target (lbs)	Base Load (lbs)	Required Reduction (lbs)	Required Reduction (%)	BMAP 1 Required Reduction (lbs)
Brevard County	10,470	0.344	3,606	14,741	11,135	75.5%	3,711.8
Cape Canaveral	856	0.344	295	1,957	1,663	84.9%	554.2
Cape Canaveral AFS	13,795	0.344	4,751	10,790	6,039	56.0%	2,013.0
Cocoa Beach	1,857	0.344	640	3,781	3,141	83.1%	1,047.2
FDOT 5	386	0.344	133	1,076	943	87.6%	314.4
Indian Harbour Beach	1,251	0.344	431	2,092	1,662	79.4%	553.8
Kennedy Space Center	18,540	0.344	6,385	8,576	2,191	25.5%	730.4
Patrick AFB	2,134	0.344	735	7,500	6,766	90.2%	2,255.2
Satellite Beach	1,488	0.344	512	2,462	1,949	79.2%	649.8
de minimus	609	-	566	566	0	0.0%	0.0
Total	**51,385**	-	**18,053**	**53,543**	**35,489**	**66.3%**	**11,829.7**

8.5 Existing Conditions Model

FDEP provided the existing conditions model for the whole Banana River Lagoon. QLH overlaid the TMDL jurisdictional boundary onto the BRL model and keyholed out an existing conditions model for Satellite Beach. QLH then overlaid the subbasin boundaries and performed loading calculations for each subbasin. The resulting TN and TP loadings for each of the City's historic subbasins were calculated using FDEP coverages. (Table 9).

8.5.1 Existing BMP Credits

The existing conditions baseline for the PLSM model is based upon the dataset for the year 2000. FDEP recognizes that many entities have implemented BMPs in the intervening years since 2000. Accordingly, removal allocations listed in Table 8 can be reduced to account for projects built between 2000 and 2010.

Table 9 - Year 2000 Pollutant Load Summary by Historic Subbasin

Subbasin	Area (acres)	TN Load (lb/yr)	TP Load (lb/yr)
South Housing	275.47	3869.38	937.24
Desoto	287.63	2470.41	356.79
Cassia	172.06	1876.67	363.26
Grant Street	145.30	1612.41	314.06
Lori Lane	159.45	1483.63	232.49
North	95.69	1432.87	367.88
West Side	117.48	1176.15	195.20
South Ditch	152.72	1020.41	153.06
Roosevelt	64.18	658.93	112.97
Park Avenue	29.59	297.01	48.90
Sansom Island	54.51	193.16	11.23
Jackson Street	10.32	175.18	44.16
Lansing Island	37.42	135.84	8.08
Tortoise Island	13.26	111.81	16.20
Totals	1,615.08	16,513.85	3,161.53

To date Satellite Beach has constructed a number of stormwater treatment systems as retrofit projects to address water quality and water quantity concerns. For an existing retrofit project to qualify for TMDL credits it must meet the following conditions.

1. Be constructed after the year 2000, the base year for the PLSM model. FDEP assumed that any BMPs constructed before 2000 would be accounted for in the biological assessment used at that time for TMDL development. BMPs constructed before 2000 through the normal permitting process were given an automatic 30% reduction for TN and 50% reduction for TP.
2. Be a water quality project that was **not** part of a permit requirement for new development or constructed as mitigation for another City project.
3. Be a water quality project associated with a new development permit where the BMP was designed to a higher level of treatment than required by permit conditions. Credit may be obtained for the excess treatment provided by the BMP above and beyond normal design criteria.
4. Be on FDEP's list for types of approved water quality BMPs.

Stormwater Solutions reviewed ERPs for City projects constructed along Jackson Blvd, Desoto Pkwy, Cassia Blvd, and at the Library. Based upon the above criteria, 10 projects were determined to qualify for TMDL allocation credits. The estimated pollutant load reductions for these projects were calculated and submitted to FDEP for TMDL credits as shown in Appendix 1. Locations of the existing basins receiving TMDL credits are shown on Figure 8.

The apparent basin with the highest nutrient loadings was South Housing basin, with 3,869 lbs/yr of TN and 937 lbs/yr of TP. However, analysis of the PLSM model input for the South Housing basin indicated that no credits were given for the existing stormwater ponds for this area. The ERPs for the private developments in the South Housing basin were obtained after 2000 and appropriate credits will not be received until the City updates their GIS coverages. At that point the loadings for the South Housing basin will be reduced by 30% for TN and 50% for TP for ERP credits plus an undetermined amount for revised land use changes.

The next highest loadings were from the Desoto basin, with 2,470 lbs/yr of TN and 356 lbs/yr of TP. The City has completed seven retrofit projects that could receive BMAP credits in the Desoto basin. Stormwater Solutions submitted the City's existing projects for BMAP credits in September 2010, calculating that 759 lbs/yr of TN and 165 lbs/yr of TP could be received for these projects. FDEP has not made a final determination of the credits that will be allowed for the City's retrofit projects. Similarly, the City has recently completed retrofit projects in the Cassia basin, which had the third highest nutrient loadings.

8.5.2 Existing TMDL Project Credits

Based upon the above criteria, ten previously constructed retrofit projects were determined to qualify for TMDL allocation credits. Table 10 lists projects that were submitted to FDEP for existing BMP credits as well as the credits that FDEP permitted. A total of 542.68 acres of the City as shown on Figure 8 have been retrofit with projects receiving TMDL credits. A large amount of this area was treated several times with multiple BMPs in a treatment train. Detailed pollutant load reduction calculations using methods described in Section 9 are shown in Appendix 4.

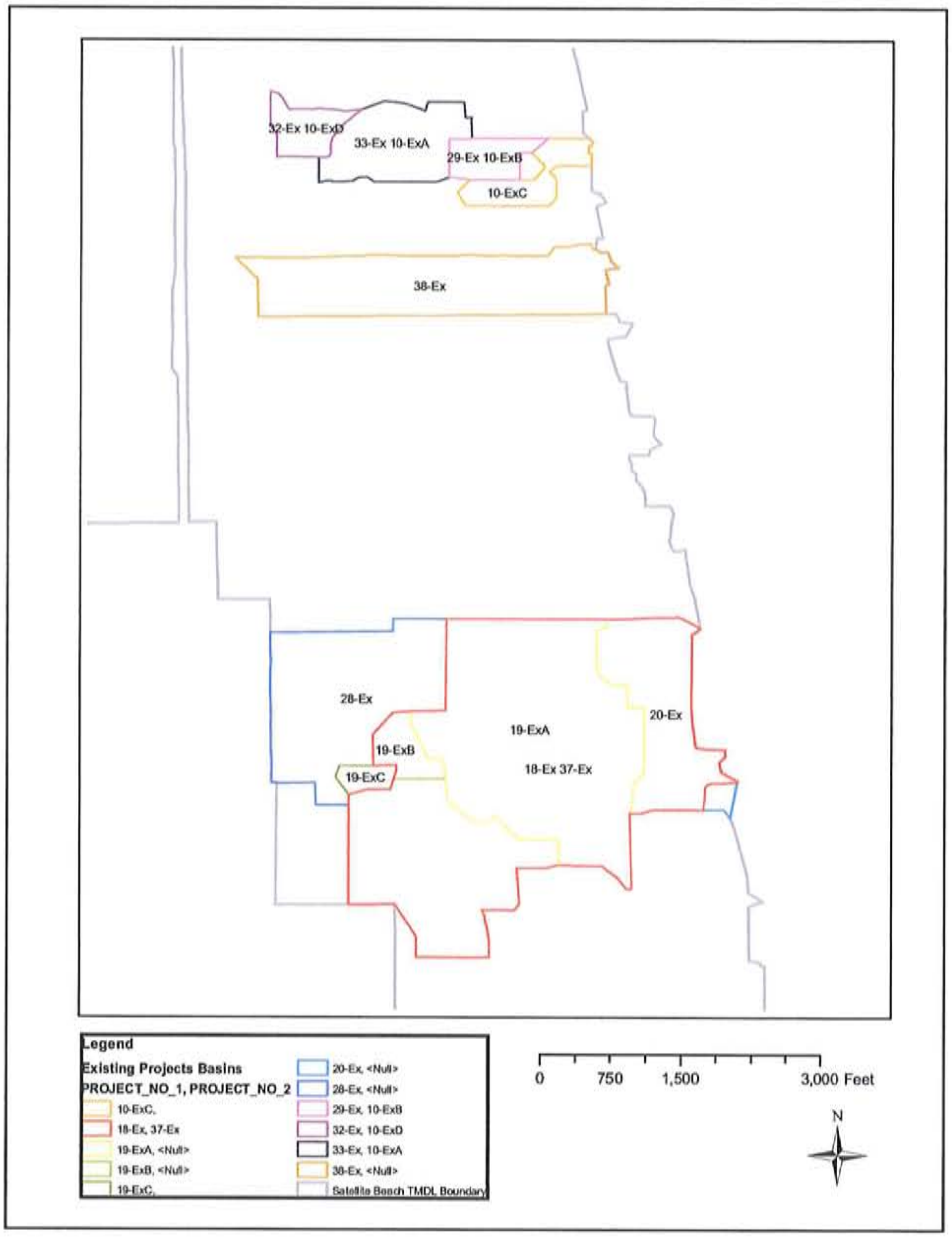


Figure 8 – Existing Basins Receiving TMDL Credits

Table 10 - TMDL Credits for Existing Retrofit Projects

Project Number	Project Name	Pounds of TN Removed	Pounds of TP Removed
33-Ex	Pineapple Baffle Box	0.00	0.00
29-EX	Orange Baffle Box	0.00	0.00
32-Ex	Avacado CDS	0.00	3.20
19-ExA	Desoto Exfiltration	10.00	1.40
19-ExB	Desoto Exfiltration	7.00	1.00
19-ExC	Desoto Exfiltration	6.00	0.90
10-ExA	Jackson Exfiltration	72.80	2.20
10-ExB	Jackson Exfiltration	6.00	0.80
10-ExC	Jackson Exfiltration	3.00	0.40
10-ExD	Jackson Exfiltration	6.00	1.70
20-Ex	Coconut Exfiltration	11.19	1.79
18-Ex	Jamaica Blvd Ponds	644.00	171.70
28-EX	Desoto Baffle Boxes	69.90	12.10
37-Ex	Jamaica Pond Reuse	268	22.6
38-Ex	Roosevelt Baffle Box	106.8	14.4
Totals		**1210.69**	**234.19**

9.0 TMDL ALLOCATION REDUCTION STRATEGY

9.1 Model Refinement

An in-depth analysis of the PLSM model as used for Satellite Beach revealed four issues that have the potential for significantly revising the model results. The first two issues were the GIS data for Land Use and Existing Treatment Area coverages. The third was the application of RO factors developed for urban areas and inappropriately applied to Sansom Island. Another issue was with the EMCs used for the land use category 5100 (Streams and Waterways).

9.1.1 GIS Coverages

As discussed in Section 8.4, GIS coverages for the year 2000 Land Use, Soils, and Existing Treatment Areas were used by FDEP for the PLSM model. An accuracy verification was made for Existing Treatment Areas by overlaying the year 2000 coverage on the aerial photograph shown in Figure 9. Although Lansing Island, Tortoise Island, and South Base Housing areas have existing permitted treatment systems, they were not part of FDEP's Existing Treatment Area coverage. **An initial rerun of the model just to provide treatment credits for those three areas showed a potential TN reduction of 1,296 lb/yr and a TP reduction of 461 lb/yr.** Complete updating of the Existing Treatment Areas coverage could reveal other areas to receive BMP credits.

Stormwater Solutions recommends that the City update all GIS coverages in the first five-year cycle and submit the revisions for TMDL credits.

9.1.2 Runoff Coefficient

Another primary variable used in the PLSM model is the runoff coefficient, called a "C" factor in many models but called an "RO" factor in PLSM. RO factors have historically been used as a measure of rainfall runoff for individual high intensity storms in urban areas to calculate pipe sizes with the rational formula. The RO factor is reasonably accurate for small, urbanized basins with significant impervious areas, but the basin and soil characteristics at Sansom Island do not meet this description. The PLSM model is based on average annual rainfall to calculate mass annual loadings.

Figure 9 - PLSM Treatment Areas

"Runoff coefficients were never intended to provide estimates of annual runoff volumes." (Harper, 2010). With 90% of the storms in Florida being one inch or less of rainfall, there is little runoff from these storms if there is significant pervious areas in the basins. Use of standard RO factors for areas like Sansom Island will significantly over estimate runoff volumes. Dr. Harper proposes the use of another variable called a "Delivery Ratio" (DR) that more accurately calculates a lower runoff volume for large watersheds with large depressional storage volumes. A "Delivery Ratio" is the fraction of generated runoff that reaches the water body. Delivery Ratios are a function of:

- Watershed Size – Large watersheds have smaller delivery ratios
- Depressional storage – large amounts of depressional storage decreases delivery ratio
- Internal waterbodies – provide internal storage which reduces delivery ratio

All three of these watershed characteristics apply to Sansom Island and could result in lower estimates of runoff volumes and pollutant loads.

Preliminary investigations into this concept by Dr. Harper indicates that DR numbers may range from 0.4 to 0.5, indicating a 40% to 50% reduction of runoff volume and associated pollutant loads. For purposes of this report a DR of 0.4 is used to calculate TMDL credits that will result from derivation of DR factors for Sansom Island. **Based upon this calculation, potential TN reductions of 77.3 lb/yr and TP reductions of 4.5 lb/yr might be achieved.**

Stormwater Solutions recommends that Satellite Beach undertake a study to develop Delivery Ratio factors for soil and topographic conditions on Sansom Island.

9.1.3 Event Mean Concentrations

Another primary variable used in the PLSM model is the EMC (pollutant concentration) for TN and TP associated with various land uses. Bays and estuaries (Land Use 5400) such as the BRL have an EMC of "0" mg/L indicating there are no pollutants associated with or caused by that land use other than atmospheric deposition. The City's TMDL jurisdictional boundary includes 198 acres of the Banana River. Assigning a "0" value to these areas is an acknowledgement by FDEP that the City should not incur costs to reduce nutrients from this land use. The City has 49.7 acres of waters in Land Use 5100 (Streams and Waterways) e.g.: the Grand Canal and residential canals. This land use has associated EMC loadings of 0.6 mg/L for TN and 0.05 mg/L for TP, **resulting in calculated loadings of 310 lb/yr of TN and 26 lb/yr of TP.** There does not appear to be a reasonable explanation for why there would be pollutant loadings for the Grand Canal or other residential canals but not the Banana River. This aspect of the PLSM model is particularly onerous in that these waters are listed as Waters of the State and the City is not allowed to implement BMPs in Waters of the State to reduce these loadings. Therefore, BMPs in other areas of the City must overcompensate for assigned loadings to the Grand Canal.

Stormwater Solutions recommends that the City request a change in EMCs used in the PLSM model for Land Use 5100 properties and receive according TMDL credits. In addition the City should pursue legislative change that would allow treatment in Waters of the State for purposes of meeting TMDL allocations.

9.2 Best Management Practices (BMP) Evaluation

In order to provide recommendations for proposed stormwater retrofit systems, several techniques and methodologies were reviewed. The use of each specific BMP was based on the site constraints, desired goals, and water quality and/or quantity control. Identified below are various structural BMPs evaluated.

- Dry Retention Ponds
- Wet Detention Ponds
- Exfiltration Trenches
- Vault Boxes
- Inlet Traps
- Vegetated Islands
- Modular Wetlands
- Stormwater Reuse

A detailed discussion and evaluation of each structural BMP follows.

<u>Dry Retention Ponds</u>

Dry retention ponds are excavated ponds that trap stormwater runoff and infiltrate the water into the ground. Since infiltration is the primary method by which runoff exits the basins, these BMPs can only be located in areas with good soil drainage characteristics and seasonal high water tables below the pond bottom. Poorly draining soils with high groundwater tables in the western part of the City limit the use of dry retention ponds to the eastern sector of the City.

<u>Exfiltration Trenches</u>

Exfiltration trenches are designed to retain stormwater below the ground surface. Traditional subsurface retention facilities are excavated trenches with perforated pipe surrounded by coarse graded aggregate. Stormwater runoff is collected and routed into the pipe. Water is exfiltrated from the pipe, infiltrates the trench walls, and percolates into the ground. The use of the pipe is viewed as a means to increase the storage available in the storm system to allow percolation. Most designs include a weir control structure to capture the first flush only and divert the remaining runoff away from the trench system to the outfall. There are also a number of specialty exfiltration structures and pipes available that may be more efficient for trapping specific volumes of water than traditional perforated pipes.

The purpose of exfiltration systems is to prevent the "first flush" of stormwater runoff from reaching surface waters, thus promoting water quality improvement and reducing the runoff volume and peak discharge rate from a site. The decrease in peak discharge rates contributes to a reduction in downstream flooding and channel degradation. These systems also promote recharge of groundwater supplies.

Exfiltration trenches require little space to be dedicated for their construction and are very inconspicuous. They can be placed under a parking lot or in a grassed area. The trench works best when the groundwater table is at least two feet below the trench bottom. The soil must also be permeable enough to allow for exfiltration of the trench in a reasonable amount of time. Like dry retention ponds, the utilization of exfiltration trenches are limited to the eastern side of the City where ground water depths are low and soils are permeable. Dry retention ponds and exfiltration trenches will improve flooding along streets by taking the storage volume offline of the conveyance system.

<u>Wet Detention Ponds</u>

Wet detention ponds are the most common and most researched BMPs in Florida. These are ponds designed to maintain a permanent pool of water up to the seasonal high groundwater level. The control structure has a small weir or orifice set at the normal water level. The orifice is designed to slowly release the detention volume over a 24 – 72 hour period following a storm event. A larger rectangular or V-notch weir is set at a higher level which corresponds to the detention volume required, generally 1 inch of runoff over the drainage basin. The weir length is designed to allow post development flow rates out of the pond to be equal to or less than the predevelopment flow rates of the drainage basin for the design events in accordance with local regulations. This design flow rate determines the depth of water storage above the weir elevation and the amount of water that must be released during large storms to prevent upstream flooding.

Wet detention basins require a large amount of dedicated land for their construction. The normal water surface elevation is controlled by the seasonal high ground water elevation. A minimum depth of 5 feet below normal water surface will prevent cattail growth. Wet detention ponds can provide high levels of treatment for sediment and nutrients. In addition, they provide flood attenuation benefits for surrounding areas.

Removal efficiencies in this type of pond are primarily a result of residence time in the permanent pool. Annual residence time is equal to the permanent pool volume divided by the annual runoff volume. The longer the residence time, the higher the removal efficiency.

An additional benefit of installing wet detention ponds is that by providing storage volume and peak flow attenuation in the ponds, upstream drainage pipes can be upsized to increase flood control level of service for upstream properties.

Vegetated Islands

Pollutant removal performance of a wet detention pond can be enhanced through periodic harvesting of vegetation of vegetation that grows in the pond. One means of facilitating this process is to use artificial floating islands of vegetation. The island is a floating plastic material with cutouts for inserting plants in perforated cups. The vegetation on these islands is more effective at pollutant removal than littoral zones (pond area where plants naturally grow) that have water level fluctuations. Plant roots in water have more efficient pollutant uptake than plant roots in soil. Specific types of vegetation are used that have been shown to maximize nutrient uptake through continuously submerged roots. The islands are movable and can be placed in the middle of a pond for maximum pollutant exposure. The islands are pulled to shore and harvested to provide a definitive removal of pollutants bound in the vegetative mass.

Research by the Beemats company has shown that a once a year schedule of harvesting at the end of the summer corresponds with optimal nutrient uptake and new seasonal plant growth. New plants are then placed on the islands that are then pulled to selected locations via cables and anchors. Floating islands also provide excellent aesthetic benefits.

Vault Boxes

End of pipe BMPs include baffle boxes, grit chambers and oil/water separators. They are designed to prevent sediment, oil, and grease from entering storm drains and stormwater exfiltration systems. These structures normally consist of a large, rectangular, concrete box divided into chambers where sediment, grit, and oil are separated from stormwater runoff utilizing various baffles as it passes through the chamber. Some vault boxes have screens that trap grass, leaves, and floating debris and keep them in a dry state. Keeping the organic debris dry prevents the leaching of nutrients into the downstream waters, providing significant nutrient removal. Research by FDEP has shown that screened vault boxes provide effective nutrient removal only in drainage basins with significant tree canopy coverage. The small amount of tree coverage in the City reduces the ability of vault boxes to remove pollutants from leaves. Grass clipping accumulations do not appear to be a significant problem in the City, leaving sediment as the principle pollutant to be captured in vault boxes. It would be more economical for the City to collect sediment via street sweeping or with inlet traps than going to the expense of installing more vault boxes.

Inlet Traps

In even smaller ultra urban situations, inlet traps can be used to collect trash, floating debris, sediment, hydrocarbons, leaves, and grass clippings from the streets. These devices can be customized for most sizes of grated inlets or curb opening inlets. With either grated or curb inlets, a fiberglass, cloth, or metal basket is inserted in a fashion that does not obstruct flows and cause upstream hydraulic head losses. They also provide nutrient and sediment removal for stormwater runoff by holding organic debris in the dry inlet, preventing leaching of nutrients into receiving waters. Inlet devices are most effective at removing nutrients in basins with significant tree coverage and other vegetation such as grass clippings. These BMPs have low installation costs compared to other BMPs, but have higher associated maintenance costs for cleaning of the small volume baskets.

Modular Wetlands

Bioclean Environmental Services manufactures a wetland in a box unit called a Modular Wetland. (Figure 10). These ultra urban BMPs can be installed along existing streets and parking lots where small surface flows are diverted through the unit that has three unit processes of screening, filtration of gross solids, and vegetative uptake of pollutants from the water column. Specific vegetation that can survive local dry seasons is planted in these flush-with-the-ground concrete boxes. Flow rates for these BMPs are limited to 2 cfs. Modular Wetlands are not on FDEP's list of BMPs that may receive TMDL credits.

Stormwater Reuse

Over recent years, stormwater harvesting and reuse have emerged as new fields of sustainable water management. Harvesting and reusing stormwater offers both a potential alternative water supply for non-drinking uses and a means to further reduce stormwater pollution in our waterways. The general application of stormwater reuse is to withdraw water from a stormwater treatment pond and use it for irrigation in select areas. Taking water from a pond directly removes pollutants from being discharged to downstream waters. FDEP offers design criteria in the new statewide stormwater rules, as well as gives credits toward meeting TMDL allocations as a direct runoff volume reduction.

Design of a stormwater reuse system requires a careful water balance analysis to determine excess storage capacity in the pond. The limiting conditions of the system design will be the low system demand for irrigation water during the wet season. Pond volumes are used to store water during the wet season so there will be available water during the dry season. A design constraint is that storing water during the wet season may lead to flooding as pond elevations rise. If there is not enough storage capacity for dry season demand, the system should be designed to switch to alternative irrigation methods from wells, potable water, or wastewater reuse.

Another consideration to consider is exposure to humans of the pollutants in stormwater. There have been documented random occurrences of cryptosporidium parasite outbreaks in stormwater reuse ponds. To control this health threat, FDEP design criteria require the use of four feet of sand filter between the pond and the withdrawal pipes.

The expense of installing a reuse distribution system in residential areas is significant, generally limiting reuse operations to parks and open areas near a reuse pond.

Figure 10 – Modular Wetland BMP

9.3 Maintenance of Structural Controls

Inspections:

Annual or semi-annual inspections are recommended for all BMPs, with additional inspections performed following major storm events. A qualified stormwater inspector who has certification through the Florida Stormwater Association or the Florida Water Pollution Control Operators Association should perform inspections. The inspector should verify that detention facilities recover within the specified time-period and control structures are free of debris and sediment. In addition, the weir or controlling structure and side slopes of the basin should be checked to ensure that they do not show signs of erosion, settlement, slope failure, or vehicular damage. Littoral zones should be inspected to ensure that acceptable survival rate of planted species is maintained. Exfiltration, infiltration, and filter systems should be inspected yearly to insure system effectiveness. Inspections should be performed using standardized inspection sheets and records maintained on results and corrective actions.

Routine Maintenance:

Routine maintenance of pond BMPs should include debris removal, sediment removal when sand bars have formed or pond volumes have decreased by 30%, mowing of side slopes, removal of exotic or invasive species, and clearing of vegetation and debris around the control device to prevent clogging. This practice, when performed on a regular basis, will keep pond BMPs in proper working order and visually attractive so the pond can function as an amenity. Vault box type BMPs should be cleaned with a vacuum truck once or twice a year, depending on the individual basin sedimentation rate. Inlet traps require cleaning two to three times a year or more to maintain their effectiveness. Vegetated islands should be inspected monthly to ensure they remain in desired locations.

Mowing:

Mowing is a large routine maintenance expense, performed for both aesthetic and operational reasons. Periodic mowing to control nuisance vegetation must be performed on side-slopes, embankments, emergency spillways and other grassed areas of stormwater facilities. Allowing excessive woody stemmed or invasive vegetation to grow in dry ponds will reduce treatment volumes.

Debris and Litter Removal:

In order to decrease the probability of debris clogging the outfall or inlet structure, trash screens should be strategically placed near them. During mowing, debris and litter should be removed from the facility for both aesthetic and operational reasons.

Non-Routine Maintenance:

When extraordinary corrective measures are needed, non-routine maintenance may be required. Such maintenance includes replacing control structures, large scale dredging of ponds to restore design elevations, major harvesting of nuisance aquatic vegetation, and regrading of side slopes.

Erosion and Structural Repair:

Areas of erosion and slope failure should be filled, compacted, and re-seeded as soon as possible. In addition, major damage to inlet and outlet structures should be corrected in a timely manner. Access to ponds is necessary for excavating equipment, trucks, mowers, and personnel for maintenance procedures. Where access is particularly difficult or impractical, ponds should be over-designed to allow for additional sediment accumulation.

Sediment Removal and Disposal:

Sediment deposition should be continually monitored in the basin. The maintenance plan should specify a specific point or elevation (typically based on the approved design) at which the sediment should be removed. Owners, operators, and maintenance authorities should be aware that significant concentrations of heavy metals (e.g. lead, zinc and cadmium), as well as some organics such as pesticides, might accumulate at the bottom of these treatment facilities.

Testing of sediment following FDEP protocols for stormwater disposal should be conducted to determine the potential pollutant concentration prior to disposal by means of land spreading or transportation to a Class III landfill.

Nuisance Control:

Standing water or soggy conditions within a stormwater facility can create nuisance problems. Odors, mosquitoes, weeds, and litter can all be potential problems in stormwater facilities. Wetland plants maintained at proper levels in wet detention ponds can harbor birds, predatory insects, and fish that serve as a natural check on mosquitoes. Regular maintenance to remove debris and excessive vegetation and ensure control structure functionality will also help control these potential problems.

9.4 BMP Selection

As has been discussed, there are numerous techniques in common use for stormwater treatment. There is no "one" BMP for all situations. Each BMP has strengths and weaknesses, as well as design limitations that must be evaluated for each retrofit location. The BMP Selection Criteria in Table 11 was developed for BMP selection at Satellite Beach.

Table 11 – BMP Selection Criteria

BMP	Design Factor					Type of Pollutant	
	Land Area Needed	Groundwater Distance From BMP	Soil Type Needed	Cost	Maintenance	Total Nitrogen % Removal	Total Phosphorus % Removal
Dry Retention	High	12 inches	A or B	Medium	Low	60 - 99	60 - 99
Wet Detention	High	At NWL	Any	High	Medium	35 - 40	60 - 70
Vegetated Islands	Low	NA	Any	Medium	Medium	20	20
Vault Boxes	Low	NA	NA	Medium	Medium	.5 - 19	2.30-15.5
Inlet Devices	None	NA	NA	Low	Medium	*	*
* Based on cleanout records							

Ponds of any sort are the most common BMP used due to their ability to treat the highest number of pollutant parameters and their ability to reduce downstream flooding. They have high construction cost, low maintenance cost, and require the most land area of any BMP. In dense, urban areas it is often not feasible to construct a pond, leading to the evaluation of alternate BMPs. The factors generally used in choosing a BMP are:

- Required Land Area
- Desired Pollutant to be Removed

- Pollutant Removal Effectiveness
- Groundwater Elevation
- Type of Soil
- BMP Cost/Maintenance Requirements
- Compatibility with current and future land use

Some BMPs like inlet traps have a lower construction cost and a higher maintenance costs. Others such as traditional ponds and exfiltration trenches have a higher construction cost and lower maintenance costs. Consideration should be given for the long term costs of any selected BMP.

Based upon the discussions above, the four types of potential structural BMPs selected for retrofitting the City were wet detention ponds, dry retention swales, exfiltration trenches, and vegetated islands. Projects were chosen using the above selection criteria in consideration with other BMPs in a basin. In addition, stormwater reuse may be a feasible BMP at select sites such as the proposed ponds near the Library. Without a detailed water balance analysis to evaluate the potential reuse volume it is not feasible to predict pollutant removals at this conceptual stage. Therefore, stormwater reuse could be a viable BMP but is not recommended in this report.

