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Boynton Inlet Contributing Area Watershed Management Plan

Palm Beach County, FL

June 2018

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AHED	ArcHydro Enhanced Database
BMAP	Best Management Action Plan
BMP	best management practice
cfs	cubic feet per second
Chla	chlorophyll-a
COW	Code and Ordinance Worksheet
CPW	Center for Watershed Protection
EPA	Environmental Protection Agency
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDEP Model Ordinance	FDEP's Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
GI-BMP	Green Industry Best Management Practices
GIS	Geographic Information System
HW	Horsley Witten Group
IA	Impervious Area
ICA	inlet contributing area
in	inches
in/yr	inches per year
LA	load allocation
lb N/person/yr	pounds of nitrogen per person per year
lb/ac/yr	pounds per acre per year
lb/yr	pounds per year
LBSP	land-based sources of pollution
LWDD	Lake Worth Drainage District
mg/L	milligrams per liter
mgd	million gallons per day
mi^2	square miles
MOS	margin of safety
MS4s	municipal separate storm sewer systems
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
OSTDS	onsite sewage treatment and disposal system
PBC	Palm Beach County
PRBs	permeable reactive barriers
PUDs	Planned Unit Developments
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SSO	sanitary sewer overflow
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorous
TSI	trophic state index
TSS	total suspended solids
WBID	water body identification number
WCA1	Water Conservation Area 1
WLA	waste load allocation
WQ	water quality
WWTF	waste water treatment facility

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EXECUTIVE SUMMARY

The overarching goal of this watershed planning effort is to reduce the loads of nutrients (total nitrogen (TN) and total phosphorus (TP)) and total suspended solids (TSS) from land based sources of pollution (LBSP) in the Boynton Inlet Contributing Area (ICA) to the coastal habitats that support southeast Florida's coral reefs. The Boynton ICA comprises approximately 150 square miles in Palm Beach County. The purpose of this watershed management plan is two-fold. This document aims to: 1) describe a path forward for meeting the pollutant load reduction goal for the Boynton ICA; and 2) pilot a methodology for rapid assessment and planning in watersheds in southeastern Florida guided by EPA's Watershed Assessment approach. This methodology can help managers identify, evaluate, and focus long-term management approaches, while at the same time taking early implementation steps.

This report presents the results from a planning-level pollutant loading model and site visits within a targeted study area to assess a variety of pollutant load reduction strategies and develop general recommendations for watershed improvements. The estimated net flow of water from the land in the Boynton ICA is 190 million gallons per day (mgd), or 31.25 watershed inches. The estimated annual net loads of TN, TP and TSS from the watershed (what is entering the watershed minus what is leaving the watershed) are 367,000 lbs TN, 39,000 lbs TP, and 2, 244,000 lbs TSS. The overall generation of pollution loads from the watershed results in estimated loads of 691,000 lbs TN, 53,000 lbs TP and 3,211,000 lbs of TSS. Among the 14 subwatersheds delineated as part of this planning process, subwatershed H generates the largest TN load and subwatershed M generates the largest TP and TSS loads. Subwatershed I, which is the core of the targeted study area in this watershed planning effort, was in the middle of the pack in terms of pollutant load generation.

Of the nitrogen load reduction strategies evaluated in the pollutant load model, the strategy that was potentially the most effective and cost effective by far was the reduction of fertilizer use in the watershed. All options to reduce the use of traditional septic systems (including enhanced nitrogen removal systems, package plants, and sewer to wastewater treatment facilities) also appear to be quite effective at reducing nitrogen loads, although these approaches vary in expense. While stormwater practices, on the whole, rank as the least cost effective management strategies, with a potential pollution reduction capability approximately an order of magnitude smaller than the other approaches when applied across the watershed, they will be an absolutely necessary tool in the nutrient reduction approach in order to meet TMDL and other reduction goals.

Preliminary concept designs, estimates of pollutant load reduction benefits, and construction cost estimates were developed for a handful of representative sites in the targeted study area, as

examples of potential stormwater retrofits pilot projects that could be implemented. In addition, pollutant loading estimates and implementation cost estimates are presented for a suite of stormwater, wastewater and nonstructural management strategies applied at across the entire Boynton ICA.

Recommendations presented in this plan, based on the site visits and modeling analysis, generally include:

- Fertilizer use reduction across the watershed, through the promulgation of local regulations.
- Facilities served by septic systems, particularly along the barrier islands, should be connected to the sewer for treatment at an existing centralized wastewater treatment facility. The modeling analysis in this watershed plan shows that this is the most effective and least costly approach (on a unit cost/lb TN removed basis) to improve the water quality and reduce nitrogen loading from wastewater discharges.
- Construction of stormwater retrofits at a handful of sites to serve as pilot projects, using as a starting point the site assessments and concept plans developed as part of this plan.
- Increased targeted water quality and flow monitoring at key inflow and outflow locations of individual subwatersheds and water bodies (e.g., Lake Ida).

1.0 INTRODUCTION

1.1 Approach

The Boynton Inlet Contributing Area (ICA) in southeast Florida includes Palm Beach County (PBC) and portions of 17 municipalities. It is bounded by Lake Worth Road (State Road 802) to the north and Yamato Road (State Road 794) to the south. The western boundary is approximately defined by Water Conservation Area 1 (WCA1) and Florida State Road 7. The Boynton ICA is one of nine ICA's in southeast Florida that contribute land-based sources of pollution (LBSPs) to the Atlantic Ocean and the coral reef system located off the coast of southeastern Florida.

The Boynton ICA is a large watershed comprising approximately 150 square miles in eastern Palm Beach County, approximately half of which is occupied by residential land uses in the form of Planned Unit Developments (PUDs) (41.1% of the ICA), single family residential (8.4% of the ICA) and multi-family residential (3.8% of the ICA), and the remainder divided among roadways, golf courses, commercial land uses and agriculture. The large size and complexity of urban land use in this ICA presents a daunting challenge for watershed restoration planning. This project pilots a methodology for rapid assessment and planning in large watersheds (>100 sq miles) to help managers identify, evaluate, and focus long-term management approaches while at the same time taking early implementation steps. Often times, the need (or perceived need) for expensive, very detailed site specific information interferes with a big-picture approach to water quality management, and hinders the ability of policy makers and managers to take action while continuing to gather information. It is our hope that this watershed plan and the methodology used to develop it will serve as an example for other watershed managers and stakeholders who strive to take action while continuing to collect and analyze data. We also anticipate that this watershed plan, which addresses in part the nine minimum elements of the EPA watershed planning approach (EPA, 2008), may serve as a basis for focused efforts to secure grant funding for additional assessment and implementation projects to mitigate pollutant loads.

Our initial approach was to develop a management plan for a smaller, representative subwatershed within the Boynton ICA, and then extrapolate the results to the larger Boynton ICA. However, once we started examining flow and water quality data, we recognized that data availability and monitoring locations were such that we needed to develop our models at the scale of the full Boynton ICA. Once we did this, we were able to use our watershed-scale assumptions about pollutant loads from different land uses to estimate the pollutant loads at the subwatershed scale. We then

9 Minimum Elements of a Watershed Plan
(EPA, 2008)

1. Identify and quantify sources of pollution in watershed
2. Identify water quality target or goal and pollutant reductions needed to achieve goal
3. Identify the BMPs that will help to achieve reductions needed to meet water quality goal/target
4. Describe the financial and technical assistance needed to implement the identified BMPs
5. Describe the outreach to stakeholders and how their input was incorporated and the role of stakeholders to implement the plan
6. Estimate a schedule to implement BMPs identified in plan
7. Describe the milestones and estimated time frames for the implementation of BMPs
8. Identify the criteria that will be used to assess water quality improvement as the plan is implemented
9. Describe the monitoring plan that will collect water quality data need to measure water quality improvement

performed over 75 site visits across a smaller study area to better understand the existing conditions on a variety of land uses and to evaluate load reduction potential of various restoration strategies, (e.g., stormwater management practices, wastewater treatment and disposal practices, and fertilizer reductions), which might be possible on different land use types. For 13 of these sites, selected as representative examples of a variety of typical settings in the study area, we developed a retrofit concept plan and planning level cost estimate to implement the recommended improvements. We used the site assessment information to inform how we modeled the potential pollutant reductions that could be achieved from individual or combined strategies within the subwatershed study area, and then across the full Boynton ICA. This watershed plan documents these efforts and provides a set of pollutant load reduction strategies that could be implemented across the Boynton ICA, with the ultimate goal of improving the water quality in the coastal estuaries and near shore waters.

The modeling effort for this plan included an examination and collection of existing water quality and canal flow data to develop a basic flow model of the watershed and a land-based pollutant loading estimate of total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS) from the watershed. This model was also used to establish a set of working estimates of pollutant loading coefficients and loading rates for the different land uses in the Boynton ICA, as well as other land-based pollutant sources including fertilizer use and wastewater discharge. We also established from existing research a set of pollutant reduction efficiencies for the most common types of stormwater treatment practices found in the Boynton ICA and incorporated these into the pollutant loading model to account for current stormwater management already implemented in the watershed.

Throughout this effort, we worked with local stakeholders to gather information and data; solicit feedback on our assumptions and understanding; and inform our selections of the study area, appropriate pollution reduction strategies and recommendations for consideration in this plan. We built upon the network of stakeholders developed through our prior watershed planning effort across southeast Florida (Pickering and Baker, 2015), and contracted with a local expert, Alan Wertepny, PE, of the firm Mock•Roos, to provide local technical knowledge and expertise. In addition to numerous communications with local stakeholders, we hosted two public meetings to present our progress and solicit feedback and guidance for our next steps. The meeting summaries of these two meetings (February 9, 2017 and October 18, 2017) are presented in Attachment A.

At the February 9, 2017 meeting, the model, loading estimates, loading coefficients and assumptions applicable across the entire Boynton ICA were presented to project partners and stakeholders in the region for refinement before using the model to evaluate the potential effectiveness of various pollutant reduction strategies in the Boynton ICA. We also worked with stakeholders at a workshop to select a subwatershed study area that would be representative of the Boynton ICA for our more detailed assessment. The stakeholders concluded that Subwatershed ‘I’ (Figure 1) would be most representative and advantageous to use as our focus. In addition, the subwatershed analysis includes several land uses from Subwatershed ‘J’ that were representative of the development patterns along the Intracoastal Waterway and the outer barrier beach setting, as well as agricultural land uses in the western sections of the Boynton ICA. The subwatershed study area is described in more detail in the following sections. At the October 18, 2107 meeting, we presented results and observations from our more detailed site assessments within the focus area subwatersheds.

1.2 Description of Boynton ICA

The Boynton ICA is the land area that generally drains to two major east-west canals, the C-15 and the C-16, and ultimately discharges to the Intracoastal Waterway in the southern end of Lake Worth Lagoon and then out to the Atlantic Coast via the Boynton Inlet (Figure 1). It stretches from the municipality of Lake Worth in the northeast to Highland Beach in the southeast, and from the Loxahatchee National Wildlife Refuge to the west to the Atlantic Ocean in the east. The Boynton ICA is approximately 150 square miles in total, with approximately 128 square miles draining into the Intracoastal Waterway via the C-15 and C-16 canals, and the remainder draining directly to the Intracoastal Waterway.

Figure 1 presents the extent of the Boynton ICA as well as the 14 subwatersheds that were delineated by HW for this project.

Historical development patterns in the Boynton ICA are typical of southeast Florida and can easily be observed in aerial photographs of the area. Development in this area first occurred along the Route 1 corridor, just west of the Intracoastal Waterway, in the late 1800s and early 1900s. This area coincides with the railway, which was the first real transit that provided access and opportunity for economic development. Dense residential neighborhoods and small urban centers developed along this corridor, where a small ridge in the land provided some separation from the swamps to the west and provided access to the Intracoastal Waterway to the east. With Route 1, and later I-95, came population growth, and residential development began encroaching on the Intracoastal Waterway and extending out to the barrier beach. The area to the west was converted to agricultural use with the help of a large network of water management canals. Beginning approximately in the 1980s, residential growth in this area rapidly expanded to the west facilitated by the existence of the water management canals that could drain land to make it more accessible for development. Residential development began to occur in large planned unit developments (PUD), converting agricultural land to more profitable residential land. Notably, these PUDs were developed in accordance with a set of land development regulations and stormwater management standards implemented first through the stormwater rule in 1979 (Chapter 17-4.248, F.A.C), which was updated significantly in 1985 (Livingston, no date), and then through the Environmental Resource Permit program established in 1995, and which did not apply to the earlier land development in the eastern portion of the ICA. Development along the Intracoastal Waterway and barrier islands also increased rapidly during this time period. Many seasonal coastal residences were converted to permanent residences, increasing the intensity of land use in the I-95 corridor. This population growth and development boom has continued to today, continually pushing the interface between residential planned unit developments and agriculture further to the west, and diminishing the extent of agricultural land uses in the region.

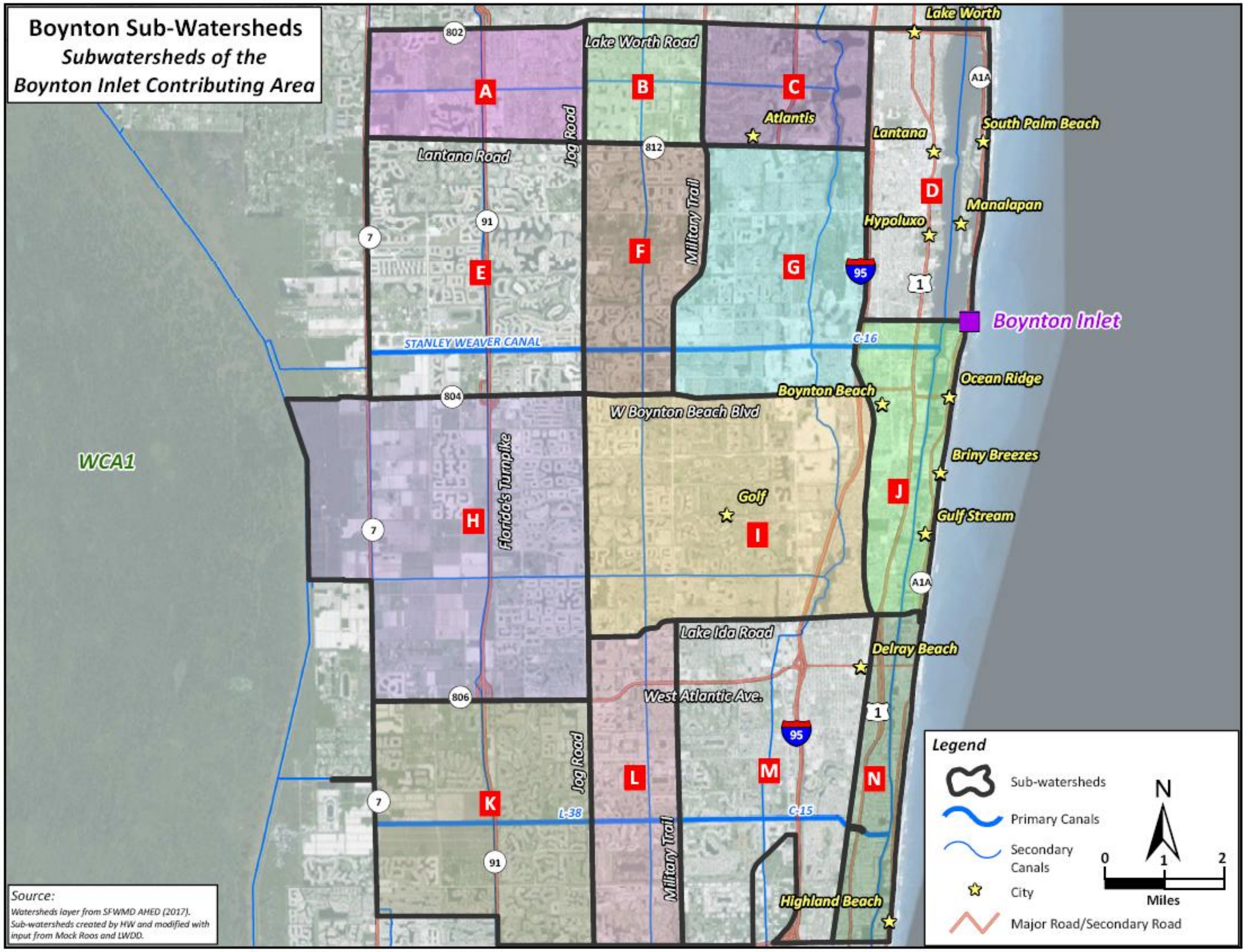

Figure 1. Boynton ICA and subwatershed boundaries

1.3 Description of Subwatershed Study Area

The study area for this subwatershed plan includes Subwatershed 'I' of the Boynton ICA, as well as portions of Subwatershed 'J' that represent additional land uses along the Route 1 corridor, the Intracoastal Waterway and outer barrier beach setting (see Figure 2). In addition, we included a site assessment, basic analysis and recommendations for agricultural lands located predominantly in the western portion of the Boynton ICA, in order to incorporate all representative land uses into our study.

Subwatershed 'I' includes: Lake Ida, a significant portion of the City of Boynton Beach, a small densely developed portion of the City of Delray Beach, unincorporated areas of PBC, and portions of the I-95 corridor managed by the Florida Department of Transportation (FDOT). Within its 18 square miles, almost half (43%) of the subwatershed is comprised of residential land uses, followed by open spaces, parks, and golf courses (20%) and highways and roads (15%). Subwatershed 'J' is smaller, with 6.44 square miles, but has a similar proportion of residential development (42%), open spaces, parks and golf courses (19%), and highways and roads (18%) ().

Table 1. Land use distribution in the Boynton ICA and Subwatersheds 'I' and 'J'.

Land Use Category	Boynton ICA		Subwatershed I		Subwatershed J	
	Area (mi^2)	%	Area (mi^2)	%	Area (mi^2)	%
Agriculture-Crops/Citrus/Pasture/Sod	9.35	6.3%	0.06	0.3%	0.00	0.0%
Agriculture-Equine	1.16	0.8%	0.03	0.2%	0.00	0.0%
Agriculture-Nurseries	1.70	1.1%	0.01	0.1%	0.00	0.0%
High Intensity Commercial	3.79	2.5%	0.27	1.5%	0.23	3.5%
Low Intensity Commercial	5.96	4.0%	0.95	5.3%	0.45	6.9%
Golf Course	10.80	7.2%	2.59	14.3%	0.31	4.8%
Light Industrial	2.37	1.6%	0.24	1.3%	0.05	0.8%
Low Density Residential	0.19	0.1%	0.04	0.2%	0.02	0.3%
Multi-Family Residential	5.74	3.8%	0.44	2.4%	0.87	13.3%
Open Space/Parks	7.95	5.3%	0.55	3.0%	0.77	11.8%
Planned Unit Development	61.46	41.1%	8.97	49.6%	0.05	0.8%
Highway/Roads	15.94	10.7%	1.74	9.6%	1.23	18.9%
Single Family Residential	12.55	8.4%	1.36	7.5%	1.76	27.0%
Uplands	2.38	1.6%	0.00	0.0%	0.11	1.7%
Wetlands	0.24	0.2%	0.00	0.0%	0.03	0.5%
Water	7.88	5.3%	0.83	4.6%	0.65	10.0%
TOTAL	**149.47**	**100%**	**18.07**	**100.0%**	**6.52**	**100.0%**

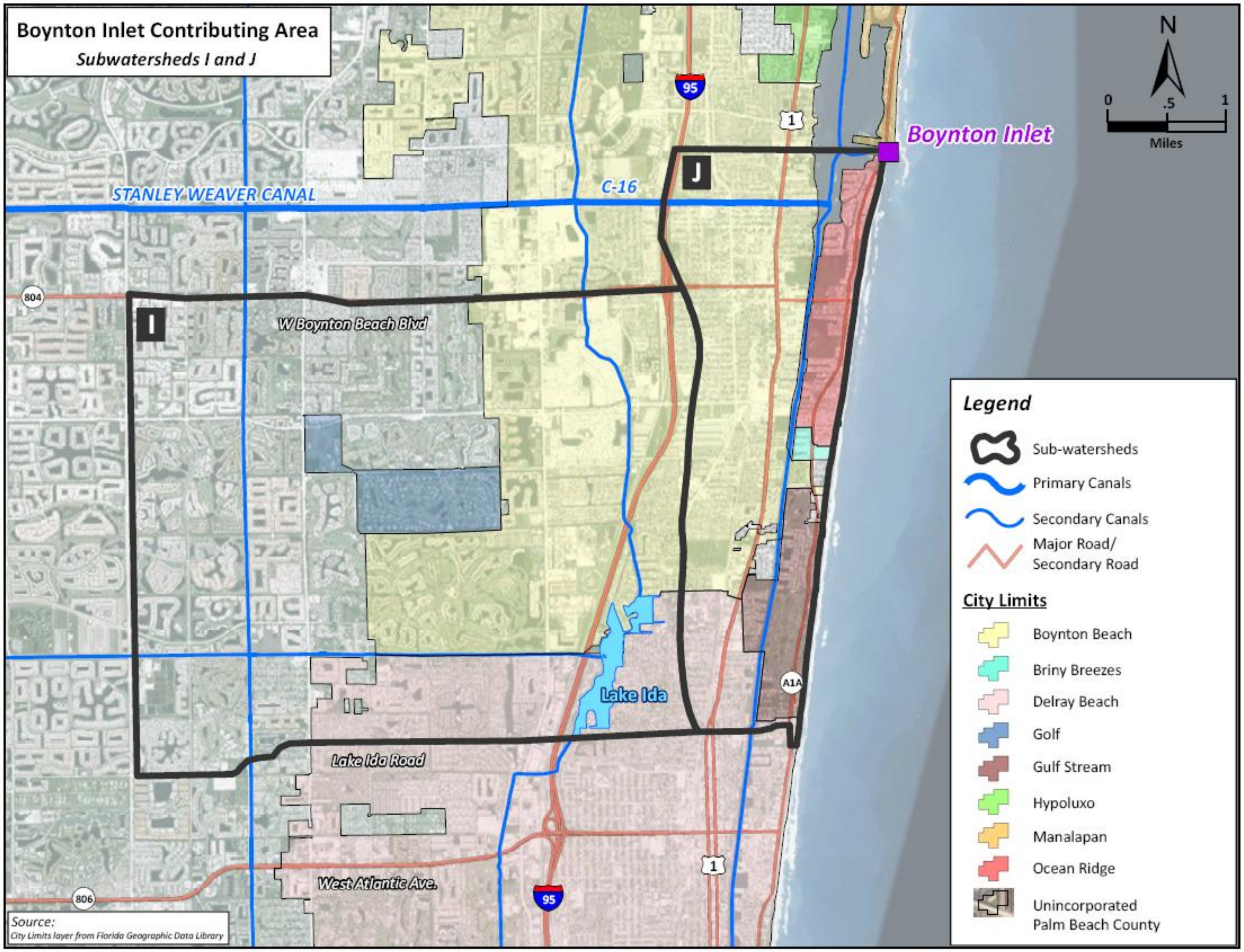

Figure 2. Subwatersheds 'I' and 'J' of the Boynton ICA.

1.4 Water quality impairments in study area

The goal of Boynton ICA watershed restoration is to reduce nutrient (TN and TP) and TSS loads from LBSP to the coastal habitats that support the southeast Florida coral reef ecosystem. The detailed mechanics of water circulation and flow through and within the Intracoastal Waterway and the Boynton Inlet are not fully understood, documented or modeled to date, and are beyond the scope of this project. The watershed management approach is based on the general understanding, supported by NOAA and FDEP, that reducing the pollutant loads generated from the land within the watershed will ultimately benefit the water quality in the estuarine system of the Intracoastal Waterway that supports the coral reef ecosystem, as well as the coral reefs themselves.

The Florida Watershed Restoration Act sets out a process by which the water quality of surface water bodies is assessed, and a plan is developed to improve the water quality of waters that are 'impaired,' as required under the Federal Clean Water Act. Water bodies are designated as impaired when the water quality does not support the designated uses for those waters; impaired waters become the focus of a formal process to reduce pollutant loading through watershed planning and permitting (see Section 1.5).

FDEP uses a system of water body identification numbers (WBIDs) to identify water body units for water quality tracking and impairment designation. Within the Boynton ICA, there are two lakes within the Chain of Lakes that are designated as impaired by FDEP. These two impaired lakes are Lake Ida, WBID 3262A within Subwatershed 'I', and Lake Osborne, WBID 3256A within Subwatersheds 'C' and 'G', which are both impaired for the nutrients chlorophyll-a and phosphorus. In addition, three canal WBIDs in the Boynton ICA are designated as impaired for nutrients as measured by chlorophyll-a only: WBID 3262B1, which refers to the E-1 Canal in the southwestern edge of the Boynton ICA; WBID 3262, which refers to a segment of the E-4 Canal in Subwatershed 'M' in Delray Beach; and WBID 3262D, which refers to a the E-3 Canal in Subwatershed 'I' located in unincorporated PBC. The impaired water bodies within the Boynton ICA are presented in Figure 3.

Among the water quality impairments within the Boynton ICA, Lake Ida is a significant focus of FDEP, which is using the regulation of municipal separate storm sewer systems (MS4s) under the NPDES Program to require water quality improvements. A Total Maximum Daily Load (TMDL) has been developed for Lake Ida to frame this effort. A TMDL is "the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. A TMDL determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant."[1] The following section provides a more detailed discussion of the Lake Ida TMDL.

1.5 Lake Ida TMDL

Lake Ida (WBID 3262A) is part of the Chain of Lakes Watershed, a series of lakes connected by the E-4 Canal that runs north-south (see WBID 3262A in Figure 3). It is a Class III freshwater water body, with designated uses of recreation, propagation, and maintenance of a healthy, well-balanced

[1] https://www.epa.gov/tmdl/program-overview-total-maximum-daily-loads-tmdl

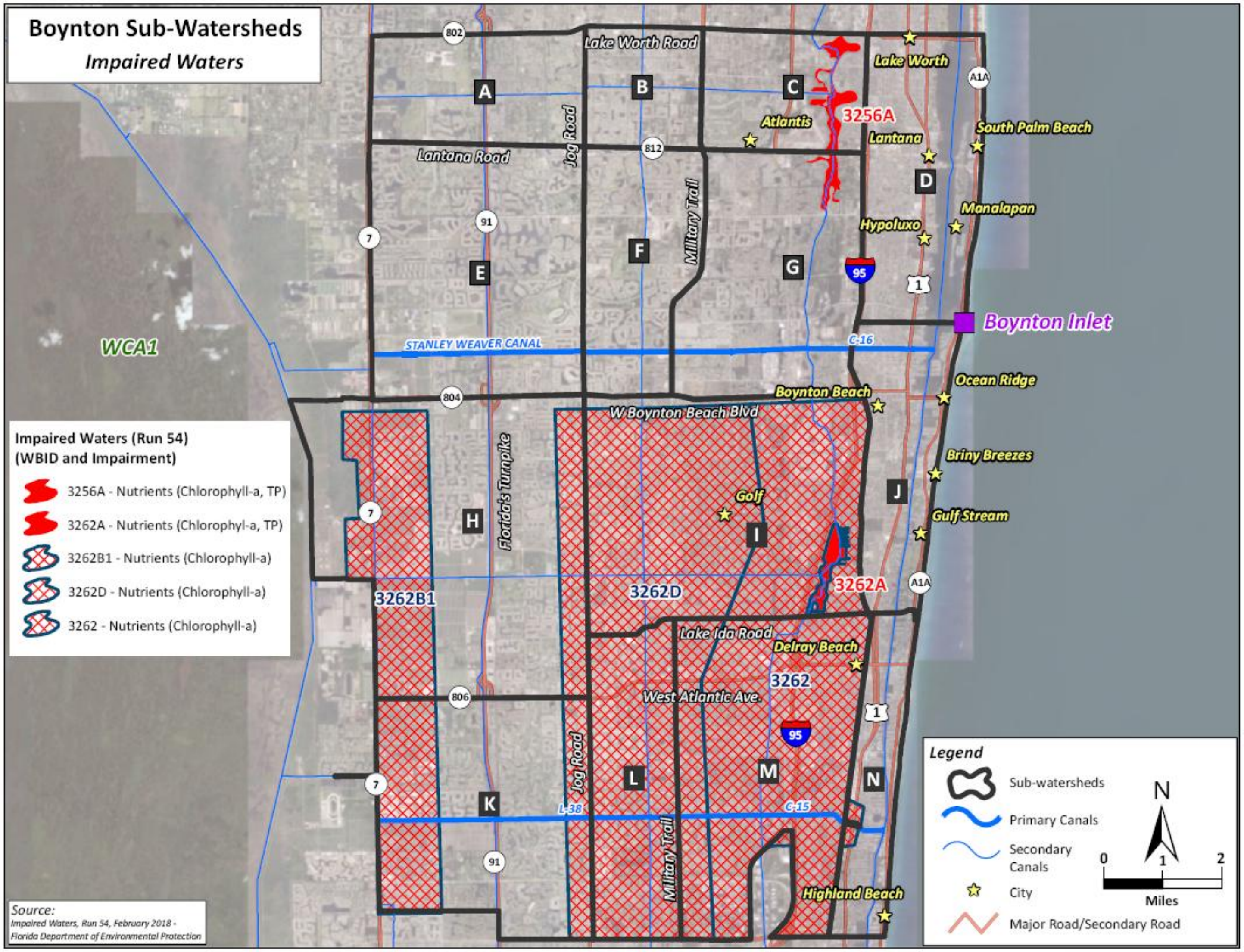

Figure 3. Designated water body impairments in the Boynton ICA.

population of fish and wildlife. Lake Ida, together with the nearby Lake Eden, was determined to be impaired for nutrients in 2010 because it did not meet the applicable Class III narrative criterion that states, "Nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna."[2] To quantify this narrative criterion, impairment is based upon calculation of the Trophic State Index (TSI), which in this case includes concentrations for TN, TP, and chlorophyll-a (Chla). As a first step in determining impairment, the limiting nutrient(s) of the water body must be identified. Lake Ida was found to be co-limited by both TN and TP. In the case of co-limitation, the final TSI is the result of averaging the Chla TSI with both the TN and TP TSIs. Lake Ida was listed as impaired because two final TSI annual averages exceeded the required threshold value for nutrient impairment of 60 TSI.[3] This threshold level of 60 TSI is Florida-specific and is the level at which phytoplankton generally switch to communities dominated by blue-green algae, which sets up unfavorable conditions for lakes.

Because it is listed as impaired, a TMDL was developed for Lake Ida in 2012, as required by Section 303(d) of the federal Clean Water Act (EPA, 2012). A TMDL quantifies the maximum amount of a given causative pollutant that a water body can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. In doing so, TMDLs set important water quality restoration goals. The goal of the Lake Ida TMDL is to identify the maximum allowable TN and TP loadings (the causative pollutants) from the watershed so that Lake Ida will meet the narrative nutrient criteria and thereby maintain its designated use as a Class III water.

In the TMDL, modeling was used to determine the assimilative capacity of Lake Ida, resulting in in-lake target concentrations for TN and TP of 0.857 mg/L and 0.062 mg/L, respectively. At (or below) these in-lake concentrations of nutrients, the algal response in the lake is thought to be favorable (i.e., not too much blue-green algae). To achieve these target concentrations, it was determined that the watershed loads needed to be reduced by 20% for TN and 45% for TP.

Lake Ida TMDL

	TN	TP
In-Lake Target (*mg/L*)	**0.857**	**0.062**
Watershed Reduction	**20%**	**45%**

The TMDL allocates acceptable loads among all of the known pollutant sources in the watershed so that appropriate control measures can be implemented to achieve the water quality standards. The TMDL is expressed as a sum of the point source loads (Wasteload Allocations or WLAs), nonpoint source loads (Load Allocations or LAs), and an appropriate margin of safety (MOS). The following sources of TN and TP were identified in the Lake Ida watershed:

- Point sources (WLAs):
    - One National Pollution Discharge Elimination System (NPDES) MS4 permit, which is held by PBC & Co Permittees (Phase I FLS000018), which includes Florida Department of Transportation (FDOT) Turnpike District/District 4
    - No NPDES permitted wastewater facilities

[2] Rule 62-302.530(48)(b), FAC
[3] For more information on how the Florida Department of Environmental Protection identified impaired waters, refer to the Identification of Impaired Surface Water Rule, Rule 62-303, FAC.

- Nonpoint sources (LAs):
  - Onsite sewage treatment and disposal systems (OSTDSs), or septic systems, which often failing to provide effective nutrient removal due to porous soils and high groundwater levels or due to being installed too close to irrigation wells that drawdown untreated wastewater
  - Sanitary sewer overflows (SSOs), especially during storm events
  - Wildlife impacts, particularly bird feces

The WLAs for stormwater were calculated as a percent reduction, rather than the more typical mass per day that is used for point sources, because it is difficult to quantify loads from MS4s and challenging to distinguish loads from MS4s from other nonpoint sources. As summarized in Table 2, the TMDL for Lake Ida is expressed in terms of percent reductions from watershed TN and TP, and in-lake target TN and TP concentrations that represent the long-term annual average load of TN and TP the water body can assimilate and still maintain the Class III narrative nutrient criterion.

Table 2. TMDL components for nutrients in Lake Ida (from the 2012 Lake Ida TMDL (EPA 2012)).

Parameter	TMDL	WLA		LA (% reduction)	MOS
		Wastewater	NPDES Stormwater (% reduction)		
TN	0.857 mg/L	N/A	20%	20%	Implicit
TP	0.062 mg/L	N/A	45%	45%	Implicit

Notes: N/A = Not Applicable

As Table 2 shows, in order to meet the TMDL, the MS4 permit holders (PBC & Co, including FDOT Turnpike District/District 4) must reduce the anthropogenic loads associated with stormwater outfalls that it owns or has responsibility for by 20% for TN and by 45% for TP. The permit holder is not responsible for reducing other nonpoint source loads in its jurisdiction. The nonpoint source loads (LAs) must also be reduced by 20% for TN and 45% for TP. It should be noted that the nonpoint sources (LAs) include loading from stormwater discharges regulated by FDEP and the water management districts that are not part of the NPDES stormwater program.[4]

The TMDL report, completed in 2012, is supposed to be followed by the development and implementation of a restoration plan to meet the TMDL goals set out in Table 2. This is often accomplished cooperatively with stakeholders by creating a Best Management Action Plan (BMAP). Among other components, the BMAP typically includes load reduction requirements for stakeholders and a description of load reduction activities to be undertaken (e.g., best management practices (BMPs)). As of the date of this report, a BMAP has not been created for the Lake Ida TMDL. The recommended pollutant loading reduction strategies in this watershed management plan may serve to inform the future BMAP or surrogate action plan.

FDEP has been working with stakeholders to address the challenges and constraints of developing BMAPs by developing alternative collaborative watershed based plans that provide reasonable assurances of improvement to water quality in impaired waters. One purpose of this Reasonable

[4] See Appendix A of EPA (2012).

Assurance Plan (RAP) approach is to avoid regulation and permit limits through TMDLs, which can place an undue strain on the local stakeholders. RAPs allow the stakeholders to help define and commit to the best methods to achieve water quality improvements (i.e., a bottom up approach to regulation). Examples of this more collaborative approach include the Florida Keys RAP, the Tampa Bay Estuary RAP, the Shell, Prairie and Joshua Creeks RAP, and the Lake Seminole RAP (https://floridadep.gov/dear/watershed-assessment-section/content/4b-assessments-raps).

2.0 POLLUTANT LOADING

The purpose of this section is to document the procedure for estimating the nutrient and sediment pollutant loads from the Boynton ICA to the Intracoastal Waterway. In Section 5.0 of this report, we will evaluate the pollutant loading reductions that may be achieved by implementing various non-structural and structural pollutant reduction strategies. This is the first step in developing a watershed management plan to reduce nutrient and sediment pollutant load from the Boynton ICA to the local receiving waters.

The ArcHydro Enhanced Database (AHED) developed by the South Florida Water Management District (SFWMD) was previously used to delineate ICAs for all of the nine inlets in Southeast Florida (Pickering and Baker, 2015). These ICAs were developed with assistance and feedback from SFWMD for purposes of this study. This watershed plan addresses the Boynton ICA, one of the nine ICA's in southeast Florida. Within the Boynton ICA, we delineated 15 subwatersheds in consultation with Mock•Roos Associates (HW's local subconsultant for this project), PBC, FDEP, and the Lake Worth Drainage District (LWDD).

The water flow model and pollutant loading model used in this watershed assessment were developed for the entire Boynton ICA, and then the resulting land use pollutant loading assumptions were applied at the subwatershed scale to estimate pollutant loading and potential load reductions within the smaller study area. Because of the limited locations for which we could access existing coincident flow and water quality data, we could only validate our model results at the Boynton ICA scale. The followings sections present a discussion of the model and model results.

2.1 Compilation and Characterization of Existing Materials

2.1.1 GIS Mapping

Base maps containing subwatershed boundaries, primary roads, and the primary and secondary canal systems provided a basis for analysis of pollutant loading and pollutant load reduction modeling. Other data served as inputs to the watershed load model, including: land use types, areas served by septic systems, areas with known stormwater management practices, MS4s, well locations, flow control/monitoring structures and water quality monitoring locations. Most of these model input layers originated from FDEP or PBC GIS data layers, and some were refined based on local knowledge for use in this project. These are further described below.

2.1.2 Flow Monitoring

There are 11 flow-monitoring sites within the Boynton ICA either maintained by SFWMD or LWDD. Of these sites, the most important are at the S40 and S41 structures at the outlets of the C-15 and C16 canal, respectively. These two sites were used to quantify the total surface water flow out of the ICA via the canal system into the Intracoastal Waterway. Three structures (G94A, G94B, and G94C) at the western edge of the Boynton ICA near the WCA1 were used to quantify the total surface water flow into the Boynton ICA (Figure 4). Daily flows were averaged over the last 10 years to give an annual average inflow and outflow for the Boynton ICA.

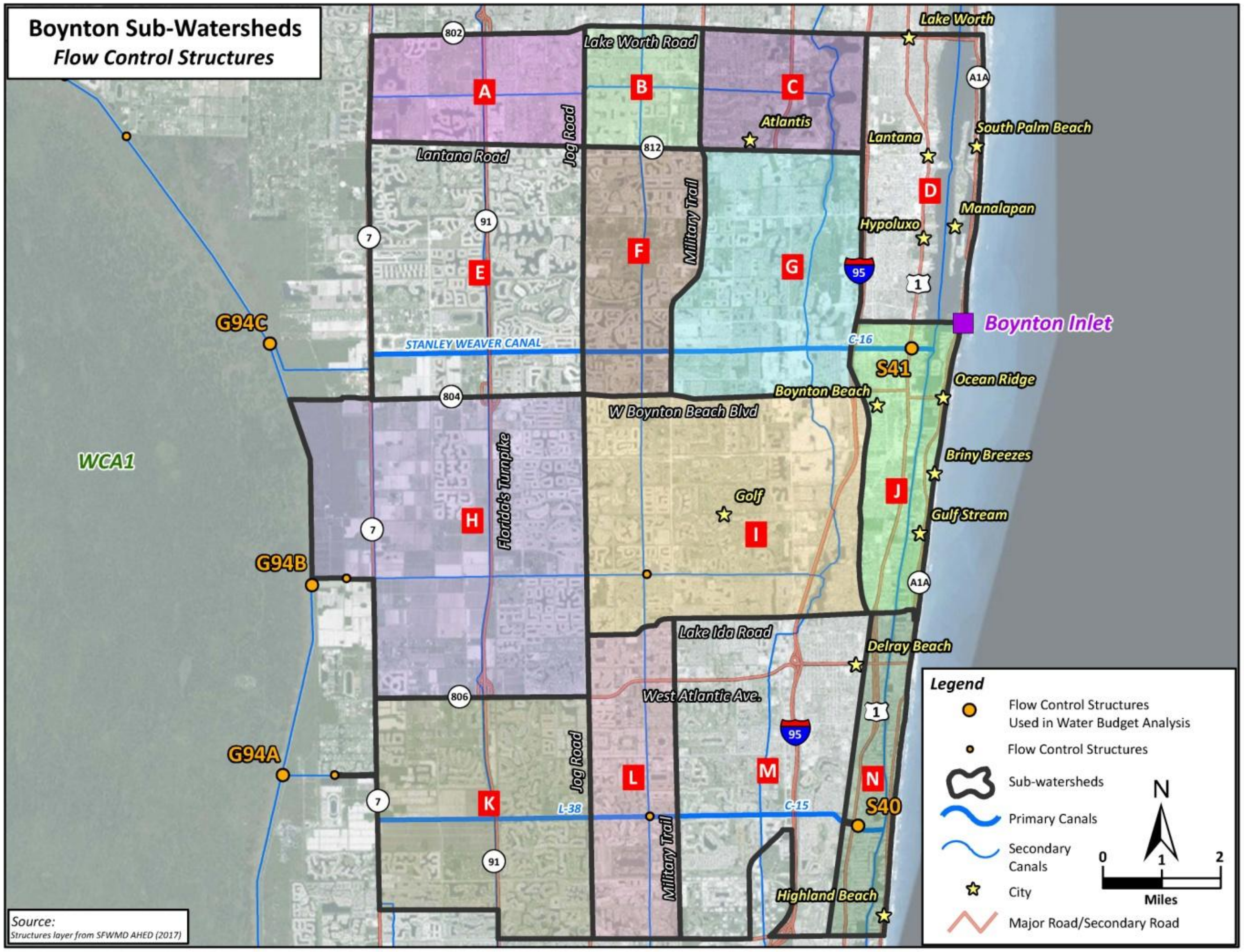

Figure 4. Location of key flow control structures managing flow into and out of the Boynton ICA

2.1.3 Water Quality Monitoring Locations

According to the data reviewed, there are over 570 water quality monitoring sites within the Boynton ICA, and over 340 of them have nutrient measurements. Of these sites, the most important sites for characterizing the water quality discharging from the Boynton ICA are at the outlets to the C-15 canal (C14S40) and the C16 canal (C16S41). The data for these sites were compiled by Mock•Roos in the annual PBC MS4 reports from the Environmental Protection Agency's (EPA) STORET database and PBC and FDEP sources. Water quality monitoring sites LOX6, LOX7, and LOXA124 in the WCA1 on the western edge of the Boynton ICA were used to characterize the water quality entering the watershed. The nutrient data from these sites were extracted from SFWMD's water quality database (DBHYDRO. These key water quality monitoring location are presented in Figure 5.

Periodic water quality measurements were averaged over the last 5 years to give an annual average inflow and outflow water quality concentration for the Boynton ICA. The average nutrient concentrations from these sites were used in combination with the average flow measurements to quantify the average nutrient loads leaving the canal system (i.e., a best available estimate of loads discharging from the Boynton ICA).

2.1.4 Subwatershed Boundaries

Subwatersheds were delineated within the Boynton ICA. Flow directions given in the HydroEdge layer of the AHED database (SFWMD, 2016a) and water level control depths given in a map from the Lake Worth Drainage District (LWDD, 2014) enabled us to develop a draft map that subdivided the ICA into 15 smaller subwatersheds. The water control structures that are located along two north-south roads (Jog Road and Military Trail) form north-south boundaries to the new subwatersheds. A draft subwatershed map was presented at a February 2017 stakeholder meeting and confirmed based on feedback from Mock•Roos, PBC and LWDD Staff.

2.1.5 Modified Land Use

In order to use the land use data layer to aid in estimating pollutant loads, the original PBC existing land use data layer (Palm Beach County, 2013) was modified. After discussion with stakeholders and researching the watershed, we decided it would be useful to separate out the Planned Unit Developments (PUDs) from other residential development types. PUDs in this context refer to large residential developments that are managed by homeowner associations with their own bylaws, maintenance arrangements, and access limitations. These PUDs are responsible for their own stormwater management and landscaping maintenance. The decision to separate out PUDs from other land use categories is based on the understanding that PUDs have been, and continue to be, permitted and constructed in accordance with a set of effective applicable stormwater management standards, in contrast to other older residential development. PUDs are generally recognizable by a unique development pattern of regular lots along internal neighborhood roads within large tracts or blocks, with large man-made stormwater basins; thus, we could create an estimated PUD data layer by delineating PUDs using parcel boundaries and aerial photography (Figure 6). The PUD category includes a mixture of different base residential land use categories in the original land use layer; therefore, the population density and loading coefficients for PUDs were all calculated as an area weighted average using the numbers from the underlying land use categories (see loading discussion later in this report).

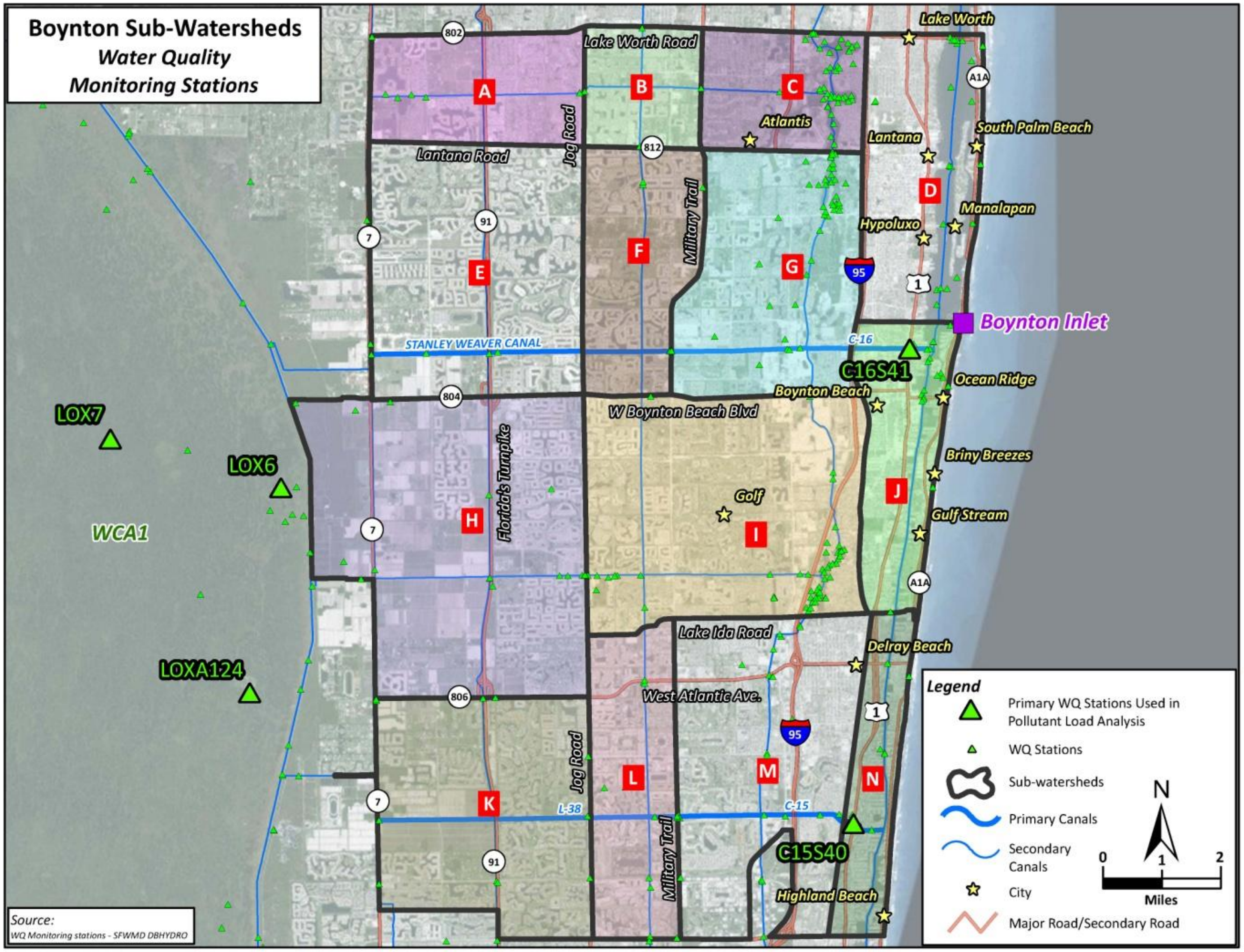

Figure 5. Locations of Key Water Quality Monitoring Sites

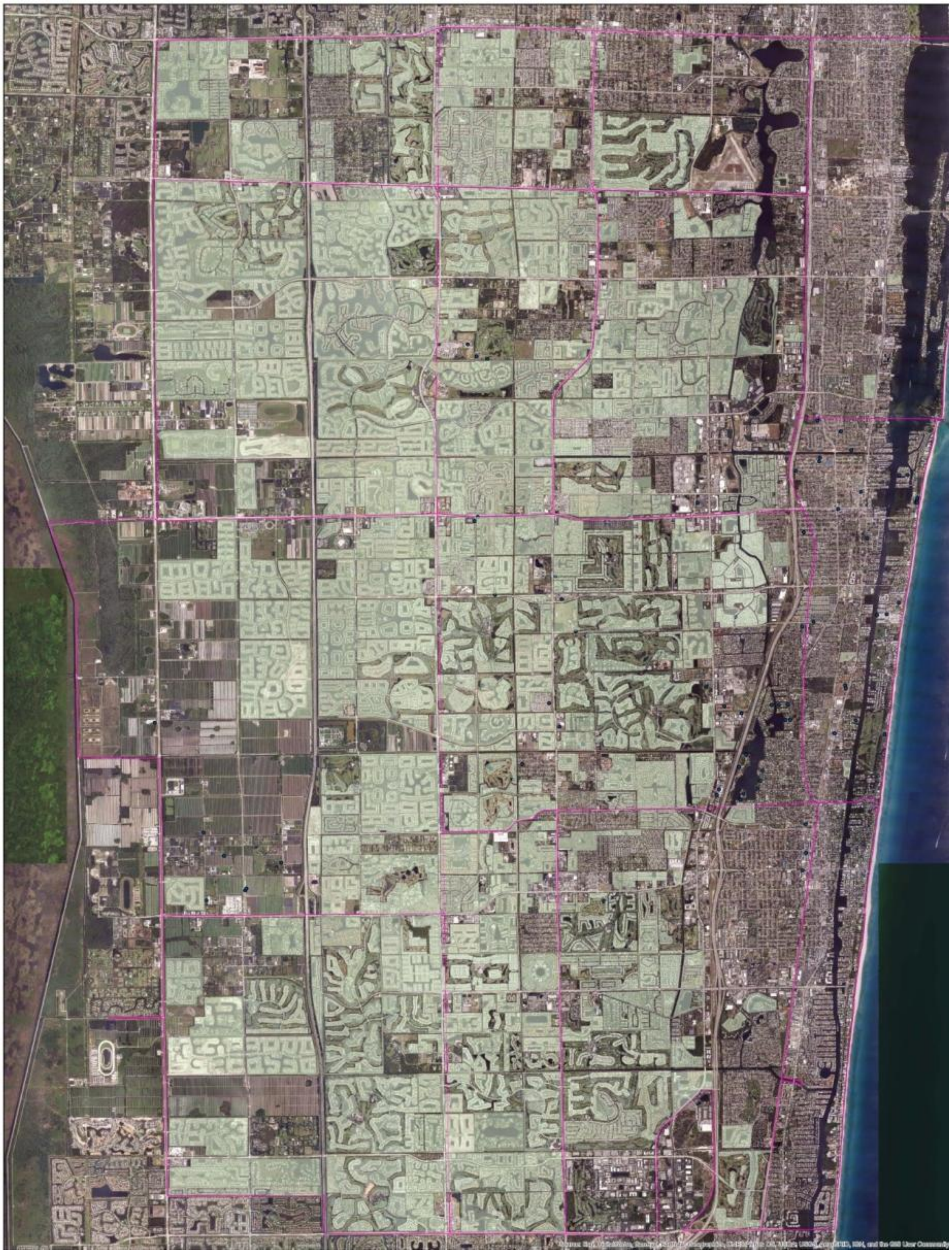

Figure 6. Estimated delineation of 'planned unit developments' (shaded green) within the Boynton ICA

2.2 Water Budget for the Boynton ICA

A water budget was developed for the area within the Boynton ICA above the canal outlet (127.8 sq. mi.) in order to quantify water quantity inputs and outputs to the Boynton ICA and to provide a better estimate of the land-based flow component delivering pollutants to the Intracoastal Waterway. Defining the land-based runoff as accurately as possible is important for determining the land-based pollutant load that can be managed with source controls or through improved or additional BMP designs for nutrient and sediment removal.

Flow data and estimates were compiled from a variety of sources to provide the most comprehensive understanding of flows through the Boynton ICA. Measured values were determined from existing SFWMD data, modeled values were extracted from the South Florida Water Management Model (SFWMM), and estimated values were compiled based on best available data.

2.2.1 Canal Flows

Ten years of daily flow data (2005-2014) were used from the SFWMD canal structures at the inflow structures at western ICA boundary near the WCA1 (G94A, G94B, G94C) and at the outflow structures just upstream of the estuary at a subwatershed boundary (S40, S41). Daily flows were averaged over the last 10 years to give an annual average inflow and outflow for the Boynton ICA.

2.2.2 Groundwater Flows

Groundwater inflows were extracted from ten years (1996-2005) of modeled groundwater flow data from the SFWMM model at the western ICA boundary near the WCA1 (SFWMM model rows 44-52 and columns 35-36) and at the outflow to the estuary at the eastern ICA boundary (SFWMM model rows 44-52 and columns 39-40). Actual groundwater flows were scaled from the SFWMM model values using the ratio of the ICA length from north to south to total model cell length covering the ICA boundaries.

2.2.3 Municipal and Industrial Water Flows

Public and industrial water withdrawals were extracted from the entire SFWMM model simulation period (1965-2005) for the cells covering the ICA area (model rows 44-52 and columns 35-40). According to SFWMD, these data actually represent 2012 pumping values and are therefore considered to be representative of current conditions (SFWMD, pers. comm.). Urban withdrawals were scaled from the SFWMM grid values using the ratio of the ICA area to total grid area covering the ICA. Return flow from public and industrial irrigation was assumed to be 50% (a typical value) of the irrigation use (assumed to be 30% of total use), which gives 15% (50% times 30%) of the total withdrawals. Wastewater recharge was assumed to be 80% (SFWMD, 2016b) of the non-consumptive use (assumed to be 70% of total use), which gives 56% (80% times 70%) of the total withdrawals.

2.2.4 Septic Return Flows

Septic return flows (i.e. private wastewater) were determined from a GIS layer of septic areas combined with population estimates for those areas. Population density was determined for each land use by intersecting the PBC land use layer with the census tract data and determining average population density by land use class. The values for each land use class were adjusted slightly by lowering the population density for barren areas (highways, open spaces, etc.) and increasing the populated land use classes (residential), while still preserving total PBC population of about 1.3 million people. The final population density estimates for each land use are presented in Table 3. The population density for the planned unit development land use category created by HW for this analysis is an area-weighted average of the population densities from the base land uses comprising the PUD category.

Table 3. Population density by FDEP land use class

FDEP Category	Population Density (people/acre)
Agriculture-Crops/Citrus/Pasture/Sod	0.2
Agriculture-Equine	1
Agriculture-Nurseries	1
Light Industrial	5
Low Intensity Commercial	4
High Intensity Commercial	2
Highway/Roads	3
Low Density Residential	3
Single Family Residential	5
Multi-Family Residential	9
Planned Unit Development	3.68
Golf Course	2
Open Space/Parks	0.2
Uplands	0.2
Wetlands	0.2
Water	0.2

The flow of private wastewater returning to the watershed via septic systems (septic return flow) was estimated by assuming a non-consumptive use of 48 gallons/person/day (FDOH, 2015). Based on an estimated 32,409 people in the Boynton ICA on septic systems, the estimated septic return flow is 1.6 million gallons per day (mgd). Private well withdrawals were estimated by dividing this number by the estimated percentage of non-consumptive use (assumed to 70% of total use). Return flow from private irrigation was assumed to be 50% (a typical value) of the irrigation use (assumed to be 30% of total use), which results in 15% (50% times 30%) of the total withdrawals.

2.2.5 Agricultural Water Flows

Agricultural water withdrawals were also extracted from the ten years (1996-2005) of agricultural withdrawal data from the SFWMM model for all the model cells covering the ICA area. Actual agricultural withdrawals were scaled from the SFWMM grid values using the ratio of the ICA area to total grid area covering the ICA. Return flow from agricultural irrigation was assumed to be 50% (a typical value) of the total agricultural withdrawal.

2.2.6 Water Budget Calculation

Net flow overland is the difference between the flow into the ICA and the measured flow out of the ICA. The flow into the ICA is comprised of flows measured at the monitoring structures 94A, 94B and 94C, groundwater flow into ICA, estimated flows into the ground from the recharge of public and industrial wastewater and septic systems, and estimated flows into the ground form public and industrial irrigation as well as private residential irrigation. The flow out of the ICA is comprised of flows discharging from the S4 and S41 flow structures on the C-15 and C-16 canals, the estimated groundwater flows out of the ICA, and withdrawals for public and industrial water supply, private water supply, and agricultural irrigation. An annual water budget for this area was estimated for a period that corresponds roughly to the last 10 years, depending on data availability. The budget equation is given below as:

Q-LANDnet = Q-G94Ain + Q-G94Bin + Q-G94Cin + Q-GWin + Q-RPUBrf + Q-WPUBrf + Q-WRPRVrf + Q-WPRVrf + Q-WAGRrf – Q-S40out – Q-S41out – Q-GWout – Q-WPUBout – Q-WPRVout - Q-WAGRout

where:

Q-LANDnet	= Calculated net land flow (P-ET)
Q-G94Ain	= Measured G94A flow
Q-G94Bin	= Measured G94B flow
Q-G94Cin	= Measured G94C flow
Q-GWin	= Modeled groundwater flow
Q-RPUBrf	= Estimated public & industrial recharge from wastewater
Q-WPUBrf	= Estimated public & industrial irrigation return flow
Q-WRPRVrf	= Estimated private septic return flows
Q-WPRVrf	= Estimated private irrigation return flow
Q-WAGRrf	= Estimated agricultural water irrigation return flow
Q-S40out	= Measured S40 flow
Q-S41out	= Measured S41 flow
Q-GWout	= Measured groundwater flow
Q-WPUBout	= Modeled public and industrial well withdrawals
Q-WPRVout	= Estimated private well withdrawals
Q-WAGRout	= Modeled agricultural irrigation withdrawals

Individual categories of net flows are calculated as follows:

Net Land Runoff =	calculated net land flow
Net Canal Flow =	canal inflow (G94A, G94B, and G94C) – canal outflow (S40, S41)
Net Groundwater Flow =	groundwater flow in – groundwater flow out
Net Agric Well Flow =	agricultural water irrigation return flow – agricultural irrigation withdrawals
Net Private Well Flow =	private septic system returns – private well withdrawals
Net Pub/Ind Well Flow =	pub/ind recharge from wastewater + pub/ind irrigation return flow – pub/ind well withdrawals

The flow rates and associated data sources used in the water budget calculations are provided in Table 4 and the net flows are presented in a pie chart in Figure 7. Based on this model and its assumptions, the total overland flow (including both surface runoff and groundwater flow into ditches) for the Boynton ICA watershed above the S40 and S41 structures is estimated to be 31.25 inches per year (in/yr).

Table 4. Annual water budget for Boynton ICA

Source	Flow (cfs)	Flow (mgd)	Flow (in)	Flow Source
Measured G94C flow	9.2	5.9	0.97	SFWMD measured 2005-2014
Measured G94B flow	2.7	1.7	0.29	SFWMD measured 2005-2014
Measured G94A flow	13.1	8.5	1.40	SFWMD measured 2005-2014
Modeled groundwater flow	10.8	6.9	1.14	SFWMM 1965-2005 (scaled to model rows 44-52)
Estimated public & industrial recharge from wastewater	47.9	31.0	5.09	56% of urban well withdrawals
Estimated public & industrial irrigation return flow	12.8	8.3	1.36	15% of urban well withdrawals
Estimated private septic return flows	2.4	1.6	0.26	Private non-consumptive use (population*70 gppd)
Estimated private irrigation return flow	0.5	0.3	0.05	15% of private well withdrawals
Estimated agricultural water irrigation return flow	28.8	18.6	3.06	50% of agricultural withdrawals
Measured S40 flow	-65.6	-42.4	-6.96	SFWMD measured 2005-2014
Measured S41 flow	-186.2	-120.3	-19.77	SFWMD measured 2005-2014
Measured groundwater flow	-24.2	-15.6	-2.57	SFWMM 1965-2005 (scaled to model rows 44-52)
Modeled public and industrial well withdrawals	-85.6	-55.3	-9.08	SFWMM 1996-2005 (above C-15 & C-16 outlets only)
Estimated private well withdrawals	-3.4	-2.2	-0.37	143% of private non-consumptive use
Modeled agricultural irrigation withdrawals	-57.7	-37.3	-6.13	SFWMM 1996-2005 (above C-15 & C-16 outlets only)
Calculated net land flow	**294.4**	**190.3**	**31.25**	**Calculated from flows in and out of the ICA**

Notes: cfs = cubic feet per second, mgd = million gallons per day, in = inches across the watershed
Negative flows indicate flows out of the watershed. Positive numbers indicate flows into the watershed.

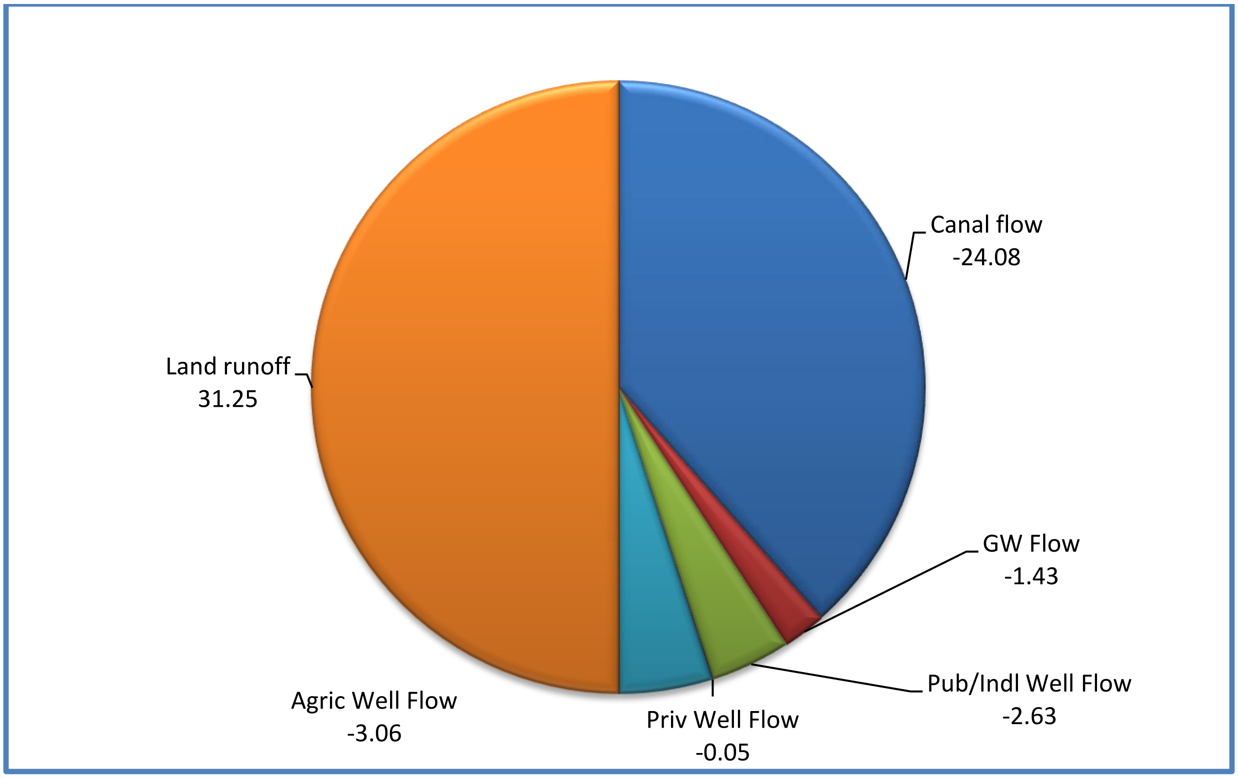

Figure 7. Net flows (watershed inches/year) through the Boynton ICA

2.3 Pollutant Budget for the Boynton ICA

Nitrogen, phosphorus and sediment budgets were also developed for the drainage area above the canal outlets (127.8 square miles) using the above flows and appropriate constituent concentrations observed in the water quality monitoring data. Periodic water quality measurements were averaged over the last 5 years to give an annual average inflow and outflow water quality concentration for the Boynton ICA

2.3.1 Canal Water Quality

Measured canal inflow concentrations were determined from five years of water quality (WQ) data (2010-2014) from WQ stations in WCA1 (LOX6, LOX7 and LOXA126) near the G94A, G94B and G94C inflow structures. Canal outflow concentrations were determined at the WQ stations near the outlets to the estuary (C14S40 and C516S41) at the outflow structures S40 and S41.

