

SUPPORT DOCUMENT FOR THE
***2007 Orange Creek Basin
Management Action Plan***

FOR THE IMPLEMENTATION OF TOTAL MAXIMUM DAILY LOADS
ADOPTED BY THE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

in the

Orange Creek Basin

Developed by the Orange Creek Basin Working Group
in Cooperation with the
Florida Department of Environmental Protection
Division of Water Resource Management
Bureau of Watershed Management

May 27, 2008

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LIST OF ACRONYMS AND ABBREVIATIONS

ACEPD	Alachua County Environmental Protection Department
ACHD	Alachua County Health Department
ACMF	Austin Cary Memorial Forest
ACRWCCA	Alachua County Recreation and Water Conservation and Control Authority
APHA	American Public Health Association
ARA	Antibiotic resistance analysis
BMAP	Basin Management Action Plan
BMI	Benthic macroinvertebrate
BMP	Best management practice
BOD	Biological oxygen demand
BWG	Basin Working Group
CDS	Continuous deflective separation
cfs	Cubic feet per second
cm ²	Centimeter
COGPWD	City of Gainesville Public Works Department
CP	Current Problems, Inc.
CR	County Road
DACS	Florida Department of Agriculture and Consumer Services
DAP	Di-ammonium phosphate
DEP	Florida Department of Environmental Protection
DMR	Discharge monitoring report
DO	Dissolved oxygen
DOF	Division of Forestry
DOT	Florida Department of Transportation
EPA	U.S. Environmental Protection Agency
EPAC	Environmental Protection Advisory Committee
E&S	Erosion and sediment
ESOZ	Environmentally Sensitive Overlay Zone
F.A.C.	Florida Administrative Code
FPC	Facilities Planning and Construction
F.S.	Florida Statutes
FWC	Florida Fish and Wildlife Conservation Commission
FWRA	Florida Watershed Restoration Act
FY	Fiscal year
GFWFC	Florida Game and Fresh Water Fish Commission
GIS	Geographic information system
GRU	Gainesville Regional Utilities
ha	Hectare
HMMC	Hazardous Materials Management Code
HOA	Homeowners association
I&I	Infiltration and Inflow
IWRM	Integrated Water Resource Monitoring
LDRs	Land development regulations
LEED	Leadership in Energy and Environmental Design
kg	Kilogram
km ²	Square kilometer
lbs	Pounds
MEP	Maximum extent practicable
mg/L	Milligrams per liter
mL	Milliliter
MPN	Most probable number

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MS4	Municipal separate storm sewer system
MSL	Mean sea level
MST	Microbial source tracking
N	Nitrogen
NATL	Natural Area and Teaching Lab
NE	Northeast
NELAC	National Environmental Laboratory Accreditation Conference
NGVD	National Geodetic Vertical Datum
NH3	Un-ionized ammonia
NIPF	Nonindustrial private forest
NO2	Nitrite
NO3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NW	Northwest
O&M	Operations and maintenance
PLRG	Pollutant Load Reduction Goal
OFW	Outstanding Florida Water
P	Phosphorus
PCR	Polymerase Chain Reaction
PWD	Public Works Department
QA/QC	Quality assurance/quality control
RT-PCR	Reverse Transcriptase Polymerase Chain Reaction
SE	Southeast
SEEP	Stormwater Ecological Enhancement Project
SFRC	School of Forest Resources and Conservation
SHWD	Seasonal high water table
SJRWMD	St. Johns River Water Management District
SMU	Stormwater management utility
SQG	Small Quantity Generator
SOP	Standard Operating Procedure
SR	State Road
SRF	State Revolving Fund
SRWMD	Suwannee River Water Management District
SSO	Sanitary sewer overflow
SU	Standard units
SW	Southwest
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
SWMP	Stormwater management program
TAZ	Transportation Analysis Zone
TKN	Total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TSI	Trophic State Index
TSS	Total suspended solids
UF–IFAS	University of Florida–Institute of Food and Agricultural Sciences
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WAV	Watershed Action Volunteers

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WBID	Waterbody identification
WMP	Watershed Management Plan
WQC	Water quality code
Yr	Year
µg/L	Micrograms per liter

ACKNOWLEDGMENTS

The Orange Creek Basin Management Action Plan was prepared as part of a five-year cycle to implement Total Maximum Daily Loads (TMDLs) adopted by the Florida Department of Environmental Protection (DEP) in the Orange Creek Basin. It was developed by the Orange Creek Basin Working Group (BWG), identified below, with participation from affected local, regional, and state governmental interests; elected officials and citizens; and private interests.

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OVERVIEW OF THE ORANGE CREEK BASIN MANAGEMENT ACTION PLAN

The Orange Creek Basin covers approximately 1,040 square kilometers (km²), including portions of the city of Gainesville, Alachua County, and Marion County. Newnans Lake, Orange Lake, and Lochloosa Lake are the largest surface waterbodies. A number of significant urban creeks are present in the Gainesville area, including Hogtown Creek, Tumblin Creek, and Sweetwater Branch. The basin also includes Alachua Sink, which is located south of Gainesville on Paynes Prairie.

The Orange Creek Basin Working Group (BWG) worked for over three years to develop a basin management action plan (BMAP) to address Total Maximum Daily Loads (TMDLs) adopted by the Florida Department of Environmental Protection (DEP) for the Orange Creek Basin. This working group comprises a wide variety of stakeholders, including the following:

- | | |
|---|---|
| • Alachua County (Environmental Protection Department, Public Works, and Environmental Protection Advisory Committee) | • Sustainable Alachua County |
| • Marion County (Clean Water Program) | • Suwannee St. Johns Sierra Club |
| • City of Gainesville | • Plum Creek Timber Company |
| • Town of McIntosh | • Florida Forestry Association |
| • Gainesville Regional Utilities | • St. Johns River Water Management District |
| • Gainesville Clean Water Partnership | • Florida Department of Transportation, District 2 |
| • Gainesville Water Management Committee | • Florida Fish and Wildlife Conservation Commission |
| • University of Florida | • Florida Department of Agriculture and Consumer Services (includes Division of Forestry) |
| • Women for Wise Growth | • Alachua County Health Department |

A significant outcome of the BMAP process in the Orange Creek Basin has been an unprecedented level of stakeholder participation and commitment. Dozens of working group members worked hard at long monthly meetings for over three years. The BMAP process in the Orange Creek Basin fostered positive communication and cooperation among basin stakeholders. They put aside some long-standing differences, finding common ground among competing interests. Together they identified creative solutions to complex water pollution issues and are taking decisive steps toward realizing those solutions. These successful collaborations on behalf of the basin's surface waters would have been less likely without TMDLs and the BMAP process.

The Orange Creek BMAP represents this collaborative effort and the significant commitment of stakeholder resources. Focusing on seven impaired waters in the basin (**Lakes:** Newnans, Orange, and Wauberg; **Sinks:** Alachua; **Creeks:** Hogtown, Tumblin, and Sweetwater), the BMAP describes the current state of knowledge about these waterbodies; water quality issues; projects already completed or in progress to address these issues; and steps that local, regional, and state entities will take in the future to address TMDL allocations. Management actions in the BMAP are directed toward the specific parameters for which each waterbody is impaired. It is crucial that stakeholder efforts in developing this plan be translated into actions that have a tangible effect on the community.

Total Maximum Daily Loads

Total maximum daily loads (TMDLs) are water quality targets established for waterbodies that do not meet state water quality standards. They are specific to both a waterbody and a pollutant (e.g., total nitrogen [TN], total phosphorus [TP], fecal coliform). TMDLs, which DEP adopts by rule, establish the maximum amount of specific pollutants that a waterbody can assimilate while maintaining its designated uses. For waterbodies in the Orange Creek Basin, all of which are Class III, “maintaining its designated use” means that these waterbodies must have suitable water quality for recreational use and for the propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

DEP has adopted TMDLs for the following waterbodies in the basin:

- Newnans Lake
- Orange Lake
- Lake Wauberg
- Alachua Sink
- Hatchet Creek
- Hogtown Creek
- Tumblin Creek
- Sweetwater Branch

Though a TMDL for iron was adopted for Hatchet Creek, it was determined that high iron levels were natural. Management actions for Hatchet Creek were not included in the adopted BMAP.

Waterbody Summaries

Table 1 summarizes the management actions that have been completed, are in progress, or are under consideration to reduce target pollutants in these impaired waterbodies. The text following the table summarizes the state of knowledge, the key unknowns, future studies, and the anticipated benefits of the management actions for each waterbody.

Table 1. Summary of management actions being implemented/proposed in the Orange Creek BMAP

MANAGEMENT ACTIONS	NEWNANS LAKE	ORANGE LAKE	LAKE WAUBERG	ALACHUA SINK	LOCHLOOSA LAKE	HOGTOWN CREEK	TUMBLIN CREEK	SWEETWATER BRANCH
Structural Best Management Practices (BMPs)	•				•	•	•	•
Agricultural BMPs	•	•	•		•			
Restoration and Water Quality Improvement Projects	•	•			•	•		•
Regulations, Ordinances, and Guidelines	•	•	•	•	•	•	•	•
Special Studies and Planning Efforts	•	•	•	•	•	•	•	•
Education and Outreach	•	•	•	•	•	•	•	•
Stormwater Permit Program Implementation	•	•	•	•	•			
Land Acquisition	•	•		•	•			•

Urban Creeks (Hogtown and Tumblin Creeks; Sweetwater Branch)

Parameter Causing Impairment: Fecal Coliform Bacteria

What We Know

- Elevated coliform counts are regularly observed in all three creeks throughout the year.
- Compared with the state standard of 800 counts per 100 milliliters (counts/100mL), Tumblin Creek exceeded the standard 75% of the time; Sweetwater Branch, 48%; and Hogtown Creek, 89%.
- Sources of coliform include failing septic tank systems, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from the improper disposal of waste material, domestic pets, and wildlife.
- Secondary growth within stormwater systems and in creek sediments may also contribute to persistent elevated coliform levels.

Completed and Planned Management Actions

- Sediment bacteria evaluation,
- Septic tank system management,
- Illicit connection elimination,
- Municipal separate storm sewer system (MS4) permit compliance,
- Wastewater system integrity testing, rehabilitation/repairs, and routine operations/maintenance,
- Bacteria source tracking study,
- Expanded monitoring,
- Stream restoration and vegetative enhancements,
- Sediment removal and control (e.g., inlet protection, duck pond continuous deflective separation [CDS] units, hydrodynamic separators),
- Optical brightener studies,
- Stormwater parks (four), and
- Public education and outreach, including the use of community-based social marketing principles.

Potential Management Actions

- Septic tank system evaluation and maintenance, repair, or removal, and
- Assessments of sediment bacteria load.

Management Action Highlights

- Based on the results of ambient fecal coliform monitoring, microbial source tracking, alternative bacteriological monitoring, and optical brightener analyses, 10 sites with consistently high levels of fecal coliform were identified. Human genetic markers were detected during source tracking at 8 of these sites.

- DEP, the Alachua County Environmental Protection Department (ACEPD), Alachua County Health Department (ACHD), City of Gainesville Public Works Department (COGPWD), Florida Department of Transportation (DOT), and Gainesville Regional Utilities (GRU) have joined efforts to evaluate and remediate coliform sources in these “hot spot” areas. Resources have been committed by each of these entities, and preliminary monitoring is under way.
- The approach includes the following:
 - Performing initial confirmatory baseflow fecal coliform sampling,
 - Assessing existing programs and activities focused on reducing coliform in the creeks and identifying areas needing improvement,
 - Mapping infrastructure components into a GIS format within specific study areas,
 - Conducting coordinated field evaluations of public and private sanitary sewer lines (including connection and laterals), septic systems, and storm sewer lines,
 - Repairing infrastructure as necessary, and
 - Performing postevaluative sampling to document water quality improvements.
- This approach will be tested in a pilot area before being expanded to the full list of “hot spots.” If the approach is not producing the intended results, the project partners will modify the project for the remaining areas of concern.

Key Unknowns

- The extent to which the regrowth of bacteria occurs in creek sediments,
- The relative magnitude of urban campsites as a source of fecal coliform, and
- The relative magnitude of wildlife as a source of fecal coliform.

Alachua Sink

Parameter Causing Impairment: TN

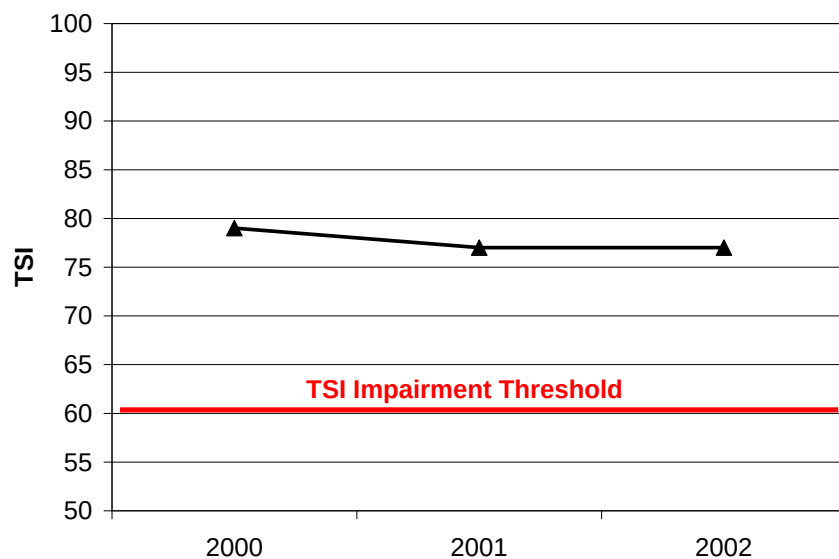
What We Know

- Alachua Sink (Waterbody Identification [WBID] Number 2720A) is located on the northern edge of Paynes Prairie, south of the city of Gainesville and approximately 2.5 miles east of U.S. Highway 441. It consists of a small lake, with a corresponding solution sink that recharges the Floridan aquifer.
- The surrounding drainage basin for Alachua Sink is approximately 2,758 acres. There are two well-defined inflows into Alachua Sink: Sweetwater Branch and a canal that connects Alachua Lake to Alachua Sink (a combined drainage area of 39,373 acres).
- Alachua Lake is the inundated portion of Paynes Prairie. Presumably, any runoff coming into Paynes Prairie that does not sink into the ground is incorporated into Alachua Lake, and some portion is shunted to Alachua Sink during high-water conditions.
- Major sources of flow to Paynes Prairie include Bivens Arm, Prairie Creek (which connects the prairie to Newnans Lake), and Camps Canal.
- Based on long-term U.S. Geological Survey (USGS) flow measurements (1942–91), about 41% of the flow from Newnans Lake goes south into Paynes Prairie, and the rest flows towards Orange Lake by way of Camps Canal (Gottgens

and Montague, 1988). The Alachua Sink waterbody has an outlet stream that discharges to the primary sinkhole.

- There are wastewater dischargers in the watershed: the Main Street Domestic Wastewater Reclamation Facility (WRF) and the John R. Kelly Generating Station. The Main Street WRF is an advanced secondary activated sludge domestic wastewater treatment facility that discharges treated wastewater to Sweetwater Branch. The John R. Kelly Generating Station discharges cooling tower and low-volume wastewater into Sweetwater Branch. Other discharges into Sweetwater Branch, and ultimately Alachua Sink, include stormwater from the eastern portions of Gainesville.
- Alachua Sink is verified as impaired for nutrients, based on Trophic State Index (TSI) values well above the threshold of 60 (**Figure 1**). Based on phytoplankton communities and the TN/TP ratio, Alachua Sink is considered nitrogen limited. Thus, the TMDL for Alachua Sink was expressed in terms of TN reductions to achieve water quality standards.

Figure 1. Alachua Sink TSI values, 2000–02



Source: Gao et al., 2006.

What We Know

- TSI values in Alachua Lake have shown little seasonal or annual variation from 2000 to 2002. The average TSI during this period was 78. Lakes with a TSI value above 60 are considered to have poor water quality.
- Hydrologic variation in Alachua Lake may affect TN and TP concentrations in the water column of Alachua Sink through the oxidation of exposed sediment during periods of low water and the resuspension of this material during high lake stage.
- Medium-density residential, forest, and water/wetland areas are the primary land use types in the entire watershed (including the Sweetwater and Alachua Lake watersheds). The land area that drains directly to Alachua Sink is 51% forest and 43% water/wetland.
- Significant land use changes and population growth are not anticipated in the Alachua Sink watershed in the next 5 to 10 years.

Completed and Planned Management Actions

- Main Street WRF upgrades to facilitate wastewater reuse, and
- Land acquisition.

Potential Management Actions

- Sweetwater Branch/Paynes Prairie Sheetflow Project.

Key Unknowns

- Detailed understanding of the sink's hydrodynamics and response to nutrient inputs.

Future Studies

- Pollutant Load Reduction Goal (PLRG) studies: Spatial nutrient loading dynamics, nitrogen fixation, and stormwater nutrient loading. This research will refine TN and TP source identification outlined in the TMDL. Specific research projects include a nitrogen (N)-fixation study being conducted by the St. Johns River Water Management District (SJRWMD) on similar lakes in the region. The application of PLRG results in Newnans Lake would benefit nutrient levels in Alachua Sink because of the hydrologic connection through Paynes Prairie.

Adequacy of Management Actions To Meet TMDL Reductions

- The BWG will work toward improvements in TSI values as a result of implementing management actions in the Alachua Sink watershed. At this time, it is expected that the Sweetwater Branch/Paynes Prairie Sheetflow project will meet the TN TMDL for Alachua Sink. However, confirmation of this expectation will require the completion of project design and full implementation.

Newnans Lake

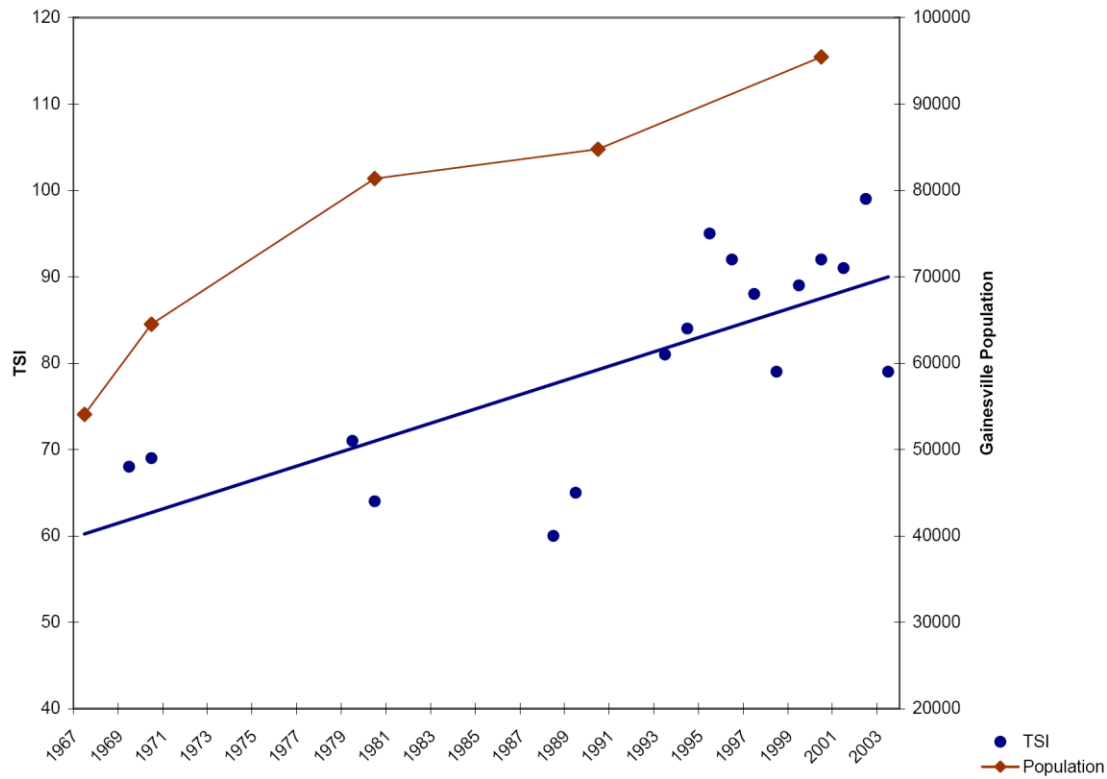
Parameters Causing Impairment: TN, TP

What We Know

- Newnans Lake has been hypereutrophic since at least 1999. The mean annual TSI for Newnans Lake from 1999 to 2003 was 93. Lakes with a TSI value above 60 are considered to have poor water quality. **Figure 2** shows TSI trends compared with the city of Gainesville population, and **Figure 3** shows historical loading sources and hydrologic modifications in Newnans Lake from 1964 to 2000.
- Newnans Lake has higher TN, TP, and chlorophyll a concentrations than 75% of Central Valley region lakes.
- Water quality in Newnans Lake has shown a declining trend since 1969. Statistically significant decreases in Secchi depth and increases in chlorophyll a, TN, TP, and total suspended solids (TSS) have been observed since the late 1960s (the late 1970s for TSS). Data for trend analysis prior to those periods are unavailable.
- Tributary inflows from Hatchet and Little Hatchet Creeks are the next largest source of TN and TP.
- Loading from on-site wastewater systems represents no more than 3% of the TN load.
- Blue-green algae are the dominant phytoplankton species in Newnans Lake (92%), at a biovolume consistently twice that of Orange Lake and Lochloosa Lake.

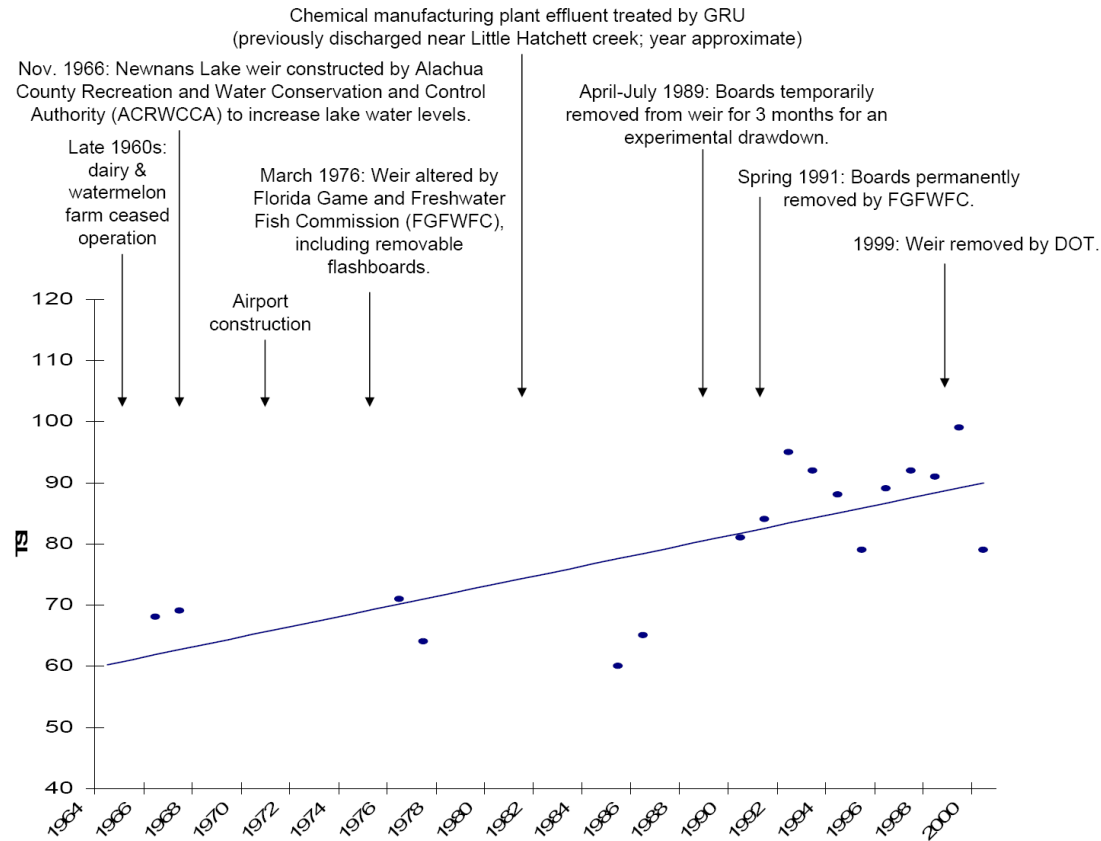
- A significant portion of the Newnans Lake watershed is commercial silviculture property, with limited acreage in other agricultural commodities. However, agriculture is a relatively minor source of nutrients to Newnans Lake. Thus, despite its prominence in acreage, silviculture land provides a very small portion of the overall nutrient load to Newnans Lake compared with the other land use types in the watershed.
- Several large industrial silviculture operators manage most of the commercial silviculture acreage in the Newnans Lake watershed. All of these large silviculture operators are participating in the Division of Forestry BMP implementation program.
- Significant land use changes are not anticipated in the Newnans Lake watershed in the next 5 to 10 years.

Figure 2. Newnans Lake TSI trends, compared with the city of Gainesville population



Source: Di et al., 2006 (water quality); M. Hoge, personal communication, 2007 (population).

Figure 3. Historical loading sources and hydrologic modifications in Newnans Lake



Note: Significant ditching also occurred during this period.
Source: SJRWMD, 2006c; Dyer, Riddle, Mills and Precourt, 2003.

Completed and Planned Management Actions

- Land acquisition,
- Silviculture and other agricultural BMP implementation, including 2004 fertilizer BMPs,
- Additional outreach to small private forestry landowners for BMP implementation,
- MS4 Program,
- Stormwater management improvements and studies,
- DEP ground water study, and
- Public education and outreach.

Potential Management Actions

- Brittany Estates Mobile Home Park wastewater upgrade,
- Implementation of a basinwide shoreline buffer restoration program,
- The restoration of disturbed wetlands,
- Alachua County parks septic tank system upgrades, and
- Residential septic tank system inspections and upgrades.

Key Unknowns

- TN and TP nutrient load in lake sediment,
- Nitrogen fixation rates specific to Newnans Lake and the relative magnitude of TN loading resulting from nitrogen fixation,
- Quantifiable load reductions from proposed management actions,
- The extent to which wildlife are a nutrient source, and
- The effect of wetland alterations on water quality in Newnans Lake.

Future Studies

- PLRG studies: Spatial nutrient loading dynamics, nitrogen fixation, and stormwater nutrient loading. This research will refine TN and TP source identification outlined in the TMDL. Specific research projects include an N-fixation study being conducted by the SJRWMD on similar lakes in the region.
- Internal recycling rates (i.e., TN and TP translocation between lake sediments and the water column). Internal recycling of nutrients stored in lake sediments was identified in the TMDL as the largest source of TN and TP loads (71.8% and 52.4%, respectively).
- Isotope study to investigate historical vs. current loads, including which are industrial vs. domestic sources.
- The investigation of the effects of historical loads and hydrologic modifications on current water quality conditions.
- The investigation of shad harvesting as a nutrient management tool.
- The investigation of benefits that could be achieved through hydrologic restoration.

Adequacy of Management Actions to Meet TMDL Reductions

- The BWG will work toward improvements in TSI values as a result of implementing management actions in the Newnans Lake watershed. At this time, the degree of TSI improvement is difficult to predict, as insufficient data are available to quantify nutrient reductions. Project benefits will be evaluated through data collected during project implementation and the application of the basin monitoring strategy. Future research that resolves current unknowns will allow for the implementation of additional management actions with greater certainty regarding the anticipated outcome.

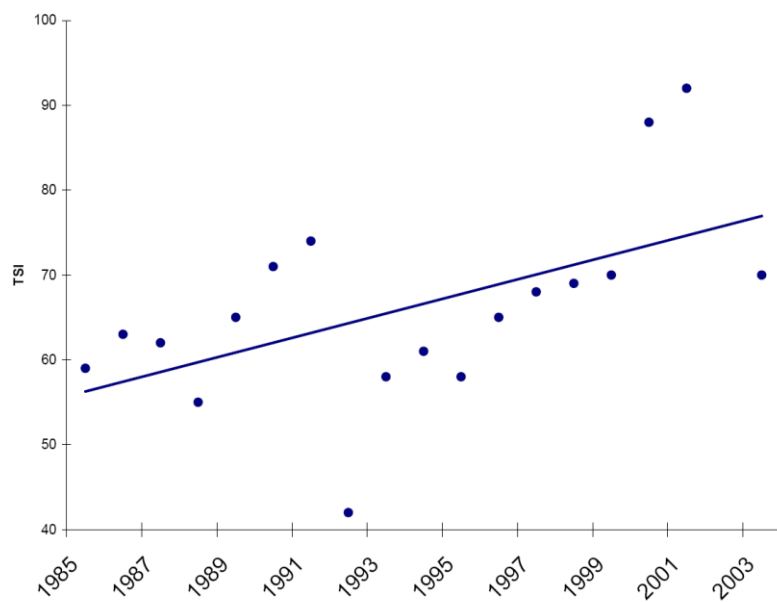
Orange Lake

Parameter Causing Impairment: TP

What We Know

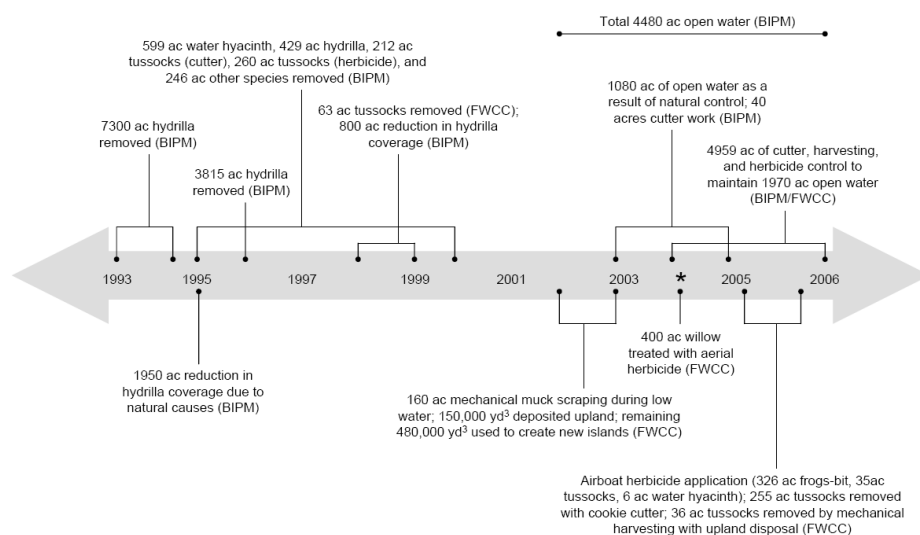
- Orange Lake has been hypereutrophic since at least 1999, based on TN, chlorophyll a, and Secchi depth data. The mean annual TSI for Orange Lake from 1999–2003 was 77. Lakes with a TSI value above 60 are considered to have poor water quality.
- Orange Lake has higher TP and chlorophyll a concentrations than 75% of Central Valley region lakes.
- Water quality in Orange Lake has shown a declining trend since 1985 (**Figure 4**). Statistically significant decreases in Secchi depth and increases in chlorophyll a, TN, TP, TSS, and turbidity have been observed since 1985. Data for trend analysis prior to that date are unavailable.
- Orange Lake is unique in the dominance of agriculture as a TP source (21.5%). Loading from water and wetland areas as well as atmospheric deposition comprise 32% of the TP load into Orange Lake.
- Aquatic plant management may play a significant role in Orange Lake nutrient loading, translocation, and recycling (**Figure 5**).
- Blue-green algae are the dominant phytoplankton species in Orange Lake (87%).
- A large portion of the Orange Lake watershed is involved in commercial silviculture activity, with most of this acreage held by several large industrial silviculture operators. All of these large silviculture operators are participating in the Division of Forestry BMP implementation program mentioned above for Newnans Lake.

Figure 4. Orange Lake TSI trend, 1985–2003



Source: Di et al., 2006.

