ATKINS

Technical Memorandum

To: **Mac Hatcher, PM Collier County**

From: **Moris Cabezas, PBS&J**

Date: **May 25, 2011**

Re: **Watershed Model Update and Plan Development**
Contract 08-5122, PO 4500106318
Phase 2, Element 4: Watershed Management Regulatory Review

1.0 Introduction

An important component of watershed management planning is the identification of non-structural Best Management Practices (BMPs) for watershed management. Non-structural BMPs focus on preserving and protecting natural features of the landscape and attempt to manage stormwater at its source. Their evaluation includes an analysis of the applicable regulatory framework. In this document, the recommended non-structural initiatives address issues that range from land development guidelines to water quality monitoring.

The purpose of the analyses presented herein is to formulate recommendations that would allow for the implementation of an environmentally sustainable management program. The implementation of that program will guide future land development activities in Collier County and it is of critical importance to control impacts in terms of water quantity, water quality, and ecological protection. Its program objective is to:

a) Promote more effective site planning and minimize water quantity and water quality anthropogenic impacts

b) Promote preservation of the natural systems

c) Help meet the County's regulatory requirements

2.0 Regulatory Background

In Florida, "Waters of the State" are protected per the Water Resources Act, Chapter 373 FS. The Act provides for the establishment of permit programs, including those related to surface water management systems and the Environmental Resource Permit (ERP) process. The ERP addresses issues of water quantity, water quality, and wetland protection. In Collier County the ERP process is implemented by the South Florida Water Management District (SFWMD) per the regulations codified in Title 40-E of the Florida Administrative Code (FAC). Regulations relate to water quantity, water quality, and wetland protection/mitigation.

In terms of water quality, minimum standards for Florida streams have been established depending on a stream designated use. Chapter 62-303 FAC defines the State water quality standards. The condition of a water body not meeting standards is referred to as "impairment".

The issues of Florida impaired water bodies came to light as part of the recent implementation of the Total Maximum Daily Load (TMDL) program by the FDEP, which requires identification of water bodies that do not meet applicable State water quality standards. The process for identifying impaired water bodies is as described in the State's Impaired Waters Rule Chapter (IWR) 62-303 FAC. As part of that process, FDEP determined that a large number of water bodies in the State are impaired or potentially impaired. Impairments are particularly prevalent for nutrients, which have been found to be the most common impairment parameter throughout Florida. FDEP has found several impaired water bodies in Collier County. A detailed evaluation of the TMDL issues was conducted as part of this project. Results are described in the Watershed Management Plan Technical Report.

Surface water management, also referred to as stormwater management, is also the responsibility of local governments, in this case Collier County. The County's Growth Management Plan (GMP), Public Facilities Element, Drainage Sub-Element, indicates that "stormwater management refers to a set of comprehensive strategies for dealing with stormwater quantity and stormwater quality issues." Goal 2 of the GMP Conservation and Coastal Management Element states that the County "shall complete the prioritization and begin the process of preparing Watershed Management Plans, which contain appropriate mechanisms to protect the County's estuarine and wetland systems." Regulations pertaining to stormwater management are included in various ordinances and the Land Development Code (LDC).

3.0 Recommended Non-Structural Initiatives

The existing conditions analysis conducted as part of the watershed management planning process helped assess the magnitude of the anthropogenic impacts in Collier County in terms of a) water quantity management including fresh water discharge patterns to the estuaries; b) water quality in the existing streams, canals, and estuaries, and c) natural system hydrology and habitat. It was concluded that, in spite of current regulations, the local environment has been subject to significant impact. That is consistent with evaluations conducted by the State of Florida, which have indicated that current permitting requirements are unable to comply with the State Water Policy (62-40.416) and control impacts of new development.

An important finding of the analysis of alternatives conducted as part of the watershed management plan was that the recommended structural watershed projects that were analyzed and proposed as part of the watershed management plan will not be enough to have a significantly effect on the restoration of the currently affected environment. Therefore, implementation of non-structural initiatives is necessary to complement the structural watershed improvement measures. The proposed non-structural initiatives are listed in **Table 1**. Specific descriptions of the proposed initiatives follow.

Table 1
Recommended Non-Structural Initiatives

Initiative	Description
1	Low Impact Development (LID) Program
2	Stormwater Retrofit Program
3	Fee-Based Stormwater Utility Incentive Program
4	Allowable Maximum Site Discharges
5	Stormwater Runoff Volume Control
6	Verification of No Floodplain Impact
7	Flood Protection Levels of Service Criteria
8	Golden Gate Estates Transfer of Development Rights Program
9	Golden Gate Estates Watershed Mitigation Program
10	Modified Operations of Water Control Structures
11	Expanded Water Quality Monitoring Program
12	Additional Watershed Protection Programs

4.0 Initiative 1: Low Impact Development (LID) Program

This initiative proposes implementation of a Low Impact Development (LID) program that would apply to all new development in Collier County. LID is a well established approach to stormwater management that relies on hydrology-based site planning and design. LID aims at minimizing the volume of runoff and associated pollutant loads reaching the receiving water bodies and managing it as close as possible to where it is generated. Techniques defined as micro-controls are implemented in a dispersed fashion throughout a site. Following is a description of the program's background and recommended implementation strategy.

4.1 Current Collier County Runoff Treatment Requirement

The Collier County Growth Management Plan, Conservation and Coastal Management Element, Ordinance 2008-10, and the Land Development Code (LDC) Section 3.07.00, require that until the Watershed Management Plans are completed all new development and re-development projects meet 150 percent of the ERP water quality volumetric requirements. This interim requirement basically considers that all waters in the County should be held to the same standards as those applicable to Outstanding Florida Waters. This requirement also reflects the County's intention to provide additional protection to water quality beyond those provided by the State. The effectiveness of the County's stormwater treatment requirement was evaluated as part of this project. The results of the evaluation are described below.

Concurrently with the implementation of the TMDL program, FDEP conducted various studies to determine if the existing technology-based design criteria for stormwater systems are helping

meet State Water Policy (62-40.416), by which such systems should be designed to achieve at least 80 percent reduction of the average annual pollutant loads ”that would cause or contribute to violations of State water quality standards”. FDEP’s studies demonstrated that current design criteria for wet detention, which is the most common stormwater runoff treatment method in Collier County, generally meet the State Water Policy requirements for removal of total suspended solids (TSS). However, nutrient removal efficiencies amount to less than 70 and 45 percent for total phosphorus and total nitrogen, respectively. In addition, nutrient removal efficiency (nitrogen and phosphorus) decreases substantially after an initial detention time of about 14 to 20 days, which is a feature of the standard design. **Figure 1** shows schematically the components of a traditional wet detention pond. **Figures 2 and 3** show the relationship of detention time to removal efficiency of phosphorus and nitrogen, respectively.

Figure 1. Schematic of Wet Detention Pond Components (from FDEP 2007)

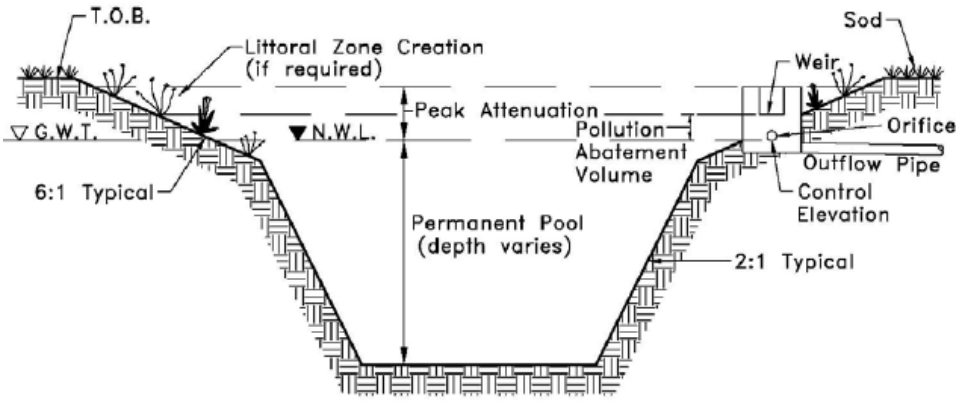


Figure 2. Removal Efficiency of Total Phosphorus in Wet Detention Ponds as a Function of Detention Time

