Technical Memorandum

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

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

Date: **March 31, 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 an analysis of its implementation within the applicable regulatory framework. The purpose of this memorandum is to provide a description of the current regulations governing stormwater management in Collier County and present recommendations that would allow implementation of an environmentally sustainable stormwater management program. The implementation of this management program will guide future land development activities in Collier County and its implementation is critical to controlling the potential impacts of development activities on water quantity, water quality, and natural systems in the watershed. The objectives of the sustainable stormwater management program are to:

- Promote more effective site planning and minimize anthropogenic impacts to water quantity and water quality
- Promote preservation of the natural systems
- Help reduce development costs

The regulatory recommendations presented in this memorandum pertain primarily to permitting requirements addressing County water quality and quantity issues. Recommendations are also made regarding funding mechanisms, retrofitting public facilities for stormwater management, and incentives for retrofitting private property.

2.0 Regulatory Background

In Florida, “Waters of the State” are protected per the Water Resources Act, Chapter 373 F.S. under which permit programs, including those related to surface water management systems and the Environmental Resource Permit (ERP) process, are established. The ERP process in Collier County is implemented by the South Florida Water Management District (SFWMD) per Title 40-E of the Florida Administrative Code (FAC). Regulations relate to water quantity, water quality, and wetland protection/mitigation.

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) includes a Public Facilities Element and corresponding Drainage Sub-Element that state "stormwater management refers to a set of comprehensive strategies for dealing with stormwater quantity and stormwater quality issues." County regulations pertaining to stormwater management are included in various ordinances and the Land Development Code (LDC).

3.0 Regulatory Review

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) hydrology and habitat compared to the natural system, b) water quality in the existing streams, canals, and estuaries, and c) fresh water discharge patterns to the estuaries. It was concluded that, in spite of current regulations, the local natural systems have been subject to significant impacts. In addition, evaluations of the surface water management regulatory framework conducted by the State of Florida have indicated that under current permitting requirements, impacts of new development cannot be mitigated.

Numerous structural watershed projects have been analyzed and proposed as part of the watershed management plan. However, it is clear that structural measures alone will be able to only partially restore the currently affected natural systems and environment. A change in the regulatory framework is a critical component of the long-term watershed protection strategy. In the following section, regulatory changes are proposed that are aimed to help complement the proposed structural watershed improvement measures. These changes address issues of water quality as well as water quantity.

3.1 Water Quality

3.1.1 Regulations

Stormwater runoff impacts the water quality in the receiving streams. Minimum standards for

The issues of Florida impaired water bodies came to light as part of the recent implementation of the Total Maximum Daily Load (TMDL) program developed 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 (IWR) Chapter 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 a separate technical memorandum).

Concurrently with the implementation of the TMDL program, FDEP conducted various studies to evaluate whether existing technology-based design criteria for stormwater systems are helping meet State Water Policy (62-40.416), under 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. However, nutrient removal efficiencies amount to less than 70 and 45 percent for total phosphorus and total nitrogen, respectively.

Based on these considerations, FDEP concluded that the current design requirements for stormwater Best Management Practices (BMPs) are not adequate to meet State law and an update of the Florida Statewide Stormwater Treatment Rule was necessary. A main requirement of the proposed updated stormwater rule is that post-development pollution loads should not exceed the pre-development loads. Pre-development is defined as the natural native landscape, i.e. prior to introduction of canals and control structures. This would necessitate the implementation of new approaches to remove the additional anthropogenic pollution load, including the implementation of water quality treatment trains.

The application of the proposed updated FDEP stormwater rule would have provided an effective approach to control water quality impacts of new development. However, it is unlikely it will be adopted in the near future and current regulatory requirements are anticipated to remain in place over the foreseeable future and mitigation of development impacts at the local level will be critical to achieve the County's environmental protection goals.

It must be recognized that implementation of a water quality protection program that enhances the current permitting requirements faces a significant challenge due to the limitations of the current permitting process by the State. Current SFWMD regulations for water quality require that treatment be provided for one inch of runoff over the developed area or 2.5 inches times the percentage of imperviousness, whichever is greater. However, no permitting credit is given for the application of alternative on-site runoff management strategies and/or techniques. With no incentive, developers are likely to continue traditional designs, which may be more attractive to potential developers. Consequently, the recommendations presented here are based on modification to existing requirements coupled with the implementation of incentives.