2.3.2 Groundwater Quality

Groundwater quality was estimated from a variety of sources. Groundwater and well withdrawal concentrations were estimated from available groundwater data, septic concentrations were estimated from literature values (FDOH, 2015; Lowe et al., 2009), wastewater return concentrations were set below the maximum allowable values for advanced wastewater treatment (FS, no date), while irrigation return flow concentrations were estimated at twice the groundwater values (best professional judgment).

2.3.3 Pollutant Budgets

Annual pollutant budgets for TN, TP, and TSS were determined for a period that corresponds roughly to the last 10 years depending on data availability. The pollutant loading budget calculation mimics the flow calculations in structure, and uses the same categories of watershed inputs and outputs. All the variables have the same definitions as they do in the water budget but are preceded by a "P" instead of a "Q" to represent annual pollutant loads (in pounds per year (lb/yr)).

The budget equation is given below as:

P-LANDnet = PG94Ain + PG94Bin + PG94Cin + PGWin + PRPUBrf + PWPUBrf + PWRPRVrf + PWPRVrf + PWAGRrf – PS40out – PS41out – PGWout – PWPUBout – PWPRVout – PWAGRout

The details of the water budget are presented in Table 4 and presented graphically in Figure 7. A summary of the pollutant budgets is given in Table 5 showing the assumed concentrations and loads with figures for net pollutant loads following. The annual nitrogen, phosphorus and sediment loads generated in the watershed above the S40 and S41 structures were estimated to be 366,813 lbs/yr TN, 38,807 lbs/yr TP, and 2,243,533 lbs/yr TSS.

Table 5. Nitrogen, phosphorus and sediment loads for Boynton ICA

Source	TN Conc. (mg/L)	TN Load (lb/yr)	TP Conc. (mg/L)	TP Load (lb/yr)	TSS Conc. (mg/L)	TSS Load (lb/yr)
Measured G94C flow	1.10	19,848	0.02	271	0.50	9,022
Measured G94B flow	1.10	5,827	0.02	79	0.50	2,648
Measured G94A flow	1.10	28,459	0.02	388	0.50	12,936
Modeled groundwater flow	1.10	23,285	0.01	212	0.01	212
Estimated public & industrial recharge from wastewater	2.00	188,661	0.05	4,717	0.03	2,830
Estimated public & industrial irrigation return flow	4.20	106,122	0.10	2,527	0.02	505
Estimated private septic returns	46.22	219,035	0.05	237	0.03	142
Estimated private irrigation return flow	4.20	4,265	0.10	102	0.02	20
Estimated agricultural water irrigation return flow	4.20	238,530	0.15	8,519	0.03	1,704
Measured S41 flow	1.00	-366,584	0.06	-21,995	5.30	-1,942,896
Measured S40 flow	0.99	-127,826	0.11	-14,203	2.50	-322,793
Measured groundwater flow	2.10	-99,949	0.05	-2,380	0.02	-952
Modeled public and industrial well withdrawals	2.10	-353,739	0.05	-8,422	0.02	-3,369
Estimated private well withdrawals	2.10	-14,216	0.05	-338	0.02	-135
Modeled agricultural irrigation withdrawals	2.10	-238,530	0.08	-8,519	0.03	-3,408
Calculated net load in the land flow	**0.63**	**366,813**	**0.07**	**38,807**	**3.87**	**2,243,533**

Notes: mg/L = milligrams per liter, lb/yr = pounds per year

Figure 8, Figure 9 and Figure 10 show the nitrogen, phosphorous, and TSS budgets for the Boynton ICA, respectively.

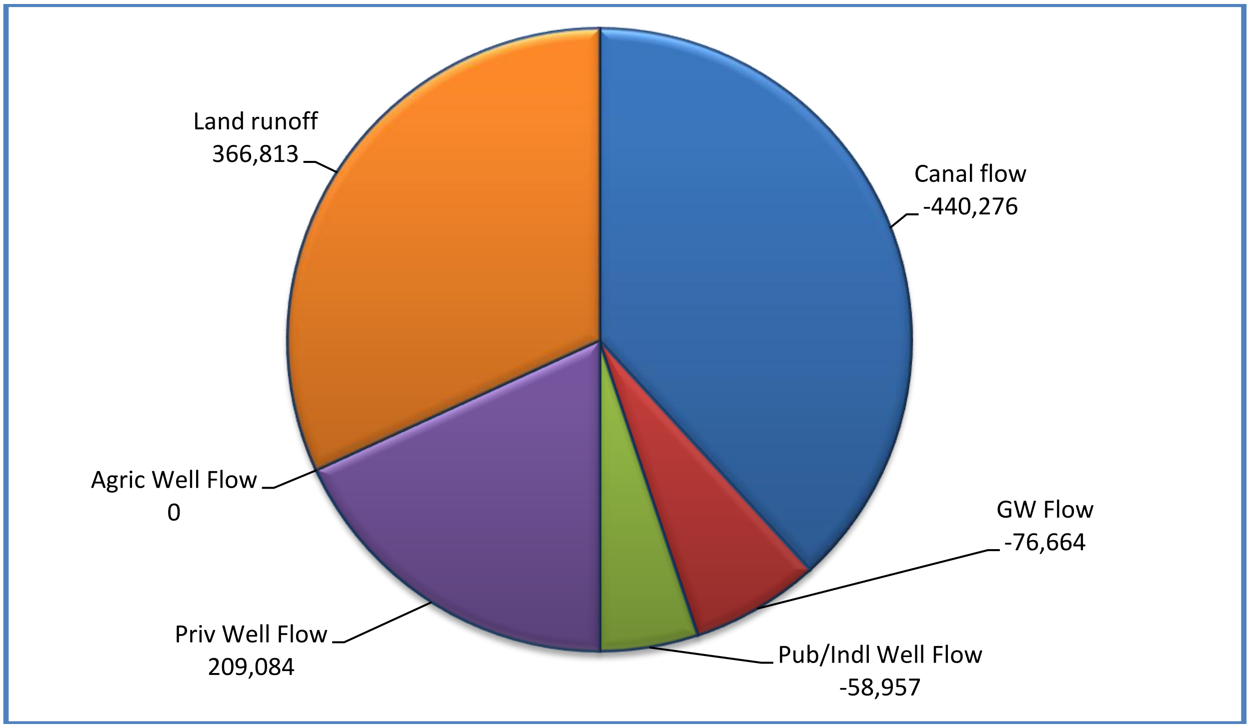

Figure 8. Total nitrogen budget (lb/yr) for Boynton ICA

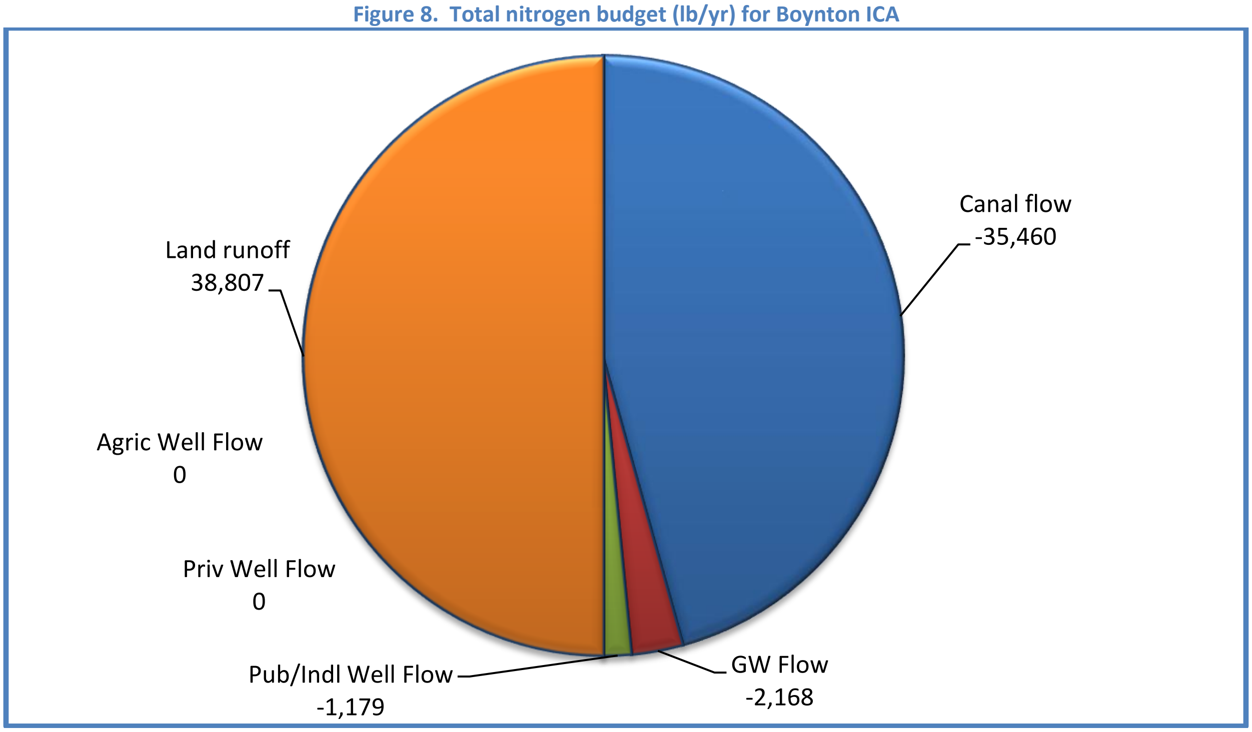

Figure 9. Total phosphorus budget (lb/yr) for Boynton ICA

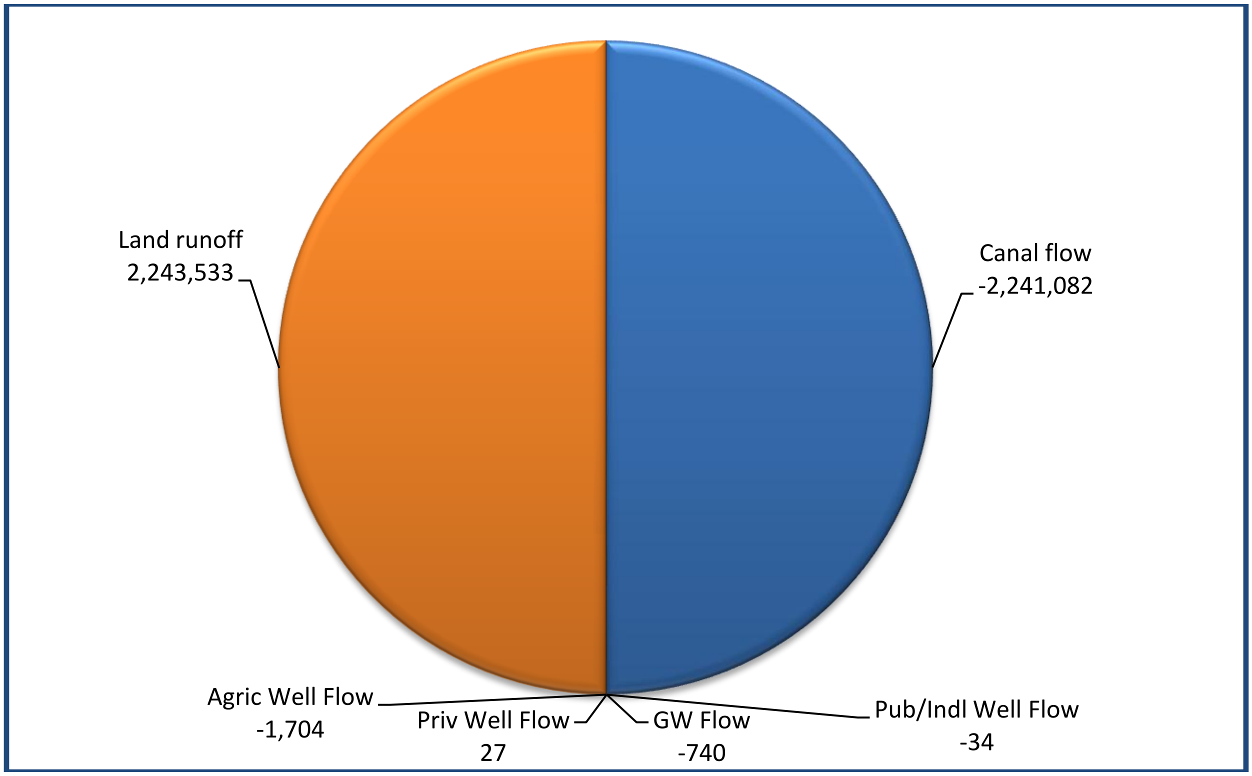

Figure 10. Total suspended solids budget (lbs/yr) for Boynton ICA

2.4 Land-based Pollutant Load Modeling

The land-based loads estimated in the budget analysis above were used to calibrate a land-use based model for the Boynton ICA watershed upgradient of the S40 and S41 structures. This land-based model will be useful for identifying land uses and locations where there are high source loads. This information will also be useful for evaluating mitigation options.

GIS was used to create the overlay data needed for the load modeling analysis. The data for each individual polygon were derived by combining the GIS data layers presented in Table 6, using the "union" function.

Table 6. GIS data used in load modeling

GIS Layer Description	Data Fields Used	Number	Layer Source
Land Use	DEP, Category	16*	PBC, Mock Roos, HW
BMP Type	HW_Type	9	PBC, Mock Roos, HW
Septic	Sep_Served	2	PBC, Mock Roos
Population Density	POPDEN_est	16	HW
Soil Type	HYDGRP	4	PBC, Mock Roos
MS4 Boundaries	SYS_OWN	19	PBC, Mock Roos
Subwatersheds	Subws	15	HW

* Included planned unit development (PUD)

2.4.1 Loading Model

Pollutant loads generated by individual land uses in the Boynton ICA were calculated by calibrating the estimates against the net watershed pollutant loads presented in the prior section. Land use based loads for each land use are calculated as the product of the land area and the loading coefficient for that land use polygon, and are then adjusted for the load reductions provided by existing stormwater BMPs as well as the load increases provided by septic systems.

The land-based loading model for each land use polygon is given by:

LULoad = LoadCoeff * Area * (1-BMPred) + Septic Load

where

LULoad	= land use constituent load (lb/yr)
LoadCoeff	= land use loading coefficient (lb/ac/yr)
BMPred	= reduction in land use load from known BMP (fraction)
SepLoad	= septic load for TN only (lb/yr)

2.4.2 Loading Coefficients

Land-based loading coefficients for TN, TP, and TSS were derived from two principal sources: Harper & Baker (2007) and Zheng (2011). The first source, Harper and Baker (2007), provides event mean concentrations (EMCs) for nitrogen, phosphorus and sediment for a number of land use classes with runoff coefficients by land use and hydrologic soil group. The annual loading rates (lb/ac/yr) for nitrogen, phosphorus and sediment were computed using the average runoff coefficient over the four hydrologic soil groups with the EMCs. Zheng (2011) reported the land-based loading coefficients for TN and TP, but not for TSS.

The land use loading coefficients for TN and TP from both studies were found to be similar to one another for the urban land uses; however, for the agricultural classes, Zheng (2011) loads were approximately twice the loads presented in Harper and Baker (2007). Since Harper is widely considered an expert in Florida urban runoff water quality, and since Zheng (2011) is more heavily focused on agricultural runoff than urban runoff, HW used the Harper and Baker (2007) loads for the urban land uses and the Zheng (2011) loads for the agricultural land uses. Zheng (2011) did not include any TSS load estimates, so HW used agricultural TSS load estimates from Harper and Baker (2007). Table 7 summarizes the literature values used in the initial loading model calibration.

Table 7. Initial land use loading coefficients

Category	TN Load (lb/ac/yr)	TP Load (lb/ac/yr)	TSS Load (lb/ac/yr)
Agriculture-Crops/Citrus/Pasture/Sod	4.2	0.7	56.9
Agriculture-Equine	12.5	1.8	250.0
Agriculture-Nurseries	3.9	0.3	27.0
Light Industrial	7.0	1.5	349.7
Low Intensity Commercial	6.9	1.0	335.2
High Intensity Commercial	18.5	2.7	537.1
Highway/Roads	11.0	1.5	250.2

Category	TN Load (lb/ac/yr)	TP Load (lb/ac/yr)	TSS Load (lb/ac/yr)
Low Density Residential	3.7	0.4	53.4
Single Family Residential	6.7	1.1	120.9
Multi-Family Residential	13.5	3.0	453.5
Planned Urban Development	7.0	1.2	169.6
Golf Course	4.0	0.7	109.0
Open Space/Parks	3.7	0.4	53.4
Uplands	1.3	0.1	9.7
Wetlands	1.0	0.2	5.0
Water	1.0	0.2	5.0

Notes: lb/ac/yr = pounds per acre per year

2.4.3 Pollutant Reduction Estimates for Existing Stormwater Practices

Land areas associated with existing stormwater practices were identified in the GIS data layer provided to HW by Mock•Roos. The data layer includes mapped areas for a host of stormwater management practices, including dry detention basins, exfiltration basins, proprietary control devices, wet detention basins and combinations of these practices. By far, the most common existing stormwater practice in the Boynton ICA is the wet detention basin. Each stormwater control listed in Table 8 was assigned a pollution reduction coefficient based on the accepted values reported by FDEP (FDEP 2016).

Table 8. Pollutant reductions for existing stormwater practices

Types of Existing Stormwater Practices	TN Reduction (%)	TP Reduction (%)	TSS Reduction (%)
Dry Detention Basin (Dry)	10	10	50
Exfiltration Basin (Exf)	45	65	90
Proprietary Control Device (PCD)	30	40	90
Wet Detention Basin (Wet)	50	80	90
Dry/PCD in combination	37	46	95
Dry/Wet in combination	55	82	95
Exf/Dry in combination	51	69	95
Exf/PCD in combination	62	79	99

2.4.4 Septic Loads

Areas with septic systems, or OSTDS, were identified by the Sep_Served variable in the septic system data layer. Nitrogen loads from OSTDS were calculated using the land use based population density and an annual per capita nitrogen loading rate. HW used two reports (Lowe et al., 2009; FDOH, 2015) to estimate the average nitrogen load in septic system effluent to be 9.0 pounds of nitrogen per person per year (lb N/person/yr). That number was then reduced by 25% to account for losses in the drain field (MEP, 2006), resulting in an estimated net loading rate to groundwater of 6.75 lb N/person/year from septic systems. No septic loads were estimated for phosphorus or total suspended solids.

2.4.5 Calibration

HW calibrated the estimated nutrient loading rates to match the estimated land-based loads presented earlier in Table 5 for the Boynton ICA drainage area above the canal outlets (127.8 square miles). The relative relationship of loading rates among land uses was preserved by simply scaling all the values up or down using a common multiplier. The scaling coefficients used for TN, TP and TSS were 0.95, 0.87 and 0.40, respectively. The calibrated land use coefficients used in our analysis are presented in Table 9.

Table 9. Final land use loading coefficients

Category	TN Load (lb/ac/yr)	TP Load (lb/ac/yr)	TSS Load (lb/ac/yr)
Agriculture-Crops/Citrus/Pasture/Sod	4.0	0.6	22.5
Agriculture-Equine	11.9	1.6	98.8
Agriculture-Nurseries	3.7	0.3	10.7
Light Industrial	6.6	1.3	138.1
Low Intensity Commercial	6.5	0.9	132.4
High Intensity Commercial	17.6	2.3	212.2
Highway/Roads	10.5	1.3	98.8
Low Density Residential	3.6	0.4	21.1
Single Family Residential	6.3	0.9	47.8
Multi-Family Residential	12.8	2.6	179.1
Planned Urban Development	6.7	1.0	67.0
Golf Course	3.8	0.6	43.1
Open Space/Parks	3.6	0.4	21.1
Uplands	1.3	0.1	3.8
Wetlands	1.0	0.2	2.0
Water	1.0	0.2	2.0

These values were applied to the land uses within each subwatershed to calculate an estimated load of TN, TP and TSS in each of the 15 subwatersheds of the Boynton ICA. These loads are presented in Table 10.

Table 10. Nitrogen, phosphorus and sediment loads for Boynton subwatersheds

Subwatershed	Area (mi^2)	TN Load (lb/yr)	TP Load (lb/yr)	TSS Load (lb/yr)
A	6.8	50,195	2,217	123,917
B	4.1	27,952	1,707	106,188
C	5.7	42,880	2,763	197,151
D	9.5	43,667	5,970	413,876
E	15.6	55,738	3,060	137,767
F	7.6	29,829	1,732	83,263
G	12.0	76,349	3,731	214,095
H	21.8	85,367	6,188	295,132
I	18.1	60,086	5,179	323,483
J	6.5	44,614	4,212	284,541
K	14.0	54,309	3,158	145,956
L	7.7	29,926	1,711	86,704
M	15.3	64,015	7,483	522,173
N	4.8	25,670	3,848	276,518
ALL	**149.5**	**690,595**	**52,960**	**3,210,765**

2.4.6 Lake Ida

Subwatershed 'I' is the only subwatershed within the Boynton ICA that has a TMDL, which established pollutant load reduction goals for TN and TP. Since the MS4s in this subwatershed have regulatory responsibilities associated with meeting the restoration goals, the MS4s requested that HW provide assistance in estimating the existing MS4 loads. In response, HW performed additional pollutant loading analyses for the areas within the MS4 boundaries within Subwatershed ‘I,’ using MS4 information provided by Mock•Roos. Pollutant loading contributions from each of the four affected Palm Beach County MS4s (Boynton Beach, Delray Beach, FDOT District IV and Palm Beach County) are presented in Table 11 and a map of the MS4 contributing areas within Subwatershed ‘I’ is shown in Figure 11.

Table 11. Nitrogen, phosphorus and sediment loads for MS4 Areas within Subwatershed ‘I’

MS4 Area Within Subwatershed I	TN Load (lb/yr)	TP Load (lb/yr)	TSS Load (lb/yr)
Boynton Beach MS4	3,396	225	7,562
Delray Beach MS4	648	93	5,785
FDOT District IV	2,799	340	25,621
Palm Beach County	3,487	392	29,102
ALL MS4	**10,330**	**1,050**	**68,070**
ALL Subwatershed ‘I’	60,086	5,179	323,483
ALL MS4 (as % of Subwatershed ‘I’)	**17.2%**	**20.3%**	**21.0%**

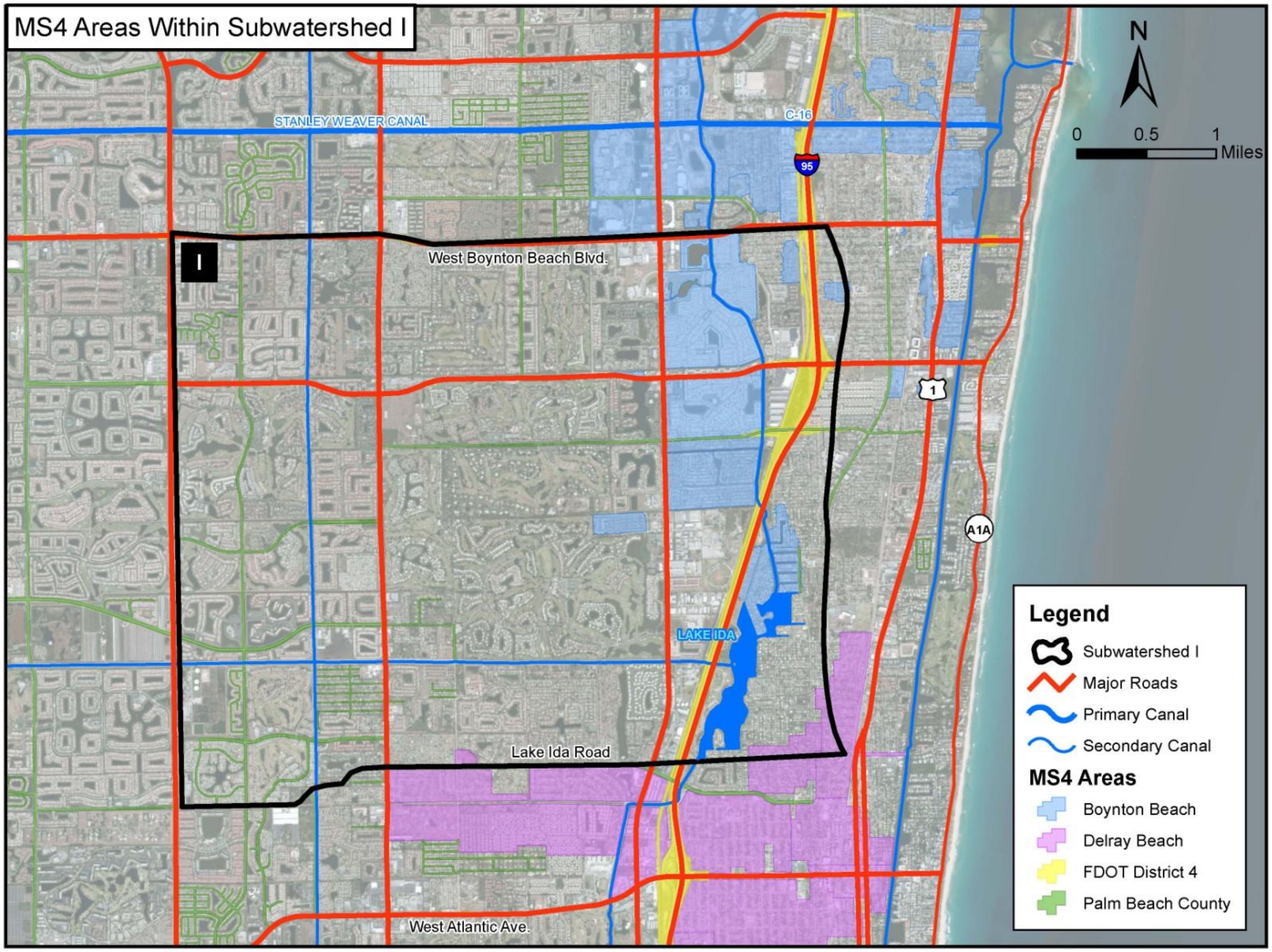

Figure 11. MS4 Areas within Subwatershed 'I'

3.0 SITE ASSESSMENTS

The Boynton ICA is too large to be assessed within the scope of this project. Therefore, HW performed a set of site assessments within a smaller study area that was representative of the larger Boynton ICA. During the development of this watershed management plan, we worked with Boynton ICA stakeholders to identify a subwatershed that would be suitably representative of the land uses and development patterns of the larger Boynton ICA, within which we could perform a series of site assessments. The purpose of these site assessments is to better understand the local site conditions and constraints in order to make informed recommendations about appropriate land-based pollution load reduction strategies within the Boynton ICA. The outcome of a February 2017 stakeholder meeting hosted by the City of Boynton Beach (see Attachment A for meeting summary) was the selection of Subwatershed 'I', with the agreement that this would be supplemented by portions of Subwatershed 'J' and sites representative of agricultural land uses in the western Boynton ICA. This combination would allow us to visit and consider all representative land uses within the Boynton ICA. Subwatershed 'I' was also of particular interest to many stakeholders because it contains Lake Ida, which is the subject of a TMDL requiring nitrogen and phosphorus load reductions from MS4s and nonpoint pollution sources (see Section 1.5).

3.1 Site Selection and Visits

Prior to conducting field work, sites were selected based on GIS data and aerial photography to ensure that the set of locations could be visited efficiently and included a diversity of land use types, development patterns, age of development, potential pollutant sources, potential constraints, and geographic locations. From October 16-17, 2017, a team of four HW environmental engineers and planners with watershed planning expertise performed over 75 site visits (See Figure 12 and Figure 13 for site locations. The site identification numbers begin with the letter of the subwatershed in which they are located). At each site, HW made observations and generated preliminary recommendations about potential site retrofits that would reduce the pollutant loads. Field data was recorded using GIS-enabled tablets. Site locations were adjusted as needed in the field; in many cases, those identified during the site selection process were divided into multiple sites based on field observations and retrofit opportunities. Each site visit was approximately 15 to 30 minutes, depending on the complexity of the site and the number of retrofit opportunities observed. Following the site assessments, HW met with local municipal stakeholders on October 18, 2017 at the Boynton Beach Utilities Department offices to present these general observations for discussion and feedback. The notes from that meeting are presented in Attachment A. The raw output from the site assessments is provided in Attachment B.

HW developed concept design sketches and preliminary planning level construction cost estimates for a recommended potential retrofit at 13 of the site assessment sites. A summary of these concepts and costs is provided in Table 12 below. These concept sketches are included in the site assessment reports in Attachment B. (Note: Refer to Section 5.2 for the set of assumptions and references used to develop these cost estimates. Section 5.2 presents costs for management scenarios across the study subwatershed 'I' and the Boynton ICA.)

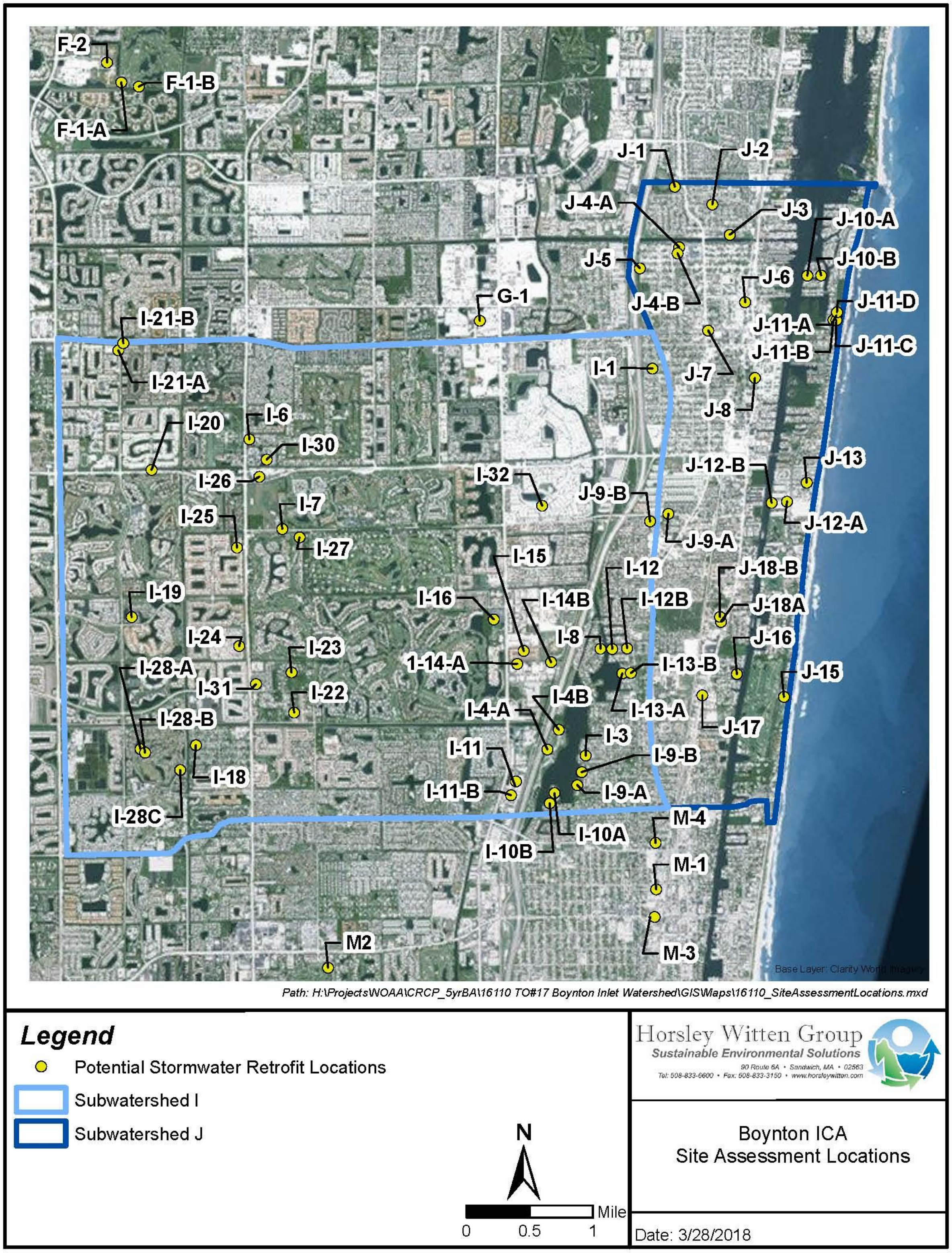

Figure 12. Site assessment locations in subwatershed study area (excluding western agricultural areas)

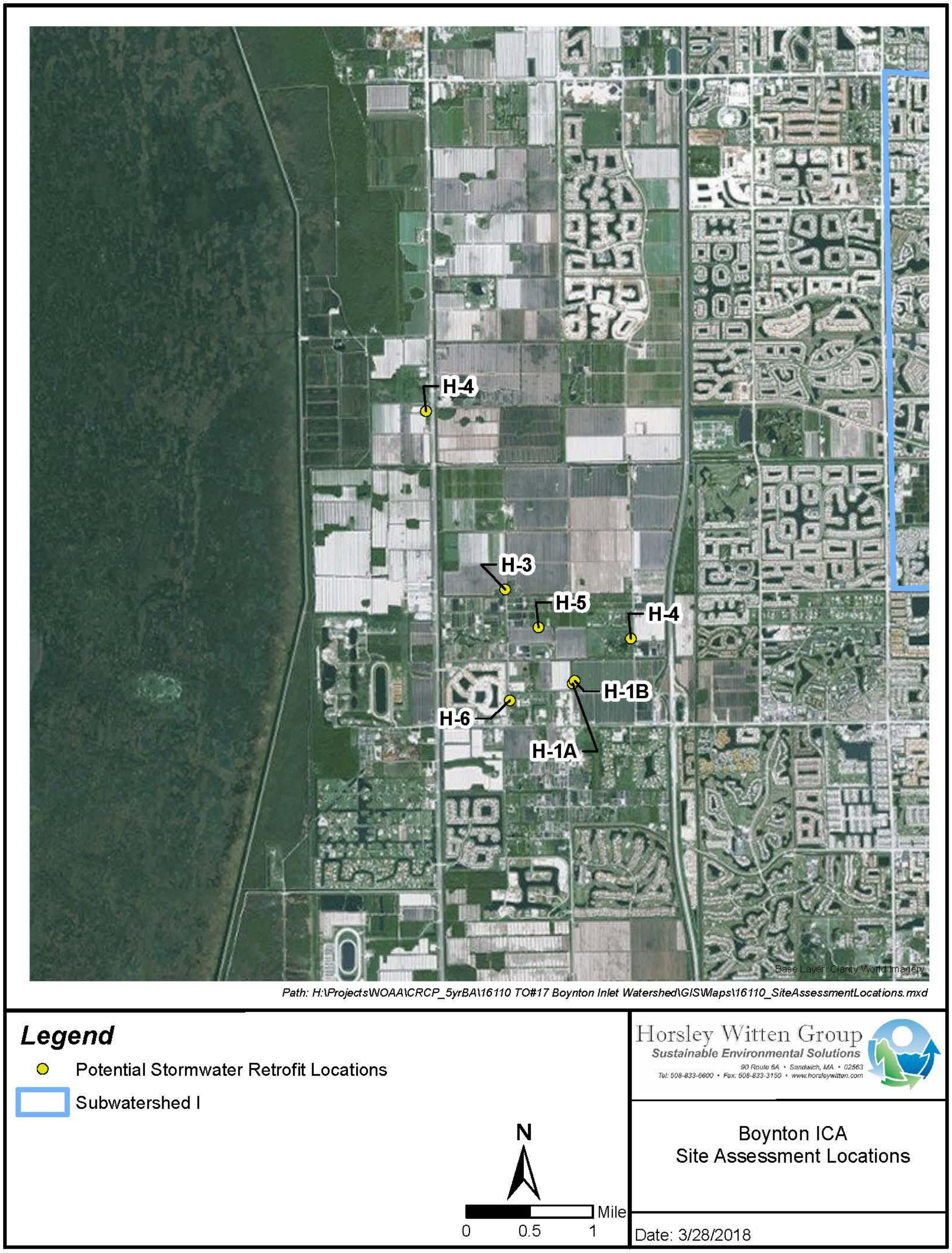

Figure 13. Site Assessment locations in agricultural areas west of subwatershed 'I'

Table 12. Sites for which concept sketches, cost estimates, and load reduction estimates were developed

Proposed Retrofit		Drainage Area			Target Volume	Estimated Cost		Estimated Existing Load			Estimated Load Removed		
ID	Practice Type	Land Use	DA acres	%IA*	WQv cf (1.25")	Unit cost/ cf	Total	TN	TP	TSS	TN	TP	TSS
J6	Tree trench and bioswale	Industrial	1.44	95%	6,207	$35.00	$217,256	9.5	1.9	198.9	3.3	0.7	159.1
J9A	Enhanced N removal swale	Highway/roads	0.6	55%	1,497	$24.30	$36,386	6.3	0.8	59.3	3.8	0.4	17.8
J9B	Wet swale	Low Int Commercial	1.06	80%	3,848	$21.60	$83,112	6.9	1.0	140.3	2.8	0.4	42.1
J10A	Bioretention	Residential-SF	1.55	60%	4,220	$27.00	$113,937	9.8	1.4	74.1	2.9	0.4	59.3
J10B	Bioretention	Residential-SF	0.51	60%	1,388	$27.00	$37,489	3.2	0.5	24.4	1.0	0.1	19.5
J11BC	Bioswale or N-swale	Park	2.76	50%	6,262	$27.00	$169,067	9.9	1.1	58.2	3.0	0.3	46.6
I3	Enhanced N removal swale	Residential-SF	8.35	50%	18,944	$24.30	$460,341	52.6	7.5	399.1	31.6	3.8	119.7
I10A	Bioretention	Park	1.57	80%	5,699	$27.00	$153,876	5.7	0.6	33.1	1.7	0.2	26.5
I11	Enhanced N removal swale	Low Int Commercial	0.59	40%	1,071	$24.30	$26,022	3.8	0.5	78.1	1.5	0.2	23.4
I23	Bioretention/rain garden	Residential-SF	8.1	30%	11,026	$10.00	$110,261	51.0	7.3	387.2	15.3	2.2	309.7
I31	Bioretention	High Int Commercial	8	80%	29,040	$27.00	$784,080	140.8	18.4	1,697.6	42.2	5.5	1,358.1
M1	Tree trench	High Int Commercial	0.18	90%	735	$40.50	$29,771	3.2	0.4	38.2	1.2	0.2	30.6
M2	Bump outs	High Int Commercial	0.17	90%	694	$40.50	$28,117	3.0	0.4	36.1	0.9	0.1	28.9

*estimated based on aerial imagery

3.2 General Observations

The sites visited by HW included a variety of representative land uses, including residential areas of different densities, parks and open space, golf courses, commercial shopping plazas, urban center commercial areas, road rights of ways, mobile home parks, and industrial and business parks. Below is a set of general observations from these site visits, which were used to inform the suite of pollution reduction strategies presented in Section 0 and the management strategies discussed and evaluated in Section 0. These observations were also discussed with stakeholders at the October 18, 2017 meeting in Boynton Beach.

Observations included:

- Many residential areas and road rights of way include grassed areas where swales once functioned or where swales could be implemented to manage stormwater runoff. Swales appear to have been filled in over time by sediment buildup, routine lawn mowing, re-grading, and landscaping upgrades, such that they no longer function effectively. There appears to be a significant opportunity to incorporate swales into these areas, and in many settings these swales can be enhanced with raised inlets or an organic filter to improve the nitrogen removal efficiency.

- Many commercial and industrial parks could incorporate additional stormwater practices, such as bioretention systems and enhanced swales, into the road rights of way and parking areas to enhance pollutant removal as part of a treatment train (multiple practices in series) approach to stormwater management.

- Due to their density, older urban centers and downtown areas are a challenging setting for stormwater improvements. However, some opportunities do exist to integrate bioretention bumpouts and tree trenches into the road rights of way and sidewalks, which can improve water quality treatment as well as provide aesthetic and traffic calming enhancements.

- Pavement reduction and disconnection of impervious area, including rooftops, can be employed for better site design in many settings, particularly at ‘big box’ retail shopping centers, shopping plazas, and residential developments.

- Vegetated buffers can be maintained in many settings simply by reducing the frequency of mowing in a set distance to water features and stormwater ponds, canals, the tidal shoreline, and lakes. By allowing vegetation (mainly grass) to grow longer within a buffer area, the buffer provides an additional filter for runoff, reduces shoreline erosion, and reduces the use of fertilizers in close proximity to open water bodies.

- The creation and maintenance of buffers also applies to agricultural settings, where crops are often grown directly adjacent to small irrigation channels or horse paddocks comprised mostly of bare soil drain directly overland to stormwater pond features with little to no surrounding vegetation.

- Landscaping in general appears to be intensively managed with both mowing and fertilizer and pesticide use throughout the watershed, including within planned residential developments, commercial areas, business parks, golf courses, and single family neighborhoods. Fertilizer use contributes to nitrogen and phosphorus loading from these land uses. A reduction in fertilizer use or more rigorous regulation of nitrogen and phosphorus in permitted fertilizers could provide a simple and effective reduction in pollutant loading throughout the watershed.

- There were many examples in the study area of good stormwater practices that can be used to demonstrate better site design. These included a porous parking lot that drained to a swale at a local church, a parking lot at a local recreational park that was designed to drain as sheet flow to a forested depression for infiltration, and a commercial/industrial site that included a small bioretention area in the corner of the lot to capture the runoff from a small parking area instead of draining into the street as the neighboring properties do.

- Open space/parks offer great opportunities to demonstrate different technologies and native plants and are highly visible educational opportunities for the public as well as for landscapers and builders.

- Porous concrete and permeable pavers have a tremendous potential for use.

- Pond improvements were not a focus of this effort, assuming that recent design standards have maximized performance of these technologies. However, upgradient GI features to improve nutrient removal through a treatment train approach could help reduce the total runoff volumes and amount of nutrients going into these ponds making them more attractive community amenities.

4.0 LAND-BASED POLLUTION REDUCTION STRATEGIES

There are a wide variety of strategies available to reduce land-based pollutant loads. This chapter presents an overview of multiple different approaches and practices that can be employed in the Boynton watershed to reduce loads of nitrogen, phosphorus and total suspended solids to the estuarine system in the Intracoastal Waterway and the near shore waters off the coast of Florida that support coral reefs in southeast Florida. The purpose of this chapter is to introduce these practices and provide a point of reference for consideration of these practices, which are incorporated into management strategies that are analyzed further in Section 0. The descriptions provided here are not comprehensive, and the reader is encouraged to seek out the references noted in these sections for more detailed information. The pollution reduction strategies in this chapter are presented in three categories: stormwater practices, wastewater practices, and nonstructural strategies, including better site design concepts and fertilizer controls.

4.1 Stormwater Practices

A variety of stormwater practices (BMPs) have been utilized throughout southeast Florida. BMPs are chosen and implemented by practitioners based on a number of factors, including physical limitations (e.g., high groundwater elevation, soils, slope, etc.), pollutant removal capability, cost, complexity to design, and ease of implementation. According to Florida's 2010 *Draft Stormwater Quality Applicant's Handbook* (the Handbook), BMPs fall into three basic categories: retention BMPs, detention BMPs, and source controls (FDEP and FL Water Management Districts, 2010).

Retention and detention BMPs are both "structural" pollutant removal practices. Retention BMPs, also known as infiltration practices, do not discharge runoff to the surface; instead, runoff is "retained" through infiltration into the underlying soils, evaporation, or evapotranspiration. Detention BMPs temporarily detain runoff prior to discharge at the surface, usually at a reduced flow rate. The following types of structural BMPs are included in Florida's stormwater design and guidance manuals (including FDEP and FL Water Management Districts, 2010; MRI et al., 2003):

- Retention systems (also known as infiltration systems), these include retention basins, exfiltration trenches, underground retention systems, including permeable pavements with underlying retention systems;
- Wet detention basins (wet ponds);
- Grassed waterways and swales;
- Landscaped retention systems (bioretention);
- Stormwater filter systems (often sand or organic media filters);
- Green Roofs (vegetated rooftop systems); and
- Wetland stormwater treatment system.

Source control BMPs are so-called "non-structural" BMPs that are used to minimize the amount of stormwater generated and/or to minimize the amount of pollutants that get into the stormwater stream. Several non-structural management measures have documented capabilities to reduce pollutant loads to receiving waters, including the following that are included in Florida's design and guidance manuals:

- Vegetated natural buffers;
- Natural area conservation;

- Reforestation; and
- Xeriscaping (aka Florida Friendly Landscaping).

Lastly, there are a range of enhancements, operational measures, and innovations that practitioners have employed to increase pollutant capture and reduce loads both from upland stormwater sources (e.g., pavements and rooftops) as well as within BMPs and/or receiving waters, such as lakes and canals. The more common of these include:

- Stormwater treatment trains (BMPs constructed in series to achieve enhanced pollutant removal);
- Management aquatic plant systems (e.g., floating wetlands or littoral zones);
- Stormwater harvesting;
- Chemical treatment of water bodies (e.g., alum treatments to promote coagulation); and
- Media enhancements to filtration systems (e.g., wood chips/mulch, iron filings, water treatment residuals, etc.).

Most of the BMPs listed above are documented in the Handbook, which describes design criteria, methodologies, and the computations necessary to achieve permit compliance, in addition to methods for enhanced nutrient removal. A recap of the Handbook is beyond the scope of this Watershed Management Plan. However, the land uses, terrain, physical limitations and nutrient reduction goals of the Boynton ICA dictate a management approach that uses some of the key BMPs described in the Handbook, with additional suggested design enhancements and/or modifications.

The following subset of BMPs is recommended for more widespread use as part of the Watershed Management Plan. These include both currently applied BMPs, as well as recommended enhancements to achieve better nutrient removal. These BMPs are recommended based on our understanding of the watershed, our observations of the built environment and the variety of settings for installing BMPs within that built environment, and our site assessments presented in Section 0. The potential effectiveness of employing these BMPs within the targeted subwatershed 'I' as well as across the broader Boynton ICA is evaluated and presented in Section 0. A comparison of the application criteria for each of the BMPs is included in Table 13 following the descriptions below.

4.1.1 Water Quality Swales

Water quality swales are vegetated, broad, shallow earthen channels that attenuate stormwater runoff volumes and peak rates as flows are conveyed downstream (Figure 14). Swales are ideally suited for locations with flatter terrain and lower density areas where there is adequate open space to accommodate the relatively large land area requirements of this BMPs (refer to Table 13). Raised culverts, check dams (or swale blocks) and wide depressions in swales are often used to increase storage, infiltration and settling of sediment and nutrient uptake from stormwater runoff by attenuating flows. Treatment swales provide efficient pollutant removal through sedimentation, adsorption, biological uptake and microbial breakdown. Swales with raised culverts or blocks essentially act like linear retention systems where the treatment volume is allowed to percolate into the underlying soils. To achieve the target pollutant removal rating, the required treatment volume must be routed to the swale and allowed to percolate into the ground before discharge.

Figure 14. Mowed swale on the top (filled in with accumulated sediment) and vegetated swale on the bottom, observed along El Clair Ranch Road in Boynton Beach, FL. (HW File Photo).

Recent enhancements to more traditional BMPs have shown that adding organic matter within an anaerobic environment can enhance nitrogen removal (Figure 15). These are often called permeable reactive barriers (PRBs). As water flows through the PRB within the anaerobic saturated environment, the 'reactive' organic material converts the nitrate in the water to nitrogen gas, thereby removing the nitrogen from the water. This reactive material is organic and is typically made out of wood chips or wood-based mulch. It reduces the dissolved oxygen in the groundwater and supplies organic carbon to a level at which biological denitrification occurs.

The PBR concept can be combined with swales to improve the nitrogen removal efficiency in swales. The enhanced N removing swale does not really envision the construction of a "barrier"; instead, a series of reactive material "walls" would be constructed perpendicular to the flow of groundwater to allow for interception. The treatment volume would still need to be completely contained within the swale above the groundwater elevation, but may provide both surface and subsurface storage.

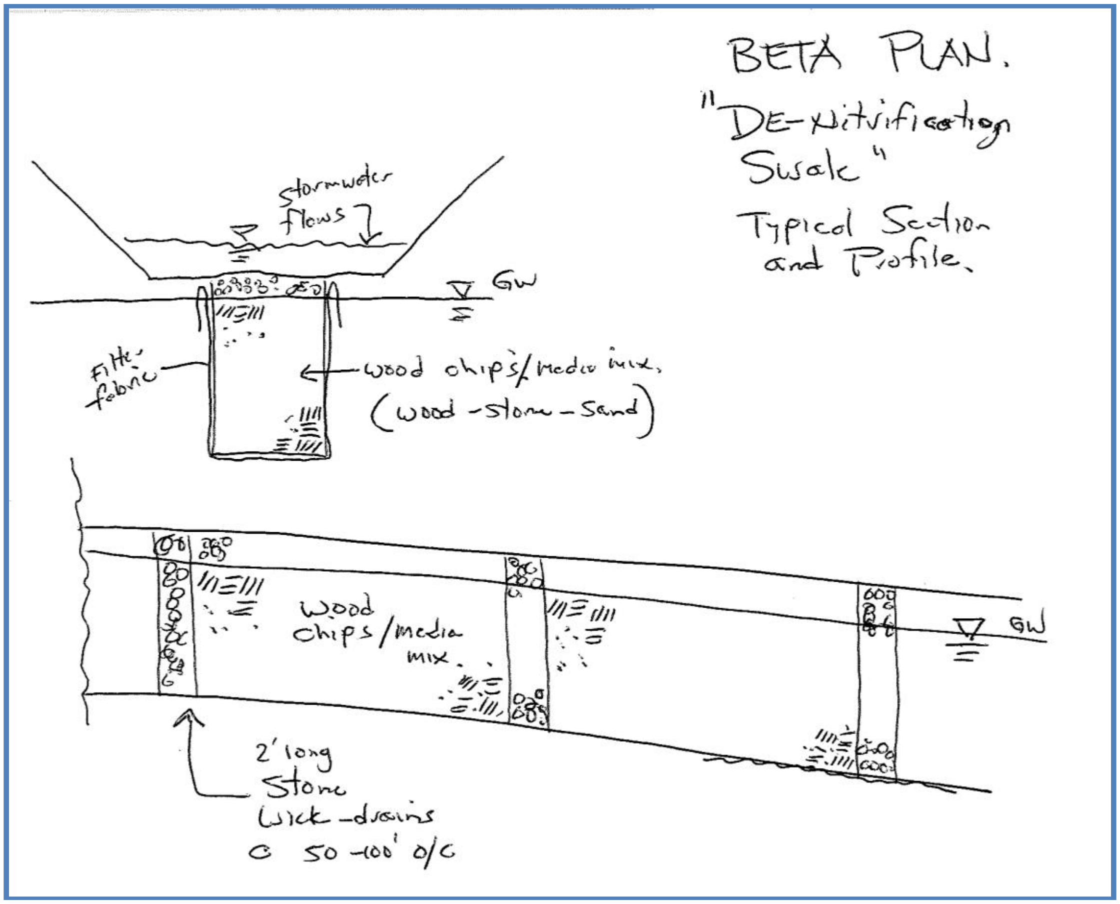

Figure 15. Preliminary concept design of an enhanced N removing (denitrification) swale (Richard Claytor, P.E., HW)

4.1.2 Bioretention Systems

Bioretention systems are one of the most widely adaptable BMPs and are suited for a wide range of land uses with very few physical limitations (refer to Table 13). Bioretention systems are shallow, landscaped depressions with soil and vegetation that are typically smaller in size and frequently distributed throughout a contributing area (Figure 16 and Figure 17). Underdrain systems may or may not be incorporated into bioretention facilities depending on whether infiltration to the subsurface is desired. Exfiltrating bioretention systems generally incorporate a complex soil matrix, but do not have an underdrain or impermeable liner and therefore allow for infiltration of stormwater into the subsurface.

Stormwater runoff receives treatment by filtering through the native, amended, or complex soil matrix and through uptake by native woody and herbaceous plants that are chosen based on site conditions. Bioretention systems are able to reduce sediments and take up nutrients, oil and grease, and trace metals. However, TP removal efficiencies can be reduced or phosphorus can be exported from the system when compost or soils with high P concentrations are used.

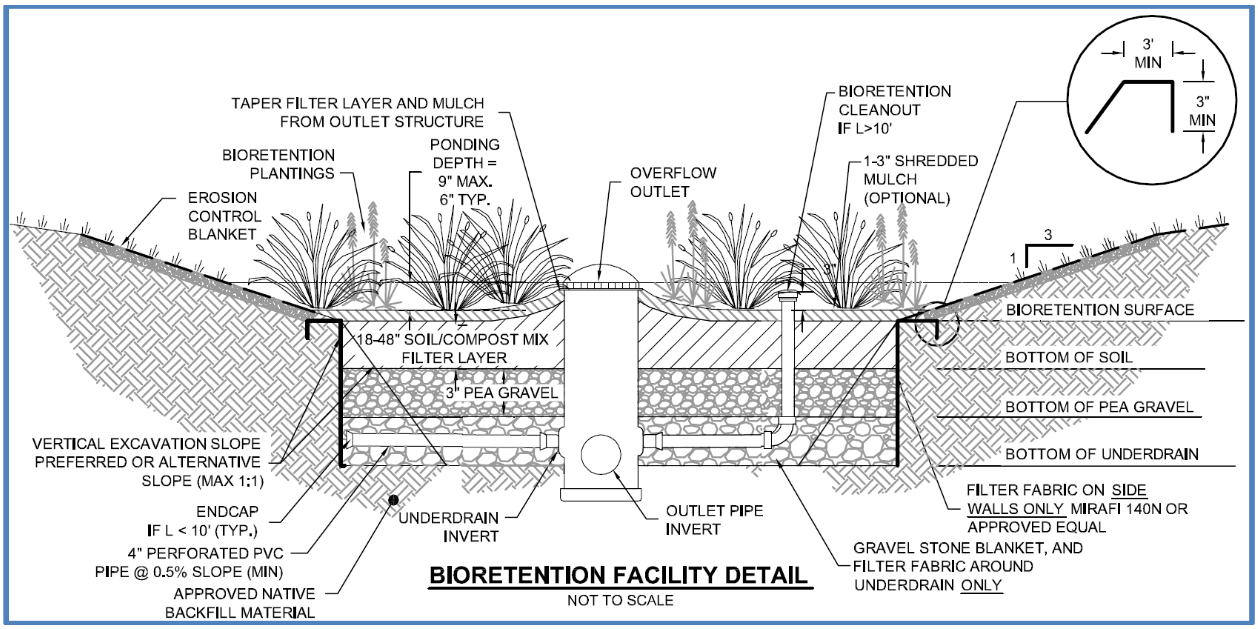

Figure 16. Schematic of a bioretention cell (underdrain optional). (HW).

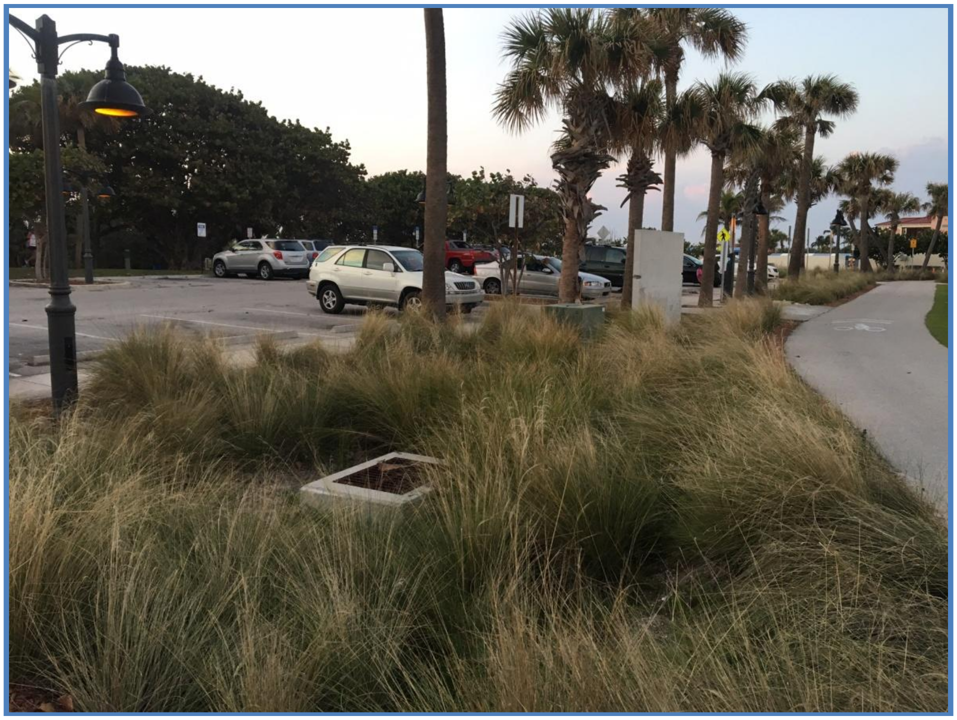

Figure 17. Example of a bioretention cell near Lake Worth Beach Park, FL (HW file photo).

Rain gardens are simpler types of bioretention systems with native or amended soils and vegetation, but no underdrain (Figure 18). Rain gardens are typically designed to capture stormwater from small, adjacent areas.

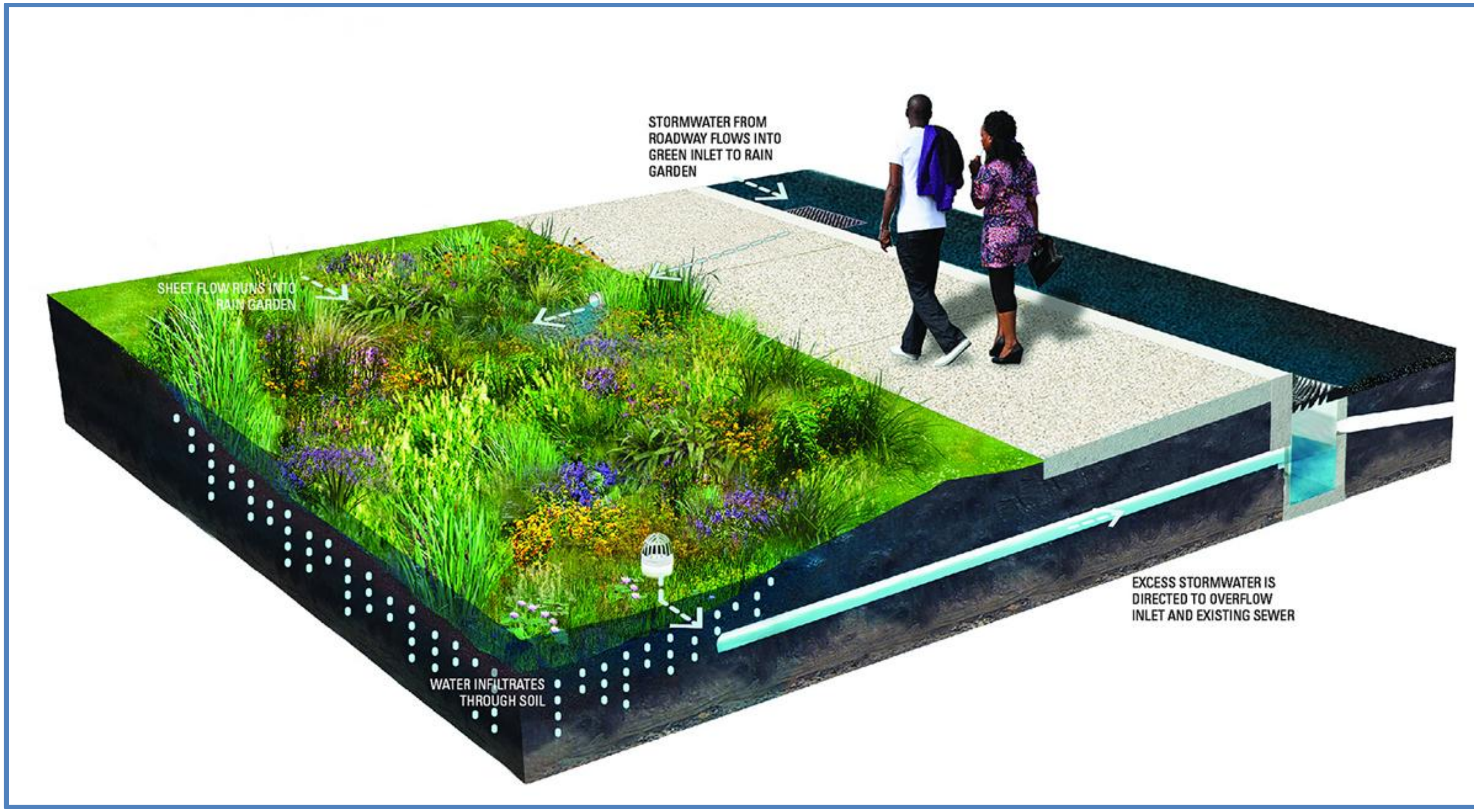

Figure 18. Schematic of a rain garden.
Source: Philadelphia Water Department

Stormwater planters are small contained landscaped treatment practices that can be installed either in the ground or above ground (Figure 19 and Figure 20). There are two types of stormwater planters: retention planters, which allow runoff to infiltrate into the subsurface and flow-through planters, which are lined on the bottom and have an underdrain system. Planters are often located in sidewalk areas or adjacent to buildings to capture and treat limited volumes of runoff, frequently from rooftops through downspouts. The sidewalls are often constructed of concrete.

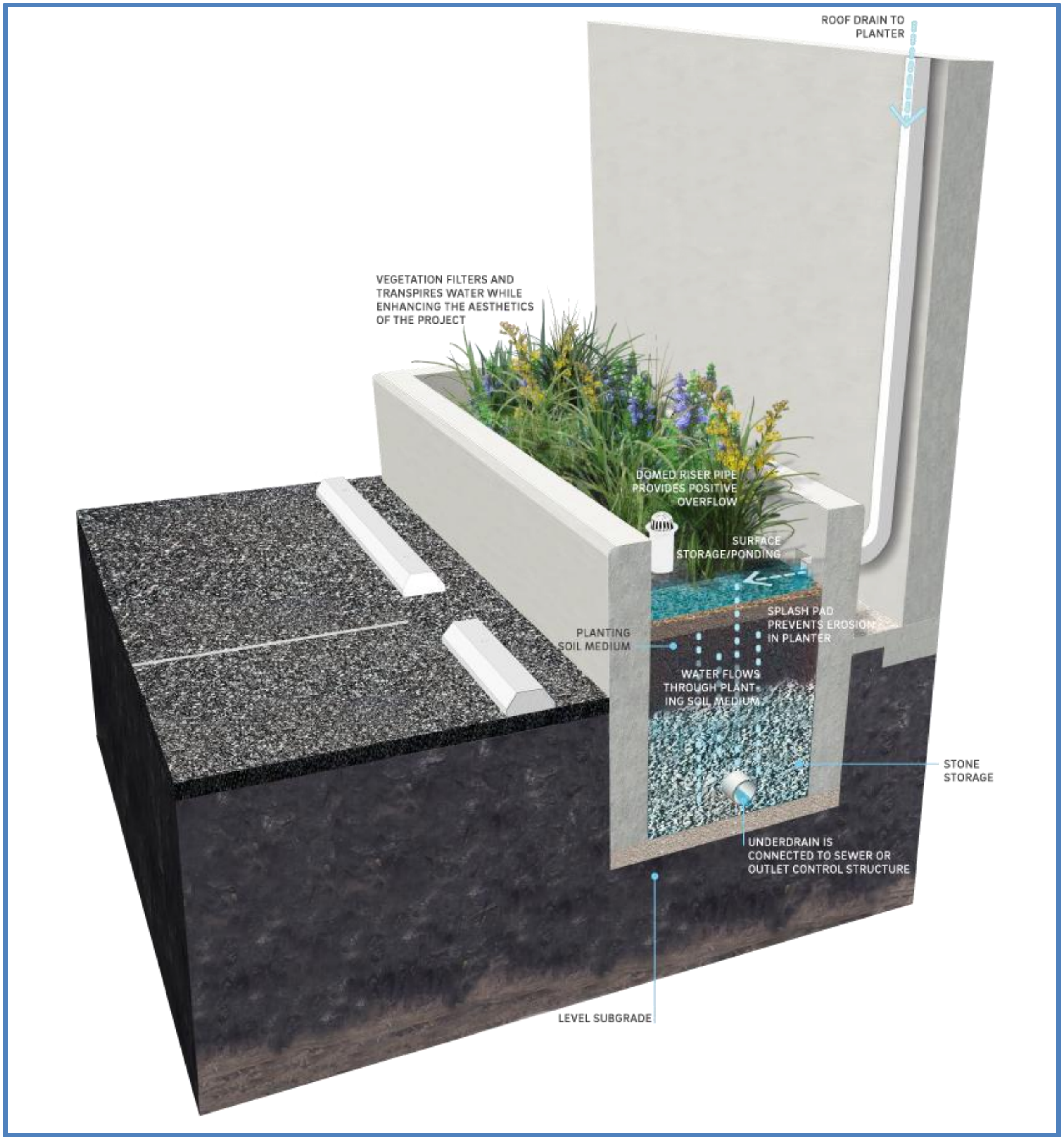

Figure 19. Schematic of a stormwater planter (linear and underdrain system optional).
Source: Philadelphia Water Department

Figure 20. Example of a stormwater planter in a residential area of Portland, OR.