Figure 5. Aquatic plant management activity summary for Orange Lake



* 1500 acres new open water as a result of storms (BIPM)

BIPM = Department of Environmental Protection Bureau of Invasive Plant Management
FWCC=Fish and Wildlife Conservation Commission

Source: Orange Creek BWG members.

- Significant land use changes are not anticipated in the Orange Lake watershed in the next 5 to 10 years, except for some condominium development and associated land clearing and septic tank system installation on the west side of the lake.

Completed and Planned Management Actions

- Land acquisition,
- Silviculture and other agricultural BMP implementation,
- Additional outreach to small private forestry landowners for BMP implementation,
- MS4 Program,
- Florida Department of Transportation (DOT) stormwater management improvements,
- Marion County Clean Farms Initiative,
- Public education and outreach, and
- Better coordination of sampling and aquatic plant management activities to ensure that samples truly reflect ambient conditions.

Potential Management Actions

- The implementation of a basinwide shoreline buffer restoration program, and
- The restoration of disturbed wetlands.

Key Unknowns

- Significant external loads of TN and TP remain to be identified,
- TN and TP nutrient load in lake sediment,
- Internal recycling rates (i.e., TN and TP translocation between lake sediments and the water column),
- The effect of aquatic plant management activities on nutrient loading, translocation, and recycling,
- Nitrogen fixation rates specific to Orange Lake and the relative magnitude of TN loading resulting from nitrogen fixation,
- Quantifiable load reductions from proposed management actions,
- The extent to which wildlife are a nutrient source,
- The significance of Camps Canal to TP loads in Orange Lake (Camps Canal was identified as the most significant TP source in the TMDL), and
- The benefits of upstream lake restoration.

Future Studies

- PLRG studies: Spatial nutrient loading dynamics, nitrogen fixation, and stormwater nutrient loading. This research will refine TN and TP source identification outlined in the TMDL. Specific research projects include an N-fixation study being conducted by the SJRWMD on similar lakes in the region.
- Internal recycling rates (i.e., TN and TP translocation between lake sediments and the water column) and sediment flux.
- Much of the future research and studies for Newnans Lake will also be applicable to Orange Lake.
- A literature review to document the benefits of aquatic plant management, including options for improving management strategies to promote natural lake functions.

Anticipated Results of Management Actions

- The BWG will work toward improvements in TSI values as a result of implementing management actions in the Orange Lake watershed. At this time, the degree of TSI improvement is difficult to predict, as insufficient data are available to quantify nutrient reductions. Project benefits will be evaluated through data collected during project implementation and the application of the basin monitoring strategy

Lake Wauberg

Parameters Causing Impairment: TN and TP

What We Know

- Lake Wauberg has been hypereutrophic since at least 1990, based on TN, TP, and chlorophyll a data.

- From 1990 to 2000, water quality was consistently poor, as indicated by a mean annual TSI of 72.3 during this period. Lakes with a TSI value above 60 are considered to have poor water quality.

Completed and Planned Management Actions

- Septic tank system evaluation and repairs at private residences and University of Florida recreation area.

Potential Management Actions

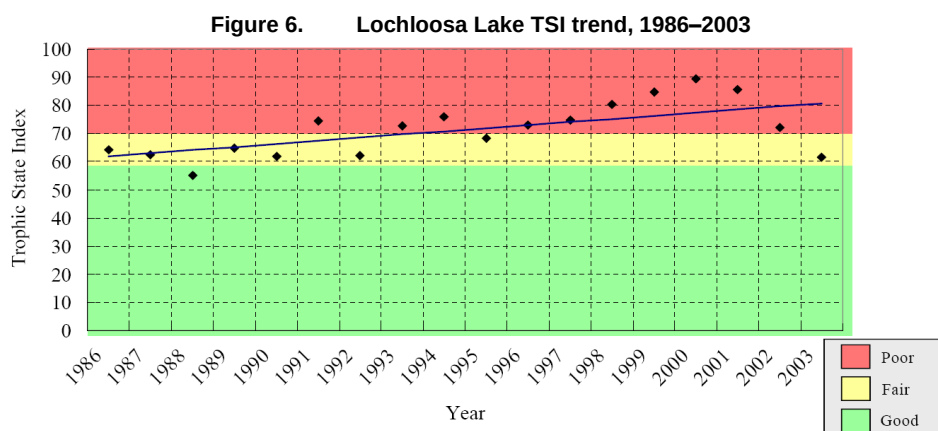
- The expansion of septic tank system evaluation and repairs.

Lochloosa Lake

Parameters Causing Impairment: TN and TP

What We Know

- Lochloosa Lake has been hypereutrophic since at least 1999, based on TN, chlorophyll a, and Secchi depth data, with an average TSI of 85 (1999–2003).
- Lochloosa Lake has higher TN concentrations than 75% of Central Valley region lakes.
- Water quality in Lochloosa degraded from 1986–2000, as evidenced by increasing TSI values (**Figure 6**).
- Water quality improvements have been observed in recent years, reflected in the downward TSI trend observed from 2000–03 (**Figure 6**).



Source: Di et al., 2006.

Key Unknowns

- The extent to which the herbicide treatment benefited water quality has not been evaluated in detail.
- Data collected for TMDL purposes included a period when the lake was herbicided and transformed from a macrophyte-dominated system to a more open-water system (1995–2001). The lake may return to a more natural state without the reductions from anthropogenic sources.

Based on these two key unknowns, DEP elected to re-evaluate the status of the lake in the next watershed cycle and did not adopt a nutrient TMDL for Lochloosa Lake. As such, the lake is only addressed briefly in this BMAP.

Completed and Planned Management Actions

- Data collection on Lochloosa Lake will continue to allow for continued evaluation of water quality trends,
- Water quality conditions in Lochloosa Lake will be reevaluated in the next TMDL cycle, and
- A number of land acquisition projects have occurred that will help maintain natural land cover and promote healthy water quality conditions (e.g., the Lochloosa Wildlife Conservation Area).

Anticipated Outcomes of BMAP Implementation

As a result of this BMAP, stakeholders expect the following outcomes:

- An enhanced understanding of basin hydrology, water quality, and pollutant sources,

- The ability to systematically identify and evaluate management actions and predict their benefits,
- Improvement in water quality trends in both urban creeks and rural lakes,
- Decreased loading of TMDL target pollutants, and
- Enhanced public awareness of pollutant sources, impacts, and management actions.

BMAP Cost and Time Frame

The management actions identified in Tables 10.1 through 10.9 of the BMAP contain descriptions, cost information, and time lines for each project. Where the cost of a project could not be adequately defined, it is indicated as unavailable in the tables. Certain types of projects (such as nonstructural BMP implementation, land acquisition, and maintenance) do not easily lend themselves to a full accounting of costs for the waterbody addressed by the project. In the case of BMP implementation and land acquisition, some of the true cost of implementation is carried by private landowners and is not readily available, or involves in-kind service, or the transactions are still ongoing and the complete cost is still not known. Other costs for maintenance and operation activities are generally not accounted for on an individual waterbody basis, but rather cover larger areas, as indicated in the tables, including many waterbodies. Similarly, some special study projects are not fully developed, and the final costs are not known at this time.

Funding sources range from local stormwater fees to regional, state, and federal cost-share grants. BWG members will be exploring new opportunities for funding assistance as they become available to meet the TMDLs in a reasonable time frame and an economically feasible manner. Table 8.1 identifies potential funding sources for projects

BMAP Follow-up

The BWG will track its implementation efforts and monitor water quality in the TMDL waterbodies (through existing water quality monitoring programs), to ensure that the BMAP is carried out and to measure its effectiveness. It will meet periodically (approximately every six months) to discuss implementation issues, consider new information, and determine what other management actions are needed for the waterbodies not projected to meet their TMDLs.

SUPPORT DOCUMENT FOR THE
**2007 Orange Creek Basin
Management Action Plan**

CHAPTER 1: CONTEXT, PURPOSE, AND SCOPE OF THE PLAN

1.1 Water Quality Restoration Framework

1.1.1 Water Quality Standards

Florida's water quality standards are designed to ensure that the state's waters can be used for their designated purposes, such as drinking water, recreation, and agriculture. Currently, most surface waters in Florida are categorized as Class III waters; they must be suitable for recreation and must support the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. **Table 1.1** shows Florida's designated use categories for surface water.

Under Section 303(d) of the federal Clean Water Act, every two years each state must identify its potentially impaired estuaries, lakes, rivers, and streams, that do not meet their designated uses and are not expected to improve within the subsequent two years. The Florida Department of Environmental Protection (DEP) is responsible for developing this "303(d) list" of impaired waters.

Table 1.1. Designated use attainment categories for Florida surface waters

CATEGORY	DESCRIPTION
Class I*	Potable water supplies
Class II*	Shellfish propagation or harvesting
Class III	Recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife
Class IV	Agricultural water supplies
Class V**	Navigation, utility, and industrial use (<i>no current Class V designations</i>)

Class I and II waters include the uses of the classifications below them.

**There are no Class V waters in Florida.

1.1.2 Verified Impairments and Total Maximum Daily Loads

Florida's 303(d) list identifies hundreds of waterbody segments that fall short of water quality standards. The three most common water quality concerns are coliform bacteria, nutrients, and oxygen-demanding substances. **Appendix A** provides a list of target pollutants across Florida. These listed waterbody segments are candidates for more detailed assessments of water quality to determine whether they are impaired according to state statutory and rule criteria. DEP's Planning List dated April 19, 2004 (**Table 1.2**) identified waterbodies that were potentially impaired.

Based on the Planning List, further water quality sampling occurs to verify these impairments. Using these data, waterbodies on the Planning List are evaluated to identify the subset that is impaired for individual water quality parameters. This Verified List of impaired waters identifies the waterbodies in the Orange Creek Basin for which DEP will develop and adopt Total Maximum Daily Loads (TMDLs) (**Table 1.3**) and the

schedule for developing those TMDLs. A TMDL is the maximum amount of a specific pollutant that a waterbody can assimilate while maintaining its designated uses.

Table 1.2. Orange Creek Basin Planning List waterbodies (April 19, 2004)

WBID	WATERBODY SEGMENT	PLANNING LIST PARAMETER
2688	Hatchet Creek	Dissolved oxygen (DO)
2688	Hatchet Creek	Lead
2696	Possum Creek	Fecal coliform
2698	Hogtown Creek	Total coliform*
2705	Newnans Lake Outlet	Nutrients (TSI)
2705	Newnans Lake Outlet	Turbidity
2705	Newnans Lake Outlet	Un-ionized ammonia (NH ₃)
2711	Sweetwater Branch	Total coliform*
2711	Sweetwater Branch	Nutrients
2717	Kanapaha Lake	Nutrients
2720	Alachua Sink Outlet	Nutrients (Trophic State Index [TSI])
2747	Orange Creek	Lead
2747	Orange Creek	Silver
2749	Orange Lake Reach	Nutrients (TSI)
2749	Orange Lake Reach	DO
2754	Cross Creek	Total suspended solids (TSS)
2754	Cross Creek	Biological oxygen demand (BOD)
2705A	Prairie Creek	Turbidity
2705A	Prairie Creek	Biology
2705A	Prairie Creek	Nutrients
2705B	Newnans Lake	Turbidity
2705B	Newnans Lake	Un-ionized NH ₃
2713D	Little Orange Lake	Nutrients (TSI)
2718A	Tumblin Creek	DO
2718A	Tumblin Creek	BOD
2738A	Lochloosa Lake	Selenium
2749A	Orange Lake	Lead
2749A	Orange Lake	Mercury in Fish
2749A	Orange Lake	Silver
2749A	Orange Lake	Copper

*Total coliform was removed from state water quality standards after the development of the Orange Creek Basin Planning List.

Table 1.3.TMDLs in the Orange Creek Basin

TMDL CATEGORY	WATERBODY WBID	PARAMETER	TMDL BASELINE LOADING (LBS/YEAR)	TMDL (LBS/YEAR)	WASTELOAD ALLOCATION		LOAD ALLOCATION (LBS/YEAR)	% REDUCTION NEEDED
					WASTEWATER (LBS/YEAR)	NPDES* STORMWATER (% REDUCTION)		
Nutrients	Newnans Lake 2705B	Total nitrogen (TN)	315,510	85,470	3,104	-	82,366	74%
		Total phosphorus (TP)	25,732	10,924	386	-	10,538	59%
	Orange Lake 2749A	TP	27,889	15,262	-	-	15,262	45%
	Lake Wauberg 2741	TN	4,064	2,062.4	-	-	2,062.4	51%
		TP	748	374	-	-	374	50%
	Alachua Sink 2720A	TN	462,550	256,322	41,003	45%	215,319	45%
TMDL CATEGORY	WATERBODY WBID	PARAMETER	TMDL BASELINE LOADING (COUNTS/ 100mL)	TMDL (COUNTS/ 100mL)	WASTELOAD ALLOCATION		LOAD ALLOCATION (COUNTS/100mL OR % REDUCTION)	% REDUCTION NEEDED
					WASTEWATER (COUNTS/DAY)	NPDES STORMWATER (% REDUCTION)		
Coliform	Hogtown Creek 2698	Fecal coliform	1,633	800	-	51%	51%	51%
	Tumblin Creek 2718A	Fecal coliform	3,077	800	-	74%	74%	74%
	Sweetwater Branch 2711	Fecal coliform	2,667	800	2.27E + 11	70%	70%	70%
TMDL CATEGORY	WATERBODY WBID	PARAMETER	TMDL BASELINE LOADING (LBS/DAY)	TMDL (LBS/DAY)	WASTELOAD ALLOCATION		LOAD ALLOCATION (LBS/DAY)	% REDUCTION NEEDED
					WASTEWATER (LBS/DAY)	NPDES STORMWATER		
Iron	Hatchet Creek 2688	Iron	52	35.91	5.6	-	30.31	30.8%

lbs – Pounds

mL – Milliliter

NPDES – National Pollutant Discharge Elimination System

The water quality evaluation and decision processes for listing impaired waters and establishing TMDLs are authorized by Section 403.067, Florida Statutes (F.S.) (the Florida Watershed Restoration Act [FWRA]), and contained in Florida's Identification of Impaired Surface Waters Rule, Rule 62-303, Florida Administrative Code (F.A.C.). **Appendix B** contains the FWRA.

TMDLs are developed and implemented as part of a watershed management cycle, based on the state's 52 river basins. This approach uses a schedule that rotates through these river basins over a 5-year repeated cycle (see **Appendix C**) to evaluate waters, determine impairments, and develop and implement management strategies to restore impaired waters to their designated uses. **Table 1.4** summarizes the 5 phases of the watershed management cycle. The development of this BMAP constitutes the completion of Phase 4. Phase 5, TMDL implementation, has already begun for a number of the projects outlined in this BMAP. As a Group 1 basin, the Orange Creek Basin will return to Phase 1 during 2008 as the second 5-year cycle begins.

Table 1.4. Phases of the watershed management cycle

Phase 1	Preliminary Evaluation of Water Quality
Phase 2	Strategic Monitoring and Assessment To Verify Water Quality Impairments
Phase 3	Development and Adoption of TMDLs for Waters Verified as Impaired
Phase 4	Development of Management Actions To Achieve the TMDL
Phase 5	Implementation of TMDL(s), Including Monitoring and Assessment

1.1.3 Impaired Waters and TMDLs in the Orange Creek Basin

All surface waters (including wetlands) in the Orange Creek Basin are designated as Class III waters in accordance with Rule 62-302, F.A.C. The Class III designation includes aquatic life use support, primary contact and recreation, and the protection of human health. Within the Orange Creek Basin, nine waterbodies do not meet their designated uses and have been verified by DEP as impaired. For eight of the impaired waterbodies, DEP has determined the pollutant levels (TMDLs) that each can receive and still maintain its Class III designated use. Corresponding pollutant reductions needed to achieve the TMDLs have been developed.

In the intervening period between TMDL development and BMAP development in the Orange Creek Basin, total coliform bacteria were removed from Florida's water quality standards (Environmental Regulation Commission meeting, September 28, 2006). As such, total coliform TMDLs adopted in the Orange Creek Basin are no longer considered binding on stakeholders. From a practical perspective, management actions identified to decrease fecal coliform levels (Chapter 5) will also decrease total coliform levels. Fecal coliform management actions are also assumed to decrease nutrient inputs.

This is a key assumption for management in the Hatchet Creek sub-basin. Hatchet Creek is verified as impaired for iron and total coliform, not fecal coliform. However, because the creek is a significant source of nutrient loading into Newnans Lake, coliform management actions will continue to be implemented in the Hatchet Creek sub-basin, based on the assumption that management to decrease coliform levels in this sub-basin will help achieve the Newnans Lake nutrient TMDL.

1.2 TMDL Implementation

Rule-adopted TMDLs may be implemented through basin management action plans (BMAPs), which contain actions to reduce and prevent pollutant discharges through various cost-effective means. During Phase 4 of the TMDL process, BMAPs or other implementation approaches are developed jointly by DEP and the affected stakeholders in the various basins. A basin may have more than one BMAP, based on practical considerations. The FWRA (Section 403.067, F.S.) contains provisions that guide the development of BMAPs and other TMDL implementation approaches. **Appendix D** contains a summary of the statutory provisions guiding BMAP development and implementation.

Stakeholder involvement is critical to the success of the TMDL Program and varies with each phase of implementation to achieve different purposes. The BMAP development process is structured to achieve cooperation and consensus among a broad range of interested parties. Under statute, DEP invites stakeholders to participate in the BMAP development process and encourages public participation to the greatest practicable extent. DEP must hold at least one noticed public meeting in the basin to discuss and receive comments during the planning process. Stakeholder involvement is essential to develop, gain support for, and secure commitments to implement the BMAP.

1.3 The Orange Creek Basin Management Action Plan

1.3.1 Stakeholder Involvement

Orange Creek Basin stakeholders chose unanimously to establish one Basin Working Group (BWG), with the option of creating small working groups to address specific concerns or issues. Members of the BWG comprise these subgroups, which meet separately from the BWG and present their findings to the BWG for consideration and consensus decision making. This process generated one BMAP that addresses the current TMDLs in the Orange Creek Basin.

The BWG, comprising stakeholder members representing a variety of entities, used a consensus-based collaborative approach when making decisions regarding the content of the BMAP. Its mission statement is as follows:

The mission of the Orange Creek Basin TMDL Working Group is to develop a Basin Management Action Plan for the Orange Creek Basin based on consensus decision making, using best available science.

It was necessary to define what constitutes a consensus agreement for the BWG, short of unanimous agreement. However, the BWG concluded that accepting a proposal without full unanimity would be a default position, when necessary to move the process forward and to complete the development of the BMAP on schedule. The BWG agreed to make every effort to develop proposals that all members could support.

With rare exception, the BWG met monthly from October 2004 till September 2007. Periodically, briefings were provided to the Gainesville Recreation, Cultural Affairs, and Public Works Committee, the Alachua County Community Planning Group, Gainesville Water Management Advisory Committee, and the Alachua County Environmental Protection Advisory Committee. A community public meeting was held on November 7,

2007. All BWG and stakeholder meetings were held within the basin and were open to the public.

1.3.2 Plan Purpose

The purpose of this plan is to identify cost-effective projects and activities that contribute toward achieving DEP-adopted TMDLs in the Orange Creek Basin, for the following impaired waterbodies:

- Newnans Lake
- Orange Lake
- Lake Wauberg
- Alachua Sink
- Hogtown Creek
- Tumblin Creek
- Sweetwater Branch

The BMAP also documents the BWG's support of the management actions contained in it, and the BWG's intention to implement these actions equitably among responsible stakeholders in reasonable time frames, contingent on available funding and the acquisition of necessary approvals and permits.

The BWG agreed that the development of the BMAP should do the following:

- Involve the community and specific entities,
- Help develop a shared understanding of different points of view,
- Be within the context of the DEP five-year basin management cycle,
- Use adaptive management principles, and
- Focus on achieving the TMDL load reductions.

1.3.3 Plan Scope

The Orange Creek BMAP area is defined as the portion of the basin encompassing the seven sub-basins within which DEP has adopted TMDLs: Newnans Lake (includes Hatchet Creek as a tributary), Orange Lake, Lake Wauberg, Alachua Sink, Hogtown Creek, Tumblin Creek, and Sweetwater Branch. The BMAP area is located entirely within Alachua and Marion Counties.

The Orange Creek BMAP addresses TMDLs adopted by DEP for nutrients and fecal coliform bacteria. Although other important water quality issues exist in the basin, they are beyond the scope of this BMAP (**Table 1.3**). The plan remains consistent with Chapter 403.067, F.S. and allows the BWG to expedite plan development and implementation. It is anticipated that other water quality issues may benefit from the actions included in this BMAP. Despite the fact that four of the TMDL waters have nutrient TMDLs, while the other three have coliform TMDLs (and one iron TMDL), the BWG decided to create only one BMAP addressing the lake, creek, and Alachua Sink TMDLs in the Orange Creek Basin.

1.3.4 Geographic Area

The Orange Creek Basin drainage area covers approximately 602 square miles and is located in central and eastern Alachua County, northern Marion County, and southwestern Putnam County (**Figure 1.1**). The basin is divided into six major sub-basins: Hogtown Creek (*includes Tumblin Creek*), Payne's Prairie (*includes Lake Wauberg, Alachua Sink, and Sweetwater Branch*), Newnans Lake (*includes Hatchet Creek*), Lochloosa Lake, Orange Lake, and Orange Creek. Each sub-basin has unique issues influencing water quality, including the degree of existing and anticipated development, the number and type of sources, and geographic considerations. The Hogtown Creek and Payne's Prairie watersheds receive the most urban drainage, while the Lake Lochloosa and Orange Lake watersheds are largely rural.

The sub-basins identified above encompass nine impaired waterbodies, eight of which have DEP-adopted TMDLs (**Figure 1.2**). DEP adopted or proposed TMDLs in 2003 for waterbodies within the Hogtown Creek, Payne's Prairie, Newnans Lake, Lochloosa Lake, and Orange Lake watersheds, representing approximately 471 square miles of the Orange Creek Basin. DEP and local partners are currently collecting data to further analyze the water quality impairments within the basin.

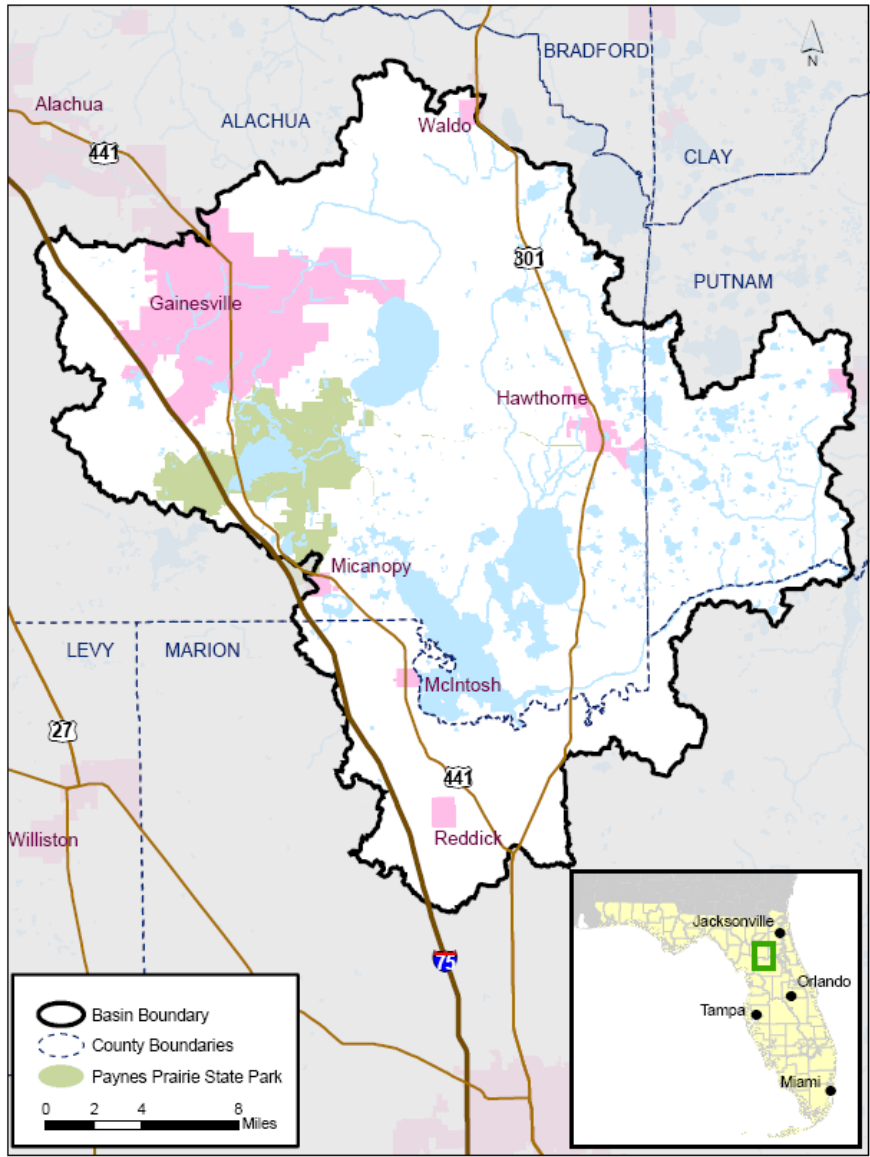
1.3.5 Jurisdictions and Regulatory Responsibilities

The largest municipality in the Orange Creek Basin is Gainesville. The Gainesville urban area, as determined by the 2001 U.S. Census, covers 77.3 square miles virtually in the center of Alachua County, Florida (**Figure 1.3**). The city limits of the incorporated city of Gainesville compose 70% of the urban area. Most of the urban area lies within, and to the west of, the city of Gainesville limits. The center of the urban area is at approximately 29°39'44" N and 82°22'26" W.

The towns of Micanopy, McIntosh, Reddick, and Hawthorne are also located within the basin. The remaining portions of Alachua and Marion Counties are largely rural in character. Agriculture, silviculture, and low-density residential land uses are most common. **Figure 1.4** shows land use in the Orange Creek Basin.

The DEP's Northeast District Office covers the portion of the BMAP area that lies within Alachua and Putnam Counties. DEP's Central District Office covers the BMAP area that lies within Marion County. Most of the BMAP area lies within the St. Johns River Water Management District (SJRWMD), but small portions in the northwestern and southwestern areas of the basin lie within the Suwannee River Water Management District (SRWMD) and Southwest Florida Water Management District (SWFWMD), respectively. The city of Gainesville, Alachua County, Marion County, DOT, and the University of Florida are also considered Phase II Municipal Separate Stormwater System (MS4) permittees (*see Section 3.4 for details and information on other MS4 permittees in the basin*).

Figure 1.1. Orange Creek Basin location



Source: DEP Watershed Planning and Coordination Section, 2007.

Figure 1.2. Orange Creek BMAP area and TMDL waterbodies

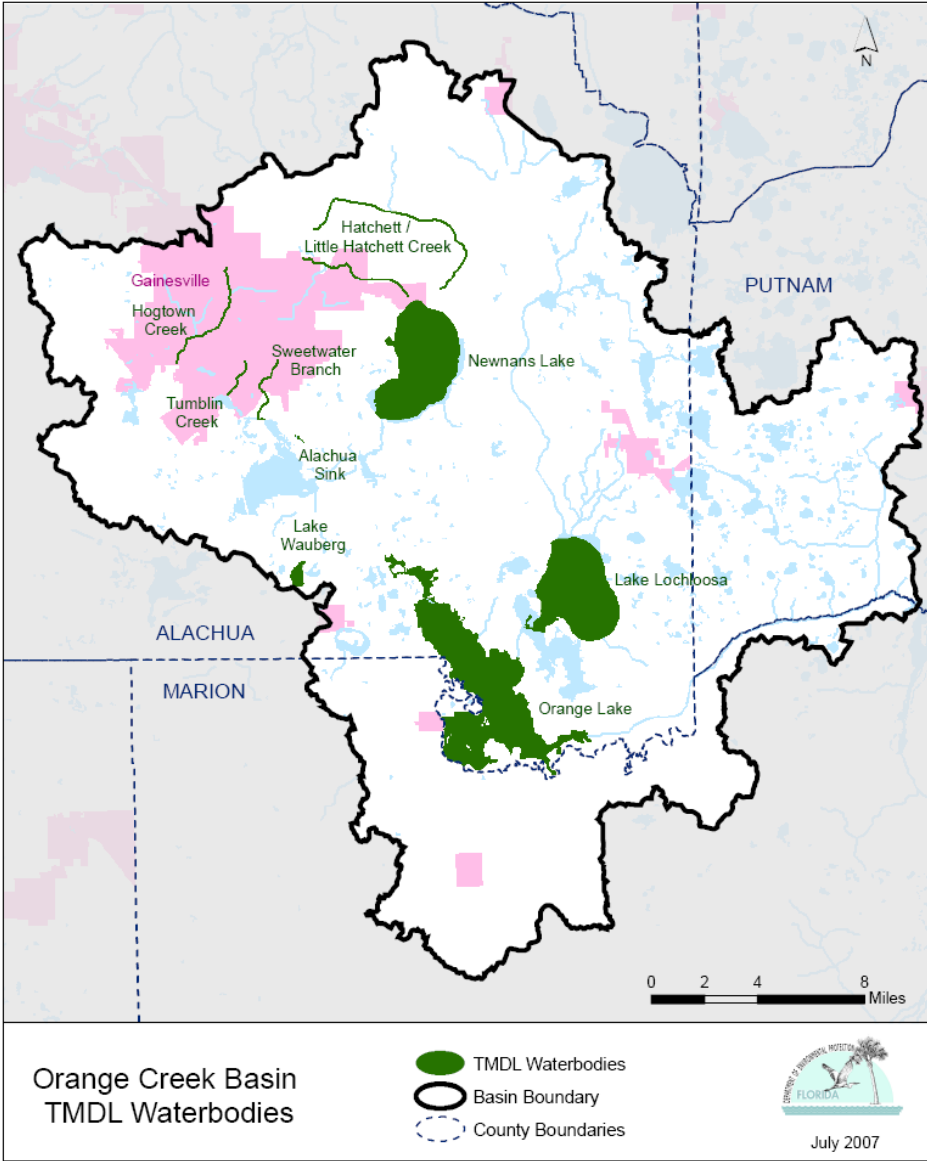


Figure 1.3. Gainesville urban area

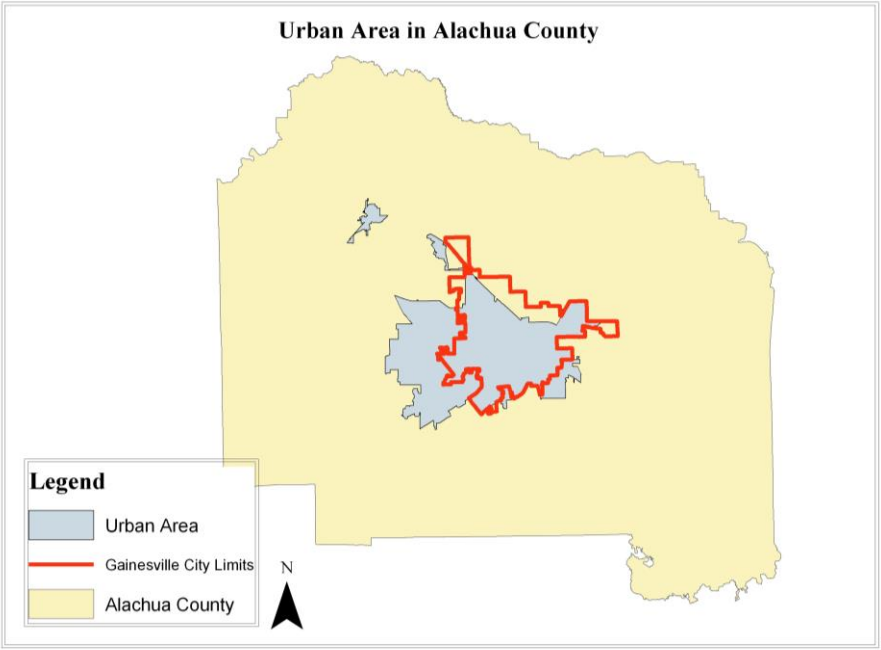
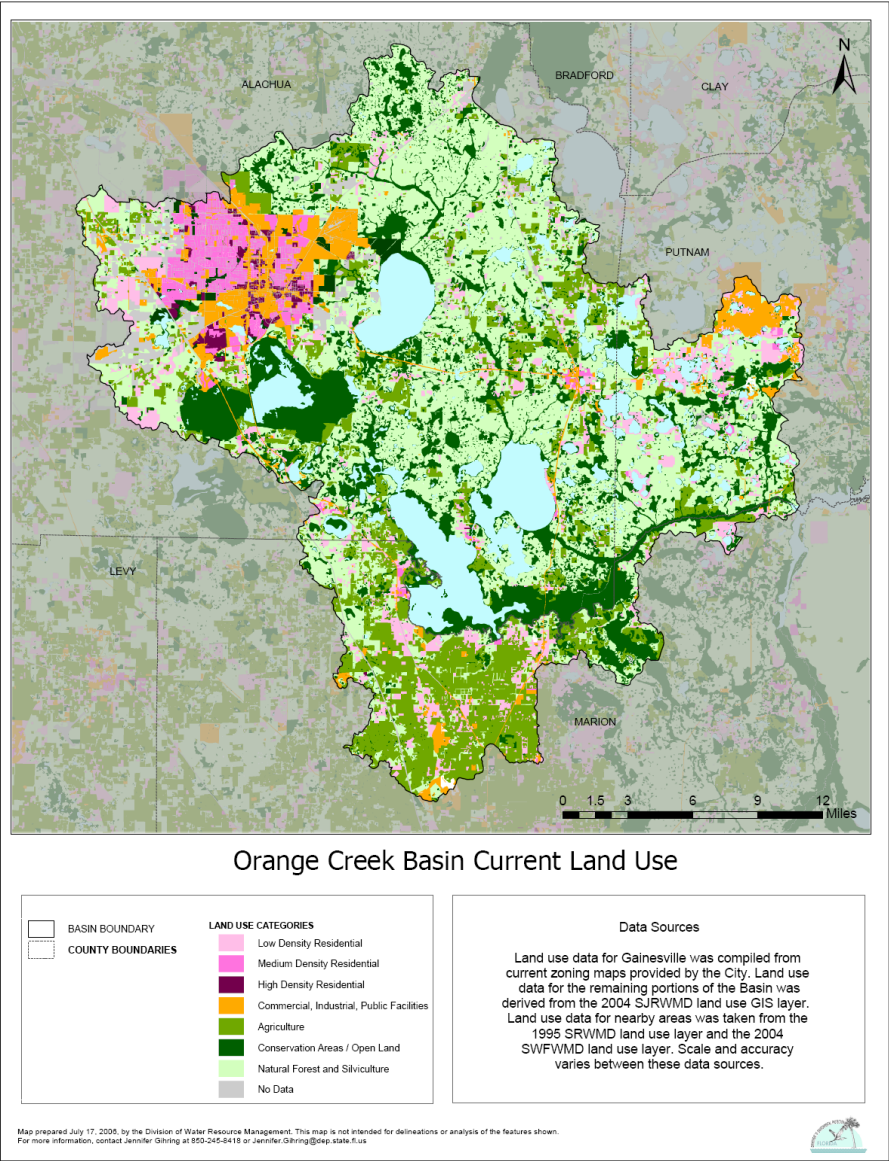


Figure 1.4. Land use in the Orange Creek Basin



1.3.6 TMDLs in the Orange Creek Basin

Table 1.3 lists the TMDLs that DEP has established for impaired waters in the Orange Creek Basin, with more detailed information in **Appendix E**.