The Collier County GMP, Conservation and Coastal Management Element, Ordinance 2008-10, and the 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 holds all waters in the County to the same standards as those applicable to designated 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 most commonly used runoff treatment system in South Florida is wet detention. In practice this has meant that wet detention ponds have been designed to provide an additional 50 percent

of detention time in the permanent pool. It is likely that this modified design has contributed to a further reduction in the discharge of total suspended solids (TSS) to the County's waters. However, recent research (ERD, 2007) has found that the removal capacity of nutrients in detention systems increases at a very slow rate after about the first 20 days of detention. Therefore, only small gains in nutrient removal are being achieved by the County requirement. **Figures 1 and 2** illustrate the relationship of detention time to removal efficiency of total phosphorus and total nitrogen, respectively.

Figure 1. Removal Efficiency of Total Phosphorus in Wet Detention Ponds as a Function of Detention Time

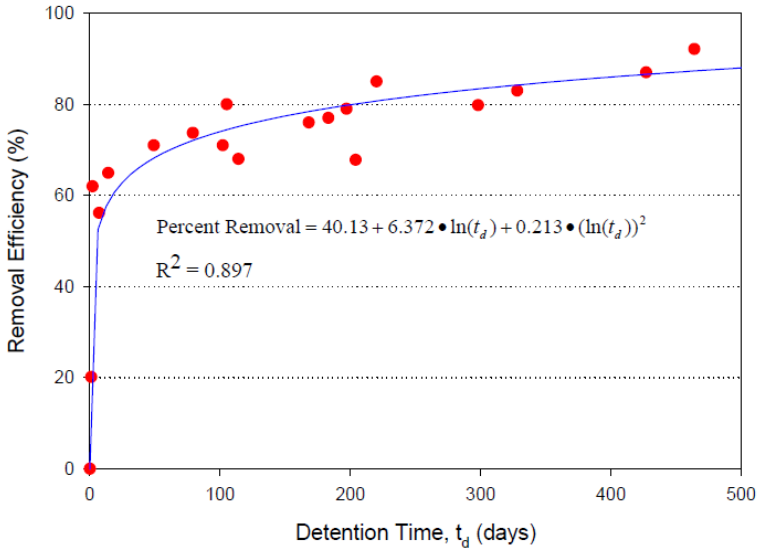
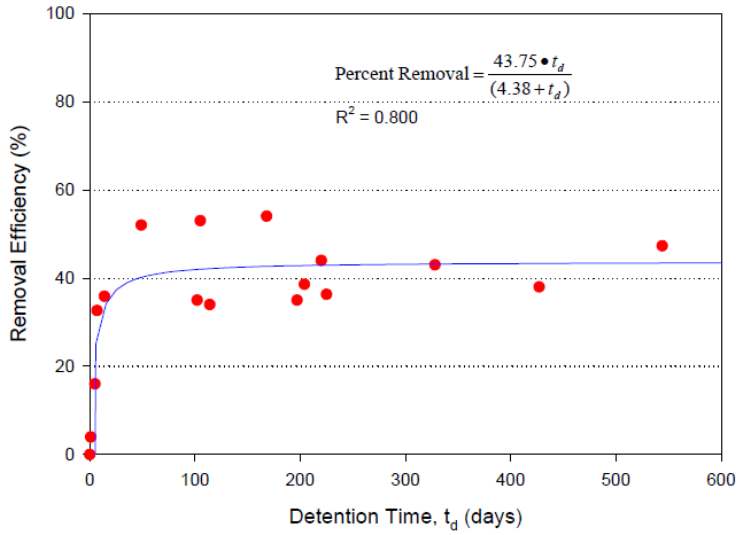


Figure 2. Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Detention Time



3.1.2 Recommendations

A new approach based on the preservation of a site's natural features to minimize pollution loads and help preserve the natural system is recommended. Such approach should be consistent with the concept of Low Impact Development (LID). 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 slowing surface water runoff and subsequently increasing surface water infiltration into the soils closer to the source of the discharge, thereby replicating the natural pathways of groundwater infiltration. Further descriptions of the LID concept are provided in Appendix A.