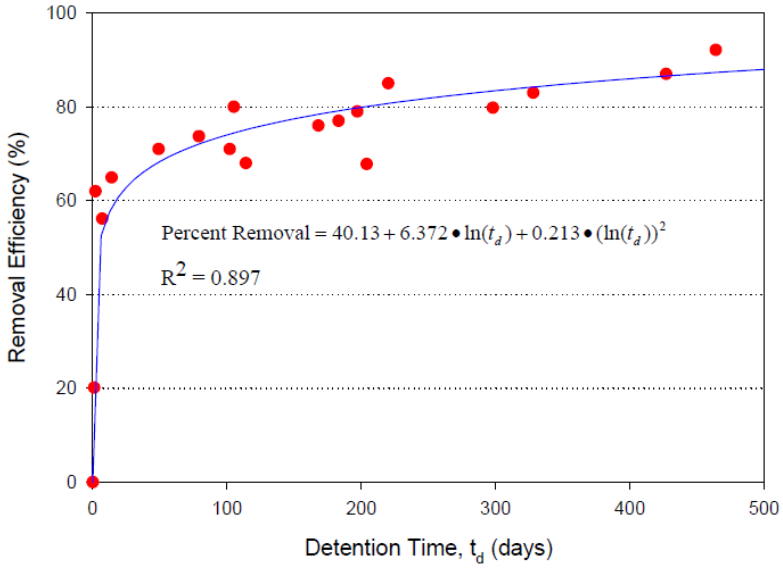
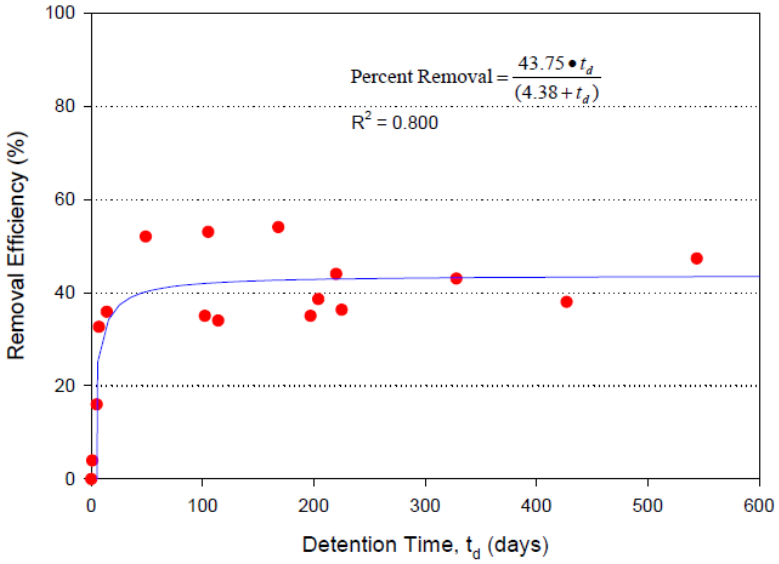


Figure 3. Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Detention Time



Based on the removal characteristics of detention treatment facilities, it is likely that the County's additional treatment volumetric requirement has contributed to a further reduction in the discharge of total suspended solids (TSS) to the County's waters. However, it is also likely that small gains in nutrient removal are being achieved. In addition, the current practice of meeting the treatment requirement by simply increasing the volume of the treatment pool (pollution abatement volume), as opposed to increasing the size of the permanent pool further reduces the effectiveness of the treatment requirement. Research (FDEPD, 2007) has shown that treatment for nutrients occurs in the permanent pool.

4.2 Description of the Recommended LID Program

As described above, FDEP's studies have concluded that the current design requirements for stormwater Best Management Practices (BMPs) are not adequate to meet State law. The agency also concluded that an update of the Florida Statewide Stormwater Treatment Rule was necessary and a draft new rule was developed. A main requirement of the drafted new rule is that post-development pollution loads should not exceed the pre-development loads. Pre-development is defined as the natural native landscape. This would make necessary the implementation of new approaches to remove the additional anthropogenic pollution load, including the implementation of treatment trains.

The application of the proposed FDEP stormwater rule would provide an effective approach to control water quality impacts of new development. However, it is unlikely it will be adopted in the near future. Therefore, it is safe to assume that the State current regulatory requirements would remain in place over the foreseeable future and that mitigation of growth impacts at the local level will be critical to achieve environmental protection goals.

It is recommended that a new approach based on the preservation of a site's natural features be implemented to minimize pollution loads and help preserve the natural system. Such approach should be consistent with the concept of Low Impact Development (LID). As indicated previously, LID aims at minimizing the volume of runoff reaching the receiving water bodies and managing it as close as possible to where it is generated. Techniques defined as micro-controls are implemented in a dispersed fashion throughout a site. The basic principle is to attempt to mimic pre-development hydrology by retaining or treating stormwater runoff close to the source thereby replicating the natural pathways. Further descriptions of the LID concept are provided in Appendix A.

The proposed new approach should be based on **requiring that the nutrient load associated with 50 percent of the basic ERP requirement be treated by LID**. SFWMD regulations for water quality establish that the basic runoff treatment requirement for new development is one inch of runoff over the developed area or 2.5 inches times the percentage of imperviousness, whichever is greater. The basic runoff treatment requirement described above applies to discharges to all water bodies considered to be Waters of the State, except for discharges into Outstanding Florida Waters (OFWs) or currently impaired water bodies. In those cases, the treatment requirement is 150 percent of the basic treatment criteria. The proposed LID treatment should be for the nutrient load generated by 0.5 inches of runoff over the developed area or 1.25 inches times the percentage of imperviousness, whichever is greater.

Although the benefit of the current requirement is limited, based on input from local stakeholders it was decided that the 150% treatment be maintained and the LID approach be set as an additional land development requirement.

4.3 Application of the Recommended LID Program

In practice, the LID techniques applied to a particular development should be left at the discretion of the designer as conditions may vary substantially between sites. The techniques could be applied at the lot level or at the subdivision level. Because runoff reduction is the most efficient method to reduce pollution loads, infiltration techniques should be considered when possible. From that standpoint it was estimated that for residential areas, based on typical lot designs for single-family homes under zoning categories RSF-3 through RSF-6, and assuming an average DCIA of 25 percent and an SCS curve number (CN) of 74 for the non-DCIA areas (a CN of 74 represents soils type C), the design storm event for LID design should be 1.5 inches, which represents approximately the 93th percentile event. This means that the nutrient pollutant load associated with 93 percent of the storms would be eliminated by LID if infiltration methods are used at a site. For parking facilities, assuming a 90 percent DCIA, the design event is 1.30 inches. This rainfall event represents approximately the 90th percentile.

It is recognized that the construction of infiltration systems is not always possible in areas of high water table elevations. In those cases, LID techniques may be limited to construction of localized dry detention areas whose storage capacity is recovered by installation of drain systems, or localized created wetland systems. Until the County establishes specific design criteria, the pollution removal calculations to design these facilities can be made based on best available literature data. Documents that could be used as reference to facilitate design include

the “Stormwater Quality Applicant’s Handbook” developed by FDEP as part of the draft stormwater rule and the Sarasota County, Florida, LID manual. The FDEP handbook defines design criteria for numerous types of BMPs from retention basins and exfiltration trenches to swales, pervious pavement, and underground storage facilities. The Sarasota County manual focuses on detention with biofiltration and pervious pavement. The establishment and adoption of design criteria for various types of facilities may be conducted as part of the implementation of the overall initiative.

4.4 LID Cost Effectiveness

Although the concept and application of LID has been promoted and studied for over 20 years, it is still considered a new and emerging technology and there is some apprehension in the development community as to installation costs. This is particularly important at the initial stages of an LID implementation program because construction costs for LID technologies are often site-specific and developers may see some increases in site assessment and design. Also, the development community may be concerned with long-term maintenance costs associated with LID techniques including on-site management of stormwater facilities. However, numerous studies (Foss 2005; Conservation Research Institute 2005; U.S. EPA 2005; Zickler 2004) have demonstrated that LID can compare favorably with conventional controls in a side-by-side analysis of installation and maintenance costs. LID costs may be higher in terms of installation of site specific technologies, but savings are accrued because of the reduced stormwater conveyance systems capacity needs and the reduced load of sediments to existing ponds, which eliminates the need of dredging to restore the facilities’ treatment efficiency and aesthetic characteristics.