Remember that retrofit BMPs constructed before 2000 and new development BMPs are invisible in the TMDL process. However, these BMPs do exist and must be recognized when selecting additional projects in a basin. Duplication of unit processes or BMPs in a basin will achieve little additional treatment effectiveness. For instance, adding a second wet pond to a basin would give little additional treatment because the unit process of biological uptake in the first wet pond would probably have already reached its maximum benefit. However, adding a dry pond (the infiltration unit process) upstream of an existing wet pond to create a treatment train would achieve desirable results of additional treatment for the overall basin.

Projects recommended in this study are conceptual in nature, with no hydraulic modeling to support conveyance sizing. Treatment volumes estimated are reasonably close to design values and are obtainable within the constraints of assumed soil and groundwater conditions. It is important to note that with retrofit projects of this nature, not all design and permitting criteria with the SJRWMD have to be followed. Designing the largest BMP possible within the existing land and financial constraints is allowable for permitting purposes. Final engineering and designs will be required for the proposed projects before they go to the construction phase.

Stormwater retrofit projects based upon runoff reduction provide additional flood control benefits by removing runoff volumes from the conveyance system. Exfiltration and swale projects on the east side of town will reduce runoff that flows to the low lying western side of the City. Proposed ponds along S.R. 513 may not directly reduce upstream flooding, but system storage would enable the City to upgrade pipe systems east of S.R. 513 where undersized pipes give low levels of service for flood control. Hydraulic analysis for upgrading pipes was not performed in this study but should be performed when ponds are permitted and constructed. **Constructing ponds will be the only way to enable larger pipes to be installed in the flood prone areas of the City.**

9.5 Proposed Conditions Modeling

It is important to note that FDEP will perform all final existing and proposed pollutant load modeling for TMDL compliance using the PLSM model. Stormwater Solutions has used FDEP's PLSM database as a tool to select proposed retrofit projects and estimate associated pollutant load reductions. Stormwater Solutions' calculations will be close to actual FDEP calculations. Differences between Stormwater Solutions' and FDEP calculations should not affect overall project planning.

Except as noted, all land uses in the proposed (future) conditions were considered the same as the existing conditions. This assumption was made with respect to pollutant loadings because new development ERP permits will require matching pre verses post pollutant loads, achieving a no net impact on pollutant loading from new development activities. In other words, accounting for future increases in pollutant loads from new development or changes in land use are not appropriate because new rules will not allow any increase.

A subbasin drainage area was delineated for each proposed BMP, resulting in a new GIS coverage for additional new subbasins (Figure 11. Appendix 5 is a summary of proposed pollutant loads calculated for each subbasin. Each new BMP had the same existing and proposed loads. Node diagrams as shown in Appendix 3 indicate the recommended combination of BMPs and their pollutant load interconnectivity. Note that a pollutant loading Node diagram may be different than a traditional hydraulic Node diagram.

The existing conditions PLSM model assumed a constant BMP removal efficiency of 30% for TN and 50% for TP for all BMPs. Proposed project BMP removal efficiencies for TN and TP were calculated for each BMP as shown below. All other aspects of the proposed conditions model remained the same when modeling proposed conditions. Any potential updates to GIS coverages in the subbasins would result in different load reductions than shown in this report.

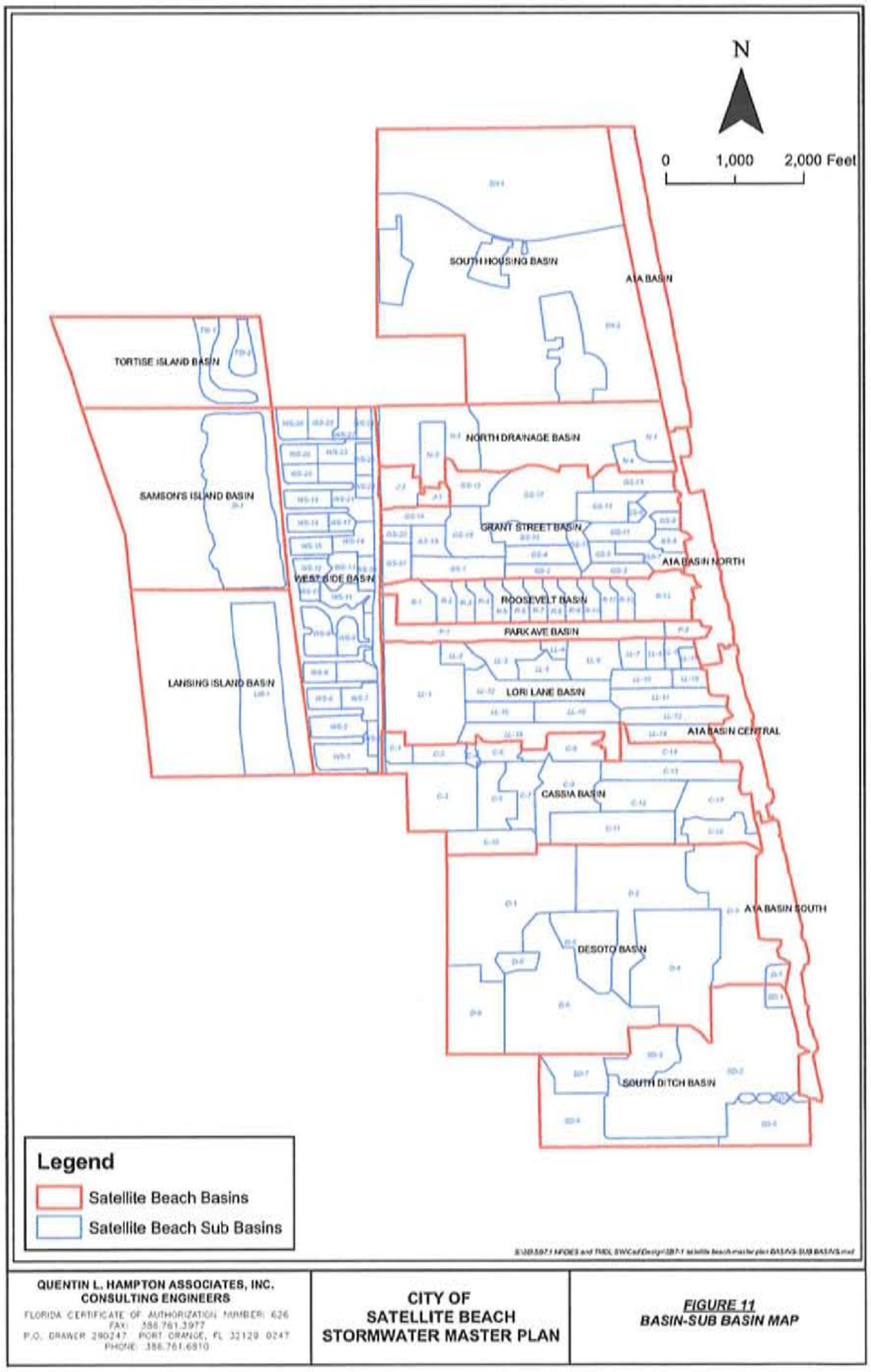


Figure 11 – Drainage Basin Map

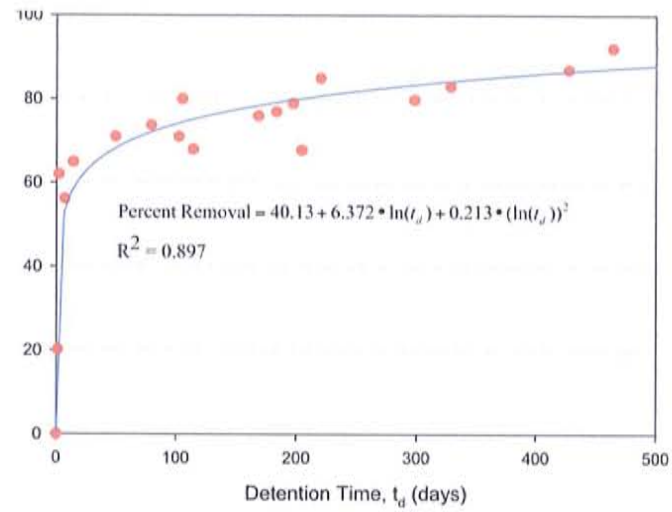


Figure 12 - Removal Efficiency of Total Phosphorus in Wet Detention Ponds

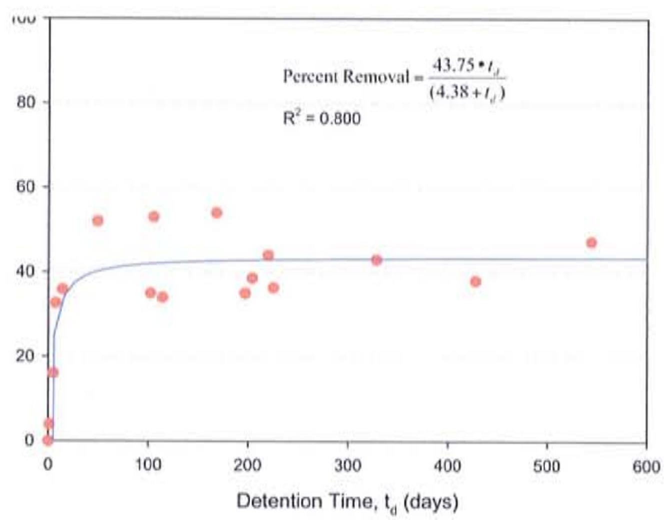


Figure 13 - Removal Efficiency of Total Nitrogen in Wet Detention Ponds

<u>Treatment Trains</u>

To maximize pollutant removals it is often necessary to use more than one BMP in a basin in a treatment Train effect. Each BMP treats via a unit process. Using the same unit process twice in a basin may not increase treatment. Pollutant removal calculations were made assuming each project stood in isolation. Once final projects are selected the pollutant removals should be recalculated based upon the ultimate treatment train grouping.

10.0 PROPOSED STRUCTURAL BMP PROJECTS

Careful scrutiny of the City's drainage basins, topography, and use of BMP Selection Criteria from Table 11 has identified a number of strategic locations where BMP projects could be implemented. A combination of large and small projects was chosen, enabling the City to select a suite of projects to fit each year's budget.

The Cassia Basin project is currently under construction and the North Basin project will start in the near future. Both of these projects will provide significant pollutant treatment upon completion. For purposes of project development, these two projects are considered to be existing projects and pollutant modeling was performed accordingly. For purposes of the FDEP BMAP process these two projects are considered future projects because they are not completed.

After preliminary screening for locational factors, 28 potential proposed BMPs were identified where cost effective projects could be implemented. Some of these projects were divided into phases in order reduce the annual impact of the total cost. Each proposed project was modeled using PLSM for pollutant loadings and the methods from Section 9.5 for pollutant removals. Input data for each proposed project is shown in Table 12. A summation of potential pollutant removals shows that more projects were identified than would be necessary to meet TMDL allocations for the first two five year cycles. Several of the projects will require land acquisition and might not come to fruition. Hence, more than a bare minimum list of BMPs was selected. See Table 13 for a summation of proposed project pollutant loading removals. A summary description and project details for each proposed project are shown below. Project locations are shown in Figure 14.

Note that projects identified below are conceptual in nature, with no hydraulic modeling to support pipe sizes. Treatment volumes estimated are reasonably close to design values and are obtainable within the constraints of assumed soil and groundwater conditions. It is important to acknowledge that with retrofit projects of this nature, all of the normal design and permitting criteria with the SJRWMD may not have to be completely followed. Designing the largest BMP possible within the existing land and financial constraints is allowable for permitting purposes. Final engineering and designs will be required for most of the proposed projects.

Table 12 - Proposed Project Model Data

Project No.	BMP Type	Basin No.	Soil Type	Acres Treated (ac)	Land Use
1A Post Office	Wet Detention	N-1,2,3,4	B/D	95.69	5200
1B Post Office	Beemats	N-1,2,3,4	B/D	95.69	5200
2 Emerald Court	Inlet Trap	WS-24	C	2.34	1300
3A Jackson and S. Patrick	Wet Detention	WS-29, J1,2	C	12.13	1400
3B Jackson and S. Patrick	Beemats	WS-29, J1,2	C	12.13	1400
4A Jackson	Wet Detention	J1	C	2.82	1700
4B Jackson	Beemats	J1	C	2.82	1700
5 Lincoln	Exfiltration	GS-8,9	C	5.74	1400
6 Publix	Dry Pond	N-4	C	4.92	1400
7A Roosevelt and S. Patrick	Wet Detention	WS-30, R1-13, GS-14,20,21	C	261.13	1300
7B Roosevelt and S. Patrick	Beemats	WS-30, R1-13, GS-14,20,21	C	261.13	1300
8A Cinnamon	Wet Detention	C-2	C	4.89	1200
8B Cinnamon	Beemats	C-2	C	4.89	1200
9 A Elwood Pond	Wet Pond	LL-10,11, 13,14,18	C	35.06	1200
9B Elwood Pond	Beemats	LL-10,11, 13,14,18	C	35.06	1200
10EX-A Jackson	Exfiltration	GS-17	C	24.68	1200,1700
10EX-B Jackson	Exfiltration	GS-10	C	8.23	1200,1700
10EX-C Jackson	Exfiltration	GS-11	C	11.71	1200,1400
10EX-D Jackson	Exfiltration	GS-12	C	8.6	1200,1700
11 South Base Housing	Beemats	SH2	C	167.67	1700

Project No.	BMP Type	Basin No.	Soil Type	Acres Treated (ac)	Land Use
12 Elwood	Exfiltration	LL-18	A	3.11	1200
13 Palm	Exfiltration	D-7, SD-1	A	4.54	1400
14 Palmetto	Exfiltration	SD-4	A	2.41	1200
15 South Ditch	Swale	SD-5	A	16.91	1200
16A Library 1	Wet Detention	SD-3	C	14.1	3300
16B Library 1	Beemats	SD-3	C	14.1	3300
17A Library 2	Wet Detention	SD-1-4,6	C	135.81	4200,7400
17B Library 2	Beemats	SD-1-4,6	C	135.81	4200,7400
18EX Jamaica	Wet Detention	SD-1,D2-5	C	214.2	1200, 3300
19EX-A Desoto	Exfiltration	D2,4,5,7	C	149.42	1300
19EX-B Desoto	Exfiltration	SD-8	C	214.11	1200
20EX Coconut	Exfiltration	D-3	C	37.47	1200
21 Desoto Park	Beemats	D-1-9, SD-1	C,A	298.83	1200,1860
22 Ocean Spray	Baffle Box	C-12	A,C	32.52	1200
23 Cassia	Baffle Box	C-13	A,C	35.54	1200
24 Ocean Spray	Exfiltration	C-12	A,C	12.76	1200
25 Greenway	Exfiltration	C-11	C	19.76	1200
26 Ocean Spray	Exfiltration	C-17	A,C	22.64	1200
27 Temple	Exfiltration	C-14	C	9.5	1200
28EX Desoto	3-Baffle Boxes	D2-8	C	57.92	1200
29Ex Orange	Baffle Box	GS-10	C	16.55	1200
30 North Outfall	Exfiltration	N1,N4	A,C,B/D	63.78	1700
31 City Hall	Beemats	C2-17	C,A	172.06	1200
32EX Avacado	Baffle Box	GS-12	C	8.6	1700
33EX Pineapple	Baffle Box	GS-17	C	24.68	
34 Tortoise Island	Beemats	TIB-1,2	C	13.26	1200,1700
35 Lansing Island	Beemats	LIB-1	C	37.42	1300
36 Jamaica Pond	Beemats	SD-1,D2-7,10	C,A	214.2	1200
37Ex Jamaica Reuse	Reuse	SD-1,D2-7,10	C,A	214.2	1200
38EX Roosevelt	Baffle Box	R-2-3	C	55.76	1200

Table 13 - Proposed Project Pollutant Removals

Project No.	BMP Type	Basin No.	Area Treated (Acres)	TN % Removal	TP % Removal	TN Removal (lb/yr)	TP Removal (lb/yr)
1A Post Office	Wet Det.	N 1-4	95.69	32.19	57.40	350.00	161.00
1B Post Office	Beemats	N 1-4	95.69	20.00	20.00	147.43	23.91
3A Jackson and S. Patrick	Wet Det.	WS-29, J1,2	12.13	25.44	52.33	54.95	24.84
3B Jackson and S. Patrick	Beemats	WS-29, J1,2	12.13	20.00	20.00	29.31	4.42
4A Jackson	Wet Det.	J1	2.82	40.34	68.61	16.10	6.42
4B Jackson	Beemats	J1	2.82	20.00	20.00	4.76	0.59
5 Lincoln	Exfiltration	GS-8,9	5.74	49.70	49.70	33.27	6.69
6 Publix	Dry Pond	N-4	4.92	86.60	86.60	76.91	19.75
7A Roosevelt and S. Patrick	Wet Det.	WS-30, R1-13, GS-14, 20, 21	261.13	28.69	54.61	625.48	221.67
7B Roosevelt and S. Patrick	Beemats	WS-30, R1-13, GS-14, 20,21	261.13	20.00	20.00	435.99	81.19
8A Cinnamon	Wet Det.	C-2	4.89	38.05	64.06	20.12	6.02
8B Cinnamon	Beemats	C-2	4.89	20.00	20.00	6.06	0.58
9A Elwood Pond	Wet Det.	LL-10, 11,13,14,18	35.06	20.30	49.00	65.16	23.35
9B Elwood Pond	Beemats	LL-10, 11,13,14,18	35.06	20.00	20.00	52.85	5.10
11 South Base Housing	Beemats	SH2	167.67	20.00	20.00	451.13	108.51
12 Elwood	Exfiltration	LL-18	3.11	62.30	62.30	13.92	1.96
13 Palm	Exfiltration	D-7, SD-1	4.54	63.80	63.80	28.49	6.36
14 Palmetto	Exfiltration	SD-4	2.41	77.90	77.90	34.78	7.76
15 South Ditch	Swale	SD-5	16.91	76.30	76.30	71.62	10.94

Project No.	BMP Type	Basin No.	Area Treated (Acres)	TN % Removal	TP % Removal	TN Removal (lb/yr)	TP Removal (lb/yr)
16A Library 1	Wet Det.	SD-3	14.10	42.18	75.33	51.31	13.09
16B Library 1	Beemats	SD-3	14.10	20.00	20.00	14.07	0.86
17A Library 2	Wet Det.	SD-1-4, 6	135.81	36.22	61.53	265.20	70.5
17B Library 2	Beemats	SD-1-4, 6	135.81	20.00	20.00	93.41	8.82
21 Desoto Park	Beemats	D-1-9, SD-1	298.83	20.00	20.00	218.5	20.11
22 Ocean Spray (Cassia)	Baffle Box	C-12	32.52	7.75	9.53	14.07	2.48
23 Cassia (Cassia)	Baffle Box	C-13	35.54	15.50	19.05	24.35	6.81
24 Ocean Spray (Cassia)	Exfiltration	C-12	12.76	9.64	9.64	13.48	2.62
25 Greenway (Cassia)	Exfiltration	C-11	19.76	3.10	3.10	5.63	0.81
26 Ocean Spray (Cassia)	Exfiltration	C-17	22.64	0.30	0.30	0.52	0.11
27 Temple (Cassia)	Exfiltration	C-14	9.50	3.10	3.10	2.70	0.38
30 North Outfall	Exfiltration, Baffle Box	N1,N4	63.78	30.20	30.20	270.79	268.12
31 City Hall	Beemats	C3-14, 16,17	172.06	5.00	10.00	71.34	13.15
34 Tortoise Island	Beemats	TIB-1,2	13.26	20.00	20.00	22.36	3.24
35 Lansing Island	Beemats	LIB-1	37.42	20.00	20.00	27.17	1.62
36 Jamaica Pond	Beemats	SD-1, D2-7,10	214.20	20.00	20.00	286.77	41.23

Figure 14 - Proposed Project Locations

10.1 Project 1

The North Basin consisting of school, commercial, and residential properties drains west into the Banana River with minimal treatment. An existing shallow wet detention pond located north of the Post Office on S.R. 513 provides treatment for commercial property. The pond is overgrown with vegetation and marginally effective. There is a low-lying vacant parcel west of the pond that will be difficult to develop due to high ground water levels. The first phase of a two-part project would be to acquire the existing pond and outparcel and convert them to a larger regional wet detention pond. Maintenance of the shallow existing pond is difficult, evidenced by the lack of maintenance to date. See Figure 15.

Making the pond deeper and larger would increase the treatment efficiency of the BMP. In addition, the soon to be constructed North Basin project will construct a double 30" pipe along S.R. 513 adjacent to this proposed pond. That project will provide minimal treatment for the 88.43 acre basin to the east. The new double 30" pipe should be diverted into the proposed pond to provide an estimated removal of 350 lb/year of TN removal and 423 lb/year of TP removal. *Stormwater Solutions recommends that additional junction boxes be installed on the North Basin pipes to facilitate future diversions for Project 1.*

In addition to expanding the size of the pond to provide additional treatment, Beemats should be installed as a second phase and harvested to continuously polish the water prior to discharge, further reducing nutrients to the Banana River. This project is estimated to cost $532,883, including land acquisition.

Figure 15 – Existing Pond Site

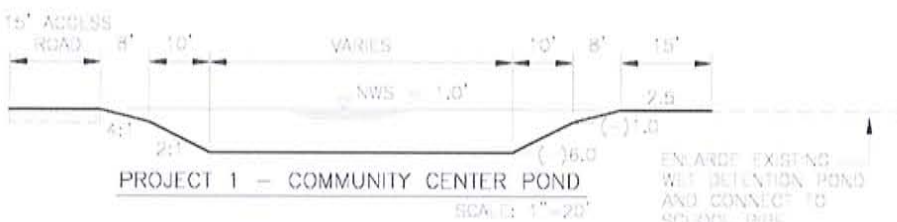


Figure 16 Project 1 Detail

10.2 Project 2

Project 2 consists of inserting an inlet trap at the end of the cul-de-sac on Emerald Court located on the west side of S.R. 513 in the West Side Basin. See Figure 17. A pipe from this inlet runs northward out of the City limits to Brevard County. The stormwater runoff sheet flows to the inlet, coming from a residential area of 2.34 acres in size. Due to the small dimensions of the inlet, it may be necessary to reconstruct the inlet to accommodate inlet trap dimensions. With proper maintenance, the inlet trap will remove debris and sediment from the runoff. FDEP does not give presumptive pollutant removal credits for inlet traps since removal is entirely dependent upon maintenance frequency. However, FDEP will give credits for actual sediments removed each year based on documented cleaning records. Stormwater Solutions recommends that the City initiate a procedure for tracking sediment removal from these type of BMPs. The cost of an inlet trap is approximately $1,000 if the inlet does not require rebuilding.

Figure 17 – Proposed Inlet Trap Location

10.3 Project 3

The southern side of the Community Center site drains via a 34" x 53" pipe across S.R. 513 to a residential canal between Anderson Court and South Hedgecock Square. Stormwater is discharged to the canal with no treatment. On the east side of S.R. 513, north of Jackson Court, there is a vacant parcel of land for sale. The 34" x 53" pipe crosses this vacant land, making this location a perfect place for a wet detention pond with beemats to treat stormwater before entering the canal. The drainage basin for this outfall is 12.13 acres of commercial and residential property that discharges 198 lbs/yr of TN and 49 lbs/yr of TP. A 0.5 acre pond would give reductions of 46 lb/yr of TN and 23 lb/yr of TP.

Figure 18 – Project 3 Location

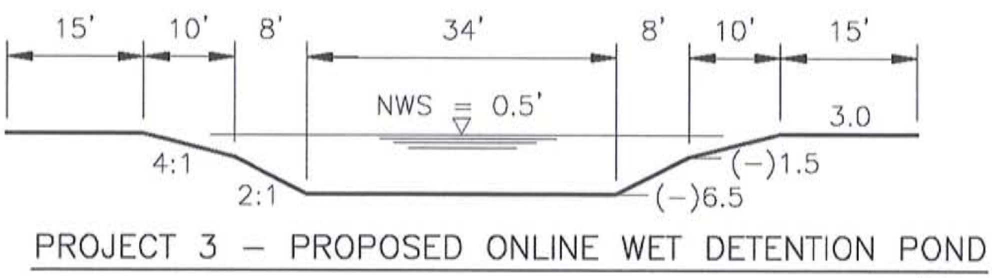


Figure 19 – Project 3 Detail

10.4 Project 4

Project 4 would entail acquisition of a vacant lot on the west end of Jackson Avenue and constructing a wet detention pond to treat stormwater runoff from 1.86 acres of residential property. See Figure 20. An existing pipe on the south side of Jackson could be extended to the site or the project could be configured to be an off line pond without an outfall. Beemats could also be installed in the wet pond for additional nutrient removal. The estimated cost of this project is $184,424, including land acquisition. Flooding along Jackson would be reduced due to the pond storage volume.

Figure 20 – Proposed Pond Location on Vacant Lot

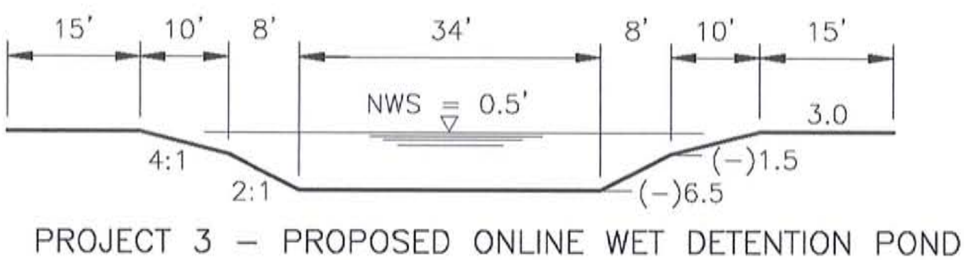


Figure 21 – Project 4 Detail

10.5 Project 5

Project 5 consists of installing an exfiltration system under Lincoln Street and a portion of Grant Avenue, treating 2.25 acres of residential land. Due to well-drained soils and the depth of the water table, the site is conducive to exfiltration for treatment of this residential area on the east side of town. There are no sanitary sewers at this location that could cause conflicts. The exfiltration trench would consist of 97 feet of perforated 18" pipe in a 3.5 foot x 2 foot gravel bed. The cost is estimated to be $200,813, removing 33 lbs/yr of TN and 7 lbs/yr of TP.

Figure 22 – Lincoln Street

10.6 Project 6

At the west side of the Publix building there is a large parking lot that is seldom used. The vast paved area of the Publix shopping center leads to high runoff volumes and severe flooding both at the east side of Publix as well as at the adjacent high school. While recent construction of a small pond on the north side of the shopping center will reduce flooding to some degree, the pipes draining the area are still undersized by today's standards and will continue to lead to flooding. Stormwater from this subbasin is not treated.

Project 6 consists of land or easement acquisition of a select area of the parking lot behind Publix and excavation of a dry retention pond to catch and treat stormwater. There would be no connection of the pond to a storm system. When the pond fills it will overflow to the nearby inlet and pipe that currently drains the area. The proximity of this site to the beach will allow infiltration of approximately 1.5 inches of stormwater runoff into the underlying sandy soils. This pond would treat 4.94 acres of impervious commercial land at an estimated cost of $204,059. The pond can be configured to enable continued access to the loading docks at the back of the Publix. There would be no loss of functionality to Publix. *This project would reduce flooding in the Publix area and downstream school grounds by storing runoff on site.*

Figure 23 Project 6 Location at Publix Parking Lot

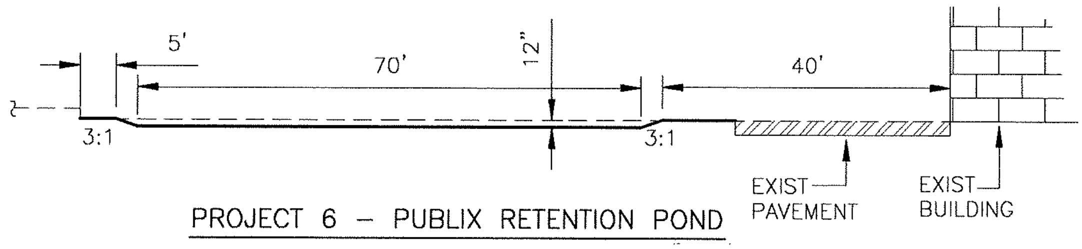
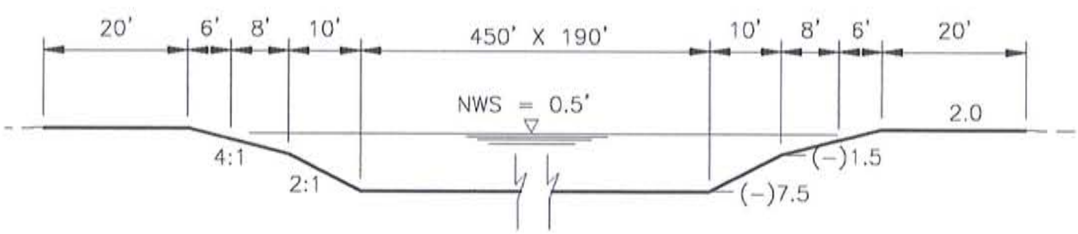


Figure 24 – Publix Pond Detail

10.7 Project 7

The Grant Street and Roosevelt Avenue drainage basins discharge untreated water from 261 acres through a 76" x 48" RCP to a canal south of Seville Court. Project 7 consists of acquiring land on the west side of S.R. 513 where there is an abandoned apartment and boat yard. The buildings would be demolished and a 2 acre wet detention pond constructed. The proposed BMP would remove 625 lb/yr of TN and 222 lb/yr of TP prior to discharge into the Banana River. This will be the only proposed BMP for the Roosevelt basin. Costs of the project are estimated at $$2,619,410 The second phase of the project would be installing and harvesting Beemats to provide additional treatment and removal of 435 lb/yr of TN and 81 lb/yr of TP. Construction of this project will greatly reduce sedimentation and maintenance in the residential canal. *A pond at this location would allow upstream piping to be increased to reduce flooding along Grant Street and Roosevelt Ave.*

Figure 25 – Abandoned Building at Project 7 Location



PROJECT 7 – ROOSEVELT WET DETENTION POND

Figure 26 – Project 7 Detail

10.8 Project 8

Project 8 is similar to project 4, whereby a wet detention pond would be created on an empty lot on Cinnamon Avenue between homes to provide treatment for runoff from 4.9 acres of residential land. The pond would remove 19 lb/yr of TN removal and 6 lb/yr of TP annually at an estimated cost of $204,059. The installation of Beemats would provide further removal of nutrients from the runoff. This project would improve the flooding level of service along Cinnamon Ave.