The application of LID concepts to land development has been assessed herein by determining the storm event that generates a runoff volume equal to 0.5 inches. The goal is to remove the anthropogenic pollutant load associated with this runoff volume. For example, for residential areas, based on typical lot designs for single-family homes under zoning categories RSF-3 through RSF-6, a typical residential lot has a Directly Connected Impervious Area (DCIA) of approximately 25 percent. Using the Soil Conservation Service (SCS) curve number (CN) method and assuming a CN of 74 for the non-DCIA areas, which represents soil type C (slow infiltration), the design storm event for LID design should be 1.5 inches of rainfall. For parking facilities, assuming a 90 percent DCIA, the design event is 1.3 inches. Based on rainfall statistics for South Florida, the 1.5 and 1.3 inch rainfall events represent approximately the 90^{th} percentile. This means that either no runoff pollutant load will be discharged from residential and parking areas for 90 percent of the storms.

As stated above, the goal of the new approach should be simply to retain (no discharge) the pollutant load associated with an additional 0.5 inches of runoff when compared to traditional designs. As conditions may vary substantially between sites, the LID techniques applied to a particular development should be left to the discretion of the designer and could be applied at the lot level or at the subdivision level. Documents that could be adopted by the County 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 delineates design criteria for numerous types of BMPs from retention basins and exfiltration trenches to swales and underground storage and cisterns. The Sarasota County manual focuses on detention with bio-filtration and pervious pavement.

Collier County staff, the development community, consultants (architects, landscape architects, and professional engineers), and the public should all be involved in a public awareness and education campaign to promote the benefits of the proposed approach. The literature on LID describes LID designs as often more cost effective than the conventional stormwater management design because the size of needed conveyance facilities is substantially reduced, thus reducing capital and operations and maintenance (O&M) costs. Also, from a developer's standpoint, the land not used for construction of treatment facilities (i.e. the additional 50 percent detention pond area) can be turned into home sites. However, it is recognized that, at least initially, there may be some reluctance by the development community to adopt the new

concepts. Therefore, various incentives are proposed through changes in the LDC and listed in **Table 1**.

An important design feature associated with LID is cluster development. Collier County has already developed site design standards for cluster development. It is recommended that the County revisits the road width criteria to consider the average daily traffic (ADT) needs and make that a part of the cluster development standards. A minimum road width of 18 feet is recommended for local streets based on an ADT of less than 400 trips, resulting in roads serving either 36 single family homes or 60 multi-family units. If necessary, parking demand could be met by driveways or grass shoulders and the County may consider allowing drainage using grass swales in urban areas.

The off-site parking recommendations should not have negative impacts of safety and would result in additional availability of land area for new development. It should be recognized that the current design standards for parking lots were defined several years ago when cars were generally larger and more difficult to maneuver.

Table 1. LDC Potential Modifications to Treat Runoff for an Additional 50 Percent of State Requirements

LDC Section	Potential Modifications and Incentives
4.02. Building dimension standards	**4.02.01 Dimensional standards for principle uses** Promote cluster development by allowing 18 feet road widths for local streets serving less than 36 single family units or less than 60 multi-family units.
4.05. Off-street parking and loading	**4.05.02 Design standards** 1. Allow aisle width reduced by 2 feet except for parallel parking 2. Allow grassed swale dividers along opposing parking spaces. Paved parking space depth reduced from 18 to 16.5 feet if wheel stop is located 0.5 foot from swale edge
4.06. Landscaping buffering and vegetation retention	**4.06.03 Landscaping requirements for vehicular use areas and rights-of-way** 1. Allow use of depressed landscape islands to be used for water retention 2. Allow rows of parking spaces to contain 20 spaces, instead of 10, between islands if drainage is directed to grassed swale divider 3. Allow swale divider area to count as part of the off-parking interior vegetated areas 4. Allow parking stalls to be up to 100 ft away (instead of 50 feet) from a tree. Allow one tree for every 500 square feet (instead of 250 square feet) on interior landscaped area
6.05. Water management systems and drainage improvement standards	**6.05.01 Stormwater management system requirements** Allow in- -ground percolation type retention systems to achieve water quality retention for residential subdivisions if designed per LID manual requirements