DEP did not adopt a TMDL for Lochloosa Lake based on the following considerations:

- The relationship between the measured data and the empirical modeling was weak, due in large part to the data being collected during a period when the lake was herbicided and transformed from a macrophyte-dominated system to a more open-water system.
- The lake may return to a more natural state without the reductions from anthropogenic sources; therefore, DEP elected to re-evaluate the status of the lake in the next watershed cycle.

A TMDL was also adopted for Alachua Sink (WBID 2720A) requiring a 45% reduction in TN loading to the sink.

The map in **Figure 1.2** shows impaired waters in the Orange Creek Basin where TMDLs have been adopted. **Figure 1.3** identifies the sub-basins associated with these impaired waters. DEP and local partners continue to collect data to further analyze Planning List waterbodies in the basin.

1.3.7 Pollutant Allocations

Categories for Rule Allocations

The rules adopting TMDLs must establish reasonable and equitable allocations that will alone, or in conjunction with other management and restoration activities, attain the TMDL (Section 403.067, F.S.). Allocations may be to individual sources, source categories, or basins that discharge to the impaired waterbody. The allocations in rule identify either how much pollutant discharge in pounds per year (lbs/yr) each source designation may continue to contribute (**discharge allocation**), or the lbs/yr or percent of its loading the source designation must reduce (**reduction allocation**). Currently, the TMDL allocation categories are as follows:

- **Wasteload Allocation** – The allocation to point sources permitted under the NPDES Program, which includes the following:
 - **Wastewater Allocation:** Allocation to industrial and domestic wastewater facilities.
 - **NPDES Stormwater Allocation:** Allocation to NPDES stormwater permittees that operate MS4s (see the discussion on MS4s in **Section 1.3.5**). These permittees are treated as point sources under the TMDL Program.
- **Load Allocation** – The allocation to nonpoint sources, which includes agricultural runoff and stormwater from areas that are not covered by an MS4.

Table 1.3 lists the pollutant load allocations adopted by rule for each of the Orange Creek Basin waterbodies with a TMDL. In Hatchet Creek, the NPDES stormwater allocation is a 30.8% reduction in loading (reduction allocation). The allocations for Alachua Sink include a 41,003 lbs/yr NPDES wastewater discharge allocation, and a 45% NPDES stormwater reduction allocation. Whether an allocation is expressed as a

needed reduction or an allowable discharge, the result is the same. The source must limit the amount of discharge for which it is responsible.

Under the FWRA, the TMDL allocation may be an “initial” allocation among point and nonpoint sources. In such cases, the “detailed” allocation to specific point sources and specific categories of nonpoint sources may be established in the BMAP. The FWRA further states that the BMAP may make detailed allocations to individual “basins” (i.e., sub-basins) or to all basins as a whole, as appropriate. Both initial and detailed allocations must be determined based on a number of factors listed in the FWRA, including cost-benefit, technical and environmental feasibility, implementation time frames, and others (see **Appendix B**). Detailed allocations are most appropriate in basins with multiple point sources, detailed source identification, and sufficient data to support the division of the initial TMDL allocations.

The BWG agreed that, for the purposes of the initial BMAP, it would not be appropriate or cost-effective to try to calculate detailed allocations. Therefore, detailed allocations were not developed, based on the following considerations:

- Only two major point sources are identified in the TMDL wasteload allocations for nutrients: domestic wastewater (GRU) and municipal stormwater discharges. Municipal stormwater discharges also have allocations in the bacteria TMDLs. Allocations to these sources were adequately documented in the TMDL.
- Uncertainty about the sources of both fecal coliform bacteria and nutrients requires further source investigation to determine whether it is necessary and feasible to allocate specific responsibility among nonpoint sources. Formulating allocations more detailed than those adopted in the TMDLs, particularly for bacteria, is speculative with the current data and information available.
- The SJRWMD is developing PLRGs for Newnans Lake, Lochloosa Lake, and Orange Lake that should provide additional information on major sources of nutrient pollutants and allowable loadings. Once developed, the PLRGs will help identify where reductions can be made.
- Although local governments and DOT have independent permit responsibilities, the interconnectedness of their stormwater infrastructure requires local municipal separate storm sewer system (MS4) permittees to cooperate closely to meet their permit responsibilities. Therefore, the BWG did not assign responsibility for reductions to the specific entities that share common stormwater infrastructure. This cooperation occurs in part through the Gainesville Clean Water Partnership between the City of Gainesville, DOT, and Alachua County. Together the partnership shares NPDES permit responsibilities. The partnership also cooperates in implementing TMDL projects.

The BWG preferred to work cooperatively to identify the projects and activities that would most effectively achieve load reductions. Some of these activities involve additional research to identify and target pollutant sources, in order to ensure cost-effective solutions.

Due to the uncertainty and inability to identify and attribute detailed load allocations, the BWG was unable to assess whether activities contained within the BMAP will be sufficient to achieve each individual TMDL. However as each five-year basin cycle is completed and more information is gathered, it is anticipated that the future revisions to the BMAP will include strategies to ultimately achieve the TMDLs for each waterbody.

1.4 BMAP Assumptions and Considerations

The water quality impacts of BMAP implementation are based on the following fundamental assumptions and considerations:

- **Multiparameter Impacts** – Actions in this BMAP that decrease fecal coliform will also decrease nutrients.
- **Unquantified Project Impacts** – Some of the projects and activities contained in the BMAP cannot be quantified with regard to the reductions in coliform or nutrients they might achieve. However, because of their positive project impact, it is assumed that these actions will help reduce pollutant loads.
- **Source Identification** – Fecal coliform impairment sources are particularly difficult to trace. For this reason, source identification studies are included as management actions.
- **Future Growth** – Based on U.S. Census Bureau data gathered and evaluated through the BMAP process, basinwide future growth predicted through 2015 is not expected to substantially increase pollutant loads. However, emerging growth patterns in the east Gainesville area of the basin indicate that Census predictions may not adequately reflect the changes in land use that could occur in that area or other localized parts of the basin with large tracts of undeveloped land. It is uncertain to what extent future growth in these more localized areas will increase pollutant loads. There are programs in place to ensure that the possible effects are reduced, but extra effort may be needed.
- **Water Quality Issues** – This BMAP addresses water quality issues in the basin for which impairments were identified at the start of the BMAP process. Other water quality issues (e.g., erosion control, hazardous waste, etc.) are addressed through programs other than the TMDL Program.
- **Implementation Schedule** – BMAP implementation will be a long-term process. While many of the projects and activities contained in the BMAP are recently completed or currently ongoing, key projects and studies may extend beyond the first five-year BMAP cycle. Therefore, TMDLs established for impaired waters in the basin will not necessarily be achieved in the near term. Regular follow-up and continued BWG activity will ensure that management actions are carried out and that their incremental effects are assessed. As each five-year basin cycle is completed and more information is gathered, additional management actions to achieve TMDLs will be developed.

CHAPTER 2: ORANGE CREEK BASIN SETTING, WATER QUALITY TRENDS, AND WATER QUALITY ISSUES

2.1 Hydrology and Water Management

Lochloosa Lake, together with Orange and Newnans Lakes, are the main surface waterbodies in the Orange Creek Basin. The entire Orange Creek Basin covers about 602 square miles and lies within the Central Lowlands topographical region (Clark et al., 1964). The area generally has karst topography. In those portions of the basin overlain by the Hawthorn Formation, the Floridan aquifer is confined. In these conditions, natural discharge from the Floridan aquifer can occur where the confining layer is thin or absent. Such conditions exist at Magnesia Springs north of Lochloosa Lake (Pyne, 1985).

2.1.1 Lake Surface Area

The surface area of lakes in the Orange Creek Basin fluctuates widely due to drought and heavy rainfall. **Table 2.1** includes lake stage and acreage estimates from the SJRWMD based on a geographic information system (GIS) analysis. Additional lake acreage work was completed for Orange Lake using direct observations (J. Hinkle, DEP, 2002). This study estimated the area of Orange Lake as 1,820 acres in 2002, significantly lower than the 2,745-acre minimum estimate noted below.

In the hydrologic descriptions below, lake acreages are taken from the *Florida Lakes Gazetteer*. However, the TMDL models were calibrated against measured data, including the measured lake surface area. Given the variability in surface area measurements and the need to calibrate the model over time, surface areas used for TMDL development were the long-term annual average lake surface area, based on the annual average lake stages for the period of record for TMDL development.

Table 2.1. Orange Creek Basin lake statistics: Stage (feet) (NGVD) and area (acres)

	MINIMUM		MEDIAN		MAXIMUM		PERIOD OF RECORD
	STAGE	LAKE AREA	STAGE	LAKE AREA	STAGE	LAKE AREA	
Orange Lake	49.57	2,745	57.87	12,703	61.50	15,600	1933–2006
Lochloosa Lake	53.88	5,483	57.75	6,114	61.94	10,602	1936–2006
Newnans Lake	60.86	4,730	66.50	6,399	71.21	8,087	1936–2006

Source: SJRWMD, 2006a. These figures were obtained through a GIS analysis using detailed lake bathymetry (1-foot contours) in combination with stage data.

NGVD – National Geodetic Vertical Datum

2.1.2 Surface Water Flow

Rainfall recharges surface water directly and indirectly within the Orange Creek Basin. Ground water from the surficial and intermediate aquifers or aquifer systems provides the primary source of baseflow to the streams in the basin. There are five major watersheds in the Orange Creek Basin: Hogtown Creek, Paynes Prairie, Newnans Lake, Lochloosa Lake, and Orange Lake. **Figure 2.1** shows these sub-basins, and **Figure 2.2** shows surface water flow directions.

The Hogtown Creek watershed is a closed basin discharging to the Floridan aquifer system via Haile Sink on Hogtown Prairie west of the Cody Scarp. There are many tributaries to the creek, the largest being Possum Creek. Hogtown and Possum Creeks and their associated tributaries drain most of northwestern Gainesville. The direction of flow is generally south and west, although Possum Creek flows south and east to its confluence with Hogtown. Hogtown Creek flows through a series of wetlands between Southwest (SW) 2nd Avenue in Gainesville and its terminus at Haile Sink. The median flow in Hogtown Creek, measured at County Road (CR) 30 upstream of Hogtown Prairie and Haile Sink under baseflow conditions from May 1994 through September 2002, was 9.50 cubic feet per second (cfs) (Alachua County Environmental Protection Department [ACEPD], 2004).

The Paynes Prairie watershed includes two major streams: Sweetwater Branch and Tumblin Creek. The median flow in Sweetwater Branch at State Road (SR) 331 from February 1994 through April 2003 under baseflow conditions was 10.74 cfs (ACEPD, 2004). The median flow in Tumblin Creek downstream of Bivens Arm Lake (Bivens Arm Outfall) at SR 331 from September 1996 through August 2002 under baseflow conditions was 1.1 cfs (ACEPD, 2004). Paynes Prairie also receives water from Prairie Creek via Camps Canal.

On the prairie itself there are two major waterbodies: Alachua Sink and the associated Primary Sink Feature and Alachua Lake, a large wetland system. The water on Paynes Prairie discharges to the Floridan aquifer system via the Primary Sink Feature at Alachua Sink. The Paynes Prairie system can hold a large volume of water; after the 2004 hurricanes the surface water on the prairie covered an area twice the size of Newnans Lake (J. Weimer, DEP, personal communication, 2006).

Newnans Lake receives water from three primary sources: Hatchet Creek, Little Hatchet Creek, and Lake Forest Creek. Hatchet Creek, flowing east and south, contributes the greatest volume of water to Newnans Lake and has several large tributaries, including Bee Tree Creek, which converges with Hatchet Creek north of SR 26 above the north end of Newnans Lake. The median flow in Hatchet Creek measured near SR 26 from May 1993 through March 2003 under baseflow conditions was 1.53 cfs (ACEPD, 2004). Little Hatchet and Lake Forest Creeks enter Newnans Lake from the northwest and west, respectively. All three creeks are intermittently dry during drought periods. Newnans Lake discharges water to Prairie Creek on the southern side of the lake at SR 20. The water from Prairie Creek flows south toward Paynes Prairie and Orange Lake.

Figure 2.1. Orange Creek Basin sub-basins

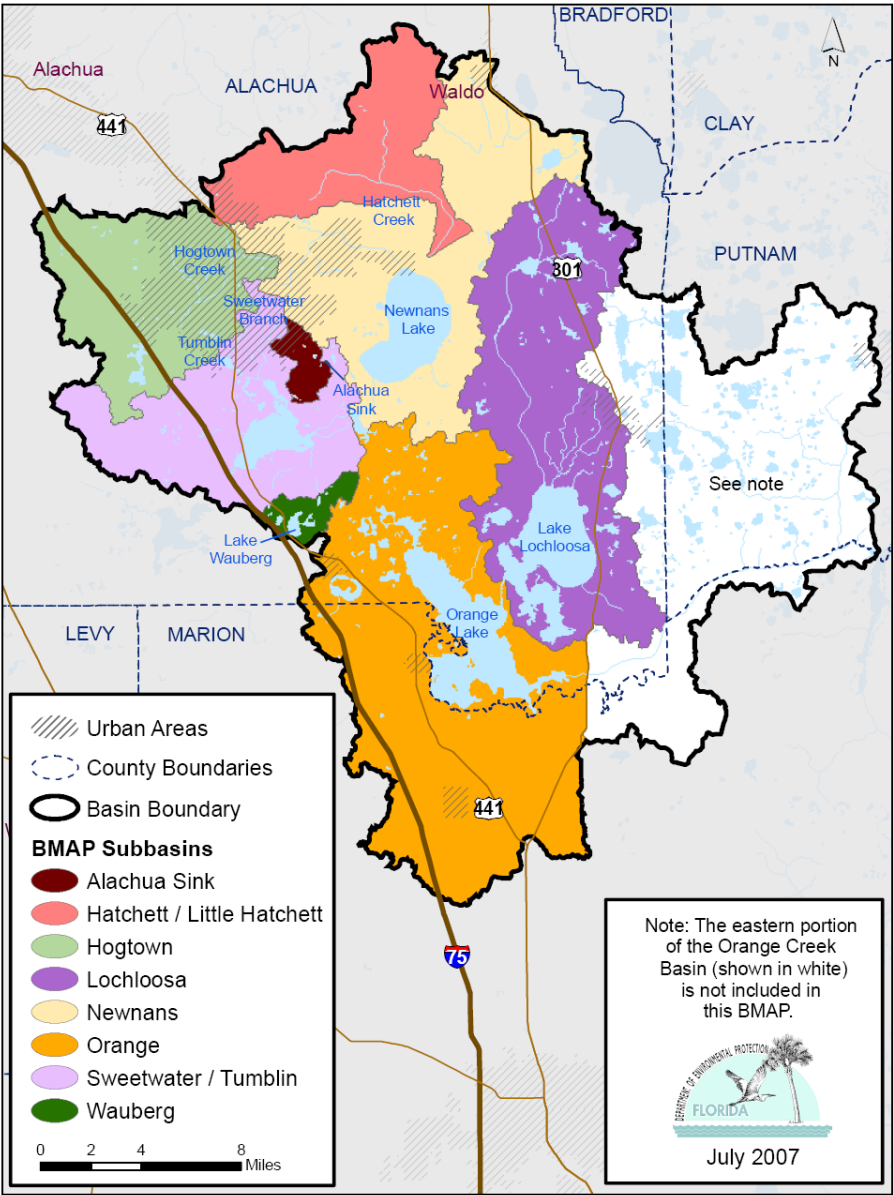
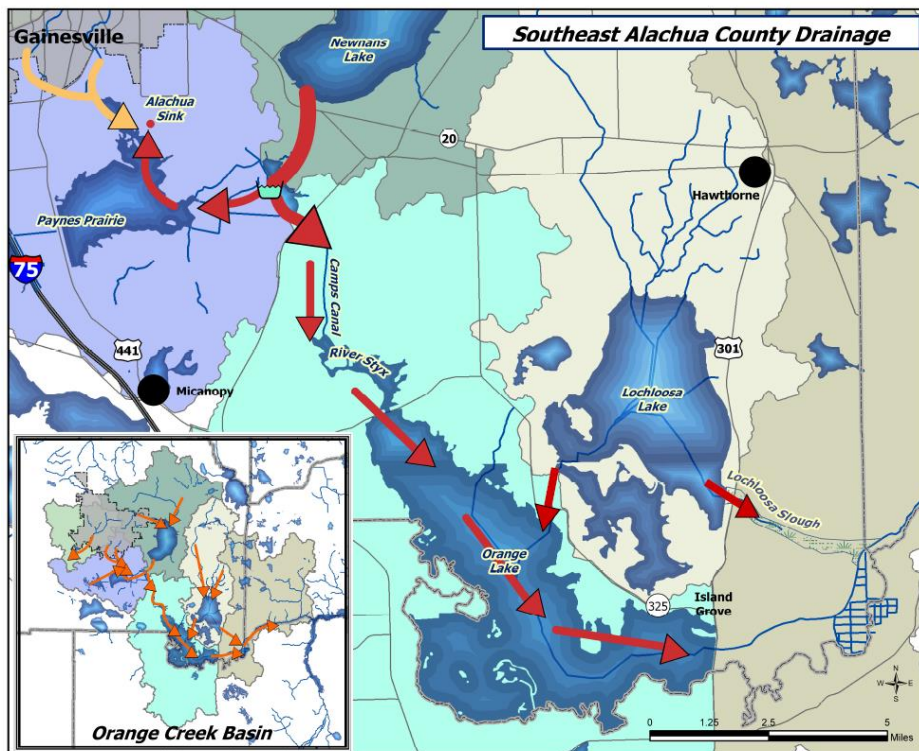


Figure 2.2. Surface water flow—Orange Creek Basin lakes



Source: ACEPD, 2004.

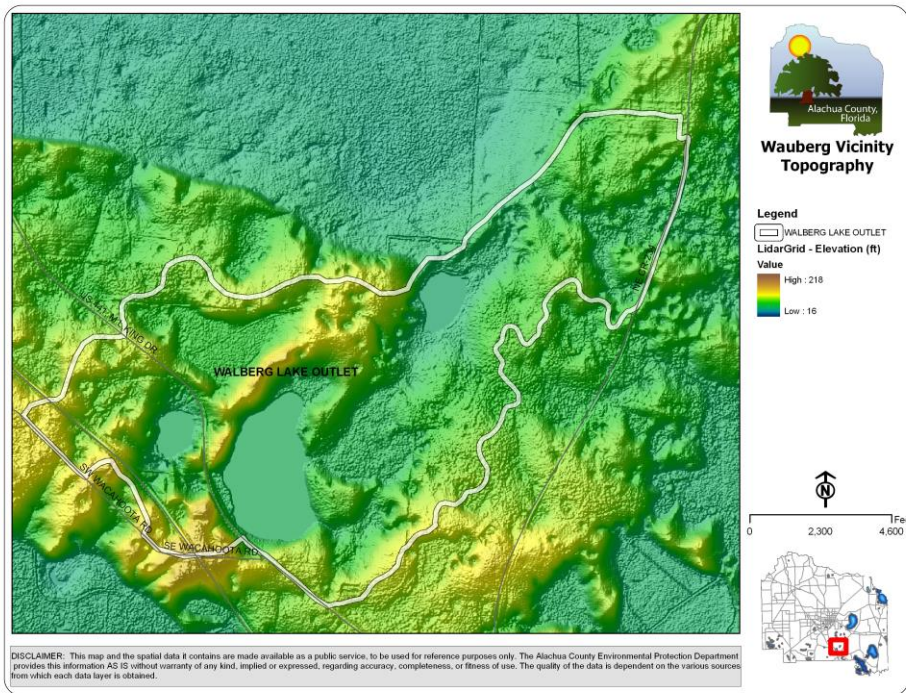
The primary surface water input to Lochloosa Lake is from Lochloosa Creek, which flows south and enters the north side of the lake. The creek receives baseflow from large expanses of pine flatwoods and wetlands in the watershed. Smaller creeks near the city of Hawthorne also flow south to the north end of Lochloosa Lake. Water exits Lochloosa Lake and enters Orange Lake through Cross Creek.

The Orange Lake watershed is located in southeastern Alachua and northern Marion Counties. The major surface water inputs to Orange Lake are from the River Styx on the north side of the lake and Cross Creek, which discharges from Lochloosa Lake. Water exits Orange Lake by ground water discharge and surface water flow. Ground water discharge to the Floridan aquifer system occurs via a sinkhole complex at the southwest end of the lake in the vicinity of Heagy Burry Park in Marion County. Surface discharge from the lake takes place through Orange Creek via a broad crested weir at U.S. Highway 301 on the southeast side of the lake.

Lake Wauberg, which receives most of its recharge directly from rainfall, discharges to the east through Sawgrass Pond to Chacala Pond (Opper, 1982). **Figure 2.3** shows Lake Wauberg's inflow and outflow. Opper (1982) reported that surface water outflow from the lake stopped when lake levels were below 66.60 feet above mean sea level (MSL).

Under periods of low or normal water levels, Lake Wauberg, Burnt Pond Marsh, and George's Pond remain unconnected. The hydrology of the watershed may change during periods of extremely high water levels, with some of the waterbodies connected. Burnt Pond Marsh, located north of the University of Florida (UF) property, is connected by a ditch and culvert (under U.S. Highway 441) to George's Pond. During October 2006, the ditch was dry and no water flowed from the marsh to George's Pond. George's Pond is isolated under low water and normal water levels. Under extremely high water levels, George's Pond may be connected to Lake Wauberg through a series of wetlands and ditches on the south side of the pond that could allow water to flow beneath U.S. Highway 441 to the lake.

Figure 2.3. Lake Wauberg inflow and outflow



2.1.3 Surficial Ground Water Flow

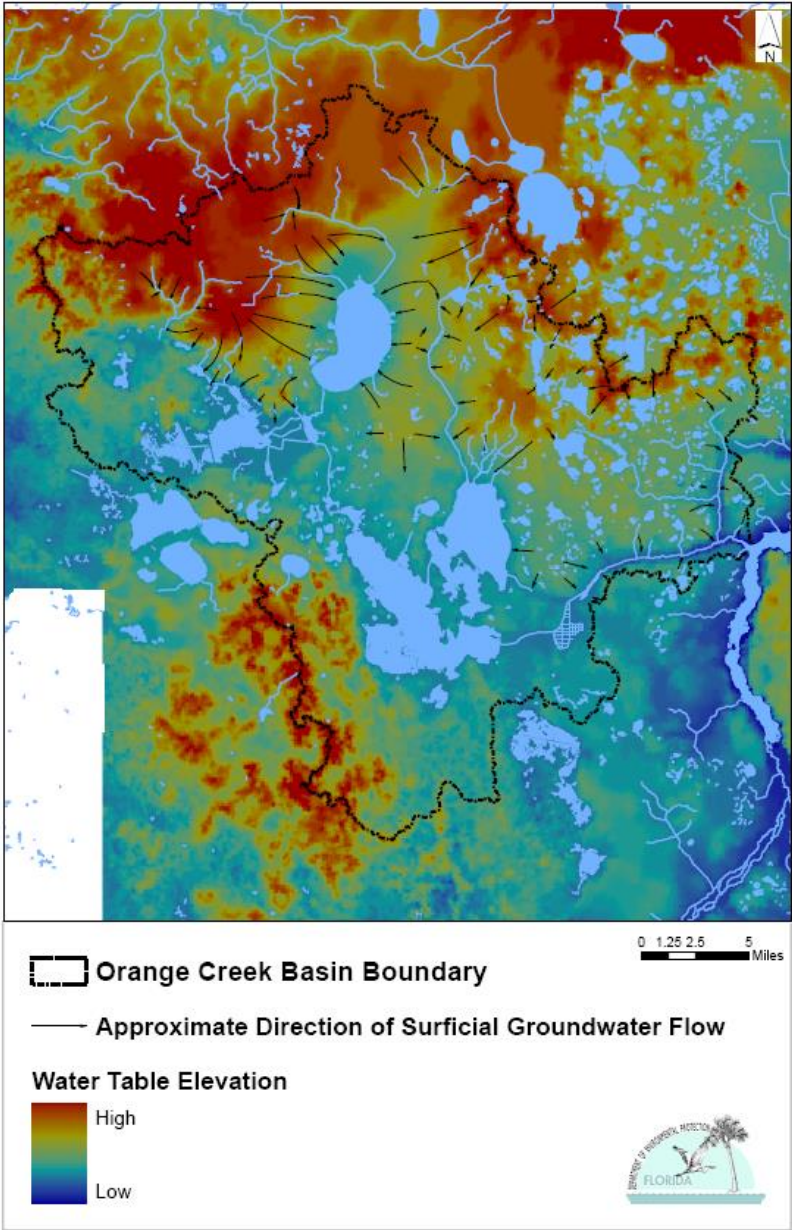
Rainfall recharges surface water and ground water within the Orange Creek Basin. Ground water from the surficial and intermediate aquifers or aquifer systems provides the primary source of baseflow to the basin's streams. The deeper Floridan aquifer system underlies all of Alachua County at depth but only discharges to surface waters where the potentiometric surface (water surface) is higher than the land elevation. Examples of this include the flowing wells at Magnesia Springs in the Grove Park area and potential upward seepage into Lochloosa Lake. The surficial and intermediate aquifers discharge to the creeks as elevation drops and the streams down cut through the Hawthorn Group formations east of the Cody Scarp. **Figure 2.4** shows surficial ground water flow in the Orange Creek Basin.

The surficial aquifer comprises primarily quartz sands, becoming clayey at depth. In most of eastern Alachua County, the surficial aquifer exists under water table conditions and discharges to streams when they intercept the surficial aquifer. Where relief is high, such as in the upper reaches of the Hogtown Creek watershed, the surficial aquifer discharges to the creeks directly as small springs and seeps or indirectly through associated small wetlands. Where relief is low, such as in some areas of the Little Hatchet Creek watershed, water from the surficial aquifer may discharge to streams during part of the year. In these areas of low relief, the surficial aquifer may receive recharge during times of the year when surface water levels are high. Ground water seepage to the creeks frequently occurs at the base of the surficial aquifer where the lower permeability Hawthorn Group clays are encountered. Ground water flow in the surficial aquifer generally follows topography. **Figure 2.4** identifies the general direction of surface water flow in the Orange Creek Basin.

The surficial aquifer system is not present throughout much of western Alachua County. In this area, water in the Floridan aquifer system is unconfined or very poorly semiconfined and exists under water table conditions. Areas within the Orange Creek Basin where a surficial aquifer may not be present include the western part of the Paynes Prairie watershed and areas in the south and west of the Orange Lake watershed. In the western portion of the Orange Creek Basin in the urban area of Gainesville, there are many small closed or stream-to-sink watersheds or basins. In these areas, the surficial aquifer system may not exist or only exists as an intermittent perched water table discharging via sinks or swallets to the Floridan aquifer system during periods of high rainfall. Examples include the Smith Creek and Rutledge Drain system.

In Alachua County east of the Cody Scarp, the Hawthorn Group formations provide both a confining unit above the Floridan aquifer and discrete water-bearing units collectively known as the intermediate aquifer or aquifer system. The intermediate aquifer by definition exists under confined conditions. Within the intermediate aquifer system, sands, clayey sands, carbonates (limestone and dolomite), and phosphatic materials can yield water. Through natural down cutting and dissection of the land surface by streams, these water-bearing units yield baseflow to many of the creeks. The Hawthorn Group formations are also exposed along the creek banks and streambeds as resistant beds that define the stream channels. Most water seeps out of the banks along seepage slopes; however, some springs do exist. One named spring, Glen Springs,

Figure 2.4. Surficial ground water flow



located in the upper reaches of Hogtown Creek, discharges from the intermediate aquifer. This fourth-magnitude spring had a mean historical discharge, from 1941 through 1972, of 0.35 cfs (Rosenau et al., 1977).

The Floridan aquifer or aquifer system does not contribute flow to the streams in the Gainesville urban area or to the Newnans Lake tributaries. The Floridan aquifer potentiometric surface and the Ocala Limestone, which is the uppermost geologic formation that constitutes the Floridan aquifer in Alachua County, are both lower in elevation than the creeks in the Gainesville urban area and the tributaries to Newnans Lake. Instead, the creeks that cross the Cody Scarp end in swallow holes or swallets that move surface water down, recharging the Floridan aquifer. Two large swallets in the area are Haile Sink, the terminus of Hogtown Creek on Hogtown Prairie, and the Primary Sink Feature at Alachua Sink on Paynes Prairie, which receives water from Alachua Lake (on Paynes Prairie), Tumblin Creek, and Sweetwater Branch. Phelps (1987) reported that water recharged the Floridan aquifer system from Hogtown Creek at an average rate of 19.2 cfs via Haile Sink and 15.3 to 35.7 cfs through Alachua Sink. Surface water also discharges to the Floridan aquifer system in Orange Lake via a sinkhole complex at the southwest end of the lake in the vicinity of Heagy Burry Park, located in Marion County.