Figure 27 – Project 8 Location

10.9 Project 9

At the southeast corner of Elwood Avenue and Temple Street there is an existing dry retention pond owned by the City that provides treatment for 8.76 acres of residential land. A stormdrain pipe from Basins L-11 and L-13 passes along the east side of the pond and turns to the west, but is not connected to the pond. Project 9 consists of upgrading the dry pond by excavating a wet pond to a six foot depth. The adjacent stormdrain pipe would be diverted to the pond giving treatment for another 26.3 acres. This pond would provide more flood attenuation than the existing pond. Costs are estimated at $61,927. Treatment from the pond would reduce TN by 65 lb/yr and TP by 23 lbs/yr. Phase 2 of the project would be installation of Beemats.

Figure 28 – Project 9 Location

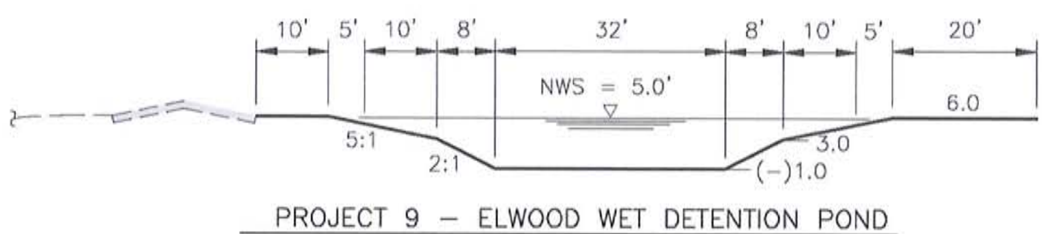


Figure 29 - Project 9 Details

10.10 Project 11

In the South Base Housing basin there are 3 existing private wet detention ponds on the south side of Shearwater Drive. With acquisition of drainage easements the City could install Beemats on these ponds for Project 11. Beemats would have a 5% area coverage of the ponds at a cost of $126,360. Annual maintenance costs are estimated at $46,800. TN removal would be 451 lb/yr and TP removal would be 109 lb/yr. Reuse of water from these and other ponds for irrigation could be feasible. Design and costing of such systems are not included in this analysis.

Figure 30 – Project 11 Location

Figure 31 – Project 11 Location

10.11 Project 12

Project 12 consists of installing an exfiltration pipe at the east end of Elwood Avenue between A1A and Tangelo Street. The pipe would be 420 feet of perforated ADS in a 3 foot by 4 foot gravel trench. This system located in a residential area would provide treatment of 0.34 inches of stormwater runoff from 3.11 acres, reducing the pollutant loads to the Banana River by 14 lb/yr for TN and 2 lb/yr for TP. Cost of the project is estimated to be $106,920.

Figure 32 – Elwood Avenue

10.12 Project 13

On the east side of town where soils are well-drained and the water table is low, infiltration practices are recommended. Project 13 is a prime location for this type of BMP, consisting of 550 feet of 30" exfiltration pipe in a 4 foot x 4.5 foot gravel trench installed along Palm Drive from Desoto Parkway southward to Magellan Avenue. This system treats the first 0.34 inches of runoff from 4.59 acres of a residential area. An estimated cost of $138,037 would reduce TN by 28 lb/yr and TP by 6.2 lb/yr.

Figure 33 – Palm Drive

10.13 Project 14

Project 14 consists of constructing an exfiltration system beneath approximately 4 blocks of Palmetto (starting at Poinsettia, heading east) to capture the first 0.65 inches from 2.41 acres of runoff in a residential area. The exfiltration trench would be 500 feet of 30" perforated pipe and 600 feet of 24" perforated pipe. The pipes would be offline, not connected to other drain pipes and would have the additional benefit of reducing flooding in the area at a cost of $271,350. TN removal would be 35 lb/yr and TP removal would be 7.8 lb/yr.

Figure 34 - Palmetto Ave

10.14 Project 15

Along the south boundary of Satellite Beach is vacant right of way with a stormdrain pipe flowing westward to a large outfall ditch. The right-of-way is grassed except for the paved ends of the streets. There are a series of inlets at the ends of the streets catching water running southward. Project 15 consists of constructing a 1,520 foot long cascading grassed swale in the right-of-way, excavating two feet below existing grade. The asphalt cul-de-sacs would be modified and land regraded so water would not flow directly into the inlets. If necessary the inlets could be reconstructed. This BMP will capture the first 0.6 inches of runoff from 16.91 acres of residential area, reducing the annual pollutant loads to the Banana River by 72 pounds of TN and 11 lbs of TP. The cost is estimated to be $93,852.

Figure 35 – South Ditch Right-of-Way

10.15 Project 16

Project 16 consists of constructing a 1.63 acre wet pond on vacant land adjacent north of the library. An existing 18 inch stormdrain on Robert Way would be diverted to the pond to treat 14.1 acres of residential land. The normal water level of the pond would be elevation 2.0. This pond would discharge to another newly constructed pond to the south (Project 17) via a new 18" pipe. Environmental issues with scrub and gopher tortoises and would have to be addressed. No land acquisition would be required for this project. Installation of Beemats would enhance nutrient reductions, giving a total reduction of 75.6 lbs/yr of TN and 5.8 lbs/yr of TP. Estimated costs for this project are $213,800.

Figure 36 – Library Park Pond 1 Site

10.16 Project 17

At the southeast corner of the library park another 2.31 acre wet detention pond is proposed for Project 17. A 30" storm drain will be diverted from Robin Way to receive and treat runoff from 135.81 acres of residential property as well as the discharge from the Project 16 pond before sending the treated water south to the existing ditch and eventually to the Banana River. Beemats should be installed for additional treatment giving a total removal of 405 lbs/yr f TN and 91 lbs/yr for nutrients. Costs are estimated at $304,236.

Figure 37 – Library Park Pond Site

10.17 Project 21

East of Desoto Park is a canal receiving the discharges from the Desoto storm drain system. This canal is considered Waters of the State with a direct connection to the Banana River. Project 21 consists of widening the existing canal to enable excavation to a minimum depth of three feet to support installation and growth of Beemats. A weir will be installed to sever the connection to Waters of the State. Permitting for this project will be difficult, probably requiring a submerged pipe in the weir to allow saltwater movement and fish migration into the canal. Costs of the project are estimated at $26,325. Pollutant removal benefits will be reduction of TN by 186 lb/yr and TP by 15 lb/yr.

Figure 38 - Desoto Park Beemat Site

10.18 Project 31

Project 31 consists of installing Beemats in the deep sections of the ditch being constructed in front of City Hall as part of the Cassia Phase 2 project. Beemats would enhance the pollutant removals of the Cassia treatment train at a cost of $10,530. Pollutant removals are estimated at 71 lbs/yr of TN and 13 lbs/yr for TP.

Figure 39 – City Hall Site

10.19 Project 34

On Tortoise Island there are two existing wet detention ponds within the Satellite Beach City limits. These ponds could be easily retrofitted with Beemats to provide additional pollutant removal from these sites without the need to construct new ponds. Estimated costs for Beemats at these locations are $52,650, plus annual harvesting and replacement of $19,500. Benefits from this project would be removal of 22 lb/yr of TN removal and 3.2 lb/yr of TP removal.

Figure 40 – Tortoise Island Beemat Pond

10.20 Project 35

On Lansing Island there are two existing wet detention ponds. Project 35 consists of installing 14,500 square feet of Beemats on these lakes to provide additional pollutant removal from these sites without the need to construct new ponds. Estimated costs for Beemats at these locations are $152,685, plus annual harvesting and replacement costs of $56,550. Benefits from this project would be removal of 27 lb/yr of TN removal and 1.6 lb/yr of TP removal.

Figure 41 - Lansing Island Site

10.21 Project 36

Project 36 is near the library and consists of installing Beemats in the three existing offline detention ponds from the Desoto Blvd system. Beemats would enhance the treatment ability of the existing ponds. There are 3 ponds in this area that receive high nutrient loads as evidenced by the duck weeds in Figure 42. These ponds are already used for reuse irrigation for the park. Reuse withdrawals would need to be monitored to maintain at least three feet of depth for the Beemats. Costs for Beemats installation are estimated to be $42,120 with an annual maintenance cost of $15,600. Pollutant load reductions are estimated to be 186 lbs/yr for TN and 15 lbs/yr for TP.

Figure 42 – Jamaica Pond Site

10.22 Discussion

Twenty-one structural BMPs are selected by Stormwater Solutions as potential retrofit projects. There is a combination of small and large projects, allowing flexibility of project selection to meet City budgetary limitations. Wet detention ponds along S.R. 513 will require land acquisition of properties that are listed for sale or have been abandoned. Land acquisition, permitting, and construction are long processes. Even though there may not be funds available for project construction at this time, it would be prudent to pursue land acquisition now at depressed prices so that project sites are available in the future when funding becomes available. *Remember that these wet ponds could enable enlargement of upstream piping for flood control in residential areas.*

Stormwater retrofitting is an opportunistic endeavor. The list of potential projects is by no means exhaustive. There may be other sites where land becomes available for projects through storm damage, fires, abandonment, or other circumstances.

Structural projects are prioritized by using the construction cost per pound of TN removed annually. Using cost per pound of TP removed gives almost the same priority listing. Using cost per pound of pollutant removed as a major factor in the project selection decision ensures maximum cost benefit is received for TMDL credits received. This measure is a starting point, but there are other factors to be considered in project selection such as overall construction costs, political factors, public input, and competing public uses on available land.

10.23 Cost Estimates

Cost estimates were prepared for each of the proposed projects listed above. Typical details shown in the project descriptions were used for estimating construction quantities. Unit prices were based upon recent comparable projects in the local area. Costs included a 20% contingency, 15% engineering, and 8% surveying fees. A summary of costs is shown in Table 14 with detailed breakdowns given in Appendix 7. Land costs were estimated by using the Market Value from the Property Appraiser's database and adding 20%. Land values have fallen considerably the last few years and there opportunities to acquire land at low prices. Lost tax costs were taken as the property taxes paid to the City according to the Tax Collector's web site.

Table 14 - Proposed Structural Project Costs and Pollutant Load Summary

Project No.	BMP Type	TN Removal (lb/yr)	TP Removal (lb/yr)	Estimated Costs	Cost per pound TN Removed	Cost per pound TP Removed
9B* Elwood Ave	Beemats	52.85	5.10	$ 5,160	$ 97.64	$ 1,012.16
21 Desoto Park	Beemats	218.50	20.11	$ 26,325	$ 120.48	$ 1,308.77
7B* Roosevelt and S. Patrick	Beemats	435.99	81.19	$ 55,224	$ 126.66	$ 680.22
36 Jamaica Pond	Beemats	286.77	41.23	$ 42,120	$ 146.88	$ 1,021.69
31 City Hall	Beemats	71.34	13.15	$ 10,530	$ 147.61	$ 800.82
11 South Base Housing	Beemats	451.13	108.51	$ 126,360	$ 280.10	$ 1,164.48
1B* Post Office	Beemats	147.42	23.91	$ 58,968	$ 400.00	$ 2,466.37
3B* Jackson and S. Patrick	Beemats	29.31	4.42	$ 13,104	$ 447.11	$ 2,962.47
17B* Library 2	Beemats	93.41	8.82	$ 47,385	$ 507.30	$ 5,372.28
8B* Cinnamon	Beemats	6.06	0.58	$ 5,160	$ 851.47	$ 8,921.77
9A Elwood Pond	Wet Det.	65.16	23.35	$ 61,927	$ 950.43	$ 2,651.81
17A Library 2	Wet Det.	265.20	70.53	$ 304,236	$ 1,147.20	$ 4,313.80
4B* Jackson	Beemats	4.76	0.59	$ 5,616	$ 1,179.64	$ 9,552.96
15 South Ditch	Swale	71.62	10.94	$ 93,852	$ 1,310.36	$ 8,581.28
1A Post Office	Wet Det.	349.96	161.09	$ 532,883	$ 1,522.70	$ 3,307.93
34 Tortoise Island	Beemats	22.36	3.24	$ 52,650	$ 2,354.65	$ 16,260.04
16B* Library 1	Beemats	14.07	0.86	$ 34,749	$ 2,469.77	$ 40,523.59
6 Publix	Dry Pond	76.91	19.75	$ 204,059	$ 2,653.24	$ 10,332.65
22-27 Cassia	Exfiltration, Baffle Box	386.00	92.00	$ 1,124,588	$ 2,913.44	$ 12,223.78
16A Library 1	Wet Det.	51.31	13.09	$ 213,800	$ 4,166.72	$ 16,329.92
30 North Outfall	Exfiltration Baffle Box	270.79	70.56	$ 1,131,930	$ 4,180.08	$ 16,043.23
7A Roosevelt and S. Patrick	Wet Det.	625.48	221.67	$ 2,619,410	$ 4,187.86	$ 11,816.45
13 Palm	Exfiltration	28.49	6.36	$ 138,038	$ 4,845.68	$ 21,719.58
35 Lansing Island	Beemats	27.17	1.62	$ 152,685	$ 5,620.03	$ 94,483.29
5 Lincoln	Exfiltration	33.27	6.69	$ 200,813	$ 6,035.09	$ 29,996.03
12 Elwood	Exfiltration	13.92	1.96	$ 106,920	$ 7,682.24	$ 54,656.43
14 Palmetto	Exfiltration	34.78	7.76	$ 271,350	$ 7,801.37	$ 34,967.73
3A Jackson and S. Patrick	Wet Det.	54.95	24.84	$ 457,340	$ 8,322.37	$ 18,409.36
8A Cinnamon	Wet Det.	20.12	6.02	$ 208,670	$ 10,370.60	$ 34,652.39
4A Jackson	Wet Det.	16.10	6.42	$ 184,424	$ 11,457.65	$ 28,709.37
Totals		**4,209.08**	**1,049.93**	**$ 8,485,113**		

* This project can not be implemented until the associated wet detention pond is constructed

10.24 Non Structural BMPs

In addition to Structural BMPs, further pollutant loadings could be obtained through implementing a combination of several so called soft, or nonstructural, programs that should be undertaken by the City. These programs mirror requirements of the City's current NPDES MS4 permit and are effective methods for source controls that reduce the pollutant loadings entering the MS4 system. It is often more cost effective to prevent pollutants from entering the stormwater than to remove them from the stormwater once they are dissolved into it.

Non-structural BMPs

- Ordinance Revisions
- Reductions in the use of Pesticides, Herbicides, and Fertilizer
- Illicit Discharge Control
- Street Sweeping

10.24.1 Sediment Control

An obvious source of gross solids and pollutants entering stormdrains is debris and sediments in the streets. Many pollutants such as heavy metals and automobile fluids bind to sediment particles that are transported to receiving waters. Street sweeping effectively removes a quantifiable mass of sediments and associated pollutants from pavement.

Currently the City has a street sweeping program that collects 45 cubic yards of sediment every three months. Based upon a preliminary report from the University of Florida regarding pollutant loadings in sediments, Stormwater Solutions calculated that the City is removing 578 lb/yr of TN and 202 lb/yr of TP. **Stormwater Solutions recommends that the City apply for TMDL credits for their street sweeping activities.** Detailed records of sediments removed by street sweeping should be kept for TMDL credits. Software such as Sediment Tracker would assist the City in record keeping for street sweeping and other maintenance activities.

Another practice undertaken by the City for sediment reductions is cleaning of pipes and ditches and replacement of failing stormdrain pipes. With documentation of these practices the City might receive TMDL credits for pollutants in sediment removed, as well as show compliance with NPDES permit Element 6.

10.24.2 Publication Education

Up to 6% TMDL credits are available to the City for implementation of Public Education programs. There are several components of a Public Education program that are acceptable to FDEP. A summary of these activities and reporting requirements are shown below as taken from FDEP handouts.

Summary of Your Organization's Education Activities

Check "yes" or "no" in the table below for each type of education activity.

Activity	Yes	No
Florida Yards and Neighborhoods program		
Local codes and ordinances		
Landscaping		
Irrigation		
Fertilizer		
Pet waste management		
Public Service Announcements (PSA)		
Informational Pamphlets		
Website		
Inspection program and call-in number for illicit discharges		

- Supporting Details on Your Organization's Education Activities
- Florida Yards and Neighborhoods Program - provide details on participation in the program
- Local codes and ordinances - list which of the four types of ordinances is adopted, reference the code, and provide some details for each ordinance
- PSAs - describe what the PSAs focus on, where they are aired, and how many times per year
- Pamphlets/Presentations - describe what the pamphlets and/or presentations focus on, where the presentations were given and estimated number of people reached, and how the pamphlets are distributed and estimated number distributed
- Website - provide the link to the website and a brief description of its content
- Illicit Discharge Program - briefly describe the program

<u>Criteria for Acceptable Education Activities</u>

1. Local funding to implement the Florida Yards and Neighborhoods (FYN) program within the city or county.
2. Local land development codes or ordinances that require Florida Friendly landscaping on all new developments, require commercial landscapers to obtain training and certification through the Green Industry Best Management Practice (BMP) program, require irrigation systems per Sections 125.568 and 166.048, Florida Statutes (F.S.), and Section 373.185, F.S., and which specify fertilizer application rates and types. Local ordinances that control pet waste and require that residents pick up and properly dispose of pet wastes. Full credit given if local codes include all four components (landscaping, irrigation, fertilizer, and pet waste management), partial credit for programs that only require one or two components. Model ordinances are available at: http://www.dep.state.fl.us/water/nonpoint/pubs.htm and model irrigation ordinances are available from the St. Johns River Water Management District (SJRWMD).
3. Implementation of public service announcements (PSAs) on local cable or commercial television and radio stations. PSAs can include those developed locally or those developed through the Think About Personal Pollution (TAPP) Campaign (http://www.tappwater.org/). Other PSAs are available through the University of Central Florida (UCF) Stormwater Academy (http://www.stormwater.ucf.edu).
4. Informational pamphlets on pollution prevention, fertilizer application, Florida Friendly Landscaping, water conservation, septic tank maintenance, etc. The Stormwater Education ToolBox (SET) is available on-line from the UCF Stormwater Management Academy (http://www.stormwater.ucf.edu). Presentations on the above topics to civic groups, local businesses, students, and the general public.
5. Websites to provide information on reducing nutrient pollution for homeowners and businesses.
6. Inspection program and public call-in number to address illicit discharges.

Guidelines for Percent Reduction

- If all six types of activities are conducted by an entity, then the full 6% reduction is assigned.
- If an entity only has the PSAs, websites, brochures, and the inspection program, they will receive a 1% reduction credit.
- If an entity only has FYN, they will receive a 3% reduction credit.

- If an entity only has the Florida friendly ordinances (landscaping, irrigation, fertilizer, and pet waste management), then they will receive a 2% reduction.
- Other combinations of efforts are analyzed on a case-by-case basis for credit.

Claiming Credit

In order for credit to be given in the BMAP, each entity that wishes to include education in their project submittal must provide a detailed write up that outlines their current and planned education and outreach efforts which help to reduce nutrient loads. These efforts should be quantified to the extent possible (e.g. the number of pamphlets distributed per year, number of presentations given per year). Depending on the level of effort demonstrated by the detailed description of the local education program, the amount of reduction credited may be adjusted at the Department's discretion.

11.0 IMPLEMENTATION PROGRAM

Stormwater Solutions recommends a two part strategy for the City to achieve TMDL compliance in the first five year cycle. The first component is to make corrections to the GIS coverages of the PLSM model to reflect accurate existing land uses and BMP locations. The second is to implement five Public Education programs recommended by FDEP. Table 16 shows that these two recommendations will allow the City to meet their first five-year cycle allocations with no new BMP construction. Accounting for the Cassia and North Basin projects gives credits toward the second five-year reductions.

Table 16 – TMDL Implementation Plan

	TN (lb/yr)	TP (lb/yr)
FDEP Required 5 Year Reduction	3,500	650
FDEP Required 10 Year Reduction	7,000	1,300
FDEP Required 15 Year Reduction	10,501	1,949
Proposed Nonstructural and Scheduled Reductions		
Reduction from GIS Treatment Area Updates	1,296	461
Reduction from GIS EMC changes for Land Use 5100	310	26
Reduction from Proposed Runoff Coefficient Study	77	5
Reduction from Proposed Public Education Programs (3%)	419	77
Reduction from Street Sweeping	578	202
Reduction from Existing BMPs	1,211	234
Reduction from Proposed North Basin BMPs	325	79
Reduction from Proposed Cassia BMPs.	61	13
Subtotal	**4,277**	**1,097**
Remaining 5 Year Reductions Required	0	0
Remaining 10 Year Reductions Required	2,723	203
Remaining 15 Year Reductions Required	6,224	852
Proposed Structural Reductions from Table 14	3,586	1,448
Projected Remaining 10 Year Reductions	0	0
Projected Remaining 15 Year Reductions	2,638	0

Construction of the projects listed in Table 14 will allow the City to meet the second five-year cycle allocations at an estimated cost of $8,485,113. No reasonable projects were identified for the third five-year cycle. At this point in time FDEP is reassessing pollutant load allocations for the City. The required loads may fall significantly, negating the need for additional BMPs. If the load allocations are not reduced to a reasonable level, Stormwater Solutions recommends that the City negotiate the allocations to a lower level or seek legislative relief. It is also recommended that the City participate in the monitoring phase of the BMAP to determine the accuracy of pollutant loads predicted in the PLSM model.

11.1 Funding

Satellite Beach has a Stormwater Utility with an ERU rate of $5.41 per month. Annual revenues generated are approximately $304,000. Construction of the proposed projects would only reduce nutrient loadings to approximately 74% of the 15 year levels recommended in the FDEP TMDLs. To effectively implement TMDL mandated improvements, the City should investigate additional sources of funding for their stormwater program. Possible sources of funding include:

State Revolving Fund Program

FDEP operates the State Revolving Loan Program in which communities borrow funds from the State to implement a large number of CIP projects on an accelerated basis and repay the loan over a long time period at a low interest rate, similar to bonding. The City's Stormwater Utility fees would be pledged as collateral for the loan. Several years of lead time is required to qualify for the loan and to be placed on the funding list. Satellite Beach may wish to investigate these types of loans.

Grant Funding

Many communities obtain grant funding for stormwater CIP projects to leverage their utility fees. There are several sources of funding available from Water Management District, state, and federal agencies for stormwater projects. Most funding is for stormwater quality projects, but there is flood control funding available from the Department of Community Affairs (DCA). Satellite Beach has successfully acquired grant funding from several sources in the past. Most grants are funded for projects in the $500,000 to $1,000,000 range. The City should pursue additional grants for proposed stormwater projects.

Utility Fee Increases

The most straightforward way to increase revenues for stormwater CIP projects is to increase the Stormwater Utility fees. Once the economic climate improves the City should make long term budget projections to prepare for fee increases necessary to construct the second cycle of expensive retrofit projects.

Bank Loans

Satellite Beach has secured bank loans for previous stormwater projects. Additional borrowing from banks could be pursued for future projects.

Inter-local Cost Sharing

All of the communities along the Indian River face funding difficulties. Economies of scale can be achieved for certain programs and projects if communities band together to share resources and funds for BMP projects. This will require a certain amount of change, planning, and creativity in budgeting and constructing new projects. FDOT will be a prime participant in this process. They too must meet TMDL allocations, but they have no land available for retrofitting their facilities. The locations of recommended projects along SR 513 would allow FDOT to enter into joint projects that would treat both City and FDOT lands. FDEP indicates that Cities may share projects and TMDL credits anywhere in the BRL basin.

12.0 SUMMARY AND RECOMMENDATIONS

In 2007 EPA developed TMDLs for the Indian River Lagoon, including the Banana River Lagoon adjacent to Satellite Beach. EPA's TMDLs required an annual 63% reduction of TN and 67% reduction of TP from stormwater systems entering the BRL. FDEP was required to enforce EPA's TMDLs or develop their own TMDLs. In 2009 FDEP chose the latter and established TMDLs for the BRL. FDEP is developing a detailed restoration plan for the basin through the BMAP process, the fourth stage of a five stage TMDL process for the BRL. **The primary objective of the TMDL program is to return the BRL seagrass coverages to maximum historic levels by reducing TN and TP concentrations in the BRL.**

FDEP established an overall pollutant loading model of the BRL using the SJRWMD's GIS based PLSM model. While this model was not robust, it was chosen for ease of regulation and enforcement.

Satellite Beach engaged QLH and Stormwater Solutions to perform a TMDL Assessment to determine the impacts of TMDL requirements upon the City, and then to develop a strategy to be used by the City for compliance with required pollutant load reductions. The steps used to perform the assessment were:

1. Obtain GIS coverages and the PLSM model from FDEP that were used to calculate TMDL allocations.
2. Develop selection criteria for potential BMP retrofit sites from geographical characteristics.
3. Attend ongoing meetings with FDEP as part of the BMAP process to develop load allocations for entities and to assist the City with required TMDL submittals.
4. Use FDEP's PLSM model to calculate pollutant removal benefits from proposed BMP projects.
5. Prioritize a structural project list based upon costs per pound of pollutant removed.
6. Develop an implementation plan of structural and nonstructural BMPs for the City to utilize to meet TMDL allocations.

12.1 BMAP Process

FDEP is currently going through the BMAP process with entities along the BRL. While the general objectives of the BMAP are defined, the exact details of the final BMAP are unknown since it is a work in process. Final BMAP criteria and agreements are targeted for adoption by the end of 2011.

FDEP uses the BMAP process to achieve TMDL goals by:

- Assigning pollutant load allocations in terms of pounds per year reduction of TN and TP to the communities and stakeholders within the watershed; and
- Obtaining commitments from communities for implementing specific retrofit projects and other measures to reduce pollutant loadings to meet TMDL reductions.

On June 14, 2010 FDEP issued specific load reduction mandates for each community along the BRL. **The mandate for Satellite Beach was to reduce existing TN loads by 75.3% annually (10,501 pounds) and TP loads by 79.2% annually (1,949 pounds).** FDEP will enforce BMAP mandates through the City's NPDES MS4 permit.

FDEP will require that the City commit to constructing retrofit projects and implementing other measures that will meet these load reduction goals in three five-year cycles over the next 15 years. At this point FDEP will only be requiring commitment to meeting the first five-year cycle of nutrient load reductions. Keep in mind that these goals and measures will probably change with each five-year cycle. FDEP will re-evaluate the TMDL allocations and health of the Indian River Lagoon at five-year intervals. Adjustments to the allocations may be reduced if future monitoring of the BRL indicates that the River's health is improving more rapidly than anticipated.

12.2 Recommendations

Stormwater Solutions developed the following strategy for the City to achieve TMDL compliance through a combination of model corrections, nonstructural practices, and construction of structural BMPs shown in Table 16.

1. Year 2000 GIS coverages for land use and ERP locations were used for the PLSM model. A comparison of the Year 2000 verses current coverages show obvious changes that will impact the loadings calculated in the PLSM model. In addition, there are a number of errors in the ERP areas in the PLSM model. For instance, the FDEP coverage for ERP areas does not recognize the stormwater systems at South Base Housing, Tortoise Island, or Lansing Island, leading to large overestimations of pollutant loadings. **All of the GIS coverages used in the PLSM model should be updated to current data.**

2. The Runoff Coefficients (RO factors) used in the PLSM model for Sansom Island are typically used for urbanized, small drainage basins. RO factors have historically been used to calculate flow rates for pipe sizing. RO values were never intended to provide estimates of annual runoff volumes. With 90% of the storms in Florida being one inch or less, there will be low runoff volumes from areas like Sansom Island that have little impervious areas and highly percolating soils.