3.2 Water Quantity

3.2.1 Regulations

Water quantity is also an important component of any stormwater management program because the reduction in quantity (runoff volume) is the basis for reducing pollutant loads. However, water quantity also refers to the conditions resulting from large, infrequent, storm events. The current State ERP requirement has been adopted by the County and requires mitigation for post-development peak stages for the 25-year/72-hour design storm event. The problem with this approach is that changes in discharge timing from pre-development conditions may impact other areas, especially downstream, that are not surrounding proposed new development. This is aggravated by the fact that, as demonstrated by the computer model simulations conducted as part of this project, inter-basin flow transfers are common in Collier County during large storm events.

An approach that other Florida municipalities have adopted to alleviate the impacts of high volume discharges is to limit both peak discharges and volumes to pre-development conditions. It should be noted that the District has developed maximum allowable discharges for various South Florida Canals, and the County has established allowable off-site discharges for some segments of the secondary drainage system (Ordinance 2007-11). However, no current regulatory requirements limit the discharge of additional runoff volume resulting from the increased extent of impervious areas.

3.2.2 Recommendations

Updating land development regulations to require that post-development volume mitigation not exceed pre-development conditions is recommended. This approach, combined with the current requirement that flood elevations are not exceeded anywhere in the watershed, would ensure that the three hydrologic factors, water elevations, runoff volume, and timing of discharges, are maintained from pre-development conditions. To limit the effect that this recommendation would have on new development it is recommended that the design storm event be the 25-year/24-hour event (as opposed to the 25-year/72-hour event). More stringent requirements for volume control using events with a larger duration or longer return period may be considered at a later date.

Preliminary calculations indicate that the additional land necessary to achieve the needed watershed storage would vary depending on the new development's DCIA. **Table 2** lists the additional land area available for storage as a percent of total built area and the actual percent of total development land for residential developments where at least 60 and 30 percent of the gross area are devoted to usable open space, per LDC Section 4.02.00. For example, in a development with 50 percent DCIA, 14.1 percent of the development would be set aside for volume control if open areas in the development are not considered. However, if the development has 60 percent open area, then only 5.6 percent of the total area (development + open area) would be set aside for volume control. Similarly, if the development has 30 percent open area, 9.8 percent of the area would be set aside for volume control.

Table 2. Amount of DCIA and Corresponding Percent of Area Available for Volume Control

% DCIA of Built Area*	Area Necessary for Volume Control		
	Percent of Built Area	Percent of Site with 60% Open Area	Percent of Site with 30% Open Area
50	14.1	5.6	9.8
40	12.1	4.8	8.5
30	9.9	3.9	6.9
25	8.9	3.6	6.2
20	7.9	3.2	5.5
15	6.7	2.7	4.7

*Built Area refers to area developed as single-family residential, not including open areas

Another water quantity-related recommendation pertains to the policies in County's GMP 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. The GMP also 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".

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, it is critical that discharges due to future development are controlled such that peak water stages are not increased at any point along affected canal systems. It is recommended that the County require that each development permit be verified using a regional computer model, such as the Tomasello model developed by the County, for floodplain management purposes, or a MIKE-SHE model developed using a smaller grid size, e.g. 500 feet. 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.

Another aspect of a stormwater management program associated with water quantity is the flood protection levels of service (FPLOS). The FPLOS is a measure of the acceptable flooding depth along public roads that is considered not to pose a threat to the health and safety of the community. The more stringent the FPLOS criteria, the more expensive the drainage improvements needed to meet those criteria. In addition, the larger the drainage system, the greater the potential impact to the natural environment. Therefore, a balance must be achieved between risk, cost, and environmental impacts.

Collier County has defined FPLOS criteria based strictly on the 25-year/3-day storm event for all road types. The FPLOS, as defined in the ordinances, vary from "A" representing no flooding, to "D" representing substandard service (a detailed discussion of the FPLOS analysis conducted as

part of this project, and associated recommendations, are provided in a separate technical memorandum).