Street-based bioretention systems know as bumpouts and bioswales are design adaptations to collect roadway runoff from the adjacent road or street. These systems often have both an above ground and below ground component, and usually have an underdrain system (to avoid impacts to roadway subbases). Bumpouts and bioswales are often planted with low herbaceous vegetation only to avoid impacts to vehicular sight distances

4.1.3 Tree Trenches

A stormwater tree trench is one or more trees that are connected by an underground infiltration system (Figure 21 and Figure 22). Due to their higher cost (refer to Table 13) compared to other practices, tree trenches are typically used in areas with limited space (e.g. urban/high density areas) where other practices are not feasible.

On the surface, a stormwater tree trench looks just like a typical street tree pit. However, underground, there is an engineered system to manage the incoming runoff. This system is composed of a trench dug along the side of road (typical under a sidewalk), lined with a permeable geotextile fabric, filled with stone or gravel, and topped off with soil and trees. Stormwater runoff flows through a catch basin that directs the treatment volume to the stormwater tree trench. The runoff is stored in the empty spaces between the stones, watering the trees and slowly infiltrating through the bottom. When the capacity of the infiltration system is exceeded, stormwater runoff exits the catch basin in the street via a high-flow bypass pipe.

Figure 21. Photo-simulation of an enhanced tree trench
(Source: https://www.greenblue.com/na/trees-in-hardscape-structural-stability-vs-rootable-soil/)

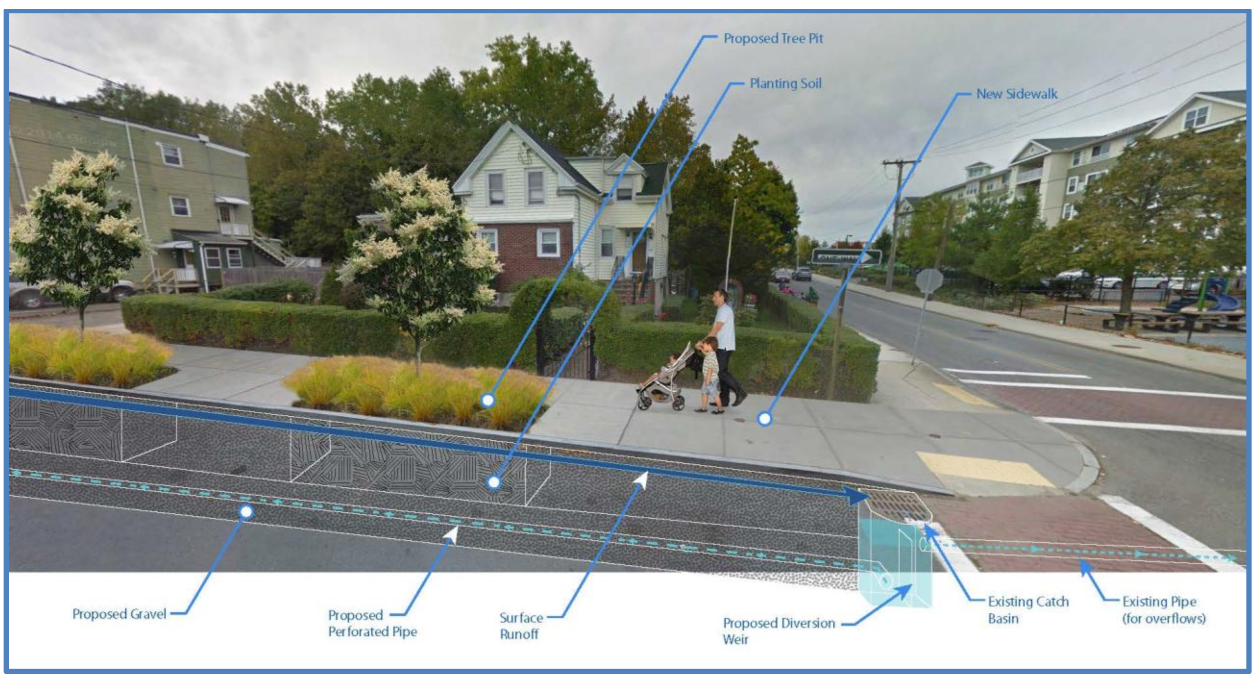

Figure 22. Photo-simulation of an enhanced tree trench (HW).

4.1.4 New and Enhanced Vegetated Buffers

Vegetated buffers are areas with vegetation that promote nutrient uptake and stabilization of soils that are placed in some sort of conservation easement or set aside and lie between developed lands and receiving waters or wetlands (Figure 23). Buffers are not intended to be the primary stormwater management system for the area contributing drainage to the water resource. They are most commonly used to treat only the rear-lot potions of a development that typically doesn't drain to a primary BMP. They are most effective on locations with flatter terrain (refer to Table 13). Vegetated buffers can be effective BMPs where overland flow is directed to the buffer area. These buffers provide filtration, allow for sediment deposition, infiltration, adsorption, decomposition, and evapotranspiration.

Buffers provide the added benefit of providing additional setback from waters and wetlands to reduced incidental impacts from adjacent development, such as dumping of yard wastes into resources, construction site sediment impacts, utility trench impacts, and incidental dumping of trash, litter and debris.

Figure 23. Example of a vegetated no-mow buffer
Source: blogs.tallahassee.com (Photo credit: Mark Tancig, Leon County Public Works).

Table 13 provides a summary of the various applications and limitations for swales, bioretention systems, tree trenches, and buffers.

Table 13. Comparison chart of recommended stormwater BMPs and criteria for their use and application.

BMP Criteria	Stormwater BMP Type			
	Swales	Bioretention	Tree Trench	Buffers
Applicable land uses	Lower density residential, roads, highways, institutional uses	All land uses; exfiltrating bioretention systems have limits for pollutant hotspot land uses and concerns for roadway subbase/subgrade impacts	High density residential and commercial land uses; infiltrating tree trenches have limits for pollutant hotspot land uses and concerns for roadway subbase/subgrade impacts	Lower to medium density residential rear lots
Soil	Higher permeability silts and sandy soils	For exfiltrating bioretention, higher permeability silts and sandy soils	For infiltrating tree trenches, higher permeability silts and sandy soils	Higher permeability silts and sandy soils
Groundwater	2 ft min. separation to groundwater; for enhanced N removing swale, bottom of reactive media intercepts groundwater	2 ft min. separation to groundwater; bottom of the facility should be above groundwater	2 ft min. separation to groundwater	2 ft min. separation to groundwater
Slope	Flatter, longitudinal slopes, <2.0%	Steep slopes (>5%) may require terracing to maintain nearly flat surface areas	Steep slopes (> 5%) may result in overly deep trenches	Slope of buffer measured perpendicular to the flow should be less than 16.6%
Drainage area	<5 acres to any one inflow point	<5 acres to any one inflow point; should be sited runoff source	<1 acre for any 1 tree trench system	Only the rear lots of residential areas; 25 ft min. buffer width
Pollutant Reduction Capacity	TN 40% TP 40% TSS 30%	TN 30% TP 30% TSS 80%	TN 38% TP 50% TSS 80%	TN 25% TP 25% TSS 50%
Enhanced N Pollutant Reduction Capacity	TN 60% TP 50% TSS 30%	Enhanced N removal with upturned elbows or saturated bottom zones	Enhanced N removal with upturned elbows or saturated bottom zones	
Pretreatment		Pretreatment is necessary for all bioretention systems to remove sediments, trash and debris, and other materials that contribute to premature clogging. Typical pretreatment for bioretention systems are water quality inlets, filter strips, and vegetated buffers.	Pretreatment is provided by the deep sump in the catch basin to remove sediments, trash and debris, and other materials that may contribute to premature clogging. Typical pretreatment for bioretention systems are water quality inlets, filter strips, and vegetated buffers.	
Other		Plant species must be tolerant of drought and wet conditions		Permanently protected legal reservation of the buffer and vegetated with Florida Friendly landscaping

4.2 Wastewater Practices

Improving the treatment of wastewater is a key component of any pollutant reduction plan because wastewater often contains high levels of nutrients, pathogens, and organics. There are three primary ways in which wastewater is treated: Onsite sewage treatment and disposal systems (OSTDS, also known as septic systems), public sanitary sewer systems, and package plants. Converting septic systems to a sewer system or to package plants is one way to improve the treatment of wastewater and thereby reduce pollutant loading, particularly nitrogen loading, which is not addressed by traditional OSTDS.

OSTDS are designed to remove bacteria from wastewater, as a matter of public health. They also function to remove phosphorus through soil adsorption in the leach field. However, even when properly functioning, traditional septic systems do little to remove nitrogen from wastewater. In addition, OSTDS are often ineffective in southeastern Florida primarily because of relatively high groundwater levels, as well as the development and regulatory history of the area and lack of proper maintenance. OSTDS typically have a buried septic tank that receives wastewater and separates solids, allowing liquids to discharge to a drain field. Water that enters the drain field is then supposed to percolate through unsaturated soil, during which time the soil naturally removes phosphorus, bacteria and other pollutants before the water reaches the groundwater table. The problem in southeastern Florida is that the water table is naturally very high (typically less than four feet (48 inches) below ground surface) and therefore there is a limited depth of unsaturated soil in which to operate a drain field. This is exacerbated in the rainy summer months, when the water table can rise to two feet (24 inches) below ground surface or less (Meeroff et al., 2007). The result is that wastewater does not get treated properly in drain fields and instead goes directly into the groundwater system.

Sea level rise is already exacerbating the problem of failing OSTDS in southern Florida.[5] Projections specific to southern Florida indicate that sea level will rise six (6) inches to 12 inches by 2030, 14 inches to 34 inches by 2060, and 31 inches to 81 inches by 2100 (LeJeune, 2015). Increasing sea level forces the groundwater table to rise near the coast, particularly in the porous soils of southeastern Florida, which means that OSTDS drain fields will have an even narrower depth of unsaturated soil in which to treat wastewater.

The Florida Department of Health (FDOH) is the primary authority for specific, statewide regulations controlling the installation and use of OSTDS. The 2017 Florida Statues include regulations for OSTDS under Chapter 381.0065.[6] OSTDS design standards are part of the Florida Administrative Code (FAC) at 381.0065, Florida Statutes (FS) and Chapter 64E-6, F.A.C. (effective date July 16, 2013).[7] The FAC includes site evaluation criteria (Section 64E-6.006), according to which the water table elevation at the wettest season of the year must be at least *24 inches below the bottom surface of the drainfield*. Thus, if summer groundwater levels are already typically 24 inches or less below ground surface, OSTDS will not be permitted given that the bottom surface of the drainfield (which is

[5] http://www.southeastfloridaclimatecompact.org/news/miami-sea-level-rise-is-coming-for-your-poop/
[6] http://www.flsenate.gov/Laws/Statutes/2017/381.0065
[7] http://www.floridahealth.gov/environmental-health/onsite-sewage/forms-publications/_documents/64e-6.pdf

buried beneath the ground) must be 24 inches from the water table.[8] As noted above, this will only get more problematic when as sea level rises 6 to 12 inches by 2030, forcing further increases in water table elevation.

In addition to high groundwater levels, many OSTDS in the Boynton ICA, particularly on the barrier islands, were installed on relatively small lots and in high densities, conditions that do not provide sufficient area for properly-sized drain fields. This was allowed to occur because the systems were installed prior to the current more stringent regulations. In addition, many of these houses were historically only inhabited during the winter months, when groundwater levels are lower and therefore OSTDS performed better. However, now many of these houses are now occupied year-round and the OSTDS fail in the rainy months because of higher groundwater levels. Lack of adequate OSTDS maintenance also contributes to their inefficiency and failure (Meeroff et al., 2007).

In Section 64E-6.008, the FAC specifies minimum design flows for OSTDS based on the estimated daily sewage flow as determined by the number of bedrooms and the square footage for residential properties (generally 100 gallons per day per bedroom). Commercial and institutional properties have alternate calculation methods, also provided in Section 64E-6.008. This information on minimum design flows is then used in combination with soil type to determine the appropriate size of the septic tank and the drain field. Using the FAC tables, a simplified calculation of drain field dimensions is provided below for reference:

- Under the most ideal conditions (sandy soils) a 3-bedroom home would require a trench surface area of 375 square feet and a bed surface area of 500 square feet.
- Under the least ideal conditions allowable (finer-grained soils), a 3-bedroom home would require a trench surface area of 860 square feet and a bed surface are of 1,500 square feet.

In densely populated areas, such as the barrier islands, many drain fields are most likely smaller than the design standards because they were built before the regulations were in place and, as noted above, at a time when the houses were only used in the drier winter months. If the owner wanted to replace an older system, not only would they likely have to raise or mound the system to get enough unsaturated depth, there is likely insufficient space to build a new drain field to the proper size.

Given the challenges facing OSTDS users in the watershed and their impacts on water quality, alternative solutions need to be considered. As noted above, the most efficient option would be for OSTDS to be removed and for the properties to be connected to existing sewer systems. Recognizing the need to move properties away from OSTDS, the Florida Statues include a section on the connection of existing OSTDS to central sewer systems at Chapter 381.00655.[9] This statute states that the owner of a properly functioning OSTDS *must* connect the system to an available publically owned (or investor-owned) sewerage system within one year after written notification that the system is available for connection. The owners of an OSTDS that needs repair or modification must connect to the available sewerage system within 90 days. The rule also requires the publically owned (or investor-owned) sewerage system to notify the OSTDS owners of the availability of a connection within a year of it becoming available.

[8] Note that the FAC does provide specification for alternative, mounded and filled systems which seek to accommodate for high water table conditions.
[9] http://www.flsenate.gov/Laws/Statutes/2017/381.00655

In locations where sewer connections are not possible, package plants could be considered. Package plants are essentially small wastewater treatment plants that can function on a variety of scales. For example, a small package plant was installed at Oceanfront Park in Boynton Beach to replace an out of date system and reduce maintenance costs for treating water from the bathrooms and concession stand.[10] Similar types of package plants could be used to treat wastewater in residential areas where sewer system hook ups are not yet available.

Three main settings within the Boynton watershed that are served by OSTDSs are described below and also represented in Figure 24:

- Barrier Islands – The barrier islands include the majority of the parcels with OSTDS in the Subwatershed. This area includes numerous mobile home parks with individual or community OSTDS. In order to convert properties from OSTDS, installation of strategically-placed package plants could be considered or, possibly, extension of the sewer system.[11] Individual households with OSTDS could also consider upgrading to enhanced nitrogen-removal OSTDS systems.

- Route 1 Corridor - A second, much smaller group of parcels on OSTDS are along the Route 1 corridor. As with the barrier island, this is an area of older development that has some relic OSTDS. These properties likely have access to established sewer lines and could be assessed for possible hook up.

- Western Subwatershed – The small number of properties on OSTDS for the western part of the Subwatershed are mostly farms and other older less densely populated properties. As redevelopment progresses west, these OSTDS will likely be replaced with either sewer service or package plants. Therefore, properties in the western Subwatershed are considered a lower priority in terms of pollutant reduction than the barrier islands and the Route 1 corridor, located closer to the coastal waters.

[10] http://www.sun-sentinel.com/local/palm-beach/boynton-beach/fl-boynton-beach-new-waste-water-plant-20160301-story.html

[11] Other climate change impacts - such as increased storm surge, coastal erosion, and storm intensity - are putting pressure on coastal communities, particularly barrier islands. Municipalities should consider these potential impacts, and the option of coastal retreat, before costly infrastructure investments are made, such as extending sanitary sewers further along barrier islands and adding more connections. Coastal retreat means literally leaving the coast, removing houses that are not going to be sustainable in the face of climate change impacts, and replacing them with more adaptable uses, such as open space and recreation areas. This is a difficult choice to make, but one that could be realistically considered given the challenges facing southeastern Florida. The City of Boynton Beach recognized this reality, at least in part, in their 2015 Climate Action Plan, with a recommendation to: “Revise building codes and land development regulations to discourage new development or post-disaster redevelopment in vulnerable areas to reduce future risk and economic losses associated with sea level rise and flooding.” (LeJeune, 2015)

Other potential improvements to address problematic or ineffective OSTDs are also under consideration in Florida. One category of improvements includes nitrogen removal technologies that enhance the nitrification/denitrification process in OSTDs, usually prior to discharge to the leach field or in the leach field itself. Further evaluation of these technologies is being documented by technical experts under contract with the Florida Department of Health Onsite Sewage Program Office (http://www.floridahealth.gov/environmental-health/onsite-sewage/research/nitrogen-reduction.html). Another potential management option under preliminary consideration in Florida to address this particular issue is to manage septic system maintenance through a utility program, whereby system owners would pay a fee to the wastewater utility to undertake regular maintenance for each system. However, this approach does not address the fact that most existing OSTDs are simply not designed to remove nitrogen.

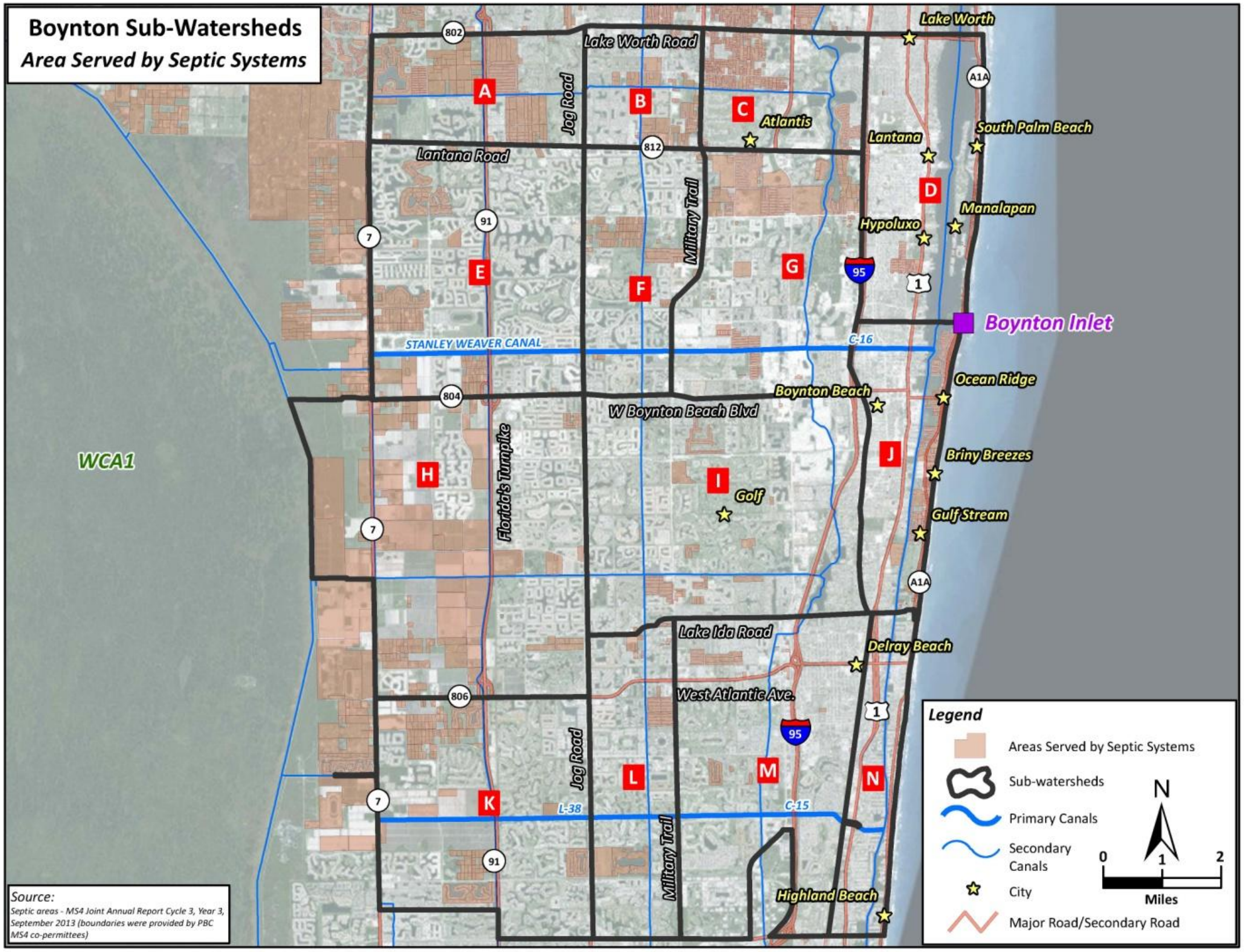

Figure 24. Map of the Boynton ICA showing parcels that are currently serviced by OSTDS (septic systems).

4.3 Nonstructural Strategies

4.3.1 Better Site Design

Increasing the amount of stormwater that can infiltrate on a site is crucial to improving water quality because soil acts as a natural filter for many pollutants. Communities in the Subwatershed can reduce their pollutant loads by improving the design of their developments to increase onsite infiltration and thereby reduce the amount of potentially polluted stormwater leaving a site.

"Better site design" is term used to describe a suite of non-structural and policy-related practices intended to reduce the amount of runoff and pollutants generated at a site and then provide for some degree of on-site treatment and control of runoff (AECOM et al., 2016). Implementing principles of better site design can help communities in the Subwatershed make changes during development or redevelopment to reduce impervious cover, increase natural areas, and use pervious areas for more effective stormwater treatment.

A variety of handbooks and manuals exist to assist communities with better site design. EPA has a list of dozens of these resources on their Green Infrastructure Design and Implementation website.[12] Some examples from the Southeast include the *Sarasota County Low Impact Development Guidance Document* (Sarasota County, 2015) and the *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual* (CWP, 2009). The state of Georgia also updated their stormwater manual in 2016, which now includes an entire chapter on better site design (Chapter 3 of AECOM et al., 2016) While these resources may include state- or region-specific variations, the common goals of all of these resources are to reduce impervious cover, prevent stormwater pollution, and conserve natural vegetated areas.

A seminal resource on this subject, the Center for Watershed Protection 's (CPW) *Better Site Design: A Handbook for Changing Development Rules in Your Community* outlines 22 model development principles to achieve these common goals (CWP, 1998). This resource was published in 1998 and focused on development of new subdivisions, but its principles are still relevant and form the basis for many subsequent better site design guidance documents. Some examples of these principles that are directly relevant to better site design in the Subwatershed include:

> Principle No. 1 - Reduce residential street widths with minimum pavement width needed to support travel lanes, on-street parking, and emergency, maintenance and service vehicle access. Street width should be based on traffic volume.
>
> Principle No. 6 – The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking spaces. Existing parking ratios should be reviewed for conformance taking into account local and national experience to see if lower ratios are warranted and feasible.
>
> Principle No. 7 – Parking codes should be revised to lower parking requirements where mass transit is available or enforceable shared parking arrangements are made.

[12] https://www.epa.gov/green-infrastructure/green-infrastructure-design-and-implementation

Principle No. 8 – Reduce parking lot imperviousness by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover areas.

Principle No. 16 – Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway and the stormwater conveyance system.

Local codes and ordinances can sometimes be a significant challenge to stormwater management guided by better site design principles and in some cases may promote development patterns that exacerbate stormwater problem or prohibit “better site design.” This is generally because these codes and ordinances can be outdated and/or they originate from a complex web of governing bodies. To address these challenges, CWP provides a useful *Code and Ordinance Worksheet* (CWP, 2017a) (COW) and *COW Scoring Spreadsheet* (CWP, 2017b). The COW addresses new development, redevelopment and changes in the technology of green infrastructure for stormwater management.

The 2017 COW provides municipalities with a tool to review the codes and ordinances that influence *how* development happens (rather than *where* development happens). The COW assumes that the development (or redevelopment) is already planned and communities want to reduce the impact of the development on local water resources, in addition to improving neighborhood character and reducing construction costs. The tool then helps communities target and, if necessary, work to change codes and ordinances that are obstacles to better site design. The CWP’s *Code and Ordinance Worksheet* could be a valuable resource for communities in the Subwatershed and is included in Attachment C.

Currently, there are many opportunities within Subwatershed ‘I’ to implement better site design principles and improve water quality. Below, we identify some general site design problems observed during our site reconnaissance, followed by better site design recommendations:

- *Problem: Parking lots are much larger than they need to be.*
    - Reduce the size of parking lots to meet normal demand, rather than an estimate of greatest possible demand (e.g., the Christmas shopping demand). For example, the 2016 Georgia Stormwater Manual notes that the conventional minimum parking ratio for a shopping center is 5 spaces per 1,000 square feet of gross floor area, but the *actual* average parking demand is 3.97 spaces per 1,000 square feet of gross floor area (AECOM et al., 2016).
    - Reduce parking lot size requirements in areas with public transit and where shared parking arrangements can be made between businesses.
    - Reduce parking lot size further by including compact car spaces, minimizing stall dimensions, and using efficient parking lanes.
    - Consider building parking structures to reduce parking lot footprints in high density areas.
    - CPW’s *Code and Ordinance Worksheet* (Attachment C) can be used to help municipalities modify local parking ordinances, if necessary.

- *Problem: Parking lots provide little to no opportunity for on-site infiltration.*
    - Incorporate green infrastructure stormwater management practices into parking lots to promote on-site infiltration:
        - Direct parking lot stormwater drainage to correctly-sized bioretention facilities, which can also be attractive landscape features.
        - Direct parking lot stormwater drainage to dry swales, perimeter sand filters, or filter strips depending on the site conditions such as slope and soil.
        - Use permeable pavement materials could be used if possible (pavers, pervious concrete, porous asphalt).
        - Use pervious pavement material or, even better, vegetated areas, for any overflow or extra parking areas.

- *Problem: Commercial rooftops and residential properties discharge stormwater directly to pavement.*
    - Capture roof runoff in barrels or cisterns for onsite reuse to water landscaping.
    - Redirect roof runoff to vegetated areas that allow for infiltration. Ponding of water can be avoided through proper engineering.

- *Problem: Streets are wider than they need to be.*
    - Reduce residential street width based on the actual traffic volumes and parking needs on a given street. The Georgia Stormwater Manual (AECOM et al., 2016) provides various width recommendations, such as:
        - 10-12 feet for residential access alleys with no parking
        - 18-20 feet with parking/queuing on one side for lower volume streets
        - 18-20 feet with no parking for higher volume streets
        - 26-28 feet with parking/queuing on both sides for lower volume streets
        - 26-28 feet with parking on one side and two travel lanes for higher volume streets
    - Add landscaped and vegetated strips down the middle of existing wide roadways.
    - Reduce the width of the overall right-of-way, which include the roadway pavement, curbing, buffers, sidewalks, utilities, drainage, and grading. Utilities should be located within the pavement section of the right-of-way wherever feasible.
    - CPW's *Code and Ordinance Worksheet* (Attachment C) can be used to help municipalities modify local roadway and right-of-way ordinances, if necessary.

- *Problem: Cul-de-sacs, which are an inefficient use of space for optimizing infiltration and better site design.*
    - Minimize the use of cul-de-sacs by considering alternative turnaround shapes and designs.
    - Reduce the radius of cul-de-sacs to the minimum needed for emergency and maintenance vehicles.
    - Incorporate landscaped areas in the middle of existing cul-de-sacs to reduce their impervious cover.

4.3.2 Fertilizer Controls

Fertilizer used on residential lawns and commercial green spaces can be a significant source of pollutant loading (primarily nitrogen and phosphorous), particularly when the fertilizer is excessively applied, is applied too close to water bodies, or is applied during wet weather periods. To address this issue, various ordinances have been introduced throughout the State of Florida to control fertilizer use on residential properties. However, at this point in time, the system of ordinances is not cohesive across the state, or even within individual counties. The following section describes the current regulatory controls for residential fertilizer use in Palm Beach County and the municipalities of Boynton Beach and Delray Beach, which comprise the majority of Subwatershed 'I'. Examples of stronger ordinances from other Florida municipalities are provided, as well as recommendations for how the communities in the Boynton ICA could better control fertilizer use to reduce nitrogen and phosphorous loading through ordinances and training.

Current Regulatory Controls in the State of Florida

Per Florida Statute §403.9337,[13] the State of Florida requires county and local governments located within the watershed of a water body listed as impaired for nutrients (303(d)-listed), such as Lake Ida, to adopt FDEP's Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes (the FDEP Model Ordinance; FDEP, 2010). This ordinance is not applicable to agricultural land uses.

As summarized by Clean Water Action (2014), the FDEP Model Ordinance includes the following:

1. A ban on fertilizer application during the "Prohibited Application Period" or saturated soils. The "Prohibited Application Period" is undefined, but the model's guidance notes that some ordinances have prohibited application during the summer rainy season.

2. Fertilizer must not be applied within ten (10) feet of any pond, stream, watercourse, lake, canal, or wetland or from the top of a seawall, unless a deflector shield, drop spreader, or liquid applicator with a visible and sharply defined edge, is used, in which case a minimum of 3 feet shall be maintained. There is an exemption for newly planted turf and/or landscape plants to be fertilized within the zone for sixty (60) days beginning 30 days after planting.

3. A voluntary ten (10) foot low maintenance zone is strongly recommended, but not mandated, from any pond, stream, water course, lake, wetland or from the top of a seawall. A swale/berm system is recommended for installation at the landward edge of this low maintenance zone to capture and filter runoff.

4. No specific additional requirements regarding fertilizer content and application rated for golf courses, parks and athletic fields other than what is required by RULE 5E-1.003(2)(d), F.A.C. Fertilizers may be applied to other urban turn in amounts specified by turf type and geographic location according to Rule 5E-1.003(2), F.A.C. Fertilizers containing nitrogen or phosphorus must not be applied to other urban turf

[13] https://www.flsenate.gov/laws/statutes/2011/403.9337

for the first 30 days after seeding or sodding unless there is an emergency pursuant to certain conditions.

5. Specified application practices, including deflector shields and the requirement not to apply fertilizer on any impervious surfaces.

6. Exemptions for farming operations and scientific research.

7. Requirements for training and licensing of commercial applicators.

Figure 25. Example of Florida Friendly landscaping
Source: gardeningsolutions.ifas.ufl.edu

Current Regulatory Controls in Palm Beach County

PBC has adopted a fertilizer ordinance, referred to as the Florida-Friendly Fertilizer Ordinance, Article XVI, Ordinance No. 2012-039 § I, 10-30-12.[14] This county ordinance is applicable to the approximately 84% of PBC that is unincorporated. The PBC ordinance is based on the FDEP's Model Ordinance and is *not* more stringent. As such, the ordinance states that fertilizers containing nitrogen and phosphorous cannot be applied during the "prohibited application period" or to "saturated soils". Section 11-402 of the PBC ordinance provides the following definitions:

- Prohibited application period - "the time period during which a flood watch or warning, a tropical storm watch or warning, or a hurricane watch or warning is in effect for any portion of Palm Beach County, issued by the National Weather Service, or if heavy rain (two (2) inches or more within a twenty-four-hour period) is likely."
- Saturated soils - "a soil in which the voids are filled with water. Saturation does not require flow. For the purposes of this article, soils shall be considered saturated if standing water is present or the pressure of a person standing on the soil causes the release of free water."

The 39 incorporated municipalities in PBC are responsible for their own fertilizer ordinances. If, as noted above, there is a 303(d)-listed water body in their municipality, then by March 2, 2013, they were required to adopt either the state's FDEP Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes or their own version of an ordinance that complies with the requirements set forth in the FDEP Model Ordinance.[15] If there are no 303(d)-listed water bodies in a municipality, then they are not required to have a fertilizer ordinance.

According to Laurie Albrecht, University of Florida Extension Agent for PBC at the Florida-Friendly Landscaping Program, there are no "summer blackout periods" in all of PBC (specified dates for which application of fertilizer is not allowed by an ordinance).[16] Ms. Albrecht indicated that most municipalities in PBC that have their own ordinances have adopted the FDEP Model Ordinance, some with minor alterations. There are two municipalities in PBC (Greenacres[17] and Wellington) that have ordinances that are slightly stricter than the FDEP Model Ordinance; the primary difference is that these communities' ordinances *require* (rather than *recommend*) a 10-foot fertilizer free zone around water bodies without allowing for a smaller zone with the use of a deflector shield (Clean Water Action, 2014).

Current Regulatory Controls in City of Boynton Beach

The City of Boynton Beach does not have a specific fertilizer ordinance; ordinance 11-019,[18] however, did amend the city's Land Development Regulations (Section III of the Code of Ordinances) to add "Florida-Friendly Landscaping Standards and Provisions." According to Ordinance 11-019, the city used the FDEP Model Ordinance as a guide to draft amendments to the

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[14] https://library.municode.com/fl/palm_beach_county/codes/code_of_ordinances?nodeId=PABECOCO_CH11ENRECO_ARTXVIFLIEFEUS

[15] Palm Beach County MS4 website on fertilizers: http://pbco-npdes.org/FHP.asp?menu=SWMPMenu

[16] Personal communication with Laurie Albrecht, Extension Agent for Palm Beach County with the University of Florida Florida-Friendly Landscaping Program, January 31, 2018.

[17] Greenacres Ordinance No. 2012-20, https://greenacresfl.gov/sites/default/files/fileattachments/ordinance/16701/2._ordinance_no._2012-20.pdf

[18] Boynton Beach Ordinance 11-019: http://151.132.105.195/WebLink/DocView.aspx?dbid=0&id=46189&page=1&cr=1

Land Development Regulations. However, the current Land Development Regulations do not appear to have specific regulations related to the timing or the means for applying nitrogen- and phosphorous-containing fertilizer. Under Article II, Section 3, the following fertilizer controls are included:

- Application of “weed and feed” products should be made in accordance with the most current version of the Florida-Friendly Best Management Practices for Protection of Water Resources.
- Landscape maintenance for hire should be performed in accordance with recommendations in the Florida-Friendly Best Management Practices for Protection of Water Resources.
- Grass clippings should not be blown or swept into storm drains, conveyances or water bodies.
- When mowing near a shoreline, direct the chute away from the water body. Riparian or littoral zone plants that do not require mowing or fertilization should be planted in these areas.
- Grading of properties adjacent to water bodies should include the use of berms and/or swales to intercept surface runoff of water and debris that may contain fertilizers or pesticides.
- A voluntary 6 foot low maintenance zone is recommended by water bodies.

The Florida-Friendly Landscaping Program noted that the Boynton Beach code is less stringent than the FDEP Model Ordinance with regards to fertilizer controls.[19]

<u>City of Delray Beach</u>

The City of Delray Beach also does not have a specific fertilizer ordinance. They do commit a few paragraphs of their Landscape Regulations to fertilizer management at Article 4.6, Section 4.6.16(I), which were amended under Ordinance 6-12.[20] Provisions related to fertilizer controls include:

- Application of “weed and feed” products should be made in accordance with the most current version of the Florida-Friendly Best Management Practices for Protection of Water Resources.
- Yard waste cannot be disposed of near shorelines, swales, or storm drains, and grass clippings should be left on lawns.
- Spreader deflector shields are required when fertilizing via rotary spreaders and deflectors must be positioned to deflect away from impervious surfaces, fertilizer-free zones, and water bodies.
- Fertilizer cannot be applied on impervious surfaces and it cannot be washed or blown into storm drains, water bodies, or ditches.

The Florida-Friendly Landscaping Program noted that the Delray Beach code is not more stringent than the FDEP Model Ordinance with regards to fertilizer controls.[21]

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[19] Table of local fertilizer ordinances for the State of Florida compiled by the Florida-Friendly Landscaping Program, updated 6/1/2016: http://fyn.ifas.ufl.edu/fert_ordinances.html

[20] City of Delray Beach Ordinance 6-12: http://weblink.mydelraybeach.com/LFExternal/0/doc/121282/Page1.aspx

[21] Table of local fertilizer ordinances for the State of Florida compiled by the Florida-Friendly Landscaping Program, updated 6/1/2016: http://fyn.ifas.ufl.edu/fert_ordinances.html

Examples of More Stringent Fertilizer Ordinances

While PBC does not have any county or local ordinances that are significantly more protective than the FDEP Model Ordinance, there are other municipalities across the state with stricter fertilizer ordinances. Two examples are provided here: the Manatee County Ordinance and the Pinellas County Ordinance. For additional examples, see Table 3 of Clean Water Action's report (2014) and Florida-Friendly Landscaping Program's local fertilizer ordinance table.[22]

The Manatee County Fertilizer Ordinance (11-21) and the Pinellas County Fertilizer Ordinance (10-06) are similar and are significantly more stringent than the FDEP Model Ordinance. One page summaries for each ordinance are included in Attachment D. Table 14 summarizes the common components of these ordinances.

Table 14. Common components of the Manatee and Pinellas County Fertilizer Ordinances.

Fertilizer Control	Summary
Restricted Season	No application of N or P products between June 1st and September 30th.
Weather Restrictions	No application of N or P products if the National Weather Service forecasts heavy rains within 24 hours.
Phosphorous	No phosphorous fertilizer is allowed unless soil tests show a deficiency.
Nitrogen	Nitrogen application rate restrictions: 4 pounds/1000 square feet/year (liquid nitrogen should not exceed 0.5 pounds/1000 square feet/application). At least 50% of granular fertilizer must be slow release. No nitrogen within first 30 days of newly-installed landscape.
Fertilizer Free Zones	Fertilizers cannot be applied within 10 feet of a water body.
Grass and Landscape Debris	Grass and landscape debris cannot be blown or washed into storm drains, conveyances or roadways.
Application Method Restrictions	Deflector shields must be used to keep granules off of impervious surfaces and out of waterways. Fertilizers cannot be applied directly to impervious surfaces.
Training	Specific training and licensing required for commercial operators.

Note: Summaries of both ordinances are included in Attachment D.

There may be additional nuances between Manatee County and Pinellas County ordinances for some of the fertilizer controls listed in Table 14 . One notable difference is that the Pinellas County ordinance imposes limitations on retail sales of fertilizers within the county, while the Manatee County ordinance does not. The requirements for training also vary slightly. In Pinellas County, commercial fertilizer applicators must be state-certified in Green Industry BMPs and licensed through the state, while landscape staff must be trained in county-approved BMPs for moving, trimming, and landscape debris management. In Manatee County, fertilizer applicators must obtain the Limited Certification for Urban Landscape Fertilizer Application and landscape supervisors must obtain county-approved BMP training. Landscape employees must either receive country training or employer-provided BMP training. These are slight differences in terms of training requirements, but it exhibits the variations that are possible from one ordinance to another.

[22] Table of local fertilizer ordinances for the State of Florida compiled by the Florida-Friendly Landscaping Program, updated 6/1/2016: http://fyn.ifas.ufl.edu/fert_ordinances.html

Recommendations

Based on the discussion above of how the communities in the Boynton ICA are currently regulating fertilizer use and examples of other, more stringent, ordinances, we recommend implementing stronger regulations to reduce the use of fertilizers with nitrogen and phosphorus components throughout the Boynton ICA. Section 5.0 presents pollutant load reduction calculations from a variety of management scenarios, and it is clear that reducing fertilizer use is among the most cost effective strategies. Based on the review of other regulations in Florida, we recommend the following changes, as a start.

1. At a minimum, the communities should adopt the PBC fertilizer ordinance (Ordinance No. 2012-039), referred to as Florida-Friendly Fertilizer Ordinance. This is based closely on (and is not more stringent than) the FDEP Model Ordinance.

If additional restrictions can be adopted, then (in agreement with Clean Water Action (2014) and based on other strong ordinances such as those in Manatee and Pinellas County) the following are suggested:

2. Prohibit the use of nitrogen- and phosphorous-containing fertilizer from June 1st to September 30th.
3. Establish fertilizer-free zones within 10-feet of any water body.
4. Require all nitrogen fertilizer to be at least 50% slow release.
5. Limit the total amount of nitrogen applied to 4 pounds per 1,000 square feet per year.

In terms of commercial training, the Florida Friendly Landscaping Program, which worked with the FDEP to develop its Model Ordinance, provides Green Industry Best Management Practices (GI-BMP) training which all commercial fertilizer applicators must obtain to get a license per Florida Statue 482.1562. Many local ordinances also require this training.

6. Require GI-BMP training for commercial landscape professionals.
7. Training must be conducted in the staff members' preferred language.

Educating the public is also important because many people choose to fertilize their own properties without a commercial landscaper. Garden shops and other retailers are the primary point of contact for homeowners that fertilize and can therefore be useful for education. Water utility companies and local governments also have an opportunity to educate homeowners about fertilizer and lawn care in relation to stormwater.

8. Require fertilizer retailers (e.g., garden supply stores) to have signs up in their stores in the vicinity of nitrogen and phosphorous fertilizers outlining the ordinance requirements. A standard sign could be created for stores to post.
9. Training for store staff on the ordinance is also recommended because they are likely to field questions from home owners.
10. Water utility companies could be required/ recommended to include inserts with water utility bills about fertilizer ordinances.
11. Demonstration gardens could be planted in public areas to show the public how they can use more native plants that require less or no fertilizer.

The following programs are available for development of and education about fertilizer ordinances:

- The Florida Friendly Landscaping Program is a hub of information about fertilizer ordinances and training: http://ffl.ifas.ufl.edu/index.html.
- Contact information for the Palm Beach County Extension Agent: http://ffl.ifas.ufl.edu/counties/palmbeachcontact.php
- The Palm Beach County MS4 site that has information on fertilizer ordinances and how a municipality can draft an ordinance: http://pbco-npdes.org/FHP.asp?menu=SWMPMenu
- The Tampa Bay Estuary Program has created an educational program called "Be Floridian" to information homeowners of restrictions and promote "Florida-Friendly" yards: http://befloridian.org/.

5.0 EVALUATION OF LOAD REDUCTION STRATEGIES

A suite of management strategies was developed based on the modeling, research, and site assessments presented in this plan. The potential effectiveness of these strategies was then evaluated using the land-based pollutant loading model and treatment efficiencies for each practice to provide insight into which strategies or suite of strategies might be the most effective in reducing pollutants in the subwatershed 'I' study area as well as across the full Boynton ICA. The proposed practices that we evaluated using the land-based loading model are presented in Table 15, along with the pollutant removal efficiencies for TN, TP and TSS. These practices were evaluated within a set of management scenarios in which the practices were applied to specific land uses at an application rate that was considered reasonable. The express purpose of this evaluation is to inform watershed managers about the potential management options in the watershed, and to compare the potential effectiveness of different approaches to one another. The scenarios are presented below, followed by the modeling results for subwatershed 'I' and the Boynton ICA.

Table 15. Pollutant reductions for proposed practices

Proposed Practice	Practice Type	TN Reduction (%)	TP Reduction (%)	TSS Reduction (%)
Agricultural Fertilizer Reduction	Non-Structural/ Stormwater	25	25	0
Urban Fertilizer Reduction	Non-Structural/ Stormwater	25	25	0
Water Quality Swales with Raised Culverts	Stormwater	40	40	30
Bioretention Areas / Rain Gardens	Stormwater	30	30	80
Stormwater Bumpouts	Stormwater	30	30	80
New and Enhanced Buffers	Stormwater	25	25	50
Tree Trenches	Stormwater	38	50	80
Enhanced N Removal Swale	Stormwater	60	50	30
Advanced Septic	Septic	45	0	0
Package Plant	Septic	70	0	0
Advanced WWTF	Septic	85	0	0

5.1 Subwatershed Pollutant Reduction Scenarios

Eleven pollutant reduction scenarios were developed to evaluate the effect of a particular load reduction practice or strategy on a mix of selected land uses. These practices are applied to varying extents across different land use categories, using reasonable assumptions based on our site assessments and watershed observations. These scenarios are intended to be examples, and could ultimately be adjusted in the future to 'test' the potential effectiveness of different implementation strategies. These scenarios are summarized below and the potential pollutant loading results of the scenario modeling for Subwatershed 'I' are provided below in Table 17.

Scenarios

1. Agricultural Fertilizer Reduction. TN and TP loads were reduced by 25% in 100% of the agricultural areas only.

2. Urban Fertilizer Reduction. TN and TP loads were reduced by 25% in 100% of the commercial, industrial, and residential areas. For this scenario only, residential includes planned unit developments (PUDs).
3. Water Quality Swales with Raised Culverts. These BMPs were applied in 5% of the light commercial and residential areas and 20% of the highway areas.
4. Bioretention Areas / Rain Gardens. These BMPs were applied in 10% of the commercial, industrial, multi-family residential and open space areas plus 5% of the low density and single family residential areas.
5. Stormwater Bumpouts. These BMPs were applied in 5% of the commercial and residential areas.
6. New and Enhanced Buffers. These BMPs were applied in 30% of all agricultural areas and 10% of the golf and open space areas.
7. Tree Trenches. These BMPs were applied in 5% of commercial, industrial, multi-family residential and open space areas.
8. Enhanced N Removal Swales. These BMPs were applied in 5% of industrial, 10% of the low-density and single family residential and 20% of the highway areas.
9. Advanced Septic. This BMP would convert all current septic systems on all land uses to advanced septic systems resulting in a 45% reduction in the TN septic load.
10. Package Plant. This BMP would connect all current septic systems on all land uses to local package plant systems resulting in a 70% reduction in the TN septic load.
11. Advanced WWTF. This BMP would connect all current septic systems on all land uses to an advanced wastewater treatment facility (WWTF) resulting in an 85% reduction in the TN septic load.

Table 16. Application rates of proposed BMPs across land use categories in each proposed scenario

Land Use Category	Application Rates of Proposed BMPs to Land Use Category in Each Pollutant Reduction Scenario										
	1	2	3	4	5	6	7	8	9	10	11
Agriculture- Crops/Citrus/Pasture/Sod	100%					30%					
Agriculture- Equine	100%					30%					
Agriculture- Nurseries	100%					30%					
Light Industrial		100%		10%			5%	5%			
Low Intensity Commercial		100%	5%	10%	5%		5%				
High Intensity Commercial		100%		10%	5%		5%				
Highways/Roads			20%					20%			
Low Density Residential		100%	5%	5%	5%			10%			
Single Family Residential		100%	5%	5%	5%			10%			
Multi-Family Residential		100%	5%	10%	5%		5%				
Planned Unit Development		100%									
Golf Course				10%		10%					
Open Space/Parks				10%		10%	5%				
Current Septic Systems									100%	100%	100%

Table 17. Pollutant reductions for proposed scenarios in Subwatershed 'I'.

Proposed Scenario	TN Reduction (%)	TP Reduction (%)	TSS Reduction (%)
CURRENT CONDITIONS (Total Load, lb/yr)			
1. Agricultural Fertilizer Reduction	0.1	0.2	0.0
2. Urban Fertilizer Reduction	14.6	17.5	0.0
3. Water Quality Swales with Raised Culverts	1.7	2.4	2.1
4. Bioretention Areas / Rain Gardens	0.8	1.2	4.0
5. Stormwater Bumpouts	0.3	0.6	1.8
6. New and Enhanced Buffers	0.2	0.2	0.3
7. Tree Trenches	0.3	0.8	1.7
8. Enhanced N Removal Swale	2.6	2.9	1.9
All Stormwater Practices	**20.8**	**25.7**	**11.8**
9. Advanced Septic	7.4	0.0	0.0
10. Package Plant	11.5	0.0	0.0
11. Advanced WWTF	14.0	0.0	0.0
All Stormwater Practices + Advanced WWTF	**34.7**	**25.7**	**11.8**

Recall that the TMDL for Lake Ida calls for a 20% reduction in TN loading and a 45% reduction in TP loading. The application of stormwater practices across the watershed, or a combination of stormwater and wastewater approaches, would have the potential to address the TN reduction requirements. The stormwater management scenarios presented would have the potential to achieve a significant reduction in TP loading but would not achieve the required 45% reduction. Additional TP reductions could be achieved by applying the stormwater practices at greater implementation rates across the subwatershed than presented in our scenarios. This would require a more detailed look at feasibility and sizing of practices across the subwatershed. In addition, note that Subwatershed 'I' represents the contributing area to Lake Ida under normal operating conditions. Also note that the MS4s in Subwatershed 'I' make up approximately 15% of the area of Subwatershed 'I' and are only responsible for reducing the loads from their respective outfalls.

Table 18,

Table 19 and Table 20 present the potential pollutant reductions that could be achieved by applying the above management scenarios to the individual MS4 areas within Subwatershed 'I'. Table 21 presents the same information for the sum of all MS4 areas within Subwatershed 'I.' When the same scenarios presented above are applied in the model across the full Boynton ICA, similar reductions are produced, as shown in Table 22.

Table 18. Nitrogen reductions for proposed scenarios within Individual MS4 Areas in Subwatershed 'I'.

Proposed Scenario	TN Load (lb/yr)				TN Reduction (% of MS4 Load)			
	Boynton Beach MS4	Delray Beach MS4	FDOT District IV	PB County MS4	Boynton Beach MS4	Delray Beach MS4	FDOT District IV	PB County MS4
CURRENT CONDITIONS	*3,396*	*648*	*2,799*	*3,487*	0.0	0.0	0.0	0.0
Agricultural Fertilizer Reduction	*3,396*	*648*	*2,799*	*3,487*	0.0	0.0	0.0	0.0
Urban Fertilizer Reduction	*2,731*	*542*	*2,789*	*3,468*	19.6	16.4	0.3	0.6
Water Quality Swales with Raised Culverts	*3,320*	*625*	*2,597*	*3,217*	2.2	3.6	7.2	7.8
Bioretention Areas / Rain Gardens	*3,369*	*639*	*2,790*	*3,487*	0.8	1.4	0.3	0.0
Stormwater Bumpouts	*3,378*	*642*	*2,798*	*3,487*	0.5	1.0	0.0	0.0
New and Enhanced Buffers	*3,394*	*647*	*2,792*	*3,487*	0.0	0.1	0.2	0.0
Tree Trenches	*3,387*	*646*	*2,793*	*3,487*	0.3	0.4	0.2	0.0
Enhanced N Removal Swale	*3,272*	*606*	*2,497*	*3,082*	3.7	6.6	10.8	11.6
All Stormwater Practices (Incl. fertilizer reductions)	***2,474***	***458***	***2,266***	***2,790***	**27.1**	**29.4**	**19.0**	**20.0**
Advanced Septic	*3,396*	*648*	*2,799*	*3,480*	0.0	0.0	0.0	0.2
Package Plant	*3,396*	*648*	*2,799*	*3,476*	0.0	0.0	0.0	0.3
Advanced WWTF	*3,396*	*648*	*2,799*	*3,473*	0.0	0.0	0.0	0.4
All Stormwater Practices + Advanced WWTF	***2,474***	***458***	***2,266***	***2,776***	**27.1**	**29.4**	**19.0**	**20.4**

Table 19. Phosphorus reductions for proposed scenarios within Individual MS4 Areas in Subwatershed 'I'.

Proposed Scenario	TP Load (lb/yr)				TP Reduction (% of MS4 Load)			
	Boynton Beach MS4	Delray Beach MS4	FDOT District 4	PB County MS4	Boynton Beach MS4	Delray Beach MS4	FDOT District 4	PB County MS4
CURRENT CONDITIONS	*225*	*93*	*340*	*392*	0.0	0.0	0.0	0.0
Agricultural Fertilizer Reduction	*225*	*93*	*340*	*392*	0.0	0.0	0.0	0.0
Urban Fertilizer Reduction	*180*	*76*	*338*	*390*	20.1	17.7	0.4	0.6
Water Quality Swales with Raised Culverts	*220*	*89*	*315*	*361*	2.2	3.4	7.3	7.8
Bioretention Areas / Rain Gardens	*223*	*91*	*339*	*392*	0.9	1.5	0.3	0.0
Stormwater Bumpouts	*224*	*92*	*340*	*392*	0.6	1.1	0.0	0.0
New and Enhanced Buffers	*225*	*92*	*339*	*392*	0.0	0.1	0.2	0.0
Tree Trenches	*224*	*92*	*339*	*392*	0.4	0.6	0.2	0.0
Enhanced N Removal Swale	*219*	*88*	*309*	*354*	3.0	5.1	9.1	9.7
All Stormwater Practices (Incl. fertilizer reductions)	***164***	***65***	***281***	***321***	**27.1**	**29.4**	**17.4**	**18.2**
Advanced Septic	*225*	*93*	*340*	*392*	0.0	0.0	0.0	0.0
Package Plant	*225*	*93*	*340*	*392*	0.0	0.0	0.0	0.0
Advanced WWTF	*225*	*93*	*340*	*392*	0.0	0.0	0.0	0.0
All Stormwater Practices + Advanced WWTF	***164***	***65***	***281***	***321***	**27.1**	**29.4**	**17.4**	**18.2**

Table 20. TSS reductions for proposed scenarios applied within Individual MS4 Areas in Subwatershed 'I'.

Proposed Scenario	TSS Load (lb/yr)				TSS Reduction (% of MS4 Load)			
	Boynton Beach MS4	Delray Beach MS4	FDOT District 4	PB County MS4	Boynton Beach MS4	Delray Beach MS4	FDOT District 4	PB County MS4
CURRENT CONDITIONS	*7,562*	*5,785*	*25,621*	*29,102*	0.0	0.0	0.0	0.0
Agricultural Fertilizer Reduction	*7,562*	*5,785*	*25,621*	*29,102*	0.0	0.0	0.0	0.0
Urban Fertilizer Reduction	*7,562*	*5,785*	*25,621*	*29,102*	0.0	0.0	0.0	0.0
Water Quality Swales with Raised Culverts	*7,426*	*5,624*	*24,198*	*27,392*	1.8	2.8	5.6	5.9
Bioretention Areas / Rain Gardens	*7,381*	*5,565*	*25,465*	*29,084*	2.4	3.8	0.6	0.1
Stormwater Bumpouts	*7,447*	*5,633*	*25,602*	*29,097*	1.5	2.6	0.1	0.0
New and Enhanced Buffers	*7,555*	*5,774*	*25,548*	*29,095*	0.1	0.2	0.3	0.0
Tree Trenches	*7,505*	*5,726*	*25,544*	*29,094*	0.8	1.0	0.3	0.0
Enhanced N Removal Swale	*7,423*	*5,604*	*24,203*	*27,393*	1.8	3.1	5.5	5.9
All Stormwater Practices (Incl. fertilizer reductions)	***6,928***	***4,999***	***22,452***	***25,645***	**8.4**	**13.6**	**12.4**	**11.9**
Advanced Septic	*7,562*	*5,785*	*25,621*	*29,102*	0.0	0.0	0.0	0.0
Package Plant	*7,562*	*5,785*	*25,621*	*29,102*	0.0	0.0	0.0	0.0
Advanced WWTF	*7,562*	*5,785*	*25,621*	*29,102*	0.0	0.0	0.0	0.0
All Stormwater Practices + Advanced WWTF	***6,928***	***4,999***	***22,452***	***25,645***	**8.4**	**13.6**	**12.4**	**11.9**

Table 21. Total pollutant load reductions for proposed scenarios applied across all MS4 Areas in Subwatershed 'I'.

Proposed Scenario	TN			TP			TSS		
	Total Load (lb/yr)	Reduction (% of MS4 load)	Reduction (% of Subshed 'I' load)	Total Load (lb/yr)	Reduction (% of MS4 load)	Reduction (% of Subshed 'I' load)	Total Load (lb/yr)	Reduction (% of MS4 load)	Reduction (% of Subshed 'I' load)
CURRENT CONDITIONS									
Total Subwatershed 'I' Load	60,080			5,179			323,483		
Total MS4 Load	10,330			1,049			68,071		
POLLUTANT REDUCTION SCENARIOS									
Agricultural Fertilizer Reduction	10,329	0.0	0.0	1,049	0.0	0.0	68,071	0.0	0.0
Urban Fertilizer Reduction	9,529	7.7	1.3	984	6.2	1.3	68,071	0.0	0.0
Water Quality Swales with Raised Culverts	9,759	5.5	1.0	986	6.0	1.2	64,641	5.0	1.1
Bioretention Areas / Rain Gardens	10,285	0.4	0.1	1,045	0.4	0.1	67,494	0.8	0.2
Stormwater Bumpouts	10,305	0.2	0.0	1,047	0.2	0.0	67,779	0.4	0.1
New and Enhanced Buffers	10,320	0.1	0.0	1,048	0.1	0.0	67,972	0.1	0.0
Tree Trenches	10,313	0.2	0.0	1,047	0.2	0.0	67,868	0.3	0.1
Enhanced N Removal Swale	9,456	8.5	1.5	969	7.7	1.6	64,623	5.1	1.1
All Stormwater Practices (Incl. fertilizer reductions)	**7,987**	**22.7**	**3.9**	**831**	**20.8**	**4.2**	**60,024**	**11.8**	**2.5**
Advanced Septic	10,322	0.1	0.0	1,049	0.0	0.0	68,071	0.0	0.0
Package Plant	10,318	0.1	0.0	1,049	0.0	0.0	68,071	0.0	0.0
Advanced WWTF	10,316	0.1	0.0	1,049	0.0	0.0	68,071	0.0	0.0
All Stormwater Practices + Advanced WWTF	**7,973**	**22.8**	**3.9**	**831**	**20.8**	**4.2**	**60,024**	**11.8**	**2.5**

Table 22. Pollutant reductions for proposed scenarios across the Boynton ICA.

Proposed Scenario	TN Reduction (%)	TP Reduction (%)	TSS Reduction (%)
Agricultural Fertilizer Reduction	1.2	2.2	0.0
Urban Fertilizer Reduction	10.7	16.3	0.0
Water Quality Swales with Raised Culverts	1.3	2.2	1.9
Bioretention Areas / Rain Gardens	0.7	1.2	3.9
Stormwater Bumpouts	0.3	0.6	1.8
New and Enhanced Buffers	0.4	0.8	1.1
Tree Trenches	0.3	0.8	1.7
Enhanced N Removal Swale	2.0	2.6	1.8
All Stormwater Practices (Incl. fertilizer reductions)	**17.2**	**26.8**	**12.3**
Advanced Septic	15.0	0.0	0.0
Package Plant	23.4	0.0	0.0
Advanced WWTF	28.4	0.0	0.0
All Stormwater Practices + Advanced WWTF	**45.6**	**26.8**	**12.3**

The reduction of urban fertilizer application is by far the most effective stormwater practice. Each of the wastewater practices is effective at reducing TN, and each would require more detailed site specific evaluation to determine what option would be feasible. In addition, the potential costs of implementing these practices will inform the decision about implementation and prioritizing. Planning level implementation costs are presented in Section 5.2.

5.2 Estimated Planning Level Costs for Proposed Management Scenarios

A planning level estimate of construction costs was developed for the entire Boynton ICA to evaluate and compare each of the scenarios presented above. These costs are presented in Table 23 based on an estimated unit cost, which was then applied across the Boynton ICA. These costs include a number of planning assumptions about construction costs, materials costs, and stormwater and wastewater treatment volumes and flow rates, as well as an overall presumption about the feasibility of implementing these management options across the ICA. These assumptions are denoted in the notes associated with the table. As a result of these assumptions, these costs should be evaluated for purposes of scale and comparison among management options. The costs are also converted in unit costs to remove a pound of pollutant (TN, TP and TSS), to evaluate and compare the cost effectiveness for each pollutant.

According to the planning level costs presented, fertilizer reductions provide by far the most cost effective reductions of TN and TP across the ICA, and, as shown in Table 22, have the greatest overall potential to reduce these pollutants when compared to other stormwater practices. The wastewater practices would provide by far the most reductions in TN across the watershed, and would also be the most cost-effective approaches. However, these approaches do not address TP or TSS loading. Among the stormwater practices (other than fertilizer reductions), the water quality swales and bioretention systems provide the greatest potential for reductions of TN, TP and TSS, and they appear to be the most cost effective as well.

Table 23. Costs for proposed watershed management scenarios applied across the Boynton ICA

Proposed Retrofit BMP	Notes	Unit Type	Cost per Unit	Number of Units	Construction Cost ($)	TN Reduction Cost ($/lb)	TP Reduction Cost ($/lb)	TSS Reduction Cost ($/lb)
Agricultural Fertilizer Reduction	1	Area (ac)	12	7,816	93,797	11	80	-
Urban Fertilizer Reduction	2	Area (ac)	0	58,921	0	0	0	-
Water Quality Swales with Raised Culverts	3	IA (ac)	100,000	1,610	161,027,203	16,938	138,213	2,588
Bioretention Areas / Rain Gardens	4	IA (ac)	92,000	1,037	95,424,959	20,156	144,558	757
Stormwater Bumpouts	5	IA (ac)	180,000	489	88,092,999	40,888	277,708	1,494
New and Enhanced Buffers	6	Area (ac)	300	709	212,710	64	511	6
Tree Trenches	7	IA (ac)	120,000	435	52,155,704	22,879	118,666	956
Enhanced N Removal Swale	8	IA (ac)	110,000	1,544	169,836,121	12,087	122,346	2,996
All Stormwater Practices		-	-	-	**566,843,492**	**4,769**	**39,974**	**1,440**
Advanced Septic	9	Household	20,000	15,294	305,880,418	2,958	-	-
Package Plant	10	Household	15,000	15,294	229,410,314	1,426	-	-
Advanced WWTF	11	Household	11,000	15,294	168,234,230	861	-	-
All Stormwater Practices + Advanced WWTF		-	-	-	**735,077,722**	**2,339**	**51,837**	**1,868**

(1) Non-CNMP nutrient plan for <300 ac is $3,000 (USDA-EQIP, 2018) + $2/ac for basic nutrient management (USDA-CSP, 2018).

(2) No construction or implementation cost is assumed to reduce fertilizer use in this scenario. Additional costs would be associated with changing the regulation of fertilizer use, as well as training, education and enforcement

(3-5) Cost in $/cf (CRWA, 2010; HW, 2011) was converted to $/IA (ac) using 1.25 inches of runoff.

(6) Average cost is for grass buffers (MD-CE, no date). Land area treated was converted to buffer area constructed using a land:buffer ratio of 4:1.

(7-8) Cost in $/cf (CRWA, 2010; HW, 2011) was converted to $/IA (ac) using 1.25 inches of runoff.

(9) Assumptions: $30,000 for 330 gpd system (HW best professional judgment, 2018); non-consumptive flow is 48 gallons per person per day (gppd) (FDOH, 2015); design flow is twice the non-consumptive flow; 2.32 people/house (US Census, 2010); no costs included for pipes or hookup.

(10) Assumptions: $1M for 25,000 gpd system (HW best professional judgment, 2018); non-consumptive flow is 48 gppd (FDOH, 2015); design flow is twice the non-consumptive flow; 2.32 people/house (US Census, 2010); cost includes ten 50-ft 6" lateral pipes at $50/ft, one 500-ft 8" main at $60/ft, and 3 manholes at $3,000 each per ten houses (Wildwood, 2016).

(11) Assumptions: $7M for 0.5 mgd flow (HW, 2018); non-consumptive flow is 48 gppd (FDOH, 2015); design flow is twice the consumptive flow; 2.32 people/house (Census, 2010); cost includes one 75-ft 6" lateral at $50/ft and a $4,000 hookup fee (Wildwood, 2016; Florida, no date).

6.0 MANAGEMENT RECOMMENDATIONS

6.1 Approach to large scale watershed planning

This watershed planning effort was a valuable approach to assessment and planning for a large scale watershed such as the Boynton ICA. It met the challenge of working with a limited budget across a large watershed area. With the basic template now drafted for the flow modeling, pollutant loading model, rapid site assessments, and retrofit management strategies, this basic approach seems feasible in other large watersheds. In consideration of applying this same method to other large watersheds in southeast Florida or beyond, this basic template should be reviewed and vetted by stakeholders to evaluate its use and effectiveness, and to revise and augment this approach as needed for broader application.

The setting for this watershed plan is a heavily developed area with multiple jurisdictions, making the setting quite complicated for municipal and regional managers to try to work toward the same overall water quality improvement goals. This challenge is actually what makes this watershed planning approach the most valuable. It gives multiple jurisdictions and interests a way to organize their energy and analysis to begin the planning effort, and to begin to evaluate actions that can be taken to improve the watershed conditions.