   Dr. Harvey Harper, author of much of Florida's proposed Statewide Stormwater Rule, recommends that the use of the variable "Delivery Ratio" is more appropriate for calculating the volume of water that reaches a water body after flowing over large pervious or undeveloped areas. Harper 2010. Use of a Delivery Ratio for Sansom Island could potentially result in as much as a 30% reduction of baseline modeled TN and TP loadings for the island. **Stormwater Solutions recommends a study be undertaken to develop the concept of Delivery Ratios with the intent to reduce calculated runoff volumes and pollutant loads from Sansom Island.**

3. A third measure is associated with the Land Use classification 5100 for the Grand Canal. Sections of the BRL in the City's TMDL jurisdictional area are of Land Use 5400, which have "0" pollutant loadings assigned to that land use. Land Use 5100 has pollutant EMCs and resulting loadings assigned to it in a seemingly arbitrary method. Both the BRL and Grand Canal are salt water bodies and should have no pollutant loadings. **The City should request that the EMCs for Land Use 5100 be reset to 0 mg/L.**

4. **The City should commence with a Street Sweeping program** to remove obvious sediments and trash from entering their canals. Credits for nutrient removal will be issued based upon documented pounds of sediments removed by street sweeping. Keeping sediments out of canals will also reduce the frequency of dredging of the canals.

5. **A properly documented Public Education program should be implemented** to receive TMDL credits for the activities of:
    a. Revising ordinances regarding Landscaping, Irrigation, Fertilizer, and Pet Waste Management
    b. Public Service Announcements
    c. Distributing Informational Pamphlets
    d. Creating a stormwater website
    e. Illicit discharges inspection program and call-in number

6. **Load reductions should be obtained from existing structural BMPs.** Preliminary TMDL credits were obtained for existing retrofit projects constructed after the year 2000. Credits issued by FDEP for the De Soto baffle box and Coconut Exfiltration pipes were incorrectly set at 0. Upon consultation with Stormwater Solutions, FDEP committed to give TMDL credits for those projects. When the new TMDL allocations are issued the City should verify that credits for these two projects are received.

Implementation of these recommended measures should result in the City meeting their removal allocations for the first five-year BMAP cycle. Meeting the reductions required for the second five-year cycle will come from an extensive retrofit program to construct most of the projects shown on Table 14. No recommendations are given for meeting load reductions for the third five-year cycle.

The Table 14 list of proposed structural BMPs was developed by:

1. Selecting technically and financially feasible projects;
2. Using the PLSM model to calculate pollutant loads;
3. Calculating pollutant removals for each project;
4. And performing a cost benefit analysis to prioritize projects.

TMDLs are constantly evolving with frequent changes to allocations, acceptable BMPs, and BMP calculation methods. Meeting these challenges will require considerable resources from the City in terms of both funding and manpower. The City has been very progressive by installing numerous retrofit projects, resulting in being able to meet the first five-year TMDL allocations with little additional effort. The easy retrofit projects have been built, leaving more difficult projects for the second BMAP period. Several of these projects will require land acquisition. While this is a difficult subject to address during these difficult economic times, land prices are lower now than they will be in the future and the City should consider the savings to be realized by starting the acquisition process now.

13.0 REFERENCES

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APPENDIX 1

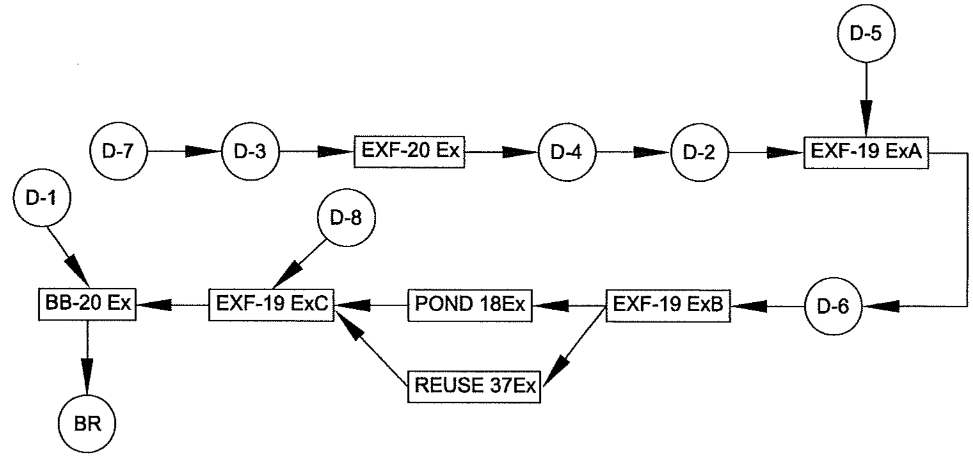
TMDL CREDIT SUBMITTAL

Project Number	Project Name	Lead Entity	Lead Entity's Contact Name	Contact Phone Number	Contact E-mail Address	Project Partner(s)	Project Type (select from the dropdown box)	Project Location (Lat/Long in Decimal Degrees)		Associated Permit #, if applicable
33-Ex	Pineapple Baffle Box	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	1=Stormwater Retrofit (CDS or baffle box)	28.18193	-80.599948	40-009-65366-1
29-EX	Orange Baffle Box	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	1=Stormwater Retrofit (CDS or baffle box)	28.1821	-80.596979	40-009-65366-1
32-Ex	Avacado CDS	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	1=Stormwater Retrofit (CDS or baffle box)	28.18179	-80.602956	40-009-88915-1
19-ExA	Desoto Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.16496	-80.597443	42-009-96852-1
19-ExB	Desoto Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.16496	-80.597443	42-009-96852-1
19-ExC	Desoto Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.16496	-80.597443	42-009-96852-1
10-ExA	Jackson Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.18121	-80.599444	40-009-65366-1
10-ExB	Jackson Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.18324	-80.595554	40-009-65366-1
10-ExC	Jackson Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.18293	-80.593933	40-009-65366-1
10-ExD	Jackson Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.18289	-80.602878	40-009-65366-1
20-Ex	Coconut Exfiltration	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	13=Other structural BMP	28.16657	-80.589607	40-009-84388-1
18-Ex	Jamaica Blvd Ponds	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	3=Wet detention pond	28.16102	-80.597936	40-009-84388-1
28-EX	Desoto Baffle Boxes	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	1=Stormwater Retrofit (CDS or baffle box)	28.16496	-80.597443	42-009-96852-1
37-Ex	Jamaica Pond Reuse	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	14=Other non-structural project	28.16102	-80.597936	40-009-84388-1
38-Ex	Roosevelt Baffle Box	Satellite Bch	Allen Potter	321-777-2309	apotter@satellitebeach.org	NA	1=Stormwater Retrofit (CDS or baffle box)	28.17955	-80.603135	NA

Description of Additional Treatment Provided Beyond Permit Requirements, if applicable	Project Description	Project Footprint (Acres)	Treated Acres	Part of a Treatment Train (yes/no)	Associated Projects in Treatment Train, if applicable	Project Cost	Annual O&M Cost	Funding Source(s)	Project Status (select from the dropdown box)	Start Date of Project	Completion Date of Project	Project Area Map (select from dropdown box)	Name of Project Area Map File	Pounds of TN Removed	Pounds of TP Removed	Pounds of TSS Removed	Comments
NA	Type 1 Baffle Box Retrofit	NA	24.68	yes	10-ExA			SBSU	1=Completed		2006	1=GIS shapefile	Point_Treatments.shp	58.90	13.64		
NA	Type 1 Baffle Box Retrofit	NA	8.23	yes	10Ex-B			SBSU	1=Completed		11/2002	1=GIS shapefile	Point_Treatments.shp	0.23	0.17		
NA	Type 1 Baffle Box Retrofit	NA	8.6	yes	10Ex-D			SBSU	1=Completed		11/2002	1=GIS shapefile	Point_Treatments.shp	2.03	0.12		
NA	Exfiltration Pipes	NA	110.46	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU, FDEP	1=Completed		04/2005	1=GIS shapefile	Line_Treatments.shp	61.90	8.97		
NA	Exfiltration Pipes	NA	7.74	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU, FDEP	1=Completed		04/2005	1=GIS shapefile	Line_Treatments.shp	30.60	4.70		
NA	Exfiltration Pipes	NA	3.54	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU, FDEP	1=Completed		04/2005	1=GIS shapefile	Line_Treatments.shp	22.00	3.20		
NA	Exfiltration Pipes	NA	24.66	yes	33-Ex			SBSU	1=Completed		11/2002	1=GIS shapefile	Line_Treatments.shp	58.90	13.63		
NA	Exfiltration Pipes	NA	8.22	yes	29-Ex			SBSU	1=Completed		11/2002	1=GIS shapefile	Line_Treatments.shp	30.53	4.71		
NA	Exfiltration Pipes	NA	11.72	no				SBSU	1=Completed		11/2002	1=GIS shapefile	Line_Treatments.shp	22.06	3.24		
NA	Exfiltration Pipes	NA	8.59	yes	32-Ex			SBSU	1=Completed		11/2002	1=GIS shapefile	Line_Treatments.shp	40.10	10.70		
NA	Exfiltration Pipes	NA	39.74	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU, FDEP	1=Completed		4/2005	1=GIS shapefile	Line_Treatments.shp	11.19	1.79		
NA	Offline Wet Detntion Ponds	3.76	214.2	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU, FDEP	1=Completed		6/2007	1=GIS shapefile	Pond_Treatments.shp	578.40	141.40		
NA	3-Type 2 Baffle Boxes	NA	57.89	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU, FDEP	1=Completed		6/2007	1=GIS shapefile	Point_Treatments.shp	69.90	12.10		
NA	Stormwater Reuse for Irrigation	3.76	214.2	yes	19Ex-A, 19Ex-B, 19Ex-C,20-Ex,20-Ex,28-Ex,37-Ex			SBSU	1=Completed		6/2002	1=GIS shapefile	Pond_Treatments.shp	157.7	22.7		Removes 66.54 ac-ft/yr of stormwater from Jamaica pond
NA	Type 2 Baffle Box	NA	55.76	no	NA			SBSU	1=Completed		1996	1=GIS shapefile	Point_Treatments.shp				
													Total Removed	1144.44	241.07		
													5 Year Removal Allocation	3500	649.8		

APPENDIX 2

NODE DIAGRAMS FOR EXISTING TMDL CREDIT PROJECTS



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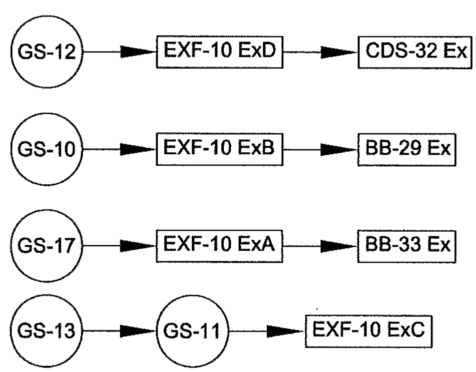

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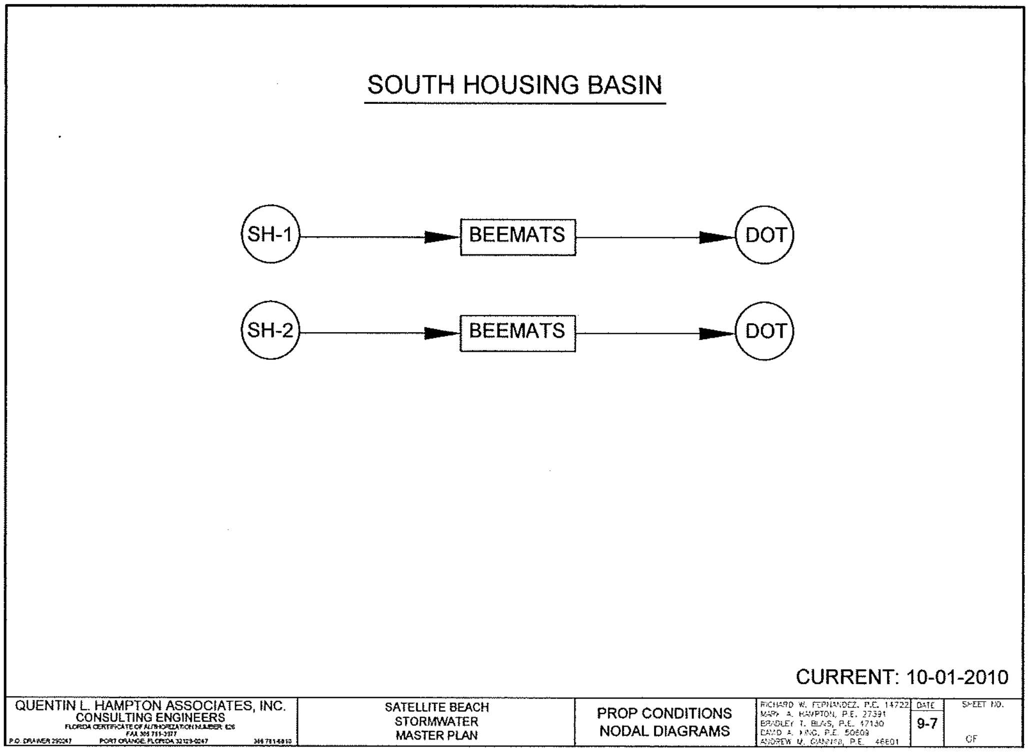
APPENDIX 3

NODE DIAGRAMS FOR PROPOSED PROJECTS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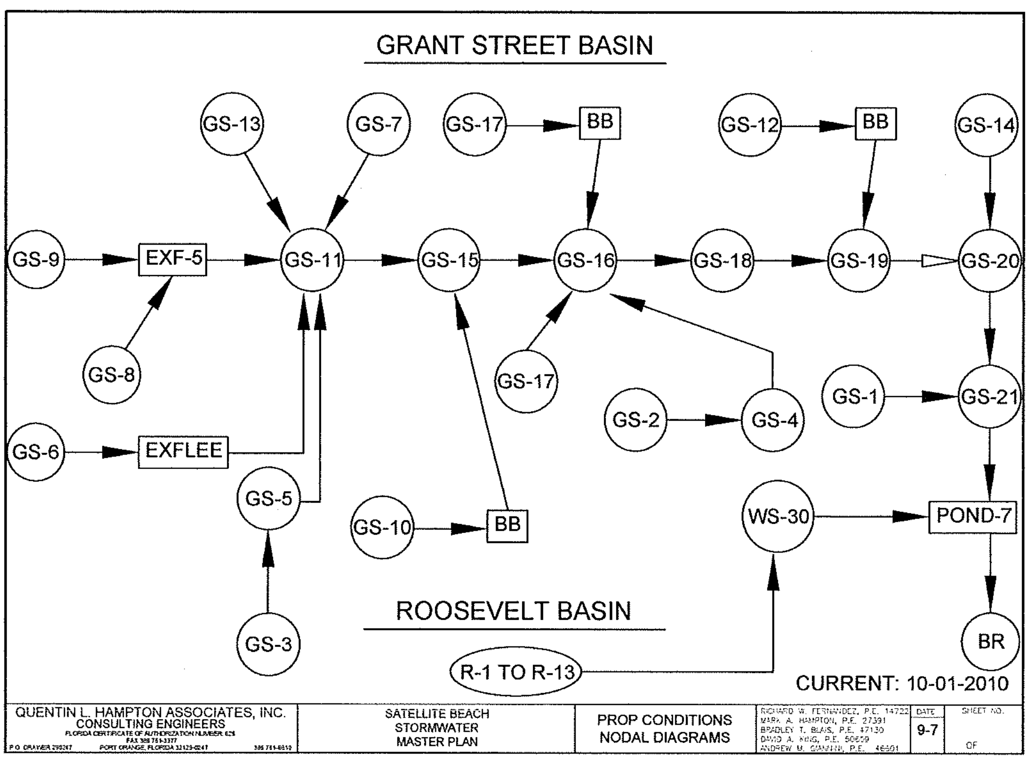
SH-1
BEEMATS
DOT
SH-2
BEEMATS
DOT
CURRENT: 10-01-2010
QUENTIN L. HAMPTON ASSOCIATES, INC.
CONSULTING ENGINEERS
SATELLITE BEACH
STORMWATER
MASTER PLAN
PROP CONDITIONS
NODAL DIAGRAMS
DATE
9-7
SHEET NO.
OF


GRANT STREET BASIN
GS-13
GS-7
GS-17
BB
GS-12
BB
GS-14
GS-9
EXF-5
GS-11
GS-15
GS-16
GS-18
GS-19
GS-20
GS-8
GS-17
GS-2
GS-4
GS-1
GS-21
GS-6
EXFLEE
GS-5
GS-10
BB
WS-30
POND-7
ROOSEVELT BASIN
GS-3
R-1 TO R-13
BR
CURRENT: 10-01-2010
QUENTIN L. HAMPTON ASSOCIATES, INC.
CONSULTING ENGINEERS
SATELLITE BEACH
STORMWATER
MASTER PLAN
PROP CONDITIONS
NODAL DIAGRAMS
DATE
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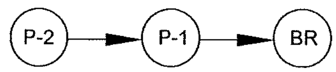
OF

PARK AVE BASIN



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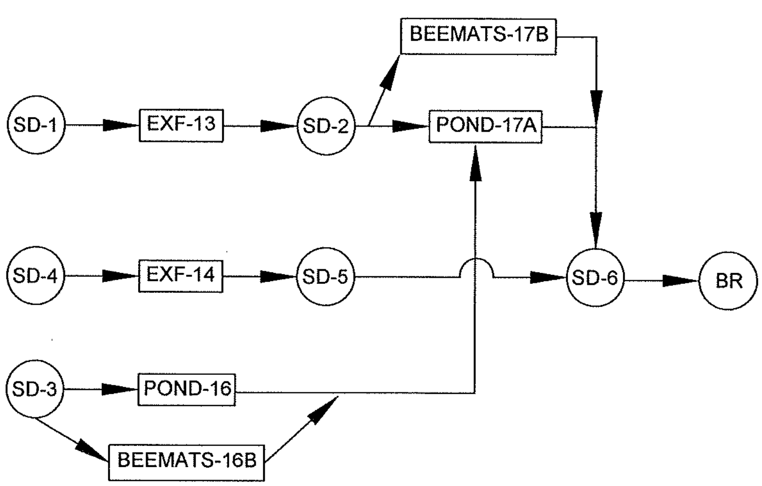
SOUTH DITCH BASIN



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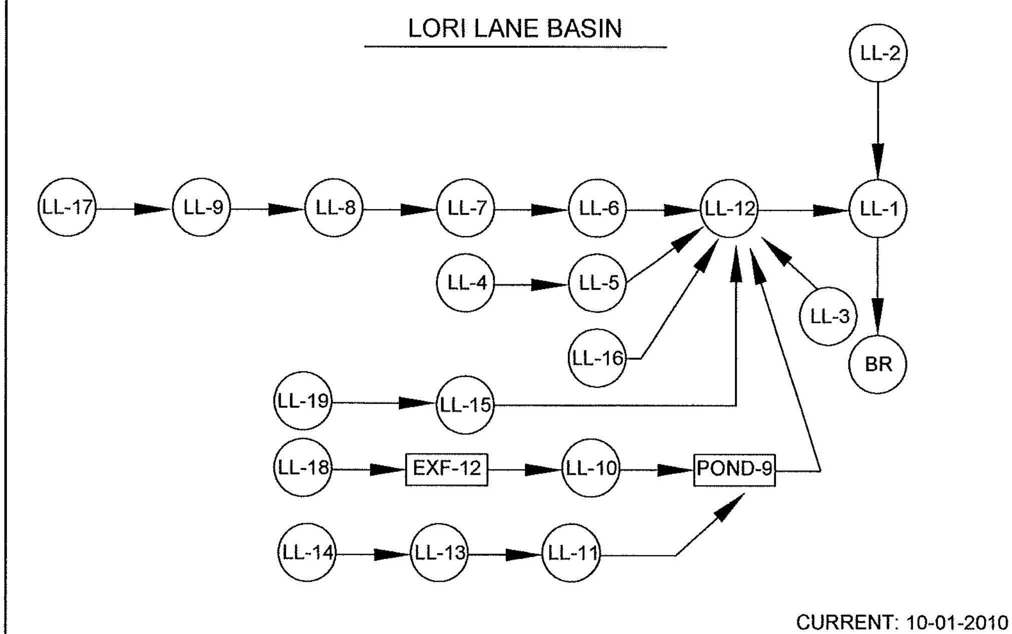

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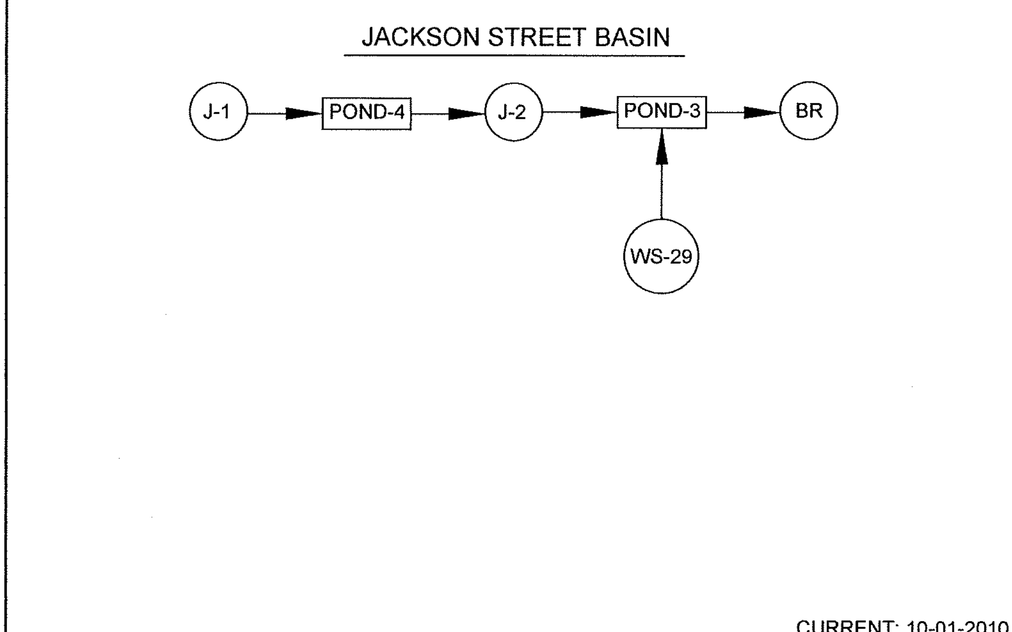

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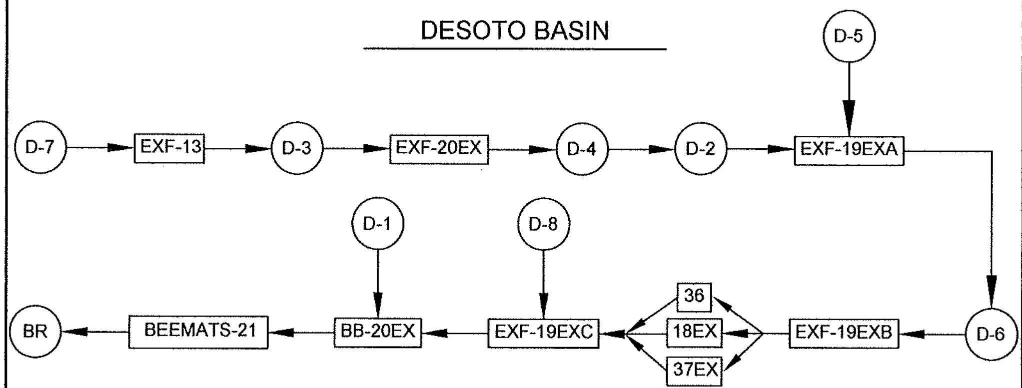
DESOTO BASIN



CURRENT: 10-01-2010

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APPENDIX 4

EXISTING POLLUTANT LOAD CALCULATIONS

Satellite Beach Project 10EX-A - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration Pipe, no gravel bed

Land Use : 1200,1700 **Basin No.** GS-17

Drainage Area: 24.68 acres

Soil Type: C

C value = 0.635 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **60.94** **ac-ft/yr**

<u>Pollutant Loads</u>

Annual TN Load from PLSM model = 314.66 lb/yr

Annual TP Load from PLSM model = 72.87 lb/yr

<u>Calculate retention volume</u>

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
24	1373	4311.22	0.099
18	433	764.79	0.018
Totals		**5076.01**	**0.117**

1" Retention Volume = 2.06 ac-ft

Retention Volume Provided = **0.06** inches

<u>Calculate Removal Efficiency</u>

% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.2 %
Interpolate for 0.06" - Removal Efficiency = 18.72 %

Annual TN load removed = 58.90 lb
Annual TP load removed = 13.64 lb
Annual TN Load passing to downstream baffle box on Pineapple = 255.76 lb
Annual TP Load passing to downstream baffle box on Pineapple = 59.23 lb

Satellite Beach Project 10EX-B - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe, no gravel bed

Land Use : 1200,1700 **Basin No.** GS-10

Drainage Area: 8.23 acres

Soil Type: C

C value = 0.42 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **13.44** **ac-ft/yr**

Pollutant Loads

Annual TN Load from PLSM model = 77.25 lb/yr

Annual TP Load from PLSM model = 11.92 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
24	1444	4534.16	0.104

1" Retention Volume = 0.69 ac-ft

Retention Volume Provided = **0.15** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2
Removal Efficiency for 0.1 " = 31.2 %
Removal Efficiency for 0.2" = 47.9

Interpolate for 0.15" - Removal Efficiency = 39.55 %

Annual TN load removed = 30.55 lb
Annual TP load removed = 4.71 lb
Annual TN Load passing to downstream baffle box on Orange Street = 46.70 lb
Annual TP Load passing to downstream baffle box on Orange Street = 7.21 lb

Satellite Beach Project 10EX-C - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe, no gravel bed

Land Use : 1200,1400 **Basin No.** GS-6,11

Drainage Area: 11.71 acres

Soil Type: C

C value = 0.407 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **18.53** **ac-ft/yr**

Pollutant Loads

Annual TN Load from PLSM model = 100.82 lb/yr
Annual TP Load from PLSM model = 14.77 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	609	2987.91	0.069

1" Retention Volume = 0.98 ac-ft

Retention Volume Provided = **0.07** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.2 %

Interpolate for 0.07" - Removal Efficiency = 21.84 %

Annual TN load removed = 22.02 lb
Annual TP load removed = 3.23 lb
Annual TN Load passing to downstream Roosevelt Pond (Project 7) = 78.80 lb
Annual TP Load passing to downstream Roosevelt Pond (Project 7) = 11.54 lb

Satellite Beach Project 10EX-D - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe, no gravel bed

Land Use : 1200, 1700 **Basin No.** GS-12

Drainage Area: 8.6 acres

Soil Type: C

C value = 0.786 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **26.28** **ac-ft/yr**

Pollutant Loads

Annual TN Load from PLSM model = 128.56 lb/yr
Annual TP Load from PLSM model = 34.14 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	609	2987.91	0.069

1" Retention Volume = 0.72 ac-ft

Retention Volume Provided = **0.10** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.2 %

Annual TN load removed = 40.11 lb
Annual TP load removed = 10.65 lb

Annual TN Load passing to downstream CDS Unit (Project 32-Ex) = 88.45 lb
Annual TP Load passing to downstream CDS Unit (Project 32-Ex) = 23.49 lb

Satellite Beach Project 18-Ex Jamaica
Pollutant Removal Calculations

BMP Type: Wet Pond 2/16/11

Land Use : 1200, 3300 **Basin No.** SD-1,D2-7,10

Drainage Area: 214.2 acres

Basins D2-7 have already received treatment from exfiltration pipe. Pick up treated loads from those areas (from Project 19-ExB + 19-ExB+D-6 + SD-1)

Soil Type: C

C value = 0.75 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in) = **624.66** **ac-ft/yr**

From PLSM model TN Load = 936.83 +31.17 +452.37+649.92 = 1,433.83 lbs/yr
From PLSM model TP Load = 135.7+3.69+64.36+2.38 = 206.13 lbs/yr

Calculate removal efficiency for existing wet detention ponds

Pond 1 is east of Jamaica
Normal Water Level at elevation 2.0
Water depth = 7 feet
Calculate stage storage below normal water level

Elevation	**Area (ac)**	**Depth change**	**Ave. Area (ac)**	**Volume (ac-ft)**
2	0.314	0	0	0
-5	0.142	7	0.228	1.596
Cumulative Volume (PPV)				**1.596**

Pond 2 is west of Jamaica
Normal Water Level at elevation 2
Water depth = 7 feet

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)
2	0.298	0	0	0
-5	0.213	7	0.2555	1.79
Cumulative Volume (PPV)				**1.79**

Pond 3 is south of Jamaica
Normal Water Level at elevation 2
Water depth = 11 feet

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)
2	1.34	0	0	0
-2	1.05	4	1.195	4.78
-9	0.86	7	0.955	6.685
Cumulative Volume (PPV)				**11.465**

