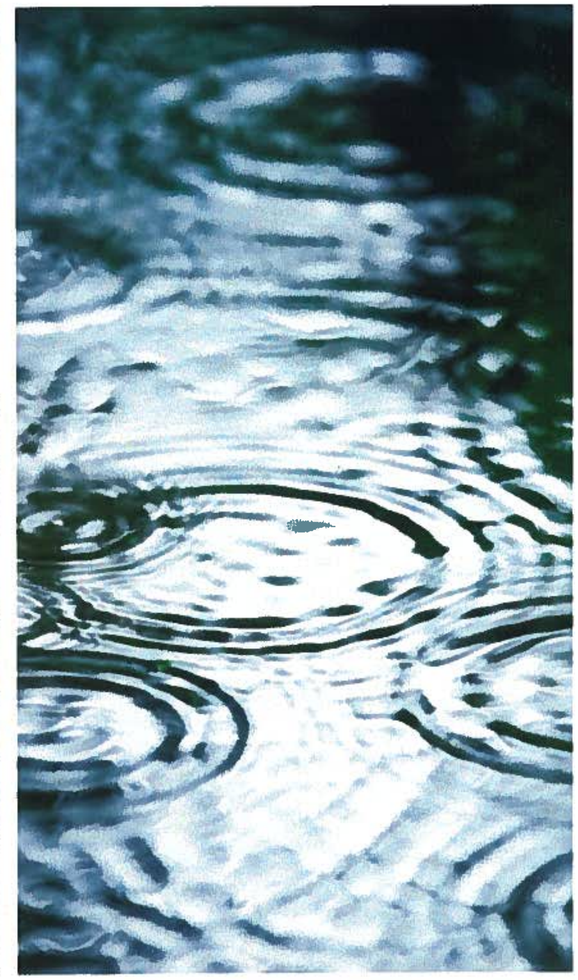

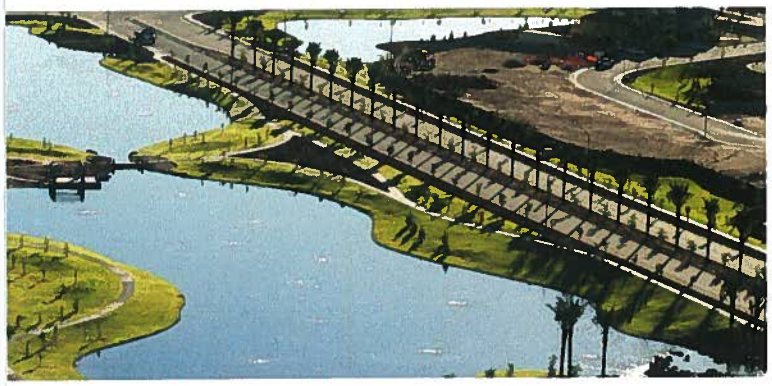

Stormwater Reuse Study

for Florida Department of Transportation

June 2013

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STATE OF FLORIDA · DEPARTMENT OF TRANSPORTATION

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Stormwater Reuse Study
for
FDOT Central Office

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Section 1
Purpose of the Study

1.1 Purpose of the Study

The Florida Department of Transportation (FDOT) is interested in exploring the opportunities for the reuse of stormwater that is controlled within its roadway rights-of-way and the hundreds of associated stormwater management facilities throughout the state of Florida.

As presented to the FDOT by GAI in late 2011, the reuse of stormwater creates the possible opportunity of reducing stormwater pond size and associated land acquisition costs of planned FDOT projects, to off-set the future anticipated costs of larger ponds needed to address TMDL guidelines, to transfer or eliminate pond maintenance costs by water-for-services agreements, and also has the capability to generate revenue if the appropriate End-User of the stormwater is motivated to purchase the stormwater. A combination of the aforementioned potential benefits should also be considered as a way to facilitate a successful agreement between the FDOT and the potential End-User for the mutually desired harvesting of the Department's stormwater.

This Stormwater Reuse Study includes:

- An informative narrative of the how stormwater can be effectively reused.
- The benefits of stormwater reuse to the FDOT and the End-User.
- Coordination with the Water Management Districts and FDEP regarding environmental and permitting issues associated with the reuse of stormwater. Also included is a review of the possible grant funds that are available from various state agencies to support this creative Alternative Water Supply (AWS) initiative.
- Potential stormwater reuse related challenges to overcome.
- Identification of potential End-Users that may be motivated to buy or trade for the harvesting of stormwater runoff from the FDOT stormwater management facilities.
- Data Analysis, evaluation and ranking of potential opportunities.

- Concept development, including order-of-magnitude cost estimates, of potential stormwater reuse opportunities.
- Development of “draft” FDOT/End-User Agreements.
- Recommended change to the FDOT PD&E process.
- Summary of Findings and Recommendations

The authors of this Study will provide insight to a critical question discussed at the Kick-Off meeting, which is;   **“What is the systemic hindrance for the reuse of stormwater?”**

Section 2
An Introduction to Stormwater Reuse

2.1 An Introduction to Stormwater Reuse (SWR)

Stormwater Reuse is the practice of using stormwater from a pond to replace water being used from other sources and to provide a cost effective alternative water source. The water is typically used for non-potable purposes, unless it is highly treated. The most common and practical method for stormwater reuse is direct surface water withdrawal from a wet stormwater pond. When using this method, an in-line filtration device must be installed. Another common method uses a horizontal well with the parent soil providing the necessary filtration. The choice of withdrawal method depends on the economics of system construction as well as the availability of supplemental make-up water sources such as surficial aquifer, deep aquifer, ponds, reclaimed, and potable as a last option. The horizontal well frequently has little or no problem with providing a safe yield of water.

Highways are a major source of water for stormwater reuse. The FDOT manages the runoff water from highways and other transportation related facilities, and frequently regional or on-site wet detention ponds are used. These wet detention ponds collect stormwater from watershed areas that may include a combination of land uses. Examples of these land uses are highways, residential, commercial, industrial, agricultural, and natural undisturbed. Thus, the FDOT may provide a beneficial service to adjacent land owners by using SWR to treat and dispose of their stormwater runoff.

One potential use of detained highway runoff water from wet ponds is lawn irrigation. The wet pond water used for lawn irrigation will reduce dependency on costly potable water for irrigation. This benefit alone may save substantial potable water supplies as well as reduce the cost of lawn irrigation. Potable water savings and cost savings result any time potable water is replaced with stormwater. One example is using stormwater for cooling tower make-up water. Still another use is for agricultural washing of feeding sites and other washing operations, which are acceptable practices by the WMDs.

Another major benefit of stormwater reuse is the reduction of mass of pollutant. When stormwater is used, there is less water discharged to adjacent waters and pollution mass is reduced relative to the option of no water harvesting. For impaired waters, the reduced discharge will help meet a need to lower the mass of pollutants which is transferred in many cases to an average daily basis reduction.

Still another important potential beneficial result of stormwater reuse is maintaining a hydrologic balance within watersheds. When watersheds are partly paved, they discharge more stormwater to adjacent water bodies relative to the existing vegetative cover. Thus, less water seeping into the ground decreases spring flow. In many cases the stormwater (or rainfall) is removed from the watershed by the paved areas and prevented from recharging the aquifer. To balance the hydrologic cycle and increase water returning to the groundwater aquifer, SWR ponds are used.

Protecting wetlands in a developed area can be a substantial cost especially if deep wells have to be used to add water to the wetlands. Stormwater may be used to help in re-hydration of wetlands. Past uses of the harvested water have made it possible for partnerships between the operator of a highway and the local users of the water, with benefits to both.

It is important to note that SWR facilities can and in many cases do have excess water supply capacity, especially when fitted with horizontal wells. The information in this report will explore the various dynamics of pond yield, water quality, and the cost effectiveness of the harvesting process.

Section 3
Benefits of Stormwater Reuse

3.1 Potential Benefits to the FDOT

The FDOT controls more water than any other single entity in the state. As water resources continue to diminish, water is becoming more and more valuable. For all intent and purposes, the FDOT is “warehousing” its water assets, and losing a substantial portion of it to filtration and evaporation. As with most creative initiatives, there is usually a motivational benefit that drives the process. The FDOT’s Mission Statement is “Serving the people of Florida by delivering a transportation system that is fatality and congestion free…while sustaining the quality of our environment.” Delivering on that statement will take more money than is currently available. Finding ways to leverage under-utilized assets is one way to help overcome an economic deficit. Finding a way to leverage the FDOT’s water assets makes economic sense. Finding End-Users that are motivated to value trade with the Department to receive and reuse the FDOT’s stormwater as an Alternative Water Supply (AWS) because of their particular needs make stormwater reuse a win/win scenario for both parties. Simply said, moving this Stormwater Reuse initiative forward and gaining commitments from End-Users in need of the Department’s stormwater would prove to be beneficial to the FDOT. Economic, environmental and political benefits to the Department associated with SWR value trading with End-Users could include:

<u>For Retrofit type projects</u>

+ Transfer of existing pond site maintenance costs (ie, grass mowing, weed and algae control, etc.) from the FDOT to the End-User.
+ Flood mitigation
+ TMDL credits in applicable watersheds. Note: At this time are no definitive policies for credit determination, and are usually based on Basin Management Action Plans.

+ Other possible value trade items (ie, land donation, embankment fill dirt, or utility relocations provided by the End-User that would benefit the FDOT, etc.)

<u>For new Planned type projects</u>

+ Reduction or elimination of stormwater ponds and associated land acquisition and /or right-of-way costs.
+ TMDL credits in applicable watersheds. (see note above)
+ Value trading for embankment fill dirt needed on an FDOT project that is excavated from an End-User's Stormwater Reuse reservoir.
+ Other possible value trade items (ie, land donation or utility relocations provided by the End- User that would benefit the FDOT, etc.)

Additional Value on a local or statewide level could include:

+ The environmental benefits associated with wetland rehydration.
+ The environmental benefits of low flow augmentation of streams and rivers.
+ The environmental benefits of aquifer recharge, and a means to minimize saltwater intrusion.

+ Political Capital achieved through environmental stewardship.

Point-of-Interest: The highest economic trade value benefits to the FDOT would be achieved through Stormwater Reuse opportunities on Planned Projects.

3.2 Potential Benefits to the End-Users

This Stormwater Reuse initiative promotes water quality and conservation efforts and will have a positive impact on the overall water resources of the State. Potential End-Users with established Consumptive Use Permits (CUP) would benefit from the possibility of taking stormwater from FDOT ponds as an Alternative Water Supply when reclaimed wastewater is not readily available. It will be established as a part of this Study that several municipalities throughout the state are looking for additional sources of water to augment their potable water use, and to meet their overall water supply demand. As the Florida economy recovers from the great recession, it is anticipated that many communities will experience water shortages. For municipalities that don't have a well established reclaim water supplied irrigation program and are not maxed out on their CUP, using stormwater for irrigation increases the available potable water supply to support new development. The FDOT will be at the forefront of assisting End-Users in meeting their water needs by actively pursuing this Stormwater Reuse Initiative.

Supply and demand aside, the economics of Stormwater Reuse makes sense to possible End-Users. The cost to deliver stormwater for irrigation usage ranges from 2 to 10 times less expensive than potable water, and from 1 to 2 times less than reclaimed water. As a result of the 4 year recession, municipalities have learned to look for ways to reduce their operating costs while trying to provide the same level of public service as possible. The reuse of stormwater is one way to reduce costs and help facilitate tax generating new development.

Additional environmental and political benefits similar to those noted in section 3.1 above can also be achieved by the End-Users.

Point-of-Interest: For End-Users, Stormwater Reuse makes economic sense and may help facilitate tax generating new development.

Section 4
Regulatory Agency Support of Stormwater Reuse

4.1 Statewide Alternative Water Supply (AWS) Initiatives, Mandates, and Statutes

The following discussion of Alternative Water Supply (AWS) addresses issues related to compliance with State Rules as well as proper planning and design for AWS sites.

Issue: Cooperation

Alternative Water Supply (AWS) development is encouraged in the State of Florida. This is evident considering funding for AWS projects by the Water Management Districts and the clear direction of the Legislature. In 2012, Florida Statute Section 373.707 clearly defined the purpose of AWS legislation to encourage cooperation in the development of water supplies and to provide for AWS development. The Statute required a mandatory participation among agencies as stated in paragraph c) as "cooperative efforts between municipalities, counties, special districts, water management districts, and the Department of Environmental Protection are mandatory in order to meet the water needs of rapidly urbanizing areas in a manner that will supply adequate and dependable supplies of water where needed without resulting in adverse effects upon the areas from which such water is withdrawn." Thus, the problem confronting water supply agencies is to have cooperative agreements.

Issue: Withdrawal of Surface, Ground, and Reuse Water

The legislative intent further requires that agencies should use all practical means of obtaining water, including, but not limited to, withdrawals of surface water and groundwater, reuse, and desalinization, and will necessitate not only cooperation but also well-coordinated activities. It is clear that the reuse of highway stormwater from a surface or groundwater reservoir is part of the legislative intent. It is also clear that

FDOT is a cooperative partner and is also required by Florida Statute to support the development of Alternative Water Supplies.

Issue: Stormwater Storage Methods

Physical land constraints and local acceptance of an impoundment location should be considered in site selection. Stormwater reuse is the practice of impounding stormwater in a reservoir, pond, groundwater area, or cistern. The water is typically used for non potable purposes, unless it is highly treated. A common and practical method for reuse is by direct surface water withdrawal from a wet stormwater detention pond or a regional reservoir. When using this method, an in-line filtration device must be also used. Another common method uses a horizontal well for groundwater withdrawal with the parent soil providing for the filtration of contaminants. The choice of the storage method depends on the economics of system construction as well as the availability of adjacent source waters to be used as “back-up” during times when the impounded water is limited in quantity. The horizontal well frequently has little or no problem with providing a safe yield of water and the quantity is finite but not a limiting factor.

Issue: Sustaining the Quality of the Environment

Within section 373.016, F.S., there is clear direction that any AWS system must preserve the natural resources, fish and wildlife in the area impacted by the AWS. The FDOT mission statement also states that “The Department will provide safe, interconnected statewide transportation … while sustaining the quality of our environment.” Thus when groundwater or surface water is used, there is a question related to the identification of withdrawal rates that do not affect surface and ground water quality as well as not affecting vegetation and wildlife in the area of withdrawal.

Issue: Runoff Water Quality

Highways are a major source of water for reuse, but sometimes runoff from other land uses are mixed with highway runoff. Examples of these non highway land uses are residential, commercial, industrial, agricultural, and natural undisturbed. Thus, the issue of runoff water quality will need to be addressed as the runoff water may be polluted and the pollution must be minimized for public safety reasons.

Issue: Economic Benefit

One potential use of detained highway runoff water from reservoirs is lawn irrigation. The storage water used for lawn irrigation will reduce dependency on costly potable water for irrigation. This benefit alone may save substantial potable water supplies as well as the reduce cost of lawn irrigation. Other potable and cost savings result any time potable water is replaced with stormwater reuse. Another use is for cooling tower make up water. Still another is used for agricultural washing of feeding sites and other washing operations. The general requirement for treatment is filtration or the same as urban irrigation. The intent is to find users or an authority that will use the water and in a manner that provides an economic value to business development and to the citizens.

Issue: Cost

Quite simply the cost of an alternative water supply must be competitive with other water supply sources.

Issue: Responsibility

A utility or authority must be established to operate and maintain the water supply in a legal binding way. The responsible party to operate and maintain the water supply must provide the necessary legal and technical capabilities.

Issue: Reduction of Pollution Mass in Discharge Waters

Another major benefit is mass of pollutant reduction when the runoff water is not discharged to impaired waters or to waters with a total maximum daily load limitation. When stormwater is reused, there is less water discharged to adjacent waters and pollution mass is reduced relative to the option of no water reuse. For impaired waters, the reduced discharge will help meet a need to lower the mass of pollutants on a yearly basis which is transferred in many cases to an average daily basis reduction.

Issue: Maintaining Low Flow and Hydrologic Balance

Another important potential beneficial use, especially in springshed and estuary areas is for maintaining a hydrologic balance within watersheds. When watersheds are partly paved, they discharge more stormwater to adjacent water bodies relative to the existing vegetative cover. Thus less water going into the ground decreases spring flow. On the other hand more fresh water discharged to a saline environment has a negative effect on the organisms which exist with a saline environment such as an estuary. Stormwater is generated from impervious areas and prevented from recharging the aquifer. The stormwater in coastal areas may provide excess fresh water to estuaries.

Issue: Other Beneficial Uses

Since reuse facilities can and in many cases do have excess water supply capacity (especially with horizontal wells), there is a supply of water available for fire-fighting from stormwater reuse ponds. In Florida, horizontal wells are even used without ponds just to provide water for fighting fires.

Protecting wetlands in a developed area can be a substantial cost especially if deep wells have to be used to add water to the wetlands. Stormwater may be used to help in wetland re-hydration.

Issue: Funding for Development of AWS

F.S. 373.707 specifies that funding is a “shared responsibility of water suppliers and users, the State of Florida, and the Water Management Districts.

4.2 Disposition of the Water Management Districts and FDEP regarding Stormwater Reuse

Discussions with staff in the 5 State Water Management Districts (WMD) and the FDEP were conducted to obtain information regarding their current policies and procedures for reviewing and permitting Stormwater Reuse projects, and to identify any significant obstacles, with regard to permitting issues, that would need to be overcome. Most of these discussions also included WMD staff sharing information regarding entities that are in need or have a desire to develop Alternative Water Supplies. The following are the results of those discussions.

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

A meeting to discuss permitting issues was held with Michelle Hopkins, Environmental Resource Permit Bureau Chief and Paul O'Neil, Regulatory Outreach Director on April 20, 2012. Follow-up telephone calls were made to Hopkins and O'Neil in addition to telephone calls with Mark Hammond, Resource Management Director and Anthony Paul Andrade, Reuse Coordinator relative to alternative water supply were held.

Policies and Procedures for Permitting Stormwater Reuse:

A statement of general support for Stormwater Reuse (SWR) was made, and subsequently noted that each case is treated separately because of the variability of groundwater conditions. Storage simulations based on local meteorological conditions are an approach recommended. However, they do accept the design methodologies called "REV curves" for the situations where groundwater is not an issue. It also appears that the use of REV curves are a justified approach based on the need to meet impaired waters, like for the downtown Largo ponds. They had not used the SHARP model but recommend it or a similar approach for safe yield analyses.

Areas in Need of Alternative Water Supplies:

The primary areas in need of alternative water supplies are Hillsborough and Pasco Counties. The use would be determined by the Counties. The applicant for any alternative water source will have to demonstrate a safe yield from storage. It was recommended that the mixing with reclaimed water be considered. The issue of the need is directed by local agencies and constrained by a water use permit (WUP). The need is not determined by the District, but the allocation of water is.

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

A meeting for permit issues was held with Cammie Dewey, Environmental Resources Permit Program Manager on April 24, 2012. Follow-up phone calls with Dewey in addition to telephone calls with Glenn Forrest, Senior Professional Engineer relative to alternative water supply were held.

Policies and Procedures for Permitting Stormwater Reuse:

SJRWMD has been involved with the permitting of Stormwater Reuse projects for over 20 years. There are reuse projects within the District primarily for irrigation water. The permit is issued based on their current Manual of Practice and the use of the "REV curves." A need to protect the surrounding wetlands and not to provide more water than necessary is a constraint. Thus the use of the SHARP model as well as obtaining a Consumptive Use Permit (CUP) is needed. Their permit process however may change with the new Legislative directive to "streamline" the permit process, or make it more common among the Water Management District agencies as well as the Department of Environmental Protection. This "streamlining" effort was scheduled for conclusion in late June, 2012, but will continue into next year on issues related to justifiable differences among regions.

Areas in Need of Alternative Water Supplies:

For Alternative Water Supplies, there appears to be many options and Mr. Forrest said that he would meet with us to see if he can help with local government participation. He specifically mentioned the following 1) Nova Canal, 2) West Volusia and an I-4 interchange, 3) Trout Lake, 4) US1 at Palm Coast Roadway for hydration of wetlands, and 5) Dunlawton Pond with the City of Port Orange. It appears that these specific local areas are in need of alternative water supplies and the search is being supported by the District.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

For alternative water supplies, phone calls were made on April 23, 2012 with Stacy Adams and Gary Ritter, both special project directors. In addition, Tony Waterhouse, Director of Environmental Resource Permitting was contacted relative to the permit process and the "streamlining" processes.

Policies and Procedures for Permitting Stormwater Reuse:

It was noted that the SWR pond area and volume will have to be documented by using simulations to show the design size of the pond and the effects of the water withdrawal. The State "Streamlining" process will most likely determine what has to be done for permitting. Other than the need to properly demonstrate "Safe" yield through analysis, no significant permitting obstacles were expressed.

Areas in Need of Alternative Water Supplies:

While the District has not been granted significant monies to support these types of projects in the last three years, they still have an interest in promoting joint uses. They mentioned as one of their more successful programs the reuse of treated wastewater. Nevertheless, they recognize the value of stormwater storage. The Utility most in need at this time is Palm Beach County. The others are Lake Regional Utility and Glades Utility.

Agricultural interests are most in need of water and are those near Lake Okeechobee and the Indian River Lagoon. Examples of reservoirs and other joint use of stormwater in the past were done by: C&B Farms, James D. Hull, and Williamson Cattle.

For the Indian River Estuary area, one significant project now underway with the need for an alternative water supply is the Indian River Citrus Grove Owners efforts using the Evans Grove in the C-25 basin. Here there is the possibility of using waters from both the St. Johns and the South Florida Water Management Districts. Another significant project is the widening of SR 70 in St. Lucie County in the C-24 basin. The District needs help in reducing the rate at which fresh water reaches the Indian River Lagoon. If the water from SR 70 can be stored, that would be helpful to meeting the goal of reducing discharges to the Indian River Lagoon.

For the Lake Okeechobee Watershed, there is an aggressive program lead by Benita Whalen, a District Employee. The District has a cost assistance program that helps build alternative water supply systems on privately owned agricultural property. This is part of the Northern Everglades Project.

SUWANNEE RIVER WATER MANAGEMENT DISTRICT

Policies and Procedures for Permitting Stormwater Reuse:

Mr. Patrick Webster, Senior Professional Engineer, was contacted on April 25, 2013. The District is involved with stormwater reuse issues related to agricultural uses, and to the mitigation of flooding on the Starke Bypass in Bradford County. They will adopt the “streamlining” results and would support alternative reuse of water provided it can be operated to meet standards set as conditions to permits.

Areas in Need of Alternative Water Supplies:

The District has a funding program for minor water supply projects, natural system improvements, and mitigation of flooding conditions. The value of the program is 1.5 million dollars each year. If reuse water is available for agricultural needs, then there is also a cost share program available. Agricultural interest is most likely the area of greatest need for water.

However, urban projects of immediate interest for stormwater reuse are the widening of Interstate highways 10 and 75. There was also identified a need to protect spring flow by adding to the groundwater resources.

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Michael Bateman, Bureau Chief for Environmental Resources Permitting has been identified as the person for both permitting reuse and for identifying alternative water supply issues. Phone calls were made on April 23, 26, and September 14, 2012 to determine the District level of interest. Michael sits on both the Permit committee and the Consumptive Use Permit committee. They meet once per month on CUP issues and continuously on permitting issues.

Policies and Procedures for Permitting Stormwater Reuse:

They have adopted the current level of design for stormwater reuse. It was in the draft stormwater rule in the spring of 2013. They are an active partner in the “streamlining” of regulations. Their Manual of Practices I and II will be most helpful in determining the state-wide final publication. Reuse is part of the permitting rules.

Areas in Need of Alternative Water Supplies:

There is no urban area in need of additional water, however they see the value and would like to encourage some reuse in the Tallahassee area. The applications for alternative uses come mainly from agriculture and one from aquaculture. They have no cost sharing program.

STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION REGULATION

Various telephone calls to FDEP personnel including Richard Musgrove, Professional Engineer who is in charge of various aspects of the technical portion of the “streamlining” process have been made. Reuse will be part of the final BMP set of options. It is too early to get detailed information on the permit process or a program for users of stormwater, however stormwater reuse design details within the current Applicants Handbook from SJRWMD is forming the basis of review.

Policies and Procedures for Permitting Stormwater Reuse:

Completion of a Manual of Practice that will streamline the permit process is their first priority. There most likely will be two Manuals, the first to have common elements and the second to have regional specific interest along with design details.

Areas in Need of Alternative Water Supplies:

The FDEP is definitely in support of alternative water supply and encourage reuse of all waters. It was made clear that any of the Alternative water supply plans must first identify a user. Then the FDEP can get involved in assistance and regulation.

SUMMARY

Policies and Procedures for Permitting Stormwater Reuse:

It is apparent that the Districts are in agreement that the reuse of stormwater should be permitted and storage capacity for safe yield has to be demonstrated. There are no technical obstacles to obtaining a permit. Nevertheless, the engineers must either know how to perform simulations or be knowledgeable on the use of the “REV” curves. The substitute to the use of simulation is to use “REV” curves.

A reduction in the mass of pollutants discharged is a major benefit and should be an alternative means of meeting TMDL or impaired water criteria. The SJRWMD has had the REV curve as part of their Manual of Practice since the early 1990’s. However the applicant must prove that the stormwater reuse system has no net effect on adjacent wetlands. Also acceptable are reuse ponds that are lined to minimize groundwater inputs. The use of the SHARP model will definitely be of benefit in this regard.

There are current efforts to develop a “streamlining” process for permitting which will result in two Applicant Handbooks, one will be common to all the Districts and the other will treat those BMPs which are affected by regional characteristics as well as provide design details. An example of regional characteristics will be the retention of stormwater in sink hole prone areas. In the future, there will be a decision expected from the streamlining process on details for design of reuse ponds. Those details are expected to be the same as those now being used for stormwater reuse ponds.

Stormwater Reuse appears to be supported by all the Districts and DEP based on the need to meet impaired water criteria or total maximum daily load reduction. Most importantly if a minimum treatment level of 80% for nutrients is determined, then wet ponds cannot meet the 80% and Stormwater Reuse is one option to meet the 80% criteria. Indeed and in some cases, the amount of area needed for a surface pond may be reduced because of the increased efficiency of stormwater reuse ponds for a given holding volume relative to a wet pond. On the other hand, surficial aquifer storage may be an option and a cost effective one. Surficial aquifer storage should not be confused with deep aquifer storage which has separate and more complex permitting issues. Economics also appear to be a major interest to the permitting agencies.

Areas in Need of Alternative Water Supplies:

The use of stormwater with treated wastewater was recommended by all the District personnel, and most likely for irrigation. Safe yield was the major concern.

There were recommendations to use wastewater with stormwater. There is a need or requirement in many locations to not discharge treated wastewater mainly because it is too high in nutrients. For impaired waters, there is also a need to reduce stormwater discharges. Thus use of both treated wastewater and stormwater is justified to meet a receiving water standard.

The most common use of stormwater is for irrigation, however all District personnel recognize other needs. Nevertheless there is not a focused effort to identify and support the replacement of potable water used for non potable purposes. Rather there is a reactionary but support mechanism in the Districts when a Utility or a Business (mainly agricultural) is in need of additional water. Large reservoirs appear to be the solution and highway runoff may be an option to be added to these.

One innovative program is operated by SFWMD to pay land owners for keeping water on their land. In this way, the storage with controlled discharge is maintained as a low impact development alternative. Transportation systems can provide land for this stormwater storage. The constraints are to not discharge an excessive pollution mass and hold a volume of water on site while reducing cost such that there is an operating schedule of when to use each source of water over time.

Also, if applicable, a determination of the TMDL credits that could be awarded as a result of the project would be determined by the FDEP at the State Level. There are however no definitive policies for credit determination, and are usually based on Basin Management Action Plans. It is important to note that pond waters not discharged by SWR is viewed by the WMD staff as being similar to pond waters not discharged due to infiltration from the pond.

Note: There appears to be an underlying prejudice against the use of stormwater mainly because it is “not available when needed”. It is unclear whether this prejudice is a result of a lack of understanding as to how horizontal wells can alleviate this perceived problem, or rooted in other concerns. This matter will be further explored later in this Study.

Points-of-interest: There is general support for Stormwater Reuse throughout the regulatory community provided safe yield is demonstrated.

4.3 Funding Opportunities for End-Users

Grants are available for End-Users to construct these programs, as there are multiple competitive grant programs within the State of Florida under which this program would qualify. GAI has researched the availability of these programs to End-Users, as well as spoken with the awarding agencies. GAI has received awards from these agencies in the past on multiple stormwater projects. The contents of this Section include general information regarding the programs including what criteria is evaluated when scoring the competitive applications.

4.3.1 Section 319/TMDL Grants

Section 319 and Total Maximum Daily Loadings (TMDL) Grants are both provided by the Florida Department of Environmental Protection (FDEP). These programs assist the Environmental Protection Agency (EPA) in achieving goals set forth to reduce the amount of pollutants discharged into various impaired water bodies across the State of Florida.

TMDL Water Quality Restoration Grants

The FDEP receives documentary stamp funding for the implementation of projects to reduce urban nonpoint source pollution discharged to impaired waters. The funds are restricted to projects that reduce stormwater pollutant loadings from lands that were developed without stormwater treatment which discharge to water bodies on the State's verified list of impaired waters, to water bodies with a FDEP proposed or adopted TMDL regulations or water bodies with a FDEP proposed or adopted Basin Management Action Plan (BMAP). These funds are used for urban stormwater retrofitting projects undertaken by local governments, water management districts, or other government entities. The funds can be used to provide stormwater treatment for the widening of existing roadways associated with redevelopment activities, and to treat existing problems as well. It is a requirement that Land acquisition, design, and permitting are near completion at the time of the grant application. There is always the possibility that the applicant could spend valuable resources acquiring land and preparing design documents, and not receive the grant. As such, it is advised that the applicant prepare conceptual design and supporting data, and have a pre-application and preliminary scoring session with the applicable grant administrator prior to conducting land acquisition and final design activities. Grant Applications are ranked three (3) times per year in May, July, and November. They are scored competitively and awarded funding based on ranking and funding availability.

The following types of projects are eligible for the TMDL Water Quality Restoration Grant:

- A project that reduces stormwater pollutant loadings from urban areas that discharge to water bodies on the state's verified list of impaired waters.
- A project that is at least at the 60% design phase.
- A project that is permitted or the permit has been scheduled for approval at the next meeting of the water management district governing board.
- The project includes storm event monitoring to determine the actual load reduction.
- The construction will be completed within three (3) years of appropriation of the funds by the Legislature in order to ensure funds remain available.

The TMDL program could fund a maximum of 50% of the project and the entity sponsoring the project must fund a minimum out-of-pocket expense of at least 25%. While the TMDL grant will not fund land acquisition, design, or permitting, all of these items are eligible to count as a match share from the sponsor. Additionally, while the TMDL program will only fund up to 50% of the project, it is possible that other entities such as Water Management District could pay for an addition 25%. Thus, reducing the cost by 75% for the sponsor, and only leaving a 25% out-of-pocket responsibility for the sponsor.

The projects are ranked and scored under Chapter 62-305, F.A.C., and the criteria that they are evaluated under include:

- Impairment status of the receiving water body
- Anticipated Load Reduction of the pollutants of concern
- Percentage of local matching funds
- Cost effectiveness based on the cost per pound of Total Nitrogen and/or Total Phosphorous removed per acre treated

- Inclusion of a detailed and robust educational component geared towards public awareness of the environmental benefits of water quality programs.
- Whether the local government sponsor has implemented a dedicated funding source for stormwater management, such as a stormwater utility fee.

Section 319 Grants

The Nonpoint Source Management Section administers grant money it receives from EPA through Section 319(h) of the Federal Clean Water Act. These grant funds can be used to implement projects or programs that will help to reduce nonpoint sources of pollution. Projects or programs must be conducted within the state's NPS priority watersheds, which are the State's Surface Water Improvement and Management watersheds and National Estuary Program waters. All projects must include at least a 40% nonfederal match.

In recent years the FDEP has awarded Section 319 Funds between $4 million and $5 million annually to local governments and others, with the majority of funding being used to support the construction of stormwater treatment facilities. Eligible grant recipients include state agencies, local governments, colleges, universities, non-profit organizations, public utilities, and storm water management districts with priority given to those recipients who are actively engaging the Basin Management Action Plan process.

Examples of fundable projects include: demonstration and evaluation of Best Management Practices (BMPs), nonpoint pollution reduction in priority watersheds, ground water protection from nonpoint sources, public education programs on nonpoint source management, etc. All approved projects will be contracted with the Department of Environmental Protection and managed by the staff of the Nonpoint Source Management Section. Project proposals are due each year in late May with project selection completed by September.

The 319 Program rules are very similar to that of the TMDL program. Major differences are the match share requirements, and also that costs that are accepted as “match share” in the TMDL program are not accepted in the 319 program, such as land acquisition. The 319 Program only scores and ranks applicants once per year.

Upon selection and EPA approval, the FDEP and Grant Recipient must enter into a contract. The contract is managed by FDEP’s Nonpoint Source Management Section and the recipient’s designated manager. Grant funds are administered on a cost-reimbursement basis.

The grant period has been shortened due to federal requirements and projects must now be completed within approximately three (3) years. Grant funds are made available to the Recipient one and a half (1 ½) years after project selection.

4.3.2 St. Johns River Water Management District

Funding

The mission of the St. Johns River Water Management District (District) is to “ensure the sustainable use and protection of water resources for the benefit of the people of the District and the state of Florida.” In support of this mission, the District develops and implements strategies that help provide sufficient water resources for users and the environment.

To help accomplish their objective, the District is seeking participation from stakeholders who play key roles in promoting resource conservation through new methods, technology and enforcement of landscape irrigation ordinances and related education efforts. The District’s annual Water Conservation Cost-Share

Program helps to demonstrate new concepts in the development and execution of water conservation projects.

The District is accepting applications until May 1, 2013 for cost-share funding for construction of water resource development, alternative water supply development and spring-shed nutrient-loading reduction projects that address one of more of the following District strategic initiatives:

- Springs Protection
- North Florida Water Supply Partnership
- Central Florida Water Initiative
- Minimum Flows and Levels Prevention and Recovery

Greatest consideration will be given by the District to projects that:

- Develop or expand alternative water supplies that reduce the dependency on traditional groundwater sources
- Implement a minimum flows and levels prevention and recovery strategy
- Provide water quality and/or quantity benefits
- Have regional benefits
- Involve multiple partners
- Can demonstrate quantifiable water resource benefits

The Stormwater Reuse partners could apply for funds, qualifying under the new and innovative technology and practices category. The Stormwater Reuse concept is looked upon favorably because it accomplishes three (3) District objectives: 1) improve water quality and 2) conserve potable water, and (3) aid the District in achieving hydrologic criteria requirements.

The District's preliminary budget for Fiscal Year 2013-2014 that begins October 1, 2013 includes $8 million in cooperative funding. The District will match up to 40% of project construction costs. The District's cost-share percentage will be based upon the projects quantifiable water resource benefits and alignment with the goals of the District's strategic initiative.

No maximum award value has been set for individual projects. Projects are eligible to receive up to a 50 percent cost-share on the basis of a negotiated, performance-based contract and a commitment to the continuous monitoring of equipment and project performance metrics. Funds administered through this program will be reimbursed on a quarterly basis after the project components have been completed and paid for by the cost-sharing recipient.

The projects supported by the Water Conservation Cost-Share Program will include the introduction and use of performance metrics, reliability testing of water conserving devices, conservation education, and other measures for self-management by participating utilities.

The program seeks to identify new methods for using water efficiently within local utilities and the District, and to implement conservation measures that reduce consumption prior to the need to develop new sources. It specifically encourages the reduction of water use among those user groups with the highest consumption.

All local government recipients must assist in water conservation efforts by adopting and actively enforcing a landscape irrigation ordinance that fully implements the landscape irrigation provisions in District Rule 40C-2.042(2), *Florida Administrative Code***,** and which does not in any other manner regulate the consumptive use of water. If recipient local government does not already have such an ordinance in place, an ordinance shall be adopted within 180 days of the

Governing Board authorization; provided, however, that this date may be extended by the District upon a showing of good cause, within the District's sole discretion and judgment.

When the End-User has adopted a compliant landscape irrigation ordinance that fully implements the landscape irrigation provisions in District Rule 40C-2.042(2), *Florida Administrative Code*, including adequate enforcement mechanisms, and that does not in any other manner regulate the consumptive use of water, all funding under an agreement for a water conservation cost-share project is contingent upon the ordinance remaining in effect during the term of the agreement. In the event the ordinance is repealed or modified such that it no longer meets the requirements of this paragraph, funding of the water conservation cost-share agreement shall immediately cease and recipient shall, within 30 days of ordinance repeal or modification, return to the District all funds that have been provided.

4.3.3 Southwest Florida Water Management District

Funding

The Southwest Florida Water Management District (SWFMD) has developed the Cooperative Funding Initiative (CFI) program. This program covers up to 50% of the cost of projects that help create sustainable water resources, enhance conservation efforts, restore natural systems and provide flood protection. All CFI funding decisions are made by volunteer Governing Board Members who are well informed on the specific resources and challenges within their areas.

The types of projects that will considered for funding are as follows:

1. Watershed Evaluation: the watershed evaluation provides information used for management decisions and regulatory review. Information gathered is used to define costs for future elements of the watershed management program.
2. Immediate Maintenance of Intermediate Level Systems

3. Watershed Management Plans: The watershed management plan provides an understanding of the capacity of the watershed, its level of service and an alternative analysis to address deficiencies.
4. Implementation of Stormwater Improvements: Implementation of best management practices (BMPs) for flood protection is addressed through structural and non-structural methods. These include design and permitting, land acquisitions and easements, construction of BMPs, construction engineering and inspection.
5. Data Management of Watershed Parameters and Updates to Watershed Models: These include updates to digital terrain models, updates to GIS parameters and infrastructure changes.
6. Stormwater Utilities: The District will assist local governments in establishing a dedicated funding source to manage their stormwater infrastructure.

The guidelines for the District's Funding Initiative focus solely on projects associated with flood protection beyond the "local system" level. However the District may consider cooperative participation in flood protection projects that involve the local system, if the project incorporates significant water quality, natural systems or water supply benefits.

Watershed Management and Stormwater Improvement-Flood Protection projects funded by the District represent a wide variety of issues in water resource management that require evaluation, analysis, reporting, mapping, surveying, preliminary engineering, engineering design, permitting, production of construction documents, land and easement acquisition, and construction. The District's cooperative funding program seeks to leverage funds available at local governments to address flood protection issues on a watershed basis, above the local level.

Successful applicants follow these steps to fund local projects:

1. Indentify a project: Each project should address one or more of the District's areas of responsibility: water supply, flood protection, water quality and natural systems.
2. Match funds: The CFI was created to leverage funds between the Governing Board and cooperators. At least 50% must be a hard-dollar match from other sources.
3. Ask for help: Government affairs program managers are available year-round in four (4) locations across the district.
4. Know your competition: Many of the most successful projects use state-of-the-art technology or best management practices to protect, conserve, restore or enhance the area's water resources and ecology. Cost-benefit calculations also are important, as is the potential impact of the project across the region.
5. Check your project: View the forms their staff members use to evaluate proposals.
6. Watch the clock: The CFI schedule requires that all requests for funding be submitted by 5 p.m. on the first Friday of October.

4.3.4 South Florida Water Management District

Funding

Due to the growing urban population and agricultural operations in South Florida, the South Florida Water Management District has developed an Alternative Water Supply Funding Assistance program. Funding is based on the type of alternative water supply technology used, eligible construction costs and the amount of previous funding applied to a particular project.

The District Governing Board makes the final funding determination of all projects. Funding for projects will be applied annually, and projects can be funded in phases. There is no guarantee is made that there will be year-to-year funding for particular projects. Funding may be limited annually depending on how many applicants.

In fiscal year 2012 the District approved 7 projects with a funding level of $2,720,000. This year the District has approved 8 projects with a funding level of $2,808,000. Funding for alternative water supply projects has varied drastically over the past eight years from as high as $45,570,000 in fiscal year 2008 to $1,560,500 in fiscal year 2010. In 2011 the District funded a 2 MGD Reclaimed Water/Stormwater Augmentation project for the City of St. Cloud in Osceola County. The District also funded $1,000,000 for an intake structure and pump station at the Golden Gate Canal in the City of Naples, located in Collier County Florida.

The District develops alternative water supplies sources to diversify the supply while reducing their dependence on fresh water sources. Examples of all alternative water supply projects that will be considered for funding are as follows:

- Stormwater (for use by a consumptive use permittee)
- Saltwater and brackish water
- Water reuse
- Surface water captured predominately during heavy rainfalls
- Sources made available through the addition of new storage capacity
- Any other source designated as nontraditional in a regional water supply plan

4.3.5 Suwannee River Water Management District

Funding

The SRWMD has an Alternative Water Supply Funding Assistance program. Funding is based on the type of alternative water supply technology used, eligible construction costs, and the amount of previous funding applied to a particular project.

4.3.6 Northwest Florida Water Management District

Funding

The NWFWMD does not have a cost sharing program. They send applicants to FDEP and recommend funding using the EPA 319 program funds.

4.3.7 Department of Environmental Protection State Revolving Fund

The Florida Department of Environmental Protection administers the Clean Water State Revolving Fund (SRF) which provides low-interest loans for planning, designing, and constructing water pollution control facilities. Projects eligible for SRF loans include stormwater management facilities, wastewater management facilities, reclaimed wastewater reuse facilities, pollution control practices associated with agricultural stormwater runoff pollution control activities, and estuary protection activities and facilities. Eligibility is established in the federal Clean Water Act. Local governments (municipalities, counties, authorities, special districts, and agencies thereof) are eligible for loans to control wastewater and stormwater pollution. Non-governmental agencies (basically any entity that can repay the loan) are eligible for loans to control stormwater pollution related to agricultural operations.

Funds are made available for preconstruction loans and construction loans. The loan terms include a 20-year amortization and low-interest rates. Preconstruction loans are available to all communities and provide up-front disbursements for administrative services, project planning, and project design. Financing rates are based on the median household income, the poverty index, and the unemployment index, but average just over 50% of the market rate.

The application process can be started upon request of the project sponsor at any time. However, the availability of funds is the greatest at the beginning of the State fiscal year. A hearing is held quarterly to allocate funds amongst applicants. The hearings are typically held in January, April, July and October on the second Wednesday of that month.

The maximum amount of funds available to one sponsor during a fiscal year is 25% of the programs available funds. Normally the maximum amount is established by a segment cap, which is generally set at $15-$20 million. When a project sponsor qualifies for funding in excess of that available to it in any one fiscal year the project shall be scheduled to receive funding in subsequent fiscal years subject to the segment cap.

While there is no minimum loan amount project sponsors should consider program requirements (like planning, design, permitting, and audit requirements) before deciding to proceed with loan funding. It is recommended that the loan amount be a minimum of $250,000.

4.3.8 Stormwater System Revenue Bond

Another option for obtaining funding for stormwater harvesting projects would be to issue a revenue bond to cover the capital expenses of the project. The bond market is currently offering very favorable rates to potential End-Users. Issuing a revenue bond would mean that the bond sponsor would have to have an established revenue stream to cover the repayment of the bond or a stormwater utility would have to be established by the User with an ad valorem tax being created or user charges being initiated. This would also require the User to prepare a Consulting Engineer’s Report, which would have to include a Financial Feasibility study.

Several cities throughout the State of Florida have financed their stormwater system improvements through revenue bonds:

- City of Clearwater - $19,365,000 Series 2012
- City of Oakland Park- $5,765,000 Series 2011
- City of Miami Beach - $52,130,000 Series 2011

Point-of-Interest: There are a number of state funded grant programs that demonstrate the statewide support for developing viable AWSs. These grants are available to the End-Users and would help off-set the capital costs of infrastructure retrofits associated with SWR projects. This is important because the FDOT should not be placed in a position of offering the stormwater and paying the capital costs to implement the project.

Section 5
Potential Challenges to Overcome

5.1 Marketing of Signature Success Stories

A key axiom of successful marketing states that: “ Before breaking into a new market, you need relevant content to raise the interest of your target audience and demonstrate that you belong and are a viable vendor.”

The relevant content of the Department’s Stormwater Reuse Initiative is that there is an ever increasing need for economically available water, and the FDOT has an incredible amount of stormwater warehoused in their stormwater management facilities that it is willing to value trade to in-need End-Users. The in-need End-User is the targeted audience, and the FDOT is certainly a viable vendor with plenty of available product.

The success or failure of this Initiative will be rooted in the Department’s ability to raise awareness amongst its targeted in-need End-Users, and its own District Drainage Engineers.

Over the past few years the FDOT has participated in Stormwater Reuse projects with the City of Orlando (at Dubsdread Golf Course), and the City of Miramar (at Exit 7 along Interstate 75). The Miramar SWR project was featured at the South Florida Utility Council Meeting, and at a special technical outreach conference by the UCF Stormwater Management Academy. The UCF conference was attended by over 50 people including FDOT, NCDOT, and WMD personnel, and was web-casted to many other interested parties. This type of positive exposure is important to keeping SWR in the minds of FDOT District Drainage Engineers (DDrEngs), Regulatory Personnel, and possible End-Users.

Moving forward, it is imperative that thoughtfully considered pilot projects be implemented to create a series of success stories that can be used to market this important water resource initiative. Consideration should be given to early pilot projects being partially subsidized by the Department in combination with other state funding to encourage End-User participation. Subsequently, a statewide awareness and marketing campaign should be rolled out to tout the working successes and trumpet the many values of the FDOT’s Stormwater Reuse program. One possible marketing technique to keep the SWR initiative in the forefront of the water resource community might be the creation of an “Environmental Homerun Award” given by the FDOTCentral Office to the key entities responsible for creating the FDOT’s Year’s BEST SWR project.

Point-of-Interest: Implementing a number of successful pilot projects, and then marketing this Initiative will be one of the key elements to the success of the FDOT's Stormwater Reuse Program.

5.2 Continued education of the District Drainage Engineers about Stormwater Reuse, and the need to be alert to Value Trading opportunities

As evidenced by the commissioning of this report and the ongoing championing of Stormwater Reuse (SWR) by the FDOT's State Hydraulics Engineer, the Department is clearly committed to an honest assessment of the viability of leveraging its stormwater assets. Lobbying and championing legislative change at the State level, and promoting SWR at the District level should be the critical responsibility of the Central Office. After the program has been set-up to succeed, it will be the Drainage Engineers at the District level that will drive the progress and associated success of the program. For this reason the following is recommended relative to the District Drainage Engineer's (DDrE) support of this Initiative and implementation:

+ Each District Drainage Engineer should receive whatever additional training and education is needed to understand the regulatory and operational issues associated with SWR opportunities, and become knowledgeable with the various value trading alternatives that should be explored with potential End-Users.

+ A listing of all potential End-Users in each District should be developed by the DDrE. This list should include the appropriate contact person at: municipal utility departments, large land owners, utility commissions, golf course owners, private investor owned utilities, water authorities, large HOAs, and power companies. Once the list is developed, a formal letter should be sent by the DDrE to every potential End-User in their District to present the Department's position regarding Stormwater Reuse (SWR) and its desire to partner with the End-Users on SWR projects. Any positive responses should be explored, collected information should be entered into a herein proposed newly created SWR data base, and notification sent to the Central Office.

+ The DDrE should have a bi-yearly coordination meeting with their Water Management District(s) counterparts to discuss Stormwater Reuse opportunities within their WMD(s).

+ The DDrE should have bi-yearly meetings with the Alternative Water Supply (AWS) Planner at the WMD(s) to discuss entities that are or will be required to meet regulatory sanctions.

+ All roadway projects reviewed by the DDrE and his/her staff should be screened and assessed as a possible SWR candidate.

+ The Central Office should request that each DDrE send them bi-yearly reports summarizing their progress with the SWR program within their District. Up-dating of the District's SWR opportunities in the SWR data base should be done at this time as well.

Point-of-Interest: Drainage Engineers at the District level will drive the progress and associated success of the SWR program once the program is set-up to succeed by the Central Office.

5.3 Seasonality of Available Stormwater in Florida

Florida's annual rainy season that runs from early June through September is the period when the majority of Florida's rainfall occurs. During the latter half of this period, the wet stormwater ponds are generally at their seasonal high water (SHW) elevations. Normally, from the end of the rainy season in October all the way through May, these same ponds see their water levels recede to their seasonal low water elevations. This visible receding of water levels and the lack of rainfall for weeks, gives rise to the notion that there is not an opportunity to extract water from that location during that time frame. This mindset, held by many of the WMD staff and potential End-Users poses a challenge to the successful reuse of stormwater for irrigation purposes. Simply put, when stormwater appears to be most plentiful and available for reuse the demand for irrigation water is at its lowest point, and when irrigation water is in high demand stormwater is at its lower visible levels and perceived to be least available. Thus, storage in the surficial aquifer, which can be significant, makes up the deficiency during long dry periods. The supporting fact is that safe yield extraction of groundwater from the surficial aquifer at pond harvesting sites using horizontal wells is not adversely affected by seasonal rainfall as is widely perceived. Geo-hydraulic modeling must be done to demonstrate that supply wells in the radius of influence of the harvesting site aren't adversely affected.

If the desire is to capture and retain large volumes of surface runoff from larger drainage basins for later reuse, then Regional Stormwater Facilities (ponds and surficial aquifers) become the facility of choice. A number of proactive thinking municipalities that understand the critical nature of water resource management in Florida have planned and/or built large scale storage reservoirs for the purpose of storing stormwater to take advantage of Florida's non-uniform rainfall distribution. Others have created reservoirs where they comingle stormwater and reclaimed wastewater water. This further allows them to manage and balance their reclaimed supply with seasonally fluctuating irrigation water demands.

Through their progressive thinking, the Water Management Districts (WMD) are in support of creating large scale Regional Multi-User Stormwater Management Facilities. Joint participation from any combination of municipalities, large land owners, FDOT, WMDs, and private investor-owned utilities creates an economy of scale condition that benefits all parties involved. These types of regional facilities are of particular benefit to the FDOT if the regional facility allows for the elimination of FDOT roadway project ponds, and the associated high right-of-way acquisition costs.

Point-of-Interest: The perception of "seasonality" associated with stormwater for use as irrigation water is an obstacle in the way SWR is perceived and pursued. The seasonality issue is minimized when horizontal wells are used for extraction.

5.4 Reclaimed Wastewater as a First Priority for Irrigation Water

It is understood that all waters, regardless of source, must be considered as Alternative Water Supply (AWS). The reuse of stormwater certainly falls into the category of an AWS. Reclaimed water also falls into the AWS category particularly when being used as an irrigation water supply. Because one of the primary uses of stormwater is for irrigation purposes, it falls in direct competition with reclaimed wastewater.The disposal of wastewater was problematic as late as the mid-1960s. Wastewater contains high levels of nutrients such as nitrogen and phosphorus. The build-up of nutrients in a water body, called eutrophication, encourages the overgrowth of weeds, algae, and cyanobacteria (blue-green algae). This may cause an algal bloom which is a rapid growth in the algae population. A high algae population is not sustainable and eventually most of it will die off. The decomposition of the algae by bacteria uses up so much of the oxygen in the water that it may cause animal habitats to be harmed. In addition to causing deoxygenation at night, some algal species produce toxins that are harmful to animal life. Treatment processes are required to remove nitrogen, phosphorus, and algae. Because there are nutrients in stormwater and reclaimed wastewater, discharge into streams and rivers is closely regulated to mitigate harm to the eco-systems of those water bodies.

These same nutrients can be beneficial to plant life when used as irrigation water. Back in the mid-1960s, Tallahassee entered into the market of treating wastewater to a level where it was safe to use for agricultural irrigation purposes. That was one of the initial reclaimed wastewater reuse projects in Florida. But these early users were single need farmers. At the same time, there was a desire to expand this concept to include public access irrigation projects. The perceived health care concerns and stigma attached to the reuse of wastewater took years to overcome. Today, the use of reclaimed wastewater for public use irrigation is accepted as an important water conservation technique and viable AWS. The production of wastewater is never ending and ever growing so the necessity of having to dispose of it by environmentally friendly techniques commands special attention. Land spreading through public and agricultural use irrigation has become the primary disposal method of wastewater in many communities across the state of Florida. The reliable, plentiful, and relatively safe characteristics of reclaimed wastewater used for irrigation purposes has given the State's water resource regulators a method of wastewater disposal. It's important to this Study to understand that this widely accepted position took decades to achieve and was borne out of necessity. Furthermore, over the past 25 years, hundreds of millions of dollars have been invested in infrastructure improvements by municipalities to facilitate the use of reclaimed wastewater for irrigation purposes. Large amounts of Federal (National Facilities Funding Program) and State dollars were used to subsidize many of these reclaimed wastewater programs. **This brings us to the heart of the question posed in Section 1: "What is the systemic hindrance for the reuse of stormwater?"** The answer lies in the facts that the most logical reuse of stormwater is for irrigation water, and that is also the primary use of reclaimed wastewater. In most areas, they are in direct competition in that regard, but to use an old sports adage, they are not competing on a level playing field. CUP/WUP regulators count surface water and/or surficial ground water extraction against the permitted allocation of water, whereas reclaimed water is not counted against the CUPs/WUPs. So why would this matter to an End-User? The End-Users that would be ideal candidates as reuse partners have their water supply governed by a CUP/WUP. As an example: If an End-User is allocated one million gpd and are able to produce a half million gpd of reclaimed wastewater that is not counted towards their CUP/WUP gpd allocation, they would have a half million gpd available for irrigation and still have one million gpd for potable use. As a second example: If that same End-User opted to harvest a half million gpd of stormwater, they would now have the same half million gpd for irrigation but only a half million gpd for potable use. This approach would be detrimental to the growth planning of their community. The cost of the reclaimed wastewater would need to be extraordinary higher than stormwater reuse for the stormwater option to be chosen. **So therein lies the systemic hindrance. The FDEP's and WMD's current regulatory position creates a deterrent to the use of stormwater for irrigation purposes.**

It's important to note that this is an inclination towards reclaimed wastewater is not necessarily against SWR. But because of the current regulations, SWR is viewed more of an augmenting AWS than a primary one. Nevertheless, in some cases, there is insufficient reclaimed water in a given area and the reuse of stormwater is needed as a cost effective alternative.

Point-of-interest: The current regulatory asymmetry of counting SWR against a CUP/WUP but not counting reclaimed wastewater, creates a deterrent to End-Users for using stormwater as a significant irrigation supply option when a reclaimed wastewater supply is available. As such, reclaimed wastewater is viewed as a primary source of irrigation water, while stormwater is not.

5.5 Concerns about Contaminants in Untreated Stormwater

A variety of created impervious surfaces has changed the natural return of stormwater back into the soil. Instead of being absorbing by the soil, rain picks up oils, grease, heavy metals, sediment, pesticides and fertilizers that enter through storm drains and into stormwater ponds or in many instances directly into natural waterways. Eventually these polluted flows, if untreated, degrade these waterways.

Stormwater runoff adversely affects water quality, habitat and biological resources, public health and welfare, and the aesthetic appearance of natural waterways.

Setting physical impacts aside due to erosion, scour, deposition associated with increased frequency, and volume of runoff, the concerns discussed herein are nutrients , petrochemical, organics, toxins, and pathogens in untreated stormwater. Nutrients have been discussed earlier in this report.

Petroleum Hydrocarbons

Petroleum hydrocarbons of primary interest to human health include the aromatic hydrocarbons (i.e., benzene, toluene, ethyl benzene, and xylene), gasoline additives, and a variety of polycyclic aromatic hydrocarbons (PAHs). Petroleum hydrocarbons come from parking lots and roadways, leaking underground storage tanks, auto emissions, and improper disposal of waste oil. They are typically concentrated along transportation and urban corridors.

Petroleum hydrocarbons are known for their acute toxicity at low concentrations (Schueler, 1987). A study, conducted by Shepp in 1996, measured the petroleum hydrocarbon concentrations in urban runoff from a variety of impervious areas in the District of Columbia and suburban Maryland. That study found there is a positive correlation between the amount of car traffic and the concentration of hydrocarbons in runoff, with median concentrations ranging from 0.7 to 6.6 mg/L. Concentrations at these levels exceed the maximum concentrations recommended for the protection of drinking water supplies and fisheries protection.

Synthetic Organics

Synthetic organic compounds include a variety of manufactured compounds such as pesticides, solvents and household and industrial chemicals. According to an EPA's Nationwide Urban Runoff Program (NURP) study, the frequency that synthetic organic contaminants were detected as priority pollutants in stormwater is relatively low. Even so, synthetic organics still represent a health threat. Even at low concentrations, some synthetic organics over a long period of time have the potential to pose severe health risks to humans and aquatic life though direct ingestion or bioaccumulation in the food chain. There is also some evidence that pesticides were found in higher concentrations in urban areas than agricultural areas (US EPA, 1995).

Pathogens

Untreated stormwater also carries disease-causing bacteria, viruses, and protozoa from fecal contamination from wildlife, livestock, and pets. These pathogens can cause

Upper respiratory and gastrointestinal illness, eye and ear infections, and skin rashes of various degrees of severity.

Stormwater Best Management Practices

Due to the adverse impacts noted above, the proper treatment of stormwater is critical if stormwater is to be considered safe for public access irrigation water. A number of physical and biochemical processes can be employed in stormwater treatment such as sedimentation, filtration, infiltration, adsorption, biological uptake, biological conversion, and degradation. Stormwater ponds and constructed wetlands are effective stormwater best management practices (BMPs).

Stormwater ponds provide quiescent conditions with long retention times that allow a variety of pollutants such as suspended solids, metals, nutrients and organics to be removed by sedimentation, adsorption, and biological conversion. Degradation of organic compounds, uptake of nutrients and metals by aquatic plants, biological conversion of organic compounds by micro-organisms, and volatilization of hydrocarbons and volatile organics can provide additional water quality benefits. Note: Nearly two years of data are available from the stormwater reuse study in the City of Miramar to demonstrate the pollutant removal efficiency of a regional stormwater pond.

Other pollutant removal mechanisms include filtration by underlying soil and specially mixed media systems that encompass a series of horizontal wells where pond water and the upper groundwater is extracted for harvesting. A 2007 study by Dr Martin Wanielista, PHD and the University of Central Florida for the FDOT and FDEP was conducted to demonstrate the capability of filtration of pond water extracted through horizontal wells to reduce algal masses and toxins in regional type stormwater management facilities. The Wanielista study is provided in **Appendix A**. The Wanielista study noted: "The filtration mechanism of natural soil material appears to be an effective means of reducing the total Cyanobacteria counts and the potentially toxic Cyanotoxin Microcystin counts as well. There were no Microcystin toxins after filtration that exceeded the World Health Organization drinking water standard of one ug/L. The Microcystin toxins are produced from the Cyanobacteria and were shown to be significantly reduced by the natural soil media."

Relating to this water quality issue, there were a number of discussions with Regulators and potential End-Users during the study period regarding the health risks associated with stormwater reuse. While there is a general sense that retention time and soil filtration will remove the vast majority of the contaminants, there is a reluctance to use untreated stormwater for public access irrigation water without disinfection. While every potential harvesting site will have its own unique water quality issues to address, through an abundance of care by the End-Users, the selected projects shown in Section 7 include horizontal well filtration and hypochlorite disinfection. Typically, the level of disinfection will depend on site specific water quality conditions, and would only be needed when mixing the reused stormwater with reclaimed wastewater. **Note: The FDEP currently does not prescribe water quality standards for the reuse of stormwater for public access irrigation water.**

Point-of-Interest: The combination of retention time, micro soil filtration through horizontal wells, and disinfection provides a reasonable assurance that no adverse public health impacts would occur through the reuse of stormwater as a public access irrigation supply.

5.6 High Yield vs Safe Yield

In many instances, the harvesting of stormwater involves not only the collection of surface runoff from storm events, but also the drawing off of groundwater at a pond site. As such, it is important to understand the distinction between High Yield and Safe Yield of the harvested volume. While the typical desire will be to draw off as much stormwater as possible from a harvesting site (High Yield), there are "Safe" yield concerns as it relates to the groundwater flow net that is affected within a calculable distance surrounding the harvesting site further described later as the Area of Influence. Of greatest concern in this regard is the lowering of groundwater in the vicinity of an environmentally sensitive wetland area that may be in the area of influence of the harvesting impacts. The dehydration and resulting degradation of wetlands is not an acceptable or permittable resultant from a harvesting operation.

In order to understand the relationship between the drawdown rate/volume and the resulting changes to the affected flow net, a geo-hydraulic computer modeling program called Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) is utilized. The use and characteristics of the SHARP model are presented in Section 6, and application of the modeling at site specific harvesting locations is shown in Section 7.

Point-of-Interest: High yield doesn't necessarily equate to Safe yield. While high yield will dictate the economics, Safe yield should always be the primary consideration when analyzing potential harvesting sites.

5.7 Impacts of Changing Design, Permitting, and Schedule of FDOT Projects that are in the Design/Permitting phase

The introduction of an End-User match requires a determination of stormwater volume available, stormwater volume needed, timing of stormwater availability and how both parties will manage long term use of the stormwater. The potential challenge to selecting an ongoing FDOT project match not only involves the assessment of schedule and cost but how this affects the project funding scheduled and design scope of work.

FDOT project funding can control decision making since the ability to modify a project is affected by spending commitments on design, right-of-way and construction schedules. If committed funding is limited to design of a select project, then the flexibility of adjusting the project schedule and scope of work is increased and limitations to these changes is reflected by project complexity. FDOT will be challenged with production impacts affecting internal design staff and external consultant contracts. The End-User and FDOT will be challenged with a decision to modify existing scope of work and may need to anticipate expediting an independent scope of work to improve meeting scheduled milestones.

If project right-of-way funding is allocated, then a level of emphasis on planned right-of-way changes should be considered. If a reduction in proposed right-of-way can be clearly determined, as a consequence of the stormwater need, then FDOT may want to consider if the right-of-way savings are substantial enough to delay the right-of-way schedules. However if right-of-way schedules cannot be adjusted, then any vetting of pond reduction should be completed before right-of-way negotiations move forward to avoid the risk of the findings not complimenting the planned acquisition. FDOT negotiations on right-of-way acquisitions must not be compromised by the introduction of an additional option that creates an incomplete assessment to final right-of-way.

When project construction is funded, FDOT will want to ensure changes to a project are not affecting the contractor scope of work commitment. If construction documents are near completion and design changes may affect construction procurement, then a decision on progressing with the stormwater harvesting options should consider a retrofit that follows final construction. Construction funded projects have a window of opportunity, since timing of the End-User's need could occur early enough to not affect construction funding and therefore offer the FDOT sufficient time for vetting the issues.

The opportunity to add an End-User as an alternate outfall requires an understanding of the proposed project scope of work. Key elements to review in the scope of work include details to both existing and proposed conditions to typical section, corridor right-of-way, stormwater collection and stormwater ponds. The project elements define the initial condition under which extraction of the stormwater must be considered. The challenge to any corridor change will be to define how to proceed with project alternates to determine related costs and how both End-User and FDOT produce project changes within existing design or independent to design. The approach to alternate designs should be clear in how it modifies the scope of work, schedule and preliminary costs.

Determining the viability of extracting stormwater from FDOT rights-of way will vary with design completion. The stormwater harvesting opportunity must consider how stormwater collection and distribution work around project conditions. A key design challenge will include impacts to the timing of environmental permits and clear approach to flood control, outfall restrictions, off-site bypass flow and other environmental issues (i.e. endangered species, contamination, archaeology, wetlands, etc.). Design projects that are impacted by wetlands for example would need to consider changes to the impacts to permitting, and any planned mitigation whether permanent, secondary or temporary. Ideally implementing the change to an FDOT stormwater outfall condition during early stages of design maximizes saving associated with facility design, future right-of-way costs and construction cost expectations. Clearly identifying the impacts to any of the scope of work elements is critical to whether the project is viable at the design stage or as a retrofit following construction.

Point-of-Interest: The FDOT's State Hydraulics Engineer has indicated a willingness to consider impacting FDOT project production schedules if the cost savings of a SWR opportunity is significant.

5.8 Concerns Associated with Agreements with Private Sector Entities

The Department of Transportation's mission is to provide a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity and preserves the quality of our environment and communities. This mission requires that FDOT assures itself and the public that stormwater runoff from state roadways is managed effectively and responsibly in perpetuity. The Department needs certainty that all drainage systems it funds, constructs or relies upon are constructed, maintained and operated effectively.

The Department's requirements raise concerns with entering stormwater reuse agreements with private sector partners who may have complex development agreements that provide a limited role for the developer and envision successor corporations providing long term financing and maintenance. The Department must be assured that partners will be able to financially afford the operation and maintenance of a stormwater reuse facility virtually forever.

The Department should seek partners that are stable organizations, that have a secure long term source of income, and that routinely provide Operation and Maintenance (O&M) services internally as part of their core business or provide O&M services through a long term contract with a third party. The ideal partner that would meet all of these conditions is likely a public partner or quasi government partner. The risk of default on O&M is minimized with such a candidate since an established government or quasi-government partner has a long term source of income and such partners rarely demise or leave the area.

A municipality or public utility would most likely be in existence for the duration of the stormwater reuse facility's lifespan and would have a consistent and constant funding source to be able to financially afford the O&M of a stormwater reuse facility. The partners often provide stormwater reuse services as part of its core business and have a department within its organization that would be responsible for the O&M of the stormwater systems. Contracting with a partner possessing these attributes significantly decreases the Department's risks of default on the O&M by the partner.

With regard to private sector partners, the Department's duty to provide a safe and efficient transportation system requires close coordination regarding the completion of private sector constructed facilities. The stormwater reuse partner may also be required to meet the demands of a strictly imposed schedule to complete the construction of the harvesting infrastructure in order to avoid conflicts with Department projects.

Private sector stormwater reuse partners have funding risks not present with established governments. Private developers often go through economic cycles risking loss of business, shutdowns and in some cases bankruptcy. When funds run short, one of the first cutbacks would be operation and maintenance on the retention pond. Failure to operate and maintain the harvesting area would create environmental and flooding liabilities for the Department.

It is not only economic frailty that creates risk for the Department; often it can be the structure of a private developer's project that is a stumbling block. Most developers begin as the owner of unimproved land. The developer contracts with individuals to improve and sell improved lots. When the development is built out, the developer moves on and gives up his ownership interest even in the common areas. The lot owners are left with the common area and the cost of its operation and maintenance. The developer may leave behind a homeowner's association but, the financial strength of the association will be dependent on a number of variables going forward including the lot owners' willingness to continue paying dues.

Other concerns with private partners may be that the private entities' project may appear to provide special benefits to a smaller group of citizens instead of benefit to the public as a whole. Private partners could also change focus and choose to abandon or withdraw from a project due to a change of ownership or leadership. A private developer's insurance may be more limited and provide less protection in the event of an incident.

Liability is a major risk with private companies. For instance, a Limited Liability Company (LLC), has the status of being legally responsible only to a limited amount for its debt. This is the principal advantage of doing business as an LLC. It affords the company limited liability. This advantage enjoyed by an LLC is a disadvantage when it comes to teaming with the Department in a stormwater reuse arrangement. The LLC, a shell company, is the owner of its assets and bound by its liabilities. The liabilities of the members/shareholders however, are limited to the nominal value of the shares held by them. Members/shareholders are not personally liable for the company's debts. This means that if the company becomes insolvent, the members/shareholders can walk away with no liability. The Department prefers a partner that has greater financial responsibility and resources to survive even challenging economic times.

A method to reduce the risk of partnering with a less than ideal candidate would be to execute protective contractual provisions as part of the Stormwater Reuse Agreement that provide additional confidence that the Department's interests are protected.

For instance, the Department's partners could be contractually required to purchase surety bonds with defined guidelines guaranteeing the performance of O&M of the stormwater facilities. A surety bond issued by a bonding company on behalf of the Department's partner would guarantee that the partner will fulfill the obligation of O&M. In the event that the obligations of the partner are not met, the Department would recover the costs of O&M. This makes surety bonds ideal for large government projects where completion is vital. Government organizations use surety bonds in almost all of their outside contracts.

As an alternative to surety bonds the Department could contractually require its partners to purchase insurance policies that would insure the continued O&M of the stormwater facilities. The insurance would need to be specially written and paid for in a lump sum fashion up front in order to insure continued insurance for the duration of the stormwater facility's lifespan. An insurance policy covering the O&M of a stormwater facility could guarantee the cost of O&M in the event that the Department's partner failed to meet its obligations.

Additionally, indemnification agreements should also be included in the Stormwater Reuse agreement whereby the partner would indemnify the Department for any expenses, fees or costs expended due to the partner's failure to provide continuous O&M. An example follows;

> **Partner** hereby agrees to indemnify and hold the Department and its officers, agents, and employees harmless of and from any and all claim, demand, damage, liability, cost or expense of any nature whatsoever arising out of or related to the exercise of **Partner**'s rights hereunder or the construction, use or maintenance of the system, except for matters due to the sole negligence of **Partner** or its officers, agents, or employees. In the event of any loss, damage, claim or expense resulting from **Partner**'s performance or non-performance of the services authorized under this Agreement, **Partner** shall be wholly liable.

In short, there is no guarantee that any partner will be secure and financially stable "forever". There are however, terms and conditions that the Department should demand that would provide the protections necessary to insure the stormwater facility's O&M for the life of the facility. The terms and conditions along with a highly selective and regulated process for identifying appropriate stormwater reuse partners will assure the Department that the expense of operation and maintenance of the stormwater reuse facility will be covered virtually forever.

Many of these concerns can be dealt with by including clauses in the stormwater reuse agreement to create contingency actions. However, FDOT cannot afford to contract with a developer who will not remain once a development is complete. There needs to be a level of comfort for the Department that the partner will be stable for a long period of time. The stormwater reuse agreements do incorporate safeguards for the Department to have the right to step into the place of a developer who no longer is providing the promised services, however, the emergency clause is provided to serve as a true emergency. There should be no desire on the part of the Department to contract with a partner in order to have to retake the control of a stormwater harvesting area.

Point-Of-Interest: Entering into SWR Agreements with private sector End-Users has increased risks and warrants a higher level of vetting and subsequent assurances than municipal partners.

Section 6
Data Collection, Analysis, and Ranking of Potential Reuse Opportunities

6.1 Data Collection

The collection and review of available pertinent data is an important part of any feasibility study. As shown below, existing condition data has been collected and reviewed for use as the basis of the Study.

6.1.1 Collected Data

The following is a listing of the Maps and Report/Data collected and used as part of the study and subsequent analysis:

Maps:

+ Topographic Maps
+ Aerial Maps
+ Rainfall Zone Maps
+ Existing and Proposed Land Use Maps
+ Soil Maps
+ Wetland Maps
+ Flood Plain and Flood Plain Impacts Maps
+ Drainage Maps
+ GIS Infrastructure Maps
+ USDA Natural Resources Conservation Service Soil Survey Maps

Reports/Data:

+ Preliminary Engineering Reports (PER)
+ P D & E Reports
+ Pond Siting Reports (PSR)
+ Drainage Basin Characteristics
+ Criteria and Methodology Data

- Treatment and Attenuation Volume Data
- Final Selected Pond Sites
- Summary of Stormwater Pond Recommendations
- Utility and Municipal Water Rate Data
- Rainfall Distribution Data
- Geotechnical Reports
- FDOT Construction Drawings

6.1.2 Potential Stormwater End-Users

As part of the Data Collection phase of the Study, potential End-Users of harvested stormwater were identified on two levels. Primary users would be governmental and private utility system operators with existing or planned reclaimed water utility systems. Primary users would have operating and maintenance utility systems in place. Under this scenario, the FDOT's involvement could be limited to simply contracting the bulk trade for the harvested stormwater. The responsibility for providing the necessary utility infrastructure, and the operation and maintenance of the utility as well as the source pond maintenance would lie with the governmental/private utility system operator.

Secondary Users would be private entities that have significant irrigation water needs for purposes such as golf course/community common area irrigation, agricultural irrigation and commercial or industrial process needs. Generally, these entities will have Consumptive Use Permits (CUP) for the withdrawal of ground water for irrigation purposes. These entities generally do not have the resources of a typical utility operator, so their use of FDOT harvested stormwater would have to be in close proximity to their site and require very limited infrastructure investment. Again, the FDOT could enter into an agreement for the bulk trade of the harvested stormwater. Pond maintenance responsibilities could be retained by the FDOT or negotiated over to the End-User as part of the agreement.

6.1.3 Geotechnical Data

Geotechnical data that reflects soil classifications and groundwater conditions is information critical in determining potential yield conditions at a particular harvesting site. The geotechnical data obtained during this study was used to establish the site specific geo-hydraulic conditions needed for the SHARP modeling presented later in the report.

6.1.4 Water Rate Data/Charges

In order to understand a potential End-User's decision making process as it relates to economics, an understanding of their water rate schedule is necessary. The rate schedule is a good indicator of the municipality's cost to deliver potable water to its customers. In addition, reviews of water rate charges will identify if that municipality provides irrigation water through an established reclaim water distribution system. Since the primary use of harvested stormwater is for irrigation, understanding the End-Users reclaim economics and operations is vital to fleshing out potential partners for the Department.

Reclaimed water rates can be developed in various ways. The standard for developing these rates is extremely variable when compared to setting rates for water and wastewater systems. Examples of these rate structures may be to set a fixed fee for recovery of capital costs, and a consumption charge that is a percentage of the cost of potable water per 1,000 gallons. Other utilities could measure this on a more complex level through enlisting a private consultancy to evaluate usage and growth to develop rates that would recover a certain level of the cost of providing the overall service. It is difficult to fully recover the cost of offering reclaimed water service through rates because the value of the water is much less than that of potable water.

There are various ways that Utilities can assess Customer fees, such as fixed charges, consumption charges, connection charges, charges based on meter size (ERCs), etc.

6.2 Reviews and Discussions with the WMD's Alternative Water Supply Planners

The following Memorandums were prepared to document early discussions with the WMD's Alternative Water Supply planners at the St Johns, South Florida, and Southwest Florida Water Management Districts in an effort to identify potential in-need End-Users. They reflect the general nature of the discussions, and are not intended to imply verbatim responses.

memo

gai consultants

Date: 7/23/12

To: Richard A. Cima, P.E.

From: Brett Hart

cc:

Subject: St. Johns River Water Management District Alternative Water Supply Initiatives

Recently, I spoke with Jim Gross, Technical Program Manager of Water Supply for the St. Johns River Water Management District (SJRWMD or the District) regarding the Alternative Water Supply efforts for the District. Mr. Gross explained that the District assists with water supply utilities and local governments in identifying and implementing alternative water supply projects to help meet future water needs. Mr. Gross provided me a table of the planned projects that the District is involved in. He emphasized to me that several of the projects are "best-case scenario's", assuming the District doesn't have funding reductions.

Alternative Water Supply projects are so critical in the SJRWMD because the Floridan Aquifer, which is the primary source of water in Northeast and east-central Florida,is nearing it's sustainable limits and because water conservation only will not be sufficient enough to completely offset the projected growth in water demand. As part of its responsibilities, the District has identified potential alternative water supply sources to investigate if and to what extent these sources can be developed and used without unacceptable impacts to the environment.

The District plans to utilize varying source water types to address their water supply demands. Some of these various source water types include: surface water for potable use, brackish groundwater for potable use, seawater source for potable use, reclaimed water and reclaimed augmentation. The planned projects vary considerably in size and scope. The construction costs for the planned projects vary from $340,000 to over $1 billion.

One of the biggest initiatives that the SJRWMD has undergone is the Taylor Creek Reservoir. The Taylor Creek Reservoir is located in Orange and Osceola counties near the St. Johns River and State Road 520. The reservoir was designed to provide flood water storage and water supply benefits in the drainage basin of the upper St. Johns River. Water from the reservoir flows into Taylor Creek, which empties into the St. Johns River about 4.3 miles downstream. The City of Cocoa began using the reservoir for water supply in 1999, and it permitted to withdraw 8.8 MGD from the reservoir to supplement its groundwater sources. Some improvements that are anticipated for the Taylor Creek Resevoir is to change the current operating schedule and corresponding water levels, which range from 41 to 43 feet, to an operating schedule that would bring the water level in the reservoir to 46 feet. Raising the water level would increase the water supply yield from the resevoir without any supplemental diversions from the St. Johns River. Currently several utility partners are considering developing and using the additional water. The City of Cocoa is speardheading the effort, together with the City of Titusville, Orange County Utilities, Orlando Utilities Commission, Tohopekaliga Water, and East Central Florida Services Inc, to increase potable drinking water supplies for these partners. Expected quanity will likely be in the 12 to 24 MGD range.

memo

gai consultants

Date: 7/23/12

To: Richard A. Cima, P.E.

From: Brett Hart

cc:

Subject: South Florida Water Management District Alternative Water Supply Initiatives

Recently, I spoke with Linda Hoppes, Lead Planner of the South Florida Water Management District (SFWMD or District), regarding the Alternative Water Supply initiatives planned for the District. Ms. Hoppes explained that the District has several alternative water supply projects currently active. The District has put a high priority on alternative water supply efforts due to the increased demand for water because of the growing urban populations and agricultural uses in South Florida.

The SFWMD has been very active in alternative water supply projects since 1997. Between 1997 and 2012, the District has partially financed alternative water supply projects totaling approximately $1.4 billion in construction costs. The District provided approximately $204 million in grants toward 474 alternative water supply projects that produced 429 million gallons of water per day (MGD).

The Approved Alternative Water Supply Projects for Fiscal Year 2012 include:

- **The 3.5 MGD Reclaimed Water Facility Phase II for the Town of Davie**. The Town will receive $100,000 in funding towards the anticipated $917,600 of construction costs for FY 2012.
- **The 1.3 MGD Lake Region Water Treatment Plant Wellfield Improvements for Palm Beach County Water Utililities**. The County will receive $500,000 in funding towards the anticipated $1,583,140 in construction costs for FY 2012.
- **The 1.5 MGD Reverse Osmosis Water Treatment Plant Phase 1A for the City of Labelle.** The City will receive $300,000 in funding towards the anticipated $1,316,590 in construction costs for FY 2012.
- **The North County Regional Water Treatment Plant Modification for Collier County Utilities**. The County will receive $250,000 in funding towards the anticipated $2,200,000 in construction costs for FY 2012.
- **The Aquifer Storage and Recovery Efforts at Livingston Road for Collier County Utilities**. The County will receive $100,000 in funding towards the $2,000,000 in anticipated construction costs for FY 2012.
- **The Aquifer Storage and Recovery Efforts at Well #4 for the City of Naples**. The City will receive $980,000 in funding towards the $2,500,000 in estimated construction costs for FY 2012.
- **The Reclaimed Water Production Facility Phase III Restoration for the City of Marco Island**. The City will receive $490,000 in funding towards the $3,300,000 in anticipated construction costs for FY 2012.

Some recently funded major projects for the District include:

- The South Central Regional Wastewater Treatment Center underwent an expansion project that increased the plant's capacity from 10 MGD to 24 MGD. The 14 MGD expansion allowed the plant to process 100% of incoming effluent into treated, reclaimed water available for irrigation, and virtually elimates effluent discharge through ocean outfalls. The expansion was completed in 2008 for a total project cost of $18.6 million, including $7 million from the District.
- The Tohopekaliga Water Authority's Parkway Water Reclamation Project enhanced the existing facility by installing a covered tank that increases reclaimed water storage capacity to 7.5 million gallons of water a day. A new high-service pump also provides reclaimed water customers with a more consistent supply source and improved water pressure. Improvements were completed in 2009 for a total project cost of $3.8 million, including approximately $982,000 in SFWMD funding.
- The Little Cypress Tail Water Recovery Project at C & B Farms in Hendry County reduced the amount of well water drawn from the Lower Tamiami Aquifer and reduces the farm's energy costs for irrigation. Thid is accomplished through a drip irrigation system with lift pumps using water recovered from the farm's 200 acre water retention area and irrigation canals. The project also reduced the amount of phosphorous in water discharged to the C-139 Drainage District. Improvements were completed in 2008 for a total project cost of $1.5 million, including $363,000 in SFWMD funding.

memo

gai consultants

Date:	7/23/12
To:	Richard A. Cima, P.E.
From:	Brett Hart
cc:	

Subject: **Southwest Florida Water Management District Alternative Water Supply Initiatives**

Recently, I spoke with Jason Mickel, Senior Planner of the Southwest Florida Water Management District (SWFWMD or the District), regarding the Alternative Water Supply initiatives planned for the District. Mr. Mickel explained that the District has separate Regional Water Supply Plans for the four regions located in the District: Heartland, Tampa Bay, Northern and Southern. Each Regional Water Supply plan contain separate alternative water supply initiatives. The Northern Planning Region has recently developed a Water Supply Plan but did not have one previously because of a lack of regional impacts from groundwater withdrawal. However, water supply planning and development activities have been ongoing at a high level in the region for the past decade. Like many of other Water Management Districts, funding has been cut significantly over the past few years and the scope of projects has been limited.