2.1.4 Newnans Lake

Newnans Lake is located in a topographical region of the state known as the Central Lowlands (Clark et al., 1964). The geology of the area is dominated by the Hawthorn Group formations, which are relatively impermeable and act as a confining layer separating surface water from the influence of the Floridan aquifer. Poorly drained soil and low elevation gradients of the area result in moderately high sheetflow and poorly defined channels. Ponds and wetlands occur throughout the area. The major sources of water to the lake include surface runoff, subsurface flow, and direct rainfall (Canfield, 1981).

The lake is a typical shallow basin lake that covers 6,399 acres at median stage, and naturally fluctuates between 4,730 acres and 8,087 acres due to drought and heavy rainfall. The maximum depth is no more than 12 feet, and the mean depth is approximately 5 feet (Nordlie, 1976). A large drainage area north of the lake supplies inflow via three streams: Hatchet Creek, Little Hatchet Creek, and Lake Forest Creek. Hatchet Creek provides the greatest inflow to the lake. The lake's single major surface water outlet is Prairie Creek. Once water leaves the lake, about 41% of the flow (long-term average) goes the south and into Paynes Prairie through 3 large culverts. The remainder flows into Orange Lake by way of Camp's Canal (Gottgens and Montague, 1987).¹

In 1966, the Alachua County Recreation and Water Conservation and Control Authority (ACRWCCA) constructed a weir at the outlet of Newnans Lake to increase the water level. The weir was altered in 1976 by the Florida Game and Fresh Water Fish Commission (GFWFC) (now the Florida Fish and Wildlife Conservation Commission [FWC]) to include removable boards for lake management purposes. Boards were removed permanently from the weir in 1991 to increase lake level fluctuation. **Table 2.2** provides a history of activities at the Newnans Lake outlet structure since 1966. **Figure 2.5** shows a January 1992 photograph of the former weir.

¹ Flow into Paynes Prairie through the culverts was reserved by rule in 1995 by the SJRWMD Governing Board.

Table 2.2. History of activities at the Newnans Lake outlet structure, 1966–99

November 1966	The ACRWCCA constructs the Newnans Lake weir to increase lake water levels. The original concrete structure consists of a fixed weir with a crest at 66.7 feet above MSL and a supplementary low-flow orifice (invert elevation unknown) designed to discharge 10 cfs with the lake at the crest elevation.
March 1976	The GFWFC alters the weir to include removal flashboards that provide the option for lake level fluctuations. This modification is intended to allow better management of the lake, including drawdown, and consists of a cut in the existing structure approximately 70 feet wide and 6.8 feet deep, with slotted columns and flashboards for continued control options. However, during most of the structure's history, the flashboards are kept in place to maintain water levels.
April 24–July 17, 1989	The boards are temporarily removed from the weir for 3 months for an experimental drawdown of the lake to study the impact of lower water levels on the sediment and biology of the lake. Results in Gottgens and Crisman, 1992.
Spring 1991	After meetings of the Newnans Lake Task Force, the GFWFC permanently removes the boards from the weir to allow natural lake level fluctuations.
1999	DOT removes the weir when it rebuilds the SR 20 bridge over Prairie Creek.

Compiled by SJRWMD, 2002. Sources: Gottgens, 1993; Gottgens and Crisman, 1992; Nagid et al., 2001; Robison et al., 1997; Weimer, J., DEP, personal communication, 2006.

Figure 2.5. Photograph of former weir at the outlet of Newnans Lake, SR 20 Bridge, January 1992



The diversion of Prairie Creek from Paynes Prairie to Orange Lake, and the construction of the Orange Lake Weir, Newnans Lake Dam, and three major highways (U.S. Highways 301 and 441 and Interstate 75 [I-75]) have altered natural flow patterns and water level fluctuations in the Orange Creek Basin. Newnans Lake has become hypereutrophic, and woody vegetation has spread over a part of Paynes Prairie as the result of some of these hydrologic alterations (SJRWMD, 2005).

2.1.5 Orange Lake

Orange Lake is also located in the Central Lowlands (Clark et al., 1964). The geology of the area is dominated by the Hawthorn Group formations, which are about 50 feet thick where Orange Lake is located (Scott, 1988). The Hawthorn Group is relatively impermeable and acts as a confining layer to separate surface water from the influence of the Floridan aquifer. However, a connection between the lake water and Floridan aquifer exists through a sinkhole system located in the southwest part of Orange Lake. Because the potentiometric surface of this area is about the same as or lower than the long-term average elevation of the lake surface (57.8 feet) (Lasi, 1999), the lake water moves downward. Therefore, it is not anticipated that the Floridan aquifer will have a significant direct influence on the lake water quality.

Orange Lake, a shallow lake with a relatively large surface area of 12,703 acres at median stage, naturally fluctuates between 2,745 acres and 15,600 acres due to drought and heavy rainfall, respectively (SJRWMD, 2006a). Minimum lake acreage estimates as low as 1,820 acres have been developed through direct observation (J. Hinkle, DEP, personal communication, 2002). The maximum depth of the lake under average conditions is about 12 feet, and the mean depth is approximately 5.5 feet (Deevey, 1989). Major sources of water to the lake include interflow via Camps Canal/River Styx from Newnans Lake and Cross Creek from Lochloosa Lake, surface runoff from the watershed, and direct precipitation into the lake. Water flows out of the lake through the sinkhole system located in the southwest part of the lake and through a notched, fixed-crest weir at the U.S. Highway 301 bridge into the headwater wetlands of Orange Creek. Orange Creek drains into the lower Ocklawaha River Basin. The Orange Lake watershed drains about 87,339 acres.

2.1.6 Lake Wauberg

Lake Wauberg is located in the Central Valley of the Ocklawaha River Basin (Alachua County), approximately 8 miles south of Gainesville. The lake is located in the Fairfield Hills physiographic province (White, 1970). Relief in the watershed is relatively high, with land surface elevations ranging from 58 to 136 feet above NGVD. Erosional remnants and karst features dominate the region. Shallow prairies, flat-bottomed lakes, and hilly terrain characterize the surrounding area. Lake Wauberg is situated among remnant hills that comprise Hawthorn Group materials (White, 1970; Oppen, 1982). Lake Wauberg is a "perched lake," with the lake bottom covered in organic matter and clay materials eroded from the surrounding Hawthorn Group formations (Oppen, 1982). In this area, the Hawthorn Group formations support a shallow surficial aquifer (or water table aquifer) and the lake (Oppen, 1982).

Lake Wauberg has a surface area of 248 acres, with a mean depth of 12 feet (Florida LakeWatch). The watershed for the lake encompasses 3,394 acres and includes a number of other waterbodies: Burnt Pond Marsh (to the north, covering 238 acres),

George's Pond (to the west of U.S. Highway 441, covering 32 acres), Sawgrass Pond (to the east of Lake Wauberg, covering 241 acres) and Chacala Pond (53 acres). These estimates of area are based on GIS analysis of SJRWMD Land Use and Land Cover 2004 vector digital data (D. Gijssels, personal communication, November 30, 2006). In this analysis of the data, Lake Wauberg itself was found to cover 235 acres and there were a total of 1,126 acres of wetlands in the watershed, covering approximately one-third of the watershed's total land area (D. Gijssels, personal communication, November 30, 2006).

2.1.7 Alachua Sink

Alachua Sink (WBID 2720A) is located on the northern edge of Paynes Prairie, south of the city of Gainesville and approximately 2.5 miles east of U.S. Highway 441. It consists of a small lake, with a corresponding solution sink known as the Primary Sink Feature that recharges the Floridan aquifer (Jones Edmunds & Associates, Inc., 2003). Alachua Sink had a surface area of about 13.5 acres and a mean depth of around 1 meter in 2003 before the recent flooding of the prairie. Alachua Lake is the inundated portion of Paynes Prairie.

Alachua Sink, Alachua Lake, and Paynes Prairie are part of a dynamic system where major changes in hydrology are observed in periods of extreme wet and dry conditions. Alachua Sink and Alachua Lake are separate waterbodies during periods of drought and/or low rainfall. In wet years the entire prairie is flooded and these two waterbodies coalesce. The reported formation of Alachua Lake in 1876, when the prairie flooded, and the subsequent draining of the lake in 1891, has been a topic of discussion since the draining occurred. Heavy rains were noted prior to the formation of the lake (Jensen, 1985), and the possibility exists that the formation of the lake was related to a short-term climatic event (Ritter, 1991). Alachua Lake periodically refloods such that Alachua Sink and Alachua Lake are one waterbody. Such events occurred in 1998 and again in 2004–05 (J. Weimer, 2006).

Table 2.3 lists the historical wet and dry periods in Alachua Sink and Alachua Lake between 1823 and 1941.

The dominant, underlying geologic component of the area is the Ocala Formation, with younger overlying terrace deposits of undifferentiated sediments, sand, and clayey sand (Gottgens and Montague, 1988). The Ocala Formation is a soft, porous limestone, interbedded with dense, hard limestone and dolomite (Clark et al., 1964). Sink formations have occurred in the area through subterranean erosion by ground water solution of the limestone (McGrail et al., 1998). The Cody Scarp, roughly at the 100 to 110 NGVD elevations, is a significant geologic feature in the area. Karst features dominate the scarp domain. The streams entering Paynes Prairie receive much of their water from surficial and intermediate aquifer seeps and springs.

Table 2.3. Historical wet and dry periods—Alachua Sink and Alachua Lake, 1823–1941

DATE	STATE OF PRAIRIE
1823	Flooded
1824	Dry
1857	Flooded
Soon after	Dry
1861	Flooded
Soon after	Dry
1876	Flooded to form Alachua Lake
1880	Alachua Lake full
1891	Dry
1941	Flooded

Based on Jensen, 1985.

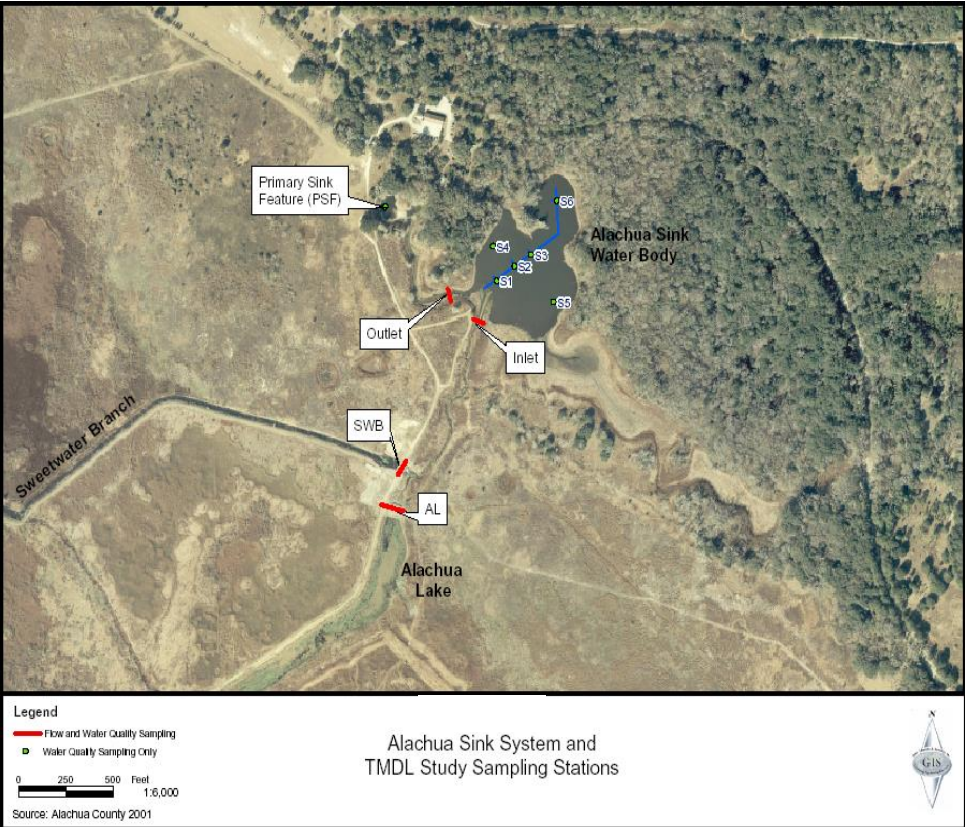
The surrounding drainage basin for the lake covers approximately 2,758 acres. There are two well-defined inflows into the lake: Sweetwater Canal and a canal that connects Alachua Lake to Alachua Sink (a combined drainage area of 39,373 acres). **Figure 2.6** provides an aerial view of Alachua Sink and its inflow canals. The Alachua Sink waterbody has an outlet stream that flows to the primary sink feature. Major sources of flow to Paynes Prairie include Sweetwater Branch (Bivens Arm) and Prairie Creek (which drains from Newnans Lake). About 45% of the flow, as a long-term average, from Newnans Lake via Prairie Creek goes south into Paynes Prairie through 3 large culverts, and the rest flows towards Orange Lake by way of Camps Canal (Gottgens and Montague, 1987). Flow into Paynes Prairie was reserved under the SJRWMD's *Reservation of Water Rule* to support fish and wildlife.

The surface water on Paynes Prairie, including Prairie Creek, is controlled by a series of channels, locks, and pumps that were installed in the eastern part of the prairie during 1928 and 1929 to divert water away from Alachua Sink to Orange Lake (Jensen, 1985). Before the locks and channels were installed, Paynes Prairie historically fluctuated between a lake and a dry prairie due to the infiltration rate of Alachua Sink and the changes in ground water levels (Pirkle, 1956). Not until the 1970s, after the state purchased the land, was a control station built to allow some water from Newnans Lake to again flow to Alachua Sink (Jensen, 1985).

2.1.8 Lochloosa Lake

Lochloosa Lake is located in the eastern part of Alachua County, approximately 15 miles southeast of Gainesville and 4 miles south of Hawthorne. The lake covers 6,114 acres at median stage and naturally fluctuates between 5,483 and 10,602 acres due to drought and heavy rainfall, respectively (SJRWMD, 2006a). The lake has a maximum depth of 11 feet and a mean depth of 7 feet (Langeland, 1982), and its watershed covers 52,000 acres. A large drainage area to the north supplies most of the surface water inflow through Lochloosa Creek. The primary outflow is through Cross Creek, although an unknown amount of drainage occurs when Lochloosa Lake is at high stage to Orange Creek through Lochloosa Slough in the southeastern corner of the lake (Gottgens and Montague, 1987).

Figure 2.6. Aerial view of Alachua Sink and inflow canals from Sweetwater Branch and Paynes Prairie/Alachua Lake



Cross Creek, the surface water connection between Lochloosa Lake and Orange Lake, is only about 1,600 meters long and has a watershed of about 321 acres.

Poorly drained soil and the low elevation gradients of the area result in moderately high sheetflow and poorly defined channels. Ponds and wetlands occur throughout the area. The major sources of water to Lochloosa Lake include surface runoff, subsurface flow, and direct rainfall (Canfield, 1981). Ground water from deep aquifers is not a regular part of the lake's overall water balance (Deevy, 1988). This is supported by data that indicate a low mineral content of the lake waters (Gottens and Montague, 1987).

The primary mechanisms by which water is lost from Lochloosa Lake are drainage through the pervious sediments that make up the lake bottom, solution cavities, evapotranspiration, and discharge to surface streams, primarily Cross Creek. While the lake responds quickly to monthly net rainfall, annual or decades-long lake level variations appear to be controlled by changes in the artesian pressure affecting downward leakage through the lake bed (Deevy, 1988).

2.1.9 Hatchet Creek

Hatchet Creek, located northeast of the city of Gainesville, is a tributary, and drains into Newnans Lake. Considered a blackwater stream (low pH and high color), it is approximately 10.8 miles long, with a contributing watershed of approximately 41,285 acres, or 64.5 square miles. Two major tributaries in the watershed are Forest Creek, in the western part of the basin, and Bee Tree Creek, which drains the entire eastern part of the watershed. Bee Tree Creek joins the main channel of Hatchet Creek upstream of SR 26 in the vicinity of the Newnans Lake Conservation Area, which incorporates the former Gumroot Swamp Conservation Area. Land surface elevation ranges from 165 feet in the upper basin to 75 feet (NGVD) near Newnans Lake.

Deleted: that leads to and essentially forms the headwaters of the Ocklawaha River in Alachua County

The Hatchet Creek watershed is located along the southern margin of the Northern Highlands physiographic province (White, 1970). Land surface elevations range from 165 to 75 feet (NGVD), decreasing as Hatchet Creek reaches the northern end of Newnans Lake. In the watershed, Plio-Pleistocene terrace deposits of sands, silts, clayey sands, and sandy clays overlie the sediments of the Hawthorn Group formations (Spangler in Thomas et al., 1985).

In the headwaters, forested wetlands and pine flatwoods dominate the landscape. Forest and rural open areas (64%) dominate land use in the Hatchet Creek watershed. Other significant land uses include water and wetlands (22%), low-density residential (5%), and agricultural (5%). Urban and built-up land uses represent less than 8% of the watershed acreage (Lassiter, 2003). Primarily due to its rural setting and the presence of conservation areas, several segments of Hatchet Creek have the characteristics of a healthy ecosystem, including good habitat for macroinvertebrates and other aquatic life.

2.1.10 Hogtown Creek

Hogtown Creek is located in the city of Gainesville (central Alachua County). The creek is approximately 5.7 miles long and receives stormwater runoff from the city of Gainesville, which it discharges to the Floridan aquifer through Haile Sink. Approximately 65% of the land use in the Hogtown Creek watershed and surrounding Hogtown Prairie is low-density residential, 15% is commercial, with the remaining 20%

divided between mixed hardwood forest, forested wetlands, and silvicultural, agricultural, and institutional uses (ACEPD, 2004).

The Hogtown Creek watershed is located along the western and southern margins of the Northern Highlands physiographic province (White, 1970). Relief is high in the watershed. In many areas the creek and tributaries are deeply incised, exposing Hawthorn Group materials consisting of sands, silts, clayey sands, sandy clays, carbonates (limestone and dolomite), and phosphates. Hogtown Creek crosses the Cody Scarp and discharges to Haile Sink in Hogtown Prairie, west of I-75.

Hogtown Creek has numerous tributaries, with four of the largest being Possum Creek, Springstead Creek, Rattlesnake Branch, and Elizabeth Creek. These all join Hogtown Creek in the area between Northwest (NW) 39th Avenue and University Avenue.

2.1.11 Tumblin Creek

Tumblin Creek is located in the city of Gainesville and is approximately 2.3 miles long. The creek flows into Bivens Arm Lake. The outflow of Bivens Arm then travels to Paynes Prairie, where it enters the Floridan aquifer via the Primary Sink Feature adjacent to Alachua Sink. The headwaters of the creek, which extend north from SW 5th Avenue to NW 8th Avenue, west to 13th Street, and east to Main Street, are channelized through the underground concrete culverts of the MS4. Sources of baseflow include springs and seeps at the base of the surficial aquifer and, lower in the basin, permeable units within the intermediate aquifer system.

The Tumblin Creek watershed encompasses about 3.8 square miles of urban Gainesville. CH2M HILL (1985) reported 60% of this area to be impervious. The sub-basin is highly urbanized, except for the Bivens Arm floodplain, and includes some areas of development directly along the creek.

The Tumblin Creek watershed is located along the southwestern margin of the Northern Highlands physiographic province (White, 1970). As the main stream channel flows southwest, elevations decrease, exposing recent sands as well as Plio-Pleistocene Terrace deposits (comprising sands and clays) and Miocene age formations of the Hawthorn Group (Spangler in Thomas et al., 1985). The Hawthorn Group formations are extremely variable but generally consist of sands, silts, clays, carbonates (limestone and dolostone), and phosphates (Scott, 1988). Many of the more resistant beds can be observed outcropping along the bank or in the streambed.

2.1.12 Sweetwater Branch

Sweetwater Branch, an urban creek, flows through the city of Gainesville. Approximately 2.8 miles long, it drains 3.3 square miles and is one of the smaller creeks in the Orange Creek Basin. Soils in the Sweetwater Branch watershed range from moderately well drained in the upper portion of the watershed to poorly drained in the lower reaches. The creek watershed is mainly contained within the limits of the city of Gainesville. It continues to flow into Paynes Prairie Preserve State Park and ultimately discharges to the Floridan aquifer via the Primary Sink Feature adjacent to Alachua Sink. Though there is one permitted domestic wastewater discharge to Sweetwater Branch, the GRU Main Street Water Reclamation Facility (WRF), urban and residential runoff are thought to be significant sources of bacterial contamination. Sweetwater Branch has one major tributary, Rosewood Branch, located in the northeastern part of the watershed.

The upper reaches of the Sweetwater Branch watershed are in the Northern Highlands physiographic province (White, 1970). As land surface elevations decrease toward Paynes Prairie, Sweetwater Branch crosses the Cody Scarp into the Alachua Lake Cross Valley in the Central Highlands physiographic province (White, 1970). Mean elevations range from 180 to 59 feet (NGVD). Sediments of the Hawthorn Group formations are exposed along the stream banks in the lower reaches of the watershed, where more recent Plio-Pleistocene terrace deposits of sands, silts, and clays have been eroded (Spangler in Thomas et al., 1985).

Roughly 60% of the watershed is impervious (ACEPD, 2004). The upper third of the basin is highly developed and consists mostly of residential and commercial land uses. This portion of the basin includes the Duck Pond neighborhood and the areas surrounding the Rosewood Branch tributary. The housing consists of a mixture of single-family homes and high-density apartments and condominiums. The lower two-thirds of the watershed contains some residential development but is used largely for commercial, industrial, and institutional purposes.

2.1.13 Streamflow

The mean streamflow of Hatchet Creek, measured at the SR 26 crossing, was 5.9 cfs based on SJRWMD data from May 1993 through March 2003 (n=762) (ACEPD, 2004). Streamflow in Hatchet Creek ranges from 0, when the stream dries up, to a maximum of 263.5 cfs for the 10-year period of record. Under stormflow conditions, the mean streamflow was 37.5 cfs (n=12). The flow from Hatchet Creek is the largest inflow to Newnans Lake (ACEPD, 2004).

The mean streamflows in Hogtown Creek are the highest of all creeks in Gainesville (ACEPD, 2004). The mean streamflow at the CR 30 (SW 24th Avenue) bridge is 18.59 cfs (n=11,274). The maximum streamflow recorded at this station over the 30-year period of record was 860 cfs in September 1988. The largest tributary to Hogtown Creek, Possum Creek, had a mean streamflow of 4.20 cfs (n=740) for the period of record, from September 1996 through September 1999 (ACEPD, 2004). It also receives an average discharge of 0.346 cfs from Glen Springs, an intermediate aquifer spring.

The SJRWMD collected streamflow data on Tumblin Creek at both US 441 (TUM441) and at US 331 (TUM331), the outfall from Bivens Arm Lake. The mean streamflow at TUM441 is 1.6 cfs, while it is 2.6 cfs farther downstream at TUM331 (ACEPD, 2004). Although the mean flow for TUM331 is higher than TUM441, the former is characterized by intermittent flow, while the latter flows continually through the seasons. The mean flows in Tumblin Creek are the lowest of all urban streams in Gainesville (ACEPD, 2004). Storm flows were higher than those on Possum Creek but substantially less than those on both Sweetwater Branch and Hogtown Creek (ACEPD, 2004).

The SJRWMD collected extensive streamflow data at both the Depot Avenue (DEPOT) and SR 331 (SWB331) crossings (ACEPD, 2004). The mean streamflow at DEPOT is 1.2 cfs (n=1,119) for the period of record from October 1999 through January 2003 (ACEPD, 2004). The mean discharge from the GRU Main Street WRF is 8.5 cfs. Downstream from the Main Street WRF at SWB331, the mean streamflow is 12.7 cfs (n=1,856) for the period of record from February 1994 through April 2003 (ACEPD, 2004).

Flow data for this period (2004) are also available from the SJRWMD for the following three sites: Lochloosa Creek at Grove Park, Camps Canal at Rochelle, and Orange Lake Outlet at Citra. **Appendix F** provides tables with 2004 daily flow values at these sites (G. McDermot, SJRWMD, personal communication, 2006). The mean streamflow in Camps Canal from January 1, 2004, through December 31, 2004, was 38.46 cfs. The mean streamflow in Lochloosa during this same time was 56.33 cfs. For the Orange Lake discharge, the mean daily streamflow was 63.70 cfs.

2.2 Land Use Change and Population Growth

This section of the Orange Creek BMAP evaluates future growth impacts from 2005 through 2015. In addition to the value of considering future growth from a resource standpoint, Paragraph 403.067(7)(a)(2), F.S., requires that BMAPs “identify the mechanisms by which potential future increases in pollutant loading will be addressed.” The Orange Creek Basin analysis focuses on population growth as a measure of the location and intensity of future growth in the basin to address the potential future increases in pollutant loading.

As new land is developed, less rain filters into the ground, and runoff and the pollutants carried in that runoff increase. Population growth also affects pollutant loading by increasing the intensity of activities such as traffic, lawn fertilization, pet ownership, and others. Where land is developed can significantly mitigate or magnify these impacts. To maintain the load reductions gained through BMAP implementation, local governments, businesses, citizens, and others will need to practice pollution prevention on a continuing basis through land use decisions, ordinance adoption and enforcement, public education efforts, best management practices (BMPs), personal habits, and other means. Even with enhanced stormwater requirements for new development, future growth is likely to lead to increased pollutant loadings caused by increased stormwater from traffic and the use of existing commercial and public facilities, and by increased domestic wastewater discharges.

2.2.1 Data Sources

A variety of sources provide estimates of future population growth in the Orange Creek Basin. These include the North Central Florida Regional Planning Council, DOT, Alachua County Comprehensive Plan, Marion County Comprehensive Plan, City of Gainesville Comprehensive Plan, SJRWMD, and U.S. Census Bureau. **Appendix G** contains additional information on future land use for the city of Gainesville, Alachua County, and Marion County.

Based on recommendations from local planning staff, Transportation Analysis Zone (TAZ) data from the Gainesville Metropolitan Transportation Planning Organization and Ocala/Marion County Transportation Planning Organization were selected as the primary resource for evaluating future population projections in the Orange Creek Basin. TAZs are areas delineated by state and/or local transportation officials for tabulating traffic-related data—especially journey-to-work and place-of-work statistics. A TAZ usually consists of one or more census blocks, block groups, or census tracts. TAZ data are based on U.S. Census data and Bureau of Economic and Business Research projections. TAZ data are reviewed closely by local planners during their compilation. The spatial extent of each zone is highly variable, ranging from 1 acre to over 15,000 acres, roughly corresponding to population density.

TAZ data include a variety of demographic and transportation statistics. For this analysis, only the population estimates were used. Population data were aggregated across all housing types (e.g., single family, multifamily). These future growth estimates do not include increases in commercial or industrial activities not associated with increases in residential population.

Appendix G contains additional descriptions of land use, zoning, and future growth potential in the Orange Creek Basin.

2.2.2 Analysis Method

TAZ data were obtained from the Gainesville Metropolitan Transportation Planning Organization for the Gainesville and Alachua County portions of the basin and the Ocala/Marion County Transportation Planning Organization for the Marion County portion. Although the general nature and purpose of TAZ data are the same, these organizations provided slightly different datasets for Alachua versus Marion County. Population estimates in Alachua County TAZs were available for 2000 and 2015, while Marion County estimates were available for 2000 and 2025. Population by TAZ for Alachua County was extrapolated out to 2015 based on 1990–2000 population and growth rates. For Marion County, population growth was estimated through straight-line interpolation between the 2000 and 2025 endpoints. The result was an estimate of total population for each TAZ in five-year increments from 2000 through 2015.

These population estimates were then used to calculate population density by TAZ, thus accounting for the wide variation in TAZ size. To provide a more accurate estimate of anticipated population density, land uses incompatible with development (open-water and conservation areas) were removed from the total acreage of each TAZ. Conservation lands included areas managed by the SJRWMD and lands acquired by Alachua County through the Alachua County Forever Program. Population density and density change over time were then calculated using these revised TAZ acreages.

The population density growth estimates provided a general sense of the location and intensity of increasing density in the basin. BWG members felt that quantitative estimates of pollutant loading from future growth were not needed for the Orange Creek Basin.

2.2.3 Future Growth Estimates

Figures 2.7 and **2.8** show 2010 and 2015 population density estimates by TAZ, respectively. The figures also show areas with a greater than 50% increase in population density (hatched areas). **Figure 2.7** identifies areas of rapid growth from 2005–10, while **Figure 2.8** shows the same for 2010–15. The TMDL sub-basins are also shown.

Population projections based on TAZ data are roughly comparable to projections in the City of Gainesville Comprehensive Plan, the Alachua County Comprehensive Plan, and those developed by the SJRWMD for water supply planning purposes (**Table 2.4**). The Alachua County Comprehensive Plan projections are higher because they are based on a full-county population. Only a portion of the county is located within the Orange Creek Basin. Given the uneven distribution of population within the county, the reduction of this projection based on the acres of the county contained within the basin would not be accurate.

Table 2.4. Comparison of TAZ projected population estimates with other data sources

YEAR	SOURCE	ALACHUA COUNTY POPULATION ESTIMATE	MARION COUNTY POPULATION ESTIMATE
2000	U.S. Census	180,206 (115,753 of this is in Gainesville)	8,781
2005	TAZ	198,851 (118,142 of this is in Gainesville)	8,297
	SJRWMD	178,949 (includes Gainesville)	8,698
	Alachua County Comprehensive Plan	237,100 (106,677 of this is in Gainesville)	N/A
2010	TAZ	212,668 (124,581 of this is in Gainesville)	8,687
	SJRWMD	190,506	9,894
	Alachua County Comprehensive Plan	253,600 (113,279 of this is in Gainesville)	N/A

Sources:

Alachua County Comprehensive Plan: 2001–2020 (Future Land Use Element). These estimates match those in the City of Gainesville Comprehensive Plan, February 6, 2001 (Future Land Use Element, Table 9).

SJRWMD via Richard Doty, GIS Associates, June 2006.