4.0 Economic Incentives

4.1 Types of Incentives

The implementation of the LID concept (described in section 3.1.2) should include a number of incentives. The incentives proposed here relate to changes in the design criteria per the LDC, as well as the stormwater utilities and the Municipal Services Taxing Unit (MSTU) program.

In terms of the stormwater utilities, Collier County Ordinance 2008-80 describes the funding mechanism and the County's commitment to properly fund the stormwater program. The funds are proceeds from 0.15 mills ($0.15 per $1,000 of taxable value) of ad valorem tax revenues, which are deposited into Fund 325. Funding spans through and includes fiscal year 2025. Although the stormwater utility funds the stormwater program, it is not setup to set up to allow an incentive program.

4.2 Recommendations

Financing the utility by changing to a fee-based system that in turn is based on the volume of runoff discharged from each property is recommended. The goal would be to maintain the same County revenue, but using a different structure.

Similar to other utilities in Florida, a fee could be established based on Equivalent Residential Units (ERUs) that represent the volume of runoff discharged from a typical home in the County. The annual fee for each user would depend on the number of ERUs. However, "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 design to provide retention of stormwater runoff

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. As indicated above, 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.

A simple ERU fee structure sometimes results in large fees imposed on businesses that include large parking facilities. Some type of credit system could be applied to the business sector to reduce the fee impact. However, the credit should be applicable within a defined time frame, i.e. 5 years, to provide further incentive for retrofitting programs. Finally, although the financial benefit to Collier County may be small, it should be noted that the ERU fee structure allows collection of funds from federal facilities, which currently do not contribute to the ad valorem tax revenue.

MSTUs are another mechanism available to provide incentives for implementing a stormwater management program. MSTUs are established by ordinance to assess benefiting properties typically for capital improvement projects such as paving, drainage, and water and sewer projects. The MSTU programs encourage residents to financially participate in implementing capital improvement projects. To encourage residents to participate, the County agrees to pay a portion of a project's costs and assesses the residents for the remaining amount. The resident participation occurs in the form of annual assessments that would typically last between 5-10 years. Collier County should promote the implementation of stormwater management projects that include LID retrofitting.

5.0 Retrofit of Public Facilities Recommendations

In addition to helping retrofit private property, it is recommended that the County initiates a program to stormwater retrofit public facilities, including the Government Center and the public school parking facilities. This program not only will benefit the natural systems in the County, but would be an example of the County's commitment to environmental protection and provide opportunities for educating the community on stormwater issues.

An additional retrofit program that may be considered by the County involves the purchasing of small parcels in areas where stormwater treatment is limited An area that would significantly benefit from this approach is Golden Gate Estates where more than 400 streets dead end at a drainage canal. 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. 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.

6.0 Summary

An important component of the implementation of the Collier County Watershed Management Plans is the update of the existing regulations that pertain to water quantity and quality and the implementation of a sustainable stormwater management plan. The application of new stormwater management concepts that would help reduce anthropogenic impacts to water quantity and quality, promote preservation of the natural system, and help reduce development costs are presented here. Recommendations include modifications to existing permitting requirements, additional funding mechanisms, public facility retrofits for stormwater treatment, and private property incentives for stormwater retrofits. Updating the regulatory framework means updating the County's comprehensive plan, ordinances and land development regulations. In addition, County staff, the consultant community (architects, landscape architects, and professional engineers), developers and the public should all be participants in a public awareness and education campaign to promote the benefits of the proposed approach.

7.0 References

Collier County. 2004. Land Development Code. Naples, Florida

Environmental Research and Design (ERD). 2007. Evaluation of Current Stormwater Design Criteria within the State of Florida. Orlando, Florida.

Florida Department of Environmental Protection. 2010 Draft. Environmental Resource Permit. Stormwater Quality Applicant's Handbook.

Gregory, J. Stormwater Infiltration at the Scale of an Individual Residential Lot in North Central Florida. University of Central Florida. Orlando, Florida.

Metropolitan Washington Council of Governments. 1995. Site Planning for Urban Stream Protection. Washington D.C.

South Florida Water Management District. 2000. Basis of Review for Environmental Resource Permit Applications. West Palm Beach, Florida

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.

7.1 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.

7.2 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.