The following is a list of previously partially funded projects by the District:

- The District partnered with Polk County to construct an exploratory/test well into the Lower Floridan aquifer in the northeast part of the County. The project was completed in 2009 and the County is hopeful that the well could provide an alternative water source in a high-growth area of that County that lacks other readily available supplies. The District is now helping to fund reclaimed water storage infrastucture and an additional monitor well.
- As part of a Partnership Agreement between the District and Tampa Bay Water (TBW), the District provided partial funding for the development of alternative water supplies to offset a reduction in groundwater withdrawals and to meet growing demands. One of the funded projects was a seawater desalination facility in Hillsborough County on Tampa Bay. The District also provided funding for the cities of Tarpon Springs, Oldsmar and Clearwater to augment water supplies by developing brackish groundwater wellfields and reverse osmosis membrane treatment facilities.
- The District entered into an agreement with the Peace River Manasota Regional Water Supply Authority (PRMRWSA) to co-fund a major expansion of PRMRWSA's facilities in Desoto County. The expansion consisted to two projects: a six-billion gallon off-stream reservoir and expansion of potable water treatment facilities to boost capacity from 24 MGD to 48 MGD. These two projects, which were recently completed, give the PRMRWSA the ability to withdraw and store water from the Peace River in sufficient quantity to deliver the full 32.7 MGD allowed in its water use permit to customers in its four-county service area. The projects are also critical components in the District's Southern Water Use Caution Area (SWUCA) recovery strategy, which promotes the use of alternative water supplies to meet growing public supply demands in coastal communities while reserving limited groundwater supplies for agriculture and other inland users.

- Another recently completed water supply project was the expansion of the City of Punta Gorda's water treatment plant capacity from 8 mgd to 10 mgd. This project will secure the City's water supply well into the future and provide excess capacity, that potentially could be shared with the other regional partners, provide rotational capacity and resting of sources, and help with emergency supply interruptions.

Point-of-Interest : The staff position of AWS planners at the Water Management Districts is a clear indication of the critical nature of water resources in the state of Florida. All of the AWS planners contacted during this study recognize stormwater as an AWS that should be developed more fully.

6.3 Listing of Consumptive Use and Water Use Permits (CUP/WUP) holders

As part of data collection, a review of Consumptive Use and Water Use Permits (CUP/WUP) Holders was conducted to help identify End-Users in need of an Alternative Water Supply (AWS) to augment their current water supply demands. This data was integrated into the evaluation matrix as one of the key ranking elements of possible End-User matches. Showing the ability to develop/use AWSs will be a pre-requisite of obtaining approval for extending and expanding their CUPs/WUPs.

The following are the CUP/WUP Holders from the St Johns, South Florida, and Southwest Florida Districts that will face expiration by 12/31/14.

Southwest Florida Water Management District

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
2-009-1711-5	CUP Individual	Orlando Utilities Commission	Orlando Utilities Commission-Indi	Transfer of Ownership- The District Authorizes, as limited by the attached permit conditions, the use of 158.87 million gallons per year of groundwater from the Surficial aquifer for electrical power generation, 299,300.0 million gallons per year of surface water from the Indian River Lagoon for electrical power generation, 1.0 million gallons per year of groundwater from the Surficial aquifer for urban landscape irrigation, and 0.5 million gallons per year of reclaimed water for urban landscape irrigation through 2014.	Brevard	1/18/2012	1/19/2012	11/13/2014
20-019-414-3	CUP General	Clay County School Board	Clay Hill Elementary	This permit authorizes the use of ground water from the Floridan aquifer for the household use of 877 people and urban landscape irrigation for 4 acres.	Clay	2/6/1998	8/17/1998	8/17/2013
2-009-1798-3	CUP Individual	Cape Publications Inc	Florida Today	The District authorizes the use of 11.930 MGY for Landscape.	Brevard	3/29/1993	7/13/1993	7/13/2013
2-069-279-7	CUP Individual	Harbor Hills Utilities Ltd	Harbor Hills	The applicant proposes to withdraw 0.817 million gallons per day of water for public supply use, household, commercial/industrial, urban landscape, and water utility type uses and 0.647 million gallons per day of surface water for the irrigation of a 136 acre golf course.	Lake	12/28/2006	6/24/2010	6/24/2013
20-069-271-10	CUP General	La Viance Property Acquisition LLC	Lake Emma Road	The applicant proposes to withdraw 0.025 million gallons per day of surface water for the irrigation of 44 acres of vegetables.	Lake	1/8/2008	5/19/2008	5/19/2013
2-069-288-3	CUP Individual	Lake Joanna Estates Assoc Inc	Lake Joanna Estates	The applicant proposes to withdraw 0.063 milliion gallons per day of surface water for urban landscape irrigation, cooling and air conditioning and for essential use (fire protection) and 0.007 million gallons per day of ground water for the household use of 140 people and water utility use.	Lake	8/24/2007	5/13/2008	5/14/2013
20-109-1278-7	CUP General	East Coast Aggregates LLC, East Coas	Westwind Borrow Pit	Ownership Transfer - The District authorizes, as limited by the attached permit conditions, the use of 178.85 mgy (0.490 mgd average) of surface water to be re-circulated on-site to facilitate a sand mining operation.	St. Johns	12/31/2009	12/31/2009	4/25/2013
20-061-245-3	CUP General	Indian River Cnty Bd Of Cnty Comm	800 Gardenia St.	Permit Transfer	Indian River	6/17/2008	8/25/2008	2/3/2013

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
20-127-358-9	CUP General	Lombardy Farms LLC	Lombardy Farms	The applicant proposes to withdraw 0.03 million gallons per day of ground water to irrigate fern and citrus trees; 0.09 million gallons per day of surface water to irrigate fern and citrus trees; 0.02 million gallons per day of ground water to freeze protect fern and citrus trees; 0.06 million gallons per day of surface water to freeze protect fern and citrus trees and 0.0001 million gallons per day to water horses.	Volusia	1/11/2008	10/28/2010	1/8/2013
20-069-277-4	CUP General	Clermont Scapes Inc	Store #6 Grove	The use of ground water from the Floridan aquifer for irrigation of 30 acres of citrus using an over head irritation system.	Lake	12/14/2001	12/14/2001	12/27/2012
2-031-38-6	CUP Individual	Estuary Corporation	Dee Dot Timberlands	The District issued a permit on December 12, 2000, authorizing the use of 219 million gallons per year of ground water from the Floridan aquifer for water based recreation use, irrigation of landscape areas for the managers residence, and outside (cleaning) type uses.	Duval	12/9/2005	5/9/2006	12/12/2012
20-003-1-4	CUP General	Northeast Florida State Hospital	NORTHEAST FLORIDA STATE HOSI	Use of ground water from the Floridan aquifer to supply an estimated fluctuating population of between 500 - 600 patients and approximately 1100 employees with water for domestic/cooling use and essential use (fire protection). USE STATUS: This is a renewal of a previously issued permit with a request for a reduction in allocation. The use has been reviewed as existing for the period commencing with the issuance of the original permit. Present	Baker	11/19/2001	11/4/1997	10/31/2012
20-009-1868-4	CUP General	Ronald DiMenna	Merritt Island Grove	Transfer - for the use of 77 million gallons per year of surface water for dewatering 31 acres of citrus.	Brevard	9/24/2010	10/19/2010	10/31/2012
20-127-349-5	CUP General	John A & Michelle L Puckett	Puckett	Use of ground water from the Floridan aquifer for irrigation and frost/freeze protection of 30.0 acres of fern and use of surface water from a retention pond for irrigation and freeze protection of 50.0 acres of citrus. Use Status: This is a renewas of a previoulsy issued permit with a modification for an increase in acreage.	Volusia	4/28/2005	4/28/2005	10/16/2012
2-083-399-11	CUP Individual	Del Webb's Spruce Creek Communiti	Spruce Creek Golf and Country Cl	The applicant proposes to withdraw 0.767 million gallons per day of water to irrigate 271.49 acres of golf course.	Marion	12/26/2003	10/9/2007	10/9/2012
2-061-248-2	CUP Individual	Becker Groves Inc	Becker Groves	Use of ground water from the Floridan aquifer for backup irrigation and freeze protection of 920 acres of citrus using a micro-spray irrigation system.	Indian River	6/2/1997	10/7/1997	10/7/2012

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
2-061-2341-5	CUP Individual	Grand Harbor Limited Inc	GRAND HARBOR GOLF COURSE	This permit authorizes the use of reclaimed water from the Gifford WWTP, surface water from an on-site stormwater management system and adjacent canal, ground water from the Floridan aquifer for irrigation of 8 acres of nursery and augmentation of two 2.4	Indian River	1/13/1997	10/7/1997	10/7/2012
20-061-219-3	CUP General	Torwest Inc	Vincent Grove	Use of ground water from the Floridan aquifer to irrigate and frost / freeze protect 45 acres of citrus using micro-spray irrigation. USE STATUS: This is a renewal of a previously issued permit.	Indian River	3/17/2008	4/14/2008	10/6/2012
20-061-221-4	CUP General	Indian River Memorial Hospital	Golf Course Grove	Use of ground water from the Floridan aquifer to irrigate and freeze protect 40 acres of citrus using micro-spray irrigation. Formerly known as 2-061-0070. USE STATUS: This is a renewal of a previously issued permit.	Indian River	7/25/2003	12/22/2003	10/6/2012
20-069-290-2	CUP General	Midway Manor MHP	Midway Manor	Use of groundwater from the Floridan aquifer for public supply and general household use at a 40 lot RV park and 26 lot mobile home park. Formerly known as 2-069-1050AUV. The District authorizes the use of 0.047 MGD for Household.	Lake	6/11/1997	9/29/1997	9/29/2012
20-061-1661-4	CUP General	Premier Citrus LLC	Commander Nursery	Use of groundwater from the Floridan aquifer for micro-drip irrigation 263.8 acres of citrus and use of groundwater from the surficial aquifer for household use. USE STATUS: This is a renewal of a previously issued permit with a modification for an additional use (household use).	Indian River	9/14/2006	12/1/2006	9/19/2012
20-061-220-4	CUP General	Sasson (Trs) & Kassab	Sawyer/Westgate	Transfer - Use of ground water from the Floridan aquifer to irrigate 86 acres of citrus using a microjet irrigation system and for frost and freeze protection of 86 acres of citrus.	Indian River	12/17/2010	12/20/2010	9/16/2012
2-061-249-4	CUP Individual	Divosta Homes LP	The Isles at Waterway Village Pha	The applicant proposes to withdraw 0.52 million gallons per day of surface water to irrigate 114 acres of urban landscape, 0.1 million gallons per day of groundwater for pasture irrigation, 0.005 million gallons per day of groundwater for livestock watering, and 2.66 million gallons per day for dewatering to facilitate construction.	Indian River	6/27/2005	4/11/2006	9/16/2012
20-095-308-4	CUP General	Project Orlando LLC	Jeff Goerdt	The use of ground water from the Floridan aquifer for irrigation and freeze protection of 10 acres of citrus using a microjet system.	Orange	1/22/2008	2/21/2008	9/16/2012
20-127-354-4	CUP General	Wm F Puckett Inc	SHUMAN AND RYALS	The District authorizes the use of groundwater from the Floridan aquifer for irrigation and frost/freeze protection of 28.0 acres of fern.	Volusia	11/9/1999	11/9/1999	9/16/2012

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
20-127-369-3	CUP General	Curtis W Richardson Inc	Barretts	Use of ground water from the Floridan aquifer for irrigation of 8.0 acres of fern and freeze protection of 8.0 acres of fern. USE STATUS: This is a renewal of a previously issued permit. ASSOCIATED PERMITS: Downgraded from 2-127-0102.	Volusia	5/30/1997	9/16/1997	9/16/2012
20-009-1877-2	CUP General	Turtle Creek Golf Club	TURTLE CREEK GOLF CLUB	Use of ground water from the Floridan aquifer, and stormwater and surface water from a wholly owned lake, to irrigate 70 acres of golf course turf. Use Status: This is a renewal of a previously issued permit with no increase in allocation.	Brevard	7/5/1996	9/16/1997	9/16/2012
20-127-347-5	CUP General	Greens Dairy LLC	Greens Dairy	Transfer - Use of ground water from the Floridan aquifer for irrigation of 8.0 acres of fern and freeze protection of 5.0 acres of fern.	Volusia	1/21/2011	1/25/2011	9/3/2012
20-127-388-4	CUP General	Ronald G & Carine Lee Puckett	A & M Fernery	Permit Transfer - Groundwater use from Floridan aquifer for irrigation of 28.0 acres of fern. Use of surface water for freeze protection of 25.0 acres of fern.	Volusia	5/21/2007	5/21/2007	9/3/2012
20-069-291-2	CUP General	Faryna Grove Care & Harvesting	Osborne	Use of ground water from Floridan aquifer to irrigate 20 acres of citrus using a microspray irrigation system.	Lake	6/2/1997	8/26/1997	8/26/2012
2-095-306-4	CUP Individual	City Of Orlando	Dubsdread Golf Course	The applicant proposes to withdraw 0.19 million gallons per day of ground water for irrigation of 72 acres of golf course turf.	Orange	6/12/2008	11/11/2008	8/26/2012
20-127-365-4	CUP General	Melanie Green	Melanie Green	The District authorizes the use of groundwater from the Floridan aquifer for irrigation of 5.0 acres of fern and freeze protection of 3.0 acres of fern.	Volusia	1/6/2006	2/3/2006	8/26/2012
20-127-371-5	CUP General	Alpha Fern Co	Olson	The District authorizes the use of ground water from the Floridan Aquifer and surface water from a wholly owned pond to irrigate and frost/freeze protect 16.5 acres of assorted fern and 1.0 acre of citrus. Formerly known as 2-127-0173.	Volusia	3/29/2001	11/7/2001	8/26/2012
2-035-1977-6	CUP Individual	The Golf Group of Palm Coast LLC	Matanzas Woods Golf Course	The District authorizes the use of 117.9 million gallons per year of surface water from the stormwater management system to irrigate 118 acres of golf course turf using an overhead sprinkler irrigation system through 2012.	Flagler	12/2/2011	12/29/2011	8/11/2012
20-069-99-3	CUP General	Knight Lake LLC	Knight Lake LLC	The use of ground water from the Floridan aquifer for irrigation and freeze protection of 16 acres of citrus using a microjet system	Lake	9/23/2005	10/20/2005	8/5/2012
20-061-246-3	CUP General	Twin Pair Grove	Twin Pair Grove	Use of ground water from the Floridan aquifer and surface water from an internal pond to irrigate 17 acres of citrus using micro-spray irrigation.	Indian River	6/13/1997	8/5/1997	8/5/2012

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
20-069-284-3	CUP General	M & J Groves, Inc.	Baker Road Block	The use of ground water from the Floridan aquifer for irrigation and freeze protection of 43 acres of citrus using a microjet system. USE STATUS: This is a renewal of a previously-issued permit with a request for a decrease in allocation. The use has been reviewed as an existing use pursuant to Chapter 373.226, F.S. ASSOCIATED PERMITS: This permit was previously issued as CUP no. 2-069-0366.	Lake	6/5/1997	8/5/1997	8/5/2012
20-127-335-4	CUP General	Mayo Holdings LLC	Shaw Lake	Use of ground water form the Floridan aquifer to irrigate and frost/freeze protect 18 acres of fern using an overhead sprinkler system. Surface water from Shaw Lake can be used as an emergency back-up for frost/freeze protection only. Use Status : This is a renewal of a previously issued permit with a modification for a decrease in irrigation allocation. The existing use has been reviewed as existing pursuant to chapter 373.226, F.S.	Volusia	2/17/2005	2/17/2005	8/5/2012
20-019-32-4	CUP General	Department of Military Affairs	Camp Blanding	Use of ground water from the Floridan Aquifer to supply an estimated fluctuating population of between 500 - 5000 with water for household use, comercial/industrial use, landscape irrigation, water utility and fire protection.	Clay	4/11/1997	8/29/1997	7/31/2012
20-127-337-3	CUP General	Freeman Greenlund	FREEMANS HOUSE	USE STATUS: This is a renewal of a previously issued permit with a modification for a decrease in irrigation allocation. The existing use has been reviewed as existing pursuant to Chapter 373.226, F.S. ASSOCIATED PERMIT:2-127-0024AUR (Previous permit)	Volusia	6/3/1997	7/25/1997	7/25/2012
20-095-302-3	CUP General	Tran Trex Foliage Inc	Tran Trex Foliage	Use of ground water from the Floridan aquifer for two acres of nursery irrigation.	Orange	5/9/1997	6/30/1997	6/30/2012
20-009-1846-2	CUP General	Walter Straub Tropical Fish Farm	WALTER STRAUB TROPICAL FISH F	Use of ground water from the Floridian aquifer to supply the needs of a tropical fish farm. USE STATUS This is a renewal of a previously issued permit with decrease in allocation.	Brevard	12/26/1996	6/26/1997	6/26/2012
20-127-197-4	CUP General	Franklin & April Drury	Reed Nurseries	The District authorizes the use of ground water from the Floridan Aquifer to irrigate and freeze protect 3.6 acres of Leather Leaf Fern using an overhead sprinkler system.	Volusia	3/8/2001	11/7/2001	6/3/2012

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
20-009-1749-4	CUP General	South Shores Utility Association, Inc	South Shores	Use of ground water from the Floridan aquifer for household use, fire protection (essential use), and water utility use of an estimated population of 651 people; and for landscape of 13.76 acres of turf. The District authorizes the use of 43.230 MGY for Household.	Brevard	8/14/2009	10/21/2009	5/16/2012
20-127-200-4	CUP General	Barred Owl Farm LLC	Barred Owl Farm	The use of surface water from a Tailwater pond to irrigate 16.5 acres of tree fern. Use Status: This is a renewal of a previously issued permit with a modification for an increase in acreage and irrigation allocation, the elimination of freeze protection allocation, and a change in irrigation source. The existing use has been reviewed as existing pursuant to chapter 373.226, F.S. and the modification has been reviewed as a new use.	Volusia	5/17/2006	6/9/2006	4/21/2012
20-001-1684-2	CUP General	FL Dept of Corrections	Gainesville Work Camp	The use of groundwater from the Floridan aquifer for irrigation of 1.0 acre of urban landscape. USE STATUS: This is a renewal of a previously issued permit with a modification for a decrease in allocation and has been reviewed as existing. ASSOCIATED PERMITS: Downgraded from 2-001-0052UVG	Alachua	9/12/1996	4/21/1997	4/21/2012
TCUP-109-1300-	Temporary CUP	Fred & Jeff Parker Farms	485 Acre Farm	TCUP AGRICULTURE	St. Johns	3/5/2012	3/13/2012	4/9/2012
20-009-1831-2	CUP General	Lighthouse Cove Condominium Asso	Lighthouse Cove	Use of ground water from the Floridan aquifer for household use and for fire protection (essential use), and groundwater from the surficial aquifer for 2.52 acres of urban landscape irrigation. The District authorizes the use of 3.500 MGY for Household.	Brevard	8/5/1996	2/11/1997	2/11/2012
2-019-422-6	CUP Individual	Iluka Resources Inc	Iluka Resources	This District issued a permit in November 1999 for the use of 2.5 million gallons per day of ground water for commercial/industrial mining purposes.	Clay	4/21/2006	12/11/2007	12/31/2011
20-109-1360-7	CUP General	LinksCorp Florida Cimarrone LLC	Cimarrone Golf and Country Club	Use of reclaimed water from United Waters wastewater treatment facility, stormwater from a permitted surfaced water management system and ground water from the Floridian aquifer to irrigate approximately 107 acres of golf course turf and 30 acres of landscaping.	St. Johns	7/10/2000	6/7/2001	11/30/2011
20-061-2198-6	CUP General	The Suntree Partners	The Suntree Partners	The use of 0.09 million gallons per day of groundwater from the Floridan aquifer for cattle watering and pasture irrigation.	Indian River	6/18/2001	9/19/2001	9/19/2011
2-031-589-3	CUP Individual	Navy Public Works Center Jax	Naval Station Mayport	The applicant proposes to withdraw 1.750 mgd of ground water for PS, C/I and GC; and 0.214 mgd of surface water from Lake Wonderwod for GC; and 12.320 mgd of surface water from the St. Johns River for ESS.	Duval	2/11/1999	7/10/2001	7/10/2011

Permit Number	Permit Type	Applicant Name	Project Name	Description	County	Received Date	Decision Date	Expiration Date
20-069-1670-5	CUP General	Lake Jackson Ridge at Mascotte LLC	Odis Fenders Citrus Nursery	Permit Transfer	Lake	10/10/2007	11/6/2007	7/3/2011
2-009-1740-6	CUP Individual	Centerline Holdings LLC	Mary A Grove	Permit Transfer	Brevard	2/27/2007	3/5/2007	4/9/2011

South Florida Water Management District

APPLICATION NO	PERMIT NO	APPROVED	RECEIVED DATE	ISSUING OFFICE	STATUS	PERMIT TYPE	PERMIT_STATUS	EXPIRATION DATE	PROJECT ACRES	PROJECT NAME	DEADLINE	WATERSOU	COUNTY	LOCATION	LANDUSES
961031-1	53-00150-\	5-Feb-97	31-Oct-96	WPB	Complete	Water Use (Permit Transfer)	ACTIVE	9-Dec-14		Indian Lakes Utilities	12-Jan-97	Floridan A	Polk	S4-9 17 18/	Public Water Supply
960318-9	36-02843-\	16-Apr-96	18-Mar-96	FTM	Complete	Water Use Modification (General Permit)	ACTIVE	4-Nov-14	4.5	Department Of Transportation Testing Laboratory	17-Apr-96	Mid-Hawth	Lee	S3/T44/R2!	Public Water Supply
951226-5	11-01238-\	10-Apr-96	26-Dec-95	FTM	Complete	Water Use Modification (General Permit)	ACTIVE	10-Jul-14	28	Collier Gro Nursery	16-Mar-96	Lower Tam	Collier	S19 29 30/	Landscape;Public Water Supply;Agricultural
980918-5	06-01942-\	12-Oct-98	18-Sep-98	WPB	Complete	Water Use (Letter Modification)	ACTIVE	2-Mar-14	8	Capella Enterprises	18-Oct-98	Biscayne A	Broward	S07/T48/R	Agricultural;Public Water Supply
020718-20	49-00724-\	23-Oct-02	18-Jul-02	ORL	Complete	Water Use Modification (General Permit)	ACTIVE	23-Dec-13	100	Austin Tindall Park	26-Sep-02	Floridan A	Osceola	S11/T25/R:	Landscape;Public Water Supply
951130-8	36-02684-\	10-Apr-96	30-Nov-95	FTM	Complete	Water Use Modification (General Permit)	ACTIVE	10-Dec-13	2.5	Koreshan Unity Foundation	17-Apr-96	Mid-Hawth	Lee	S33/T46/R.	Public Water Supply;Landscape
020607-7	56-01157-\	1-Aug-02	7-Jun-02	WPB	Complete	Water Use (Letter Modification)	ACTIVE	28-Jun-13	0.77	Bayshore Plaza	7-Jul-02	Surficial A	St Lucie	S5/T37/R4(	Public Water Supply
960808-4	13-00642-\	31-Jan-97	8-Aug-96	WPB	Complete	Water Use Modification (General Permit)	ACTIVE	25-May-13	75.69	Castello Hammocks Park Nature Center Bldg	1-Jan-97	Biscayne A	Miami-Da	S17/T56/R:	Public Water Supply
020225-8	36-04463-\	15-May-03	25-Feb-02	FTM	Complete	New Water Use	ACTIVE	15-May-13	1278	Bonita Farms 1 And 2	11-May-03	On-Site Bo	Lee	S17 20/T47	Public Water Supply;Industrial
010816-10	47-00381-\	16-Nov-01	16-Aug-01	WPB	Complete	Water Use (Letter Modification)	ACTIVE	7-May-13	18	Okeechobee Field Station	15-Sep-01	Surficial A	Okeechob	S13/T37/R:	Public Water Supply;Landscape
020213-9	56-00627-\	10-Apr-03	13-Feb-02	WPB	Complete	Water Use Renewal	ACTIVE	10-Apr-13	387	Spanish Lakes Fairways	22-Sep-02	Surficial A	St Lucie	S6 7/T34/R	Public Water Supply
991112-16	47-00411-\	21-Mar-00	12-Nov-99	WPB	Complete	Water Use (Permit Transfer)	ACTIVE	1-Apr-13	23.32	Oak Mobile Home Park	14-Jan-00	Surficial A	Okeechob	S4 9/T38/R	Public Water Supply
950622-1	11-01098-\	26-Jun-95	22-Jun-95	FTM	Complete	Water Use (Letter Modification)	ACTIVE	15-Mar-13	0.25	Sw Florida Research & Education Center	22-Jul-95	Sandstone	Collier	S20/T46/R.	Public Water Supply
030210-6	56-01123-\	25-Aug-04	10-Feb-03	WPB	Complete	Water Use (Permit Transfer-Minor Gp)	ACTIVE	19-Jan-13	11.54	Ft Pierce Blending Plant	2-Jul-03	Surficial A	St Lucie	S29/T35/R	Industrial;Landscape;Public Water Supply

APPLICATION NO	PERMIT NO	APPROVED	RECEIVED DATE	ISSUING OFFICE	STATUS	PERMIT TYPE	PERMIT_STATUS	EXPIRATION DATE	PROJECT ACRES	PROJECT NAME	DEADLINE	WATERSOU	COUNTY	LOCATION	LANDUSES
950727-8	49-00665-\	25-Aug-95	27-Jul-95	WPB	Complete	Water Use Modification (General Permit)	ACTIVE	28-Dec-12	53.2	Hammock Pointe	26-Aug-95	Floridan Ac	Osceola	S5/T25/R3:	Public Water Supply
020425-17	53-00024-\	22-Nov-02	25-Apr-02	WPB	Complete	Water Use Renewal (General Permit)	ACTIVE	22-Nov-12	320	Walk-In-Water Lake Estates	23-Oct-02	Floridan Ac	Polk	S20 29/T3C	Public Water Supply
991228-1	22-00238-\	1-May-01	28-Dec-99	WPB	Complete	Water Use (Permit Transfer)	ACTIVE	30-Sep-12	205	Palmdale Sand Mine	11-Oct-00	Sandstone	Glades	S12 13/T41	Public Water Supply
000321-9	43-00704-\	14-Apr-00	21-Mar-00	WPB	Complete	Water Use (Letter Modification)	ACTIVE	26-May-12	149	Dunklin Memorial Camp	20-Apr-00	Surficial Ac	Martin	S17 18/T38	Public Water Supply;Livestock
961119-7	43-00704-\	11-Dec-96	19-Nov-96	WPB	Complete	Water Use (Letter Modification)	ACTIVE	26-May-12	149	Dunklin Memorial Church Inc	19-Dec-96	Shallow Aq	Martin	S17 18/T38	Public Water Supply
010608-3	56-00401-\	14-Mar-02	8-Jun-01	WPB	Complete	Water Use Renewal	ACTIVE	14-Mar-12	324	Spanish Lakes Mobile Home Park	1-Feb-02	Surficial Ac	St Lucie	S1/T34/R39	Public Water Supply
020501-15	26-00472-\	28-Aug-03	1-May-02	WPB	Complete	Water Use (Permit Transfer)	ACTIVE	14-Feb-12	15.1	Hermanos Luna Inc	4-Apr-03	Lower Haw	Hendry	S33/T43/R:	Public Water Supply
010306-9	43-00699-\	6-Apr-01	6-Mar-01	WPB	Complete	Water Use (Letter Modification)	ACTIVE	27-Jan-12	15.2	Humane Society Of The Treasure Coast	5-Apr-01	Surficial Ac	Martin	S23/T38/R4	Public Water Supply;Landscape
000606-8	43-00699-\	21-Jun-00	6-Jun-00	WPB	Complete	Water Use (Letter Modification)	ACTIVE	27-Jan-12	15.2	Humane Society Of The Treasure Coast	6-Jul-00	Surficial Ac	Martin	S23/T38/R4	Landscape;Public Water Supply
010905-11	43-00491-\	4-Dec-02	5-Sep-01	WPB	Complete	Water Use (Permit Transfer)	ACTIVE	1-Jul-11	100	Cobblestone Country Club	5-Oct-01	Surficial Ac	Martin	S1 12/T38/	Public Water Supply
971224-8	43-00089-\	10-May-06	24-Dec-97	WPB	Complete	Water Use Renewal	ACTIVE	10-May-11	17307.3	Vista Salerno	30-Mar-06	Surficial Ac	Martin	S12 13/T38	Public Water Supply
990712-10	50-02650-\	3-Apr-00	12-Jul-99	WPB	Complete	Water Use (Permit Transfer)	ENTIRE PEI	19-Feb-11	11.4	Lox Road Recycling Station	30-Sep-99	On-Site Lak	Palm Beac	S19 30/T47	Industrial;Public Water Supply;Landscape
001121-9	48-00009-\	19-Jan-01	21-Nov-00	ORL	Complete	Water Use (Letter Modification)	ACTIVE	19-Jan-11	28000	Reedy Creek Improvement District	21-Dec-00	Floridan Ac	Orange	S1-4 9-16 2	Public Water Supply;Golf Course;Landscape

Southwest Florida Water Management District

Permit #	Rev #	Project Name	Permittee Name	City	Class	County	Issue Date	Expire Date	Avg GPD	Type
4681	005	FIRETOWER GROVE	Ben Hill Griffin, Inc.	FROSTPROOF	Renewal	HIGHLANDS	12/29/2004 12:00 AM	12/29/2014 12:00 AM	104,200	General
7488	003	FOXFIRE PROPERTIES LLC	Foxfire Properties LLC	APOLLO BEACH	Letter Modification	SARASOTA	5/9/2003	12/28/2014	172,800	General
7635	004	MCCLURE FARMS	McClure Properties, Ltd	PALMETTO	Letter Modification	MANATEE	5/8/2003	12/28/2014	238,000	General
3430	005	YU AN FARMS CO	Young Farms	Ruskin	Renewal	HILLSBOROUGH	12/22/2004	12/22/2014	146,400	General
70	008	PEACE RIVER CITRUS PRODUCTS INC	PEACE RIVER CITRUS PRODUCTS INC	ARCADIA	Modification	DESOTO	9/2/2011	12/20/2014	266,500	General
3837	012	FALKNER FARMS	John Falkner, LLC	Myakka City	Letter Modification	MANATEE	5/18/2011	12/16/2014	4,232,000	Individual
7672	005	MEADOW OAKS GOLF & COUNTRY CLUB	Ron & Nancy-Andy & Chris Padova Mat & Bev L	HUDSON	Letter Modification	PASCO	11/30/2007	12/11/2014	322,000	General
1207	007	GAPWAY GROVES	Gapway Groves	AUBURNDALE	Letter Modification	POLK	8/23/2010	12/6/2014	150,600	General
6278	006	SUN RIDGE EXPANSION PROJECT	M & V LLC \ Attn. Brian Randolf	Groveland	Modification	POLK	10/19/2007	12/6/2014	272,700	General
3742	003	PARADISE FRUIT COMPANY, INC.	Paradise Fruit Company, Inc. Ft. Property	PLANT CITY	Letter Modification	HILLSBOROUGH	12/4/2002	11/30/2014	452,000	General
6639	002	SANDBAR GROVES	Blanton Road Land Trust	TAMPA	Letter Modification	PASCO	11/30/2007 12:00 AM	11/28/2014 12:00 AM	133,000	General
5414	004	HILL TOP	Kahn Service	SEBRING	SWUCA Automated Update	POLK	1/1/2003	11/21/2014	130,700	General
6841	010	DESOTO CORRECTIONAL INSTITUTE	Desoto County Utilities	Arcadia	Modification	DESOTO	11/18/2008	11/18/2014	821,600	Individual
408	008	CITRUS WORLD	Citrus World Inc	LAKE WALES	Renewal	POLK	11/16/2004	11/16/2014	2,182,700	Individual
6154	004	JOHN F & EDWARD L SMOAK-ETAL	John F & Edward L Smoak-Etal	LAKE PLACID	SWUCA Automated Update	HIGHLANDS	1/1/2003 12:00 AM	11/7/2014 12:00 AM	160,000	General
6925	002	WALTER S & CAROL M FARR	Farr Groves LLC	WAUCHULA	SWUCA Automated Update	HARDEE	1/1/2003	11/6/2014	95,500	General
2644	005	EPCO RANCH	Epco Ranch, Inc.	SAN ANTONIO	Letter Modification	PASCO	7/3/2008	11/2/2014	80,400	General
4662	006	R THOMAS CHAPMAN	R Chapman	CLEARWATER	Letter Modification	MANATEE	1/1/2003	11/1/2014	123,300	General
2698	008	SID LARKIN & SON INC	Sid Larkin & Son Inc Enterprise Recycling & Dis	DADE CITY	Letter Modification	PASCO	12/1/2009	10/28/2014	1,940,000	Individual
1626	003	SCHMIDT FARMS	Albert M Quagliani & Amelia Ann Skolnick C/O	PLANT CITY	Modification	HILLSBOROUGH	10/28/2003	10/19/2014	106,800	General
170	003	PAMPLIN OF BRADENTON LLC MICHAEL	Pamplin & Smith, LLC	ANNA MARIA	SWUCA Automated Update	POLK	1/1/2003 12:00 AM	10/9/2014 12:00 AM	112,200	General
4228	005	PEACE VALLEY GROVES INC	Peace Valley Groves Inc	LAKELAND	Renewal	MANATEE	10/5/2004	10/5/2014	301,700	General
4229	005	PEACE VALLEY 5	Peace Valley Groves Inc	LAKELAND	Renewal	HARDEE	9/22/2004 12:00 AM	9/22/2014 12:00 AM	145,400	General
4734	004	CITY OF NEW PORT RICHEY	City Of New Port Richey	NEW PORT RICHEY	Letter Modification	PASCO	8/26/2011 1:20 PM	9/16/2014 12:00 AM	490,000	Individual
3066	003	BIGHAM HIDE CO	Bigham Hide Co	COLEMAN	Letter Modification	SUMTER	12/6/2001	9/16/2014	182,000	General
2722	004	GROVES 418 AND 415	Hunt Bros Service Inc	LAKE WALES	SWUCA Automated Update	POLK	1/1/2003	9/15/2014	117,400	General
6709	006	PORT CHARLOTTE GOLF CLUB LLC	Port Charlotte Golf Course LLC	PORT CHARLOTTE	Renewal	CHARLOTTE	9/10/2009	9/10/2014	59,600	General
3715	008	Spencer Creek West Farm	Spencer Farms, Inc.	Tampa	Modification	HILLSBOROUGH	9/29/2011	9/3/2014	344,600	General
6160	005	L D SMITH JR	L D Smith Jr	LAKE PLACID	SWUCA Automated Update	HIGHLANDS	1/1/2003 12:00 AM	8/29/2014 12:00 AM	89,600	General
1253	006	FLORIDA GOLD SPRAYFIELD	Cutrale Citrus Juices Usa Inc	AUBURNDALE	Modification	POLK	5/12/2009	8/26/2014	184,300	General
5109	003	SONJA BROOKS	Sonja Brooks	OCALA	Renewal	LEVY	8/26/2004	8/26/2014	220,700	General
4301	005	SUN GROWN CITRUS LP	Sun Grown Citrus LLC / Attn: Connally Barnett	Fort Meade	Renewal	POLK	8/24/2004	8/24/2014	608,500	Individual
1368	007	SW Lake Panasoffkee	Lake Panasoffkee Water Assoc Inc	Lake Panasoffkee	Letter Modification	SUMTER	7/11/2011	8/22/2014	410,000	General
4300	004	SEBRING GROVE	Diner Citrus and Cattle Company	Punta Gorda	Renewal	HIGHLANDS	8/19/2004	8/19/2014	100,200	General
2113	005	WYLIE L & WYLIE R HINTON	Wylie L & Wylie R Hinton	RIVERVIEW	Letter Modification	POLK	12/20/2006	8/12/2014	156,000	General
3292	003	JOE L DAVIS SR & J W CREWS JR	Joe L Davis Sr & J W Crews Jr	AVON PARK	SWUCA Automated Update	HARDEE	1/1/2003	8/12/2014	116,500	General
4560	011	WILSON BANKS	Ben Hill Griffin, Inc.	FROSTPROOF	Letter Modification	POLK	4/10/2008	8/10/2014	395,000	General
2614	005	VERNON CLYDE HOLLINGSWORTH JR &	Vernon Clyde Hollingsworth Jr & Betty Jo Hollir	ARCADIA	Letter Modification	HARDEE	4/21/2005 12:00 AM	8/3/2014 12:00 AM	165,800	General
3135	007	COUNTY LINE	Crews Groves Inc	Avon Park	Renewal	HARDEE	7/29/2004	7/29/2014	440,900	General
6077	007	MCCLURE-MYAKKA	McClure Properties, Ltd	Palmetto	Letter Modification	MANATEE	5/28/2008 12:00 AM	7/27/2014 12:00 AM	3,077,900	Individual
7024	003	TASTESPIRE, INC	Tastespire, Inc	Riverview	SWUCA Automated Update	POLK	1/1/2003 12:00 AM	7/26/2014 12:00 AM	109,800	General
2130	006	FORT FAMILY PARTNERSHIP	Fort Family Partnership Limited	FORT MEADE	Letter Modification	POLK	4/29/2004	7/21/2014	102,000	General
3954	004	MOSAIC PHOSPHATES CO	Mosaic Phosphates Co	MULBERRY	Letter Modification	MANATEE	5/9/2003	7/19/2014	370,600	General
4378	003	PAT CARLTON	Pat Carlton	DUETTE	SWUCA Automated Update	MANATEE	1/1/2003	7/19/2014	357,200	General
6169	009	P & D BLOCK	J R Paul Properties Inc	LABELLE	Letter Modification	HIGHLANDS	5/1/2009	7/15/2014	80,100	General
7755	005	TOWN OF YANKEETOWN	Town Of Yankeetown	Yankeetown	Letter Modification	LEVY	6/20/2011	7/11/2014	128,000	General
6259	004	PETTIT FARM	Ag-Mart Produce Inc	PLANT CITY	Renewal	HILLSBOROUGH	7/9/2004	7/9/2014	300,700	General
390	005	STRAWBERRY STATION	Strawberry Station Inc	DOVER	Letter Modification	HILLSBOROUGH	11/30/2007	7/8/2014	382,200	General
7515	005	SOUTH FLORIDA SOD INC	South Florida Sod Inc	AVON PARK	Renewal	HIGHLANDS	6/30/2004	6/30/2014	496,200	General
2128	005	BVG GROVES INC	Bvg Groves Inc	FORT MEADE	Renewal	HILLSBOROUGH	6/28/2004	6/28/2014	100,800	General
3251	008	GLENN AND FRANCES WILLIAMSON	Glenn & Frances Williamson	DOVER	Letter Modification	HILLSBOROUGH	9/26/2007	6/23/2014	493,900	General
5258	005	WILLIAMSON STRAWBERRY FARM-GREEN SI	Samuel D & Anne M Williamson	DOVER	Letter Modification	HILLSBOROUGH	7/7/2005	6/23/2014	133,500	General
3997	002	FAVORITE FARMS INC	Favorite Farms Inc	DOVER	Letter Modification	HILLSBOROUGH	4/25/1997	6/17/2014	172,000	General
4382	002	JEFFREY W & KAREN POWELL	Jeff Powell	DOVER	SWUCA Automated Update	HILLSBOROUGH	1/1/2003	6/12/2014	150,000	General
2215	005	MEMORIAL PARK CEMETERY INC	Memorial Park Cemetery Inc	ST PETERSBURG	Letter Modification	PINELLAS	12/18/2008	6/9/2014	285,000	General
6064	006	CITRUS PRIDE NO 3	James D & Robert C Brewer	NOCATEE	SWUCA Automated Update	DESOTO	1/1/2003	6/8/2014	143,600	General
1840	006	BERRY BAY FARMS	Berry Bay Farms At Jaymar Inc	Dover	Renewal	HILLSBOROUGH	6/7/2004 12:00 AM	6/7/2014 12:00 AM	219,500	General
6233	006	BIG BEND STATION	Tampa Electric Co	Tampa	Letter Modification	HILLSBOROUGH	6/30/2004	6/4/2014	234,000	General
3668	004	SUMMERTREE	Utilities Inc of Florida, ATTN: Patrick Flynn	Altamonte Springs	Letter Modification	PASCO	7/14/2011 10:01 AM	6/1/2014 10:01 AM	375,000	General

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1247	004	SANDPIPER GOLF & COUNTRY CLUB	Sandpiper Golf & Country Club	LAKELAND	Renewal	POLK	6/1/1993	6/1/2014	309,000	General
7733	002	THE LINKS OF LAKE BERNADETTE	The Links Of Lake Bernadette, Inc.	ZEPHYRHILLS	Letter Modification	PASCO	11/30/2007 12:00 AM	5/31/2014 12:00 AM	231,000	General
898	007	GARNER GROVES AND CATTLE	Garner Groves & Cattle Co Inc	ARCADIA	Renewal	DESOTO	5/25/2004	5/25/2014 12:00 AM	138,400	General
4432	005	WARDLAW GROVES	Hunt Bros, Inc.	Lake Wales	Renewal	POLK	5/14/2004 12:00 AM	5/14/2014 12:00 AM	217,400	General
1252	003	LYNCHBURG GROVES	Lynchburg Groves	WINTER HAVEN	SWUCA Automated Update	POLK	1/1/2003 12:00 AM	5/13/2014 12:00 AM	242,800	General
4516	008	CENTRAL RIDGE INC	Central Ridge Inc	FROSTPROOF	Renewal	POLK	5/13/2004 12:00 AM	5/13/2014 12:00 AM	141,600	General
2439	004	GERTRUDE FEIL MARITAL TRUST	Gertrude Feil Marital Trust Dba Lake Mcleod As	NEW YORK	Renewal	POLK	5/12/2004	5/12/2014	265,700	General
6163	003	SMOAK GROVES INC	Smoak Groves Inc	LAKE PLACID	SWUCA Automated Update	HIGHLANDS	1/1/2003	5/8/2014	322,200	General
6167	007	EDWARD L SMOAK REV TRUST	Edward L Smoak Revocable Trust	LAKE PLACID	Modification	HIGHLANDS	3/26/2009	5/6/2014	165,500	General
2177	006	Buckhorn Properties, Inc.	Buckhorn Properties, Inc.	Valrico	Ownership Transfer	HILLSBOROUGH	1/27/2011 10:52 AM	4/27/2014 10:52 AM	113,300	General
6165	003	SMOAK GROVES INC	Smoak Groves Inc	LAKE PLACID	SWUCA Automated Update	HIGHLANDS	1/1/2003	4/22/2014	242,900	General
6166	005	SMOAK GROVES INC	Smoak Groves Inc	LAKE PLACID	SWUCA Permit Modifications	HIGHLANDS	1/1/2003 12:00 AM	4/22/2014 12:00 AM	217,300	General
3897	009	SARASOTA GOLF CLUB	Civix Sarasota Gc LLC	Sarasota	Renewal	SARASOTA	4/13/2004	4/13/2014	107,600	General
4144	004	PLEASANT VIEW NURSERY	Douglas A. and Sherill Holmberg	Valrico	Modification	HILLSBOROUGH	10/20/1998	4/8/2014	301,000	General
1245	004	RONALD F & SHARON D MOYE	Ronald F & Sharon D Moye	Wauchula	SWUCA Automated Update	HARDEE	1/1/2003	4/7/2014	128,800	General
6179	008	BLOCK #11 DUNTY BLOCK	Grigsby Prop Llc & Alan Grigsby Trust Of J E Gr	LAKE PLACID	SWUCA Automated Update	HIGHLANDS	1/1/2003	3/27/2014	224,600	General
6189	006	LAKE SIRENA AREA BLOCK	George P. Jr. & Marilyn S. Mason	LAKE PLACID	Letter Modification	HIGHLANDS	4/23/2004 12:00 AM	3/24/2014 12:00 AM	116,700	General
6174	007	SADDLEBAG LAKE RESORT	Saddlebag Lake Owners Association Inc.	LAKE WALES	Letter Modification	POLK	9/26/2011	3/21/2014	117,200	General
865	004	REGISTER STRAWBERRY FARM	Marcus Glenn & Sarah F Williamson	DOVER	Modification	HILLSBOROUGH	4/16/2008 12:00 AM	3/13/2014 12:00 AM	132,900	General
1283	003	PARKER GROVE	J W Crews	WAUCHULA	SWUCA Automated Update	HARDEE	1/1/2003	3/10/2014	102,500	General
5019	005	BEREAH GROVE	Alico Inc	Ft. Myers	Renewal	POLK	3/5/2004 12:00 AM	3/5/2014 12:00 AM	335,000	General
3716	007	STANALAND FARM	Goodson Farms Inc	BALM	Renewal	HILLSBOROUGH	3/2/2004	3/2/2014	130,300	General
7119	012	POLK/AUBURNDALE	City of Auburndale	AUBURNDALE	Letter Modification	POLK	7/18/2011 2:23 PM	2/26/2014 12:00 AM	7,036,300	Individual
7627	004	City of Brooksville	City Of Brooksville	Brooksville	Letter Modification	HERNANDO	12/8/2011	2/25/2014	2,448,000	Individual
2906	004	LONG GROVE	Ben Hill Griffin, Inc.	FROSTPROOF	Renewal	DESOTO	2/20/2004	2/20/2014	120,500	General
3160	005	C & H GROVES INC	C & H Groves Inc	ARCADIA	Renewal	DESOTO	2/16/2004	2/16/2014	135,900	General
30	007	CITY OF BOWLING GREEN MUNICIPAL	City Of Bowling Green Municipal Water System	BOWLING GREEN	Letter Modification	HARDEE	7/15/2011	2/15/2014	386,000	General
3356	005	ERNEST M HAEFELE JR & MAGGIE M	Ernest M Haefele Jr & Maggie M Savich	Riverview	Letter Modification	HILLSBOROUGH	9/11/2006	1/30/2014	259,000	General
4736	003	LYKES BROS	Lykes Bros. Inc	TAMPA	Letter Modification	PASCO	11/30/2007 12:00 AM	1/29/2014 12:00 AM	267,000	General
4231	006	BROOKSVILLE RIDGE BLUEBERRIES LLC	Maryann B Stein	LUTZ	Letter Modification	HERNANDO	2/1/2011	1/26/2014	117,200	General
3390	008	COUNTY LINE 120	Evans Properties, Inc. / Attn: Ronald L. Edward	Vero Beach	Letter Modification	PASCO	11/23/2010	1/20/2014	202,300	General
6020	006	BIG TREE NURSERY	Big Tree Nursery	DOVER	Letter Modification	HILLSBOROUGH	9/9/2004	1/12/2014	243,400	General
6211	006	REDWATER GROVE	Ben Hill Griffin, Inc.	FROSTPROOF	Renewal	HIGHLANDS	1/12/2004	1/12/2014	257,600	General
2503	006	ESTES GROVES	Estes Groves Inc	VERO BEACH	Letter Modification	POLK	6/15/2005	12/31/2013	188,700	General
2746	005	SUNNYBREEZE PALMS GOLF COURSE INC	Sunnybreeze Palms Golf Course Bill Baker	ARCADIA	SWUCA Automated Update	DESOTO	1/1/2003 12:00 AM	12/28/2013 12:00 AM	333,100	General
985	007	BALM FARM	Diehl Family Lp	WIMAUMA	Modification	HILLSBOROUGH	12/18/2007 12:00 AM	12/18/2013 12:00 AM	2,328,000	Individual
645	007	CITY OF FORT MEADE	City Of Fort Meade	Fort Meade	Letter Modification	POLK	6/16/2011	12/16/2013	1,013,500	Individual
6203	004	DAVIS FARMS	Wayne & Gerald Davis & Ml Davis Dba Davis Fa	BRANDON	Renewal	HILLSBOROUGH	12/16/2003	12/16/2013	839,100	Individual
1445	005	ROCKING V RANCH	Rocking V Ranch, LLC, Attn:Lamar Varn	Plant City	Modification	HILLSBOROUGH	1/17/2012	12/11/2013	75,000	General
2619	004	REESE GROVES	Lucille E Reese	LAKELAND	Renewal	HILLSBOROUGH	12/3/2003	12/3/2013	173,400	General
7112	005	BLACK JACK	L C Smith Iii William L Peeples & Dimitri Artzib	SEBRING	Renewal	HIGHLANDS	12/3/2003 12:00 AM	12/3/2013 12:00 AM	101,000	General
5951	003	DAN C SHELFER	Dan C Shelfer	ARCADIA	SWUCA Automated Update	DESOTO	1/1/2003	11/28/2013	157,800	General
5270	010	TOWN OF LAKE PLACID	Town Of Lake Placid	LAKE PLACID	Letter Modification	HIGHLANDS	10/5/2011 1:14 PM	11/26/2013 12:00 AM	1,192,000	Individual
3182	008	FGUA-Seven Springs (FKA Aloha Utilities)	Florida Governmental Utility Authority	Longwood	Letter Modification	PASCO	2/2/2012	11/26/2013	2,040,000	Individual
636	006	INTERCHANGE FARMS INC	Michael D Council-William Spencer-W E Currie	RUSKIN	Letter Modification	HILLSBOROUGH	6/16/2005	11/26/2013	147,600	General
2840	005	FLORIDA WATER SERVICES INC	Hillsborough County	Tampa	Letter Modification	HILLSBOROUGH	5/6/2003 12:00 AM	11/26/2013 12:00 AM	396,000	General
279	008	JASMINE LAKES UTILITY	Aqua Utilities Florida Inc./Attn: Judy Wallingfor	Lady Lake	Letter Modification	PASCO	5/13/2011	11/24/2013	330,000	General
1636	004	FRASSRAND ESTATES INC	Frassrand Estates Inc & Gude Family Cattle Inc	DADE CITY	Letter Modification	PASCO	11/30/2007	11/23/2013	177,000	General
208	014	FERRIS FARMS	G. William Wilde	FLORAL CITY	Letter Modification	CITRUS	12/15/2009 10:12 AM	11/22/2013 10:12 AM	296,880	General
5897	004	BARTHLE BROTHERS RANCH	Barthle Brothers Ranch Inc	SAN ANTONIO	Letter Modification	PASCO	11/30/2007	11/22/2013	515,000	Individual
7049	002	CARL L PIPPIN	Carl Pippin	PLANT CITY	Renewal	HILLSBOROUGH	11/17/1989	11/17/2013	192,000	General
5086	007	VONANN GROVES INC	Vonann Groves Inc	LAKE WALES	Modification	POLK	9/15/2011	11/15/2013	400,000	General
4461	009	CITY OF WAUCHULA	City Of Wauchula	WAUCHULA	Letter Modification	HARDEE	1/25/2012 9:46 AM	10/30/2013 12:00 AM	1,189,700	Individual
6100	004	BABE ZAHARIAS GOLF COURSE	City Of Tampa & Tampa Sports Authority	TAMPA	Renewal	HILLSBOROUGH	10/28/2003	10/28/2013	178,800	General
1928	006	LAKESIDE COUNTRY CLUB	Brassboys Enterprises Inc	INVERNESS	Modification	CITRUS	2/2/1998	10/27/2013	133,000	General
1356	006	SWEETHILL GROVE	Apac-Georgia Inc	Tampa	Ownership Transfer	POLK	11/6/2010	10/24/2013	499,900	General
3955	006	R & S BURNTSTORE HARBORSIDE LLC	GREEN BULL LLC	SAINT PETERSBURG	Ownership Transfer	MANATEE	5/18/2011	10/22/2013	193,300	General
2501	007	SEIBELS ENTERPRISES INC	Seibels Enterprises Inc	VERO BEACH	Letter Modification	POLK	7/22/2005	10/21/2013	226,500	General
5711	005	Pit # 29	C. C. Calhoun, Inc.	Dundee	Letter Modification	POLK	12/22/2011	10/16/2013	107,100	General

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7408	003	CHARLIE CREEK 95 ACRE BLOCK	Southern Sisters Family Lp	AVON PARK	Modification	HARDEE	7/21/2003	10/16/2013	108,400	General
6585	001	OCALA JOCKEY CLUB INC	Ocala Jockey Club Inc	REDDICK	Renewal	MARION	10/5/1989 12:00 AM	10/5/2013 12:00 AM	191,000	General
4550	007	CITY OF SAN ANTONIO	City Of San Antonio	San Antonio	Letter Modification	PASCO	5/4/2011 12:50 PM	10/3/2013 12:50 PM	228,600	General
4996	004	B & B HOLLAND GROVES LLC	B & B Holland Groves LLC/Attn:Joseph K. Brow	Chicago	SWUCA Automated Update	HILLSBOROUGH	1/1/2003	9/28/2013	111,000	General
377	008	MARION CO UTILITIES-MARION OAKS	Marion Co Utilities Dept	Ocala	Modification	MARION	4/18/2011	9/25/2013	3,200,000	Individual
6426	003	LEMON BAY GOLF CLUB INC	Lemon Bay Golf Club Inc	ENGLEWOOD	SWUCA Automated Update	CHARLOTTE	1/1/2003	9/24/2013	182,600	General
6670	007	MOSAIC FERTILIZER LLC	Mosaic Fertilizer LLC	Lithia	Letter Modification	POLK	9/17/2004	9/24/2013	424,600	General
4086	010	CARGILL JUICE NORTH AMERICA INC	Cargill Juice North America Inc	FROSTPROOF	Letter Modification	HIGHLANDS	11/30/2007 12:00 AM	9/21/2013 12:00 AM	438,800	General
3381	003	EVANS PRPERTIES	Evans Properties, Inc. / Attn: Ronald L. Edward	Vero Beach	Letter Modification	PASCO	11/30/2007	9/17/2013	161,000	General
4940	001	THELMA O STRONG	Thelma O Strong	LONGWOOD	Renewal	SUMTER	9/14/1990	9/14/2013	267,000	General
2731	002	LARGO GOLF COURSE	City Of Largo Largo Golf Course	LARGO	Renewal	PINELLAS	9/12/1991	9/12/2013	104,000	General
6920	005	CITY OF EAGLE LAKE PUBLIC SUPPLY	City of Eagle Lake	EAGLE LAKE	Letter Modification	POLK	7/18/2011	8/28/2013	946,800	Individual
4817	009	PEACEFUL HORSE LLC	Peaceful Horse LLC	NORTH FORT MYERS	Renewal	HARDEE	8/28/2007	8/28/2013	589,800	Individual
7299	005	LWV UTILITIES	L W V Utilities Inc	New Port Richey	Letter Modification	PASCO	7/11/2011	8/27/2013	115,000	General
503	010	REEDER FARMS	J T Reeder Part Lllp & Snell Family Lp Of Sw Fl	PALMETTO	Letter Modification	HILLSBOROUGH, I	12/11/2007	8/26/2013	874,800	Individual
6371	011	SUMMERFIELD FARMS	Summerfield Farms Inc/Thomas Miller	Brandon	Letter Modification	HILLSBOROUGH	10/13/2005	8/26/2013	1,332,100	Individual
56	004	MADDOX GROVES LIMITED	Maddox Groves Limited	WAUCHULA	Modification	HARDEE	8/13/2003	8/16/2013	105,100	General
4611	006	CARY MERCER	Cary Mercer	ARCADIA	Letter Modification	DESOTO	7/17/2003	8/15/2013	132,900	General
1089	004	DOUBLE SIX INC	Double Six Inc	LAKE PLACID	Renewal	HARDEE	8/14/2003	8/14/2013	281,100	General
2321	006	Griffin Investment Properties	Griffin Investment Properties, Ltd., Attn: Mr. Ja	Plant City	Modification	HILLSBOROUGH	5/19/2011 2:16 PM	8/12/2013 12:00 AM	148,600	General
5656	006	WATERLEFE GOLF AND RIVER CLUB	Waterlefe CDD	TAMPA	Renewal	MANATEE	8/12/2003 12:00 AM	8/12/2013 12:00 AM	254,900	General
660	006	FARMLAND RESERVE INC	Farmland Reserve Inc.	Ruskin	Letter Modification	HILLSBOROUGH	4/16/2009 12:00 AM	8/8/2013 12:00 AM	499,800	General
6409	006	Perry Cattle LLC	Perry Cattle LLC	Lake Placid	Ownership Transfer	HIGHLANDS	11/26/2010	8/6/2013	198,300	General
7651	003	MUNICIPAL GOLF COURSE	City Of Bradenton	Bradenton	SWUCA Automated Update	MANATEE	1/1/2003	8/6/2013	231,000	General
6360	004	US 41 & BIG BEND	Hardy Huntley	Pinellas Park	SWUCA Automated Update	HILLSBOROUGH	1/1/2003	8/2/2013	104,000	General
6411	005	DESOTO 293 LAND TRUST	Desoto Land Trust 360	NAPLES	Letter Modification	DESOTO	1/26/2012	8/1/2013	227,300	General
7586	001	HWY 92 REAL ESTATE INVESTMENTS	Hwy 92 Real Estate Investments LLC	Hoschton	Renewal	HILLSBOROUGH	7/27/1990	7/27/2013	150,000	General
2136	005	VONANN & MYERS GROVES	C Dennis Carlton Sr & Lee F	TAMPA	Renewal	HILLSBOROUGH	7/23/2003 12:00 AM	7/23/2013 12:00 AM	194,400	General
6592	002	SPRING HILL COUNTRY CLUB	Lemkco Florida Inc	Spring Hill	Letter Modification	HERNANDO	2/5/1996 12:00 AM	7/22/2013 12:00 AM	409,000	General
504	005	RAY BOB GROVES INC	Ray Bob Groves Inc	LAKELAND	SWUCA Permit Modifications	POLK	1/1/2003	7/10/2013	151,000	General
6337	007	FAVORITE FARMS	Favorite Farms Inc	DOVER	Renewal	HILLSBOROUGH	7/9/2003	7/9/2013	249,100	General
2125	009	CARLTON FARMS	Horse Creek Partnership Et Al &	WAUCHULA	Letter Modification	DESOTO, HARDEE	6/3/2009 12:00 AM	6/26/2013 12:00 AM	607,400	Individual
4318	005	VERNA WELL FIELD	City of Sarsota Public Works	SARASOTA	Letter Modification	SARASOTA	8/16/2011	6/24/2013	6,000,000	Individual
201	003	SMITH RYALS ROAD HOLDINGS	Smith Ryals Road Holdings LLC	PLANT CITY	Modification	HILLSBOROUGH	1/31/2008 12:00 AM	6/24/2013 12:00 AM	103,900	General
1276	004	STRAWBERRY RANCH	Ronnie E & Pamela D Young	SYDNEY	Renewal	HILLSBOROUGH	6/10/2003 12:00 AM	6/10/2013 12:00 AM	235,400	General
7475	004	PELICAN GROVES INC	Pelican Groves Inc A Florida Corporation	ARCADIA	Letter Modification	DESOTO	7/21/2008	6/8/2013	248,000	General
3060	007	LEE TE KIM	Lee Te Kim	RUSKIN	SWUCA Manual Update	HILLSBOROUGH	1/1/2003	6/7/2013	146,100	General
1109	005	PAUL-CHASE GROVE	Brent Monk & Betsy Monk	WINDERMERE	Letter Modification	POLK	1/1/2003	6/6/2013	140,100	General
1161	005	LAKE BUFFUM GROVE LTD	Lake Buffum Grove Ltd	ALTURAS	Renewal	POLK	6/6/2003 12:00 AM	6/6/2013 12:00 AM	120,100	General
217	004	COCA-COLA FOUNTAIN	Coca-Cola Co	Dunedin	Renewal	PINELLAS	6/4/2003	6/4/2013	165,000	General
3975	009	KIBLER PARCEL	John Falkner, LLC	Myakka City	Letter Modification	MANATEE	4/22/2011 12:12 PM	5/27/2013 12:00 AM	2,053,900	Individual
1946	011	VALENCIA LAKES	Hills Co Assoc Ii Iii Iv Llp	WIMAUMA	Modification	HILLSBOROUGH	5/4/2010	5/25/2013	229,800	General
1087	004	TARPON BREEZE HOA	Meridian Land Holdings LLC	Burnsville	Renewal	POLK	5/14/2003	5/14/2013	120,900	General
690	003	GERALD J MCLEAN TRUST DATED	Gerald J Mclean Trust Dated 34325	LAKE WORTH	SWUCA Automated Update	HARDEE	1/1/2003	5/5/2013	119,300	General
910	005	ADAMS GROVE	Berry Groves Inc	LA BELLE	Renewal	POLK	5/1/2003	5/1/2013	174,000	General
4792	002	QUALITY PETROLEUM CORP	Quality Petroleum Corp	LAKELAND	Renewal	LAKE	4/26/1990	4/26/2013	271,000	General
1771	006	MCIVER GROVE	Diner Citrus and Cattle Company	Punta Gorda	Renewal	DESOTO	4/16/2003	4/16/2013	131,900	General
5054	005	TOWN & COUNTRY RV RESORT & GOLF CLUB	Jes Investments Inc	DADE CITY	Letter Modification	PASCO	7/15/2008	4/11/2013	146,500	General
263	005	C DENNIS CARLTON	C Dennis Carlton	TAMPA	Renewal	HILLSBOROUGH	8/5/2008 12:00 AM	4/10/2013 12:00 AM	164,300	General
1723	007	SUNNY BREEZE GROVE	Sunny South Packing Co	ARCADIA	Renewal	DESOTO	4/4/2003 12:00 AM	4/4/2013 12:00 AM	316,500	General
6217	007	PALMA CEIA GOLF & COUNTRY CLUB	Palma Ceia Golf & Country Club	TAMPA	Renewal	HILLSBOROUGH	3/28/2003	3/28/2013	210,600	General
772	004	MUD LAKE	Putnam Groves Inc / Attn: Dudley Putnam II	BARTOW	Renewal	POLK	3/24/2003	3/24/2013	140,300	General
7512	001	PAUL T ELLIOTT	Paul Elliott	TAMPA	Renewal	HILLSBOROUGH	3/15/1990	3/15/2013	130,000	General
683	006	ROHLFING GROVES CO	Rohlfing Groves Co	AUBURNDALE	Renewal	POLK	2/28/2003	2/28/2013	134,300	General
4826	010	PLAZA MATERIALS	Central State Aggregates LLC	Crystal Springs	Letter Modification	PASCO	5/10/2011	2/21/2013	113,500	General
836	004	MELLA J LEWIS	Mella J Lewis Life Estate	DOVER	Modification	HILLSBOROUGH	2/8/2011	2/19/2013	71,000	General
6313	006	BBS FARMS INC	BBS Farms Inc.	Wimauma	SWUCA Automated Update	HILLSBOROUGH	1/1/2003 12:00 AM	2/14/2013 12:00 AM	207,200	General
775	006	SLB & B OF WAUCHULA LLC	Slb & B Of Wauchula LLC	PLANTATION	Letter Modification	HARDEE	1/17/2012	2/8/2013	132,800	General
2870	005	COBRENE GROVES	Holly Hill Fruit Products Co Inc. Attn: James Br	DAVENPORT	Ownership Transfer	HARDEE	10/17/2011	2/2/2013	122,700	General

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2924	002	SB ASSOCIATES LP	SB Associates, LP	Wesley Chapel	Renewal	PASCO	2/2/1990	2/2/2013	297,000	General
425	005	JEFFERSON GROVE	Jefferson Grove Ltd	ALTURAS	Letter Modification	POLK	1/6/2010	1/30/2013	158,500	General
426	004	ALLAPATAH CRAGG GROVES CORP	Carson Futch	WEST PALM BEACH	SWUCA Automated Update	POLK	1/1/2003	1/30/2013	121,000	General
429	004	JEFFERSON GROVE	Jefferson Grove Ltd	ALTURAS	Letter Modification	POLK	4/4/2003 12:00 AM	1/30/2013 12:00 AM	106,400	General
1776	011	City of Plant City	City of Plant City, Attn: Gregory Horwedel, City	Plant City	Letter Modification	HILLSBOROUGH	8/10/2011	1/28/2013	9,852,000	Individual
527	005	LELAND/CHARLIE GROVES	Donald E & Susan C Smith& Stephen M & Jenni	WAUCHULA	Modification	HARDEE	8/5/2008 12:00 AM	1/28/2013 12:00 AM	258,800	General
5385	007	ROLLING GREEN GOLF CLUB	Ct-Rolling Green Llc C/O Rolling Green Golf Clu	SARASOTA	SWUCA Automated Update	SARASOTA	2/4/2003	1/24/2013	196,200	General
1977	004	HERBERT BOLTIN JR	Herbert Boltin Jr	DADE CITY	Letter Modification	PASCO	11/30/2007	1/21/2013	153,000	General
7058	003	GERALD DAVIS, INC.	Gerald Davis, Inc.	BALM	SWUCA Permit Modifications	HILLSBOROUGH	1/1/2003 12:00 AM	1/11/2013 12:00 AM	101,000	General
3590	004	BUENA VISTA MOBILE HOME PARK	Utilities Inc of Florida, ATTN: Patrick Flynn	Altamonte Springs	Letter Modification	PASCO	4/25/2011	1/9/2013	170,000	General
1444	005	Circle G Farms	Charles G. Grimes, Trustee and Betty J. Grimes	Plant City	Letter Modification	HILLSBOROUGH	9/7/2011 3:58 PM	12/29/2012 12:00 AM	245,200	General
963	004	GAPWAY GROVES	Gapway Groves	AUBURNDALE	Renewal	POLK	12/26/2002	12/26/2012	160,000	General
2647	004	MARTIN ROBERTS TRUST	Martin Roberts Trust C/O Kelly Durrance	WAUCHULA	SWUCA Automated Update	HARDEE	1/1/2003	12/20/2012	213,600	General
3726	003	HIGH POINT GOLF CLUB, INC.	High Point Golf Club, Inc.	BROOKSVILLE	Renewal	HERNANDO	12/14/1993	12/14/2012	149,000	General
6176	004	SMOAK GROVES INC	Smoak Groves Inc	LAKE PLACID	Renewal	HIGHLANDS	12/13/2002	12/13/2012	314,500	General
3578	004	BOONES WHOLESALE NURSERY	Charles & Jean Fulford	PLANT CITY	Modification	HILLSBOROUGH	2/1/2005	12/4/2012	207,800	General
6989	001	CARL ALLEN	Carl Allen	OCALA	Renewal	MARION	11/27/1989	11/27/2012	126,000	General
689	007	Strawberry Crest	School Board Of Hillsborough Co	Tampa	Modification	HILLSBOROUGH	6/16/2009	11/15/2012	141,800	General
707	006	Clublink US Corporation	Clublink US Corporation / Robert Visentin	Sun City Center	Ownership Transfer	HILLSBOROUGH	12/1/2011	11/13/2012	118,600	General
7698	004	COUNTY LINE GROVE	Ben Hill Griffin, Inc.	FROSTPROOF	Letter Modification	POLK	11/4/2005	11/7/2012	116,600	General
4730	003	MICHAEL R LANGLEY	Michael R. Langley	CLERMONT	Letter Modification	LAKE	3/22/1995 12:00 AM	11/6/2012 12:00 AM	110,000	General
1955	004	JONES GILLISPIE & CLYATT GROVE	Jones Gillispie & Clyatt Grove	FORT MEADE	SWUCA Automated Update	POLK	1/1/2003	11/5/2012	103,200	General
2670	006	DONALD & DEBORAH BALABAN	Donald M & Deborah L Balaban	TEMPLE TERRACE	Modification	HILLSBOROUGH	2/16/2011	10/31/2012	304,800	General
7576	003	CANNON RANCH	Cannon Ranch LLC	MONTEREY	Letter Modification	PASCO	11/30/2007	10/30/2012	360,000	General
5689	004	FARREN DAKIN DAIRY	Farren R & Christina M Dakin	MYAKKA CITY	Letter Modification	MANATEE	12/17/2004	10/22/2012	412,000	General
1130	004	JOHN AND JAMES MARING	James Maring	Dover	Modification	HILLSBOROUGH	8/18/2004	10/18/2012	106,700	General
6535	003	MOSAIC FERTILIZER LLC		OVIEDO	Renewal	HILLSBOROUGH	1/13/2010	10/17/2012	274,400	General
7497	004	MOODY LAKE	Ann Oakley Maggard And Dale Edward Maggard	DADE CITY	Letter Modification	PASCO	11/30/2007	10/14/2012	139,100	General
7145	001	ROMEO RIDGE RANCH	Romeo Ridge Ranch Terry Roberts	DUNNELLON	Renewal	MARION	10/9/1989 12:00 AM	10/9/2012 12:00 AM	164,000	General
7535	003	DESOTO LAND HOLDINGS LLLP	James C Bickett	CENTRAL CITY	Ownership Transfer	DESOTO	1/27/2012 9:13 AM	10/5/2012 9:13 AM	89,600	General
3522	011	BURNT STORE WELLFIELD	Charlotte County Utilities	Port Charlotte	Letter Modification	CHARLOTTE	9/22/2011	9/26/2012	3,172,000	Individual
148	003	YUENGLING BREWING CO OF TAMPA	Yuengling Brewing Co Of Tampa Inc	TAMPA	Renewal	HILLSBOROUGH	9/24/2002	9/24/2012	666,000	Individual
5626	006	ROBERT J BARBEN INC	Robert J Barben Inc	Avon Park	SWUCA Automated Update	HIGHLANDS	1/1/2003	9/24/2012	459,100	General
7448	006	SUN-N-FUN RV RESORT	ROYALTY RESORT CORPORATION	SARASOTA	Letter Modification	SARASOTA	6/6/2011	9/21/2012	237,100	General
5635	006	Story Groves	Story Groves Inc	LAKE WALES	Ownership Transfer	POLK	5/4/2010	9/21/2012	294,500	General
480	003	DALE JOHNSON	Dale Johnson Johnson	WAUCHULA	SWUCA Automated Update	HARDEE	1/1/2003	9/18/2012	124,300	General
6293	005	PALM-AIRE COUNTRY CLUB	Palm-Aire Country Club	SARASOTA	SWUCA Manual Update	MANATEE	2/4/2003	9/17/2012	398,900	General
5646	009	PINECREST GOLF CLUB	Pinecrest On Lotela Inc	AVON PARK	SWUCA Manual Update	HIGHLANDS	1/1/2003 12:00 AM	9/10/2012 12:00 AM	146,600	General
4507	006	LINKS AT GREENFIELD PLANTATION	The Links Partnership, Ltd	BRADENTON	Letter Modification	MANATEE	5/2/2003 12:00 AM	9/7/2012 12:00 AM	305,700	General
4554	005	F L M INC	FLM, Inc.	Brandon	Letter Modification	HARDEE	7/28/2006	9/6/2012	131,400	General
5912	003	NINFA C DAVIS	Ninfa Davis	WAUCHULA	Modification	HARDEE	1/21/2010 8:52 AM	9/3/2012 8:52 AM	108,000	General
3794	006	LAKE VERNA LLC	Verna Asset Management LLC	Tampa	Ownership Transfer	MANATEE	6/8/2011	8/28/2012	350,200	General
6364	011	PLANTATION MANAGEMENT ASSOC	Advanced Management Inc	VENICE	Letter Modification	SARASOTA	7/8/2005	8/27/2012	1,275,100	Individual
5264	008	BRUSHY CREEK TRACT	Mosaic Fertilizer LLC	Lithia	SWUCA Automated Update	HARDEE	1/1/2003 12:00 AM	8/21/2012 12:00 AM	182,600	General
7380	001	ARTHUR HUNTER MCNEER-FLORENCE M	Arthur Hunter Mcneer-Florence M Hamilton & R	LAKE ALFRED	Renewal	SUMTER	8/17/1990 12:00 AM	8/17/2012 12:00 AM	216,000	General
4735	003	TRIPLE J RANCH INC	Triple J Ranch Inc	DADE CITY	Modification	PASCO	1/29/1998	8/13/2012	280,000	General
7415	002	NED H FOLKS	Ned H Folks	DUNNELLON	Renewal	MARION	8/13/1990	8/13/2012	171,000	General
6443	003	ROBERT L & GLORIA J PLATT	Robert L & Gloria J Platt	DADE CITY	Letter Modification	HILLSBOROUGH	11/19/1990 12:00 AM	8/10/2012 12:00 AM	187,000	General
4980	009	PLACID LAKES	Lake Placid Holding Co	LAKE PLACID	Letter Modification	HIGHLANDS	1/4/2012	8/5/2012	401,100	General
6507	008	POLK CO UTILITIES CRUSA	Polk Co BOCC Util. Division / Attn: Krystal Azza	Winter Haven	Letter Modification	POLK	7/14/2008	7/31/2012	2,271,000	Individual
2189	005	EPPS NURSERY	Epps Nursery Inc	PLANT CITY	Renewal	HILLSBOROUGH	7/30/2002	7/30/2012	126,100	General
7326	003	KRUSEN PROPERTIES LLC	Krusen Properties LLC	Tampa	Letter Modification	PASCO	11/30/2007	7/23/2012	447,100	General
5666	004	Vivek Welfare & Educational Foundation Inc	Vivek Welfare & Educational Foundation Inc	ORLANDO	Ownership Transfer	POLK	6/15/2010 2:39 PM	7/22/2012 2:39 PM	75,000	General
4878	002	Larry W. Ennis	Larry & Judith Ennis	Plant City	District Letter Modification	HILLSBOROUGH	3/6/2012	7/21/2012	44,000	General
1869	007	FLORIDA STAR FARMS INC	Edward,Lawrence E.,Deborah J. Swindle,& Circ	Dover	Ownership Transfer	HILLSBOROUGH	11/5/2010	7/20/2012	180,500	General
3596	002	Eddie A. Jones, Trustee	Eddie A. Jones Revocable Living Trust, Trenda	SYDNEY	Modification	HILLSBOROUGH	10/12/2009 5:45 PM	7/16/2012 12:00 AM	66,400	General
3369	003	CONSTANTIN ARTZIBUSHEV, ET AL	Constantin Artzibushev, Et Al	TAMPA	Letter Modification	HILLSBOROUGH	8/24/1993	7/13/2012	160,000	General
697	004	INTERLACHEN GROVES INC	Interlachen Groves Inc	ALTURAS	SWUCA Automated Update	POLK	1/1/2003 12:00 AM	7/11/2012 12:00 AM	104,800	General
327	004	IRRIGATION PROJECT #1	Waverly Growers Cooperative	WAVERLY	SWUCA Automated Update	POLK	1/1/2003 12:00 AM	7/10/2012 12:00 AM	110,600	General

Permit #	Rev #	Project Name	Permittee Name	City	Class	County	Issue Date	Expire Date	Avg GPD	Type
7362	002	LAKE SEMINOLE	Pinellas Co Parks & Conservation Department	Largo	Letter Modification	PINELLAS	2/1/2008 12:00 AM	7/10/2012 12:00 AM	177,000	General
3802	010	MIXON FRUIT FARMS	Mixon Fruit Farms Inc	BRADENTON	Letter Modification	MANATEE	8/20/2008	7/9/2012	24,100	General
7274	003	GRADY E & WILBUR F DEAN	Grady E & Wilbur F Dean	BRONSON	Letter Modification	LEVY	5/6/1998	7/5/2012	165,000	General
5386	005	WILLIAMSON STRAWBERRY FARM GALLAGHE	Samuel D & Anne M Williamson	DOVER	Modification	HILLSBOROUGH	2/16/2005	7/3/2012	229,100	General
3042	004	RINGLING CTR FOR ELEPHANT CONSERVATI	Feld Development Corporation	VIENNA	Modification	POLK	7/26/2000	6/27/2012	106,000	General
3707	007	BAYOU CLUB AND BARDMOORE GOLF CLUB	Bayou Golf LLC	MANASSAS	Letter Modification	PINELLAS	11/2/2007	6/25/2012	512,000	Individual
6147	006	HOME BLOCK	Grady Smoak Groves Inc	LAKE PLACID	SWUCA Permit Modifications	HIGHLANDS	1/1/2003 12:00 AM	6/24/2012 12:00 AM	161,600	General
7639	002	ELI HERSCHBERGER	Eli Herschberger	SARASOTA	SWUCA Automated Update	SARASOTA	2/4/2003	6/19/2012	216,600	General
3055	007	SPEEDLING NURSERY	Speedling Inc	Sun City	Letter Modification	HILLSBOROUGH	1/21/2011	6/15/2012	301,700	General
7640	003	ROBERT H & PEGGY E PARKE	Robert H. & Peggy E. Parke	Dover	Modification	HILLSBOROUGH	2/27/2003	6/13/2012	276,900	General
3941	007	MISSION VALLEY GOLF CLUB	Mission Valley Golf & Country Club Inc	LAUREL	Modification	SARASOTA	12/11/2009	6/11/2012	312,500	General
3838	006	FIRE TOWER FARM	Cspr Ltd / Attn: Stuart Chin	PARRISH	Letter Modification	MANATEE	5/7/2003	6/5/2012	252,000	General
4487	004	BEN HILL GRIFFIN INC	Ben Hill Griffin, Inc.	FROSTPROOF	SWUCA Automated Update	HARDEE	1/1/2003	6/5/2012	302,100	General
6624	006	City of Lake Alfred Public Supply	City of Lake Alfred / Attn: John Deaton, Utilitie	Lake Alfred	Letter Modification	POLK	8/3/2011	5/30/2012	1,380,800	Individual
1809	005	PUTNAM GROVES INC	Putnam Groves Inc / Attn: Dudley Putnam II	BARTOW	SWUCA Manual Update	HARDEE	1/1/2003	5/28/2012	2,034,000	Individual
4893	007	WEEKI WACHEE SPRINGS	Fdep And Swfwmd	TALLAHASSEE	Letter Modification	HERNANDO	11/20/2009	5/24/2012	132,200	General
4942	004	IMC PHOSPHATES	Mosaic Fertilizer LLC	Lithia	SWUCA Automated Update	HILLSBOROUGH	1/1/2003	5/20/2012	315,900	General
1458	005	LAKE BUFFUM	Hurlburt Construction Inc	DOVER	Modification	POLK	6/16/2003	5/9/2012	169,300	General
2362	004	S DAVID CONERLY	S David Conerly	WAUCHULA	Modification	HARDEE	5/6/2008	5/8/2012	127,400	General
5159	003	SANDLIN FARMS	Arthur Sandlin	WILLISTON	Renewal	LEVY	5/8/2002 12:00 AM	5/8/2012 12:00 AM	358,000	General
5648	007	GATOR CREEK GOLF CLUB INC	Gator Creek Golf Club Inc., Attention: Mark Sc	SARASOTA	SWUCA Automated Update	SARASOTA	1/1/2003 12:00 AM	5/6/2012 12:00 AM	258,800	General
7185	004	CITY OF WEBSTER	City Of Webster	Webster	Letter Modification	SUMTER	4/25/2011	5/2/2012	234,000	General
7134	002	MARGARET HOLLINGSWORTH	Margaret Hollingsworth	ARCADIA	SWUCA Automated Update	DESOTO	1/1/2003	5/2/2012	145,400	General
6413	004	THREE GEE DEE COMPANY	Hillsborough Co Real Estate Dept	TAMPA	SWUCA Automated Update	HILLSBOROUGH	1/1/2003	4/27/2012	197,500	General
4725	007	City of Arcadia	Arcadia WTP	ARCADIA	Letter Modification	DESOTO	10/28/2011 2:22 PM	4/23/2012 12:00 AM	1,117,000	Individual
4421	006	JACK P & MERIBETH J SIZEMORE	Jack Sizemore	Plant City	SWUCA Automated Update	HILLSBOROUGH	1/1/2003	4/23/2012	590,700	Individual
3854	003	CHUCK DOWNS JR	Chuck Downs Jr	SARASOTA	SWUCA Automated Update	SARASOTA	1/1/2003	4/9/2012	217,500	General
3853	004	MYAKKAHATCHEE RANCH LLC	Triple 7 Ranch LLC	TAMPA	SWUCA Automated Update	MANATEE	1/1/2003	4/5/2012	251,700	General
6000	004	PA-MA-CA-SU GROVES INC	Lake Placid Groves 93 LLC Attn: Israel Feit	HOLLYWOOD	SWUCA Automated Update	HIGHLANDS	1/1/2003	3/27/2012	117,600	General
5893	011	TOWN OF DUNDEE PUBLIC SUPPLY	Town of Dundee Public Works Dept	Dundee	Letter Modification	POLK	8/2/2011	3/26/2012	1,831,000	Individual
5122	004	WHITEHURST CATTLE CO	Whitehurst Cattle Company	Williston	Renewal	LEVY, MARION	3/26/2002 12:00 AM	3/26/2012 12:00 AM	1,030,000	Individual
7178	005	OAK RUN	Development & Construction Corp Of America	OCALA	Renewal	MARION	3/1/2002	3/1/2012	363,000	General
2320	014	BUSCH GARDENS TAMPA & ADVENTURE ISL	Seaworld Parks & Entertainment, LLC	TAMPA	Letter Modification	HILLSBOROUGH	3/4/2010	2/26/2012	1,810,000	Individual
1780	010	Hillsborough County BOCC	Hillsborough County BOCC/Attn:Kurt G. Greml	Tampa	Ownership Transfer	HILLSBOROUGH	10/12/2011 2:45 PM	2/25/2012 2:45 PM	558,700	Individual
3493	009	BARTOW 98 DEVELOPMENT	Bartow 98 Development Corp.	Boca Raton	Modification	POLK	8/7/2008 12:00 AM	2/19/2012 12:00 AM	116,000	General
285	005	ALBRITTON & SONS LTD	Lake Garfield Grove LLC / Attn: Nicholas F. Alb	ALTURAS	Modification	POLK	12/23/2009	2/16/2012	132,100	General
5800	006	REESE GROVES	Rand Reese	Lakeland	SWUCA Automated Update	HILLSBOROUGH	2/4/2003	2/15/2012	153,700	General
3341	004	GEORGE N BECK & GLENN ELLIOTT BECK	George N Beck &	Windemere	Modification	HARDEE	4/8/2009	2/5/2012	127,600	General
3391	007	EVANS PROPERTIES	Evans Properties, Inc. / Attn: Ronald L. Edward	Vero Beach	Letter Modification	PASCO	11/30/2007 12:00 AM	1/29/2012 12:00 AM	1,044,000	Individual
7184	002	MANIT PILUEK	Manit Piluek	Plant City	Letter Modification	HILLSBOROUGH	1/4/2012	12/27/2011	13,800	General
5693	005	ANDY D TAYLOR RANCH LLC	Andy D Taylor Ranch LLC	Myakka City	SWUCA Automated Update	MANATEE	1/1/2003	12/10/2011	132,800	General
438	008	FORT MEADE CHEMICAL PLANT	US Agri-Chemicals Corporation	FORT MEADE	Renewal	POLK	11/30/2006 12:00 AM	11/30/2011 12:00 AM	9,150,000	Individual
3534	008	RICHLOAM STATE FISH HATCHERY	Florida Fish & Wildlife Conserv Commission / A	WEBSTER	Letter Modification	SUMTER	3/10/2004	11/27/2011	1,901,000	Individual
6101	005	ROCKY POINT GOLF COURSE	Tampa Sports Authority & City Of Tampa	Tampa	Letter Modification	HILLSBOROUGH	12/4/2002	11/1/2011	148,000	General
4087	005	L T RANCH INC	L T Partners LLLP	Sarasota	SWUCA Manual Update	SARASOTA	1/1/2003 12:00 AM	10/30/2011 12:00 AM	1,128,000	Individual
6505	011	NORTHWEST REGIONAL UTILITY SERVICE AF	Polk Co BOCC Util. Division / Attn: Krystal Azz	Winter Haven	Letter Modification	POLK	8/25/2008	10/30/2011	5,085,000	Individual
7248	002	SCHWARTZ HARDEE PROPERTIES LLC	Schwartz Hardee Properties LLC	Sarasota	SWUCA Automated Update	HARDEE	1/1/2003 12:00 AM	10/25/2011 12:00 AM	137,300	General
451	004	TANLER WATER CO	Tanler Water Company/Attn: Jeff Knox	Dade City	Letter Modification	PASCO	11/30/2007	9/27/2011	3,514,000	Individual
6508	009	SOUTHEAST REGIONAL UTILITY SERVICE AR	Polk Co BOCC Util. Division / Attn: Krystal Azz	Winter Haven	Modification	POLK	10/30/2007	9/27/2011	1,367,300	Individual
1861	007	PLANT CITY PROCESSING PLANT	Coronet Industries, Inc.	PLANT CITY	Letter Modification	HILLSBOROUGH	4/5/2007 12:00 AM	9/25/2011 12:00 AM	740,000	Individual
5620	005	HC & WE SAFFOLD	Hiram C Saffold	Wimauma	SWUCA Automated Update	MANATEE	1/1/2003 12:00 AM	9/25/2011 12:00 AM	678,400	Individual
7031	004	ADAMATMAR LLC	Adamatmar LLC	Lakewood Ranch	Letter Modification	MANATEE	5/12/2003	9/24/2011	317,500	General
1631	008	DADE CITY	City of Dade City/Attn: Gordon Onderdonk, P.E	DADE CITY	Renewal	PASCO	8/28/2001	8/28/2011	2,275,000	Individual
2665	005	AVANT GROVE	M & V LLC \ Attn. Brian Randolf	Groveland	Letter Modification	DESOTO	3/21/2007	8/28/2011	676,500	Individual
4412	012	MYAKKA CITY FARM	Pacific Land LTD	Palmetto	Letter Modification	MANATEE	5/22/2008	8/28/2011	3,417,300	Individual
7470	006	MANATEE CO UTILITY OPER E CO WELLFIELD	Manatee County Board Of County Commissione	Bradenton	Modification	MANATEE	2/27/2007 12:00 AM	8/28/2011 12:00 AM	15,986,000	Individual
7681	004	STEPHENS ROAD FARM	Frank Diehl	Wimauma	Letter Modification	HILLSBOROUGH	6/3/2004	8/28/2011	397,000	General
4307	005	THE TREELEADERS INC	The Treeleader Inc	PARRISH	Letter Modification	MANATEE	4/9/2009	8/6/2011	400,900	General
7451	005	J WILLIS L WILLIS J WILLIS & M WILLIS	Josiah W Willis, Linda Willis, Josiah E Willis & M	Wimauma	SWUCA Automated Update	HILLSBOROUGH	1/1/2003 12:00 AM	7/24/2011 12:00 AM	620,700	Individual

Permit #	Rev #	Project Name	Permittee Name	City	Class	County	Issue Date	Expire Date	Avg GPD	Type
1967	001	ALFRED A. MCKETHAN	Alfred A. Mckethan	BROOKSVILLE	Renewal	HERNANDO	6/6/1989	6/6/2011	113,000	General
3258	006	PARKER FARMS	South Fort Meade Partnership & Parker Farms I	BOWLING GREEN	Renewal	HARDEE	4/26/2005	4/26/2011	1,170,600	Individual
3845	005	JERRY FLINT & CECIL DAUGHTREY JR	Jerry Flint & Cecil Daughtrey Jr	ARCADIA	SWUCA Automated Update	SARASOTA	1/1/2003	4/24/2011	1,535,500	Individual
4447	005	BATISTA & EVELYN MADONIA	Batista & Evelyn Madonia	Plant City	SWUCA Automated Update	MANATEE	1/1/2003	3/20/2011	1,353,500	Individual
4528	006	NNP SOUTHBEND II LLC	Nnp Southbend Ii LLC	TAMPA	Letter Modification	HILLSBOROUGH	9/10/2004 12:00 AM	3/20/2011 12:00 AM	416,500	General

6.4 Potential End-User Ranking Matrix

The over-riding intent of the Data Collection and subsequent Analysis was to determine if there are interested End-Users in need of harvested stormwater in reasonable proximity to medium or high safe yield existing or planned Ponds.