N/A – Not applicable

Figure 2.7. Orange Creek Basin population density (2010) and areas of rapid growth (2005–10)

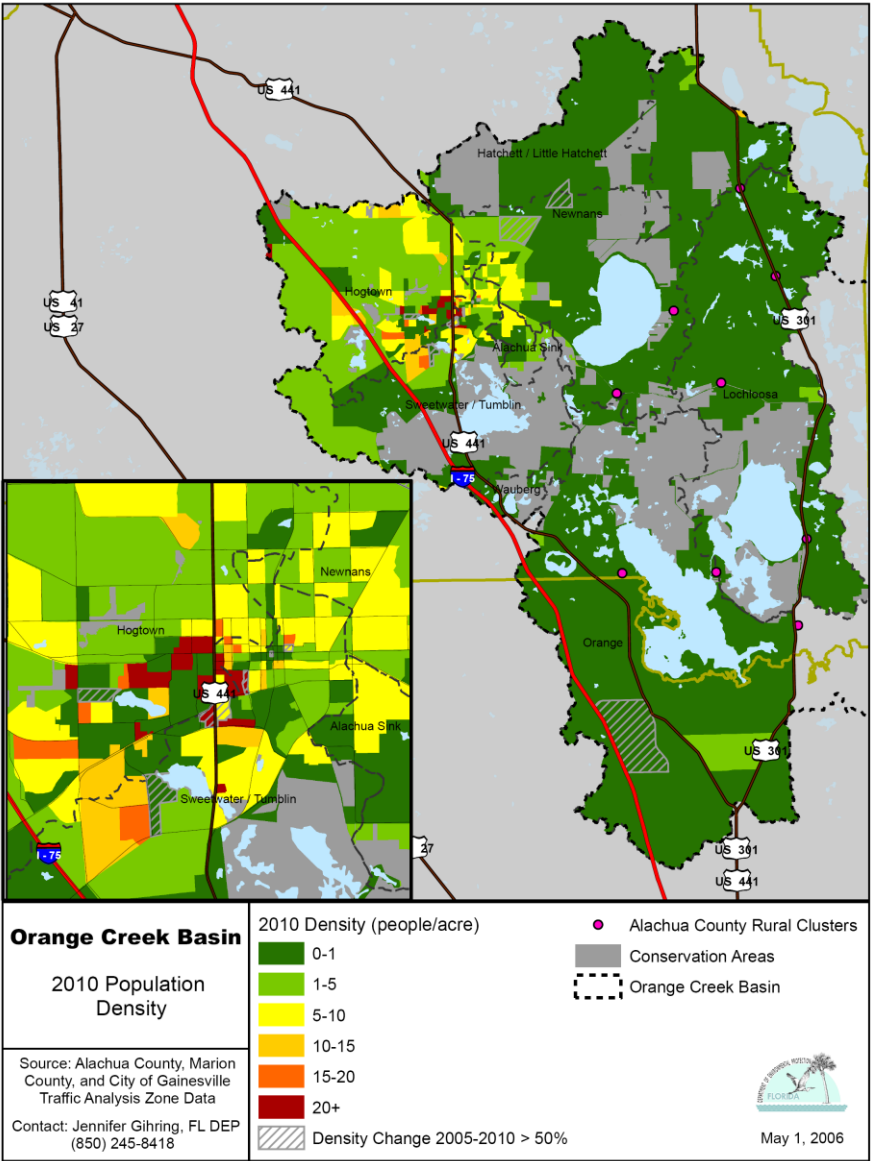
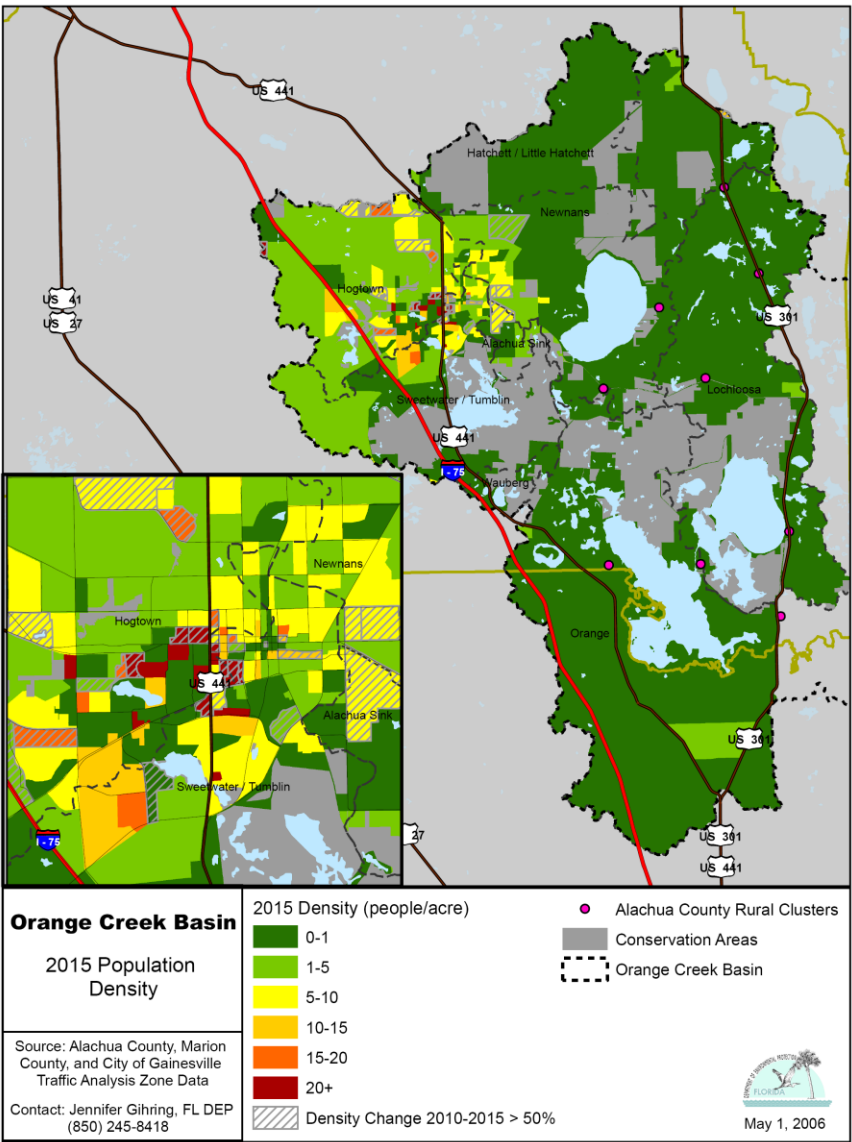


Figure 2.8. Orange Creek Basin population density (2015) and areas of rapid growth (2010–15)



2.2.4 Impacts of Future Growth

Patterns of population growth are very similar from 2005–10 versus 2010–15. The majority of growth is anticipated within Gainesville and in areas directly north and west of the city, including portions of the I-75 corridor.

Covering most of the city of Gainesville, the Sweetwater Branch/Tumblin Creek and Hogtown Creek sub-basins have the highest population density in the basin. Furthermore, the majority of future growth is expected to occur in these sub-basins (see the inset in **Figure 2.8**). Portions of these sub-basins are expected to increase more than 50% in population density from 2010–15.

In the absence of pollution prevention activities, further increases in population density in the urbanized portions of these sub-basins may increase coliform levels in Hogtown Creek, Tumblin Creek, and Sweetwater Branch. However, management actions outlined in the BMAP, including the control of pet waste, will minimize the effects of this future growth (see *Chapter 3*).

Growth in the eastern and southern portions of the Orange Creek Basin will be limited. Several rural areas show a rapid relative increase in density. However, these areas are starting from a very low population density (less than 1 person per acre). As such, significant water quality impacts from these population increases are unlikely.

Basinwide, future growth predicted through 2015 is not expected to substantially increase pollutant loads. However, emerging growth patterns in east Gainesville, particularly the Newnans Lake sub-basin, indicate that Census predictions may not adequately reflect the changes in land use that could occur in that area or other localized parts of the basin. Local governments in the basin have a variety of programs in place to manage the water quality impacts of future growth, but extra caution in future permitting may be needed in specific locations within the basin. Chapter 3 discusses these management programs. The combination of low overall population growth pressure, the implementation of stormwater management for new development, and the retrofitting of older developed areas will minimize water quality impacts associated with future population growth in the basin.

2.3 Water Quality Trends

The data for establishing TMDLs for impaired waterbodies in the Orange Creek Basin were taken from the periods listed in **Table 2.5**.

Table 2.5. TMDL data periods, by waterbody

WATERBODY	TMDL DATA PERIOD	WATERBODY	TMDL DATA PERIOD
Newnans Lake	1996–2000	Hatchet Creek	1995–2002
Orange Lake	January 1995– December 2000	Hogtown Creek	1995–2002
Lake Wauberg	1990–2000	Tumblin Creek	1995–2000
Alachua Sink	2000–04	Sweetwater Branch	2000–04

The SJRWMD statistically analyzed TSI trends for Newnans and Orange Lakes and Lochloosa Lake for the period of record through 2003, and found a significant deterioration in water quality since 1969 in Newnans Lake and since 1986 in Orange Lake and Lochloosa Lake. In this analysis, the SJRWMD used the recent four-year (2003–06) average values of TN, TP, and chlorophyll a data, as well as calculated annual TSI, to examine the water quality status in the three lakes.

Table 2.6 shows the average concentration for TP, TN, and chlorophyll a, as well as TSI, for the three lakes from 2003 to 2006. These results indicate that Newnans Lake is hypereutrophic, as indicated by very high TN, TP, and chlorophyll a concentrations. Orange Lake is hypereutrophic based on TN and TP and eutrophic based on chlorophyll a concentration. Lochloosa Lake is hypereutrophic based on TN and eutrophic based on TP and chlorophyll a concentration. The TSIs indicate that water quality in Lochloosa Lake and Orange Lake is fair and in Newnans Lake, poor.

Table 2.6. Average TP, TN, and chlorophyll a concentration and TSI in three Orange Creek Basin lakes, 2003–06

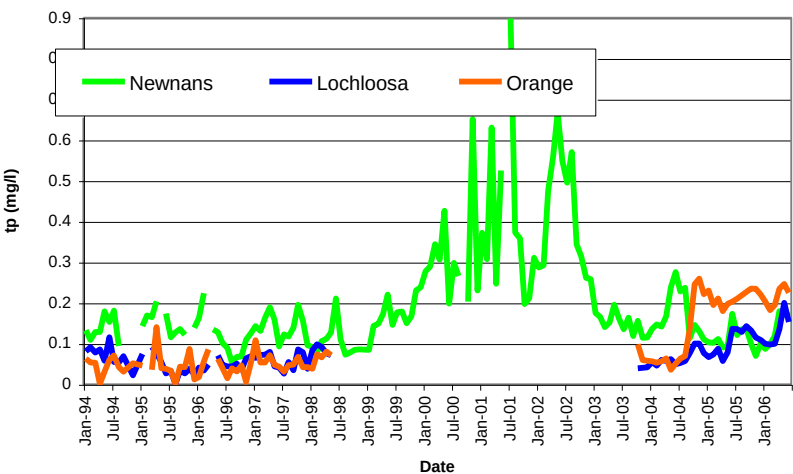
LAKE	TP (MG/L)	TN (MG/L)	CHLOROPHYLL A (µG/L)	TSI
Lochloosa	0.090	1.59	20	62
Newnans	0.140	2.43	65	74
Orange	0.160	1.92	33	69

mg/L – Milligrams per liter
µg/L – Micrograms per liter

The water quality trends are examined by plotting TP, TP, and chlorophyll a monthly concentration data from 1994 to 2006. **Figures 2.9 to 2.11** show the monthly TP, TN, and chlorophyll a concentrations for all three lakes during this period. The data gap is due to the low water level in Lochloosa Lake and Orange Lake for that period. From 1998 to late 2002, Newnans Lake had the worst water quality ever based on all the historical data that could be found. Prior to 2004, Newnans Lake had the highest TP, TN, and chlorophyll a concentration most of the time among the three lakes, and Orange Lake had the best water quality among the lakes. Since September 2004, Orange Lake has had the highest TP concentration in all the three lakes. The TP concentration in Orange Lake reached a historic high in the past two years.

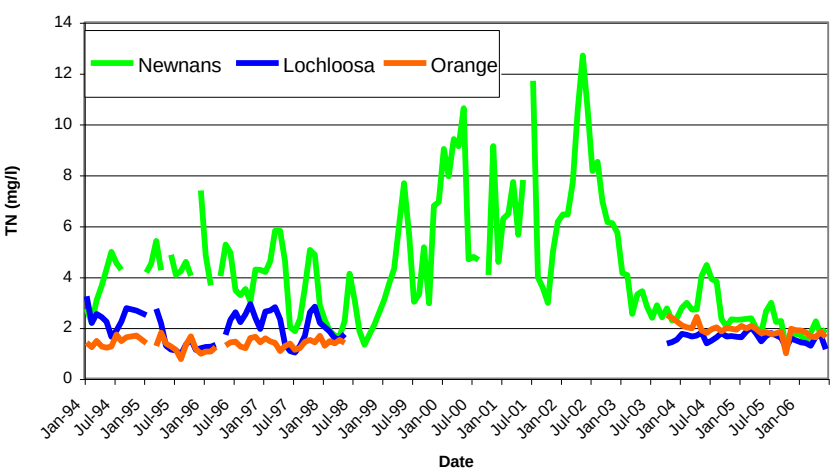
Figures 2.12 through 2.15 illustrate water quality trends from 2003 to 2006. Based on TP and TN concentration (**Figures 2.12 and 2.13**, respectively) and the average annual TSI (**Figure 2.15**), the water quality trend in Newnans Lake is improving. For Orange Lake and Lochloosa Lake, the trend is not as clear as for Newnans Lake. The TP concentration chart (**Figure 2.12**) indicates that water quality is deteriorating in both lakes; however, as **Figure 2.15** shows, the TSI values from 2003 to 2006 indicate that the water quality is improving or not changing in these two lakes.

Figure 2.9. TP concentration in three Orange Creek Basin lakes, 1994–2006



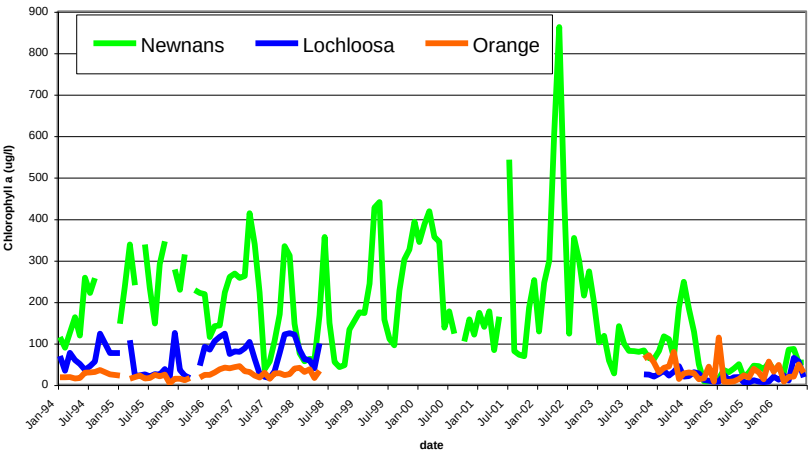
Source: SJRWMD, 2006.

Figure 2.10. TN concentration in three Orange Creek Basin lakes, 1994–2006



Source: SJRWMD, 2006.

Figure 2.11. Chlorophyll a concentration in three Orange Creek Basin lakes, 1994–2006



Source: SJRWMD, 2006.

Figure 2.12 TP concentration in three Orange Creek Basin lakes, 2003–06

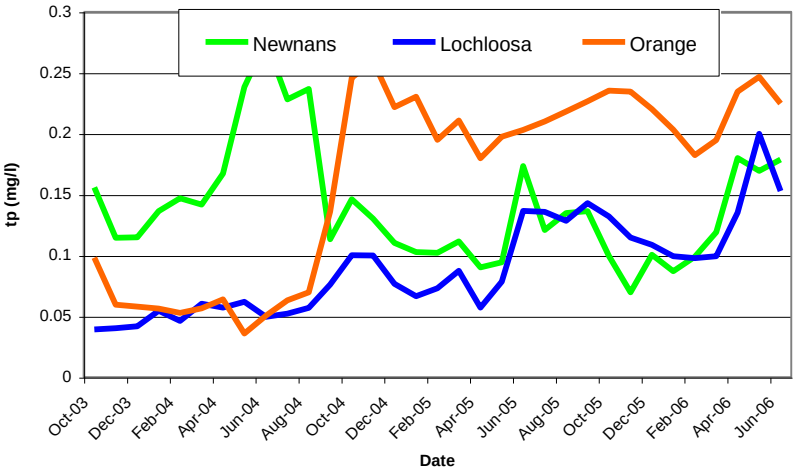


Figure 2.13. TN concentration in three Orange Creek Basin lakes, 2003–06

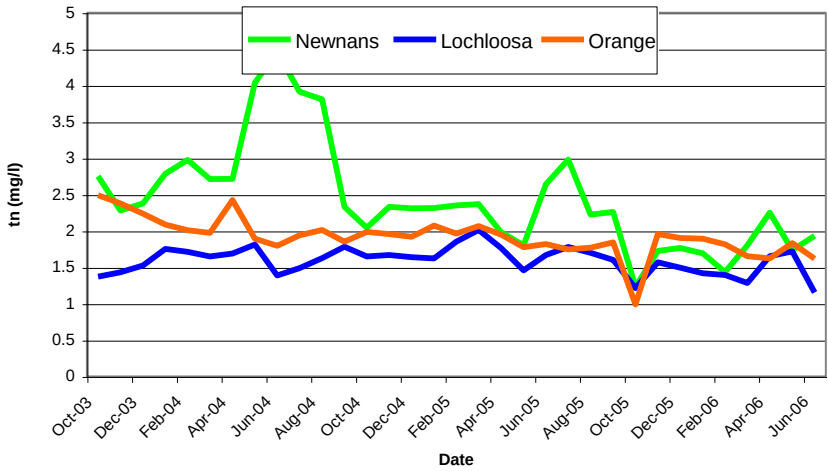


Figure 2.14. Chlorophyll a concentration in three Orange Creek Basin lakes, 2003–06

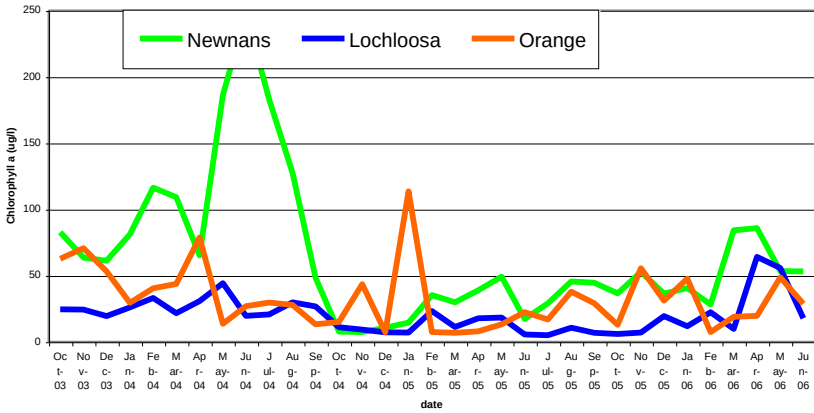
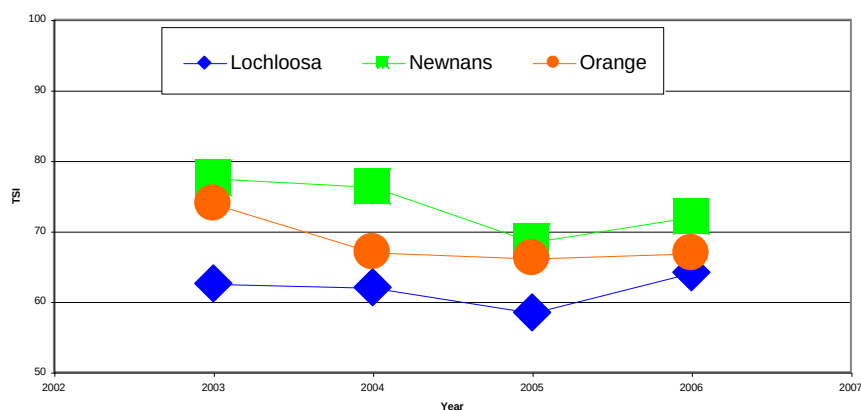


Figure 2.15 Average annual TSI in three Orange Creek Basin lakes, 2003–06



2.4 Water Quality Issues

The Orange Creek BWG categorized the current water quality issues in the basin for the purposes of BMAP development as follows:

- **Primary** – Issues most likely to be directly linked to the TMDLs established for the Orange Creek Basin that need to be addressed in the BMAP during this TMDL/BMAP cycle. These are generally the causes of DEP-verified impairments. The BWG identified the following primary issues:
 - Point source control,
 - MS4s,
 - Nonpoint stormwater runoff,
 - Aquatic plant management,
 - Tributary inflows,
 - Septic tank systems, and
 - Increased loading from future growth.
- **Secondary** – Issues that either result from primary issues, or are not of significant enough impact to be categorized as primary issues. These are likely to be addressed indirectly through BMAP strategies developed for primary issues. The BWG identified the following secondary issues:
 - Internal recycling of nutrients,
 - Leakage from wastewater collection systems,
 - Aquatic plant management,

- Altered hydrology, and
 - Discharges to ground water.
- **Other** – Issues least likely to be directly linked to the current TMDLs. These might be addressed indirectly through BMAP strategies or other (concurrent or future) broad-based efforts within the community, such as growth management and pollution prevention.

Table 2.7 lists primary, secondary, and other issues by sub-basin and identifies the entity primarily responsible for addressing each issue. Each issue is also identified as high priority, low to medium priority, or impacts currently unknown. This prioritization is both issue and sub-basin specific. The prioritized list of issues is based on extensive discussions, information from water quality–related plans and reports on the Orange Creek Basin (e.g., DEP's *Ocklawaha Water Quality Assessment Report*), and local knowledge. The list represents the priorities of the BWG at the time of BMAP development. These water quality issues and potential sources may not be identified in the adopted TMDLs for each waterbody. The table is meant to provide a general framework of water issues that may need to be addressed or resolved to achieve the TMDLs in the Orange Creek Basin. It is not intended to allocate load reductions specified in the adopted TMDLs to the potential sources or responsible parties listed.

Table 2.7. Summary of water quality issues/potential sources for Orange Creek Basin TMDLs

WATER QUALITY ISSUES ¹ ● HIGH-PRIORITY ISSUE ◇ LOW- TO MEDIUM-PRIORITY ISSUE ◇ IMPACTS CURRENTLY UNKNOWN		ORANGE CREEK SUB-BASIN (WBID)								
		NEWNANS LAKE (2705B)	ORANGE LAKE (2749A)	LAKE WAUBERG (2741)	ALACHUA SINK (2720A)	LOCHLOOSA LAKE/CROSS CREEK (2738A/2754)	HATCHET CREEK (2688)	HOGTOWN CREEK (2698)	TUMBLIN CREEK (2718A)	SWEET-WATER BRANCH (2711)
		TN & TP	TP/CHL-A	TN & TP	PENDING	DEFERRED	IRON	FECAL COLIF.	FECAL COLIF	FECAL COLIF.
PRIMARY ISSUES		ENTITY ²								
Point Source Control										
▪ Municipal Plant Discharges	GRU									
– Main Street WRF										
– Kelly Power Plant										
▪ Wastewater Infrastructure	GRU									
– Leakage from wastewater collection systems							•	•	•	•
– Illegal connections to surface water	ACEPD							•	•	•
– Private collection systems (including overflows)	DEP/ACEPD	•						•	•	•
▪ Package Plants	DEP/ACEPD	•	•	•	•	•	•			
MS4 Stormwater Systems (outfalls)	GCWP*							•	•	•
Nonpoint Stormwater Runoff			•					•	•	•
▪ Stormwater runoff from developed areas										
– Private roadways/parking lots	ACEPD	•						•	•	•
– Roads/rights of way	DOT/AC/M**C/McIn./GWCP	•	•		•	•				•
– Hawthorne stormwater	ACEPD					•				
– Animal waste	GCWP*							•	•	•
– Homeless populations along streambanks	GCWP*/Gainesville							•	•	•
– Landscaping/lawns	GCWP*/ACEPD	•	•	•	•	•	•			•
– Surface water system outfalls	GCWP*/ACEPD	•	•	•	•	•				
▪ Agricultural Runoff	DACS									
– Animal/livestock farms		•	•			◇	◇		•	
– Crop farms		•	•			◇	◇		•	
▪ Silviculture Activities	DACS/LAND-	○	○			○				

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		ORANGE CREEK SUB-BASIN (WBID)								
WATER QUALITY ISSUES¹ • HIGH-PRIORITY ISSUE ○ LOW- TO MEDIUM-PRIORITY ISSUE ◇ IMPACTS CURRENTLY UNKNOWN		NEWNANS LAKE (2705B)	ORANGE LAKE (2749A)	LAKE WAUBERG (2741)	ALACHUA SINK (2720A)	LOCHLOOSA LAKE/CROS S CREEK (2738A/2754)	HATCHET CREEK (2688)	HOGTOWN CREEK (2698)	TUMBLIN CREEK (2718A)	SWEET- WATER BRANCH (2711)
		TN & TP	TP/CHL-A	TN & TP	PENDING	DEFERRED	IRON	FECAL COLIF.	FECAL COLIF	FECAL COLIF.
PRIMARY ISSUES		ENTITY ²								
	OWNERS									
Tributary Inflows	N/A		•			•				
▪ From Prairie Creek, Bivens Arm, Alachua Lake					•					
▪ From Lake Forest Creek alteration		•								
▪ From Hatchet Creek		◇								
▪ From Little Hatchet Creek		○								
Septic Tank Systems (see density map for residential septic)	ACHD/ ACEPD	•	•	•	•	•	•	•	•	•
▪ Lakeview		•								
▪ Southwest Corner–Unincorporated Alachua County						•				
▪ Town of Windsor		•								
Increased Loading from Future Growth	AC/MC	•	•	•	•	•	•	•	•	•
SECONDARY ISSUES										
Internal Recycling of Nutrients	N/A	•	•	○	•	○				
Leakage from Wastewater Collection Systems	GRU	•								
Aquatic Plant Management	DEP	◇	◇	◇		◇				
Altered Hydrology ³	N/A	•	•	•	•	•	•	•	•	•
Discharges to Ground Water	N/A									
▪ Nitrate to aquifer through sinkhole					•					
▪ Discharge to aquifer via Haile Sink								•		
OTHER ISSUES										
Recreational Use	N/A	○	○	○		○	○			
Erosion and Sedimentation	N/A							•	•	•
Overflows from GRU Sewer System	GRU/DEP	○					○	○	○	○
Leakage from Wastewater Collection Systems	GRU				○					

¹ These water quality issues and potential sources may not be identified in the adopted TMDLs for each waterbody. The table is meant to provide a general framework of water issues that may need to be addressed or resolved to achieve the TMDLs in the Orange Creek Basin. It is not intended to allocate load reductions specified in the adopted TMDLs to the potential sources or responsible parties listed. This table is subject to review and revision during BMAP implementation.

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² This column indicates who will be most likely to develop and implement a related BMAP strategy.

³ Further study and discussion are needed to determine the nature of the altered hydrology, whether the alterations directly contribute to loadings, and whether to address these alterations in the BMAP.

* The GCWP does not function as a regulatory entity. It is a cooperative partnership of the city of Gainesville, Alachua County, and DOT, dedicated to working with the Gainesville community for healthy waterways.

AC – Alachua County

ACEPD – Alachua County Environmental Protection Department

ACHD – Alachua County Health Department

DACS – Florida Department of Agriculture and Consumer Services

DOT – Florida Department of Transportation

GCWP – Gainesville Clean Water Partnership

GRU – Gainesville Regional Utilities

MC – Marion County

McIn – Town of McIntosh

N/A – Not applicable

SW – Stormwater

CHAPTER 3. BROAD-BASED MANAGEMENT ACTIONS

A wide variety of management programs, projects, and activities is in place to achieve the load reductions required to meet the TMDL(s) for the Orange Creek Basin. **Table 3.1** summarizes programs that are in place to address TMDL(s) basinwide, including activities such as stormwater retrofit projects, urban stormwater BMPs, habitat restoration, land development regulations (LDRs), public education/outreach, and others. Examples of current management actions include the following:

- Wastewater infrastructure maintenance, operation, repair and upgrade (includes septic systems)
 - Centralized wastewater collection system integrity testing
 -
- Stormwater Retrofits
 - Paving and drainage upgrades
 - Failing infrastructure replacement and improvement
- Urban Structural BMPs
 - Regional wet detention stormwater ponds
 - Dry retention stormwater ponds
- Urban Nonstructural BMPs
 - - Cleaning up pet waste
 - Street sweeping
 - Baffle boxes and CDS units
- Agricultural/Silvicultural BMPs
 - Silviculture BMP manual
 - Row crop BMP manual
 - Exclusion of livestock from sensitive areas
 - Clean Farms Initiative including equine BMPs
- Habitat Restoration
 - Stream and pond riparian buffer restoration
 - Lake fish habitat restoration
- Ordinances, LDRs, and Zoning
 - Development guidelines
 - Special planning zones to encourage low impact development
 - Water quality code
- Land Acquisition for Conservation and Stormwater Management

- Education and Outreach
 - Watershed Action Volunteers (WAV) Program
 - Elvis the Otter Program
 - Current Problems /Adopt a River Programs

This chapter describes management programs, projects, and activities that are broadly applied across the basin (**Table 3.1**). Chapter 4 provides more detail on management actions that specifically address nutrient impairment in lake sub-basins, and Chapter 5 provides details on coliform impairments in urban creeks. **Appendix E** provides detailed project information.

Regulatory permit programs are one mechanism used to reduce pollutant loading in the Orange Creek Basin. These programs address the reduction of current loads (e.g., NPDES outreach efforts) and limit the impact of future growth (e.g., the SJRWMD's Environmental Resource Permitting [ERP] Program). Nonregulatory programs also facilitate the reduction of pollutant loads. All of the programs discussed in this chapter seek cooperative solutions between administering agencies, local governments, and regulated entities.

3.1 Point Source Permitting

Protecting the amount and quality of water resources is the goal of proper wastewater management. DEP issues wastewater permits for domestic and industrial wastewater discharges (**Table 3.2**).

DEP issues permits for systems that treat and reuse by land application the treated effluent as reclaimed water. Other facilities provide treated effluent and discharge to surface waters, and DEP issues permits under the coordination of the federally delegated NPDES Program.

Domestic wastewater facilities are those principally designed to collect and treat sanitary wastewater or sewage from dwellings or homes, business buildings, institutions, and the like. Otherwise, individually permitted facilities are classified as industrial wastewater treatment facilities.

Table 3.1. Primary existing programs that address pollutant loadings in the Orange Creek Basin

PROGRAM	LEAD ENTITY	BRIEF DESCRIPTION
Regulatory		
Point Source Permitting	DEP	Issue permits and associated effluent limitations for industrial and domestic wastewater facilities.
ERP	SJRWMD	Establish permit provisions to address construction activity that would affect wetlands, alter surface water flows, or contribute to water pollution.
Water Quality Code Complaint and Spill Response Program	ACEPD	Prohibit nonstormwater discharges into the MS4 system; respond 24 hours a day to spills.
Illicit Discharge/Elimination Program	ACEPD	Detect and eliminate any nonstormwater discharges to the MS4s.
NPDES	GCWP	Implement the six minimum control measures: public education and outreach, public participation, illicit discharge detection and elimination, construction site runoff control, postconstruction runoff control, and pollution prevention.
Facility Inspection Program	ACEPD	Visually inspect storm drains and stormwater management systems in the vicinity of regulated facilities; visually inspect floor drains; collect water quality samples as necessary.
Septic Tank System Management	Alachua County Health Dept, Marion County Health Dept, City of Gainesville, and GRU	Carry out local studies and efforts to identify failing septic tank systems
Non-regulatory		
Surface Water Improvement and Management (SWIM) Program	SJRWMD	Carry out goals, strategies, programs, and projects to restore water quality and aquatic and wetlands habitats in the major lakes and streams of the Orange Creek Basin.
PLRGs	SJRWMD	Reduce external loadings of nutrient pollutants through the establishment and implementation of loading goals.
WAV Program	City of Gainesville/ ACEPD	Train and equip volunteers to give pollution prevention presentations; use water quality monitoring field test kits; assist in stream surveys and other activities.
Current Problems Program	City of Gainesville/ ACEPD	Involve county residents in pollution prevention through participation in cleanup and restoration activities.
Other Pollution Prevention Programs	GCWP	Carry out public information campaigns, environmental festivals, partnerships with businesses/organizations.
BMP Program	GCWP	Develop pollution prevention BMPs for government and business; distribute fact sheets through existing programs.
Low-impact Development (LID)	Local Governments	Increase infiltration, limit site disturbance, limit impervious surfaces, and implement other activities that decrease the impact of land development.
Agricultural BMPs (including silviculture)	DACS and Private Landowners	Implement approved BMPs for pollution prevention.