Dual Scale – Large Watershed and Small Study Area

Coming together for a watershed-based effort that addresses both the large scale watershed as well as a more targeted study subwatershed area provides two different levels of involvement and feedback from stakeholders. Stakeholders in the larger watershed can stay involved and learn from the detailed assessment in the smaller study area, and those in the smaller study area can move more quickly toward a detailed understanding of the watershed conditions and site specific mitigation measures. In the end, stakeholders at both scales benefit from a watershed management plan.

Data Collection Template

Future efforts to replicate this watershed planning approach should consider a more directed template of information needs or key questions to guide the data collection efforts. In such a large watershed, with so much work already underway by individual sectors, it can quickly become overwhelming to try to understand 'everything' that is going on in a watershed all at once. The framework from this watershed plan and analysis could be used to develop such a template for future efforts in other watersheds.

Stakeholder Involvement

The most significant element of this watershed plan was the active involvement and interest from key watershed stakeholders. The stakeholder meetings and the discussion that they generated to iron out some important answers about how to interpret and use flow data, water quality data, and the local regulatory setting in the watershed were invaluable. These watershed plans cannot be developed in a vacuum but require input and guidance from those who will be working with the analysis and recommendations. If anything, this aspect of the planning process should be enhanced, and certainly not underestimated, in future watershed planning efforts.

Additional Data Needs and Considerations

Additional data that would be useful at the large watershed scale includes:

- Information about the wastewater pollutant loads to the upper (directly connected) and lower (more disconnected) aquifers, in order to improve pollutant loading estimates. In addition, more detailed mapping of sewers and individual septic system locations and sizes could be incorporated into the initial data collection and analysis phase. This would help to improve the pollutant loading estimates and develop more detailed recommendations for wastewater management improvements.
- Additional data points where long term flow and water quality data coincide with one another, for purposes of modeling. In the Boynton ICA, we were able to use data to characterize reasonably well the flows and loads entering the watershed form the west and discharging to the east. However, we were less certain about the flows and water quality entering or leaving in the north and south boundaries of the watershed.
- This watershed planning effort was undertaken quite separately from climate adaptation and resilience efforts within the watershed. However, impacts from and management of land based sources of pollution clearly intersects with climate resilience issues, particularly in the coastal setting of southeast Florida. In future watershed planning efforts, climate change impacts and climate resilience should be explicitly considered.

6.2 Next steps for Boynton ICA

The recommendations for next steps in the Boynton ICA as a whole include a combination of code reforms, guidance, trainings and education, more detailed prioritization process for implementation of projects, and wastewater management improvements. More specific recommendations for the Subwatersheds 'I and 'J' study area are provided separately below.

Municipal Codes Updates and Fertilizer Restrictions

Local municipalities should implement stricter regulation of fertilizer use or even sales, particularly N and P fertilizers, in the watershed. This is clearly the most cost effective approach, from a technical perspective, and would have the quickest implementation schedule of any proposed improvement. The benefits could be monitored as soon as a policy change is implemented. One challenge for this recommendation is the effort involved in promulgating new regulation, but this is minimal compared to potential benefits and the potential costs of other mitigation practices. Another challenge is monitoring and enforcement of the new regulation. However, because fertilizer application is typically done by a single industry, the landscape maintenance industry, consistency of regulations across the region can make it easier for industry to comply. Training of that industry can also be useful in enforcing the regulations (as further described in the Training and Education section below).

Codes should also be reviewed and audited to ensure that better site design principles and green stormwater management practices are required and encouraged, and not prohibited by accident. The CWP code and ordinance worksheet could be used to evaluate and develop recommendations for improvements in each municipality, so that new development and redevelopment would better manage stormwater and other water quality and water efficiency impacts. Over time, this will begin to transform the watershed, due to the rapid growth and redevelopment that is occurring.

The enforcement of permits that govern stormwater management design, construction and maintenance could be strengthened. Permits for planned unit developments discharging to SFWMD canals are issued by SFWMD and FDEP issues Environmental Resource Permits for other large scale projects. However, there is little inspection or reporting to ensure that stormwater management systems continue to function as designed, even if they are designed to meet rigorous standards.   Enforcement and inspections are expensive undertakings, but the proper function of stormwater practices can be easily compromised by a change in landscaping, poor maintenance, and a lack of understanding of the systems.

Green Infrastructure Design Manual

A design manual to provide a menu of green infrastructure practices and better site design options could benefit the municipal managers as well as local private engineers and landscape architects. A design manual provides a basis of understanding for all practitioners, so that everyone can speak the same language, work with the same menu of practices, and have the same understanding of the pollutant removal efficiencies, design constraints, appropriate settings and materials for the practices. The manual can be referenced by municipal ordinances or regulations, and could be used as a reference for stormwater and site development permits.

In addition, a manual can also highlights the costs and benefits of green infrastructure and provide examples of how green infrastructure is providing multiple cross-cutting benefits to a community or region. In particular, it would be helpful to provide case study examples of how green infrastructure investments are helping to revitalize communities in Florida by increasing property values, creating economic opportunity and addressing legacy stormwater issues. Examples might include Cascades Park in Tallahassee (https://fbpe.org/cascades-re-development-project/), Depot Park stormwater park in East Gainesville (http://www.depotpark.org/history/), and Alachua County (http://www2.ku.edu/~kutc/pdffiles/Green%20Infrastructure%20Case%20Studies.pdf and https://icma.org/sites/default/files/2767_.pdf).

Training and Education:

Landscapers and site maintenance professionals receive training on fertilizer application. Additional training should be provided, in the appropriate required languages, for other elements of landscaping, including the design and maintenance of innovative vegetated stormwater practices, and how to recognize stormwater practices versus general landscaping.

Local civil engineers, including private engineers as well as municipal engineers, should receive regular training on the menu of effective green stormwater practices. This training should include site visits and information sharing sessions among engineers, maintenance staff, and environmental managers to promote familiarity with these practices, and facilitate the evolution of design improvements specific to the challenges of the area, such as climate, groundwater, proximity to canals, etc.

Local municipal staff and home owner association officials from large developments should receive training on inspections of stormwater practices so they can understand when their systems are working and when they need repairs or maintenance. Ultimately, a more rigorous maintenance reporting requirement for site permitted by the local municipalities, FDEP or the SFWMD would be useful to ensure that inspections and maintenance occur regularly and repairs are made.

The well-established Florida Friendly Landscaping program at the University of Florida Cooperative Extension Service should also be fully embraced as a resource for this education and training effort.

Prioritization Process for Implementation of Projects:

This watershed plan uses a land use based pollutant loading analysis to assess current loads and potential load reductions from a variety of management strategies. A valuable next step would include the development and implementation of a prioritization process (likely involving GIS data as well as guidance from municipal staff) to identify specific locations in the watershed where improvements would provide the highest return on investment for pollutant load reduction. Given a limited budget for implementation, an implementation prioritization process would help identify which areas of the watershed and which implementation strategies to implement first. This would build upon the analysis provided in this watershed plan, to apply the recommended management strategies and example concept designs to specific locations on the ground, and would provide a more detailed roadmap for managers.

Wastewater Management Improvements:

Facilities currently served by septic systems should be connected to the sewer for treatment at an existing WWTF. The modeling analysis in this watershed plan clearly indicate that this is the most effective and least costly (on a unit cost/lb TN removed basis) approach to improve the water quality and reduce nitrogen pollutant loading from wastewater discharges. Note, however, that these improvements will do little to reduce TP loading if the current systems are functioning properly. However, we know from the research that many current systems are failing due to inundation from elevated groundwater and from a lack of maintenance. In these cases, the sewer hookup would create multiple benefits. Our study did not evaluate the proximity of septic locations to existing sewers; an important next step would be to evaluate the proximity of existing sewer lines to properties served by septic systems, the available sewer and WWTF capacity, and estimated cost to extend the sewer and/or increase capacity. In the meantime, any new development or redevelopment should be required to examine the option of connecting to the sewer, and the water quality benefits should be well quantified to provide a comprehensive cost-benefit analysis to ensure that connections are undertaken when appropriate.

Establishment of a Watershed Advisory Committee

This watershed plan provides a basic roadmap for managing the watershed to improve the quality of surface waters, and will require a more detailed implementation plan based on prioritization and commitments from a wide variety of partners and stakeholders. A Watershed Advisory Committee would guide the development of this more detailed implementation plan, and manage the accountability and tracking of progress toward water quality improvements. The committee should consist of stakeholder agencies and municipalities, including MS4 permittees as well as FDEP, SFWMD, LWDD, and representatives of the land uses that would be affected by the recommendations of this plan, such as commercial business organizations in business park, commercial shopping center and town center settings, PUDs, the landscaping industry and others.

This committee could build upon the stakeholders that participated in the development of the current watershed plan, and incorporate the already established cooperative effort among the Palm Beach County MS4 permittees to meet their permit requirements.

6.3 Subwatershed I and J

There are a variety of potential opportunities to retrofit existing properties in the subwatershed study area. In addition, there are opportunities for nonstructural improvements to policies, design and maintenance practices within the watershed that could provide significant water quality benefits. Based on the site observation, research, and modeling performed in the development of this watershed plan, we have developed recommendations for improved management of the subwatershed study area in order to reduce land-based pollutant loads. The study area was selected as a microcosm representing similar characteristics and land uses found across the entire Boynton ICA. As a result, the management recommendations for the subwatershed study area can be applied broadly in the Boynton ICA as well.

Structural Stormwater Practices:

On a cost per treatment basis[23], stormwater retrofitting is one of the most expensive and least cost effective ways to reduce watershed loads. Of the practices considered (ponds excluded), water quality swales and bioretention systems are generally the most cost effective practices to address nutrients and TSS from stormwater runoff, according to the modeling. However, in areas where these practices may not be feasible, other practices such as tree trenches, stormwater bumpouts and enhanced vegetated (no mow) buffers should also be considered. We recommend that the Cities of Delray Beach and Boynton Beach as well as Palm Beach County undertake a series of small pilot retrofit projects to demonstrate the design, construction and maintenance of these practices in a variety of settings. Perhaps working with universities or high schools, these practices could be monitored to evaluate their effectiveness, make adjustments to design elements and provide a basis for future stormwater improvements.

Specifically, we recommend installing retrofit pilot projects at several suitable sites that we assessed and presented in Section 0 of this watershed plan. HW included a recommended priority ranking for the use of available funding based on the site assessments and concept. These sites and priority ranking are presented in Table 24. Educational signage at each site would enhance the effectiveness of the projects in educating the public about the benefits, in preparation for more projects across the watershed.

[23] However, importantly, we note that there are many additional benefits to property values, aesthetics, and open space improvements that are not quantified here and that substantially augment the host of benefits to the local community that can be provided by these green stormwater retrofits.

Table 24. Stormwater Retrofits Recommended for Pilot Project Implementation

Priority	Site ID	Recommended Stormwater BMP Type	Contributing Area Primary Land Use
1	J11BC	Bioswale or N-swale	Park
1	M1	Tree trench	High Intensity Commercial
1	M2	Bump outs	High Intensity Commercial
2	J10A	Bioretention	Residential - Single Family
2	I10A	Bioretention	Park
3	J9A	Enhanced N removal swale	Highway/Roads
3	I23	Bioretention/rain garden	Residential - Single Family

Monitoring

A watershed monitoring plan should be developed for a single subwatershed for the purpose of documenting improvements over time as a result of implementation of retrofits. The plan should include water quality parameters of interest (nitrogen and phosphorus) as well as flow at key locations so that the watershed flow model can be improved. One of the challenges of this watershed planning effort was developing a flow model at a scale smaller than the full Boynton ICA. We were unable to do that because of the limited locations where flow data and water quality were generally coincident.

In Lake Ida as a particular example, more information is needed about the specific flow volumes and direction of flows into the lake and out of the lake in order to develop a flow model. However, the Cities of Boynton Beach and Delray Beach, as MS4 permittees, recently submitted and received approval for an ambient water quality monitoring plan that will monitor water quality at seven key locations in Lake Ida, including the inflow locations into Lake Eden and Lake Ida from LWDD canals and MS4 discharges and the outflow from Lake Ida in the southwest corner. The approved monitoring plan is included in Attachment E. This monitoring plan is developed in order to document improvements in water quality as retrofits are implemented to eventually meet the TMDL. The results documented in the Lake Ida watershed could be applied across other similar Chain of Lakes watershed or elsewhere in southeastern Florida to make management decisions.

7.0 CONCLUSION

This watershed plan represents a pilot methodology for rapid assessment and planning for a large watershed (>100 square miles). The modeling and cost estimating presented in this watershed management plan provide a basis for comparing and prioritizing management options at a broad planning scale. The targeted site assessments provide a method for rapid understanding of a representative subwatershed, and the development of a reasonable suite of management options appropriate for the setting. The assumptions and recommendations developed for the representative subwatershed can be reasonably extrapolated across the full subwatershed to develop and compare broader cost estimates and estimates of pollutant loading effectiveness. Following a rigorous review and vetting of this methodology, this same or similar methodology can be repeated in other large watersheds in southeastern Florida, or elsewhere.

A significant challenge with performing rapid watershed assessment and planning at this large scale is the simple fact that a large heavily populated watershed includes a significant network of stakeholders, as well as state, regional and municipal regulatory programs, data sets, and prior research. Many managers are faced with the difficult challenge of balancing the budget with the sense of responsibility for fully understanding the details and mechanics of the watershed. More examples of this rapid assessment planning approach will help to better define that balance and the expectations for the watershed plans, and will help the users (planners, municipalities, regulators, engineers, and policy makers) to have clear expectations of the product and the next steps.

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Boynton Inlet Contributing Area Watershed Management Plan

Attachment A

Stakeholder Meeting Summaries

February 9, 2017 Meeting
October 18, 2017 Meeting

February 9, 2017 Meeting

Boynton Inlet Subwatershed Selection Meeting

City of Boynton Beach, FL
February 9, 2017

Meeting Notes

Welcome

Kurtis Gregg and Rob Ferguson, NOAA Coral Reef Conservation Program, provided a brief welcome to the group. The Boynton Inlet Contributing Area Management Plan project is funded by the NOAA Coral Conservation Program.

Introductions

Ellie Baker, Senior Environmental Planner at the Horsley Witten Group (HW) and Project Manager for the Boynton Inlet Watershed Management Plan project, provided a brief introduction to the project and how we arrived at the meeting. The Boynton Inlet Watershed boundary was presented to the group, as well as a basic overview of the purpose of the meeting, which was to select a subwatershed area to focus on for more in-depth assessment and management planning in the next phase of our work.

In order to foster dialogue in the room, we then proceeded with introductions by everyone in attendance, including name, affiliation, and specific interest in the project. The list of attendees is attached. A summary of some opening comments from meeting attendees is provided below.

- Patrick Martin, Lake Worth Drainage District (LWDD), suggested that we should include additional control structures on our maps, because we are not currently accounting for some significant inflows of water into the ICA. In particular, he suggested we include inflows from the north.

- A summary of the drivers/reasons for participants to attend this meeting:
  - Municipal NPDES and TMDL requirements in Lake Ida
  - Development of a new comprehensive plan underway in Lantana
  - City of Lake Worth will be implementing best management practices and septic conversions identified in their Master Plan
  - Florida DOT NPDES requirements
  - Relevance of offshore reef quality

- Dana Wusinich-Mendez reiterated that coral improvement is the primary goal of this watershed planning and water quality mitigation effort.

Subwatersheds and Pollutant Load Estimates in the Boynton ICA

Ellie Baker presented an overview of our subwatershed delineation, basic hydrologic model (logic model) of the watershed, and basic pollutant loading model of the watershed.

Questions and discussion included the following:

- Groundwater quality is variable with the least confidence in our model. At the scale and level of effort of this project, we cannot access and incorporate sufficient data for a solid understanding of the quality and flow of groundwater entering and exiting the watershed.

- Salinity was not identified as a pollutant of concern in our model. How important is salinity, and why is it not included? Salinity (or the influx of freshwater flows) is important in southeastern Florida on an event basis, as a result of storm events and the mechanical manipulation of the canal systems to store or release water through and from the coastal watersheds. However, this appears to be less significant in this watershed than, for example, in the St. Lucie watershed, where there are larger influxes of fresh water from outside the watershed combined with lower flushing rates. Our model is representative of the average annual condition, rather than assessing specific storm conditions.

- As a point of clarification, the points of measurement (control point) for the hydrologic model are the control structures S41 and S40, rather than the Boynton Inlet itself.

- Patrick Martin, LWDD, provided more guidance about including additional pump structures in our hydrologic model. We do not currently include the water being pumped into the system from the C-51 basin to the north of the Boynton Inlet ICA. This is a big inflow that is not included. We would not need to change our ICA boundary, but rather include the inflow of water and the associated water quality data in our hydrologic and water quality models.

- We need to update our map of listed impairments to be consistent with the most recent list from DEP. Several impairments, including dissolved oxygen impairments, have been recently delisted. We should also consider removing the metals impairment since the source for the impairment is atmospheric deposition, and a state-wide TMDL has been developed.

- Why are we not addressing pumping scenarios in the watershed? We are using an average condition in the watershed for our modeling and assessment rather than attempting to capture as assess specific pumping scenarios. Our assessment is representative of the average annual condition, and the individual pumping events are not representative of the average condition. In addition, the individual pumping scenarios introduce an inordinate level of complexity to the models, beyond the scope of our work.

- The subwatershed boundaries provide a basic way to break the watershed into smaller areas for more detailed assessment. However, in reality, the subwatershed boundaries are somewhat fluid because the water levels in the canals are so heavily manipulated.

Facilitated Discussion to Select a Representative Subwatershed

The group divided into two discussion groups to discuss and make recommendations as to which subwatershed should be the focus of our detailed watershed assessment. The summary notes from each discussion are presented below, with thanks to Anne Kitchell of HW (Group 1) and Pattie Gertenbach of E Sciences Inc. (Group 2). Following the group discussions, we reconvened altogether for a report out and lively discussion. The summary from this final discussion is also presented below.

Group 1

Group 1 discussed several options for subwatersheds or other defined areas to study in the next phase of the project. These options are presented in the table below. A significant concern of focus of the discussion was that the focus area should include a full suite of development types and land uses, if possible. Since some of the subwatersheds that are presented below do not include all of the land use types, the group resented the option of focusing on a single subwatershed, and then tacking on an analysis of additional land uses from other areas in the Boynton ICA to fill in the gaps. The group also discussed whether the western boundary of Subwatershed I should be adjusted eastward along Military Trail, similar to the western boundaries of Subwatersheds G and M. HW will explore this following the meeting and adjust the boundary as appropriate.

Table 1. Group One Subwatershed/Focus Area Discussion Summary

Subwatershed/Areas Discussed	Pros	Cons
Subwatershed G	• Has most land uses, including old and new • Close to inlet • May have more data than H, most monitoring stations • Highest N loads • 12 sq mile • Stable subwatershed divides • 17% still on septic	• No agriculture represented • Not the priority of the City • Only 20% is in the regulated Municipal Separate Storm Sewer System (MS4) area
Swath along the Stanley Weaver canal (C-16)	• Includes all land use • Discharge is close to Boynton inlet • Use of a transect for study seems scientific • Can keep study area size small/manageable	• Not a single hydrologic discharge point • Loses a place-based connection to a specific sub-watershed • Loses interest of key stakeholders • Likely to need more funds to assess adequately
Subwatershed I	• Would help address TMDL for Lake Ida • Lots of data available • Lots of partners working here (DOT, Delray, City of Boynton) • Military Trail may be western boundary divide, which would make it smaller	• Big area, need more funds • Only 3% still on septic • Only 15% is in the regulated MS4 area • Need to study additional land uses to assess loads for land uses not in this sub-watershed
Subwatersheds H,I,J together	• Captures coastal area and agriculture, along with other land uses	• Big area, need more funds
Subwatershed G or I, with selected areas in J and in agriculture area	• May be best option	• Larger than just one subwatershed, need more funds

Group 2

The group discussed whether including Agricultural Reserve areas in the study was necessary and useful. In these areas, county code requires that 60% of the area is preserved for agricultural uses. In recent years, there has been significant pressure to develop these areas for residential uses, so they have been changing. In addition, agriculture falls under different regulation than residential and commercial development. This might make it difficult to implement best management practices in these areas.

The group also discussed the pattern of development from the coast to the inland areas, and the associated land based sources of pollutants. East of Military Trail was developed prior to 1980s, prior to SFWMD Environmental Resource Permits (ERPs) being in place. The older areas are generally more densely developed and are lacking in stormwater treatment practices. In many cases, these areas are still on septic systems as well. West of Military Trail, the development is more recent. There is still some Agriculture remaining in Subwatershed K, but that land is being allowed to be developed.
The group discussed what criteria we should use in selecting a subwatershed:

- Representative of different ages of development
- Presence of septic tanks
- Presence of stormwater treatment facilities (BMPs)
- Ability to implement recommendations

The BBICA hydrology is highly controlled. WCA is set at about 16.0 ft and gradually steps down to 8.0 ft to east. A lot of guidance for the subwatershed boundaries is from management of the Lake Worth Drainage District (LWDD) system, everything is interconnected. The boundaries were set up to capture average, annual loading. Loading = Land Use EMC – BMP load reductions + septic inputs. Baseflow was taken into consideration. The C-16 has a larger pump than the C-15, so pulls drainage north to the C-16; someone also noted that Boynton Inlet has more flow than Boca Inlet (although Jack Stamates referenced his published data that indicated that Boynton Inlet flow is actually slightly greater than the Boca Inlet flow).

Palm Beach County ERM has a lot of data on the Chain of Lakes, but has stopped that sampling. There is also a lot of data for WCA1, and along C-15 and C-16.

There is a sewer line along the coast, so the areas there on septic could be put on sewer. The pollutant load contribution from these eastern septic areas is not known. Most of these areas are low density.

Most of LWDD ditches (canals) are very shallow, but Lake Ida is deep and acts as a sink.

Subwatershed M is probably showing up high on pollutant loads because it does not have a lot of lakes (stormwater basins), an indication it was developed before the ERP program; it was developed in 1950s to 1970s. This is Delray, the oldest and largest municipality in BBICA.

The group members voted for their top 2 or 3 subwatersheds and provided reasons to support their votes. The supporting reasons are summarized in the table below. Subwatershed I was the overwhelming recommendation of Group 2.

Table 2. Group Two Subwatershed/Focus Area Discussion Summary

Subwatershed/Areas Discussed	Pros	Cons
Subwatershed I	• TMDL for Lake Ida • Large amount of water quality data • Lots of structures • Variety of soil groups • Variety of land uses and development ages • Includes septic systems • Includes parks (potential for education) • Includes golf courses • Direct connection to C-16 • Includes I-95 • Lake Ida TMDL has to be addressed by MS4s	
Subwatershed J	• Includes eastern land uses	• Would be difficult to model due to lake of data
Subwatershed M	• Highest TP, partially includes Lake Ida • Similar to Subwatershed I	• Similar to I, but no TMDL
Subwatershed D	• Loading is high • Urbanized, built out, good mix of land uses • Not many BMPs in place • High educational opportunity • Lantana is working on a SWMP concurrently • Includes eastern land uses	
Subwatershed G	• Diverse land uses and implementation of BMPs • Good data availability	

Report Out and Discussion

The two groups each reported out about their discussions and recommendations, and the full group discussed the options. A portion of the discussion focused on whether we should be concerned with capturing agriculture in the assessment area, given the discussions at the Group 2 table. Agricultural area in the Boynton ICA may be declining in size under development pressure, and implementing BMPs may be difficult in the agricultural areas because those areas are exempt from some state and federal regulatory water quality requirements.

The group also discussed the merits of focusing on more than one subwatershed, for example, combining subwatersheds I and J in order to capture a larger diversity of land use types and development age. The group recognized that the level of effort for that work would be greater than what was originally budgeted.

The group discussion did not lead to a final consensus on a recommendation. Instead, we concluded with two final recommendations for the project team of HW, NOAA, and FDEP to consider following the meeting before making a final selection. These recommendations were:

1. **Subwatershed I.** This subwatershed includes Lake Ida, which is impaired, and contains a variety of land use types and development patterns. It will also garner interest and collaboration from stakeholder entities, particularly municipalities and Florida Department of Transportation, which have a particular interest and stake in addressing water quality issues in Lake Ida. This subwatershed also appears to have the largest body of water quality data and greatest number of monitoring stations, compared to other subwatersheds. Because this subwatershed does not include agricultural areas (in western Boynton ICA) or coastal areas (eastern Boynton ICA), we were encouraged to include those land uses in the assessments if possible.

2. **A Transect Approach (A swath of land along C-16 Canal, or a combination of subwatersheds H, I and J).** This approach would capture the variety of land uses and land development patterns that are found from east to west across the Boynton ICA. It would also provide a direct connection between the assessment area and flows into the Intracoastal Waterway and the Boynton Inlet. The area of land, and accompanying effort for assessment, to address subwatersheds H, I and J, would be potentially three times greater than addressing just one subwatershed. The C-16 swath approach would create a disconnect from the concept of a watershed plan for a watershed unit of study.

Action items

- HW will coordinate with Patrick Martin, LWDD, to add inflow points from the C-51, the E-4 and the Hillsboro inlet, as appropriate, and obtain additional mapping of control structures that we have not yet included.

- HW will communicate with Patrick Martin, LWDD, and Alan Wertepny, Mock Roos, to review the western boundary of Subwatershed I and revise accordingly.

- HW will revise the impairments map to remove those impairments that have been de-listed and remove the mercury impairments (source is from air not water, addressed in a state-wide TMDL).

- Alan Wertepny, Mock Roos, will provide HW with updated impairment data from DEP.

- Alan Wertepny, Mock Roos, will provide HW with updated water quality for the C-51 basin (north of Boynton ICA).

- HW will circulate a meeting summary to meting attendees via email.

- HW will work with the core project team at NOAA and FDEP to select a subwatershed/study area for the next phase of the project (from the two options presented above), and inform the project partners by email.

Attachments

- Meeting Handouts (tables and maps)
- Meeting Presentation
- List of Attendees

Note: The materials provided at the meeting are working draft documents for discussion. They should not be considered as final documents or referenced as definitive data for any other purpose.

Boynton Watershed Plan Project Partner Meeting
February 9, 2017
Boynton Beach, Florida

SIGN IN

Name (Print)	Affiliation/Organization	Email
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Subwatershed	Total Area (sq mi)	Land Use (% of total subwatershed) Agriculture land	Highway/ Roads	Commercial/ Industrial	Golf Course	Open Space/ Parks	Residential	Water/ Wetlands	Impaired Waters WBIDs	Types of Impairments	Municipal Drainage System (% of total subwatershed) MS4 Area	Non-MS4 Area
A	6.78	8%	13%	4%	10%	18%	35%	10%		NONE	9%	91%
B	4.08	1%	16%	13%	0%	9%	51%	9%		NONE	14%	86%
C	5.63	0%	12%	20%	9%	11%	32%	15%	3256D	Dissolved Oxygen, Nutrients (Chlor-a)	36%	64%
D	9.49	0%	18%	12%	0%	8%	37%	26%	3226F2	Mercury (in fish tissue), Copper, Nutrients (Historic Chlor-a)	32%	68%
E	15.51	13%	13%	5%	6%	11%	32%	20%	3256B	Dissolved Oxygen, Nutrients (Chlor-a)	7%	93%
F	7.59	3%	14%	8%	6%	16%	37%	16%	3256B	Dissolved Oxygen, Nutrients (Chlor-a)	7%	93%
G	11.95	0%	14%	17%	4%	10%	43%	12%	3256B 3256D	Dissolved Oxygen, Nutrients (Chlor-a) Dissolved Oxygen, Nutrients (Chlor-a)	20%	80%
H	21.79	42%	11%	4%	3%	17%	15%	8%	3256B 3262D 3262B	Dissolved Oxygen, Nutrients (Chlor-a) Dissolved Oxygen, Nutrients (Chlor-a) Nutrients (Chlor-a)	5%	95%
I	18.00	1%	15%	10%	14%	6%	43%	9%	3262A 3262D 3262	Nutrients (TSI) Dissolved Oxygen, Nutrients (Chlor-a) Nutrients (Chlor-a)	15%	85%
J	6.44	0%	18%	11%	5%	14%	42%	11%	3226F3	Mercury (in fish tissue), Copper, Nutrients (Historic Chlor-a)	26%	75%
K	13.88	20%	15%	3%	11%	12%	27%	12%	3262B 3262D	Nutrients (Chlor-a) Dissolved Oxygen, Nutrients (Chlor-a)	5%	95%
L	7.71	3%	17%	10%	11%	7%	40%	12%	3262D	Dissolved Oxygen, Nutrients (Chlor-a)	4%	96%
M	14.94	0%	22%	17%	13%	7%	37%	4%	3262D 3262	Dissolved Oxygen, Nutrients (Chlor-a) Nutrients (Chlor-a)	36%	65%
N	4.53	0%	19%	16%	0%	9%	43%	13%	3226F3	Mercury (in fish tissue), Copper, Nutrients (Historic Chlor-a)	35%	66%
TOTAL	148.32											

Subwatershed	Total Area (sq mi)	Stormwater Treatment (% of total subwatershed)					Wastewater Management (% of total subwatershed)		Wells (>100,000 GPD)	Well Protection Zones (% of total subwatershed		Water Quality Stations	Canal Miles	
		Dry Detention	Wet Detention	Dry / Wet Detention	Exfiltration	No Treatment	Onsite Septic	Sewer	Number of Wells	Zones 1-3	Zone 4	Number	Primary	Secondary
A	6.78	1%	52%	4%	0%	43%	32%	68%	0	1%	2%	6	0.00	5.53
B	4.08	4%	50%	5%	0%	41%	19%	81%	2	0%	0%	4	0.00	4.07
C	5.63	4%	31%	2%	0%	63%	16%	84%	1	6%	8%	48	0.00	4.72
D	9.49	4%	2%	0%	0%	93%	2%	98%	21	14%	57%	28	0.00	5.00
E	15.51	1%	75%	6%	0%	19%	11%	89%	0	0%	2%	4	3.60	7.91
F	7.59	7%	77%	1%	0%	15%	8%	92%	9	17%	12%	8	1.50	5.72
G	11.95	2%	66%	4%	0%	28%	17%	83%	3	1%	7%	50	3.12	7.35
H	21.79	0%	36%	5%	0%	59%	29%	71%	21	11%	31%	18	0.00	14.32
I	18.00	1%	70%	1%	0%	28%	3%	97%	20	7%	16%	62	1.46	12.19
J	6.44	9%	9%	0%	0%	82%	11%	89%	8	4%	16%	29	0.00	6.84
K	13.88	1%	69%	3%	0%	28%	13%	87%	6	9%	13%	10	3.60	11.78
L	7.71	2%	65%	20%	0%	14%	8%	92%	5	13%	17%	12	1.51	6.82
M	14.94	7%	35%	8%	0%	50%	2%	98%	26	8%	26%	23	3.17	7.56
N	4.53	3%	0%	1%	0%	96%	0%	100%	0	3%	20%	9	0.48	6.03
TOTAL	148.32													

Pollutant Load Estimates for Each Subwatershed

Subwatershed	Area (ac)	Area (sq mi)	Total N Load (lbs/yr)	Total N Load (% of ICA Load)	Total P Load (lbs/yr)	Total P Load (% of ICA Load)	TSS Load (lbs/yr)	TSS Load (% of ICA Load)
A	4,356	6.8	54,769	7.5%	2,249	4.1%	120,665	3.7%
B	2,616	4.1	30,531	4.2%	1,840	3.3%	111,026	3.4%
C	3,618	5.7	47,115	6.4%	3,095	5.6%	203,990	6.3%
D	6,110	9.5	54,766	7.5%	**6,956**	**12.6%**	**424,737**	**13.1%**
E	**9,963**	**15.6**	51,048	7.0%	2,250	4.1%	117,157	3.6%
F	4,860	7.6	27,157	3.7%	1,340	2.4%	72,365	2.2%
G	7,666	12.0	**82,327**	**11.3%**	3,793	6.9%	229,723	7.1%
H	**13,979**	**21.8**	**75,926**	**10.4%**	**5,952**	**10.8%**	256,192	7.9%
I	**11,562**	**18.1**	65,113	8.9%	5,410	9.8%	**349,164**	**10.8%**
J	4,173	6.5	52,126	7.1%	4,844	8.8%	291,976	9.0%
K	8,971	14.0	50,768	6.9%	2,646	4.8%	125,918	3.9%
L	4,939	7.7	28,942	4.0%	1,590	2.9%	94,877	2.9%
M	**9,806**	**15.3**	**77,479**	**10.6%**	**8,773**	**15.9%**	**566,241**	**17.4%**
N	3,040	4.8	32,946	4.5%	4,490	8.1%	283,497	8.7%
TOTAL	**95,658**	**149.5**	**731,013**		**55,226**		**3,247,529**	

Stormwater Practice Pollutant Removal Efficiencies (Draft Feb 9, 2017)

Stormwater BMP Category	Pollutant Removal Efficiencies (%)		
	Total Nitrogen	Total Phosphorus	TSS
Dry Detention	10	20	50
Dry Detention/Proprietary Control Device	37	52	90
Dry Detention/Wet Detention	79	94	98
Exfiltration	45	60	90
Exfiltration/Dry Detention	51	68	95
Exfiltration/Proprietary Control Device	62	76	98
Exfiltration/Wet Detention	84	96	99
Proprietary Control Device	30	40	80
Wet Detention	70	90	90

Summary of Net Flow and Loads

Type of Flow	Flow (in)	TP Load (lb/yr)	TN Load (lb/yr)	TSS Load (lb/yr)
Canal flow	-24.08	-440,276	-35,460	-2,241,082
GW Flow	-1.43	-76,664	-2,168	-740
Public/Industrial Well Flow	-2.63	-58,957	-1,179	-34
Private Well Flow	-0.08	195,793	0	39
Agricultural Well Flow	-3.06	0	0	-1,704
Land Runoff	31.28	380,104	38,807	2,243,521

Pollutant Load Coefficients (Draft Feb 9, 2017)

DEP Land Cover Category	Load Coefficients, Working Model Best Fit (lb/ac/yr) TN	TP	TSS		Literature Numbers (lb/ac/yr) TN	TP	TSS
Agriculture-Crops/Citrus/Pasture/Sod	5.10	0.70	23.03		4.18	0.69	56.87
Agriculture-Equine	15.23	1.86	101.25		12.48	1.82	250.00
Agriculture-Nurseries	4.77	0.33	10.95		3.91	0.32	27.04
High Intensity Commercial	22.56	2.71	217.52		18.49	2.66	537.09
Low Density Commercial	8.39	1.06	135.74		6.88	1.04	335.16
Golf Course	4.89	0.73	44.16		4.01	0.71	109.03
Light Industrial	8.53	1.55	141.64		6.99	1.52	349.73
Low Density Residential	4.56	0.45	21.62		3.74	0.44	53.39
Single Family Residential	8.15	1.08	48.98		6.68	1.05	120.95
Multi-Family Residential	16.50	3.09	183.66		13.52	3.03	453.48
Open Space/Parks	4.56	0.45	21.62		3.74	0.44	53.39
Highway/Roads	13.42	1.51	101.35		11.00	1.48	250.24
Uplands	1.62	0.06	3.93		1.33	0.06	9.71
Wetlands	1.22	0.20	2.03		1.00	0.20	5.00
Water	1.22	0.20	2.03		1.00	0.20	5.00

HW adjustments for best fit:	**1.220**	**1.020**	**0.405**

October 18, 2017 Meeting

Boynton Watershed Plan Project Partner Meeting
October 18, 2017
1:30 PM – 3:30 PM

NOAA CORAL REEF CONSERVATION PROGRAM

Boynton Beach Utilities Office
124 E. Woolbright Rd.
Boynton Beach, FL

Attendees:

Ellie Baker, Senior Project Manager, Horsley Witten Group (HW)
Jen Relstab, Water Resources Engineer, HW
Alan Wertepny, Mock Roos
Paul Davis, Audubon volunteer, formerly Palm Beach County ERM
Chris Roscheck, Engineering Division Manager, City of Boynton Beach
Waneya Bryant, Interim Field Ops Manager (Maintenance), City of Boynton Beach
Francisco Pagan, Florida DEP CRCP
Pattie Gertenbach, E Sciences, consultant to FDOT
Angela Prymas, Senior Engineer, Utilities Department, City of Boynton Beach
Liz Perez, Collective Water Resources, consultant to City of Boynton Beach
Jeff Needle, Stormwater Program Manager, City of Delray Beach

Overview of the Meeting

The purpose of the meeting was to present to the group our site visit observations and initial ideas about how these types of sites could be retrofitted with different stormwater practice, site designs or maintenance practices to mitigate the pollutant loading from the site into receiving waters. This meeting followed two days of site visits by four HW staff (two teams of two) to over 50 sites across the I and J watersheds to observe a variety of representative land uses and ages of development in the watershed. Land uses included a variety of residential areas (trailer park communities, dense older residential development east of I-95, large planned developments with common stormwater facilities, etc.), commercial/industrial areas, commercial office parks, commercial strip malls and big box complexes, parks and recreation complexes, and agriculture. In an effort to visit a variety of land uses that would be representative across the Boynton Inlet Watershed, to the extent possible, we preselected sites within subwatershed I as well as neighboring J and west in the agricultural/development boundary area.

Ellie Baker presented HW's observations, photographs, and initial pollution mitigation design ideas for each site were captured in computer tablets in the field. These observations and ideas were presented to the meeting participants in a Powerpoint presentation (attached in PDF format) for the purpose of gathering feedback and input about our understanding of the sites we observed, our initial recommendations about stormwater retrofits and other improvements, and anything we may have missed.

Meeting and Discussion Notes:

1. Introductions

2. Background (Presented by Ellie Baker)

- Subwatershed I and J are the primary focus right now, and observations and recommendations will be extrapolated to other subwatersheds across the Boynton Inlet watershed in a final Boynton Inlet Contributing Area Watershed Plan
- Our site visits looked at various land uses and ages of developments
- Included specifically areas adjacent to Lake Ida
- Prior to site visits, we used GIS to pre-identify over 50 sites
- Used iPads with GIS/GPS capabilities to collect data and site assessment observations

3. Presentation of Site Assessments (Presented by Ellie Baker)

Themes:

- Buffers to waterways and drainage structures should be increased where possible
- More vegetated practices should be used to manage stormwater
- Reduce impervious surfaces
- Reorganize/redesign parking lots

Buffers:

- Increase buffers along canals, surface waters and adjacent to catch basins (example from Boynton Beach golf course)
- Concerns/Comments:
  - Depends on who is maintaining the canal
  - Currently removing trees and other vegetation to make sure that capacity is available
  - Animals (snakes) in buffer vegetation also a concern
  - Keep in mind how these things came to be – trying to move water as fast as possible in/out of the area
  - South Florida aesthetic loves green grass
  - Need more education on this topic for engineers, public
  - Practical maintenance of the canals
  - Not really talking about bioretention areas in SE FL right now
  - Typical developers and engineers not really thinking about green stormwater practices
  - Difficult to overcome for people, powerful perception of critters being in the grass
  - Consider animals burrowing into the canal slopes if vegetated
  - SFWMD and LWDD require/create a backslope away from the canal when they do improvements, could incorporate that into other practice

Vegetated Practices:

- Several opportunities to implement green stormwater practices in existing vegetated areas
- Commercial/Industrial opportunities:
  - Existing depressions, swales and green space could be retrofitted

    - Add tree canopy
- Roadway:
    - Enhance existing swales by amending soils, possibly use wood chips trench in ground for denitrification
- Downtown and Commercial Areas:
    - Take advantage of existing drainage patterns, add in bioretention area, bioretention bumpouts or tree pits
- Residential settings:
    - Swales or depressions in front of houses and in cul-de-sacs have benefit of filtering and slowing down before getting into drainage system
    - Swales are getting filled in – need to make sure that these are maintained
- Liz:
    - Florida has some guidance on proprietary soils for managing nitrogen
    - Bioabsorption Activated Material (BAM), UCF stormwater academy, BOLD and GOLD (Marty Wanielista), studies have been done
    - Broward County examples
    - West Palm Beach installing similar project with soils amendments
    - West Palm Beach is doing bumpouts, about to be finished soon
    - Parking lot retrofits
        - Runoff out of a parking lot and flooding issue
        - Current positive design example: Detura at 610 Clematis, near CityPlace, West Palm Beach and close to Intracoastal (currently in design)
        - Municipalities concerned about safety, clogging drains
    - Complete streets need dialogue with stormwater engineers to encourage multiple uses
    - BAM can stop root intrusion to protect utilities
- Pattie:
    - Marty Wanielista is looking at evaluating product with various groundwater tables with DOT (Central Florida)
    - Denitrification can keep going as long as anaerobic (dry season may be issue)
    - Agree, 20-25 years for design life of wood chips
- Jeff
    - Looks like this approach would require more maintenance
    - Landscapers and homeowners fill in the swale
    - Cypress trees with moist feet could be an option
    - Mangrove islands as living shorelines, sometimes in front of retaining walls
- Angela
    - Mangroves are being used more as living walls, shorelines, as hedges in place of rip rap and retaining walls

Reduce Impervious Surfaces:

- Remove impervious areas in cul-de-sacs, parking lots and driveways where feasible
- Greatest benefit is in unused or overflow parking areas

Parking lot Redesign:

- Use medians as green spaces, swales and bioretention
- Redesign to encourage flow to medians
- Increase canopy (shade for parking too)

- Reduce impervious area

Local Positive Examples Observed:

- Turf parking at church, draining into central swale
- Recreation area parking drains into low depressed vegetated area, no erosion observed

Maintenance:

- Swales and inlets are being clogged by debris and are being regraded over time as identified
- Pattie:
    - Work with landscape people to see how they can keep these properly vegetated
- Paul:
    - Look for ways to reduce nitrogen and sediment loading in upgradient areas, not just in areas directly adjacent to waters. These types of systems presented here would be beneficial.

4. Question & Answer (Group Discussion)

- Low profile planting palette for buffers and bioretention areas?
    - Pattie:
        - DOT is working on looking at low profile plants
        - Extension service might have more info
    - Jeff:
        - SFWMD should have a planting guide for this
    - Liz:
        - Urban projects have some species, sandy palette
        - SFWMD probably also has something available
        - Would like to have an LID guide in the future with communities and Palm Beach County
        - Education would be a huge part of this effort, needed to change mindset of typical south Florida landscaping
- Rooftop disconnection and reuse of runoff
    - Alan:
        - Lots of erosion caused by rooftop runoff that is unnecessarily drained onto pavement or otherwise uncontrolled.
        - Could look at land development codes to make changes for future development – add LID evaluation

Misc. comments:

- Jeff:
    - Gardens Mall has depressed green space with raised outlets for better extended detention
- Ellie:
    - What about Agricultural practices? What retrofits might be appropriate? More buffers form surface waters, and backsloping land away from canals.
- Alan:
    - Ag continues in Agricultural Reserve areas

    - Water quality is not often discussed, often not applying best management practices because it is optional
    - High TN, TP in the canals
    - Ag BMPs are optional, until there is a TMDL

5. Next Steps (presented by Ellie Baker)

- Extrapolate (menu or matrix) to associate practices with certain settings/land uses within the subwatersheds to develop the subwatershed plan
- Working on model methodology to try to apply pollutant reduction (treatment) numbers to the practices to provide a planning level reduction estimate
- Will then extrapolate further across the full Boynton watershed

6. Concluding Comments (Group Discussion)

- Liz:
    - Several factors you would look at for BMPs
    - Menu/Zones of BMPs that can be used, but need to think of constraints
        - Groundwater elevations
        - Soils
    - What about BMP effectiveness?
    - Use the effort at some level to discuss with the South Florida Management District to discuss credit for permitting
    - Relative loading analysis using Simple Method would help to evaluate options
- Alan:
    - If you have an impaired waterbody, need to do a pre- and post-analysis to evaluate impacts/benefits
    - Harvey Harper Methodology
        - Reduction efficiencies
        - Presumptive approach – if you build to design specs, then you get a certain removal credit
    - DEP Section 319 grants
        - Need to monitor the project after installation to demonstrate benefit
- Pattie:
    - Bonita Springs pilot project - baffle boxes picking up twice the reduction
    - Building permits – intracoastal, southwest ranches, Isla Morada
        - Need to put a swale in their backyard, front yard (in the code)
- Jeff:
    - Delray Beach has a standard of one inch of retention before swale and in swale
    - Disregard residential areas west of Congress. All private developments build to stormwater standard.
- Paul:
    - Are we looking at aquatic vegetation?
    - What about septics and package plants? (Ocean Ridge, one at park)
- Angela:
    - Septic systems on the barrier island should be removed
- Chris:
    - Residences don’t get charged until they are connected to the system
    - Public Health manages the septic systems

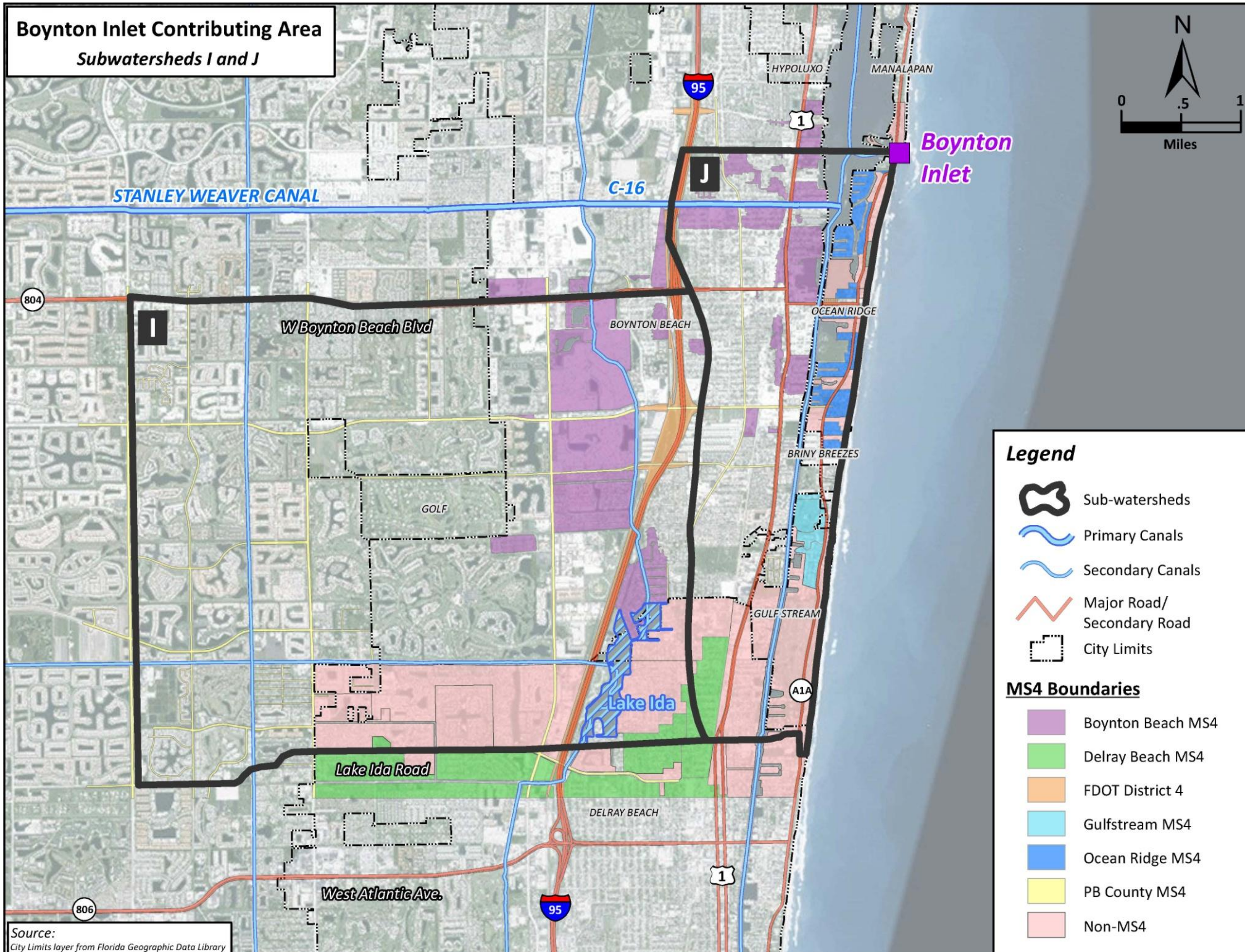
- There are some areas that want water and sewer currently and are going through the system
- Alan:
  - Northern parts of Palm Beach County have legislation to address the septic systems
- Angela:
  - Private versus MS4: private developments who is looking into what they do?
  - Lake Ida is part of the canal – how do we comply with Lake Ida with all of these private developments?
- Ellie:
  - Identifying responsible parties and what can be done to address the MS4 requirements and other requirements
- Jeff:
  - Water Management District: You probably will need to write a letter and get an exemption, have on the records
  - More permitting required if you increase discharge, different issue
  - Also need to work with zoning/planner staff for projects in downtown areas, would consider aesthetics of landscaping and pedestrian/traffic impacts
- Liz:
  - Commissioners and residents may be more of an issue than any 'permitting' requirements
  - Climate change and SLR not really discussed right now – these GI BMPs are adaptable practices!
- Permitting requirements for stormwater retrofits like we described today? When a municipality wants to do a stormwater retrofit in a developed area, what permits are required and from what agency? Design standards?
  - Alan: below threshold for alteration, no ERP permit needed
  - Biggest hurdle would be municipal process/approvals from departments, plus public support
  - Delray, Boynton Beach staff would help shepherd/approve retrofits

Boynton Watershed Plan
Project Partner Meeting

Ellie Baker and Jennifer Relstab, Horsley Witten Group

In support of NOAA Coral Reef Conservation Program

October 18, 2017, Boynton Beach, Florida


Boynton Inlet Contributing Area
Subwatersheds I and J
STANLEY WEAVER CANAL
C-16
HYPOLUXO
MANALAPAN
Boynton Inlet
J
I
W Boynton Beach Blvd
BOYNTON BEACH
OCEAN RIDGE
BRINY BREEZES
GOLF
GULF STREAM
Lake Ida
Lake Ida Road
DELRAY BEACH
West Atlantic Ave.
95
1
804
806
A1A
N
0
.5
1
Miles
Legend
Sub-watersheds
Primary Canals
Secondary Canals
Major Road/
Secondary Road
City Limits
MS4 Boundaries
Boynton Beach MS4
Delray Beach MS4
FDOT District 4
Gulfstream MS4
Ocean Ridge MS4
PB County MS4
Non-MS4
Source:
City Limits layer from Florida Geographic Data Library

Meeting Agenda

- Introductions
  - Thank you to Angela Prymus for hosting!
- Site assessments at representative sites
  - Discussion of select retrofit concepts
- Discussion/Questions
- Next steps

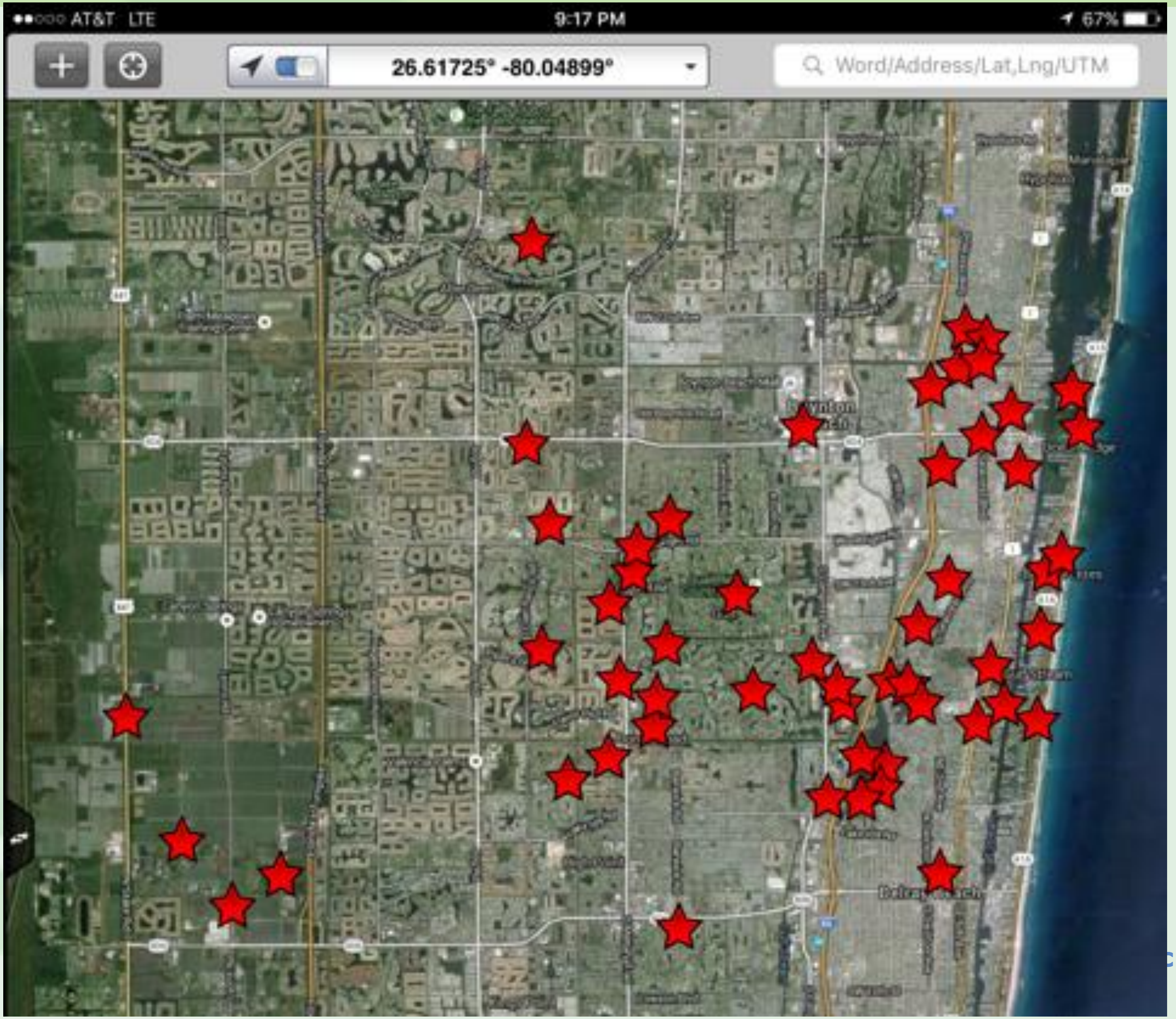
Site Assessments at Representative Sites

- Variety of representative land uses
  - Residential, urban, roadway, commercial, industrial, agriculture, park, golf

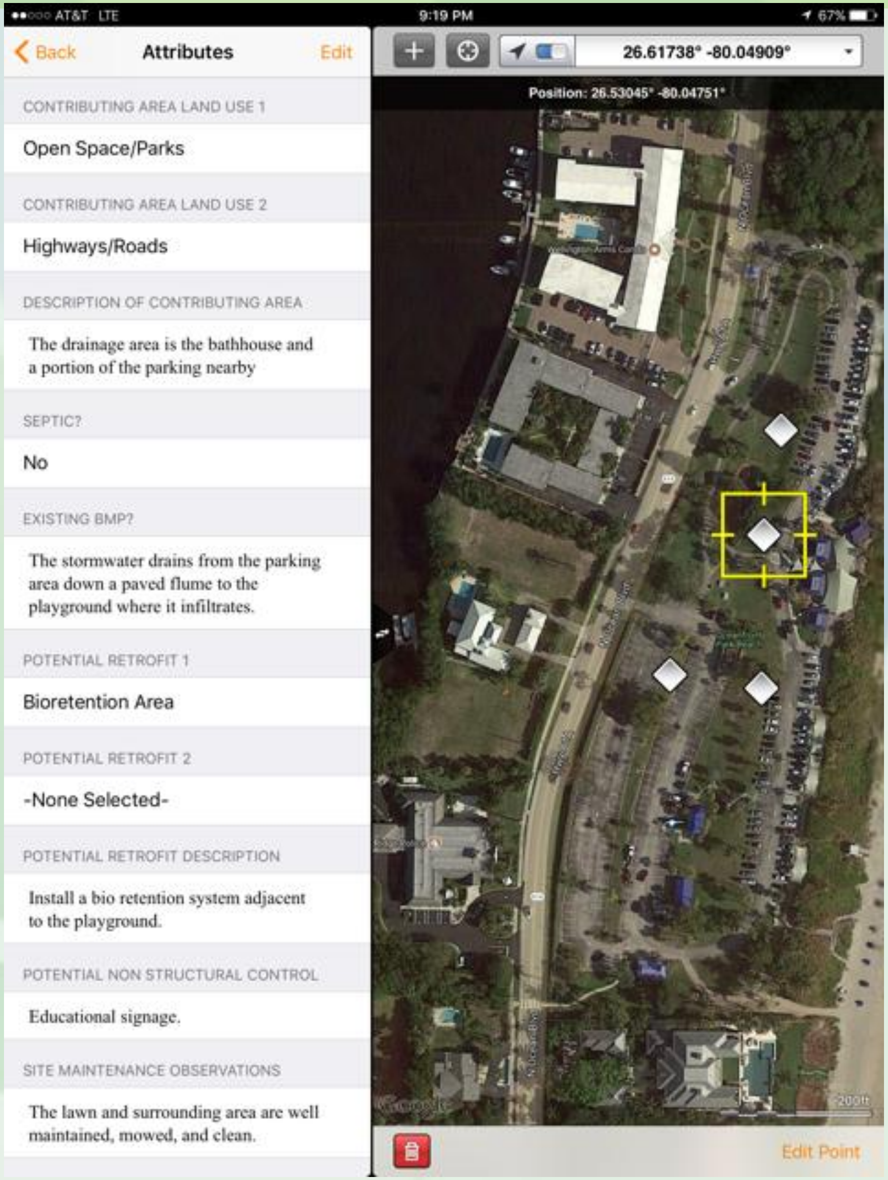
- Older and newer development types

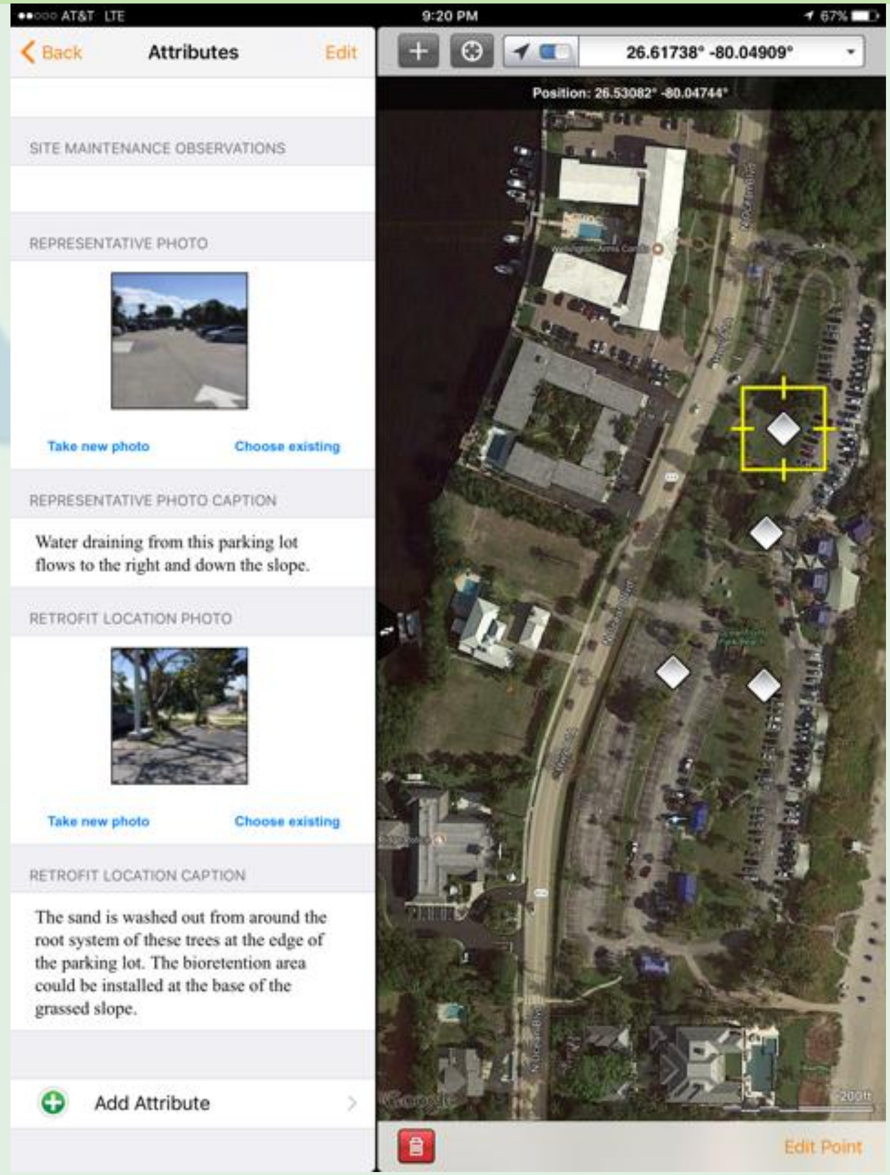
- Adjacent to or directly discharging to Lake Ida

Visited over 50 Sites



Data Collection/Observations





Stormwater/Site Improvement Themes

- Increase vegetated buffers
- Increase vegetated practices
- Reduce impervious surfaces
- Reorganize parking lots

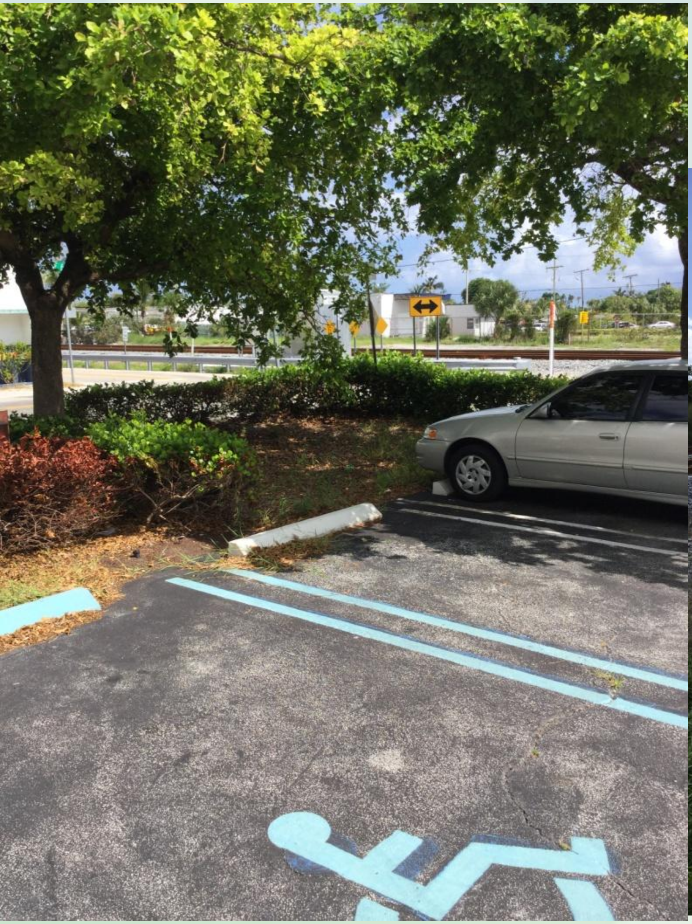
Buffers

Boynton Beach Muni Golf Course

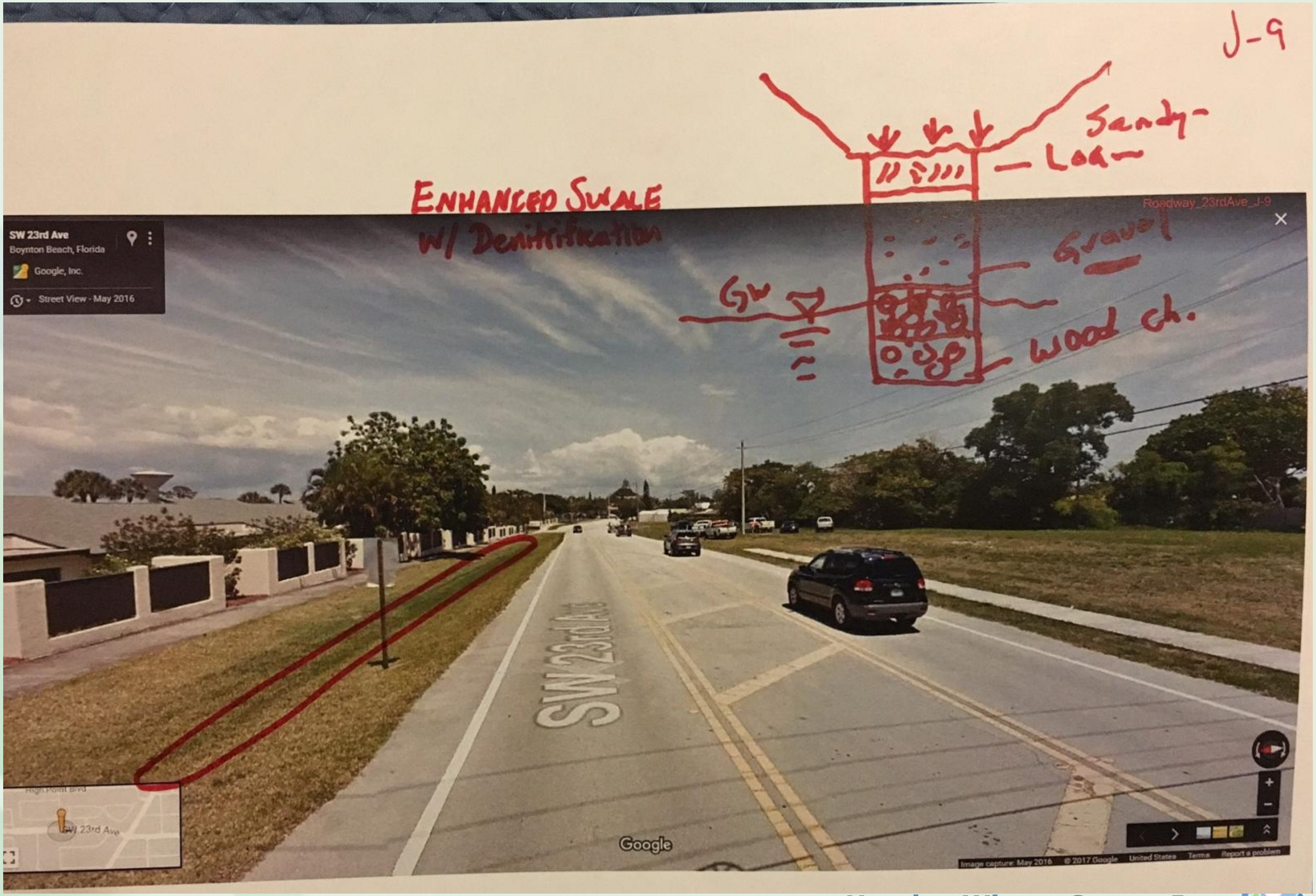
Buffer – Mowed or Not?