A unique qualitative approach was used to rank each potential End-User. The ranking criteria used for the analysis included critical factors that are important to both the FDOT and the potential End-User in determining feasible matches. The vast majority of these critical factors fall into the categories of economics, regulatory, timing, operational, environmental, political, and volume yield. These factors were given point values commensurate with their importance with each other. Factors such as timing, FDOT project cost savings, liability, high/safe yield, delivery cost point, and willingness of the End-User were given maximum values compared to the other ranking factors shown.

As this Study has progressed, it has become apparent that in addition to all of the ranking criteria used, the dynamics of timing will play a large part in when a potential candidate will become a truly viable match partner. This Study identified potential End-Users at all stages of readiness. As such, the Department should plan to continue discussions with the identified potential matches to be in position to partner with these End-Users when the timing for a Stormwater Reuse Agreement is optimal for both parties.

Enclosed is the ranking matrix of the 40+ identified End-Users. The End-Users with the highest point value are the ones that at this point in time seem to be the most logical to pursue to the next level.

Summary of Reviewed Stormwater Reuse Opportunities
Stormwater Reuse Study
Contract No. C9458

Projects highlighted into "RED": NO GO. highlighted into "Yellow": For Future Consideration.

									Evaluation Matrix (Please see the criteria on the next work sheet)																				
#	FDOT District	FDOT Road	County	FDOT Facility/Location	Responsible Engineer	Possible End User	Type of Value Trading	Comments	Pollution Abatement (20 Points)	Reduction of Land Acquisition (500 Points)	599 – Regional Pond Compliance (20 Points)	Impact on FDOT Project (-50 Points)	TMDL Credits (20 Points)	Timing (500 Points)	Flood Mitigation (50 Points)	Transfer of Maintenance Costs (100 Points)	Construction Cost Savings (100 Points)	No Liability Issues (500 points)	Willingness of the End-User (500 points)	Estimated Safe Reuse Stormwater Yield (100 points)	Cost per 1000 Gallon (100 points)	Alternative Water Supply Need (50 points)	Regulatory Requirements (50 points)	Aquifer Transfer Credits (20 points)	Flexibility for Expansion (20 points)	Political Acceptance (50 points)	Wetland Rehydration (50 points)	Low Flow Augmentation (50 points)	Total Score
1	District 5	SR 17/92 & SR27	Polk	SR 17/92 SR 27	Cima	Haines City	Take-over of FDOT pond and swale maintenance	FDOT stormwater would be used for low flow augmentation of possibly two City ponds/lakes. Firehouse NW corner of 92 & 27	20	0	0	0	20	500	0	100	0	500	500	50	75	25	50	0	20	50	50	25	1985
2	District 2	SR 21	Clay	Outer Beltway/SR21	Hoogland / Ramirez	Clay County Utility Authority	Possible reduction of pond size (PD&E)	Clay County has a planned stormwater reservoir that would be a key factor in taking the stormwater for Reuse.	20	500	20	-50	20	400	50	100	100	500	500	100	100	50	50	20	20	50	0	50	2600
3	District 2	SR 223	Bradford	Starke Bypass/SR 223	Hoogland / Ramirez	SRWMD	Possible reduction of pond size	The stormwater would be used at Starke for minimum flow level augmentation.	20	500	20	-50	20	400	50	100	0	500	500	100	100	0	0	0	20	50	0	50	2380
4	District 4	SR 5, I-95, SR 710, Turnpike	Palm Beach	SR 5, I-95, SR 710, Turnpike	Ameno	Riviera Beach Utility District	Take-over of FDOT pond/swale maintenance, as well field supplement.	This Utility is interested in taking FDOT stormwater to utilize in their water treatment plant. They are programmed to drill 2 new water supply wells by 2014. Jay gave a presentation. We received a Letter of Interest and maps of wellfields and raw water mains (going through potential FDOT pond locations). 5 locations have been indentified by the City. One of the locations identified is adjacent to a current FDOT project, "Martin Luther King Blvd. Phase B". The City doesn't have a reuse water system and have no WUP requirements for reuse from SFWMD. The City's interest is in supplementing their raw water supply. They must install two additional wells by 2014. Concern is to communicate with SFWMD.	20	0	20	-25	20	500	0	100	0	500	500	100	100	50	0	0	0	50	0	0	1935
5	District 5	SR 415	Volusia	SR 415	Wanielista	City of Deltona	Aquifer Recharge and Water Supply	415 widening has just started and that water can be transported to a planned SJRWMD reservoir at Deep Creek. Also opportunity on the other end of 415. East End Service area for Deltona. Contact person is Gerald Chancellor 386 878 8998 (direct line). It is a possibility if the DOT can alter their current plans by changing the wet detention pond design to one of stormwater reuse from the reservoir.	20	0	20	-50	20	200	0	100	0	500	500	100	100	50	50	20	0	25	0	0	1655
6	District 5	SR 50	Orange	SR 50	Cima/Wanielista	City of Ocoee	Flood Mitigation and Water Supply	Lake Bennett along SR50 floods and there is a need for water supply within the City. The City CUP has maxed out. They do not have sufficient reclaimed water and need an alternate supply and stormwater is high on their list. SR 50 crossing of Lake is in final design. City of Ocoee Contact person is David Wheeler 407 905 3100 X 1505 (direct). It is a definite possibility, interaction with the SJRWMD is needed.	20	0	20	0	20	500	50	100	0	500	500	100	100	50	50	20	0	50	0	0	2080
7	District 4	ACOE Canal	Lake	Private Property	Hartman	Groveland Utilities	TBD	Agree to participate, Attorney Michael Minton, President Ron Edwards	20	500	0	-50	20	250	50	0	100	500	500	100	100	50	50	20	20	50	0	0	2280
8	District 7	SR 52	Hillsborough County	SR 52	Hoogland / Ramirez	Tampa Bay Water Authority	Aquifer Recharge	This was an opportunity of interest noted by Ms. Megan Arasteh at our DDr Engineers Meeting that will be further explored.	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
9	District 5	Nova Road	Volusia	Nova Road/Nova Canal	Cima	City of Daytona Beach	Flood Mitigation	GAI is having discussions with the City of Daytona Beach on a possible reservoir to accept stormwater from the Nova/Navy Canal	20	0	0	0	20	0	50	100	0	500	50	100	100	0	50	0	20	25	0	0	1035
10	District 5	SR 421	Volusia	SR 421	Wanielista	City of Port Orange	Flood Mitigation	Dunlawton Pond….. Project not called Dunlawton Pond. The Legislature and DOT have funded at $ 2.5 million for a reservoir and reclaimed area storage, but need additional capacity. They have opportunities to make their system larger. Quentin Hampton has the design to date. City of Port Orange Dunlawton Road area. Contact person is Shannon Lewis, Asst City Manager, 386 506 5501 (general #). It is a definite possibility but must have interaction with the SJRWMD. they have an interest but do not have as much information as others...in the hold category.	20	0	20	-25	20	100	50	100	0	400	500	100	75	50	50	20	0	25	0	0	1505
11	District 5	SR 441	Lake	SR 441 to include Wekiva Parkway	Wanielista/Cima	City of Mount Dora	Possible reduction of pond size (PD&E)	The City is interested in stormwater Reuse. They have a planned Thrill Hill reservoir that would be a key factor in taking the stormwater for Reuse. BESH Engineering doing a feasibility study to take Wekiva parkway /441 stormwater. No money from SJRWMD. They do not have a preliminary plan or SJRWMD approval in place at this time. Lincoln Avenue and 441 Contact person is Paul Lahr 352 735 7155 Ext 1832.	20	250	20	-25	20	100	50	100	0	500	500	100	50	50	50	20	0	0	0	0	1805
12	District 4	I-95, US-1, Turnpike	Palm Beach	I-95, US-1, Turnpike	Ameno / Ramirez	City of West Palm Beach Utilities	wetlands/water supply	Possible reuse of stormwater for their advanced wastewater treatment (AWT) program. Jay gave a presentation. They will send us a Letter of Interest. Two potential locations: Grassy Waters Park west of Turnpike and the Clear Lake system adjacent to I-95. The City's interest if water for either wetlands or supplemental surface water supply.	0	0	0	0	0	0	0	0	0	500	400	0	0	40	50	0	0	0	0	0	990
13	District 2	SR 223	Bradford	Private Property	Hartman	Avery Roberts, Roberts L +T	Water Supply	"NO-GO", future consideration.	20	500	20	-50	20	0	50	100	0	0	250	100	75	0	0	0	20	50	0	50	1205
14	District 1	SR 17, 27 and 540	Polk	SR 17, 27 and 540	Wanielista	City of Winter Haven	Flood Mitigation and Water Supply	Along SR 17, 540 and 27 City of Winter Haven contact is Ms Kim Hansel 863 287 3630	20	0	0	-50	20	400	50	100	0	500	250	100	75	50	50	20	0	25	0	0	1610
15	District 4	I75	Broward	east of I-75	Ameno / Wanielista / Ramirez	Miramar Expansion From 1-4 MGD	Reuse Supplement/Water Supply	Jay gave a presentation. The City has excess reuse capacity east of I-75. Not interested at this moment. **Future consideration.**	20	0	0	0	20	50	50	0	0	500	300	75	75	40	50	0	20	40	0	0	1240
16	District 5	SR 50	Osceola	Private Property	Hartman	Deseret	Water Supply	50, Beachline, Nova Road. TCR; using highway stormwater harvesting discharges onto watershed for the taylor creek reservoir and the L-73 canal---not developed into a match---from roadways shown	20	0	0	0	20	300	50	0	0	250	250	100	75	50	0	20	20	25	0	0	1180
17	District 1	SR70	Manatee	Private Property	Hartman	Schoeder Manatee Stormwater Utility – Contract	Flow Augmentation	I-75 and SR 70 stormwater harvesting to augment the stormwater utility at SMR---not developed into a match yet.	20	0	0	0	20	100	50	0	0	400	250	100	50	50	0	20	0	25	0	0	1085
18	District 1	I-75 and US 1	Sarasota	I-75 and US 1	Hartman	City of North Port	Low Flow Augmentation	Cindy Mick – Tom Cloud – SWTP US 41 + Others, I 75 and US 41 stormwater harvesting to augment the low flows in the Myakahatchee creek and water reservoir ---not yet developed.	20	0	0	-50	20	100	0	100	0	400	250	100	50	50	0	20	0	25	0	50	1135
19	District 3	SR 77, SR 20, and US 231	Bay	SR 77, SR 20, and US 231	Hartman	Bay County	Flow Augmentation and Water Supply	SW Harvesting for SWTP, Well Field Recharge, SR 77, SR 20 and US 231 stormwater harvesting to augment the Bay county reservoir and for drawdown mitigation of their regional well field---not yet developed	20	0	0	0	0	0	50	100	0	500	500	100	50	0	50	0	0	25	0	50	1445
20	District 2	TBD	St Johns	Nocatee Parkway	Ramirez	Nocatee Reuse	TBD	CDD/St. Johns County. Governmental Management Service.	0	0	0	0	0	0	0	0	0	400	250	50	50	0	0	0	0	40	0	0	790
21	District 7	SR 60	Hillsborough	SR-60, I-75, I-275, I-4	Hartman / Ramirez / Hoogland	Hillsborough County	TBD	Future Consideration. No meeting was conducted.	0	0	0	0	0	0	0	0	0	400	250	50	50	0	0	0	0	30	0	0	780
22	District 7	TP589, I-75, I-275	Pasco	TP589, I-75, I-275	Hoogland / Hartman	Pasco County	TBD	Not now, future. The County feels like they had their hands tied due to Hillsb. watershed special basin restrictions/conditions.	0	0	0	0	0	0	0	0	0	400	250	50	50	0	0	0	0	40	0	0	790
23	District 2	I-95	St. Johns	I-95	Hoogland / Ramirez	St. Johns County Utility	TBD	Not interested presently because of the financial situation. Future consideration	0	0	0	0	0	0	0	0	0	400	250	50	50	0	0	0	0	25	0	0	775
24	District 3	SR 263	Leon	Tallahassee Cascade Park	Wanielisa	City of Tallahassee	TMDL Credit	Demand at this time is satisfied, but in the future there is a need for parkland irrigation; Contact person: John Cox 859 891 6867	20	0	0	0	20	0	0	100	0	400	250	50	50	0	0	0	0	25	0	0	915
25	District 3	392 A	Bay	Gulf Highland Beach Resort	Wanielista	HOA	Water Supply	Need golf course water, have not however talked to the best person yet. Contact person: Paul Johnson, General Manager 850 249 0564 Panama Beach	20	0	0	0	0	250	0	100	0	250	250	50	50	50	0	0	0	25	0	0	1045
26	District 3	I-79 and I-95	Bay	Marcus Point Golf Course	Wanielista	Private Development	Water Supply	Golf Course Water, currently been turned down to get reclaimed water. Contact person: Neal Nash, 850 484 9770	20	0	0	0	0	250	0	100	0	250	250	50	50	50	0	0	0	25	0	0	1045
27	District 1	TBD	Sarasota	TBD	Shruder / Ramirez	FPL – Stormwater Supplemental	TBD	Hines III Cooling Water, no information obtained.	20	0	0	0	0	250	0	100	0	250	250	50	50	50	0	0	0	25	0	0	1045
28	District 4	TBD	Broward	TBD	Ameno / Ramirez	Ft. Lauderdale	TBD	Future Consideration, no information so far.	20	0	0	0	0	250	0	100	0	250	250	50	50	50	0	0	0	25	0	0	1045
29	District 4	Turnpike, I-95, US-1	Palm Beach	Turnpike, I-95, US-1	Ameno / Ramirez	Palm Beach County	Reuse Supplement/Water Supply	Jay gave a presentation. They are looking for 3 MGD stormwater to supplement reuse system along south Palm Beach County line. They were so interested they contacted the FDOT themselves. But FDOT said it doesn't have the capacity in that area. Currently stormwater is going to local canals. **Will not be considered for now.**	20	0	0	0	0	100	0	100	0	500	500	50	75	50	0	0	0	50	0	0	1445
30	District 3	SR 263	Leon	SR 263	Hartman	City of Tallahassee Utility Dept.	Possible reduction of pond size (PD&E)	GAI reviewed the project plans and found a SWR benefit for TMDL reduction. The Project Manager then spoke to the Utility Director about taking the stormwater. At this time, the Utility is not interested in taking the stormwater for Reuse. **Will not be considered for this project.**	20	500	20	-25	20	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	635
31	District 1		Polk County	SR 33	Hartman	Polk City	No	**Will not be considered for this project.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	District 5	US-1, I-95	Flagler	US-1, I-95	Ramirez	Palm Coast	Wetland Re-hydration	Not Interested. Will not be considered. Brian Mathews	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	50	0	70
33	District 5	I-4	Volusia	I-4	Cima	West Volusia	TBD	46A / 417	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	District 5	SR 40	Marion	SR 40	Wanielista	Ocala/Marion County	TMDL Credit	SR 40 has been designed and operates now for reducing flow but no plans for reuse and the widening project is in the national forest. **Will not be considered.**	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	50
35	District 1	I-4, TP 570, SR 17, I-75, Polk County Expressway	Polk	I-4, TP 570, SR 17, I-75, Polk County Expressway	Hoogland / Ramirez	Polk County	TBD	Not Interested. Will not be considered.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	District 2	I-10	Duval	I-10	Hartman / Ramirez	JEA/Plum Creek		**Will not be considered for this project.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	District 5	SR 11	Flagler	SR 11	Ramirez	City of Bunnell	TBD	Black Branch River….. AWS for failing water plant… Not interested, not aware of the stormwater reuse concept. **Will not be considered.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	District 5		Orange		Wanielista	City of Winter Garden		no significant contact with City. **Will not be considered for this project.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	District 4		Indian River		Wanielista / Hartman	Fellsmere Project	Water Supply	IMG, city, Larry Napier 1-772-571-1616 SJRWMD is moving ahead with a reservoir west of the city at approximately 5000 acres. This reservoir will service agricultural needs. no highway construction planned in the area. **Will not be considered.**	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	50
40	District 2			CR. 210	Hoogland	CDD World of Golf Village		Not Interested.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	District 4				Ameno / Ramirez	City of Boca Raton		They are not interested since most FDOT projects discharge stormwater to City's swales. **Will not be considered for this project.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

6.5 Use of SHARP Modeling

Stormwater reuse from a pond for irrigation of adjacent lands is promoted as one way that may reduce pond discharge while supplementing valuable potable water used for irrigation. Reduction of pond discharge reduces the mass of pollutants in the discharge. The Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) model is used to predict the operation of the wet ponds proposed for stormwater harvesting. The model integrates the interaction of surface water and groundwater in a defined catchment area. The SHARP model is capable of assessing harvest safe-yield and discharge from a pond, including the prediction of the percentage of runoff into a harvesting pond that is not discharged.

Stormwater ponds involve retention and detention with slow release of stormwater runoff into adjacent surface and ground waters. The detention of the stormwater runoff allows for settling of the suspended pollutants to the pond bed prior to release through a control mechanism. A harvesting pond has the potential to reduce the volume of discharge and consequently release less pollutant load downstream.

The volume of water in the harvesting pond is one determining factor that influences the harvesting process. Thus, the mechanism of surface and subsurface water movement in the catchment area contributing to the pond needs an adequate modeling tool that predicts accurate estimation of pond water volume available for harvesting and discharge to maintain the natural regime. The present state of science requires the use of numerical models for the mapping of the spatial characters of the catchment area and pond. Economical and computational difficulties in sourcing the data needed to implement such an elaborate effort have discouraged research and application for numerical models. Therefore, accurate prediction of the water movement through deterministic modeling process becomes critical when considering pond water harvesting as a stormwater management system.

The model, Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) is based on the interaction between the pond water storage and subsurface water. The model is designed to simulate the interaction of the overall pond water balance and the catchment area geologic and hydrologic data; predicts downstream flow; and accounts for the effect groundwater seepage on the pond water quality and quantity. In addition, the model is designed to predict the percentage of runoff into a wet detention pond that is not discharged (capture volume) and the groundwater contribution to harvesting.

Stormwater Reuse Pond

Numerous studies have been conducted on the need to use stormwater runoff and the benefits from such activity. However, only few publications useful in predicting the percent of runoff water captured using harvesting methods are available. The design and analysis model provide series of rate-efficiency-volume (REV) curves to aid the design of harvesting ponds under the assumptions that there is minimal groundwater input and output to the pond. The primary use of the REV curves and the proposed model is to retain surface runoff water within a watershed and to reduce the mass of pollutants in the discharges to surface water bodies.

Harvesting Pond Simulation Model

The development, validation, and calibration show that mathematical mass balance model can simulate the operation of a stormwater harvesting pond that has minimal groundwater exchange. The mass balance for the harvesting pond is based on inflow from rainfall events, discharge from the pond, and a harvesting volume rate. Water is discharged from the pond when the temporary storage volume exceeds the available storage. A relationship between the efficiency or runoff capture (note that this is runoff not discharge), harvesting rate and harvesting volume of the pond for a continuous time model was established from a simulation for specified period. Using local rainfall data, the simulation process provided the tools for the creation of charts of the harvesting rate, efficiency and harvesting volume (REV) for different rainfall regions. The net flow of groundwater into a pond was assumed to equal zero, and the average evaporation rate for a pond in Florida was considered approximately equal to the average precipitation on the pond in a one-year period. It is important to factor in the availability and nearness of the water use facility in the design considerations for a stormwater harvesting pond, as there may be more water available. Additionally, when located near sensitive streams, pumping rates of the water should be controlled so as not to diminish or eliminate downstream flows needed to sustain aquatic life. If located next to wetlands, the impact of the groundwater extraction on the wetland must be evaluated.

SHARP Model Development and Operation

Several approaches have been developed to model various hydrologic processes of watersheds . The processes of water movement on the surface and in the unsaturated and saturated zones of the subsurface often require rigorous analyses. Therefore, simplification of the concepts into a mass balance approach with accountability of water is helpful in the development of adequate representation of water volumes in mathematical models. The simplifications in water movement on the surface and subsurface within a watershed model would reduce the rigorous analysis required to model the interaction between rainfall runoff, infiltration, evapotranspiration, vadose zone water redistribution, groundwater flow, and seepage to open free-water bodies. Accurate simulation of the various processes based on the fundamental principles is essential in whatever simplifications and assumptions are made in a model.

The model simulates the interactions of hydrologic processes of water movement, storage, and harvesting in stormwater management systems of a watershed. A model is developed that simulates the integration of the physical processes of water movement in a pond, the atmosphere, soil surface, and subsurface within the unsaturated and saturated zones in order to quantify discharge and harvesting water volume from a watershed pond. The SHARP model is based on the analysis of stormwater harvesting with the option for groundwater input to and from a harvesting pond based on the principles of mass balance on pond storage and groundwater movement in a catchment area.

SHARP model is deterministic but variable in time. It is a mass balance model designed to simulate the impact of harvesting pond water in regions where there is a possibility of sub surface inflow to and outflow from the pond while predicting the discharge and harvesting volume for any time period of interest. The model uses equations for the hydrologic and hydraulic processes of stormwater in a watershed, both in surface and subsurface phases. The SHARP model is programmed to accept watershed data generally available in most watershed management and local authorities. The model is structured to reduce the number of calibrated parameters by the use of readily available measurable physical parameters and, when appropriate, empirical data. The development of the SHARP model is governed by mathematical deterministic relationships as conceptual components.

Development of Model Components

The water dynamics in a catchment at the surface-subsurface interface and pond water-groundwater interface modeling are critical in providing predictive tool for effectively evaluating the management needs of harvesting available pond water and control the discharge from pond. Determination of the saturated contributing surfaces and their evolution in time and space, and the relative contributions of the surface and subsurface to stream flow and pond are important issues in stormwater harvesting in a catchment area hydrology. Richard's equation is used to describe the water dynamics in the three physical domains of the land surface, vadose zone, and saturated zone with domain dependent parameters. The relationship of the three Physical Domains is shown in Figure A below. Adopted in the development of the model components are contributive effects of the three physical domains to the pond, which flow is dominated by harvesting and discharge characteristics.

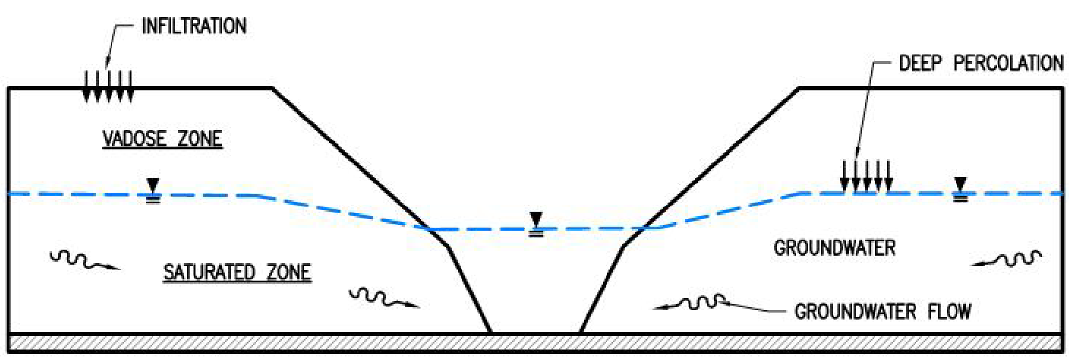


Figure A 3 Physical Domains of Groundwater Flow

Model Basic Concepts

The model components are developed to describe the hydrologic processes inherent in the movement of water on the surface and in the subsurface. The basic governing processes for the surface and subsurface movement are expressed in the combination of continuity and water budget equations for the pond storage (S_P), soil moisture storage (S_M), and groundwater recharge (S_{GW}).

Hydrologic Model

The hydrologic process involves interrelated sub-components of physical processes such as rainfall, irrigation, infiltration, surface runoff, subsurface water redistribution, and groundwater flow.

SHARP model loops the hydrologic processes of a detention pond to the adjacent land surface and subsurface dependent of the climatic conditions in the watershed.

Model Operation

SHARP model, driven by precipitation, simulates the flow interactions of land surface and subsurface vadose zones, and the free-water surface and saturated zones. SHARP is an urban hydrology model with an hourly time step which integrates variety of soil characteristics, soil cover, surface slopes, rainfall and irrigation rates, fluctuations in groundwater levels, and water gradient. The relevance of the model is limited by the size of the watershed, as it is developed for pond catchment in a watershed. The model is a periodic loop of sequential computational processes of all the components in the hydrologic cycle. Preceding the loop are input parameters, boundary and initialization conditions followed by the model interactions to produce simulated monthly or yearly hydrologic values and graphic outputs.

SHARP model is developed using Microsoft Window-Excel interface to facilitate data entry, parameterization, characterization, and generation of numerical and graphical outputs. The model is composed of five modules, namely: LAND, ET, INFIL, SEEP, and POND. Brief descriptions of the five modules are presented below.

LAND Module

LAND module is the input unit that allows the user to specify watershed parameters, land uses and management, soil properties, and seasonal variations on weather data. The location inputs are geographic data such as the longitude, latitude, and elevation for the watershed location and pond catchment area. This allows for the definition of appropriate boundary for accurate simulation of water movement in the system. Meteorological parameters are essentially measured data or estimated from relevant formulations available in literatures and sourced from the National Weather Services (NWS) or local agencies. In addition, topographic description of the study area is relevant for selecting the hydrologic soil group that helps in identifying the soil types and defines the land use, percent imperviousness, urbanization level, slope, and vegetative cover and type. Finally, the control parameters are basically system management controls to regulate the irrigation process frequency, volume, turfgrass water needs; required harvest volume; and pond storage capacity. Other regulations may have to be incorporated into the model simulation.

ET Module

The ET module simulates the reference and crop evapotranspiration process by energy balance and turf grass needs for computing the actual evapotranspiration (AET) based on the FAO equation. Vegetation parameters for turfgrass in Florida are obtained from literature, and Argentine Bahia was the dominant turfgrass in the catchment area. The ET module simulates the irrigation needs of turfgrass, irrigation quantity, and irrigation timing from the antecedent soil-moisture content and evapotranspiration data.

INFIL Module

INFIL module simulates the processes of infiltration, surface runoff, and soil water storage.

SEEP Module

The SEEP module simulates the process of water movement in the soil subsurface by water redistribution, deep percolation, and groundwater seepage. Infiltrated water is redistributed downward by soil matric and gravity potentials and upwards into the atmosphere by evapotranspiration in the soil subsurface. Estimation of the redistributed water is based on the rectangular profile. Soil-water above the field capacity in the root zone drains to the groundwater as deep percolation and is governed by the soil characteristics. Flow is assumed as one-dimension, so lateral flow in the vadose zone is ignored. Estimation for deep percolation is based on both steady and unsteady state flow processes in the soil during and after precipitation, respectively. Deep percolation from on steady-state flow is gravity driven and is calculated when the soil moisture content is equal or greater than the moisture content at field capacity of the root zone or unsaturated layer.

Soil moisture in the unsaturated zone is influenced by moisture losses from actual evapotranspiration within the root zone and deep percolation. The soil moisture content is estimated based on the mass balance of flow in the unsaturated zone for each layer of soil.

POND Module

POND module simulates the pond storage using outputs from ET, INFIL, and SEEP modules, and rainfall data. Pond storage volume computation is based on the initial volume, rainfall on the pond and seepage from groundwater into the pond as inputs; and pumped irrigation volume, discharge volume, evaporation, and seepage to the surrounding soil as output. This is computed for hourly time step to provide a real time simulation of water available for irrigation. Pond storage volume is controlled by the setup of minimum and maximum storage volumes. At the minimum storage volume mark, the release of water for irrigation is stopped and at the maximum storage volume mark discharge of pond water commences.

Input and Output

SHARP model is a continuous simulation model designed to perform simulation in response to the periodic needs for stormwater management. Outputs from the model consist of periodic plots of rainfall and irrigation characterization, pond storage volume, harvesting storage volume, pond discharge volume, soil water volume, and groundwater volume. Basic data inputs in the model are used to develop periodic water storage in the pond, vadose (unsaturated) zone, and saturated zone to predict pond water harvesting volume availability and needs, total discharge volume, and percentage of surface runoff discharged. The movement of water in the watershed is synthesized from the model and inputted automatically within the model for specified hourly time step. The watershed characteristics and initial soil properties are used to set the initial boundary conditions of the model.

Model Parameters

SHARP model consists of specific watershed parameters that provide the mechanism to adjust the simulation for given catchment surface and soil characteristics, area, topography, and management conditions. It is designed to be used in a wide range of pond catchment areas, which must be evaluated for every model application. Some of these parameters could be evaluated from known watershed characteristics, while others that could not be precisely determined would be evaluated through calibration with existing data or laboratory analyses. These are categorized as system, meteorological, and control parameters described in the LAND module. The following parameters are defined by calibration, experimentation, or published data of hydraulic conductivity, porosity and void ratio, initial water content, residual water content, saturation water content, and the initial depth of groundwater table. Constants and exponential parameters are used to aid calculation of other model parameters through the simulation process. Data for the pond's sediment, permanent pool, harvesting volume, and overflow volumes are management decisions and adapted to simulate the pond storage.

SHARP Model Application

The model is applied to a catchment area to verify its functionality, performance, and reliability.

Results and Discussion

Groundwater models are qualitatively analyzed for overall performance using efficiency criteria for error measurements, calibrations and validation of the model.

Parameters calibrated for SHARP modeling include; saturated hydraulic conductivities, pore size distribution, turfgrass growth parameters, soil field capacity, discharge pumping rate, infiltration capacity, and surface storage. Both discharge pumping rate and discharge level are calibrated because the operational rate and discharge level vary at every use.

Validation Period Simulation Results

After the calibration of SHARP model, evaluation to validate the model is conducted using parameters from the calibration period to set the discharge pumping rate, discharge elevation, irrigation scheduling, and land cover.

SHARP Output Results

The SHARP model has the additional capability to display graphically the effect of stormwater harvesting to the groundwater drawdown, pond discharge volume, and stormwater runoff contribution to harvesting.

The harvest safe yield is the volume of water harvested from the pond without unacceptable effects on the groundwater. So, even when the weekly rate is increased at the same regular interval the corresponding change in the annual harvest volume is minimal, thus, groundwater contribution to the pond is regulated.

The percent of groundwater component is obtained from the fraction of groundwater seepage to the total intake of the pond per volume of weekly irrigation rate. The groundwater seepage to the pond increases as the weekly irrigation volume increases, but this is used as harvest volume rather than being discharged, which meets one of the reasons for the establishment of stormwater harvesting pond as a best management practice (BMP). This is expected due to the fact that a drawdown of the pond water level will significantly lead to increased seepage from the effective groundwater within the zone of influence.

The concerns on the effect of harvesting from wet detention pond on groundwater are addressed by the SHARP model in its capability to predict a safe yield to determine an acceptable maximum harvesting rate.

Conclusions

The SHARP model developed for a stormwater harvesting pond uniquely accesses the interaction of surface water and groundwater in a catchment area and reasonably predicts the water movement through deterministic modeling process using basic mass balance principles of a catchment area hydrologic cycle. The model confirms that harvesting ponds reduce the volume of discharge, and consequently, the pond releases less pollutant load downstream and increases groundwater recharge, as substantial volume of annual stormwater runoff is returned to the watershed. Furthermore, output from the SHARP model provides the user(s) the capability to assess harvest safe-yield and flow between a pond and surrounding land with or without harvesting, and predict the percentage of runoff into a wet detention pond that is not discharged. This is relevant to stormwater management and planning due to the fact that the basic process of stormwater harvesting involves the capture and storage of stormwater runoff in a harvesting pond and gradual use to irrigate adjacent pervious areas or for consumptive use (no return to the pond).

In addition to the pond water elevation, the model simulates the groundwater level by the computation of the infiltration, evapotranspiration, runoff, deep percolation, lateral seepage, and total precipitation. However, these parameters were not calibrated or validated in this study because of no measured data for the pilot site. The calibration and validation of these parameters would promise significant improvement and provide a tool for assessing stormwater harvesting schemes for any catchment area.

Note: A complete version of the SHARP Model whitepaper prepared for the Miramar, Florida Stormwater Reuse pilot project is provided in **Appendix B.**

Point-of-interest: The Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) model is an accepted scientific method of analyzing the effects of stormwater harvesting on impounded pond water and the inter-connected surficial aquifer.

6.6 The "Ideal Match"

The idea of an "Ideal Match" is easy to define but much harder to quantify. The "Ideal Match" is that scenario which will achieve significant benefit to both the FDOT and the End-User with no significant negative environmental impacts, and with no significant liability exposure. The difficulty in quantifying the Ideal scenario stems from the numerous variables that define "benefit". Benefits to either the FDOT or the End-User may be economics, regulatory, timing, operational, environmental, political, yield based, or any combination of these elements. In a do nothing scenario, the FDOT maintains its status quo on all of these elements with no pressing need to re-use the stormwater, whereas the in-need End-User continues on its quest to satisfy any number of these elements.

Because of these dynamics; in order for the Department's Stormwater Reuse vision to come to fruition, the focus should be twofold. The first is through awareness training within the Water Resource Community making it clear and obvious that the FDOT is very willing and able to provide stormwater for harvesting. The second focus should be on the aggressive identification and documentation of in-need End-Users that have an immediate need or an identified future need. Development of a statewide data base that is populated and subsequently updated by each District Drainage Engineer on a required quarterly basis will allow the Department to stay connected with the potential partnering candidates.

Section 7
Conceptual Development of Reuse Opportunities

7.1 Reducing from 40+ Reviewed Opportunities to the Selected 3

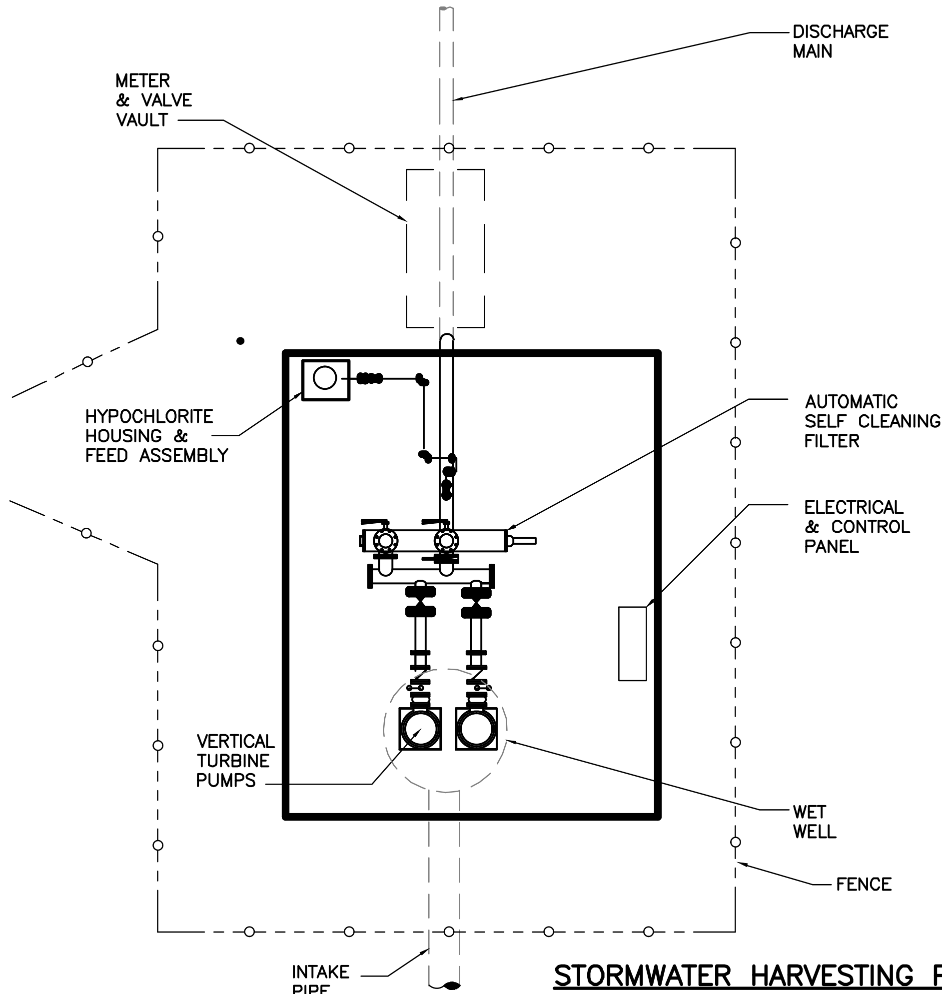
Much of the efforts made during this Study centered around the identification of in-need End-Users. As shown on the ranking Matrix, there are a number of in-need End-Users that are in various stages of moving forward with an Alternative Water Source such as the harvesting of stormwater. The ranking Matrix created a mechanism by which the economics, regulatory, timing, operational, environmental, political, and yield based needs could be compared against the other in-need End-Users. Through the use of the ranking Matrix along with information gathered through direct discussions, a recommended short listing of six potential opportunities that had the correct characteristics to be a viable candidate for use as pilot projects were brought forward and presented to the Department for consideration. The intent was to reduce from these six opportunities to three potential projects that would be further analyzed and developed. The six recommended opportunities included: the Outer Beltway and Starke Bypass in north Florida, the cities of Haines City and Ocoee in central Florida, and the cities of Miramar and Riviera Beach in south Florida. After careful consideration, the Department requested that the City of Ocoee, City of Riviera Beach, and the City of Haines City opportunities be further developed. The three selected opportunities offer an important sampling of variables that will help to understand a number of the conditions that these opportunities will encounter if/when implemented. The three selected opportunities are in three different Water Management Districts, and are associated with FDOT stormwater ponds that either currently exist, are currently under construction, or are still in the design/permitting stage.

7.2 Stormwater Pumping Station

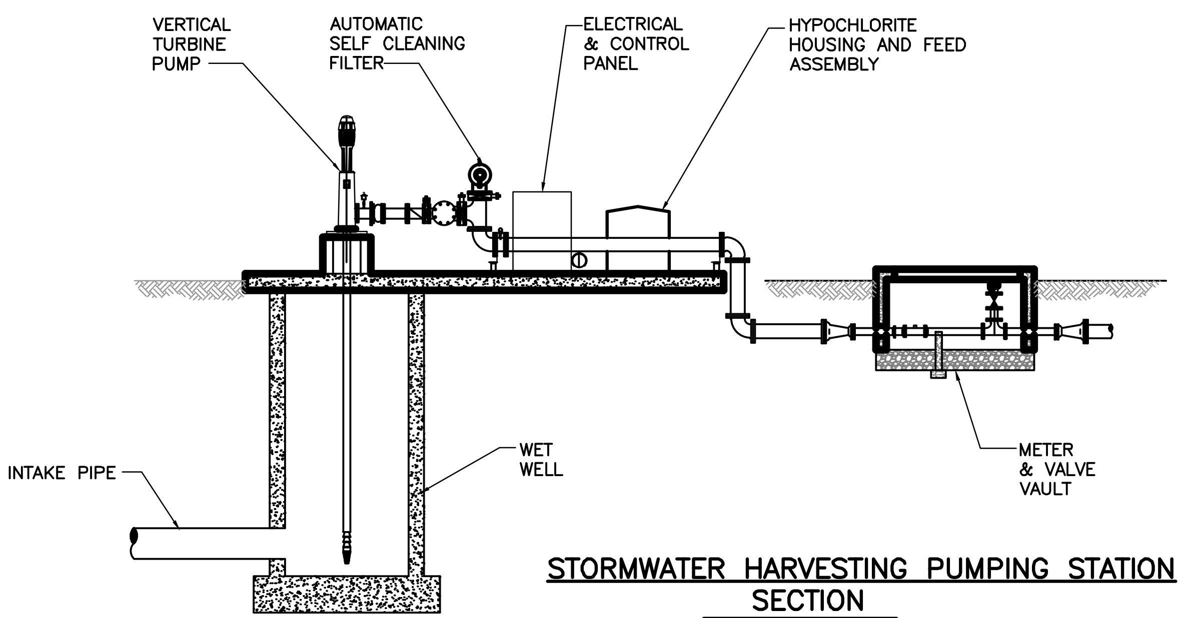
All three of the proposed concept development scenarios presented in this section involve a stormwater pumping component. The proposed pumping station concept is based on using vertical turbine pumps with a wet well. Water intake would consist of a series of horizontal wells piped to the pumping station wet well. Vertical turbine pumps were selected because of their reliability, and low maintenance when compared to submersible pumps, suction pumps or vertical multi-stage centrifugal pumps. The vertical turbine pumps do have a higher up-front cost but they are more energy efficient. They reduce annual electrical costs, will have a longer service life and are more cost effective on a life cycle basis than the other types of pumps.

The pump station would be equipped with a self-cleaning filter to remove particulates as well as a chlorine injection system for disinfection that satisfies the chlorine demand when reused stormwater is injected into an existing reclaimed system. The pumping station could utilize 55 gallon drums of hypochlorite to reduce maintenance costs and the safety hazard gaseous chlorine presents. The proposed pumping station would be equipped with telemetry (if deemed necessary) for remote control/monitoring by wireless communication.

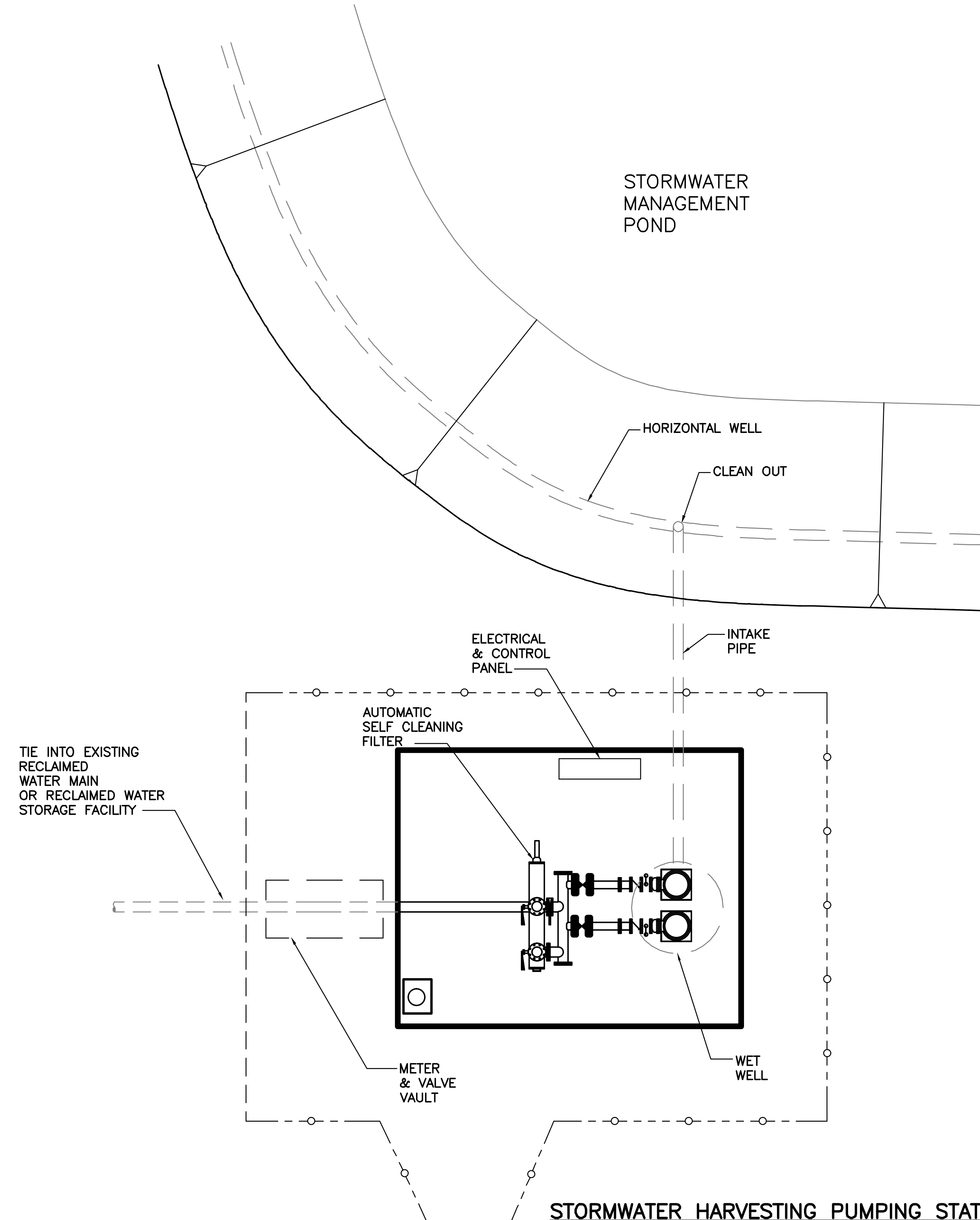
There are a number of pre-packaged skid mounted pumping stations on the market associated with the golf course and agricultural industries. These could meet the requirements of the End-User at a lower cost and would significantly reduce the design and capital costs. A typical stormwater pumping station concept plan is presented in Exhibit 7.2-1.



STORMWATER HARVESTING PUMPING STATION
PLAN
NTS



STORMWATER HARVESTING PUMPING STATION
SECTION
NTS



STORMWATER HARVESTING PUMPING STATION
SITE PLAN
NTS

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Stormwater Harvesting Pumping Station Concept

EXHIBIT
7.2-1

7.3 Horizontal Wells

For the 3 selected projects, the reuse water is removed from the pond using a horizontal well. The required length, diameter, and depth of the horizontal wells are a function of the site specific conditions and safe yield volume to be extracted. The well is typically placed about twelve feet below the normal water level of the pond but again would vary based on the specific site conditions. The typical minimum width of trench is four feet. Figure 7.3.1 shows a cross-section of a typical Horizontal Well which illustrates important elevations and distances. The lower two-thirds of the trench is back-filled with a sand/ special filter media mix to enhance the removal of contaminates from the stormwater present in the pond, and a more rapid movement of water to the collection pipe. A perforated pipe with a permeable sock cover (usually a two ply filter wrap) is used at the bottom of the trench to collect the water.

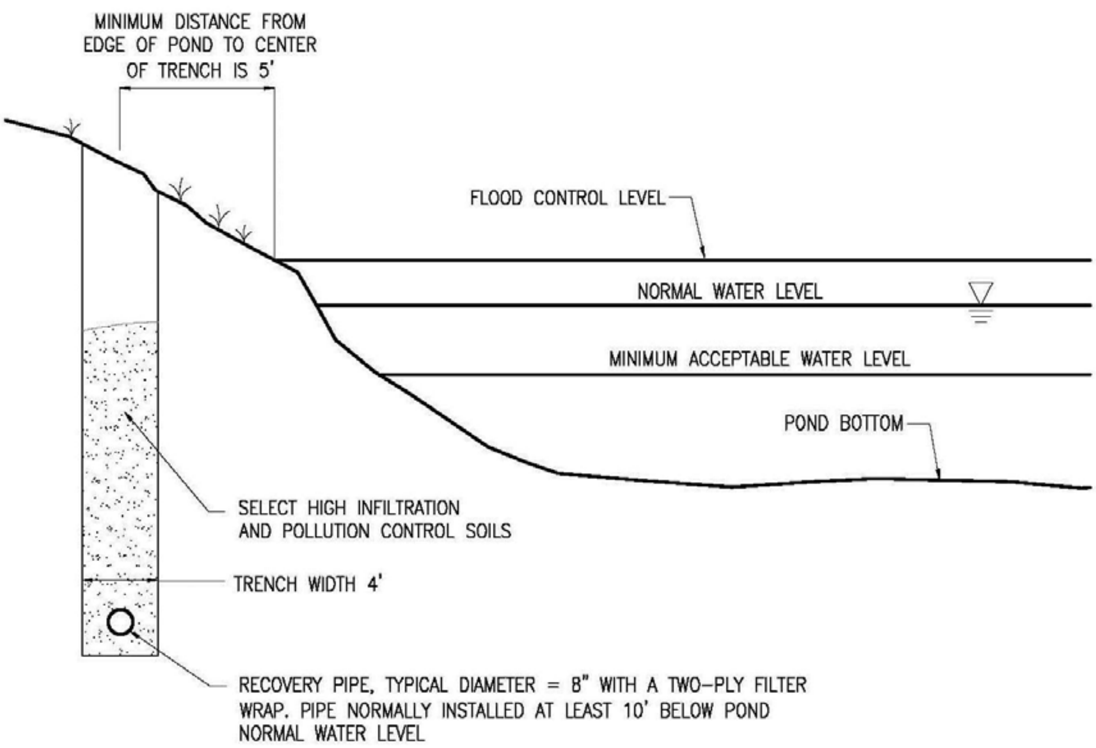

Figure 7.3.1 : Cross-Section of a Horizontal Well

Note: In addition to the contaminant reductions noted in Section 5.5 , the stormwater reuse system that uses horizontal wells consistently produces a water of less than five NTU for turbidity.

There are more than 300 systems using horizontal wells currently in operation in Florida. This technology was first used in 1987 and introduced within the State of Florida in 1989 (HSSI, 2007). A comparison of a horizontal well to a vertical well is shown in Figure 7.3.2 and illustrates a standard section for a horizontal well installation vs a vertical well. For the same depth into the surficial aquifer, the horizontal well will remove more water than a vertical well. A four to eight inch diameter pipe is commonly used since larger pipes do not usually provide a proportionally greater flow volume. As an example; for most soils, the 500 foot length of a six inch pipe shown can develop between 250-500 gallons of water per minute, depending on soil permeability.

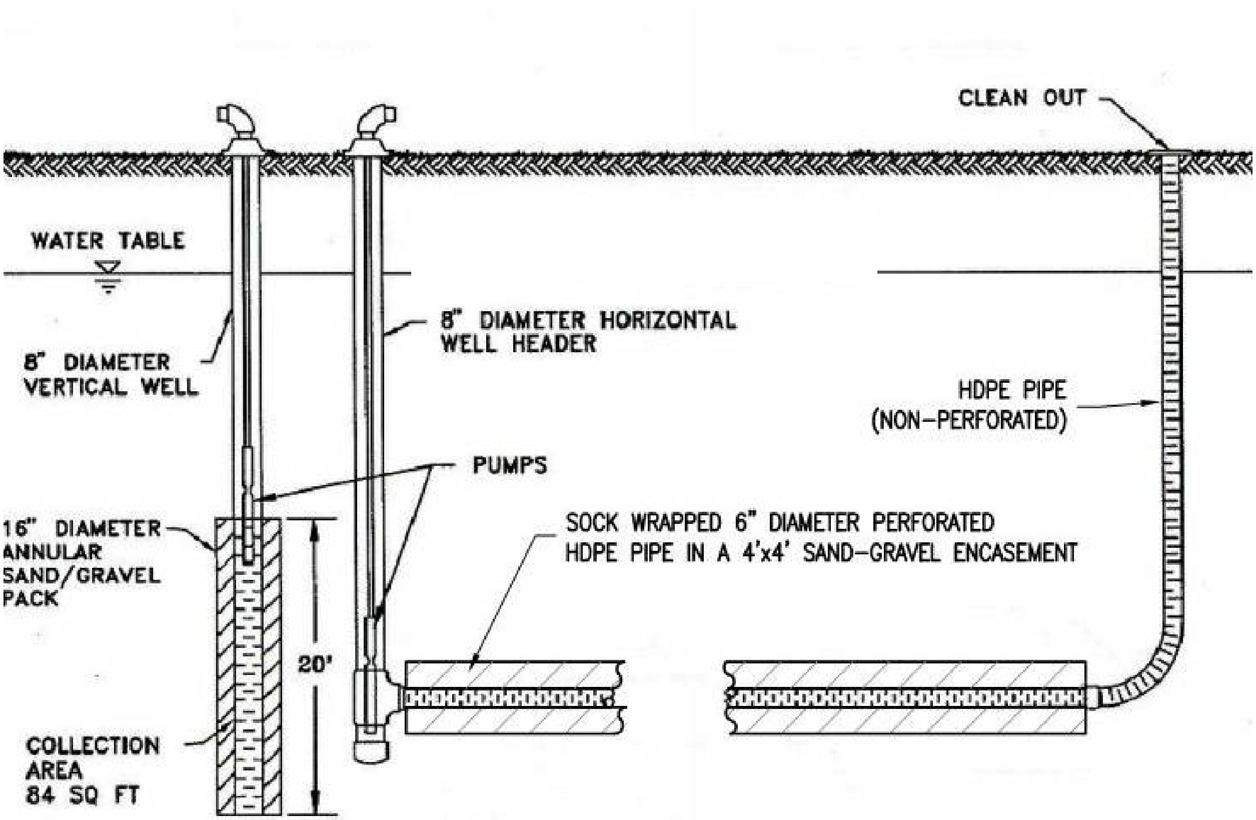

Figure 7.3.2: Horizontal Well Section and Comparison to a Vertical Well

The following sections show the conceptual plan development, cost estimating, safe yield modeling, estimated delivery price point, and permitting issues related to the 3 selected potential projects.

7.4 Potential Project #1 – City of Ocoee

7.4.1 The City of Ocoee Stormwater Reuse Concept Plan

The City of Ocoee project is comprised of a single proposed wet bottom stormwater retention/detention pond that will be constructed on South Bluford Avenue just south of SR 50. The stormwater harvesting pumping station would be located at the north corner of the Pond. The proposed concept is to collect the stormwater from horizontal wells and pump it via a forcemain to the City's planned reclaimed water system located on the north side of SR 50. The horizontal wells/pumping station would provide filtration and chlorination of the discharged stormwater. Note: The City Engineer requested that a chlorination component be added to the project. The City of Ocoee concept plan is presented in Exhibit 7.4-1.

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City of Ocoee
Stormwater Reuse Concept Plan

EXHIBIT
7.4-1

7.4.2 The City of Ocoee Conceptual Cost Estimates

An order-of-magnitude cost estimate of the proposed City of Ocoee concept plan includes: the capital costs for the pumping station, the necessary site improvements, cost to bring power and data to the pond site, the forcemain to connect to their existing reclaimed wastewater system, miscellaneous construction costs, and the design and permitting costs. As shown on the following spreadsheets, the estimated costs are estimated at $232,000 including design and permitting costs. The capital costs were amortized over twenty years with an annual capital cost of $18,400.

The operation and maintenance costs for the stormwater pumping station are estimated and include maintenance labor, aquatic weed removal, electrical and telemetry communication costs. The total annual operations and maintenance costs are estimated at $10,400. **The unit cost for providing 1,000 gallons is $0.55.** This assumes an average 10 hour/day operation of the pump/well.

Note: The City of Ocoee's Utility Water Rate Schedule is provided in **Appendix C**.

FDOT Stormwater Reuse Study
City of Ocoee
Cost Summary (Conceptual Level)

CITY OF OCOEE COST SUMMARY

Proposed FDOT Pond on Bluford Ave south of SR 50

Harvested Stormwater Annual Yield		
	52.56	MGY
	0.144	MGD
Capital Costs		
Total	$231,000	
Annual (20yr, 5%)	$18,400	
Cost per 1, 000 GAL of harvested stormwater	$ 0.35	
Maintenance Costs		
Annual	$10,400	
Cost per 1, 000 GAL of harvested stormwater	$ 0.20	
Total Annual Cost (Capital & Maintenance)	$ 28,800	
Total Cost per 1,000 GAL of harvested stormwater	$ 0.55	
Comparative cost per 1,000 GAL from the City's Rate Schedule	$1.93	

FDOT Stormwater Reuse Study
City of Ocoee
Capital Costs (Conceptual Level)

CAPITAL IMPROVEMENTS	Quantity	Units	Unit Price	Amount		
Pump Station						
P.S., 20 hp, 400gpm, filter; chemical feed; electrical/control panel	1	LS	40,000	40,000		
Hypochlorite storage enclosure/feed pump	1	LS	1,000	1,000		
Flow meter upgrade	1	LS	1,000	1,000		
Telemetry	1	LS	4,000	4,000		
Subtotal					$ 46,000	
Site Work						
P.S wet well 6' diameter, 10-12' deep	1	LS	8,000	8,000		
Horizontal wells (500 LF)	500	LF	40	20,000		
Meter /valve box	1	LS	3,000	3,000		
6' C/L fencing	200	LF	10	2,000		
12' swing gate	0	EA	600	600		
Stabilized roadway	376	SY	4	1,504		
Subtotal					$ 36,000	
Utilities						
Electric service, 480V, 3ph	1	EA	10,000	10,000		
Comm line	1	EA	1,500	1,500		
Subtotal					$ 12,000	
Forcemain						
6" PVC pipe	1,000	LF	40	40,000		
6" valves	5	EA	750	3,750		
Misc fittings allowance				3,000		
Tie-in to existing reclaimed waterline	1	LS	2,500	2,500		
Subtotal					$ 50,000	
Misc Const Costs						
General conditions & mobilization	1	LS		14,400		
MOT	1	LS		1,000		
Testing & permitting	1	LS		3,000		
Contingency	1	LS		28,000		
Subtotal					$ 47,000	
Const Subtotal						$ 191,000
Soft Costs						
Design, geotechnical & permitting	1	LS	35,000	35,000		
Permitting fees	1	LS	6,000	6,000		
Subtotal					$ 41,000	
Project Total Design & Const Costs						$ 232,000
Annual Costs over 20yr @ 5%						$18,400

FDOT Stormwater Reuse Study
City of Ocoee
Maintenance Costs (Conceptual Level)

ANNUAL MAINTENANCE COSTS

		Quantity	Units	Unit Price	Amount		
Pumping Station							
	Chemical Hypochlorite	1000	GAL	3.00	3,000		
	Routine maint (2 hr/month)	24	HR	45.00	1,080		
Subtotal						$ 4,100	
Site Work							
	mowing (1.5 hr @ $60/hr per event)	18	EA	90	1,620		
	aquatic weed removal (15 hr @ $260/hr once every three yrs)	5	HR	260	1,300		
Subtotal						$ 3,000	
					-		
Utilities					-		
	Electric	18,000	kWhr	$ 0.15	$ 2,700		
	Comm	12	Month	$50	600		
Subtotal						$ 3,300	
Total Annual Maintenance Costs							$ 10,400

7.5 Potential Project #2 – City of Riviera Beach

7.5.1 The City of Riviera Beach Stormwater Reuse Concept Plan

The City of Riviera Beach project is comprised of dual retention/detention ponds that are being constructed on SR 710 (MLK Blvd). The stormwater harvesting pumping stations would be located at the pond corner closest to SR 710 as shown on the concept plan. The proposed concept is to collect the stormwater from horizontal wells and pump it via a short forcemain to the City's existing raw waterline located on the north side of SR 710. The horizontal wells/pumping station would provide filtration and chlorination of the discharged stormwater. Note: The Palm County Health Department Manager requested that a chlorination component be added to the project. The City of Riviera Beach concept plan is presented in Exhibit 7.5-1.

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City of Riviera Beach
Stormwater Reuse Concept Plan

EXHIBIT
7.5-1

7.5.2 The City of Riviera Beach Conceptual Cost Estimates

An order-of-magnitude cost estimate of the proposed City of Riviera Beach concept plan includes: the capital costs for the pumping station, the necessary site improvements, cost to bring power and data to the pond site, the forcemain to connect to the existing raw water system, miscellaneous construction costs, and the design and permitting costs. As shown on the following spreadsheets, the capital costs are estimated at $166,000 including design and permitting costs. The capital costs were amortized over twenty years with an annual capital cost of $13,150.

The operation and maintenance costs for the stormwater pumping station are estimated and include maintenance labor, aquatic weed removal, electrical and telemetry communication costs. The total annual operations and maintenance costs are estimated at $9,500. **The unit cost for providing 1,000 gallons is $0.69.** This assumes an average 10 hour/day operation of the pump/well.

The Riviera Beach project included two ponds of similar size within a few hundred feet of each other on SR 710. The data noted above was developed for one pond. It is anticipated that the safe yield and cost to deliver reuse water will be similar for either pond.

Note: The City of Riviera Beach's Utility Water Rate Schedule is provided in **Appendix C**.

FDOT Stormwater Reuse Study
City of Riviera Beach
Cost Summary (Conceptual Level)

CITY OF RIVIERA BEACH COST SUMMARY

FDOT Ponds under construction on SR 710 (MLK Blvd)

Harvested Stormwater Annual Yield			
		32.85	MGY
		0.090	MGD
Capital Costs			
Total		$166,000	
Annual (20yr, 5%)		$13,150	
Cost per 1, 000 GAL of harvested stormwater	$	0.40	
Maintenance Costs			
Annual		$9,500	
Cost per 1, 000 GAL of harvested stormwater	$	0.29	
Total Annual Cost (Capital & Maintenance)	$	22,650	
Total Cost per 1,000 GAL of harvested stormwater	$	0.69	
Comparative cost per 1,000 GAL from the City's Rate Schedule		$6.90	

FDOT Stormwater Reuse Study
City of Riviera Beach
Capital Costs (Conceptual Level)

CAPITAL IMPROVEMENTS		Quantity	Units	Unit Price	Amount	Subtotal	Total
Pump Station							
	P.S., 20 hp, 400gpm, filter; chemical feed; electrical/control panel	1	LS	40,000	40,000		
	Hypochlorite storage enclosure/feed pump	1	LS	1,000	1,000		
	Flow meter upgrade	1	LS	1,000	1,000		
	Telemetry	1	LS	4,000	4,000		
Subtotal						$ 46,000	
Site Work							
	P.S wet well 6' diameter, 10-12' deep	1	LS	8,000	8,000		
	Horizontal wells (500 LF)	500	LF	40	20,000		
	Meter /valve box	1	LS	3,000	3,000		
	6' C/L fencing	0	LF	10	-		
	12' double swing gate	0	EA	1,200	-		
	Stabilized roadway	376	SY	4	1,504		
Subtotal						$ 33,000	
Utilities							
	Electric service, 480V, 3ph	1	EA	10,000	10,000		
	Comm line	1	EA	1,500	1,500		
Subtotal						$ 12,000	
Forcemain							
	6" PVC pipe	40	LF	50	2,000		
	6" valves	2	EA	750	1,500		
	Misc fittings allowance				1,500		
	Tie-in to reclaimed water recovery facility	1	LS	3,000	3,000		
Subtotal						$ 8,000	
Misc Const Costs							
	General conditions & mobilization	1	LS		9,000		
	MOT	1	LS		1,000		
	Testing & permitting	1	LS		2,000		
	Contingency	1	LS		25,000		
Subtotal						$ 37,000	
Const Subtotal							$ 136,000
Soft Costs							
	Design, geotechnical & permitting	1	LS	24,000	24,000		
	Permitting fees	1	LS	6,000	6,000		
Subtotal						$ 30,000	
Project Total Design & Const Costs							$ 166,000
Annual Costs over 20yr @ 5%							$13,150

FDOT Stormwater Reuse Study
City of Riviera Beach
Maintenance Costs (Conceptual Level)

ANNUAL MAINTENANCE COSTS

		Quantity	Units	Unit Price	Amount	Subtotal	Total
Pumping Station							
	Chemical Hypochlorite	800	GAL	3.00	2,400		
	Routine maint (2 hr/month)	24	HR	45.00	1,080		
Subtotal						$ 3,500	
Site Work							
	mowing (1.5 hr @ $60/hr per event)	18	EA	90	1,620		
	aquatic weed removal (15 hr @ $260/hr once every three yrs)	5	HR	260	1,300		
Subtotal						$ 3,000	
					-		
Utilities					-		
	Electric	16,000	kWhr	$ 0.15	$ 2,400		
	Comm	12	Month	$50	600		
Subtotal						$ 3,000	
Total Annual Maintenance Costs							$ 9,500

7.6 Potential Project #3 – City of Haines City

7.6.1 The City of Haines City Stormwater Reuse Concept Plan

The City of Haines City project is comprised of a single existing wet bottom stormwater retention/detention pond that is located on the south side of Old Polk City Road just west of US 27. The stormwater harvesting pumping station would be located at the southeast corner of the Pond. The proposed concept is to collect the stormwater from horizontal wells and pump it via a small forcemain to the City's existing irrigation system that irrigates the landscape areas in the US 27 roadway corridor. The horizontal wells/pumping station would provide filtration and chlorination of the discharged stormwater. Note: The City's Public Works Director requested that a chlorination component be added to the project. The City of Haines City concept plan is presented in Exhibit 7.6-1.

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City of Haines City
Stormwater Reuse Concept Plan

EXHIBIT

7.6-1

7.6.2 The City of Haines City Conceptual Cost Estimates

An order-of-magnitude cost estimate of the proposed City of Haines City concept plan includes: the capital costs for the pumping station, the necessary site improvements, cost to bring power to the pond site, the forcemain to connect to the existing irrigation system, miscellaneous construction costs, and the design and permitting costs. As shown on the following spreadsheets, the capital costs are estimated at $169,000 including design and permitting costs. The capital costs were amortized over twenty years with an annual capital cost of $13,800.

The operation and maintenance costs for the stormwater pumping station are estimated and include maintenance labor, aquatic weed removal, and electrical costs. The total annual operations and maintenance costs are estimated at $8,300. **The unit cost for providing 1,000 gallons is $0.69.** This assumes an average 10 hour/day operation of the pump/well.

Note: The City of Haines City's Utility Water Rate Schedule is provided in **Appendix C.**

FDOT Stormwater Reuse Study
City of Haines City
Cost Summary (Conceptual Level)

CITY OF HAINES CITY COST SUMMARY

Existing FDOT Pond on Old Polk City Road west of US 27

Harvested Stormwater Annual Yield		
	32.00	MGY
	0.088	MGD
Capital Costs		
Total	$169,000	
Annual (20yr, 5%)	$13,800	
Cost per 1, 000 GAL of harvested stormwater	$ 0.43	
Maintenance Costs		
Annual	$8,300	
Cost per 1, 000 GAL of harvested stormwater	$ 0.26	
Total Annual Cost (Capital & Maintenance)	$ 22,100	
Total Cost per 1,000 GAL of harvested stormwater	$ 0.69	
Comparative Costs per 1,000 GAL from the City's Rate Schedule	$3.17	

FDOT Stormwater Reuse Study
City of Haines City
Capital Costs (Conceptual Level)

CAPITAL IMPROVEMENTS		Quantity	Units	Unit Price	Amount	Subtotal	Total
Pump Station							
	P.S., 15 hp, 200gpm, filter; chemical feed; electrical/control panel	1	LS	35,000	35,000		
	Hypochlorite storage enclosure/feed pump	1	LS	1,000	1,000		
	Flow meter upgrade	1	LS	1,000	1,000		
	Telemetry	0	LS		-		
Subtotal						$ 37,000	
Site Work							
	Sod	1	LS	3,000	3,000		
	P.S wet well 6' diameter, 10-12' deep	1	LS	8,000	8,000		
	Horizontal wells (300 LF)	300	LF	40	12,000		
	Meter /valve box	1	LS	2,500	2,500		
	6' C/L fencing	0	LF	10	-		
	12' double swing gate	1	EA	1,200	1,200		
	Stabilized roadway	376	SY	4	1,504		
Subtotal						$ 29,000	
Utilities							
	Electric service, 480V, 3ph	1	EA	8,000	8,000		
	Comm line	1	EA		-		
Subtotal						$ 8,000	
Forcemain							
	4" PVC pipe	700	LF	30	21,000		
	4" valves	5	EA	750	3,750		
	Misc fittings allowance				3,000		
	Tie-in to existing irrigation main	1	LS	1,500	1,500		
Subtotal						$ 30,000	
Misc Const Costs							
	General conditions & mobilization	1	LS		10,000		
	MOT	1	LS		1,000		
	Testing & permitting	1	LS		3,000		
	Contingency	1	LS		20,000		
Subtotal						$ 34,000	
Const Subtotal							$ 138,000
Soft Costs							
	Design, geotechnical & permitting	1	LS	25,000	25,000		
	Permitting fees	1	LS	6,000	6,000		
Subtotal						$ 31,000	
Project Total Design & Const Costs							$ 169,000
Annual Costs over 20yr @ 5%							$13,800

FDOT Stormwater Reuse Study
City of Haines City
Maintenance Costs (Conceptual Level)

ANNUAL MAINTENANCE COSTS

		Quantity	Units	Unit Price	Amount		
Pumping Station							
	Chemical Hypochlorite	800	GAL	3.00	2,400		
	Routine maint (2 hr/month)	24	HR	45.00	1,080		
Subtotal						$ 3,500	
Site Work							
	mowing (1.5 hr @ $60/hr per event)	18	EA	90	1,620		
	aquatic weed removal (15 hr @ $260/hr once every three yrs)	5	HR	260	1,300		
Subtotal						$ 3,000	
					-		
Utilities					-		
	Electric	12,000	kWhr	$ 0.15	$ 1,800		
	Comm	0	Month	$50	-		
Subtotal						$ 1,800	
Total Annual Maintenance Costs							$ 8,300

7.7 End-User's Capital Cost Reductions through Grants

With the funding sources mentioned in Section 4.3, all of the stormwater reuse End-Users will have the potential to actively seek out capital cost funding assistance. In conjunction with the conceptual cost estimates contained in this Section, the End-Users have a potential to receive up to 75% of the construction costs in the form of a Grant. The End-Users may then only be accountable for design/permitting fees and 25% of the construction costs, which would significantly reduce the capital financial burden to the End-Users. While 75% grants may be achievable, 50% grant subsidies are more typical. For TMDL and Section 319 Grants, the additional water quality monitoring and reports that are a required portion of the grant funded project may increase the overall project costs slightly, however, the grants that will be received as a completion of those activities will heavily outweigh the monitoring and reporting costs. By reducing the capital costs through grant funding, the bulk rate cost of the harvested stormwater could be reduced by up to $0.50 per 1,000 gallons depending on the capital costs of the delivery infrastructure and safe yield of the harvesting operation. For all intent and purposes, the economics of whether stormwater can be reliably delivered at a clearly lower rate than the End-User can currently deliver to its customers will be an important deciding factor as to whether a partnership will be formed.

7.8 WMD and FDEP's reaction to the 3 selected Projects

There are three purposes of these discussions with information based on current policies and procedures for Stormwater Reuse within a Florida Water Management District (WMD) and the Florida Department of Environmental Protection (DEP).

1. The first is to document the permit process and any obstacles to obtaining permits for SWR projects.
2. The second is to determine any other regulatory issues, such as consumptive and water use permits, and supplemental information for reuse systems, and
3. Document funding opportunities from either FDEP or WMD for these sites.

Review of Environmental Permit Requirements as well as meetings and phone conversations with FDEP and WMD personnel were the mechanisms for this effort.

There is one project in each of three Water Management Districts. The project review meetings were held in February 2013.

7.8.1 Potential Project #1 – Proposed Stormwater Reuse Pond in the City of Ocoee (SR 50)

It is proposed to use stored water from a proposed wet detention pond along SR 50 in the Ocoee area as a supplemental source of water for the City's reclaimed water system. This proposed project is located within the St. Johns River Water Management District (SJRWMD).

Meetings for permit issues were held with Cammie Dewey, stormwater engineer, environmental resource program manager at the central Florida office.

<u>Permitting Stormwater Reuse with Environmental Resource and Consumptive Use Permits</u>

SJRWMD has been permitting stormwater reuse for at least 20 years. The permit is issued based on their current Manual of Practice and the use of the "REV curves" as found in Stormwater Handbook ("Applicant's Handbook: Regulation of Stormwater Management Systems Chapter 40C-42, F.A.C."). An Environmental Resource Permit (ERP) would be required for the project. Sections 14, 20, and 31 apply to wet detention, stormwater criteria, and stormwater reuse systems.

Protection of the surrounding wetlands and provision to limit water use rates are constraints. The use of the SHARP model is beneficial to provide an estimate of water withdrawn from the ground as well as from surface waters. A consumptive use permit (CUP) is needed if the draft from the pond exceeds 100,000 gallons per day on the average. Thus, an ERP and a CUP permit may both be necessary. It is likely that the stormwater reuse pond can generate more than 100,000 gallons per day of reuse water on the average.

The extraction of groundwater at the site would go against the City's CUP because it would be viewed as a water well.

The project doesn't interact with any impaired water bodies, so no TMDL issues are in play.

There may be money available for co-operative funding projects with the City of Ocoee as the applicant. We are encouraged to apply for funding.

Florida Department of Environmental Protection

Chris Ferraro, manager of water resources and Denise Judy, Domestic Wastewater Permitting Manager in the Orlando office were contacted. A minor revision permit form will have to be submitted. The treatment required will be filtration with disinfection. However, the water after disinfection does not have to maintain a residual. If the pond water were to be used on a golf course (or any single user), there is no need for disinfection.

7.8.2 Potential Project #2 - Stormwater Reuse Ponds under construction in the City of Riviera Beach (SR 710)

It is proposed to use stored water from a wet detention pond along SR 710 in the Riviera Beach area as a supplemental source of raw water in a potable water treatment plant. It is located with the South Florida Water Management District (SFWMD).

For treatment options and alternative water supplies, phone calls were made with Stacy Adams and Gary Ritter SFWMD special project directors. In addition, Tony Waterhouse, SFWMD Director of Environmental Resource Permits was contacted relative to the permit process and the "streamlining" processes. This is a new concept but the process for a permit to use stormwater (surface water) will follow the standard one for any surface water source.

Permitting Stormwater Reuse with Environmental Resource and Consumptive Use Permits

The pond area and volume has to be documented using simulations to show the design size of the pond and the effects on the adjacent areas. Ultimately the project would need to be run through the Regional model to determine the geo-hydraulic impact of the project. There is no adjacent vegetation that would be affected by a removal of surface waters at the site. There is however groundwater that may infiltrate into the pond when water is withdrawn thus water quality and salinity levels must be documented. According to the DOH, there is no need for disinfection before entering the raw water supply line.

It was noted that the withdrawal of the stormwater runoff from the pond is not a part of the CUP, but the extraction of groundwater at the site would go against their CUP because it would be viewed as a well field.

The project doesn't interact with any impaired water bodies, so no TMDL issues are in play.

At this time, there is no plan for funding this type of project, but the team recommends sampling of the water extracted from horizontal wells. Also, it is recommended to apply for funding using innovative grant and demonstration applications. The raw water supply for the City is primarily from the surficial aquifer and SWR facility can be part of its well field.

Palm Beach County Health Department

For this type of stormwater reuse project in this location, the FDEP would delegate approval to the Palm County Health Department. Discussions were conducted with Mr. Lefevre (senior manager) who had misgivings about pumping stormwater directly into the City's raw waterline without disinfection. When asked if he could approve the project if disinfection were added, he indicated that he would need to understand the water quality issues better before he could approve such a project.

7.8.3 Potential Project #3 - Existing Wet Detention Pond in Haines City (US 27)

There is an existing wet detention pond constructed and the retrofitting of infrastructure is recommended to create a harvesting pond. Irrigation water is proposed from the pond for the local area. This proposed project is located within the Southwest Florida Water Management District (SWFWMD).

A meeting for permit issues in the District was held with alternative water supply staff, namely .Mario Cabana, and Paul Andrade, District Reuse Coordinators relative to designation of this site as an alternative water supply. Also a telephone conversation was held with Richard Alt, Director of Environmental Resource Permits on specifics related to an ERP permit. Meetings were also held with Veronica Craw, Springs and Environmental Flows Section Manager. She is the initial contact for a cooperative funding applications in the Haines City area. The funding applications are usually submitted in October of each year.