Total PPV for all 3 ponds = 14.85

Calculate Residence Time

Mean pond depth = pond volume/pond area = **7.61** **feet**

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume

t_d = PPV ac-ft / Annual Runoff Volume = **8.7** **days**

Calculate Mass Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$
TP % Removal = $40.13 + (6.372 \times \ln(t_d)) + .213 \times (\ln(t_d))^2$

TN Removal Efficiency = **29.07** **%**
TP Removal Efficiency = **54.9** **%**

Calculate Annual Removals

TN Removal = **416.9** **lb/yr**

TP Removal = **113.1** **lb/yr**

Annual TN Load passing to downstream Basin D-9 = 1,016.96 lb
Annual TP Load passing to downstream Basin D-9 = 92.98 lb

Satellite Beach Project 19-ExA - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe at east end of Desoto exfiltration pipes
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-2,3,4,5,7

Drainage Area: 149.42 acres
Basins D-3 has its own exfiltration systems (Project 20-Ex). Therefore this Project 19-ExA will have an effective treatment area of 110.46 ac from Basins D-2,4,5,7

Soil Type: C

C value = 0.385 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **165.36** **ac-ft/yr**

From PLSM model TN Load = 998.75 lbs/yr
From PLSM model TP Load = 144.67 lbs/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	2000	9812.50	0.225

1" Retention Volume = 9.21 ac-ft

Retention Volume Provided = **0.02** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2
Removal Efficiency for 0.1 " = 31.2 %

Interpolate for 0.02" - Removal Efficiency = 6.2 %

Annual TN load removed = 61.92 lb
Annual TP load removed = 8.97 lb
Annual TN Load passing to downstream Jamaica Pond in Basin SD-1 (Project 18-Ex) = 936.83 lb
Annual TP Load passing to downstream Jamaica Pond in Basin SD-1 (Project 18-Ex) = 135.70 lb

Satellite Beach Project 19-ExB - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe in middle of Desoto Treatment Train
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-2,3,4,5,7,10

Drainage Area: 214.11 acres

Runoff from Basins D2-5 andD-7 enter upstream exfiltration before entering these exfiltration pipes. Therefore runoff volume treated in these exfiltration pipes will only be from Basin D-10 of 7.74 ac

Soil Type: C

C value = 0.35 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **10.53** **ac-ft/yr**

Annual TN Load from PLSM model = 64.04 lb/yr

Annual TP Load from PLSM model = 9.07 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	1300	6378.13	0.146

One inch retention volume from D-10 = 0.645 ac-ft

Retention Volume Provided = **0.23** **inches**

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2 Appendix F
Removal Efficiency for 0.2 " = 47.9 %

Removal Efficiency for 0.3" = 59.3

Interpolate for 0.23" - Removal Efficiency = 51.32 %

Annual TN load removed = **32.87** **lb**
Annual TP load removed = **5.38** **lb**

Water from this basin passes to Jamaica Pond (Project 18-Ex)

Annual TN Load passing to Jamaica Pond = 31.17 lb
Annual TP Load passing to Jamaica Pond = 3.69 lb

Satellite Beach Project 19-ExC - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe at west end of Desoto Treatment Train
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-2,3,4,5,6,7,8,SD-1

Drainage Area: 214.11 acres

Treatment Area is from Basin D-8: 3.54 Ac

Soil Type: C

C value = 0.44 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **6.06** **ac-ft/yr**

Annual TN Load from PLSM model = 32.19 lb/yr

Annual TP Load from PLSM model = 4.56 lb/yr

<u>Calculate retention volume</u>

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	1040	5102.50	0.117

One inch retention volume from D-8 = 0.295 ac-ft

Retention Volume Provided = 0.40 inches

<u>Calculate Removal Efficiency</u>
% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2 Appendix F
Removal Efficiency for 0.4 " = 66.84 %

Annual TN load removed = 21.52 lb
Annual TP load removed = 3.05 lb

Annual TN Load passed from Project 19ExC to Project 28-Ex = 10.67 lb
Annual TP Load passed from Projects 20-Ex, 19-ExA, and 19-Ex-B to Project 28-Ex = 1.51 lb

Satellite Beach Project 20 Ex - Coconut Street
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe Upstream of Desoto Exfiltration Pipe
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-3

Drainage Area: 37.47 acres

Soil Type: C

C value = 0.417 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **60.76** **ac-ft/yr**

Annual TN Load from PLSM model = 359.96 lb/yr

Annual TP Load from PLSM model = 57.42 lb/yr

Calculate retention volume

Pipe Size	Length (ft)	Volume (cf)	Volume (ac-ft)
18"	341	602.29	0.014
24"	355	1114.70	0.026
Total			**0.039**

1" Retention Volume = 3.12 ac-ft

Retention Volume Provided = **0.01** inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2
Removal Efficiency for 0.1 " = 31.1 %

Interpolate for 0.01" - Removal Efficiency = 3.1 %

Annual TN load removed = 11.16 lb
Annual TP load removed = 1.78 lb

Water passes to downstream exfiltration pipe (Project 19Ex-A). Downstream pipe has already provided treatment for it's basin and can not treat water from D-3. D-3 water will pass to Jamaica Pond for biological treatment.

Annual TN Load passing to Jamaica Pond (Project 18-Ex) = 348.80 lb
Annual TP Load passing to Jamaica Pond (Project 18-Ex) = 55.64 lb

Satellite Beach Project 28Ex - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: 3 - Type 2 Baffle Boxes

Land Use : 1200 **Basin No.** D-1-8, SD-1

Drainage Area: 57.92 acres

While the whole Desoto basin passes through the baffle boxes, the upstream BMPs of the treatment train will remove gross solids before they enter the baffle boxes. Therefore the baffle boxes only provide effective treatment of gross solids from Basin D-1.

Treatment Area: 57.84

Soil Type: C

C value = 0.332 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

= **74.67** **ac-ft/yr**

Annual TN Load from PLSM model = 450.63 lb/yr

Annual TP Load from PLSM model = 63.51 lb/yr

Type 2 Baffle Box TN removal = 15.5 %

Type 2 Baffle Box TP removal = 19.05 %

TN Removal = **69.85** **lb/yr**
TP Removal = **12.10** **lb/yr**

TN annual load passing downstream from basin D-1 = 380.78 lb
TN annual load passing downstream from basin D-1 = 51.41 lb

Satellite Beach Project 29Ex - Orange
Pollutant Removal Calculations

10/5/10

BMP Type: Type 1 Baffle Box
Receives water from Project 10-ExB

Land Use : 1200 **Basin No.** GS-10,13

Drainage Area: 16.55 acres

Treatment Area is Basin 10: 8.23 acres

Soil Type: C

C value = 0.425 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **13.60** **ac-ft/yr**

Annual TN Load from Project 10-ExB = 46.7 lb/yr

Annual TP Load from Project 10-ExB = 7.21 lb/yr

Type 1 Baffle Box TN removal = 0.5 %

Type 1 Baffle Box TP removal = 2.3 %

TN Removal = **0.23** **lb/yr**
TP Removal = **0.17** **lb/yr**

TN annual load passing downstream to Roosevelt Pond (Prop. Project 7) = 46.47 lb
TP annual load passing downstream to Roosevelt Pond (Prop. Project 7) = 4.91 lb

Satellite Beach Project 32Ex - Avacado
Pollutant Removal Calculations

10/5/10

BMP Type: CDS Unit downstream of Project 10Ex-D
Receives water from Project 10-ExD

Land Use : 1700 **Basin No.** GS-12

Drainage Area: 8.6 acres

Soil Type: C

C value = 0.785 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **26.25** **ac-ft/yr**

Annual TN Load from Project 10Ex-D =	88.45	lb/yr
Annual TP Load from Project 10Ex-D =	23.49	lb/yr
Type 1 Baffle Box TN removal =	2.3	%
Type 1 Baffle Box TP removal =	0.5	%
TN Removal =	**2.03**	**lb/yr**
TP Removal =	**0.12**	**lb/yr**
TN annual load passing downstream to Roosevelt Pond (Prop. Project 7) =	86.42	lb
TN annual load passing downstream to Roosevelt Pond (Prop. Project 7) =	23.37	lb

Satellite Beach Project 33Ex - Pineapple Street
Pollutant Removal Calculations

10/5/10

BMP Type: Type 1 Baffle Box
Receives water from Project 10-ExA

Land Use : 1200,1700 **Basin No.** GS-17

Drainage Area: 24.68 acres

Soil Type: C

C value = 0.635 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **60.94** **ac-ft/yr**

Annual TN Load from Project 10-ExA = 255.76 lb/yr

Annual TP Load from Project 10-ExA = 59.23 lb/yr

Type 1 Baffle Box TN removal = 0.5 %

Type 1 Baffle Box TP removal = 2.3 %

TN Removal = **1.28** **lb/yr**
TP Removal = **1.36** **lb/yr**

TN annual load passing downstream to Roosevelt Pond (Project 7) = 254.48 lb
TN annual load passing downstream to Roosevelt Pond (Project 7) = 57.87 lb

Yellow is user input. Green is automatically calculated

Satellite Beach Project 37Ex - Jamaica Pond
Pollutant Removal Calculations

10/5/10

BMP Type: Reuse

Land Use : 1200 **Basin No.** SD-1,D2-7,10

Drainage Area: 214.2 acres

Soil Type: C

C value = 0.726 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **604.67** **ac-ft/yr**

TN Load from PLSM model = **1433.88** **lb/yr**

TP Load from PLSM model = **206.13** **lb/yr**

Water is pulled from the Jamaica Pond for irrigating adjacent park.
Reuse volume = 59,400 gallons per day* = 66.54 ac-ft/yr

Reuse volume = 11.00 % of total annual volume.

Use removal efficiency = 11.00 %

TN Removal = **157.79** **lb/yr**
TP Removal = **22.68** **lb/yr**

* From historic records

Satellite Beach Project 38 - Roosevelt
Pollutant Removal Calculations

10/5/10

BMP Type:	Type 2 Baffle Box				
Land Use :	1200		**Basin No.**	R2-13	
Drainage Area:	55.76	acres			
Soil Type:	C				
C value =		0.44	from PLSM		

Calculate annual runoff volume

Annual rainfall =	46.66	inches		

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

= **95.40** **ac-ft/yr**

TN from upstream Basins =	**560.67**	**lb/yr**
TP from upstream Basins =	**92.81**	**lb/yr**
Type 2 Baffle Box TN removal =	19.05	%
Type 2 Baffle Box TP removal =	15.5	%
TN Removal =	**106.81**	**lb/yr**
TP Removal =	**14.39**	**lb/yr**

TN load passing downstream to Roosevelt Pond (Project 7) =	453.86	lb/yr
TN load passing downstream to Roosevelt Pond (Project 7) =	78.42	lb/yr

APPENDIX 4

EXISTING POLLUTANT LOAD CALCULATIONS

Satellite Beach Project 10EX-A - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration Pipe, no gravel bed

Land Use : 1200,1700 **Basin No.** GS-17

Drainage Area: 24.68 acres

Soil Type: C

C value = 0.635 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **60.94** **ac-ft/yr**

Pollutant Loads

Annual TN Load from PLSM model = 314.66 lb/yr

Annual TP Load from PLSM model = 72.87 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
24	1373	4311.22	0.099
18	433	764.79	0.018
Totals		**5076.01**	**0.117**

1" Retention Volume = 2.06 ac-ft

Retention Volume Provided = **0.06** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.2 %
Interpolate for 0.06" - Removal Efficiency = 18.72 %

Annual TN load removed = **58.90** **lb**
Annual TP load removed = **13.64** **lb**
Annual TN Load passing to downstream baffle box on Pineapple = 255.76 lb
Annual TP Load passing to downstream baffle box on Pineapple = 59.23 lb

Satellite Beach Project 10EX-B - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe, no gravel bed

Land Use : 1200,1700 **Basin No.** GS-10

Drainage Area: 8.23 acres

Soil Type: C

C value = 0.42 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **13.44** **ac-ft/yr**

Pollutant Loads
Annual TN Load from PLSM model = 77.25 lb/yr

Annual TP Load from PLSM model = 11.92 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
24	1444	4534.16	0.104

1" Retention Volume = 0.69 ac-ft

Retention Volume Provided = **0.15** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2
Removal Efficiency for 0.1 " = 31.2 %
Removal Efficiency for 0.2" = 47.9

Interpolate for 0.15" - Removal Efficiency = 39.55 %

Annual TN load removed = 30.55 lb
Annual TP load removed = 4.71 lb
Annual TN Load passing to downstream baffle box on Orange Street = 46.70 lb
Annual TP Load passing to downstream baffle box on Orange Street = 7.21 lb

Satellite Beach Project 10EX-C - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe, no gravel bed

Land Use : 1200,1400 **Basin No.** GS-6,11

Drainage Area: 11.71 acres

Soil Type: C

C value = 0.407 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **18.53** **ac-ft/yr**

Pollutant Loads

Annual TN Load from PLSM model = 100.82 lb/yr
Annual TP Load from PLSM model = 14.77 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	609	2987.91	0.069

1" Retention Volume = 0.98 ac-ft

Retention Volume Provided = **0.07** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.2 %

Interpolate for 0.07" - Removal Efficiency = 21.84 %

Annual TN load removed = **22.02** **lb**
Annual TP load removed = **3.23** **lb**
Annual TN Load passing to downstream Roosevelt Pond (Project 7) = 78.80 lb
Annual TP Load passing to downstream Roosevelt Pond (Project 7) = 11.54 lb

Satellite Beach Project 10EX-D - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe, no gravel bed

Land Use : 1200, 1700 **Basin No.** GS-12

Drainage Area: 8.6 acres

Soil Type: C

C value = 0.786 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **26.28** **ac-ft/yr**

Pollutant Loads

Annual TN Load from PLSM model = 128.56 lb/yr
Annual TP Load from PLSM model = 34.14 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	609	2987.91	0.069

1" Retention Volume = 0.72 ac-ft

Retention Volume Provided = **0.10** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.2 %

Annual TN load removed = 40.11 lb
Annual TP load removed = 10.65 lb

Annual TN Load passing to downstream CDS Unit (Project 32-Ex) = 88.45 lb
Annual TP Load passing to downstream CDS Unit (Project 32-Ex) = 23.49 lb

Satellite Beach Project 18-Ex Jamaica
Pollutant Removal Calculations

BMP Type: Wet Pond 2/16/11

Land Use : 1200, 3300 **Basin No.** SD-1,D2-7,10

Drainage Area: 214.2 acres

Basins D2-7 have already received treatment from exfiltration pipe. Pick up treated loads from those areas (from Project 19-ExB + 19-ExB+D-6 + SD-1)

Soil Type: C

C value = 0.75 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in) = **624.66** **ac-ft/yr**

From PLSM model TN Load = 936.83 +31.17 +452.37+649.92 = 1,433.83 lbs/yr
From PLSM model TP Load = 135.7+3.69+64.36+2.38 = 206.13 lbs/yr

Calculate removal efficiency for existing wet detention ponds

Pond 1 is east of Jamaica
Normal Water Level at elevation 2.0
Water depth = 7 feet
Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)
2	0.314	0	0	0
-5	0.142	7	0.228	1.596
Cumulative Volume (PPV)				**1.596**

Pond 2 is west of Jamaica
Normal Water Level at elevation 2
Water depth = 7 feet

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)
2	0.298	0	0	0
-5	0.213	7	0.2555	1.79
Cumulative Volume (PPV)				**1.79**

Pond 3 is south of Jamaica
Normal Water Level at elevation 2
Water depth = 11 feet

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)
2	1.34	0	0	0
-2	1.05	4	1.195	4.78
-9	0.86	7	0.955	6.685
Cumulative Volume (PPV)				**11.465**

Total PPV for all 3 ponds = 14.85

Calculate Residence Time

Mean pond depth = pond volume/pond area = **7.61** **feet**

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume

t_d = PPV ac-ft / Annual Runoff Volume = **8.7** **days**

Calculate Mass Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$
TP % Removal = $40.13 + (6.372 \times \ln(t_d)) + .213 \times (\ln(t_d))^2$

TN Removal Efficiency = **29.07** **%**
TP Removal Efficiency = **54.9** **%**

Calculate Annual Removals

TN Removal = **416.9** **lb/yr**

TP Removal = **113.1** **lb/yr**

Annual TN Load passing to downstream Basin D-9 = 1,016.96 lb
Annual TP Load passing to downstream Basin D-9 = 92.98 lb

Satellite Beach Project 19-ExA - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe at east end of Desoto exfiltration pipes
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-2,3,4,5,7

Drainage Area: 149.42 acres
Basins D-3 has its own exfiltration systems (Project 20-Ex). Therefore this Project 19-ExA will have an effective treatment area of 110.46 ac from Basins D-2,4,5,7

Soil Type: C

C value = 0.385 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **165.36** **ac-ft/yr**

From PLSM model TN Load = 998.75 lbs/yr
From PLSM model TP Load = 144.67 lbs/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	2000	9812.50	0.225

1" Retention Volume = 9.21 ac-ft

Retention Volume Provided = **0.02** inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2
Removal Efficiency for 0.1 " = 31.2 %

Interpolate for 0.02" - Removal Efficiency = 6.2 %

Annual TN load removed = 61.92 lb
Annual TP load removed = 8.97 lb
Annual TN Load passing to downstream Jamaica Pond in Basin SD-1 (Project 18-Ex) = 936.83 lb
Annual TP Load passing to downstream Jamaica Pond in Basin SD-1 (Project 18-Ex) = 135.70 lb

Satellite Beach Project 19-ExB - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe in middle of Desoto Treatment Train
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-2,3,4,5,7,10

Drainage Area: 214.11 acres

Runoff from Basins D2-5 andD-7 enter upstream exfiltration before entering these exfiltration pipes. Therefore runoff volume treated in these exfiltration pipes will only be from Basin D-10 of 7.74 ac

Soil Type: C

C value = 0.35 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **10.53** **ac-ft/yr**

Annual TN Load from PLSM model = 64.04 lb/yr

Annual TP Load from PLSM model = 9.07 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	1300	6378.13	0.146

One inch retention volume from D-10 = 0.645 ac-ft

Retention Volume Provided = 0.23 inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2 Appendix F
Removal Efficiency for 0.2 " = 47.9 %

Removal Efficiency for 0.3" = 59.3

Interpolate for 0.23" - Removal Efficiency = 51.32 %

Annual TN load removed = 32.87 lb
Annual TP load removed = 5.38 lb

Water from this basin passes to Jamaica Pond (Project 18-Ex)

Annual TN Load passing to Jamaica Pond = 31.17 lb
Annual TP Load passing to Jamaica Pond = 3.69 lb

Satellite Beach Project 19-ExC - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe at west end of Desoto Treatment Train
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-2,3,4,5,6,7,8,SD-1

Drainage Area: 214.11 acres

Treatment Area is from Basin D-8: 3.54 Ac

Soil Type: C

C value = 0.44 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **6.06** **ac-ft/yr**

Annual TN Load from PLSM model = 32.19 lb/yr

Annual TP Load from PLSM model = 4.56 lb/yr

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	1040	5102.50	0.117

One inch retention volume from D-8 = 0.295 ac-ft

Retention Volume Provided = 0.40 inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2 Appendix F
Removal Efficiency for 0.4 " = 66.84 %

Annual TN load removed = 21.52 lb
Annual TP load removed = 3.05 lb

Annual TN Load passed from Project 19ExC to Project 28-Ex = 10.67 lb
Annual TP Load passed from Projects 20-Ex, 19-ExA, and 19-Ex-B to Project 28-Ex = 1.51 lb

Satellite Beach Project 20 Ex - Coconut Street
Pollutant Removal Calculations

10/5/10

BMP Type: Existing Exfiltration Pipe Upstream of Desoto Exfiltration Pipe
No gravel bed, just wrapped pipe

Land Use : 1200 **Basin No.** D-3

Drainage Area: 37.47 acres

Soil Type: C

C value = 0.417 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **60.76** **ac-ft/yr**

Annual TN Load from PLSM model = 359.96 lb/yr

Annual TP Load from PLSM model = 57.42 lb/yr

Calculate retention volume

Pipe Size	Length (ft)	Volume (cf)	Volume (ac-ft)
18"	341	602.29	0.014
24"	355	1114.70	0.026
Total			**0.039**

1" Retention Volume = 3.12 ac-ft

Retention Volume Provided = **0.01** inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74
% Total Impervious Area = 40

From Table 2
Removal Efficiency for 0.1 " = 31.1 %

Interpolate for 0.01" - Removal Efficiency = 3.1 %

Annual TN load removed = 11.16 lb
Annual TP load removed = 1.78 lb

Water passes to downstream exfiltration pipe (Project 19Ex-A). Downstream pipe has already provided treatment for it's basin and can not treat water from D-3. D-3 water will pass to Jamaica Pond for biological treatment.

Annual TN Load passing to Jamaica Pond (Project 18-Ex) = 348.80 lb
Annual TP Load passing to Jamaica Pond (Project 18-Ex) = 55.64 lb

Satellite Beach Project 28Ex - Desoto
Pollutant Removal Calculations

10/5/10

BMP Type: 3 - Type 2 Baffle Boxes

Land Use : 1200 **Basin No.** D-1-8, SD-1

Drainage Area: 57.92 acres

While the whole Desoto basin passes through the baffle boxes, the upstream BMPs of the treatment train will remove gross solids before they enter the baffle boxes. Therefore the baffle boxes only provide effective treatment of gross solids from Basin D-1.

Treatment Area: 57.84

Soil Type: C

C value = 0.332 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

= **74.67** **ac-ft/yr**

Annual TN Load from PLSM model = 450.63 lb/yr

Annual TP Load from PLSM model = 63.51 lb/yr

Type 2 Baffle Box TN removal = 15.5 %

Type 2 Baffle Box TP removal = 19.05 %

TN Removal = **69.85** **lb/yr**
TP Removal = **12.10** **lb/yr**

TN annual load passing downstream from basin D-1 = 380.78 lb
TN annual load passing downstream from basin D-1 = 51.41 lb

Satellite Beach Project 29Ex - Orange
Pollutant Removal Calculations

10/5/10

BMP Type: Type 1 Baffle Box
Receives water from Project 10-ExB

Land Use : 1200 **Basin No.** GS-10,13

Drainage Area: 16.55 acres

Treatment Area is Basin 10: 8.23 acres

Soil Type: C

C value = 0.425 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **13.60** **ac-ft/yr**

Annual TN Load from Project 10-ExB = 46.7 lb/yr

Annual TP Load from Project 10-ExB = 7.21 lb/yr

Type 1 Baffle Box TN removal = 0.5 %

Type 1 Baffle Box TP removal = 2.3 %

TN Removal = **0.23** **lb/yr**
TP Removal = **0.17** **lb/yr**

TN annual load passing downstream to Roosevelt Pond (Prop. Project 7) = 46.47 lb
TP annual load passing downstream to Roosevelt Pond (Prop. Project 7) = 4.91 lb

Satellite Beach Project 32Ex - Avacado
Pollutant Removal Calculations

10/5/10

BMP Type: CDS Unit downstream of Project 10Ex-D
Receives water from Project 10-ExD

Land Use :	1700		**Basin No.**	GS-12
Drainage Area:	8.6	acres		
Soil Type:	C			
C value =		0.785	from PLSM	

Calculate annual runoff volume

Annual rainfall =	46.66	inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

= **26.25** **ac-ft/yr**

Annual TN Load from Project 10Ex-D =		88.45	lb/yr
Annual TP Load from Project 10Ex-D =		23.49	lb/yr
Type 1 Baffle Box TN removal =	2.3	%	
Type 1 Baffle Box TP removal =	0.5	%	

TN Removal =	**2.03**	**lb/yr**
TP Removal =	**0.12**	**lb/yr**

TN annual load passing downstream to Roosevelt Pond (Prop. Project 7) =	86.42	lb
TN annual load passing downstream to Roosevelt Pond (Prop. Project 7) =	23.37	lb

Satellite Beach Project 33Ex - Pineapple Street
Pollutant Removal Calculations

10/5/10

BMP Type: Type 1 Baffle Box
Receives water from Project 10-ExA

Land Use : 1200,1700 **Basin No.** GS-17

Drainage Area: 24.68 acres

Soil Type: C

C value = 0.635 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **60.94** **ac-ft/yr**

Annual TN Load from Project 10-ExA = 255.76 lb/yr

Annual TP Load from Project 10-ExA = 59.23 lb/yr

Type 1 Baffle Box TN removal = 0.5 %

Type 1 Baffle Box TP removal = 2.3 %

TN Removal = **1.28** **lb/yr**
TP Removal = **1.36** **lb/yr**

TN annual load passing downstream to Roosevelt Pond (Project 7) = 254.48 lb
TN annual load passing downstream to Roosevelt Pond (Project 7) = 57.87 lb

Yellow is user input. Green is automatically calculated

Satellite Beach Project 37Ex - Jamaica Pond
Pollutant Removal Calculations

10/5/10

BMP Type:	Reuse				
Land Use :	1200		**Basin No.**	SD-1,D2-7,10	
Drainage Area:	214.2	acres			
Soil Type:	C				
C value =		0.726	from PLSM		

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **604.67** **ac-ft/yr**

TN Load from PLSM model = **1433.88** **lb/yr**

TP Load from PLSM model = **206.13** **lb/yr**

Water is pulled from the Jamaica Pond for irrigating adjacent park.
Reuse volume = 59,400 gallons per day* = 66.54 ac-ft/yr

Reuse volume = 11.00 % of total annual volume.

Use removal efficiency = 11.00 %

TN Removal = **157.79** **lb/yr**
TP Removal = **22.68** **lb/yr**

* From historic records

Satellite Beach Project 38 - Roosevelt
Pollutant Removal Calculations

10/5/10

BMP Type:	Type 2 Baffle Box				
Land Use :	1200		**Basin No.**	R2-13	
Drainage Area:	55.76	acres			
Soil Type:	C				
C value =		0.44	from PLSM		

<u>Calculate annual runoff volume</u>

Annual rainfall =		46.66	inches		

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

			=	**95.40**	**ac-ft/yr**
TN from upstream Basins =		**560.67**	**lb/yr**		
TP from upstream Basins =		**92.81**	**lb/yr**		
Type 2 Baffle Box TN removal =		19.05	%		
Type 2 Baffle Box TP removal =		15.5	%		
TN Removal =		**106.81**	**lb/yr**		
TP Removal =		**14.39**	**lb/yr**		
TN load passing downstream to Roosevelt Pond (Project 7) =				453.86	lb/yr
TN load passing downstream to Roosevelt Pond (Project 7) =				78.42	lb/yr

APPENDIX 5

PROPOSED POLLUTANT LOAD CALCULATIONS

Satellite Beach Project 1A - Post Office
Pollutant Removal Calculations

10/5/10

BMP Type: Wet Pond

Land Use : 1400,1300,1700 **Basin No.** N-1,2,3,4

Drainage Area: 95.69 acres

Soil Type: B/D

C value = 0.72 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **267.89** **ac-ft/yr**

Assume first flush from Projects 6 does not reach Project 30 exfiltration pipes until they are full.
Therefore Project 30 pipes do not treat runoff from Project 6. Project 6 loads go straight to Project 1.