Vegetated Practices - Commercial/Industrial Setting

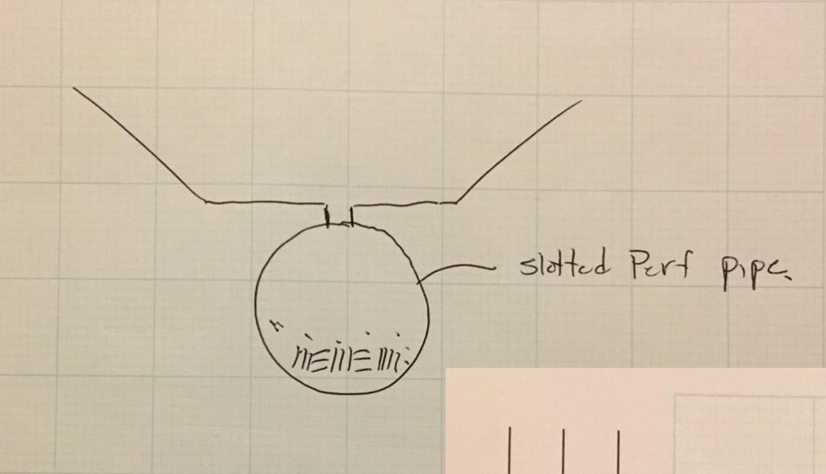
North Railroad Ave, Commercial/Industrial District

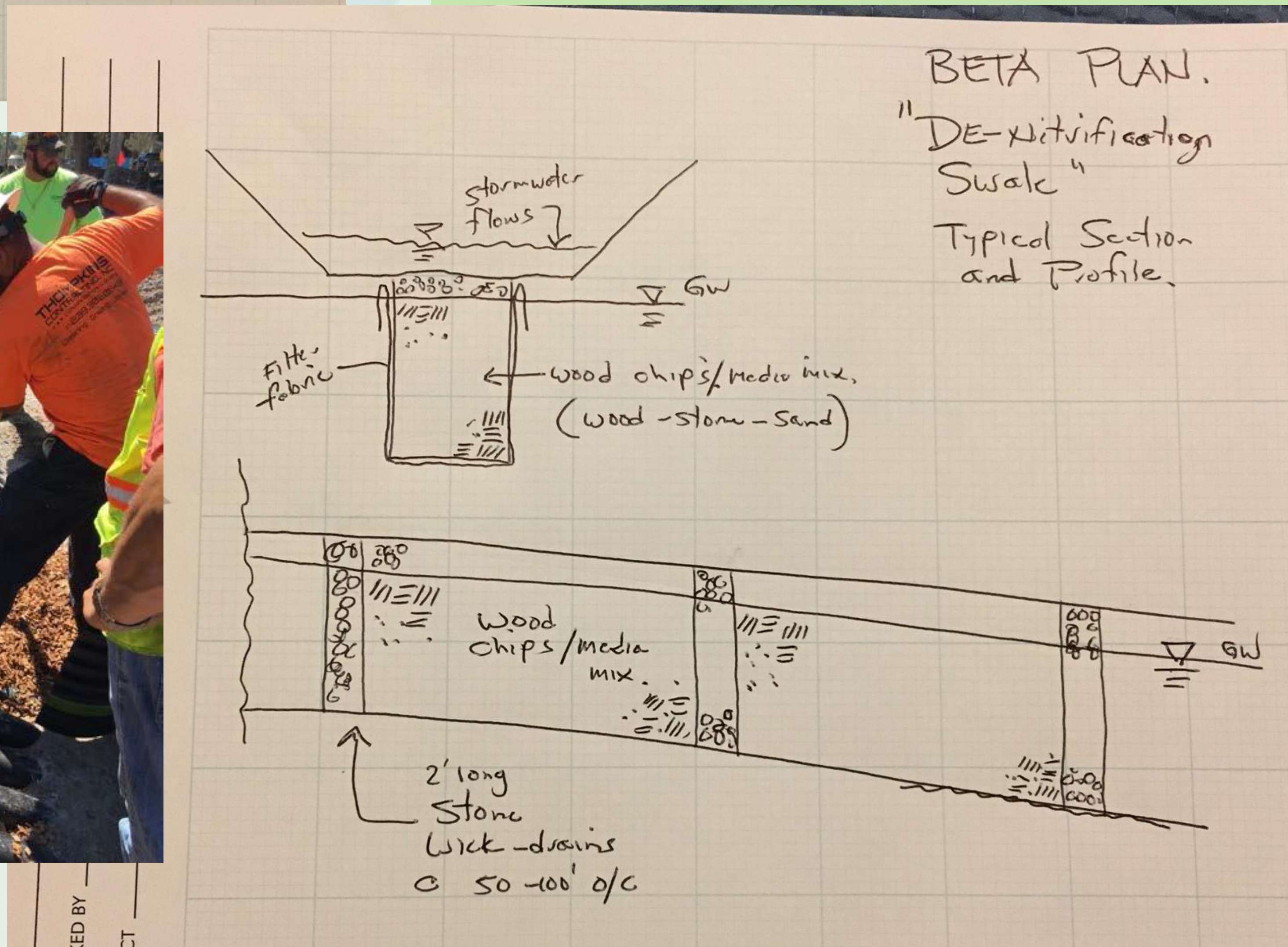


Vegetated Practices - Roadway



Denitrification Swale Concept





Bonita Springs example

Horsley Witten Group, Inc.

Vegetated Practices - Downtown/Commercial Areas


LIQUORS

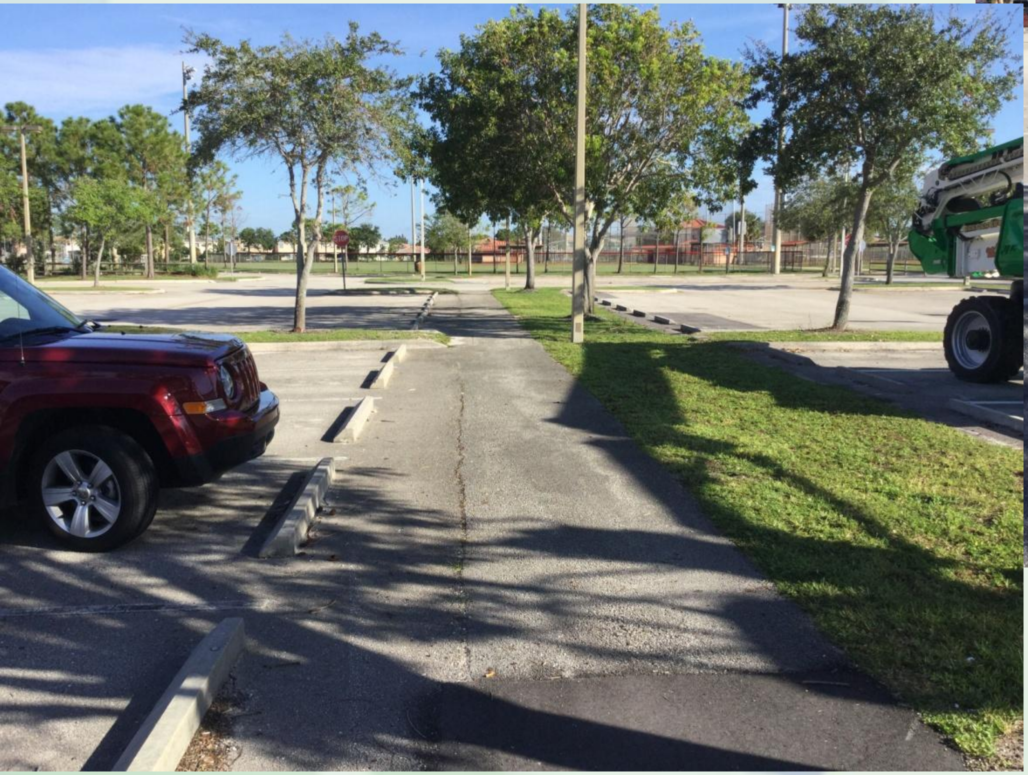
Vegetated Practices Residential Settings

Swales and bioretention areas

Reduce Impervious Surface

Parking Lot Redesign

West Boynton Park and Recreation




PEDIATRIC ASSOCIATES
OLD NAVY
STOP

OceanFront Park

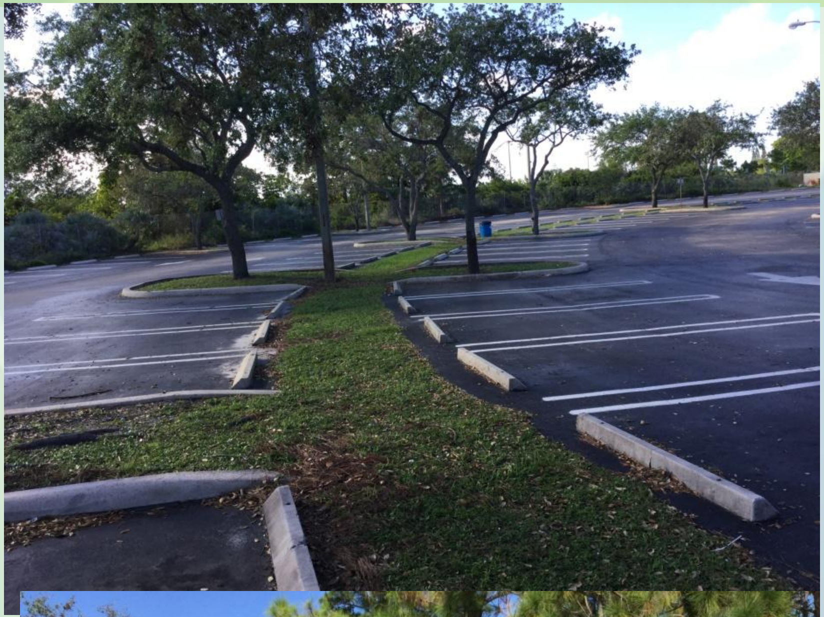
Lake Ida East Park


F

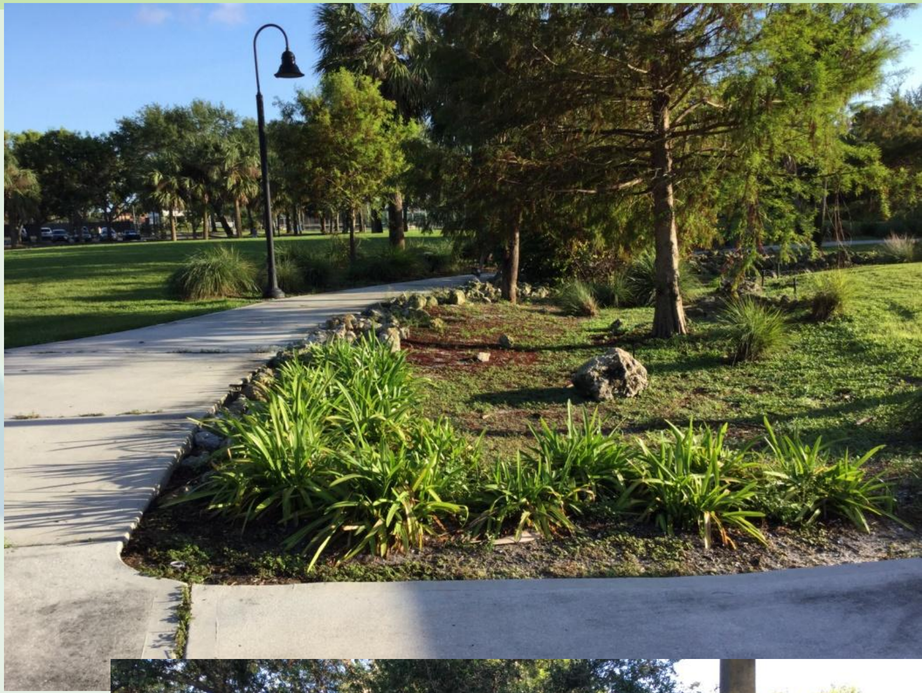

Found some great local examples

Church near Boynton Beach City Hall

Hester Community Center (J-1)
(N. Seacrest Blvd and 17 Ave NW)




Barrier Free Park



Swale maintenance

Q&A

- Maintenance practices for roadside swales?
  - How often are they dredged?
- Why are edges of ponds and canals mowed?
- Low profile plant palette?
- How is maintenance tracked?
- Rooftop disconnection/reuse?
- Other examples/ lessons learned?
- What did we miss?

Next Steps

- Extrapolate across the watershed based on similar land use patterns, to assign potential BMPs.
- Develop a subwatershed management plan for “I” that draws upon our observations and an understanding of permitting and regulation. (Dec 2018)
- Extrapolate to a Boynton Inlet Contributing Area Watershed Plan. (Feb 2018)

Thank you

Please reach out with
additional thoughts or information:

Ellie Baker, Sr. Environmental Planner
ebaker@horsleywitten.com
603-658-1660

Boynton Inlet Contributing Area Watershed Management Plan

Attachment B

Site Assessment Forms

Subwatershed F

Subwatershed G

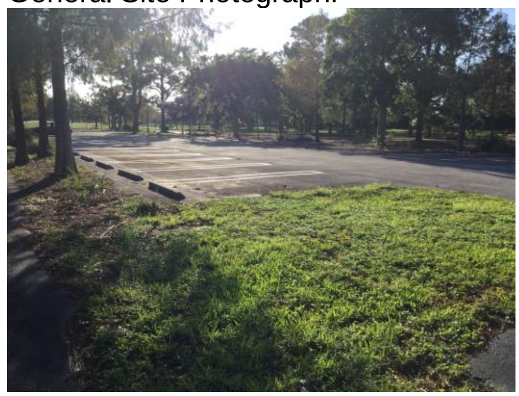
Subwatershed H

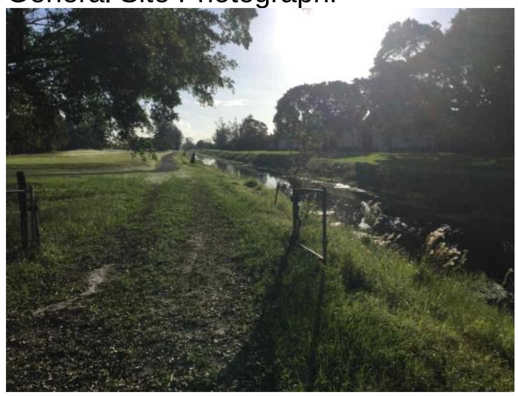
Subwatershed I

Subwatershed J

Subwatershed M

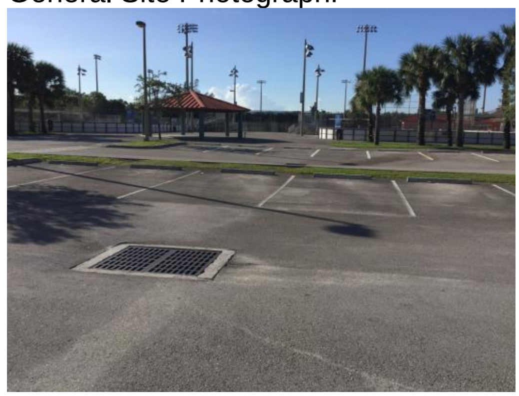
Subwatershed F

Site Identification Number: F-1-A	
EXISTING CONDITIONS	
Land use(s) of contributing area: Golf Course -None Selected- Additional Description: Parking area for the the public golf.	General Site Photograph:  *Caption:*
Description of existing BMP(s): Sheet flow to a drain. Overland flow.	Observations about Site Maintenance: The parking lot is generally well maintained, but there is little drainage infrastructure to maintain.
Is the site on Septic? -None Selected-	
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Pretreatment Practice Water Quality Swale Additional Description: The parking lot can be re-designed to provide swales or bioretention between parking Aisles.	Proposed Retrofit Location:  *Caption:*
Potential Non Structural Controls:	
Date and Time of Site Visit: Oct 17, 2017, 8:45 AM	Staff Initials: JER, ESB

Site Identification Number: F-1-B	
EXISTING CONDITIONS	
Land use(s) of contributing area: Golf Course -None Selected- Additional Description: Public golf course that is well maintained with short mowed grass. The grass is mowed to edge of the canal and to the edge of all catch basins located throughout the course.	General Site Photograph:  *Caption:*
Description of existing BMP(s): Just drains through the course. Is the site on Septic? -None Selected-	Observations about Site Maintenance: The site across the canal is a condo complex with a large manicured lawn. It could also be a buffer.
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Other -None Selected- Additional Description: The canal buffer should be vegetated with low profile vegetation, and possibly move paths away from canal.	Proposed Retrofit Location:  *Caption:*
Potential Non Structural Controls:Fertilizer management. This course is well maintained and appears that it may not overuse fertilizer but as a practice, the fertilizer application should be minimized. Buffers around catch basin drains.	
Date and Time of Site Visit: Oct 17, 2017, 9:12 AM	Staff Initials: JER, ESB

Site Identification Number: F-2

EXISTING CONDITIONS

<table>
<tr><td>Land use(s) of contributing area:
Open Space/Parks
Highways/Roads
Additional Description:
West Boynton Recreation Center. Parking lot, tennis courts, basketball courts, rink, play areas</td><td>General Site Photograph:

Caption: Parking lot and drives in park</td></tr>
<tr><td>Description of existing BMP(s):
None</td><td rowspan="2">Observations about Site Maintenance:
Catch basins filled with juice boxes.</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
</table>

PROPOSED RETROFIT

<table>
<tr><td>Potential Retrofit BMP(s):
Water Quality Swale
Other

Additional Description:
Redesign parking to direct runoff towards grassed swale medians. Alternatively use permeable pavement options for spaces with current design. Subsurface Chambers may be option if shallow.</td><td>Proposed Retrofit Location:

Caption: Green space can be added to parking lot in medians. Subsurface Chambers may an option if shallow.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Increase buffers adjacent to canal, limit fertilizer use</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 9:28 AM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

Subwatershed G

Site Identification Number: G-1

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
-None Selected-
Additional Description:
Parking lot

General Site Photograph:

Caption:

Description of existing BMP(s):
Dry basins, not sure where all of the water is connected

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Pretreatment Practice
Other

Additional Description:
Retrofit medians of parking lots as grass swales and direct towards tree pit or tree trench.

Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:Add green space and trees to reduce heat island and promote filtering of pollutants. Reuse roof runoff.

Date and Time of Site Visit: Oct 17, 2017, 3:27 PM	Staff Initials: JER, ESB

Subwatershed H

<table>
<tr><th colspan="2">Site Identification Number: H-1A</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Agriculture
Highways/Roads
Additional Description:
Agricultural</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: Grass swale in the ROW</td></tr>
<tr><td>Description of existing BMP(s):
None</td><td rowspan="2">Observations about Site Maintenance:
Chalky substance on grasses. Flared end sections are clogged.</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Add buffer to swales. Native grasses and low profile veg.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: Limit mowing to the edge. Improve treatment using native species.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:No mow to edge to provide filtering of runoff from road that flows overland.</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 1:45 PM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

<table>
<tr><th colspan="2">Site Identification Number: H-1B</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Agriculture
-None Selected-
Additional Description:
Sugar cane, plotted plants, misc</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: Multiple crops/plants in Agricultural Reserve</td></tr>
<tr><td>Description of existing BMP(s):
None</td><td rowspan="2">Observations about Site Maintenance:
Filter fabric in canal.</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Pretreatment Practice
Other

Additional Description:
Recommend increasing buffer to Canal and planting native grasses and vegetation to filter pollutants. Recommend rotating crops as necessary to reduce release of pollutants to canal.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: Increase buffer to drainage ditches and canals. Use sediment erosion controls properly to manage wind blown and runoff sediment.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Increase buffer on canal. Plant filtering native grasses and shrubs.</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 1:59 PM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

Site Identification Number: H-3	
EXISTING CONDITIONS	
Land use(s) of contributing area: Agriculture -None Selected- Additional Description: Combo of nursery plants adjacent to the drainage ditch and canal.	General Site Photograph:  *Caption:*
Description of existing BMP(s): Drainage ditches are used and managed for irrigation. Is the site on Septic? -None Selected-	Observations about Site Maintenance:
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Other -None Selected- Additional Description: Plants should be maintained outside of a given buffer distance. The buffer should also be maintained from any inlets as well. Erosion controls and erosion control blankets are placed in some areas. The use of fertilizers and pesticides should be well m	Proposed Retrofit Location:  *Caption: This drainage ditch is around the edge of the adjacent field of potted nursery plants. It discharges directly into the large canal untreated.*
Potential Non Structural Controls:	
Date and Time of Site Visit: Oct 17, 2017, 2:15 PM	Staff Initials: All

Site Identification Number: H-4	
EXISTING CONDITIONS	
Land use(s) of contributing area: Agriculture -None Selected- Additional Description: We did not visit this one. Already viewed representative farms.	General Site Photograph: *Caption:*
Description of existing BMP(s): Is the site on Septic? -None Selected-	Observations about Site Maintenance:
PROPOSED RETROFIT	
Potential Retrofit BMP(s): -None Selected- -None Selected- Additional Description:	Proposed Retrofit Location: *Caption:*
Potential Non Structural Controls:	
Date and Time of Site Visit: Oct 17, 2017, 2:37 PM	Staff Initials: All

Site Identification Number: H-4	
EXISTING CONDITIONS	
Land use(s) of contributing area: Agriculture -None Selected- Additional Description:	General Site Photograph:  *Caption:*
Description of existing BMP(s):	Observations about Site Maintenance:
Is the site on Septic? Unknown	
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Other -None Selected- Additional Description: Newly planted crops, in plastic, add buffers, erosion control blanket	Proposed Retrofit Location:  *Caption:*
Potential Non Structural Controls:Sugar cane used as a windbreaker	
Date and Time of Site Visit: Oct 17, 2017, 2:35 PM	Staff Initials: EB/JR/KM/RC

Site Identification Number: H-5	
EXISTING CONDITIONS	
Land use(s) of contributing area: Highway/Roads Agriculture Additional Description: End of roadway adjacent to agriculture operations, newly constructed road.	General Site Photograph:  *Caption:*
Description of existing BMP(s): Irrigation ponds to drainage ditches/canals. Is the site on Septic? Unknown	Observations about Site Maintenance:
PROPOSED RETROFIT	
Potential Retrofit BMP(s): -None Selected- -None Selected- Additional Description:	Proposed Retrofit Location:  *Caption:*
Potential Non Structural Controls:Nutrient management of crops, buffers, crop rotation, irrigation pond management (harvest of invasive aquatic plants)? Erosion control fabric for drainage	
Date and Time of Site Visit: Oct 17, 2017, 1:57 PM	Staff Initials: KM/RC/JR/EB

Site Identification Number: H-6

EXISTING CONDITIONS

Land use(s) of contributing area:
Agriculture
-None Selected-
Additional Description:
Horse farm

General Site Photograph:

Caption: Horse farm

Description of existing BMP(s):

Is the site on Septic? Unknown

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
-None Selected-
-None Selected-

Additional Description:

Proposed Retrofit Location:

Caption: Horse farm drainage.

Potential Non Structural Controls:Implement BMPs for nonpoint source pollution reduction.

Date and Time of Site Visit: Oct 17, 2017, 2:20 PM

Staff Initials: KM/RC/EBJR

Subwatershed I

<table>
<tr><th colspan="2">Site Identification Number: I-1</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Many of the existing swales have been filled in, replace with defined nitrogen enhancing swales.</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption:</td></tr>
<tr><td>Description of existing BMP(s):</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Water Quality Swale
Bioretention Area

Additional Description:</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 3:17 PM</td><td>Staff Initials: RAC/ESB</td></tr>
</table>

Site Identification Number: I-3

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Driveways, roof, road

General Site Photograph:

Caption: Residential neighborhood

Description of existing BMP(s):
None.

Is the site on Septic? No

Observations about Site Maintenance:
Non native grasses.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
Sand/Organic Filter

Additional Description:
Swales with organic amendments in ROW in front of houses. Surface is a grass depression. Possible to retrofit with future drainage or road improvements.

Proposed Retrofit Location:

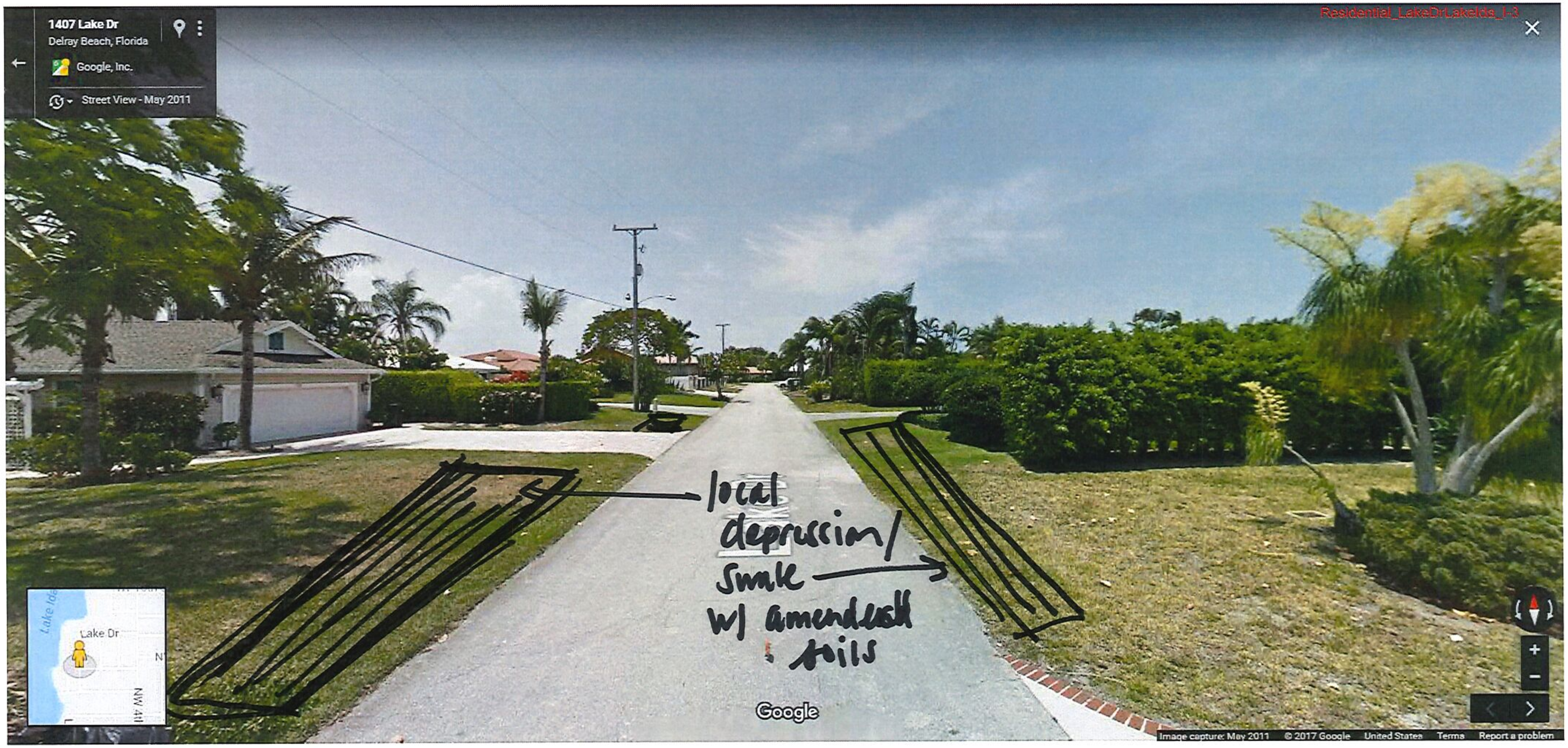
Caption: Swales in front of homes

Potential Non Structural Controls:Public education about native planting. Encourage buffers on Lake Ida, no mow to lake.

Date and Time of Site Visit: Oct 16, 2017, 10:20 AM

Staff Initials: KM, JR

1-3



1407 Lake Dr
Delray Beach, Florida
Google, Inc.
Street View - May 2011
Residential_LakeDrLakelds_I-3
local depression/ swale w/ amended soils
Google
Lake Dr
Image capture: May 2011 © 2017 Google United States Terms Report a problem

T-2

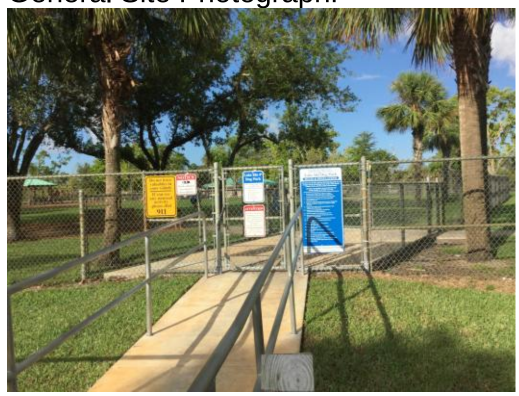

Preliminary drainage area
I-3
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Site Identification Number: I-4-A

EXISTING CONDITIONS

Land use(s) of contributing area:
Open Space/Parks
-None Selected-
Additional Description:
Parking lots, road, dog park

General Site Photograph:



Caption:

Description of existing BMP(s):
Dry basins. Overflow catch basins.

Is the site on Septic? No

Observations about Site Maintenance:
Currently mowing to buffer edge.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Other

Additional Description:
Bioretention areas as demonstration practices near pavilions. Increase treatment and slow down water with check dams and increased veg in ex dry basins. Porous pavement sidewalk or parking.

Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:No mow buffers, buffer enhancement. Reduce or eliminate fertilizers if used.

Date and Time of Site Visit: Oct 16, 2017, 8:53 AM	Staff Initials: KM, JR

Site Identification Number: I-4B

EXISTING CONDITIONS

Land use(s) of contributing area:
Open Space/Parks
-None Selected-
Additional Description:
Lake Ida Park

General Site Photograph:

Caption: Mowing up to slope of canal

Description of existing BMP(s):
No

Is the site on Septic? No

Observations about Site Maintenance:
Mowing to edge of lawn.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Increase buffer, no mow to waterway

Proposed Retrofit Location:

Caption: Increase buffer to canal

Potential Non Structural Controls:Increase buffer to waterway

Date and Time of Site Visit: Oct 16, 2017, 8:57 AM

Staff Initials: JR, KM

1-4


Park_LakeIdaWest_I-4
Lake Ida Park Rd
Delray Beach, Florida
Google, Inc.
Street View - May 2011
add buffer adjacent to waterway
enhance existing depressions by raising inlet and/or adding organics
Google
Image capture: May 2011 © 2017 Google United States Terms Report a problem

Site Identification Number: I-6		
EXISTING CONDITIONS		
Land use(s) of contributing area: Golf Course -None Selected- Additional Description: Gated, did not visit	General Site Photograph: *Caption:*	
Description of existing BMP(s): Is the site on Septic? -None Selected-	Observations about Site Maintenance:	
PROPOSED RETROFIT		
Potential Retrofit BMP(s): -None Selected- -None Selected- Additional Description:	Proposed Retrofit Location: *Caption:*	
Potential Non Structural Controls:		
Date and Time of Site Visit: Oct 17, 2017, 11:20 AM		Staff Initials: JER, ESB

Site Identification Number: I-7

EXISTING CONDITIONS

Land use(s) of contributing area:
- Agriculture
- Highways/Roads

Additional Description:
Horse farm with open fields.

General Site Photograph:

Caption:

Description of existing BMP(s):
Wet ponds with no vegetated buffer. Front portion of the property drains to catch basin on right of way.

Is the site on Septic? Yes

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
- Other
- Water Quality Swale

Additional Description:
Enhance wet pond buffer. Review management plan for opportunities to reduce sources from animal waste. Enhance the existing swales along Golf Rd.

Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:Animal waste management.

Date and Time of Site Visit: Oct 17, 2017, 11:32 AM	Staff Initials: JER, ESB

Site Identification Number: I-8

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
-None Selected-
Additional Description:
Residential cul de sac at canal.

General Site Photograph:

Caption: Residential street.

Description of existing BMP(s):
Grass swale after catch basin and headwall. No catch basins along street

Is the site on Septic? No

Observations about Site Maintenance:
Catch basin clean out. No mowing to canal bank. Removal of impervious area in cul de sac.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Pretreatment Practice
Water Quality Swale

Additional Description:
Pretreatment practice prior to end of cul de sac. Clean out catch basin. Leave swale and make enhancements. Alternative: implement forebay and bio

Proposed Retrofit Location:

Caption: Tiered swale. Leave current structure and clean out or remove and created tiered swale.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 12:57 PM

Staff Initials: KM,JR

Site Identification Number: I-9-A

EXISTING CONDITIONS

Land use(s) of contributing area:
Open Space/Parks
Residential
Additional Description:
Residential park adjacent to low traffic street. Park drains to Lake Ida.

General Site Photograph:

Caption: Lake Ida Park

Description of existing BMP(s):
Some conveyance swales.

Observations about Site Maintenance:
One way parking lot road width is 24 ft. Suggest reducing width but note that road serves as boat launch.

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:
Retrofit of parking lot area. Attempt to redirect runoff through vegetated hedges to lower catch basin rather than parking lot catch basin.

Proposed Retrofit Location:

Caption: Redirect runoff through vegetated center island and through to low point on the opposite side of the hedges closest to Lake Ida.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 10:57 AM	Staff Initials: JR, KM

<table>
<tr><th colspan="2">Site Identification Number: I-9-B</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td>Land use(s) of contributing area:
Open Space/Parks
Residential
Additional Description:
Park and low traffic residential area</td><td>General Site Photograph:


Caption: Lake view park</td></tr>
<tr><td>Description of existing BMP(s):
Yes. Curb cuts along north edge of park. Scouring along park grasses.

Is the site on Septic? No</td><td>Observations about Site Maintenance:</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td>Potential Retrofit BMP(s):
Other
Water Quality Swale

Additional Description:
Along with curb cuts, add bioswale or vegetated filter as conveyance for runoff from street to park. Space is passive, not along path area.</td><td>Proposed Retrofit Location:

Caption: Add bioswale or filter as conveyance.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 11:09 AM</td><td>Staff Initials: JR,KM</td></tr>
</table>

Site Identification Number: I-10A

EXISTING CONDITIONS

Land use(s) of contributing area:
Open Space/Parks
-None Selected-
Additional Description:
Parking lot

General Site Photograph:

Caption: Lake Ida East Park and Playhouse

Description of existing BMP(s):
None

Observations about Site Maintenance:
Mowing up to waters edge in most places. Creating habitat may reduce mosquitos

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Sand/Organic Filter

Additional Description:
No CBS or other infrastructure. Crown about middle of drive lanes. Make middle a depression With overflow. Filter on edges of parking lot on other side of wheel stops.

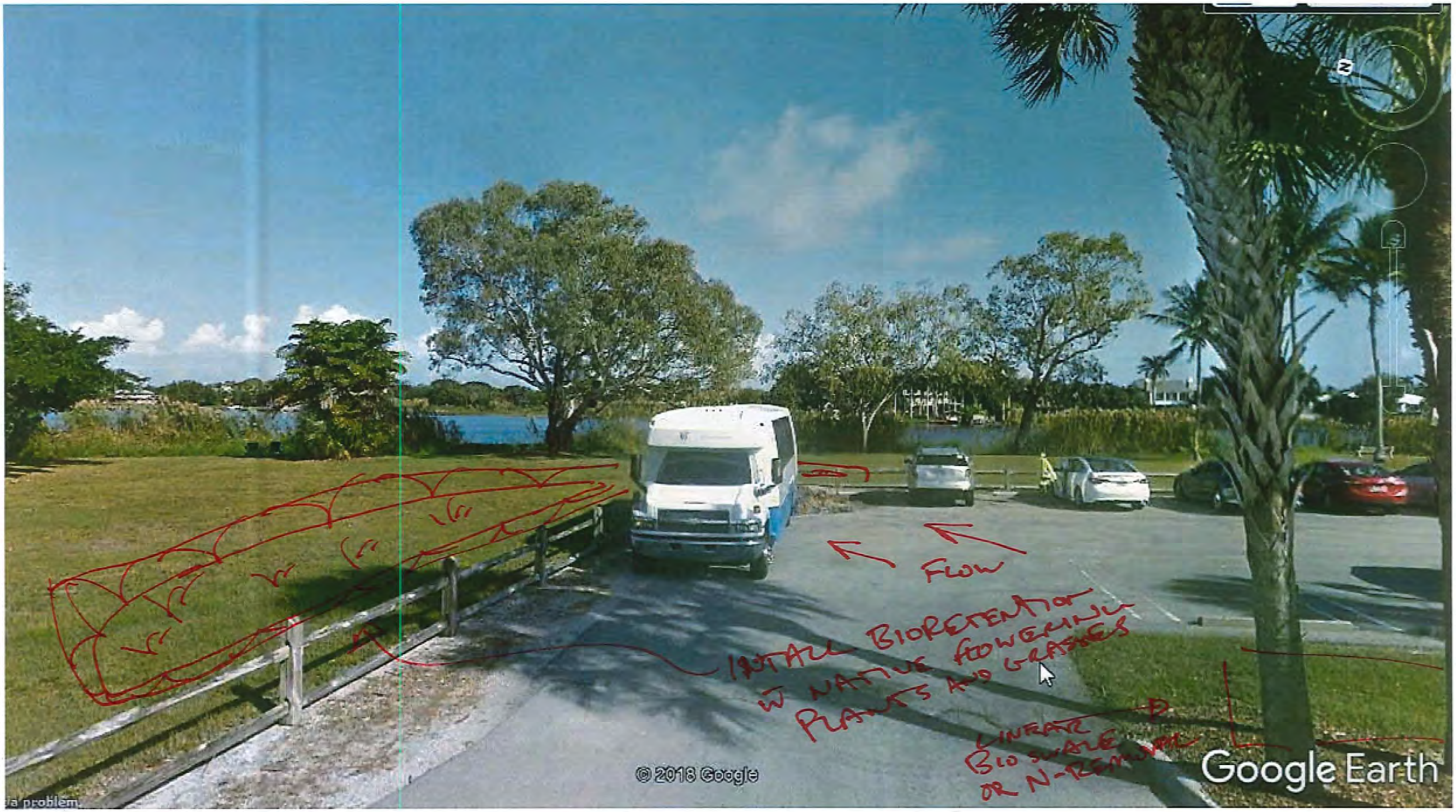
Proposed Retrofit Location:

Caption: Add swales in median and filter strips at edges of parking lot. Add bio in corner at low point.

Potential Non Structural Controls:Buffer, no mow to Lake Ida. Make parking lot one way to reduce pavement.

Date and Time of Site Visit: Oct 16, 2017, 11:38 AM	Staff Initials: JR, KM

I-10A



PARK – MULTIPLE OPTIONS
* RAIN GARDEN DEMO ??

8
I-10A
12
10
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

<table>
<tr><th colspan="2">Site Identification Number: I-10B</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Highway/Roads
-None Selected-
Additional Description:
Drive into park and residential road.</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: Erosion adjacent to roadway</td></tr>
<tr><td>Description of existing BMP(s):
None. Concrete paved waterway to water.</td><td rowspan="2">Observations about Site Maintenance:
Erosion of ROW and gullying.</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Bioretention Area
Water Quality Swale

Additional Description:
Curb water and redirect to practice in park.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: Curb road and redirect water to bio in park.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 11:50 AM</td><td>Staff Initials: JR, KM</td></tr>
</table>

Site Identification Number: I-11

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
Highways/Roads
Additional Description:
Commercial office/industrial park. Blocked drainage system. Scouring along parking lots.

General Site Photograph:

Caption: Commercial office park roadway.

Description of existing BMP(s):

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Pretreatment Practice
-None Selected-

Additional Description:
Potential underground mulch treatment along swale with connection to catch basin

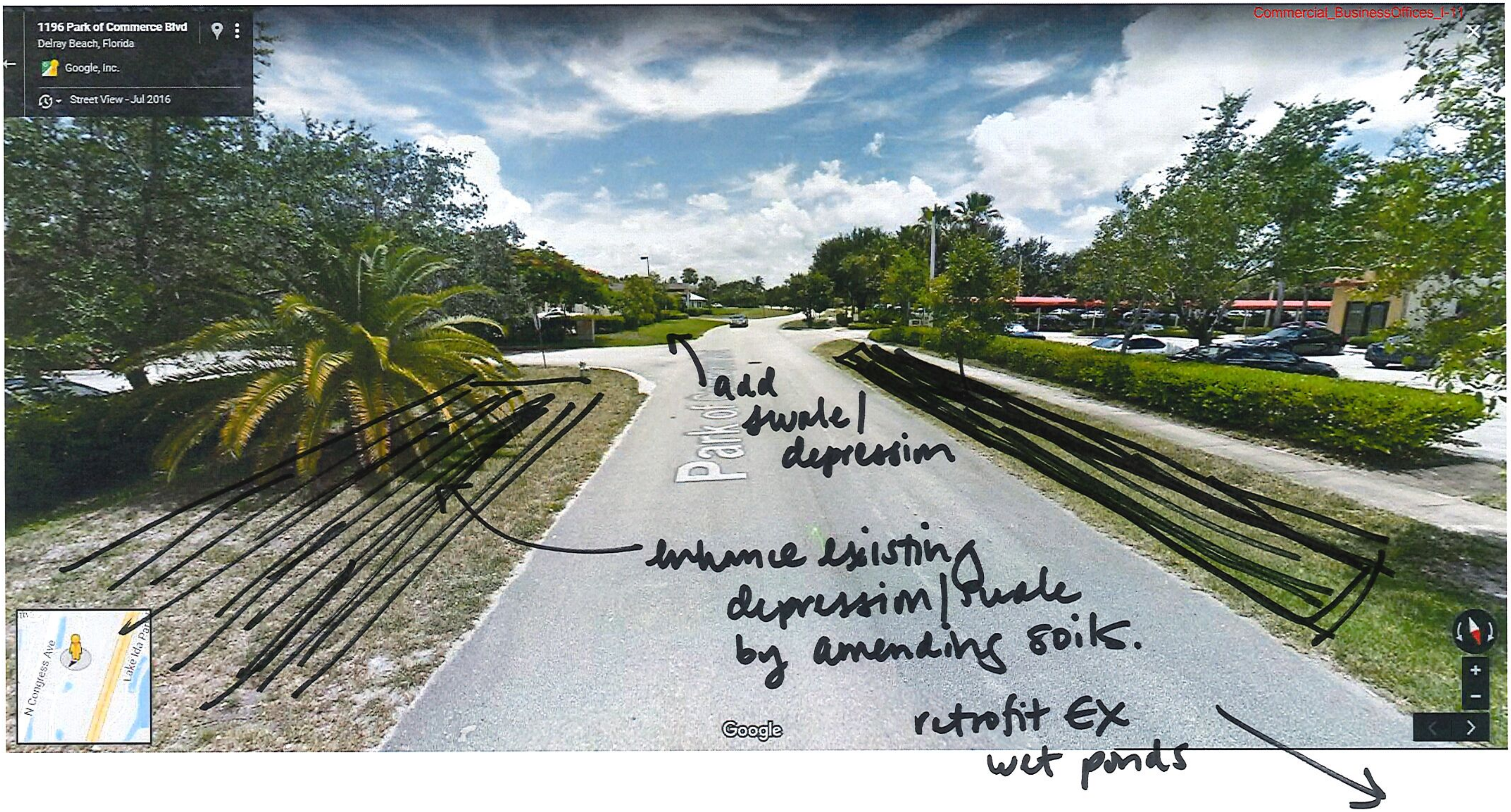
Proposed Retrofit Location:

Caption: Subsurface treatment to remove nitrogen.

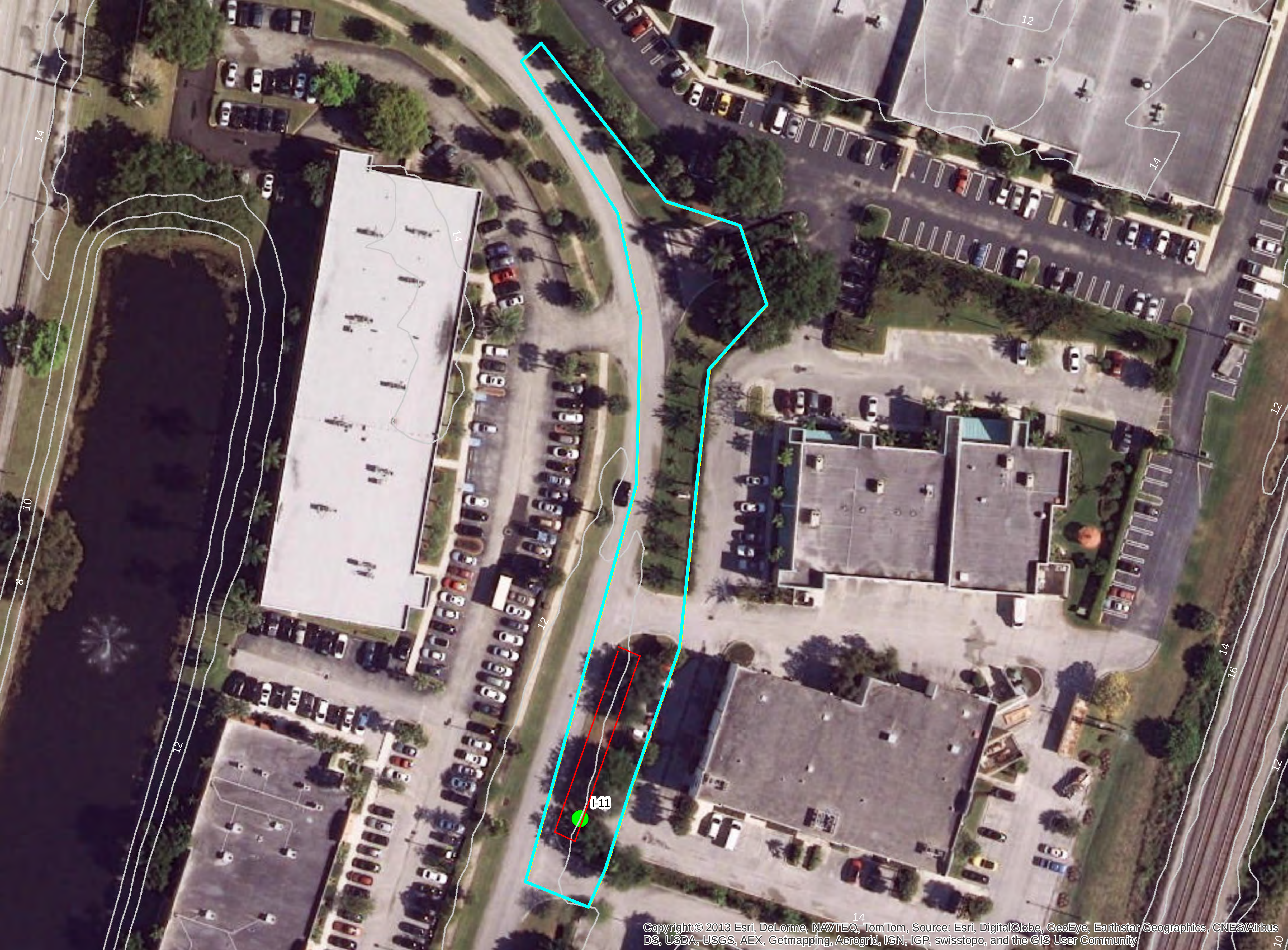
Potential Non Structural Controls:Downspout disconnections

Date and Time of Site Visit: Oct 16, 2017, 9:35 AM	Staff Initials: KM, JR, EB,RC

I-11



1196 Park of Commerce Blvd
Delray Beach, Florida
Google, Inc.
Street View - Jul 2016
Commercial_BusinessOffices_I-11
Park of
Google
N Congress Ave
Lake Ida
add swale/depression
enhance existing depression/swale by amending soils.
retrofit EX wet ponds


I-11
12
14
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16
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Site Identification Number: I-11-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
Highways/Roads
Additional Description:
Commercial and industrial office park

General Site Photograph:

Caption: Wet basin

Description of existing BMP(s):
Yes, wet basin.

Observations about Site Maintenance:

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
Pretreatment Practice

Additional Description:
Implement sediment forebay. Shoreline enhancement along basin edge with wetland bench.

Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 9:59 AM

Staff Initials: KM, EB, JR, RC

<table>
<tr><th colspan="2">Site Identification Number: I-12</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td>Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Residential neighborhood with sidewalks on both sides. Driveways have depression at end to capture water.</td><td>General Site Photograph:

Caption: Cul-de-sac with sidewalks on both sides.</td></tr>
<tr><td>Description of existing BMP(s):
None</td><td rowspan="2">Observations about Site Maintenance:
Watering of sidewalk. Mowing to edges of water.</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td>Potential Retrofit BMP(s):
Water Quality Swale
Bioretention Area

Additional Description:
Remove impervious area to allow swale and/or bio to filter water before discharging to canal. Could also have smaller, localized depressions in front of houses to capture water or swales to convey water down to larger practice.</td><td>Proposed Retrofit Location:

Caption: Swale to bio in cul-de-sac by removing pavement</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Remove impervious area from cul-de-sac. Could limit sidewalk to one side. Limit watering to lawn. Buffer to waterway.</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 12:27 PM</td><td>Staff Initials: JR, KM</td></tr>
</table>

Site Identification Number: I-12B

EXISTING CONDITIONS

Land use(s) of contributing area:
Highway/Roads
Residential
Additional Description:
Road crowned to sides.

General Site Photograph:

Caption: Large vegetated ROW with paired catch basins

Description of existing BMP(s):
None.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:
Create swales on either side of ROW. Amend soils to filter pollutants.

Proposed Retrofit Location:

Caption: Swales with amended soils. Raise catch basin to promote treatment.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 12:46 PM	Staff Initials: JR, KM

Site Identification Number: I-13-A

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Residential street adjacent to larger road

General Site Photograph:

Caption: Residential street.

Description of existing BMP(s):
None.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Removal of impervious cover before catch basin, with direct drainage to Lake Ida. Recognize sewer utility location may be an issue.

Proposed Retrofit Location:

Caption: Reduce impervious cover, add bio or swale before drainage to catch basin at the end of the street.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 12:11 PM	Staff Initials: JR, KM

Site Identification Number: I-13-B

EXISTING CONDITIONS

Land use(s) of contributing area:
- Residential
- Highways/Roads

Additional Description:
Roadway with no BMPs. Catch basins on either side of road, like drain directly to Lake Ida.

General Site Photograph:

Caption:

Description of existing BMP(s):

Observations about Site Maintenance:

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
- Sand/Organic Filter
- Other

Additional Description:
Add vegetated/organic filter strip adjacent to roadway, before sidewalk catch basin. Right of way appears to be large, during construction use permeable pavement.

Proposed Retrofit Location:

Caption: Add vegetated/organic filter strip adjacent to roadway, before sidewalk catch basin. Small area for vegetated strip. Right of way appears to be large, during construction use permeable pavement."

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 12:16 PM	Staff Initials: KM, JR

<table>
<tr><th colspan="2">Site Identification Number: 1-14-A</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td>Land use(s) of contributing area:
Commercial/Industrial
-None Selected-
Additional Description:
Light indistrial</td><td>General Site Photograph:

Caption: Long SW wet basin behind light industrial.</td></tr>
<tr><td>Description of existing BMP(s):
Long linear wet basin behind office park.</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td>Potential Retrofit BMP(s):
Water Quality Swale
Bioretention Area

Additional Description:
Lot by lot evaluation of opportunities in medians and underutilized landscape islands. Swales and bios.</td><td>Proposed Retrofit Location:

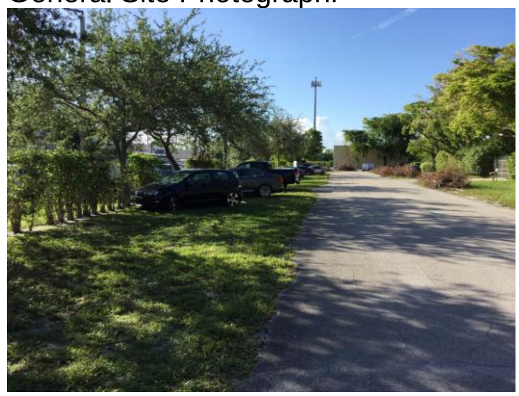
Caption: Underutilized landscape islands. Add Swales and bios. Reduce impervious cover where possible.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Impervious cover reduction.</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 3:30 PM</td><td>Staff Initials: KM/RC</td></tr>
</table>

Site Identification Number: I-14B

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
-None Selected-
Additional Description:
Industrial office Park, several different light industrial uses.

General Site Photograph:



Caption: Light industrial underutilized landscape areas but good use of parking on turf.

Description of existing BMP(s):
Yes, large linear wet basin, seems like most of the properties rain to it. Each property likely has some on-site controls.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
Bioretention Area

Additional Description:
Lot by lot evaluation of opportunities in medians and underutilized landscape islands. Swales and bios.

Proposed Retrofit Location:

Caption: Underutilized landscape islands. Add Swales and bios. Reduce impervious cover where possible.

Potential Non Structural Controls:Impervious cover reduction where not needed.

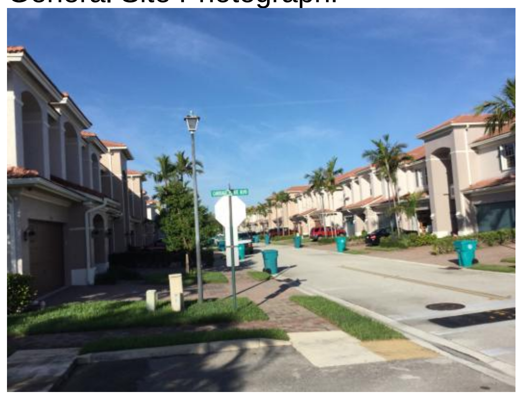
Date and Time of Site Visit: Oct 17, 2017, 9:26 AM	Staff Initials: KM/RC

Site Identification Number: I-15

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
-None Selected-
Additional Description:
High density apartment complex

General Site Photograph:



Caption: Apartment complex with gutters and drains.

Description of existing BMP(s):
Disconnected downspouts in backyards.

Is the site on Septic? -None Selected-

Observations about Site Maintenance:
Appears that runoff is directed to underground chamber or offsite SW facility.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
-None Selected-
-None Selected-

Additional Description:
Disconnect front downspouts. Consider rain barrels or cisterns for lawn care/irrigation

Proposed Retrofit Location:

Caption: Downspout disconnection.

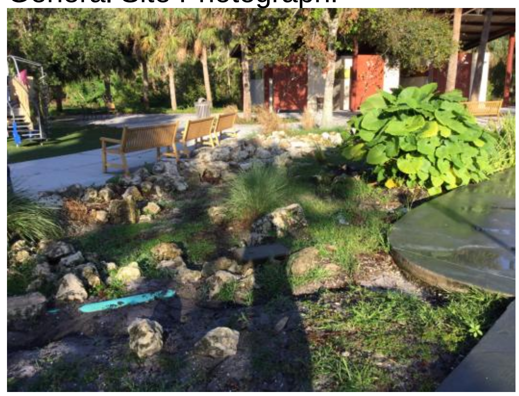
Potential Non Structural Controls:Rain barrels

Date and Time of Site Visit: Oct 17, 2017, 9:09 AM	Staff Initials: KM, RC

I-15

Directly connected D/S. Infront

Rear to green space

Site Identification Number: I-16	
EXISTING CONDITIONS	
Land use(s) of contributing area: Open Space/Parks -None Selected- Additional Description: Park and parking lot	General Site Photograph:  *Caption: Barrier Free Park*
Description of existing BMP(s): Park has bioswales and depressed runoff channels draining to wetland. Pervious surfaces throughout playground. Good examples of GI in parks.	Observations about Site Maintenance:
Is the site on Septic? No	
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Water Quality Swale -None Selected- Additional Description: Improve vegetation in parking lot median. Depress and create grass swale or bioswale, depending on maintenance capacity.	Proposed Retrofit Location:  *Caption: Continue BMP use in park playgrounds, improve parking lot drainage with swales at medians.*
Potential Non Structural Controls:	
Date and Time of Site Visit: Oct 17, 2017, 8:49 AM	Staff Initials: KM,RC

<table>
<tr><td colspan="2">Site Identification Number: I-18</td></tr>
<tr><td colspan="2">EXISTING CONDITIONS</td></tr>
<tr><td>Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Reasonably low maintenance lawn's, of the road in reasonable condition.</td><td>General Site Photograph:

Caption: Residential St</td></tr>
<tr><td>Description of existing BMP(s):
Roadside swales

Is the site on Septic? Yes</td><td>Observations about Site Maintenance:</td></tr>
<tr><td colspan="2">PROPOSED RETROFIT</td></tr>
<tr><td>Potential Retrofit BMP(s):
-None Selected-
Bioretention Area

Additional Description:
Enhance water quality swale for nitrogen removal</td><td>Proposed Retrofit Location:

Caption: Add swale for nitrogen removal.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Encourage septic system maintenance</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 10:40 AM</td><td>Staff Initials: KM/RC</td></tr>
</table>

Site Identification Number: I-19	
EXISTING CONDITIONS	
Land use(s) of contributing area: Residential Highways/Roads Additional Description: Reasonably well maintained roadway; fairly high input lawns	General Site Photograph:  *Caption: Residential street with heavy impervious cover.*
Description of existing BMP(s): No Is the site on Septic? No	Observations about Site Maintenance:
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Water Quality Swale Bioretention Area Additional Description: Bioretention at the low points within right away	Proposed Retrofit Location:  *Caption: Add long bioswale adjacent to homes but in public ROW. Remove impervious cover at cul de sacs where applicable.*
Potential Non Structural Controls:Reduce impervious cover of cul-de-sacs	
Date and Time of Site Visit: Oct 17, 2017, 3:11 PM	Staff Initials: KM/RC

<table>
<tr><th colspan="2">Site Identification Number: I-20</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
-None Selected-
-None Selected-
Additional Description:
Did not visit. Gated</td><td>General Site Photograph:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td>Description of existing BMP(s):</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? -None Selected-</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
-None Selected-
-None Selected-

Additional Description:</td><td>Proposed Retrofit Location:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 11:16 AM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

<table>
<tr><th colspan="2">Site Identification Number: I-21-A</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Highway/Roads
-None Selected-
Additional Description:
Large secondary road, 1 lane in each direction plus turning lanes.</td><td>General Site Photograph:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td>Description of existing BMP(s):
Existing swales on both sides of road. The pipes under roadways are 24", and are half full with water. One swale is not mowed and has a guard rail, but the other is mowed with no guardrail. What is the reason? The swale on the far side is much small</td><td rowspan="2">Observations about Site Maintenance:
The existing swales are filled in with sediment and then grass grows on top of the sediment and overtime the bottom of the swelling elevation rises. The inlet and outlet pipes become submerged in sediment.</td></tr>
<tr><td>Is the site on Septic? -None Selected-</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:
The existing swales are filling in with sediment. They should be excavated out to bring them down to the original elevations.</td><td>Proposed Retrofit Location:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:The swales need more regular maintenance.</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 9:51 AM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

Site Identification Number: I-21-B

EXISTING CONDITIONS

Land use(s) of contributing area: Highway/Roads -None Selected- Additional Description: Large ten lane road and intersection.	General Site Photograph:  *Caption: The amount of pavement draining to the canal with no pretreatment is very significant.*
Description of existing BMP(s): Catch basin to canal system. Is the site on Septic? -None Selected-	Observations about Site Maintenance: The canal walls and adjacent area are extremely well maintained by mowing. The grass is kept short.

PROPOSED RETROFIT

Potential Retrofit BMP(s): Pretreatment Practice -None Selected- Additional Description: Let the vegetation grow in more and restrict mowing. Provide a pretreatment system, such as a swirl separator?	Proposed Retrofit Location:  *Caption: Allowing some vegetation to grow in along the buffer as well as inserting a pretreatment device could help, since the runoff gets absolutely no treatment.*

Potential Non Structural Controls:Less mowing.

Date and Time of Site Visit: Oct 17, 2017, 10:17 AM	Staff Initials: JER,ESB

Site Identification Number: I-22

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
New subdivision

General Site Photograph:

Caption: Newer development. Narrow road at 23 ft.

Description of existing BMP(s):
Existing wet pond

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Impervious cover reduction, and cul-de-sac and eyebrows. At wet pond, habitat enhancements: wetland plants below and above permanent pool. Sediment forebay.

Proposed Retrofit Location:

Caption: Reduce impervious cover at eyebrow and cul de sac.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 17, 2017, 11:47 AM

Staff Initials: KM/RC

Site Identification Number: I-23

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Residential development wet pond

General Site Photograph:

Caption: Wet pond

Description of existing BMP(s):
Wet pond

Is the site on Septic? Yes

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Wet Basin
Bioretention Area

Additional Description:
Sediment forebay, add bioretention before catch basins in street.