Permitting Stormwater Reuse with Environmental Resource and Water Use Permits

For the existing pond, the quantity of water proposed for irrigation is less than 100,000 gallons per day. There is an existing permit. Thus there is no need for another ERP, provided the withdrawal is less than 100,000 gallons per day. However, a letter modification to the existing permit should be filed to document the change in pond operation. The letter should mention the value to the community from the additional treatment provided. It is understood that the reuse water will replace potable water, thus saving the City valuable water supplies. The letter should not be very time consuming or detailed to complete.

There is no need for a Water Use Permit (WUP). This District calls the Consumptive Use Permit (CUP) a WUP. The conditions for a WUP applies to intakes lines which are more than 4 inches in diameter, or the receiving water has a minimum low flow (MLF) restriction, or is considered “stressed”, meaning in need of water. The pond discharge is to Lake Mehaffey, and it is not on the stressed or MLF lists of water bodies.

The project doesn't interact with any impaired water bodies, so no TMDL issues are in play.

CUP or WUP Permits

There is agreement among the Districts that a CUP or WUP (SWFWMD) is needed when the reuse rate exceeds 100,000 gallons per day on the average.

A project funding opportunity is available for all three sites from the Florida Department of Environmental Protection through their 319 program. All three projects would qualify for funding and must be submitted by a local municipality. This is a cost matching program and the applicant is usually a City or County with matching monies from another entity. The FDOT would not be the applicant. Instructions for application and other data are found at: http://www.dep.state.fl.us/water/nonpoint/319h.htm. Proposals are usually due the end of May for funding in the following year.

Point-of-Interest: Based upon discussions and presentations to the WMDs and FDEP, there are moderately strong indications that all three projects would be permittable and eligible for grant funding.

7.9 SHARP Modeling Results for Draw-Down and Yield

Yield and Drawdown Data for the Ocoee, Riviera Beach and Haines City Ponds

The purpose of the information in this section is to provide an estimate of the pond yield and extent of drawdown for the watershed and rainfall conditions of each location. In the three selected locations, the pond water from the highway right-of-way is an alternative water supply. The yield is the volume of water extracted from the pond location. The yield depends on many factors. Two of the more critical factors are the pump control elevation or the draw-down elevation of the supply pipe and the groundwater water levels in the potentially affected area. There is a choice of control elevations at which to set the level of drawdown. The lower a control elevation, the greater the yield. However when the control elevation is below the pond normal water elevation, there is most likely a decrease in groundwater in areas adjacent to the well.

The method of withdrawal is a horizontal well. It consists of perforated or slotted pipe placed in a horizontal trench at a control elevation around a pond. The distance of the trench from the pond edge is generally greater than 3 feet but less than 10 feet. There is preferential pollution control and flow media used between the pond and the trench. The media is used to provide filtration and sorption of the pond water and any groundwater that may be mixed with the pond water as the water enters the well.

If the control elevation for withdrawal is set at or above the normal water table depth, there is a minor amount or no groundwater extracted. In most cases, groundwater may be recharged from a pond to the ground when pond levels are consistently above the normal groundwater, but the amounts are generally small compared to a surface water discharge.

When the horizontal well pipe is set below normal ground water levels, groundwater withdrawal is added to the yield. The drawdown can affect the surrounding vegetation or water movement in an area, such as salt water intrusion, and thus any withdrawal must be considered within that which is considered as a safe yield. To address the depth to which the water table is lowered, an analytical approach to related pumping rates at different pump control elevations are evaluated at all three sites. An unconfined aquifer which is believed to be the physical case for all three locations is assumed for analysis. The aim is to present data showing the fraction of the yield or water reused from a pond that is from runoff, rainfall on the pond, and groundwater. In addition the extent of the drawdown is also estimated.

The yield from each pond was determined based on the average yearly condition. The average rainfall is used to estimate a long term average pond yield. The average rainfall is also important in determining the extent of drawdown of the surrounding water table in an average year. Thus a 24 hour rainfall or cumulative rainfall in a season is not used because a year of data provides a more accurate estimate of the average yield. A year with a lower rainfall can be used but then only provides data for that one year. Thus an average year is used to provide for a long term estimate of yield and drawdown effects.

The drawdown distance from the pond without any other input of water to the ground is also assumed as the worst condition of drawdown. Thus with a horizontal well the drawdown is estimated for the side of the pond that is not influenced by the pond water that may be infiltrating downward from the pond bottom or sides.

The three pond locations are unique in terms of their watershed condition, location of the pump control elevation with respect to the pond water levels, and the use of the water. The yield from each pond is determined by the runoff and rainfall in the area, the soil conditions around the pond, the pump control elevation in addition to the use of the water. Design parameters for the three locations affecting the yield and drawdown are shown in Table 1.

Table 1. Design Conditions for Yield and Groundwater Drawdown Estimates

Input parameter		Ocoee SR 50 Lake Bennet	Riviera Beach SR 710	Haines City SR 27 Lake Mehaffey
Location of Project	Lat/Long	25.98N 80.36W	26.76N 80.07W	28.12N 81.63W
Catchment Area	Acres	37.8	6.84	4.04, 6.14
Impervious Area	Acres	25.5	3.58	1.94, 1.94
SHWT Elevation	Feet	116.0	6.2	126.3
Semi Impermeable elevation	Feet	90.0	0	90.0
Pond Area @ discharge	Acres	4.6	1.72	1.8
Initial Pond Elevation	Feet	116.0	12	126.3
Discharge Elevation	Feet	118.0	15	127.6
Permanent Pool Elev.	Feet	114.0	10	126.3
Pond Bottom Elev.	Feet	108.0	7.2	123.0
Ground Elevation	Feet	122.0	17.0	133.5
Water Use		Supplement Reclaim	Water Treatment	Irrigation
Discharge	Type	Weir	Pump	Weir/orifice
Pump Control Elevation	Feet	Varies	Varies	Varies
		114, 112, 108, 104	10, 8.5, 7.2, 5	123, 120
Max Length of Well	Feet	2000	1000	500

Management Allowed Depletion		Storage to Control	Raw Water to Control	Irrigation
Rate	gpm	200, 500, 1000	200, 500, 750	100,250
Irrigation Area	Acres/rate	N/A	N/A	2.1, 4.2/0.7in/wk
Hydraulic Cond.	in/hr	8.27	13.9	2.4
Depth of Surface Layer	inches	360	180	720
Soil Type		Sandy	Sandy	A2-4
Meteorological Data		Orlando Airport	West Palm Beach	Winter Garden
Simulation Year		2008	1997	2010

Analytical Approach

Historical analysis on well drawdown is based on vertical wells with steady radial flows with the well at the center and using Darcy's Law. Thus, for horizontal wells, the equations need to be modified to suit the geometry of the well. In a study, Zhan and Zlotnik, 2002 performed three-dimensional, semi-analytical solutions to evaluate drawdown near horizontal and slanted wells with finite screened trench length. The results showed time related responses typical of an unconfined aquifer: the early time period of pumping indicates rapid change in water levels; intermediate time shows flat level, and the last time interval shows a converges to the These type curves. These curves describe flow in an unconfined aquifer based on non equilibrium well pumping equation. The drawdown at the late time period (sufficiently large time) of pumping a horizontal well was similar to a large diameter vertical well (Zhan and Zlotnik 2002).

The removal of water by pumping a well in an unconfined aquifer results in the lowering of the groundwater level surrounding the well. The drawdown at any point surrounding the well is the distance the water is lowered from the initial groundwater level before pumping. The effect is a cone of lowered groundwater level that shows the drawdown with distance from the well. The cone is referred to as the cone of depression, and the outer limit of the cone defines the radius of influence from a specific yield. A simplified drawdown analysis of a horizontal pumping well at steady state condition was used to simulate the cone of depression. The model is executed using a Microsoft Excel program. An example of the drawdown field is shown in Figure A. Horizontal wells can produce between 0.20 to 0.75 gpm/linear foot of well.

References

Zhan, H. and Zlotnik, V.A., 2002. “Groundwater flow to a horizontal or slanted well in an unconfined aquifer”; Water Resources Research, vol. 38, no. 7.

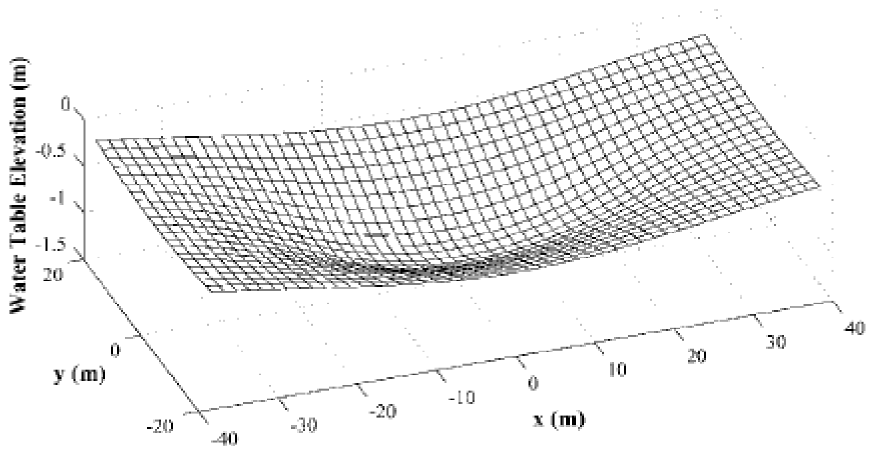


Figure A - General Schematic of the Groundwater Levels Adjacent to a Horizontal Well

Yield and Drawdown Analysis Modeling for the three Reuse Ponds

SR 50 Pond near Lake Bennet in the City of Ocoee

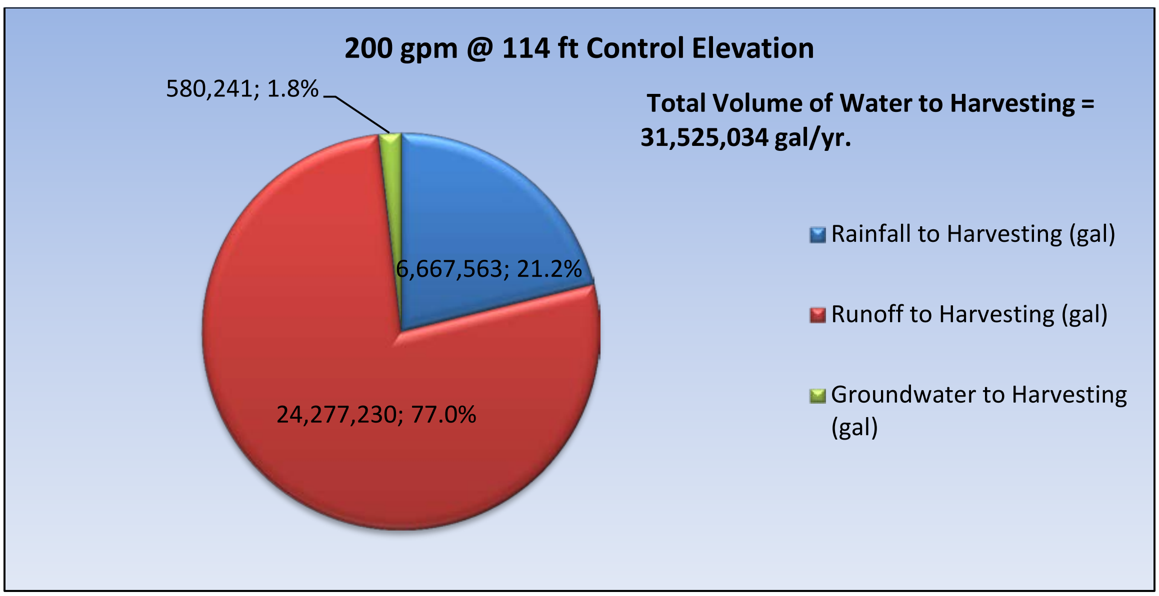
This site is used to supplement the reclaimed water supply of the City. Thus, the horizontal well is appropriate in the sense that it provides for filtration as required by regulation. There is no specified quantity of reuse, thus three different reuse rates and four different pump control elevations will be examined to offer the City a choice of how much water is available at different rates and pump elevations. Also, to minimize flooding at nearby Lake Bennet, a high pond discharge elevation is set and with reuse from the pond, less water goes into the Lake. In fact with all reuse pump elevations and volumes, no water is discharged to the Lake. The permanent pool elevation of the pond is 114 feet, with a bottom at 108 feet. Thus the highest pump control elevation is set at 114, and other control elevations are set at 112, 108 and 104 feet. For three different harvest rates and four pump control elevations, the annual harvested yields are shown in Table 2. The lower the pump control elevation, the greater the yield. At the higher pump control elevations (114 and 112), the yield does not depend on the pump rate because the reuse water is limited by only that available from runoff and rain on the pond. However, at deeper pump control elevations, groundwater is available for reuse and the rate of pumping can exceed the volume from stormwater at the higher rates of pumping and thus affect the yield, and the specifics of any possible CUP.

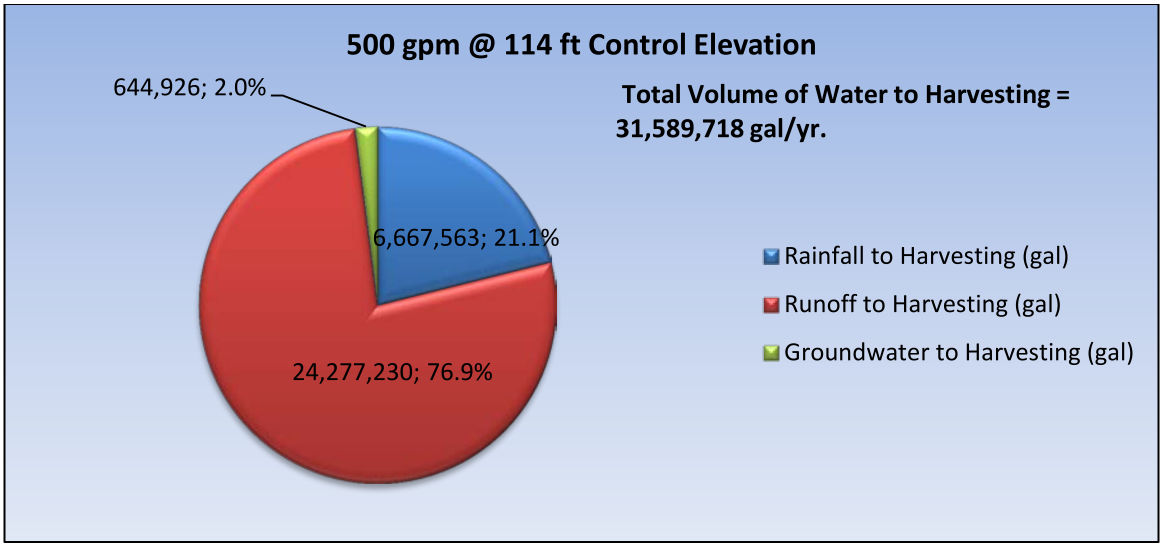
Table 2. SR 50 Pond Annual Yields for Four Pump Control Elevations and Three Harvest Rates

Pump Control Elevation (ft)	Harvesting or Pump Rate (gpm)	Annual Yield (gallons)
114	200	31,525,034
	500	31,589,718
	1000	31,656,703
112	200	37,497,124
	500	37,555,396
	1000	37,579,229
108	200	55,273,020
	500	66,143,912
	1000	83,657,850
104	200	106,834,740
	500	264,736,776
	1000	528,064,807

For the SR 50 pond, the percentage of water from runoff, rainfall on the pond and groundwater is calculated as shown in Figures 1-4. Each Figure representing a pump control elevation and three pumping rates. The pumping rates were selected based on the maximum length of horizontal well around the pond and the range of extraction that can be expected when using a horizontal well. The average is 0.50 gallons per minute/linear foot (gpm/LF) of well with a minimum of 0.2 gpm/LF. For all three sites, 0.50 gpm/LF is reasonable based on the soil types. The horizontal well distance can be at least 1000 feet and 2000 feet is the maximum.

At the 114 foot pumping elevation which is the pond permanent pool elevation, the supply of water is primarily from stormwater and rain water which falls on the pond (see Figure 1). There is limited groundwater for reuse. A small increase is noted at the higher pumping rate because the reuse water is removed faster relative to the lower rates allowing more but limited groundwater to infiltrate into the pond. The daily average yield is about 31.5 million gallons per year or 86,000 gallons per day (gpd) for all three pumping rates.





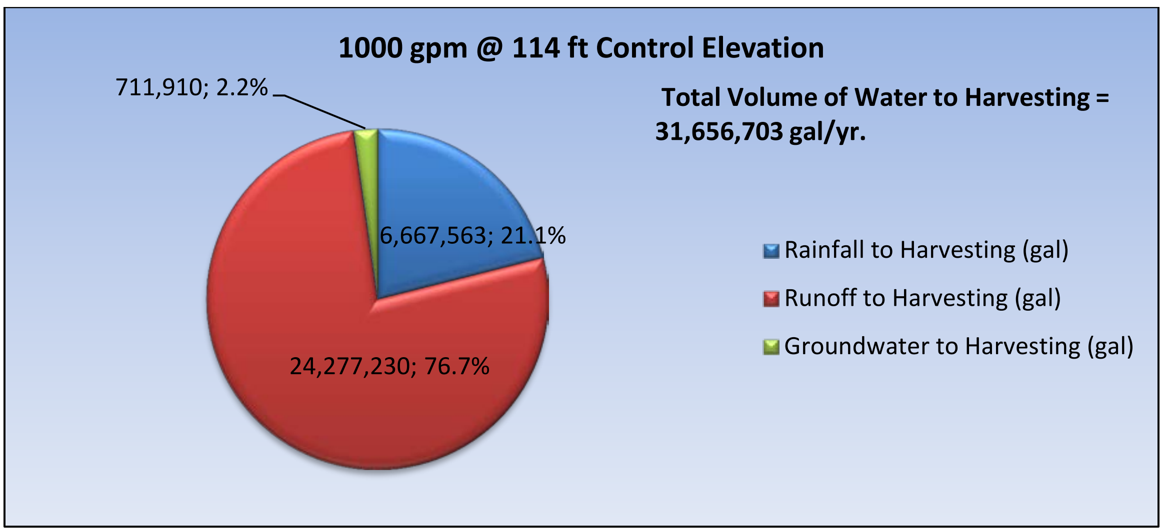


Figure 1 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 114 feet at SR 50 Pond in the City of Ocoee

Shown in Figure 2 are the percent of yield from the groundwater, runoff, and rainfall on the pond with annual yield when the pump control elevation is at 112 feet or 2 foot below the permanent pool elevation. At this elevation, the horizontal well has groundwater input. However groundwater input does not significantly change with pumping rate because the pump control elevation is only two feet below the permanent pool elevation. The daily average yield is about 103,000 gpd.

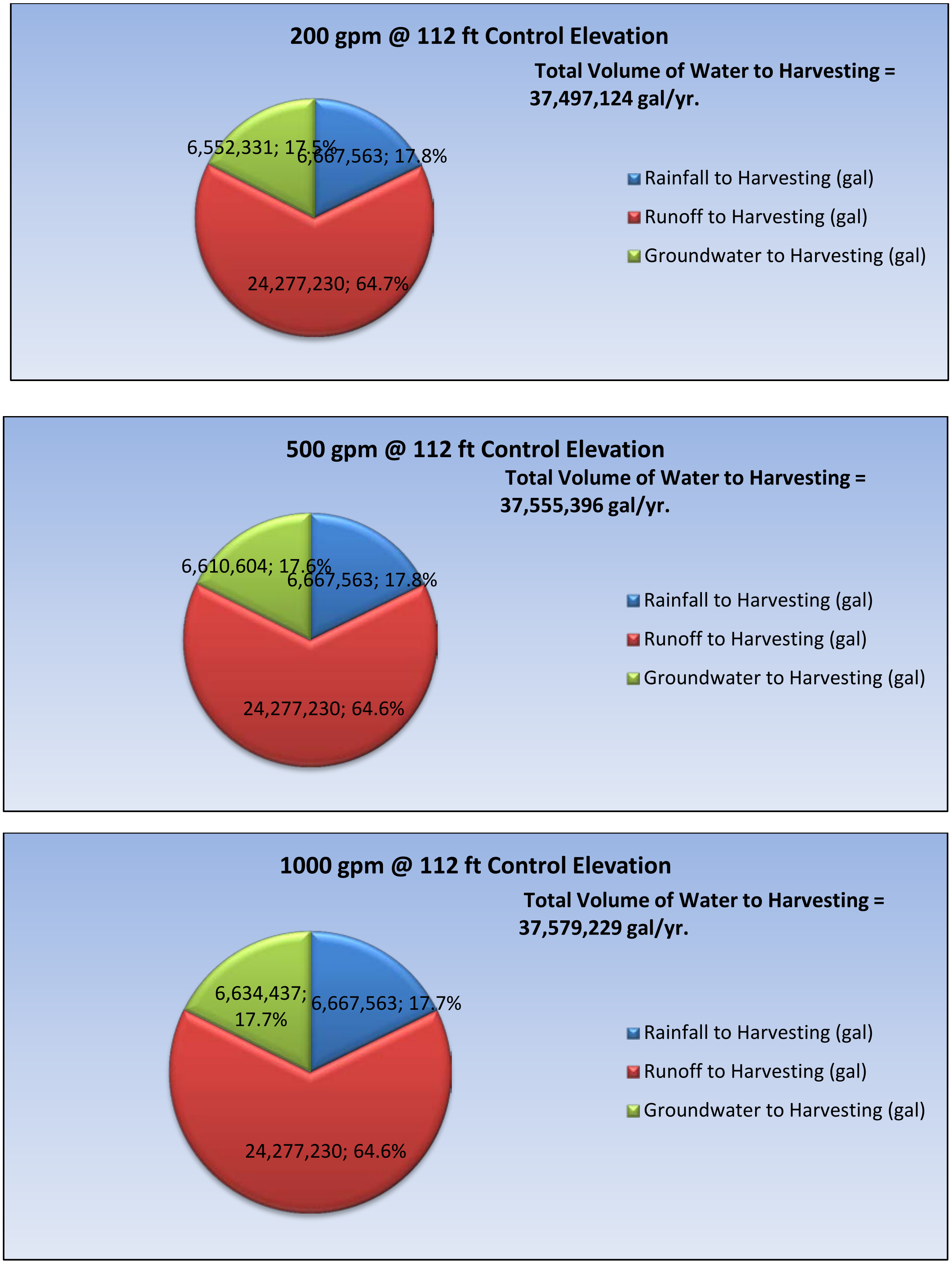
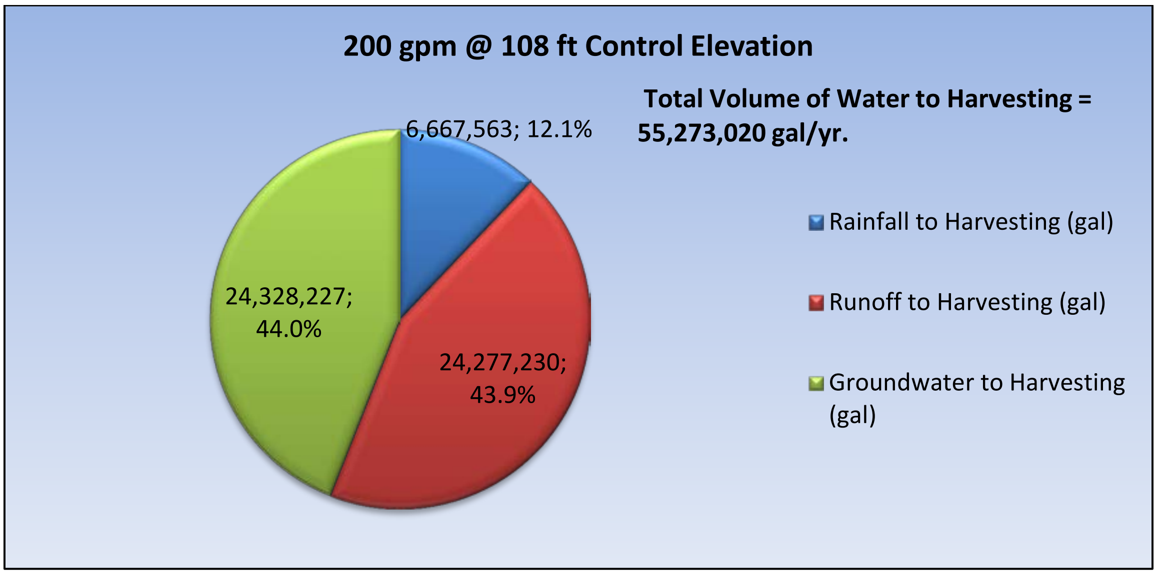
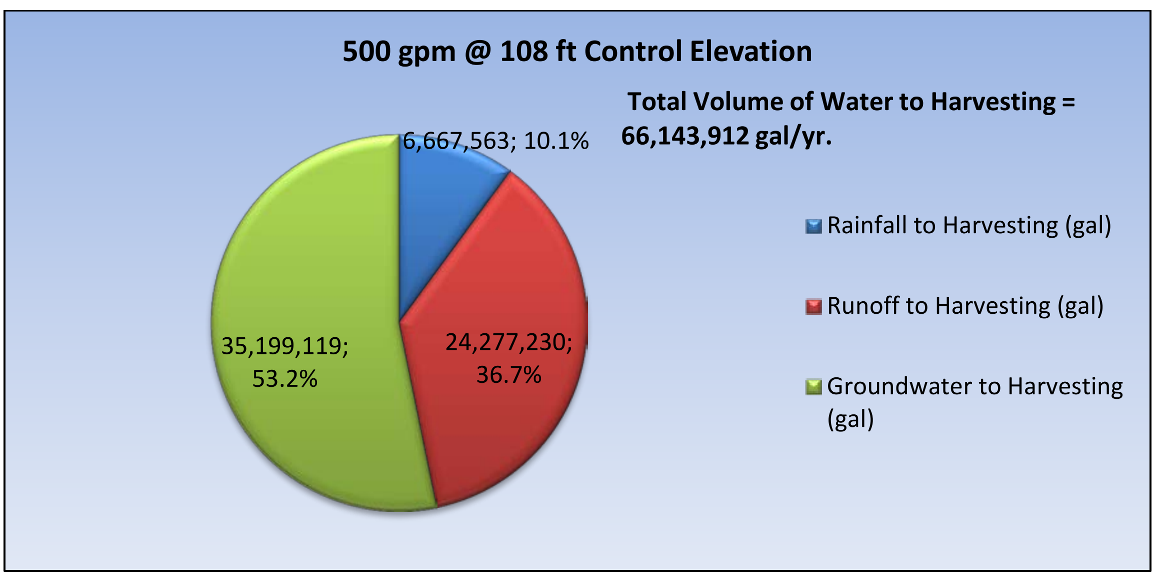


Figure 2 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 112 Feet at SR 50 Pond in the City of Ocoee

Shown in Figure 3 are the percent of yield from the groundwater, runoff, and rainfall on the pond with annual yield when the pump control elevation is set at 108 feet or at the bottom of the pond. At this elevation, the horizontal well has groundwater input and it increases with increasing pumping rates. The daily average yield is about 151,000 gpd at a pump rate of 200 gpm, 181,000 gpd at 500 gpm, and 229,000 gallons per day at a pump rate of 1000 gpm.





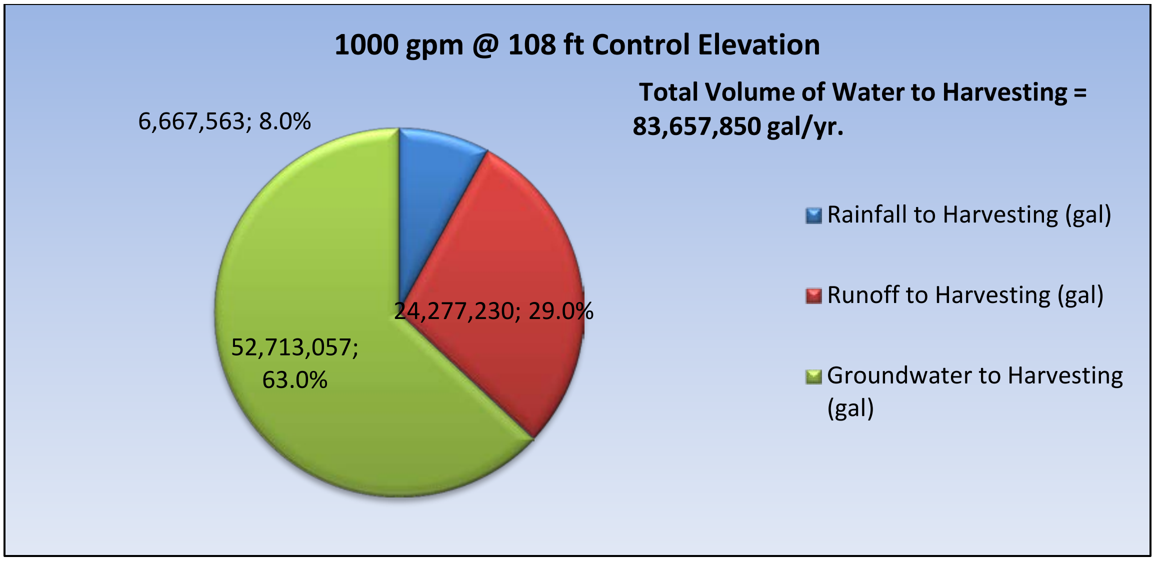
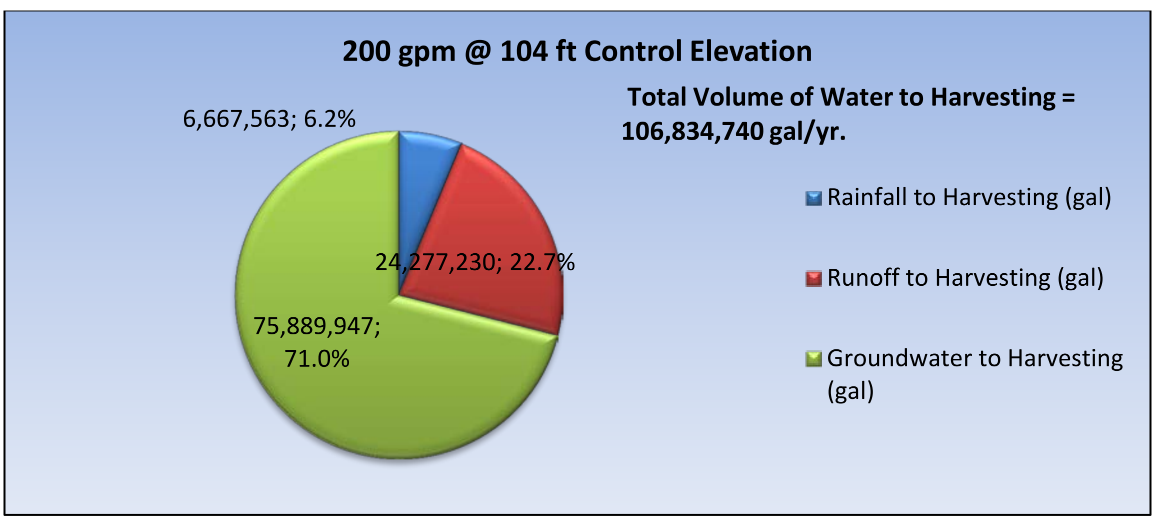
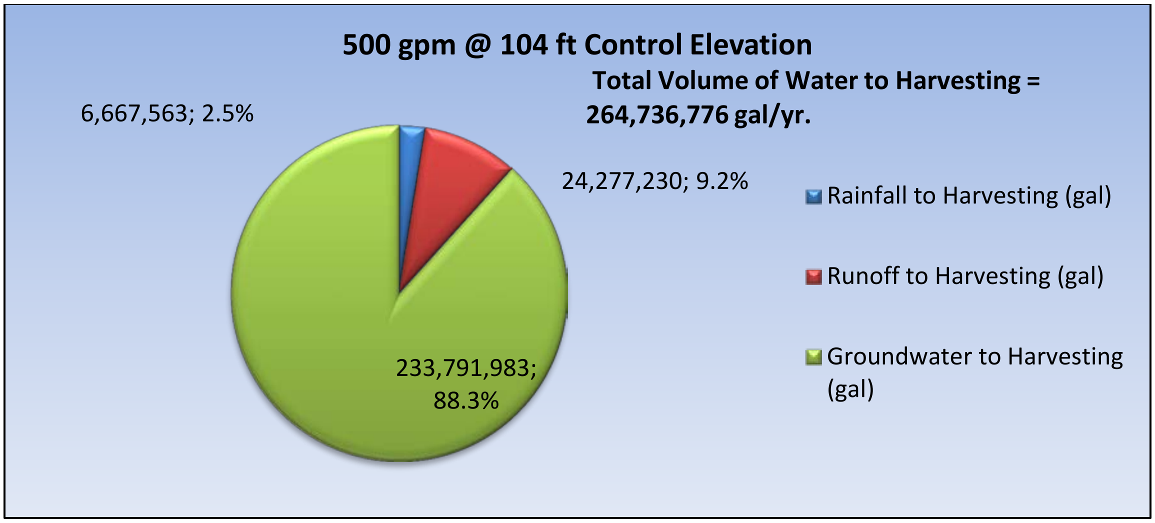


Figure 3 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 108 Feet at SR 50 Pond in the City of Ocoee

Shown in Figure 4 are the percent of yield from the groundwater, runoff, and rainfall on the pond with annual yield when the pump control elevation is at 104 feet or 4 feet below the pond. The daily average yield ranges from about 290,000 gallons per day at a pump rate of 200 gpm to 1,440,000 gallons per day at a pump rate of 1000 gpm. The limitation at this depth is the length of the horizontal well as the yield is from the pump working 24 hours a day, every day of the year. The horizontal well for this SR 50 pond area can yield significant quantities of water.





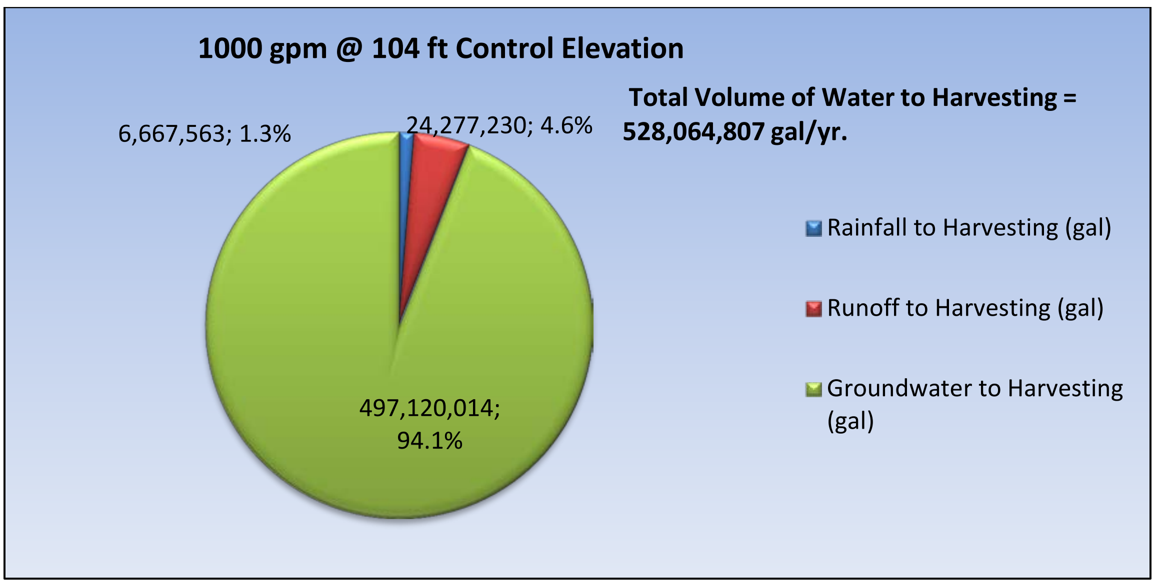


Figure 4 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 104 Feet at SR 50 Pond in the City of Ocoee

The maximum radius of influence for the three pumping rates is shown in Table 3. There does not appear to be any sensitive vegetation within the radius of influence at any of the pumping rates.

Table 3 Well Radius of Influence for SR 50 Pond Near Lake Bennet in the City of Ocoee

SR 50 City of Ocoee, Lake Bennet Groundwater Recovery			
Pump Rate (gpm)	200	500	1000
Radius of Influence (ft)	304.4	481.3	680.7

Flooding is a consideration since the pond may discharge to Lake Bennet. By operating the pond at a lower elevation (below the discharge of 118), storage volume will be available for extreme rainfall events. For an average pond area of 3 acres with a pump elevation at the pond bottom, the pond provides storage of 9.5 inches of rainfall when the total watershed of 37.8 acres contributes runoff or 14 inches when only 25.5 acres of impervious area contributes. Over 24 hours at the site, the 25 year rain event is about 8.5 inches, and the 100 year is about 11.5 inches. For all reuse pump elevation settings there was no discharge to the Lake resulting in a 100% reduction in pollution loading such as nutrients and suspended solids to the Lake, and the added benefit of reducing the flooding potential during the average rainfall year.

In summary, it is recommended to use a horizontal well at 500 gpm and a pump control elevation of 108 (bottom of pond). This rate and pump elevation can reasonably supply about 66 million gallons of water a year as a supplement to a reclaimed water supply. The maximum radius of influence is less than 500 feet, and there is no environmental sensitive area within 500 feet of the horizontal well. Thus the safe yield based on the local area modeling presented here would be 66 million gallons per year or 180,000 gallons per day on the average. To supply 66 million gallons per year, the percentage from groundwater is 53.2, and that from runoff and rainfall on the pond is 46.8. There are various other yields that are possible with other pump control elevations and pump rates. A regional model of inputs and withdrawals can be used with the results of this model to determine if there is any regional affects. This analysis also gives the City other options to consider when deciding on flood control and reuse water demands.

SR 710 Pond in Riviera Beach

This site is used to supplement the raw water supply of the City. When the existing water supply wells are not in operation or are in need of "resting", an alternative water supply must be used. Thus, the horizontal well in the area of a stormwater pond is appropriate in the sense that the water from stormwater and the adjacent groundwater provides an alternative water supply. The raw water is also filtered with a horizontal well and the treatment cost is reduced.

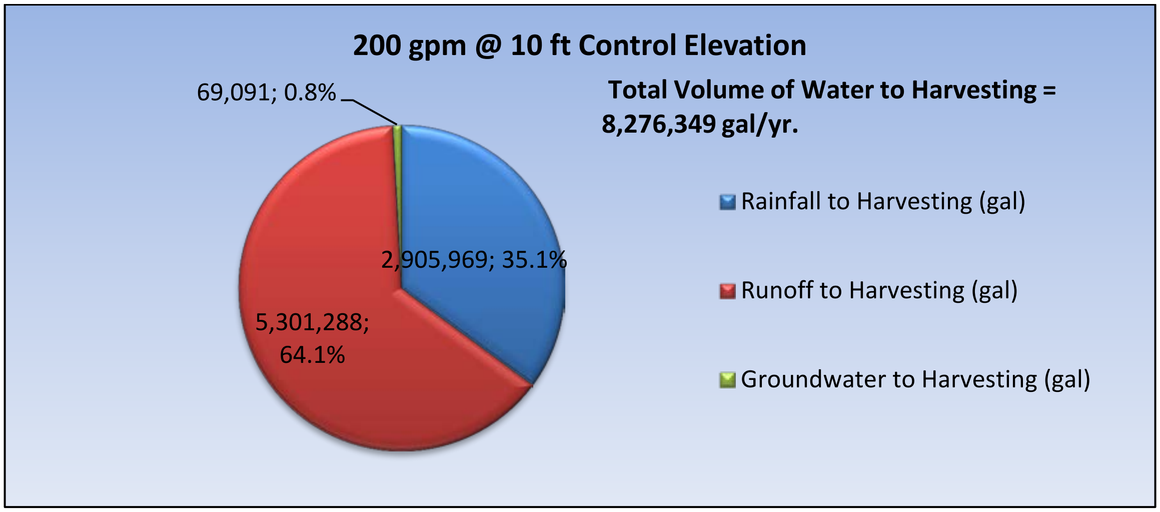
There is no demand quantity of reused stormwater specified at this time, thus three different reuse rates and four different pump control elevations will be examined to offer the City a choice of how much water is available at different rates and pump elevations. The permanent pool elevation of the pond is 10 feet and the pond bottom is at 7.2 feet. Thus the highest pump control elevation is set at 10, and other control elevations are set at 8.5, 7.2 and 5.0 feet. For three different harvest rates and four pump control elevations, the annual harvested yields are shown in Table 4. The lower the pump control elevation, the greater the yield. At the higher pump control elevations (10 and 8.5), the yield does not depend on the pump rate because the reuse water is limited by only that available from runoff and rain on the pond and to a lesser extent on the groundwater. However, at deeper pump control elevations, groundwater is available for reuse and thus affects the yield. Note: All runoff water was used for the raw water supply because the control elevation was set high (15') relative to the permanent pool (10') and the extraction schedule was once a day, if water was available. Thus there was a 100% reduction in pollution as measured by nutrients and suspended solids. There is an added benefit of reducing the flooding potential during the average rainfall year.

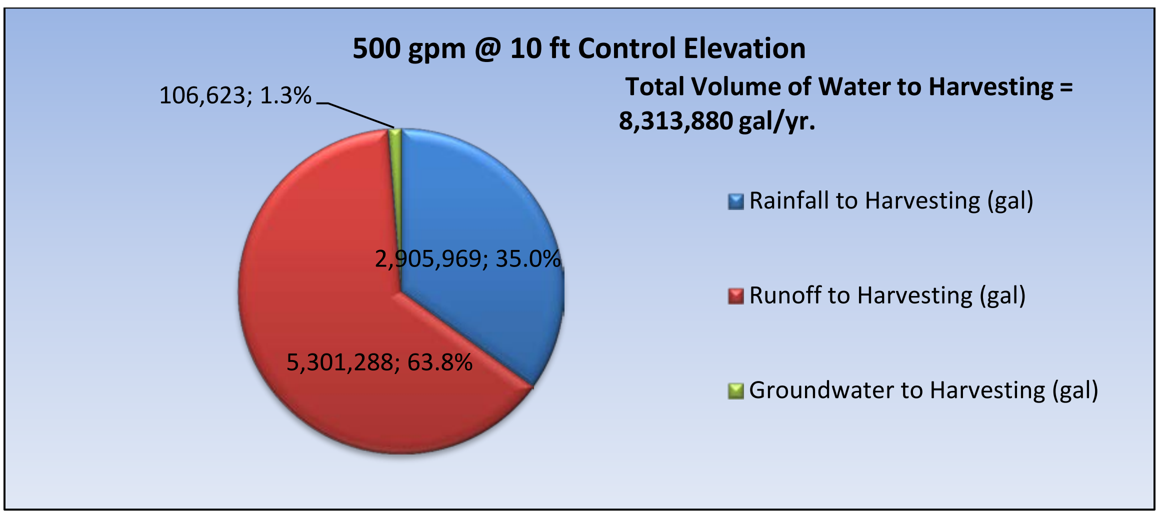
Table 4 SR 710 Pond Annual Yields for Four Pump Control Elevations and Three Harvest Rates

Control Elevation (ft.)	Harvesting Rate (gpm)	Annual Harvested Volume (gal)
10.0	200	8,276,349
	500	8,313,880
	750	8,337,463
8.5	200	9,935,681
	500	9,972,749
	750	9,998,680
7.2	200	17,774,903
	500	24,411,251
	750	29,724,508
	200	105,514,338
5.0	500	263,168,895
	750	394,567,404

For the SR 710 pond, the percentage of water from runoff, rainfall on the pond and groundwater is calculated and shown in Figures 5-8. Each Figure representing a pump control elevation and three pumping rates. The pumping rates were selected based on the maximum length of horizontal well around the pond and the range of extraction that can be expected when using a horizontal well. For this site, the average rate is 0.50 gallons per minute/linear foot (gpm/LF) of well with a minimum of 0.2 gpm/LF and a maximum of 0.75 gpm/LF based on the rock and soil types. Also the horizontal well distance can be up to 1000 feet.

In Figure 5, the percentage of yield from the groundwater, runoff, and , rainfall on the pond are compared at three different pump rates and a pump control elevation at the permanent pool level of 10 feet. There is limited groundwater input and all the stormwater and pond rainfall water available is used with any one pump rate. The average daily yield is 22,700 gallons.





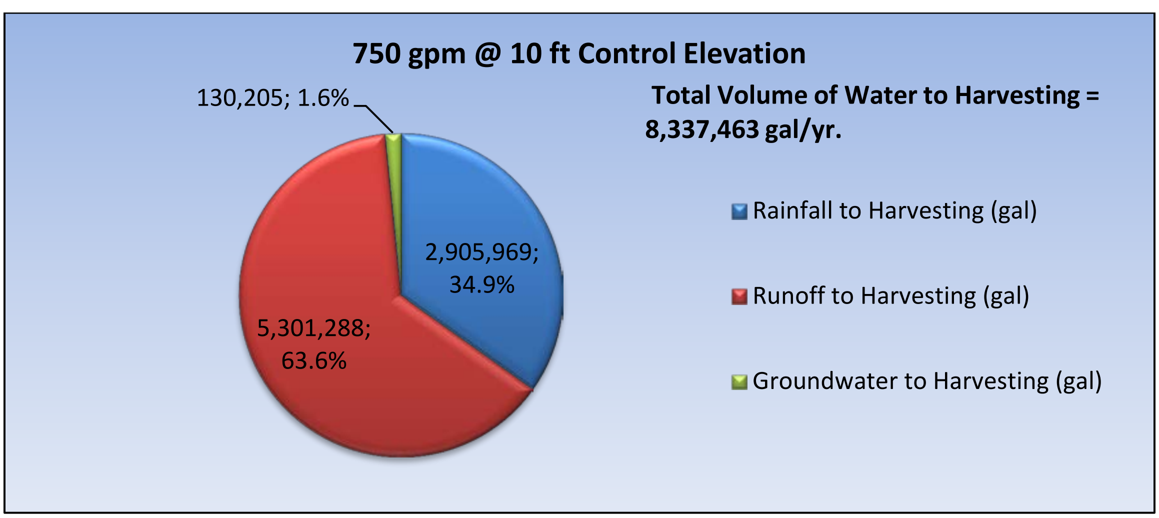
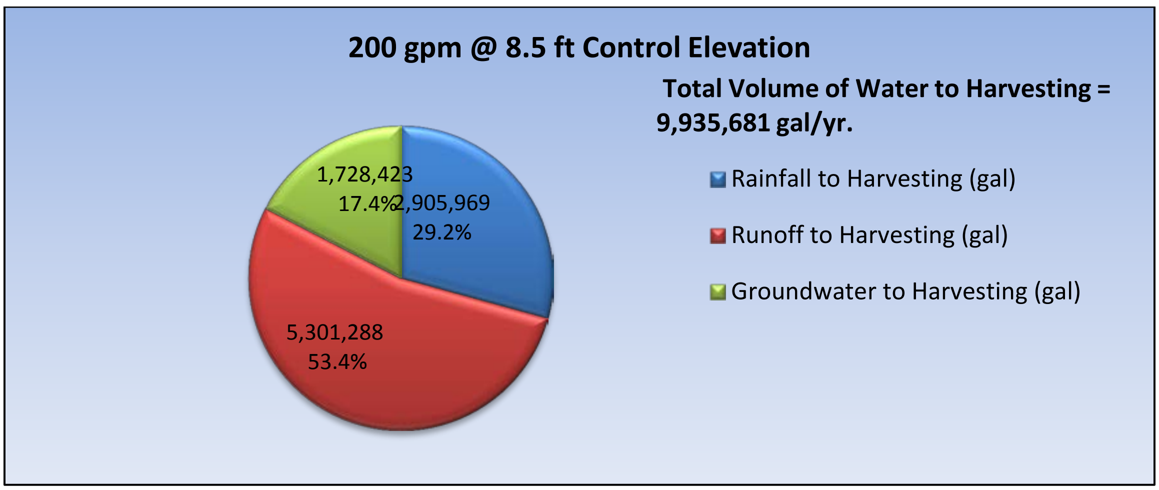
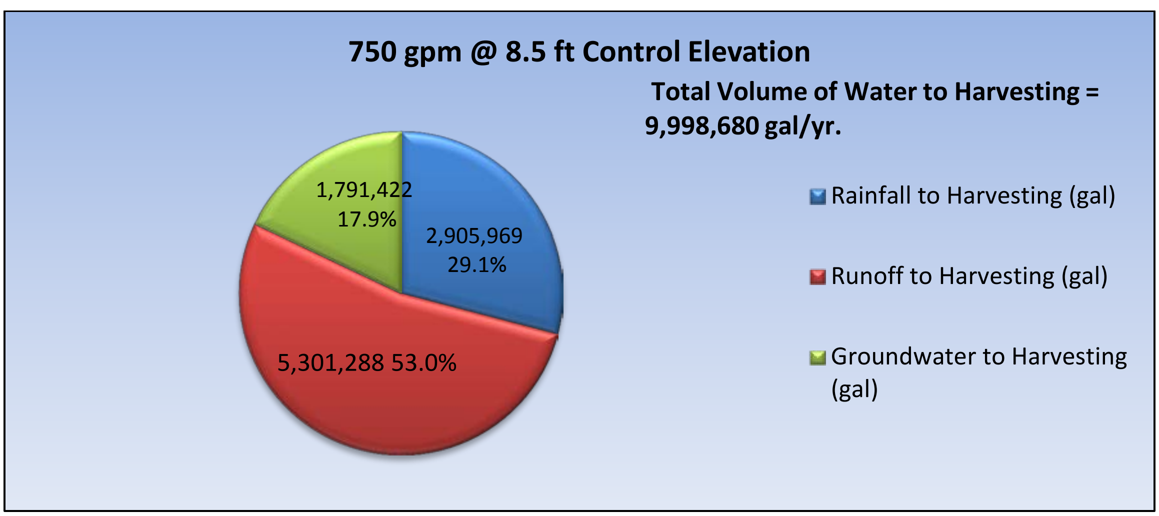


Figure 5 Percentage of Raw Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 10 feet at SR 710 Pond in the City of Riviera Beach. In Figure 6, the percentage of yield from stormwater, pond rainfall and groundwater are compared at three different pump rates and a pump control elevation set at 8.5 feet or 1.5 foot below the permanent pool elevation. At this elevation, the horizontal well has groundwater input, but it does not significantly change with pumping rate because at the lowest pump rate of 200 gpm almost all the groundwater is extracted. The average daily yield is 27,400 gpd.





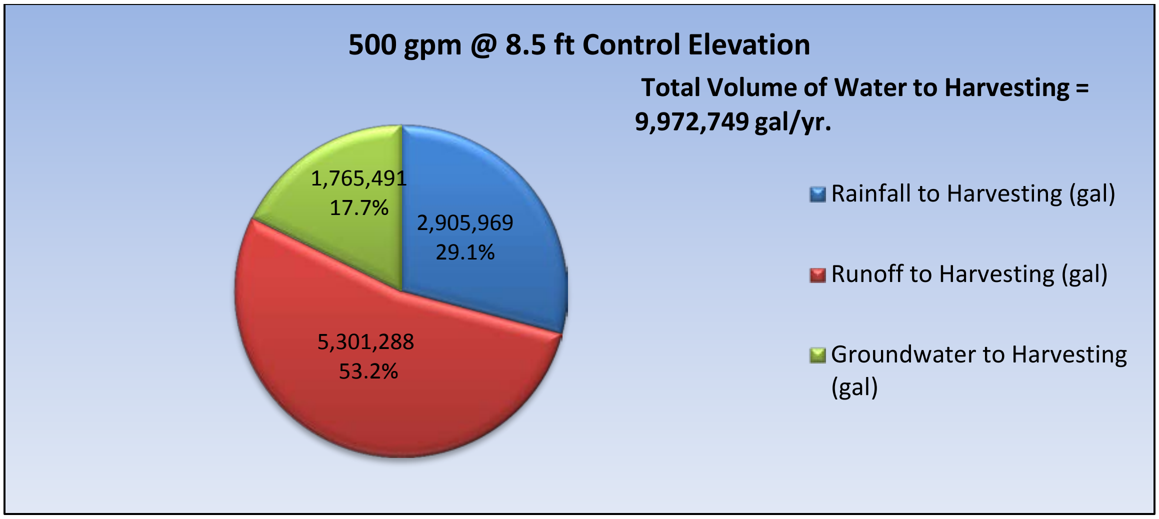
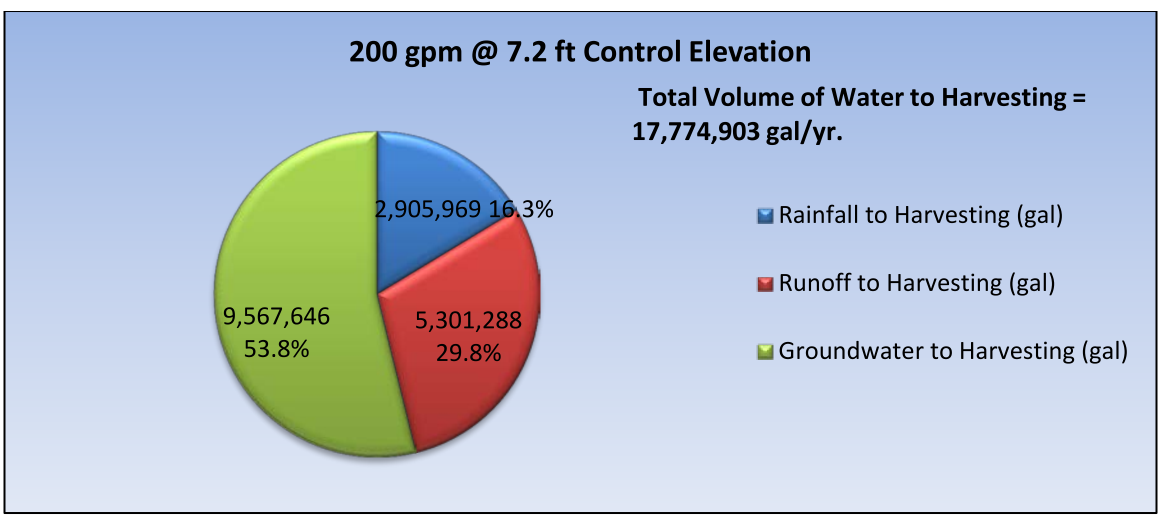


Figure 6 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 8.5 Feet at SR 710 Pond in the City of Riviera Beach

In Figure 7, the percentage of yield from stormwater, pond rainfall and groundwater are compared at three different pump rates and a pump control elevation set at 7.2 feet or the bottom of the pond. At this elevation, the horizontal well has groundwater input, and it does change with pumping rate because there is groundwater available for pumping. The average daily yield at 200 gpm, 500 gpm and 750 gpm is 48,000 gpd, 67,000 gpd and 81,400 gpd respectively.



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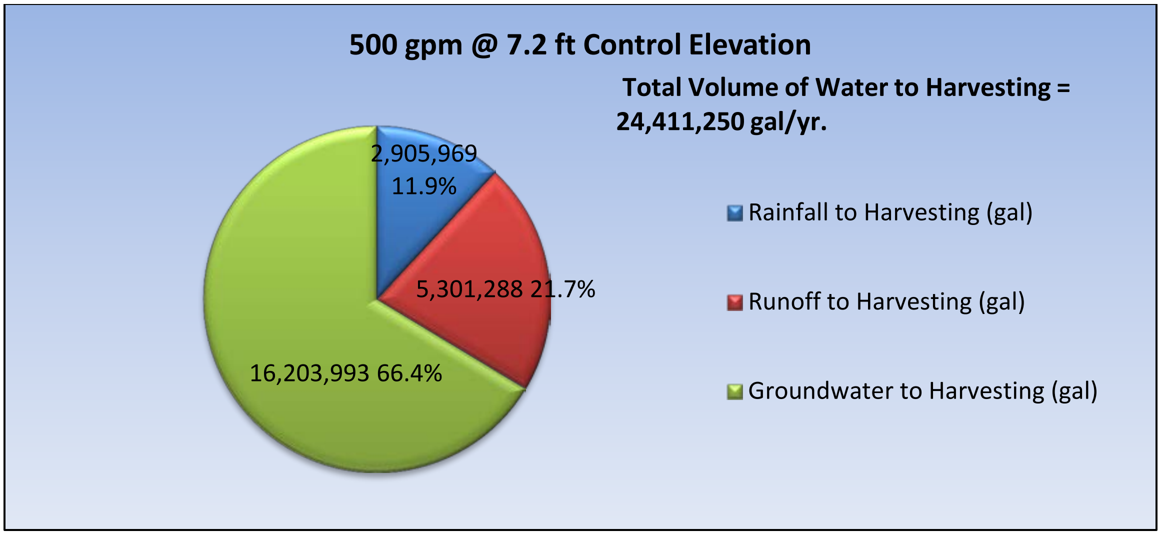


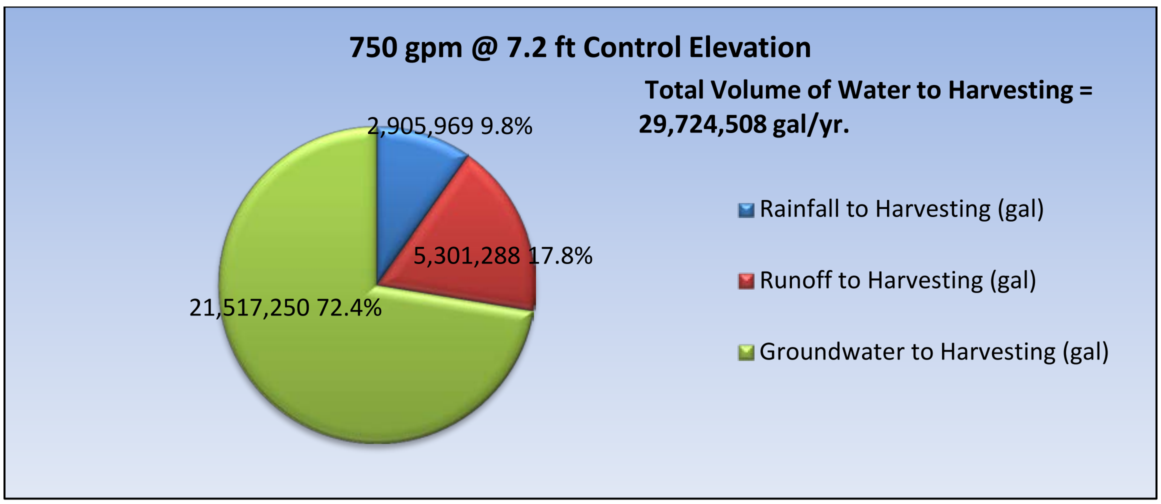


Figure 7 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 7.2 Feet at SR 710 Pond in the City of Riviera Beach

In Figure 8, the percentage of yield is primarily from groundwater at the three pump rates and a pump control elevation of 5.0 feet which is below the bottom of the pond. At 5.0 feet, there is no limit on the groundwater supply at these pump rates, because the pump runs 24 hours a day, 7 days a week. The yield is limited by the pumping rate. The average daily yield at 200 gpm, 500 gpm and 750 gpm is 288,000 gpd, 720,000 gpd and 1,080,000 gpd respectively.

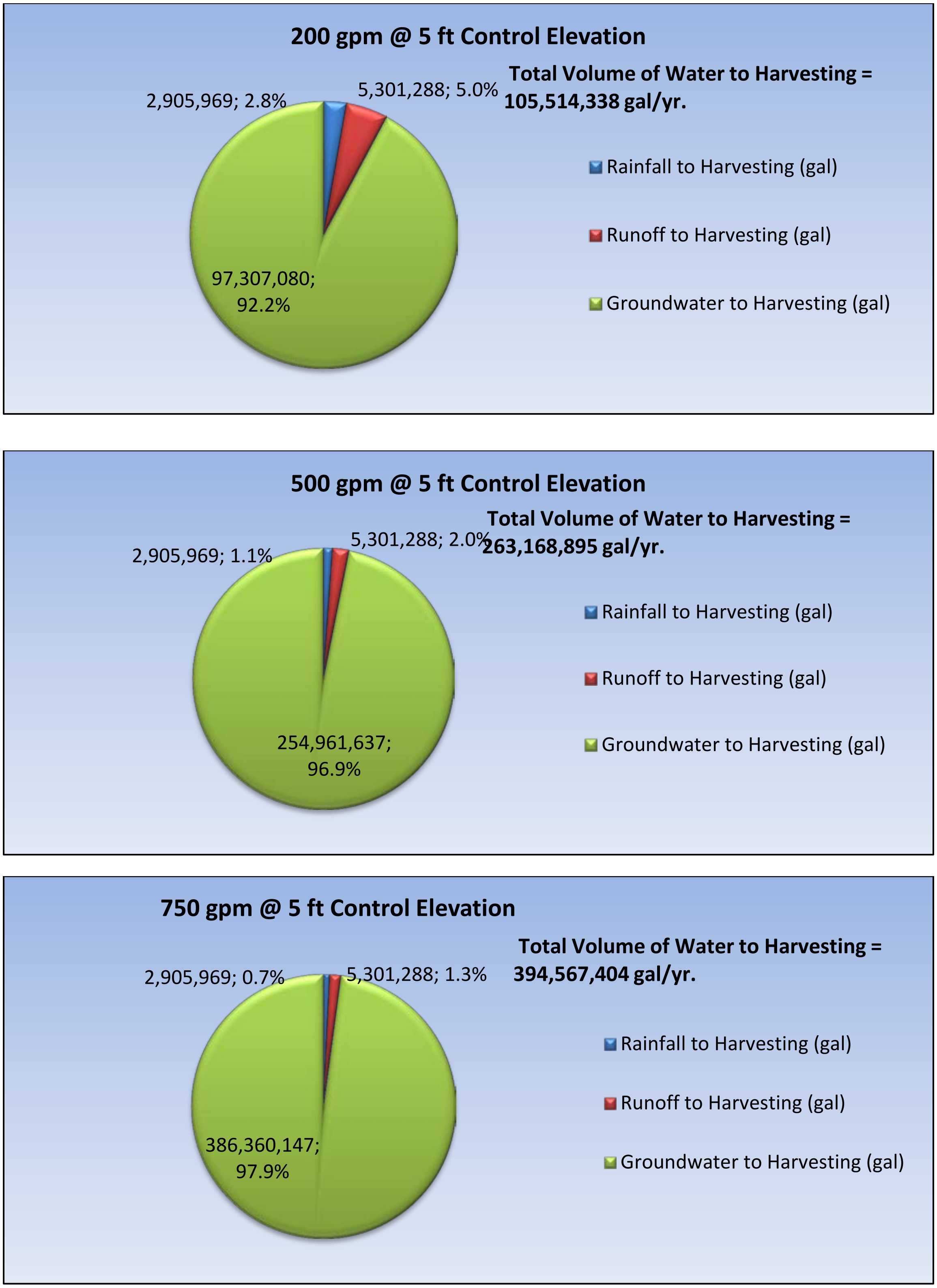


Figure 8 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Three Pumping Rates and a Pump Control Elevation of 5.0 Feet at SR 710 Pond in the City of Riviera Beach

The maximum radius of influence for the three pumping rates is presented in Table 5. There does not appear to be any sensitive vegetation within the radius of influence at any of the pumping rates.

Table 5 Well Radius of Influence for SR 710 Pond in the City of Riviera

SR 710 Riviera Beach Groundwater Recovery			
Pump Rate (gpm)	200	500	750
Radius of Influence (ft)	270.1	427.1	523.0

In summary, it is recommended to use a horizontal well to provide for raw water from the area where a SR 710 pond is located. The well pump depth can be established to provide for primarily stormwater or primarily groundwater. The radius of influence for the well depends on the pumping rate. At 750 gpm or the largest most likely pumping rate the radius of influence is about 523 feet. There does not appear to be any sensitive vegetation within this area, however the amount of water pumped and thus the depth of the pump control elevation will have to be determined from a regional water supply model. The pond site can most likely generate from about 8 million gallons a year to over 100 million gallons per year. This analysis also gives the City other options to consider when deciding on raw water supply as well as reuse water demands.

US 27 Pond in Haines City

This is an existing pond. Upon site visit, the condition of the fence and debris and plants in the pond indicate the need for maintenance before a reuse system is put in place. There is electrical service close by to facilitate pump operation. Debris, unwanted vegetation or cat tails and accumulation of soil must be removed from around the inlet area. Once maintained, the pond water can be reused for irrigation.

The watershed is primarily highway with some areas adjacent to the highway and highway median areas in need of irrigation. The watershed area is 1.94 impervious acres.

There are two irrigation areas that are probable, one is an FDOT area of 2.1 acres and the other is for an additional potential irrigation area of 2.1 acres outside of the FDOT right-of-way. There are other nearby areas within the City in need of irrigation, but no exact locations have been decided upon. The feasibility of providing reuse water for irrigation under two irrigation options will be determined. The primary questions are:

1) Is there sufficient water available for irrigation during an average rainfall year in the wet detention pond along US 27?
2) If so, how much can be supplied for both irrigation areas (2.1 and 4.2 acres)?
3) What portion of the irrigation water will come from stormwater to include rainfall on the pond?
4) How much of the irrigation water will come from the groundwater?

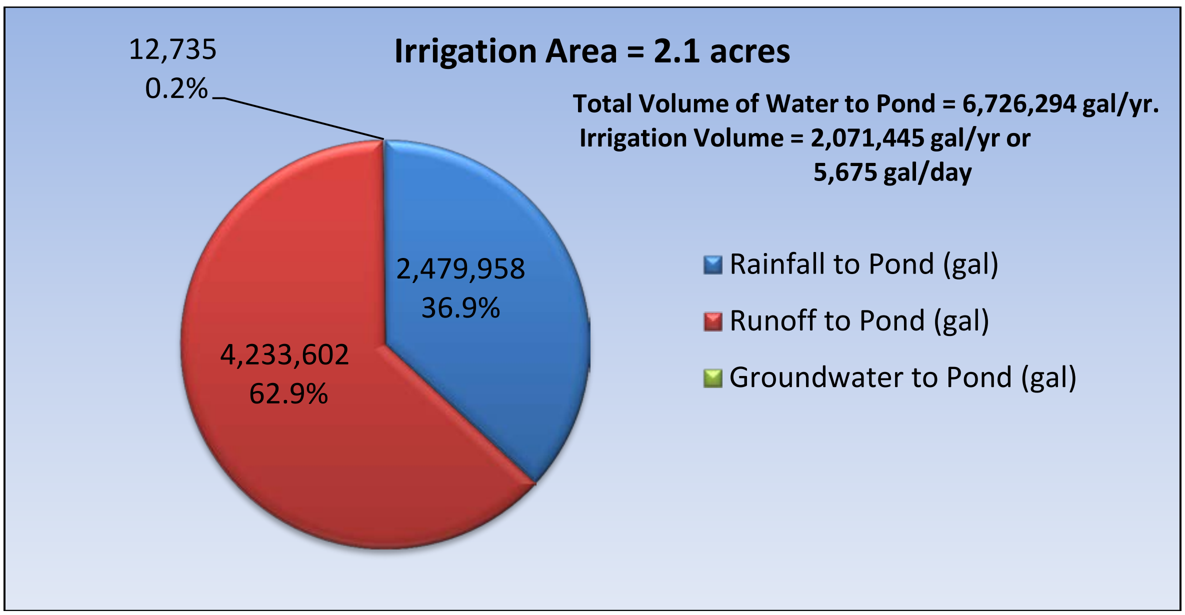
Water in the pond discharges to Lake Mehaffey. There is no minimum flow requirement for discharge to Lake Mehaffey. The discharge pond elevation is at 127.6 feet with a permanent pool elevation at 126.3, which is the seasonal high water table elevation. The pond bottom is at 123 feet. The pond area is 1.8 acres, relatively large for the impervious watershed area. The maximum length of horizontal well is 500 feet and the most likely rate of use is about 100-250 gpm. At this rate, irrigation zones can provide sufficient water and the irrigation cycle can be maintained within a 6 hour time period.

The water in the pond is sufficient for irrigation. During the average year, the wet detention pond will provide sufficient water for irrigation based on the rainfall pattern for the area. The volume of water needed for each irrigation area is shown in Table 6.

Table 6. Annual Irrigation Volume for Two Areas at an Average Irrigation Rate of 0.70 in/week

Irrigation Area	Annual Irrigation Volume (gal)
2.1 acres	2,071,445
4.2 acres	4,142,891

Stormwater and rainfall on the pond are sufficient to provide irrigation without supplement during the average year. There is a minimal use of groundwater (0.2%) and not significantly. When stormwater reuse for irrigation is practiced at a control elevation set at the bottom of the pond, the yearly volume and percentage of groundwater, runoff, and rainfall on the pond that is used for irrigation is shown in Figure 9 for the two assumed irrigation areas, namely 2.1 and 4.2 acres. The average daily yield is 5,675 to 11,350 gpd for 2.1 and 4.2 acres respectively.



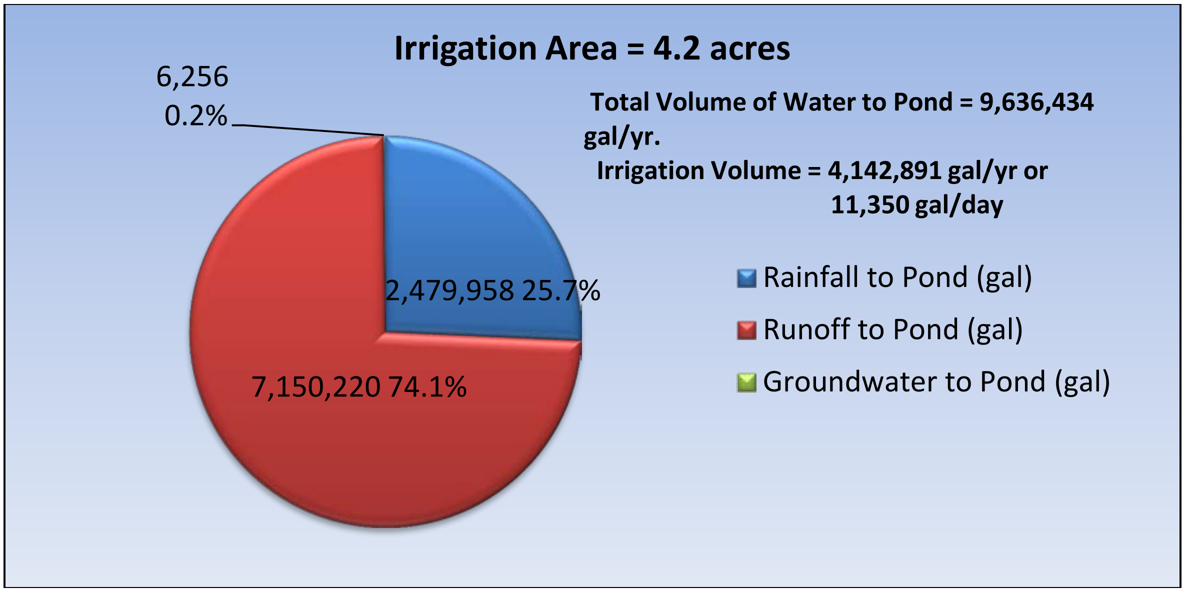


Figure 9 Percentage of Irrigation Water from Runoff, Pond Rainfall, and Groundwater for Two Irrigation areas along US 27 Using a Stormwater pond in Haines City

US 27 pond water level varies during the year with rainfall events and the irrigation schedule (see Figure 10). Using the average year, the percent of runoff discharged from the pond when irrigating 2.1 acre is about 53.6% as shown in Figure 11. Thus, there is a 46.4% reduction in pollution load to Lake Mehaffey. If the irrigation area were increased to 4.2 acres or the irrigation rate increased to 1.4 in/wk, then there would be a 67.1% reduction in pollution load (see 1.4 in/wk on the "X" axis of Figure 11. The results of Figure 11 are for 2.1 irrigation acres and 0.7 in/wk irrigation rate. The rate and the area can be changed and the percent of stormwater not discharged also estimated from Figure 11.

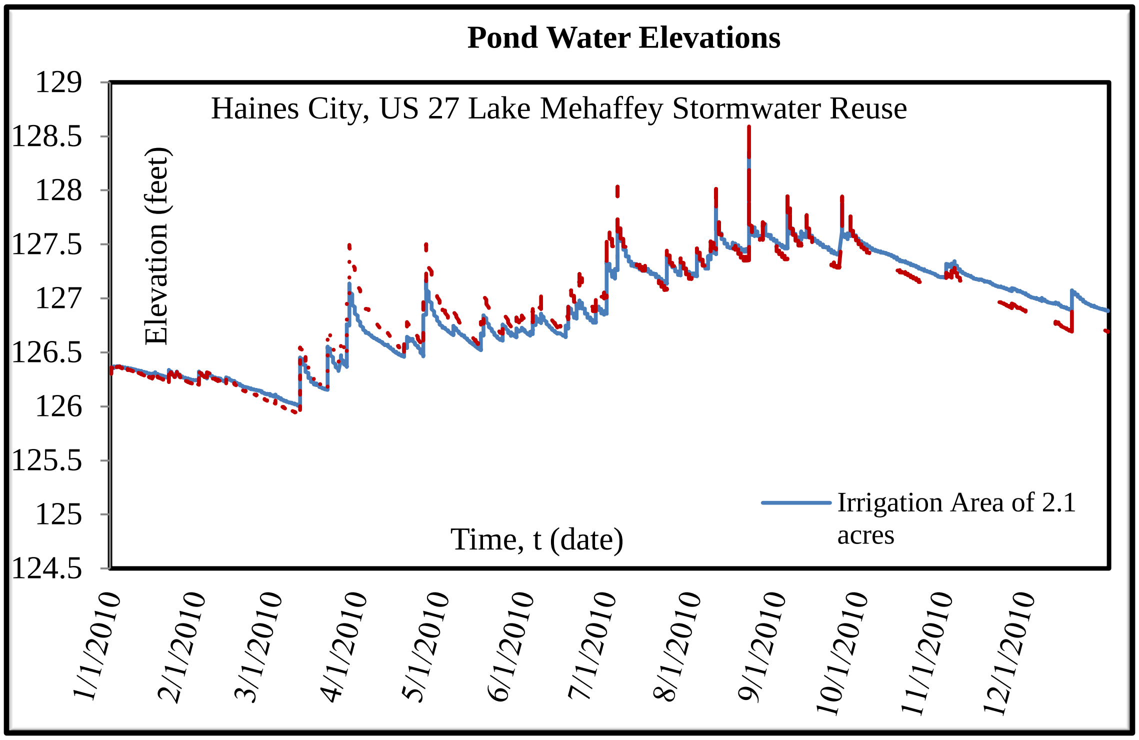


Figure 10 Water Level Fluctuation in the Average Rainfall Year During Irrigation Reuse

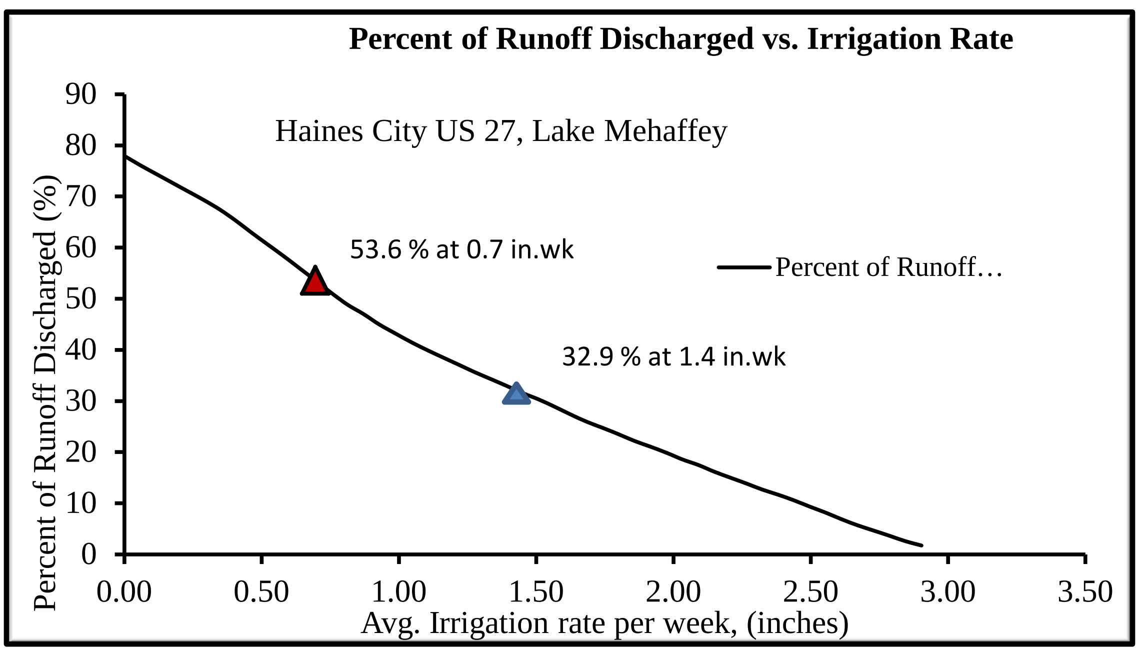


Figure 11 Percent of Pond Discharged that is Stormwater as a Function of Irrigation Rate

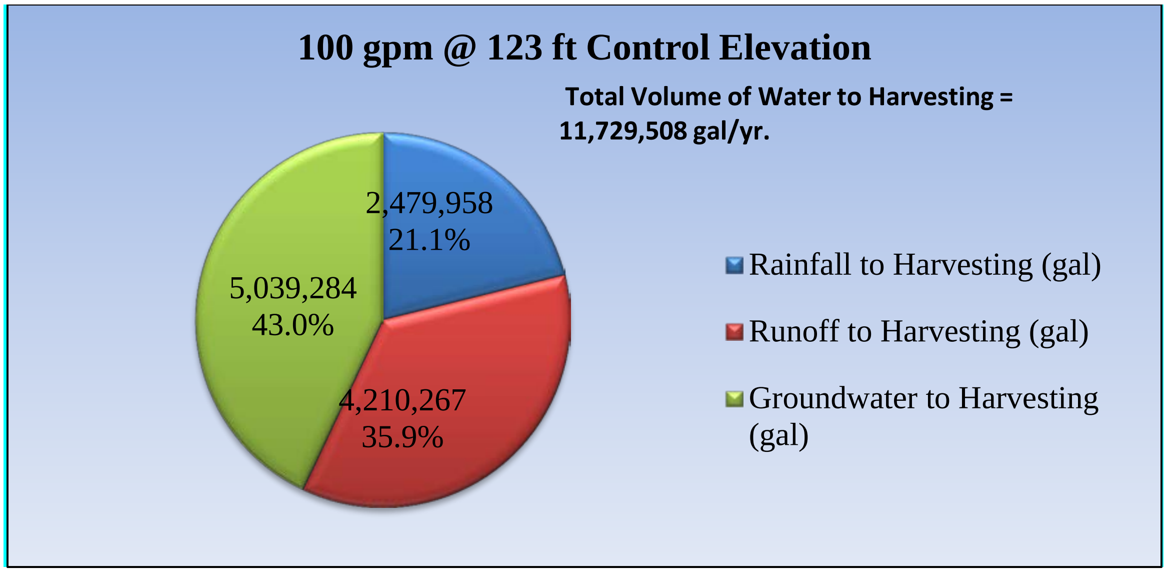
In summary, the US 27 pond can provide irrigation water for areas along the US 27 roadway with little groundwater use. The water use is less than 100,000 gpd, thus no permit is needed from the water management district.

Next, harvesting from the US 27 pond to estimate maximum yield at two pump control elevations are determined. A pump control elevation was set at the pond bottom elevation of 123 feet. Another pump control elevation is set at 120 feet. Two different harvest rates are used. The annual harvest volumes for the two control elevations and two harvest rates are shown in Table 7. The lower the pump control elevation, the greater the yield. At the deeper pump control elevations, groundwater is more available for reuse and the rate of pumping can exceed the volume from stormwater at the higher rates of pumping and thus affect the yield. The combination of length of horizontal well and the rate of flow per linear foot has a significant effect on the harvest volume as shown when the harvesting rate increases from 100 to 250 gpm especially at the 120 foot control elevation. At the lower pump control elevation and for both harvesting rates, there is no discharge from the pond during the average year.

Table 7 US 27 Pond Annual Yields for Two Pump Control Elevations and Two Harvest Rates

Control Elevation (ft.)	Harvesting Rate (gpm)	Annual Harvested Volume (gal)
123	100	11,729,508
	250	14,247,225
120	100	52,583,138
	250	131,411,260

At the 123 foot pumping elevation which is the pond bottom elevation, the supply of water is from all three sources; stormwater, groundwater and rain water on the pond (see Figure 12). An increase in groundwater is noted at the higher pumping rate because groundwater is available. The average yield is about 11.7 to 14.2 million gallons per year or 32,000 – 39,000 gallons per day (gpd) for the two pumping rates.