In summary, consistent with current research, the implementation of the proposed LID program is expected to be at worst cost neutral for the development community. The main benefit of implementing the proposed program is the achievement of countywide water quality improvements of the County’s water bodies due to pollution load reductions.

4.5 LID Implementation Incentives

Although the implementation of the proposed LID program is likely not to increase development costs, we believe incentives to land developers are necessary to help offset the perception that traditional designs are less expensive and perhaps more attractive to potential buyers than the proposed approach. Various incentives are proposed through changes in the Land Development Code (LDC). They are listed in **Table 2**.

The recommended incentives are listed by LDC chapter and refer mainly to modifications to road and parking design criteria. An important recommendation is for the County to revisit the road width criteria to consider the average daily traffic (ADT) needs. A minimum road width for local streets is recommended to be set at 18 ft based on an ADT of less than 400. That results in roads serving either 36 single family homes or 60 multi-family units. The proposed Design would be consistent with the American Association of State Highway and Transportation Officials (AASHTO) standards.

Table 2
Low Impact Development Incentives

4.02.01 Dimensional standards for principle uses 1. Allow 18-ft width on local roads having an ADT of 400 trips (36 single family homes) when using cluster development standards. This is consistent with ASHTO standards.
4.04.00 Transportation System Standards 1. Promote design of swales on local roads. 2. Allow road medians to be designed as depressed surfaces that can collected and treat road runoff
4.05.02 Parking design standards 1. Promote parking lots design using surfaces with pervious materials that promote water infiltration 2. Aisle width reduced by 2' except for parallel parking 3. Allow grassed swale dividers along opposing parking spaces. Parking space depth reduced from 18' to 16.5' if wheel stop is located 0.5' from edge of swale
4.05.04 Parking space requirements 1. Modify the LDC to only address minimum counts for typical use/demand. Allow the developer or facility owner to provide what is believed necessary for peak use. **2.** Reduce the minimum retail shop and store and department store parking requirement from 1 per 250 square feet to 1 per 500 square feet of indoor/outdoor retail area. **3.** Allow for up to 25% grass spaces (or other suitable permeable pavement) for developments regardless of parking count. There should be at least 3 paved spaces (excluding handicap parking). Allow use of identified grassed areas for locating dry detention facilities.
4.06.03 Landscaping requirements for vehicular use areas and rights-of-way 1. Allow use of depressed landscape islands 2. Allow rows of parking spaces to contain 20 spaces, instead of 10, between islands if drainage is directed to grassed swale dividers **3.** Allow swale divider area and grass parking areas to count as part of the off-parking interior vegetated areas. **4.** Allow parking stalls to be up to 100 ft away from a tree. Allow one tree for every 500 ft2 on interior landscaped area
6.05.01 Stormwater management system requirements 1. Allow in--ground percolation type retention systems to achieve water quality retention if designed per LID manual requirements

The off-site parking recommendations refer to modified requirements for minimum parking spaces, parking aisle widths, and general design features. The new design features would not diminish the safety or aesthetic characteristics of the parking facilities. It should be considered that many of the current design standards for parking lots were established years ago when cars were generally larger and more difficult to maneuver.

5.0 Initiative 2: Stormwater Retrofit Program

The implementation of the LID program will help control impacts of new development. However, restoration and protection of the existing natural system will require establishment of retrofit programs for existing development. A proposed initiative is to establish a stormwater retrofit program that would aim to:

- Retrofit public facilities, including parking lots in public buildings such as the Government Center and public schools.
- Install local runoff treatment facilities in areas that lack treatment systems
- Retrofit private facilities by working with Municipal Services Taxing Units (MSTUs)

Retrofit Public Facilities. The County operates a number of public facilities that may benefit by incorporation of LID features. Parking lots, in particular, could be re-designed to route the drainage flows to depressed islands or grassed areas. It may also be possible to install pre-manufactured treatment systems in some locations (i.e. baffle boxes) as long as the systems are capable of removing target pollutants. This program not only will benefit the natural systems in the County, but would also provide opportunities for educating the community on stormwater issues and would be an example of the County's commitment to environmental protection

Install Local Runoff Treatment Facilities. A retrofit program that may be considered by the County involves the acquisition of small parcels in areas where stormwater treatment is limited. The program would consist of converting those parcels to local runoff treatment facilities such as retention ponds or created wetlands. Stormwater runoff would be routed to these facilities prior to discharging into a canal. An area that would significantly benefit from this approach is Golden Gate Estates where more than 400 streets dead end at a drainage canal. It is estimated, for example, that a 5-acre lot can accommodate a 3 to 4-acre retention/detention pond or wetland system that would be able to treat a drainage area of approximate 50 to 70 acres. In addition to runoff treatment, these facilities can provide better wetland connectivity and improve the local habitat.

Retrofit private facilities by working with MSTUs. MSTUs are another mechanism available to provide incentives for implementing a stormwater retrofit management program. MSTUs are established by ordinance to assess benefiting properties typically for capital improvement projects such as paving, drainage, and stormwater projects. The MSTU programs encourage residents to financially participate in implementing capital improvement projects. To encourage residents to participate, the County would agree to pay a portion of a project's costs and assess the residents for the remaining amount. The residents' participation would occur in the form of annual assessments that could typically last between 5-10 years.

It is recommended that the County establishes a program dedicated to fund stormwater retrofits. The program would be funded using current stormwater utility revenues and could be complemented by funds available from State of Federal grants such as the 319(h). The projects would be selected from a prioritized list to be developed by County staff. The project list would be flexible to accommodate changes due to funding sources, public preferences, and/or water quality improvement needs. It will be important for the County to keep track of any funded projects to receive the corresponding TMDL credit.

6.0 Initiative 3: Fee-Based Stormwater Utility Incentive Program

Ordinance 2008-80 describes the funding mechanism for stormwater projects through the stormwater utility, and states the County's commitment to properly fund the program. Funds are proceeds from 0.15 mills of ad valorem tax revenues, which are deposited into Fund 325. According to the Ordinance, the funding spans through, and including, fiscal year 2025.

Although the stormwater utility funds the stormwater program, it is not setup to allow implementation of an incentive program. It is recommended that the financing of the utility be changed to a fee-based system that in turn would be based on the volume of runoff discharged from each property. The goal would be to maintain the same revenue, but using a different fee structure.

Similar to other utilities in Florida, an annual fee could be established based on the concept of Equivalent Residential Units (ERUs), which represents the volume of runoff discharged from a "typical home" in the County. The fee for each user would depend on the number of ERUs. A "typical home" can be defined as a developed parcel with no stormwater controls. Credit should be provided to parcels, or entire developments, that have been designed to provide treatment of stormwater runoff through LID techniques.

The advantage of the proposed fee structure is that it can be used to provide incentives for both new development and retrofit of private property. For example, new developments that are designed per the LID concepts could use the stormwater fee structure to market sales of homes that pay a lower stormwater utility fee. The fee could also be used to provide credit to private property when retrofitting programs are implemented. Property owners would weigh the retrofitting costs with the benefit of a reduced stormwater fee.

It is recognized that the ERU fee structure sometimes results in large fees imposed on businesses that include large parking facilities. A credit system could be applied to the business sector to reduce the initial fee impact. However, the credit should be applicable within a defined time frame, i.e. 5 years, to further incentivize implementation of retrofitting programs.

Finally, although the benefit to Collier County may be small, it should be noted that the ERU fee structure allows collection of funds from federal facilities, which do not contribute to the ad valorem tax revenue.

7.0 Initiative 4: Allowable Maximum Site Discharges

Another water quantity-related recommendation pertains to the policies in County's Growth Management Plan, Public Facilities Element, Drainage Sub-Element, that state that the drainage system should have adequate stormwater management capacity at the time a development permit is issues. Also, it indicates that the system has to be designed "so as to ensure that the final outlet point has adequate capacity to handle all discharges from the upstream portion of the watershed under conditions present at the time of design".