TN from Basins N-2,3= **449.29** **lb/yr**
TN from Projects 6,30 (Basins N-1,4) = **637.77** **lb/yr**
Total TN loading = **1,087.06** **lb/yr**

TP from Basins N2,3 = **114.51** **lb/yr**
TP from Projects 6,30 (Basins N-1,4) = **622.75** **lb/yr**
Total TP loading = **737.26** **lb/yr**

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Calculate stage storage

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume (ac-ft)
4	2.18		0		0
1	1.51	3	1.845	0	5.535
-1	1.27	2	1.39	2.78	2.78
-6	1.2	5	1.235	6.175	6.175
Cumulative Volume (PPV)				8.955	14.49

Calculate Residence Time

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume
= **12.2** **days**

Calculate Mass Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$ = **32.19** %
TP % Removal = $40.13 + (6.372 \times \ln(td)) + .213 \times (\ln(td))^2$ = **57.4** %

Calculate Annual Mass Removals

TN Removal = **350.0** **lb/yr**

TP Removal = **423.2** **lb/yr**

Satellite Beach Project 1B - Post Office
Pollutant Removal Calculations

BMP Type:	Beemats				10/6/10
Land Use :	1400,1300,1700		**Basin No.**	N-1,2,3,4	
Drainage Area:	95.69	acres			
Soil Type:	B/D				
C value =		0.72	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in) =

				267.89	**ac-ft/yr**

TN from Basins N-2,3=	**449.29**	**lb/yr**
TN from Projects 6,30 (Basins N-1,4) =	**287.87**	**lb/yr**
Total TN loading =	**737.16**	**lb/yr**
TP from Basins N2,3 =	**114.51**	**lb/yr**
TP from Projects 6,30 (Basins N-1,4) =	**0.00**	**lb/yr**
Total TP loading =	**114.51**	**lb/yr**

Calculate Annual Mass Removals

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal =	**147.43**	**lb/yr**
TP Removal =	**22.90**	**lb/yr**

Satellite Beach Project 3A - Jackson and S. Patrick
Pollutant Removal Calculations 10/5/10

BMP Type: Wet Pond

Land Use : 1200,1700,1400,1300 **Basin No.** WS-29,J1,2

Drainage Area: 12.13 acres

Soil Type: C

C value = 0.75 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **35.37** **ac-ft/yr**

TN from upstream Basins J2,W29 = 182.45 lb/yr
TN from Project 4 (Basin J-1) = 15.82 lb/yr
Total TN loading = 198.27 lb/yr

TN from upstream Basins J2,W29 = 44.61 lb/yr
TN from Project 4 (Basin J-1) = 4.55 lb/yr
Total TP loading = 49.16 lb/yr

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Pond removal efficiency is a function of permanent pool volume below normal water level

Calculate stage storage

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume (ac-ft)
4	0.45		0		0
1	0.24	3	0.345	0	1.035
-1	0.1	2	0.17	0.34	0.34
-6	0	5	0.05	0.25	0.25
Cumulative Volume (PPV)				**0.59**	**1.625**

Calculate Residence Time

Mean pond depth = pond volume/pond area = **2.46** **feet**

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume

= **6.1** **days**

Calculate Mass Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$
TP % Removal = $40.13 + (6.372 \times \ln(t_d)) + .213 \times (\ln(t_d))^2$

TN Removal Efficiency = 25.44 %
TP Removal Efficiency = 52.3 %

Calculate Annual Mass Removals

TN Removal = 46.42 lb/yr

TP Removal = 23.35 lb/yr

Satellite Beach Project 3B - Jackson and S. Patrick
Pollutant Removal Calculations

10/5/10

BMP Type:	Beemats				
Land Use :	1200,1700,1400,1300		**Basin No.**	WS-29,J1,2	
Drainage Area:	12.13	acres			
Soil Type:	C				
C value =		0.75	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

	35.37	**ac-ft/yr**

TN from upstream Basins J2,W29 =	182.45	lb/yr
TN from Project 4 (Basin J-1) =	23.80	lb/yr
Total TN loading =	**206.25**	**lb/yr**
TN from upstream Basins J2,W29 =	44.61	lb/yr
TN from Project 4 (Basin J-1) =	2.94	lb/yr
Total TP loading =	**47.55**	**lb/yr**

Calculate Annual Mass Removals

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal =	**41.25**	**lb/yr**
TP Removal =	**9.51**	**lb/yr**

Satellite Beach Project 4A - Jackson
Pollutant Removal Calculations

10/5/10

BMP Type: Wet Pond

Land Use : 1200,1700 **Basin No.** J1

Drainage Area: 2.82 acres

Soil Type: C

C value = 0.7 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
7.68 **ac-ft/yr**

TN from PLSM = **39.90** **lb/yr**
TP from PLSM = **9.36** **lb/yr**

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Pond removal efficiency is a function of permanent pool volume below normal water level

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume (ac-ft)
2	0.26				0
1	0.23	1	0.245	0	0.245
-1	0.16	2	0.195	0.39	0.39
-6	0.12	5	0.14	0.7	0.7
Cumulative Volume (PPV)				**1.09**	**1.335**

Calculate Residence Time
Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume =
51.83 days

Calculate Mass Removal Efficiencies

TN % Removal = 43.75 x t_d / (4.38 + t_d)
TP % Removal = 40.13 + (6.372 x ln(t_d)) + .213 x (ln(t_d))^2

TN Removal Efficiency = **40.34** %
TP Removal Efficiency = **68.6** %

Calculate Annual Mass Removals

TN Removal = **16.10** **lb/yr**

TP Removal = **6.42** **lb/yr**

TN passing to downstream Project 3 = 23.80 lb/yr

TP passing to downstream Project 3 = 2.94 lb/yr

Satellite Beach Project 4B - Jackson
Pollutant Removal Calculations 10/5/10

BMP Type:	Beemats				
Land Use :	1200,1700		**Basin No.**	J1	
Drainage Area:	2.82	acres			
Soil Type:	C				
C value =		0.7	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

				7.68	**ac-ft/yr**
TN from PLSM =		**39.90**	**lb/yr**		
TP from PLSM =		**9.36**	**lb/yr**		

Calculate Annual Mass Removals

Assume removal efficiency for TN and TP for Beemats =			20	%	
TN Removal =		**7.98**	**lb/yr**		
TP Removal =		**1.87**	**lb/yr**		

TN passing to downstream Project 3 if both Projects 4A and B are constructed

			15.82	lb/yr	

TP passing to downstream Project 3 if both Projects 4A and B are constructed

			4.55	lb/yr	

Satellite Beach Project 5 Lincoln
Pollutant Removal Calculations

10/5/10

BMP Type:	Exfiltration					
Land Use :	1400		**Basin No.**	GS-8,9		
Drainage Area:	5.74	acres				
Soil Type:	C					
C value =		0.56	from PLSM			
Calculate annual runoff volume						
Annual rainfall for PAFB =		46.66	inches			
Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)						
			=	**12.50**	**ac-ft/yr**	
TN from PLSM =		**66.95**	**lb/yr**			
TP from PLSM =		**13.47**	**lb/yr**			
970 lf of 18" perforated pipe. 3.5' x 2' gravel trench						
Calculate Storage Volume						
Pipe Volume = 970 x 0.75 x 0.75 x 3.14 =			1713	cf		
Trench Volume = 0.5 x((970 x 3.5 x 2) - 1713) =			2539	cf		
Total Retention Volume =			4252	cf =	0.098	ac-ft
Retention Volume = .0137/.478 =						
Calculate Removal Efficiencies						
1" Retention = DA/12 =		0.48	ac-ft			
Provided retention =		0.20	inches			
% DCIA =		25.00				
NDCIA CN =		74.00				
TN % Removal =		49.70				
TP % Removal =		49.70				
TN Removal =		**33.27**	**lb/yr**			
TP Removal =		**6.69**	**lb/yr**			
TN passing to downstream Project 7 =		33.68	lb/yr			
TP passing to downstream Project 7 =		6.78	lb/yr			

Satellite Beach Project 6 - Publix
Pollutant Removal Calculations

10/5/10

BMP Type: Dry Pond

Land Use : 1400 **Basin No.** N-4

Drainage Area: 4.92 acres

Soil Type: C

C value = 0.89 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **17.03** **ac-ft/yr**

TN from PLSM = **88.81** **lb/yr**
TP from PLSM = **22.80** **lb/yr**

Calculate Storage Volume

Elevation	Area (ac)	Depth Change (ft)	Ave. Area (ac)	Volume (ac-ft)
8	0.642	0	0	0.00
7	0.584	1	0.613	0.61
Cumulative Volume				**0.61**

Calculate Removal Efficiencies

1" Retention = DA/12 = 0.41 ac-ft
Provided retention = 1.50 inches

% DCIA = 75.00
NDCIA CN = 74.00

TN % Removal = 86.60
TP % Removal = 86.60

TN Removal = **76.91** **lb/yr**
TP Removal = **19.75** **lb/yr**

TN passing to downstream Project 1 = 11.90 lb/yr
TP passing to downstream Project 1 = 3.06 lb/yr

Satellite Beach Project 7A - Roosevelt and S. Patrick
Pollutant Removal Calculations

10/7/10

BMP Type: Wet Pond

Land Use : 1200,1300 **Basin No.** WS-30,R1-13,GS-1-20

Drainage Area: 261.13 acres

Soil Type: C

C value = 0.418 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= 424.42 **ac-ft/yr**

Total TN Load = **2179.93** **lb/yr**

Total TP Load = **405.93** **lb/yr**

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Pond removal efficiency is a function of permanent pool volume below normal water level

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Volume (ac-ft)
4	2.14		0		0
1	1.71	3	1.925	0	5.775
-1	1.42	2	1.565	3.13	3.13
-6	1.21	5	1.315	6.575	6.575
Cumulative Volume (PPV)				**9.71**	**15.48**

Calculate Residence Time

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume=
8.3 **days**

Calculate Mass Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$

TP % Removal = $40.13 + (6.372 \times \ln(t_d)) + .213 \times (\ln(t_d))^2$

TN Removal Efficiency = **28.69** %
TP Removal Efficiency = **54.6** %

Calculate Annual Removals

TN Removal = **625.5** **lb/yr**

TP Removal = **221.7** **lb/yr**

Satellite Beach Project 7B - Roosevelt and S. Patrick
Pollutant Removal Calculations

10/7/10

BMP Type:	Beemats				
Land Use :	1200,1300		**Basin No.**	WS-30,Roosevelt,GS-14,20,21	
Drainage Area:	261.13	acres			
Soil Type:	C				
C value =		0.418	from PLSM		
Calculate annual runoff volume					
Annual rainfall =		46.66	inches		
Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)					
			=	424.42	**ac-ft/yr**
TN from upstream Basins =		2179.93	lb/yr		
TP from upstream Basins =		405.93	lb/yr		
Calculate Annual Removals					
Assume removal efficiency for TN and TP for Beemats =			20	%	
TN Removal =		**435.99**	**lb/yr**		
TP Removal =		**81.19**	**lb/yr**		

Satellite Beach Project 8A - Cinnamon
Pollutant Removal Calculations

10/6/10

BMP Type: Wet Pond

Land Use : 1200,1700 **Basin No.** C-2

Drainage Area: 4.89 acres

Soil Type: C

C value = 0.46 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
8.75 **ac-ft/yr**

TN from PLSM = **50.42** **lb/yr**
TP from PLSM = **8.91** **lb/yr**

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Pond removal efficiency is a function of permanent pool volume below normal water level

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume
1.5	0.23		0		0
-0.5	0.16	3	0.195	0	0.585
-5.5	0.12	5	0.14	0.7	0.7
Cumulative Volume (PPV)				**0.70**	**1.285**

Calculate Residence Time

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume
= **29.2** **days**

Calculate Mass Removal Efficiencies

TN % Removal = 43.75 x t_d / (4.38 + t_d)
TP % Removal = 40.13 + (6.372 x ln(t_d)) + .213 x $(\ln(t_d))^2$

TN Removal Efficiency = **38.05** **%**
TP Removal Efficiency = **64.1** **%**

Calculate Mass Removals

TN mass removal = **19.18** **lb/yr**
TP mass removal = **5.71** **lb/yr**

Satellite Beach Project 8B - Cinnamon
Pollutant Removal Calculations 10/5/10

BMP Type:	Beemats				
Land Use :	1200,1700		**Basin No.**	C-2	
Drainage Area:	4.89	acres			
Soil Type:	C				
C value =		0.46	from PLSM		

<u>Calculate annual runoff volume</u>

Annual rainfall =		46.66	inches		

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

				8.75	**ac-ft/yr**
TN from PLSM =		**50.42**	**lb/yr**		
TP from PLSM =		**8.91**	**lb/yr**		

<u>Calculate Annual Removals</u>

Assume removal efficiency for TN and TP for Beemats =		20	%
TN Removal =	**10.08**	**lb/yr**	
TP Removal =	**1.78**	**lb/yr**	

Satellite Beach Project 9A - Elwood
Pollutant Removal Calculations

10/5/10

BMP Type: Wet Pond

Land Use : 1200 **Basin No.** LL-10,11,13,14,18

Drainage Area: 35.06 acres

Soil Type: C
C value = 0.39 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **53.17** **ac-ft/yr**

TN from Basins LL-10,11,13,14 =	320.96	lb/yr
TN from Project 12 (Basin LL-18) =	8.42	lb/yr
Total TN loading =	**329.38**	**lb/yr**

TP from Basins LL-10,11,13,14 =	47.66	**lb/yr**
TP from Project 12 (Basin LL-18) =	1.18	**lb/yr**
Total TP loading =	**48.84**	**lb/yr**

Calculate Storage Volume

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume (ac-ft)
5	0.23		0		0
3	0.16	2	0.195	0	0.39
-1	0.12	4	0.14	0.56	0.56
Cumulative Volume (PPV)				**0.56**	**0.95**

Calculate Residence Time

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume
= **3.8** **days**

Calculate Mass Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$

TP % Removal = $40.13 + (6.372 \times \ln(t_d)) + .213 \times (\ln(t_d))^2$

TN Removal Efficiency = 20.30 %
TP Removal Efficiency = 49.0 %

Calculate Annual Removals

TN Removal = **65.16** **lb/yr**
TP Removal = **23.35** **lb/yr**

Satellite Beach Project 9B - Elwood
Pollutant Removal Calculations 2/18/11

BMP Type: Beemats

Land Use : 1200 **Basin No.** LL-10,11,13,14,18

Drainage Are 35.06 acres

Soil Type: C
C value = 0.39 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **53.17** **ac-ft/yr**

TN from Basins LL-10,11,13,14 =	320.96	lb/yr
TN from Project 12 (Basin LL-18) =	8.42	lb/yr
Total TN loading =	**329.38**	**lb/yr**
TP from Basins LL-10,11,13,14 =	47.66	**lb/yr**
TP from Project 12 (Basin LL-18) =	1.18	**lb/yr**
Total TP loading =	**48.84**	**lb/yr**

<u>Calculate Annual Removals</u>

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal = **65.88** **lb/yr**

TP Removal = **9.77** **lb/yr**

Satellite Beach Project 11 - South Base Housing
Pollutant Removal Calculations

10/5/10

BMP Type:	Beemats				
Land Use :	1300		**Basin No.**	SH-2	
Drainage Area:	167.67	acres			
Soil Type:	C				
C value =		0.62	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

				404.21	**ac-ft/yr**
TN from PLSM =	**2255.64**	**lb/yr**			
TP from PLSM =	**542.56**	**lb/yr**			

Calculate Annual Removals

Assume removal efficiency for TN and TP for Beemats =			20	%	
TN Removed =				**451.1**	**lb/yr**
TP Removed =				**108.5**	**lb/yr**

Satellite Beach Project 12 - Elwood
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration pipe

Land Use :	1200		**Basin No.**	LL-18	
Drainage Area:	3.11	acres			
Soil Type:	C				
C value =		0.3	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

			=	**3.63**	**ac-ft/yr**
TN from PLSM =		**22.34**	**lb/yr**		
TP from PLSM =		**3.14**	**lb/yr**		

420 lf of 24" perforated pipe
3' x 4' gravel trench
Assume gravel has 50% voids

Calculate Storage Volume

Pipe Volume = 420 x 1 x 3.14 =	1319	cf		
Trench Volume = 0.5 x((420 x 3 x 4) - 1319) =	2539	cf		
Total Retention Volume =	3858	cf =	0.089	ac-ft

Calculate Removal Efficiencies

1" Retention = DA/12 =	0.26	ac-ft		
Provided retention =	0.34	inches		
% DCIA =	25.00			
NDCIA CN =	74.00			

From Table 2

Removal Efficiency for 0.3 " =	59.3	%		
Removal Efficiency for 0.4" =	66.8	%		
Interpolate for 0.34" - Removal Efficiency =		62.3	%	
TN Removal =	**13.92**	**lb/yr**		
TP Removal =	**1.96**	**lb/yr**		
TN passing to downstream Project 9 =	8.42	lb/yr		
TP passing to downstream Project 9 =	1.18	lb/yr		

Satellite Beach Project 13 - Palm
Pollutant Removal Calculations

10/5/10

BMP Type:	Exfiltration Pipe					
Land Use :	1300		**Basin No.**	SD1, D7		
Drainage Area:	4.54	acres				
Soil Type:	A					
C value =		0.51	from PLSM			
Calculate annual runoff volume						
Annual rainfall =		46.66	inches			
Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)						
			=	**9.00**	**ac-ft/yr**	
TN from PLSM model =		**44.65**	**lb/yr**			
TP from PLSM model =		**9.96**	**lb/yr**			
550 lf of 30" pipe in 4' x 4.5' trench						
Assume gravel has 50% voids						
Calculate Storage Volume						
Pipe Volume = 550 x 1.25 x 1.25 x 3.14 =			2698	cf		
Trench Volume = 0.5 x ((500 x 4 x 4.5) - 2551)) =			3224	cf		
Total Retention Volume =			5922	cf =	0.136	ac-ft
1" Retention Volume =		0.38	ac-ft			
Retention Volume Provided =		**0.36**	inches			
Calculate Removal Efficiency						
% DCIA =		25				
NDCIA CN =		74				
From Table 2						
Removal Efficiency for 0.3 " =		59.3	%			
Removal Efficiency for 0.4 " =		66.8	%			
Interpolate for 0.34" - Removal Efficiency =			63.8	%		
TN Removal =		**28.49**	**lb**			
TP Removal =		**6.36**	**lb**			
TN Load passing to downstream Project 17 (Basin SD-2) =				16.16	lb/yr	
TP Load passing to downstream Project 17 (Basin SD-2) =				3.61	lb/yr	

Satellite Beach Project 14 - Palmetto
Pollutant Removal Calculations

10/5/10

BMP Type: Exfiltration Pipe

Land Use : 1200 **Basin No.** SD 4

Drainage Area: 2.41 acres

Soil Type: A

C value = 0.25 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **2.34** **ac-ft/yr**

TN from upstream Basins = **44.65** **lb/yr**
TP from upstream Basins = **9.96** **lb/yr**

500 lf of 30" pipe in 4' x 4.5' trench
600 lf of 24" pipe in 4' x 3.5' trench
Assume gravel has 50% voids

Calculate Storage Volume

30" pipe

Pipe Volume = 500 x 1.25 x 1.25 x 3.14 =	2453	cf		
Trench Volume = 0.5 x ((500 x 4 x 4.5) - 2551)) =	3224	cf		
Total Retention Volume =	5677	cf =	0.130	ac-ft

24" pipe

Pipe Volume = 600 x 1 x 3.14 =	1884	cf
Trench Volume = 0.5 x ((600 x 3.5 x 4) - 2551)) =	3258	cf

1" Retention Volume = 0.20 ac-ft

Retention Volume Provided = 0.65 inches

Calculate Removal Efficiency

% DCIA = 25
NDCIA CN = 74

From Table 2

Removal Efficiency for 0.6 " = 76.3 %
Removal Efficiency for 0.7 " = 79.4 %
Interpolate for 0.65" - Removal Efficiency = 77.9 %

TN Removal = **34.78** **lb**
TP Removal = **7.76** **lb**

Annual TN Load passing to downstream Project 17 (Basin SD-2) = 9.87 lb/yr
Annual TP Load passing to downstream Project 17 (Basin SD-2) = 2.20 lb/yr

Satellite Beach Project 15 - South Ditch
Pollutant Removal Calculations

10/5/10

BMP Type:	Dry Retention Swale				
Land Use :	1200		**Basin No.**	SD 5	
Drainage Area:	16.91	acres			
Soil Type:	A				
C value =		0.24	from PLSM		
Calculate annual runoff volume					
Annual rainfall =		46.66	inches		
Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)					
			=	**15.78**	**ac-ft/yr**
TN from upstream Basins =		**93.87**	**lb/yr**		
TP from upstream Basins =		**14.33**	**lb/yr**		
Calculate retention volume					
Dry pond 1520' x 12' x 2'/43560 =			0.84	ac-ft	
1" Retention Volume =		1.41	ac-ft		
Retention Volume Provided =		**0.60**	**inches**		
Calculate Removal Efficiency					
% DCIA =		25			
NDCIA CN =		74			
From Table 2					
Removal Efficiency for 0.6 " =		76.3	%		
Annual TN load removed =		**71.62**	**lb**		
Annual TP load removed =		**10.94**	**lb**		

Satellite Beach Project 16A Library Pond 1
Pollutant Removal Calculations

10/6/10

BMP Type: Wet Pond

Land Use : 1200, 1300, 3200 **Basin No.** SD-3

Drainage Area: 14.1 acres

Soil Type: C

C value = 0.39 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

21.38 **ac-ft/yr**

TN from upstream Basins = **121.66** **lb/yr**
TP from upstream Basins = **17.38** **lb/yr**

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume (ac-ft)
4	1.63				0
2	1.18	3	1.405	0	4.215
0	1.02	2	1.1	2.2	2.2
-5	0.85	5	0.935	4.675	4.675
Cumulative Volume (PPV)				**6.875**	**11.09**

Calculate Residence Time

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume

= **117.4** **days**

Calculate Mass Removal Efficiencies

TN % Removal = 43.75 x t_d / (4.38 + t_d)

TP % Removal = 40.13 + (6.372 x ln(t_d)) + .213 x (ln(t_d))^2

TN Removal Efficiency = 42.18 %
TP Removal Efficiency = 75.3 %

Calculate Annual Removals

TN removal = **51.3** **lb/yr**

TP removal = **13.1** **lb/yr**

TN Load passing down to Project 17 = 70.35 lb/yr
TP Load passing down to Project 17 = 4.29 lb/yr

Satellite Beach Project 16B - Library Pond 1
Pollutant Removal Calculations

10/5/10

BMP Type:	Beemats				
Land Use :	1200, 1300, 3200		**Basin No.**	SD-3	
Drainage Area:	14.1	acres			
Soil Type:	C				
C value =		0.39	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

				21.38	**ac-ft/yr**
TN from PLSM =		**121.66**	**lb/yr**		
TP from PLSM =		**17.38**	**lb/yr**		

Calculate Annual Removals

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal =		**24.33**	**lb/yr**
TP Removal =		**3.48**	**lb/yr**

Satellite Beach Project 17A Library Pond 2
Pollutant Removal Calculations

10/6/10

BMP Type: Wet Pond

Land Use : 1200, 7400 **Basin No.** SD-1-4,6

Drainage Area: 135.81 acres

Basins SD-1,3,4 receive treatment in upstream Projects 13,14,16

Soil Type: A,C

C value = 0.329 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

173.74 ac-ft/yr

TN from upstream Projects 13,14,16* = 72.05 lb/yr
TN from Basin SD-2 = 649.92 lb/yr
Total TN = 721.97 lb/yr

TP from upstream Projects 13,14,16* = 6.62 lb/yr
TP from Basin SD-2 = 105.39 lb/yr
Total TP = 112.01 lb/yr

Calculate removal efficiency for proposed wet detention pond

Normal Water Level at elevation 1.0

4:1 side slopes to elevation -1.0

2:1 side slopes to elevation -6.0

Pond depth = 7 feet.

Pond removal efficiency is a function of permanent pool volume below normal water level

Calculate stage storage below normal water level

Elevation	Area (ac)	Depth change	Ave. Area (ac)	Volume (ac-ft)	Exc. Volume (ac-ft)
4	2.31				0
1	1.69	3	2	0	6
-1	1.51	2	1.6	3.2	3.2
-6	1.22	5	1.365	6.825	6.825
Cumulative Volume (PPV)				**10.025**	**16.025**

Calculate Residence Time

Annual Residence Time (t_d) = Permanent Pool Volume / Annual Runoff Volume

t_d = 14.5 ac-ft / 1602 ac-ft/yr x 12 in/ft x 365 days/yr = **21.1 days**

Calculate Removal Efficiencies

TN % Removal = $43.75 \times t_d / (4.38 + t_d)$
TP % Removal = $40.13 + (6.372 \times \ln(t_d)) + .213 \times (\ln(t_d))^2$

TN Removal Efficiency = 36.22 %
TP Removal Efficiency = 61.5 %

Calculate Annual Removals

TN Removal = 261.5 lb/yr

TP Removal = 68.9 lb/yr

*Beemats load reudctions are subtracted from wet pond totals to downstream basins

Satellite Beach Project 17B - Library Pond 2
Pollutant Removal Calculations

10/6/10

Land Use : 1200, 7400 **Basin No.** SD-1-4,6

Drainage Area: 135.81 acres

Basins SD-1,3,4 receive treatment in upstream Projects 13,14,16

Soil Type: A,C

C value = 0.329 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

173.74 ac-ft/yr

TN from upstream Projects 13,14,16* =	72.72	lb/yr
TN from Basin SD-2 =	649.92	lb/yr
Total TN =	**722.64**	**lb/yr**
TP from upstream Projects 13,14,16* =	6.77	lb/yr
TP from Basin SD-2 =	105.39	lb/yr
Total TP =	**112.16**	**lb/yr**

Assume Beemats Removal Efficincy = 20 %

<u>Calculate Annual Removals</u>

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal = **144.53** **lb/yr**

TP Removal = **22.43** **lb/yr**

Satellite Beach Project 21 Desoto Park
Pollutant Removal Calculations

10/5/10

BMP Type:	Beemats			
Land Use :	1200, 1860		**Basin No.**	D1-9, SD-1
Drainage Area:	298.83	acres		
Soil Type:	C			
C value =		0.366	from PLSM	

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual generated runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
425.27 **ac-ft/yr**

TN from upstream Projects 19-Ex-C +28-Ex+ 20-Ex+ 13+ 18-E - 37-Ex - 36*=	991.44	lb/yr
TN from Basin D-9 =	112.48	lb/yr
Total TN =	**1103.92**	**lb/yr**

TP from upstream Projects 19-Ex-C+ 28-Ex+ 20-Ex+ 13+ 18-Ex - 37-Ex - 36* =	88.59	lb/yr
TP from Basin D-9 =	13.19	lb/yr
Total TP =	**101.78**	**lb/yr**

Calculate Pollutant Loadings

TN concentration =	**1.77**	**mg/L from PLSM**
TP concentration =	**0.48**	**mg/L from PLSM**

Calculate Annual Removals

Assume removal efficiency for TN and TP for Beema 20 %

TN annual mass removal = **220.78** **lb**

TP annual mass removal = **20.36** **lb**

* Note that Beemat and Reuse removals from Project 37-Ex and 36 are subtracted from Project 38-Ex passdown loads

Satellite Beach Project 22 - Ocean Spray
Pollutant Removal Calculations

10/7/10

BMP Type:	Type 2 Baffle Box				
Land Use :	1200		**Basin No.**	C-11,12	
Drainage Area:	32.52	acres			

Loads from Basin C-12 have already been treated with exfiltration pipe. Only untreated water from **Basin C-11 will be treated by baffle box.**

Treatment Area:	19.76	acres			
Soil Type:	A				
C value =		0.49	from PLSM		

<u>Calculate annual runoff volume</u>

Annual rainfall =		46.66	inches		

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

			=	**61.96**	**ac-ft/yr**
TN from upstream Projects 24,25 =		302.27	lb/yr		
Use TN from Basin C-11 =		**181.52**	**lb/yr**		
TP from upstream Projects 24,25 =		49.85	lb/yr		
Use TP from Basin C-11 =		**26.06**	**lb/yr**		
Type 2 Baffle Box TN removal =		7.75	% because 1/2 of basin is already treated		
Type 2 Baffle Box TP removal =		9.525	% because 1/2 of basin is already treated		
TN Removal =		**14.07**	**lb/yr**		
TP Removal =		**2.48**	**lb/yr**		
Annual TN load passing to downstream Project 27 =				469.72	lb/yr
Annual TP load passing to downstream Project 27 =				73.43	lb/yr

Satellite Beach Project 23 - Cassia
Pollutant Removal Calculations

10/6/10

BMP Type:	Type 2 Baffle Box				
Land Use :	1200		**Basin No.**	C-13,16,17	

Treatment Area is only for Basin C-13. Load from project 26 has already been treated for particulates. Dissolved pollutants will pass on through the box.