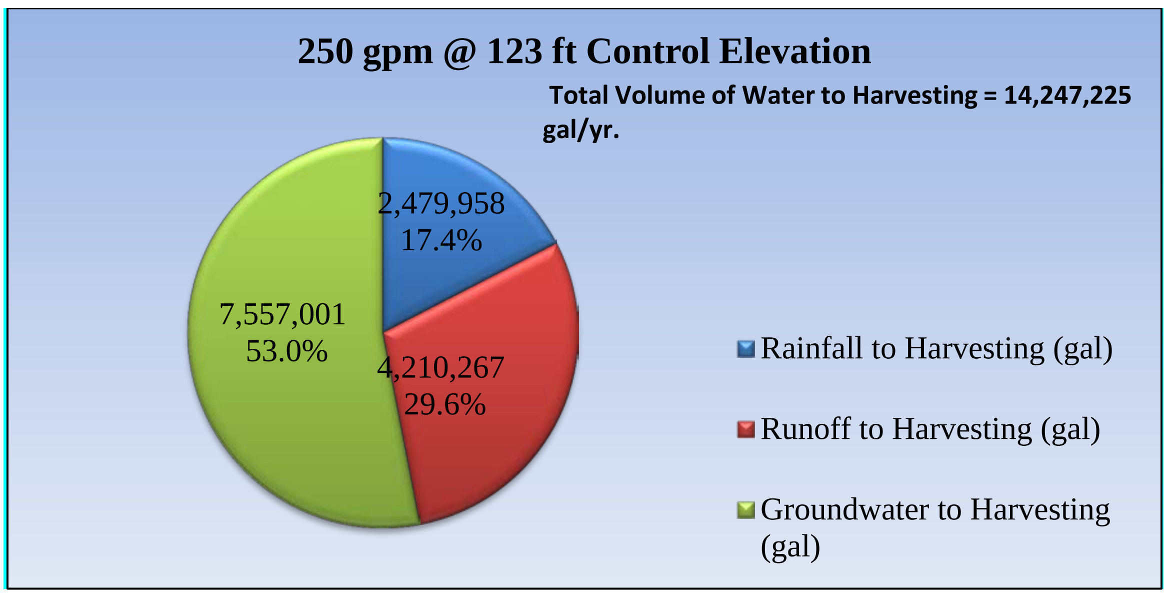
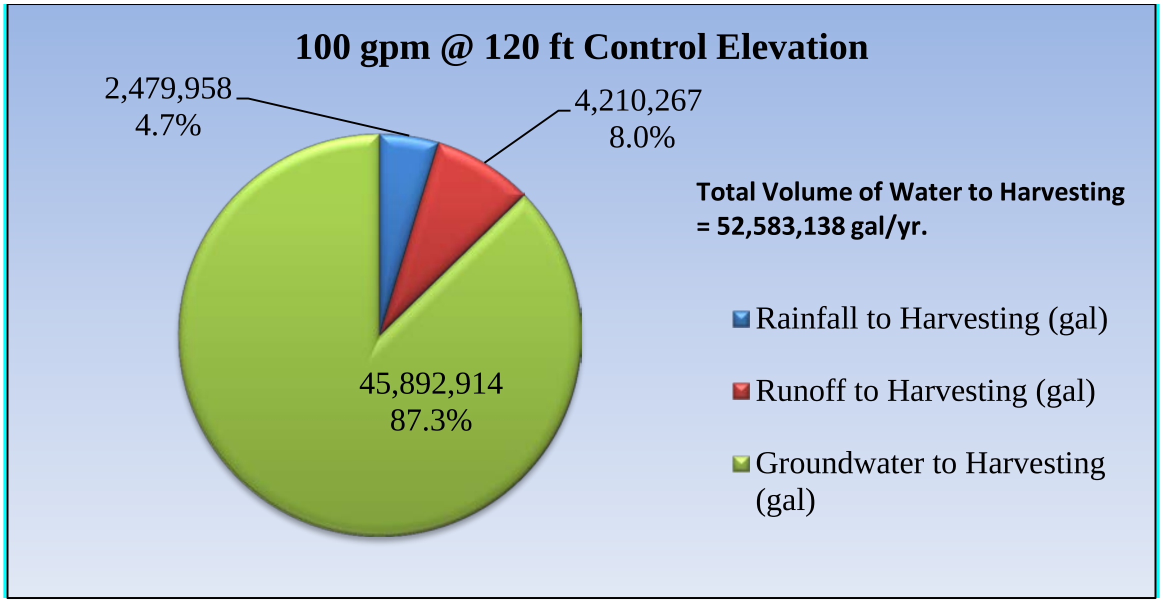


Figure 12 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Two Pumping Rates and a Pump Control Elevation of 123 feet at US 27 Pond in Haines City

At the 120 foot pumping elevation which is three feet below the pond bottom elevation, the supply of water is primarily from groundwater (see Figure 13). An increase in the volume of groundwater is noted at the higher pumping rate because groundwater is available. The average yield is about 52.5 to 131.4 million gallons per year or 144,000 – 360,000 gallons per day (gpd) for the two pumping rates. The pump will have to operate 24 hours a day every day of the year at this pump elevation to achieve the yield at both pump rates.



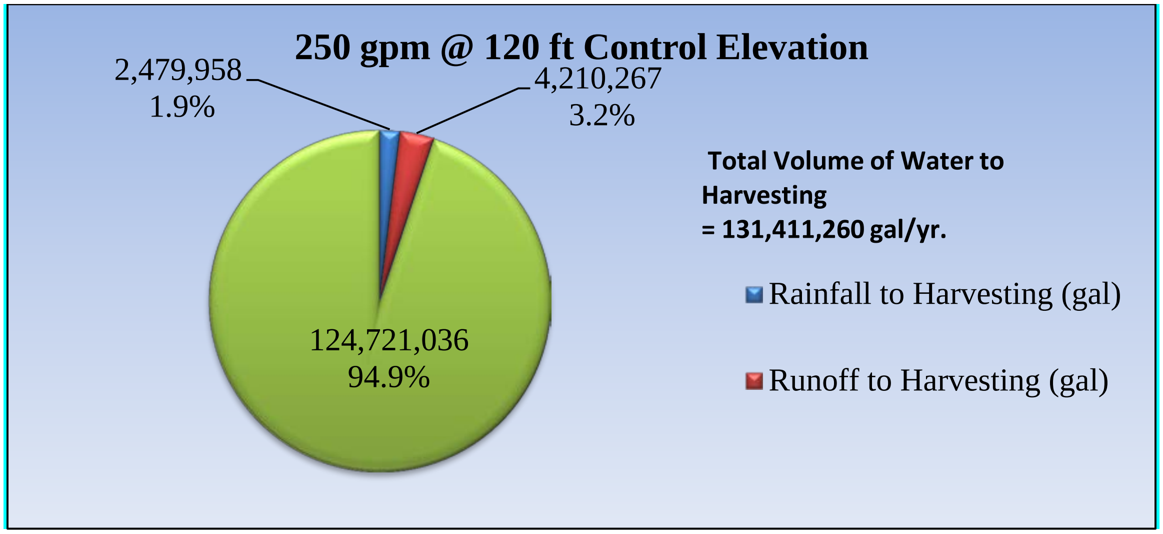


Figure 13 Percentage of Reuse Water from Runoff, Pond Rainfall, and Groundwater for Two Pumping Rates and a Pump Control Elevation of 120 feet at US 27 Pond in Haines City

The maximum radius of influence for the two pumping rates is shown in Table 8. There does not appear to be any sensitive vegetation within the radius of influence for either of the two pumping rates.

Table 8 Well Radius of Influence for US 27 Pond in Haines City

US 27 Lake Mehaffey Groundwater Recovery		
Pump Rate (gpm)	100	250
Radius of Influence (ft)	215	340

In summary, it is recommended to use a horizontal well to provide reuse water from the area where a US 27 pond is located. A horizontal well can be used to provide for irrigation of areas within the watershed and additional yield for other uses. The radius of influence for the well depends on the pumping rate. At 250 gpm or the largest most likely pumping rate, the radius of influence is about 340 feet. There does not appear to be any sensitive vegetation within this area, however the amount of water pumped and thus the depth of the pump control elevation will have to be determined from a regional water supply model. The pond site can most likely generate from about 11.8 million gallons a year to over 100 million gallons per year. This analysis also gives the City other options to consider when deciding on irrigation within the watershed and additional water for reuse including other irrigation areas within the City.

Point-of-Interest: The SHARP modeling was instrumental in determining the site specific safe yield conditions at the 3 project sites. This safe yield information was used to develop the delivery cost point for the SWR.

Section 8
Draft FDOT / End-User Agreements

8.1 Draft Agreements

As part of the implementation of any Stormwater Reuse project, an Agreement between the Department and the End-User would be executed to document the negotiated terms, conditions, and responsibilities of the parties involved. All “what-if” worst case default scenarios should be considered in the preparation of the Agreement with appropriate consequential accountability measures clearly presented. Any formal Agreement would of course be reviewed by the legal representative from each party. The following are “Draft” Agreements developed as examples for the 3 selected potential projects.

8.2 Draft Agreement for Potential Project #1 – City of Ocoee

The following Stormwater Reuse Agreement documents the granting by FDOT a stormwater harvesting and maintenance easement of the FDOT proposed wet retention/detention pond located on South Bluford Avenue just south of S.R. 50 to the City of Ocoee, Florida, hereafter (CITY). By granting a stormwater reuse and maintenance easement of the pond area to the CITY, FDOT turns over and the CITY accepts all of the maintenance responsibility and costs of operation of the pond. FDOT would retain fee simple ownership of the property and drainage, retention/detention and emergency maintenance rights over the property. This insures FDOT’s continuing right to use the pond for its original intended purpose, the collection and treatment of stormwater from the FDOT roadway.

The agreement provides that the CITY would have the right to use the stormwater as an alternative water source by developing infrastructure to connect the pond to the City’s existing reclaimed waterline in order to augment the City’s secondary sources of water. The City would have the right to modify and expand the pond on to additional property provided that it obtains ownership rights over the additional property. CITY obtains rights to develop stormwater harvesting improvements and infrastructure at the CITY’s costs in order to reuse the stormwater to mitigate the water management district’s restriction mandates. The CITY would be required to meet all standards imposed by permitting authorities and to obtain all permits. This usage of the stormwater should reduce the mass of pollutants from the existing pond enhancing water quality to surface water bodies as well as provide flood mitigation. It may also allow for possible TMDL credits for the FDOT, or the End-User if negotiated that way . The agreement provides value to the community by providing an alternate source of water and reducing the reliance on potable water. Every gallon of stormwater (alternate source water) used for irrigation saves a gallon of potable water.

Pursuant to this agreement the CITY takes on the cost of maintenance and the responsibility to retain or use the water quantities as permitted. The agreement provides indemnification and emergency action rights to protect FDOT’s interest.

The agreement provides for an approval process prior to construction of improvements but allows latitude for the CITY to develop necessary infrastructure. The Agreement also provides language to protect the integrity of the FDOT road project and the utility of the pond for storage and reuse of stormwater.

Please note that GAI is not a law firm and does not warrant this agreement. This agreement is a rough draft and merely a sample of a form that may be used to document the terms of the agreement between the CITY and FDOT. This agreement should not be used without legal counsel and legal review.

<u>STORMWATER REUSE AGREEMENT</u>

This Agreement, entered into this _____ day of _____________, 2013 by and between Ocoee, Florida, ("CITY"), and the State Of Florida Department Of Transportation, ("FDOT");

WITNESSETH:

WHEREAS, FDOT shall be the fee simple owner of certain real property with a proposed stormwater pond located at S. Bluford Avenue and S.R. 50 in Ocoee, Florida (hereinafter referred to as a Stormwater Reuse Area (SWRA)) located in Orange County, Florida, as described and set forth in Exhibit "A".

WHEREAS, CITY wishes to develop infrastructure to provide drainage, and to obtain a cost effective alternative source of water for its reclaimed waterline from the SWRA (hereinafter referred to as “Stormwater Reuse/Drainage Improvements”):

WHEREAS, CITY wishes to support economic development and address the water supply challenges of the state by reducing the use of potable water by utilizing an alternate source of less expensive water to help mitigate the water management district’s water restriction mandates.

WHEREAS, CITY wishes to obtain from FDOT a perpetual exclusive stormwater harvesting and maintenance easement for the purposes of modifying SWRA to construct, operate and maintain an effective stormwater harvesting operation.

WHEREAS, CITY would construct at its costs the modifications of the FDOT SWRA in order to operate and maintain the water harvesting area, that shall drain both the FDOT improvements to be served by the FDOT’s SWRA and shall serve as a stormwater reuse pond: and

WHEREAS, CITY will operate and maintain the pond and the stormwater reuse infrastructure at its own cost.

WHEREAS the stormwater reuse project will reduce the mass of pollutants to surface water bodies providing an enhancement to the water quality in the areas surface waters. It will also provide possible TMDL credits.

WHEREAS, pursuant to the terms and conditions of this Agreement, the FDOT is prepared to grant the CITY a stormwater reuse and maintenance easement to allow modification, expansion, drainage and harvesting of stormwater;

NOW, THEREFORE, in consideration of the premises herein contained, the parties hereto agree as follows:

1. FDOT Interest. The CITY and FDOT acknowledge and agree that FDOT owns the subject SWRA in fee simple.

2. Future Reuse of FDOT Stormwater. The CITY and FDOT acknowledge and agree that CITY requires that the SWRA be modified for stormwater reuse/drainage with CITY to facilitate the CITY's construction on the Real Property. Any such improvement, modification or expansion of FDOT's SWRA for stormwater reuse shall be subject to the following terms and conditions:

(a) At such time as CITY desires to modify, expand, or otherwise improve SWRA, CITY shall send a written request to FDOT specifying the exact nature of the proposed modification, expansion or improvement of the SWRA. Said written request shall, at a minimum, be accompanied by the following items:

(1) A signed and sealed survey of the proposed modified , expanded or improved stormwater reuse area, delineation of the Additional Stormwater Reuse/Drainage Area(s), and the legal description of the Additional SWRA(s);

(2) Evidence of CITY's ownership rights of any Additional SWR Area. In the event that the title evidence discloses any matter not found acceptable by FDOT, no relocation will take place; and

(3) The amount of square footage of the proposed stormwater reuse area, including Additional Reuse/Drainage Area, and the configuration of the requested Stormwater Reuse/Drainage area(s); The parties agree that the entire SWRA shall be included in the Stormwater Reuse/Drainage area and shall be maintained by the CITY. Provided, however, that piping conveying stormwater into the SWRA from FDOT roadway shall remain the responsibility of FDOT, unless piping is modified by the City's Project Plan

(4) The CITY's Project Plan, together with engineering information, including but not limited to detailed design of the modified, expanded or improved storm water reuse area(s), drainage improvements, drainage calculations and other calculations, materials and quantities, effect on easement, and engineering information sufficient for the FDOT to make a determination of the adequacy of the proposed Stormwater Reuse/Drainage area(s) (under the standards set forth in subparagraph 3(b) below.

(b) The FDOT shall have up to two hundred seventy (270) days from the date of the written request to review the proposed stormwater reuse area(s) for adequacy. The proposed Stormwater Reuse area(s) will be adequate if all the following conditions are met as demonstrated by the information submitted as part of the request:

(1) Functional equivalent outfall to the same water bodies as provided by the original SWRA is provided;

(2) The proposed stormwater reuse area(s) meet all applicable environmental permitting requirements that are in place as of the time of the request, and also meet any criteria and comply with any conditions as the environmental permitting authorities may require as of the time of the request, for the joint uses intended by the CITY and by the FDOT; and

(3) The proposed stormwater reuse area(s) otherwise provide the functional equivalent of the old facility for FDOT usage as to storage, treatment, and retention function, including volumes and rates of flow, in addition to providing for the proposed usage by the CITY of the

Stormwater Reuse/Drainage area(s), under reasonable engineering judgment.

(4) The piping and ancillary and appurtenant drainage for the modified, expanded or improved Stormwater Reuse/Drainage structure and Additional Reuse/Drainage Area shall be of sufficient size to accommodate the Minimum Drainage Capacity as most recently established by the FDOT, prior to the date of the request, for a 100 year, 240 hour storm event.

(c) In the event that the FDOT fails to advise the CITY within two hundred seventy (270) days as to the adequacy of the proposed Stormwater Reuse/Drainage area(s), they will be deemed to be adequate, provided that the CITY properly and fully complied with its obligation to supply all necessary information as specified in subparagraph 2.(a) above and provided that said information otherwise supports the conclusion of adequacy under the standards set forth in subparagraph 2.(b) above.

(d) In the event the FDOT objects to the proposed stormwater reuse area(s), because the FDOT believes that the standards set forth in subparagraph 2.(b) above are not met and the parties are not able to negotiate the disagreement, the new proposed Stormwater Reuse/Drainage area(s),shall be deemed inadequate and the modification of the FDOT's water retention area(s) will not take place, so long as the FDOT has operated in good faith in applying the standards of adequacy and in attempting to negotiate the disagreement.

(e) If the FDOT has deemed the proposed stormwater reuse area(s) to be adequate, the following will occur:

(1) FDOT will within forty-five (45) days grant to the CITY a perpetual, exclusive stormwater reuse and maintenance easement over, across and through the reuse Area(s) for purposes of stormwater drainage and retention into the modified, expanded, or improved reuse area(s) to be constructed in part thereon by the CITY. The CITY shall be granted the right to modify, expand or improve the Stormwater Reuse/Drainage area(s), for purposes of stormwater drainage retention and reuse. The parties agree that this STORMWATER REUSE AGREEMENT shall be an attachment to the easement and serve as the terms and conditions for exercise of the easement rights by the CITY.

(2) The easement is subject to and conditional on CITY agreeing to be solely responsible for all improvements to be made on the Real Property, including the stormwater reuse/Drainage Improvements and the CITY agreeing to construct the Reuse/Drainage Improvements, including the modification, expansion, or improvements of the FDOT SWRA, in accordance with the CITY's Project Plans.

(4) Upon the conveyance of said easement, CITY shall be responsible for all ongoing maintenance of the Reuse/Drainage area(s) including trash removal and lawn maintenance (hereinafter referred to as "Regular Maintenance"), and all future capital improvements to the Reuse/drainage area(s) (hereinafter referred to as "Capital Improvement Maintenance"). An example of Capital Improvement Maintenance would be structural piping improvements, repair and maintenance. Should either the CITY or FDOT determine that Capital Improvement Maintenance is required, they shall notify the other party with a description of the work to be performed. After the FDOT has approved the scope of the work to be performed, and the parties have worked with each other in good faith to agree on the estimated cost for the CITY to perform such work, the CITY will perform the work in accordance with said agreement. In the event that, after commencement of such work by the CITY, the CITY or FDOT determines that changes need to be made to the scope of such work, and to the estimated cost of such work, the FDOT shall have the right to approve any such changes to the scope or cost of the work. In the event either of the parties are unable to reach agreement on any Capital Improvement Maintenance, then either party may bring an action in circuit court for a determination by the court of the need, scope and cost of such Capital Improvement Maintenance. This action shall not be construed as relating to an eminent domain action and the parties' costs may be borne pursuant to any other statutes, case law, and rules of civil procedure which are applicable.

(5) Notwithstanding anything in this Agreement to the contrary, CITY hereby agrees that FDOT shall have the continued right to discharge and transmit into the Storm Water Reuse/Drainage area(s),at rates and volumes consistent with FDOT's use as intended in FDOT Project on SR 50.

(6) In the event that FDOT undertakes any major road improvements to State Road 50, FDOT agrees that any additional drainage created by any such major road improvements shall not be directed into the modified, expanded or improved reuse/drainage area(s) unless and until FDOT and CITY make further

alterations or improvements to the Stormwater Reuse/Drainage area(s), to accommodate any such additional drainage.

(7) CITY agrees to construct the Reuse/Drainage Improvements, including the modified, expanded, or improved Stormwater Reuse/Drainage area(s), in accordance with the CITY's Project Plans, at its sole cost and expense. In the event that CITY, after beginning the construction fails to complete the construction to the modified, expanded, or improved reuse/drainage area(s), in accordance with the Plans or abandons the construction, FDOT shall have the right, but not the obligation to enter the reuse/drainage area(s) and perform such work as FDOT, in its sole discretion deems necessary to accommodate the drainage from FDOT's system. In such event, CITY shall be liable to FDOT for any and all costs and expenses incurred in connection with any such work performed by FDOT. CITY, prior to commencement of any work for the modified, expanded, or improved Stormwater Reuse/Drainage area(s),shall supply to FDOT a bond provided by a surety authorized to do business in the State of Florida, payable to the Governor and his successors in office and conditioned for the prompt, faithful, and efficient performance of the construction of the modified, expanded, or improved Stormwater Reuse/Drainage area(s), according to the Plans and within the time periods specified herein, and for the prompt payment of all persons furnishing labor, material, equipment, and supplies therefore. FDOT shall be entitled to first pursue its rights under the bond prior to entering the Additional Reuse/Drainage Area(s) to perform any work on its own. CITY hereby acknowledges that the continuation of FDOT's drainage is of great importance to the public health, safety and welfare, and hereby releases FDOT from and of any and all claims, liabilities or demands of any nature whatsoever arising out of or related to the exercise by FDOT of its rights under this paragraph.

(8) CITY agrees that it shall be CITY's sole responsibility and obligation to obtain any and all necessary approvals or permits from any other governmental entity (including, but not limited to, any applicable Water Management District) prior to beginning any construction on the Real Property. In the event that construction is halted due to a breach by CITY of this requirement, FDOT may proceed pursuant to subparagraph (2) (e) (7) hereof in order to assure the continuation of its drainage.

(9) CITY shall take all steps necessary during construction to provide sufficient erosions protection on the Real Property to avoid any failure of the drainage system and to avoid any washout of ground or other matter into the road right of way and shall also take such other and further steps as may be necessary to protect the roadway from any other damage due to CITY's activities hereunder.

(10) CITY shall at all times be solely responsible for adequate Regular Maintenance and Capital Improvement Maintenance, as defined in subparagraph (2) (e) (4), of the modified, expanded, or improved reuse/drainage area(s), at CITY's sole cost and expense so as to assure continued functioning of the stormwater reuse/drainage/management system as planned. In the event that CITY fails to adequately perform such Regular Maintenance and Capital Improvement Maintenance, FDOT may, but is not obligated to, enter the property to perform such maintenance, in which event FDOT shall be entitled to charge the cost of such Regular Maintenance and Capital Improvement Maintenance to CITY. However, before the FDOT may perform such Regular Maintenance it must give written notice to CITY specifying the work to be performed and allow five (5) business days for CITY to enter and perform any such Regular Maintenance. Before the FDOT may perform Capital Improvement Maintenance it must give written notice to CITY specifying the work to be performed, proceed pursuant to subparagraph (2) (e) (4) to work with the CITY on the matter for up to thirty (30) days, and allow sixty (60) days thereafter for CITY to perform any such Capital Improvement Maintenance, unless the FDOT reasonably deems said maintenance to be an emergency, in which case it may proceed immediately to perform the maintenance. The provisions of subparagraph (4) (e) (7) hereof regarding collection of said amount and release of liability for the work performed shall apply to any Regular Maintenance and any Capital Improvement Maintenance work performed by FDOT pursuant to this paragraph.

(11) In the event that the CITY's Project Plans call for any work to be performed on FDOT property, the CITY is hereby granted a license to enter onto such FDOT property for the purposes of performing such work. In the event that it becomes necessary for FDOT to enter CITY owned property under the terms of this agreement, FDOT is hereby granted a license to enter on to such CITY property for purposes of emergency maintenance and operation. CITY agrees that upon completion of the construction, it will restore any FDOT property, including the SR 50 Road right of way, to its original condition, except for any modifications made to other FDOT property pursuant to the Plans. In no event shall CITY take

any actions pursuant to this paragraph which would in any way damage the road physically or impair its function. Any work performed on the FDOT right of way shall conform to the FDOT manual on Traffic Controls and Safe Practices for Street and Highway Construction, Maintenance and CITY Operation.

(12) FDOT shall have the right to make such inspections as it deems necessary to make sure that CITY is at all times complying with the terms and conditions of this Agreement.

(13) No future modifications to the system constructed by CITY or to the drainage as otherwise shown on the CITY's Project Plans shall be undertaken by CITY without the prior written consent of FDOT. CITY hereby acknowledges that depending on the nature of any such planned future modifications; the CITY may be required to make application for a drainage permit.

(14) No further drainage permit from the Department shall be required of CITY with regard to the work authorized to be performed pursuant to this Agreement, including the improvements to the Real Property; however, this provision shall not relieve CITY of the obligation to obtain permits for work other than that as authorized pursuant to this Agreement or for future alterations, expansions, or modifications to the system constructed by CITY.

(15) Nothing herein shall be construed as preventing FDOT from making such future road improvements to SR 50 as it deems, in its discretion, desirable provided the yield from the SWR facility is not decreased.

(16) CITY hereby agrees to indemnify and hold the FDOT and its officers, agents, and employees harmless of and from any and all claim, demand, damage, liability, cost or expense of any nature whatsoever arising out of or related to the exercise of CITY's rights hereunder or the construction, use or maintenance of the system, except for matters due to the sole negligence of FDOT or its officers, agents, or employees. In the event of any loss, damage, claim or expense resulting from CITY's performance or non-performance of the services authorized under this Agreement, CITY shall be wholly liable.

(17) CITY shall be solely responsible for locating and identifying potential conflicts with any utilities located in the right of way with respect to work to be performed in the right of way. Adjustment for said conflicts and responsibility for any damages to any utilities shall be the sole responsibility of CITY.

(18) The CITY's request to modify expand or improve for use as a Stormwater Reuse/Drainage area(s),under this paragraph 2 shall be exercised only once, and no further request for additional use of the FDOT's Interest will be permitted except by a subsequent and separate mutual agreement of the parties.

3. Miscellaneous.

(a) This Agreement shall be binding on the successors and assigns of CITY, on the successors and assigns of the FDOT, and shall be deemed to be a burden on and flowing with the modified, expanded, or improved Stormwater Reuse/Drainage area(s), and shall be a benefit and appurtenance to the property and modified FDOT SWRA.

(b) Time is of the essence in the performance under this Agreement.

(c) This Agreement and the obligations of the parties hereunder shall survive the CITY's delivery of the deeds of conveyance pursuant hereto.

(d) This Agreement constitutes the entire and final expression of the parties with regard to the subject matter hereof.

(e) This Agreement shall be governed by and construed in accordance with Florida Law.

(f) Nothing in this Agreement, nor the FDOT's acceptance of the proposed modified, expanded, or improved Stormwater Reuse/Drainage area(s), under paragraph 2 hereof, shall be construed as a waiver of any permitting requirements for any improvements made by the CITY upon the Real Property and the CITY shall at all times be required to fully comply with any and all applicable statutes or rules with regard to any such improvements.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date set forth above.

Signed, sealed and delivered

in the presence of: OCOEE, FLORIDA:

WITNESS:

ADDRESS:

WITNESS:

ADDRESS:

State of Florida

Department of Transportation

________________________ By:

WITNESS:_______________

ADDRESS:_______________ Director of Operations

________________________ District

Boulevard

Florida xxxxx

WITNESS:

ADDRESS:

Approved:

District Counsel

STATE OF FLORIDA

COUNTY OF

The foregoing instrument was acknowledged before me this _____ day of __________,2013, by . He is personally known to me or has produced ____ as identification.

Name:

Title or Rank:

Serial Number:

STATE OF FLORIDA

COUNTY OF AAAA

The foregoing instrument was acknowledged before me this ____ day of ____________, 2013, by _______________ as District Secretary, District XX, of the State of Florida, Department of Transportation, who is personally known to me or who has produced ____ as identification.

Name:

Title or Rank:

8.3 Draft Agreement for Potential Project #2 – City of Riviera Beach

The following Stormwater Reuse Agreement documents the granting by FDOT a stormwater harvesting and maintenance easement of the two FDOT retention/detention ponds located on Dr. Martin Luther King Jr. Boulevard (SR 710) to the City of Riviera Beach, Florida, hereafter (CITY). By granting a stormwater reuse and maintenance easement of the pond areas to the CITY, FDOT turns over and the CITY accepts all of the maintenance responsibility and costs of operation of the pond. FDOT would retain fee simple ownership of the property and drainage, retention and emergency maintenance rights over the property. This insures FDOT’s continuing right to use the pond for its original intended purpose, the collection of stormwater from the FDOT roadway.

The agreement provides that the CITY would have the right to use the stormwater as an alternative water source by developing infrastructure to connect the ponds to the City’s existing raw watermain in order to augment the City’s primary source of water. The City would have the right to modify and expand the ponds on to additional property provided that it obtains ownership rights over the additional property. CITY obtains rights to develop stormwater reuse improvements and infrastructure at the CITY’s costs in order to reuse the stormwater to augment its raw water supply. The CITY would be required to meet all standards imposed by permitting authorities and to obtain all permits. This usage of the stormwater should reduce the mass of pollutants from the existing ponds, enhancing water quality to surface water bodies, as well as provide flood mitigation. This Agreement may also allow for possible TMDL credits for the FDOT or possibly the End-User if negotiated that way. The agreement provides value to the community by providing an alternate source of potable water. Every gallon of stormwater (alternate source water) converted to potable water reduces the demand on the aquifer.

Pursuant to this agreement the CITY takes on the cost of maintenance and the responsibility to retain or use the water quantities as permitted. The agreement provides indemnification and emergency action rights to protect FDOT’s interest.

The agreement provides for an approval process prior to construction of improvements but allows latitude for the CITY to develop necessary infrastructure. The Agreement also provides language to protect the integrity of the FDOT road project and the utility of the ponds for storage and reuse of stormwater.

Please note that GAI is not a law firm and does not warrant this agreement. This agreement is a rough draft and merely a sample of a form that may be used to document the terms of the agreement between the CITY and FDOT. This agreement should not be used without legal counsel and legal review.

STORMWATER REUSE AGREEMENT

This Agreement, entered into this _____ day of _____________, 2013 by and between Riviera Beach, Florida, ("CITY"), and the State Of Florida Department Of Transportation, ("FDOT");

WITNESSETH:

WHEREAS, FDOT shall be the fee simple owner of certain real property with a proposed stormwater pond located at Dr. Martin Luther King, Jr. Boulevard in Riviera Beach, Florida (hereinafter referred to as Stormwater Reuse Area (SWRA)) located in Palm Beach County, Florida, as described and set forth in Exhibit "A".

WHEREAS, CITY wishes to develop infrastructure to provide drainage, and to obtain a cost effective alternative source of water for its raw watermain from the SWRA:

WHEREAS, CITY wishes to support economic development and address the water supply challenges of the state by reducing the use of current groundwater supply by providing an alternate source of less expensive water to help mitigate the water management district's water restriction mandates.

WHEREAS CITY wishes to obtain from FDOT a perpetual exclusive stormwater reuse and maintenance easement for the purposes of modifying the SWRA to construct , operate and maintain an effective stormwater reuse operation.

WHEREAS, CITY would construct at its costs the modifications of the FDOT SWRA in order to operate and maintain the water harvesting area, that shall drain both the FDOT improvements to be served by the FDOT's SWRA and shall serve as a stormwater reuse pond: and

WHEREAS, CITY will operate and maintain the SWRA and the stormwater reuse infrastructure at its own cost.

WHEREAS the stormwater reuse project will reduce the mass of pollutants to surface water bodies providing an enhancement to the water quality in the areas surface waters. It will also provide possible TMDL credits.

WHEREAS, pursuant to the terms and conditions of this Agreement, the FDOT is prepared to grant the CITY a stormwater reuse and maintenance easement to allow modification, expansion, drainage and stormwater reuse of the two ponds;

NOW, THEREFORE, in consideration of the premises herein contained, the parties hereto agree as follows:

1. FDOT Interest. The CITY and FDOT acknowledge and agree that FDOT owns the subject SWRA in fee simple.

2. Future Reuse of FDOT Stormwater. The CITY and FDOT acknowledge and agree that CITY requires that the SWRA be modified for reuse/drainage with CITY to facilitate the CITY's construction on the Real Property. Any such improvement, modification or expansion of FDOT's SWRA for reuse shall be subject to the following terms and conditions:

(a) At such time as CITY desires to modify, expand, or otherwise improve the SWRA, CITY shall send a written request to FDOT specifying the exact nature of the proposed modification, expansion or improvement of the SWRA. Said written request shall, at a minimum, be accompanied by the following items:

(1) A signed and sealed survey of the proposed modified , expanded or improved water reuse area, delineation of the Additional Reuse/Drainage Area(s), and the legal description of the Additional Reuse Area(s);

(2) Evidence of CITY's ownership rights of any Additional Reuse Area. In the event that the title evidence discloses any matter not found acceptable by FDOT, no relocation will take place; and

(3) The amount of square footage of the proposed storm water reuse area, including Additional Reuse/Drainage Area, and the configuration of the requested Stormwater Reuse/Drainage area(s); The parties agree that the entire SWRA shall be included in the Stormwater Reuse/Drainage area and shall be maintained by the CITY. Provided, however, that piping conveying stormwater into the SWRA from the FDOT roadway shall remain the responsibility of FDOT, unless piping is modified by the City's Project Plan

(4) The CITY's Project Plan, together with engineering information, including but not limited to detailed design of the modified, expanded or improved stormwater reuse area(s), drainage improvements, drainage calculations and other calculations, materials and quantities, effect on easement, and engineering information sufficient for the FDOT to make a determination of the adequacy of the proposed Stormwater Reuse/Drainage area(s) (under the standards set forth in subparagraph 3(b) below.

(b) The FDOT shall have up to two hundred seventy (270) days from the date of the written request to review the proposed stormwater reuse area(s) for adequacy. The proposed Stormwater Reuse area(s) will be adequate if all the following conditions are met as demonstrated by the information submitted as part of the request:

(1) Functional equivalent outfall to the same water bodies as provided by the original stormwater facility is provided;

(2) The proposed stormwater reuse area(s) meet all applicable environmental permitting requirements that are in place as of the time of the request, and also meet any criteria and comply with any conditions as the environmental permitting authorities may require as of the time of the request, for the joint uses intended by the CITY and by the FDOT; and

(3) The proposed stormwater reuse area(s) otherwise provide the functional equivalent of the proposed SWRA for FDOT usage as to storage, treatment, and retention function, including volumes and rates of flow, in addition to providing for the proposed usage by the CITY of the Stormwater Reuse/Drainage area(s), under reasonable engineering judgment.

(4) The piping and ancillary and appurtenant drainage for the modified, expanded or improved Stormwater Reuse/Drainage structure and Additional Reuse/Drainage Area shall be of sufficient size to accommodate the Minimum Drainage Capacity as most recently established by the FDOT, prior to the date of the request, for a 100 year, 240 hour storm event.

(c) In the event that the FDOT fails to advise the CITY within two hundred seventy (270) days as to the adequacy of the proposed Stormwater Reuse/Drainage area(s), they will be deemed to be adequate, provided that the CITY properly and fully complied with its obligation to supply all necessary information as specified in subparagraph 2.(a) above and provided that said information otherwise supports the conclusion of adequacy under the standards set forth in subparagraph 2.(b) above.

(d) In the event the FDOT objects to the proposed stormwater reuse area(s), because the FDOT believes that the standards set forth in subparagraph 2.(b) above are not met and the parties are not able to negotiate the disagreement, the new proposed Stormwater Reuse/Drainage area(s),shall be deemed inadequate and the modification of the FDOT's water retention area(s) will not take place, so long as the FDOT has operated in good faith in applying the standards of adequacy and in attempting to negotiate the disagreement.

(e) If the FDOT has deemed the proposed stormwater reuse area(s) to be adequate, the following will occur:

(1) FDOT will within forty-five (45) days grant to the CITY a perpetual, exclusive stormwater reuse and maintenance easement over, across and through the reuse Area(s) for purposes of stormwater drainage and retention into the modified, expanded, or improved reuse area(s) to be constructed in part thereon by the CITY. The CITY shall be granted the right to modify, expand or improve the Stormwater Reuse/Drainage area(s), for purposes of stormwater drainage retention and reuse. The parties agree that this STORMWATER REUSE AGREEMENT shall be an attachment to the easement and serve as the terms and conditions for exercise of the easement rights by the City.

(2) The easement is subject to and conditional on CITY agreeing to be solely responsible for all improvements to be made on the Real Property, including the Stormwater Reuse/Drainage Improvements and the CITY agreeing to construct the Reuse/Drainage Improvements, including the modification, expansion, or improvements of the FDOT SWRA, in accordance with the CITY's Project Plans.

(4) Upon the conveyance of said easement, CITY shall be responsible for all ongoing maintenance of the Reuse/Drainage area(s) including trash removal and lawn maintenance (hereinafter referred to as "Regular Maintenance"), and all future capital improvements to the Reuse/drainage area(s) (hereinafter referred to as "Capital Improvement Maintenance"). An example of Capital Improvement Maintenance would be structural piping improvements, repair and maintenance. Should either the CITY or FDOT determine that Capital Improvement Maintenance is required, they shall notify the other party with a description of the work to be performed. After the FDOT has approved the scope of the work to be performed, and the parties have worked with each other in good faith to agree on the estimated cost for the CITY to perform such work, the CITY will perform the work in accordance with said agreement. In the event that, after commencement of such work by the CITY, the CITY or FDOT determines that changes need to be made to the scope of such work, and to the estimated cost of such work, the FDOT shall have the right to approve any such changes to the scope or cost of the work. In the event either of the parties are unable to reach agreement on any Capital Improvement Maintenance, then either party may bring an action in circuit court for a determination by the court of the need, scope and cost of such Capital Improvement Maintenance. This action shall not be construed as relating to an eminent domain action and the

parties' costs may be borne pursuant to any other statutes, case law, and rules of civil procedure which are applicable.

(5) Notwithstanding anything in this Agreement to the contrary, CITY hereby agrees that FDOT shall have the continued right to discharge and transmit into the Stormwater Reuse/Drainage area(s),at rates and volumes consistent with FDOT's use as intended in FDOT Project on SR 710.

(6) In the event that FDOT undertakes any major road improvements to State Road 710, FDOT agrees that any additional drainage created by any such major road improvements shall not be directed into the modified, expanded or improved reuse/drainage area(s) unless and until FDOT and CITY make further alterations or improvements to the Stormwater Reuse/Drainage area(s), to accommodate any such additional drainage.

(7) CITY agrees to construct the Reuse/Drainage Improvements, including the modified, expanded, or improved Stormwater Reuse/Drainage area(s), in accordance with the CITY's Project Plans, at its sole cost and expense. In the event that CITY, after beginning the construction fails to complete the construction to the modified, expanded, or improved reuse/drainage area(s), in accordance with the Plans or abandons the construction, FDOT shall have the right, but not the obligation to enter the reuse/drainage area(s) and perform such work as FDOT, in its sole discretion deems necessary to accommodate the drainage from FDOT's system. In such event, CITY shall be liable to FDOT for any and all costs and expenses incurred in connection with any such work performed by FDOT. CITY, prior to commencement of any work for the modified, expanded, or improved Stormwater Reuse/Drainage area(s),shall supply to FDOT a bond provided by a surety authorized to do business in the State of Florida, payable to the Governor and his successors in office and conditioned for the prompt, faithful, and efficient performance of the construction of the modified, expanded, or improved Stormwater Reuse/Drainage area(s), according to the Plans and within the time periods specified herein, and for the prompt payment of all persons furnishing labor, material, equipment, and supplies therefore. FDOT shall be entitled to first pursue its rights under the bond prior to entering the Additional Reuse/Drainage Area(s) to perform any work on its own. CITY hereby acknowledges that the continuation of FDOT's drainage is of great importance to the public health, safety and welfare, and hereby releases FDOT from and of

any and all claims, liabilities or demands of any nature whatsoever arising out of or related to the exercise by FDOT of its rights under this paragraph.

(8) CITY agrees that it shall be CITY's sole responsibility and obligation to obtain any and all necessary approvals or permits from any other governmental entity (including, but not limited to, any applicable Water Management District) prior to beginning any construction on the Real Property. In the event that construction is halted due to a breach by CITY of this requirement, FDOT may proceed pursuant to subparagraph (2) (e) (7) hereof in order to assure the continuation of its drainage.

(9) CITY shall take all steps necessary during construction to provide sufficient erosions protection on the Real Property to avoid any failure of the drainage system and to avoid any washout of ground or other matter into the road right of way and shall also take such other and further steps as may be necessary to protect the roadway from any other damage due to CITY's activities hereunder.

(10) CITY shall at all times be solely responsible for adequate Regular Maintenance and Capital Improvement Maintenance, as defined in subparagraph (2) (e) (4), of the modified, expanded, or improved reuse/drainage area(s), at CITY's sole cost and expense so as to assure continued functioning of the stormwater reuse/drainage/management system as planned. In the event that CITY fails to adequately perform such Regular Maintenance and Capital Improvement Maintenance, FDOT may, but is not obligated to, enter the property to perform such maintenance, in which event FDOT shall be entitled to charge the cost of such Regular Maintenance and Capital Improvement Maintenance to CITY. However, before the FDOT may perform such Regular Maintenance it must give written notice to CITY specifying the work to be performed and allow five (5) business days for CITY to enter and perform any such Regular Maintenance. Before the FDOT may perform Capital Improvement Maintenance it must give written notice to CITY specifying the work to be performed, proceed pursuant to subparagraph (2) (e) (4) to work with the CITY on the matter for up to thirty (30) days, and allow sixty (60) days thereafter for CITY to perform any such Capital Improvement Maintenance, unless the FDOT reasonably deems said maintenance to be an emergency, in which case it may proceed immediately to perform the maintenance. The

provisions of subparagraph (4) (e) (7) hereof regarding collection of said amount and release of liability for the work performed shall apply to any Regular Maintenance and any Capital Improvement Maintenance work performed by FDOT pursuant to this paragraph.

(11) In the event that the CITY's Project Plans call for any work to be performed on FDOT property, the CITY is hereby granted a license to enter onto such FDOT property for the purposes of performing such work. In the event that it becomes necessary for FDOT to enter CITY owned property under the terms of this agreement, FDOT is hereby granted a license to enter on to such CITY property for purposes of emergency maintenance and operation. CITY agrees that upon completion of the construction, it will restore any FDOT property, including the SR 710 Road right of way, to its original condition, except for any modifications made to other FDOT property pursuant to the Plans. In no event shall CITY take any actions pursuant to this paragraph which would in any way damage the road physically or impair its function. Any work performed on the FDOT right of way shall conform to the FDOT manual on Traffic Controls and Safe Practices for Street and Highway Construction, Maintenance and CITY Operation.

(12) FDOT shall have the right to make such inspections as it deems necessary to make sure that CITY is at all times complying with the terms and conditions of this Agreement.

(13) No future modifications to the system constructed by CITY or to the drainage as otherwise shown on the CITY's Project Plans shall be undertaken by CITY without the prior written consent of FDOT. CITY hereby acknowledges that depending on the nature of any such planned future modifications; the CITY may be required to make application for a drainage permit.

(14) No further drainage permit from the Department shall be required of CITY with regard to the work authorized to be performed pursuant to this Agreement, including the improvements to the Real Property; however, this provision shall not relieve CITY of the obligation to obtain permits for work other than that as authorized pursuant to this Agreement or for future alterations, expansions, or modifications to the system constructed by CITY.

(15) Nothing herein shall be construed as preventing FDOT from making such future road improvements to SR 710 as it deems, in its discretion, desirable provided the yield from the SWR facility is not decreased.

(16) CITY hereby agrees to indemnify and hold the FDOT and its officers, agents, and employees harmless of and from any and all claim, demand, damage, liability, cost or expense of any nature whatsoever arising out of or related to the exercise of CITY's rights hereunder or the construction, use or maintenance of the system, except for matters due to the sole negligence of FDOT or its officers, agents, or employees. In the event of any loss, damage, claim or expense resulting from CITY's performance or non-performance of the services authorized under this Agreement, CITY shall be wholly liable.

(17) CITY shall be solely responsible for locating and identifying potential conflicts with any utilities located in the right of way with respect to work to be performed in the right of way. Adjustment for said conflicts and responsibility for any damages to any utilities shall be the sole responsibility of CITY.

(18) The CITY's request to modify expand or improve for use as a Stormwater Reuse/Drainage area(s),under this paragraph 2 shall be exercised only once, and no further request for additional use of the FDOT's Interest will be permitted except by a subsequent and separate mutual agreement of the parties.

3. Miscellaneous.

(a) This Agreement shall be binding on the successors and assigns of CITY, on the successors and assigns of the FDOT, and shall be deemed to be a burden on and flowing with the modified, expanded, or improved Stormwater Reuse/Drainage area(s), and shall be a benefit and appurtenance to the property and modified FDOT WRA.

(b) Time is of the essence in the performance under this Agreement.

(c) This Agreement and the obligations of the parties hereunder shall survive the CITY's delivery of the deeds of conveyance pursuant hereto.

(d) This Agreement constitutes the entire and final expression of the parties with regard to the subject matter hereof.

(e) This Agreement shall be governed by and construed in accordance with Florida Law.

(f) Nothing in this Agreement, nor the FDOT's acceptance of the proposed modified, expanded, or improved Stormwater Reuse/Drainage area(s), under paragraph 2 hereof, shall be construed as a waiver of any permitting requirements for any improvements made by the CITY upon the Real Property and the CITY shall at all times be required to fully comply with any and all applicable statutes or rules with regard to any such improvements.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date set forth above.

Signed, sealed and delivered

in the presence of: RIVIERA BEACH, FLORIDA:

WITNESS:

ADDRESS:

WITNESS:

ADDRESS:

State of Florida

Department of Transportation

________________________ By:

WITNESS:_______________

ADDRESS:_______________ Director of Operations

________________________ District

Boulevard

Florida xxxxx

WITNESS:

ADDRESS:

Approved:

District Counsel

STATE OF FLORIDA

COUNTY OF

The foregoing instrument was acknowledged before me this _____ day of __________,2013, by . He is personally known to me or has produced ____ as identification.

Name:

Title or Rank:

Serial Number:

STATE OF FLORIDA

COUNTY OF AAAA

The foregoing instrument was acknowledged before me this ____ day of ____________, 2013, by _______________ as District Secretary, District XX, of the State of Florida, Department of Transportation, who is personally known to me or who has produced ____ as identification.

Name:

Title or Rank:

Serial Number:

8.4 Draft Agreement for Potential Project #3 – City of Haines City

The following Stormwater Reuse Agreement documents the granting by FDOT a stormwater reuse and maintenance easement of the FDOT existing wet retention/detention pond located on Old Polk City Road just west of US 27 to the City of Haines City, Florida hereafter (CITY). By granting a stormwater reuse and maintenance easement of the water retention pond area to the CITY, FDOT turns over and the CITY accepts all of the maintenance responsibility and costs of operation of the water retention pond. FDOT would retain fee simple ownership of the property and drainage, retention and emergency maintenance rights over the property. This insures FDOT's continuing right to use the water retention pond for its original intended purpose, the collection of stormwater from the FDOT roadway.

The agreement provides that the CITY would have the right to use the stormwater as an alternative water source by developing infrastructure to connect the pond to the City's existing irrigation main on US 27. The City would also have the right to modify and expand the water retention pond on to additional property provided that it obtains ownership rights over the additional property. CITY obtains rights to develop stormwater reuse improvements and infrastructure at the CITY's costs in order to reuse the stormwater to irrigate the landscaped medians along US 27. The CITY would be required to meet all standards imposed by permitting authorities and to obtain all permits. This usage of the stormwater should reduce the mass of pollutants from the existing water retention pond enhancing water quality to surface water bodies. The Agreement may also allow for possible TMDL credits to the FDOT or the End-User if negotiated that way . The agreement provides value to the community by providing an alternate source of water and reducing the reliance on potable water. Every gallon of stormwater (alternate source water) used for irrigation saves a gallon of potable water.

Pursuant to this agreement the CITY takes on the cost of maintenance and the responsibility to retain or use the water quantities as permitted. The agreement provides indemnification and emergency action rights to protect FDOT's interest.

The agreement provides for an approval process prior to construction of improvements but allows latitude for the CITY to develop necessary infrastructure. The Agreement also provides language to protect the integrity of the FDOT road project and the utility of the water retention pond for storage and reuse of stormwater.

Please note that GAI is not a law firm and does not warrant this agreement. This agreement is a rough draft and merely a sample of a form that may be used to document the terms of the agreement between the CITY and FDOT. This agreement should not be used without legal counsel and legal review.

<u>STORMWATER REUSE AGREEMENT</u>

This Agreement, entered into this _____ day of _____________, 2013 by and between Haines City, Florida ("CITY"), and the State Of Florida Department Of Transportation, ("FDOT");

WITNESSETH:

WHEREAS, FDOT is the fee simple owner of certain real property improved with a stormwater retention pond and located at Old Polk City Road (hereinafter referred to as the Stormwater Reuse Area (SWRA)) located in Polk County, Florida, as described and set forth in Exhibit "A".

WHEREAS, CITY wishes to develop infrastructure to provide drainage, and to obtain a cost effective alternative source of water for irrigation from the SWRA (hereinafter referred to as "Stormwater Reuse/Drainage Improvements"):

WHEREAS, CITY wishes to maintain the landscaping on US 27 to support economic development and beautify the community as well as address the water supply challenges of the state by reducing the use of potable water by utilizing a secondary source of water.

WHEREAS, CITY wishes to obtain from FDOT a perpetual exclusive stormwater reuse and maintenance easement for the purposes of modifying the SWRA to construct, operate and maintain an effective stormwater reuse operation.

WHEREAS, CITY would construct at its costs the modifications of the FDOT SWRA in order to operate and maintain the water reuse area, that shall drain both the FDOT improvements to be served by the FDOT's SWRA and shall serve as a stormwater reuse water retention pond: and

WHEREAS, CITY will operate and maintain the water retention pond and the stormwater reuse infrastructure at its own cost.

WHEREAS the stormwater reuse project will reduce the mass of pollutants to surface water bodies providing an enhancement to the water quality in the areas surface waters. It will also provide possible TMDL credits.

WHEREAS, pursuant to the terms and conditions of this Agreement, the FDOT is prepared to grant the CITY a stormwater reuse and maintenance easement to allow modification, expansion, drainage and harvesting of the SWRA;

NOW, THEREFORE, in consideration of the premises herein contained, the parties hereto agree as follows:

1. FDOT Interest. The CITY and FDOT acknowledge and agree that FDOT owns the subject SWRA in fee simple.

2. Future Reuse of FDOT Stormwater. The CITY and FDOT acknowledge and agree that CITY requires that the SWRA be modified for reuse/drainage with CITY to facilitate the CITY's construction on the Real Property. Any such improvement, modification or expansion of FDOT's SWRA for reuse shall be subject to the following terms and conditions:

(a) At such time as CITY desires to modify, expand, or otherwise improve the SWRA, CITY shall send a written request to FDOT specifying the exact nature of the proposed modification, expansion or improvement of the SWRA. Said written request shall, at a minimum, be accompanied by the following items:

(1) A signed and sealed survey of the proposed modified , expanded or improved water reuse area, delineation of the Additional Reuse/Drainage Area(s), and the legal description of the Additional Reuse Area(s);

(2) Evidence of CITY's ownership rights of any Additional Reuse Area. In the event that the title evidence discloses any matter not found acceptable by FDOT, no relocation will take place; and

(3) The amount of square footage of the proposed stormwater reuse area, including Additional Reuse/Drainage Area, and the configuration of the requested Stormwater Reuse/Drainage area(s); The parties agree that the entire SWRA shall be included in the Stormwater Reuse/Drainage area and shall be maintained by the CITY. Provided, however, that piping conveying storm water into the SWRA from the FDOT roadway shall remain the responsibility of FDOT, unless piping is modified by the City’s Project Plan,

(4) The CITY’s Project Plan, together with engineering information, including but not limited to detailed design of the modified, expanded or improved stormwater reuse area(s), drainage improvements, drainage calculations and other calculations, materials and quantities, effect on easement, and engineering information sufficient for the FDOT to make a determination of the adequacy of the proposed Stormwater Reuse/Drainage area(s) (under the standards set forth in subparagraph 3(b) below.

(b) The FDOT shall have up to two hundred seventy (270) days from the date of the written request to review the proposed stormwater reuse area(s) for adequacy. The proposed Stormwater Reuse area(s) will be adequate if all the following conditions are met as demonstrated by the information submitted as part of the request:

(1) Functional equivalent outfall to the same water bodies as provided by the original SWRA is provided;

(2) The proposed stormwater reuse area(s) meet all applicable environmental permitting requirements that are in place as of the time of the request, and also meet any criteria and comply with any conditions as the environmental permitting authorities may require as of the time of the request, for the joint uses intended by the CITY and by the FDOT; and

(3) The proposed stormwater reuse area(s) otherwise provide the functional equivalent of the existing stormwater facility for FDOT usage as to storage, treatment, and retention function, including volumes and rates of flow, in addition to providing for the proposed usage by the CITY of the Stormwater Reuse/Drainage area(s), under reasonable engineering judgment.

(4) The piping and ancillary and appurtenant drainage for the modified, expanded or improved Stormwater Reuse/Drainage structure and Additional Reuse/Drainage Area shall be of sufficient size to accommodate the Minimum Drainage Capacity as most recently established by the FDOT, prior to the date of the request, for a 100 year, 240 hour storm event.

(c) In the event that the FDOT fails to advise the CITY within two hundred seventy (270) days as to the adequacy of the proposed Stormwater Reuse/Drainage area(s), they will be deemed to be adequate, provided that the CITY properly and fully complied with its obligation to supply all necessary information as specified in subparagraph 2.(a) above and provided that said information otherwise supports the conclusion of adequacy under the standards set forth in subparagraph 2.(b) above.

(d) In the event the FDOT objects to the proposed stormwater reuse area(s), because the FDOT believes that the standards set forth in subparagraph 2.(b) above are not met and the parties are not able to negotiate the disagreement, the new proposed Stormwater Reuse/Drainage area(s),shall be deemed inadequate and the modification of the FDOT’s water retention area(s) will not take place, so long as the FDOT has operated in good faith in applying the standards of adequacy and in attempting to negotiate the disagreement.

(e) If the FDOT has deemed the proposed stormwater reuse area(s) to be adequate, the following will occur:

(1) FDOT will within forty-five (45) days grant to the CITY a perpetual, exclusive stormwater reuse and maintenance easement over, across and through the reuse Area(s) for purposes of stormwater drainage and retention into the modified, expanded, or improved reuse area(s) to be constructed in part thereon by the CITY. The CITY shall be granted the right to modify, expand or improve the Stormwater Reuse/Drainage area(s), for purposes of stormwater drainage retention and reuse. The parties agree that this STORMWATER REUSE AGREEMENT shall be an attachment to the easement and serve as the terms and conditions for exercise of the easement rights by the CITY.

(2) The easement is subject to and conditional on CITY agreeing to be solely responsible for all improvements to be made on the Real Property, including the Stormwater Reuse/Drainage Improvements and the CITY agreeing to construct the Reuse/Drainage Improvements, including the modification, expansion, or improvements of the FDOT SWRA, in accordance with the CITY's Project Plans.

(4) Upon the conveyance of said easement, CITY shall be responsible for all ongoing maintenance of the Reuse/Drainage area(s) including trash removal and lawn maintenance (hereinafter referred to as "Regular Maintenance"), and all future capital improvements to the Reuse/drainage area(s) (hereinafter referred to as "Capital Improvement Maintenance"). An example of Capital Improvement Maintenance would be structural piping improvements, repair and maintenance. Should either the CITY or FDOT determine that Capital Improvement Maintenance is required, they shall notify the other party with a description of the work to be performed. After the FDOT has approved the scope of the work to be performed, and the parties have worked with each other in good faith to agree on the estimated cost for the CITY to perform such work, the CITY will perform the work in accordance with said agreement. In the event that, after commencement of such work by the CITY, the CITY or FDOT determines that changes need to be made to the scope of such work, and to the estimated cost of such work, the FDOT shall have the right to approve any such changes to the scope or cost of the work. In the event either of the parties are unable to reach agreement on any Capital Improvement Maintenance, then either party may bring an action in circuit court for a determination by the court of the need, scope and cost of such Capital Improvement Maintenance. This action shall not be construed as relating to an eminent domain action and the

parties' costs may be borne pursuant to any other statutes, case law, and rules of civil procedure which are applicable.

(5) Notwithstanding anything in this Agreement to the contrary, CITY hereby agrees that FDOT shall have the continued right to discharge and transmit into the Stormwater Reuse/Drainage area(s),at rates and volumes consistent with FDOT's use as intended in FDOT Project on US 27.

(6) In the event that FDOT undertakes any major road improvements to US 27, FDOT agrees that any additional drainage created by any such major road improvements shall not be directed into the modified, expanded or improved reuse/drainage area(s) unless and until FDOT and CITY make further alterations or improvements to the Stormwater Reuse/Drainage area(s), to accommodate any such additional drainage.

(7) CITY agrees to construct the Reuse/Drainage Improvements, including the modified, expanded, or improved Stormwater Reuse/Drainage area(s), in accordance with the CITY's Project Plans, at its sole cost and expense. In the event that CITY, after beginning the construction fails to complete the construction to the modified, expanded, or improved reuse/drainage area(s), in accordance with the Plans or abandons the construction, FDOT shall have the right, but not the obligation to enter the reuse/drainage area(s) and perform such work as FDOT, in its sole discretion deems necessary to accommodate the drainage from FDOT's system. In such event, CITY shall be liable to FDOT for any and all costs and expenses incurred in connection with any such work performed by FDOT. CITY, prior to commencement of any work for the modified, expanded, or improved Stormwater Reuse/Drainage area(s),shall supply to FDOT a bond provided by a surety authorized to do business in the State of Florida, payable to the Governor and his successors in office and conditioned for the prompt, faithful, and efficient performance of the construction of the modified, expanded, or improved Stormwater Reuse/Drainage area(s), according to the Plans and within the time periods specified herein, and for the prompt payment of all persons furnishing labor, material, equipment, and supplies therefore. FDOT shall be entitled to first pursue its rights under the bond prior to entering the Additional Reuse/Drainage Area(s) to perform any work on its own. CITY hereby acknowledges that the continuation of FDOT's drainage is of great importance to the public health, safety and welfare, and hereby releases FDOT from and of

any and all claims, liabilities or demands of any nature whatsoever arising out of or related to the exercise by FDOT of its rights under this paragraph.

(8) CITY agrees that it shall be CITY's sole responsibility and obligation to obtain any and all necessary approvals or permits from any other governmental entity (including, but not limited to, any applicable Water Management District) prior to beginning any construction on the Real Property. In the event that construction is halted due to a breach by CITY of this requirement, FDOT may proceed pursuant to subparagraph (2) (e) (7) hereof in order to assure the continuation of its drainage.

(9) CITY shall take all steps necessary during construction to provide sufficient erosions protection on the Real Property to avoid any failure of the drainage system and to avoid any washout of ground or other matter into the road right of way and shall also take such other and further steps as may be necessary to protect the roadway from any other damage due to CITY's activities hereunder.

(10) CITY shall at all times be solely responsible for adequate Regular Maintenance and Capital Improvement Maintenance, as defined in subparagraph (2) (e) (4), of the modified, expanded, or improved reuse/drainage area(s), at CITY's sole cost and expense so as to assure continued functioning of the stormwater reuse/drainage/management system as planned. In the event that CITY fails to adequately perform such Regular Maintenance and Capital Improvement Maintenance, FDOT may, but is not obligated to, enter the property to perform such maintenance, in which event FDOT shall be entitled to charge the cost of such Regular Maintenance and Capital Improvement Maintenance to CITY. However, before the FDOT may perform such Regular Maintenance it must give written notice to CITY specifying the work to be performed and allow five (5) business days for CITY to enter and perform any such Regular Maintenance. Before the FDOT may perform Capital Improvement Maintenance it must give written notice to CITY specifying the work to be performed, proceed pursuant to subparagraph (2) (e) (4) to work with the CITY on the matter for up to thirty (30) days, and allow sixty (60) days thereafter for CITY to perform any such Capital Improvement Maintenance, unless the FDOT reasonably deems said maintenance to be an emergency, in which case it may proceed immediately to perform the maintenance. The provisions of subparagraph (4) (e) (7) hereof regarding collection of said amount and release of liability for the work performed shall apply to any Regular

Maintenance and any Capital Improvement Maintenance work performed by FDOT pursuant to this paragraph.

(11) In the event that the CITY's Project Plans call for any work to be performed on FDOT property, the CITY is hereby granted a license to enter onto such FDOT property for the purposes of performing such work. In the event that it becomes necessary for FDOT to enter CITY owned property under the terms of this agreement, FDOT is hereby granted a license to enter on to such CITY property for purposes of emergency maintenance and operation. CITY agrees that upon completion of the construction, it will restore any FDOT property, including the SR 27 Road right of way, to its original condition, except for any modifications made to other FDOT property pursuant to the Plans. In no event shall CITY take any actions pursuant to this paragraph which would in any way damage the road physically or impair its function. Any work performed on the FDOT right of way shall conform to the FDOT manual on Traffic Controls and Safe Practices for Street and Highway Construction, Maintenance and CITY Operation.

(12) FDOT shall have the right to make such inspections as it deems necessary to make sure that CITY is at all times complying with the terms and conditions of this Agreement.

(13) No future modifications to the system constructed by CITY or to the drainage as otherwise shown on the CITY's Project Plans shall be undertaken by CITY without the prior written consent of FDOT. CITY hereby acknowledges that depending on the nature of any such planned future modifications; the CITY may be required to make application for a drainage permit.

(14) No further drainage permit from the Department shall be required of CITY with regard to the work authorized to be performed pursuant to this Agreement, including the improvements to the Real Property; however, this provision shall not relieve CITY of the obligation to obtain permits for work other than that as authorized pursuant to this Agreement or for future alterations, expansions, or modifications to the system constructed by CITY.

(15) Nothing herein shall be construed as preventing FDOT from making such future road improvements to US 27 as it deems, in its discretion, desirable provided the yield from the SWR facility is not decreased.

(16) CITY hereby agrees to indemnify and hold the FDOT and its officers, agents, and employees harmless of and from any and all claim, demand, damage, liability, cost or expense of any nature whatsoever arising out of or related to the exercise of CITY's rights hereunder or the construction, use or maintenance of the system, except for matters due to the sole negligence of FDOT or its officers, agents, or employees. In the event of any loss, damage, claim or expense resulting from CITY's performance or non-performance of the services authorized under this Agreement, CITY shall be wholly liable.

(17) CITY shall be solely responsible for locating and identifying potential conflicts with any utilities located in the right of way with respect to work to be performed in the right of way. Adjustment for said conflicts and responsibility for any damages to any utilities shall be the sole responsibility of CITY.

(18) The CITY's request to modify expand or improve for use as a Stormwater Reuse/Drainage area(s),under this paragraph 2 shall be exercised only once, and no further request for additional use of the FDOT's Interest will be permitted except by a subsequent and separate mutual agreement of the parties.

3. Miscellaneous.

(a) This Agreement shall be binding on the successors and assigns of CITY, on the successors and assigns of the FDOT, and shall be deemed to be a burden on and flowing with the modified, expanded, or improved Stormwater Reuse/Drainage area(s), and shall be a benefit and appurtenance to the property and modified FDOT SWRA.

(b) Time is of the essence in the performance under this Agreement.

(c) This Agreement and the obligations of the parties hereunder shall survive the CITY's delivery of the deeds of conveyance pursuant hereto.

(d) This Agreement constitutes the entire and final expression of the parties with regard to the subject matter hereof.

(e) This Agreement shall be governed by and construed in accordance with Florida Law.

(f) Nothing in this Agreement, nor the FDOT's acceptance of the proposed modified, expanded, or improved Stormwater Reuse/Drainage area(s), under paragraph 2 hereof, shall be construed as a waiver of any permitting requirements for any improvements made by the CITY upon the Real Property and the CITY shall at all times be required to fully comply with any and all applicable statutes or rules with regard to any such improvements.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date set forth above.

Signed, sealed and delivered

in the presence of: HAINES CITY, FLORIDA:

WITNESS:

ADDRESS:

WITNESS:

ADDRESS:

State of Florida

Department of Transportation

_________________________ By:

WITNESS:_______________

ADDRESS:_______________ Director of Operations

________________________ District

Boulevard

Florida xxxxx

WITNESS:

ADDRESS:

Approved:

District Counsel

STATE OF FLORIDA

COUNTY OF

The foregoing instrument was acknowledged before me this _____ day of __________,2013, by . He is personally known to me or has produced ____ as identification.

Name:

Title or Rank:

Serial Number:

STATE OF FLORIDA

COUNTY OF AAAA

The foregoing instrument was acknowledged before me this ____ day of ____________, 2013, by _______________ as District Secretary, District XX, of the State of Florida, Department of Transportation, who is personally known to me or who has produced ____ as identification.

Name:

Title or Rank:

Serial Number:

Point-of-Interest: It is extremely important that the formation of SWR Agreements protect the Department against liability and risk from potential "what if" scenarios specific to each project. Agreement should also include a contingency provision that protects the FDOT from defaulting End-Users.

Section 9
Recommended Change to the FDOT PD&E Process

The potential to include Stormwater Reuse (SWR) is increased by early identification of opportunities. Achieving the benefits of this form of stormwater management must include early planning within the Department's project development process, allowing adequate time to coordinate and develop these complex partnerships. Incorporating these facilities as part of a holistic stormwater management approach must become a vital part of project planning, and should become fully integrated into the PD&E and EDTM process itself.

The Department's PD&E Manual is essentially a highly detailed outline for how the different types of environmental documents must be prepared, and includes a high-level summary of what categories of interest must be addressed within the subject reports. While little of the document itself goes into the level of detail which would drive consideration of this alternative stormwater treatment method, its references to external criteria provide excellent opportunities to encourage investigation of Stormwater Reuse as a viable alternative to water quality treatment and attenuation.

Areas where enhancement to the PD&E manual and supporting documents/procedures can encourage evaluation of Stormwater Reuse opportunities and potential project cost savings include:

EDTM PROCESS

Including the evaluation of SWR opportunities within the EDTM process provides the best forum for local governments and agencies to provide input and consideration on stormwater treatment methods. Incorporation of this topic into training materials, reference manuals, and even project descriptions/initial notes by FDOT will help to solicit input and begin coordination at the absolute beginning of the project development.

PD&E MANUAL

Part 1, Chapter 4: Project Development Process and Engineering Considerations.

- Section 4-2.5.2 (Preliminary Design Considerations) states that concepts and reports must be prepared consistent with a number of state and federal manuals. Should a Stormwater Reuse (SWR) policy be captured within a unique document, it should be listed here; alternatively, should the decision be made to incorporate the SWR evaluation process into a pre-existing manual (i.e., the Plans Preparation Manual or

Drainage Manual), the inclusion of the documents on this list binds the two processes together, and by reference includes any SWR policy in the PD&E Process.

- Section 4-2.5.2.2 (Existing Physical Features) describes a Drainage System Inventory that must be performed. Expansion of this task to include review of surrounding land use and potential SWR End-Users would help to identify opportunities.

Part 1, Chapter 11: Public Involvement.

- Section 11-2.2.5 (Identify Stakeholders and Audience) discusses identification of participants that will have a strong interest in a particular transportation project. In addition to the examples listed, inclusion of "potential stormwater reuse customers" would call attention to the need to engage these partners.

Part 2, Chapter 9: Sociocultural Effects Evaluation.

- Section 9-2.5.4 (Evaluate Sociocultural Effects) references application of the Context Sensitive Solutions Policy; this section could be expanded to identify SWR as a means of harmonizing a stormwater treatment facility into a particular environment, promoting sustainability and an overall smaller/multi-use footprint.

Part 2, Chapter 20: Water Quality.

- The WQIE Checklist (Exhibit A) has a section where "conceptual stormwater conveyances and system" alternatives are identified. Inclusion of SWR as a check box will help in identifying this alternative.

FDOT DRAINAGE MANUAL

Part 2, Chapter 20: Water Quality.

- Section 5.3.1.1 (Design of Systems – General) describes consideration of joint use and/or regional treatment facilities. This text should be expanded to include SWR facilities to encourage their evaluation.

Point-of-interest: As previously mentioned the best opportunity for significant cost savings to the Department will most likely come from projects that integrate SWR at the planning stage with the intent to reduce pond size and associated R/W acquisition. The revision to the PD&E / EDTM process should require a SWR assessment be made, and strongly encourage SWR integration into the project. This recommended revision is an important mechanism to facilitate the SWR Initiative.

Section 10
Summary of Findings and Recommendations

10.1 Summary of Findings

- The FDOT is committed to promoting the reuse of stormwater by making available their significant volume of impounded stormwater. The commissioning of this Study, and the willingness to provide its stormwater with in-need End-Users is evidence of that commitment. FDOT will be at the forefront of assisting End-Users in meeting AWS needs by actively pursuing this Initiative. FDOT will be proactive and ahead of other potential organizations that could initiate similar projects. FDOT will have a first mover advantage by pursuing this Initiative which will include: 1) early dictation of value trading options 2) gaining experience as a Stormwater Reuse (SWR) provider 3) establishing a successful relationship with End-Users and permitting agencies.

- The need for alternative water sources has been an important focus of the State of Florida environmental regulatory agencies, and environmentally sensitive/proactive water suppliers for over a decade. SWR was first permitted by SJRWMD in 1989. There are over 600 various forms of SWR projects in place in the state of Florida. SWR is recognized and accepted as an Alternative Water Supply.

- Some conventional forms of value trading include: TMDL credits, impaired water credits, off-sets to higher value and more restrictive water supplies (such as SWR for irrigation to replace potable water), wetland hydration, and maintenance of minimum flow. These create environmental and pollution control credits to be recognized under the hydrologic criteria, and are proactive in addressing potential future criteria that may be implemented.

Additionally, the reuse of stormwater has the potential to reduce pond size requirements and costly R/W acquisition costs on newly planned projects.

These and others are forms of Value Trading scenarios that can benefit the FDOT and leverage an asset that is currently "warehoused". The FDOT would be able to Value Trade with the End-Users but would not be responsible for managing the day-to-day operations of the facilities or providing customer services. FDOT would not be accountable for setting rates and charges for the customers within the service area and other responsibilities associated with serving individual customers versus bulk customers.

- These same Value Trading scenarios will provide an in-need End-User with another AWS option at a competitive price point. As the Florida population grows, water resource management has become a critical component of community planning.

- Regulations are in place at the FDEP and Water Management District levels that permit the reuse of stormwater for many applications. Most importantly, this program promotes water quality and conservation efforts and will have a positive impact on the overall water resources of the State.

- Funding grants from the WMDs are available to municipalities to off-set capital costs associated with pumping and conveyance infrastructure.

- Stormwater Reuse is not as widely accepted as an irrigation water source option as reclaimed wastewater.

- Some District Drainage Engineers are relatively new to this concept, and as a result, are not actively pursuing SWR opportunities as aggressively as necessary to leverage the FDOT's stormwater assets.

- There is a false perception that the "seasonality" of stormwater in Florida creates a disadvantage for considering SWR when being compared to reclaimed wastewater as an irrigation water supply. This seasonality perception often leads to SWR being considered more for augmentation than a primary AWS.

- The need to dispose of wastewater, and its year-round availability makes reclaimed wastewater a first priority for irrigation water for many regulators. CUP/WUP regulators count surface water and/or surficial ground water extraction against the permitted allocation of water, whereas reclaimed water is not counted against the CUPs/WUPs. The FDEP's and WMD's current regulatory position creates a deterrent to the use of stormwater for irrigation purposes.

- Other than turbidity criteria, the FDEP does not stipulate comprehensive water quality standards for the reuse of stormwater for irrigation purposes. The combination of retention time, micro soil filtration through horizontal wells, and disinfection provides a reasonable assurance that no adverse public health impacts would occur through the reuse of stormwater as a public access irrigation supply.

- Geo-Hydraulic Modeling are technical methods used to determine "safe" yield from a harvesting site. The SHARP modeling program is one of the recognized analytical methods of understanding the effects of pond and groundwater withdrawal on the groundwater conditions within the influence area of a harvesting site.

- The FDOT's State Hydraulics Engineer has indicated that there is a willingness to consider the modifying of design plans and associated permitting, and delay the project production schedule if there is an opportunity to significantly reduce project costs.

- Entering into SWR Agreements with Private Sector End-Users has increased risk factors, such as the private entity going into bankruptcy, and warrants a higher level of vetting, and subsequent assurances than municipal partners.

- The Alternative Water Supply (AWS) planners at the WMDs are a valuable resource of knowledge, and are passionate about the need to develop AWSs. They have all expressed their support of SWR as an AWS, however the use of reclaimed wastewater is encouraged and not counted against a CUP/WUP.

- There are numerous potential End-Users statewide that present a wide variety of SWR opportunities that are in various states of readiness.

- The Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) model is an accepted scientific method of analyzing the effects of stormwater harvesting on impounded pond water and the inter-connected surficial aquifer.

- The SJRWMD, SFWMD, and SWFWMD have all expressed their support of the conceptualized SWR project that occurs in their respective District.

- The SHARP modeling results of the 3 selected projects demonstrate that there is adequate safe yield at each location to create a desirable delivery price point for the End-User.

- SWR Agreements will be the legal instrument that will establish the terms and conditions of the SWR partnership. It is important to anticipate worst case scenarios and build the appropriate contingency language into each project specific document.

- Revising the FDOT's PD & E process to include mandatory assessments of SWR opportunities in the project area would be an effective way to identify the potential to create significant cost savings.

- The three highway pond projects highlighted in this study can be used as a source of SWR. The unit cost to deliver stormwater from each project has been estimated and is significantly lower than the current potable water supply.

10.2 Recommendations

#1 The FDOT should continue forward with its Stormwater Reuse Initiative. SWR is a viable Alternative Water Supply, and is a key component of the State's Water Protection and Sustainability Program. The added support by the Department will help tremendously in the further acceptance and development of stormwater reuse. In addition, by leveraging this under-utilized asset through value trading with in-need End-Users, the Department will be optimizing an asset to assist in meeting its Mission Statement.

#2 The Department should push for Florida legislative change that would encourage potential End-Users to utilize stormwater in their water resource planning. These legislative changes should be tied to showing the benefits of SWR as it relates to environmental stewardship. An exemption to CUP/WUP permits should be encouraged that would give SWR an equal advantage to reclaimed wastewater. Another suggested approach would be to promote the acceptance and further the reuse of stormwater that incorporates the legislative direction noted in HB 599. In particular, that regional facilities that incorporate SWR be given special preference by the FDEP and WMD managers and technical staff.

#3 Commission a Treatability Study to demonstrate that harvesting stormwater through horizontal wells produces a water quality that is acceptable for public access irrigation and can be treated to a potable water standard. A determination of the need for disinfection should be a component of the Study.

#4 Implement the three selected pilot projects. This will allow the Department to examine the entire process from identifying an End-User, to the successful execution of an Agreement, through construction and turn-over of the water delivery infrastructure, and the subsequent long term O & M dependability.

#5 Market FDOT's entry into the Stormwater Reuse "business". In the process, the goal is to help debunk the perception that "seasonality" is a critical flaw in the reliability of stormwater.

#6 Educate and Train the District Drainage Engineers as needed to be advocates, and vigorous promoters of SWR.

#7 Create an End-User Data Base to track, monitor, and stay connected with potential SWR opportunities.

#8 Revise/enhance the Department's PD & E process to require the assessment of SWR opportunities on all planned projects.

#9 Solicit federal water resource dollars to support the Department's SWR Initiative.

Appendix A

Regional Stormwater Irrigation Facilities

Final Report FDOT Project BD521-03

REGIONAL STORMWATER IRRIGATION FACILITIES

A Joint Research Program of

Submitted by

Marty Wanielista

Stormwater Management Academy
University of Central Florida
Orlando, FL 32816

Editorial Review by:

Nicole Runnebaum

December 2007

Disclaimer

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

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	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Florida Department of Transportation manages the runoff water from highways and other transportation related facilities, and frequently regional detention ponds are used. One potential use of detained runoff water in regional ponds is for irrigation. The pond water used for irrigation will reduce dependency on costly potable water for irrigation. The use of regional detention ponds is also attractive because irrigation of the detained water helps FDOT meet Total Maximum Daily Load restrictions for water bodies as well as to lower maintenance cost.

The use of regional ponds for irrigation can become more common if the occurrence of harmful algae can be minimized. Cyanobacteria counts and toxins are used as the measure of harmful algae. The counts and toxic concentrations are documented in regional detention ponds and after the detained water passes through soils. The algal count in regional ponds is three orders magnitude less than that found in central Florida lakes. The count and toxic levels after filtration through soils are less than that found in the regional ponds.

To remove the detained water through soils may be done using horizontal wells. To demonstrate the operation of a horizontal well, one is constructed adjacent to the shore line of a 15 acre regional pond. The well consistently produced a flow rate needed for the irrigation demand (500 gpm), and of a quality that meets public access irrigation quality standards.

17. Key Word	18. Distribution Statement
Stormwater, Detention Ponds, Cyanobacteria, Toxins, Reuse, Horizontal Wells, Water Quality	No Restrictions

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	117	

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The authors also appreciate the reviewers of the draft document by the Florida Department of Transportation and students at the University of Central Florida. We wish to give special thanks to two former students who worked on the implementation and development of the controller used for source selection, namely Jennifer McDaniel and Gary Yocum. Thanks are also extended to three other students, Natalie Shaber, Robert Miller, and Mikhal Moberg for their field and laboratory work.

Executive Summary

The conclusion of this research is that regional ponds with horizontal wells can be used as a source of water for irrigation. This research is significant because the use of stormwater from regional ponds will reduce the amount of surface discharge pollutants from the ponds, and provide for an alternative water supply, that can be used for irrigation. Decreasing the quantity of water pollutants discharging into receiving waters will help meet total maximum daily load (TMDL) limits as well as lower the cost of maintenance of highway vegetation.

Regional ponds collect stormwater from watershed areas and these watershed areas are typically a combination of land uses. Examples of common land use classifications are highways, residential, commercial, industrial, agricultural, and natural undisturbed areas. These land uses contain pervious and impervious surfaces. Some of the pervious areas within the contributing land uses need irrigation water. The regional pond then serves as a source of irrigation water.

The use of regional ponds for irrigation can become more common if the occurrence of harmful algae can be minimized. Cyanobacteria counts and the Cyanotoxin Microcystin are used as the measure of harmful algae.

Fourteen regional ponds were sampled, which all had discharges from a roadway surface. The counts and toxic concentrations were documented in these regional detention ponds. Also, the fate of Cyanobacteria and the Cyanotoxin Microcystin is measured after regional pond water passes through soils. The algae count in regional ponds is at least three orders magnitude less than that found in central Florida lakes. The count and toxic level after filtration through soils is less than that found in the regional ponds.

Removal of detained regional pond water through soils may be done using horizontal wells. To demonstrate the operation of a horizontal well, one is constructed adjacent to the shore line of an existing regional pond on the campus of the University of Central Florida. The watershed has a four lane divided highway running through it with an average daily traffic count of about 80,000 vehicles. The 155.86 acre watershed is a mixed use area consisting of commercial, condominium, and recreational sport stadiums. The pond is 15 acres in area with a normal depth of eight feet. The well consistently produces a flow rate needed for the irrigation demand (500 gpm) and of a quality that meet public access irrigation quality.

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CHAPTER 1 – INTRODUCTION

Regional ponds collect stormwater from more than one classification of watershed or land use. The ponds can also serve as a source of irrigation water. A roadway is usually associated with each and every developed watershed, but there are many other land uses producing runoff. Examples of other land uses are: residential, commercial, industrial, agriculture, and natural or undisturbed. Irrigation for the pervious areas of these land uses is needed. Regional detention ponds can serve as the source of irrigation water; however, the water quality of the regional ponds used as a source of irrigation has not been documented. In particular, Cyanobacteria counts and toxic concentrations have not been measured. Furthermore, the currently used alternative water supply for irrigation is treated sewage (reclaimed water) which must be disinfected primarily using chlorine. Water in a stormwater pond may not need to be chlorinated, but could simply be filtered. Filtering the water through select soil materials or even the natural soils and then extracting it, using horizontal wells under and near a pond would not only be operationally easy, but may also produce a better water quality. Before installing and using the filters, it must first be shown that detained water can be extracted from a pond using a horizontal well.

In February of 2004, The Florida Department Transportation (FDOT) and the Florida Department of Environmental Protection (FDEP) funded research contracts to collect water quality data to support the concept of regional stormwater irrigation facilities. The sites selected for this research will receive stormwater from highways, but are regional in nature, and thus have input waters from other land uses. In addition, a regional facility will be constructed and initial operation will be demonstrated using a horizontal well. Runoff waters to the detention pond are from a four lane highway, an athletic complex, and a commercial area.

1.1 Objectives

The objectives of this research are:

1. Develop an algal mass and toxin data base for regional stormwater ponds that have the potential to be used for irrigation.
2. Demonstrate the use of a horizontal well for the collection of irrigation quality water from a regional facility.

1.2 Limitations

The results are constrained by the location and climate in Florida. The water quality data base is limited to algal masses and toxins.

1.3 Approach

This report consists of six chapters. Provided in the first chapter is an introduction to the topic and also a description of the research objectives. In chapter two, a review of the current state of regional ponds and information related to algal counts and toxins is presented. The site selection criteria and description of the sites is covered in chapter three. In chapter four, results and discussion of the data are shown. The demonstration details for a reuse pond are presented in chapter five. In chapter six, a discussion, summary, conclusions, and recommendations are presented.