The County has established maximum allowable off-site discharges to the drainage canal network. Ordinance 2007-11 establishes an allowable discharge of 0.15 cfs/acre for all areas in the County, except six basins and subbasins that are subject to specific discharge limitations. The ordinance al so states that "allowable off-site discharge rates shall be computed using a storm event of 3-day duration and 25-year return frequency"

Results of hydraulic analyses conducted as part of this project indicate that various segments of the primary and secondary drainage systems do not have the capacity to handle large storm events. In some cases, the canal banks are overtopped even during the 10-year design storm event. Therefore, a check on the current maximum allowable discharge was conducted. The process consisted of using the existing conditions model (EAC) developed as part of this project to simulate four design storm events, 5-year/72-hour, 10-year/72-hour, 25-year/72-hour, and 100-year/72-hour events. Results were used to determine the maximum flow that would remain within the banks of identified canal segments in the watershed. Canal segments were defined between water control structures or main canal junctions. The maximum flow was then divided by the extent of the drainage area to obtain the maximum allowable discharge rate associated with each segment. The maximum discharge rate for each segment was then compared with the maximum discharge for all downstream segments and the smaller value (actual maximum discharge rate for the segment or any of the downstream segments) was selected as the maximum allowed.

The calculated maximum discharges were then compared to those established by County regulations (RESULTS AND RECOMMENDATIONS WILL BE DECSRIBED)

8.0 Initiative 5: Stormwater Runoff Volume Control

Current ERP requirement is to mitigate post development peak stages for the 25-year/72-hour design storm event. The permitting process does not require verification of downstream impact in areas beyond those surrounding a proposed new development due to changes in discharge timing from pre-development conditions.

An approach that other Florida municipalities have adopted to control for these impacts is to limit both peak discharges and volumes to pre-development conditions. In addition to the established maximum allowable discharges for the County's canals (Ordinance 2007-11), it is recommended that the land development regulations be modified to require post-development volume mitigation not to exceed pre-development conditions for the 25-year/24-hour design storm event conditions. More stringent requirements for volume control using events with a

larger duration or longer return period may be considered at a later date. This approach, combined with the current requirement that flood elevations are not exceeded anywhere in the watershed (Initiative 6), would ensure that the three hydrologic factors, water elevations, runoff volume, and timing of discharges, are maintained from pre-development conditions.

Analysis conducted as part of the watershed management plan development process have shown that this recommendation would have basically no impact on new development because the limiting condition in terms of required site storage capacity is the allowable maximum discharge limit. The volume control requirement will simply represent a double check on potential impacts in the areas downstream from a proposed development.

9.0 Initiative 6: Verification of No Floodplain Impact

It is critical that future development discharges are controlled such that the extent of the regulatory floodplain is not increased at any point along potentially affected canal systems, as floodplain impacts would have implications associated with the National Flood Insurance Program.

It is recommended that the County implements the requirement that each development permit includes a check of no impact upstream or downstream for the 100-year/72-hour design storm event. Tools that can be used for this purpose include a) the Tomasello computer model that was developed by the County for floodplain management purposes, or b) a version of the existing conditions model (EAC) but modified using a smaller grid size, i.e. 500 ft to better define local conditions. It should be noted that the application of this recommendation would also require changing the LDC Section 3.07.02 from referencing “surrounding properties” to “any properties upstream or downstream” of a development.

10.0 Initiative 7: Flood Protection Levels of Service Criteria

Described in separate technical memorandum

11.0 Initiative 8: Golden Gate Estates Transfer of Development Rights Program

Described in separate technical memorandum

12.0 Initiative 9: Golden Gate Estates Watershed Mitigation Program

Described in separate technical memorandum

13.0 Initiative 10: Modified Operations of Water Control Structures

As discussed in the assessment of existing conditions, baseflow is a major source of excess flow to the estuaries and contributes to losses in groundwater storage. **Figures 4 and 5** show the average baseflow contribution to the individual drainage features. The maps indicate that the wetland area in the Okaloacoochee Slough, Camp Keais Strand, and the Corkscrew Swamp

provides groundwater recharge on a year round basis. The maps also indicate that large baseflow contributions to the canal network occur especially in the Golden Gate and Faka Union watersheds. It is expected that completion of the Picayune Strand Restoration Project will greatly reduce the baseflow contributions in the Faka Union watershed; therefore, the primary focus of this initiative is on structure operations in the Golden Gate – Naples Bay watershed.

A comparison of baseflow during the wet and dry seasons in the Golden Gate – Naples Bay watershed indicates that, as expected, substantially more baseflow occurs during the wet season than during the dry in terms of total volume. The water budget analysis showed that 8.51 inches of baseflow occurs in the Golden Gate – Naples Bay watershed during the wet season compared to 4.27 inches during the dry season. However, baseflow contributes more than 70 percent of the dry season fresh water discharges to the canal network, compared to 50 percent during the wet season.

Figure 6 and **Figure 7** show the average wet season and dry season baseflow contributions in the Golden Gate – Naples Bay watershed. It is interesting to note that during the dry season, recharge is predicted to occur in several locations immediately upstream of operable gates, or near shallow potable water supply well fields. The greatest volume of dry season recharge occurs immediately north of the CR951-1 structure which includes a pump to divert water from the Golden Gate Main Canal into the CR951 Canal. The results shown in **Figure 6** suggest that water pumped into the CR951 Canal is returning to the Golden Gate Main Canal via baseflow. Groundwater recharge influenced by pumping for potable water supply is also observed in the dry season near the GG-4 structure.

The maps also show that the highest predicted baseflow values occurs immediately downstream of the operable structures and that baseflow decreases along the canal toward the next downstream structure. This is most evident along the Cypress Canal segment between structures CYP-1 and GG-3. This pattern of baseflow along the length of a canal segment is the result of staging water at different elevations upstream of each structure.

Standard operating rules are defined by the SFWMD or by Collier County for each structure in the canal network. These rules primarily rely upon the water levels upstream and downstream of the individual structures and are designed to stage water at different elevations during the wet and dry seasons. During the wet season, the structures are operated to stage the canals at an elevation that is approximately one foot (1 ft) lower than the dry season. The lower elevation, paired with higher groundwater elevations due to rainfall, leads to an increase in baseflow. The defined operations may contribute to the seasonal difference in baseflow upstream and downstream of the individual structures.