Drainage Area:	35.54	acres			
Treatment Area:	12.9	acres			
Soil Type:	A,C				
C value =		0.576	from PLSM		

<u>Calculate annual runoff volume</u>

Annual rainfall =		46.66	inches		

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

			=	**79.60**	**ac-ft/yr**
TN from upstream Project 26 =		172.22	lb/yr		
Use TN from Basin C-13 =		157.11	lb/yr		
TP from upstream Project 26 =		36.90	lb/yr		
Use TP from Basin C-13 =		35.75	lb/yr		
Type 2 Baffle Box TN removal =		15.5	%		
Type 2 Baffle Box TP removal =		19.05	%		
TN Removal =		**24.35**	**lb/yr**		
TP Removal =		**6.81**	**lb/yr**		
TN load passed to downstream Project 31 =			304.98	lb/yr	
TP load passed to downstream Project 31 =			65.84	lb/yr	

Satellite Beach Project 24 - Ocean Spray
Pollutant Removal Calculations

10/7/10

BMP Type: Exfiltration

Land Use : 1200 **Basin No.** C-12

Drainage Area: 12.76 acres

Soil Type: A

C value = 0.492 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **24.41** **ac-ft/yr**

TN from upstream Basins = 139.86 lb/yr
TP from upstream Basins = 27.22 lb/yr

Calculate retention volume

Pipe Size	Length (ft)	Volume (cf)	Volume (ac-ft)
15	1024	1256.00	0.029

1" Retention Volume = 1.06 ac-ft

Retention Volume Provided = **0.03** inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.1 %

Interpolate for 0.03" - Removal Efficiency = 9.64 %

Annual TN load removed = 13.48 lb
Annual TP load removed = 2.62 lb

Annual TN Load passing to downstream Project 22 (baffle box) = 126.38 lb
Annual TN Load passing to downstream Project 22 (baffle box) = 24.60 lb

Satellite Beach Project 25 - Greenway
Pollutant Removal Calculations

10/7/10

BMP Type: Exfiltration

Land Use : 1200 **Basin No.** C-11

Drainage Area: 19.76 acres

Soil Type: C

C value = 0.39 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **29.97** **ac-ft/yr**

TN from PLSM = **181.52** **lb/yr**
TP from PLSM = **26.06** **lb/yr**

Calculate retention volume

Pipe Size	Length (ft)	Volume (cf)	Volume (ac-ft)
24	232	728.48	0.017

1" Retention Volume = 1.65 ac-ft

Retention Volume Provided = **0.01** inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.1 %

Interpolate for 0.01" - Removal Efficiency = 3.1 %

Annual TN load removed = **5.63** **lb**
Annual TP load removed = **0.81** **lb**

Annual TN Load passing to downstream Project 22 (baffle box) = 175.89 lb
Annual TP Load passing to downstream Project 22 (baffle box) = 25.25 lb

Satellite Beach Project 26 - Ocean Spray
Pollutant Removal Calculations

10/7/10

BMP Type: Exfiltration

Land Use : 1200 **Basin No.** C-16,17

Drainage Area: 22.64 acres
Basin C-16 has private wet ponds
Treatment Area is only for Basin C-17 = 14.14 acres

Soil Type: C

C value = 0.565 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **49.74 ac-ft/yr**

TN from upstream Basins = 172.74 lb/yr
TP from upstream Basins = 37.01 lb/yr

Calculate retention volume

Pipe Size	Length (ft)	Volume (cf)	Volume (ac-ft)
18	208	367.38	0.008

1" Retention Volume = 1.18 ac-ft

Retention Volume Provided = **0.01** inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 29.9 %

Interpolate for 0.01" - Removal Efficiency = 0.3 %

Annual TN load removed = 0.52 lb
Annual TP load removed = 0.11 lb

Runoff from exfiltration pipe does not receive treatment from Project 24 pipes because they will be full from runoff from Project 24 basin.
Annual TN Load passing to downstream Project 23 = 172.22 lb
Annual TP Load passing to downstream Project 23 = 36.90 lb

Satellite Beach Project 27 - Temple
Pollutant Removal Calculations

10/7/10

BMP Type:

Land Use : 1200 **Basin No.** C-14

Drainage Area: 9.5 acres

Soil Type: C

C value = 0.39 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **14.41** **ac-ft/yr**

TN from PLSM = **87.13** **lb/yr**
TP from PLSM = **12.35** **lb/yr**

Calculate retention volume

Pipe Size	Length (ft)	Volume (cf)	Volume (ac-ft)
15	228	279.66	0.006

1" Retention Volume = 0.79 ac-ft

Retention Volume Provided = **0.01** inches

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74

From Table 2
Removal Efficiency for 0.1 " = 31.1 %

Interpolate for 0.01" - Removal Efficiency = 3.1 %

Annual TN load removed = **2.70** **lb**
Annual TP load removed = **0.38** **lb**

Annual TN Load passing to downstream Project 31 = 84.43 lb
Annual TP Load passing to downstream Project 31 = 11.97 lb

Satellite Beach Project 30 - North Outfall
Pollutant Removal Calculations

BMP Type: Exfiltration

Land Use : 1700 **Basin No.** N-1, N-4

Drainage Area: 63.78 acres
Treatment Area is Basin N-1 58.86 acres
Baffle boxes are downstream of project 1. Project 1 pond will clean gross solids. No effective treatment will be provided by baffle boxes.
Soil Type: C
C value = 0.78 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **178.52** **ac-ft/yr**

TN from Basins N-1 = **884.76** **lb/yr**
TN from Project 6 (Basin N-4) = **11.90** **lb/yr**
Total TN loading = **896.66** **lb/yr**

TP fromBasin N-1 = **884.76** **lb/yr**
TP from Project 6 (Basin N-4) = **3.06** **lb/yr**
Total TP loading = **887.82** **lb/yr**

Calculate retention volume

Pipe Size (in)	Length (ft)	Volume (cf)	Volume (ac-ft)
30	3916	19212.88	0.441

One inch retention volume from D-10 = 4.905 ac-ft

Retention Volume Provided = **0.09** **inches**

Calculate Removal Efficiency
% DCIA = 25
NDCIA CN = 74

From Table 2 Appendix F
Removal Efficiency for 0.1 " = 30.2 %

TN load removed = **270.79** **lb/yr**
TP load removed = **268.12** **lb/yr**

TN Load passing to Project 1 = 625.87 lb/yr
TP Load passing to Project 1 = 619.70 lb/yr

Satellite Beach Project 31 - City Hall
Pollutant Removal Calculations

BMP Type:	Beemats				
Land Use :	1200		**Basin No.**	C-3-14,16,17	
Drainage Area:	172.06	acres			
Soil Type:	C				
C value =		0.5	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		
Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)					
			=	**334.51**	**ac-ft/yr**
TN from upstream Projects 22,23,27 =		507.6	lb/yr		
TN from Basins C-3-10		919.17	lb/yr		
Total TN =		**1426.77**	**lb/yr**		
TP from upstream Projects 22,23,27 =		86.94	lb/yr		
TP from Basins C-3-10		176.04	lb/yr		
Total TP =		**262.98**	**lb/yr**		
Assume Beemats removal for small area vs large basin =				5.00	%
TN Removal =		**71.34**	**lb/yr**		
TP Removal =		**13.15**	**lb/yr**		

Satellite Beach Project 34 - Tortoise Island
Pollutant Removal Calculations

10/6/10

BMP Type: Beemats

Land Use : 1200 **Basin No.** TIB-1,2

Drainage Area: 13.26 acres

Soil Type: C

C value = 0.4 from PLSM

Calculate annual runoff volume

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

= **20.62** **ac-ft/yr**

TN from PLSM = **111.8** **lb/yr**
TP from PLSM = **16.19** **lb/yr**

Calculate Annual Removals

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal = **22.36** **lb/yr**

TP Removal = **3.24** **lb/yr**

Satellite Beach Project 35 - Lansing Island
Pollutant Removal Calculations

10/26/10

BMP Type:	Beemats				
Land Use :	1300		**Basin No.**	LIB-1	
Drainage Area:	37.42	acres			
Soil Type:	C				
C value =		0.31	from PLSM		

Calculate annual runoff volume

Annual rainfall =		46.66	inches		

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)

			=	**45.11**	**ac-ft/yr**
TN from PLSM =		**135.84**	**lb/yr**		
TP from PLSM =		**8.08**	**lb/yr**		

Calculate Annual Mass Removals

Assume removal efficiency for TN and TP for Beemats =			20	%	
TN Removal =		**27.17**	**lb/yr**		
TP Removal =		**1.62**	**lb/yr**		

Satellite Beach Project 36 - Jamaica Pond
Pollutant Removal Calculations

BMP Type: Beemats

Land Use : 1200 **Basin No.** SD-1,D2-7,10

Drainage Area: 214.2 acres

Soil Type: C

C value = 0.726 from PLSM

<u>Calculate annual runoff volume</u>

Annual rainfall = 46.66 inches

Annual runoff volume = annual rainfall (in/yr) x C x drainage area (ac) x 1ft/12in)
= **604.67** **ac-ft/yr**

TN from upstream Basins = **1433.83** **lb/yr**
TP from upstream Basins = **206.13** **lb/yr**

<u>Calculate Annual Removals</u>

Assume removal efficiency for TN and TP for Beemats = 20 %

TN Removal = **286.77** **lb/yr**

TP Removal = **41.23** **lb/yr**

APPENDIX 6

SUBBASIN POLLUTANT LOADS

Name	Acres	Volume (ac-ft)	Total TN (lb/yr)	Total TP (lb/yr)
Water	312.36	1113.46	549.28	50.42
C-1	3.62	11.14	51.87	11.35
C-10	10.55	13.66	82.70	11.78
C-11	19.76	29.97	181.52	26.06
C-12	12.76	24.38	139.86	27.22
C-13	12.90	28.07	157.11	35.75
C-14	9.50	14.37	87.13	12.35
C-16	8.50	20.45	116.85	28.57
C-17	14.14	31.06	172.74	37.01
C-2	4.89	8.88	50.42	8.91
C-3	23.88	68.91	343.00	87.54
C-4	1.19	2.56	13.76	2.85
C-5	10.50	20.65	114.10	21.91
C-6	4.36	6.73	40.51	5.90
C-7	9.22	13.89	84.21	11.93
C-8	8.99	13.60	82.44	11.68
C-9	17.28	26.13	158.45	22.45
D-1	57.92	74.63	450.63	63.51
D-10	7.74	10.56	64.04	9.07
D-2	45.94	65.27	395.73	56.08
D-3	37.47	60.77	359.96	57.42
D-4	44.35	67.08	406.70	57.63
D-5	18.01	27.24	165.13	23.40
D-6	49.38	74.90	452.37	64.36
D-7	2.16	6.06	31.19	7.57
D-8	3.54	5.31	32.19	4.56
D-9	21.12	21.48	112.48	13.19
GS-1	10.47	15.84	96.03	13.61
GS-10	8.23	13.61	77.25	11.92
GS-11	10.34	16.52	88.47	13.04
GS-12	8.60	26.27	128.56	34.14
GS-13	8.32	27.53	133.79	33.50
GS-14	5.79	14.92	75.59	16.28
GS-15	3.96	5.99	36.31	5.15
GS-16	7.80	11.80	71.53	10.14
GS-17	24.68	60.89	314.66	72.87
GS-18	10.96	19.40	111.09	19.13
GS-19	5.28	12.30	64.59	14.32
GS-2	5.23	7.91	47.98	6.80
GS-20	2.50	5.35	28.34	5.72
GS-21	5.41	12.83	58.61	11.14
GS-3	4.89	7.39	44.81	6.35
GS-4	5.99	9.07	54.97	7.79
GS-5	3.81	5.77	34.98	4.96
GS-6	1.37	2.07	12.35	1.73

GS-7	5.94	11.23	65.55	12.02
GS-8	3.51	7.95	43.46	9.04
GS-9	2.23	4.55	23.49	4.43
J-1	2.82	7.73	39.90	9.36
J-2	7.50	25.73	135.28	34.80
LIB-1	37.42	45.41	135.84	8.08
LL-1	35.57	70.33	399.79	74.36
LL-10	5.65	7.86	47.66	6.75
LL-11	10.02	16.61	96.53	14.69
LL-12	16.48	24.92	151.11	21.41
LL-13	8.84	14.48	86.18	13.41
LL-14	7.44	11.26	68.25	9.67
LL-15	8.66	13.10	79.41	11.25
LL-16	6.94	10.50	63.66	9.02
LL-17	1.86	0.85	3.35	0.29
LL-18	3.11	3.76	22.34	3.14
LL-19	14.81	24.59	144.01	23.03
LL-2	4.11	6.21	37.68	5.34
LL-3	9.01	13.63	82.67	11.71
LL-4	2.07	3.13	18.95	2.69
LL-5	5.40	8.17	49.56	7.02
LL-6	9.83	13.49	81.81	11.59
LL-7	3.92	3.39	20.56	2.91
LL-8	2.81	2.40	14.56	2.06
LL-9	2.92	2.67	15.56	2.14
N-1	58.86	177.69	884.76	230.57
N-2	24.27	70.51	343.19	85.88
N-3	7.64	20.49	116.10	28.63
N-4	4.92	17.00	88.81	22.80
P-1	26.14	45.48	260.54	42.45
P-2	3.46	6.31	36.47	6.45
R-1	8.41	21.79	98.24	20.15
R-10	3.51	5.30	32.16	4.56
R-11	3.69	5.58	33.82	4.79
R-12	3.52	5.33	32.32	4.58
R-13	13.71	31.98	179.22	39.11
R-2	4.61	6.86	38.14	5.06
R-3	3.60	5.44	32.98	4.67
R-4	3.73	5.65	34.23	4.85
R-5	3.92	5.93	35.96	5.10
R-6	3.96	5.99	36.29	5.14
R-7	3.98	6.02	36.50	5.17
R-8	3.69	5.58	33.83	4.79
R-9	3.84	5.81	35.22	4.99
SD-1	2.38	2.97	13.46	2.38
SD-2	84.00	113.31	649.92	105.39
SD-3	14.10	21.32	121.66	17.38

SD-4	2.41	2.31	13.79	2.16
SD-5	16.91	15.81	93.87	14.33
SD-6	21.72	21.72	85.53	7.72
SD-7	11.20	11.99	42.19	3.69
SH-1	107.80	283.41	1613.74	394.67
SH-2	167.67	403.97	2255.64	542.56
SI-1	54.51	63.27	193.16	11.23
TIB-1	8.45	13.04	73.02	10.50
TIB-2	4.81	7.59	38.78	5.69
WS-1	7.50	13.68	76.79	13.01
WS-10	1.97	3.41	20.51	2.90
WS-11	5.03	7.72	44.42	6.20
WS-12	3.16	5.61	33.68	4.75
WS-13	4.88	7.51	45.38	6.55
WS-14	5.00	10.14	52.98	10.20
WS-15	3.61	5.42	31.55	4.35
WS-16	3.65	5.36	30.92	4.23
WS-17	2.24	3.32	19.90	2.80
WS-18	4.10	6.14	36.41	5.08
WS-2	1.75	6.03	31.62	8.14
WS-20	3.24	4.91	29.26	4.11
WS-21	8.27	15.91	89.32	16.16
WS-22	3.51	5.28	31.40	4.40
WS-23	4.26	7.08	42.42	6.90
WS-24	2.42	6.49	37.08	9.11
WS-25	4.41	6.86	39.89	5.77
WS-26	4.69	7.05	41.13	5.67
WS-27	3.01	7.91	44.68	10.76
WS-28	2.59	6.84	38.92	9.51
WS-29	1.81	2.13	7.27	0.45
WS-3	5.66	8.68	51.81	7.48
WS-30	2.82	7.58	43.30	10.64
WS-6	6.69	10.75	64.60	9.11
WS-7	8.67	13.77	74.23	10.81
WS-8	6.70	11.25	65.60	9.06
WS-9	5.85	8.84	51.10	7.06
Sum (All w/ water)	**1927.43**	**4111.74**	**17063.13**	**3211.95**
Inside Basins	**1611.46**	**2987.14**	**16461.98**	**3150.18**

APPENDIX 7

PROPOSED PROJECT COST ESTIMATES

Project 1A Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Wet Retention	
POND/SWALE				
Land Acquisition (commercial, vacant)	LS	$ 219,228.00	1.00	$ 219,228
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	33,000	$ 99,000
Pond Dewatering	day	$ 500.00	30	$ 15,000
Clear and Grub	ac	$ 7,000.00	2.85	$ 19,950
Sod	sf	$ 0.30	49,500	$ 14,850
SW STRUCTURE				
MES	ea	$ 3,000.00	2	$ 6,000
Junction Box	ea	$ 3,000.00	2	$ 6,000
STORM PIPE				
42"/48" RCP	lf	$ 90.00	80	$ 7,200
		Subtotal		$ 394,728
		20% Contingency		$ 78,946
		15% Engineering/Permitting/Admin		$ 59,209
		Total		**$ 532,883**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Wet Pond (mowing, spraying)	ac	$ 2,500.00	2.85	$ 7,125
Pipe	lf	$ 0.50	80	$ 40
Commercial land property Tax Loss				$ 1,488
Totals				**$ 8,653**

Project 1B Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Beemat	
Beemats Planting	sf	$ 7.80	5,600	$ 43,680
		Subtotal		$ 43,680
		15% Engineering/Permitting/Admin		$ 6,552
		20% Contingency		$ 8,736
		Total		**$ 58,968**

Yearly Maintenance/Renewal/Replacement/Tax Loss					
Beemats (replace every year)	sf	$	3.90	5600	$ 21,840
Totals					**$ 21,840**

Project 2 Preliminary Cost Estimate

		BMP TYPE:	Inlet Trap	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Inlet Trap	ea	$ 2,000	1	$ 2,000
		Subtotal		$ 2,000
		20% Contingency		$ 400
		15% Engineering/Permitting/Admin		$ 300
		Total		**$ 2,700**

Project 3A Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Wet Retention Qty	Item Cost
POND/SWALE				
Land Acquisition (commercial, vacant)	ls	$ 235,500.00	1.00	$ 235,500
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	8,100	$ 24,300
Pond Dewatering	day	$ 500.00	20	$ 10,000
Clear and Grub	ac	$ 7,000.00	0.70	$ 4,900
Sod	sf	$ 0.30	16,900	$ 5,070
SW STRUCTURE				
MES	ea	$ 3,000.00	1	$ 3,000
Manhole	ea	$ 4,000.00	4	$ 16,000
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
30"/36" RCP	lf	$ 75.00	300	$ 22,500
Subtotal				$ 338,770
20% Contingency				$ 67,754
15% Engineering/Permitting/Admin				$ 50,816
Total				**$ 457,340**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Wet Pond (mowing, spraying)	ac	$ 2,500.00	0.7	$ 1,750
Beemats (replace every 2 years)	sf	$ 3.90	1400	$ 5,460
Pipe	lf	$ 0.50	300	$ 150
Commercial land Tax Loss	ls			$ 1,598
Totals				**$ 8,958**

Project 3B Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Beemat	
Beemats Planting	sf	$ 7.80	1,400	$ 10,920
Subtotal				$ 10,920
20% Contingency				$ 2,184
15% Engineering/Permitting/Admin				$ 1,638
Total				**$ 13,104**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Beemats (replace every years)	sf	$ 3.90	1400	$ 5,460
Commercial land Tax Loss	ac	$ 3,874	0.7	$ 2,712
Totals				**$ 8,172**

Project 4A Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Wet Retention Qty	Item Cost
POND/SWALE				
Land Acquisition (residentiall, vacant)	ls	$ 86,400.00		$ 86,400
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	3,500	$ 10,500
Pond Dewatering	day	$ 500.00	10	$ 5,000
Clear and Grub	ac	$ 7,000.00	0.30	$ 2,100
Sod	sf	$ 0.30	8,100	$ 2,430
SW STRUCTURE				
Manhole	ea	$ 4,000.00	1	$ 4,000
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
18" RCP	lf	$ 50.00	80	$ 4,000
Beemats Planting	sf	$ 7.80	600	$ 4,680
		Subtotal		$ 136,610
		20% Contingency		$ 27,322
		15% Engineering/Permitting/Admin		$ 20,492
		Total		**$ 184,424**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Wet Pond (mowing, spraying)	ac	$ 2,500.00	0.3	$ 750
Beemats (replace every 2 years)	sf	$ 3.90	600	$ 2,340
Pipe	lf	$ 0.50	80	$ 40
Commercial land Tax Loss	ls			$ 586
Totals				**$ 3,716**

Project 4B Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Beemats	
Beemats Planting	sf	$ 7.80	600	$ 4,680.00
		Subtotal		$ 4,680.00
		20% Contingency		$ 936.00
		15% Engineering/Permitting/Admin		$ 702
		Total		**$ 5,616.00**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	600	$ 2,340.00
Totals				**$ 2,340.00**

Project 5 Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Exfiltration	
Erosion Control	ls	$ 7,500.00	1	$ 7,500
SW STRUCTURE				
Inlet/Manhole w/Skimmer & Sump	ea	$ 5,000.00	4	$ 20,000
EXFILTRATION TRENCH				
18" HDPE	lf	$ 75.00	970	$ 72,750
`				
Pavement Restoration	lf	$ 50.00	970	$ 48,500
Subtotal				$ 148,750
20% Contingency				$ 29,750
15% Engineering/Permitting/Admin				$ 22,313
Total				**$ 200,813**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Exfiltration Trench	lf	$ 1.00	970	$ 970
Totals				**$ 970**

Project 6 Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Dry Pond Qty	Item Cost
POND/SWALE				
Land Acquisition (commercial, developed)	ac		1.2	$ 90,455.00
Erosion Control	ls	$ 7,500.00	1	$ 7,500.00
Pond Excavation	cy	$ 3.00	5,200	$ 15,600.00
Clear and Grub	ac	$ 7,000.00	1.20	$ 8,400.00
Sod	sf	$ 0.30	52,000	$ 15,600.00
SW STRUCTURE				
MES	ea	$ 3,000.00	1	$ 3,000.00
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000.00
STORM PIPE				
24" RCP	lf	$ 60.00	10	$ 600.00
		Subtotal		$ 151,155.00
		20% Contingency		$ 30,231.00
		15% Engineering/Permitting/Admin		$ 22,673.25
		Total		**$ 204,059.25**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Pipe	lf	$ 0.50	10	$ 5.00
Commercial land Tax Loss	ls	$ 639.00	1	$ 639.00
Totals				**$ 644.00**

Project 7A Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Wet Retention Qty	Item Cost
POND/SWALE				
Land Acquisition (commercial, developed)	ac	$ 1,635,720.00	1	$ 1,635,720
Exist. Building Demolition	sf	$ 1.50	40,000	$ 60,000
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	35,000	$ 105,000
Pond Dewatering	day	$ 500.00	30	$ 15,000
Clear and Grub	ac	$ 7,000.00	3.00	$ 21,000
Sod	sf	$ 0.30	35,880	$ 10,764
SW STRUCTURE				
Manhole	ea	$ 4,000.00	3	$ 12,000
Head Wall	ea	$ 4,000.00	1	$ 4,000
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
18" RCP	lf	$ 50.00	50	$ 2,500
60" RCP	lf	$ 180.00	60	$ 10,800
Beemats Planting	sf	$ 7.80	5,900	$ 46,020
		Subtotal		$ 1,940,304
		20% Contingency		$ 388,061
		15% Engineering/Permitting/Admin		$ 291,046
		Total		**$ 2,619,410**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Wet Pond (mowing, spraying)	ac	$ 2,500.00	3	$ 7,500
Beemats (replace every 2 years)	sf	$ 3.90	5900	$ 23,010
Pipe	lf	$ 0.50	110	$ 55
Commercial land Tax Loss	ls			$ 11,100
Totals				**$ 41,665**

Project 7B Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Beemats	
Beemats Planting	sf	$ 7.80	5,900	$ 46,020
		Subtotal		$ 46,020
		20% Contingency		$ 9,204
		15% Engineering/Permitting/Admin		$ 6,903
		Total		**$ 55,224**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	5900	$ 23,010
Totals				**$ 23,010**

Project 8A Preliminary Cost Estimate

		BMP TYPE:	Wet Retention	
Item	Unit	Unit Cost	Qty	Item Cost
POND/SWALE				
Land Acquisition (residential, vacant)	ac	$ 86,400.00	1.00	$ 86,400
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	2,900	$ 8,700
Pond Dewatering	day	$ 500.00	10	$ 5,000
Clear and Grub	ac	$ 7,000.00	0.25	$ 1,750
Sod	sf	$ 0.30	7,400	$ 2,220
SW STRUCTURE				
MES	ea	$ 3,000.00	1	$ 3,000
Nutrient Separating Baffle Box	ea	$ 50,000.00	-	$ -
Inlet	ea	$ 3,500.00	2	$ 7,000
Manhole	ea	$ 4,000.00	2	$ 8,000
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
18" RCP	lf	$ 50.00	300	$ 15,000
		Subtotal		$ 154,570
		20% Contingency		$ 30,914
		15% Engineering/Permitting/Admin		$ 23,186
		Total		**$ 208,670**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Wet Pond (mowing, spraying)	ac	$ 2,500.00	0.25	$ 625
Beemats (replace every year)	sf	$ 3.90	490	$ 1,911
Pipe	lf	$ 0.50	300	$ 150
Totals				**$ 2,686**

Project 8B Preliminary Cost Estimate

		BMP TYPE:	Beemats	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Beemats Planting	sf	$ 7.80	490	$ 3,822
		Subtotal		$ 3,822
		20% Contingency		$ 764
		15% Engineering/Permitting/Admin		$ 573
		Total		**$ 5,160**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Wet Pond (mowing, spraying)	ac	$ 2,500.00	0.25	$ 625
Beemats (replace every year)	sf	$ 3.90	490	$ 1,911
Pipe	lf	$ 0.50	300	$ 150
Totals				**$ 2,686**

Project 9 Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Wet Retention Qty	Item Cost
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	1,400	$ 4,200
Pond Dewatering	day	$ 500.00	5	$ 2,500
Clear and Grub	ac	$ 7,000.00	0.25	$ 1,750
Sod	sf	$ 0.30	7,000	$ 2,100
SW STRUCTURE				
MES	ea	$ 3,000.00	1	$ 3,000
Manhole	ea	$ 4,000.00	2	$ 8,000
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
18" RCP	lf	$ 50.00	60	$ 3,000
Beemats Planting	sf	$ 7.80	490	$ 3,822
		Subtotal		$ 45,872
		20% Contingency		$ 9,174
		15% Engineering/Permitting/Admin		$ 6,881
		Total		**$ 61,927**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Wet Pond (mowing, spraying)	ac	$ 2,500.00	0.25	$ 625
Pipe	lf	$ 0.50	60	$ 30
Totals				**$ 655**

Project 9B Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Beemats	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Beemats Planting	sf	$ 7.80	490	$ 3,822
		Subtotal		$ 3,822
		20% Contingency		$ 764
		15% Engineering/Permitting/Admin		$ 573
		Total		**$ 5,160**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Wet Pond (mowing,	ac	$ 2,500.00	0.25	$ 625
Beemats (replace e	sf	$ 3.90	490	$ 1,911
Pipe	lf	$ 0.50	300	$ 150
Totals				**$ 2,686**

Project 11 Preliminary Cost Estimate

		BMP TYPE:	Beemats	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Beemats Planting	sf	$ 7.80	12,000	$ 93,600
		Subtotal		$ 93,600
		20% Contingency		$ 18,720
		15% Engineering/Permitting/Admin		$ 14,040
		Total		**$ 126,360**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	12000	$ 46,800
Totals				**$ 46,800**

Project 12 Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Exfiltration Qty	Item Cost
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500.00
Inlet/Manhole w/Skimmer & Sump	ea	$ 5,000.00	3	$ 15,000.00
24" HDPE	lf	$ 85.00	420	$ 35,700.00
Pavement Restoration	lf	$ 50.00	420	$ 21,000.00
		Subtotal		$ 79,200.00
		20% Contingency		$ 15,840.00
		15% Engineering/Permitting/Admin		$ 11,880.00
		Total		**$ 106,920.00**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Exfiltration Trench	lf	$ 1.00	420	$ 420.00
Totals				**$ 420.00**

Project 13 Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Exfiltration Qty	Item Cost
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500.00
Inlet/Manhole w/Skimmer & Sump	ea	$ 5,000.00	3	$ 15,000.00
30" HDPE	lf	$ 95.00	550	$ 52,250.00
Pavement Restoration	lf	$ 50.00	550	$ 27,500.00
			Subtotal	$ 102,250.00
			20% Contingency	$ 20,450.00
			15% Engineering/Permitting/Admin	$ 15,337.50
			Total	**$ 138,037.50**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Exfiltration Trench	lf	$ 1.00	550	$ 550.00
Totals				**$ 550.00**

Project 14 Preliminary Cost Estimate

		BMP TYPE:	Exfiltration	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500.00
Inlet/Manhole w/Skimmer & Sump	ea	$ 5,000.00	8	$ 40,000.00
24" HDPE	lf	$ 85.00	600	$ 51,000.00
30" HDPE	lf	$ 95.00	500	$ 47,500.00
Pavement Restoration	lf	$ 50.00	1,100	$ 55,000.00
			Subtotal	$ 201,000.00
			20% Contingency	$ 40,200.00
			15% Engineering/Permitting/Admin	$ 30,150.00
			Total	**$ 271,350.00**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Exfiltration Trench	lf	$ 1.00	1100	$ 1,100.00
Totals				**$ 1,100.00**

Project 15 Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Swale	
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500.00
Pond Excavation	cy	$ 3.00	2,000	$ 6,000.00
Clear and Grub	ac	$ 7,000.00	0.70	$ 4,900.00
Sod	sf	$ 0.30	30,400	$ 9,120.00
SW STRUCTURE				
Inlet	ea	$ 3,500.00	12	$ 42,000.00
		Subtotal		$ 69,520.00
		20% Contingency		$ 13,904.00
		15% Engineering/Permitting/Admin		$ 10,428.00
		Total		**$ 93,852.00**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Dry Pond (mowing)	ac	$ 1,500.00	0.7	$ 1,050.00
Totals				**$ 1,050.00**

Project 16A Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Wet Detention Qty	Item Cost
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	19,500	$ 58,500
Pond Dewatering	day	$ 500.00	20	$ 10,000
Clear and Grub	ac	$ 7,000.00	1.68	$ 11,760
Sod	sf	$ 0.30	22,900	$ 6,870
SW STRUCTURE				
MES	ea	$ 3,000.00	1	$ 3,000
Nutrient Separating Baffle Box	ea	$ 50,000.00	-	$ -
Inlet	ea	$ 3,500.00	-	$ -
Manhole	ea	$ 4,000.00	1	$ 4,000
Inlet/Manhole w/Skimmer & Sump	ea	$ 5,000.00	-	$ -
Junction Box	ea	$ 3,000.00	-	$ -
Inlet Trap	ea	$ 2,000.00	-	$ -
Head Wall	ea	$ 4,000.00	-	$ -
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
18" RCP	lf	$ 50.00	420	$ 21,000
24" RCP	lf	$ 60.00	-	$ -
30"/36" RCP	lf	$ 75.00	-	$ -
42"/48" RCP	lf	$ 90.00	-	$ -
60" RCP	lf	$ 180.00	-	$ -
EXFILTRATION TRENCH				
18" HDPE	lf	$ 75.00	-	$ -
24" HDPE	lf	$ 85.00	-	$ -
30" HDPE	lf	$ 95.00	-	$ -
Pavement Restoration	lf	$ 50.00	-	$ -
Beemats Planting	sf	$ 7.80	3,300	$ 25,740
		Subtotal		$ 158,370
		20% Contingency		$ 31,674
		15% Engineering/Permitting/Admin		$ 23,756
		Total		**$ 213,800**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Wet Pond (mowing, spraying)	ac	$ 2,500.00	1.68	$ 4,200
Beemats (replace every year)	sf	$ 3.90	3300	$ 12,870
Pipe	lf	$ 0.50	420	$ 210
Totals				**$ 17,280**