CHAPTER 2 – BACKGROUND

A regional facility for stormwater management is a detention pond that collects stormwater from more than one land use and usually includes runoff from roadways. The stormwater in the detention pond can be used for irrigation (Wanielista et.al., 1991). Currently, potable water is used in most parts of Florida for irrigating lawns, washing automobiles, and other consumptive uses. A non-potable source could be less costly relative to a potable source; however, some non-potable sources are becoming scarce. In 2003, eleven counties in Florida reported at least 85% of the reclaimed water is now used for non-potable uses (Water Reuse Work Group, 2003), and there is a demand for more than can be supplied. At the demonstration site for this research, a reclaimed line has been available for two years, but no reclaimed water was allocated. Thus, stormwater became a source to satisfy the demand for non-potable water.

Regional and even single watershed ponds are found throughout the State, especially in areas with high water tables. These ponds frequently discharge more water than they collect because of high water table and poorly drained soil conditions; however, some of the detained water can be used for irrigation. Some of the benefits of converting detention ponds to regional irrigation ponds are:

1. The regional irrigation pond will continue to assist in meeting Water Management District Environmental Resource Permits in terms of peak discharge and water quality management.
2. When using irrigation from the regional ponds, the volume of stormwater discharged to surface waters decreases relative to no-reuse, and thus total maximum daily loads (TMDL) of pollutants are reduced. Regional ponds with irrigation will help FDOT, other government agencies, and private developers meet the new TMDL regulations.
3. Drinking water is used for irrigation of lawns. The use of irrigation water from a regional

facility will replace the use of drinking water. This has a direct benefit in areas that rely on groundwater as the sole drinking water source. The drinking water supply is not only sustained, but wetlands dependent on the groundwater are enhanced and maintained as well.

4. The cost of providing water for drinking and irrigation purposes decreases because the irrigation water from the regional ponds will cost less than drinking water.
5. A regional irrigation pond as part of a FDOT highway project can be purchased with construction money. The operation can then be assumed by a stormwater utility or irrigation utility, thus improving the operational effectiveness of such systems.
6. In some groundwater protected areas, such as Springsheds, a yearly hydrologic water budget must be maintained. Thus, the use of detention ponds with irrigation can help in the maintenance of the annual hydrologic budget.

2.1 Past Research for the Design and Operation of a Reuse Stormwater Pond

Stormwater ponds are designed for pollution control and flood control. Pollution control can also be achieved in terms of mass removal by reducing the discharged volume of water. Furthermore, if the detained water is of acceptable quality it can be irrigated. Filtration of detained water through natural soils adjacent to ponds may be also possible, and may even improve water quality.

Gravity filtration systems in detention ponds were monitored to document operational and pollution removal effectiveness in the past (Wanielista, 1986, Harper and Miracle, 1993, and Dyer, Riddle, Mills and Precourt, Inc, 1995). These were shallow, wet detention ponds with bottom and bank filtration systems. The filtration depth was only a few inches to a few feet and the discharges from the filtration systems were not used for irrigation. The results of the monitoring indicated that particulate species in the stormwater were reduced, but the average pollution removal effectiveness for dissolved species, especially nitrogen, was low, and in a few events total nitrogen was exported. In addition, clogging was a problem when peat or fine silt materials were used as the filtration materials (Nnadi, et.al., 1997).

Wet detention pond design criteria were thus modified to include the recovery of the pollution control volume using pumps for irrigation. These ponds are called stormwater reuse ponds, and are normally wet all year. The design criteria are listed in a FDEP report (Wanielista, et. al., 1991). Using these design criteria, a pond was designed and operated in Winter Park, Florida (Wanielista and J. Bradner, 1992). The documentation of the water quantity irrigation efficiencies for which this pond was designed validated the model used for sizing a wet detention pond for irrigation, and are based on the effective impervious area (Wanielista, et.al., 1997). For regional ponds, the design criteria are thus established and an example design curve, called a REV curve used for central Florida, is shown in Figure 1.

Biological organisms are naturally selected in a soil column and on the ground surface. Past studies indicate that hydrocarbon-degrading bacteria were naturally selected along highways and the number of bacteria decreased at a distance from the road edge. The population of bacteria was positively correlated with the amount of hydrocarbon substrate in the environments in ditches adjacent to highways (Wanielista, et.al., 1978). In other studies, (Wanielista, and Charba, et.al., 1991) it was demonstrated that granular activated carbon did decrease Trihalomethane Formation Potential.

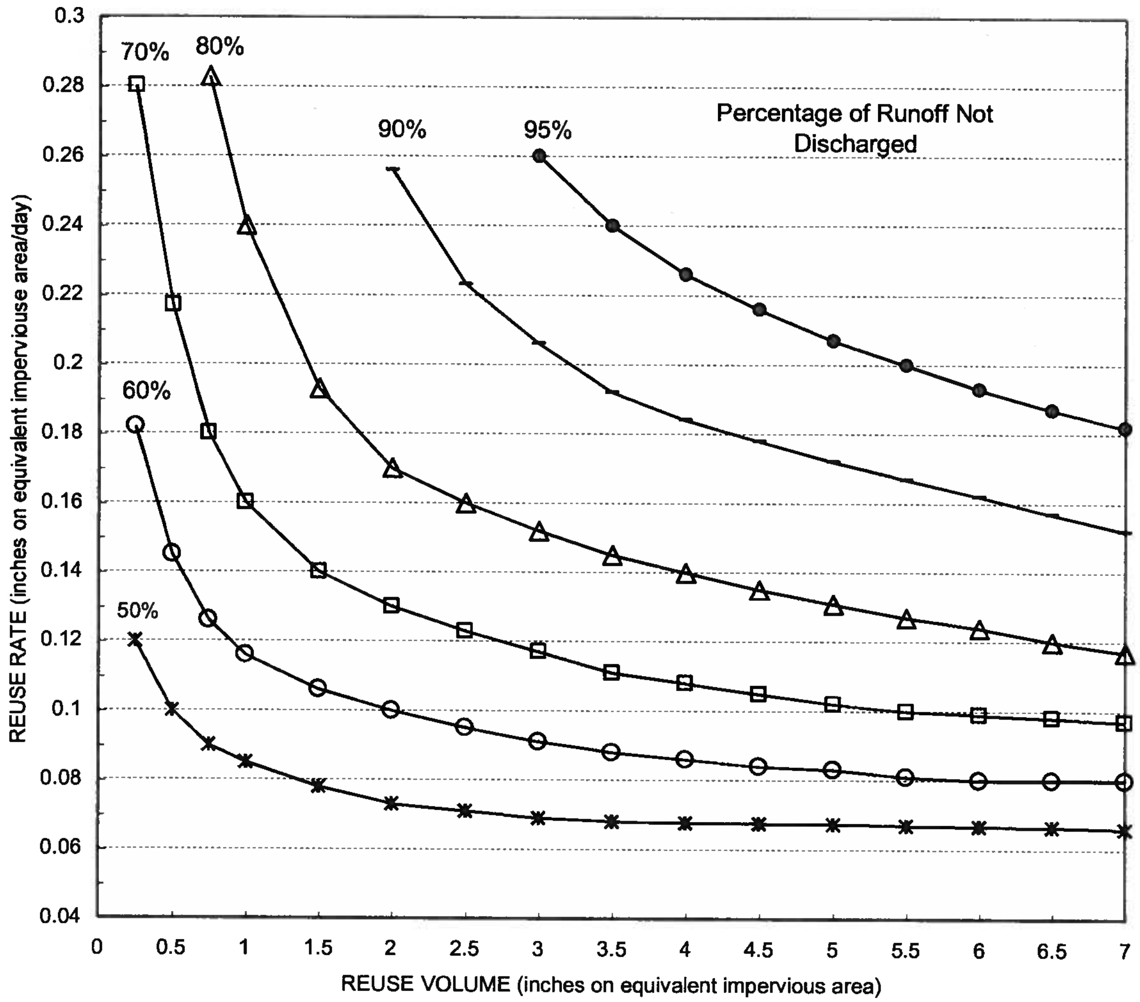


Figure 1: Reuse Curve for Designing a Reuse Volume and Irrigation Rate for Central Florida (From Wanielista, Yousef, et.al, 1991)

Within stormwater there are pollutants, classified as nutrients, organics, solids, metals, oils, bacteria, and others. The average loading rates for these have been documented (Harper, 1994, and Wanielista and Yousef, 1993, pg. 126). These pollutants are not found in high concentrations in irrigation quality waters, and thus some must be removed before irrigation. Some methods are better than others to remove pollutants, and there is excellent documentation of the watershed approach and the best management practices in many publications (Livingston, et.al., 1988, Ruston, 2001, and Ruston, 2002). This research will concentrate on documenting the removal of public health related pollutants by soils and in regional ponds. In Figure two, there are two pond schematics, one for detention and one for retention. Both pond systems can be used to supply irrigation water.

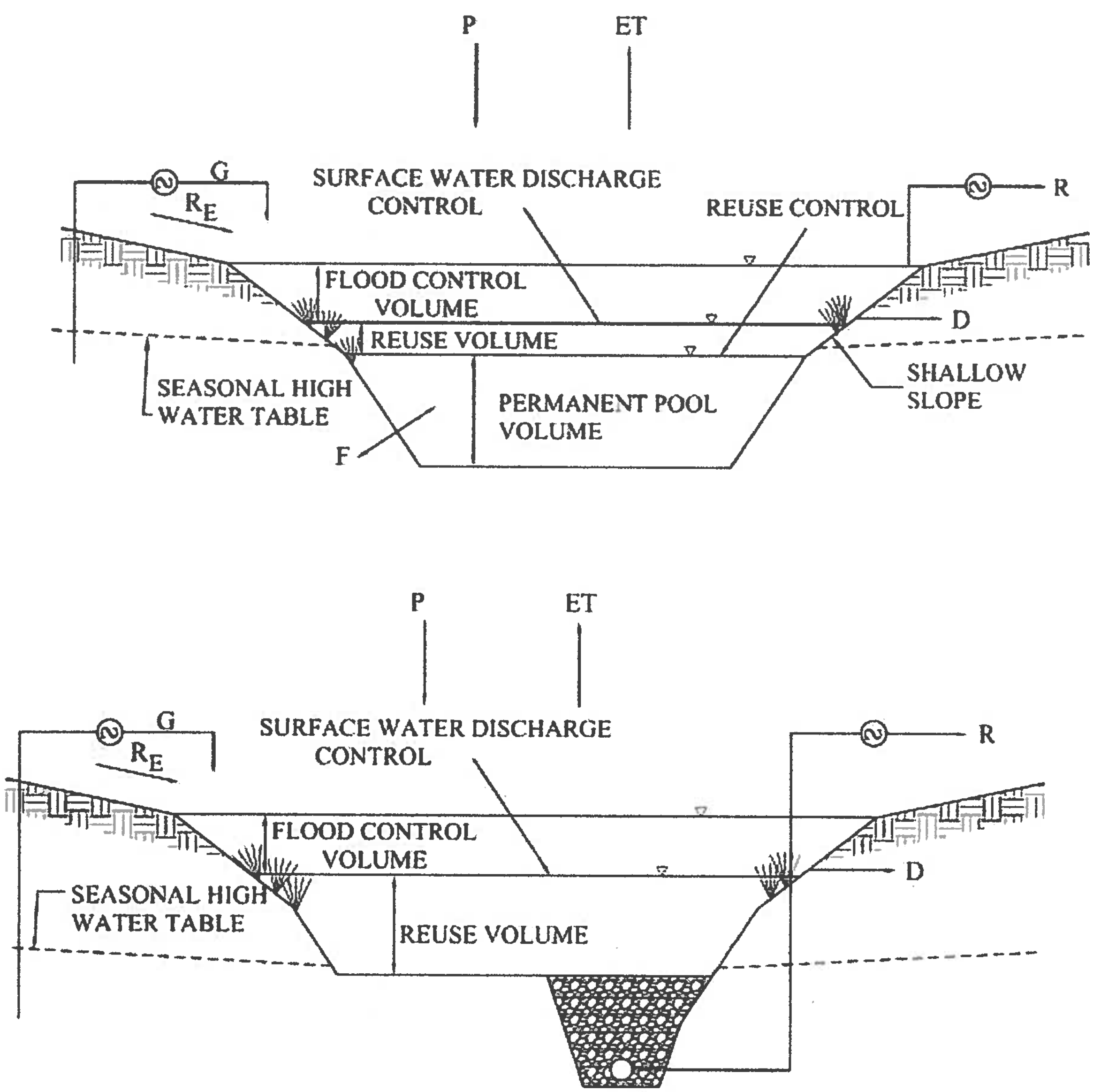


Figure 2: Schematics of Stormwater Ponds with Irrigation System Equipment

CHAPTER 3 – FIELD SITE DESCRIPTIONS

3.1 Site Selection

The necessity to evaluate stormwater ponds as a potential source of Cyanobacteria has become evident for several reasons. Cyanobacteria has been identified and documented within larger water bodies throughout the state of Florida, but very little investigation has been conducted on smaller water bodies. Stormwater ponds are an abundant and readily available water source and are a practical, commonly used source for irrigation. A stormwater pond located within residential area is regularly used for irrigation with little or no treatment prior to use. It is not uncommon for residents to pump water directly from the small water bodies for irrigation purposes. The tendency for algae to proliferate within these water bodies is easily observed by casual glances. Due to the extensive growth of Cyanobacteria in Florida waters and the potential for human exposure to airborne toxins associated with Cyanobacteria, the need for evaluation of these sources is evident.

Since small water bodies are just as susceptible to algae growth as large water bodies, stormwater and small residential ponds were selected for this study. The stormwater ponds that were selected are located in central Florida within the Orlando area. The ponds are located within residential developments (Lake Condel, Terrier Pond), on the University of Central Florida campus, near an industrial site (Lake Patrik), alongside a major expressway (SR 417) and by the side of heavily traveled urban roadways (Horatio Avenue, University Boulevard). The ponds for this study were chosen on the basis that they exhibit desirable characteristics as irrigation sources.

The occurrence of rainfall after a long period of no rainfall can influence algal blooms. According to Orange County Environmental Protection Division (Bortles, 2005), the largest blooms will occur within three to five days following a rain event provided that another rain event will not occur, but the rain event may hinder the algae growth.

3.1.1 Initial Site Selection

A windshield survey was conducted in order to evaluate potential pond sites for this investigation. This consisted of traveling along central Florida roads and residential areas to visually observe potential ponds that exhibited excessive algae growth. This method was used in conjunction with ponds recommended by the Orange County Environmental Protection Division that are currently being studied for Cyanobacteria.

3.1.2 Selected Regional Ponds with land use classifications

Residential
1 Lake Condel
2 Terrier Pond

University of Central Florida Campus
3 Irrigation Ponds
4 Pegasus Pond

Industrial
5 Lake Patrik

S.R. 417 - Greenway
6 NB, at Lee Vista Boulevard exit
7 SB, 0.5 miles south of Lee Vista Boulevard
8 NB, at SR 528 (Beeline) exit
9 NB, 2 miles north of Narcoossee Road
10 NB, 1 mile north of Narcoossee Road

Urban Roadways
11 University Boulevard and Hall Road
12 University Boulevard and S.R. 417, NW corner
13 Horatio Avenue and Via Tuscany No. 1
14 Horatio Avenue and Via Tuscany No. 2

The USGS Quadrangle and Soil Conservation Service (SCS) Soil Survey maps for each stormwater pond site and photographs are shown in the Appendix.

3.2 Pond Sampling

The sample depths utilized for this testing were within several inches of the water surface. This depth was selected because some ponds were shallow or with average depths in the dry season, of less than three feet. The sample locations were also limited to several feet of the water body's shoreline. For this study, samples were collected from an area in the pond where the algal blooms were present. Sampling from the deeper half (or lower) water column presented the potential for introducing pond bottom mud and decaying vegetation. This sampling technique also presented limitations due to the limited length, approximately six feet long, of the sampling pole used to collect the sample. Additionally, wading into the water body was not practiced during the sampling events. Samples that were collected near the water surface may have reduced levels of bacteria due the utilization of the necessary nutrients by competing vegetation, such as duckweed, which is prominent at many of the pond locations.

There were many method and materials utilized to collect the samples. One of these materials included a six-foot long PVC pole with an attachment to hold a 1-liter amber sample bottle. The bottles were rinsed three times with the pond water prior to collecting the sample to be analyzed. The sampling technique itself involved keeping the open end of the sample bottle facing downward as the bottle was immersed into the pond. This was done to minimize the chance of water entering the bottle prior to reaching the desired depth.

Samples were collected for pH and alkalinity during the months of October, December and February, when Cyanobacteria growth is most likely not at its peak growth. Temperatures above 25 degrees Celsius promote the highest level of Cyanobacteria growth (Chorus and Bartram, 1999), but the algae are able to grow at temperatures ranging from 17 to 22 degrees Celsius (Kurmayer et al., 2002). Although conditions were conducive for bacteria growth based on observations of algae blooms in the ponds and information provided by Orange County, more favorable conditions were experienced during the warmer months of the spring and summer. These conditions supported a more active growing season for the bacteria. Samples were collected during April and August to satisfy the more desirable conditions for algal growth. It was also noted that samples collected during the summer months at Lake Condel in previous years by Orange County were also observed to exhibit readily detectable levels of Cyanobacteria. These samples were obtained as part of a previous study and were collected by Orange County as part of the ongoing study of Cyanobacteria levels within Lake Condel (Bortles, 2005).

3.3 Filtrate Sampling

Pond stormwater was added to four chambers with A-3 soils (poorly-graded) since these soils were the most common soils found near or at the stormwater ponds. Samples for analyses were taken four feet below the chamber surfaces. Three of the chambers were covered with grass and one was not covered. Amber bottles were used for sampling.

CHAPTER 4 – ALGAL RESULTS AND DISCUSSION

Within this Chapter, Cyanobacteria population counts, potentially toxic (PTOX) counts, and toxin concentrations are reported for stormwater ponds and filtrate. The filtrate was obtained after 50 inches of pond waters (from S.R. 417-1, Pegasus and Lake Condel ponds) passed through four feet of a poorly graded sandy soil typical of that on the campus of UCF. The next data reported are comparisons between data sets from this sampling and between one other lake's data set.

The methods and analyses used to determine the population and concentration were performed by the same laboratory, namely GreenWater Laboratories of Palatka, Florida. An initial analyses was conducted at the University of Central Florida and thus indicated the presence of Cyanobacteria, but was not quantified. The use of the GreenWater Laboratory for comparative quantitative analyses minimized the potential variations in analytical results so that the counts and concentrations determined could be compared without variability between labs. The use of one lab minimized the possibility of different techniques from different laboratories, which may have provided additional variance for populations and concentrations. In addition, a previous study for lake populations was performed by GreenWater and thus the comparisons to that lake data also reduce variability possibilities among labs.

4.1 Cyanobacteria Populations

Forty-five stormwater ponds in central Florida were visited and past sampling results from Orange County helped identify potential ponds for the research. Of these 45 ponds, 24 had indications of blue green algal activity. Those 24 ponds were again sampled and 14 of them were identified qualitatively as having blue green algal blooms. These same ponds also had the visual appearance of the algae. Also, there was different land use associated with these 14 ponds, which were a criterion for choice. Terrier Pond was sampled at two locations because it has a history of Cyanobacteria populations and resident respiratory problems.

Total Cyanobacteria and potential toxic (PTOX) counts per milliliter are shown in Table 1 for two sampling periods, April, which is the start of the visible bloom activity, and August, in

Table 1: Total and PTOX Counts for Two Sampling Periods

APRIL 2005 Sample Description	Total CYANO Units/mL	PTOX CYANO Units/mL	AUGUST 2005 Sample Description	Total CYANO Units/mL	PTOX CYANO Units/mL
Filtrate #1	1,167	0	Filtrate #1	2,928	**1**
Filtrate #2	130	0	Filtrate #2	686	**0**
Filtrate #3	751	0	Filtrate #3	650	**0**
			Filtrate #4	1,231	**0**
			Filtrate #4 replicate	583	**0**
Residential					
Lake Condel	12,590	**227**	Lake Condel	36,412	**1,844**
Terrier Pond East	650	**499**	Terrier Pond East	1,746	**191**
Terrier Pond South	2,223	**635**	Terrier Pond South	1,501	**265**
University of Central Florida Campus					
Irrigation Ponds	298	0	Irrigation Ponds		
Pegasus	1,387	**68**	Pegasus	3,450	**38**
Industrial					
Lake Patrik	557	**390**	Lake Patrik	5,011	**3,759**
SR 417 Roadways					
SR 417-1	824	**476**	SR 417-1	33,640	**20,691**
SR 417-2	2,620	**1,427**	SR 417-2	17,578	**14,312**
SR 417-3	1,005	**183**	SR 417-3	11,038	**5,897**
SR 417-4	3,267	**2,814**	SR 417-4	13,797	**9,064**
SR 417-5	491,690*	**318**	SR 417-5	499	**4**
Urban Roadways					
Hall Road	389	0			
Horatio 1	0	0	Horatio 1	7,825	**2,681**
Horatio 2	270	0	Horatio 2	613	**8**
University & SR 417 NW	420	**11**			

* Not included in statistical analyses

the middle of algal bloom activity. The filtrate PTOX counts were at or near zero, while the detention ponds had identifiable counts. Alkalinity and pH were recorded 34 times and averaged 45 mg $CaCO_3$ per mL and 7.4 respectively with standard deviations of 10.5 and 0.4. Comparisons for average counts among land uses are shown below in Figure 3.

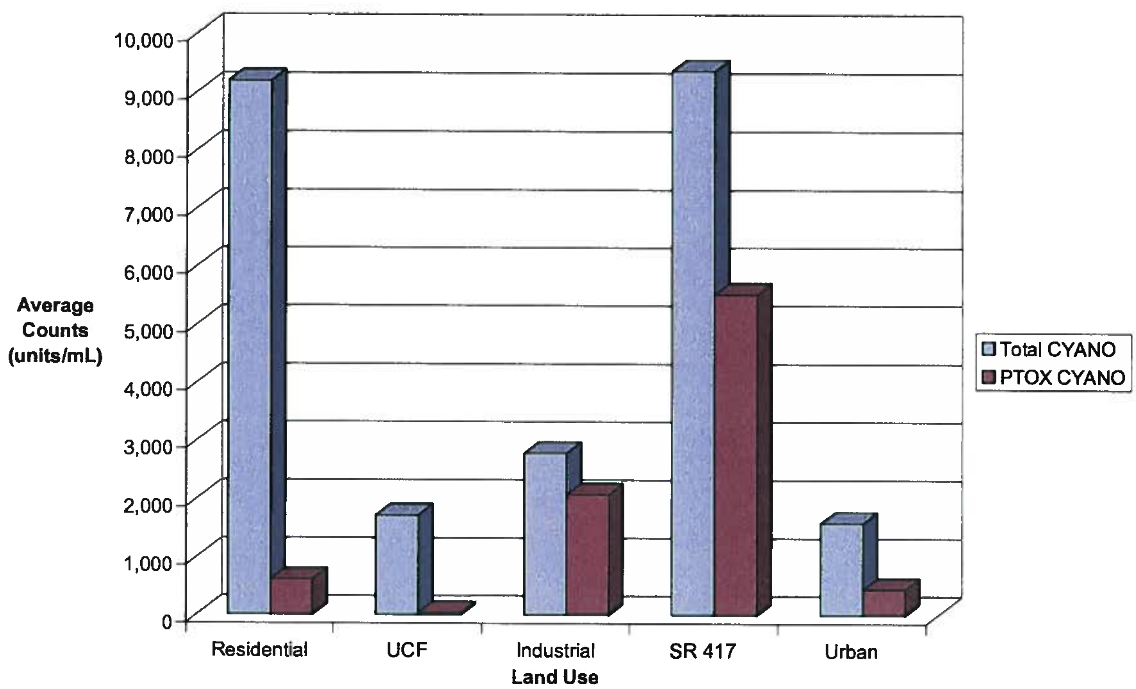


Figure 3: Comparison of Total and PTOX Cyanobacteria Average Counts vs. Land Use

The average Cyanobacteria counts for the stormwater ponds were 34,546 total and 470 PTOX in April with standard deviations of 3,113 and 724 respectively. One result for total count at SR 417-5 was eliminated from the average calculations because it was greater than three standard deviations from the mean, and likely was in error. For the filtrate, the averages were 682 and 0 counts with standard deviations of 426 and zero respectively. For the August 2005 sampling, the averages were 11,093 total and 4,896 PTOX with standard deviations of 11,924 and 6,371 respectively. For the filtrate, the averages were 1,216 total and 0.2 PTOX with standard deviations of 887 and 0.4 respectively. Thus, on average and for field data, the filtration was removing both total counts and PTOX levels of Cyanobacteria.

4.2 Stormwater and Lake Cyanobacteria Population Comparisons

For central Florida lakes, data on total and PTOX counts are available from GreenWater laboratories. These data are shown in Table 2. If we compare the results from the stormwater ponds to those of the central Florida lakes, the stormwater ponds total Cyanobacteria counts and the potentially toxic Cyanobacteria counts (PTOX) averages are much lower.

Table 2: Total and PTOX Populations in Central Florida Lakes

Sample Description	Sampling Date	Total CYANO Units/mL	PTOX Units/mL
Lake Apopka	Year 1	1,361,860	13,550
	Year 2	1,136,098	1,864
Lake Beauclair	Year 1	650,370	154,190
	Year 2	449,210	69,420
Lake Dora	Year 1	581,110	144,590
	Year 2	500,196	129,510
Lake Eustis	Year 1	<285,000	
	Year 2	<285,000	40,520
Lake Griffin	Year 1	<285,000	
	Year 2	<285,000	
Lake Harris	Year 1	235,570	
	Year 2	116,700	41,990
Lake Yale	Year 1	<285,000	
	Year 2	<285,000	

from:
Chapman et al, 2004, "Cyanobacteria Populations in Seven Central Florida Lakes"
15th Annual Conference of the Florida Lake Management Society, Tampa Florida

There was not a count on the number of samples associated with the lake data, and thus no statistical comparisons could be done. However, the pond count average data are about two orders of magnitude lower than the lake data. For the April sampling, there was only one stormwater pond total count that was higher than the lake total counts, and the value reported for

Lake Harris (491,690 Units/mL vs. 116,700 Units/mL). In addition, there was one PTOX count exceeding the lake Apopka PTOX count (2,814 Units/mL vs. 1,864 Units/mL). The second sampling event did not have a total counts that exceeded the lake counts, but for six stormwater ponds, PTOX counts were greater than those at Lake Apopka. Thus, the PTOX values in the stormwater ponds indicate that they are approximately equal at least in magnitude to those in lakes and thus if the lakes are used to supply irrigation water, then the ponds can also be used based only on PTOX.

4.3 Cyanobacteria Comparisons between Pond and Filtrate

The PTOX counts in stormwater ponds that can be used for irrigation lead to the question, "Can total and PTOX in ponds be removed by filtration using a naturally occurring soil?" For sampling in April 2005, the total pond water Cyanobacteria counts are significantly different from the filtrate total counts at the 75% level of significance. The stormwater pond PTOX counts are significantly different from the filtrate PTOX counts at the 85% level of significance. The data for these statistical analyses are shown in Table 3.

Table 3: Ponds vs. Filtrate Comparisons with Statistics April 2005

Description	Date	Total	PTOX
		Units/mL	Units/mL
Filtrate #1	4/15/2005	1,167	0
Filtrate #2	4/15/2005	130	0
Filtrate #3	4/15/2005	751	0
Residential			
Lake Condel	4/17/2005	12,590	**227**
Terrier Pond East	4/17/2005	650	**499**
Terrier Pond South	4/17/2005	2,223	**635**
University of Central Florida Campus			
South Irrigation	4/17/2005	298	0
Pegasus	4/17/2005	1,387	**68**
Industrial			
Lake Patrick	4/17/2005	557	**390**
SR 417 Roadways			
SR 417-1	4/17/2005	824	**476**
SR 417-2	4/17/2005	2,620	**1,427**
SR 417-3	4/17/2005	1,005	**183**
SR 417-4	4/17/2005	3,267	**2,814**
SR 417-5	4/17/2005	*	**318**
Urban Roadways			
Hall Road	4/17/2005	389	0
Horatio 1	4/17/2005	0	0
Horatio 2	4/17/2005	270	0
University and SR 417 NW	4/17/2005	420	**11**

* not included in statistical analyses

Table 4: Continued Ponds vs. Filtrate Comparisons with Statistics April 2005

		Total CYANO	PTOX CYANO
X bar 1	Pond AVG	1,893	470
X bar 2	Filtrate Avg	682	0.000
S1	STD DEV Ponds	3113	724
S2	STD DEV Filtrate	426	0.000
n1	# of Pond samp	14	15
n2	# of Filtrate samp	3	3
note: n1+n2=		17	18
thus use t statistic	**t Statistic**	**Total CYANO**	**PTOX CYANO**
	X1bar-X2bar	1,210	470
	(n1-1)*S^2	125970429	7340754
	(n2-1)*S^2	363073	0.000
	n1+n2-2	15	16
	(1/n1+1/n2)	0.40476	0.40000
	SQRT	1846	428
	t	0.656	1.097
	significant difference	>75%	>85%

For sampling on April 15 through 17, 2005

1) The pond water total cyanobacteria counts are significantly different from the filtrate cyanobacteria counts at the 75% level of significance.
2) The potentially toxic cyanobacteria counts are significantly different from the filtrate potentially toxic counts at the 85% level of significance

For sampling in August 2005, the pond water total Cyanobacteria population counts were significantly different from the filtrate Cyanobacteria counts at the 95% level of confidence. The stormwater pond PTOX counts are significantly different from the filtrate PTOX counts at the 90% level of significance. The data used for these statistical analyses are shown in Table 5.

Table 5: Ponds vs. Filtrate Comparisons with Statistics August 2005

Sample Description	Sampling Date	Total CYANO Units/mL	PTOX CYANO Units/mL
Filtrate #1	8/7/2005	2,928	**1**
Filtrate #2	8/7/2005	686	**0**
Filtrate #3	8/7/2005	650	**0**
Filtrate #4	8/7/2005	1,231	**0**
Filtrate #4b	8/7/2005	583	**0**
Residential			
Lake Condel	8/7/2005	36,412	**1,844**
Terrier Pond East	8/7/2005	1,746	**191**
Terrier Pond South	8/7/2005	1,501	**265**
University of Central Florida			
South Irrigation			
Pegasus	8/7/2005	3,450	**38**
Industrial			
Lake Patrick	8/6/2005	5,011	**3,759**
SR 417 Roadways			
SR 417-1	8/7/2005	33,640	**20,691**
SR 417-2	8/7/2005	17,578	**14,312**
SR 417-3	8/7/2005	11,038	**5,897**
SR 417-4	8/7/2005	13,797	**9,064**
SR 417-5	8/7/2005	499	**4**
Urban Roadways			
Horatio 1	8/7/2005	7,825	**2,681**
Horatio 2	8/7/2005	613	**8**

		Total CYANO	PTOX CYANO
X bar 1	Pond AVG	11,093	4,896
X bar 2	Filtrate Avg	1,216	0.200
S1	STD DEV Ponds	11924	6371
S2	STD DEV Filtrate	887	0.400
n1	# of Pond samp	12	12
n2	# of Filtrate samp	5	5
note: n1+n2=		17	17

thus use t statistic

t Statistic	Total CYANO	PTOX CYANO
X1bar-X2bar	9,877	4,896
(n1-1)*S^2	1564125679	446458710
(n2-1)*S^2	3146580	0.640
n1+n2-2	15	15
(1/n1+1/n2)	0.28333	0.28333
SQRT	5441	2904
t	1.815	1.686
significant difference	>95%	>90%

For sampling on August 6 through 7, 2005

1) The pond water total cyanobacteria counts are significantly different from the filtrate cyanobacteria counts at the 95% level of confidence.
2) The potentially toxic cyanobacteria counts are significantly different from the filtrate potentially toxic counts at the 90% level of significance

For the combined sampling data of April and August 2005, the pond water total Cyanobacteria counts are significantly different from the filtrate Cyanobacteria counts at the 99% level of confidence. The potentially toxic Cyanobacteria counts (PTOX) are significantly different from the filtrate potentially toxic counts (PTOX) at the 99% level of significance. The data used for the statistical analyses are shown in Table 6.

Table 6: Ponds vs. Filtrate Comparisons Combined Data and Statistics

		Total CYANO	PTOX CYANO
X bar 1	Pond AVG	6,139	2,437
X bar 2	Filtrate Avg	1,016	0.125
S1	STD DEV Ponds	9,585	4,813
S2	STD DEV Filtrate	791	0.331
n1	# of Pond samp	26	27
n2	# of Filtrate samp	8	8
note n1+n2=	thus use Z statistic	34	35
	Z Statistic	**Total CYANO**	**PTOX CYANO**
	X1bar-X2bar	5,123	**2,437**
	S1^2/n1	3,533,814	858,053
	S2^2/n2	78,303	0.014
	SQT RT	1901	926
	Z	2.70	2.63
	level of confidence	>99%	>99%

For the combined sampling of April 17 and August 7, 2005,
1) The pond water total cyanobacteria counts are significantly different from the filtrate cyanobacteria counts at the 99% level of confidence.
2) The potentially toxic cyanobacteria counts are significantly different from the filtrate potentially toxic counts at the 99% level of significance

Figure 4 on the following page presents a graphical representation for the average total and PTOX Cyanobacteria counts using the combined data from both sampling events.

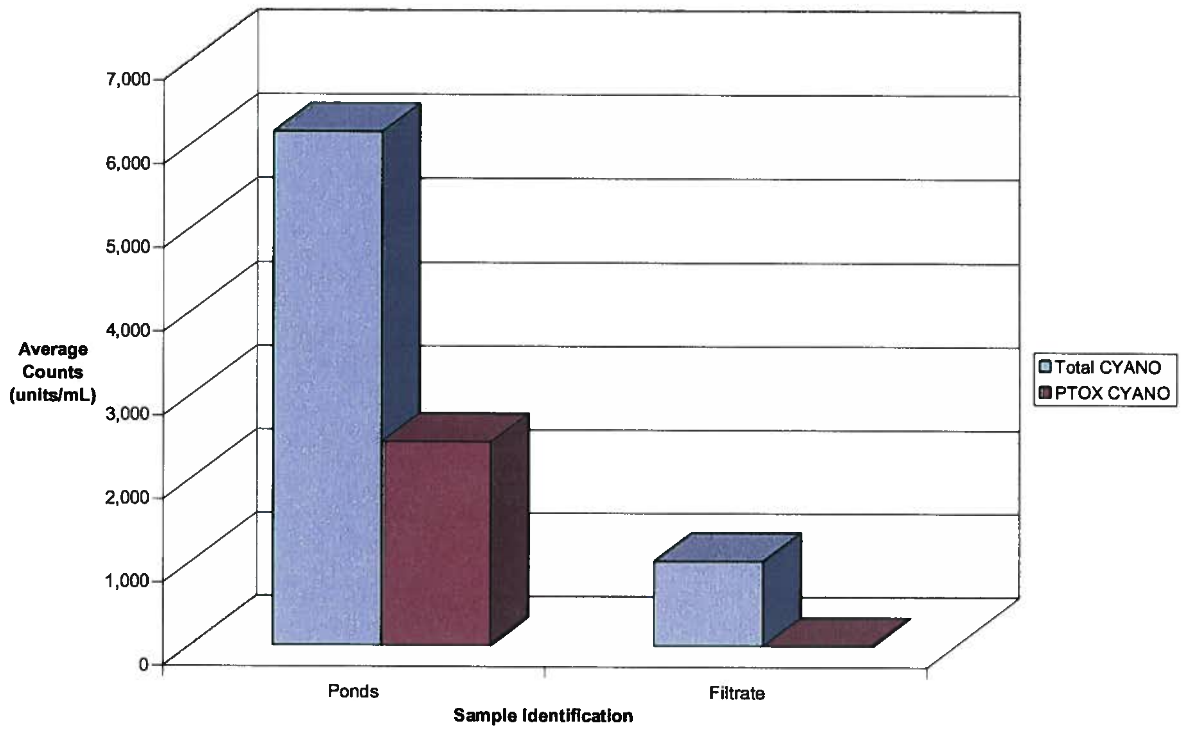


Figure 4: Pond vs. Filtrate Cyanobacteria Comparisons Using Combined Data

4.4 Cyanobacteria Toxin Concentrations

Cyanobacteria toxin concentrations were quantified using the ELISA method. These concentrations were provided by GreenWater laboratory. The toxin concentrations and the associated quality control data are shown in Tables 7 and 8. The average pond concentrations for all sites for each sampling period were 0.22 and 0.33 mg/L for the April and August sampling periods respectively. The filtrate averages were 0.23 and less than 0.04 mg/L for the April and August sampling periods respectively. The water applied to the soil columns were from the Pegasus and Lake Condel stormwater ponds. These ponds were thought to have higher concentrations of Toxins but the concentrations were relatively low (<0.04 to 0.17 mg/L). From a statistical analysis, comparing the mean values of toxin Microcystin in the ponds to the filtrate values, the results from the sampling event in April showed no significant difference existed between the two.

However, the second sampling event in August, 2005 indicated that a significant difference did exist at the level of confidence of approximately 88%. Additionally, the level of confidence when the values from both sampling events were combined was on the order of 97% for the Microcystin filtering process. A graphical comparison of the average Microcystin concentration data (ug/L) for the ponds and the filtrate is shown in Figure 5. The graph visually indicates the difference in the average values.

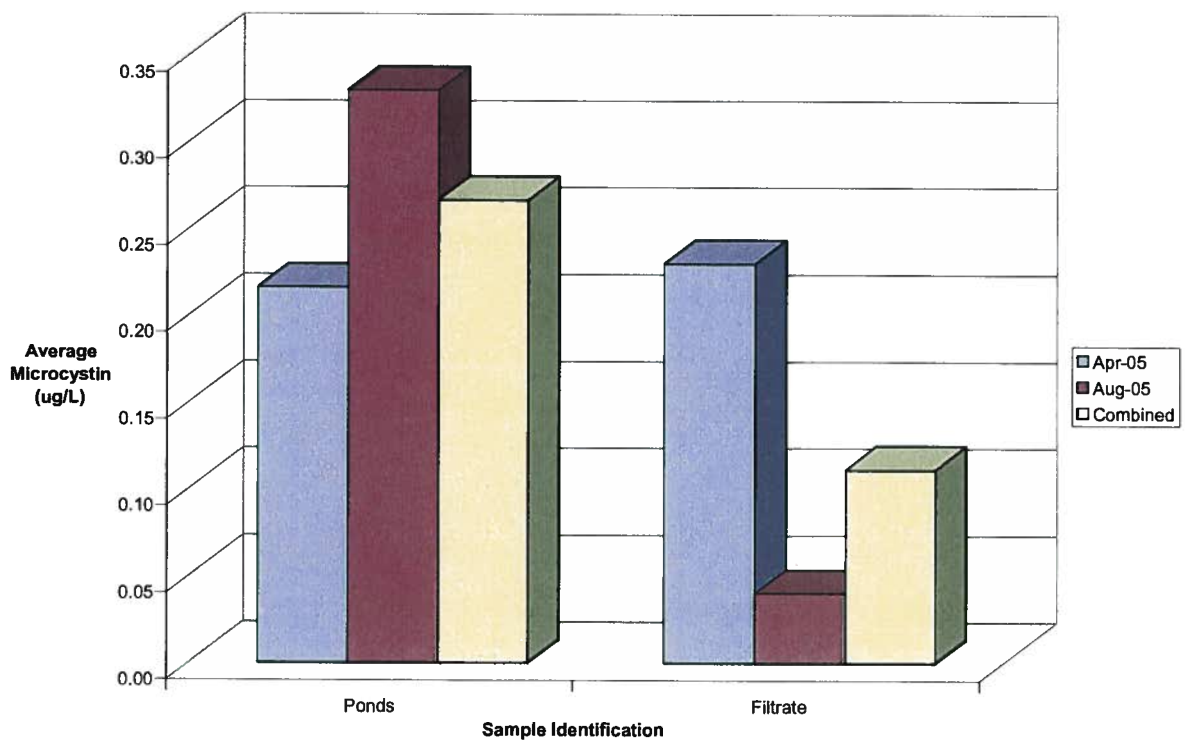


Figure 5: Ponds vs. Filtrate Microcystin Data

Table 7: Microcystin Concentrations for April 2005

ELISA Method Sampled in April 2005

Sample ID	Assay Value (ug/L)	Final Conc. Factor	Standard Recovery (%)	Corrected Spike Recovery (%)	Final Corrected Concentration (ug/L)	Average Concentration (ug/L)	Standard Deviation
Filtrate #1	0.10	1x	74	78	0.17	**0.13**	0.06
	0.05	1x	74	78	0.09		
Filtrate #2	0.12	1x	83	89	0.16	**0.18**	0.02
	0.14	1x	83	89	0.19		
Filtrate #3	0.28	1x	83	89	0.38	**0.39**	0.01
	0.29	1x	83	89	0.39		
Hall Rd	0.10	1x	98	66	0.15	**0.18**	0.04
	0.13	1x	98	66	0.20		
South Irrigation	0.24	1x	74	73	0.44	**0.49**	0.07
	0.29	1x	74	73	0.54		
Lake Patrick	0.08	1x	74	77	0.14	**0.16**	0.03
	0.10	1x	74	77	0.18		
Lake Condel	0.12	1x	98	81	0.15	**0.17**	0.02
	0.14	1x	98	81	0.18		
Terrier Pond East	0.09	1x	90	92	0.11	**0.10**	0.02
	0.07	1x	90	92	0.08		
Terrier Pond South	0.05	1x	90	92	0.06	**0.10**	0.05
	0.11	1x	90	92	0.13		
Pegasus Pond	0.11	1x	98	80	0.14	**0.16**	0.02
	0.13	1x	98	80	0.17		
SR 417-1	0.36	1x	90	92	0.43	**0.38**	0.07
	0.27	1x	90	92	0.33		
SR 417-2	0.49	1x	98	80	0.62	**0.60**	0.04
	0.45	1x	98	80	0.57		
SR 417-3	0.10	1x	98	93	0.11	**0.13**	0.03
	0.14	1x	98	93	0.15		
SR 417-4	0.14	1x	98	72	0.20	**0.20**	0.00
	0.14	1x	98	72	0.20		
SR 417-5	0.17	1x	98	97	0.18	**0.19**	0.01
	0.19	1x	98	97	0.20		
University and SR 417 NW	0.09	1x	98	78	0.12	**0.14**	0.03
	0.12	1x	98	78	0.16		
Horatio 1	0.06	1x	90	87	0.08	**0.09**	0.01
	0.07	1x	90	87	0.09		
Horatio 2	0.12	1x	90	93	0.14	**0.19**	0.06
	0.19	1x	90	93	0.23		

Quantification limit = 0.04 μg/L
No dilution ratio necessary

To provide additional evidence for the sorption of Microcystin on soil particles, laboratory batch studies were conducted to provide another estimate of the potential for adsorption of Microcystin (MC) onto soil. Microcystin-LR (MC-LR) solutions (50 mL) were prepared from commercially available standard and distilled water and were mixed with 10 g of sand for up to 46 hours. Microcystin concentrations were determined by the ELISA method.

Reductions in Microcystin concentrations ranged from 13 to 32 % (O'Reilly and Wanielista, 2006). Sorption processes likely explain this reduction because microbial degradation of MC-LR has been reported to require a three-day lag before commencing (Miller et al, 2001). In response to degradation problem, adsorption isotherms were developed, resulting in a slightly better fit to a Freundlich rather than linear isotherm. These results are consistent with findings reported by Miller et al (2001) who reported a linear isotherm coefficient of 0.80 L/kg for a sandy soil.

Table 8: Microcystin Concentrations for August 2005

ELISA Method Sampled in August 2005 Sample ID	Dilution Ratio	Final Conc. Factor	Assay Value (ug/L)	Standard Recovery (%)	Corrected Spike Recovery (%)	Final Corrected Concentration (ug/L)	Average Concentration (ug/L)	Standard Deviation
Filtrate #1	0	1x	0.02	77	98	< 0.04	**< 0.04**	0.00
	0	1x	0.03	77	98	< 0.04		
Filtrate #2	0	1x	0.02	77	98	< 0.04	**< 0.04**	0.00
	0	1x	0.02	77	98	< 0.04		
Filtrate #3	0	1x	0.03	77	98	< 0.04	**< 0.04**	0.00
	0	1x	0.01	77	98	< 0.04		
Filtrate #4	0	1x	0.02	77	98	< 0.04	**< 0.04**	0.00
	0	1x	0.02	77	98	< 0.04		
Filtrate #4b	0	1x	0.03	77	98	< 0.04	**< 0.04**	0.00
	0	1x	0.03	77	98	< 0.04		
Lake Patrick	0	1x	0.04	88	89	0.04	**0.05**	0.01
	0	1x	0.05	88	89	0.06		
Terrier Pond East	0	1x	0.07	88	89	0.08	**0.06**	0.03
	0	1x	0.04	88	89	0.04		
Terrier Pond South	0	1x	0.06	88	89	0.07	**0.08**	0.01
	0	1x	0.07	88	89	0.08		
SR 417-5	0	1x	0.08	88	89	0.09	**0.12**	0.04
	0	1x	0.13	88	89	0.15		
SR 417-4	0	1x	0.11	102	98	0.11	**0.15**	0.06
	0	1x	0.10	102	98	0.19		
SR 417-3	0	1x	0.09	102	98	0.09	**0.09**	0.00
	0	1x	0.09	102	98	0.09		
SR 417-1	1/10	10x	1.64	54	94	1.74	**1.36**	0.54
	1/10	10x	0.92	54	94	0.98		
SR 417-2	0	1x	1.33	54	94	1.41	**1.56**	0.21
	0	1x	1.61	54	94	1.7		
Lake Condel	0	1x	0.02	102	98	0.02	**0.04**	0.03
	0	1x	0.06	102	98	0.06		
Horatio 1	0	1x	0.45	54	94	0.48	**0.45**	0.04
	0	1x	0.40	54	94	0.42		
Horatio 2	0	1x	0.03	102	98	< 0.04	**< 0.04**	0.00
	0	1x	0.03	102	98	< 0.04		
Pegasus Pond	0	1x	0.01	102	98	< 0.04	**< 0.04**	0.00
	0	1x	0.02	102	98	< 0.04		

Quantification limit = 0.04 μg/L

Table 9: Statistical Analyses: Pond vs. Filtrate Microcystin Data

Single Sample Run Date of April 2005

Null Hypothesis: Xbar 1 > Xbar2 (One sided)

X bar 1	Pond AVG	0.22
X bar 2	Filtrate Avg	0.23
S1	STD DEV Ponds	0.15
S2	STD DEV Filtrate	0.11
n1	# of Pond samp	15
n2	# of Filtrate samp	3
note: n1+n2=		18

t Statistic	Toxin
X1bar-X2bar	-0.014
(n1-1)*S1^2	0.297
(n2-1)*S2^2	0.025
n1+n2-2	16
(1/n1+1/n2)	0.400
SQRT	0.090
t	-0.156
significant difference	>55%

not a significant difference

Single Sample Run Date of August 2005

Null Hypothesis: Xbar 1 > Xbar2 (One sided)

X bar 1	Pond AVG	0.33
X bar 2	Filtrate Avg	0.04
S1	STD DEV Ponds	0.52
S2	STD DEV Filtrate	0.00
n1	# of Pond samp	12
n2	# of Filtrate samp	5
note: n1+n2=		17

t Statistic	Toxin
X1bar-X2bar	0.290
(n1-1)*S1^2	2.970
(n2-1)*S2^2	0.000
n1+n2-2	15
(1/n1+1/n2)	0.283
SQRT	0.237
t	1.223
significant difference	~88%

Combined Sampling Data

Null Hypothesis: Xbar 1 > Xbar2 (One sided)

X bar 1	Pond AVG	0.266
X bar 2	Filtrate Avg	0.111
S1	STD DEV Ponds	0.367
S2	STD DEV Filtrate	0.114
n1	# of Pond samp	27
n2	# of Filtrate samp	8
note n1+n2=		35
	Z Statistic	**Total**
	X1bar-X2bar	0.155
	S1^2/n1	0.005
	S2^2/n2	0.002
	SQT RT	0.081
	Z	1.91
	level of confidence	>97%

4.5 Pond Volume and Cyanobacteria Populations

Lake data shows population counts and concentrations that are at least two orders of magnitude greater than the stormwater ponds, with the lakes being much larger in volume and area relative to the stormwater ponds. Due to the magnitude difference, comparisons of stormwater pond volumes to the population counts and concentrations were made using the stormwater pond data. The data for pond area, average depth, and volumes along with an estimate of the watershed areas are shown in Table 10. The area data were obtained from recent air reconnaissance. The volumes were calculated from the area and an average depth, which was obtained using sounding equipment. For all of the ponds, side slopes were documented until a relatively constant depth was recorded across a pond. Depth was measured through many sections of the ponds and recorded when the change in depth was over about half foot. An average depth was calculated and the volume obtained as a function of the average depth and area. This volume is estimated as that relatively close to the pond control elevation and representative of the sampling times.

Table 10: Stormwater Pond Area, Depth, and Volume Data

	Name	Pond Area (acre)	Estimated Watershed Area*** (acre)	Watershed Type	Approximate Average Depth* (ft)	Number of Measured Points	Approximate Volume** (acre-ft)
1	Lake Condel	2.7	135	Residential	10	80	27
2	Terrier Pond	4.6	230	Residential	14	100	64
3	UCF South Irrigation Pond off Campus Road	4.4	220	Roads & Parking	6	80	26
4	UCF Pegasus Pond off Campus Road	0.6	30	Roads & Parking	6	40	3.6
5	Lake Patrik	9.4	470	Roads & Parking	11	50	103
6	SR 417-1, NB at Lee Vista Boulevard Exit	1.7	85	4 Lane Divided	8	40	14
7	SR 417-2, SB 0.5 miles south of Lee Vista Boulevard	1.8	90	4 Lane Divided	8	40	14
8	SR 417-3, NB at SR 528 (Beeline) exit	3.5	175	4 Lane Divided	8	40	28
9	SR 417-4, NB 2 miles north of Narcoossee Road	3.3	165	4 Lane Divided	8	40	26
10	SR 417-5, NB 1 mile north of Narcoossee Road	2.0	100	4 Lane Divided	8	40	16
11	University Boulevard and Hall Road	0.9	45	6 Lane Curbed	4	20	3.6
12	University Boulevard and SR 417, NW corner	4.6	230	6 Lane Curbed	6	40	28
13	Horatio Avenue and Via Tuscany No. 1	1.1	55	4 Lane Curbed	4	20	4.4
14	Horatio Avenue and Via Tuscany No. 2	0.2	10	4 Lane Curbed	3	10	0.6

* Average Depth
** Surface Area Multiplied by Average Depth
*** Based on 2% of the Watershed used for Pond Area

Both the sampling data of April and August showed no correlation between the pond volumes and the population counts, nor any correlation between pond volume and PTOX counts. The lack of correlation is shown by the statistical data and calculations in Table 11 through Table 14 for each sampling period. Thus, larger volume stormwater ponds do not have greater counts of Cyanobacteria relative to smaller ones, presumably because of proportional use of rooted vegetation (littoral zone) in all the ponds that remove nutrients.

Graphical presentations of the pond volume data and average total and PTOX were also made to visually compare the potential relationship. This comparison is shown in Figure 6.

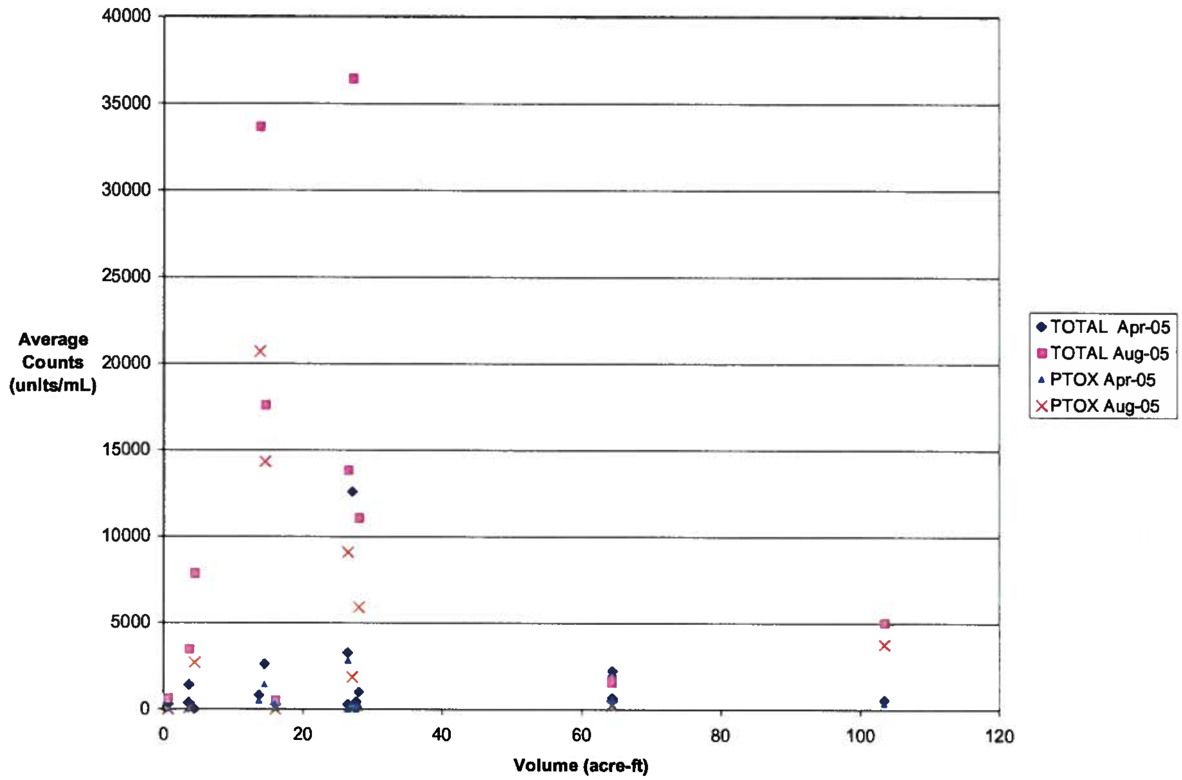


Figure 6: Pond Volume vs. Total and PTOX Counts

Table 11: Statistical Comparison of Pond Volume to Populations Counts in April 2005

	Approx Volume (acre-ft)	Total CYANO Units/mL
Lake Condel	27	12590
Terrier Pond	64	650
Terrier Pond	64	2223
UCF South Pond	26	298
UCF Pegasus Pond	3.6	1387
Lake Patrik	103	557
SR 417-1	14	824
SR 417-2	14	2620
SR 417-3	28	1005
SR 417-4	26	3267
Univ & Hall Road	3.6	389
Horatio Avenue No. 1	4.4	0
Horatio Avenue No. 2	0.6	270
Univ & SR 417, NW	28	420

SR 417-5 Sample Omitted

23092.92	135660462	-5.32746
SSxx	**SSyy**	**SSxy**

Xave	29.1	slope	-0.000231	s	3362
yave	1893	SSE	135660462	t	-0.0000104
n	14			|t|	0.0000104
				table t	13%

Table 12: Statistical Comparison of Pond Volume to Population Counts in August 2005

	Approx Volume (acre-ft)	Total CYANO Units/mL
Lake Condel	27	36412
Terrier Pond	64	1746
Terrier Pond	64	1501
UCF Pegasus Pond	3.6	3450
Lake Patrik	103	5011
SR 417-1	14	33640
SR 417-2	14	17578
SR 417-3	28	11038
SR 417-4	26	13797
SR 417-5	16	499
Horatio Avenue No. 1	4.4	7825
Horatio Avenue No. 2	0.6	613

not sampled

Univ & Hall Road
UCF South Pond
Univ & SR 417, NW

21877	1728997274	-912584
SSxx	**SSyy**	**SSxy**

Xave	30.5	slope	-41.7	s	13004
yave	12467	SSE	1690929877	t	-0.474475
n	12			|t|	0.47448
				table	48%

Table 13: Statistical Comparison of Pond Volume to PTOX in April 2005

	Approx Volume (acre-ft)	PTOX CYANO Units/mL
Lake Condel	27	227
Terrier Pond	64	499
Terrier Pond	64	635
UCF South Pond	26	0
UCF Pegasus Pond	3.6	68
Lake Patrik	103	390
SR 417-1	14	476
SR 417-2	14	1427
SR 417-3	28	183
SR 417-4	26	2814
SR 417-5	16	318
Univ & Hall Road	3.6	0
Horatio Avenue No. 1	4.4	0
Horatio Avenue No. 2	0.6	0
Univ & SR 417, NW	28	11

23349	7865094	32428
SSxx	**SSyy**	**SSxy**

Xave	28.3	slope	1.39	s	776
yave	470	SSE	7820058	t	0.27362
n	15			|t|	0.27362
				table	7%

Table 14: Statistical Comparison of Pond Volume to PTOX in August 2005

	Approx Volume (acre-ft)	PTOX CYANO Units/mL
Lake Condel	27	1844
Terrier Pond	64	191
Terrier Pond	64	265
UCF Pegasus Pond	3.6	38
Lake Patrik	103	3759
SR 417-1	14	20691
SR 417-2	14	14312
SR 417-3	28	5897
SR 417-4	26	9064
SR 417-5	16	4
Horatio Avenue No. 1	4.4	2681
Horatio Avenue No. 2	0.6	8

not sampled

Univ & Hall Road
UCF South Pond
Univ & SR 417, NW

20298.68	489280520	-539528			
SSxx	**SSyy**	**SSxy**			
Xave	27.0	slope	-26.6	s	6892
yave	4465	SSE	474940170	t	-0.54949
n	12			|t|	0.54949
				table	41%

CHAPTER 5 HORIZONTAL WELL DEMONSTRATION

A solution to water shortages in Florida is to reuse water. Water used for irrigation and food production accounts for about 80 to 90% of water used worldwide. One of the most abundant sources for irrigation is stormwater. After rainfall occurs, water travels into ditches, ponds, lakes and other receptors before finally making its way to the saline water bodies of the world. This stormwater can be recovered by removing it from these impoundments, filtering the stored water, and introducing it into existing or new water irrigation mains. One example of this stormwater recovery is the UCF Stormwater Reuse System.

A detention pond on the campus of the University of Central Florida was used to demonstrate the construction and operation of a horizontal well. The site was chosen because of its relatively poor soils for infiltration and percolation. Thus, if this detention pond could provide a safe yield of water for irrigation, other similar sites in Florida would also be possible. Water quality data were also reported for this site in chapter four.

5.1 THE UCF STORMWATER REGIONAL IRRIGATION SYSTEM

Researchers demonstrated a wet detention pond on the campus of UCF was used as a regional irrigation system. The watershed for the pond is 155.86 acres. The impervious area is about 74 acres and contains a four lane roadway. The other impervious areas are sidewalks, parking lots, and buildings which are part of a commercial area. The pervious part of the watershed is a combination of sports complex playing fields and highway shoulder areas. The pond area is 15 acres with an average depth of about eight feet at normal pond elevation.

The irrigation water is removed from the pond using a horizontal well. The horizontal well is housed at the university stadium detention pond and is approximately 1000 feet long and about twenty feet deep from land surface. The well is about twelve feet below the normal water level of the pond. Since this was a retrofit, there was no pipe laid under the pond, but instead along the edge of the pond and in a trench about four feet wide. The typical minimum width of trench is eighteen inches. A four feet wide trench was used because the parent soil was very impermeable. A schematic of trench construction details is shown in Figure 7, which illustrates important elevations and distances. The trench was back-filled with sand to provide a more rapid movement of water to the collection pipe. A perforated pipe with a permeable sock cover (usually a two ply filter wrap) was used at the bottom of the trench to collect the water.

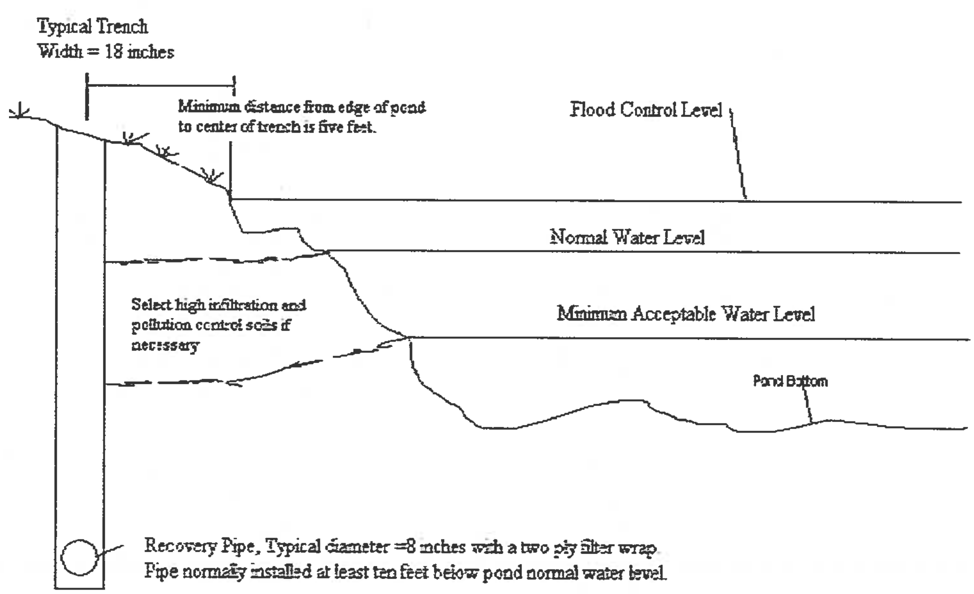


Figure 7: Horizontal Well Construction Details.

To increase the flow of water from the pond into the trenches, highly permeable stringers into the pond were used. These stringers allow preferential flow paths for water in the detention pond to enter the collection system. Perforated pipes were also extended into the detention pond to direct detained water into the trenches, as well as a special filter media for sorption of pollutants. A special filter media is used to enhance the removal of contaminates from the stormwater present in the pond and can be used to enhance stormwater quality with this system in any location. The perforated pipes were then connected to a pump and a subsequent flow rate of over 500 gpm was developed from the horizontal well. This 500 gpm flow rate was the minimum recorded flow rate over a two day period of continuous pumping. The testing lasted over a period of six weeks, pumping continuously for two days each week. The demand for irrigation water is about 77,000 gallons per day for the new UCF stadium and the surrounding grounds. For an eight hour irrigation cycle, the horizontal well can deliver about 240,000 gallons based on a pumping rate of 500 gpm.

At UCF the plan for irrigation is to use the horizontal well in conjunction with reclaimed water. The existing ground water wells would be used only if the stormwater regional detention pond and reclaimed water were discontinued. The detention pond will be the primary source for irrigation water.

Suspended solid samples from the pond water were compared to the Florida DEP reclaimed water standard. The standard for suspended solids is five mg per liter. The detention pond water suspended solids was consistently over that standard (5-9 mg/L). The water did not meet the public access standards for using reclaimed water for irrigation. Since there are no standards for detention pond water used as a source for irrigation, the reclaimed water standards were used.

Water for irrigation was taken from the horizontal well because the water quality was better as measured by turbidity and suspended solids (less that five mg/L in all samples). The stormwater recycling system with the use of the horizontal well consistently produces a water of less than five NTU for turbidity.

This horizontal well filter system can be cleaned and maintained by simply back flushing the perforated pipe; however, from the over 300 locations in operation in Florida to date, there is no need to clean them. It is believed that they can be used on any impounded water body in the State of Florida to provide an alternative water resource for water users, because of past successes and the operational success of the UCF reuse system. Five hundred systems have been installed and there are more than 300 currently in operation in Florida, with the remaining in operation across the USA. This technology was first used in 1987 and introduced within the State of Florida in 1989 (HSSI, 2007). A comparison of a horizontal well to a vertical well is shown in Figure 8 and illustrates a standard section for a horizontal well installation. For the same depth into the surficial aquifer, the horizontal well will remove more water. The length of horizontal well is shown as 500 feet in this case and the depth to the collection pipe is no more than 22 feet. Less deep horizontal wells have also been used provided the depth is below the water table. A four to eight inch diameter pipe is commonly used since larger pipes do not usually provide a proportionally greater flow volume. For most soils, the 500 foot length of a six inch pipe shown can develop between 250-500 gallons of water per minute, depending on soil permeability.

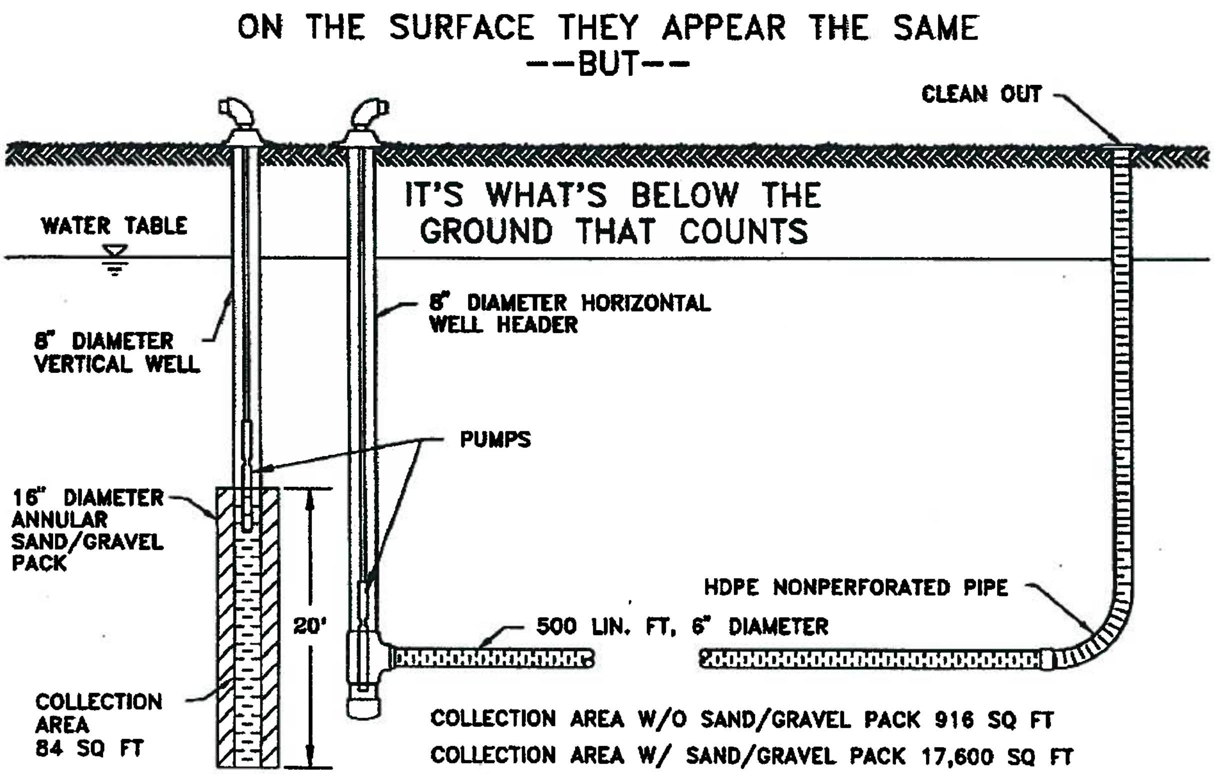


Figure 8: Horizontal Well Section and Comparison to a Vertical Well

5.2 INTELLIGENT CONTROLLER (I2 Controller)

UCF has two horizontal trenches; one each along side of the two stadium ponds. The operating plan is to alternate the selection of the trenches, and if the water level in the detention pond is lower than a preset depth value, to discontinue the use of the horizontal wells for irrigation, instead using the reclaimed source. In addition, the water quality as measured by turbidity will be used to select or to turn off the water from the pond. Pending the approval of the water management district and the state Department of Environmental Protection, the pond can also be refilled using reclaimed water. To carry out the refilling selection, an intelligent controller called I2 will be used. The I2 is a unit that will analyze the water quality properties of several water sources, as well as the depth of water in the detention pond. This same unit will then enable a water delivery/pumping system to deliver water to a water distribution/irrigation system based on the analysis of the water quality properties. At the UCF site, the particular unit has been configured for the following initial parameters:

THE I2 CONTROLLER PARAMETERS
One Water Source – Stormwater Pond
Two Water Quality Parameters – Pond Level and TSS (future), additional future parameters can be added as required
Two Delivery/Pumping Systems – Pressure Control VFD Pump Controller with a pump alternating control strategy
Distribution/Irrigation System – UCF RainBird Irrigation System
Pond Recharge Source – Reclaim Water

The general operations for the controller to receive a "Water Distribution System Request" are a signal from the water distribution/irrigation system. The distribution/irrigation system chosen is the UCF RainBird Irrigation System. Based on the water quality parameters as compared to the water quality parameter set points, the system will enable a water delivery/pumping system to deliver water from a water source (Stormwater Pond) to the water distribution/irrigation system (UCF RainBird).

There are two water delivery/pumping systems. Only one delivery/pump system shall be activated at a time. The delivery/pumping systems shall be on an alternating pumping scheme. The system shall alternate pumping systems at the end of each pumping cycle or upon a pumping system fault.

When the system is not delivering/pumping water to the distribution/irrigation system and the pond is below an operator adjustable low pond level set point, the stormwater pond shall be re-charged. For re-charging the pond, the system shall use a reclaim water system. This recharge cycle shall continue until the stormwater pond is above an operator adjustable high set point or that there is another request for water from the water distribution system.

When a “Water Distribution System Request” signal is received from the water distribution system, this system is programmed to enable a water delivery/pumping system provided the water quality parameters for the water source are acceptable. If the water quality parameters for water source are not acceptable then the system will not enable a water source.

For a water delivery/pumping system to be enabled all of the following conditions must be true:

1. “Water System Request”
2. “Water Source Water Level” >= “Water Source Low Level Set Point”
3. “Water Source TSS” <= “Water Source TSS Upper Limit Set Point”

5.2.1 System Specifications

Power Requirements: 120Vac/60Hz

I/O Requirements:

Analog Inputs (4-20mA)
- Water Source Level (0-34.6’) – Pressure Transducer provided w/Controller
- Water Source TSS (0-50 NTU)

Digital Inputs (Relay – Dry Contact)
- Water Distribution System Request
- Water Delivery System No. 1 Low Level Lockout
- Water Delivery System No. 2 Low Level Lockout

Analog Outputs (4-20mA)
- N/A

Digital Outputs (Relay – Dry Contact)
- Water Source Delivery System No. 1 Enable
- Water Source Delivery System No. 2 Enable
- Open Pond Re-charge Valve

5.2.2 Methodology of Installation:

The I2 Controller consist of an Allen-Bradley MicroLogix 1500, 24Vdc power supply, 120Vac surge suppressor, analog surge suppressors, and other miscellaneous electrical components installed in a 24" x 24" x 8" FRP NEMA 3, 3R, 4, 4X, 12, 13 Hoffman enclosure. The I2 Controller has been assembled by a UL 508 panel shop and bears the UL mark of such.

The controller shall be mounted on a rack or stand and installed per NEC and local electrical code requirements. In no way shall any penetration into the controller affect the NEMA rating of the controller. The controller shall be installed in such a way as to limit the temperature inside the enclosure to 110 F. For example, if the controller is to be installed outdoors, sun shields shall be provided by the contractor to protect the controller and to assist with keeping the controller at an acceptable temperature.

The controller has been provided with one pressure transducer to be used for water source level. This pressure transducer is to be installed by the contractor in the water source and wired back to the controller. The contractor shall provide everything necessary (labor, tools, material, and required equipment) to install the pressure transducer and to get the signal from the transducer to the controller.

The controller has an input to be used to indicate to the controller that the water distribution system requires water. The contractor shall provide this signal from the water distribution system to the controller. The contractor shall provide everything necessary (labor, tools, material, and required equipment) to provide this signal and get the signal from the water distribution system to the controller.

The controller will be been provided with two outputs. Each output shall be used to enable a water delivery system to deliver water from the water source to the water distribution system. The contractor shall provide everything necessary (labor, tools, material, and required equipment) to provide these signals from the controller to the water delivery systems.

The controller will be provided with an output to open a valve to re-charge the pond from a reclaim water source. The contractor shall provide everything necessary (labor, tools, material, and required equipment) to provide this signal from the controller to the pond re-charge valve.

The controller will be provided with additional inputs to monitor the low level cut- off status of the water delivery systems. The contractor shall provide everything necessary (labor, tools, material, and required equipment) to provide these signals from the controller to the water delivery systems.

The I2 Controller will be programmed and configured based on known water quality parameters. Modification to the program and configuration may be made in the field after installation is complete.

A representative from the I2 Controller team will be available to review the installation requirements with the contractor before the installation begins and will also be available to inspect the installation once the installation is complete.

In addition, a representative from the I2 Controller team will be available to assist with start-up and checkout of the system once the system is ready for operation.

CHAPTER 6 – CONCLUSION AND RECOMMENDATIONS

6.1 Summary

Fourteen stormwater ponds located in central Florida were sampled for Cyanobacteria total and potentially toxic (PTOX) counts and toxin concentrations. These ponds had visual appearances of Cyanobacteria, and in some ponds, Orange County Environmental Protection had identified at least the qualitative assessment of the Cyanobacteria. For two stormwater ponds, Lake Terrier and Lake Condel, there were confirmed Cyanobacteria counts. The additional stormwater ponds were chosen to represent different land uses, such as urban roads, state roads, institutional, residential and industrial. The ponds were sampled on two different occasions for the documentation of Cyanobacteria counts and toxin concentrations.

Even though Cyanobacteria were found in all of the ponds evaluated for this study, one particular location, or watershed source, did not show a greater concentration of Cyanobacteria over any other. The average counts for the stormwater ponds were 1,893 total and 470 PTOX in April 2005 with standard deviations of 3,113 and 724 respectively. For the August 2005 sampling, the average counts were 11,093 total and 4,896 PTOX with standard deviations of 11,924 and 6,371 respectively. Lake data shown total count numbers ranging from 116,700 to 1,361,860, and PTOX counts as high as 154,190.

In addition, four soil columns were used to infiltrate and percolate stormwater pond water. Pond water from three ponds along S.R. 417, Lake Condel, and Pegasus pond were applied to the columns to simulate a year of water. The columns were four feet deep and sampling occurred at this depth to detect the occurrence of Cyanobacteria counts and toxin concentrations. The columns were two foot square and filled with the most common sandy soils on the campus of UCF. The soils were poorly graded and classified as type- A hydrologic in terms of their drainage characteristics and were compacted to 92% density to simulate construction practices.

The fourteen ponds were surveyed for area and depth, which provided an estimate of the as-built and operational conditions. The volume of each pond was then calculated. Geometric data for pond sizes were not available, thus field reconnaissance for pond depths and the use of aerial maps for pond area estimation had to be obtained. This resulted in more accurate pond volume estimates relative to the use of planned construction drawings.

6.2 Conclusions

The results of this research show that total and PTOX Cyanobacteria counts and the toxins associated with them do exist in stormwater ponds across the central Florida area. This was the first documentation of such numbers and as such had no other comparative pond data; however, the total counts are much lower in the stormwater regional ponds by about two orders of magnitude, relative to those counts found in large central Florida lakes.

Assuming that relatively low levels of Cyanobacteria tend to be found in stormwater ponds, the filtration mechanism of natural soil material appears to be an effective means of reducing the total Cyanobacteria counts and the potentially toxic Cyanobacteria counts as well. There were no Microcystin toxins after filtration that exceeded the World Health Organization drinking water standard of one ug/L. The Microcystin toxins are produced from the

Cyanobacteria and were shown to be significantly reduced by the natural soil media; however, the toxin concentrations in the waters of the stormwater ponds did exceed one ug/L in seven percent of the samples.

The area and depth of each stormwater pond was evaluated and the volume of each was estimated. Larger volume and area lakes have higher Cyanobacteria counts and thus larger ponds may have higher counts. The data from this study, however, showed no statistical relationship for counts or toxin concentrations to the volume of stormwater ponds, presumably because of the proportionate amount of rooted vegetation in each pond which help remove nutrients from the water column.

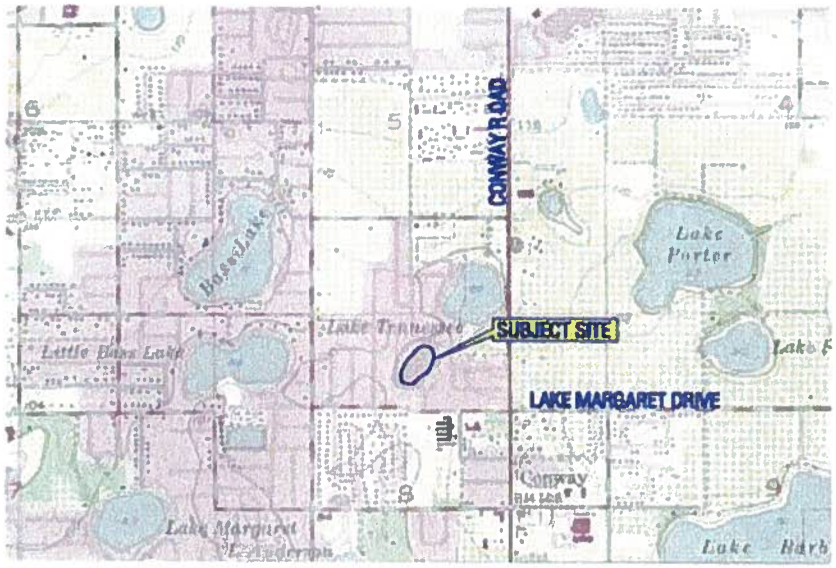
6.3 Recommendations

The results of this study conclude that stormwater ponds should be treated the same as lakes in the area relative to any regulations regarding the beneficial uses of water from lakes and ponds. This conclusion is based on site location and climate condition requirements for this study, and is based on the Cyanobacteria data of this study.

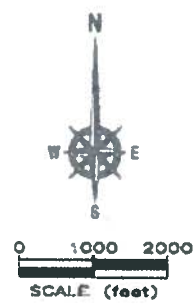
There were significant removal of total and PTOX Cyanobacteria using naturally occurring, poorly graded soils. However, further study is necessary for the removal of toxins in stormwater using these and other naturally occurring soils. Some evidence shows that additional organic content may reduce the toxins and will be examined in a continuing study, adding more definitive data on the forces causing removals. The growth rate as related to residence time may as well be important and worthy of additional research, because of the lower residence time in the stormwater ponds relative to the large lakes.

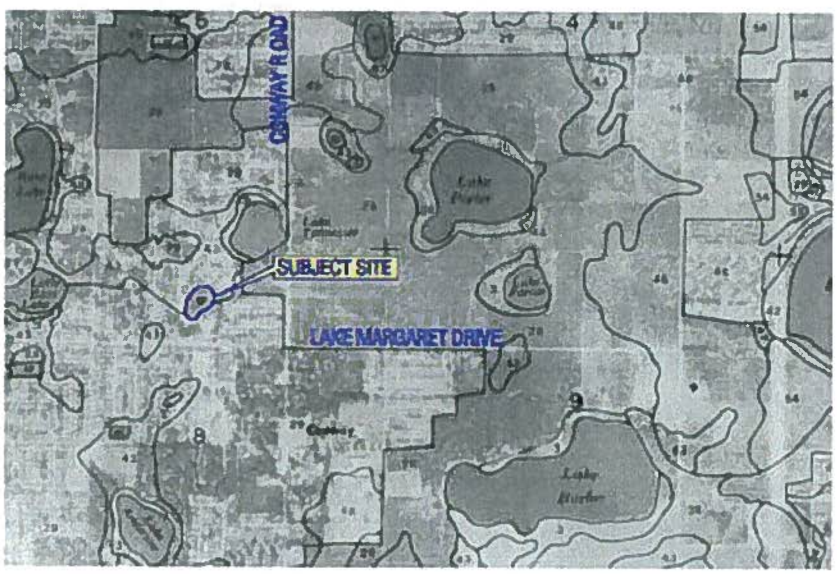
The use of regional stormwater ponds with horizontal wells should be considered to meet stormwater pollution control standards and to help reduce dependency on potable water for irrigation supply. Construction details for horizontal wells are shown in Figure 7 and are recommended for use with established ponds. Stringers about four feet wide and placed about every fifty feet along the pond edge are recommended to enhance the follow of water from the pond to the trench.