Figure 4. Average Wet Season Baseflow Contributions

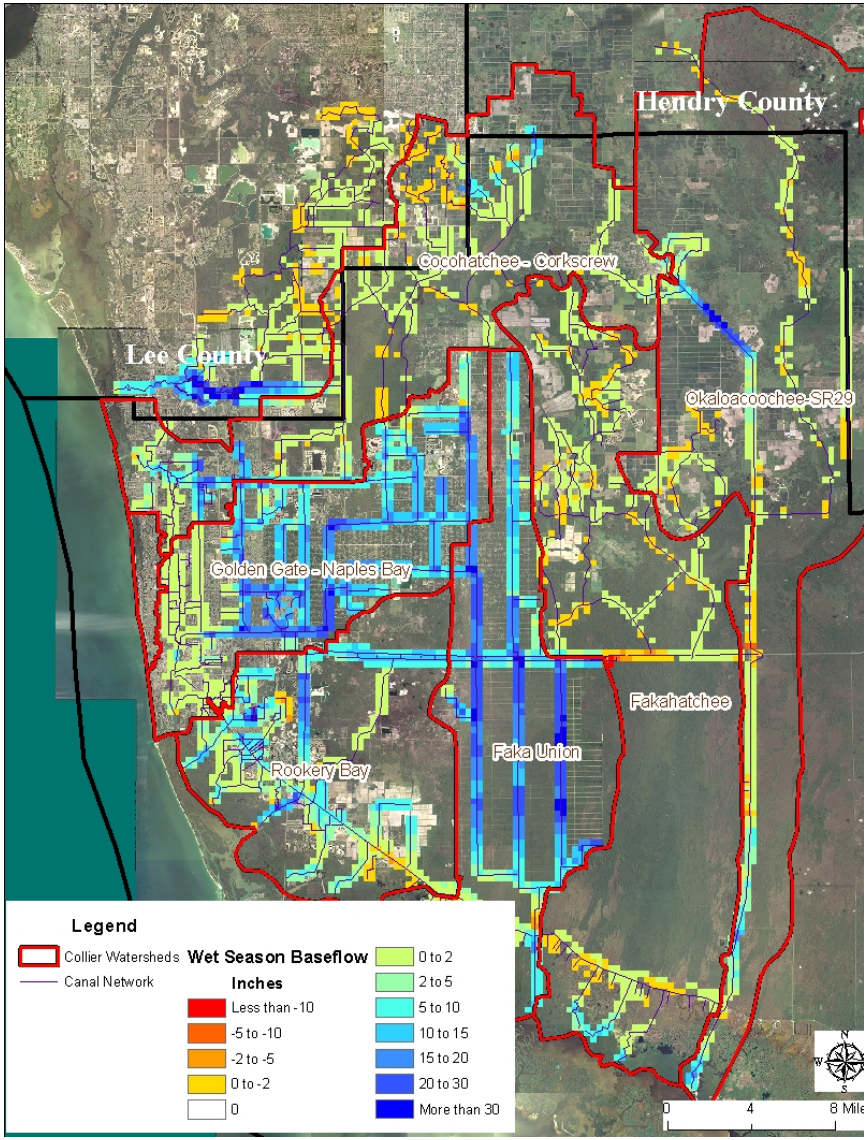


Figure 5. Average Dry Season Baseflow Contributions

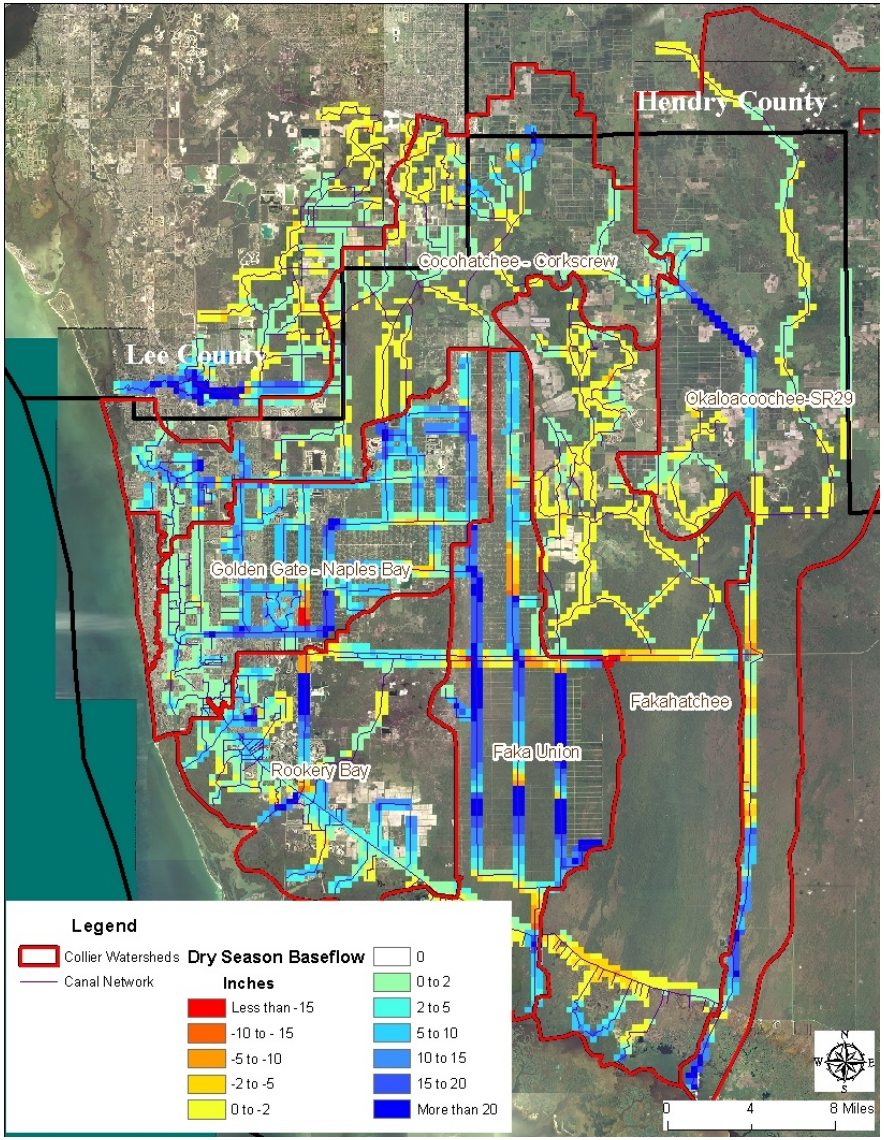


Figure 6. Average Wet Season Baseflow Contributions Golden Gate Watershed

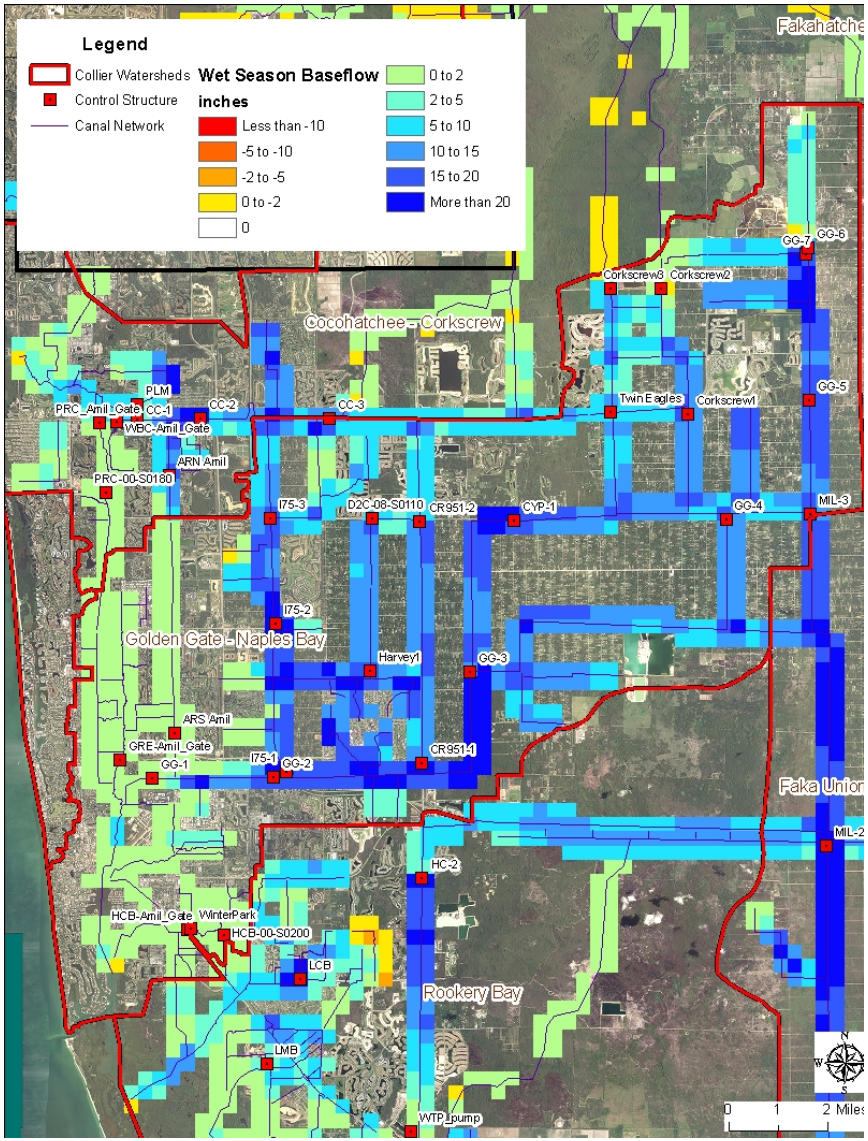


Figure 7. Average Dry Season Baseflow Contributions Golden Gate Watershed

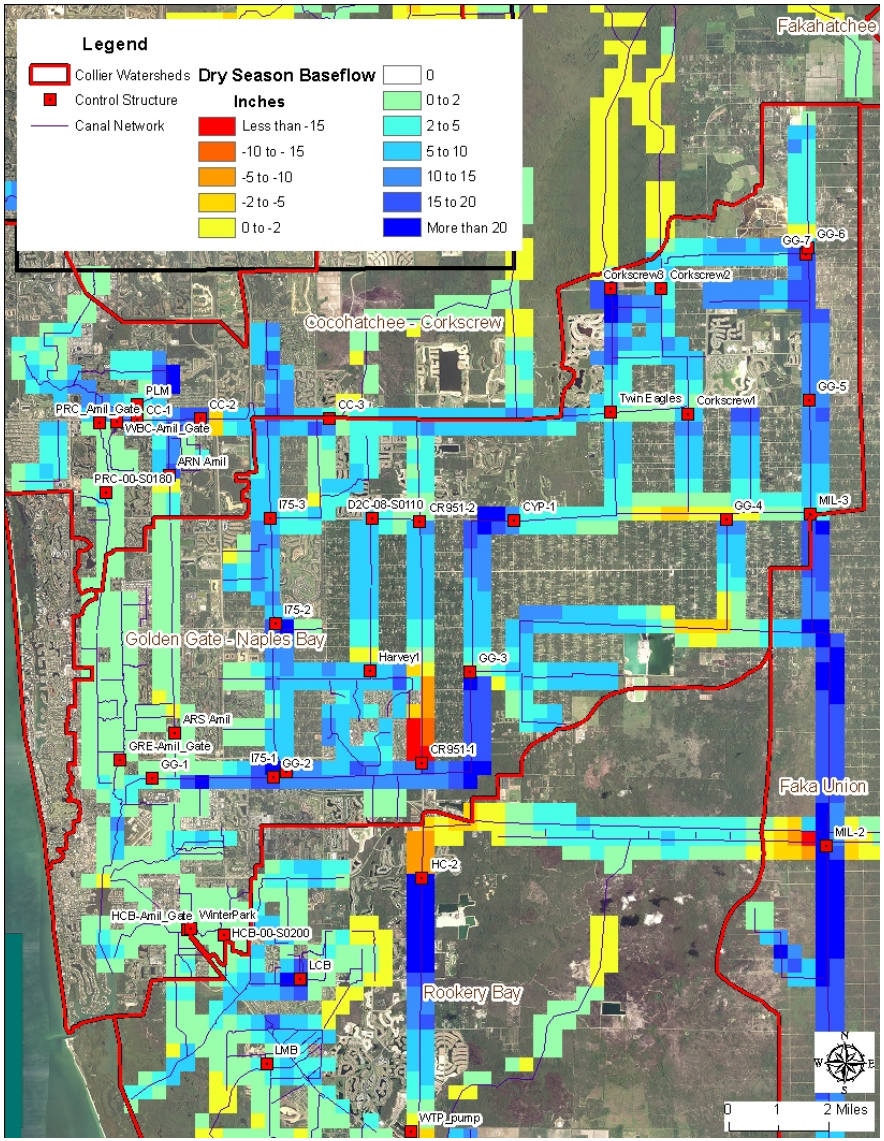
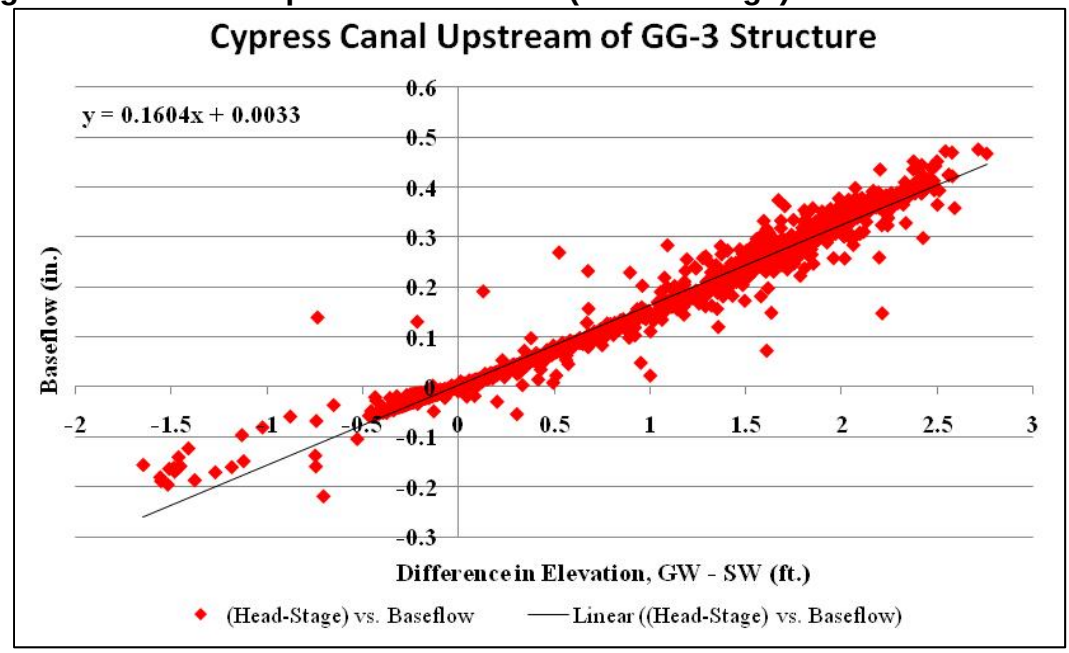


Figure 8 shows the typical relationship between baseflow and the difference in groundwater and canal water surface elevations in the Cypress Canal. The data clearly indicates that managing canal stage to more closely match groundwater elevations is an important tool for reducing the volume of baseflow entering the canal network.