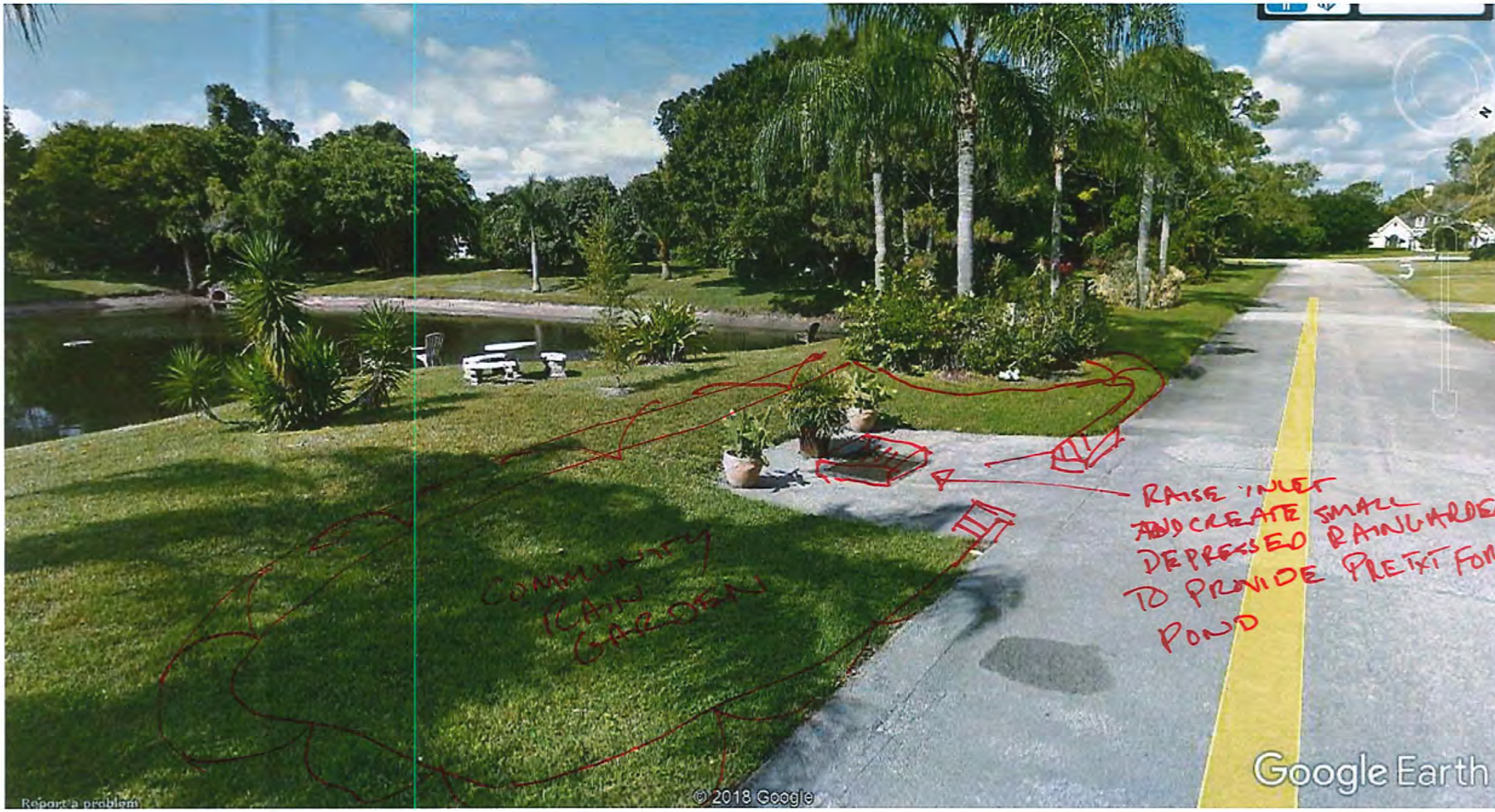
Proposed Retrofit Location:

Caption: Add bio before catch basin to wet pond.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 17, 2017, 1:09 PM	Staff Initials: KM/RC

I-23


COMMUNITY RAIN GARDEN
RAISE INLET AND CREATE SMALL DEPRESSED RAINGARDEN TO PROVIDE PRETXT FOR POND
Google Earth
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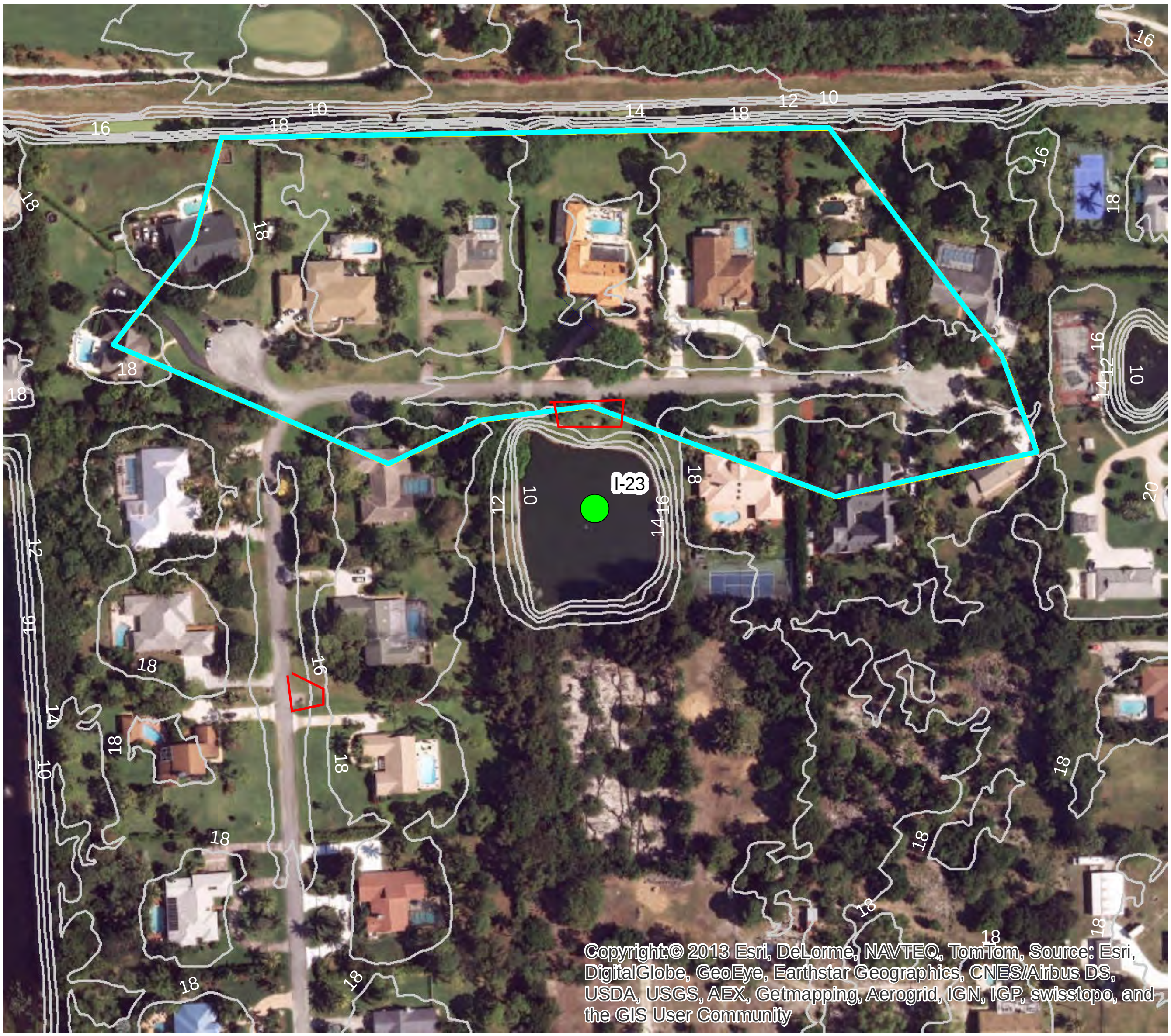
Report a problem


I-23
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Site Identification Number: I-24	
EXISTING CONDITIONS	
Land use(s) of contributing area: Residential Highways/Roads Additional Description: Mobile home park	General Site Photograph:  *Caption: Mobile home park*
Description of existing BMP(s): None Is the site on Septic? No	Observations about Site Maintenance: None
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Pretreatment Practice Proprietary Media Filter Additional Description: Catch basins at low points located in driveways. Limited space for practices. Recommend pretreatment practices and/or other proprietary product to treat runoff prior to canal. Localized depressions to manage overland flow. Possible permeable pavers for d	Proposed Retrofit Location:  *Caption: Create local depressions to manage runoff prior to catch basin.*
Potential Non Structural Controls:Rainwater harvesting	
Date and Time of Site Visit: Oct 17, 2017, 11:56 AM	Staff Initials: JER, ESB

<table>
<tr><th colspan="2">Site Identification Number: I-25</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Gated, did not visit</td><td>General Site Photograph:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td>Description of existing BMP(s):</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? -None Selected-</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
-None Selected-
-None Selected-

Additional Description:</td><td>Proposed Retrofit Location:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 11:48 AM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

Site Identification Number: I-26

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
-None Selected-

Additional Description:
This is an older commercial area, with Publix and various smaller stores. Contributing Area is parking and roof runoff.

General Site Photograph:

Caption:

Description of existing BMP(s):
Catch basin sin every other drive aisle.

Observations about Site Maintenance:
Well maintained older parking area and commercial plaza, in good shape.

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Enclose roof runoff planters to infiltrate. Possible tree trench or tree pits. Shallow subsurface infiltration system?

Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 17, 2017, 10:39 AM	Staff Initials: JER, ESB

<table>
<tr><th colspan="2">Site Identification Number: I-27</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Agriculture
Highways/Roads
Additional Description:
Gated, did not visit</td><td>General Site Photograph:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td>Description of existing BMP(s):</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? -None Selected-</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
-None Selected-
-None Selected-

Additional Description:</td><td>Proposed Retrofit Location:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 11:46 AM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

<table>
<tr><th colspan="2">Site Identification Number: I-28-A</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td>Land use(s) of contributing area:
Golf Course
Residential
Additional Description:
Parking lot in apartment complex</td><td>General Site Photograph:

Caption: Edge of parking lot. Bioretention opportunity.</td></tr>
<tr><td>Description of existing BMP(s):
Catch basins to wet pond.</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td>Potential Retrofit BMP(s):
Bioretention Area
Other

Additional Description:
Create bioretention area as educational/demo project. Reduce parking space size to 8.5 ft. Current spaces vary from 9.5 to 10 ft.</td><td>Proposed Retrofit Location:

Caption: Reduce parking space size to 8.5 ft.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Reduction of impervious cover - reduced parking space size</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 10:57 AM</td><td>Staff Initials: KM/RC</td></tr>
</table>

<table>
<tr><th colspan="2">Site Identification Number: I-28-B</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Apartment complex</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: Current wet pond</td></tr>
<tr><td>Description of existing BMP(s):
Wet pond</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Wet Basin
Other

Additional Description:
Redo side slopes, add wetland fringe, forebay, plantings along new flatter slopes, and aeration device.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: Retrofit wet pond. Add forebay and wetland plantings, and aeration device.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 11:13 AM</td><td>Staff Initials: KM/RC</td></tr>
</table>

Site Identification Number: I-28C

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Golf Course

Additional Description:
Road runoff drains to sidewalk via curb cuts

General Site Photograph:

Caption: Drainage from road and sidewalk.

Description of existing BMP(s):
Existing wet basins

Is the site on Septic? No

Observations about Site Maintenance:
All the pond side slopes are very steep; One thought is that they might discourage alligators from crawling out of the ponds, but alligators are pretty agile, lots of bank erosion on the slopes.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:
Create water quality swale between sidewalk and palm trees

Proposed Retrofit Location:

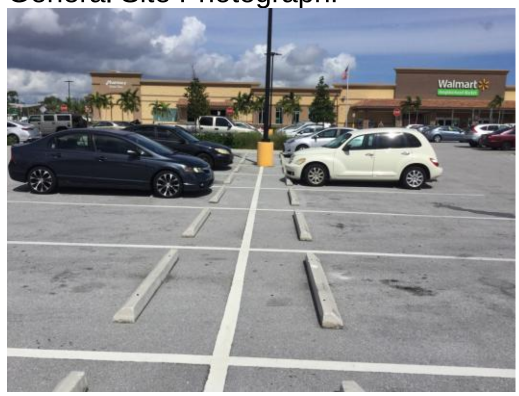
Caption: Create swale

Potential Non Structural Controls:Existing golf course does not appear to be active. Suggest converting open space to park with trails and other cool stuff

Date and Time of Site Visit: Oct 17, 2017, 11:25 AM	Staff Initials: KM/RC

<table>
<tr><th colspan="2">Site Identification Number: I-30</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Over 55 community</td><td>General Site Photograph:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td>Description of existing BMP(s):</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? -None Selected-</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
-None Selected-
-None Selected-

Additional Description:</td><td>Proposed Retrofit Location:</td></tr>
<tr><td>Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 17, 2017, 11:26 AM</td><td>Staff Initials: JER, ESB</td></tr>
</table>

Site Identification Number: I-31	
EXISTING CONDITIONS	
Land use(s) of contributing area: Commercial/Industrial Highways/Roads Additional Description: Walmart, box stores	General Site Photograph:  *Caption: Parking lot and drive aisles discharge to dry basin.*
Description of existing BMP(s): Dry basin	Observations about Site Maintenance:
Is the site on Septic? No	
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Water Quality Swale Other Additional Description: Tree trenches, tree pits, curb cuts to green/ landscaped space	Proposed Retrofit Location:  *Caption: Opportunity to use green and landscaped space for localized drainage management.*
Potential Non Structural Controls:More tree canopy to reduce heat island effect.	
Date and Time of Site Visit: Oct 17, 2017, 12:00 PM	Staff Initials: JER, ESB

I-31

IMPROVE WQ TXT FOR PONDS BY PROVIDING PRETREATMENT OPTIONS LIKE BIOS IN PARKINGLOT


I-31
18
20
16
14
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Site Identification Number: I-32

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Residential homes, similar size and shape, landscaping

General Site Photograph:

Caption: Catch basin in ROW.

Description of existing BMP(s):
Wet ponds

Is the site on Septic? No

Observations about Site Maintenance:
Likely high fertilizer use. Mowing to edges adjacent to waterways.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
Other

Additional Description:
Water quality swales with amended soils and native grasses to enhance treatment of runoff.

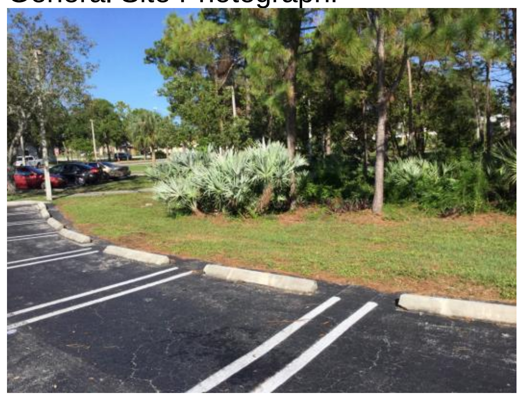
Proposed Retrofit Location:

Caption: Enhance existing depressions to create water quality swale.

Potential Non Structural Controls:Increase tree canopy to improve heat island effect and evapotranspiration. Buffer at waters edge to filter runoff.

Date and Time of Site Visit: Oct 17, 2017, 3:07 PM	Staff Initials: JER, ESB

Subwatershed J

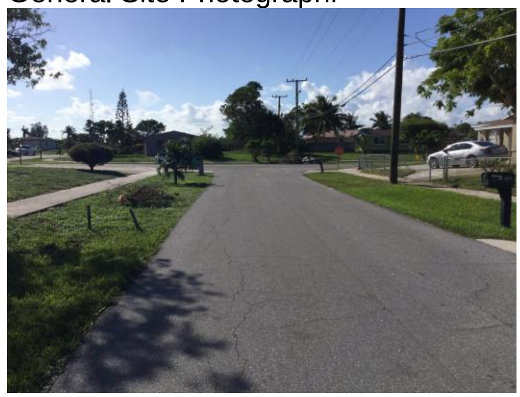
Site Identification Number: J-1	
EXISTING CONDITIONS	
Land use(s) of contributing area: Open Space/Parks -None Selected- Additional Description: Existing parking lot for recreational center. This is a great example of a low impact parking lot that is functioning well.	General Site Photograph:  *Caption: Runoff flows across the parking lot and sheet flows into the adjacent large natural area. There is no evidence of erosion.*
Description of existing BMP(s): Filter strips Is the site on Septic? No	Observations about Site Maintenance:
PROPOSED RETROFIT	
Potential Retrofit BMP(s): -None Selected- -None Selected- Additional Description:	Proposed Retrofit Location:  *Caption: This is the natural area that collects the runoff from the large parking area. The area is depressed, and water appears to infiltrate well in sandy soils.*
Potential Non Structural Controls:	
Date and Time of Site Visit: Oct 16, 2017, 4:21 PM	Staff Initials: RAC/ESB

Site Identification Number: J-2

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
The lots in this neighborhood are smaller and less manicured. There are existing swales in some sections of the road.

General Site Photograph:



Caption: This site can benefit from enhanced denitrification swales in areas where swales already exist.

Description of existing BMP(s):
Swales

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:
Denitrification swales along the edge of the road.

Proposed Retrofit Location:

Caption: Swales could be installed on either side of the road.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 4:07 PM	Staff Initials: RAC/ESB

Site Identification Number: J-3

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
-None Selected-
Additional Description:
Appears to be an under utilized parking lot with lots and lots of parking. This is a great candidate for impervious cover removal. However, if parking is needed for major events or some other reason, this is potentially a good candidate for underground

General Site Photograph:

Caption: This is the rear parking lot, which appears to be overflow or abandoned. This lot provides a lot of excess parking.

Description of existing BMP(s):
No

Observations about Site Maintenance:
Some dumping, recent bonfires, landscape debris.

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
Exfiltration Trench

Additional Description:
Central median swale or bioretention

Proposed Retrofit Location:

Caption: This existing grassed area with catch basin could be retrofitted as a bioswale.

Potential Non Structural Controls:Impervious cover removal

Date and Time of Site Visit: Oct 16, 2017, 4:07 PM

Staff Initials: RAC/ESB

Site Identification Number: J-4-A

EXISTING CONDITIONS

Land use(s) of contributing area:
Open Space/Parks
-None Selected-
Additional Description:
Existing parking lot

General Site Photograph:

Caption: A bioretention area or two could be installed at edge of parking lot where catch basins are currently located.

Description of existing BMP(s):
None

Observations about Site Maintenance:
The stormwater basin that manages the runoff is overgrown but appears to function well as an infiltration basin. The soils are very sandy, with elevation above the adjacent canal.

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
-None Selected-

Additional Description:
Two small bio retention areas could be installed at either end of the parking lot, surrounding the existing catch basins.

Proposed Retrofit Location:

Caption: A swale could be placed in this open space. The swale would discharge to the existing basin behind the photographer.

Potential Non Structural Controls:

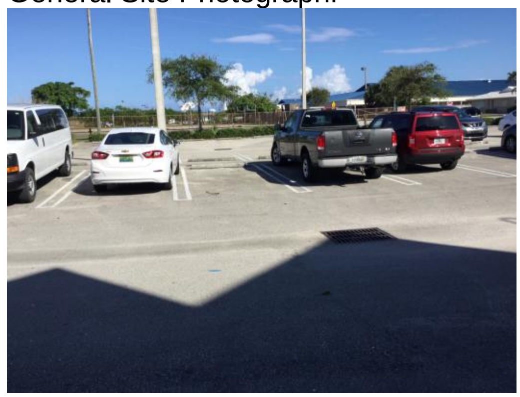
Date and Time of Site Visit: Oct 16, 2017, 3:39 PM	Staff Initials: RAC/ESB

Site Identification Number: J-4-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Open Space/Parks
-None Selected-
Additional Description:
All the drainage inlets are in the middle of the drive aisles of the parking lot; only real options are permeable asphalt or perhaps reconfiguration of the parking lot

General Site Photograph:



Caption:

Description of existing BMP(s):
Yes, Laege detention pond

Observations about Site Maintenance:

Is the site on Septic? -None Selected-

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
This site is noted to highlight the difficulty in retrofitting parking lots with catch basins in the drive aisle.

Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 3:44 PM	Staff Initials: RAC/ESB

<table>
<tr><th colspan="2">Site Identification Number: J-5</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Less manicured lawns and neighborhood with smaller homes.</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: The water runs off the road and has started to establish a swale along the side of the road.</td></tr>
<tr><td>Description of existing BMP(s):</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Water Quality Swale
Bioretention Area

Additional Description:
A swale could formalized along the edge of the road across the road from the church. The existing church parking lot would benefit from some green space, bioretention and or tree pits. Sunday parking may be a limiting factor.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: This church parking lot drains onto the street and then across to green space. A swale could be placed across the street to collect the runoff, and some tree pits could be placed in the edge of the lot.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 3:31 PM</td><td>Staff Initials: RAC/ESB</td></tr>
</table>

Site Identification Number: J-6

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
Highways/Roads
Additional Description:
Mix of small industrial sites, small parking lots, and a roadway in poor condition.

General Site Photograph:

Caption: There is an existing swale in poor overgrown condition, which could be converted to a bioswale.

Description of existing BMP(s):
Existing drainage gutter along the edge of the road at the at parking bump outs. They drain to existing depression and large catch basins with hoods.

Is the site on Septic? No

Observations about Site Maintenance:
Existing catch basins on sidestreets need to be cleaned out.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
Other

Additional Description:
Enhance existing swales parallel to the road right away, and add possible tree trenches at existing inlets.

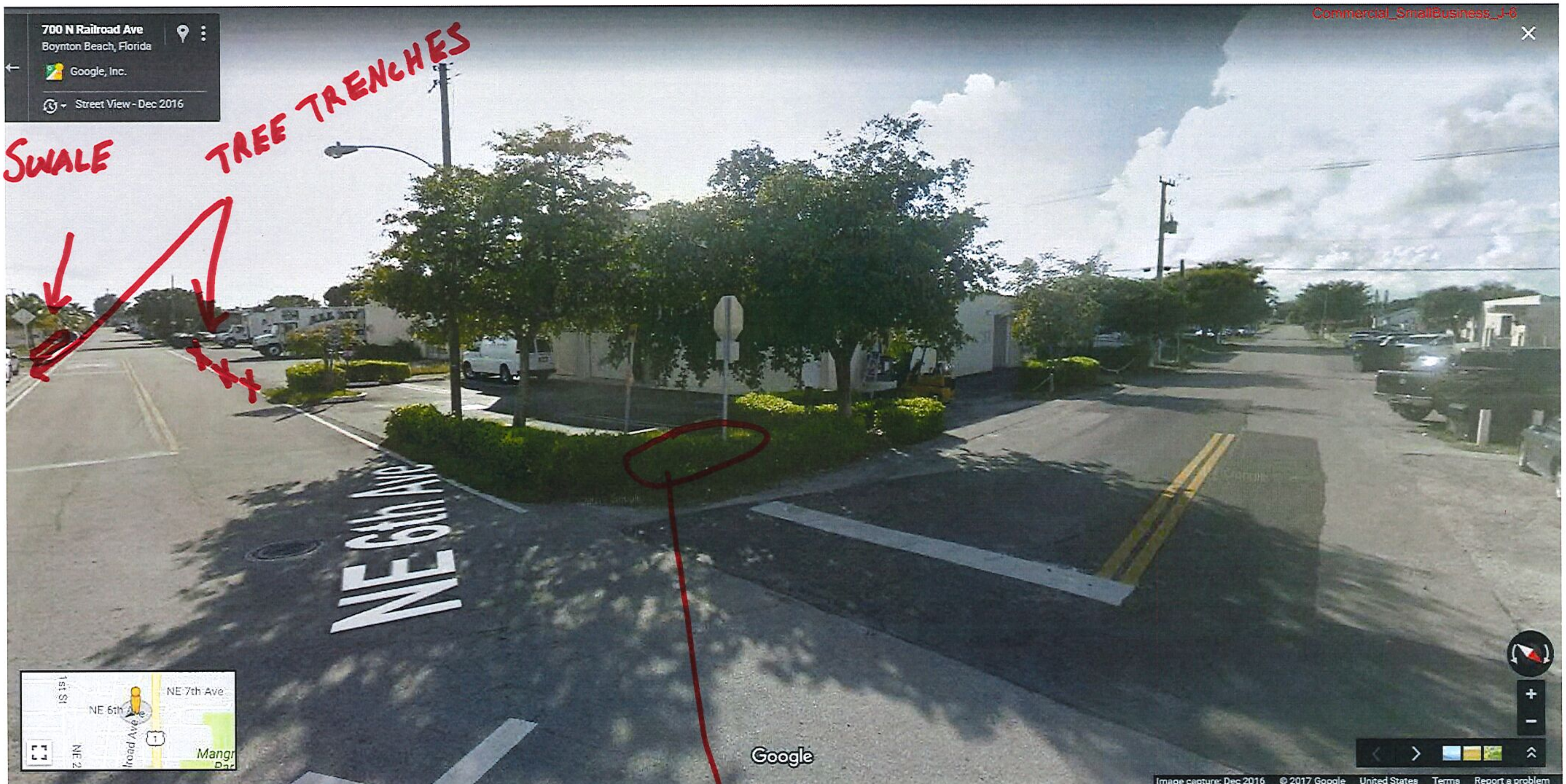
Proposed Retrofit Location:

Caption: Potential tree trench or tree pits location.

Potential Non Structural Controls:Plant trees

Date and Time of Site Visit: Oct 16, 2017, 12:23 PM	Staff Initials: RAC, ESB

J-6



EXISTING
BIO w/ CATCH BASIN

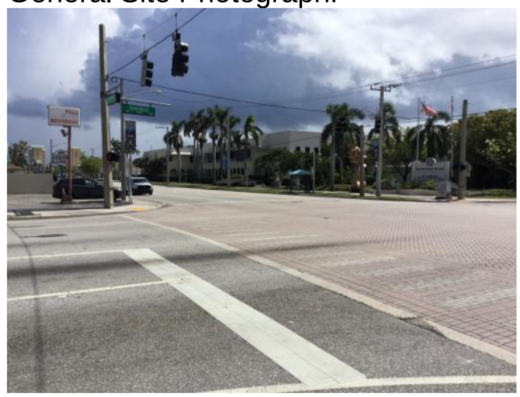

J-6
12
12
12
12
10
10
12
12
12
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Site Identification Number: J-7

EXISTING CONDITIONS

Land use(s) of contributing area:
Highway/Roads
Commercial/Industrial
Additional Description:
Major intersection of 5 lane roads.

General Site Photograph:



Caption: This is the intersection of North Seacrest and Boynton Beach Blvd.

Description of existing BMP(s):
Nothing, other than curb inlets.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Possible tree trenches with shrubs to avoid overhead wires.

Proposed Retrofit Location:

Caption: Tree trenches could be placed in the green space in front of City Hall.

Potential Non Structural Controls:Add more street trees.

Date and Time of Site Visit: Oct 16, 2017, 12:43 PM	Staff Initials: RAC, ESB

J-7

301 N Seacrest Blvd
Boynton Beach, Florida
Google, Inc.
Street View - Dec 2016
Roadway_BoyntonBeachBlvd_J-7
TREE TRENCHES
N Seacrest Blvd
Beach Blvd
804
NW 1st Ave
NE 1st Ave
W Ocean Ave
Google
Image capture: Dec 2016
© 2017 Google
United States
Terms
Report a problem

Site Identification Number: J-8

EXISTING CONDITIONS

Land use(s) of contributing area:
-None Selected-
-None Selected-

Additional Description:
The road drains away from the median, and the right-of-way is already completely utilized. This is not a great site for a retrofit.

General Site Photograph:

Caption: The road and sidewalk take up the full right of way. The street drains toward the edge rather than the median.

Description of existing BMP(s):

Is the site on Septic? -None Selected-

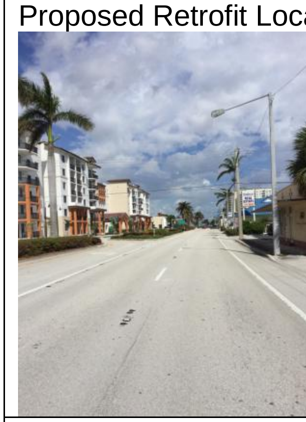
Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Maybe some tree trenches

Proposed Retrofit Location:



Caption: We could possibly add tree pits along the edge of road.

Potential Non Structural Controls:

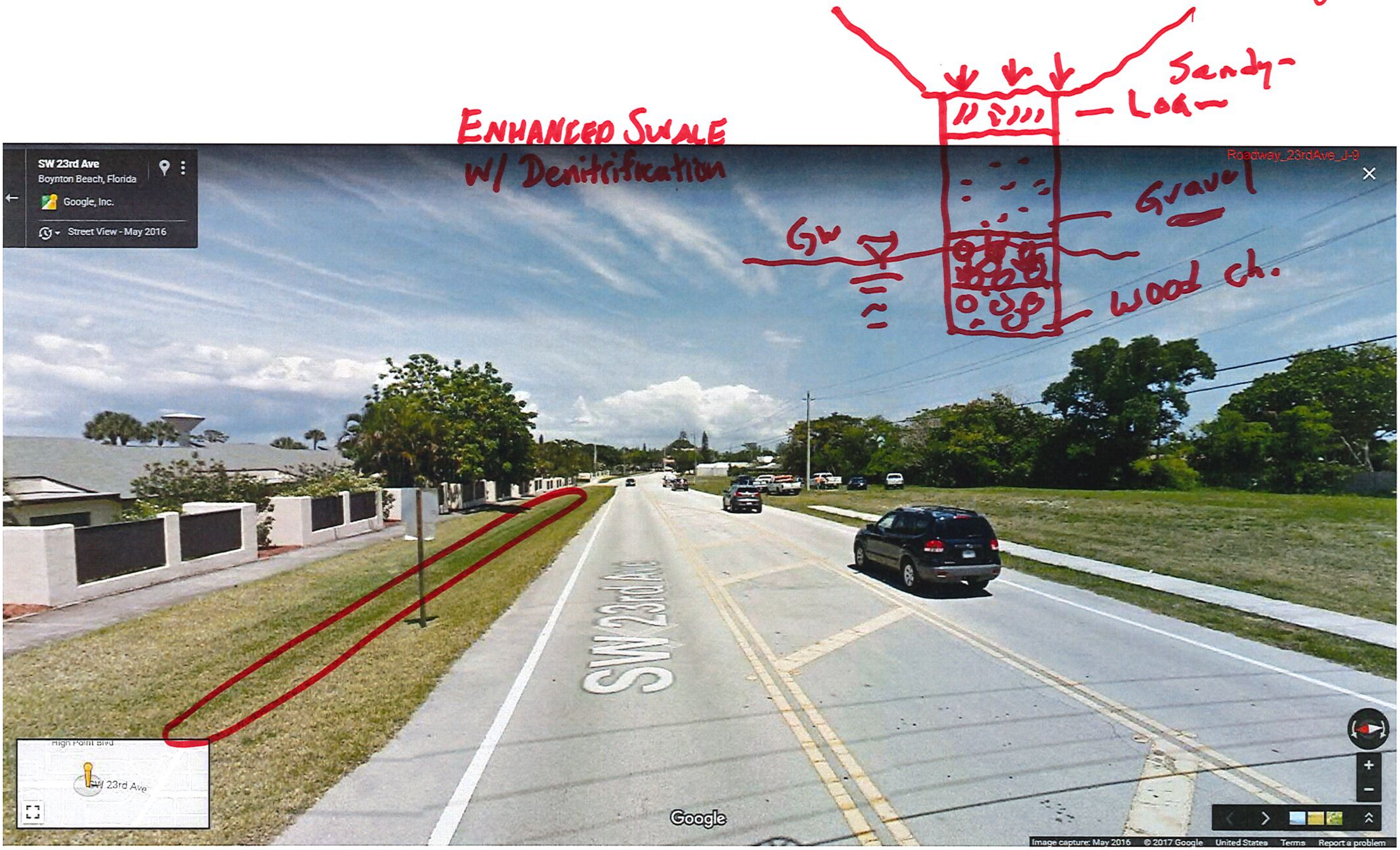
Date and Time of Site Visit: Oct 16, 2017, 12:08 PM	Staff Initials: RAC, ESB

J-8

TREE TRENCHES

Site Identification Number: J-9-A	
EXISTING CONDITIONS	
Land use(s) of contributing area: Highway/Roads Residential Additional Description: Larger right of way, open drainage	General Site Photograph:  *Caption: Road right of way*
Description of existing BMP(s): No Is the site on Septic? No	Observations about Site Maintenance: Well maintained area.
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Water Quality Swale -None Selected- Additional Description: Enhanced denitrification swale with organic media.	Proposed Retrofit Location:  *Caption: Swale at high point*
Potential Non Structural Controls:Reduce the turf area.	
Date and Time of Site Visit: Oct 16, 2017, 10:56 AM	Staff Initials: Rac, ESB

J-9


ENHANCED SWALE
W/ Denitrification
Sandy-Loam
Gravel
GW
wood ch.
Roadway_23rdAve_J-9
SW 23rd Ave
Boynton Beach, Florida
Google, Inc.
Street View - May 2016
SW 23rd Ave
High Point Blvd
SW 23rd Ave
Google
Image capture: May 2016 © 2017 Google United States Terms Report a problem

Site Identification Number: J-9-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
-None Selected-
Additional Description:
Parking lot, significant drainage issues

General Site Photograph:

Caption: Area of flooding.

Description of existing BMP(s):
No

Is the site on Septic? No

Observations about Site Maintenance:
Poor pavement condition due to standing water. Parking lot needs drainage work.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Wet Basin
Water Quality Swale

Additional Description:
Parking lot floods, reduce impervious cover, construct either wet basin, constructed wetland, water quality swale, or some combo

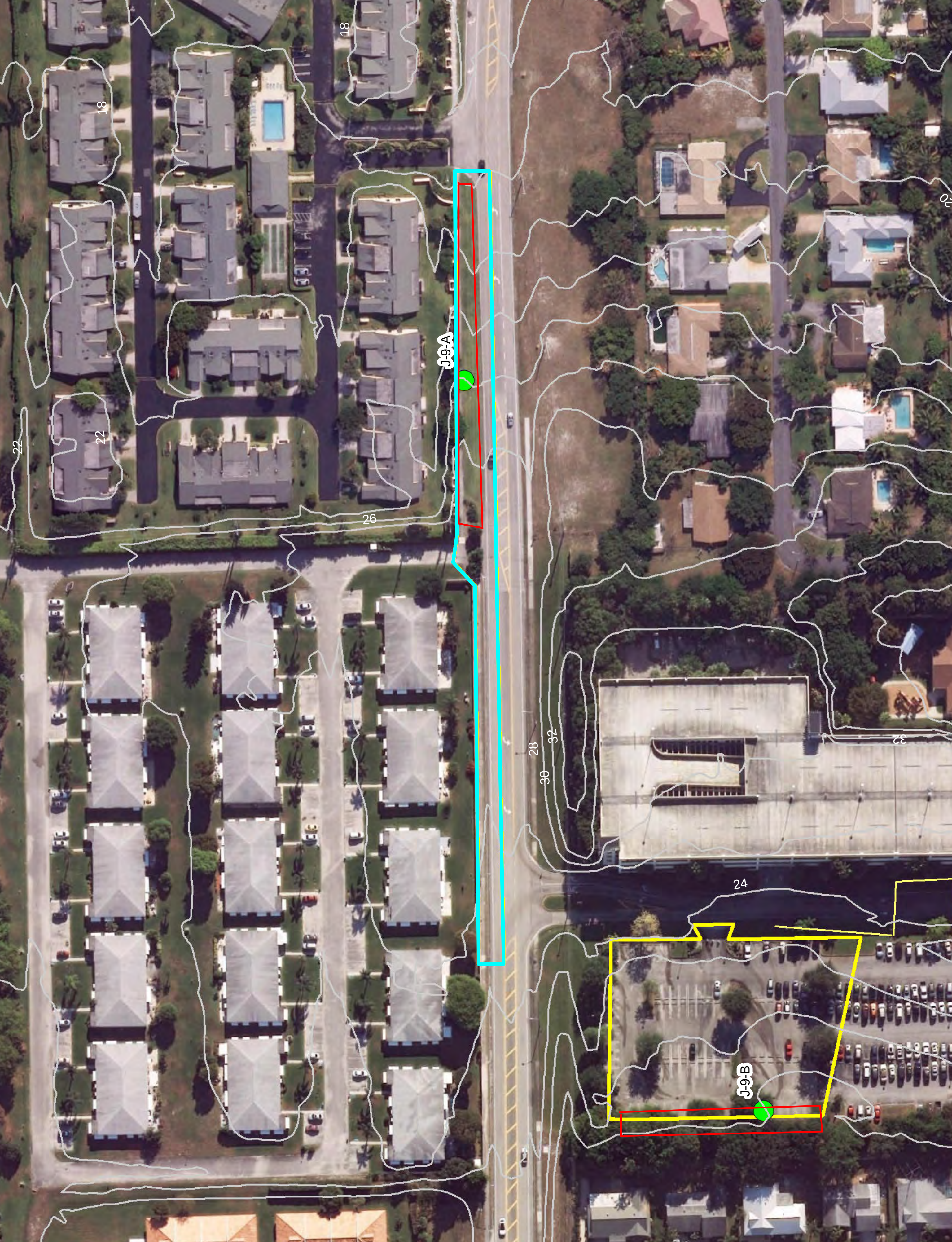
Proposed Retrofit Location:

Caption: This area of the parking lot floods regularly. It could be converted to a wet pond, wetland, or wet swale, since the water already drains there.

Potential Non Structural Controls:Reduced impervious cover

Date and Time of Site Visit: Oct 16, 2017, 11:07 AM

Staff Initials:



J-9-A
J-9-B
18
18
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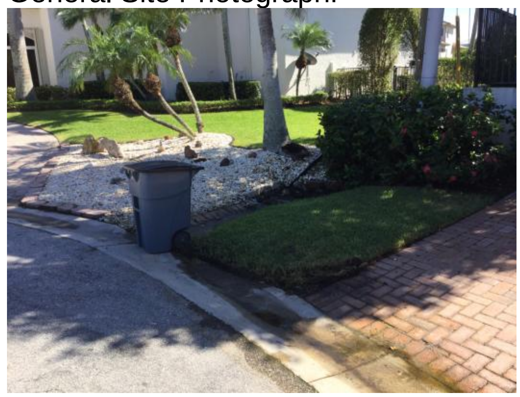
32
32

Site Identification Number: J-10-A

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Nicely manicured yards

General Site Photograph:



Caption: This catch basin collects runoff from the street and could be retrofitted as a bioswale or bioretention area.

Description of existing BMP(s):
No

Is the site on Septic? Yes

Observations about Site Maintenance:
The neighborhood is well maintained and manicured.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Water Quality Swale

Additional Description:
Homeowners have encroached on the public right-of-way. A bioretention system could be installed at the low point. This would require the relocation of some landscaping elements.

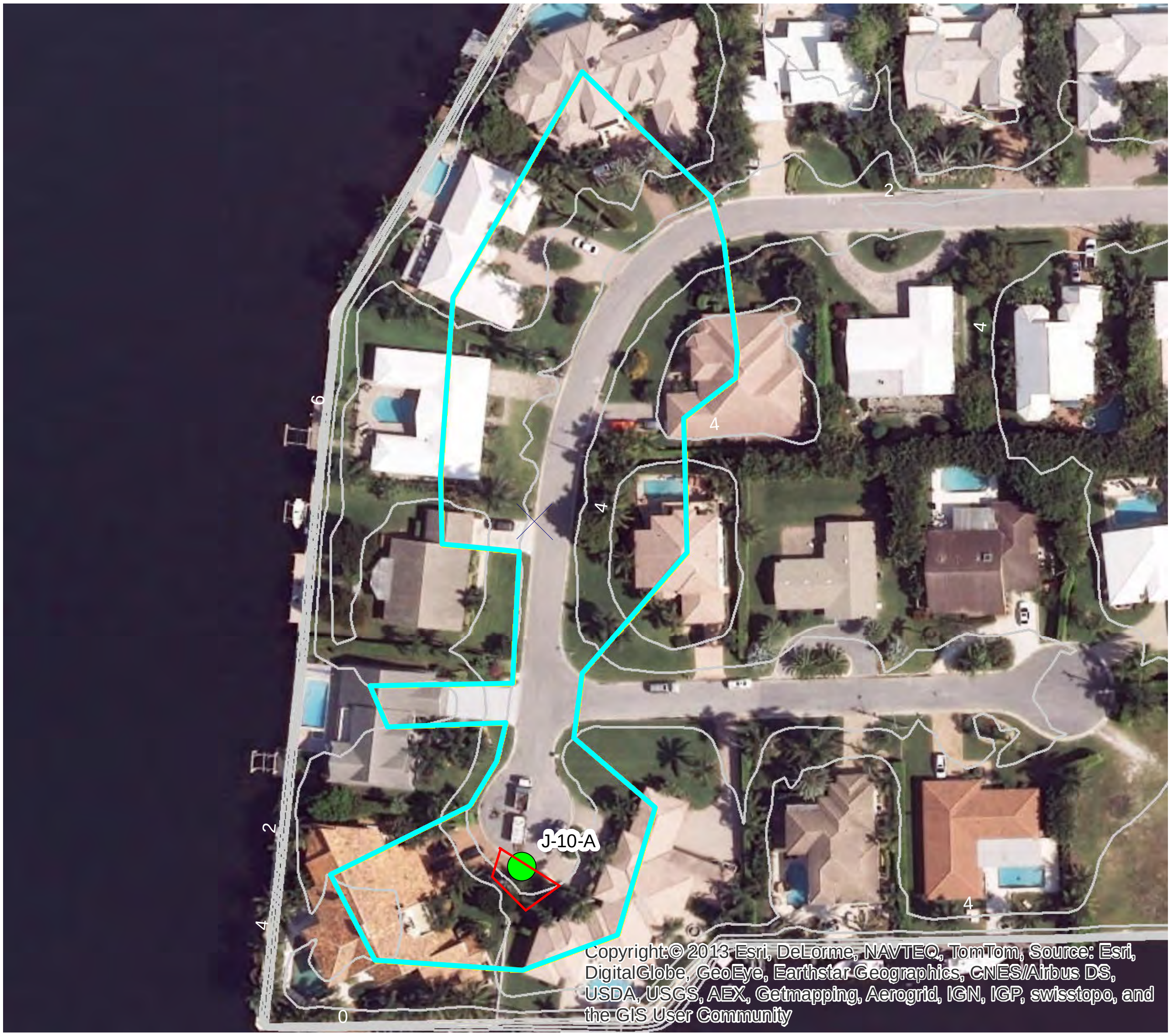
Proposed Retrofit Location:

Caption:

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 2:54 PM

Staff Initials: RAC/ESB



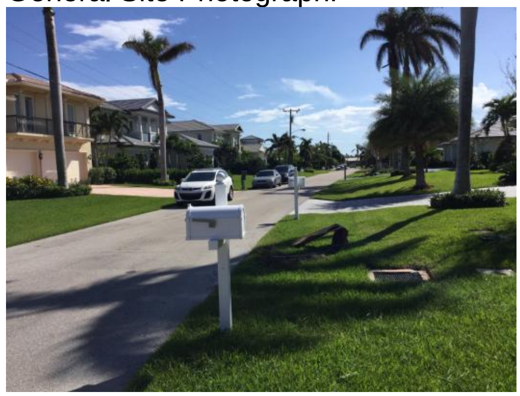
J-10-A
2
4
6
0
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Site Identification Number: J-10-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Nicely manicured lawns, and several have filled in their swales.

General Site Photograph:



Caption: This road clearly had swales early on, and the runoff flows into catch basins located within the swale in the right of way.

Description of existing BMP(s):
No

Is the site on Septic? -None Selected-

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
Bioretention Area

Additional Description:
Convert existing front lawns to nitrogen enhancing swales.

Proposed Retrofit Location:

Caption: Swales can be reintroduced to this neighborhood within the right of way.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 3:01 PM	Staff Initials: RAC/ESB

J-10B

REDUCE LAWN FERTILIZERS

J-10-B
4
4
2
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0
4
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<table>
<tr><th colspan="2">Site Identification Number: J-11-A</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td>Land use(s) of contributing area:
Open Space/Parks
Highways/Roads
Additional Description:
The drainage area is the bathhouse and a portion of the parking nearby</td><td>General Site Photograph:

Caption:</td></tr>
<tr><td>Description of existing BMP(s):
The stormwater drains from the parking area down a paved flume to the playground where it infiltrates.

Is the site on Septic? No</td><td>Observations about Site Maintenance:
The lawn and surrounding area are well maintained, mowed, and clean.</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td>Potential Retrofit BMP(s):
Bioretention Area
-None Selected-

Additional Description:
Install a bio retention system adjacent to the playground.</td><td>Proposed Retrofit Location:

Caption:</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Educational signage.</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 2:23 PM</td><td>Staff Initials: RAC, ESB</td></tr>
</table>

Site Identification Number: J-11-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Highway/Roads
Open Space/Parks
Additional Description:
Parking area as well as drainage from the upper parking lot.

General Site Photograph:

Caption: The existing parking lot has a central green space. Sand buildup indicates that runoff flows toward that green space. Runoff flows down from the upper lot as well.

Description of existing BMP(s):
The parking lot has several catch basins.

Is the site on Septic? -None Selected-

Observations about Site Maintenance:
The site is well maintained and grass is mowed, but there is some sedimentation at the edges of the lots, and the catch basin is clogged.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Pretreatment Practice

Additional Description:
Install a bio swell in the middle of the parking lot where the green Island is currently located. Possibly install pre-treatment to remove settlement.

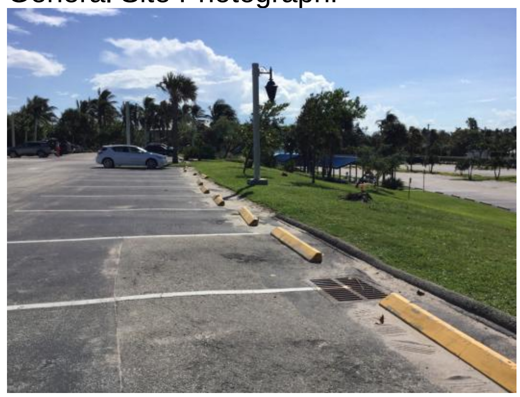
Proposed Retrofit Location:

Caption: A bioswale can be installed in the central aisle.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 2:30 PM

Staff Initials: RAC/ESB

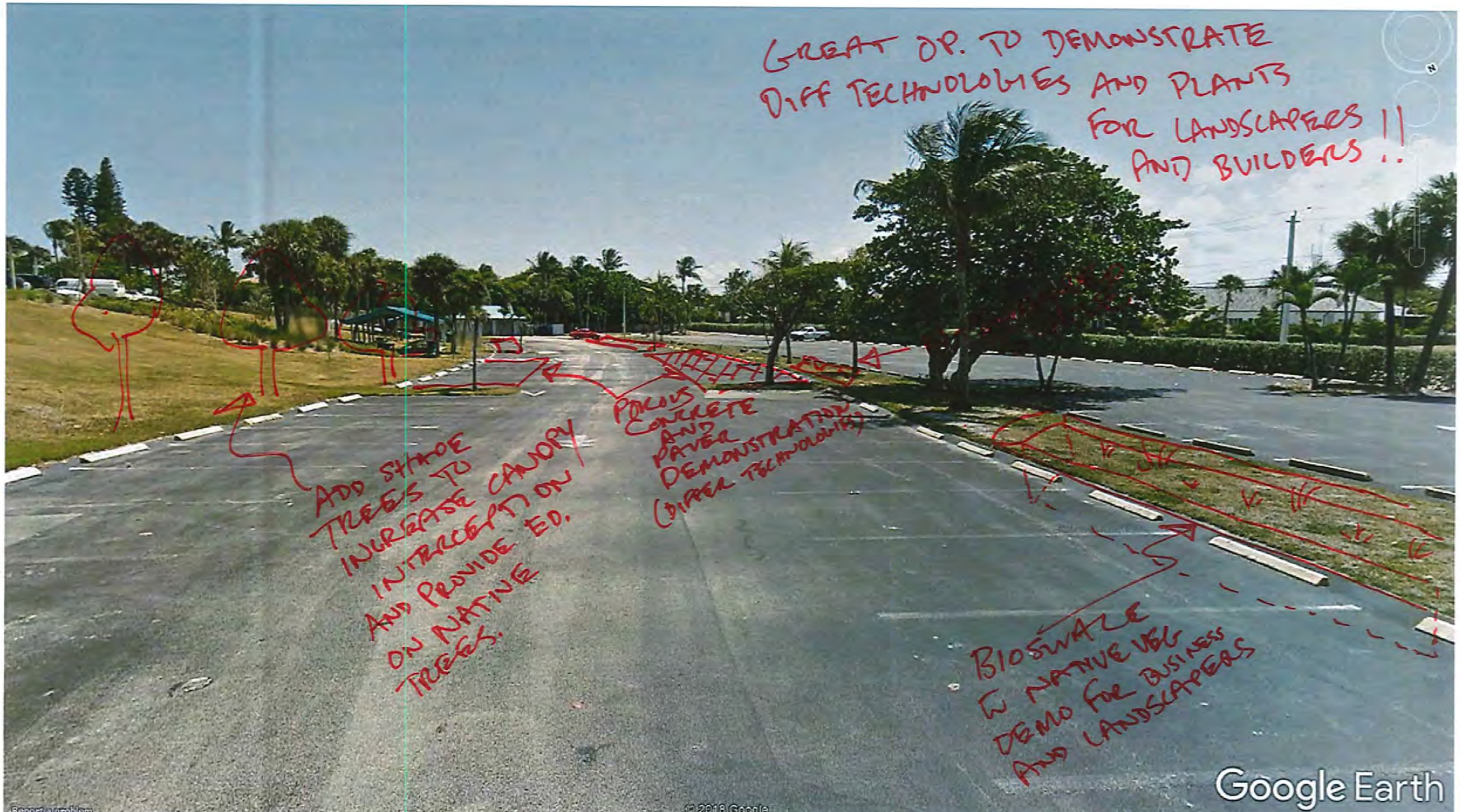
<table>
<tr><th colspan="2">Site Identification Number: J-11-C</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td>Land use(s) of contributing area:
Open Space/Parks
Highways/Roads
Additional Description:
The contributing area is the parking lot and open space.</td><td>General Site Photograph:

Caption: Stormwater drains off the edge of the parking lot as sheetflow.</td></tr>
<tr><td>Description of existing BMP(s):
Catch Basins

Is the site on Septic? No</td><td>Observations about Site Maintenance:
Sediment appears to be collecting in the corners of the parking lot indicating that water is not making it to the catch basins efficiently.</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td>Potential Retrofit BMP(s):
Water Quality Swale
Other

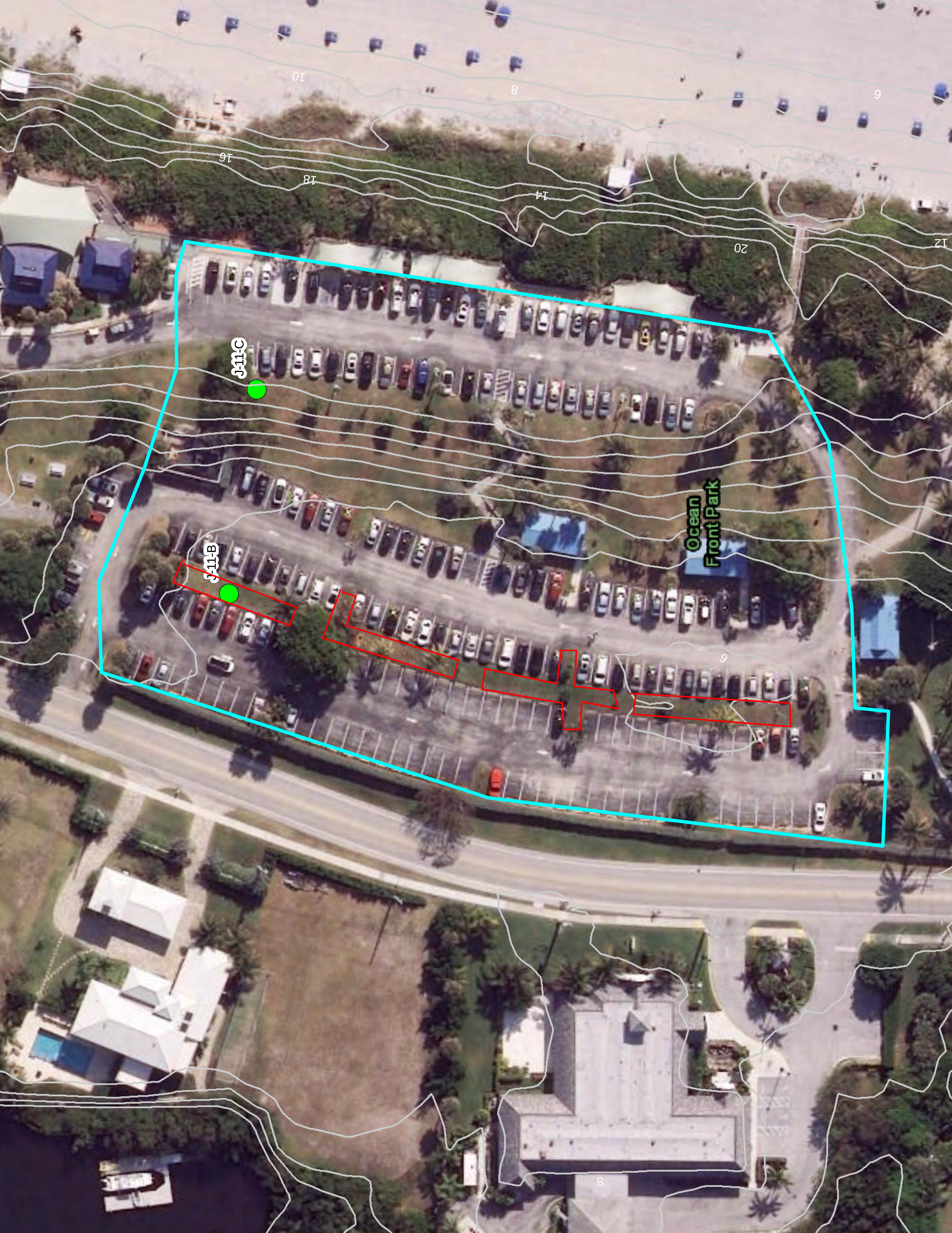
Additional Description:
Install a swale at the head of the parking spaces before the water drains down the hill. Water will infiltrate.</td><td>Proposed Retrofit Location:

Caption: The curb could be removed and replaced by a swale.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 2:37 PM</td><td>Staff Initials: RAC/ESB</td></tr>
</table>

J-11B



GREAT OP. TO DEMONSTRATE DIFF TECHNOLOGIES AND PLANTS FOR LANDSCAPERS AND BUILDERS !!
ADD SHADE TREES TO INCREASE CANOPY INTERCEPTION AND PROVIDE ED. ON NATIVE TREES.
POROUS CONCRETE AND PAVER DEMONSTRATION (DIFFER TECHNOLOGIES)
BIOSWALE W NATIVE VEG DEMO FOR BUSINESS AND LANDSCAPERS
Google Earth
© 2018 Google
Report a problem



J-11-C
J-11-B
Ocean Front Park

Site Identification Number: J-11-D

EXISTING CONDITIONS

Land use(s) of contributing area:
Highway/Roads
Open Space/Parks
Additional Description:
Stormwater is running off one side of the park down the hill.

General Site Photograph:

Caption: Water draining from this parking lot flows to the right and down the slope.

Description of existing BMP(s):
Catch basins.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
-None Selected-

Additional Description:
Install a bio retention system at the base of the hill in the green space, possibly including some trees for shade.

Proposed Retrofit Location:

Caption: The sand is washed out from around the root system of these trees at the edge of the parking lot. The bioretention area could be installed at the base of the grassed slope.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 2:42 PM	Staff Initials: RAC/ESB

<table>
<tr><th colspan="2">Site Identification Number: J-12-A</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
Commercial/Industrial
Additional Description:
Mix of single-family residential, commercial, trailer-homes.</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: Central fountain location.</td></tr>
<tr><td>Description of existing BMP(s):
None</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? No</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Bioretention Area
Sand/Organic Filter

Additional Description:
Central fountain area is a good location for a demonstration bioretention area. The runoff from N Ocean Blvd flows down the entrance road to the fountain area and beyond.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: The gas station at the corner of Briny Breezes entry and N Ocean Blvd flows directly down to the fountain area. This is a good location for a sand filter, and we could add a bio swale, but the site would lose two public parking spaces.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:Pavement reduction</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 11:26 AM</td><td>Staff Initials: RAC, ESB</td></tr>
</table>

Site Identification Number: J-12-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
-None Selected-
Additional Description:
Trailer homes

General Site Photograph:

Caption: This area is the low point at the base of the Briny Breezes community.

Description of existing BMP(s):
Drainage inlets

Observations about Site Maintenance:
The existing catch basin is completely clogged.

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Water Quality Swale

Additional Description:
Briny Breezes drains to down to the Intracoastal. At the existing low point, add a trench drain, create small bioretention swale in the green space.

Proposed Retrofit Location:

Caption: The proposed retrofit is to install a trench drain in place of the catch basin across the road to e new bioretention area in the grass. The bioretention area would infiltrate.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 11:46 AM	Staff Initials:

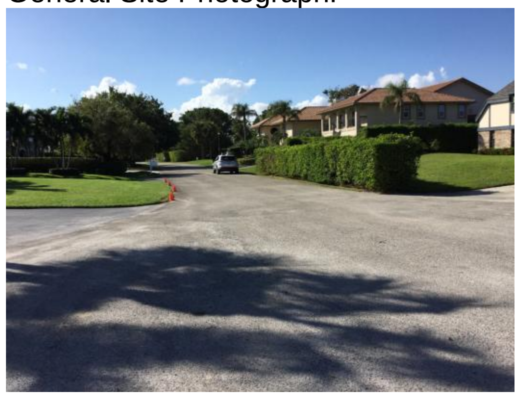
<table>
<tr><th colspan="2">Site Identification Number: J-13</th></tr>
<tr><th colspan="2">EXISTING CONDITIONS</th></tr>
<tr><td rowspan="2">Land use(s) of contributing area:
Residential
-None Selected-
Additional Description:
Narrow street with some remnant existing swales.</td><td>General Site Photograph:
</td></tr>
<tr><td>Caption: Hersey Street is flat, and appears to have originally had swales on both sides of the road. These have been filled or regarded as houses are updated.</td></tr>
<tr><td>Description of existing BMP(s):
No</td><td rowspan="2">Observations about Site Maintenance:</td></tr>
<tr><td>Is the site on Septic? Yes</td></tr>
<tr><th colspan="2">PROPOSED RETROFIT</th></tr>
<tr><td rowspan="2">Potential Retrofit BMP(s):
Bioretention Area
Other

Additional Description:
Street is pretty flat, could possibly add small narrow wet swales, or perhaps permeable pavement.</td><td>Proposed Retrofit Location:
</td></tr>
<tr><td>Caption: The road is already paved with pavers. This is an opportunity for pervious pavement and/or pavers.</td></tr>
<tr><td colspan="2">Potential Non Structural Controls:</td></tr>
<tr><td>Date and Time of Site Visit: Oct 16, 2017, 11:54 AM</td><td>Staff Initials: RAC/ESB</td></tr>
</table>

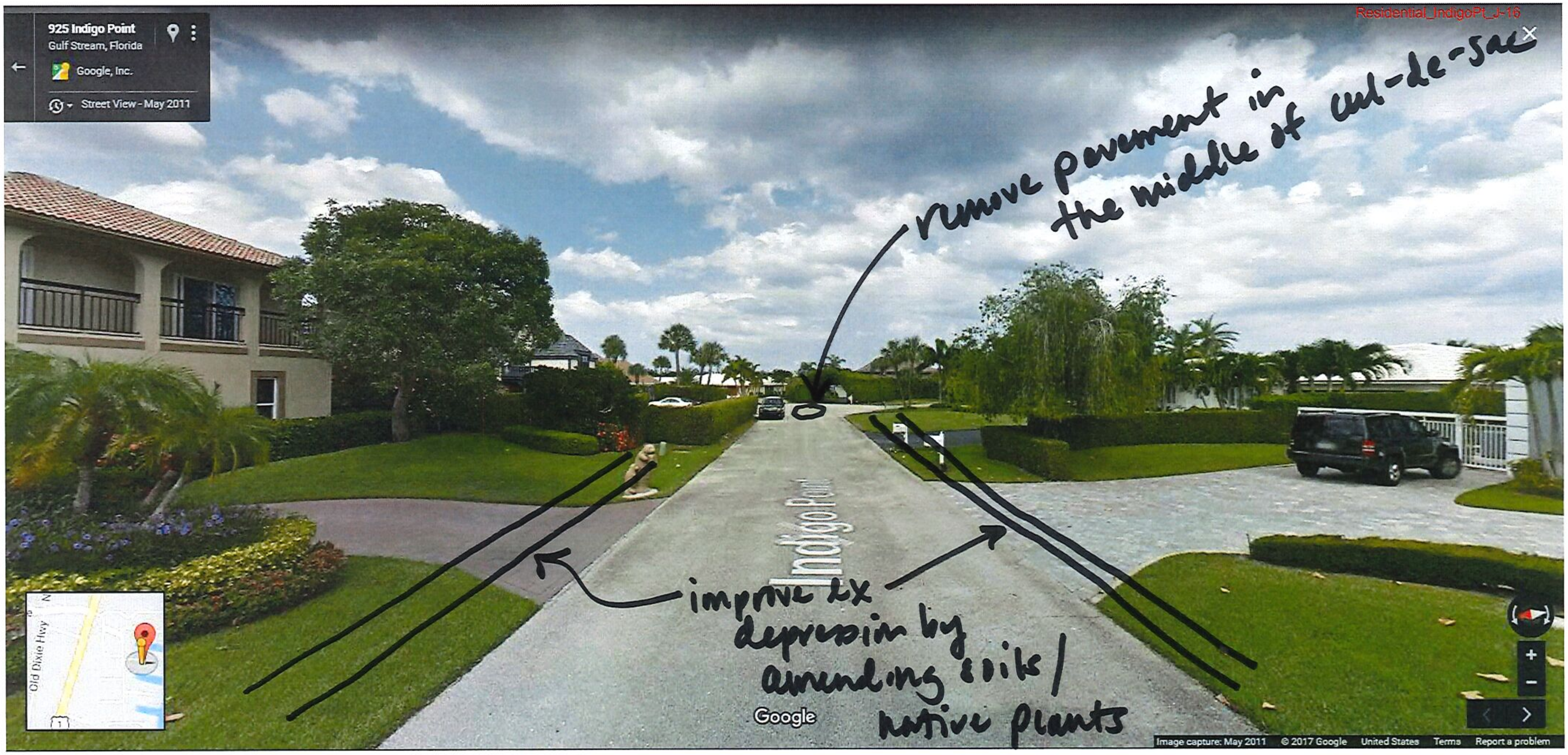
J-13


38 Hersey Dr
Ocean Ridge, Florida
Google, Inc.
Street View - May 2011
Residential_HerseyDr_J-13
Hersey Dr
BIOSWALES
PERMEABLE
PAVERS/PAVEMENT
Banyan Blvd
Google
Image capture: May 2011 © 2017 Google United States Terms Report a problem

Site Identification Number: J-15	
EXISTING CONDITIONS	
Land use(s) of contributing area: Golf Course -None Selected- Additional Description: Golf course along A1A.	General Site Photograph:  *Caption: Private golf course.*
Description of existing BMP(s): None, but brick pavers at entrance.	Observations about Site Maintenance:
Is the site on Septic? No	
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Other -None Selected- Additional Description:	Proposed Retrofit Location:  *Caption: Reduce fertilizer use, use native grasses, enhance buffer.*
Potential Non Structural Controls:Reduce fertilizer. Enhance buffers. Keep pavers. Native grasses along course while possible.	
Date and Time of Site Visit: Oct 16, 2017, 4:17 PM	Staff Initials: KM,JR

Site Identification Number: J-16	
EXISTING CONDITIONS	
Land use(s) of contributing area: Residential Highways/Roads Additional Description: Residential, drains to intercoastal waterway. Minimal frontage. Neighbor says no flooding issues.	General Site Photograph:  *Caption: Cul-de-sac in residential area with septic.*
Description of existing BMP(s): Depressions flow to existing catch basins. Is the site on Septic? Yes	Observations about Site Maintenance: House being constructed. No visible erosion controls.
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Bioretention Area Other Additional Description: Remove impervious in cul-de-sac. Swales enhanced with treatment. May need to line to reduce potential for movement of septic to waterway.	Proposed Retrofit Location:  *Caption: Remove impervious at cul-de-sac. Enhance treatment to swales by amending soils with organics.*
Potential Non Structural Controls:Remove impervious area. Replace septic.	
Date and Time of Site Visit: Oct 16, 2017, 3:54 PM	Staff Initials: JR, KM

J-16


925 Indigo Point
Gulf Stream, Florida
Google, Inc.
Street View - May 2011
Residential_IndigoPt_J-16
remove pavement in the middle of cul-de-sac
Indigo Point
improve ex depression by amending soils/ native plants
Google
Old Dixie Hwy
Image capture: May 2011 © 2017 Google United States Terms Report a problem

Site Identification Number: J-17

EXISTING CONDITIONS

Land use(s) of contributing area:
- Commercial/Industrial
- Highways/Roads

Additional Description:
Two lane divided highway, bike lane, 6.5 no parking lane

General Site Photograph:

Caption: Federal Highway ROW

Description of existing BMP(s):
None

Observations about Site Maintenance:

Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
- Water Quality Swale
- Other

Additional Description:
Move bike lane adjacent to curb. Move 6.5 foot no parking lane adjacent to existing roadway. Make bike lane permeable. Make no parking lane water quality swale or bumpouts with native landscaping for filtering.