Table 3.2. Entities in the Orange Creek Basin regulated under DEP wastewater permits

PERMITTEE	PERMIT COVERAGE DATES	PERMITTED CAPACITY ANNUAL AVERAGE DAILY FLOW (MGD)	PERMIT NUMBER	DISCHARGE
GRU–Main Street WRF	9/15/2003–9/14/2008	7.50	FL0027251	Sweetwater Branch
GRU–Kelly Power Plant	7/28/03–7/27/08	0.060	FL0040215	Sweetwater Branch
GRU–Kanapaha	3/17/03–3/16/08	14.9	FL0112895	Reuse of reclaimed water: spray irrigation, aquifer recharge
Brittany Estates Wastewater Treatment Facility (WWTF)	9/25/06–9/24/11	0.060	FLA011291	Little Hatchet Creek
City of Hawthorne WWTF	5/3/06–5/2/11	0.150	FLA011307	Land applied to rapid infiltration basins
Prairie View Apartments WWTF	8/26/05–8/25/10	0.0042	FLA011302	Land applied to rapid infiltration basins
Camp McConnell	12/9/04–12/8/09	0.0075	FLA011291	Land applied to rapid infiltration basins
UF	4/22/03–4/21/08	3.0	FLA011322	Reuse of reclaimed water: spray irrigation, aquifer recharge

mgd – Million gallons per day

3.2 Environmental Resource Permitting

Within the area addressed by the Orange Creek BMAP, activities that exceed SJRWMD permitting thresholds must be authorized by an ERP from the District (Rules 40C-4 through 40C-400, F.A.C.) that incorporates both stormwater treatment and the mitigation of any wetland impacts. To obtain an ERP where existing ambient water quality does not meet state water quality standards, an applicant must demonstrate that the proposed activity will result in a net improvement in the parameters that do not meet standards.

3.3 Surface Water Improvement and Management Program

The TMDL effort in the Ocklawaha River Basin benefits from having three SJRWMD-designated SWIM waterbodies located within its boundaries: Orange and Newnans Lakes and Lochloosa Lake.

In 2003 the SJRWMD Governing Board designated the Orange Creek Basin as a priority watershed for protection and restoration under Florida's 1987 SWIM Act (Section 373.453, F.S.). The *Orange Creek Basin Surface Water Management Plan* (Lasi and Shuman, 1996) was approved by the Orange Creek Basin Advisory Council and SJRWMD Governing Board in 1996. The plan provides a comprehensive description of various issues, goals, strategies, programs, and projects to restore water quality and aquatic and wetlands habitats in the major lakes and streams of the Orange Creek Basin.

3.4 Pollutant Load Reduction Goal Program

Since 2001, one of the SJRWMD's primary emphases in the Orange Creek Basin has been the development of PLRGs for Newnans and Orange Lakes and Lochloosa Lake. The SJRWMD is developing PLRGs to reduce the external loadings of nutrient pollutants (TP, TN) in these regionally significant lakes in the basin. PLRGs will assist DEP in refining the TMDLs for these lakes. They will also assist the SJRWMD in designing external load reduction projects to restore surface water quality to state water quality standards. Water management districts in Florida are required to develop PLRGs by the Water Resources Implementation Rule (Rule 62-40, F.A.C.). PLRG development is part of SJRWMD policy pursuant to the District Water Management Plan.

3.5 National Pollutant Discharge Elimination System Stormwater Program

The NPDES Stormwater Program regulates several entities in the basin. The basic requirements of this program serve as a foundation for the stormwater management efforts of the basin's communities. The U.S. Environmental Protection Agency (EPA) developed the federal NPDES permitting program in two phases. Phase I, started in 1990, addressed large and medium MS4s located in incorporated places and counties with populations of 100,000 or more, as well as specific industrial activities. Phase II, which started in 1999, addresses additional sources, including small MS4s. In October 2000, the EPA authorized DEP to implement the NPDES stormwater permitting program in the state. This permitting has remained separate from state stormwater/environmental resource permitting programs and local stormwater/water quality programs, which have their own regulations and permitting requirements.

Florida's rules for medium and large MS4s can be found in Rule 62-624, F.A.C. Because the MS4s in the Orange Creek Basin are all Phase II, the following discussion focuses on those requirements.

3.5.1 NPDES MS4 Phase II Stormwater Permit Requirements

Under a generic permit, operators of regulated Phase II MS4s must develop a Stormwater Management Program (SWMP) that includes BMPs, with measurable goals, to effectively implement the following six minimum control measures:

- 1. Public Education and Outreach:** Perform educational outreach regarding the harmful impacts of polluted stormwater runoff.
- 2. Public Participation/Involvement:** Comply with state and local public notice requirements and encourage other avenues for citizen involvement.
- 3. Illicit Discharge Detection and Elimination:** Implement a plan to detect and eliminate any nonstormwater discharges to the MS4, and create a system map showing outfall locations. Federal regulations define an illicit discharge as "...any discharge to an MS4 that is not composed entirely of stormwater..." and can include septic/sanitary sewer discharge, car-wash wastewater, laundry wastewater, the improper disposal of auto and household toxics, graywater, and spills from roadway accidents.
- 4. Construction Site Runoff Control:** Implement and enforce an erosion and sediment control program for construction activities.

5. **Postconstruction Runoff Control:** Implement and enforce a program to address discharges of postconstruction stormwater runoff from new development and redevelopment areas. (**NOTE:** This minimum control is met through state stormwater permitting requirements under Part IV, Chapter 373, F.S., or Rule 62-25, F.A.C., as a qualifying alternative program.)
6. **Pollution Prevention/Good Housekeeping:** Implement a program to reduce pollutant runoff from municipal operations and property and train staff in pollution prevention.

The generic permit (DEP Document 62-621.300[7][a]) also states, "If a TMDL is approved for any waterbody into which the Phase II MS4 discharges, and the TMDL includes requirements for control of stormwater discharges, the operator must review its SWMP for consistency with the TMDL allocation. If the Phase II MS4 is not meeting its TMDL allocation, the operator must modify its SWMP to comply with the provisions of the TMDL Implementation Plan applicable to the operator in accordance with the schedule in the Implementation Plan."

Table 3.3 lists local governments and other entities in the Orange Creek Basin that are currently designated as Phase II MS4s. The designation is based on a combination of factors, including population, the operation of a storm sewer system, discharge to TMDL waters, interconnection to another jurisdiction's system, and others.

Table 3.3. Entities in the Orange Creek Basin designated as regulated Phase II MS4s

PERMITTEE	PERMIT COVERAGE DATES	REPORT DUE DATE*	MS4 PERMIT NUMBER
City of Gainesville	7/09/03–7/08/08	January 8	FLR04E006
Alachua County	7/09/03–7/08/08	January 8	FLR04E005
Marion County	7/28/03–7/27/08	January 27	FLR04E021
UF	9/09/03–9/08/08	March 8	FLR04E067
DOT	6/23/03–6/22/08	December 22	FLR04E018

* Phase II MS4 reports are due annually during the first permit term. In subsequent permit terms, the reports are due for Years 2 and 4 only, unless otherwise specified by DEP.

3.6 Gainesville Clean Water Partnership

On September 20th, 2001, Alachua County, the city of Gainesville, and DOT signed an interlocal agreement for the joint implementation of the NPDES Phase II MS4 Program in the Gainesville urban area. The agreement presented a financial plan for the implementation of the minimum control measures, including the mapping requirements, public outreach, operations BMPs, and illicit discharge detection and elimination program required by the NPDES Phase II MS4 Program. For more information about the partnership and the MS4 program visit <http://www.gainesvillecreeks.org/sponsors.htm>

The agreement established the city of Gainesville as the lead agency for the joint implementation of the program. On July 8, 2002, the city hired a Program Coordinator to serve as a liaison for the three agencies involved in the agreement and to oversee the program. This includes overseeing the elements required of the permit and assisting involved divisions and departments to comply with the permit standards. The

coordinator is responsible for submitting Alachua County and City of Gainesville NPDES Phase II MS4 permits and all subsequent annual reports. DOT is responsible for submitting its own permits and reports, although this duplicates some of the information presented in the city/county permits and reports. Individual NPDES Phase II MS4 permits were obtained by Alachua County, the city of Gainesville, and DOT, as listed below. All agencies have also submitted annual reports for Permit Years 1 and 2. On August 27th, 2002, Alachua County adopted the Water Quality Code, which provided the regulatory framework for the implementation of an illicit discharge detection and elimination program in Alachua County, as required by the NPDES Phase II MS4 permits. Specifically, Section 77.10 contained regulations prohibiting nonstormwater discharges into the MS4 system. The Water Quality Code became effective on January 1st, 2003. To view the code, visit <http://www.municode.com>.

On June 24, 2003, Alachua County and the city of Gainesville signed a "Supplement to Agreement Providing Joint Implementation of the National Pollutant Discharge Elimination System Program." This additional interlocal agreement was signed to establish the Illicit Discharge Detection and Elimination Program. As part of the agreement, the ACEPD became the agency responsible for implementing this program to satisfy the NPDES Phase II MS4 permit requirements of Alachua County, the city of Gainesville, and DOT. The GCWP faced a new challenge in 2003, when DEP designated TMDLs for several watersheds in the Gainesville urban area. According to Subsection 62-621.300(7)(a)V.B., F.A.C., if a TMDL is approved for any waterbody into which a Phase II MS4 discharges, and the TMDL includes requirements for control of stormwater discharges, the operator must review its SWMP for consistency with the TMDL allocation. If the Phase II MS4 is not meeting its TMDL allocation, the operator must modify its SWMP to comply with the provisions of the TMDL Implementation Plan applicable to the operator in accordance with the schedule in the Implementation Plan. Because of this rule, members of the GCWP became active members of the Orange Creek BWG.

On September 14, 2004, Alachua County and the city of Gainesville signed a "First Amendment to the Contract for Establishment of an Illicit Discharge Detection and Elimination Program." This document allows excess funds paid by the county, if any, to be applied to the development and implementation of BMAPs, upon approval by the county engineer.

3.6.1 Public Outreach Activities

Since 2001, the GCWP has promoted pollution prevention through its own materials and has also contracted with several organizations. The sections below briefly describe the activities associated with each program. For a more detailed description, visit the websites that are provided. Information about specific activities performed by these programs is contained in the permits and annual reports, available from DEP's NPDES Stormwater Section at <http://www.dep.state.fl.us/water/stormwater/npdes/>.

Watershed Action Volunteers Program

WAV is overseen by the SJRWMD. In Alachua County, the city of Gainesville and the ACEPD locally administer the program. WAV matches committed individuals with WAV coordinators, who train and equip volunteers for a variety of important tasks related to improving the health of watersheds within the SJRWMD. WAVs are trained to prepare and give nonpoint source pollution prevention educational presentations to school

groups, civic associations, clubs, and other organizations. Specialists train volunteers to use field test kits for monitoring water quality. Volunteers also assist in stream surveys, storm drain marking events, revegetation projects, and shoreline cleanups. More information about the WAV Program can be found at:

<http://www.alachuacounty.us/government/depts/epd/natural/waterquality/wavinfo.aspx> or <http://sjr.state.fl.us/education/wav/about.html>.

Current Problems Program

Current Problems, Inc. (CP) is a nongovernmental organization focused on the connection between surface waters, pollution, and the drinking water supply, and on the cleanup of local waterways. The city of Gainesville and the ACEPD employ CP to help involve county residents in pollution prevention through community outreach; creek, pond, and sinkhole cleanups; and shoreline restoration programs. These programs encourage and assist residents to better protect local waterways by providing tools to change landscaping, lifestyle, and living habits. For more information, visit <http://www.currentproblems.org/>.

Elvis Otter Program

In 2003, the GCWP worked with talented local puppeteer Nancy Kenton to develop an elementary-level puppet show that would help to educate children about stormwater.

Nancy Kenton Puppet Productions (NKPP) created *Elvis Otter & the Creekside Gang*, a 40-minute program aimed at elementary school-age students to take place in an intimate classroom or small auditorium setting, to be performed at 44 public and private schools in Alachua County each permit year. The program teaches students about pollution prevention. Topics include, but are not limited to, watersheds, creeks, creek crossings, ditches and storm drains, littering, pets, pollution, lawns and gardens, trees and plants, leaves, ground water/aquifers, and sinkholes. The students learn the connection between the storm drain system and waterways of Alachua County, how water pollution occurs, what they can do to help prevent it, and what they can do to help Elvis and friends stay alive and safe. NKPP uses audience participation and puppet and mask characters, music, stories, magic, and colorful illustrations to relay the above messages.

In addition to visiting local schools between 2003 and 2006, Nancy and Elvis performed at special events, filmed 5 commercials for the GCWP, and produced a movie of the puppet program. The movie has been distributed to all Alachua County elementary schools. Both the commercials and movie regularly air on the local Channel 12 TV station.

Unfortunately, after 2 successful program years, Ms. Kenton has relocated to Virginia. She may be able to visit the city recording studio to film the show during Permit Year 4. For more information, visit www.gainesvillecreeks.org/get_involved/elvis1.htm.

Additional GCWP Outreach Activities

In 2004, the NPDES partners developed and released a new logo and a more descriptive public name. The GCWP makes additional public outreach efforts to work with the Gainesville community for healthy waterways. Through involvement in various public information campaigns, annual festivals, special events such as the “Creeks

Summit” of 2002 and 2004 and “Creeks Week” of 2006, and partnerships with other Gainesville organizations and businesses, the GCWP strives to acquaint Gainesville and Alachua County residents with the issues involved in caring for and protecting local waterways, and to help them recognize the contributions these waterways make every day to the community’s health, safety, comfort, and quality of life. Residents can find information about these activities and programs by visiting the GCWP’s website at www.gainesvillecreeks.org. The site describes the interdependent creeks, watersheds, and wetlands in Gainesville. Visitors to the site can learn how the Gainesville community cares for water through stormwater management, and what they can do to help keep local waterways healthy.

Illicit Discharge Detection and Elimination Program

On June 24, 2003, Alachua County and the city of Gainesville signed an interlocal agreement establishing the Illicit Discharge Detection and Elimination Program. The program strives to reduce coliform, nutrient, and other pollutant loads in local waters. As part of the agreement, the ACEPD became the agency responsible for implementing this program to satisfy the NPDES Phase II MS4 permit requirements of Alachua County, the city of Gainesville, and DOT. Individual NPDES Phase II MS4 permits were obtained by Alachua County on July 8, 2003; the city of Gainesville on July 8, 2003; and DOT on June 23, 2003.

Best Management Practices Program

The ACEPD and the GCWP develop prevention BMPs for governmental and business activities and distribute BMP fact sheets. ACEPD staff provide compliance assistance information and distribute BMP fact sheets as part of the facility inspection and complaint and spill investigation programs (*see below*). BMPs and fact sheets developed and distributed to relevant parties to date include the following (pollutants addressed in each fact sheet/BMP are in parentheses):

- Water Quality Code (nutrients and coliform),
- Erosion and Sedimentation Control at Construction Sites (sediments),
- Controlling Runoff from Car Wash Fundraisers (nutrients),
- Controlling Runoff from Gas Stations (nutrients, various other pollutants),
- Controlling Runoff from Commercial Outdoor Car Washing (nutrients),
- Water Quality Protection at Apartment Complexes (nutrients and coliform),
- Landscaping and Lawn Maintenance Services (nutrients),
- Controlling Runoff during the Remediation of Contaminated Sites (various pollutants),
- Managing Pet Wastes (coliform),
- Residential Swimming Pool Maintenance (sediments, various pollutants),
- Pressure Washing Activities (sediments, various pollutants),
- Laundry Services (nutrients, various other pollutants),
- Food Service Industry (grease, various other pollutants), and
- Paint Contractor (various pollutants).

For an updated listing of BMPs and fact sheets, visit www.gainesvillecreeks.org.

Facility Inspection Program

To improve pollution prevention, the ACEPD expanded its existing Hazardous Materials Management Code (HMMC) and Small Quantity Generator (SQG) inspection program to include compliance with the requirements of Section 77.10 of the Alachua County Water Quality Code. The expanded inspection program includes the visual inspection of storm drains and stormwater management system in the vicinity of each facility, the visual inspection of floor drains inside the facility, and, when necessary, the collection of water quality samples.

Construction Pollution Prevention Activities

The GCWP has been active in the construction community since the initiation of the respective agencies' NPDES permits. In 2003–04, the partnership took part in seven erosion and sediment (E&S) control–related training sessions. During 2004–05, the partnership sponsored one E&S control class for utilities and took part in another E&S control training class. For the 2005–06 permit period, two E&S control–related courses were held for local construction companies.

In addition to courses, the ACEPD's Illicit Discharge Detection and Elimination Program, the city of Gainesville's Stormwater Construction Program, and the SJRWMD are all active in educating the construction community on a daily basis. Through inspections, education, and enforcement, members of the GCWP are working together to make the local building community aware of pollution issues associated with construction.

Municipal Good Housekeeping Activities

In 2003, good housekeeping BMPs were developed for Alachua County and the city of Gainesville. Since then, divisions have followed and reported on the following BMPs:

- City of Gainesville Fleet Management Department BMPs
 - Fleet Management Facilities Maintenance
 - Car Wash Facilities Maintenance
 - Materials Management

- City of Gainesville Public Works Department, Engineering Division BMPs
Preconstruction Meetings
- City of Gainesville Public Works Department, Operations Division BMPs
Public Works Center Maintenance
Water Quality Treatment
Materials Management
Materials Inventory
Materials Protection
Small Engine Maintenance
Vehicle Rinsing
Hazardous Materials Storage
Spill Response and Prevention
Illegal Dumping Control
Mosquito Control
Mechanical Open Water Course Maintenance
Integrated Management Open Water Course Maintenance
Street Cleaning
Roadway and Bridge Maintenance
Stormwater System Cleaning
Catch Basin Cleaning
Sediment Trap Cleaning
Stormwater Pond Cleaning
Employee Training
- City of Gainesville Recreation and Parks Department BMPs
Dog Parks
- Alachua County Public Works Department, Engineering Division BMPs
Preconstruction Meetings
- Alachua County Public Works Department, Operations Division BMPs
Fleet Management Facilities Maintenance
Public Works Center Maintenance
Materials Management
Materials Inventory
Small Engine Maintenance
Spill Response and Prevention
Street Cleaning
Stormwater System Cleaning
Stormwater Pond Cleaning
Employee Training
- Alachua County Public Works Department, Parks Division BMPs
Dog Parks

Currently a BMP manual for municipal activities that will include and expand on the above BMPs is in production for use by city and county staff.

Additional Pollution Prevention Outreach Programs

The GCWP makes additional efforts to work with the Gainesville community for healthy waterways. Through various public information campaigns, annual festivals, and partnerships with other Gainesville organizations and businesses, it strives to acquaint Gainesville and Alachua County residents with the issues involved in caring for and protecting local waterways, and to recognize the contributions that these waterways make every day to the community's health, safety, comfort, and quality of life. Residents can find information about these activities and programs by visiting the GCWP's website at www.gainesvillecreeks.org. The site describes the interdependent creeks, watersheds, and wetlands in Gainesville. Visitors to the site can learn how the Gainesville community cares for water through stormwater management and learn what they can do to help keep local waterways healthy.

3.7 Alachua County Basinwide Programs

3.7.1 Water Quality Code Complaint and Spill Response Program

The Water Quality Code (WQC) implements Alachua County Charter Amendment 1, passed in November 2000, which gave the Board of County Commissioners of Alachua County the authority to establish standards for protecting the environment by prohibiting or regulating air or water pollution. The WQC was adopted on August 27, 2002, and became effective January 1, 2003.

The code provides the regulatory framework for implementing an illicit discharge detection and elimination program in Alachua County. It prohibits the discharge of any material into surface water, ground water, or stormwater systems that results in a violation of Florida's Surface Water Quality Standards in Rule 62-302, F.A.C.; Florida's Groundwater and Drinking Water Standards in Rules 62-520 and 62-550, F.A.C.; and/or Florida's Groundwater and Surface Water Cleanup Target Levels in Rule 62-777, F.A.C. The code authorizes the ACEPD to order cleanup, abatement, or monitoring and take other actions as needed to clean up, abate, or monitor pollutant discharges.

The WQC prohibits direct discharges to surface water and ground water of wastewater from cleaning operations, waste management, equipment storage, and maintenance and litter. It also prohibits any person from discharging nonstormwater to a stormwater system; exceptions include approved discharges by DEP or the ACEPD. The WQC requires the use of BMPs for erosion and sedimentation control for all excavations. E&S control BMPs must provide equal or better protection than those currently compiled by DEP. The WQC requires that land excavation and/or filling activities, including dewatering, must not adversely impact surface water or ground water quality. It allows for reimbursement to the county of all investigative costs incurred by the county and allows civil citations to be issued for code violations.

3.7.2 Expanded Nutrient Monitoring

The ACEPD began expanded nutrient monitoring in the lower reaches of the Sweetwater Branch watershed and on Paynes Prairie in late 2003 and early 2004. The purpose of the expanded monitoring was to differentiate the nutrient contributions coming to Alachua Sink from differing inflows located in various areas of Paynes Prairie. Sites included the channelized section of Sweetwater Branch on the prairie upstream of

Alachua Sink and before the confluence with the channel from Alachua Lake, Alachua Lake, Alachua Sink, and Alachua Channel (which is the channelized stream section between Alachua Sink and the Primary Sink Feature under low water levels).

The high water levels associated with the 2004 hurricanes precluded the continued sampling of many of these sites after August 2004. Water levels on the prairie remained high until fall 2006. ACEPD is currently re-evaluating the program and is coordinating with the SJRWMD on continued water quality monitoring of these and other selected sites. Chapter 6 provides additional information about watershed monitoring.

3.7.3. Stream and Pond Buffer Restoration/Demonstration

The ACEPD began efforts to develop a stream and pond riparian zone restoration program as a result of an EPA Five-Star Restoration Grant received in 2004. The grant project focused on the educational aspects of shoreline restoration and the implementation of these practices in a workshop format.

Three workshops were held in 2005 at Poe Springs Park on the Santa Fe River. Workshops following this format were conducted in several locations in the Orange Creek Basin in 2005 and 2006. Each workshop began with a technical discussion of shoreline restoration and maintenance by Dr. Mark Clark, University of Florida Institute of Food and Agricultural Sciences (UF–IFAS) Extension Specialist, Wetlands and Water Quality, and Assistant Professor, Soil and Water Science Department at UF and concluded with the installation of shoreline plant materials at preselected restoration sites. In the Orange Creek Basin, workshops and associated shoreline restoration activities were conducted at Springhill Park and the 5th Avenue Stormwater Park in the Sweetwater Branch watershed.

The ACEPD continues to maintain several restoration sites planted in 2004 and 2005 in conjunction with Current Problems, Inc./Adopt A River. These sites include a small area in Sweetwater Park in the Sweetwater Branch watershed and the stormwater pond at Forest Park in the Hogtown Creek watershed. The ACEPD has requested funding for 2007–08 from the FWC for shoreline restoration at boat ramp canals on Newnans Lake at Powers Park and the Windsor Boat Ramp, the canal at the county's Lochloosa Lake boat ramp, and the boat ramp canal at the Marjorie Kinnan Rawlings State Historic Site on Orange Lake.

The ACEPD is currently working with Dr. Mark Clark and the Alachua County Communications Office to develop a series of videos on shoreline restoration and stormwater pond revegetation. It anticipates the production of a series of four or five videos that can be used by staff or volunteers for presentations, homeowners associations (HOAs), and individuals and shown on local government television to inform the public about the water quality and wildlife benefits of shoreline restoration. The first restoration video, a shoreline and pond restoration overview, is in the planning stages. The first video in the series, *Alachua County Water Resources – Part 1 Making the Connection* was developed by Karst Productions, Inc. and released in 2005. It is used as part of education and outreach programs.

3.8 Centralized Wastewater Management Programs

3.8.1 GRU Wastewater System Routine Operations and Maintenance

The following describes the GRU wastewater infrastructure and routine maintenance procedures. **Appendix H** provides additional details, including pictures of GRU's maintenance activities.

Wastewater Treatment and Collection System

The city of Gainesville's wastewater treatment facilities consist of the Kanapaha and Main Street WRFs, which are permitted by DEP at a combined capacity of 22.4 mgd. Kanapaha provides advanced wastewater treatment to incoming wastewater that meets primary and secondary federal drinking water standards. Main Street also provides advanced treatment and meets Class III surface water standards. Main Street was upgraded to advanced treatment in 1990 at a cost of \$16 million. Kanapaha was expanded by 5 mgd to 15 mgd in 2003 at a cost of \$13.92 million. Both facilities have an operations and maintenance (O&M) budget of \$1.96 million for fiscal year (FY) 2007.

The city of Gainesville's wastewater collection system piping consists of 127 miles of forcemain where wastewater is conveyed under pressure by pumping stations, and 578 miles of gravity main where the wastewater flows by gravity, for a total of 705 miles of piping. The wastewater collection system also includes 160 lift stations (pumping stations) with 13,888 manholes, and covers a service area of 115 square miles. GRU's Water and Wastewater Systems has 171 budgeted full-time positions, and the wastewater collection and treatment system serves over 160,000 people. GRU wastewater collection system operations and maintenance costs were over \$71 million for FY 2007. **Figure 3.1** shows the major GRU wastewater collection facilities serving Gainesville and areas of Alachua County.

In 2006, GRU systems conveyed and treated over 5.5 billion gallons of wastewater (99.999% efficiency based on volume) and maintained a spill rate of less than 25% of the national average in 2004, 2005, 2006, and 2007 (**Figures 3.2 and 3.3**). The national average of 7.1 spills per 100 miles of collection system is based on a national survey of comparable utilities conducted by the Water Environment Research Foundation (2003). GRU's average spill rate from 2001 through 2006 was 2.3 spills per 100 miles.

Figure 3.1. GRU major wastewater collection system

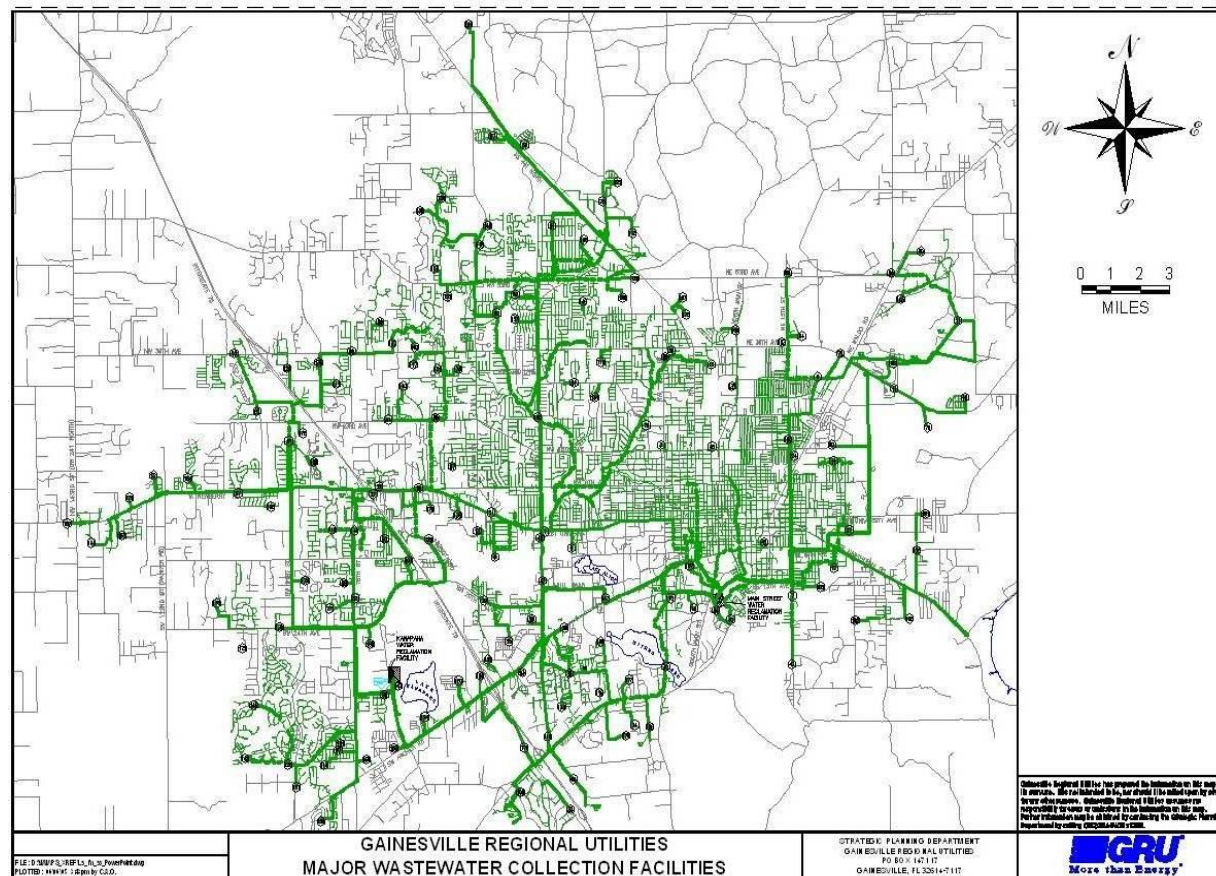
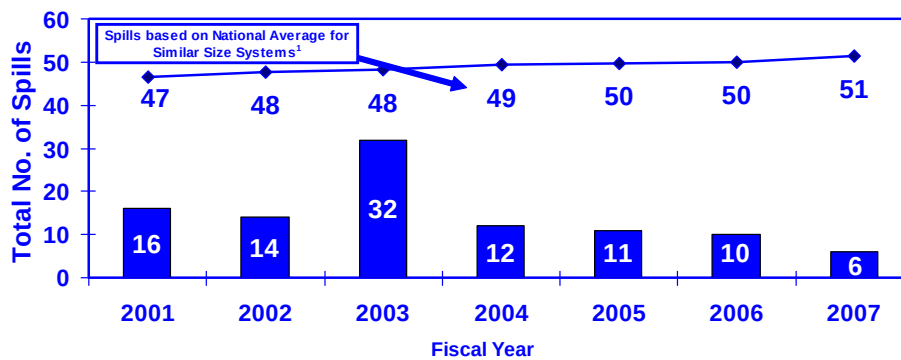
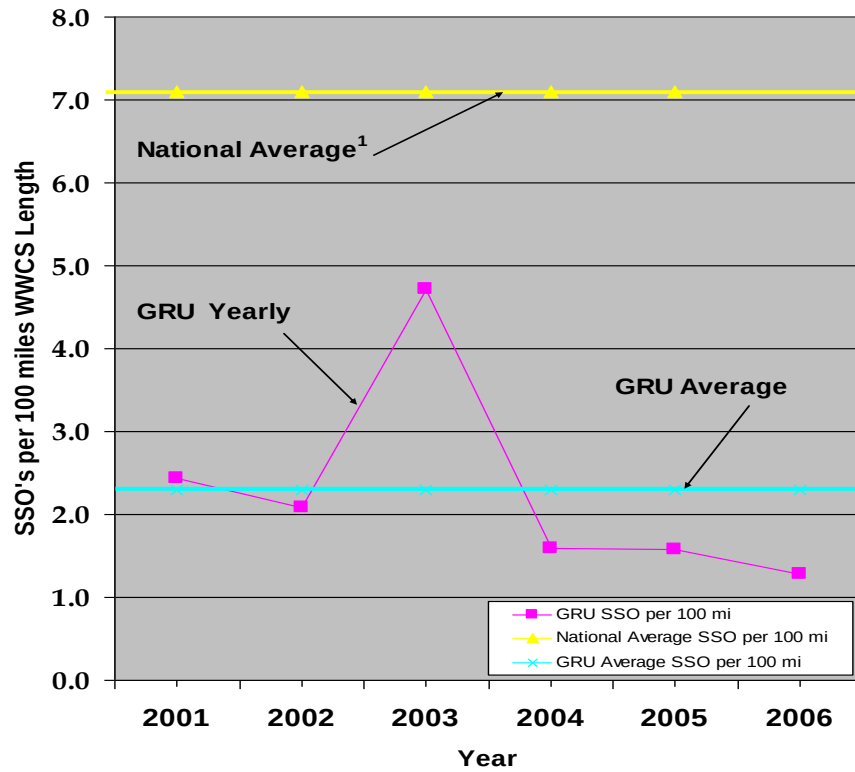


Figure 3.2. GRU wastewater system performance compared with national averages— number of spills per 100 miles of collection system length, 2001–07



¹Source: "Effective Practices for Sanitary Sewer and Collection System Operations and Maintenance"
Water Environment Research Federation (June 2003)

Figure 3.3. GRU wastewater system performance compared with national averages—sanitary sewer overflows (SSOs) per 100 miles of collection system length, 2001–06



3.8.2 Centralized Wastewater Collection System Integrity Programs and Projects

GRU's integrity programs and projects continuously protect the public and the urban creeks from wastewater release from the publicly owned and operated wastewater collection system. These programs and projects include the following:

- Closed-circuit TV Inspection/Repair and Cleaning,
- Infiltration and Inflow (I&I) Testing,
- Sliplining of Gravity Mains Adjacent to Urban Creeks,
- Forcemain Integrity Testing,
- GIS Asset Management System—Mapping and Targeted Maintenance,
- Plan Review and New Development Inspection—Redundancy, Oversizing, and New Standard Practices To Improve Reliability,
- Annual Water/Wastewater Engineering Operation and Maintenance Services, and
- Wastewater Spill Prevention Programs.