Figure 8. Relationship of Baseflow and (Head – Stage) Elevation Difference



It is recommended that Collier County work with the SFWMD to modify structure operations where possible to reduce the difference between groundwater levels and the canal surface water elevation. The potential range of operations is constrained by the design and physical limitations of the structures and may limit the ability to stage water at a seasonally higher elevation within the canal network. Therefore, design of new and replacement structures should consider seasonal groundwater head elevation data. The ability to more closely match canal stage and the groundwater head elevation will have long-term benefits to the estuaries by reducing baseflow to the canal network.

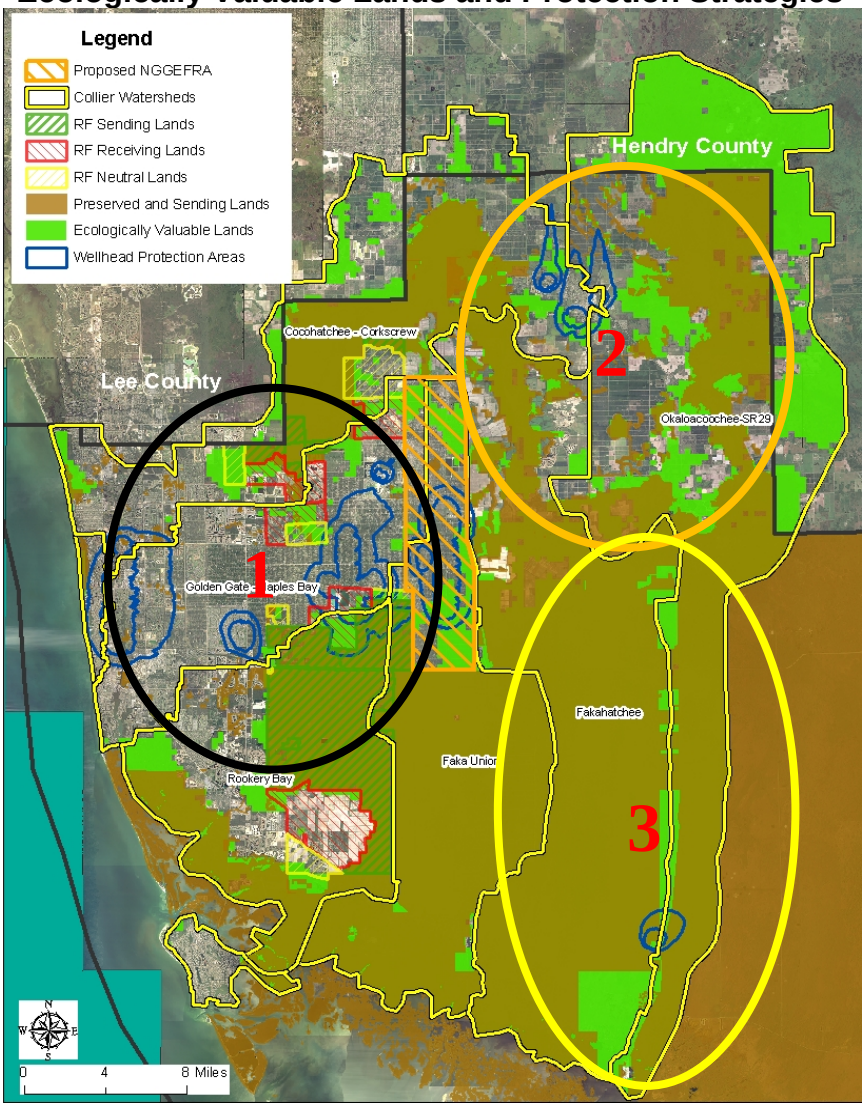
14.0 Initiative 11: Water Quality Monitoring Program