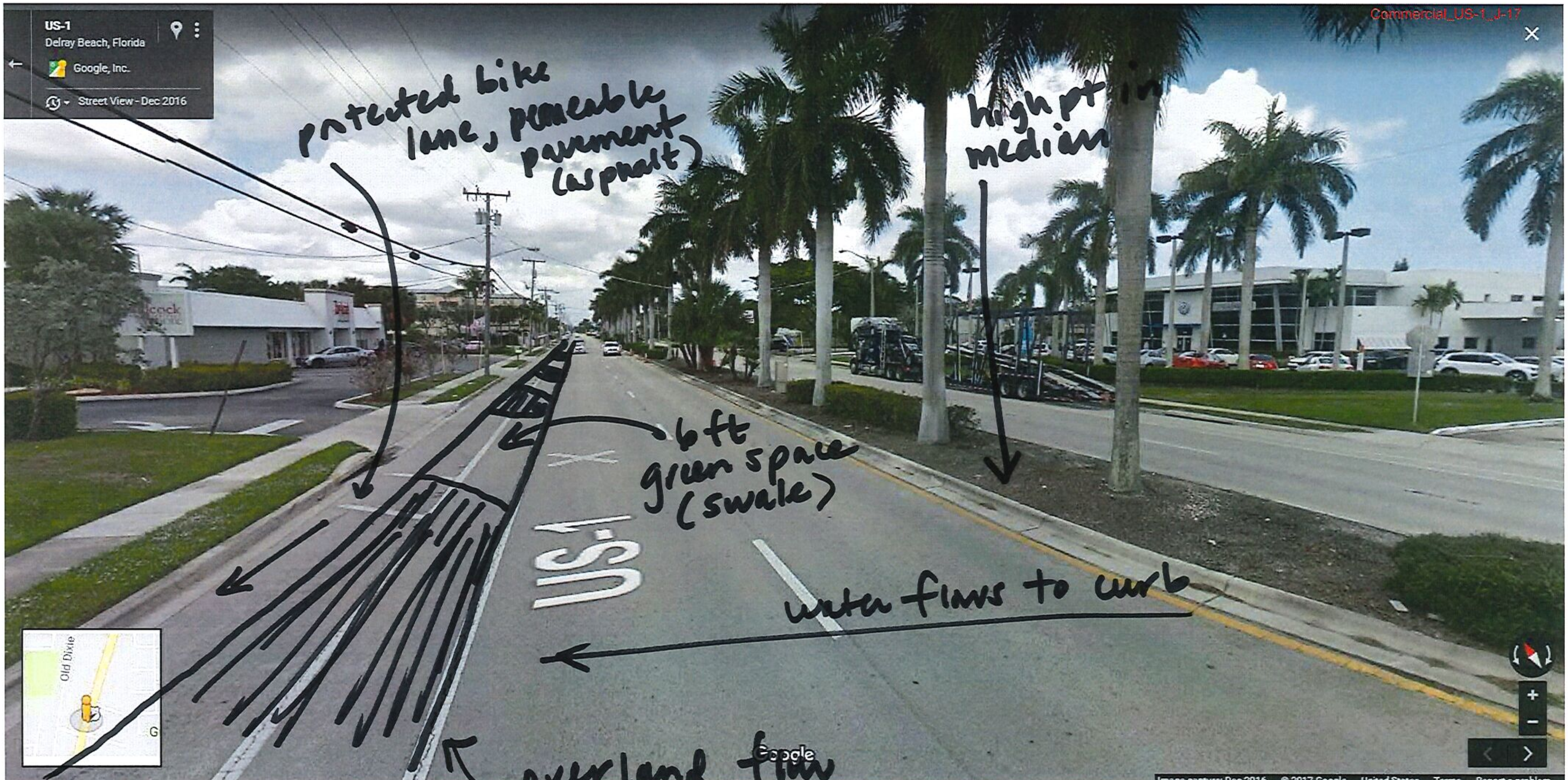
Proposed Retrofit Location:

Caption: Reduce and treat impervious by making a protected pervious bike lane and pervious filter

Potential Non Structural Controls:Remove impervious area in areas with no parking. Coordinate with local businesses for parking requirements.

Date and Time of Site Visit: Oct 16, 2017, 3:12 PM	Staff Initials: JR, KM

#1 J-17



overland flow or curb cuts.

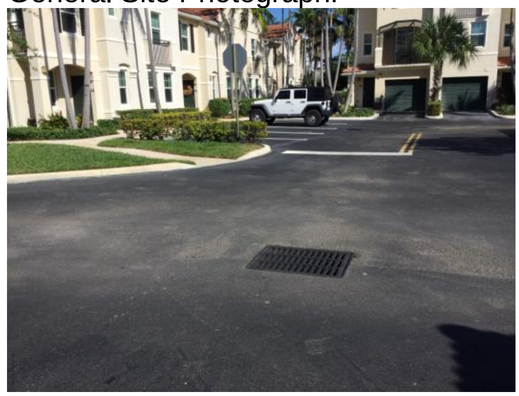
Site Identification Number: J-18A	
EXISTING CONDITIONS	
Land use(s) of contributing area: Residential -None Selected- Additional Description: Apartment complex	General Site Photograph: *Caption:*
Description of existing BMP(s): None, just catch basins. Is the site on Septic? No	Observations about Site Maintenance: Route 1 median twice as wide as further south at site J17. No additional parking lane.
PROPOSED RETROFIT	
Potential Retrofit BMP(s): Subsurface Chambers Other Additional Description: Install underground chamber with potential treatment/filtering. Alternatively or in combination, install permeable pavement on parking spots.	Proposed Retrofit Location:  *Caption:*
Potential Non Structural Controls:Pet waste stations with bags.	
Date and Time of Site Visit: Oct 16, 2017, 3:23 PM	Staff Initials: KM, JR

Site Identification Number: J-18-B

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
-None Selected-
Additional Description:
Apartment complex

General Site Photograph:



Caption: Apartment complex.

Description of existing BMP(s):
None, just catch basins.

Is the site on Septic? No

Observations about Site Maintenance:
Roof downspouts all connected. High impervious area in complex.

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Other
-None Selected-

Additional Description:
Roof downspout disconnection, rainwater harvesting, e.g., rain barrels and cisterns. Use water for plant irrigation onsite

Proposed Retrofit Location:

Caption: Disconnect roof downspouts.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 3:38 PM

Staff Initials: KM, JR

Subwatershed M

Site Identification Number: M-1

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
Highways/Roads
Additional Description:
Roads, sidewalk, roof

General Site Photograph:

Caption: Downtown shopping, art walk, restaurants

Description of existing BMP(s):
None. Tree pits with flexipave

Is the site on Septic? No

Observations about Site Maintenance:
None

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Exfiltration Trench

Additional Description:
Tree trench, tree pits, Stormwater bumpouts

Proposed Retrofit Location:

Caption: Stormwater bumpouts at crosswalks. Option for tree trenches along sidewalk.

Potential Non Structural Controls:Sweeping regularly

Date and Time of Site Visit: Oct 16, 2017, 2:34 PM	Staff Initials: JR, KM

M-1

USE MULTIPLE GREEN STREET OPTIONS AS DEMO FOR DOWNTOWN

Site Identification Number: M2

EXISTING CONDITIONS

Land use(s) of contributing area:
Golf Course
-None Selected-
Additional Description:
Golf course parking

General Site Photograph:

Caption: Main road at Sherwood Forest golf course, existing swale.

Description of existing BMP(s):
Median swale with no curb cuts along main road to golf course.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:

Proposed Retrofit Location:

Caption: Improve swale with curb cuts with concrete flume to center of swale, every 50 ft. Raise existing catch basin in swale to take overflow. Also improve adjacent parking lot landscaping in medians. Create swales.

Potential Non Structural Controls:

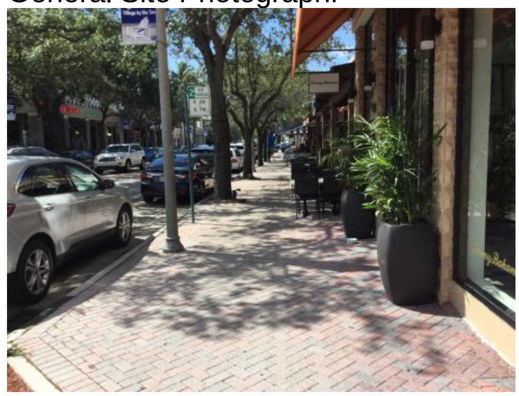
Date and Time of Site Visit: Oct 17, 2017, 10:17 AM	Staff Initials: KM/RC

Site Identification Number: M-3

EXISTING CONDITIONS

Land use(s) of contributing area:
Commercial/Industrial
Highways/Roads
Additional Description:
Downtown shopping district

General Site Photograph:



Caption: Shopping district with restaurants.

Description of existing BMP(s):
None. Existing tree pits with flexipave. Heaving due to roots.

Observations about Site Maintenance:
Animal waste sign and bags at adjacent park

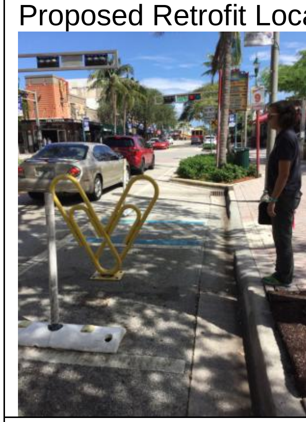
Is the site on Septic? No

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Bioretention Area
Exfiltration Trench

Additional Description:
Tree trenches, Stormwater bump outs,

Proposed Retrofit Location:

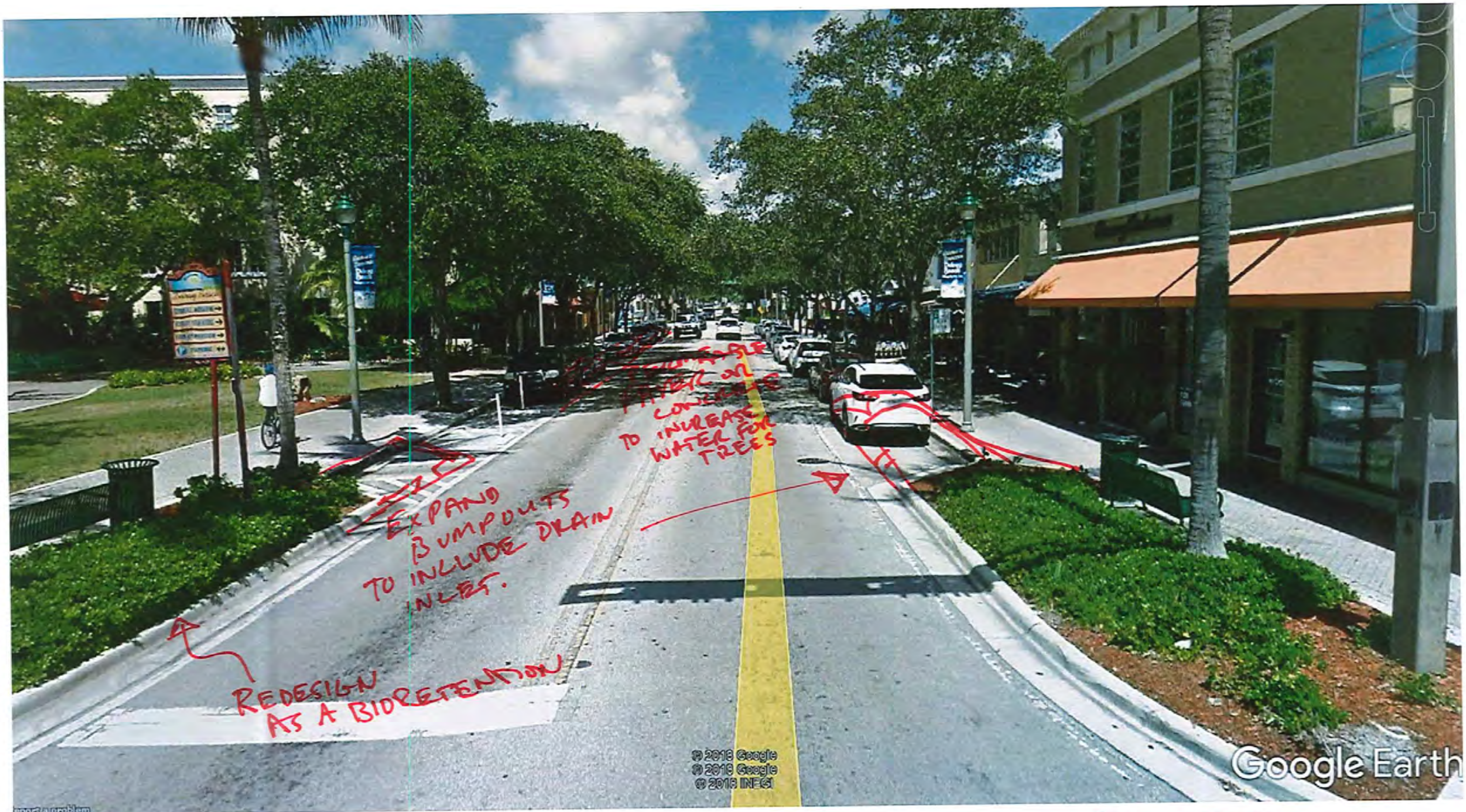


Caption: Retrofit intersection to stormwater bumpout. Tree trenches along street.

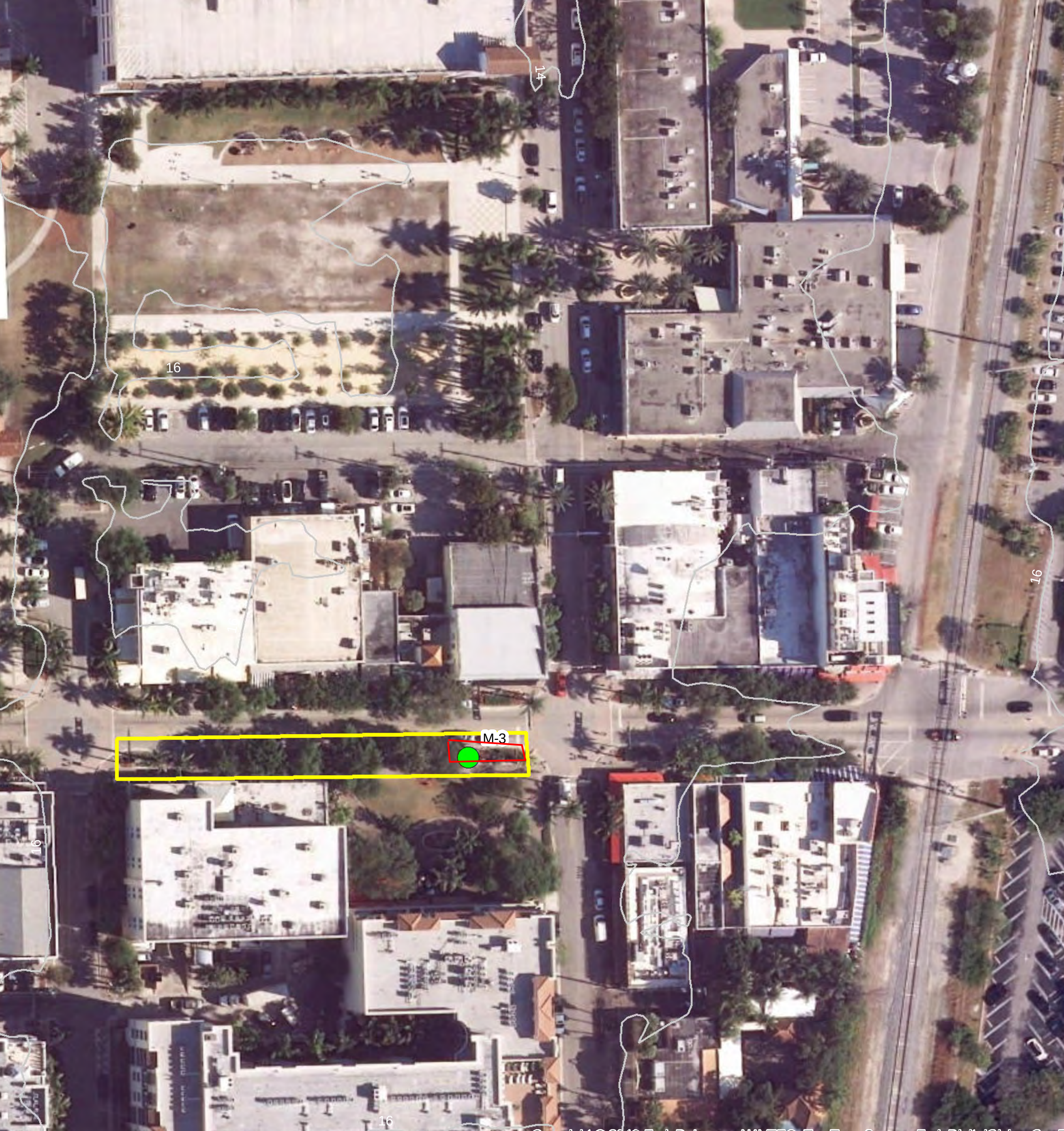
Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 2:07 PM	Staff Initials: JR, KM

M-3



DEMO DOWNTOWN GREENSTREETS


14
16
M-3
16
16
16

Site Identification Number: M-4

EXISTING CONDITIONS

Land use(s) of contributing area:
Residential
Highways/Roads
Additional Description:
Residential main road

General Site Photograph:

Caption: Del Ida Park Historic district

Description of existing BMP(s):
Depressed dry grass swales, newly constructed bump out boxes with landscaping, but no curb cuts in the bump outs.

Is the site on Septic? No

Observations about Site Maintenance:

PROPOSED RETROFIT

Potential Retrofit BMP(s):
Water Quality Swale
-None Selected-

Additional Description:
Convert dry swales to re direct runoff to centrally located GI practice with more infiltration potential/more filtering to avoid pooling. Curb cuts would be needed on existing bump outs. No catch basins visible.

Proposed Retrofit Location:

Caption: Convert dry swales to redirect runoff to centrally located GI practice with more infiltration potential/more filtering to avoid pooling. Curb cuts would be needed on existing bumps.

Potential Non Structural Controls:

Date and Time of Site Visit: Oct 16, 2017, 2:46 PM	Staff Initials: KM, JR

Boynton Inlet Contributing Area Watershed Management Plan

Attachment C

CWP Code and Ordinance Worksheet

Center for Watershed Protection's Code and Ordinance Worksheet

Center for Watershed Protection

The Code & Ordinance Worksheet

A Tool for Evaluating the Development Rules in Your Community

2017

3290 North Ridge Road, Suite 290 • Ellicott City, MD 21043
www.cwp.org • info@cwp.org

Cover photo credit (upper right): San Francisco Public Utilities Commission

All photos by Center for Watershed Protection unless otherwise noted.

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- Juli Beth Hinds, Orion Planning + Design
- Adrienne Kotula, James River Association
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- Neal Shapiro, City of Santa Monica
- Jeff Shinrock, Red Eagle Development
- Aaron Villere, National Association of City Transportation Officials

The Center would like to acknowledge the following sources that were useful in developing the revised Code and Ordinance Worksheet questions:

- *Tackling Barriers to Green Infrastructure: An Audit of Local Codes and Ordinances* (University of Wisconsin Sea Grant, and 1,000 Friends of Wisconsin, 2014)
- *Water Quality Scorecard: Incorporating Green Infrastructure Practices at the Municipal, Neighborhood and Site Scales* (EPA, 2007)
- *Ordinance Assessment* (Chicago Metropolitan Agency for Planning, 2013)

Introduction to Better Site Design and the Code and Ordinance Worksheet

Published in 1998, the Center for Watershed Protection's Better Site Design Handbook outlines 22 model development principles for site design that act to reduce impervious cover, conserve open space, prevent stormwater pollution, and reduce the overall cost of development. The model development principles were created through a national Site Planning Roundtable, a consensus-based process initiated to create more environmentally sensitive, economically viable and locally appropriate development. The roundtable consisted of over 30 influential individuals from various organizations around the nation, including environmental groups, transportation officials, planners, realtors, homebuilders, land trusts, fire officials, county managers and more.

For each model development principle, the Better Site Design Handbook summarized practices that were recommended around the nation at the time, outlined their economic and environmental benefits, addressed perceived and real barriers, and presented national case studies. The Better Site Design Handbook also presented a process for evaluating local development regulations based on the model development principles so that strategic code changes could be made in the community. The tool provided to facilitate an in-depth review of codes and ordinances at the local level was the Code and Ordinance Worksheet (COW). Since its creation, the COW has been used by the Center to conduct 13 local site planning roundtables and review local development regulations in over 75 communities in Maryland, Pennsylvania, Virginia, South Carolina, Ohio, Wisconsin, New York, Alabama, and the District of Columbia. Other organizations, such as the Cumberland River Compact, Southeast Watershed Forum, Pennsylvania Environmental Council, Potomac Conservancy, James River Association, and Tennessee Valley Authority, have used the Better Site Design process to make updates to their local codes or to conduct their own roundtables.

Runoff Reduction Practices

Runoff reduction practices, often interchangeably referred to as Green Infrastructure practices or Low Impact Development practices, are stormwater treatment strategies that aim to replicate pre-development hydrology by reducing runoff volume. Many runoff reduction practices integrate trees and other vegetation, and runoff volume is reduced through disconnecting impervious cover, infiltration, evapotranspiration, collection and re-use, and other mechanisms.

Green rooftop

Porous asphalt

Rain garden

Cistern

Why an Update?

Much has happened in the world of stormwater management and site planning since the release of the Better Site Design Handbook in 1998. Programmatic and regulatory changes driven by the advent of the National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) program have advanced the thinking about how stormwater is managed on development sites. The result has been a shift from primarily using ponds, wetlands and other large practices that detain and slowly release runoff to the integration of small stormwater management practices throughout the landscape to promote infiltration and reduce runoff. This shift has necessitated another look at how local development regulations can influence and sometimes create barriers to the use of these "runoff reduction" practices.

Since the Better Site Design Handbook was published, the development of total maximum daily loads (TMDLs) for numerous urban streams and rivers has created a need for MS4s to install stormwater management practices on developed sites as retrofits. Stormwater ordinance language that creates barriers to installing runoff reduction practices on new or redevelopment sites can also act to discourage their use as retrofits.

The 22 model development principles and the COW were developed during a time when seminal research on the important connection between impervious cover and stream health had recently been published (CWP, 1998; Schueler, 1994). New suburban development was widespread, and many communities were concerned that their local codes and ordinances created standards that resulted in excessive impervious cover (Figures 1-3). Therefore, the original COW was primarily intended to influence new residential and commercial development and, as a result, most of the COW questions applied to low or medium density (suburban) neighborhoods. The update recognizes that while the overall goals of reducing impervious cover, conserving natural areas and preventing stormwater pollution can apply to any community, some of the COW questions are not relevant for certain types of development. The instructions for using the revised COW explain how to determine which questions are most applicable for the type of development that is most prevalent in your community (e.g., new rural, suburban or urban development, redevelopment).

Figure 1. This low-density residential street accommodates two travel lanes and two on-street parking lanes, despite the fact that each house has a three-car garage and large driveway and will rarely if ever need that much on-street parking.

Figure 2. This cul-de-sac with a 50-foot radius creates a large bulb of rarely-used impervious cover.

Figure 3. This commercial parking lot sits largely empty because it was not designed for local parking demand (Photo credit: Todd Gill, Fayetteville Flyer).

The COW update also considered revised standards and supporting research on topics such as recommended stream buffer widths, parking ratios, parking stall dimensions needed to accommodate today's vehicle sizes, differing setbacks for fire-prone regions versus humid regions, and the impact of state water law on the use of rainwater harvesting practices.

Who Should Use the COW?

The COW is intended to help communities evaluate their local development regulations to identify revisions that allow or require site developers to minimize impervious cover, conserve natural areas and use runoff reduction practices to manage stormwater. The COW can be completed by municipal staff or by non-governmental organizations who wish to improve the environmental footprint and character of development in their community. It is a tool that can be used by communities who are experiencing or anticipating moderate to high pressure for new development (urban, suburban, or rural) or redevelopment.

In addition to the environmental benefits of reduced runoff and protection of natural areas, other benefits of using this tool to revise local codes and ordinances include:

- Stormwater permitting agencies are increasingly requiring the use of Runoff Reduction practices to the maximum extent practical, so removing barriers to their use can facilitate meeting permit requirements. Some state MS4 Permits (e.g., Maryland, Georgia, California, Connecticut, West Virginia) even require that permittees review their local codes and ordinances and revise them to remove barriers and better integrate Runoff Reduction practices.
- Communities who are embracing Runoff Reduction, either voluntarily or to meet volume-based stormwater management requirements or to help reduce combined sewer overflows, can better meet their goals by removing local code barriers.
- Reducing the impact of new and redevelopment can help MS4s with local or regional TMDL requirements to stay "under the cap" while still allowing for growth.
- Changing regulations to promote developments that conserve natural areas and use runoff reduction practices can support both resiliency planning and sustainability planning efforts.
- Better Site Design can reduce construction costs for developers and increase profits.
- Better Site Design also results in safer streets, neighborhood designs that promote a sense of community, more open space for recreation, and more walkable neighborhoods.

How to Use the COW

The COW allows an in-depth review of the codes and ordinances (i.e., the development rules) that shape HOW development occurs in your community. Programs, institutional frameworks and informal policies are not included in this review unless specifically documented in the codes or in a plan, manual, or other document referenced by the code. Additional resources on conducting local stormwater, forestry, wetland or other local environmental program reviews are provided in the Resources section of this document.

The model development principles and the COW are not intended to address WHERE development occurs. Rather, the assumption is that development is already planned and communities completing the COW wish to reduce the impact of expected development on local water resources, while improving neighborhood character and reducing construction costs. Many other tools and resources are available for communities who wish to change where development happens, most of which fall under the umbrella of watershed planning and Smart Growth. A list of resources is provided in the Resources section of this document.

The COW worksheet is subdivided into four categories:

1. Residential Streets and Parking Lots (Principles 1 - 10)
2. Lot Development (Principles 11 - 16)
3. Conservation of Natural Areas (Principles 17 - 22)
4. Runoff Reduction

The first three sections consist of a series of questions that correspond to each of the model development principles. Section four contains new questions added to address stormwater management standards, particularly the inclusion of runoff reduction practices. Points are assigned based on how well the current development rules agree with the site planning practices identified in the questions. The revised COW provides some background and rationale for each principle and related questions. The Better Site Design Handbook (CWP, 1998) provides additional background and research on each principle.

Preparing to Complete the Code and Ordinance Worksheet

The first step is to identify the development rules that apply in your community. Few communities include all of their rules in a single document. Rather, the development process is usually shaped by a mix of local regulations and policies, each of which may be administered by a different agency. In some cases, state and federal agencies may also exercise some authority over the local development process (e.g., wetlands, design of larger roads, stormwater management). Where this is the case, the local code will reference these state or federal standards. This task can be streamlined by having a knowledgeable person (e.g., a local land use planner or plan reviewer) read through the COW questions and make an initial list of codes and ordinances that apply for the particular community. A list of potential documents to gather is provided in Table 1.

Six Steps for Using the Code and Ordinance Worksheet

1. Gather codes, ordinances, and other documents
2. Identify authorities who administer the rules
3. Select the appropriate COW questions for your community
4. Review the regulations to find answers to the COW questions
5. Use the COW Scoring Spreadsheet to record answers, points and notes
6. Identify priority actions for the short and long term

The next step is to gather the relevant codes and ordinances. Most municipal ordinances, as well as state and federal regulations, are available online. The COW Scoring Spreadsheet provided at https://owl.cwp.org includes a worksheet to list the relevant codes and the link where each can be found. As you complete the review, you may find it necessary to also obtain design manuals, review checklists, guidance documents or specifications that are referenced in the codes in order to answer the COW questions. So identifying and gathering the relevant documents is an iterative process.

Table 1. Relevant Documents for Completing the COW
Zoning Ordinance
Subdivision Ordinance
Street Standards or Road Design Manual
Parking Requirements
Building Code
Stormwater Management, Rainwater or Drainage Ordinance
Stormwater Management Design Manual
Buffer or Floodplain Regulations
Environmental Regulations
Tree Protection or Landscaping Ordinance
Erosion and Sediment Control Ordinances
Fire Code
Grading Ordinance
Health Codes

Next, you must identify the local, state, and federal authorities that actually administer or enforce the development rules within your community. This step should be relatively easy and will provide a better understanding of the intricacies of the development review process and helps identify key members of a future local roundtable focused on changing the development rules. The COW Scoring Spreadsheet provides a worksheet for recording the agencies that influence development in your community and listing specific contacts. Space is provided for local agencies, as well as state and federal agencies.

Completing the Worksheet

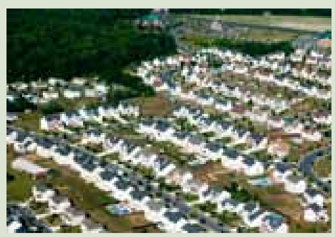
Once you have located the documents that outline your development rules and identified the authorities responsible for development in your community, you are ready for the next step. You can now use the COW Scoring Spreadsheet to compare your development rules to the model development principles. This may be a good project for an intern or graduate student to work on with input from municipal staff. In many communities that have used the COW, a non-profit organization has taken the lead on completing the worksheet, in partnership with municipal staff. Both approaches can greatly reduce the time commitment by local staff.

The worksheet is presented in the next section of this document and includes 94 questions, as well as the 22 model development principles for reference. Each question focuses on a specific site design standard, such as the minimum diameter of cul-de-sacs, the minimum width of streets, or the minimum waterway buffer width. The codes, ordinances, and other related documents you have compiled will be used to answer the questions. If your development rule agrees with the site planning benchmark, you are awarded points. If your development rule does not agree with

Selecting the COW Worksheet that Best Fits Your Community

The developed landscape is a continuum from natural areas to the urban core. Some regional planners identify transects in land use forms across this continuum with multiple breaks in their classifications. The COW Scoring Sheet simplifies these breaks with four categories: rural, suburban, urban and highly urban.

Rural
The rural landscape is characterized by open space dominated by woodland, agriculture, and other open areas. It contains scattered residential lots and subdivisions on relatively large lots. There is an auto-oriented land use pattern with limited non-residential uses. Development is primarily served by on-lot sewer and water systems. (Photo credit: Dorothy Cappiella)



Suburban
The suburban landscape is dominated by residential subdivisions containing primarily single-family housing, as well as concentrations of non-residential land uses. This landscape has an auto-oriented transportation network and can be served by public sewer and water systems or by on-lot systems. Open areas are present with the opportunity for conservation practices, buffers for natural areas and open space management. (Photo credit: Matt Rath)

Urban
The urban landscape includes historic population centers that provide commerce, civic, and cultural activities for the surrounding area. These landscapes have a pedestrian-orientation with sidewalk systems and are often served by mass transit. Public sewer and water systems are the norm here. Urban landscapes include both medium and high density areas and may experience redevelopment as well as some new construction on the few remaining unbuilt areas.

Highly Urban
Highly urban landscapes are similar to urban landscapes except that the primary development activity here is redevelopment. (Photo credit: Ted Eytan)

the site planning benchmark, or does not address it at all (in other words, the code is "silent" on the issue) you are not awarded points.

The COW can be used by rural, suburban and urban communities experiencing new development, as well as urban communities where redevelopment is prevalent. However, not all questions will be applicable in all communities. The COW Scoring Spreadsheet provides space in which to record your answers to the COW questions. The spreadsheet contains a separate section for each major community type: rural, suburban, urban and highly urban. Select the worksheet that is most appropriate for the type of development occurring in your community. Questions that are not applicable to each type of development have been grayed out and the total possible score has been adjusted accordingly.

If the mix of questions contained in the rural, suburban, urban and highly urban worksheets aren't quite right for your community, it is possible to tailor the COW questions and scoring for your municipality. Simply complete all the relevant questions in any of the four worksheets (overriding the grayed out cells where necessary). Then adjust the scoring by changing the number of total possible points to reflect the total possible score for the questions you answered. This tailoring may be useful when a specific set of questions do not apply to your community (e.g., tree conservation or tree planting questions in an arid desert environment, or rainwater harvesting questions in a state where water rights law prohibits this practice) or where local conditions are such that the pre-assigned questions for your community type are not an exact fit.

For each question, if the answer is Yes, enter the associated number of points in the "Yes" column. Most questions are worth one point for a Yes answer, but BLUE questions are worth two points and ORANGE questions are worth 0.5 points. If the answer is No; the question is not applicable (for example, the question is about a requirement in the open space ordinance but your community does not have an open space ordinance); or the codes do not address the question at all, enter an "x" in the appropriate column (No, N/A, or Codes are Silent). No points are given for these answers. Note that "Codes are Silent" is only an option for certain questions. Other questions will have a clear Yes or No answer (e.g., Does the buffer ordinance outline prohibited and allowable uses?").

Use the Notes column to record details about your responses, such as specific code language or a reference to the specific code section where the answer was found. Other notes that could be made in this column include whether or not the recommended standard is something the municipality has authority over versus a state or federal authority, and notes on any impending updates to the local codes or ordinances. This will assist later on with determining the next steps and prioritizing the necessary changes.

Calculating Your Score

The total number of points possible varies with the community type; therefore the final score is presented as a percentage of the total possible points. The COW Scoring Spreadsheet automatically calculates the total points received as well as the percentage. Your overall score provides a general indication of your community's ability to support environmentally sensitive development. As a general rule, if your overall score is lower than 80%, then it may be advisable to systematically reform your local development rules. However, it is important not to get hung up on the score or to compare it to other jurisdictions. The COW is intended to provide a constructive assessment of the current development regulations and identify the top opportunities for improvement.

How to Use the Results

Once you have completed the worksheet, go back and review your responses. For COW questions with "No" or "Codes are Silent" answers, evaluate their relative importance in your community. The next step is to use the COW benchmarks to develop short-term (1-3 years) and long-term (3-5 years) action items for the most important items. These action items can be recorded in the Action Items worksheet of the COW Scoring Spreadsheet. Some factors to consider in determining relative importance and whether actions are short or long term include:

- Time the revisions with planned updates to codes and ordinances
- Focus on the code changes that are under municipal control
- Focus on codes that give you the most bang for your buck
- Target specific areas that need the most improvement first (e.g., development rules that govern road design)
- Consider local support/local importance of specific principles
- Prioritize changes that remove direct barriers
- Consider relative ease of proposed changes (e.g., adopting a stream buffer ordinance may be a longer road than changing parking lot design standards)

When State or Federal Rules Apply

The goal of the local code and ordinance review is to identify changes that can be made at the local level. However, sometimes the local codes reference a state or federal standard which cannot be changed through a local site planning roundtable process. Communities may be able to address the identified problems through adoption of a local ordinance but the authority granted to local governments to do so varies by state.

In some states, cities, municipalities, and/or counties are granted the ability to pass laws to govern themselves as they see fit (so long as they obey the state and federal constitutions). In other states, municipalities only have the rights that are expressly granted to them by the state legislature. In these states, a city or county must obtain permission from the state legislature if it wishes to pass a law or ordinance which is not specifically permitted under existing state legislation.
https://en.wikipedia.org/wiki/Home_rule_in_the_United_States

It is important to remember that the Better Site Design principles and therefore the COW questions are not independent of each other. For example, reducing lot sizes to allow for clustering of homes can preserve significant open space and reduce overall impervious cover, but the higher density may mean having to use curb and gutter rather than open section roads, limiting some opportunities for stormwater treatment. Similarly, reducing front yard setbacks can reduce overall imperviousness by reducing driveway length; however, this may result in a need to provide on-street parking, making road widths wider and ultimately cancelling out the reduction in impervious cover achieved through shorter driveways. In each situation, tradeoffs must be made. Users of the COW may want to decide which specific design principles are more important for their communities given the advantages and potential drawbacks of each practice. This can assist with identifying the top code changes to move forward on once the COW has been completed.

This review also directly leads into the next step: making the recommended changes. Municipal staff may simply proceed with the short-term changes through their usual process of updates. Another option is a site planning roundtable process conducted at the local government level. The primary tasks of a local roundtable are to systematically review existing development rules and then determine if changes can or should be made. By providing a much-needed framework for overcoming barriers to better development, the site planning roundtable can serve as an important tool for local change. The Better Site Design Handbook (CWP, 1998) provides detailed information on how to conduct a site planning roundtable.

The COW is a useful tool to identify actions for improving local development regulations. However, having "good" codes and ordinances only works if their provisions are actually implemented. Therefore, the importance of implementing and enforcing the codes cannot be overstated. Some useful publications for designing effective code and ordinance language are listed in the Resources section of this document.

Code and Ordinance Worksheet

Residential Streets and Parking Lots

These principles focus on those codes, ordinances and standards that determine the size, shape, and construction of parking lots and roadways.

1. Street Width

<u>Principle</u>: Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access. These widths should be based on traffic volume.

Figure 4. Road widths are minimized in this Savannah, GA neighborhood; yet are wide enough to allow access for emergency vehicles

In many cities and jurisdictions, local street design manuals and standard plans require or incentivize roadways that are overbuilt for motor vehicle traffic, with wide travel-ways and large corner radii that increase impervious surfaces while increasing risk to street users. Revising local street standards to consider design speed, street type and traffic volume presents a significant opportunity to reduce impervious cover, by allowing for more compact roadways and intersections. When curb extensions are permitted, they unlock street space to introduce pervious surface and integrate runoff reduction practices within the street environment. Permeable pavements in roadways also provide a means to retain stormwater away from the street surface.

While there may be opportunities to reduce street widths on arterial roads, high volume roads and/or non-residential streets, their design is often determined by state standards and are therefore not addressed in this local code review.

Questions		Points
1	**Is the minimum roadway width allowed for streets in neighborhoods with low volume roads (less than 400 average daily trips according to AASHTO, 2001) between 18-22 feet (where bicycle lanes are not present)?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
2	**Are curb extensions that narrow the roadway (such as pinchpoints, gateways, and chicanes) permissible?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

Questions		Points
3	**Are permeable paving materials allowable on low-volume streets and/or parking lanes?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

2. Street Length

Principle: Reduce total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

Minimizing street length in residential neighborhoods can reduce the overall imperviousness created by the development and also minimize the associated land disturbance. The most common street network types include grid and curvilinear (which uses a hierarchical street pattern that includes cul-de-sacs) as well as various hybrids of the two. Although grid patterns are generally less efficient than curvilinear patterns (Canada Mortgage and Housing Corporation, 2002), the grid pattern has advantages such as greater dispersal of traffic, being more pedestrian friendly, and providing greater direct access.

The best street layout option for most neighborhoods will utilize some aspects of the grid and curvilinear systems; however, there is no one street layout that is guaranteed to minimize total street length in residential developments. Generally, a more compact street network can be achieved by reducing frontage distances and side yard setbacks and by allowing narrower lots. Smaller lots clustered together (e.g., open space developments) can also reduce the total street length. Reducing the number of non-frontage roads is another strategy for minimizing street length. Traditional Neighborhood Development is another type of design that lends itself to reduced street length because of the focus on walkability and connectedness. Long streets serving only one or two homes should be discouraged.

Types of Curb Extensions

Pinchpoints

Curb extensions at mid-block or intersection corners that narrow a street by extending the sidewalk or widening the planting strip. These can include mid-block crossing locations. (Photo credit: Kevin Robert Perry)

Gateways

A curb extension located at the entrance to a neighborhood street narrows the crossing length for pedestrians and reinforces a low-speed operating environment. (Photo credit: Dongho Chang, Seattle Department of Transportation)

Chicanes

A series of narrowings or curb extensions that alternate from one side of the street to the other forming S-shaped curves can be implemented to reduce motor vehicle speeds and unlock roadway space for pervious surface or bioretention (Photo credit: thisisbossi)

Questions		Points
4	**Does the subdivision, Planned Unit Development, or Unified Development ordinance identify reducing street length as a goal of neighborhood street design?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

3. Right-of-Way Width

Principle: Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.

Similar to street width, many communities' codes specify right-of-way widths that are based on blanket application of high-volume street design standards. This results in very wide rights-of-way that require greater clearing during road construction and consume more land that could be used for housing lots. Reducing right-of-way widths can result in less clearing and encourage more compact site design.

One component of the right-of-way that actually has a benefit to being wide is the planting strip between the sidewalk and the street as well as any median strips. These areas not only provide opportunity for stormwater treatment using bioretention or other runoff reduction practices, but they can be planted with large trees to provide shade, capture rainfall, and generally beautify and improve our neighborhoods. Increasing the width of these planting strips to at least six feet (to accomodate large shade trees) can increase the overall right-of-way width but is a tradeoff that is well worth it, especially if some existing trees can be preserved.

Questions		Points
5	**Is the recommended right-of-way width for a low-volume residential street less than 45 feet?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
6	**Does the code allow utilities to be placed under the paved section of the right-of-way to limit clearing and allow a compact development footprint?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

	Questions	Points
7	**If street trees are required, is the planting area required to be at least 6 feet to provide sufficient rooting space to support large trees?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
	N/A	*0*

4. Cul-de-Sacs

Principle: Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.

A cul-de-sac is a local street open at only one end. A large "bulb" is located at the closed end to enable emergency and service vehicles to turn around without having to back up. Cul-de-sacs are a prominent feature in many contemporary residential developments and many communities require that the bulb be 60 feet or more in radius, creating a large circle of impervious cover that is never fully utilized for turning movements. The research on cul-de-sac radii shows the following:

- *AASHTO (2011) recommends a 30 foot minimum radius for residential areas. However, some state transportation agencies (e.g., Pennsylvania Department of Transportation) will not provide road maintenance funds to municipalities if cul-de-sac radius is less than 40 feet.*
- *The International Fire Code (IFC) (ICC, 2015) specifies a minimum 48 foot radius for dead end roads greater than 150 feet in length. However, the IFC also gives the local fire department authority to determine the turning radius and to select equipment that has a more narrow turning radius. Cities and towns across the country with narrow streets and tight turns have purchased specialized emergency vehicles that can operate in these environments (City and County of San Francisco Board of Supervisors, 2015). These vehicles are designed to incorporate features that improve their operability, such as rear-mounted pumpers on fire engines and use of short-jacked ladders on fire trucks.*
- *The National Fire Protection Association's 2017 standard for fire protection infrastructure for land development in wildland, rural and suburban areas (standard NFPA 1141) requires a 60 foot minimum radius. This standard is applicable for hard-to-access and rural areas as well as those communities who may not already have adopted local building or fire codes.*

Neighborhoods that use cul-de-sac turnarounds (typically suburban but sometimes urban or rural developments) can produce less impervious cover if local codes are revised to reduce the minimum cul-de-sac radius to the IFC recommendation of 48 feet. Local fire officials can also determine whether this radius can be further reduced through investment in specialized emergency vehicles.

Questions		Points
8	**Do the street or subdivision standards allow street layouts that minimize the use of cul-de-sacs?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
9	**Is the minimum radius for cul-de-sacs 48 feet or less?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
10	**Can a landscaped island be created within the cul-de-sac?**	
	YES, and the cul-de-sac must be graded to the island with an overflow to the storm drain system, so that it can be used for stormwater treatment	*2*
	YES, but curbing is required or the island must be raised, limiting its use for stormwater treatment	*1*
	NO	*0*
	CODES ARE SILENT	*0*
11	**Are alternative turnarounds such as hammerheads and loop roads allowed?**	
	YES, alternative turnarounds are specifically mentioned in the ordinance with specific design/construction guidance provided by reference	*1*
	YES, alternative turnarounds are allowed, but no specific guidance provided on design	*0.5*
	NO	*0*
	CODES ARE SILENT	*0*

Cul-De-Sac Alternatives

Each of the options shown below serve about four homes.

1. This cul-de-sac with a 50-foot radius creates about 8,250 square feet of impervious cover

2. This loop lane reduces the need for backing up of vehicles and creates about 10% less impervious cover than Option 1.

3. This cul-de-sac also has a 50-foot radius but incorporates a vegetated island. This alternative creates about 15% less impervious cover than Option 1.

4. This hammerhead or t-shaped turnaround produces about 80% less impervious cover than Option 1. This alternative is good for very short (< 200 feet) streets. (Photo Source: Google Earth)

5. Vegetated Open Channels

Principle: Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.

Many jurisdictions require curb and gutter systems along residential streets to direct stormwater runoff. By contrast, vegetated open channels that incorporate runoff reduction practices such as dry swales, bioretention, biofilters, or vegetated swales, are often prohibited in subdivision codes. Vegetated open channels remove pollutants by allowing infiltration and filtering to occur, encourage groundwater recharge and reduce the volume of runoff generated from a site. These are generally only applicable in low or medium density developments. In neighborhoods with medium to high housing densities or other conditions that limit the use of vegetated open channels, runoff reduction practices can be integrated into curb extensions or landscape strips.

Questions		Points
12	**Are open section vegetated channels allowed where density, topography, soils, and slope permit?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
13	**Are runoff reduction practices permissible within curb extensions or landscape strips?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

6. Parking Ratios

Principle: The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance, taking into account local and national experience to see if lower ratios are warranted and feasible.

Parking demand is defined as "the number of spaces that should be provided to serve a particular land use, given factors such as the prices of parking and the availability of alternative travel modes" (ULI 2014). Parking ratios found in parking codes are intended to reflect parking demand for a particular land use and are typically stated as the number of spaces per square foot of building space, number of dwelling units, persons, or building occupancy. In reality, parking ratios in many communities do not accurately reflect the local parking demand, because they may be taken directly from another community's parking code, be based on studies of parking demand from another region, and/or do not consider local factors that can affect parking demand (e.g., price of parking, availability of public transportation, density or economic vitality). In addition, parking ratios are typically set as minimums, even when drawn from studies of peak parking demand. The result is that some parking lots have far more spaces than are actually needed, particularly in areas of mixed land use, where there are good travel options, and parking is managed for efficiency or cost (Litman, 2016).

Communities with Reduced Parking Ratios

As part of the Citywide Zoning Update effort, the City of Oakland, CA recently updated its regulations related to off-street parking and loading. These regulations had not been comprehensively reviewed since 1965 and the "one size fits all" approach to parking ratios often resulted in too much parking. The revisions have addressed this problem by eliminating parking requirements in certain zones and in other zones the amount of parking provides is determined on a project-by-project basis to reflect local demand.
These updates to the parking regulations were developed based upon an evaluation of existing parking policies and issues in Oakland, as well as a review of strategies implemented in other cities.

http://www2.oaklandnet.com/Government/o/PBN/OurOrganization/PlanningZoning/OAK030572

Other cities such as Fayetteville, AR are also addressing the problem of "excess" parking by changing their codes to eliminate minimum parking requirements for non-residential properties.

https://www.fayettevilleflyer.com/2015/10/07/fayetteville-eliminates-minimum-parking-requirements/

One approach to estimate parking demand is to start with industry standards—such as those identified in the Institute of Transportation Engineers (ITE) Parking Generation document and the Urban Land Institute (ULI) and National Parking Association (NPA)'s The Dimensions of Parking—and adjust these values to reflect local characteristics. The ITE values are based primarily on suburban sites with isolated single land uses with free parking, and not intended for highly developed areas, although the more recent editions have begun to segregate the data into various factors that influence parking demand (ITE, 2012; Kimley Horn, 2016). ULI and NPA (2010) provides recommended base parking ratios for the most common land uses found in mixed-use developments. With either source, the values should be considered base ratios to be adjusted based on local data following the process outlined in ULI and NPA (2010). A second approach to estimate parking demand (often used for event facilities) is to forecast the number of person-trips or vehicle-trips or the number of people expected to be present at peak and off-peak hours (ULI and NPA, 2010).

	Questions	Points
14	**Do parking ratios reflect local parking demand?**	
	YES, they are based on a local study of parking demand, or are based on ITE or ULI values and adjusted for local conditions	1
	NO, we simply use the ITE or ULI values, base them on a neighboring community's standards, or we do not know where they came from	0
15	**Are parking requirements set as maximums?**	
	YES	1
	NO	0
	CODES ARE SILENT	0

7. Parking Codes

Principle: Parking codes should be revised to lower parking requirements where mass transit is available or enforceable shared parking arrangements are made.

Parking demand represents the actual number of parking spaces required to accommodate parking needs of a particular land use. Mass transit can lower parking demand directly by reducing the number of vehicles driven, and therefore, vehicles parked. Cervero, Adkins, and Sullivan (2010) found there is an oversupply of parking near Transit Oriented Developments (TODs), sometimes by as much as 25–30%, when compared to parking generation rates from the ITE. Similarly, Ewing et al. (2017) found that the ratio of demand to supply was between 58 and 84% for five TODs across the country, even with parking built at 23 to 61% of ITE's guidelines.

Shared parking is a strategy that reduces the number of parking spaces needed by allowing a parking facility to serve multiple users or destinations. This approach is most successful when destinations have different peak periods during the day or week, or if they share patrons that can park at one facility and walk to multiple destinations (Litman, 2016).

	Questions	Points
16	**Are shared parking arrangements allowed?**	
	YES, shared parking is allowed by-right	2
	YES, shared parking is allowed with special exception	1
	NO	0
	CODES ARE SILENT	0

Questions		Points
17	**Are parking ratios reduced if shared parking arrangements are in place?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
	N/A	*0*
18	**Is the parking ratio reduced when multi-modal transit (e.g., mass transit, bike share or car share programs) is provided?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
19	**Can the number of parking spaces be reduced and additional parking be maintained as green space until needed for redevelopment projects?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
20	**Are parking credits provided when nearby on-street parking is available?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

8. Parking Lots

Principle: Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.

The size of a parking lot is driven by stall geometry, lot layout, and parking ratios. Many parking codes require a standard stall dimension that is geared toward larger vehicles, ranging from 162-190 square feet – often 10 feet wide and 19 feet long. The Parking Consultants Council has adopted a 6'7" wide by 17'3" long vehicle as their "design vehicle" for determining parking space and aisle dimensions (ULI and NPA, 2010). These dimensions represent the 85th percentile vehicle, which has varied slightly since 1999 but remained within an inch or two of the stated dimensions (ULI and NPA, 2010). Therefore, many communities may be able to reduce their standard parking stall dimensions while still accommodating the vast majority of today's vehicles.

Parking codes can also be amended to require that a fixed percentage of all stalls be dedicated for compact cars, with correspondingly smaller dimensions. The number of cars on the road that can comfortably fit in a compact stall has decreased considerably, from about 40-50% in 1994 to less than 20% in 2014 (ITE, 1994;

ULI and NPA 2010). However, compact stalls create up to 30% less impervious cover than standard stalls so can be an important strategy for reducing impervious cover in large parking lots.

Impervious cover can also be reduced through the use of alternative paving materials (e.g., permeable pavement, grass pavers) on regularly used parking stalls and parking lanes as well as in spillover areas for larger parking lots. Most parking codes do not distinguish between regular parking areas that are used most of the time and spillover parking, which is used only a few days per year or for special events. These are ideal locations for permeable pavers, reinforced turf products or other permeable parking options. However, if no distinction is made in the parking code, the result can be creation of enormous paved parking areas that stand empty the vast majority of the year. Communities may wish to require designation of spillover parking areas for larger parking lots and promote the use of alternative paving materials in these areas.

Figure 5. Concrete grid pavers are a good option to reduce runoff from parking lots

Questions		Points
21	**Is the minimum stall width for a standard parking space 9 feet or less?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
22	**Is the minimum stall length for a standard parking space 18 feet or less?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
23	**Is a fixed proportion (e.g., 15%) of the spaces at larger commercial parking lots required to have smaller dimensions for compact cars?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
24	**Can pervious materials be used for parking areas, including spillover or special event parking?**	
	YES	*2*
	NO	*0*
	CODES ARE SILENT	*0*

9. Structured Parking

Principle: Provide meaningful incentives to encourage structured parking to make it more economically viable.

Vertical parking structures can reduce impervious cover by reducing acreage converted for parking. However, in suburban and rural areas where land is relatively inexpensive, surface parking costs much less than a parking garage. In highly urban areas, garages are generally more economical to build than purchasing additional land. In urban and urbanizing areas, local governments should consider using incentives to encourage the building of multi-level, underground, and under the building parking garages. These incentives could come in the form of tax credits; stormwater waivers; or density, floor area, or height bonuses.

Questions		Points
25	Are there any incentives for developers to provide parking within garages rather than surface parking lots?	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

10. Parking Lot Runoff

Principle: Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

Many parking lots are almost completely impervious and they represent a significant source of stormwater pollutants and runoff. In addition to reducing the amount of impervious cover, another option is to require onsite stormwater management. Landscaping areas used to enhance the appearance of a parking lot and associated development can also be used for stormwater management. Some options include: bioretention, bio swales, perimeter sand filters, filter strips, and structural soils with trees.

Figure 6. This landscape area is designed to accept and treat stormwater runoff in this Portland, OR parking lot

Another option is to plant large trees within the landscaped areas due to their ability to reduce stormwater runoff, promote infiltration, and take up nutrients and other pollutants. A minimum width of 6 feet is recommended to support large, mature trees (Cappiella et al, 2006). Layouts that cluster trees and allow them to share rooting space are also encouraged. Lastly, even the paved portion of the lot can provide stormwater treatment through the use of permeable pavement (e.g. porous asphalt, pervious concrete or permeable pavers) in parking lot driving lanes and parking stalls.

Questions		Points
26	**Is a minimum percentage of a parking lot required to be landscaped?**	
	YES	2
	NO	0
	CODES ARE SILENT	0
27	**Is the use of runoff reduction practices within landscaped areas, setbacks, or parking areas allowed?**	
	YES	2
	NO	0
	CODES ARE SILENT	0
28	**Are flush curbs and/or curb cuts and depressed landscaped areas allowed so that runoff can be directed into vegetated landscaped islands or runoff reduction practices?**	
	YES	1
	NO	0
	CODES ARE SILENT	0
29	**Are dimensions for landscaped areas sufficient to plant large trees?**	
	YES, a minimum width 6 feet or greater is specified	1
	NO, a minimum width less than 6 feet is specified	0
	CODES ARE SILENT	0
	N/A	0
30	**Do vegetated stormwater management areas count toward required landscape minimums?**	
	YES	1
	NO	0
	CODES ARE SILENT	0
	N/A	0

Lot Development

Principles 11 through 16 focus on the regulations that determine lot size, lot shape, housing density, and the overall design and appearance of our neighborhoods.

11. Open Space Design

<u>Principle</u>: Advocate open space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.

Open space design accommodates the same number of lots on one portion of a site and conserves the remaining half or more as protected land (Figure 7). When applied in rural or low-density suburban areas, open space design (also referred to as Conservation Design in these landscapes) first identifies unbuildable wetlands, floodplains, and steep slopes, preserves all of them, and then protects half of the remaining buildable lands. The same concept applies in higher density/sewered suburban and urban landscapes, except that less land is protected. The minimum goal of conserving 50% of the buildable land has been incorporated into model ordinances adopted by several states (e.g., Pennsylvania, North Carolina, and several New England states).

In open space design, conservation of open space is achieved in part by clustering lots. It should be noted that simply using the technique of clustering lots is not sufficient to qualify as open space design. With clustering, lot standards are more flexible; but in the absence of open space design standards, the resulting open space often consists of leftover bits of unusable property.

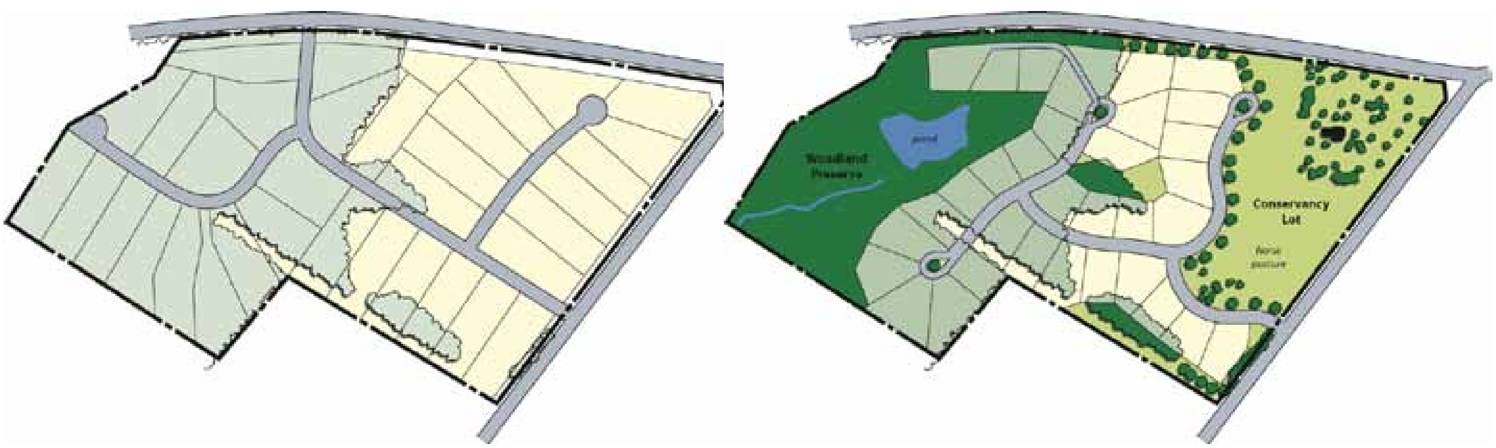


Figure 7. Conventional and open space design options for the Stratford Hall development in Weddington, NC. In both figures, 35 homes are shown on a 35-acre parcel served by public sewer. The figure on the left (conventional development) consists entirely of lots of nearly one acre in area, at a density of one dwelling unit (du)/acre. The figure on the right clusters smaller lots (about 15,000 square feet) on half the parcel, so that the other half can be preserved as open space. The density on the developed portion is about two du/acre, and the density on the other half is 0 du/acre, for an average density of one du/acre, the same as in the conventional option (Source: Randall Arendt, graphics by Natural Lands Trust).

Open space design is most applicable in suburban and rural landscapes but can be used in urban landscapes, with some caveats. Where public sewer is not available, the minimum lot size should be sufficient to provide space for on-site sewage disposal systems, unless alternatives to on-lot septic systems are allowed. Such alternatives may be off-lot individual drainfields located in the common open space, or private central sewage treatment facilities. Open space developments may rely on public sewer if located in a current service area in which case the minimum lot size becomes irrelevant. In rural districts, the extension of water/sewer service beyond currently approved boundaries is not advisable.

Questions		Points
31	**Do the ordinances require or allow open space subdivisions?**	
	YES, they are required in a designated open space zoning district	2
	YES, open space designs are an allowable option (through an overlay zone)	1
	NO	0
	CODES ARE SILENT	0
32	**Is land conservation or impervious cover reduction a major stated goal or objective of the open space design ordinance?**	
	YES	1
	NO	0
	N/A	0
33	**Is a minimum percentage of the buildable portion of the site required to be set aside as open space?**	
	YES, at least 50%	2
	YES, less than 50%	1
	NO	0
	N/A	0
34	**Is the open space determined through a stepwise design process where open space is identified first?**	
	YES	1
	NO	0
	N/A	0
35	**Is open space design a by-right form of development versus a more burdensome conditional use or warrant?**	
	YES	1
	NO	0
	N/A	0

Questions		Points
36	**Are flexible site design criteria available for developers that utilize open space or cluster design options (e.g., setbacks/lot lines, road widths, lot sizes and shapes)?**	
	YES	*1*
	NO	*0*
	N/A	*0*
37	**Are density bonuses and/or penalties used to encourage use of open space design?**	
	YES, density penalties are given for conventional development	*2*
	YES, density bonuses are provided for open space designs that exceed the minimum requirements for open space protection, up to an established maximum	*2*
	YES, density bonuses are provided for open space designs that exceed the minimum requirements for open space protection, with no cap on density bonuses	*1*
	NO	*0*
	N/A	*0*

12. Setbacks and Frontages

Principle: Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.

Conventional zoning standards usually dictate that each house be set back a minimum distance from property lines and require a minimum road frontage width. Together, these standards tend to increase the total site impervious cover. For example, frontage widths and side yard setbacks directly influence the length of roads and sidewalks, while front yard setbacks influence driveway length. Relaxing these minimum requirements can reduce site imperviousness and allow site designers flexibility in residential lot design while also addressing parking, traffic, and fire safety concerns.

Figure 8. Reduced front yard setbacks result in shorter driveways and reduced frontage distance and side yard setbacks result in shorter streets in this Savannah, GA development.

	Questions	Points
38	**Are irregular lot shapes (e.g., pie-shaped, flag lots, zipper lots) allowed in the community?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
39	**Does the code allow for variances to setback and frontage requirements?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

13. Sidewalks

Principle: Promote more flexible design standards for residential subdivision sidewalks. Where practical, consider locating sidewalks only on one side of the street and provide common walkways linking pedestrian areas.

The intent of this principle is to ensure that sidewalk design standards for residential areas are flexible and do not result in excessive impervious cover. While locating sidewalks on only one side of the street may be appropriate in some rural neighborhoods, sidewalks represent only a small proportion of total site impervious cover (from 1% to 7% of total impervious cover, depending on density, based on analysis of data from Cappiella and Brown 2001). Therefore, communities may get more "bang for their buck" by focusing on reducing roadway widths rather than eliminating or reducing sidewalk widths to reduce impervious surfaces while at the same time achieving better safety and mobility outcomes.

Figure 9. The roadway comprises a significant portion of impervious cover in this neighborhood, compared to sidewalks (Photo credit: Dorothy Cappiella)

Sidewalk widths of 5 feet may be appropriate in some neighborhoods but wider walkways will be needed as density increases. Road type, land use/density, roadway characteristics and other variables are important factors to consider in determining suitable sidewalk widths. Some guidance is provided below:

- *The United States Access Board's Guidelines for Pedestrian Facilities in the Public Right-of-Way include a continuous clear width of at least 4 feet for sidewalks. If sidewalk width is less than 5 feet, passing spaces must be provided at set intervals. These accessibility guidelines for safe passage can usually be met through driveways, intersections and other methods. https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/proposed-rights-of-way-guidelines/chapter-r3-technical-requirements*
- *The recommended minimum width to allow two people to walk side by side is 5-6 feet (NACTO, 2013, PBIC, 2015).*

- *Wider sidewalks of 8-10 feet may be desirable where sidewalks are located on only one side of the street, sidewalks are directly adjacent to moving traffic, streets are within walking distance of schools, or where higher pedestrian traffic is expected (PBIC, 2015; NACTO, 2013).*
- *Higher density residential neighborhoods (e.g., downtown residential areas that are walkable to commercial areas) may need increased widths of up to 10-12 feet. http://www.sfbetterstreets.org/design-guidelines/sidewalk-width/*

Figure 10. This paved trail connecting neighborhood streets provides a pleasant alternative to walking along the street to travel to nearby parks, bus stops and other locations.

Questions		Points
40	**Can minimum sidewalk widths for residential neighborhoods be reduced to 5 feet where safe and appropriate?**	
	YES	*2*
	NO	*0*
	CODES ARE SILENT	*0*
41	**Can alternate pedestrian networks (e.g., paved trails through common areas, walkways and bike trails connecting from cul-de-sacs to other streets) be substituted for sidewalks in the right-of-way?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
42	**Are alternative sidewalk designs that provide sufficient soil rooting volume for street trees (e.g., pop-outs or bulb-outs, curving sidewalks, tree islands) allowed?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
43	**Are alternative sidewalk construction materials that increase infiltration allowed?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

14. Driveways

<u>Principle</u>: Reduce overall lot imperviousness by promoting alternative driveway surface and shared driveways that connect two or more homes together.

	Questions	Points
44	**Are minimum driveway widths 9 feet or less (one lane) or 18 feet or less (two lanes)?**	
	YES	*1*
	NO	*0*
45	**Can pervious materials (e.g., grass, gravel, permeable pavements, etc.) be used for residential driveways?**	
	YES	*2*
	NO	*0*
	CODES ARE SILENT	*0*
46	**Can a "two track" design be used for residential driveways?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
47	**Are shared driveways permitted in residential developments?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

Figure 11. This shared driveway in Jordan Cove, CT helps to reduce impervious cover and is also constructed using permeable materials.

Figure 12. A "two-track" driveway is another way to reduce driveway imperviousness

15. Open Space Management

Principle: Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space.

If open space developments are not allowed in your community, select N/A for each question below.

	Questions	Points
48	**Does the open space design ordinance require identification of an entity (e.g., conservation organization, community association) who will be responsible for managing the open space?**	
	YES	*2*
	NO	*0*
	N/A	*0*
49	**Can open space be managed by a land trust or other qualified public or private land conservation organization (e.g., municipal parks department) through conservation easements or transfer of ownership?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
	N/A	*0*
50	**If open space cannot be managed by a third party, are there enforceable requirements to establish an association that can effectively manage the open space?**	
	YES	*1*
	NO	*0*
	N/A	*0*
51	**Are secure and permanent funding arrangements required to be established for the long-term management and maintenance of open space?**	
	YES	*1*
	NO	*0*
	N/A	*0*

Questions		Points
52	**Are there standards for the open space requiring interconnections, prioritized lists of resources to be conserved, and access standards?**	
	YES	*1*
	NO	*0*
	N/A	*0*
53	**Are allowable and unallowable uses for open space in residential developments defined?**	
	YES	*1*
	NO	*0*
	N/A	*0*
54	**Are long-term management plans that conserve natural systems required for all open space areas?**	
	YES	*1*
	NO	*0*
	N/A	*0*
55	**Is open space in a natural condition required to be protected in perpetuity by a binding conservation easement or similar legal instrument?**	
	YES	*1*
	NO	*0*
	N/A	*0*

16. Rooftop Runoff

Principle: Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway and the stormwater conveyance system.