Project 16B Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Beemats	
Beemats Planting	sf	$ 7.80	3,300	$ 25,740
		Subtotal		$ 25,740
		20% Contingency		$ 5,148
		15% Engineering/Permitting/Admin		$ 3,861
		Total		**$ 34,749**

Yearly Maintenance/Renewal/Replacement/Tax Loss				
Beemats (replace every year)	sf	$ 3.90	3300	$ 12,870
Totals				**$ 12,870**

Project 17A Preliminary Cost Estimate

Item	Unit	Unit Cost	Qty	Item Cost
		BMP TYPE:	Wet Retention	
POND/SWALE				
Erosion Control	ls	$ 7,500.00	1	$ 7,500
Pond Excavation	cy	$ 3.00	26,800	$ 80,400
Pond Dewatering	day	$ 500.00	30	$ 15,000
Clear and Grub	ac	$ 7,000.00	2.30	$ 16,100
Sod	sf	$ 0.30	39,200	$ 11,760
SW STRUCTURE				
MES	ea	$ 3,000.00	2	$ 6,000
Manhole	ea	$ 4,000.00	1	$ 4,000
Control Weir with Skimmer	ea	$ 10,000.00	1	$ 10,000
STORM PIPE				
18" RCP	lf	$ 50.00	580	$ 29,000
24" RCP	lf	$ 60.00	-	$ -
30"/36" RCP	lf	$ 75.00	140	$ 10,500
Beemats Planting	sf	$ 7.80	4,500	$ 35,100
		Subtotal		$ 225,360
		20% Contingency		$ 45,072
		15% Engineering/Permitting/Admin		$ 33,804
		Total		**$ 304,236**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Wet Pond (mowing, spraying)	ac	$ 2,500.00	2.3	$ 5,750
Beemats (replace every year)	sf	$ 3.90	4500	$ 17,550
Pipe	lf	$ 0.50	720	$ 360
Totals				**$ 23,660**

Project 17B Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Beemats Qty	Item Cost
Beemats Planting	sf	$ 7.80	4,500	$ 35,100
Subtotal				$ 35,100
20% Contingency				$ 7,020
15% Engineering/Permitting/Admin				$ 5,265
Total				**$ 47,385**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	4500	$ 17,550
Totals				**$ 17,550**

Project 21 Preliminary Cost Estimate

Item	Unit	BMP TYPE: Unit Cost	Beemats Qty	Item Cost
Beemats Planting	sf	$ 7.80	2,500	$ 19,500
		Subtotal		$ 19,500
		20% Contingency		$ 3,900
		15% Engineering/Permitting/Admin		$ 2,925
		Total		**$ 26,325**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	2500	$ 9,750
Totals				**$ 9,750**

Project 31 Preliminary Cost Estimate

		BMP TYPE:	Beemats	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Beemats Planting	sf	$ 7.80	1,000	$ 7,800
		Subtotal		$ 7,800
		20% Contingency		$ 1,560
		15% Engineering/Permitting/Admin		$ 1,170
		Total		**$ 10,530**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$	3.90	1000	$ 3,900
Totals					**$ 3,900**

Project 34 Preliminary Cost Estimate

		BMP TYPE:	Beemats	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Beemats Planting	sf	$ 7.80	5,000	$ 39,000
		Subtotal		$ 39,000
		20% Contingency		$ 7,800
		15% Engineering/Permitting/Admin		$ 5,850
		Total		**$ 52,650**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	5000	$ 19,500
Totals				**$ 19,500**

Project 35 Preliminary Cost Estimate

Item	Unit	Unit Cost		Qty	Item Cost	
		BMP TYPE:		Beemats		
Beemats Planting	sf	$	7.80	14,500	$	113,100
		Subtotal			$	113,100
		20% Contingency			$	22,620
		15% Engineering/Permitting/Admin			$	16,965
		Total			**$**	**152,685**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$	3.90	14500	$	56,550
Totals					**$**	**56,550**

Project 36 Preliminary Cost Estimate

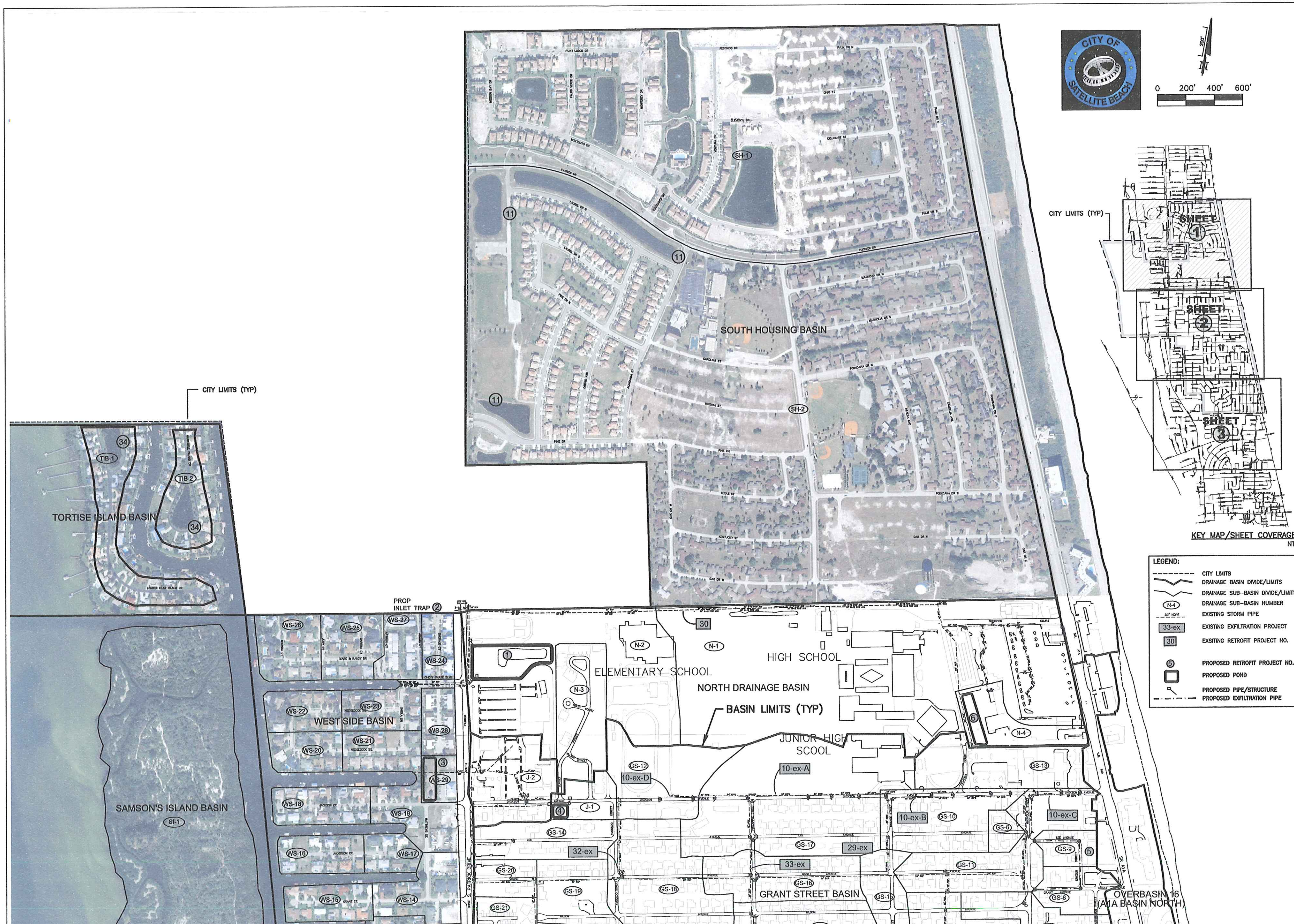
		BMP TYPE:	Beemats	
Item	**Unit**	**Unit Cost**	**Qty**	**Item Cost**
Beemats Planting	sf	$ 7.80	4,000	$ 31,200
		Subtotal		$ 31,200
		20% Contingency		$ 6,240
		15% Engineering/Permitting/Admin		$ 4,680
		Total		**$ 42,120**

Yearly Maintenance/Renewal/Replacement/Tax Loss

Beemats (replace every year)	sf	$ 3.90	4,000	$ 15,600
Totals				**$ 15,600**

APPENDIX 8

2010 EXISTING STORMWATER SYSTEM



NO	BY	REVISIONS	DATE

QUENTIN L. HAMPTON ASSOCIATES, INC.
CONSULTING ENGINEERS
FLORIDA CERTIFICATE OF AUTHORIZATION NUMBER: 626
FAX 386 761-3977
P.O. DRAWER 290247 PORT ORANGE, FLORIDA 32129-0247 386 761-6810

CITY OF
SATELLITE BEACH
BREVARD COUNTY, FLORIDA

STORMWATER MASTER PLAN

PROPOSED STORMWATER YEAR 2010-2015

MARK A. HAMPTON, P.E. 27391
BRADLEY T. BLAIS, P.E. 47130
DAVID A. KING, P.E. 50609
ANDREW M. GIANNINI, P.E. 46601
KEVIN A. LEE, P.E. 71501

DESIGNED	DK	DATE	1/11
DRAWN	PEJ	DATE	1/11
CHECKED	DK	DATE	1/11
APPROVED	DK	DATE	1/11

SCALE AS SHOWN
JOB NO. SB 7.1
SHEET NO. 1 OF 3

NO	BY	REVISIONS	DATE

QUENTIN L. HAMPTON ASSOCIATES, INC.
CONSULTING ENGINEERS
FLORIDA CERTIFICATE OF AUTHORIZATION NUMBER: 626
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CITY OF
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BREVARD COUNTY, FLORIDA

STORMWATER MASTER PLAN

PROPOSED STORMWATER YEAR 2010 - 2015

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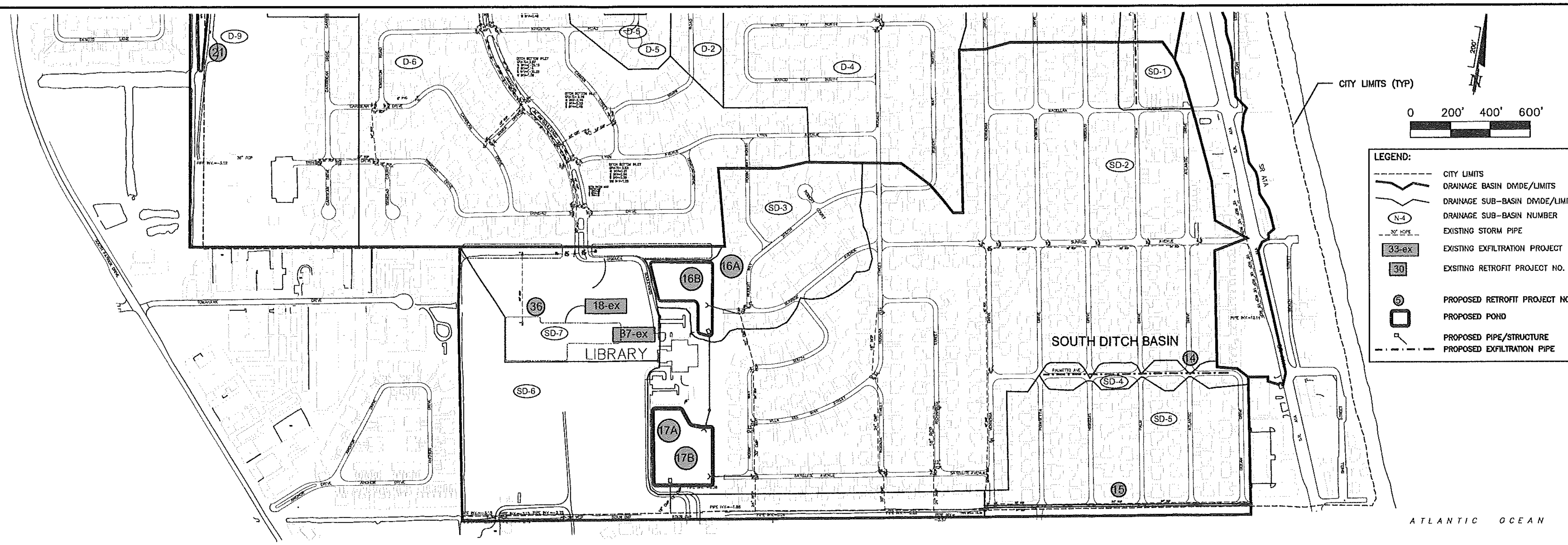
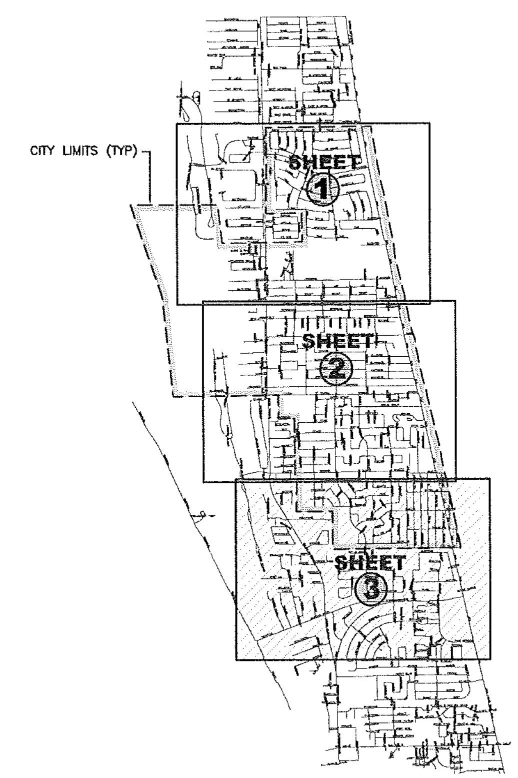
SCALE AS SHOWN
JOB NO. SB 7.1
SHEET NO. 2 OF 3





KEY MAP/SHEET COVERAGE
NTS

NO	BY	REVISIONS	DATE

QUENTIN L. HAMPTON ASSOCIATES, INC.
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CITY OF
SATELLITE BEACH
BREVARD COUNTY, FLORIDA

STORMWATER
MASTER PLAN

PROPOSED STORMWATER
YEAR 2010 - 2015

MARK A. HAMPTON, P.E. 27391
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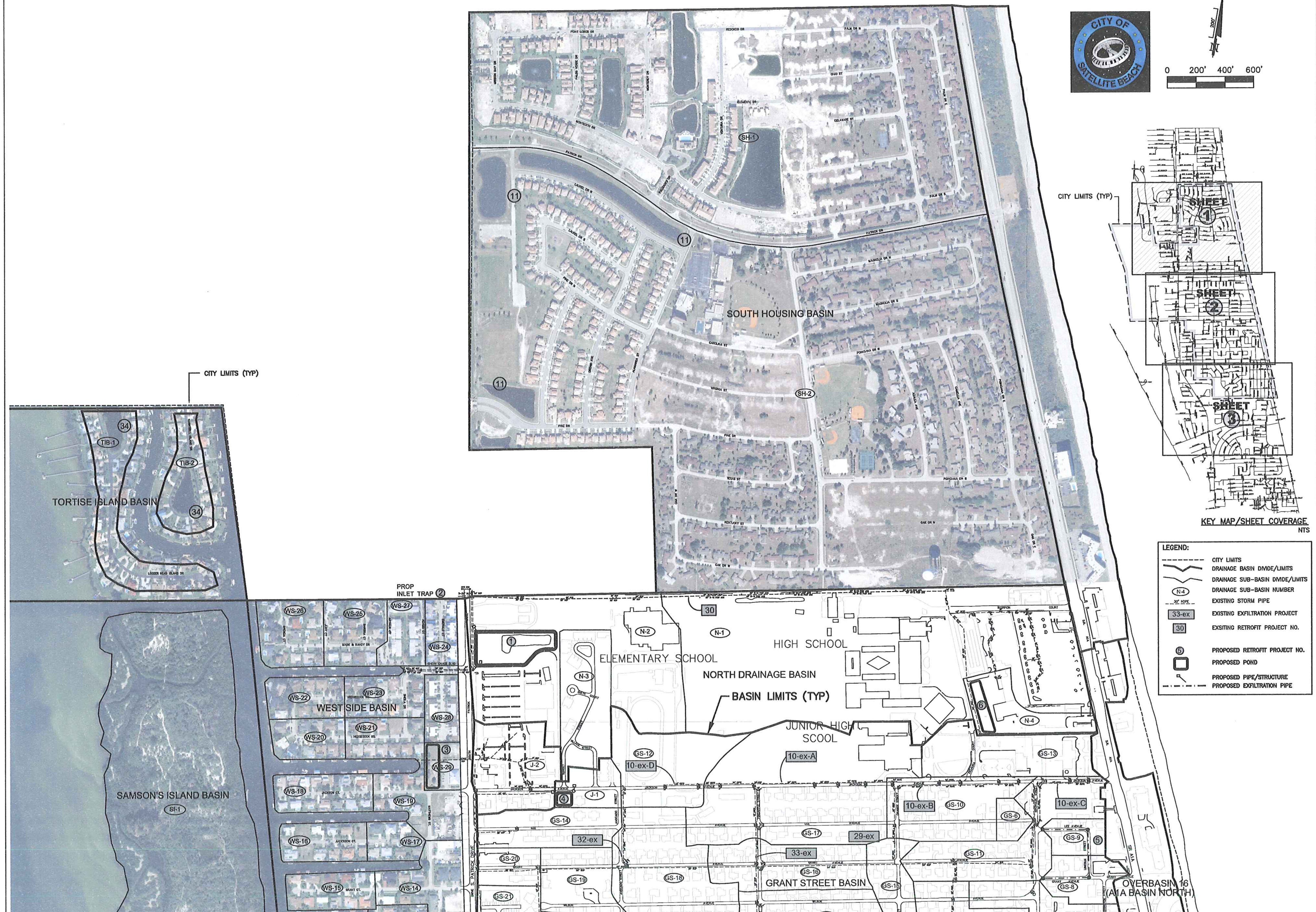
APPROVED	DK	DATE	1/11

SCALE AS SHOWN
JOB NO. SB 7.1

SHEET NO. 3 OF 3

APPENDIX 9

2010 PROPOSED STORMWATER IMPROVEMENTS



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QUENTIN L. HAMPTON ASSOCIATES, INC.
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CITY OF
SATELLITE BEACH
BREVARD COUNTY, FLORIDA

STORMWATER MASTER PLAN

PROPOSED STORMWATER YEAR 2010-2015

MARK A. HAMPTON, P.E. 27391
BRADLEY T. BLAIS, P.E. 47130
DAVID A. KING, P.E. 50609
ANDREW M. GIANNINI, P.E. 46601
KEVIN A. LEE, P.E. 71501

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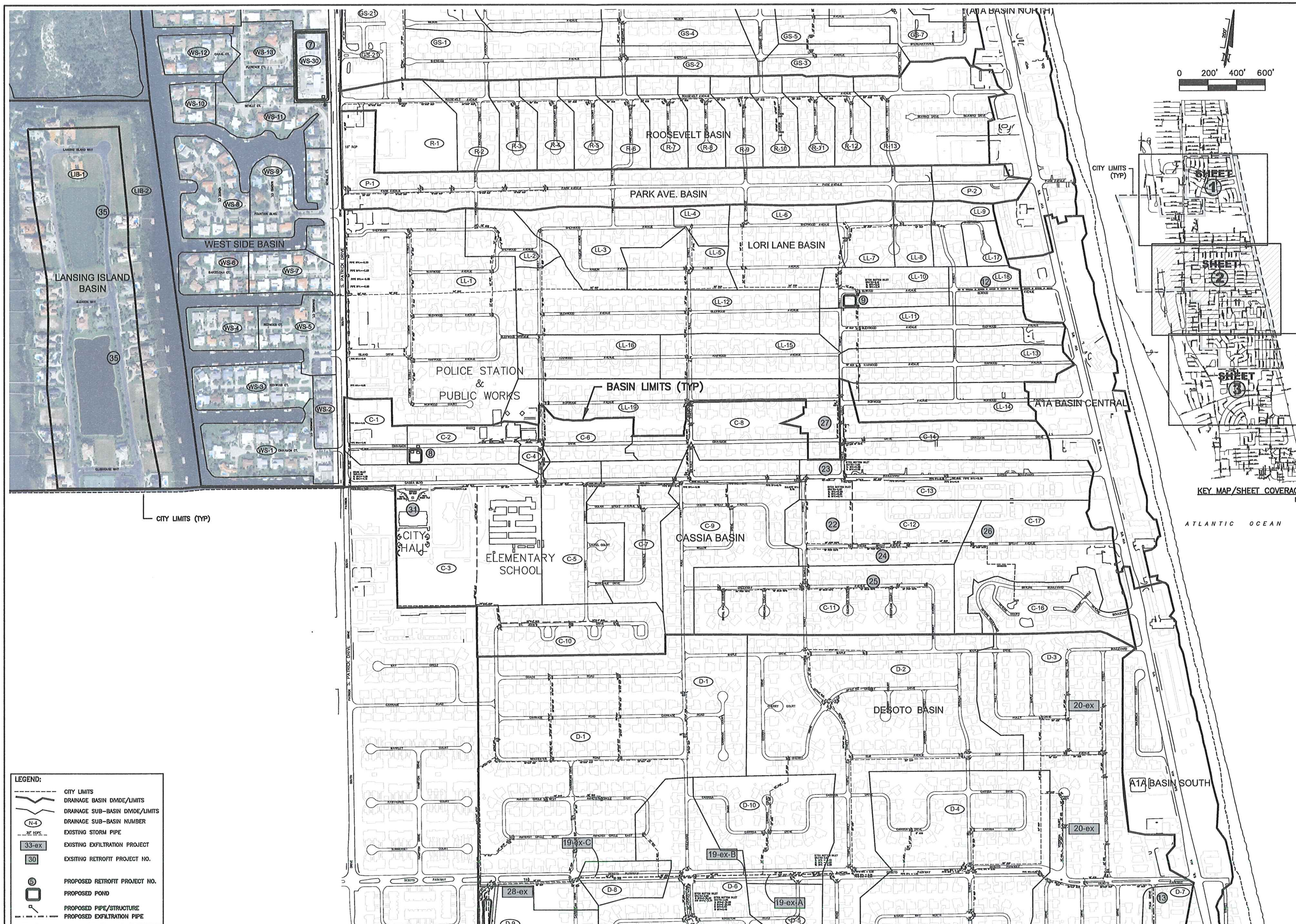
CHECKED	DK	DATE	1/11
APPROVED	DK	DATE	1/11

SCALE AS SHOWN
JOB NO. SB 7.1

SHEET NO. 1 OF 3



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QUENTIN L. HAMPTON ASSOCIATES, INC.
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CITY OF
SATELLITE BEACH
BREVARD COUNTY, FLORIDA

STORMWATER MASTER PLAN

PROPOSED STORMWATER YEAR 2010 - 2015

MARK A. HAMPTON, P.E. 27391
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DAVID A. KING, P.E. 50609
ANDREW M. GIANNINI, P.E. 46601
KEVIN A. LEE, P.E. 71501

DESIGNED	DK	DATE	1/11
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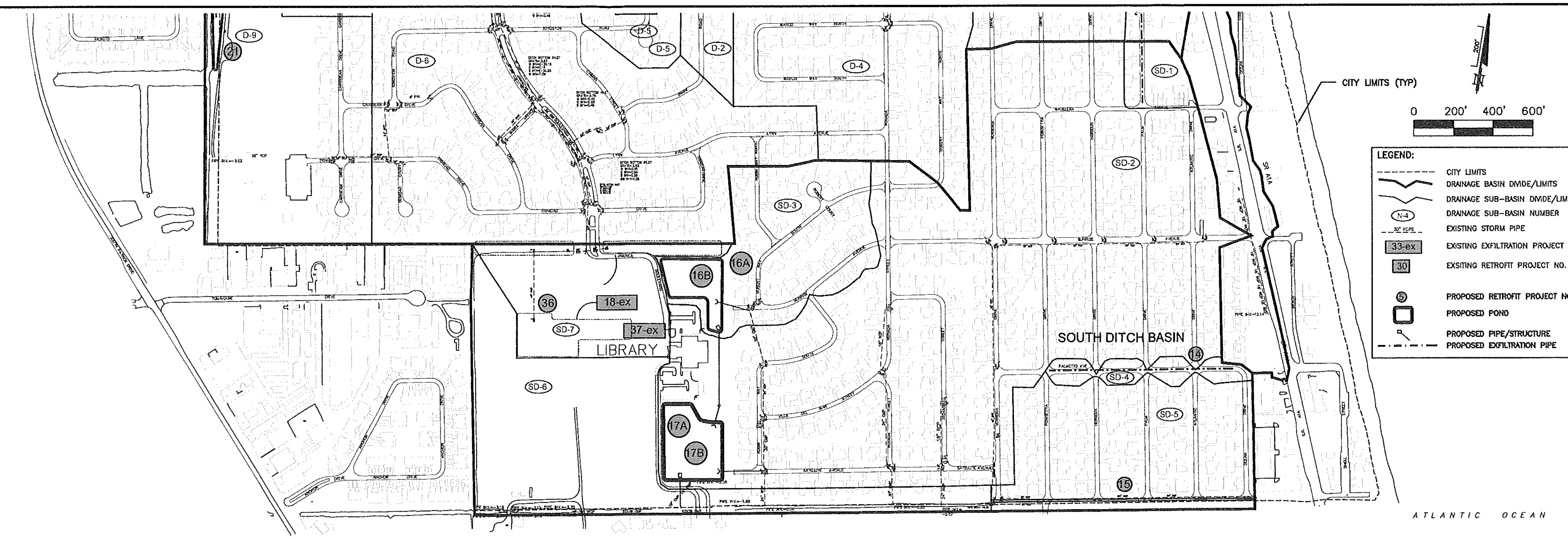
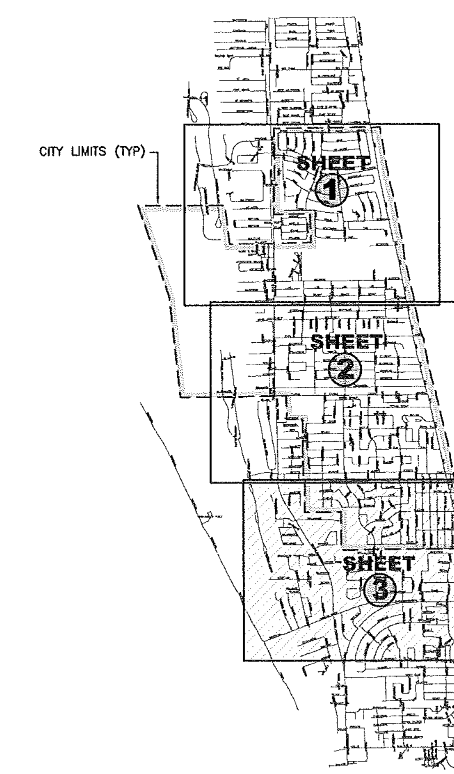
APPROVED	DK	DATE	1/11

SCALE AS SHOWN
JOB NO. SB 7.1

SHEET NO. 2 OF 3





KEY MAP/SHEET COVERAGE
NTS

NO	BY	REVISIONS	DATE

QUENTIN L. HAMPTON ASSOCIATES, INC.
CONSULTING ENGINEERS
FLORIDA CERTIFICATE OF AUTHORIZATION NUMBER: 626
FAX 386 761-3977
P.O. DRAWER 290247 PORT ORANGE, FLORIDA 32129-0247 386 761-6810

CITY OF
SATELLITE BEACH
BREVARD COUNTY, FLORIDA

STORMWATER
MASTER PLAN

PROPOSED STORMWATER
YEAR 2010 - 2015

MARK A. HAMPTON, P.E. 27391
BRADLEY T. BLAIS, P.E. 47130
DAVID A. KING, P.E. 50609
ANDREW M. GIANNINI, P.E. 46601
KEVIN A. LEE, P.E. 71501

DESIGNED	DK	DATE	1/11
DRAWN	PEJ	DATE	1/11
CHECKED	DK	DATE	1/11
APPROVED	DK	DATE	1/11

SCALE
AS SHOWN
JOB NO.
SB 7.1

SHEET NO.
3
OF 3