APPENDIX A: USGS QUADRANGLE and SCS SOIL SURVEY MAPS



PREPARED FROM:
USGS ORLANDO EAST, FLA. QUADRANGLE MAP
ISSUED 1956
PHOTOREVISED 1980
SECTION: 8
TOWNSHIP: 23 SOUTH
RANGE: 30 EAST





PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 198?
ORANGE COUNTY MAP UNIT LEGEND
W — WATER

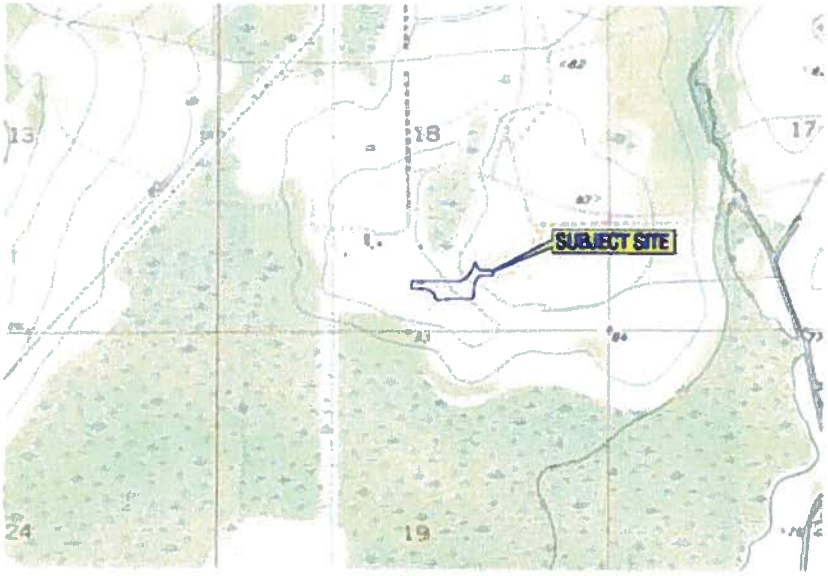
EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

LOCATION AND SOIL DESCRIPTION

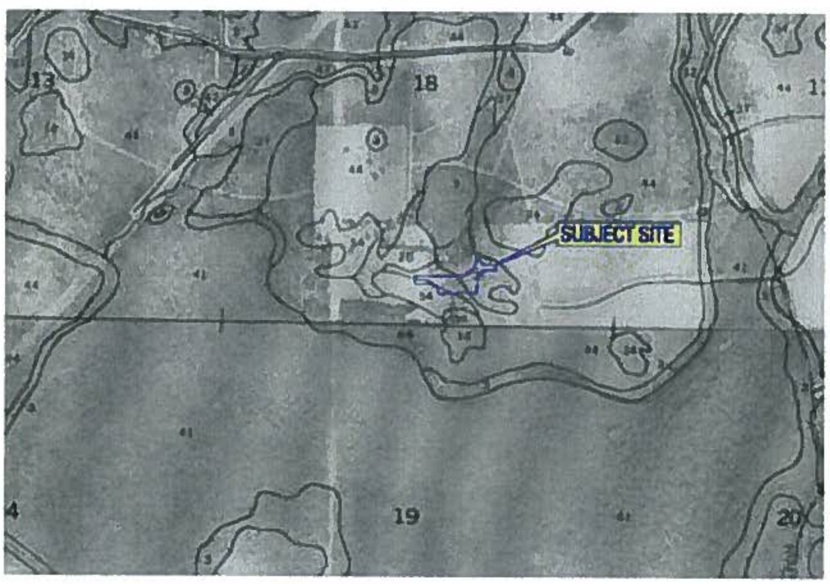
LAKE CONDEL

USGS QUADRANGLE & SCS SOIL SURVEY MAPS

Lake Condel: Location and Soil Description



PREPARED FROM:
USGS LAKE JESSAMINE, FLA. QUADRANGLE MAP
ISSUED 1953
PHOTOREVISED 1980
SECTION: 18
TOWNSHIP: 24 SOUTH
RANGE: 29 EAST



PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981
ORANGE COUNTY MAP UNIT LEGEND
37 — ST. JOHNS FINE SAND
44 — SMYRNA FINE SAND
34 — ZOLFO FINE SAND

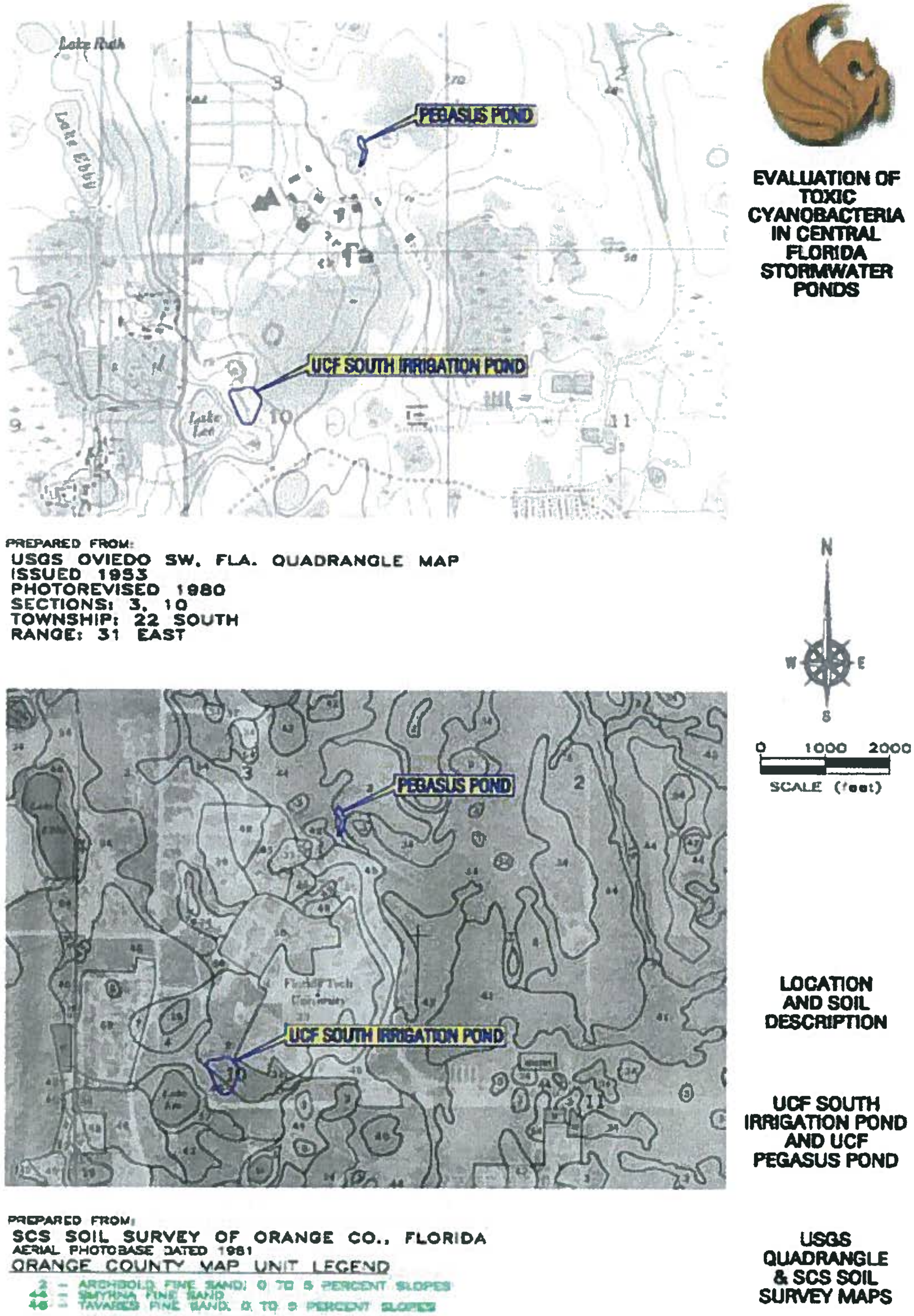
EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

LOCATION AND SOIL DESCRIPTION

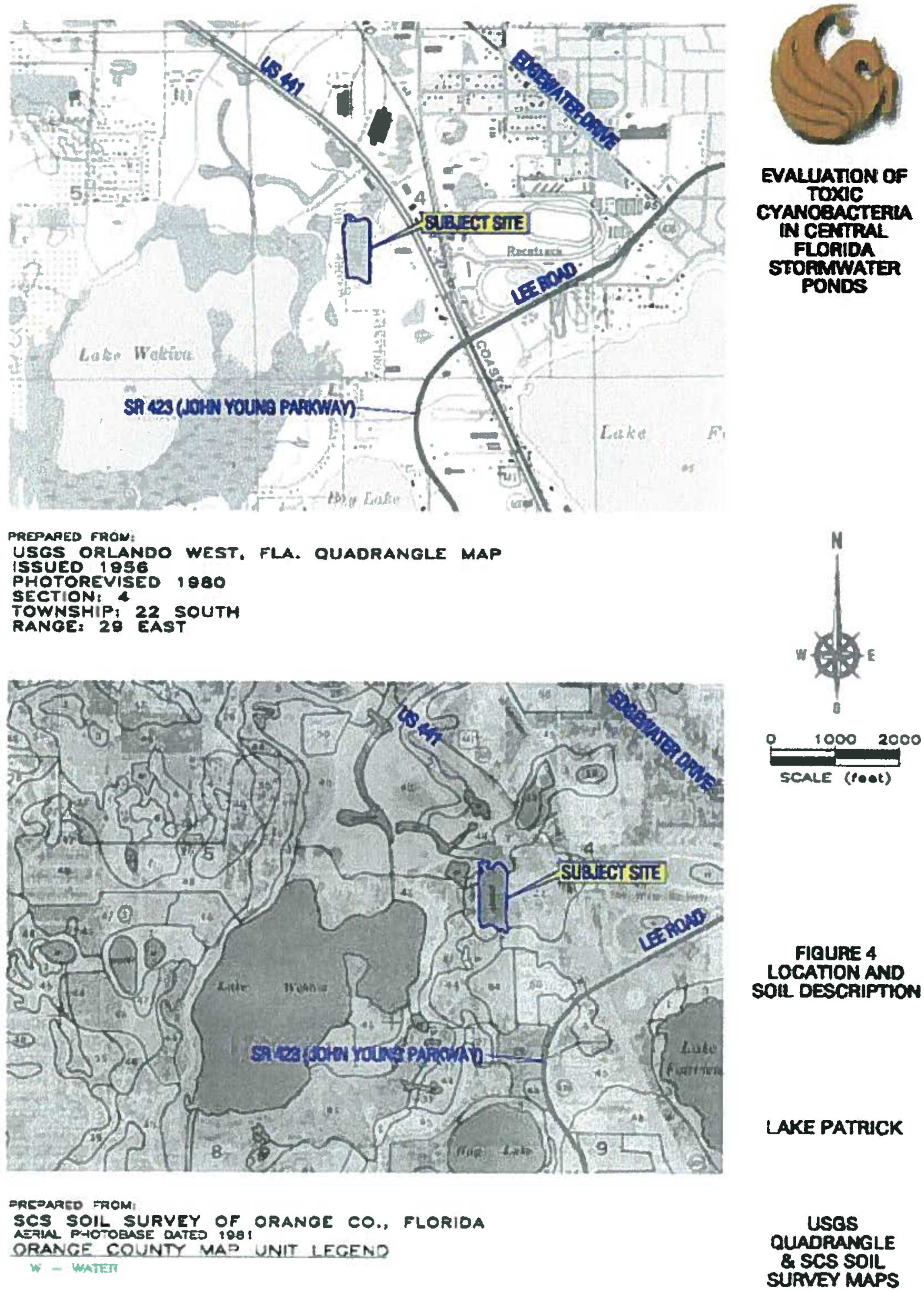
TERRIER POND

USGS QUADRANGLE & SCS SOIL SURVEY MAPS

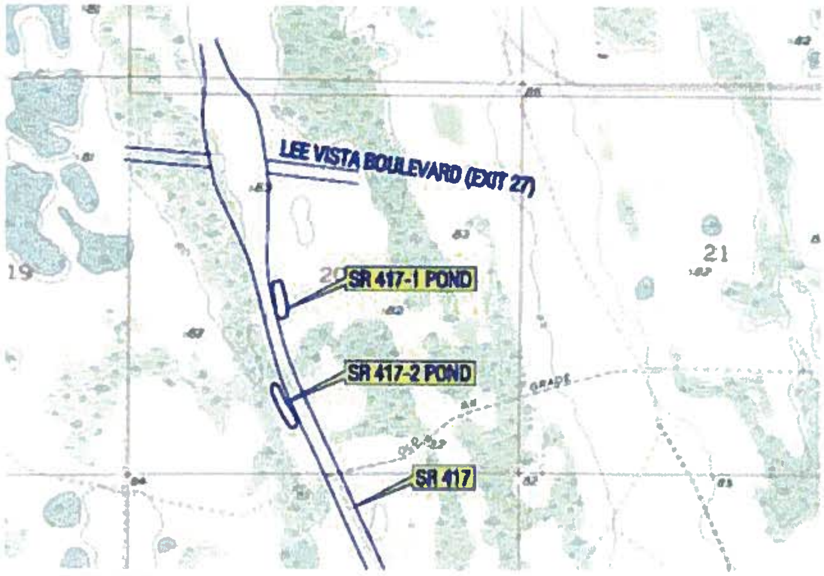
Terrier Pond: Location and Soil Description



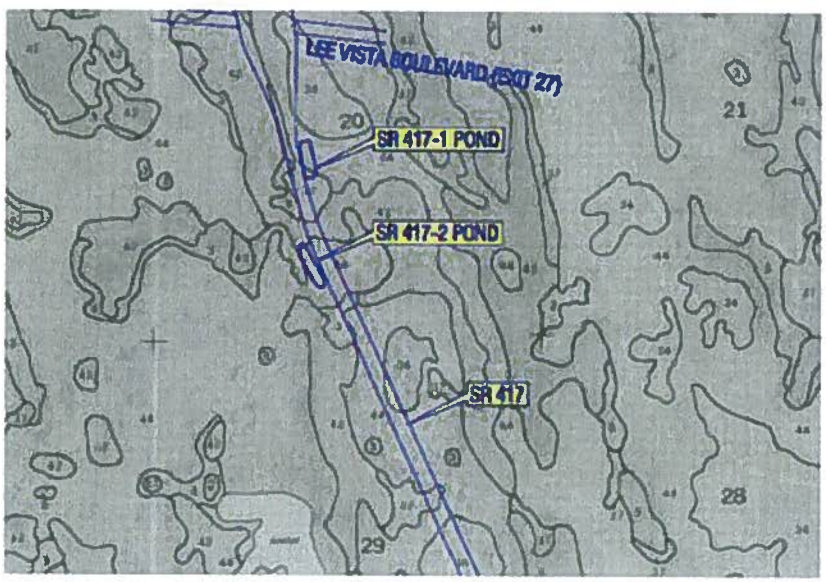
UCF South Irrigation and Pegasus Ponds: Location and Soil Description



Lake Patrik: Location and Soil Description



PREPARED FROM:
USGS NARCOOSSEE NW. FLA. QUADRANGLE MAP
ISSUED 1953
PHOTOREVISED 1980
SECTION: 20
TOWNSHIP: 23 SOUTH
RANGE: 31 EAST



PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981

ORANGE COUNTY MAP UNIT LEGEND

37 – ST. JOHNS FINE SAND
42 – SANIBEL MUCK
44 – SMYRNA FINE SAND

EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

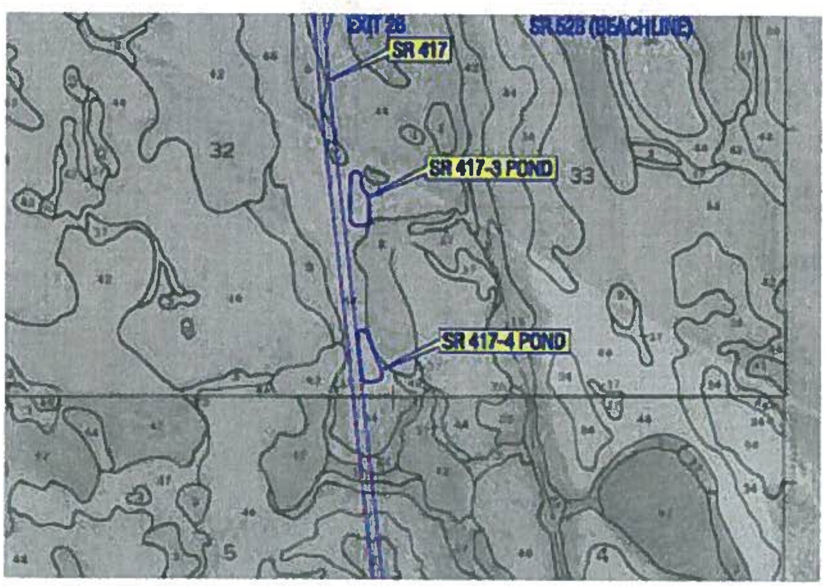
LOCATION AND SOIL DESCRIPTION

SR 417-1 AND SR 417-2 PONDS

USGS QUADRANGLE & SCS SOIL SURVEY MAPS

S.R. 417-1 and S.R. 417-2 Ponds: Location and Soil Description

PREPARED FROM:
USGS NARCOOSSEE NW, FLA. QUADRANGLE MAP
ISSUED 1953
PHOTOREVISED 1980
SECTION: 32
TOWNSHIP: 23 SOUTH
RANGE: 31 EAST



PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981
ORANGE COUNTY MAP UNIT LEGEND
44 — SMYRNA FINE SAND

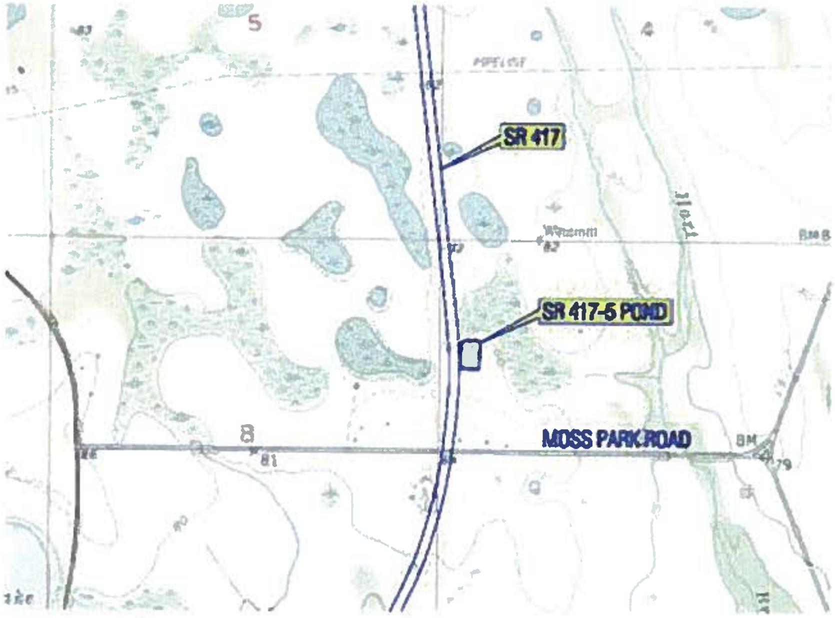
EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

LOCATION AND SOIL DESCRIPTION

SR 417-3 AND SR 417-4 PONDS

USGS QUADRANGLE & SCS SOIL SURVEY MAPS

S.R. 417-3 and S.R. 417-4 Ponds: Location and Soil Description



EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

PREPARED FROM:
USGS NARCOOSSEE NW, FLA. QUADRANGLE MAP
ISSUED 1953
PHOTOREVISED 1980
SECTION: 9
TOWNSHIP: 24 SOUTH
RANGE: 31 EAST

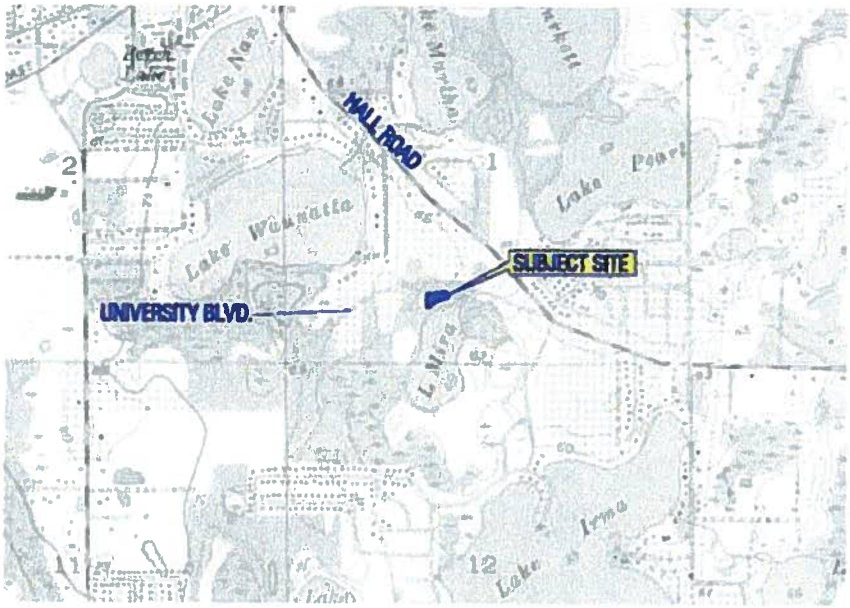
PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981
ORANGE COUNTY MAP UNIT LEGEND
44 – SMYRNA FINE SAND

LOCATION AND SOIL DESCRIPTION

SR 417-5 POND

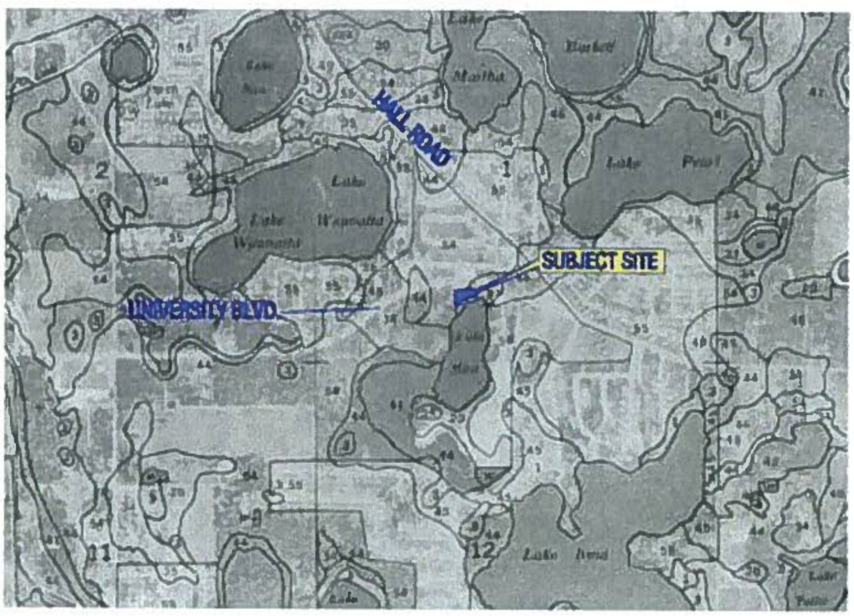
USGS QUADRANGLE & SCS SOIL SURVEY MAPS

S.R. 417-5 Pond: Location and Soil Description



EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

PREPARED FROM:
USGS ORLANDO EAST, FLA. QUADRANGLE MAP
ISSUED 1956
PHOTOREVISED 1980
SECTION: 1
TOWNSHIP: 22 SOUTH
RANGE: 30 EAST



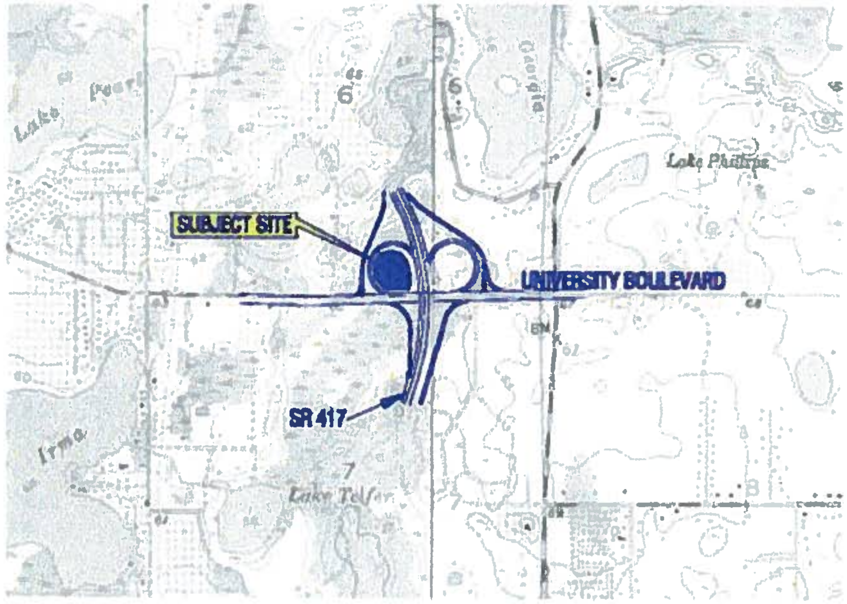
LOCATION AND SOIL DESCRIPTION

UNIVERSITY BOULEVARD AND HALL ROAD POND

PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981
ORANGE COUNTY MAP UNIT LEGEND
3 – BASINGER FINE SAND, DEPRESSIONAL
44 – SMYRNA FINE SAND
54 – ZOLFO FINE SAND

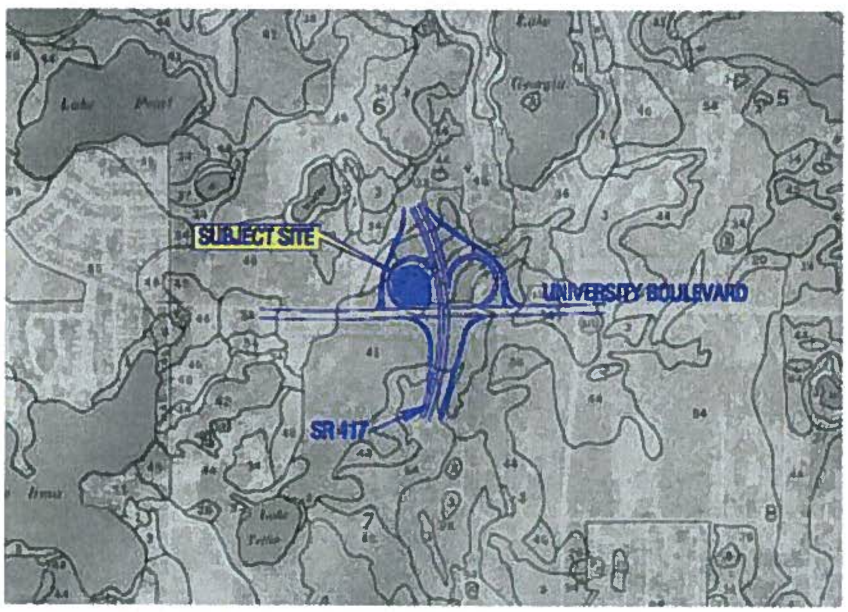
USGS QUADRANGLE & SCS SOIL SURVEY MAPS

University Blvd and Hall Road Pond: Location and Soil Description



EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

PREPARED FROM:
USGS ORLANDO EAST, FLA. QUADRANGLE MAP
ISSUED 1956
PHOTOREVISED 1980
SECTIONS: 6, 7
TOWNSHIP: 22 SOUTH
RANGE: 31 EAST



LOCATION AND SOIL DESCRIPTION

UNIVERSITY BOULEVARD AND SR 417 NW POND

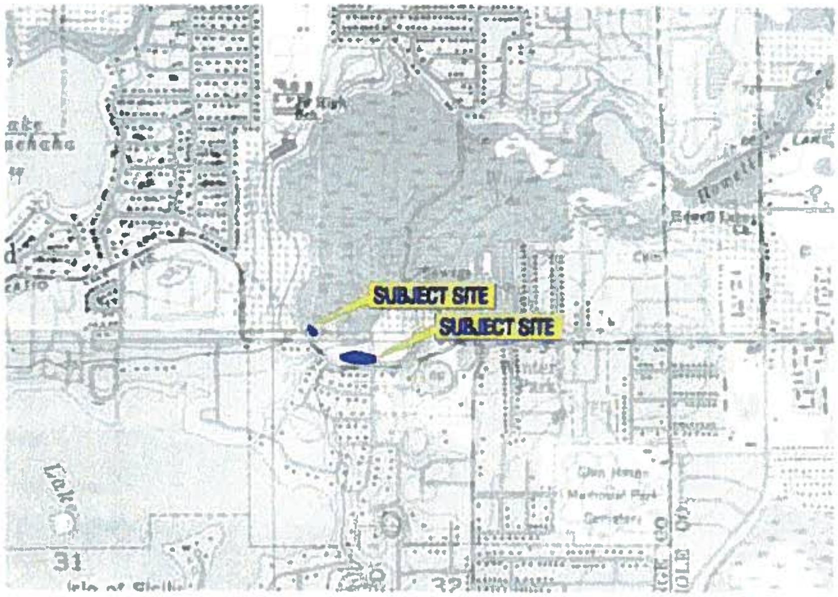
USGS QUADRANGLE & SCS SOIL SURVEY MAPS

PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981

ORANGE COUNTY MAP UNIT LEGEND

34 – POMELLO FINE SAND, 0 TO 5 PERCENT SLOPES
41 – SAMSULA–HONTOON–BASINGER ASSOCIATION, DEPRESSIONAL
44 – SMYRNA FINE SAND

University Blvd and S.R. 417 Pond: Location and Soil Description



EVALUATION OF TOXIC CYANOBACTERIA IN CENTRAL FLORIDA STORMWATER PONDS

PREPARED FROM:
USGS CASSELBERRY, FLA. QUADRANGLE MAP
ISSUED 1962
PHOTOREVISED 1980
SECTIONS: 29, 32
TOWNSHIP: 21 SOUTH
RANGE: 30 EAST

LOCATION AND SOIL DESCRIPTION

HORATIO AVENUE AND VIA TUSCANY PONDS

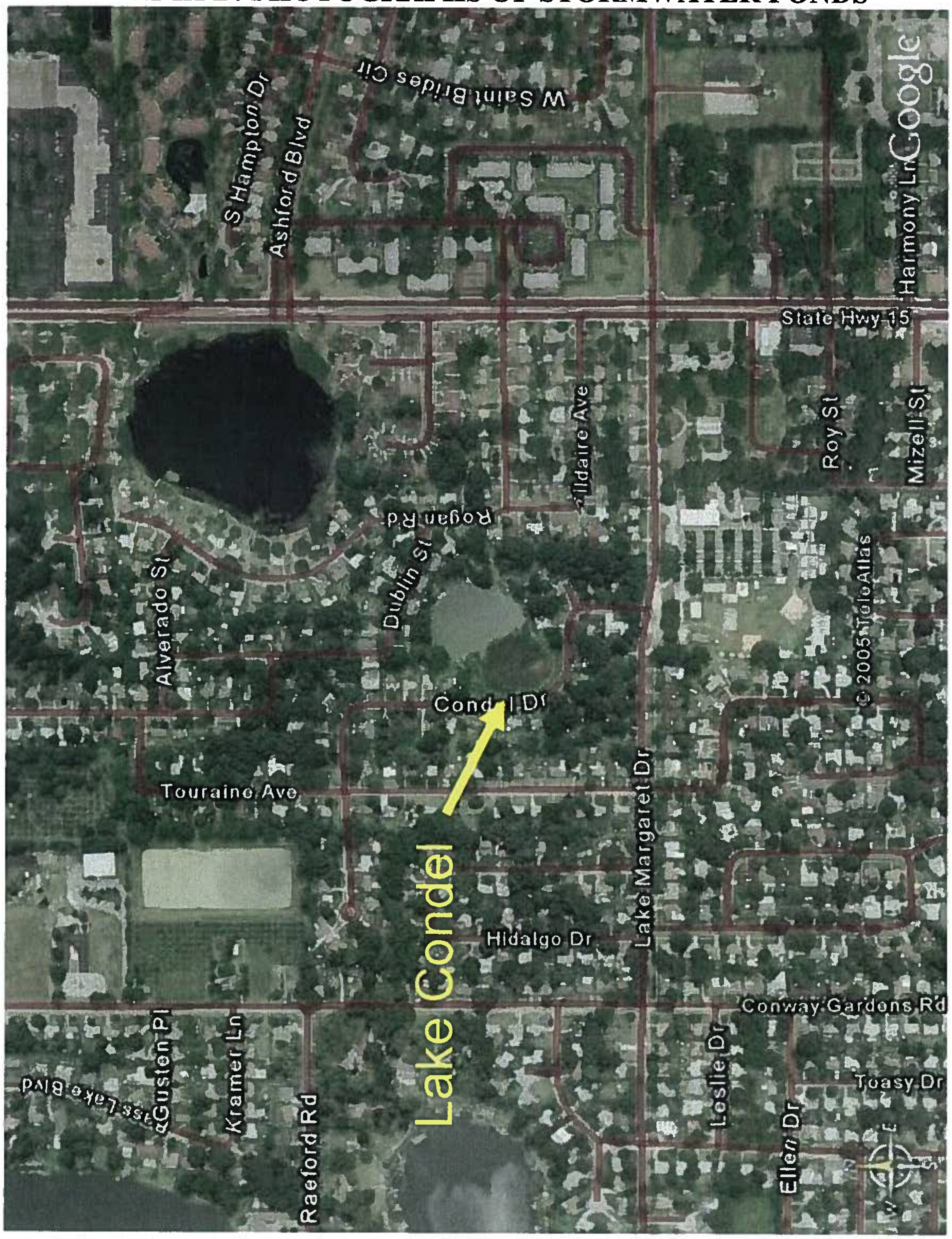
PREPARED FROM:
SCS SOIL SURVEY OF ORANGE CO., FLORIDA
AERIAL PHOTOBASE DATED 1981
ORANGE COUNTY MAP UNIT LEGEND

1 – ARENTS, NEARLY LEVEL
3 – BASINGER FINE SAND, DEPRESSIONAL
8 – CANDLER–URBAN LAND COMPLEX, 5 TO 12 PERCENT SLOPES
41 – SAMSULA–HONTOON–BASINGER ASSOCIATION, DEPRESSIONAL

USGS QUADRANGLE & SCS SOIL SURVEY MAPS

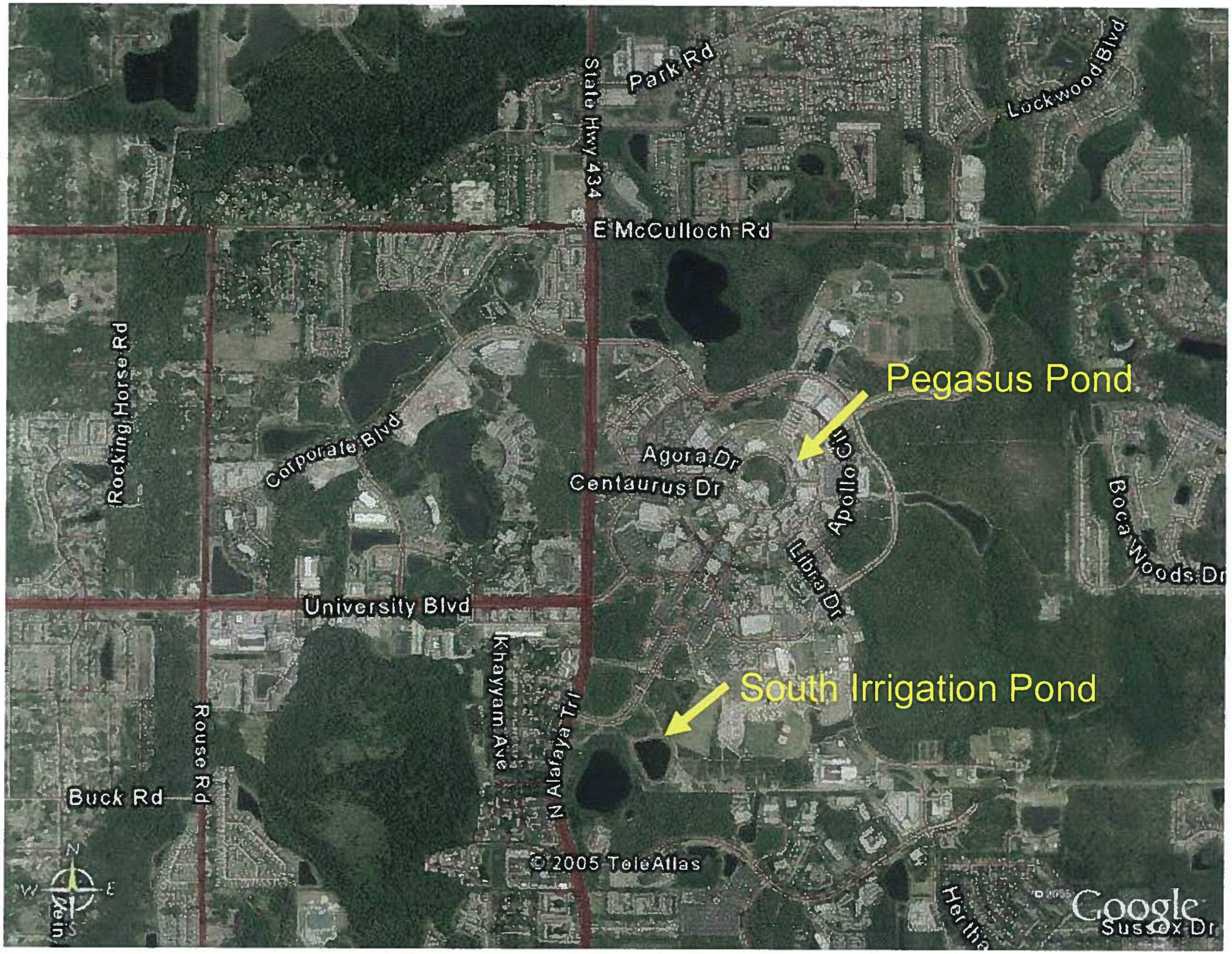
Horatio Avenue and Via Tuscany No. 1 and No. 2 Ponds: Location and Soil Description

APPENDIX B: PHOTOGRAPHS OF STORMWATER PONDS

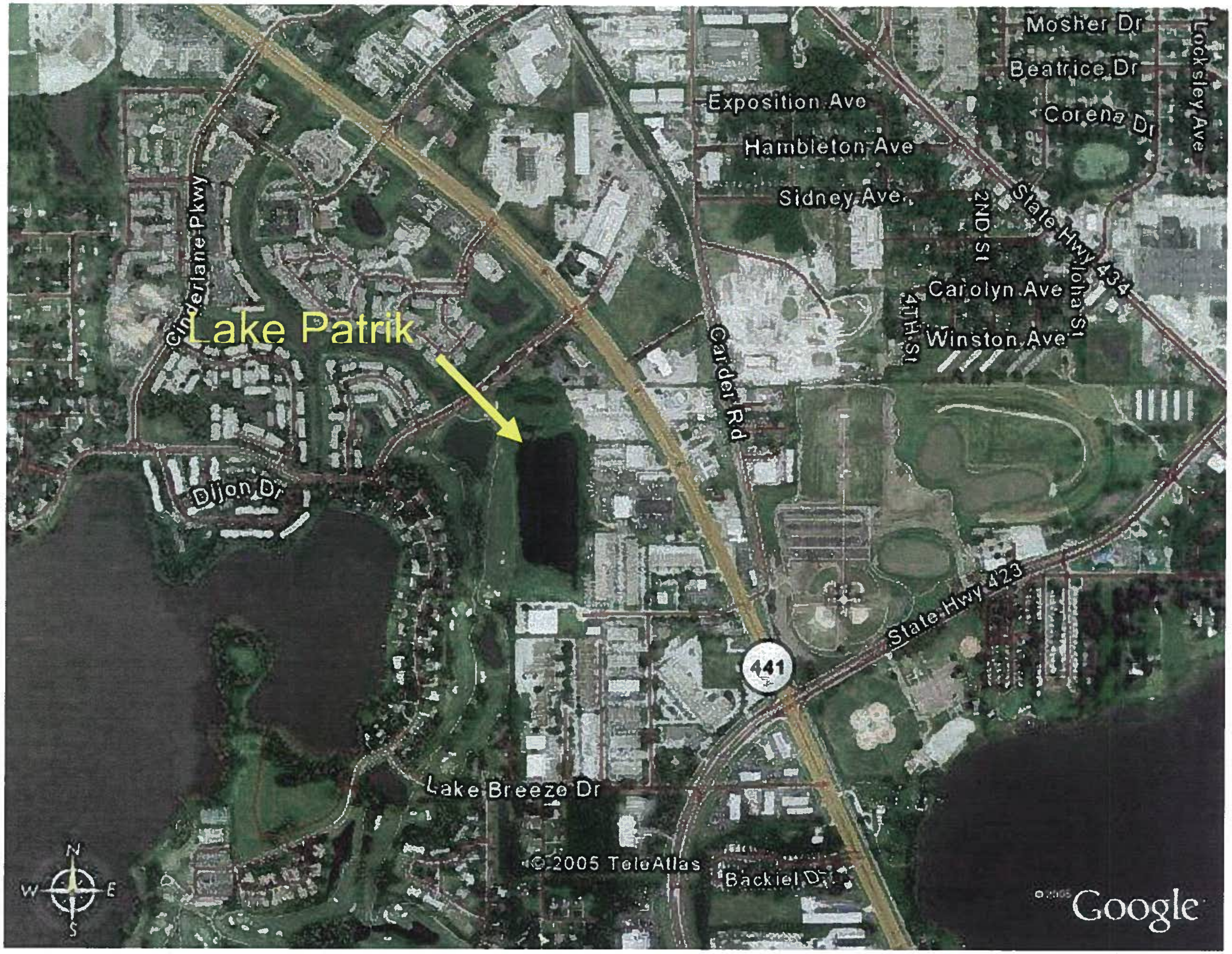


Lake Condel: Aerial photograph of subject site and surrounding area.

Terrier Pond: Aerial photograph of subject site and surrounding area.

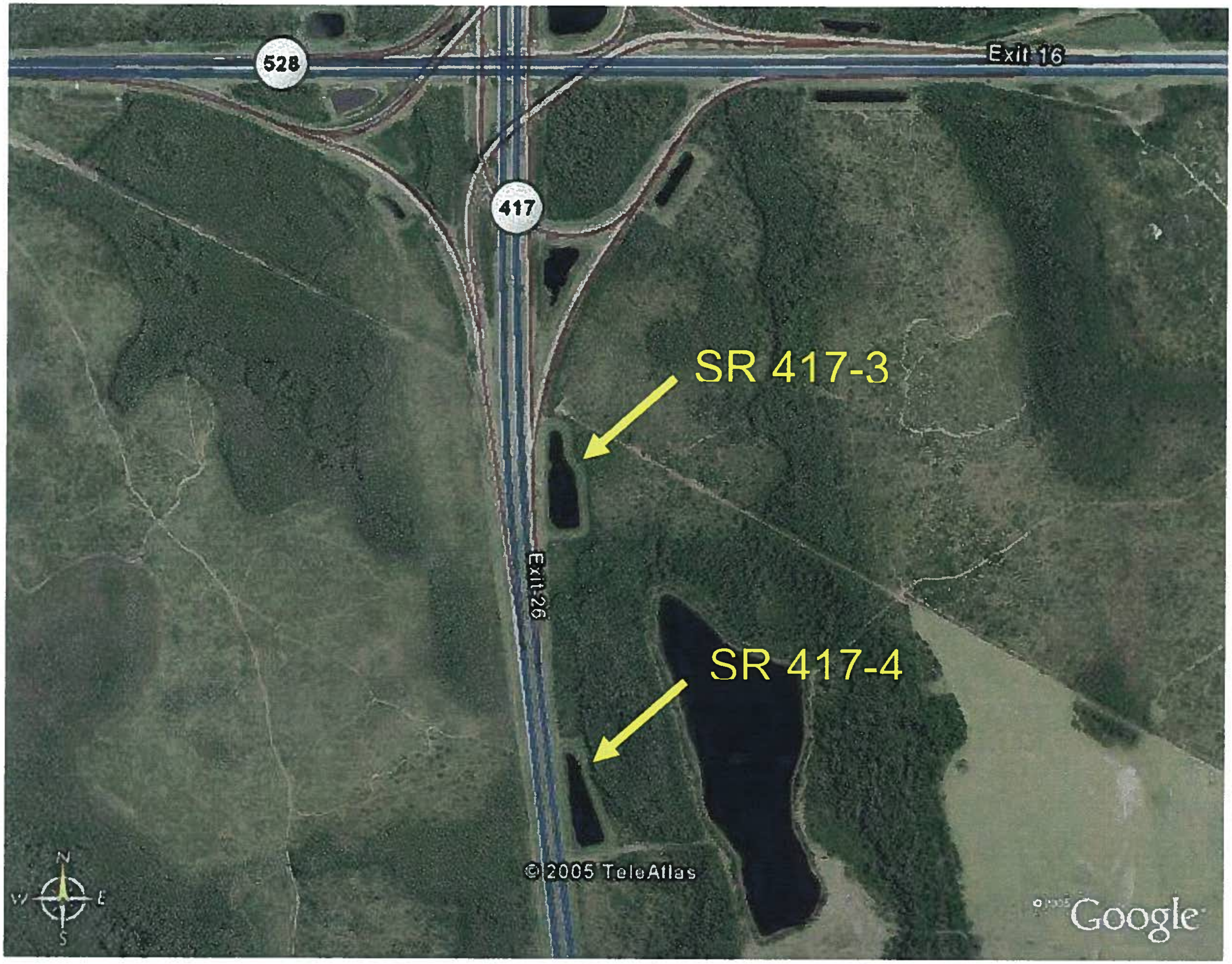


UCF South Irrigation and Pegasus Ponds: Aerial photograph of subject sites and surrounding areas.

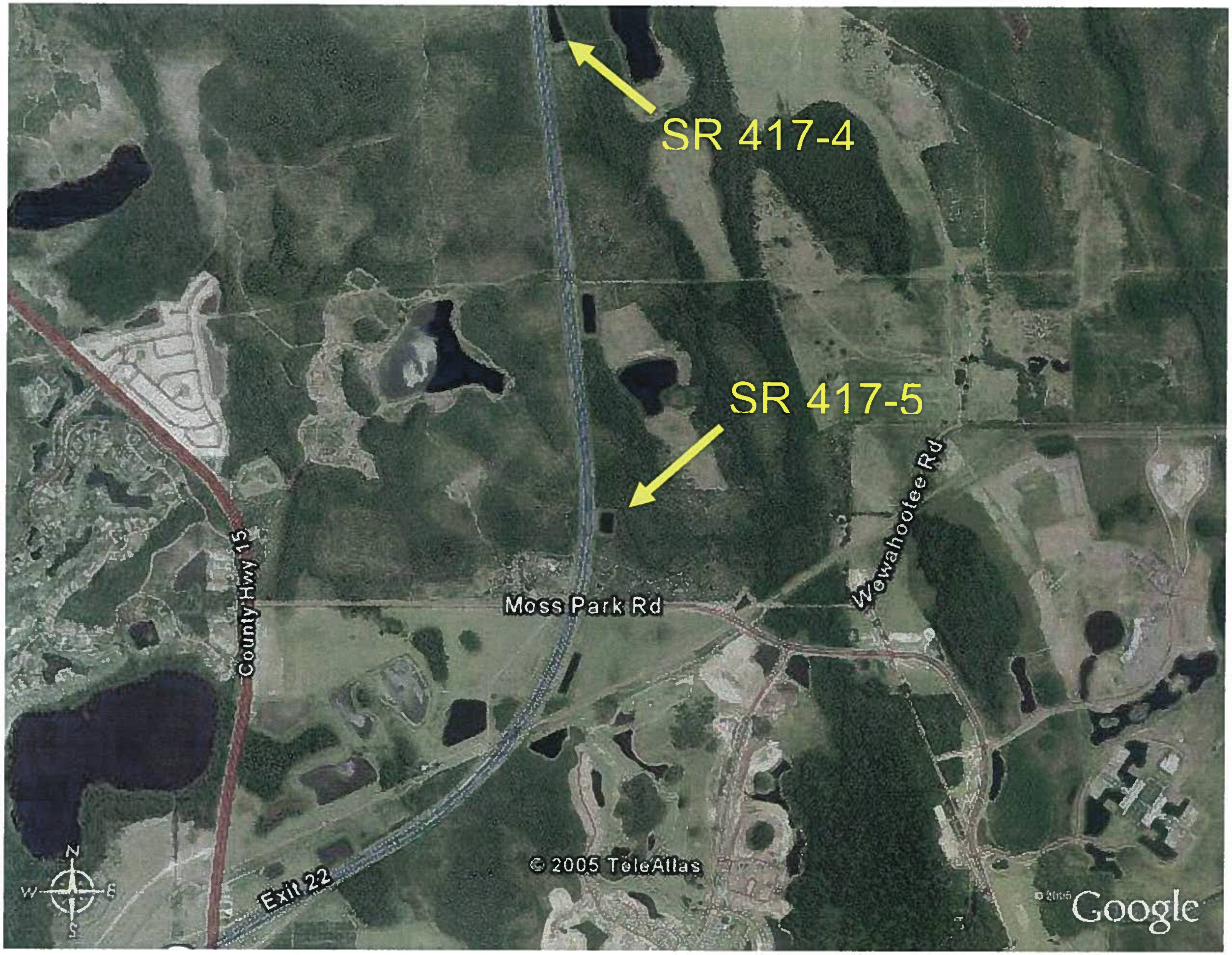


Lake Patrik: Aerial photograph of subject site and surrounding area.

S.R. 417-1 and S.R. 417-2 Ponds: Aerial photograph of subject sites and surrounding areas.



S.R. 417-3 and S.R. 417-4 Ponds: Aerial photograph of subject sites and surrounding areas.



S.R. 417-5 Pond: Aerial photograph of subject site and surrounding area.

Appendix B

SHARP Modeling Paper

Integrated Surface-Ground Water Model for Stormwater Harvesting Using Basic Mass Balance Principles

Ikiensinma Gogo-Abite, A.M.ASCE[1]; Manoj Chopra, P.E., M.ASCE[2]; Martin Wanielista, P.E., M.ASCE[3]

Abstract

Stormwater harvesting from a pond for irrigation of adjacent lands is promoted as one way that may reduce pond discharge while supplementing valuable potable water used for irrigation. Reduction of pond discharge reduces the mass of pollutants in the discharge. In this study, a Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) model was developed to predict operation of wet pond used for stormwater harvesting at Miramar Lakes, Miramar, Florida. The model integrates the interaction of surface water and groundwater in a catchment area. The SHARP model was calibrated and validated for pond water elevation. Model evaluation showed adequate prediction of pond water elevation with root mean square error (*RMSE*) between 0.07 and 0.12 m; mean absolute error (*MAE*) between 0.018 and 0.07 m; and relative index of agreement between (d_{rel}) 0.74 and 0.98 for both calibration and validation

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[2] Associate Professor and Director of Stormwater Management Academy, Department of Civil, Environmental and Construction Engineering, University of Central Florida, Orlando, FL 32816-2450. Affiliation: Member, American Society of Civil Engineers (ASCE); Email: Manoj.Chopra@ucf.edu

[3] Emeritus Professor of Engineering, Executive Director, College of Engineering & Computer Science, University of Central Florida, Orlando, FL 32816-2450. Affiliation: Member, American Society of Civil Engineers (ASCE); Email: Martin.Wanielista@ucf.edu

periods. The SHARP model is capable of assessing harvest safe-yield and discharge from a pond, including the prediction of the percentage of runoff into a harvesting pond that is not discharged.

CE Database Subject Headings: Hydrologic models; Irrigation systems; Simulation model; Soil water movement; Spreadsheets; Stormwater management; Water balance.

Introduction

Stormwater runoff is part of the hydrologic cycle in a watershed and can become a source of valuable water for harvesting. Water in ponds can be used for stormwater harvesting (Shukla and Jaber 2006). The harvested water has been shown to be environmentally acceptable and economically beneficial (Wanielista and Yousef 1993; Wanielista 2007). Stormwater ponds involve retention and detention with slow release of stormwater runoff into adjacent surface and ground waters. The detention of the stormwater runoff allows for settling of the suspended pollutants to the pond bed prior to release through a control mechanism. A harvesting pond has the potential to reduce the volume of discharge and consequently release less pollutant load downstream.

The volume of water in the harvesting pond is one determining factor that influences the harvesting process. Thus, the mechanism of surface and subsurface water movement in the catchment area contributing to the pond needs an adequate modeling tool that predicts accurate estimation of pond water volume available for harvesting and discharge to maintain the natural regime. The present state of science requires the use of numerical models for the mapping of the spatial characters of the catchment area and pond (Thompson et al. 2004). Economical and computational difficulties in sourcing the data needed to implement such an elaborate effort have discouraged research and application for numerical models. Therefore, accurate prediction of the water movement through deterministic modeling process becomes critical when considering pond water harvesting as a stormwater management system.

The objective of this study is the development and application of a mathematical model for a stormwater harvesting pond, when there is the potential for both surface and subsurface water movement occurring into and out of a pond in a catchment area. The model, Stormwater Harvesting and Assessment for Reduction of Pollution (SHARP) is based on the interaction between the pond water storage and subsurface water. The model is designed to simulate the interaction of the overall pond water balance and the catchment area geologic and hydrologic data; predicts downstream flow; and accounts for the effect groundwater seepage on the pond water quality and quantity. In addition, the model is to predict the percentage of runoff into a wet detention pond that is not discharged (capture volume) and the groundwater contribution to harvesting. Calibration and validation of the model will be performed to assess the hydrologic behavior and performance by comparison of simulated and observed data at Miramar Lakes, Miramar, Florida.

Research Background

Stormwater Harvesting Process

Stormwater harvesting is the process of harvesting of detained/retained stormwater runoff within a watershed pond for irrigation and infiltration into adjacent pervious area, and frequently these areas are within the same watershed. It further has the potential to increase groundwater recharge as a substantial volume of annual stormwater runoff is returned to the watershed. There are other uses for harvested stormwater that do not return water to the pond, such as cooling tower make-up, car washing, and other waste water carriage. A stormwater harvesting pond is designed to harvest the fraction of runoff volume in a wet detention pond for non-potable uses (Wanielista and Yousef 1993). The fraction available for harvesting (harvested volume) is considered the temporary storage volume and below the flood control discharge invert elevation. It is necessary to note that the harvesting system is likely to deplete the permanent pool volume below a discharge control elevation, and at some times, supplementary water volume may be required to maintain the volume. Presented in Figure S1 is the schematic of a typical stormwater harvesting pond cross section. Wanielista and Yousef (1993) presented the methodology and design criteria for the harvesting volume.

Stormwater Harvesting Pond

Numerous studies have been conducted on the need to use stormwater runoff and the benefits from such activity (Heitz et al. 2000; Clark et al. 2002; Jaber and Shukla 2005; Seymour 2005; Hwang and Draper 2006). However, only few publications useful in predicting the percent of runoff water captured using harvesting methods are available. The design and analysis model (Wanielista and Yousef 1993) provide series of rate-efficiency-volume (REV) curves to aid the design of harvesting ponds under the assumptions that there is minimal groundwater input and output to the pond. The primary use of the REV curves and the proposed model is to retain surface runoff water within a watershed and to reduce the mass of pollutants in the discharges to surface water bodies.

Harvesting Pond Simulation Model

The development and validation by Wanielista and Bradner (1992) and calibration by Wanielista (1993) show that mathematical mass balance model can simulate the operation of a stormwater harvesting pond that has minimal groundwater exchange. The mass balance for the harvesting pond is based on inflow from rainfall events, discharge from the pond, and a harvesting volume rate. Water is discharged from the pond when the temporary storage volume exceeds the available storage. A relationship between the efficiency or runoff capture (note that this is runoff not discharge), harvesting rate and harvesting volume of the pond for a continuous time model was established from a simulation for specified period. Using local rainfall data, the simulation process provided the tools for the creation of charts of the harvesting rate, efficiency and harvesting volume (REV) for different rainfall regions. The net flow of groundwater into a pond was assumed to equal zero, and the average evaporation rate for a pond in Florida was considered approximately equal to the average precipitation on the pond in a one-year period. It is important to factor in the availability and nearness of the water use facility in the design considerations for a stormwater harvesting pond, as there may be more water available. Additionally, when located near sensitive streams, pumping rates of the water should be controlled so as not to diminish or eliminate downstream flows needed to sustain aquatic life. If located next to wetlands, it is desirable to show the impact on the wetland.

SHARP Model Development and Operation

Several approaches have been developed to model various hydrologic processes of watersheds (Jaber and Shukla 2005; Elliott and Trowsdale 2007). The processes of water movement on the surface and in the unsaturated and saturated zones of the subsurface often require rigorous analyses. Therefore, simplification of the concepts into a mass balance approach with accountability of water is helpful in the development of adequate representation of water volumes in mathematical models (Skaggs and Khaleel 1982; Tindall and Kunkel 1999). The simplifications in water movement on the surface and subsurface within a watershed model would reduce the rigorous analysis required to model the interaction between rainfall runoff, infiltration, evapotranspiration, vadose zone water redistribution, groundwater flow, and seepage to open free-water bodies. Accurate simulation of the various processes based on the fundamental principles is essential in whatever simplifications and assumptions are made in a model.

The goal of the study is to develop a model that simulates the interactions of hydrologic processes of water movement, storage, and harvesting in stormwater management systems of a watershed. A model is developed that simulates the integration of the physical processes of water movement in a pond, the atmosphere, soil surface, and subsurface within the unsaturated and saturated zones in order to quantify discharge and harvesting water volume from a watershed pond. The SHARP model is based on the analysis of stormwater harvesting with the option for groundwater input to and from a harvesting pond based on the principles of mass balance on pond storage and groundwater movement in a catchment area.

SHARP model is deterministic but variable in time. It is a mass balance model designed to simulate the impact of harvesting pond water in regions where there is a possibility of sub surface inflow to and outflow from the pond while predicting the discharge and harvesting volume for any time period of interest. The model uses equations for the hydrologic and hydraulic processes of stormwater in a watershed, both in surface and subsurface phases (Skaggs and Khaleel 1982; Smajstral 1990; Allen et al. 1998; Shuttleworth 2007; Tadav et al. 2009). The SHARP model is programmed to accept watershed data generally available in most watershed management and local authorities. The model is structured to reduce the number of calibrated parameters by the use of readily available measurable physical parameters and, when appropriate, empirical data. The development of the SHARP model is governed by mathematical deterministic relationships as conceptual components.

Development of Model Components

The water dynamics in a catchment at the surface-subsurface interface and pond water-groundwater interface modeling are critical in providing predictive tool for effectively evaluating the management needs of harvesting available pond water and control the discharge from pond. Determination of the saturated contributing surfaces and their evolution in time and space, and the relative contributions of the surface and subsurface to stream flow and pond are important issues in stormwater harvesting in a catchment area hydrology. Richard's equation is used to describe the water dynamics in the three physical domains of the land surface, vadose zone, and saturated zone with domain dependent parameters. Adopted in the development of the model components are contributive effects of the three physical domains to the pond, which flow is dominated by harvesting and discharge characteristics.

Model Basic Concepts

Richard's equation was solved in lumped form for the different model components. The model components are developed to describe the hydrologic processes inherent in the movement of water on the surface and in the subsurface. The basic governing processes for the surface and subsurface movement are expressed in the combination of continuity and water budget equations for the pond storage (S_P), soil moisture storage (S_M), and groundwater recharge (S_{GW}).

Hydrologic Model

The hydrologic process involves interrelated sub-components of physical processes such as rainfall, irrigation, infiltration, surface runoff, subsurface water redistribution, and groundwater flow. Basically, the change in storage within the hydrologic components for surface, soil moisture, and saturated groundwater flows are expressed in Equations (1) through (3)

$$\Delta S_P = R + RO - H_{AR} - E - D \pm Q_{GW} \quad (1)$$

$$\Delta S_M = R + I_{IRR} - RO - AET - DP \quad (2)$$

$$\Delta S_{GW} = DP - Q_{GW} \quad (3)$$

where ΔS_P = change in surface storage; ΔS_M = change in soil moisture; ΔS_{GW} = change in groundwater storage; AET = actual evapotranspiration; R = rainfall; RO = runoff; H_{AR} = harvesting volume; E = free surface evaporation; D = pond discharge; I_{IRR} = irrigation volume; DP = deep percolation; and Q_{gw} = groundwater seepage. SHARP model loops the hydrologic processes of a detention pond to the adjacent land surface and subsurface dependent of the climatic conditions in the watershed.

Model Operation

SHARP model, driven by precipitation, simulates the flow interactions of land surface and subsurface vadose zones, and the free-water surface and saturated zones. SHARP is an urban hydrology model with an hourly time step which integrates variety of soil characteristics, soil cover, surface slopes, rainfall and irrigation rates, fluctuations in groundwater levels, and water gradient. The relevance of the model is limited by the size of the watershed, as it is developed for pond catchment in a watershed. The model is a periodic loop of sequential computational processes of all the components in the hydrologic cycle. Preceding the loop are input parameters, boundary and initialization conditions followed by the model interactions to produce simulated monthly or yearly hydrologic values and graphic outputs.

SHARP model is developed using Microsoft Window-Excel interface to facilitate data entry, parameterization, characterization, and generation of numerical and graphical outputs. The model is composed of five modules, namely: LAND, ET, INFIL, SEEP, and POND. Brief descriptions of the five modules and were necessary basic equations are presented in the following sections. Figure 1 presents the basic flow chart for SHARP model.

LAND Module

LAND module is the input unit that allows the user to specify watershed parameters, land uses and management, soil properties, and seasonal variations on weather data. The location inputs are geographic data such as the longitude, latitude, and elevation for the watershed location and pond catchment area. This allows for the definition of appropriate boundary for accurate simulation of water movement in the system. Meteorological parameters are essentially measured data or estimated from relevant formulations available in literatures and sourced from the National Weather Services (NWS) or local agencies. In addition, topographic description of the study area is relevant for selecting the hydrologic soil group that helps in identifying the soil types and defines the land use, percent imperviousness, urbanization level, slope, and vegetative cover and type. Finally, the control parameters are basically system management controls to regulate the irrigation process frequency, volume, turfgrass water needs; required harvest volume; and pond storage capacity, Table 1. Other regulations may have to be incorporated into the model simulation.

ET Module

The ET module simulates the reference and crop evapotranspiration process by energy balance and turf grass needs for computing the actual evapotranspiration (AET) based on the FAO equation (Allen et al. 1998). Vegetation parameters for turfgrass in Florida are obtained from literature (Morton 1990), and Argentine Bahia was the dominant turfgrass in catchment area. The ET module model the irrigation needs of turfgrass, schedule the irrigation quantity and timing from the antecedent soil-moisture content and evapotranspiration.

INFIL Module

INFIL module simulates the processes of infiltration, surface runoff, and soil water storage. SHARP model uses the Green and Ampt model for the infiltration computation (Skaggs and Khaleel 1982) as expressed in Equation 4

$$F = \begin{cases} R & \text{for } i \le k_s \\ \dfrac{\psi \cdot M}{(i.k_s)-1} & \text{for } i > k_s \end{cases} \quad (4)$$

where F = cumulative infiltration; ψ = suction at wetting front; M = soil water deficit; k_s = saturated hydraulic conductivity; and i = rainfall intensity. estimation of the surface runoff is by a water budget equation or the soil conservation service (SCS) curve number (Cronshey et al. 1986). Using the water budget model, permeable and impermeable surface runoffs are computed by Equations 5 and 6, respectively. Initial abstraction (I_a) is taken as 2.54 mm (0.1 inch) (Harper and Baker 2007).

$$RO = R + I_{IRR} - E - F \quad (5)$$

$$RO = R - I_a \quad (6)$$

SEEP Module

The SEEP module simulates the process of water movement in the soil subsurface by water redistribution, deep percolation, and groundwater seepage. Infiltrated water is redistributed downward by soil matric and gravity potentials and upwards into the atmosphere by evapotranspiration in the soil subsurface. Estimation of the redistributed water is based on the rectangular profile (Tindall and Kunkel 1999). Soil-water above the field capacity in the root zone drains to the groundwater as deep percolation and is governed by the soil characteristics. Flow is assumed as one-dimension, so lateral flow in the vadose zone is ignored. Estimation for deep percolation is based on both steady and unsteady state flow processes in the soil during and after precipitation, respectively (Bethune et al. 2008). The steady-state flow is expressed in Equation (7) as

$$DP_{SS} = f \cdot t_d \tag{7}$$

where f = infiltration rate t_d is the duration of the precipitation and DP_{SS} = deep percolation in steady state. Deep percolation from on steady-state flow is gravity driven and is calculated when the soil moisture content is equal or greater than the moisture content at field capacity of the root zone or unsaturated layer. The unsteady-state flow in the unsaturated zone is the Darcian velocity (flux rate) based on the rectangular soil-moisture redistribution profile with the assumption that the initial soil-water content corresponds to the residual soil-water content (θ_r) or effective antecedent saturation (S_{ei}) (Tindall and Kunkel 1999), expressed in Equation (8).

$$q = \frac{k_s}{(S_{ei})^{-n} + \frac{n k_s t}{F}} \tag{8}$$

where q = flux rate; S_{ei} = initial soil saturation; and n = exponent related to the pore-size distribution index λ, (3 + 2/λ), for different soil characteristics and are available in literature (Brooks and Corey 1966). Deep percolation is computed as the combination of both steady-state and unsteady-state flow processes expressed in Equation (9) for the pervious area only.

$$DP = DP_{SS} + q \tag{9}$$

Soil moisture in the unsaturated zone is influenced by moisture losses from actual evapotranspiration within the root zone and deep percolation. The soil moisture content is estimated based on the mass balance of flow in the unsaturated zone for each layer of soil as expressed by Equation (10).

$$\theta_i = \frac{S_{M,i-1} + R + I_{IRR} - RO - AET - DP}{T} \qquad (10)$$

where T = unsaturated soil layer thickness. The estimated soil moisture content is substituted into Equations (11) and (12) for the corresponding negative pressure head, $h(\theta)$ and unsaturated hydraulic conductivity, $K(\theta)$ (Brooks and Corey 1966; Rawls et al. 1982).

$$h(\theta_i) = \frac{h_{cb}}{\left(\frac{\theta_i - \theta_r}{\theta_s - \theta_r}\right)^{1/\lambda}} \qquad (11)$$

$$K(\theta_i) = K_s\left(\frac{\theta_i - \theta_r}{\theta_s - \theta_r}\right)^{n} \qquad (12)$$

where h_{cb} = bubbling pressure head; θ_i = soil moisture content; θ_r = residual soil moisture content; and θ_s = saturated soil moisture content. The estimated hydraulic conductivity as a function of soil moisture and is used to compute the groundwater recharge based on the deep percolation formulation.

Groundwater seepage equation is based on Darcy's law for porous media flows and it is a function of the water gradient and soil characteristics. In this study, seepage is related to bank flow condition resulting in the rise and fall of stream stages (Glover 1963). The rise and fall of the pond stage over time describes the flow to and return from the pond based on the relative water level difference between the groundwater and pond water, and reservoir storage. The flow

q_o out of the banks at distance, $x = 0$ at any time t per foot of bank length, and Equation (13) is expressed in volumetric flow units (L^3/T) per length of the reservoir bank.

$$q_{x=o} = \frac{HkD}{\sqrt{\pi \alpha t}} \qquad (13)$$

where H = initial drainage depth; kD = transmissibility of an aquifer; t = time; and α = diffusivity.

POND Module

POND module simulates the pond storage using outputs from ET, INFIL, and SEEP modules, and rainfall data. Pond storage volume computation is based on Equation 1, which accounts for the initial volume, rainfall on the pond and seepage from groundwater into the pond as inputs; and pumped irrigation volume, discharge volume, evaporation, and seepage to the surrounding soil as output. This is computed for hourly time step to provide a real time simulation of water available for irrigation. Pond storage volume is controlled by the setup of minimum and maximum storage volumes. At the minimum storage volume mark, the release of water for irrigation is stopped and at the maximum storage volume mark discharge of pond water commences.

Input and Output

SHARP model is a continuous simulation model designed to perform simulation in response to the periodic needs for stormwater management. Outputs from the model consist of periodic plots of rainfall and irrigation characterization, pond storage volume, harvesting storage volume, pond discharge volume, soil water volume, and groundwater volume. Basic data inputs in the model are used to develop periodic water storage in the pond, vadose (unsaturated) zone, and saturated zone to predict pond water harvesting volume availability and needs, total discharge volume, and percentage of surface runoff discharged. The movement of water in the watershed is synthesized from the model and inputted automatically within the model for specified hourly time step. The watershed characteristics and initial soil properties are used to set the initial boundary conditions of the model, shown in Table 1.

Model Parameters

SHARP model consists of specific watershed parameters that provide the mechanism to adjust the simulation for the given catchment area topographic, hydrologic, soil, and landscape and management conditions. It is designed to be used in a wide range of pond catchment areas, which must be evaluated for every model application. Some of these parameters could be evaluated from known watershed characteristics, while others that could not be precisely determined would be evaluated through calibration with existing data or laboratory analyses. These are categorized as system, meteorological, and control parameters described in the LAND module. The following parameters are defined by calibration, experimentation, or published data of hydraulic conductivity, porosity and void ratio, initial water content, residual water content, saturation water content, and the initial depth of groundwater table. Constants and exponential parameters are used to aid calculation of other model parameters through the simulation process. Data for the pond's sediment, permanent pool, harvesting volume, and overflow volumes are management decisions provided by City of Miramar and adapted to simulate the pond storage. Additional details to further explain the development of the SHARP model are found in the dissertation of the primary author (Gogo-Abite unpublished doctoral dissertation).

SHARP Model Application

The model is applied to a catchment area to verify its functionality, performance, and reliability. A simulation for SHARP model calibration and validation was performed on pond water level for year 2009 and 2008, respectively. The pond is located at the North West corner of the Miramar Parkway and Interstate 75 Expressway (25.98° N, 80.36° W and 2.12 m (7 feet) elevation) in the City of Miramar, Broward County, Florida. The catchment area is an industrial and commercial zone of approximately 80 hectare (197 acre), and has a directly connected impervious area (DCIA) of 38 hectare (94 acre) and an irrigable area of 25.5 hectare (63 acre) as shown in Figure S2. The stormwater pond surface area is 16 hectare (40 acre) and is at elevation 2.12 m (7.0 feet) and an average pond bottom elevation at -2.12 m (-7.0 feet). The general soil profile is a top layer of silty sand with rock fragments to sand from the ground surface to 1.2 m (4 feet) depth and limestone below the top layer (Ardaman & Associates 2007) .

In this study, the rainfall and meteorological data for year 2008 and 2009 were obtained for the weather station at North Perry Airport (KHWO), Hollywood, Florida (26.00° N, 80.24° W) having a 2.44 m (8 feet) surveyed elevation, which is about 11.23 km (7 miles) East of the experimental site in Miramar. The weather station records rainfall, temperature, relative humidity, wind speed and direction, atmospheric pressure, sky cover for radiation analysis; and the historical data were obtained from Weather Underground website (Wunderground 2010). Data from this site was used as inputs in both ET and INFIL modules of the SHARP model.

The City of Miramar provided the pond water elevations for years 2008 and 2009 (January through December each year) The start and end elevations for year 2008 are 0.78 m and

0.82 m (2.55 and 2.70 feet), and for year 2009 are 0.82 m and 0.88 m (2.70 and 2.89 feet), respectively, at 10 minutes interval. However, SHARP model used hourly time step hourly (Δt = 1 hr.) for simulation of pond water elevation. Model calibration period was from January 1, 2009 at 00:00 hours to December 31, 2009 at 23:59 hours. The validation period was from January 1, 2008 at 00:00 hours to December 31, 2008 23:59 hours. The pond water elevation was the control parameter for the calibration of SHARP model at the pilot site. Presented in Table 2 are the initial hydraulic properties for the pilot study.

In addition, the City of Miramar provided the management information for the pilot site. Harvesting volume is set at 113.6 m^3 per day (30000 gallons per day) for six days of the week in the year, except in the winter months (December through March) when only half of this volume is harvested. No harvesting is done when the catchment area receives rainfall above 12.7 mm (0.5 in.). The pond discharge mechanism is a pump set at a rate of 37,854 m^3 per day (10 million gallons per day) at a discharge elevation of 0.97 m (3.2 feet). However, the City reported that the discharge rate and discharged level were varied through the year and do not have records of these variable rates and levels.

Results and Discussion

Groundwater models are qualitatively analyzed for overall performance using efficiency criteria for error measurements, calibrations and validation of the model. Commonly used goodness-of-fit tests for hydrologic model performance and reported in literature are, but not limited to, root mean square error (*RMSE*), mean absolute error (*MAE*), coefficient of determination (R^2), scatter plot of observed versus simulated variables, time series plot for both observed and simulated variables, Nash-Sutcliffe coefficient (*E*), and the index of agreement (*d*) (Krause et al. 2005; Harmel et al. 2010). However, none of these criteria is singularly sufficient to provide objective assessment of model ability to reproduce observed measurements and simulated behavior. Krause et al. (2005) showed that the different criteria reflects systematic errors for varying conditions of flow volume, and recommended "a combination of different efficiency criteria complemented by the assessment of the absolute or relative volume error." Both *RMSE* and *MAE* measure the average magnitude of error in the dimension of the continuous variable measured, and ranges between zero and infinity (∞) with lower values as better forecasting model. Study show that *MAE* is an unambiguous measure of average error and is the "most natural measure of average error magnitude" (Willmott and Matsuura 2005).

The coefficient of determination, which is the squared ratio of the covariance and the multiplied standard deviations of the observed and predicted values, explains only the extent of dispersion between the observed and predicted to the combined dispersion. R^2 is reported to be insensitive to models which systematically over- or under-predict all the time (Krause et al. 2005) and is insensitive to bias between predicted and observed values (Jaber and Shukla 2004). Instead, the Nash-Sutcliffe efficiency and the index of agreement are used for better evaluation of hydrologic models. According to Krause et al. (2005), both *E* and *d* quantify the difference between observation and prediction by the absolute deviation, thus higher values have greater influence than lower ones, and are not sensitive to systematic over- or under-prediction by model during low flows. A relative deviation modification was applied to counteract problems identified in both *E* and *d* as shown in the Equations 14 and 15, respectively (Krause et al. 2005).

$$E_{rel} = 1 - \frac{\sum_{i=1}^{n} \left(\frac{O_i - P_i}{O_i} \right)^2}{\sum_{i=1}^{n} \left(\frac{O_i - P_i}{\bar{O}} \right)^2} \quad (14)$$

$$d_{rel} = 1 - \frac{\sum_{i=1}^{n} \left(\frac{O_i - P_i}{O_i} \right)^2}{\sum_{i=1}^{n} \left(\frac{\left| P_i - \bar{O} \right| + \left| O_i - \bar{O} \right|}{\bar{O}} \right)^2} \quad (15)$$

where O_i = i^{th} term of the observed value; P_i = i^{th} term of the predicted value; n = total number of observations; and $\bar{O}$ = mean of the observed values. Using the relative deviations significantly reduces the influence of absolute deviations during high flow regimes, and is more sensitive on systematic model over- or under-prediction during low flow regimes.

Parameters calibrated for SHARP model in this study were saturated hydraulic conductivities, pore size distribution, turfgrass growth parameters, soil field capacity, discharge pumping rate, infiltration capacity, and surface storage. Values for some these parameters are shown in Tables 1 and 2. Both discharge pumping rate and discharge level were calibrated because the operational rate and discharge level varied at every use as opposed to the use of a fixed rate through the calibration period in this study. The discharged was manually operated and the actual values were not available.

SHARP model evaluation was conducted by pairwise comparison of observed measurement and simulated output of pond water level for both the calibration and validation periods, and with graphical comparisons. In this study, both *RMSE* and *MAE* were used for average error measurements and the relative forms index of agreement (d_{rel}) for efficiency criteria of SHARP performance. The index of agreement is dimensionless term that measures degree of error free in model predictions and ranges between zero (no correlation) and 1.0 (perfect fit) between measured and simulated pond water level. Results of these four measures and the means and variances of the observed measurements and simulated values of the pond water level for both the calibration and validation periods are presented in Table 3.

Calibration Period Simulation Results

The break in the observed pond water elevation in Figure 2 is due to missing data for the period (06/20/2009 to 08/14/2009), no readings were recorded because of equipment malfunction. In Table 3, the model showed good prediction of the pond water elevations with efficiency criteria of 0.07 m (*RMSE*), 0.06 m (*MAE*) and 0.89 (d_{rel}) during the dry months and 0.09 m (*RMSE*), 0.07 m (*MAE*) and 0.74 (d_{rel}) in the wet months. Index of agreement of 0.74 and 0.89 are very good values for error-free model predictions evaluation. The overall calibration period model simulation has d_{rel} = 0.92, *RMSE* = 0.08 m., and *MAE* = 0.0.06 m. The difference in the elevations is explained by the lack of accurate discharge pumping rate and elevation. SHARP model imposed fixed discharge rate and elevation through the calibration period. Thus, the model may over- or under-estimate the volume of discharge from the pond, especially during high inflow volumes. In addition, there is the issue of backflow from adjacent ponds to equalize the pond elevations, which were not simulated due to lack of adequate data.

Scatter-graph plotted for the pond water elevation between the observed values and predicted data for the calibration period is presented in Figure 3. The plot showed the R^2 = 0.74 and the linear regression line equation with a gradient, b = 1.03. Value of 1.0 for R^2 means dispersion in prediction is equal to observation, and gradient b = 1.0 and intercept, a = 0 signifies perfect agreement. For proper model assessment, Krause et al. (2005) recommended that the R^2 should be weighted with the gradient (b) by the expressions in Equations 16 for an all-inclusive evaluation of model results.

$$wR^2 = \begin{cases} |b| \cdot R^2 & \text{for } b \le 1 \\ |b|^{-1} \cdot R^2 & \text{for } b > 1 \end{cases} \qquad (16)$$

The weighted coefficient of determination (wR^2) becomes 0.76 that is the model had a 24 percent under-prediction of the measured data for the calibration period. In addition to the reasons given for the model prediction accuracy, the differences between the measured and predicted may be due to averaging the initial parameters for the catchment area, soil properties, land covers and slopes, and rainfall and meteorological data obtained from the nearest weather station, about 11 km (7 miles) east of the catchment location.

Validation Period Simulation Results

After the calibration of SHARP model, evaluation to validate the model was conducted using parameters from the calibration period of January through December, 2009 to set the discharge pumping rate, discharge elevation, irrigation scheduling, and land cover. Breaks in the observed pond water elevation are also noticeable for the validation period in Figure 4 from 08/20/2008 to 09/05/2008 due to the effect of tropical storm Fay in August 2008. The validation period showed that the model closely predicted the pond water elevations, especially during the dry months of January through May and November to December with efficiency criteria of $RMSE$ = 0.02 m, MAE = 0.018 m, and d_{rel} = 0.98. The simulated pond water elevation during the wet season (June through October) dropped in elevation but followed the same trend. The efficiency criteria for the wet months (Table 3) were 0.12 m (*RMSE*), 0.1 m (*MAE*) and 0.85 (d_{rel}) which shows that the simulated values acceptably matched the observed data for the wet period of the validation year. Again, the reasons for the under-prediction during the wet months are explained in the lack of data on the varied discharge pumping rate and elevations for the pond. For the whole validation period, the efficiency criteria are $RMSE$ = 0.07 m, MAE = 0.05 m, and d_{rel} = 0.91.

In addition to the goodness-of-fit indicators are scatter-graphs of observed measurement and predicted values of the pond water elevation for the validation periods shown in Figure 5. The plot showed the R^2 = 0.72 and the linear regression line equation with gradient, b = 1.04. The weighted coefficient of determination (wR^2) becomes 0.69 that is the model had a 31 percent under-prediction of the measured data in the calibration period. The realization that R^2 is less in the validation period than the calibration period when all other efficiency criteria showed better goodness-of-fit goes to reveal the problem of using R^2 alone for model prediction accuracy. For the seasonal scatter-graphs (Figures 6 and 7), R^2 = 0.92 and 0.78, and wR^2 = 0.92 and 0.70 for the dry and wet months of the validation period, respectively, which are in agreement with the other efficiency criteria for the same period. The weighted coefficient of determination for the wet months significantly affected the entire validation period.

SHARP Output Results

The SHARP model has the additional capability to display graphically the effect of stormwater harvesting to the groundwater drawdown, pond discharge volume, and stormwater runoff contribution to harvesting. In Figure 8 is presented a plot of the percentage of runoff discharged against increase in the weekly harvest volume for each simulation period of one year.

The trend reveals an exponential decrease in percentage of runoff volume discharged with an intercept value equivalent to no harvesting. This explains that the discharge from the harvesting pond is about 108 percent of the runoff or 8 percent more water than the runoff contribution is discharged for 2009. The source of this excess water could be attributed to groundwater seepage, direct rainfall on the pond, and equalization flow from adjacent ponds. However, for the year 2008, only about 48 percent of the runoff is discharged. Subsequent increase in the weekly harvest volume showed an exponential decline in the percent of runoff discharged, which eventually decreased to zero runoff volume discharged. This gives credence to the fact that stormwater harvesting will reduce the discharge from ponds to adjacent surface water, which in effect achieves reduction in the total maximum daily load (TMDL) by volume. The plots further reveal that harvesting can significantly reduce the quantity of pollutant discharged to receiving bodies by the reduction of the volume of discharge.

However, the increases on the weekly harvest rate generate a drawdown effect on the adjacent groundwater level. At a low rate or no irrigation from the wet detention pond, the percent of groundwater contribution to the pond is about 12 and 6 percent for year 2009 and 2008, respectively, but this increased with increasing weekly harvest rate, as shown in Figure S3. This is due to the control mechanism set in the pond to regulate any undesirable effect on groundwater and the surrounding environment. The control mechanism is a permanent pool level or safe yield level, below which no harvesting is permitted. The harvest safe yield is the volume of water harvested from the pond without unacceptable effects on the groundwater. So, even when the weekly rate is increased at the same regular interval the corresponding change in the annual harvest volume is minimal, thus, groundwater contribution to the pond is regulated.