Use of rainwater harvesting practices in the arid and semi-arid West may be prohibited by water rights law. The complex legal landscape associated with the doctrine of prior appropriation complicates the process of determining whether rainwater harvesting is allowable. For example, some states clearly have jurisdiction over atmospheric rainwater, while others do not or may only under certain circumstances. In states that have jurisdiction over precipitation, some require a permit for harvest and use of rainwater, while others do not require a permit or specifically exempt rainwater harvesting. In states where a permit is required, only some actually outline a formal process by which a property owner can apply, while others do not accept permit applications. If you live in a state that prohibits or requires a permit for rainwater harvesting, some of the rooftop practices below may not be applicable in your community. EPA's Green Infrastructure in Arid and Semi-Arid Climates is a good resource to evaluate how water law may impact rainwater harvesting in your state: https://www3.epa.gov/npdes/pubs/arid_climates_casestudy.pdf.

Questions		Points
56	**Can downspouts be disconnected such that rooftop runoff flows to storage tanks, pervious areas, runoff reduction practices, etc.?**	
	YES	*2*
	NO	*0*
	CODES ARE SILENT	*0*
57	**Do current grading or drainage requirements allow for temporary ponding of stormwater on front yards or rooftops?**	
	YES	*2*
	NO	*0*
	CODES ARE SILENT	*0*
58	**Is temporary storage of rainwater in storage tanks (e.g., rain barrels or cisterns) permitted?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*
59	**Do the stormwater BMP design specifications for green roofs address structural concerns (e.g. how to determine design load of roof)?**	
	YES	*1*
	NO	*0*
60	**Do local plumbing codes allow harvested rainwater for exterior uses such as irrigation and non-potable interior uses such as toilet flushing?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

Figure 13. Three options for managing rooftop runoff in Washington, DC: 1) rain barrel, 2) green roof, and 3) disconnected downspout directed to a rain garden

Natural Areas

The natural areas principles address codes and ordinances that promote (or impede) protection of existing natural areas and incorporation of open spaces into new development.

17. Buffer Systems

Principle: Create a variable width, naturally vegetated buffer system along all perennial streams that also encompasses critical environmental features such as the 100-year floodplain, steep slopes, and freshwater wetlands.

Vegetated systems along shorelines, wetlands, and streams can protect water quality, reduce flooding impacts, provide wildlife habitat, serve as a recreation resource, and offer economic benefits to the local community. Optimal buffer widths vary with the type of waterway and the desired benefit (e.g., water quality protection versus habitat).

Figure 14. A forested buffer on either side of the stream helps to protect water quality and habitat (Photo credit: Dorothy Cappiella)

Questions		Points
61	**Do the development standards in the community require a vegetated buffer along waterways?**	
	YES	2
	NO	0
62	**Is the definition of waterway, or the regulated buffer, expansive enough to include (check all that apply):**	
	Perennial streams	0.5
	Ephemeral and intermittent streams	0.5
	Lakes	0.5
	Estuaries and shorelines	0.5
	Wetlands	0.5
	Vernal ponds	0.5
	NO	0
	CODES ARE SILENT	0
	N/A	0

Questions		Points
63	**Is the minimum buffer width 50 feet or more?**	
	YES, width is 100 feet or greater	2
	YES, width is between 50 and 99 feet	1
	NO, width is < 50 feet	0
	CODES ARE SILENT	0
	N/A	0
64	**Are buffer widths greater for sensitive resources (e.g., designated high quality streams) or in certain zones (e.g., drinking water protection)?**	
	YES	1
	NO	0
	N/A	0
65	**Is expansion of the buffer to include adjacent wetlands, steep slopes, or the 100-year floodplain required?**	
	YES	1
	NO	0
	N/A	0

18. Buffer Management

Principle: The riparian stream buffer should be preserved or restored with native vegetation that can be maintained throughout the plan review, delineation, construction, and occupancy stages of development.

The key to effective buffer preservation and management is the adoption and active enforcement of a strong buffer ordinance that requires a plan that outlines the legal rights and responsibilities for the long-term management of the buffer. Education of landowners is vital to preventing encroachment within the buffer, as well as real penalties for violation of buffer requirements to emphasize the importance of maintaining buffer integrity.

Questions		Points
66	**Does the buffer ordinance specify that a minimum percentage of the buffer be maintained with native vegetation?**	
	YES	2
	NO	0
	N/A	0

	Questions	Points
67	**Does the buffer ordinance outline prohibited uses and permitted uses that have little impact to the vegetated buffer?**	
	YES	*1*
	NO	*0*
	N/A	*0*
68	**Does the ordinance specify enforcement mechanisms?**	
	YES	*1*
	NO	*0*
	N/A	*0*
69	**Does the buffer ordinance specify a preference for buffers to be located on a parcel of common ownership (e.g., a homeowners' association)?**	
	YES	*1*
	NO	*0*
	N/A	*0*

19. Clearing and Grading

Principle: Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.

Conservation of natural areas within a site can reduce erosion and sediment and clearing and grading costs while maintaining natural features of the site. Common ordinances that can be adapted to limit clearing include: erosion and sediment control, grading, forest conservation or tree protection, and open space development.

	Questions	Points
70	**Is there any ordinance that requires the preservation of native soils, hydric soils, natural vegetation, or steep slopes at development sites?**	
	YES	2
	NO	*0*
71	**Do regulations limit the total portion of the site that can be cleared?**	
	YES	*1*
	NO	*0*

	Questions	Points
72	**Are the limits of disturbance required to be shown on construction plans and physically marked at the site?**	
	YES	*1*
	NO	*0*
73	**Are reserve septic field areas allowed to be left undisturbed until needed?**	
	YES	*1*
	NO	*0*
	CODES ARE SILENT	*0*

20. Tree Conservation

Principle: Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights of way, parking lot islands, and other landscaped areas to promote natural vegetation.

Native trees, shrubs, and grasses are important contributors to the overall quality and viability of the environment. Preservation and restoration of natural areas can provide aesthetic, environmental, and economic benefits. These will accrue as increased land values, reduced small drainage complaints, creation of habitat for wildlife, better stormwater management, lower ambient temperature, increased safety for residents, and provision of passive recreation space.

In regions of the country where trees are not the predominant native cover, the questions below may not be applicable or can be adjusted to promote preservation and planting of plants that are native to the landscape. For example, xeriscaping is an option for parts of the country where water supplies are limited. This technique uses drought tolerant native plants to landscape and can greatly increase water conservation compared to lawn-focused landscaping.

	Questions	Points
74	**Is a natural resources inventory required to identify and map natural areas?**	
	YES, and significant natural areas such as high quality forest stands, wildlife habitat and travel corridors, productive cropland, and specimen trees must be identified	*2*
	YES, but no requirements to assess resource quality	*1*
	NO	*0*

Questions		Points
75	**Is there an ordinance that requires conservation of some portion of forests, specimen trees, or other native vegetation at development sites?**	
	YES, specific conservation thresholds are identified	2
	YES, no specific conservation thresholds identified	1
	NO	0
76	**Do tree conservation requirements identify or reference methods for delineating and protecting the critical root zone of trees (sometimes referred to as "drip line")?**	
	YES	1
	NO	0
	N/A	0
77	**Do forest/tree conservation requirements specify planting new trees at sites where none exist?**	
	YES	1
	NO	0
	N/A	0
78	**Are trees and native plant materials permissible for landscaping in yards, common areas, and other open spaces?**	
	YES, some portion of landscaping must include trees and other native vegetation provided in recommended species list	2
	YES, trees and native vegetation are allowed per recommended species list	1
	NO, landscaping ordinance requires turfgrass or includes vegetation height standards that preclude use of native plants	0
79	**Does the community have an urban forestry plan that supports/is referenced by the landscaping ordinance?**	
	YES	1
	NO	0
80	**Do landscaping requirements identify or reference specifications for soil amendments, planting methods, species selection, and maintenance?**	
	YES	1
	NO	0

21. Land Conservation Incentives

Principle: Incentives and flexibility in the form of density compensation, buffer averaging, property tax reduction, stormwater credits, and by right open space development should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation consistent with locally adopted watershed plans should be encouraged.

Conservation and protection measures that require excessive administrative hurdles, such as lengthy plan reviews, additional upfront costs to developers and unclear appeal procedures can create major barriers to implementation. Incentives and flexibility are an effective way to promote adoption of conservation and protection measures.

Figure 15. Maryland's unique Forest Conservation Act helps to protect forest from development impacts and required planting new trees at sites where there is little forest to conserve

	Questions	Points
81	**Are there any incentives to developers (e.g., open space design, density bonuses, stormwater credits, or expedited design review) to conserve land above and beyond what is already required (e.g., steep slopes, wetlands)?**	
	YES	2
	NO	0
	CODES ARE SILENT	0
82	**Is flexibility to meet land conservation requirements (e.g. density compensation, buffer or lot averaging, by-right open space development, transferable development rights, off-site mitigation) offered to developers?**	
	YES	2
	NO	0
	CODES ARE SILENT	0

22. Stormwater Outfalls

Principle: New stormwater outfalls should not discharge unmanaged stormwater into jurisdictional wetlands, sole source aquifers, or other water bodies.

Stormwater runoff generated at development and redevelopment sites can represent a significant threat to the quality of streams, wetlands, and other surface and groundwater resources. Programmatic and regulatory changes, including MS4 Phase II and the adoption of TMDLs, have occurred in the field of stormwater management since the initial National Site Planning Roundtable. As a result, stormwater is required to be *treated for quality before discharge from most new development and redevelopment projects. Therefore, this principle should be a common practice in most development situations.*

On the other hand, there are no federal laws that prohibit discharge of stormwater directly into a jurisdictional wetland without pretreatment (Section 404 regulates discharge of dredge or fill material but not stormwater). The definition of what is "jurisdictional" may not include all wetland types or sizes so it is important for local governments to fill this gap in wetland protection. Other types of natural resources may be sensitive to inputs of stormwater and could be better protected by adopting special stormwater criteria. The questions below are intended to address this changing landscape of regulations regarding stormwater discharges to natural areas.

Figure 16. This tidal wetland in coastal Virginia is protected through a setback and buffer, and the adjacent development benefits from the spectacular view and access for recreation.

Questions		Points
83	**Does the stormwater code contain special treatment criteria for discharges to impaired or sensitive waters, such as natural wetlands, lakes, trout streams, nutrient-sensitive estuaries, drinking water supplies, etc.?**	
	YES	*2*
	NO	*0*
84	**Does a floodplain management ordinance exist that restricts or prohibits development within the 100-year floodplain?**	
	YES	*2*
	NO	*0*
85	**Is there a local wetland protection ordinance?**	
	YES	*1*
	NO	*0*

Runoff Reduction

Due to changes in federal, state, and local environmental regulations and in the thinking regarding the best strategies for dealing with stormwater impacts, several new questions have been added to the COW to address potential code barriers to implementation of runoff reduction techniques.

Sections 23-25 focus on the regulations that pertain to stormwater management standards, particularly the inclusion of practices that reduce runoff.

23. Stormwater Codes
The questions in this section are intended to ensure that runoff or volume reduction is included in the stormwater code.

Traditionally, stormwater codes require detention (control of peak rates of runoff), and, more recently, water quality treatment. A newer generation of stormwater codes also addresses runoff volumes through a focus on retention so that post-development runoff characteristics replicate pre-development conditions. Examples of specific code requirements include reduce post-construction runoff volume associated with a particular rainfall depth (e.g., 1 inch) or a range of design storms, or not exceed the volume associated with a forested or pasture condition. Newer codes that address runoff reduction are likely to be complementary to more traditional peak rate/detention and water quality treatment standards.

One prerequisite for runoff reduction standards and their associated runoff reduction practices is they must be introduced early in site planning in order to be integrated with the rest of site plans and layout. Processes such as pre-application meetings can help with this early integration. Clear and local or regionally-based design guidance, such as an updated stormwater design manual, is also essential for the proper application and design of the practices. It is also essential that the local code is internally consistent regarding drainage and stormwater treatment in order to avoid conflicting or confusing design standards.

	Questions	Points
86	**Do codes define rainwater harvesting and establish acceptable uses for rainwater (e.g., irrigation and toilet flushing) and corresponding treatment requirements?**	
	YES	*1*
	NO	*0*
	N/A	*0*
87	**Does the stormwater code include specific standards to reduce post-construction runoff volume (not just peak rate)?**	
	YES, runoff/volume reduction is required for most new development and redevelopment sites	*2*
	YES, the standards apply to some sites or are included as an alternative compliance method	*1*
	NO	*0*
	N/A	*0*
88	**Does the code require or have incentives for consideration of runoff reduction concepts early in the site planning process?**	
	YES, there are provisions for a pre-application meeting or similar	*2*
	YES, but the meetings are not mandatory for applicants	*1*
	NO	*0*
	N/A	*0*

Questions		Points
89	**If the code includes post-construction runoff reduction standards, is there reference to clear, understandable, and local or regionally-based design guidance or manual?**	
	YES, the code references design guidance or a manual	2
	YES, such a manual exists but it is not referenced in the code	1
	NO	0
	N/A	0
90	**Are drainage and treatment standards all in one place within the code and internally consistent?**	
	YES, codes are consolidated and consistent regarding applicability and methods	1
	NO, various code sections are conflicting or inconsistent	0
	N/A	0

24. Installation and Maintenance of Practices

The questions in this section are intended to ensure that post-construction (runoff reduction) practices are installed properly and that there are provisions to ensure long-term maintenance.

Installation and maintenance can be the "Achilles heel" of stormwater practices, especially small-scale runoff reduction practices. Many practices have failed due to these issues, and thus are not providing the hydrologic and water quality benefits they are intended to provide. For construction and installation, it is critically important that erosion and sediment control standards are integrated with the post-construction stormwater plan. For instance, areas designated for post-construction stormwater control must be protected from heavy equipment, compaction, and sediment during construction, especially if the post-construction practice will rely on infiltration or soil treatment. Post-construction practices, such as filter strips and riparian buffers, should be outside of the limits of disturbance during active construction. Performance bonds are important tools to ensure that installations are completed as per the approved plan.

Figure 17. Mulch replacement is one activity that may be included in a maintenance agreement for stormwater practices such as bioretention.

Long-term maintenance is another vital issue related to stormwater practice performance. The code can help ensure proper maintenance by making sure that practices are within easements (unless designed to be on private lots), inspectors have right-of-entry, maintenance agreements are in place that spell out the responsibilities of the property owner, and that there are periodic inspections during the post-construction phase.

Questions		Points
91	**Do erosion and sediment control standards specify protection of post-construction practice sites during active construction?**	
	YES, erosion control standards include these provisions	2
	YES, the code is not explicit but it is addressed during plan review	1
	NO	0
	N/A	0
92	**Does the code mandate performance bonds and periodic inspections to ensure proper installation of practices based on the approved plans?**	
	YES, the code includes bonding requirements and inspections during stormwater practice installation	2
	YES, the code includes bonding or inspections, but not both	1
	NO	0
	N/A	0
93	**Does the code include provisions for runoff reduction practice easements, inspector right-of-entry, maintenance agreements, and post-construction inspections?**	
	YES, all the provisions are included	2
	YES, 3 out of the 4 are included	1
	NO	0
	N/A	0

25. Off-Site Compliance

The question in this section is intended to ensure that off-site compliance or trading mechanisms are used judiciously and do not compromise local water quality.

States, regions, and localities are turning increasingly to off-site compliance strategies, such as pollution trading, banks, or allowing stormwater requirements to be met at alternative sites. These provisions can add flexibility and innovation, especially for tricky sites or areas where the local comprehensive plan calls for infill and redevelopment. However, overuse of these strategies can compromise local water quality because the treatment is happening elsewhere. A balanced off-site compliance program will require a certain level of "due diligence" treatment on-site wherever possible, while allowing flexibility for full compliance. Documentation should be provided to verify that on-site options are infeasible.

Questions		Points
94	**If off-site stormwater compliance is authorized, is some percentage of treatment required on-site?**	
	YES, applicants must provide on-site treatment to some level and provide documentation	2
	NO, many sites have automatic access to off-site compliance	*1*
	N/A	*0*

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Attachment D

Example Fertilizer Ordinances

Pinellas County Fertilizer Ordinance
Manatee County Fertilizer Ordinance

Pinellas County Fertilizer Ordinance

ARTICLE XIII. - LANDSCAPE MAINTENANCE AND FERTILIZER USE AND APPLICATION

Sec. 58-471. - Findings of fact.

As a result of adverse impacts to Pinellas County waters caused by excessive nutrients resulting from improper landscape maintenance practices and the incorrect or unnecessary application of fertilizers containing phosphorus and/or nitrogen, the Pinellas County Board of County Commissioners has determined that the lands and waters of Pinellas County are at particularly high risk for adverse effects to surface and ground water from such fertilizer containing phosphorus and/or nitrogen, particularly when not applied in accordance with best management practices established by the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (DACS), and the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS).

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-472. - Purpose and intent.

This article regulates the proper use of fertilizers by any applicator and requires proper training of commercial and institutional fertilizer applicators and landscape maintenance companies by establishing a restricted season for fertilizer application, fertilizer-free zones, low maintenance zones, exemptions, training, and licensing requirements. The article requires the use of best management practices which provide specific management guidelines to minimize negative secondary and cumulative environmental effects associated with the misuse of fertilizers and improper landscape maintenance practices. These secondary and cumulative effects have been observed in and on Pinellas County's natural and artificial stormwater and drainage conveyances, rivers, lakes, canals, estuaries, interior freshwater wetlands, and Tampa Bay. Collectively, these water bodies are an asset critical to the environmental, recreational, cultural and economic well-being of Pinellas County residents and the health of the public. Overgrowth of algae and vegetation hinder the effectiveness of flood attenuation provided by natural and artificial stormwater and drainage conveyances. Regulation of nutrients, including both phosphorus and nitrogen contained in fertilizer, will help improve and maintain water and habitat quality.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-473. - Definitions.

For this article, the following terms shall have the meanings set forth in this section unless the context clearly indicates otherwise.

Administrator means the Pinellas County Administrator, or an administrative official of Pinellas County government designated by the county administrator to administer and enforce the provisions of this article.

Application or *apply* means the actual physical deposit of fertilizer to turf or landscape plants.

Applicator means any person who applies fertilizer on turf and/or landscape plants in Pinellas County.

Article means Chapter 58, Article XIII of the Pinellas County Code of Ordinances, as amended, unless otherwise specified.

Board means the Board of County Commissioners of Pinellas County, Florida.

Best management practices or *BMP* means turf and landscape practices which minimize the negative environmental impacts of installation and maintenance of landscapes.

Code enforcement officer, official, or inspector means any designated employee or agent of Pinellas County whose duty it is to enforce codes and ordinances enacted by Pinellas County.

Commercial fertilizer applicator means any person who applies fertilizer on turf and/or landscape plants in Pinellas County in exchange for money, goods, services or other valuable consideration.

Fertilize, fertilizing, or *fertilization* means the act of applying fertilizer to turf, specialized turf, or landscape plants.

Fertilizer means any substance or mixture of substances that contains one or more recognized plant nutrients and promotes plant growth, or controls soil acidity or alkalinity, or provides other soil enrichment, or provides other corrective measures to the soil.

Granular means composed of small grains or particles.

Institutional applicator means any person, other than a noncommercial or commercial applicator, that applies fertilizer for the purpose of maintaining turf and/or landscape plants. Institutional applicators shall include, but shall not be limited to, owners and managers of public lands, schools, parks, religious institutions, utilities, industrial or business sites and any residential properties maintained in condominium and/or common ownership.

Impervious surface means a surface that has been compacted or covered with a layer of material so that it is highly resistant or prevents infiltration by stormwater. It includes roofed areas and surfaces such as compacted sand, limerock, or clay, as well as conventionally surfaced streets, sidewalks, parking lots, and other similar surfaces.

Landscape plant means any native or exotic tree, shrub, or groundcover (excluding turf).

Landscape maintenance means activities carried out to manage and maintain landscape plants including but not limited to mowing, edging, and trimming.

Low maintenance zone means an area a minimum of six feet wide adjacent to water courses which is planted with non-turf grass vegetation and managed in order to minimize the need for fertilization, watering, mowing, etc.

Pasture means land used for livestock grazing that is managed to provide feed value.

Person means any human being, business, corporation, limited liability company, partnership, limited partnership, association, club, organization, and/or any group of people acting as an organized entity.

Pinellas County Approved Best Management Practices (BMP) Training Program means a training program approved by Pinellas County that includes, at a minimum, the BMPs associated with proper mowing, trimming, irrigation, and landscape debris management.

Restricted season means June 1 through September 30.

Site supervisor means the direct supervisor of landscape maintenance personnel.

Slow or controlled release fertilizer means a fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a referenced "rapidly available nutrient fertilizer."

Specialized turf means areas of grass used for athletic fields, golf course practice and play areas, and other similar activities.

Specialized turf manager means a person responsible for fertilizing or directing the fertilization of specialized turf.

Surface water means fresh, brackish, saline or tidal waters, including but not limited to bays, rivers, lakes, streams, wetlands, springs, impoundments, as well as canals and other artificial water bodies.

Turf, sod, or *lawn* means a piece of grass-covered soil held together by the roots of the grass.

Vegetable garden means an area dedicated to the cultivation of edible plants.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-474. - Applicability.

This article shall be applicable to and shall regulate any and all applicators of fertilizer, areas of application of fertilizer, and landscape maintenance activities within Pinellas County, unless such applicator or activity is specifically exempted by the terms of this article from the regulatory provisions of this article.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-475. - Weather and seasonal restrictions.

(a) No applicator shall apply fertilizers containing nitrogen and/or phosphorous to turf and/or landscape plants during the restricted season from June 1 through September 30.

(b) No applicator shall apply fertilizers containing nitrogen and/or phosphorus to turf and/or landscape plants during a period for which the National Weather Service has issued any of the following advisories for any portion of Pinellas County: a severe thunderstorm warning or watch, flood warning or watch, tropical storm warning or watch, hurricane warning or watch, or if rain greater than or equal to two inches in a 24-hour period is forecasted.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-476. - Fertilizer content and application rate.

(a) Fertilizers shall be applied to turf and/or landscape plants at the recommended rate per the "Florida Friendly Best Management Practices for Protection of Water Resources by the Green Industries", December 2008, as revised, with no more than four pounds of nitrogen per 1,000 feet ^{2} applied in any calendar year.

(b) No fertilizer containing phosphorus shall be applied to turf and/or landscape plants in Pinellas County, except where phosphorus deficiency has been demonstrated in the soil underlying the turf and/or landscape plants by a soil analysis test performed by a State of Florida-certified laboratory. Any person who obtains such a soil analysis test showing a phosphorus deficiency and who wishes to apply phosphorus to turf and/or landscape plants shall mail a copy of the test results to Pinellas County Watershed Management Division, Attention: Division Director, 300 South Garden Avenue, Clearwater, FL 33756 prior to the application of phosphorous.

(c) Nitrogen fertilizer shall not be applied on newly established turf or new landscape plants for the first 30 days.

(d) Granular fertilizers containing nitrogen applied to turf and/or landscape plants within Pinellas County shall contain no less than 50 percent slow release nitrogen per guaranteed analysis label.

(e) Liquid fertilizers containing nitrogen applied to turf and/or landscape plants within Pinellas County shall not be applied at a rate that exceeds 0.5 lbs/1,000 feet ^{2} per application.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-477. - Impervious surfaces and mode of application.

(a) Fertilizer shall not be applied or otherwise deposited on any impervious surfaces. Any fertilizer applied or deposited, either intentionally or accidentally, on any impervious surface shall be immediately and completely removed to the greatest extent practicable. Fertilizer released on an impervious surface must be immediately contained and either legally applied to turf or any other legal site, or returned to the original or other appropriate container. Fertilizer shall not be washed, swept, or blown off impervious surfaces into stormwater drains, ditches, drainage conveyances, roadways, or surface waters.

(b) Spreader deflector shields are required when applying fertilizer by use of any broadcast or rotary spreaders. Deflector shields must be positioned such that fertilizer granules are deflected away from all impervious surfaces and surface waters.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-478. - Fertilizer-free zones.

Fertilizer shall not be applied within ten feet from the top of bank of any surface water, landward edge of the top of a seawall, designated wetland or wetland as defined by the Florida Department of Environmental Protection (Chapter 62-340, Florida Administrative Code, as it may be amended or superseded).

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-479. - Management of grass clippings and vegetative material.

It shall be a violation of this section for any person to wash, sweep, blow or otherwise cause grass clippings, vegetative material, and/or vegetative debris to be deposited into stormwater drains, ditches, drainage conveyances, surface waters, or roadways.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-480. - Exemptions.

(a) The provisions set forth above in sections 58-475(a) and 58-476 of this article shall not apply to:

(1) Golf courses. For all golf courses, the provisions of the Florida Department of Environmental Protection (FDEP) document, "BMPs for the Enhancement of Environmental Quality on Florida Golf Courses, January 2007," as updated, are required and shall be followed when applying fertilizer to golf courses.

(2) Specialized turf. Specialized turf managers are required to follow the Best Management Practices embodied in the "Florida Friendly Best Management Practices for Protection of Water Resources by the Green Industries", December 2008, as updated.

(3) Bona fide farm operations as defined in the Florida Right to Farm Act, F.S. § 823.14.

(4) Vegetable gardens, owned by individual property owners or a community, provided that fertilizer application rates do not exceed UF/IFAS recommendations per SP103 Florida Vegetable Gardening Guide, December 2008, as revised.

(5) Yard waste compost, mulches, or other similar materials that are primarily organic in nature and are applied to improve the physical condition of the soil.

(6) Tree trunk injection fertilization treatments that are performed by a certified arborist.

(b) Retail or wholesale fertilizer sellers may sell products containing nitrogen and/or phosphorus to specialized turf managers or to operators of bona fide farm operations during the restricted period for use on specialized turf or for use at bona fide farm operations, respectively.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-481. - Certification and training.

(a) *Commercial and institutional applicators.* All commercial and institutional applicators within Pinellas County shall obtain the limited certification for urban landscape fertilizer application provided for under F.S. § 482.1562, within 365 days of adoption of this article, or within 90 days of initial employment, whichever occurs later. Applicators are required to keep a copy of such certificate with them during application activities and shall present the certificate to any authorized official of the board, upon request.

(b) *Landscape maintenance.* All site supervisors and managers of professional landscape maintenance companies, as well as government and institutional landscape supervisors shall abide by and successfully complete a Pinellas County approved Best Management Practices Training Program within 545 days of adoption of this article. Upon successful completion, a certificate of completion will be provided. Landscape maintenance staff are required to keep a copy of such certificate with them during landscape maintenance activities and shall present the certificate to any authorized official of the board, upon request.

(c) Landscape Maintenance. Employees of lawn and landscape maintenance companies who are not site supervisors or managers shall also be trained in the above-referenced BMPs through a county approved training program, the company, or a contractor of the company. The training shall also include the more stringent requirements set forth in sections 58-473 through 58-483 of this article. Training may be provided by a certified site supervisor or manager employed by the company. Training shall be required of all personnel of such companies within 545 days of adoption of this article, or within 90 days of initial employment. Prior to the successful completion of said program each employee shall work under the direct physical supervision of a certified landscape maintenance employee. Landscape maintenance companies shall maintain written records of compliance with this provision and shall present training records to any authorized official of the board, upon request.

(d) All commercial and institutional applicators, site supervisors and managers of professional landscape maintenance companies, government and institutional landscape supervisors, and any employee of a lawn and landscape maintenance company shall abide by best management practices for which they have been trained or certified, as well as the provisions of this article.

(e) A vehicle decal issued by Pinellas County indicating that the company is in compliance with the training and certification requirements herein shall be affixed and maintained on the exterior of all vehicles and/or trailers used by the company in connection with landscape maintenance activities and/or the application of fertilizer within the area regulated by this article. The vehicle and trailer decals shall be provided by Pinellas County upon submittal of demonstration of compliance of the company with the requirements herein.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-482. - Retail sale of fertilizer containing nitrogen or phosphorous.

(a) Effective June 1, 2011, no person, firm, corporation, franchise, or commercial establishment shall sell, at retail, any lawn or landscape fertilizer, liquid or granular, within Pinellas County that contains any amount of nitrogen or phosphorous during the restricted season from June 1 through September 30.

(b) Granular fertilizers containing nitrogen sold at retail within Pinellas County shall contain no less than 50 percent slow release nitrogen per guaranteed analysis label.

(c) Displays of lawn and landscape fertilizers containing nitrogen or phosphorous shall not be allowed on the sales area of the retail store during the restricted season.

(d) Retailers shall post a notice stating that the use of lawn and landscape fertilizers in Pinellas County is restricted in accordance with this article.

(e) Fertilizers sold within Pinellas County shall meet the requirements set forth in Rule 5E-1.003(2), Florida Administrative Code, *Labeling Requirements For Urban Turf Fertilizers.*

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-483. - Enforcement and penalty.

Violations of this article may be punished as provided for in section 1-8 or article VIII, chapter 2 of the Pinellas County Code. Violations of this article may also be pursued under the Pinellas County Environmental Enforcement Act, as applicable.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-484. - Recommendations and additional information.

(a) A voluntary six-foot low-maintenance, "no-mow" zone is strongly recommended from those areas described as fertilizer-free zones in section 8 in order to reduce the potential for fertilizer residue entering adjacent water bodies and wetlands. A swale/berm system is recommended for installation at the landward edge of this low maintenance zone to capture and filter runoff. No vegetative material shall be deposited or left remaining in this zone or in the water. Care should be taken to prevent the overspray of aquatic weed products in this zone.

(b) It is recommended that the application of fertilizer for properties using reclaimed water service be reduced in accordance with the nutrient level contained in the reclaimed water. This information is available through the Pinellas County Utilities Department and through the Pinellas County web site.

(c) The county strongly recommends the establishment of training programs using Spanish-speaking certified BMP trainers.

(d) The county recommends that private homeowners become familiar with and utilize the recommendations of the University of Florida IFAS Florida Yards and Neighborhoods Program when applying fertilizer.

(Ord. No. 10-06, § 1, 1-19-10)

Sec. 58-485. - Areas embraced.

All territories within the legal boundaries of Pinellas County, Florida including all incorporated and unincorporated areas, shall be embraced by the provisions of this article, unless in conflict with or specifically deleted by a municipal ordinance.

(Ord. No. 10-06, § 1, 1-19-10)

Manatee County Fertilizer Ordinance

Summary of Manatee County Fertilizer Ordinance 11-21 (eff. date 6/2/11)

Item	Summary of Ordinance 11-21
Restricted Season	No application of N or P products between Jun 1 and Sep 30
Weather Restrictions for Applications	No application of N or P if a Severe Thunderstorm, Flood, Tropical Storm, or Hurricane Watch or Warning is in effect; or if heavy rain (>=2” in 24hr) is forecasted
Retail Sale	No restrictions
Application Amount Restrictions-Phosphorus	No phosphorus application unless soil tests show deficiency
Application Amount Restrictions–Nitrogen	Follow lowest recommended rates in *Florida Green Industries BMPs* with no more than 4 lbs/1000 ft^2/yr. Liquid N shall not exceed 0.5 lbs/1000 ft^2/application
Slow Release Fertilizers	All granular fertilizer shall contain no less than 50% slow release nitrogen
Other Application Restrictions	No nitrogen first 30 days of new turf or landscape plants
Fertilizer-Free Zone	No fertilizer within 10’ from the top of bank of any surface waterbody, wetland, or seawall
Application Vehicle Decal and Placarding	All applicator-owned trucks must have county-issued decal
Ordinance Exemptions	Golf courses (must follow *Env Quality on Fl Golf Courses*); Specialized turf (must follow *Florida Green Industries BMPs*); Right-to-Farm Act sites; pastures used for livestock grazing; vegetable gardens; fert. produced from Manatee County sewage
Low Maintenance Zone	6’ from any waterbody, wetland, or seawall (recommended)
Grass & Landscape Debris	Must not be washed, swept, blown, or deposited into stormwater conveyances or roadways
Application Method restrictions	Any fertilizer applied/spilled/deposited on impervious surfaces must be immediately removed. Broadcast spreaders must be equipped with deflector shields
Commercial and Institutional Applicators Training, Certification & Licensure	Must obtain the Limited Certification for Urban Landscape Fertilizer Application under s. 482.1562 Florida Statutes w/in 365 days of ord. adoption
Non-commercial Applicators Training, Certification & Licensure	Encouraged to follow IFAS FYN recommendations
Landscape Personnel Training, Certification & Licensure	Supervisors/mgrs must obtain approved BMP training from county w/in 545 days of ord. Employees must receive county or employer-provided BMP training (reciprocity with equiv. training in other counties)
Reclaimed Water	Reduce fertilizer use where reclaimed water is used (recommend.)
Enforcement	To provide a reasonable period for compliance, no enforcement proceedings shall be initiated for 365 days from ordinance adoption; warning notices possible

Notes: *Florida Green Industries BMPs* - Florida Friendly Best Management Practices for Protection of Water Resources the Green Industries (FDEP, 2008)

Env Qual on Fl Golf Courses – Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses (FDEP, 2007)

Urban Turf Rule - Rule 5E-1.003(2) F.A.C. Labeling Requirements for Urban Turf Fertilizers (FDACS, 2007)

Florida Green Industries BMPs and the *Urban Turf Rule* nitrogen application recommendations are equivalent.

ORDINANCE NO. 11-21

AN ORDINANCE OF MANATEE COUNTY, FLORIDA, REGULATING LANDSCAPE MAINTENANCE PRACTICES AND USE OF FERTILIZERS; CREATING CHAPTER 2-35 OF THE MANATEE COUNTY CODE OF ORDINANCES ENTITLED LANDSCAPE MAINTENANCE AND FERTILIZER REGULATION; PROVIDING FINDINGS OF FACT; PROVIDING PURPOSE AND INTENT; PROVIDING DEFINITIONS; PROVIDING FOR APPLICABILITY; PROVIDING WEATHER AND SEASONAL RESTRICTIONS; PROVIDING FOR FERTILIZER CONTENT AND APPLICATION RATE; PROVIDING FOR IMPERVIOUS SURFACES AND MODE OF APPLICATION; PROVIDING FOR FERTILIZER-FREE ZONES; PROVIDING FOR MANAGEMENT OF GRASS CLIPPINGS AND VEGETATIVE MATERIAL; PROVIDING EXEMPTIONS; PROVIDING FOR CERTIFICATION AND TRAINING; PROVIDING FOR ENFORCEMENT; PROVIDING RECOMMENDATIONS; PROVIDING TERRITORY EMBRACED; PROVIDING FOR REPEAL OF CONFLICTING ORDINANCES; PROVIDING FOR SEVERABILITY; AND PROVIDING EFFECTIVE DATES.

WHEREAS, the Florida Department of Environmental Protection has identified specific water bodies in Manatee County as impaired as a result of excess nutrients under the Florida Impaired Waters Rule (Chapter 62-303, Florida Administrative Code); and

WHEREAS, state and federal limits on the amount of nutrients permitted in designated impaired waters, including significant portions of the Tampa Bay and Gulf of Mexico ecosystems, may require local governments to make significant investments in water quality improvement projects; and

WHEREAS, surface water and baseflow runoff containing excess nutrients from residential neighborhoods, commercial centers, industrial areas, and other lands of Manatee County enter into natural and artificial stormwater and drainage conveyances and natural water bodies in Manatee County; and

WHEREAS, nutrients are commonly found in various forms as a fertilizer for turf and landscape application and, if applied improperly, may contribute to pollution in natural water bodies; and

WHEREAS, it is recognized that properties irrigating with reclaimed water require less fertilization; and

WHEREAS, nutrient-laden runoff containing nitrogen and phosphorous fosters undesirable plant and algae growth in natural water bodies resulting in poor water quality; and

WHEREAS, the detrimental effects of nutrient-laden runoff are magnified in a coastal community, such as Manatee County, due to the proximity of stormwater and drainage conveyances to coastal and estuarine waters; and

WHEREAS, the quality of the County's streams, lakes, and rivers, as well as Tampa Bay and the Gulf of Mexico is critical to environmental, economic, and recreational prosperity and to the health, safety, and welfare of the citizens of Manatee County; and

WHEREAS, Manatee County is developed with a variety of urban land uses, where maintained landscapes have the potential to contribute to the fertilizer-based pollutant load; and

WHEREAS, the Manatee County Comprehensive Plan provides for the ability to implement strategies, regulations, and requirements necessary to achieve and maintain pollution load reduction goals of the Tampa Bay Comprehensive Conservation Management Plan; and

WHEREAS, the Board of County Commissioners of Manatee County finds that limiting the use of nitrogen and phosphorous based fertilizer is in the public interest since it reduces the potential for nutrient-laden runoff into Manatee County's freshwater, coastal and estuarine waters, thereby improving the quality of the County's waters and reducing the need to expend scarce public resources on water quality improvement projects; and

WHEREAS, this ordinance is part of a comprehensive effort by Manatee County to reduce non-point sources of nutrient pollution through implementation and enforcement of policies and regulations regarding stormwater management, water conservation, conversion from septic systems to central sewage treatment, public education, and development standards as set forth in the Manatee County Land Development Code and supported by the Manatee County Comprehensive Plan; and

WHEREAS, the Board of County Commissioners declares that, as part of the comprehensive program to address non-point sources of nutrient pollution, which is science-based, and economically and technically feasible, it is necessary to impose additional or more stringent standards than those in the Florida Department of Environmental Protection's Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes (August 2010) in order to adequately address urban fertilizer contributions to non-point source nutrient loading to local water bodies; and

WHEREAS, in the process of adoption of this ordinance, the Board of County Commissioners has considered all relevant scientific information, including input from the Department of Environmental Protection, the Department of Agriculture and Consumer Services, and the University of Florida Institute of Food and Agricultural Sciences, to the extent provided, on the need for additional or more stringent provisions to address fertilizer as a contributor to water quality degradation, and such information has been made part of the public record at the public hearing on this ordinance; and

WHEREAS, this ordinance is countywide to ensure consistency but will be enforced at the jurisdictional level.

NOW THEREFORE, BE IT ORDAINED BY THE BOARD OF COUNTY COMMISSIONERS OF MANATEE COUNTY, FLORIDA:

Section 1. Chapter 2-35 of Manatee County Code of Ordinances is hereby created to read as follows:

Chapter 2-35 Landscape Maintenance and Fertilizer Regulation

Sec. 2-35-1. Findings of fact.

As a result of adverse impacts to Manatee County waters caused by excessive nutrients resulting from improper landscape maintenance practices and the incorrect or unnecessary application of fertilizers containing phosphorus and/or nitrogen, the Manatee County Board of County Commissioners has determined that the lands and waters of Manatee County are at particularly high risk for adverse effects to surface and ground water from such fertilizer containing phosphorus and/or nitrogen, particularly when not applied in accordance with best management practices established by the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (DACS), and the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS).

Sec. 2-35-2. Purpose and intent.

This chapter regulates the proper use of fertilizers by any applicator and requires proper training of commercial and institutional fertilizer applicators and landscape maintenance companies by establishing a restricted season for fertilizer application, fertilizer-free zones, low-maintenance zones, exemptions, training, and certification requirements. This chapter requires the use of best management practices which provide specific management guidelines to minimize negative secondary and cumulative environmental effects associated with the misuse of fertilizers and improper landscape maintenance practices. These secondary and cumulative effects have been observed in and on Manatee County's natural and artificial stormwater and drainage conveyances, rivers, lakes, canals, estuaries, interior freshwater wetlands, and Tampa Bay. Collectively, these water bodies are an asset critical to the environmental, recreational, cultural and economic well-being of Manatee County residents and the health of the public. Overgrowth of algae and vegetation hinder the effectiveness of flood attenuation provided by natural and artificial stormwater and drainage conveyances. Regulation of nutrients, including both phosphorus and nitrogen contained in fertilizer, will help improve and maintain water and habitat quality.

Sec. 2-35-3. Definitions.

As used in this chapter, the following words, terms, and phrases shall have the meanings ascribed to them in this section, except where the context clearly indicates a different meaning:

(a) Application or apply means the actual physical deposit of fertilizer to turf or landscape plants.

(b) Applicator means any person who applies fertilizer on turf and/or landscape plants in the county.

(c) Approved best management practices (BMP) training program means a training program approved by the county administrator that includes, at a minimum, the BMPs associated with proper mowing, trimming, irrigation, and landscape debris management, the most current version of the "Florida Green Industries Best Management Practices for Protection of Water Resources in Florida, December 2008", as updated, and the more stringent requirements set forth in this chapter.

(d) Best management practices or BMP mean turf and landscape practices which minimize the negative environmental impacts of installation and maintenance of landscapes.

(e) Board means the board of county commissioners of Manatee County, Florida.

(f) Code enforcement officer or code inspector means any designated employee or agent of the county whose duty it is to enforce county codes and ordinances.

(g) Commercial fertilizer applicator means any person who applies fertilizer on turf and/or landscape plants in the county in exchange for money, goods, services, or other valuable consideration.

(h) County means Manatee County, Florida.

(i) County administrator means the county administrator or the county administrator's designee responsible for administration and implementation of the provisions of this chapter.

(j) Fertilize, fertilizing, or fertilization means the act of applying fertilizer to turf, specialized turf, or landscape plants.

(k) Fertilizer means any substance or mixture of substances that contains one (1) or more recognized plant nutrients and promotes plant growth, or controls soil acidity or alkalinity, or provides other soil enrichment, or provides other corrective measures to the soil.

(l) Granular means composed of small grains or particles.

(m) Institutional applicator means any person, other than a non-commercial or commercial applicator, that applies fertilizer for the purpose of maintaining turf and/or landscape plants. Institutional applicators shall include, but shall not be limited to, owners and managers of public lands, schools, parks, religious institutions, utilities, industrial or business sites, and any residential properties maintained in condominium and/or common ownership.

(n) Impervious surface means a surface that has been compacted or covered with a layer of material so that it is highly resistant or prevents infiltration by stormwater. It includes roofed areas and surfaces such as compacted sand, limerock, or clay, as well as conventionally surfaced streets, sidewalks, parking lots, and other similar surfaces.

(o) Landscape plant means any native or exotic tree, shrub, or groundcover (excluding turf).

(p) Landscape maintenance means activities carried out to manage and maintain landscape plants, including but not limited to mowing, edging, and trimming.

(q) Low-maintenance zone means an area a minimum of six (6) feet wide adjacent to water courses which is planted with non-turf grass vegetation and managed in order to minimize the need for fertilization, watering, and mowing.

(r) Pasture means land used for livestock grazing that is managed to provide feed value.

(s) Person means any human being, business, corporation, limited liability company, partnership, limited partnership, association, club, organization, and/or any group of people acting as an organized entity.

(t) Restricted season means June 1 through September 30.

(u) Site supervisor means the direct supervisor of landscape maintenance personnel.

(v) Slow or controlled release fertilizer means a fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a referenced rapidly available nutrient fertilizer.

(w) Specialized turf means grass used for athletic fields, golf course practice and play areas, and other similar activities.

(x) Specialized turf manager means a person responsible for fertilizing or directing the fertilization of specialized turf.

(y) Surface water means fresh, brackish, saline or tidal waters, including but not limited to bays, rivers, lakes, streams, wetlands, springs, impoundments, as well as canals and other artificial water bodies.

(z) Turf, sod, or lawn means a piece of grass-covered soil held together by the roots of the grass.

(aa) Vegetable garden means an area dedicated to the cultivation of edible plants.

Sec. 2-35-4. Applicability.

This chapter shall be applicable to and shall regulate any and all applicators of fertilizer, areas of application of fertilizer, and landscape maintenance activities within the county, unless such applicator or activity is specifically exempted by the terms of this chapter from the regulatory provisions of this chapter.

Sec. 2-35-5. Weather and seasonal restrictions.

(a) No applicator shall apply fertilizers containing nitrogen and/or phosphorus to turf and/or landscape plants during the restricted season from June 1 through September 30.

(b) No applicator shall apply fertilizers containing nitrogen and/or phosphorous to turf and/or landscape plants during a period for which the National Weather Service has issued any of the following advisories for any portion of the county: a severe thunderstorm warning or watch, flood warning or watch, tropical storm warning or watch, hurricane warning or watch, or if rain greater than or equal to two (2) inches in a twenty-four (24) hour period is forecasted.

Sec. 2-35-6. Fertilizer content and application rate.

(a) Fertilizers shall be applied to turf and/or landscape plants at the lowest recommended rate according to the "Florida Green Industries Best Management Practices for Protection of Water Resources in Florida, December 2008", as updated, with no more than four (4) pounds of nitrogen per one thousand (1,000) square feet applied in any calendar year.

(b) No fertilizer containing phosphorus shall be applied to turf and/or landscape plants in the county, except where a phosphorous deficiency has been demonstrated in the soil underlying the turf and/or landscape plants by a soil analysis test performed by a State of Florida certified laboratory. Any person who obtains a soil analysis test showing a phosphorous deficiency and who wishes to apply phosphorous to turf and/or landscape plants shall provide a copy of the test results to the county administrator prior to the application of phosphorous.

(c) Nitrogen fertilizer shall not be applied on newly established turf or new landscape plants for the first thirty (30) days.

(d) Granular fertilizers containing nitrogen applied to turf and/or landscape plants within the county shall contain no less than fifty percent (50%) slow release nitrogen per guaranteed analysis label.

(e) Liquid fertilizers containing nitrogen applied to turf and/or landscape plants within the county shall not be applied at a rate that exceeds 0.5 pounds per one thousand (1,000) square feet per application.

Sec. 2-35-7. Impervious surfaces and mode of application.

(a) Fertilizer shall not be applied, spilled, or otherwise deposited on any impervious surfaces. Any fertilizer applied, spilled, or deposited, either intentionally or accidentally, on any impervious surface shall be immediately and completely removed to the greatest extent practicable. Fertilizer released on an impervious surface must be immediately contained and either legally applied to turf or any other legal site, or returned to the original or other appropriate container. Fertilizer shall not be washed, swept, or blown off impervious surfaces into stormwater drains, ditches, drainage conveyances, surface waters, or roadways.

(b) Spreader deflector shields are required when applying fertilizer by use of any broadcast or rotary spreaders. Deflector shields must be positioned such that fertilizer granules are deflected away from all impervious surfaces and surface waters.

Sec. 2-35-8. Fertilizer-free zones.

Fertilizer shall not be applied within ten (10) feet from the top of bank of any surface water, landward edge of the top of a seawall, designated wetland, or wetland as defined by FDEP (Chapter 62-340, Florida Administrative Code, as may be amended or superseded).

Sec. 2-35-9. Management of grass clippings and vegetative material.

Grass clippings, vegetative material, and/or vegetative debris shall not, either intentionally or accidentally, be washed, swept, blown, or otherwise deposited into stormwater drains, ditches, drainage conveyances, surface waters, or roadways.

Sec. 2-35-10. Exemptions.

The provisions set forth in subsection 2-35-5(a) and section 2-35-6 of this chapter shall not apply to the following:

(a) Golf courses. For all golf courses, the provisions of the FDEP document, entitled "BMP's for the Enhancement of Environmental Quality on Florida Golf Courses, January 2007", as updated, are required and shall be followed when applying fertilizer to golf courses.

(b) Specialized turf managers are required to follow the provisions of the "Florida Green Industries Best Management Practices for Protection of Water Resources in Florida, December 2008", as updated, for turf and landscape plants.

(c) Bona fide farm operations as defined in the Florida Right to Farm Act, Section 823.14, Florida Statutes.

(d) Other properties not subject to or covered under the Florida Right to Farm Act that have pastures used for grazing livestock.

(e) Vegetable gardens, owned by individual property owners or a community, provided that fertilizer application rates do not exceed UF/IFAS recommendations according to SP103 Florida Vegetable Gardening Guide, December 2008, as updated.

(f) Yard waste compost, mulches, or other similar materials that are primarily organic in nature and are applied to improve the physical condition of the soil.

(g) Tree trunk injection fertilization treatments that are performed by a certified arborist.

(h) Fertilizer made or produced by the county from sewage.

Sec. 2-35-11. Certification and training.

(a) All commercial and institutional applicators within the county shall obtain the limited certification for urban landscape fertilizer application provided for under Section 482.1562, Florida Statutes, within three hundred sixty-five (365) days of adoption of this chapter, or within ninety (90) days of initial employment, whichever occurs later. Applicators are required to keep a copy of such certificate with them during application activities and shall present the certificate to any authorized official of the county, upon request.

(b) All site supervisors and managers of professional landscape maintenance companies, as well as government and institutional landscape supervisors, shall abide by and successfully complete an approved best management practices training program within five hundred forty-five (545) days of adoption of this chapter. Upon successful completion, a certificate of completion will be provided. Landscape maintenance staff are required to keep a copy of such certificate with them during landscape maintenance activities and shall present the certificate to any authorized official of the county, upon request.

(c) Employees of lawn and landscape maintenance companies who are not site supervisors, managers or clerical personnel shall also be trained in BMPs through an approved best management practices training program or by the company or a contractor of the company. The training shall also include the more stringent requirements set forth in sections 2-35-3 through 2-35-12 of this chapter. Training may be provided by a certified site supervisor or manager employed by the company. Training shall be required of all personnel of such companies within five hundred forty-five (545) days of adoption of this chapter, or within ninety (90) days of initial employment, whichever occurs later. Prior to the successful completion of said program, each employee shall work under the direct physical supervision of a certified landscape maintenance employee. Landscape maintenance companies shall maintain written records of compliance with this provision and shall present training records to any authorized official of the county, upon request. Certifications issued to employees of lawn and landscape maintenance companies by other Florida counties and cities with equivalent approved best management practices training program requirements will be recognized by the county as meeting the certification and training requirements of this subsection.

(d) All commercial and institutional applicators, site supervisors and managers of professional landscape maintenance companies, government and institutional landscape supervisors, and any employee of a lawn and landscape maintenance company shall abide by best management practices for which they have been trained or certified, as well as the provisions of this chapter.

(e) A vehicle decal issued by the county indicating that the company is in compliance with the training and certification requirements of this section shall be affixed and maintained on the exterior of all vehicles and/or trailers used by the company in connection with landscape maintenance activities and/or the application of fertilizer within the area regulated by this chapter. The vehicle and trailer decals shall be provided by the county upon submittal of demonstration of compliance by the company with the certification and training requirements of this section.

Sec. 2-35-12. Enforcement.

(a) Violations of this chapter may be prosecuted and punished as provided in Section 125.69, Florida Statutes. Each day any violation exists shall constitute a separate offense.

(b) This chapter may be enforced in accordance with Chapter 162, Florida Statutes, and Section 2-2-25 of the Manatee County Code of Ordinances.

(c) Notwithstanding any other provision of this chapter, the county may also enforce this chapter by actions at law or in equity for damages and injunctive relief. In the event the county prevails in any such action, the county shall be entitled to an award of costs and attorney's fees.

Sec. 2-35-13. Recommendations.

(a) A voluntary six (6) foot low-maintenance, no-mow zone is recommended from those areas described as fertilizer-free zones in section 2-35-8 in order to reduce the potential for fertilizer residue entering adjacent water bodies and wetlands. A swale/berm system is recommended for installation at the landward edge of this low-maintenance zone to capture and filter runoff. No vegetative material shall be deposited or left remaining in the low-maintenance zone or in the water body or wetland. Care should be taken to prevent the overspray of aquatic weed products in the low-maintenance zone.

(b) It is recommended that the application of fertilizer for properties using reclaimed water service be reduced in accordance with the nutrient level contained in the reclaimed water. This information is available from the county administrator.

(c) The county recommends the establishment of training programs using Spanish-speaking certified BMP trainers.

(d) The county recommends that private homeowners become familiar with and utilize the recommendations of the UF/IFAS Florida Yards and Neighborhoods program when applying fertilizer.

Sec. 2-35-14. Territory embraced.

The provisions of this chapter shall embrace all territories within the legal boundaries of Manatee County, Florida, including incorporated and unincorporated areas, unless in conflict with or repealed by a municipal ordinance. In the event of such conflict or repeal, this chapter shall not be effective within the municipality.

Section 2. All county ordinances or parts of county ordinances in conflict with the provisions of this ordinance are hereby repealed to the extent of such conflict.

Section 3. If any provision of this ordinance or the application thereof to any person or circumstance is held invalid, the invalidity shall not affect other provisions or applications of the ordinance which can be given effect without the invalid provision or application, and to this end the provisions of this ordinance are declared severable.

Section 4. Except as otherwise expressly provided in this ordinance, this ordinance shall take effect upon filing with the Department of State of the State of Florida. However, a three hundred sixty-five (365) day implementation period is hereby established in order to accomplish the following:

(a) The establishment of approved best management practices training programs.

(b) For commercial fertilizer applicators, institutional applicators, and other users and applicators of fertilizer to become familiar with the provisions of this ordinance.

(c) To provide a reasonable period for compliance with the terms of this ordinance.

No enforcement proceedings shall be initiated for three hundred sixty-five (365) days from the effective date; provided, however, warning notices may be issued during the implementation period.

ADOPTED AND ENACTED, by the Board of County Commissioners of Manatee County, Florida, with a quorum present and voting, on the 24th day of May, 2011.

BOARD OF COUNTY COMMISSIONERS
MANATEE COUNTY, FLORIDA

By: ______________________
Chairman

BOARD OF COUNTY COMMISSIONERS
SEAL
MANATEE CO. FLA.

ATTEST: R.B. Shore
Clerk of the Circuit Court

By: ______________________
Deputy Clerk

Boynton Inlet Contributing Area Watershed Management Plan

Attachment E

Approved MS4 Water Quality Monitoring Plan for Lake Ida

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Noah Valenstein
Secretary

Florida Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Sent via ePost

January 19, 2018

Subject: Palm Beach County Municipal Separate Storm Sewer System (MS4)
NPDES Permit No. FLS000018-004
Lake Ida WBID 3262A Targeted Water Quality Monitoring Plan and Approval

Thank you for submitting the Targeted Water Quality Monitoring Plan for WBID 3262A, Lake Ida, for nutrients as required by Parts VIII.B.2.c of your permit, received August 23, 2017.

The Department approves the Targeted Water Quality Monitoring Plan. Future due dates:

Report	**Permit Requirement**	**Due Date**
Monitoring Summary	Year 3 ANNUAL REPORT	March 31, 2020
Supplemental SWMP	Year 4 ANNUAL REPORT	March 31, 2021
TMDL Status Report	Annual Report Section IX	Each Annual Report

If you have any questions, please feel free to contact me at Michelle.Bull@dep.state.fl.us or (850) 245-7561, or Borja Crane-Amores at (850) 245-7520 Borja.CraneAmores@dep.state.fl.us.

Sincerely

Michelle Bull

Michelle Bull
NPDES Stormwater Program

Addressees: Mr. Colin Groff, P.E., City of Boynton Beach
Marjorie G. Craig, P.E., City of Delray Beach

CC: Angela Prymas, City of Boynton Beach
Jeff Needle, City of Delray Beach
Alan Wertepny, Mock-Roos

Water Quality Monitoring Plan for Lake Ida

Palm Beach County's NPDES Permit FLS 18-00 4

This is document is intended to outline the Targeted Water Quality Monitoring Plan to satisfy Palm Beach County's NPDES permit FLS 000018-004 requirements due to Lake Ida's listing as a receiving water body with Total Maximum Daily Load (TMDL) exceedances. Lake Ida receives stormwater discharges from four (4) MS4 systems and several other watersheds within unincorporated Palm Beach County.

A targeted water quality monitoring plan is being proposed instead of storm event monitoring plan in order to establish ambient water quality conditions in Lake Ida. It should be noted that the four (4) MS4s discharge into Lake Ida directly, the City of Boynton Beach, the City of Delray Beach, Palm Beach County in the East, and FDOT in the west. Of these 4 MS4's, the contributions from Boynton Beach and Delray Beach make up only 10.1% of the total contributing watersheds discharging into the Lake (See attached Sub watershed I). The majority of stormwater water received by this lake comes from private development permitted by South Florida Water Management District into the Lake Worth Drainage District's (LWDDs) drainage network.

The Specific elements required for a Targeted Water Quality Monitoring Plan are as follows:

1. **Current Estimates of Annual Nutrient Loadings to Lake Ida** will be obtained through the hydrologic modeling efforts of NOAA. (Activity 1.3 of the NOAA scope)

2. **Identifying major sources of the nutrients discharging into Lake Ida.** The sources are a combination of urban and agricultural stormwater containing phosphorus and nitrogen from fertilizers along with legacy nutrients from agricultural uses dating back to the early part of the 20^{th} century. This will be fully developed under the NOAA effort (Activity 2.1 of the NOAA scope).

3. **Determining the change in health of Lake Ida over time** will involve an evaluation of the existing data available. There are eight years of data available in the Impaired Waters Rule (IWR) database that will be analyzed to determine the level health of Lake Ida. Evaluating the nutrient levels including the number of exceedances, the length of those exceedances, the type of exceedances, a comparison of nutrient levels in similar lakes in south Florida will assist in determining the condition of Lake Ida and impact of the TMDL exceedances to the Lake.

   A literature search may find biological studies on this Lake or other similar lakes in the region to establish a baseline for habitat and a relationship between nutrient levels and the health of shallow lakes in South Florida.

4. **Monitoring at the prioritized outfall:** MS4 Monitoring Strategies - Outfall vs Targeted (ambient) monitoring.

   Part V of the most recent version of the MS4 permit for Palm Beach County (FLS000018-004) calls for the creation of an assessment program to determine the overall effectiveness of the SWMP. This Assessment Program needs to include a water quality monitoring program intended to identify where local sources of urban stormwater is adversely affecting surface water resources. This program allows the permittee to design an appropriate plan as long as they can demonstrate the program can assess changes in the SWMP.

   Part VIII of the same permit also requires a monitoring plan strictly for TMDL waterbodies. The permit prescribed sampling calls the collection of seven (7) storm event flow weighted composites at the priority outfall of concern OR a targeted monitoring program of the receiving waters and at the priority outfalls.

   Outfall monitoring is relatively more costly, inefficient and highly uncertain. It is inherently difficult to develop representative loads from different storm events and different antecedent conditions. There is a very distinct difference between stormwater outfall monitoring and regular point sources where flows are relatively constant. Targeted monitoring is more holistic approach as the purpose of stormwater management is designed to protect the entire receiving waterbody.

   The proposed plan will be to perform Targeted (ambient) Water Quality Monitoring in Lake Ida. The Pinellas County Water Quality Ruling allows water quality of a receiving water body to be defined through targeted water quality sampling to establish ambient water quality. In fairness to the 2 MS4s that currently are responsible for executing the monitoring plan, only 16.2% of the water into the Lake comes from the four (4) existing MS4s and more specifically, the contributions from Boynton Beach and Delray Beach make up only 10.1%. The monitoring plan will include sampling locations where LWDD's E-4 canal enters Lake Ida from the north and from the south along with LWDD's L-30 lateral entering at the Middle West side of the Lakes Eden and Ida. A description of the water quality monitoring plan will be described in section #**6.**

5. **Monitoring within Lake Ida shall include biological and sediment monitoring if appropriate to the pollutant of concern**. Monitoring shall take place in Years 2-3 of the permit cycle starting in the next fiscal year, FY2018. The permittee will evaluate the appropriateness of biological monitoring based on findings in a literature search under section #3. The biological monitoring may include Lake Vegetation Index analysis to help in establish the condition of the Lake.

While biological monitoring may be helpful to determine the current health and condition of Lake Ida, sediment sampling does not seem appropriate due to the high level of uncertainties involved in sediment movement (vertical and horizontal) in shallow lakes. This lake averages 10 feet depth with a maximum depth of 20 feet, in addition to three (3) large secondary canals entering this 133 acres lake at the north and south ends, as well as in the middle. There is considerable disturbance of the lake bed during storm events and recreational boating. The uncertainty involving the sediment transport would likely leave more questions than answers. Though the legacy nutrients left in the sediments from early years of agricultural discharges from the LWDD canal network, established in 1915, has undoubtedly impacted the current nutrient levels in the Lake's sediments.

6. **Monitoring Plan Description** includes: the monitoring locations, methods of monitoring at each location, monitoring frequency, and D) a narrative detailing the monitoring plan's ability to evaluate changes in stormwater pollutant loadings and water body health over time.

   A) The Monitoring Locations are depicted on Exhibit 1. (attached)

   B) Methods of Monitoring will be **Grab Samples.**

   C) Monitoring Frequency will be **Quarterly.**

   D) Monitoring Parameters will include: **TP, TN, Chlorophyll A** and physical parameters such as **temperature, pH, conductivity** and **dissolved oxygen** (DO).

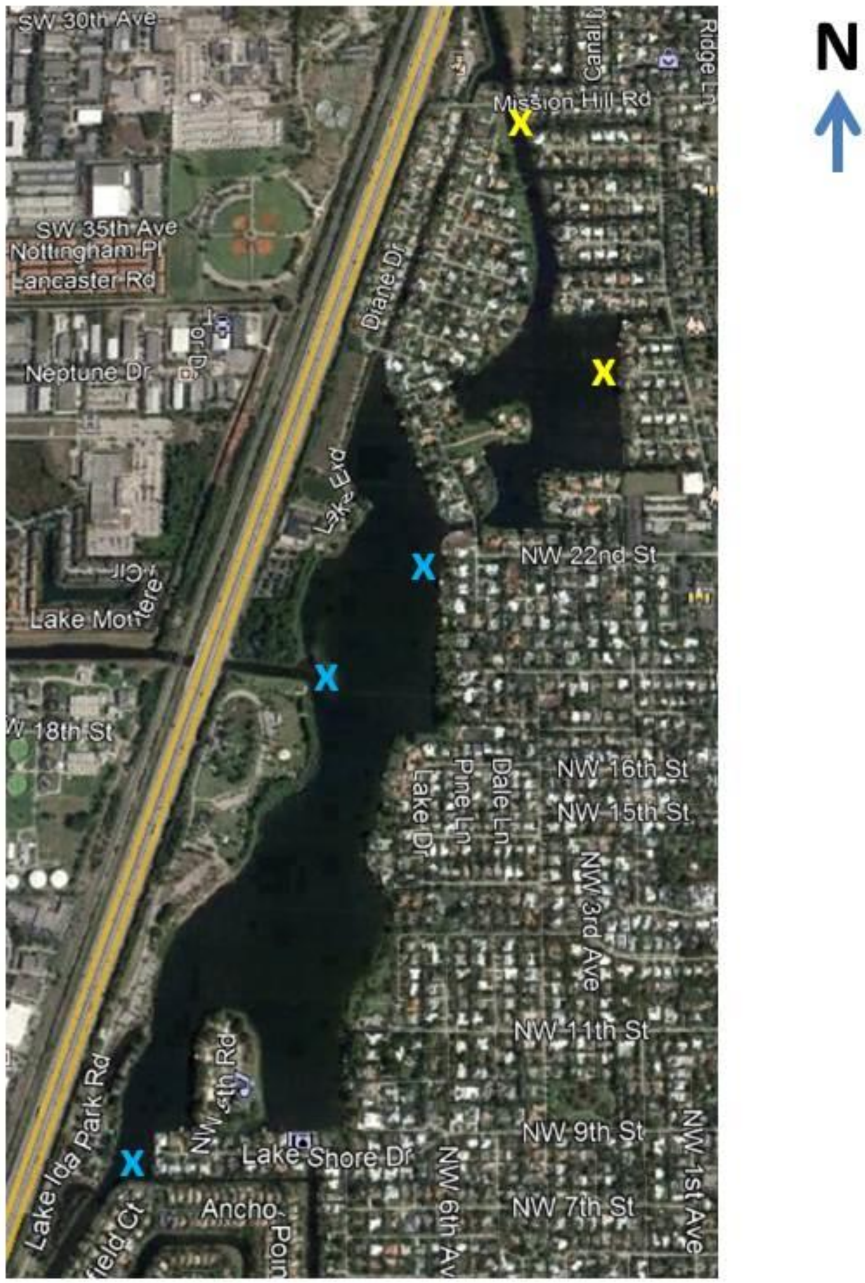
   The sample collection will be performed by a certified laboratory with the State of Florida and will be collected by licensed technician using approved procedures including collection technique and proper chain of custody.

Water Quality Monitoring Plan for Lake Ida

Palm Beach County's NPDES Permit FLS 18-00 4

Exhibit 1

Targeted Water Quality Monitoring Locations for Lake Ida



Monitoring Locations City Of Delray Beach X

Monitoring Locations City of Boynton Beach X