Described in separate technical memorandum

15.0 Initiative 12: Additional Watershed Protection Programs

Many areas of the county have high ecological value and should be protected. **Figure 9** shows the ecologically valuable lands within Collier County and highlights those areas that are currently preserved or are located within Rural Fringe or Stewardship Sending Areas. Ecologically valuable lands that are outside of these areas require additional management strategies. These are discussed below.

Figure 9
Ecologically Valuable Lands and Protection Strategies



Area 1 includes the Golden Gate Estates and portions of the Cocohatchee – Corkscrew and Rookery Bay watersheds. The lands in this area would be protected through the Collier County LID initiative and Stormwater Retrofit Programs and LID presented earlier in this document. Ecologically valuable lands that are classified as Rural Fringe Neutral lands should be re-evaluated and may be better classified as sending lands. Rural Fringe Receiving lands that are ecologically valuable will be subject to the implementation of the proposed LID policies to protect the ecological value of the land. Other ecological value lands in this area should be considered for inclusion in the proposed TDR program that was also discussed earlier.

Another incentive-based program that is recommended for implementation in agricultural areas of the Cocohatchee-Corkscrew, Fakahatchee, and Okaloacoochee/SR29 watersheds is what is referred to as Recyclable Water Containment Areas (RWCA) (Hanlon, 2005). The lands where

this is most appropriate is found within Area 2 in **Figure 9**. The basic concept of a RWCA program is that a portion of existing agricultural lands are set aside for a fixed duration of time (typically five (5) years) to capture runoff from surrounding agricultural fields.
Water that is routed to the containment areas is lost to either evaporation or infiltration, with little being allowed off-site. These containment areas are expected to remove as much as 90 percent of the nitrogen and phosphorus entering the surface water system. After a specified time period, the areas can be returned to agricultural production.

These systems are typically implemented as a contractual agreement between the private landowner and a government entity, most likely Collier County or the SFWMD. The contract provides financial incentives to the property owner to construct and manage RWCAs on their property, or to divert runoff to RWCAs located on an adjacent property owners land.

Hanlon (2005) reports the following annual storage cost for RWCAs.

- If no liner is used in the RWCA, the annual storage cost is $330 / acre-foot / year.
- If a clay liner is required, the annual storage cost is $420 / acre-foot / year.
- If a plastic liner is required, the annual storage cost is more than $620 / acre-foot / year.

These costs indicate that the RWCA program would be more cost effective than construction of stormwater treatment system, which generally include land acquisition.

Figure 9 also shows ecologically valuable lands within Area 3. These lands are located along the State Road 29 corridor, where multiple projects have been recommended by the SFWMD and the United States Army Corps of Engineers (USACE) to protect the natural system. Their location makes them ideal for incorporation into the Big Cypress Preserve and the restoration efforts in the Picayune Strand State Forest. Collier County should continue to support these agencies in their efforts to acquire these valuable land areas.

16.0 Regulatory Framework Implementation Schedule and Cost

Implementation of the Watershed Management Plan recommendations, including but not limited to the recommended Water Quality and Low Impact Development (LID) program, water quantity and flood protection policies, monitoring programs, the TDR/Mitigation Area, and any additional protection programs will require amendments to various Elements and Sub-Elements of the County's Comprehensive Growth Management Plan (GMP), including amendments to the Golden Gate Area Master Plan (GGAMP), the Future Land Use Element (FLUE), Future Land Use Map (FLUM), and the Conservation and Coastal Management Element (CCME), the Drainage Sub-Element, and potentially other Elements and Sub-Elements. These Plan amendments would then be followed by implementing Land Development Code (LDC) amendments to the degree necessary. **Table 3** shows the tasks and an estimated schedule necessary to establish the regulatory framework needed to implement the recommended initiatives. It also shows an estimate of the cost associated with County staff time required to participate in the process.

It is noted that the regulatory process at the State level is in flux at the time of preparing this estimate. Rule 9-J5 (which implements much of the Comprehensive Planning process) has been repealed. It is likely that whatever new procedures and rules are adopted, they will be more streamlined and less costly. This estimate is based upon current and known procedures, but can be revised when new procedures and established.

Table 3
Tasks, schedule, and Cost Associated with Establishment of the Regulatory Framework

Task	Days to Complete	Projected Hours	Project Cost**
Policy Discussion Regarding Proposed Watershed Plan and related GMP and LDC amendments (before EAC, CCPC, and BCC)	90	60	$7,200
Creation of TDR Oversight Committee and Committee Work Period***	360	720	$86,400
Preparation of final draft GMP amendments for public hearings before EAC, CCPC, BCC (Transmittal Hearings) and Transmittal Hearings	150	400	$48,000
DCA Review and issuance of Objection Recommendation and Comment (ORC) Report (issued 60 days after completion determination)	70	30	$3,600
County review of ORC and Adjustments to address Objections (and Recommendations and Comments). Revisions as necessary and Adoption hearings before EAC, CCPC,BCC); Begin to Draft LDDC Amendments	120	300	$36,000
Final Preparation of LDC Amendments	60	240	$28,800
LDC Amendment final draft and hearings (again, EAC, CCPC,BCC)	100	200	$24,000
Total Estimated Staff Time, Hours, and Cost for Completion (Including TDR Oversight Committee Review Period)	**1000**	**1950**	**$234,000**
Total Estimated Staff Time, Hours, and Cost for Completion (Excluding TDR Oversight Committee Review Period)	**640**	**1230**	**$147,600**

* Cost to a developer and/or homeowner have not been estimated at this time as the details of any proposed regulations are unknown. For example, costs will need to be weighed against any available incentives. Once draft LDC amendment language is developed, detailed estimated fiscal impact associated with a proposed regulation can be estimated (in fact this is required, as a part of the LDC amendment process).

** Cost is estimates at $80.00 per hour for senior level staff plus %50 cost for benefits and overhead (Total $120.00/hour). Total estimated hours with TDR Oversight support equals 1950 , plus or minus 1.0 FTE over 33 months (or about .35 FTEs per year).

*** Oversight Committee as proposed is limited in Scope (to TDR Program) thus other proposed amendments may not be subject to the Committee Review Period

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Appendix A
The Low Impact Development (LID) Approach

Research has shown the watershed imperviousness has a direct relationship with stream degradation (MWCG 1995). In addition, as indicated previously, exclusive reliance on conventional BMPs is not allowing streams to meet water quality standards. Therefore, a new approach based on the preservation of a site's natural features has been found to be an effective way to minimize pollution loads and help preserve the natural system.

LID is a well established approach to stormwater management that relies on hydrology-based site planning and design. LID aims at minimizing the volume of runoff reaching the receiving water bodies and managing it as close as possible to where it is generated. Techniques defined as micro-controls are implemented in a dispersed fashion throughout a site. The basic principle is to attempt to mimic pre-development hydrology by detaining and infiltrating rainwater close to the source thereby replicating the natural pathways. LID techniques are often more cost effective than the conventional stormwater management approach that relies primarily on fast drainage through storm drains, ditches and/or canals that take runoff to central detention facilities or to open water bodies.