Table 3.4 describes each of these programs, and **Appendix H** provides additional details. In addition to these programs, GRU participates in a number of specific projects independently (e.g., microbial source tracking) and in cooperation with other stakeholders (e.g., Paynes Prairie Sweetwater Branch Sheetflow Restoration Project). Chapters 4 (lakes) and 5 (coliform) of this document summarize these efforts.

Table 3.4. Summary of GRU centralized wastewater infrastructure operation and maintenance activities

ACTIVITY	PURPOSE	DESCRIPTION	ADDITIONAL DETAILS
Closed-circuit TV Inspection/Repair and Cleaning	Identify and repair damaged pipes.	GRU has an ongoing closed-circuit TV inspection/repair and cleaning program, and recently added a new closed-circuit TV unit (truck and crew) in FY 2006. Crews clean gravity mains with high-pressure water jets prior to closed-circuit TV inspection. As the crews inspect the lines, they log any deficiencies that may inhibit the pipe's performance. A crew follows the inspection to repair damaged pipelines as needed. If necessary, additional crews are dispatched to repair the pipe and restore it to optimum condition.	Figure 3.4. GRU closed-circuit TV inspection unit Figure 3.5. GRU wastewater collection system maintenance rate
I&I Testing	Identify and eliminate all nonwastewater flows entering the wastewater collection system.	Infiltration is water that flows into the wastewater collection system via cracks and joints that are not completely sealed in the pipe system. Inflow is water that flows directly into the wastewater collection system through manhole lids, broken cleanouts, direct illicit connections, etc. Eliminating I&I is a key component of wastewater collection system preventative maintenance. GRU crews use a number of techniques, including smoke testing, closed-circuit TV inspection, and dye testing, to find potential locations where I&I can occur. In August 2003, GRU commenced with I&I Phase 3, focusing on the urban creek areas. Where collection system defects were found, crews immediately repaired each defect before moving on the next designated test area. GRU has tested over 71% of its wastewater collection system since January 2001, with the urban creek areas covered in Phase 3 of the project during 2003, 2004, and 2005. GRU has spent \$2.8 million since 2001 on I&I and has budgeted \$1.36 million to continue this effort for the 2007–12 budget period.	Figure 3.6. GRU Sewer System I&I Elimination Program status Figure 3.7. Pictures of smoke testing being used to find sources of I&I
Sliplining of Gravity Mains Adjacent to Urban Creeks	Rehabilitate the wastewater gravity mains throughout the collection system and minimize the possibility of wastewater leakage.	GRU uses sliplining technology to rehabilitate the wastewater gravity mains throughout its collection system. Sliplining, which essentially replaces old pipe with new pipe, protects the urban creeks by minimizing the possibility of wastewater leakage. The sliplining of gravity sewer interceptor tributary small-diameter lines adjacent to creeks is ongoing. GRU sliplining projects have totaled \$4.7 million as of 2006, and the projected budget for continuing these efforts is \$681,000 over the 2007–12 budget period. The sliplining process results in a seamless, jointless "pipe-within-a-pipe" with a smooth, continuous inner surface that usually increases flow capacity. Typically installations are completed in a single day. Since the collection system provides 24-hour-per-day service, crews construct "pump arounds" to isolate GRU wastewater collection system lines for cleaning and sliplining. The sliplining process typically restores the hydraulic and structural integrity of the older pipe to that of a new pipe. While sliplining is an expensive technology, it is less invasive compared with open trench construction along the urban creek corridors.	Figure 3.8. Pictures of a sliplined pipe near Hogtown Creek Figure 3.9. Sliplined major gravity mains adjacent to Hogtown Creek and tributaries
Forcemain Integrity Testing	Test the wall thickness of major force mains.	GRU staff have identified more than 25 miles of major force mains that were constructed with ductile iron or cast iron, and are 16 inches in diameter and larger,	Figure 3.10. GRU engineers and crews performing pipe

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ACTIVITY	PURPOSE	DESCRIPTION	ADDITIONAL DETAILS
	perform pressure monitoring, and inspect air release valves to minimize the risk of infrastructure failures.	for inspection and wall thickness testing. A comprehensive program was developed and initiated to test the wall thickness of the 10 major forcemains at 48 locations, perform pressure monitoring at 6 strategic locations within the forcemain system, and inspect 52 air release valves. Nearly 1,700 pipe wall thickness test measurements have been collected to assess the overall condition of GRU's major forcemains. The following conclusions can be reached from this effort:: ▪ <i>GRU's major forcemains appear to be in relatively good condition based on the pipe wall thickness and system operating pressure data collected,</i> ▪ <i>No significant loss of pipe wall material was noted for the 10 major forcemain systems, and</i> ▪ <i>Air release valves that are not operating to specifications are to be replaced as part of a multiyear rehabilitation program.</i> GRU has initiated a program to test second-tier forcemain systems, which have piping diameters of 14 inches or smaller. As of January 2007, 6 of the 15 miles of forcemains have been identified and tested. In addition, GRU has adopted a Standard Operating Procedure (SOP) that requires pipe wall thickness testing prior to all taps (connections) to existing forcemains, to ensure quality taps to the forcemain.	wall thickness testing
GIS Asset Management System–Mapping and Targeted Maintenance	Maintain up-to-date records in a GIS format, providing increased accuracy in locating underground utilities that reduces construction accidents.	GIS facilities mapping incorporates developer- and GRU-installed wastewater and reclaimed water systems into a GIS database format, including a creek crossing pipeline assessment project that logged the GRU wastewater system creek crossings and is being used for assessment of the infrastructure for targeted maintenance. The GIS-based software system also stores mapping information and facility-specific information such as age, material, maintenance history, and adjacent utilities.	
Plan Review and New Development Inspection–Redundancy, Oversizing and New Standard Practices to Improve Reliability	Review new construction plans for compliance with all GRU design and construction standards to improve the reliability of the wastewater collection system.	GRU's requirements exceed industry standards in such areas as improved manhole connection methods, pipe materials and utility crossings (casings), and wastewater collection system oversizing and redundancy. Inspections are performed during and after the completion of construction projects to ensure compliance with construction standards. In addition, before any new gravity wastewater infrastructure is accepted by GRU for ownership and maintenance, it is inspected with closed-circuit TV cameras, flushed, smoke tested, and repaired as necessary. For forcemain systems, it is standard practice to pressure test all new systems before they are put into service.	
Annual Water/Wastewater Engineering Operation and Maintenance Services	Ensure that wastewater infrastructure facilities are available and properly sized to handle demand.	GRU executes a five-year scheduling system for initiating and administering wastewater capital projects, at an annual O&M cost of about \$650,000. It has budgeted \$70 million in capital improvements to the wastewater collection and treatment system over the 2007–11 budget cycle. Projects are timed and prioritized to ensure that facilities are available in a timely manner to meet demands as needed. The major areas of capital improvements include wastewater	

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ACTIVITY	PURPOSE	DESCRIPTION	ADDITIONAL DETAILS
		treatment facilities, lift stations, and the wastewater collection system.	
Wastewater Spill Prevention Programs	Reduce releases from the wastewater collection system to the environment.	GRU has implemented an aggressive pretreatment program focused on commercial grease control. The program includes two inspectors who inspect all food service establishments. In addition, GRU has implemented a campaign focused on residential grease control. As part of the public outreach campaign, staff distributed 5,000 grease trappers, made presentations at local schools, distributed press releases where local media assisted in getting information out to the public, and provided spill prevention information in the GRU customer bulletin.	

Figure 3.4. GRU closed-circuit TV inspection unit



Figure 3.5. GRU wastewater collection system maintenance rate

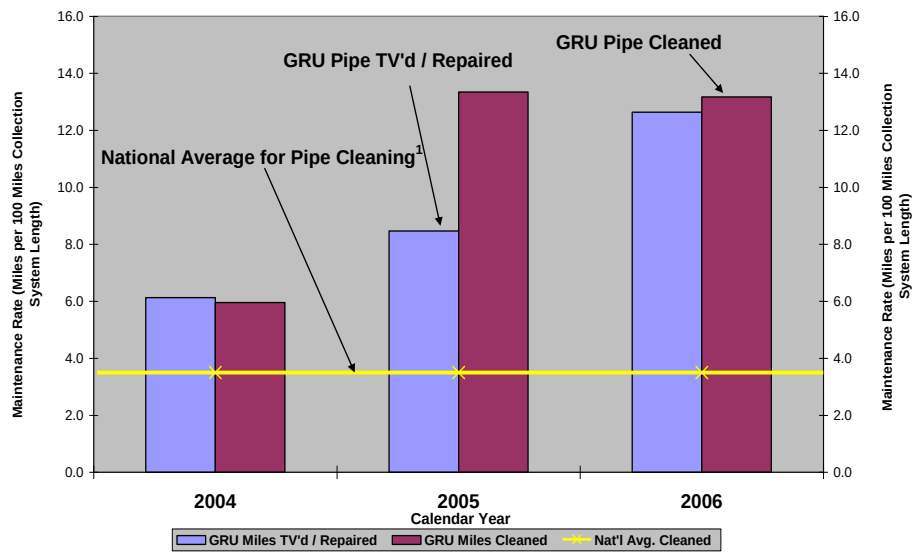
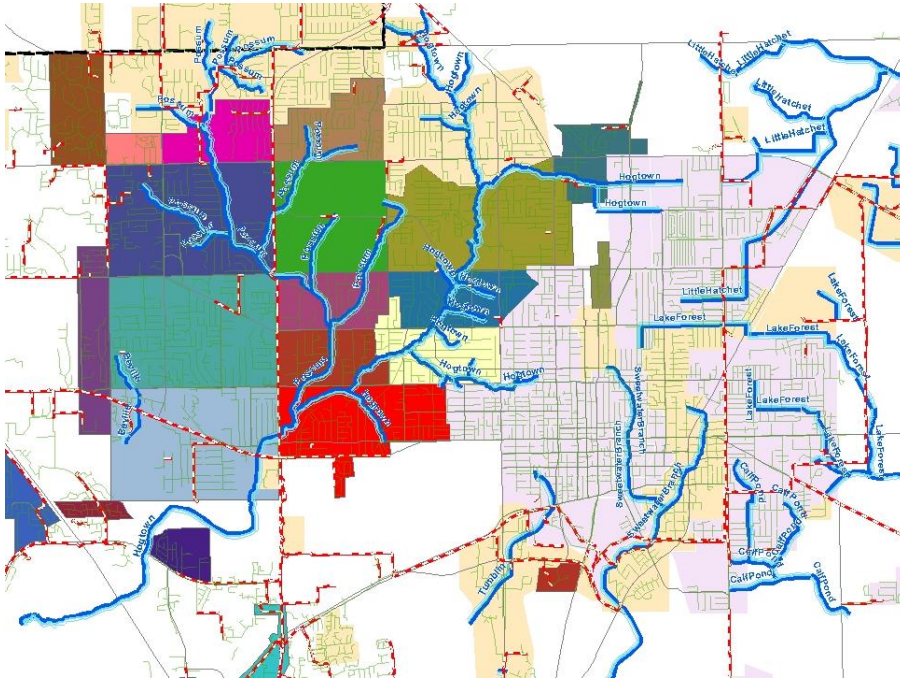


Figure 3.6. GRU Sewer System I&I Elimination Program status



Note: Colored and shaded areas represent the designated wastewater collection system tested areas in the Hogtown, Sweetwater, and Tumblin Creek watersheds. All of the GRU wastewater collection system in these urban creek areas has been tested.

Figure 3.7. Smoke testing used to find I&I



Figure 3.8. A sliplined pipe near Hogtown Creek



Figure 3.9. Sliplined major gravity mains adjacent to Hogtown Creek and tributaries

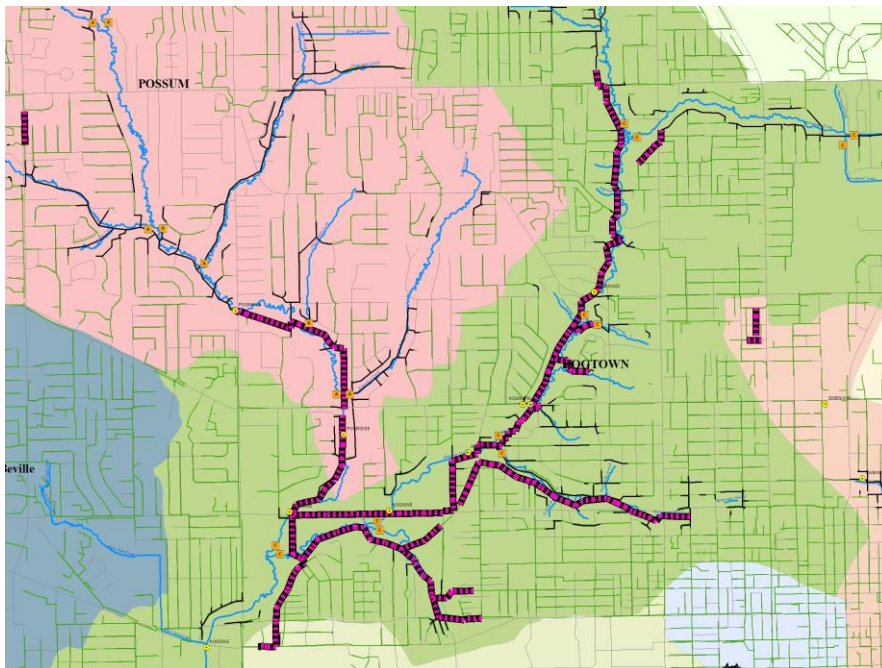


Figure 3.10. GRU engineers and crews performing pipe wall thickness testing



3.9 Septic Tank System Management

Further investigation is needed into the potential for both coliform and nutrient loadings from septic tank systems in the Orange Creek Basin. **Appendix I** contains a recent analysis of nutrient loading from on-site wastewater treatment systems in the four lake sub-basins (including Lochloosa Lake, which does not have an adopted TMDL). The BWG will be exploring options for collecting more information on septic tank system impacts in targeted areas and will be considering strategies regarding septic tank system use/restrictions that are already in place in other parts of the state. **Appendix J** contains draft guidance on septic tank system maintenance and sewer hookup that describes the legal authorities and limitations with regard to requiring maintenance and hookup.

Other ongoing efforts include the following:

Alachua County and GRU

- The ACHD limits the adverse impact of on-site sewage treatment and disposal systems (OSTDSs) on water quality through its regulatory program. Enforcing vertical and horizontal setbacks, assessing and mitigating site-specific OSTDS locations, and providing technical assistance to public and private interests all contribute to successful program implementation.
- The ACHD is working with the ACEPD to identify areas of concern with OSTDSs and to develop BMPs to reduce nutrient and fecal coliform bacteria loading. Any ordinances requiring performance-based systems adopted by the county will be managed by the ACHD with operating permits set forth in Rule 64E-6, F.A.C.
- The ACHD responds to all complaints regarding failing systems and issues a “notice to abate a sanitary nuisance” for those found to be improperly maintained.
- The ACHD has applied for a DEP grant to perform an in-depth septic tank system inventory of the whole county. The county is also proposing a

study to see if there is a need for a septic tank system maintenance program.

- The ACHD and GRU are working together on a project to eliminate or upgrade septic tank systems along urban creeks that have been identified as either having a confirmed impact to creeks or having a significant potential to contribute fecal and total coliform to creeks. The overall effort includes an intensive study by the ACHD to identify and verify septic tank system locations along creeks and to assess the potential impacts of each system to the creeks. The effort will also include a feasibility study conducted by the ACHD and GRU to identify the best approach for upgrading or eliminating septic systems with confirmed or significant potential to impact creeks.

Marion County

- Marion County is concerned about the water quality impacts of septic systems, in particular with regard to the Springshed Protection Program. One of the county's proposed measures is to require an aquifer impact analysis for proposed development, redevelopment, or change to an existing development that increases density or intensity of use within the primary and secondary springs protection zones. This analysis would include a review of pre- and postdevelopment nutrient loading and recharge rates, and discharge rates and volumes.
- With regard to domestic waste treatment and disposal, the county is considering requiring central sewer system connections in all new urban development and limiting nutrient discharge concentrations. On-site septic systems in new construction would have to meet a TN concentration of 10 mg/L. The county may also decide to require an annual operating permit for new on-site septic systems, with routine monitoring and inspection requirements. It is also discussing requirements for maintenance, repairs, and upgrades of existing septic systems.

DEP

- DEP staff support the efforts of counties by responding to complaints. A complaint can become an enforcement issue, resulting in a pump station upgrade. A proactive approach is desirable in order to encourage (or require) owners to inspect, maintain, and/or upgrade facilities. Complaint response primarily involves small, privately owned sewer pump stations where the property owner owns and maintains the lift station. Many of these stations were installed up to 30 years ago, and so the original permit requirements vary significantly from location to location.

3.10 Management Actions To Address Future Growth

The future growth analysis in **Section 2.2** of this document identified isolated areas of population pressure and the need to implement management actions to minimize the impacts of this growth. Stakeholders in the basin have a variety of programs in place to manage the water quality impacts of future growth. This section discusses the programs and policies that are in place.

Each stakeholder involved in the management of future growth operates under a specific set of guidelines, policies, and requirements that regulate development within its jurisdiction. **Table 3.5** identifies the documents that provide this guidance for each applicable stakeholder.

Table 3.5. References for Orange Creek Basin stakeholder development regulations

STAKEHOLDER	DOCUMENT (S)	REFERENCE
SJRWMD	Environmental Resource Permit Regulations	http://www.sjrwmd.com/programs/regulation/erp/index.html
Alachua County	Comprehensive Plan	http://www.growth-management.alachua.fl.us/complanning/amendments.php
Marion County	Comprehensive Plan	http://www.marioncountyfl.org/PL271/PL_Comp_Plan.htm
City of Gainesville	Comprehensive Plan	http://www.cityofgainesville.org/comdev/plan/complandocs.shtml
Alachua County	Land Development Code	http://www.growth-management.alachua.fl.us/ldr.php
Marion County	Land Development Code	http://www.municode.com/resources/gateway.asp?pid=13949&sid=9
City of Gainesville	Land Development Code	http://cityofgainesville.org/comdev/plan/landdevcode.shtml
GRU	Operating Policy	http://www.gru.com/

3.10.1 Low-impact Development

The purpose of stormwater management is first and foremost to prevent flooding, and thus conventional stormwater systems are typically designed to collect, convey, and discharge runoff as efficiently as possible. The concept of low-impact development (LID) in stormwater management was introduced in the late 1990s (EPA, 2000; <http://www.epa.gov/owow/nps/lid/lidlit.html>). This approach to land development uses various land planning and design practices and technologies to simultaneously conserve and protect natural resource systems and reduce infrastructure costs. The LID approach to land development meets flood prevention needs while also minimizing water quality impacts associated with growth.

The goal of LID is to replicate the predevelopment water balance of surface runoff, infiltration, and evapotranspiration on a site-specific basis, thus minimizing or eliminating pollutant loads into surface waters. Stormwater storage, infiltration, and ground water recharge, as well as the volume and frequency of discharges, are maintained through the use of integrated and distributed small-scale stormwater retention and detention areas, the reduction of impervious surfaces, and the lengthening of flow paths and runoff time (Coffman, 2000). The basic principle is to manage runoff at the source using decentralized techniques at the scale of individual lots.

Alachua County, Marion County, the city of Gainesville, UF, and other entities are now beginning to take innovative management action by incorporating LID techniques into future development to maintain or improve water quality in the Orange Creek Basin. There are numerous creative LID techniques to treat, use, store, retain, detain, and recharge stormwater runoff. **Table 3.6** summarizes the application of key LID principles in the basin, and **Table 3.7** provides local

examples of how those principles are being put into place. **Table 3.8** identifies local projects that have used multiple LID principles and activities to achieve water quality benefits. Given the success achieved by local governments, UF, and local developers in implementing LID principles, it is reasonable to expect that these types of projects will continue to be carried out in the basin.

Table 3.6. Application of key LID principles in the Orange Creek Basin

KEY PRINCIPLE	DESCRIPTION	APPLICATION WITHIN THE ORANGE CREEK BASIN
Preservation and protection of environmentally sensitive features	The preservation and protection of sensitive areas that affect the hydrology of a site—including streams and their buffers, floodplains, wetlands, steep slopes, high-permeability soils, and woodland conservation zones—is essential to minimizing hydrologic impacts. Requirements for protection occur primarily through land use rules established at the local governmental level.	Strategic ecosystems in Alachua County are protected through a special area planning process that can require the protection of 50% of uplands (and all wetlands). The rules can also require the clustering of development and protection of the system as a whole Alachua County also has a Preservation Buffer Overlay District that is designed to protect the quality and integrity of preservation lands from the impacts of adjacent development on wildlife, including listed species, wildlife habitat, and water quality. This district includes all real property within 660 feet of lands that are designated as Preservation according to the Future Land Use Map of Alachua County (http://growth-management.alachua.fl.us/gis/complanmaps/Flu_2020_AC_SAS.pdf). Marion County maintains an Environmentally Sensitive Overlay Zone (ESOZ) map, available through the Marion County Planning Department (2710 East Silver Springs Boulevard, Ocala, FL 34470), that includes Orange Creek and Orange Lake. The overlay zone is intended to protect environmentally sensitive lands and provide criteria for the conservation and protection of certain lakes, rivers, shorelands, wetlands, natural habitats, native vegetation and associated uplands, and other environmentally sensitive areas from the adverse effects of development, while protecting the rights of property owners. The design of the stormwater management systems in the overlay zone must imitate and use the features and functions of natural drainage ways, depressions, wetlands, floodplains, and highly permeable soils when possible. Swales, berms, or detention/retention areas are to be used when necessary to prevent stormwater runoff from flowing directly to a receiving waterbody. No developments are currently planned within this zone in the Orange Creek Basin.
Incorporation of small-scale stormwater treatment systems integrated at the lot level	Lot-level and on-site treatment systems offer the best opportunities for maintaining more natural hydrologic functions and reducing the concentration time needed to move water into larger off-site facilities, if necessary. The excessive land requirements for large-scale systems and the concomitant loss of terrestrial open space area are also avoided.	The Wood You Furniture Store, on the corner of North Main Street and 16th Avenue in Gainesville, has a small detention basin on the property. Roof runoff is directed to the detention area rather than to the street. The Burger King restaurant at Main Street and Northeast (NE) 16th Avenue in Gainesville has curb cuts that direct parking lot runoff to a depressed grassy area surrounding the building. The Woodbury Row apartment complex in Gainesville has roof drains that discharge onto a sidewalk, then into a landscaped area, and ultimately to an infiltration basin. The adjacent parking lot also slopes toward this basin. The Oxford Terrace Apartments have disconnected roof gutters that discharge into shallow depressional areas landscaped with native vegetation (Figure 3.11).

KEY PRINCIPLE	DESCRIPTION	APPLICATION WITHIN THE ORANGE CREEK BASIN
Increasing infiltration	Mechanisms that can retain stormwater on site yet still provide percolation facilitate both the protection of surface water quality and aquifer recharge.	The Taylor Square apartment complex in Gainesville uses two infiltration trenches to infiltrate parking lot and roof runoff onto the soil and eventually the surficial aquifer. The trenches are Atlantis Water Management Tank systems that have a sump to capture sediment entering the system, preventing the introduction of pollutants associated with the sediment. The Pep Boys Automotive Supercenter at 7725 W Newberry Road was developed with a vaulted stormwater system under the parking lot to provide infiltration rather than discharge. Infiltration trenches are also under construction at the Stratford Court Apartments, the Royal Palm Apartments, Oxford Terrace, and the Campus View I development.
Reduction of impervious surfaces	Buildings, parking lots, sidewalks, and other impervious surfaces generate large amounts of stormwater runoff that must be disposed of to prevent flooding. Reducing impervious surfaces within a site allows for more on-site retention of runoff, reducing off-site impacts.	Alachua County and the city of Gainesville require that at least 20% of the area of new development must be devoted to landscaping, thus ensuring the preservation of open space and reducing impervious surface in a development. Marion County allows only 70% impervious areas for Urban Commerce Districts and a 40% limit on commercial recreation and publicly owned and operated recreational sites.

Figure 3.11. Disconnected roof gutters at the Oxford Terrace Apartments



Table 3.7. Key LID activities and local projects

ACTIVITIES	DESCRIPTION	LOCAL PROJECTS
Site design	The consideration of LID strategies during the design phase of development is a way to minimize the impact of that development on water quality. Both regulatory and incentive-based approaches can be used to minimize the hydrologic impacts created by a development.	The United States Green Building Council is a coalition of leaders from the building industry working to promote buildings that are environmentally sustainable places to live and work. The council developed the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ to recognize new construction or major renovations that meet a minimum standard. The system provides credits for maximizing open space, controlling water quantity and quality, installing water-efficient landscaping, and reducing water use. In 2001, UF adopted LEED criteria for all major new construction and renovation projects. The Facilities Planning and Construction (FPC) Division of UF (http://www.facilities.ufl.edu/sustain/) is responsible for submitting university projects for LEEDs certification. Currently, FPC projects that are registered for, or have already received LEED certification, include Rinker Hall, which has roof runoff directed to cisterns for storage and slow ground water recharge; the Mary Ann Cofrin-Harn Pavilion, which has an on-site stormwater pond and is landscaped with native vegetation; the Orthopaedics Surgery and Sports Medicine Institute; the McGuire Center for Lepidoptera and Biodiversity; and the Powell Structures and Materials Testing Laboratory. As of February 2007, 133 other projects in the state are seeking LEEDs certification. Alachua County's stormwater management rules are designed to maximize overland flow through natural drainage systems and grassed overland (roadside and lot line) swales. The use of plants and natural landforms are required to slow, hold, and treat runoff from development. Both design characteristics meet the LID strategies of providing water quality treatment and retaining stormwater runoff on site rather than discharging it to surface waters. The Alachua County code also requires the clustering of any development within the Agricultural zoning classification in which more than 24 units are proposed. The city of Gainesville maintains an incentive program for developers to employ green building techniques in new developments. These incentives include fast-track permitting, fee reductions for building applications, and official green building designation by the city. Specific provisions of the program are found in Chapter 6, Article 1.5, of the City Code of Ordinances. The Gainesville Greens development, currently in the planning stages, has received this credit.
Green roofs	Green roofs, also known as vegetated roof covers, are multibeneficial structural building components that reduce roof runoff and maintain water quality by filtering, absorbing, and detaining	The Carrabba's Italian Grill on 3021 SW 34th Street in Gainesville has a green roof. The Charles R. Perry Construction Yard has the first green roof at UF. The construction yard is a demonstration area that comprises a hands-on approach to expose building construction students to the training, techniques, tools, and materials used by master craftspeople in various trades.

ACTIVITIES	DESCRIPTION	LOCAL PROJECTS
	rainfall. They are constructed of a lightweight soil media, underlain by a drainage layer and a high-quality impermeable membrane that protects the building structure. The soil is planted with a specialized mix of plants that can thrive in the harsh, dry, high-temperature conditions of the roof and tolerate short periods of inundation from storm events.	
Swales and filter strips	Swales and filter strips are bioretention systems that reduce runoff velocity, provide filtration, and allow for the infiltration and percolation of runoff.	The Entomology Center at UF has a large grassed, depressed overland flow area in the front of the building that collects and treats roof and pavement runoff (Figure 3.12). Another side of the building has runoff moving overland to a rain garden. The Autozone store on NW 13th Street in Gainesville has no curb and gutter, and all parking lot runoff moves across a grassed strip into a rain garden at the rear of the facility. The store also has two on-site detention facilities, ensuring that no runoff moves off site. The Walgreens Pharmacy on NW 13th Street in Gainesville has roof runoff and parking lot runoff directed to large vegetated swales bordering the property (Figure 3.13). The parking lot at UF's O'Connell Center has swales situated in the median between each set of rows of parking. Multiple curb cuts along each row direct runoff from each of the parking areas into the swales.
Porous (permeable) pavement	Permeable paver systems are assemblies of rigid blocks that contain drainage voids for passing runoff to the subsurface, where the water is further conveyed through base materials to secondary stormwater treatment systems. They particularly help in reducing the volume of rainfall runoff where they replace impermeable sidewalks and parking lots.	Eng, Denman & Associates, an engineering firm at 2404 NW 43rd Street in Gainesville, constructed its parking lot out of pervious pavement. The Heritage Oaks condominium has pervious pavers located where cars park. Traditional asphalt pavement abuts the pervious area but serves to collect runoff in a subsurface exfiltration basin (Figure 3.14). UF installed permeable pavers in the parking lot at the Bat House located near Lake Alice on the university campus (Figure 3.15). The pavers minimize runoff from the parking area by increasing percolation.
Bioretention	Bioretention facilities are small landscaped basins intended to provide water quality management	Windsor Hall has roof runoff draining into an underground drainage network that empties into a rain garden. The garden is large enough to store the peak flow of major storm events.

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ACTIVITIES	DESCRIPTION	LOCAL PROJECTS
	by filtering stormwater runoff before release into secondary stormwater management systems. They use plants and soil to trap and treat petroleum products, metals, nutrients, and sediments. Rain gardens are well-known examples of bioretention areas. They are typically a planted depression that is designed to take all, or as much as possible, of the excess rainwater runoff from development and its associated landscape.	The Madera project, Heritage Oaks, and the Delta Zeta Sorority House in Gainesville all use rain gardens for water quality management. All three projects are discussed in more detail later in this section. A commercial property located along NE 19th Terrace in Gainesville is employing the Filterra® stormwater bioretention filtration system, in which stormwater flows through a specially designed filter media mixture contained in a landscaped concrete container. The mixture immobilizes pollutants; those pollutants are then decomposed, volatilized, and incorporated into the biomass of the Filterra® system's micro/macro fauna and flora. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged. The Gainesville Sun newspaper building, located on U.S. Highway 441 south, has a large, naturally vegetated, depressional area that serves as a rain garden. The GRU office in downtown Gainesville has a disconnected roof gutter system that discharges into a heavily landscaped rain garden along the entire front of the building. The Royal Village Apartments in Gainesville has a rain garden established within a central courtyard area that retains roof runoff (Figure 3.16). The exterior of the complex is also surrounded by landscaped, heavily mulched, depressed areas that capture additional roof runoff.
Florida-friendly landscaping	The objective of Florida-friendly landscaping is to establish and maintain healthy landscapes by matching the right plants with existing site conditions, to minimize the use of additional resources, such as water, fertilizer, pesticides, and labor. Existing native plant communities are typically the best suited to the climate. By using native plants during landscaping, homeowners can reduce the use of fertilizers and pesticides, conserve water, provide habitat for native wildlife, and preserve water quality in adjacent waterbodies.	DEP maintains an interactive website to provide information on Florida-friendly plants and landscaping (http://www.floridayards.org). The site provides basic information, including environmental benefits and guiding principles, and includes a database of native Florida plants. Alachua County requires retention/detention areas to be landscaped with native trees, shrubs, ground covers, and native perennials appropriate to the function as a wet or dry basin. If the landscaped area is also designed to meet on-site stormwater management requirements, it must be designed to provide an aesthetic focal point, or it must be preserved in such a manner as to maintain an existing wetland.
Buffers	The use of open space or vegetated buffers minimizes direct stormwater impacts to streams and	Alachua County requires a 75-foot average development buffer for wetlands, a 100-foot average buffer for wetlands with regulated dependent species, and a 150-foot average buffer for OFWs.