The percent of groundwater component is obtained from the fraction of groundwater seepage to the total intake of the pond per volume of weekly irrigation rate. The groundwater seepage to the pond increases as the weekly irrigation volume increases, but this is used as harvest volume rather than being discharged, which meets one of the reasons for the establishment of stormwater harvesting pond as a best management practice (BMP). This is expected due to the fact that a drawdown of the pond water level will significantly lead to increased seepage from the effective groundwater within the zone of influence.

The concerns on the effect of harvesting from wet detention pond on groundwater are addressed by the SHARP model in its capability to predict a safe yield to determine an acceptable maximum harvesting rate. In Figure 9 is shown the plot of the cumulative pond inflow (rainfall, runoff, and groundwater) and outflow (discharge, harvest, and evaporation) at weekly average harvesting rate of 0.17 cm/wk. (0.02 in./wk.). In the first five months of simulation (January to May 2009) the pond outflow is higher than inflow due to the low rainfall volume and constant harvesting from the pond. In the wet months of the simulation year, the inflow became higher because of the increase rainfall volume, less evaporation, and more groundwater available for seepage to the pond.

Furthermore, the percentage of groundwater contribution is also a function of the hydraulic properties of the pond boundary soil. High hydraulic conductivity, as in this study 12.7 cm/hr. (5 in./hr.), increases the groundwater seepage, which may eventually lead to total loss of pond water to the ground for the simulated period. In Figure S4 is presented a hypothetical case when the hydraulic conductivity of the pond soil liner is set at approximately 1.3 cm/hr. (0.5 in/hr.). The percent of groundwater contribution to pond water started at low values of 10 and 5 percent and increased to 39 and 36 percent at 5.6 mm/hr. (2.2 in./hr.) average weekly irrigation rate for 2009 and 2008, respectively. The difference between percent of groundwater contribution to pond for both hydraulic conductivities (12.7 and 1.3 cm/hr.) indicate that the hydraulic property of the pond soil liner will affect the seepage volume to the pond. The plots further reveal that harvesting can significantly reduce the quantity of pollutant discharged to receiving bodies by the reduction of the volume of discharge.

The trend observed above is repeated for variable increments of average weekly irrigation to show the relative differences (Figure S5). As the harvest volume is increased the percent difference in pond storage increases negatively, that is, there is a net loss in the water available for harvesting, which also means more groundwater seepage to the pond. In Figure 10 is shown the groundwater elevation around the perimeter of the pond and the safe yield level for the catchment area.

As a check on mass balance consistency on the pond storage volume computation based on the pond surface area, the annual cumulative volumes of the factors in Equation (1) are presented in Table 4, which shows the inflow and outflow from the pond. In the calibration period, net inflow and outflow for the pond is 133.96 mm (5.27 in.), which equals the difference between starting and ending pond water elevations of 2956.56 mm and 3090.42 mm (116.40 in. and 121.67 in.), respectively. Similarly, for the validation period, net inflow and outflow for the pond is 26.92 mm (1.06 in.), which equals the difference between starting and ending pond water elevations of 2910.84 mm and 2938.30 mm (114.60 in. and 115.68 in.), respectively. In addition to the pond water elevation, the model simulates the groundwater level (Figure 10) by the computation of the infiltration (Figure S6), evapotranspiration (Figure S7), runoff (Figure S8), deep percolation (Figure S9), lateral seepage (Figure S10), and total precipitation (Figure S11). These interaction parameters were not validated in this study because of no available data for the pilot site. However, the predictability of the pond water elevation is evident that these parameters would be within statistically acceptable values.

Conclusions

The SHARP model developed for a stormwater harvesting pond uniquely accesses the interaction of surface water and groundwater in a catchment area and reasonably predicts the water movement through deterministic modeling process using basic mass balance principles of a catchment area hydrologic cycle. The model calibration (January through December 2009) performed at the pilot site, on Miramar Lakes, Miramar, Florida water elevation predicts the general trend of the lake level fluctuations and the efficiency criteria showed adequate model prediction capabilities (d_{rel} = 0.92, $RMSE$ = 0.08 m, and MAE = 0.0.06 m). SHARP was validated for January through December 2008 and the results revealed the model adequate performance in predicting the pond water elevations (d_{rel} = 0.91, $RMSE$ = 0.07 m, and MAE = 0.05 m).

The model confirms that harvesting ponds reduce the volume of discharge, and consequently, the pond releases less pollutant load downstream and increases groundwater recharge, as substantial volume of annual stormwater runoff is returned to the watershed. Furthermore, output from the SHARP model provides the user(s) the capability to assess harvest safe-yield and flow between a pond and surrounding land with or without harvesting, and predict the percentage of runoff into a wet detention pond that is not discharged. This is relevant to stormwater management and planning due to the fact that the basic process of stormwater harvesting involves the capture and storage of stormwater runoff in a harvesting pond and gradual use to irrigate adjacent pervious areas or for consumptive use (no return to the pond).

In addition to the pond water elevation, the model simulates the groundwater level by the computation of the infiltration, evapotranspiration, runoff, deep percolation, lateral seepage, and total precipitation. However, these parameters were not calibrated or validated in this study because of no measured data for the pilot site. The calibration and validation of these parameters would promise significant improvement and provide a tool for assessing stormwater harvesting schemes for any catchment area.

Notations

The following symbols are used

a = intercept
AET = actual evapotranspiration volume [L T^{-1}]
b = gradient
D = discharge [L T^{-1}]
d = index of agreement
DP = deep percolation [L T^{-1}]
DP_{SS} = deep percolation [L T^{-1}]
E = free surface water evaporation [L T^{-1}]
E = Nash-Sutcliffe coefficient
F = cumulative infiltration [L]
f = infiltration rate [L T^{-1}]
H = initial drainage depth [L]
$h(\theta)$ = negative pressure head
H_{AR} = harvesting volume [L]
h_{cb} = bubbling pressure head [L]
i = rainfall intensity [L T^{-1}]
I_a = initial abstraction [L]

I_{IRR} = irrigation volume [L]
$K(\theta)$ = unsaturated hydraulic conductivity [L T^{-1}]
KD = transmissivity [L^2 T^{-1}]
k_s = saturated hydraulic conductivity [L T^{-1}]
M = soil water deficit
MAE = mean absolute error
n = exponent related to the pore-size distribution index
$\bar{O}$ = mean of the observed values
O_i = i^{th} term of the observed value
P = precipitation directly on the pond [L]
P_i = i^{th} term of the predicted value
q = flux rate [L T^{-1}]
Q_{gw} = groundwater seepage [L T^{-1}]
q_o = volumetric flow out of the banks at x = 0 at any time t per foot of bank length [L^3 T^{-1}]
R = rainfall [L]
R^2 = coefficient of determination
$RMSE$ = root mean square error
RO = surface runoff [L]
S = pond storage [L^3]
S_{ei} = initial soil saturation
S_{GW} = groundwater storage [L]
S_M = soil moisture storage [L]
S_P = pond storage [L]
t = time [T]
T = unsaturated soil layer thickness [L]
t_d = duration of the precipitation [T]
wR^2 = weighted coefficient of determination
α = diffusivity [L^2 T^{-1}]
θ = moisture content
θ_i, θ_r, θ_s = initial, residual, and saturated soil moisture content
λ = pore-size distribution index
ψ = suction at wetting front

Supplemented Data

Figures S1 – S11 are available online in the ASCE Library (www.ascelibrary.org).

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List of Tables

Table 1 Model control parameters and calibrated values for the study area

Turfgrass Parameters			Management Allowed Depletion (MAD)		
Soil cover	Argentine Bahia		MAD during Initial Stage	70	%
Maximum grass height, H	0.30	m	MAD after Initial Stage	45	%
Mean maximum grass height, h_{crop}	0.08	m	Maximum Irrigation Depth, I_{max}	9.525	mm
Lower Limit of Evaporation, $K_{c\ min}$	0.15		Irrigation duration, t	0.5	hr.
Wetted Soil Fraction, f_w (irrigation)	1		Irrigation Interval, T_i	24	hr.
Evaporation zone depth, Z_e	0.1	m	Irrigation application rate	Variable	
Total Evaporable Water, TEW	191	mm	Time Step, Δt	1.0	hr.
Readily Evaporable Water, REW	5	mm	Harvest Storage Control	Irrigation Only	
Initial Depletion, De	13	mm	Harvesting Period per Day	6:00	hrs.
Minimum Root Depth, $Root_{min}$	0.08	m		18:00	hrs.
Maximum Root Depth, $Root_{max}$	0.30	m	Irrigation Control	Water volume	
Available Water	62.5	mm/m			
Wetted Soil Fraction (Precipitation) Initial f_w	1		Pond Discharge Weir Configuration →	Pump	
Soil Water Depletion Fraction, p	0.5	No stress	Discharge Pumping Rate	37,854	m^3

Table 2 Model initial input and boundary parameters for the soils

Soil Hydraulic Properties			
Description	**Units**	**First Layer**	**Second Layer**
Soil type		Loamy Sand	Limestone
Initial water content, θ_i	cm/cm (in./in.)	0.100	0.100
Residual saturation, θ_r	cm/cm (in./in.)	0.030	0.020
Water content at saturation, θ_s	cm/cm (in./in.)	0.300	0.200
Moisture content at field capacity, θ_{FC}	cm/cm (in./in.)	0.170	0.180
Pore size distribution index, λ		0.553	0.165
Bubbling pressure, h_{cb}	cm (in.)	14.20 (5.59)	1.00 (2.54)
Saturated hydraulic conductivity, k_s	cm/hr. (in./hr.)	6.11 (2.41)	12.70 (5.0)
Layer Depth, d	cm (in.)	124 (48)	425 (168)

Table 3 Statistical performance indicators of the observed and simulated pond water elevation

Efficiency Criteria Symbol				μ[1] (m)	s[2] (m)	C_v[3]	RMSE m (ft.)	MAE m (ft.)	d_{rel}
Yearly Observation	Jan - Dec, 2008 Validation		Observed	0.86	0.12	0.14	0.07 (0.24)	0.05 (0.16)	0.91
			Predicted	0.82	0.10	0.12			
	Jan - Dec, 2009 Calibration		Observed	0.87	0.14	0.17	0.08 (0.26)	0.06 (0.21)	0.92
			Predicted	0.87	0.14	0.17			
Seasonal Observation	2008 Validation period	Dry	Observed	0.81	0.08	0.09	0.021 (0.07)	0.018 (0.06)	0.98
			Predicted	0.81	0.07	0.09			
		Wet	Observed	0.93	0.14	0.15	0.12 (0.38)	0.10 (0.32)	0.85
			Predicted	0.93	0.14	0.15			
	2009 Calibration period	Dry	Observed	0.80	0.10	0.12	0.07 (0.24)	0.06 (0.20)	0.89
			Predicted	0.81	0.13	0.16			
		Wet	Observed	1.03	0.10	0.09	0.09 (0.30)	0.07 (0.24)	0.74
			Predicted	1.00	0.07	0.07			

[1] Sample mean
[2] Sample standard deviation
[3] Coefficient of variations

Table 4 Pond inflow and outflow parameter depths over the pond area for the simulated periods

Year	Parameter	Input, mm (in.)	Output, mm (in.)
2008 (Validation period)	Rainfall (*R*)	1119.63 (44.08)	-
	Runoff (*RO*)	1250.95 (49.25)	-
	Harvest (*H*)	-	24.24 (0.95)
	Evaporation (*E*)	-	1897.54 (74.71)
	Discharge (*D*)	-	548.08 (21.58)
	Seepage (*Q*)	341.47 (13.44)	210.44 (8.28)
2009 (Calibration period)	Rainfall (*R*)	1611.88 (63.46)	-
	Runoff (*RO*)	1880.70 (74.04)	-
	Harvest (*H*)	-	22.96 (0.9)
	Evaporation (*E*)	-	1779.27 (70.05)
	Discharge (*D*)	-	1995.03 (78.54)
	Seepage (*Q*)	601.8 (23.69)	163.17 (6.42)

List of Figure Captions

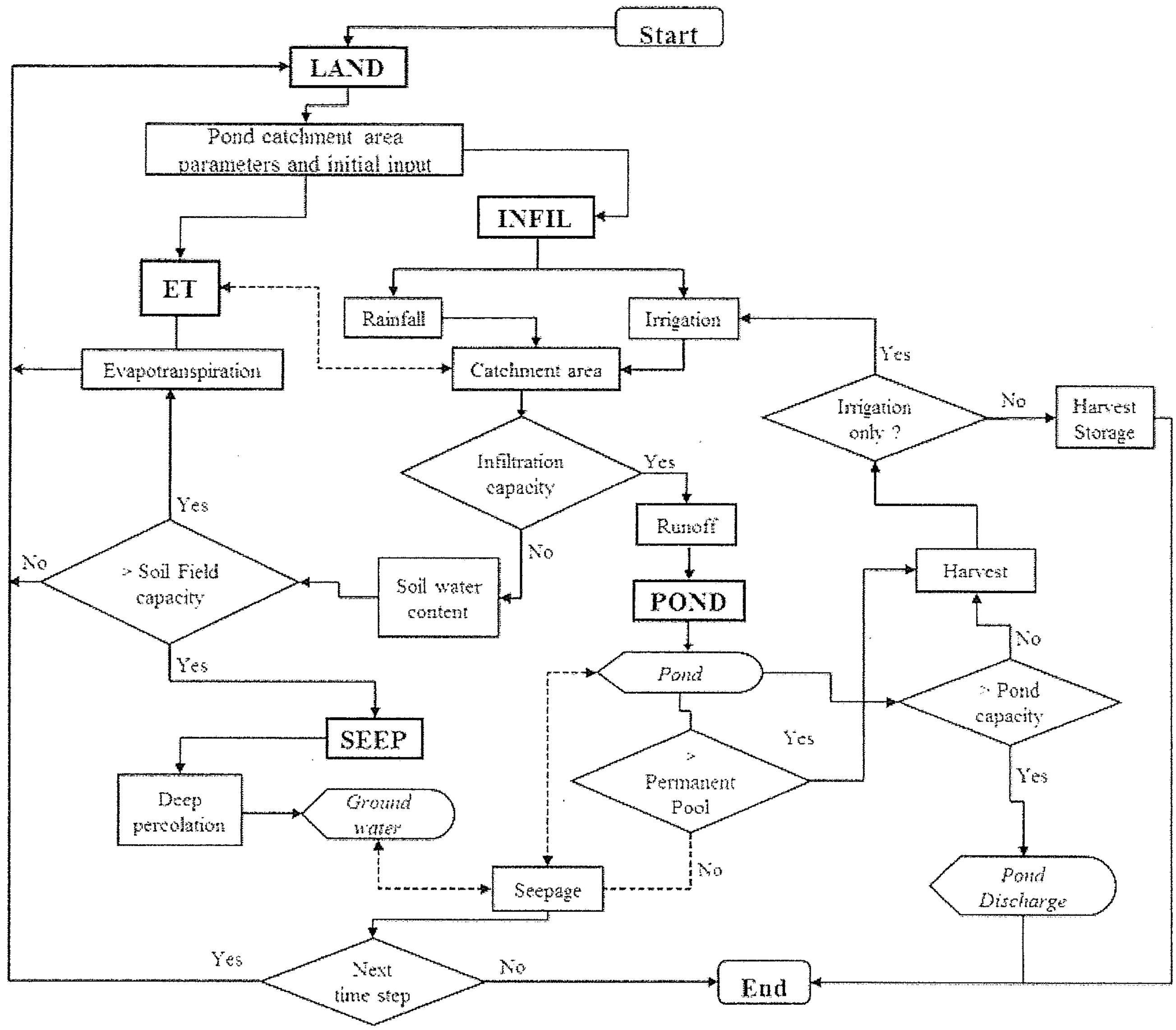


Figure 1 SHARP model basic flow chart

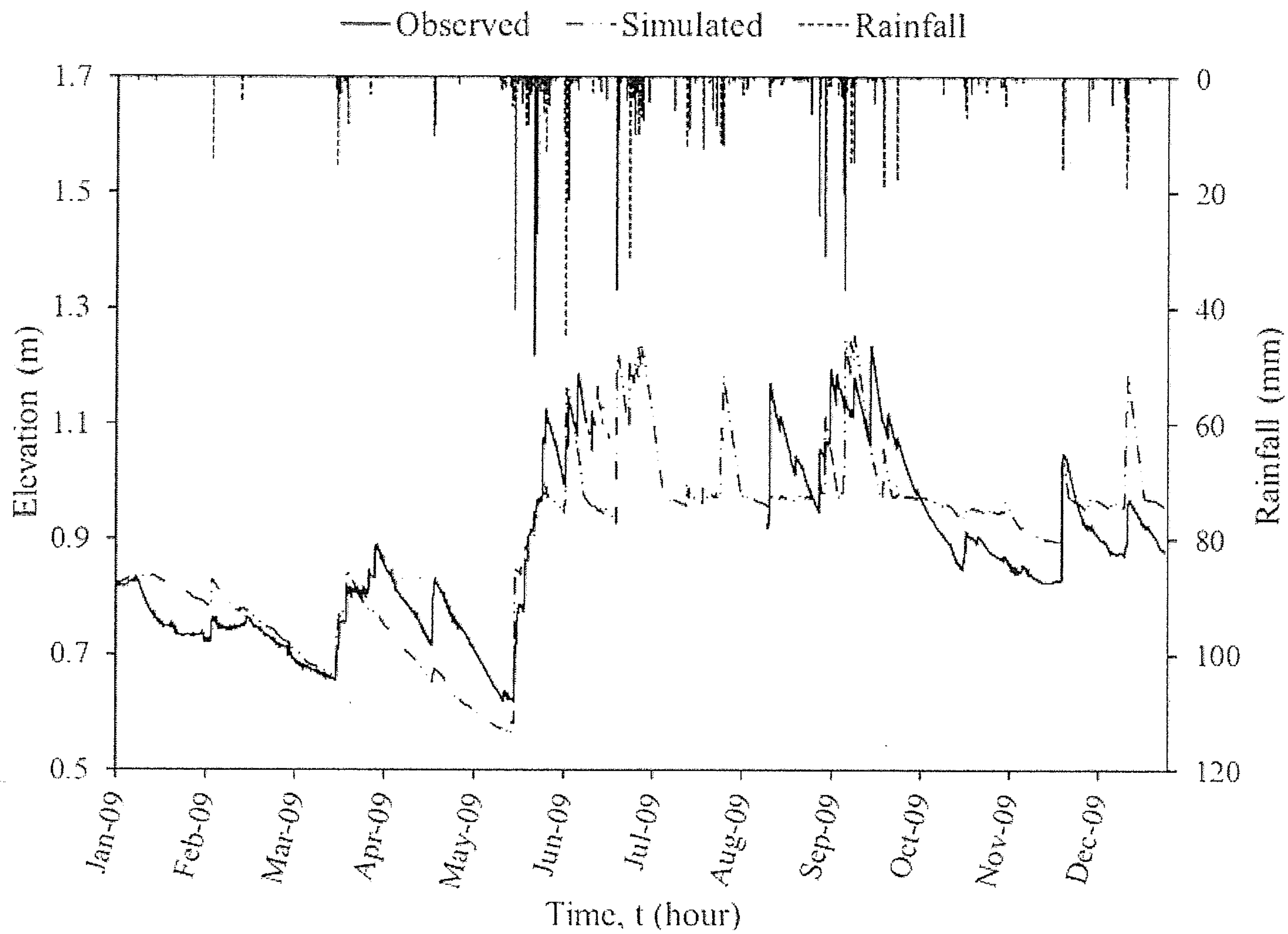


Figure 2 Observed and predicted pond water elevation for calibration period of January through December 2009

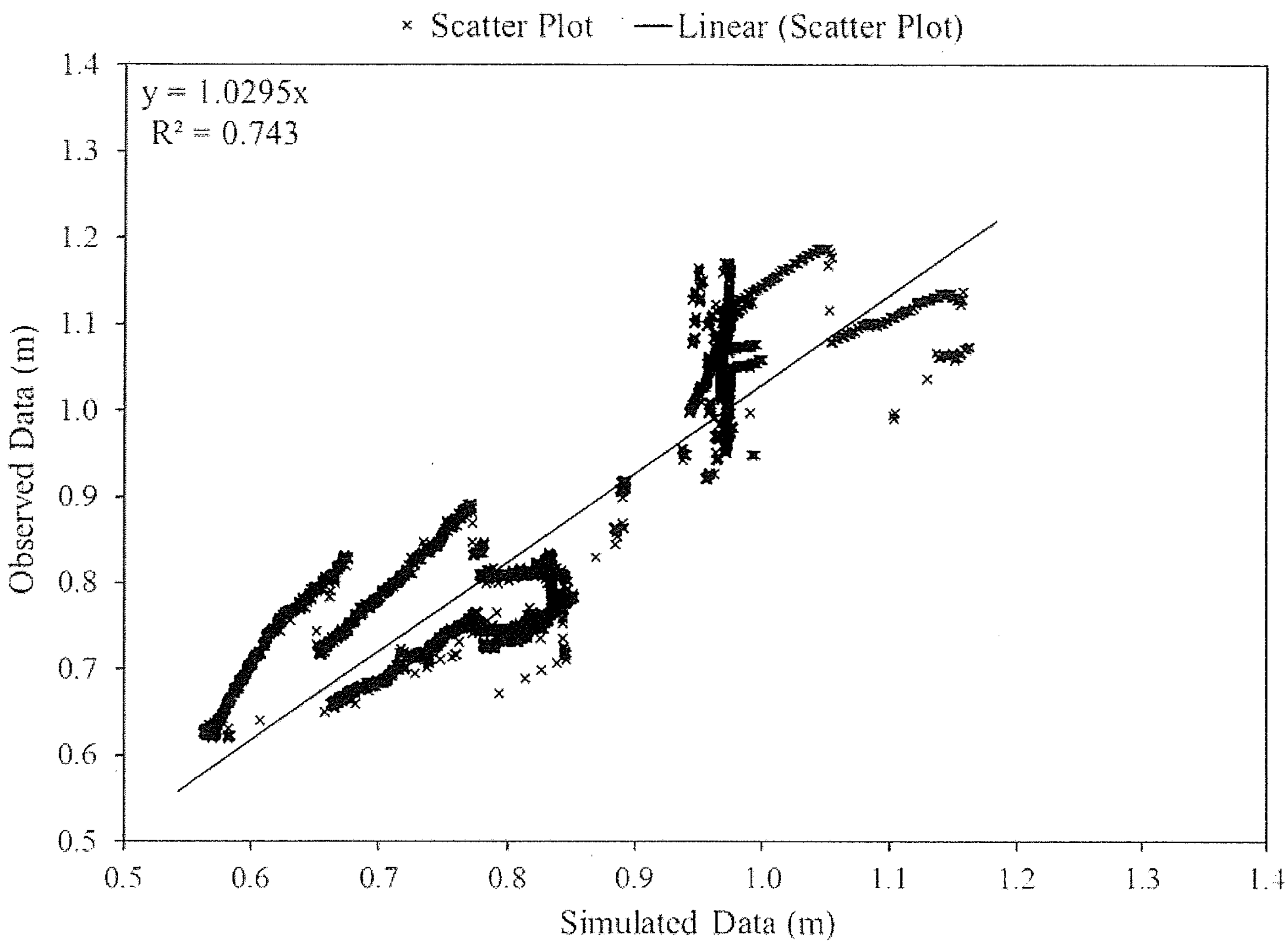


Figure 3 Scatter plot of observed versus simulated pond water level from January through December, 2009

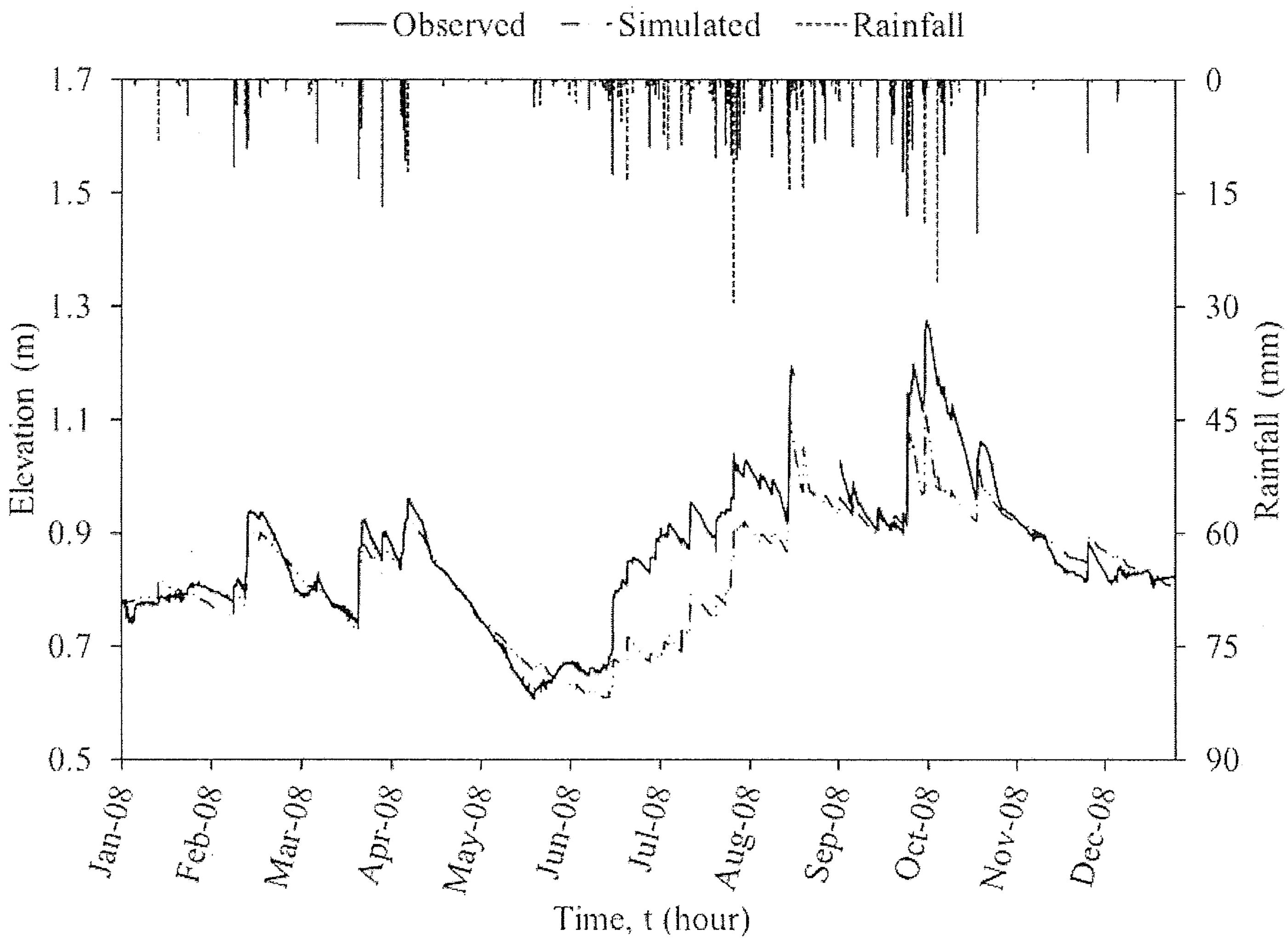


Figure 4 Observed and predicted pond water elevation for the validation period of January through December 2008

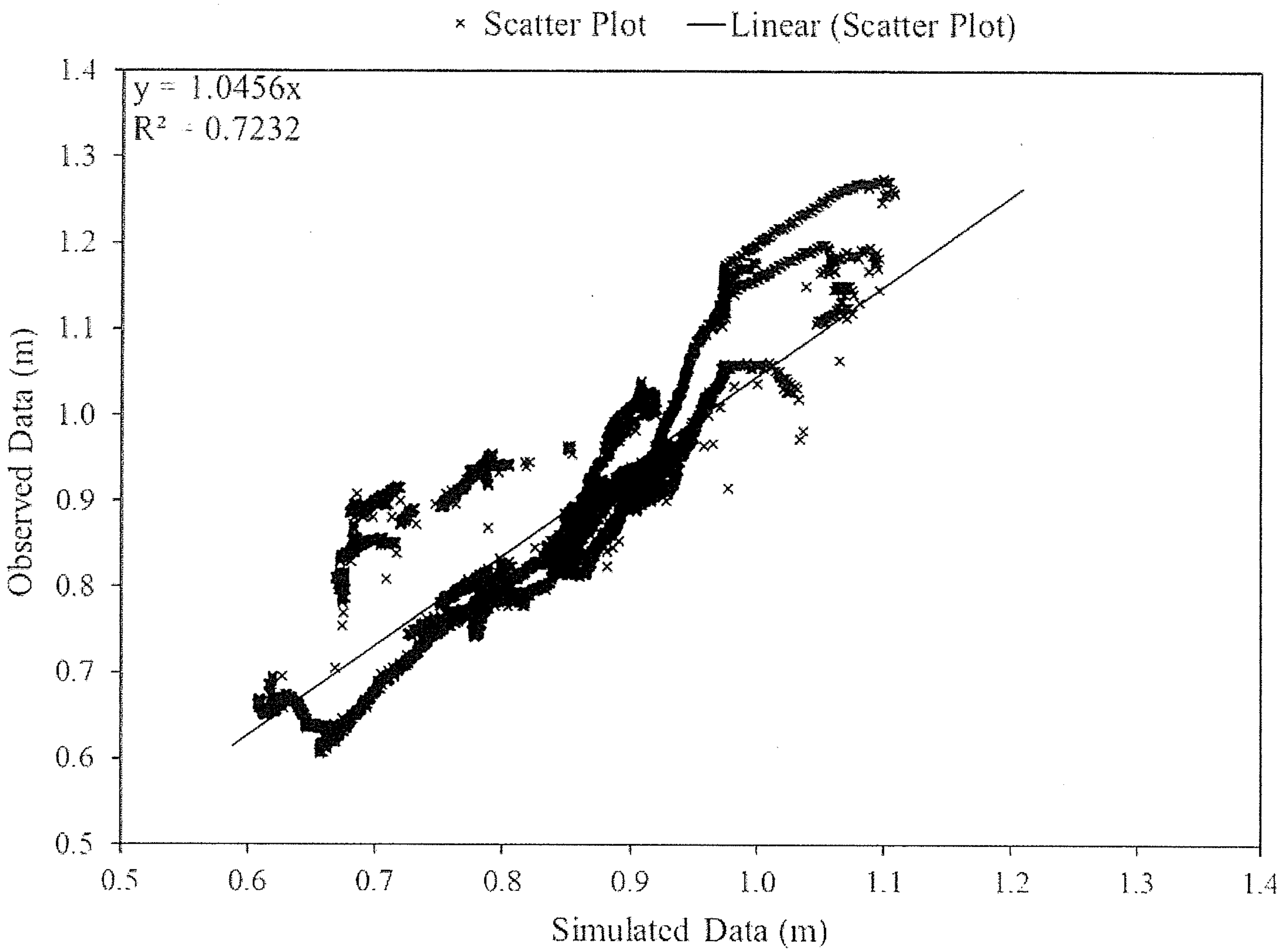


Figure 5 Scatter plot of observed versus simulated pond water level from January through December, 2008

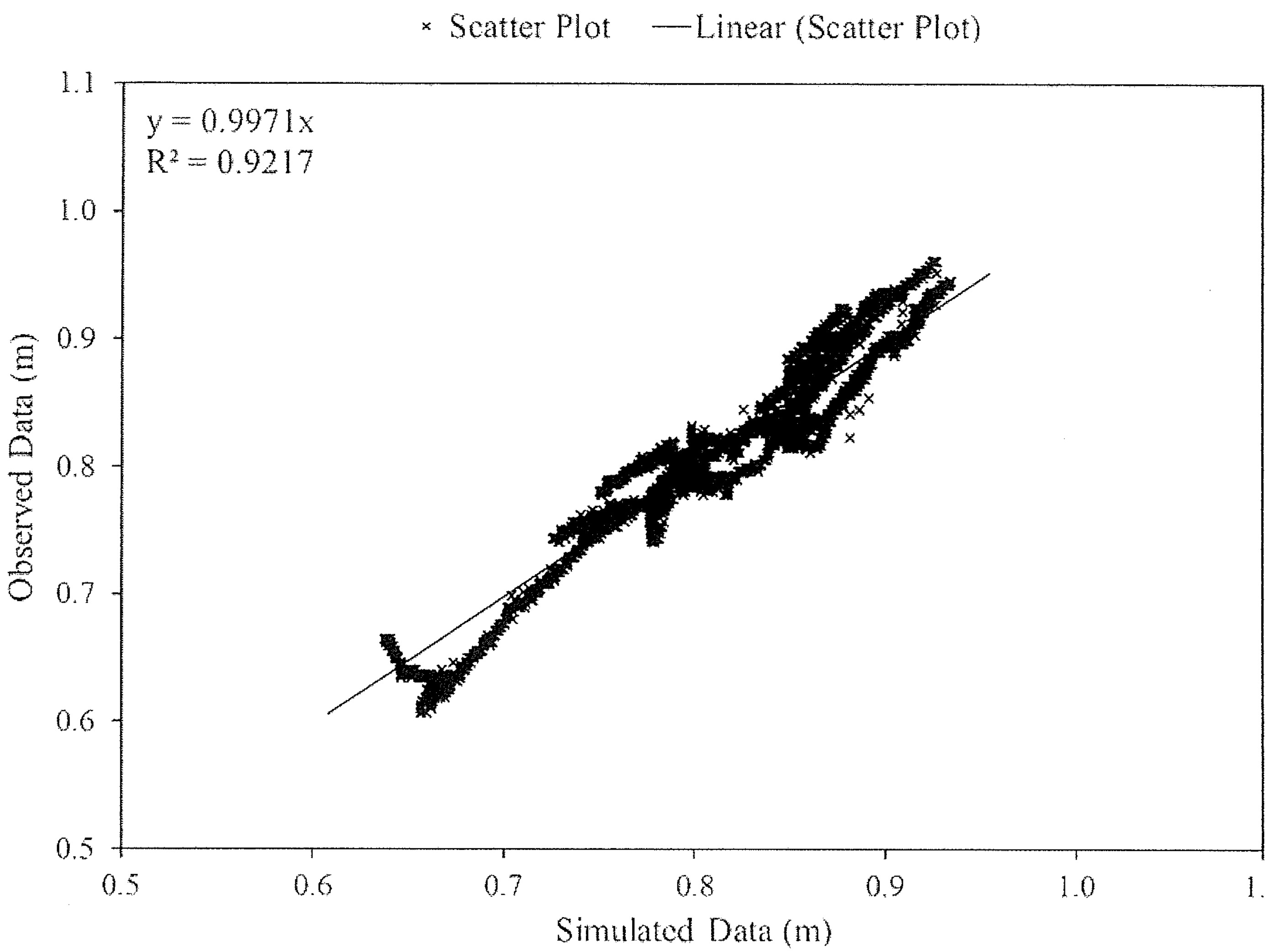


Figure 6 Scatter plot of observed versus simulated pond water level dry months in 2008

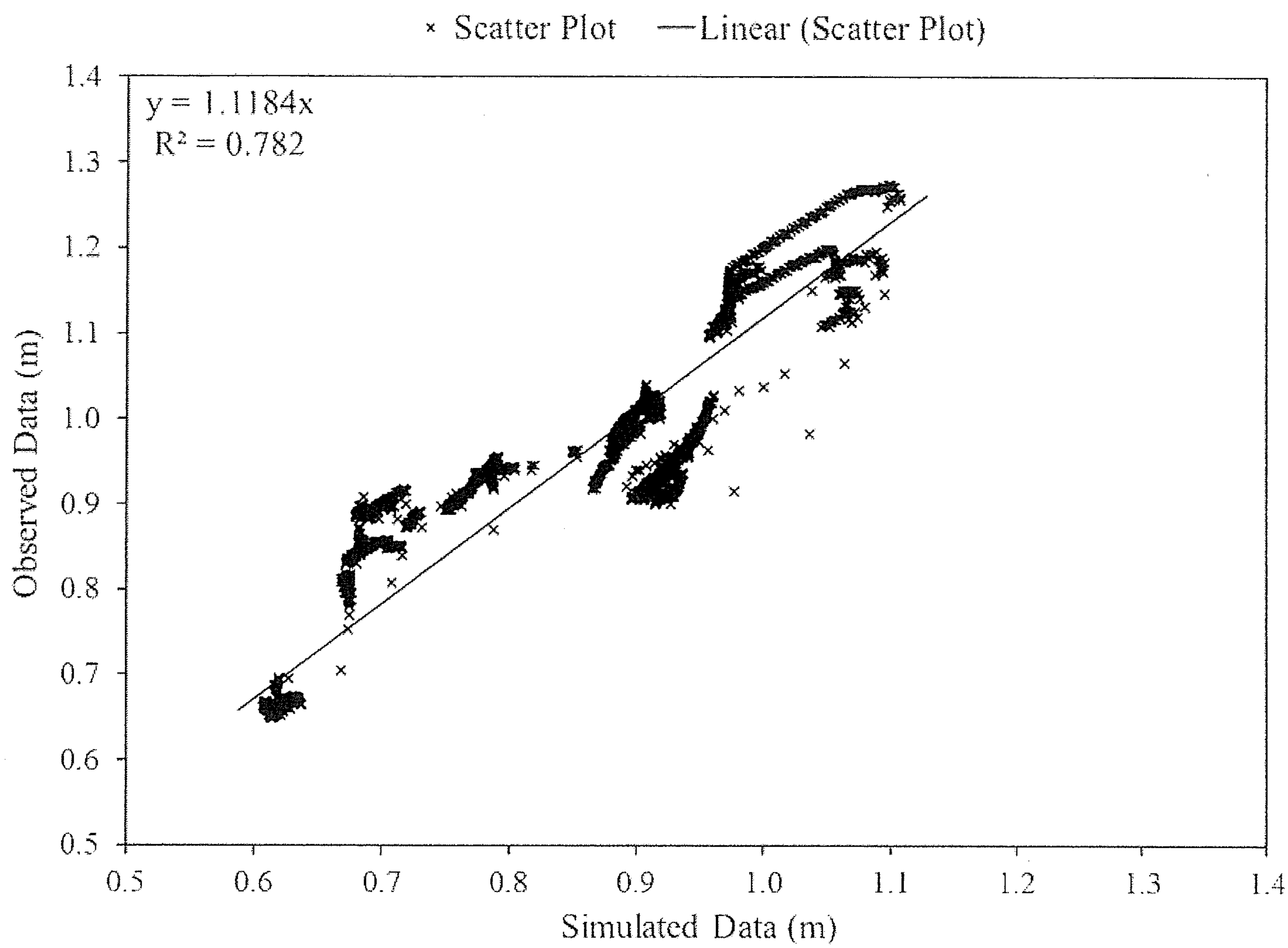


Figure 7 Scatter plot of observed versus simulated pond water level dry months in 2008

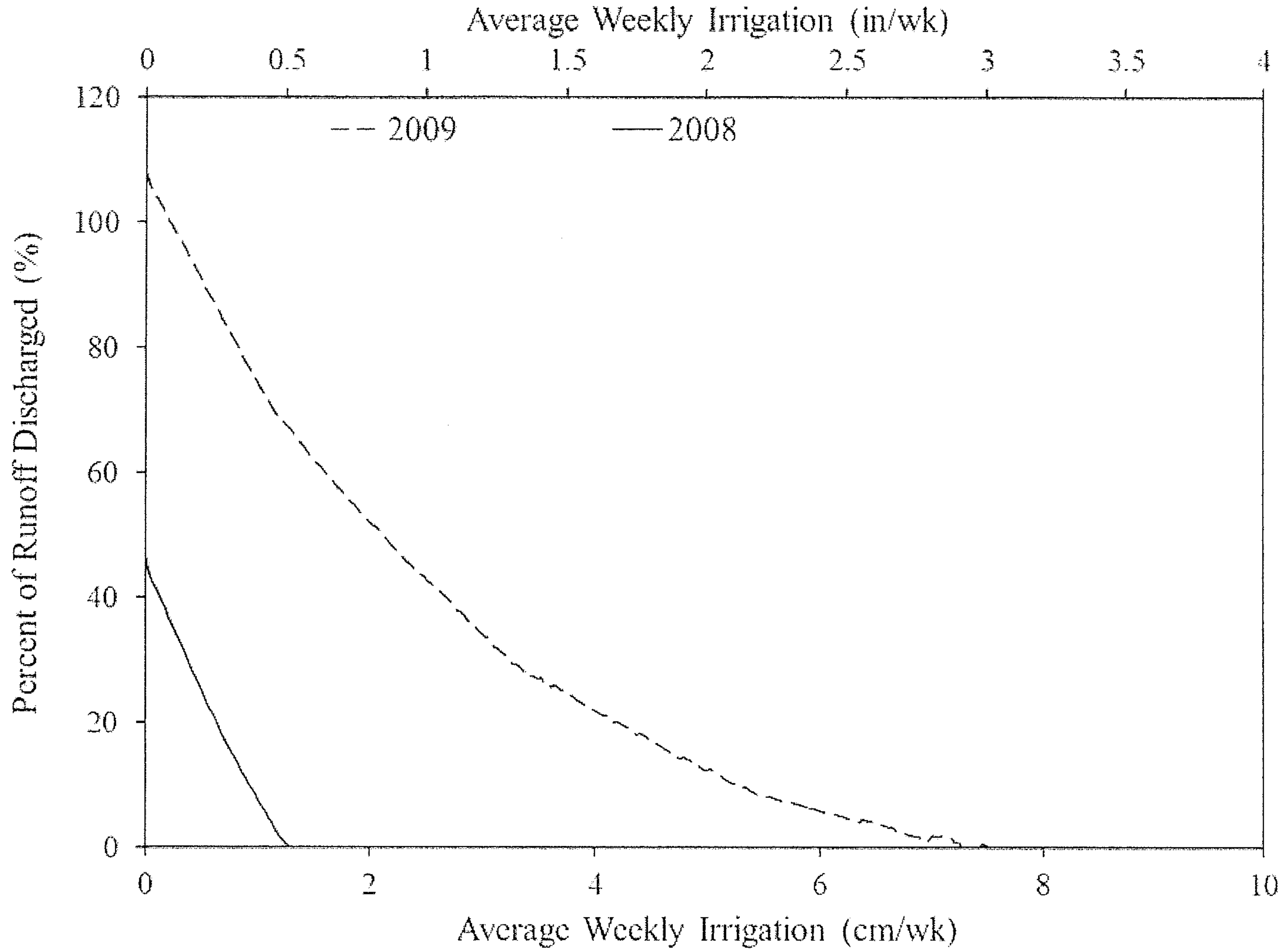


Figure 8 Percent of runoff discharged at permeability of 12.7 cm/hr. (5in/hr.)

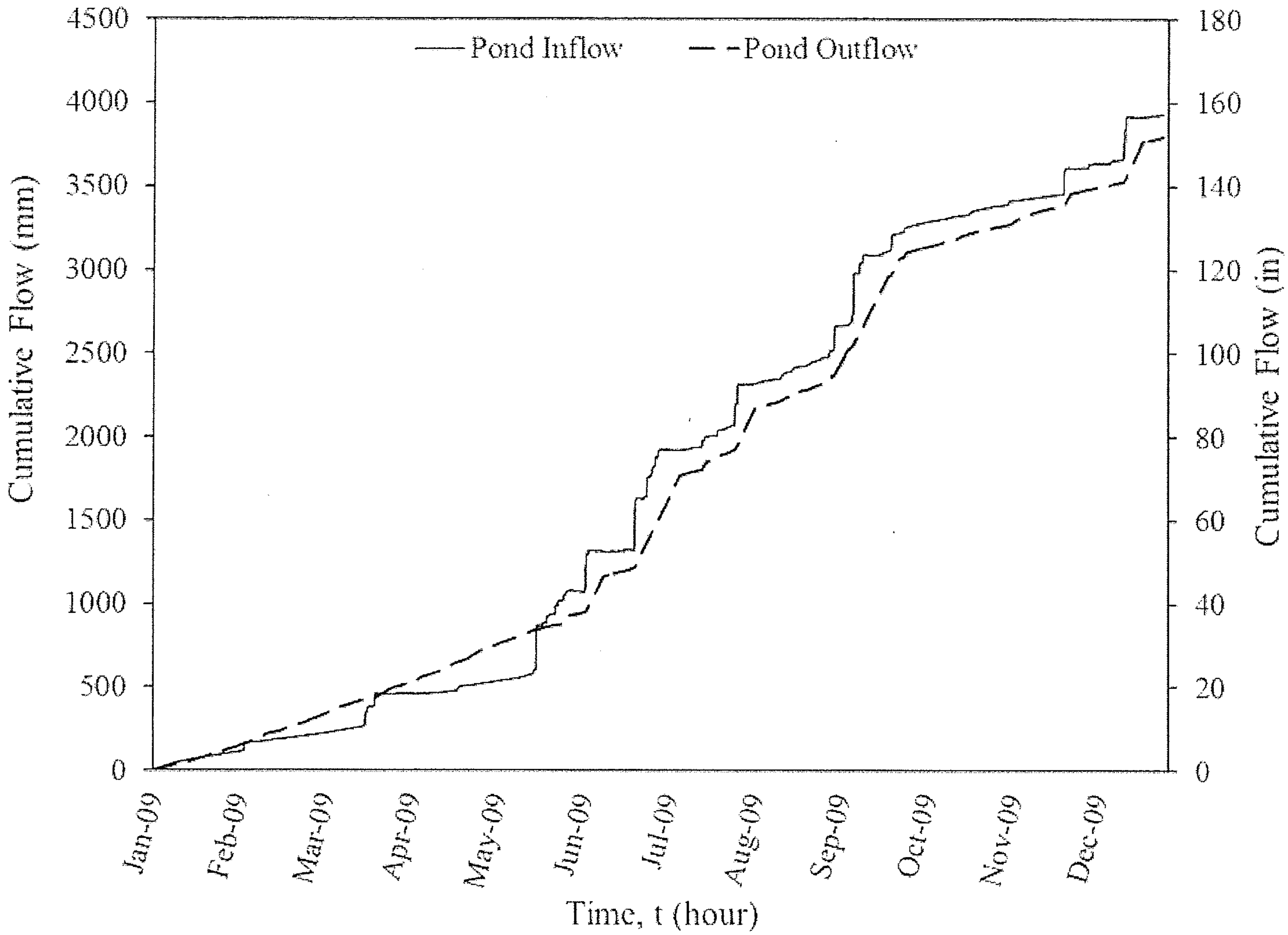


Figure 9 Cumulative inflow and outflow without irrigation in 2009

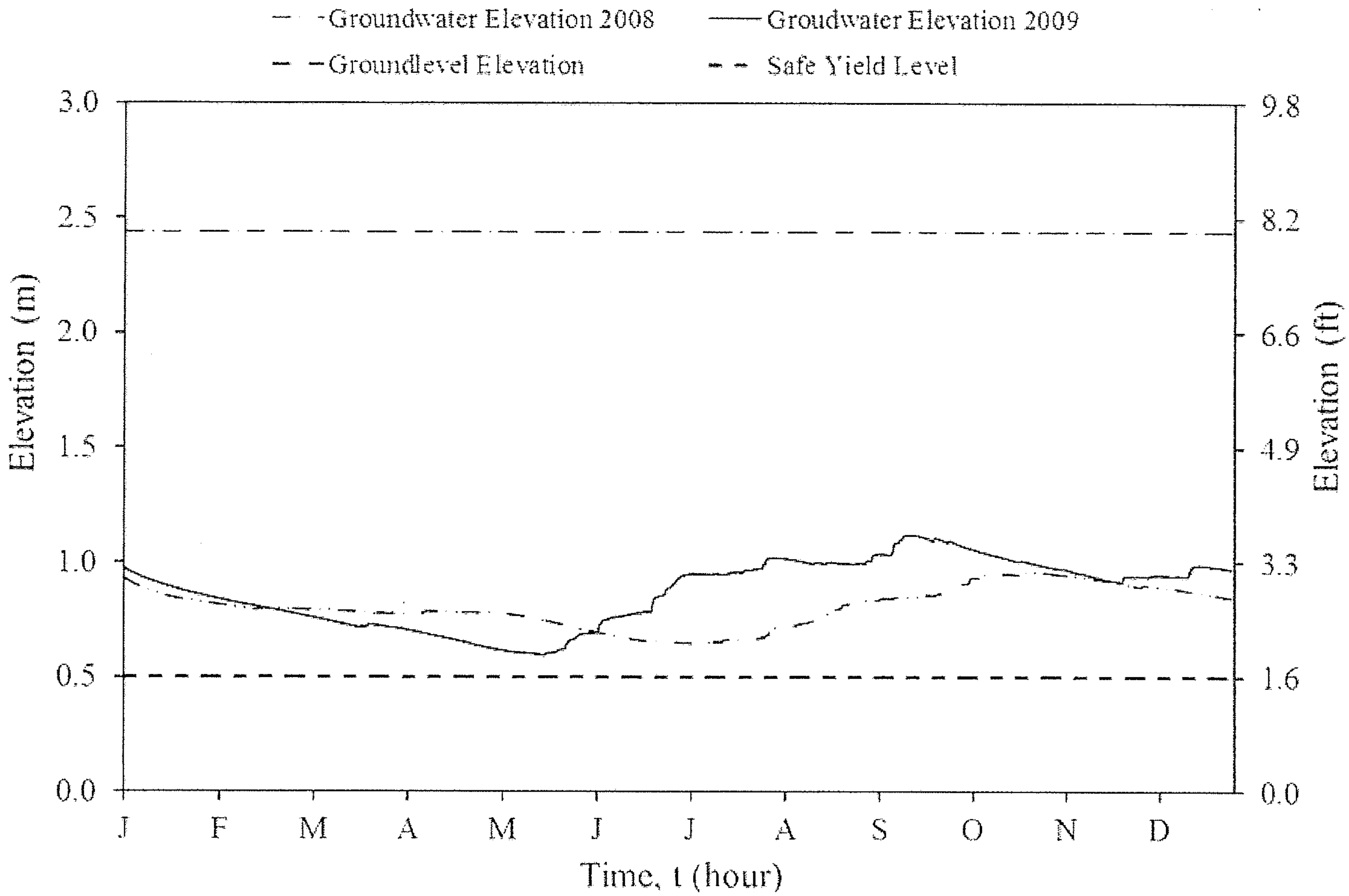


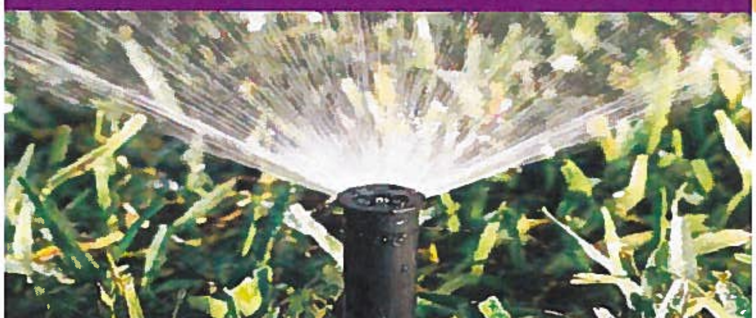
Figure 10 Groundwater elevations for the calibration and validation periods

Appendix C

Water Rate Schedules

For billing inquiries or to request service during business hours call **407-905-3191**

For after-hours emergency service please call **407-428-5766**



Payment Methods

Automatic Withdrawal: can be set up by bringing a voided check to the Utility Billing counter at City Hall

Online: you can obtain your PIN by emailing ebilling@ci.ocoee.fl.us or by calling Utility Billing at 407-905-3191

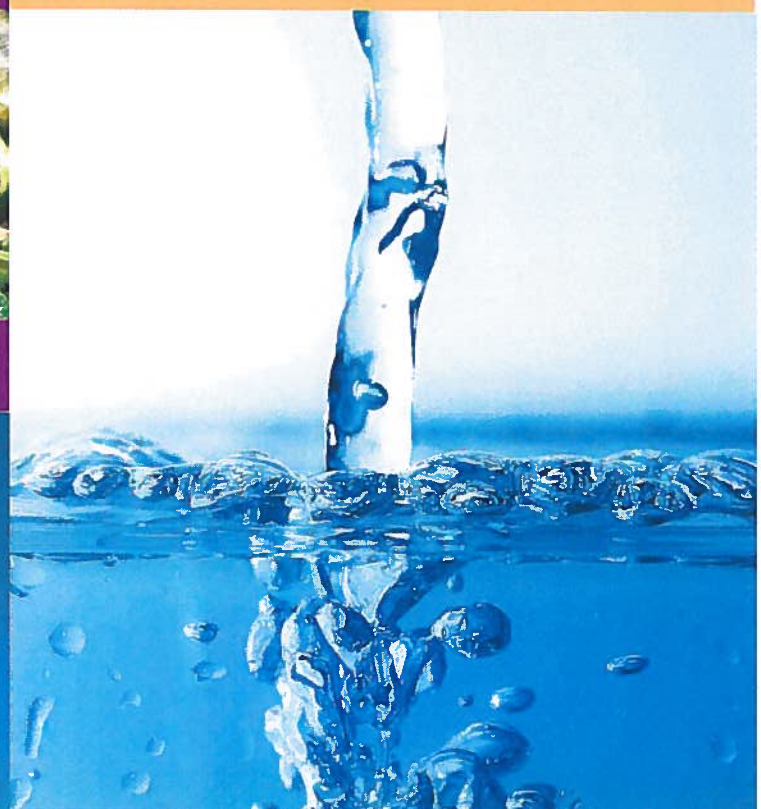
By Phone: call 1-866-974-2058 to use your credit card to pay your bill with the Point and Pay system (fees apply)

Drop Box: the stainless steel payment drop box is located just outside of City Hall at 150 N. Lakeshore Drive

In Person: stop by the Utility Billing Counter at City Hall to pay your bill 7:30 - 5:30 Monday - Thursday and 8:00 - 5:00 on Fridays

By Mail: you can mail your payment to:
P.O. Box 70
Ocoee, FL 34761

Water, Sewer & Reclaim Rates



City of Ocoee Utilities Department
Administration Office
1800 A.D. Mims Road
Ocoee, Florida 34761-4001
(across from the Jim Beech Recreation Center)

If you have any questions regarding your utilities, please call **407-905-3159**

Utilities Department Rate Schedules

Effective 10/01/2011

Water Rate Schedule

Base Facility Charge

Meter Size	Base Rate
¾"	$9.77
1"	$24.44
1½"	$48.89
2"	$78.23
3"	$156.51
4"	$244.51
6"	$489.06
8"	$782.24

Residential Volumetric Charge

Water	Per 1,000 Gallons
0 - 6,000 gallons	$1.07
6,000 - 12,000 gal	$1.34
12,000 - 18,000 gal	$1.68
18,000 - 24,000 gal	$4.20
24,000 - 30,000 gal	$6.29
> 30,000 gallons	$7.66

Non-Residential Volumetric Charge

Water	Per 1,000 Gallons
0 - 6,000 gallons	$1.07
6,000 - 12,000 gal	$1.34
12,000 - 18,000 gal	$1.68
18,000 - 24,000 gal	$2.51
24,000 - 30,000 gal	$2.51
> 30,000 gallons	$2.51

Sewer Rate Schedule

Base Facility Charge

Meter Size	Base Rate
¾"	$17.65
1"	$44.19
1½"	$87.76
2"	$141.43
3"	$282.89
4"	$442.01
6"	$887.04
8"	$1,414.46

Residential Volumetric Charge

Sewer	Per 1,000 Gallons
0 - 12,000 gallons	$2.52
> 12,000 gallons	$0

Non-Residential Volumetric Charge

Sewer	Per 1,000 Gallons
0 - 12,000 gallons	$2.52
> 12,000 gallons	$2.52

Reclaim Rate Schedule

Base Facility Charge

Meter Size	Base Rate
¾"	$7.32
1"	$18.33
1½"	$36.68
2"	$58.67
3"	$117.37
4"	$183.40
6"	$356.14
8"	$569.61
10"	$819.08
12"	$1,968.40

Residential Volumetric Charge

Reclaim	Per 1,000 Gallons
0 - 6,000 gallons	$0.78
6,000 - 12,000 gal	$1.01
12,000 - 18,000 gal	$1.26
> 18,000 gallons	$1.87

Non-Residential Volumetric Charge

Water	Per 1,000 Gallons
0 - 6,000 gallons	$0.78
6,000 - 12,000 gal	$1.01
12,000 - 18,000 gal	$1.26
> 18,000 gallons	$1.87

Si usted desea solicitar nuestro servicio u obtener más información sobre su cuenta, por favor contactenos al 407-905-3191.

Si usted tiene preguntas sobre su servicio de agua o del alcantarillado, por favor contactenos al 407-905-3159.

Unpaid bills may be assessed a $10.00 late fee five (5) days after the due date

RIVIERA BEACH.

CITY OF RIVIERA BEACH
Utility Rates effective 10/01/12

Utility Tax (only on water) = 10 %

WATER

Residential

readiness to serve charge/unit		12.72
Plus usage; Rate per thousand gallons		
	1st 9,000	2.62
	next 5,000	3.27
	next 5,000	3.92
	over 19,000	4.58

Commercial

rate includes demand billing.

3/4" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
1" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
1 1/2" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
2" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31

Commercial water rates continued.

3" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
4" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
6" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
8" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
10" meter		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31
Motels and Hotels		
readiness to serve charge/ERU		12.72
Plus usage; Rate per thousand gallons		
	1st 10,000	4.79
	next 30,000	5.55
	over 40,000	6.31

IRRIGATION METERS

Residential

readiness to serve charge/unit		12.72
Plus usage; Rate per thousand gallons		
	1st 9,000	2.62
	next 5,000	3.27
	next 5,000	3.92
	over 19,000	4.58

Commercial

readiness to serve charge/ERU		17.02
Plus usage; Rate per thousand gallons		
	1st 10,000	5.38
	next 30,000	6.14
	over 40,000	6.90

SEWER

Residential

readiness to serve charge/unit	8.22
Plus usage; Rate per thousand gallons	
usage / 1,000 gal.	1.84

based on metered water, up to a maximum of 10,000 gal./unit

Commercial

readiness to serve charge/ERU	8.22
Plus usage; Rate per thousand gallons	
usage / 1,000 gal.	3.97

based on metered water, no max.

Hotel/Motel

readiness to serve charge/ERU	8.22
Plus usage; Rate per thousand gallons	
usage / 1,000 gal.	2.86

based on metered water, no max.

Unmetered Sewer / unit	16.44

Water/Sewer Inspection Fee:

residential, single unit	10.00
commercial and multi-unit res.	25.00

TRASH AND GARBAGE

residential/unit/unit eff 10/1-9/30/12	11.24
commercial minimum 10/1-9/30/12	66.07

OTHER CHARGES

Meter Connection (Installation)

meter size:	monthly
3/4"	607.20
1"	654.62
1 1/2"	840.18
2"	886.57
3" and larger: at cost	

Fire Lines / Fire Sprinklers

2"	6.63
3"	14.21
4"	20.84
6"	27.47
8"	43.86
10"	63.14

Fire Hydrants

per month	28.93

MISCELLANEOUS

Turn-on charge:	12.50
Turn-off charge:	12.50
Turn-on charge if "Requested After Regular Working Hours":	35.00
Late-Payment Charge:	10.00
Recheck & Meter Test	30.00
test results show it reads OK or Low)	
Returned Check Charge or 5% if greater:	20.00
Unauthorized Connectio	250.00

Hydrant Meter

(3" meter)	12.72
service charge)	38.66

Capital Fees

per Equivalent Residential Unit:

water	1,809.44
sewer	1,555.62
	3,365.06

********************STANDBY-BY SERVICE: Readiness to serve, or stand-by charge) remains until the building is demolished and the meter removed permanently.********************

********************Outside City Limits: rates are (1 1/4) times the inside city rates********************

ORDINANCE NO. 12-1435

AN ORDINANCE AMENDING SECTIONS 20-26 AND 20-46 OF THE CODE OF ORDINANCES OF THE CITY OF HAINES CITY, FLORIDA; CHANGING THE RATES AND CHARGES RELATIVE TO THE FURNISHING OF WATER AND WASTEWATER SERVICES BY THE CITY; AMENDING SECTION 20-42 OF THE CODE OF ORDINANCES OF THE CITY OF HAINES CITY, FLORIDA; CHANGING THE RECLAIMED WATER RATES FOR LARGE RECLAIMED WATER USERS; PROVIDING FOR SEVERABILITY; PROVIDING FOR AN EFFECTIVE DATE.

WHEREAS, the City of Haines City, Florida, has a municipal water and wastewater system; and

WHEREAS, the City of Haines City, Florida, previously issued long-term debt for water and wastewater system capital improvements; and

WHEREAS, pursuant to the requirements of borrowing funds, the City has considered a Capital Finance Plan which recognizes the pledge of revenues received from monthly water and wastewater rates to fund the operations of the water and wastewater system and pay for the indebtedness; and

WHEREAS, the revenue generated by the rates and charges to the users of the water and wastewater system are not projected to be sufficient to pay ongoing operation and maintenance expenses, debt service requirements and capital requirements of the municipal water and wastewater system; and

WHEREAS, the City deems it desirable to increase the current rates and charges relative to the furnishing of water and wastewater in an effort to provide the municipal water and wastewater service as economically as practical for the basic needs of the users; and

WHEREAS, the City has scheduled, noticed and conducted the necessary public hearing to consider the recommendations contained in the consultant's 2009 study and all other relevant evidence in accordance with Florida law; and,

WHEREAS, the City previously adopted rate adjustment clauses calling for annual increases in water and wastewater rates and charges based upon Florida Public Service Commission indexing, which is 2.41% as set forth in Docket Number 120005-WS, Order No. PSC-12-0068-PAA-WS.

NOW, THEREFORE, BE IT ENACTED BY THE CITY COMMISSION OF THE CITY OF HAINES CITY, FLORIDA:

Section 1. Modification to Water Rates and Charges. Current Section 20-26 of the Code of Ordinances of the City of Haines City, Florida, is hereby repealed. In its place, a new Section 20-26 is hereby adopted to read as follows:

"Section 20-26. Water Rates and Charges.

The City hereby adopts the following rates, charges and regulations as a condition to the provision of water service by the City to customers as follows:

(1) *Definitions:*

(a) "Residential" means an individual dwelling unit designed for more or less permanent household occupancy which would include individual cooking and bathing facilities. Examples are a single family home, efficiency apartment unit, cooperative apartment unit, duplex unit, condominium, and multi-family residential building unit.

(b) "Commercial Service" means a use of land or a building for non-residential purposes, but shall include a residential use which has identifiable "general service" characteristics, as the term is used herein, both of which use the same water meter.

(c) "Public Authority" means a land use or a building for governmental purposes associated with the City of Haines City or any other public use located within the City limits.

(d) "Irrigation Service" means an individually-metered water service or reclaimed water service used exclusively for lawn sprinkling, irrigation of pervious surfaces, and other related service. Irrigation service can be utilized by both residential and commercial service customers.

(e) "Equivalent or Dwelling Unit" means a general service use unit which has a demand for water at about the same amount level of demand as that allocated to the average residential unit. The equivalent or dwelling unit(s) shall be estimated and rounded upward in whole number as determined by the City Manager or his/her designee.

(f) "Equivalent Residential Unit" or "ERU" generally represents the equivalent usage requirements of a single-family residential customer. For the purpose of this ordinance, an ERU will have an assigned value of 1.0. One (1) ERU is deemed to be equal to a flow of three hundred thirty (330) gallons per day (GPD) for water. The assumed ERU gallonage has been based on statistical data establishing an average residential use as reflected in the City of Haines City's Water and Wastewater System Master Plan dated October 5, 2000, and it is recognized that the uses for some types of residential units may be greater or smaller than the average assumed for this calculation.

(2) *Regular Potable Water Service Rates:*

(a) Individually-Metered Residential Service

Applicability: Potable water service in residential dwelling units with individual water meters.

Rate per Monthly Billing Period: The monthly rates for service include a base service charge and a water consumption charge. The monthly bill for service rendered to an individually-metered residential service shall equal the sum of the Base Service Charge, which serves as the minimum bill, and the water consumption charge based on all metered water consumption delivered to the premises.

Base Service Charge: The base service charge for all metered or active accounts shall reflect the applicable rates shown in the table below. The base service charge does not include an allowance for water consumption.

Description	Effective October 1, 2012
Individually-Metered Residential – Inside Water	
Base Service Charge – All meter sizes	$9.51

Consumption Charge: The rate for each one thousand (1,000) gallons or fraction thereof of water that passes through the customer's service meter shall be determined in accordance with the following schedule.

Description	Effective October 1, 2012
Individually-Metered Residential – Inside Water	
Consumption Charge	
0 - 3,000 gallons	$0.77
3,001 – 10,000 gallons	1.00
10,001 - 20,000 gallons	1.54
20,001 - 30,000 gallons	2.21
Above 30,000 gallons	3.17

(b) Master-Metered Residential, Commercial, and Public Authority Service

Applicability: For potable water service to residential dwelling units whereby one single water meter serves more than one principal residential dwelling unit and for all non-residential units.

Rate per Monthly Billing Period: The monthly rates for service include a base service charge and a water consumption charge. The monthly bill for service rendered to a master-metered residential, commercial or public authority service shall equal the sum of the Base Service Charge, which serves as the minimum bill, and the water consumption charge based on all metered water consumption delivered to the premises.

Base Service Charge: The base service charge for all metered or active accounts shall reflect the applicable rates shown in the table below. The base service charge does not include an allowance for water consumption.

Description	ERU Factor	Effective October 1, 2012
Master-Metered Residential, Commercial, and Public Authority Service – Inside Water		
Base Service Charge		
3/4" Meter	1.0	$9.51
1" Meter	2.5	23.79
1.5" Meter	5.0	47.57
2" Meter	8.0	76.11
3" Meter	16.0	152.22
4" Meter	25.0	237.85
6" Meter	50.0	475.69
8" Meter	80.0	761.11

Consumption Charge: The rate for each one thousand (1,000) gallons or fraction thereof for all quantities of water that passes through the customer's service meter shall be charged as follows:

Description	Effective October 1, 2012
Master-Metered Residential, Commercial, and Public Authority Service – Inside Water	
Consumption Charge – All metered water	$1.52

(3) *Regular Irrigation Service Rates:*

(a) <u>Individually-Metered Residential Service</u>

Applicability: Irrigation water service with separate individual water meters that serve residential dwelling units, which is in addition to the regular water meter serving the premises.

Rate per Monthly Billing Period: The monthly rates for service include a base service charge and a water consumption charge. The monthly bill for service rendered to an individually-metered residential service shall equal the sum of the Base Service Charge, which serves as the minimum bill, and the water consumption charge based on all metered water consumption delivered to the premises.

Base Service Charge: The base service charge for all metered or active accounts shall reflect the applicable rates shown in the table below. The base service charge does not include an allowance for water consumption.

Description	Effective October 1, 2012
<u>Individually-Metered Residential – Inside Irrigation</u>	
Base Service Charge – All meter sizes	$9.51

Consumption Charge: The rate for each one thousand (1,000) gallons or fraction thereof of water that passes through the customer's service meter shall be determined in accordance with the following schedule:

Description	Effective October 1, 2012
<u>Individually-Metered Residential – Inside Irrigation</u>	
Consumption Charge	
0 - 10,000 gallons	$1.54
10,001 - 20,000 gallons	2.21
Above 20,000 gallons	3.17

(b) Master-Metered Residential, Commercial, and Public Authority Service

Applicability: For irrigation water service in residential dwelling units which one single water meter serves more than one principal residential dwelling unit or for non-residential units, which is individually-metered and in addition to the regular water meter serving the premises.

Rate per Monthly Billing Period: The monthly rates for service include a base service charge and a water consumption charge. The monthly bill for service rendered to a master-metered residential, commercial or public authority service shall equal the sum of the Base Service Charge, which serves as the minimum bill, and the water consumption charge based on all metered water consumption delivered to the premises.

Base Service Charge: The base service charge for all metered or active accounts shall reflect the applicable rates shown in the table below. The base service charge does not include an allowance for water consumption.

Description	ERU Factor	Effective October 1, 2012
Master-Metered Residential, Commercial, and Public Authority Service – Inside Irrigation		
Base Service Charge		
3/4" Meter	1.0	$ 9.51
1" Meter	2.5	23.79
1.5" Meter	5.0	47.57
2" Meter	8.0	76.11
3" Meter	16.0	152.22
4" Meter	25.0	237.85
6" Meter	50.0	475.69
8" Meter	80.0	761.11

Consumption Charge: The rate for each one thousand (1,000) gallons or fraction thereof for all quantities of water that passes through the customer's service meter shall be charged as follows:

Description	Effective October 1, 2012
<u>Master-Metered Residential, Commercial, and Public Authority Service – Inside Irrigation</u>	
Consumption Charge – Blocks per 1.0 ERU	
0 - 10,000 gallons	$1.54
10,001 - 20,000 gallons	2.21
Above 20,000 gallons	3.17
Consumption Charge – Blocks per 2.5 ERU	
0 - 25,000 gallons	$1.54
25,001 - 50,000 gallons	2.21
Above 50,000 gallons	3.17
Consumption Charge – Blocks per 5.0 ERU	
0 - 50,000 gallons	$1.54
50,001 - 100,000 gallons	2.21
Above 100,000 gallons	3.17
Consumption Charge – Blocks per 8.0 ERU	
0 - 80,000 gallons	$1.54
80,001 - 160,000 gallons	2.21
Above 160,000 gallons	3.17
Consumption Charge – Blocks per 16.0 ERU	
0 - 160,000 gallons	$1.54
160,001 - 320,000 gallons	2.21
Above 320,000 gallons	3.17
Consumption Charge – Blocks per 25.0 ERU	
0 - 250,000 gallons	$1.54
250,001 - 500,000 gallons	2.21
Above 500,000 gallons	3.17
Consumption Charge – Blocks per 50.0 ERU	
0 - 500,000 gallons	$1.54
500,001 - 1,000,000 gallons	2.21
Above 1,000,000 gallons	3.17
Consumption Charge – Blocks per 80.0 ERU	
0 - 800,000 gallons	$1.54
800,001 - 1,600,000 gallons	2.21
Above 1,600,000 gallons	3.17

(4) *Annual Rate Adjustment:* Effective with bills rendered on or after October 1, 2013 (Fiscal Year 2013/2014), the City Manager may adjust the monthly base charges and consumption charges for water and irrigation services to reflect changes in operating costs without further action by the City Commission. Prior to implementation thereof, notice of such rate adjustments shall be promptly provided by the City Manager to the City Commission. The City Manager shall utilize the "price increase index" for major categories of utility operating costs which is annually adopted

by the Florida Public Service Commission as required by Florida Statute. The rate adjustment shall be based upon the application of the index to the existing user rates.

(5) *Out of City Rates:* For potable water and irrigation consumers situated outside the corporate limits of the City and receiving such service(s) from the City, such consumers shall pay for comparable services or usage as listed under subsections (2) and (3) of this section, the identical and applicable rate therein stated, plus twenty-five percent (25%)."

Section 2. **Modification of Wastewater Rates and Charges.** Current Section 20-46 of the Code of Ordinances of the City of Haines City, Florida is hereby repealed. In its place, a new Section 20-46 is hereby adopted to read as follows:

"Section 20-46. Wastewater Rates and Charges.

The City hereby adopts the following rates, charges and regulations as a condition to the provision of wastewater service by the City to customers as follows:

(1) *Definitions.*

(a) "Residential" means an individual dwelling unit designed for more or less permanent household occupancy which would include individual cooking and bathing facilities. Examples are a single family home, efficiency apartment unit, cooperative apartment unit, duplex unit, condominium, and multi-family residential building unit.

(b) "Commercial Service" means a use of land or a building for non-residential purposes, but shall include a residential use which has identifiable "general service" characteristics, as the term is used herein, both of which use the same water meter.

(c) "Public Authority" means a land use or a building for governmental purposes associated with the City of Haines City or any other public use located within the City limits.

(d) "Equivalent or Dwelling Unit" means a general service use unit which has a demand for water at about the same amount level of demand as that allocated to the average residential unit. The equivalent or dwelling unit(s) shall be estimated and rounded upward in whole number as determined by the City Manager or his/her designee.

(e) "Equivalent Residential Unit" or "ERU" generally represents the equivalent usage requirements of a single-family residential customer. For the purpose of this ordinance, an ERU will have an assigned value of 1.0. One (1) ERU is deemed to be equal to a flow of two hundred sixty (260) gallons per day (GPD) for wastewater. The assumed ERU gallonage has been based on statistical data establishing an average residential use as reflected in the City of Haines City's Water and Wastewater System

Master Plan dated October 5, 2000, and it is recognized that the uses for some types of residential units may be greater or smaller than the average assumed for this calculation.

(2) *Regular Wastewater Service Rates.*

(a) Individually-Metered Residential Service

Applicability: Wastewater service for all purposes in residential dwelling units which receives water service from the City of Haines City with an individual water meter.

Rate per Monthly Billing Period: The monthly rates for service include a base service charge and a wastewater consumption charge. The monthly bill for service rendered to an individually-metered residential service shall equal the sum of the Base Service Charge, which serves as the minimum bill, and the water consumption charge based on all metered water consumption delivered to the premises to a maximum of 10,000 gallons per month.

Base Service Charge: The base service charge for all accounts served by the City's wastewater system shall be charged based on the following schedule per bill rendered. The Base Service Charge does not include an allowance for wastewater consumption.

Description	Effective October 1, 2012
Individually-Metered Residential – Inside Wastewater	
Base Service Charge – All meter sizes	$17.47

Consumption Charge – A rate for each one thousand (1,000) gallons or fraction thereof for all quantities of water passed through the customer's service meter shall be charged based on the following schedule.

Description	Effective October 1, 2012
Individually-Metered Residential – Inside Wastewater	
Consumption Charge	
0 - 10,000 gallons	$ 4.95
Above 10,000 gallons	0.00

In no event shall the monthly consumption charge for individually metered residential service be applied to any monthly metered water consumption in excess of 10,000 gallons.

(b) Master-Metered Residential, Commercial, and Public Authority Service

Applicability: For wastewater service for all purposes in residential dwelling units, which receive water service from the City of Haines City where one single water meter serves more than one principal residential dwelling unit or for all purposes considered as non-residential.

Rate per Monthly Billing Period: The monthly rates for service include a base service charge and a wastewater consumption charge. The monthly bill for service rendered to a master-metered, commercial or public authority service shall equal the sum of the Base Service Charge, which serves as the minimum bill, and the water consumption charge based on all metered water consumption delivered to the premises.

Base Service Charge: The base service charge for all accounts served by the City's wastewater system shall be charged based on the following schedule per bill rendered. The Base Service Charge does not include an allowance for wastewater consumption.

Description	ERU	Effective October 1, 2012
Master-Metered Residential, Commercial, and Public Authority Service – Inside Wastewater		
Base Service Charge		
3/4" Meter	1.0	$ 17.47
1" Meter	2.5	43.68
1.5" Meter	5.0	87.36
2" Meter	8.0	139.77
3" Meter	16.0	279.54
4" Meter	25.0	436.78
6" Meter	50.0	873.56
8" Meter	80.0	1,397.69

Consumption Charge: A rate for each one thousand (1,000) gallons or fraction thereof for all quantities of water passed through the customer's service meter shall be charged based on the following schedule.

Description	Effective October 1, 2012
<u>**Master-Metered Residential, Commercial, and Public Authority Service – Inside Wastewater**</u> **Consumption Charge – All water usage**	$4.95

Wastewater Consumption Credit: All consumers not classified as individually-metered residential service can receive a credit in the determination of the wastewater consumption charge if sufficient evidence exists that documents that not all metered water is returned to the wastewater system. A credit to the consumption charge may be allowed by the City of Haines City if the commercial user can submit to the City sufficient proof that water used for such purposes wherein at least sixty (60) percent thereof does not reach the wastewater system, such shall be charged a fair fee to be fixed by the City Manager and based upon the percentage of water determined to be reaching the wastewater system. Additionally, a credit will also be allowed for all water consumption where a meter has been installed which measures the amount of water which is not returned to the wastewater system. The water meter will be installed in a location which is accessible by the City and will be installed based on the City's terms and conditions. The water meter will be the property of the customer and not the City and must be calibrated annually by the customer at his/her expense to the City's satisfaction in order to receive the credits. Proof of the annual water calibration must be provided to the City in order to continually receive the wastewater consumption credit from the City. In no event will a credit be issued which results in a wastewater bill being less than the base service charge.

(3) *Annual Rate Adjustment:* Effective with bills rendered on or after October 1, 2013 (Fiscal Year 2013/2014), the City Manager may adjust the monthly base charges and consumption charges for wastewater services to reflect changes in operating costs without further action by the City Commission. Prior to implementation thereof, notice of such rate adjustments shall be promptly provided by the City Manager to the City Commission. The City Manager shall utilize the "price increase index" for major categories of utility operating costs which is annually adopted by the Florida Public Service Commission as required by Florida Statute. The rate adjustment shall be based upon the application of the index to the existing user rates.

(4) *Out of City Rates*: For wastewater consumers situated outside the corporate limits of the City and receiving wastewater service from the City, such consumers shall pay for comparable services or usage as listed under subsection (2) of this section, the identical and applicable rate therein stated, plus twenty-five percent (25%)."

<u>Section 3.</u> **<u>Modification of Reclaimed Water Rates and Changes.</u>** A new Section 20-42 of the Code of Ordinances of the City of Haines City, Florida, is hereby adopted to read as follows:

"**<u>Section 20-42.</u>** **<u>Reclaimed Water Rates and Changes.</u>**

(1) The City has begun the development of a reclaimed water distribution system for purposes of ultimately delivering reclaimed water throughout its service area. Initially, however, the City's reclaimed water distribution system will be extended to take advantage of certain large users of reclaimed water so as to develop the system in a financially feasible manner. Therefore, the City adopts as initial reclaimed water rates those rates set forth hereinbelow based upon existing data and analysis. Establishing these initial rates shall not in any way bind the City to either the amounts or methodology utilized at this time. These initial rates are set forth below and apply initially to a single, large-scale user of reclaimed water.

(a) <u>Large User Service</u>

Applicability: For bulk reclaimed water service provided on either a Non-interruptible Basis or an Interruptible Basis.

Rate per Monthly Billing Period: The monthly rates for service include a reclaimed water consumption charge on all metered reclaimed water consumption delivered to the premises.

Description	Effective October 1, 2012
<u>Non-Interruptible Service</u> **Consumption Charge – All metered water**	$0.57
<u>Interruptible Service</u> **Consumption Charge – All metered water**	$0.39

(2) *Annual Rate Adjustment*: Effective with bills rendered on or after October 1, 2013 (Fiscal Year 2013/2014), the City Manager may adjust the monthly base charges and consumption charges for water and irrigation services to reflect changes in operating costs without further action by the City Commission. Prior to implementation thereof, notice of such rate adjustments shall be promptly provided by the City Manager to the City Commission. The City Manager shall utilize the "price increase index" for major categories of utility operating costs which is annually adopted by the Florida Public Service Commission as required by Florida Statute. The rate adjustment shall be based upon the application of the index to the existing user rates.

(3) *Out of City Rates*: For large reclaimed water users situated outside the corporate limits of the City and receiving such service(s) from the City, such users shall pay for comparable services or usage as listed under this Section, the identical and applicable rate therein stated, plus twenty-five percent (25%).

(4) *Rates Not Precedent*: These reclaimed water rates are based upon current data and analysis for a reclaimed water user providing economic development and using 250,000 gallons per day, average annual basis, are subject to modification, and shall not be precedent for other reclaimed water users.

Section 4. **Effective Date.** This ordinance shall take effect on October 1, 2012.

Section 5. **Severability.** If any provision or portion of this Ordinance is declared by any court of competent jurisdiction to be void, unconstitutional, or unenforceable, then all remaining provisions and portions of this Ordinance shall remain in full force and effect.

INTRODUCED AND PASSED on first reading in regular session of the City Commission of the City of Haines City, this 5th day of September, 2012.

ATTEST:

Vanessa Castillo

Vanessa Castillo, City Clerk

APPROVED:

Joanna Wilkinson

Joanna Wilkinson, Mayor

PASSED on second and final reading by the City Commission of the City of Haines City, Florida, at regular session this 20th day of September, 2012.

ATTEST:

Vanessa Castillo

Vanessa Castillo, City Clerk

APPROVED:

Roy Tyler

Joanna Wilkinson, Mayor

APPROVED AS TO FORM AND CORRECTNESS:

Fred Reilly

Fred Reilly, City Attorney

STATE OF FLORIDA

COUNTY OF POLK

I, the undersigned duly appointed City Clerk of the City of Haines City, Florida, HEREBY CERTIFY that the foregoing is a true and correct copy of Ordinance No. 12-1435, as shown in the records of the City on file in the office of the City Clerk.

WITNESS my hand and the seal of the City of Haines City, Florida, this 20th day of September, 2012.

Vanessa Castillo

Vanessa Castillo, City Clerk

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