17.1 Framework

Meeting water quality standards and addressing the water surplus/deficit issues affecting the natural system requires application of a variety of new tools and approaches that need to be grounded on a common framework consisting of the following main elements:

Hydrology Centric Site Planning. Site design should consider maintaining the natural site's hydrology, or helping restore hydrologic conditions if previously impacted. The objective should be the protection of hydrologically beneficial assets such as soils, native vegetation, wetlands, and natural drainage patterns. Hydrology centric site planning typically results in better site layout and reduced development costs.

Water Quality Improvement. The Florida stormwater treatment rule is specifically aimed at reducing the input of nutrients to receiving waters. Nutrient load reduction is most effectively attained by both reducing runoff volume and reducing sources of nitrogen and phosphorus. If stormwater runoff treatment is necessary, controls should be based on appropriate unit processes for pollution removal, particularly nitrogen and phosphorus, that considers the chemical characteristics of the pollutants.

Habitat Protection. Runoff reduction and water quality improvement have a direct beneficial effect on natural habitat. Site development should strive to preserve and/or restore natural resources on site such as wetlands and native vegetation on site.

Effective Land Use. Collier County is not yet as urbanized as other neighboring counties but development pressure is mounting. Comprehensive planning at the county level and judicious site planning at the development level allows effective deployment of new infrastructure,

reduced maintenance needs, enhanced community aesthetics, and access to natural resources for recreation.

Whole-Life Cost-Effectiveness. The implementation of a stormwater management program should consider the costs of development in terms of both construction and operation and maintenance (O&M), as well as the potential gains associated with the environmental and social benefits to the community.

Enhanced Aesthetics: Planning and engineering measures for stormwater control should be blended into streetscapes and landscapes and become assets to the community.

17.2 Implementation Techniques

LID implementation techniques are divided into three categories: planning, stormwater controls, and pollution prevention. Following is a description of these categories, along with the techniques that we believe can be implemented in Collier County.

Planning Techniques. At the site level, planning techniques are aimed at taking advantage of existing assets, especially those that help maintain the hydrology of the site and minimize runoff volume through maximization of the hydrologic performance. These techniques include:

- Promote site design based on natural hydrologic patterns by conserving / restoring such features as drainageways, wetlands, stream corridors, riparian buffers, and forested areas.
- Maximize the extent of pervious areas and areas of absorbent landscape, while minimizing paved areas.
- Disconnect impervious surfaces from conveyance systems so that runoff discharges to on-site pervious areas.
- Manage runoff close to where it is generated by creating micro-controls adjacent to paved areas
- Protect areas of permeable soils.
- Design multiple storage systems throughout the site to maximize the assimilative capacity and create redundancy.
- Minimize site disturbance during construction. Research (Gregory, 2004) has shown that to maintain predevelopment infiltration rates, identified areas within a subdivision, or specific areas within a lot, should be left undisturbed because even a small degree of compaction of imported soils has been found to drastically reduce infiltration capacity.
- Protect native vegetation existing on site. Conserve as much as possible of existing trees and shrubs

- Use native species in landscaping plans and providing sufficient top soil to promote healthy plant development and minimize chemical application needs as well as irrigation needs
- Substitute turf with native species consistent with Florida-Friendly Landscaping guidelines
- Promote cluster development practices with higher densities that reduce road length and utility footprint.
- Apply road width requirements that are consistent with actual average daily traffic needs based on the number of homes served.

Stormwater Controls Techniques. From its inception, the application of LID recognized that, depending on specific site characteristics, a versatile set of controls is needed for effective stormwater management. These techniques belong to a broad array of engineered features aimed at mitigating anthropogenic impacts in terms of both water quantity and quality. Key objectives are to minimize the volume of runoff discharged into the public collection system and design the stormwater controls in a way that is consistent with the chemical unit processes associated with the pollutants of interest. Disperse deployment of micro-controls throughout the site is emphasized, but the stormwater management strategy can also include end-of-pipe devices such as detention basins and constructed wetlands.

The strategy to treat stormwater is summarized below:

a) **Runoff segregation.** Rain that falls on roofs should not be allowed to come in contact with fertilizers and other ground-level pollutants.

b) **Stormwater controls in series.** Stormwater controls should be installed in series to obtain incremental treatment levels. It should be noted that the upstream- most controls provide the largest removal, when properly sized. The removal efficiency of additional controls downstream is much less because the influent concentrations have been reduced. Stormwater controls in series benefits system redundancy.

c) **Bioretention.** Roof runoff should be directed to bioretention areas located in the fill pads devoted to building construction. Pad configuration may have to be slightly modified to locate the bioretention facilities at sufficient distance from the buildings. The bioretention facilities should be designed to exfiltrate the water into the surficial aquifer. Stormwater planters around buildings can also be used to treat roof runoff. The filter media in the bioretention facilities shall be engineered for nutrient removal. Guidelines have been provided in the 2008 publication *Alternative Stormwater Sorption Media for the Control of Nutrients* by Marty Wanielista and Ni-Bing Chang, researchers for the Stormwater Management Academy of the University of Central Florida. From the findings of this publication, it is possible that limestone material from site excavation can be used as a component of the engineered media.

d) **Filter strips.** As implementation of imperviousness disconnection, filter strips should be added to receive runoff from paved areas and discharge it to bioretention facilities, vegetated swales, or other stormwater controls.

e) **Surface depression.** Design absorbent landscape areas as depressions that temporarily store stormwater and allow it to infiltrate. The drainage properties of these areas should be designed so that they infiltrate the water without becoming a nuisance.

f) **Permeable pavement**. Permeable asphalt or concrete should be used in parking lots as much as possible. In combination with conventional pavement for high traffic surfaces, permeable pavement is an effective way to retain runoff. The gravel reservoir below the pavement stores the water and exfiltrates it through the bottom. If drainage through the bottom is limited by the fill material, perforated pipes can be used to drain the reservoir. Several studies of permeable pavement systems are available on the University of Central Florida (UCF) Stormwater Management Academy's website http://stormwater.ucf.edu.

g) **Conveyance in vegetated swales.** Provide vegetated swales between building pads and along streets and driveways. The swales should use the engineered filter media described above. Check dams should be used to enhance infiltration.

h) **Pocket wetlands.** Distribute pocket wetlands through the site, in series with other stormwater controls, to receive up to 10 acres of areas drained by swales. Pocket wetlands can also receive drainage from pervious pavement to restore the storage in the gravel bed.

i) **Central treatment facility. Performance of conventional s**tormwater treatment facilities such as detention ponds can be enhanced with littoral shelves; settling basins or phyto-zones; wetland areas, especially upstream of outfalls; and internal berms to lengthen the flow path. Floating wetlands can also be deployed. These central facilities need to be stocked with fish to control mosquitoes.

j) **Stormwater harvesting.** Runoff stored in a detention facility can be used as a source of irrigation water. In addition to reductions of pollutant loads to surface waters, stormwater harvesting can reduce potable water use.

Other LID stormwater controls can be applied depending on the nature of the site and can lead to innovative solutions. The following are examples of these other alternatives:

- Vegetated roofs absorb rainwater and the excess can be directed to stormwater planters or bioretention facilities as described above. Vegetated roofs provide additional benefits in roof membrane longevity and cooling energy savings. These systems are most commonly deployed in large buildings with flat roofs.
- Rain barrels and cisterns can be used to collect runoff from conventional roofs. The water could be used later for irrigation but if not used, it must be drained from the cisterns to provide storage for the next rain event.

Pollution Prevention Techniques. These techniques are aimed at minimizing pollutant loads and include the following:

- Enforce fertilizer management ordinances

- Designate elements of landscaping (e.g., vegetated swales, bioretention facilities, and surface depressions planted with absorbent landscape) as stormwater management devices where no chemicals shall be applied
- Educate homeowners about impacts on water quality of excessive chemical applications. A tool available for this purpose is the Florida Yards and Neighborhood handbook.