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ACTIVITIES	DESCRIPTION	LOCAL PROJECTS
	wetlands. Vegetated buffers in particular, slow overland runoff velocities. The SJRWMD has permit requirements of a minimum development buffer of 25 feet adjacent to wetlands, as well as more stringent requirements for properties adjacent to Outstanding Florida Waters (OFWs) or within special rule areas.	Marion County requires a vegetative buffer of at least 50 feet from any wetland. Gainesville has buffering standards for areas abutting surface waters and wetlands less than or equal to 0.5 acre that do not include OFWs to be a 50-foot average, with a 35-foot minimum. For areas abutting surface waters and wetlands greater than 0.5 acre that do not include OFWs, the buffer must average 75 feet, with a 50-foot minimum. Finally, for listed OFWs, the buffer distance must average 150 feet, with a 100-foot minimum.
Education and outreach	Public education and outreach initiatives are the most direct means of providing the public and development community with an awareness and understanding of LID strategies and their role in providing for environmentally sound development practices.	In April 2006, the GCWP and Sustainable Alachua County held an Urban Redevelopment and Water Management Issues Workshop featuring a field trip to local redevelopment sites to view firsthand the ways in which stormwater facilities are being integrated into smaller and smaller sites using LID techniques. The workshop also included a discussion panel on LID. Alachua County, in collaboration with UF and the SJRWMD, scheduled a local government workshop on LID and the benefit to water quality. The workshop, scheduled for March 22, 2007, focused on surface water, ground water, and the sustainability issues associated with residential development. This type of workshop is consistent with Alachua County's Comprehensive Plan (Comp Plan) policy, which requires educational information to be made available to developers, homeowners, and other interested citizens on proper maintenance, management, restoration, and development in natural areas (for example, habitat creation, endangered species, management of development ponds, wetlands vegetation, xeriscape, water quality, and water conservation). The Marion County Clean Water Program sponsored an LID seminar for architects, developers, site planners, engineers, landscape architects, and contractors. The seminar, held on April 5, 2007, included discussions of site-planning concepts, stormwater BMPs and LID systems, permitting LID in Florida, and developer experiences with LID. Alachua and Marion County, the city of Gainesville, and the SJRWMD are sponsors of the WAV Program, which provides educational outreach and volunteer water quality monitoring. The program implements activities that promote rain gardens, the on-site management of stormwater quantity and quality, and Florida-friendly landscaping methods, all of which are LID implementation strategies. The Alachua County WAV Program and the Alachua County Extension Service present annual Rain Barrel Workshops in Gainesville. The workshops are a hands-on opportunity for homeowners to make rain catchments for use in their landscapes. In addition to creating a rain barrel they can take to use in their yards, individuals who attend the workshops learn basic water-wise landscaping skills

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ACTIVITIES	DESCRIPTION	LOCAL PROJECTS
		such as the proper use of mulch, reduction of lawn, and use of native plants. All participants take home a rain barrel and a list of plants for north central Florida. In addition to UF's commitment to LID development on-campus, the following faculty and programs are involved in the promotion of LID activities: • <i>The Program for Resource Efficient Communities (http://buildgreen.ufl.edu/) integrates and applies UF's educational and analytical assets to promote the adoption of best design, construction, and management practices that measurably reduce energy and water consumption and environmental degradation in new residential community developments. Examples include the use of native vegetation in landscaping and minimal impervious surfaces surrounding structures. Dr. Pierce Jones (http://buildgreen.ufl.edu/jones.htm), whose experience and research focus includes green building principles and practices, manages the program.</i> • <i>Dr. Mark Clark, Assistant Professor of Wetland Ecology in the Department of Soil and Water Science (http://buildgreen.ufl.edu/clark.htm), is involved in ecological engineering design using wetland processes to improve water quality and enhance the ecological function of altered landscapes.</i> • <i>Dr. John Sansalone, Associate Professor in the Department of Environmental Engineering Sciences, has research and inventive emphases on green materials and infrastructure systems in the urban environment; unit operations for stormwater and wastewater; environmental hydrology, in particular the modification of rainfall-runoff infiltration processes; and urban drainage systems and solidification/stabilization.</i> • <i>Dr. Glenn A. Acomb, Associate Professor in the Department of Landscape Architecture, has areas of specialization that include sustainable community design and land development, water conservation the landscape, and community design and the role of open space.</i> • <i>Dr. James P. Heaney, Professor and Chair of the Department of Environmental Engineering, has interests in the design and development of sustainable urban water infrastructure systems, water supply, wastewater, stormwater and simulation and optimization, and decision support systems.</i> GRU, a multiservice utility owned by the city of Gainesville, provides Gainesville and portions of Alachua County with electric, water, wastewater, natural gas, and telecommunications services. GRU's Green Building Program maintains a reference guide with information on reducing water use that can be applied to both new and existing development. Outdoor recommendations include rain shutoff devices on irrigation systems, irrigation zones for turf/plants/drought-tolerant plants, automatic timers on irrigation system, rainwater catchment, and drip irrigation.

Figure 3.12. UF Entomology Center's overland flow area



Figure 3.13a. Vegetated swale around the Walgreens Pharmacy on NW 13th Street, Gainesville



Figure 3.13b. Vegetated swale around the Walgreens Pharmacy on NW 13th Street, Gainesville



Figure 3.14. Pervious driveway into the Heritage Oaks Condominium Complex in Gainesville



Figure 3.15. Permeable pavement at the UF Bat House parking lot



Figure 3.16. Rain garden in the courtyard at the Royal Village Apartments, Gainesville



Table 3.8. Local multistrategy LID projects

PROJECT	DESCRIPTION
Madera	The Madera Project (http://www.energy.ufl.edu/) in Gainesville consists of 88 single-family homes built on a 44-acre site adjacent to UF. The university's Energy Extension Service has participated in the design and development of this ecofriendly, resource-efficient community under the direction of Professor Pierce Jones. The Madera project is being used to educate developers and contractors about specific environmental construction practices that can increase sustainability and construction efficiency, and reduce future homeowners' long-term maintenance costs. The Madera model center features a parking area with pervious pavers overlaying a wire mesh substrate to reduce compaction and maintain subsurface percolation. Roof downspouts are directed into infiltration cubes that provide temporary subsurface containment and percolation of runoff. A nearby retention area is situated in a natural depression and landscaped as a rain garden. The roadway, with a narrow right-of-way, has no curbs, with runoff directed into swales. The development is planted with native vegetation and employs green building designs and materials. An irrigation system is fitted with moisture sensors to accurately gauge when to provide supplemental irrigation to the minimal turf area in the development. The development has restrictions to protect hardwood tree canopy and understory vegetation.
UF Stormwater Ecological Enhancement Project	The Stormwater Ecological Enhancement Project (SEEP) began in 1995 with an objective to develop a management plan to enhance a stormwater retention basin located within the UF Natural Area and Teaching Lab (NATL) for species diversity, while optimizing the basin's use for research and education. The SEEP project consists of a 3-acre retention pond that is the low point of a 39.75-acre watershed. The total storage capacity of the basin is 478,000 cubic feet. The project's primary goal is to increase the diversity of flooding depths and frequency of flooding, since this is the primary factor regulating species composition in a wetland. To do this, two depressions, one 4 feet and the other 5 feet deep, were dug at the southeastern end of the pond, providing a deep, open-water habitat. At the north end, a low berm was constructed to temporarily impound 80% of the incoming stormwater. This forebay provides the first phase of treatment and is planted with species known to take up heavy metals and remove nutrients. Water from the forebay is then slowly released, first flowing through an area planted to resemble a bottom-land hardwood swamp, and moves into a shallow freshwater marsh before entering the deep-water ponds. At the southeastern end of the pond, another small berm diverts stormwater away from the deep-water ponds, increasing treatment time. The basin is planted with species that resemble those found in wetlands of north central Florida.
Gainesville Green Building Program	The purpose of the Gainesville Green Building Program is to provide the city community with a certification-based "Green Building" program to promote sustainable and environmentally friendly practices of construction and design based on an incentive strategy. It is expected that city-owned civic or office construction projects will follow the program guidelines. The program will be voluntary for all others.
Heritage Oaks*	The Heritage Oaks development in Gainesville has the majority of stormwater draining from roof drains to a landscaped area. Other roof runoff drains to a centralized infiltration trench system located under the hardscape parking lot. The system temporarily stores and treats rooftop and pavement runoff before infiltrating the subsurface. A concrete sidewalk was narrowed to half its width, and a streetside bioretention strip infiltrates runoff generated from the sidewalk hardscape and provides an aesthetically pleasing separation between sidewalk and roadway. A rain garden treats runoff from a no-

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PROJECT	DESCRIPTION
	mortar brick sidewalk and from the disconnected roof. The development incorporates pervious parking (Figure 2.29).
Delta Zeta Sorority House *	The Delta Zeta Sorority House on the southeast intersection of SW 13 th Street and SW 9 th Avenue in Gainesville has a wide landscaped area providing a large infiltration capacity that treats runoff from the sidewalk inside the property. Runoff from the roof and parking lot of the facility is conveyed to a rain garden retention area. The rain garden provides enough vertical storage capacity to temporarily store runoff from very large storms, infiltrating it into the soil gradually.
Alligator Crossing *	Alligator Crossing, located at SW 10 th Street and SW 2 nd Avenue in Gainesville, has drainage from the roof flowing off the edges onto the landscape surrounding the buildings. There is no directly connected impervious area, and a strip of forested area approximately 20 feet wide is used to infiltrate water between this property and a property to the south during and subsequent to storm events.

These projects were identified in the *Tumblin Creek Watershed Management Plan* (Jones Edmunds & Associates, Inc., 2006). The development of this report involved extensive evaluations of stormwater BMPs, including LID, for the Tumblin Creek watershed. The draft plan includes a variety of LID case studies in the watershed.

LID strategies have been proposed for a number of planned redevelopment projects in the city of Gainesville (Table 3.9). The city has also identified 20 potential BMP retrofit sites in the Tumblin Creek watershed in which LID strategies can be applied (Jones Edmunds & Associates, Inc., 2006), and is considering the construction of two subregional stormwater ponds that will include bioretention components. The ponds will be funded by local developers who can buy stormwater credits in the ponds on a first-come, first-served basis. The intent is to minimize the scale necessary to provide both adequate treatment and retention.

The city of Gainesville and the Gainesville Community Redevelopment Agency have drafted an Urban Surfaces Loading proposal to quantify selected loadings, on a statistically significant event basis, for selected cover conditions, focusing on comparing loadings from selected roofing cover conditions with selected pavement cover conditions. The results of the study will allow load differences between roof and pavement surfaces to be quantified, as a planning tool for stormwater management.

Table 3.9. Proposed LID strategies for pending redevelopment projects in the city of Gainesville

	PROPOSED LID STRATEGY				
	GRASSED SWALE	DISCONNECT ROOF	INFILTRATION/ EXFILTRATION	PERMEABLE PARKING	NATURAL LANDSCAPING
REDEVELOPMENT SITES					
1122 SW 3 rd Ave.		X	X		X
Visions		X		X	
Campus View North		X			
Campus View III		X	X		
Estates at Sorority Row		X			
BMP RETROFIT SITES					
6 th St. between NW 7 th Ave. & Depot Rd.	X				
SW 7 th Ave. between SW 12 th St. and SW 10 th St.			X		

Note: This table was current as of May 2007. Subsequent changes to these projects may have occurred.

In sum, LID and design strategies for stormwater management and water quality improvement are increasingly being implemented in the Orange Creek Basin. The major stakeholders in the basin—Alachua County, Marion County, the city of Gainesville, and UF—are receptive to and supportive of LID. These entities have specific regulatory requirements relating to LID, including the preservation and protection of environmentally sensitive features, the reduction of impervious surfaces, site design, swales, landscaping, and buffers.

A variety of completed projects in the Orange Creek Basin that have used LID demonstrate the water quality and environmental benefits of the LID system. Stakeholders have aggressively promoted LID through public education and outreach efforts, including seminars, workshops, and incentive programs.

3.10.2 Other Development-related Management Actions

Stakeholders in the basin are implementing other activities to address the impact of future growth, including the following:

- Marion County addresses the impacts of waterfront projects such as those described above through its ESOZ for various areas in the county. Lands in Marion County adjacent to Orange Lake are in an ESOZ one-half mile from the water's edge. Being within an ESOZ requires, among other things, additional buffering, stormwater management and stricter standards for sewage disposal systems. Provisions are also in place to promote open space and require larger buffers between water resources and intensive land uses.
- Alachua County Forever and the SJRWMD are actively pursuing land acquisition projects throughout the basin. These include the Newnans Lake acquisition, a \$3.7-million cooperative effort between Alachua County, the SJRWMD, and the U.S. Department of the Interior (Project NEW06). Funding is also in place for the Wainberg acquisition (Alachua County; Project NEW07) and the expansion of the Newnans Lake Conservation Area (SJRWMD; Project NEW02/HAT02). Other land acquisition projects will be pursued as funding becomes available.
- The Alachua County Comp Plan has numerous policies and programs in separate elements that complement one another to support broad environmental protections aimed at, among other things, water quality and quantity for citizens and natural resources. Specific LDRs implement these policies, which range from enforcing zoning and development activities to identified criteria for buffers and open space requirements. The county also has a stringent wetland protection ordinance in place.
- The 2001–20 Alachua County Comp Plan now includes the land use of "Preservation," which is defined as "An environmental land use category that consists of publicly owned lands which are intended for use as natural reserves or managed conservation lands for the preservation of natural resources. Preservation areas include lands owned in fee simple or less-than-fee simple title" (Conservation and Open Space Element Definitions). It is appropriate for the parcels now in public ownership and managed for conservation to receive the land use classification of Preservation. Much of the land in the basin is designated Preservation, with management by the SJRWMD.
- Similarly, a variety of programs are in place within the city of Gainesville to address the water quality impacts of future growth. The city adopted a stormwater utility billing system in 1989 to help fund citywide stormwater treatment improvements. The redevelopment of any existing impervious surfaces exceeding 4,000 square feet must meet current regulations for stormwater treatment.
- The city's Land Development Code has strict setback and development requirements for properties adjacent to wetlands, creeks, or lakes. The city has flood control, surface water, wellfield, gateway street, nature park, greenway, and uplands districts designated as overlay districts. Development plans for lots within 150 feet of any regulated waterbody must demonstrate compliance with erosion and sediment control, runoff control and treatment, and the protection of vegetation integral to the creek's ecological value. Chapter 406 of the city's development code outlines several natural resource, wetland, and floodplain protection requirements.

Through the continued implementation of LID principles, land acquisition, and continued regulatory support, the water quality effects of future growth will be minimized in the Orange Creek Basin. Because private entities carry out most development, public-private cooperation is vital if the effects of new development are to be mitigated. The

foundation for this type of cooperation exists in the basin. Relationships between the SJRWMD, local governments, the development community, and the university have been built through the implementation of the projects noted above. This foundation will be key to the ongoing success of LID and similar efforts in the Orange Creek Basin.

3.11 Agricultural BMPs

According to the Alachua County Extension Service, as of March 8, 2007, agriculture in the Orange Creek Basin consisted of the following:

- Commercial pine plantings over much of the area,
- Pasture, beef cattle, dairy,
- Several large and small blueberry plantings on the east side,
- Several pecan orchards on the east side,
- Several citrus orchards on the east side,
- A few watermelon and muskmelon plantings on the east side,
- Several nursery/greenhouse operations,
- Several small-scale mixed vegetable farms,
- A couple of peach and persimmon orchards, and
- Various crops at the UF–IFAS Pine Acres Research Center near Citra.

The two most common agricultural commodity groups in the Orange Creek Basin are cow/calf and silviculture, with silviculture being the dominant agricultural use (see **Section 3.12** for more information on silviculture). Nurseries and sod operations are also present, and equine operations are growing. There is some acreage in blueberries and noncommercial citrus, and a small amount of peanut acreage. In general, peanuts are not fertilized with direct nitrogen inputs because they are legumes and produce their own nitrogen from bacterial conversion in the root nodules. Peanuts are not double-cropped and are often grown using conservation tillage techniques; thus the pollution potential from this crop is minimal.²

In recent years, the total agricultural acreage in the Orange Creek Basin has decreased, following statewide trends in other urbanizing basins. Row crops, in particular, are on the decline in the basin. Acreage that once contained field corn and other agronomic crops has been sold to developers.

3.11.1 Office of Agricultural Water Policy BMP Programs

Through the Office of Agricultural Water Policy (OAWP), DACS develops, adopts, and implements agricultural BMPs, other than for silviculture, to reduce water quality impacts from agricultural discharges and enhance water conservation. The OAWP has adopted by rule BMPs that address the following operations in the basin:

- Container Nurseries (Rule 5M-6, F.A.C.), and
- Vegetable and Agronomic Crops (Rule 5M-8, F.A.C.).

² Wright et al., September 2006. Available: <http://edis.ifas.ufl.edu/AA258>.

The OAWP is currently developing and will be adopting BMP manuals of statewide application for cow/calf, equine, and sod operations. All of the commodity groups in this basin, except for blueberries, are expected to have adopted BMPs in place by early 2008. However, blueberry growers can effectively use BMPs adopted for the nursery, citrus, and vegetable and agronomic crops.

Although measures are not currently adopted by rule for some of the commodity groups in the basin, all agricultural groups use BMPs to some extent. The two major categories of commonly used BMPs are nutrient management and irrigation management. Nutrient management is the amount, timing, placement, and type (source) of fertilizer. It includes practices such as UF-IFAS fertilizer rate recommendations, soil tests, fertigation (fertilizing through irrigation), split fertilizer applications, foliar applications, controlled-release fertilizer, fertilizer spreader shutoff valves, and variable-rate fertilizer spreaders. Irrigation management is the maintenance, scheduling, and overall efficiency rating of irrigation systems. It typically includes conversion to low-volume systems; soil moisture monitoring; scheduling according to rainfall, temperature, and other climatic conditions; water placement; and plant groupings.

The key to successful BMP implementation is educating landowners about integrating BMPs into their daily routine to reduce pollutant loading. A detailed explanation of adopted agricultural BMPs can be found at www.floridaagwaterpolicy.com, and printed BMP manuals can be obtained in the local extension office at county agricultural centers, or by contacting OAWP field staff.

3.11.2 OAWP Process of BMP Implementation

The OAWP assists agricultural producers in selecting, funding, properly implementing, and maintaining BMPs. It employs field staff and contracts with service providers³ to work with producers to submit notices of intent (NOIs) to implement BMPs; these NOIs identify the measures appropriate for their operations. Service providers also give technical assistance to producers and help implement cost-share programs that leverage regional, state, and federal funds.

Although the DACS BMP programs are nonregulatory in nature, Paragraph 403.067(7)(b), F.S., requires that nonpoint pollutant sources (such as agriculture) included in a BMAP demonstrate compliance with pollutant reductions established to meet a TMDL, either by implementing rule-adopted BMPs or conducting water quality monitoring prescribed by DEP or a water management district. Within Alachua County, as of August 2, 2007, NOIs had been submitted for 562 acres of container-grown plants and 1,495 acres of vegetable and agronomic crops, for a total of 2,057 acres under BMP implementation.

3.11.3 Future Focus

To meet the intent of the FWRA for agriculture in the Orange Creek Basin, from 2007–12 the OAWP will, as necessary and feasible, do the following:

- Adopt BMP manuals for cow/calf, equine, container nursery, and sod operations,

³ These include Soil and Water Conservation Districts, UF-IFAS, Natural Resources Conservation Service (NRCS), and Development Councils.

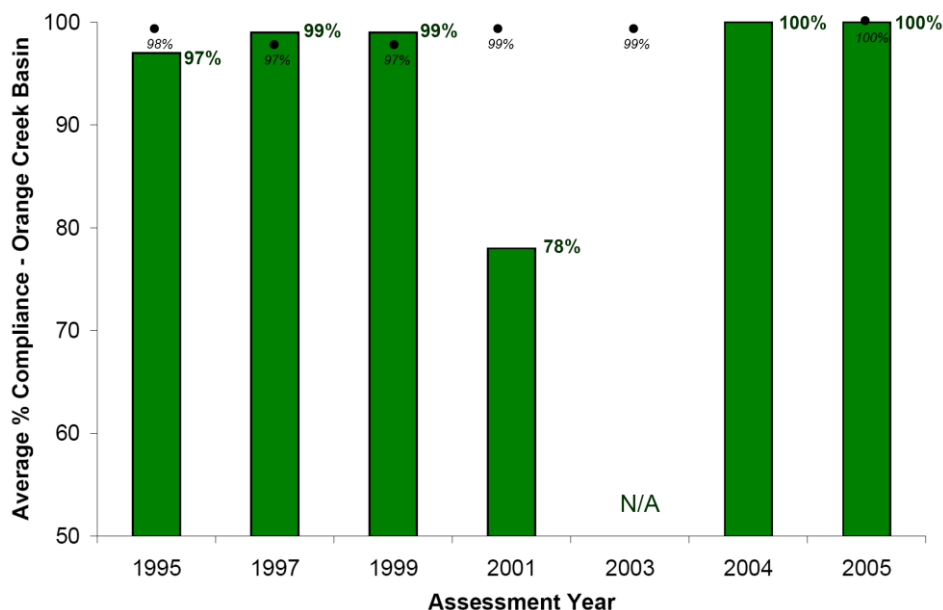
- Intensify its efforts to sign up cow/calf and equine producers for BMP implementation in the Orange Creek Basin,
- Work with DEP to identify priority cow/calf and equine BMPs and verify their effectiveness,
- Develop a BMP implementation assurance program to follow up with selected cow/calf and equine operations on whether they are implementing BMPs and keeping records according to their submitted NOIs,
- Provide or participate in training and educational opportunities for producers regarding BMP implementation and its importance to water quality, particularly TMDLs, and
- Evaluate the need for BMP enrollment and implementation assurance for other commodities in the basin and conduct these on a priority basis, as needed and feasible.

3.11.4 Silviculture

BMPs for silviculture were developed in the mid-1970s, and BMP compliance has been monitored statewide since 1981. Since 1995, compliance with silviculture BMPs in the Orange Creek Basin and vicinity has ranged from 78% to 100%, averaging 98%. A February 2005 BMP survey of active silviculture operations in the basin showed 100% compliance (**Figure 3.17**).

In addition, an analysis of past BMP survey data showed that approximately 2% of all survey sites received fertilizer applications and that 80% of those applications were on forest industry lands. Compliance with this category of BMPs was 100% for all sites considered. Forestry fertilization usually consists of di-ammonium phosphate (DAP) (a TN and phosphate/TP compound), urea (an organic TN compound), or triple-superphosphate (a phosphate/TP compound) applied at rates well below the maximum limits listed in the BMP manual. For the forest industry lands in the basin, fertilizer is typically applied twice during a 22- to 25-year period. In addition, a survey in the middle Suwannee River Basin (a much larger area), determined that approximately 10% of the total forested acres (industry and nonindustrial private forests [NIPF]) received fertilizer in any 1 year (Florida Forestry Association, 2000).

Figure 3.17. Florida silviculture BMP survey data for the Orange Creek Basin and vicinity—summary by survey year



● Average % Compliance of all survey sites in Alachua, Marion and Putnam Counties

Historically, mechanical site preparation occurs on well over half of the sites in any given BMP survey (62% in the 2003 survey). This is a common forestry practice, especially on lands that are managed intensively, and may include chopping, raking, piling, bedding, and burning. Research has shown that nutrients discharged from forestry sites may increase following timber harvesting and mechanical site preparation. However, much of the increase is attributable to higher total annual water yield resulting from the temporary reduction in evapotranspiration from trees. Nutrient export, when it occurs, is typically small (.6 kilograms per hectare per year [kg/ha/yr^{-1}] or less) and short-lived (1 year) (Fisher, 1981; Riekerk, 1983). In addition, such losses can be prevented because the nutrients are typically bound up in soil particles that are protected from erosion and sedimentation by BMPs (Lowrance et al., 1984). Compliance with BMPs for site preparation has a long-term average of 97%.

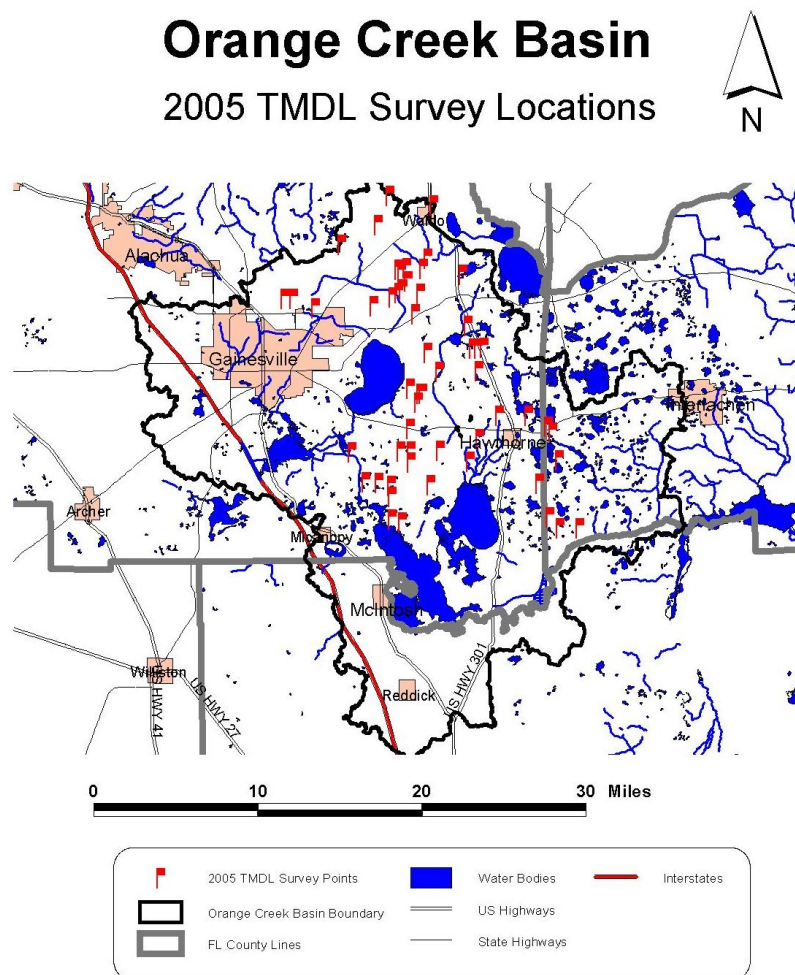
Without BMPs, forestry activities can deliver sediment and nutrients to adjacent water resources at levels that may adversely affect aquatic ecosystems chemically, physically, and biologically. However, Florida BMPs have been shown to be effective in protecting water quality and aquatic habitat by minimizing or eliminating the delivery of forestry-related sediment, nutrients, etc., and by maintaining or improving both instream and riparian habitats. BMP effectiveness research conducted in Florida reported no evidence of sediment delivery or other impacts to the aquatic ecosystem following

intensive silviculture operations on a variety of sites and under varying site conditions (Vowell, 2001; Vowell and Frydenborg, 2004).

As authorized by Section 403.067, F.S., DACS' Division of Forestry (DOF) promulgated Rule 5I-6, F.A.C., effective February 11, 2004. This rule formally adopted the Silviculture BMP Manual and provides a NOI to be submitted by forest landowners who elect to participate in the rule provisions. As of May 15, 2006, NOIs received in Alachua, Marion, and Putnam Counties amount to 82,814.65 acres, 21,747.99 acres, and 69,742.78 acres, respectively, totaling 174,305.42 acres. The rule can be accessed at the DOF website at <http://www.doacs.state.fl.us/onestop/forms/11305.pdf>.

Figure 3.18 shows the locations for the 2005 silviculture BMP survey. **Table 3.10** summarizes the management actions being implemented for silviculture activities to address TMDLs in Orange and Newnans Lakes and Lochloosa Lake.

Figure 3.18. 2005 forestry BMP compliance survey locations in the Orange Creek Basin



Legal Disclaimer: This map is the product of the Florida Division of Forestry.
No warranties are provided for data therein, its use, or its interpretation.

Created: 2/28/2006
By: Robin Marquette

Table 3.10. Silviculture management actions to address TMDLs in Orange and Newnans Lakes and Lochloosa Lake

LEAD ENTITY/ PARTNER	MANAGEMENT ACTION SUMMARY *	START/END DATE
DACS DOF	Conduct an historical analysis of compliance with silviculture BMPs in the Orange Creek Basin and vicinity, focusing on fertilization and mechanical site preparation.	Completed spring 2004
DACS DOF	Conduct a current assessment of BMP compliance in the Orange Creek Basin and vicinity to evaluate all active silviculture operations.	Completed spring 2004
DACS DOF	Conduct a basinwide solicitation of forest landowners for BMP rule "signup," focusing on nonindustrial ownerships. Verify compliance through monitoring as described above.	Completed
DACS DOF	Conduct biannual BMP compliance monitoring in the Orange Creek Basin and vicinity to capture future silviculture operations, focusing on forest fertilization and mechanical site preparation.	Ongoing
DACS DOF	Conduct basinwide BMP training/education for forest landowners, loggers, site preparation contractors, and fertilizer applicators.	Conduct three workshops by 12/31/06
DACS DOF/ Alachua County	Coordinate joint NOI to use silviculture BMPs to reduce duplication and increase awareness of silviculture operations.	Completed
Alachua County	Monitor logging activities, and carry out enforcement against operations not complying with applicable BMPs, according to county codes.	Ongoing

* See **Appendix E** for additional project details.

UF conducts additional silviculture activities in the basin. The Austin Cary Memorial Forest (ACMF) is administered under the auspices of the UF–IFAS School of Forest Resources and Conservation (SFRC). The 2,040-acre forest, a typical north Florida pine flatwoods ecosystem, was acquired to meet accreditation requirements by the Society of American Foresters. Originally the Austin Cary Demonstration Forest, the name was later changed to the Austin Cary Memorial Forest. The management of the forest recognizes its unique composition of old stands mixed with pine plantations and strives to optimize the multiple use value of this resource while continually improving its ecological integrity, economic viability, and associated management operations. Three uses of the ACMF are recognized in order of priority, as follows: (1) resident and continuing education, (2) extension and demonstration, and (3) research. The ACMF is managed primarily to teach and demonstrate forest ecosystem structure and function and the potential of a variety of sustainable land management principles and practices. A mosaic of stand conditions is requisite for reaching these objectives.

Although the forest serves a variety of purposes, several areas provide an age sequence of pine plantations operationally managed with the best current practices. A 5- to 8-year interval between clearcut harvests is used, with a maximum 30-year rotation that provides opportunities to demonstrate the variety of typical plantation products, including pulpwood, poles, and sawtimber. Silviculture activities in the forest allow for comparisons of different spacing configurations, site preparation techniques, weed control, fertilization, and/or thinning options.

Forest management practices on the ACMF have generally been low intensity, involving fire protection and periodic harvesting to meet specific forest or university needs, or to provide for research installations. Until the 1990s, revenue generated from the forest

was returned to university and state budgets, and small annual allocations for the forest were only sufficient for maintenance-level management. Silvicultural activities were limited to thinning in some compartments, the replanting of harvested or burned stands, and understory reduction, usually with prescribed burning.

Periodic pulpwood and timber harvests were conducted on the ACMF after 1950, with the early cuttings concentrating on thinning to remove old naval stores trees and for stand improvement. Several harvests involved sizeable acreages and appreciable income. For example, the 1977 and 1982 harvests to salvage fire damage and to meet UF–IFAS needs generated approximately \$450,000 in revenue. During the rest of the 1980s, there were only a few small salvage cuts or thinnings. A policy change in the mid-1990s allowed harvesting revenue to be returned to forest management, allowing for a more active approach to meeting new forest management objectives outlined in the 1989 Forest Management Plan.

In the future, the ACMF will be managed in a way that meets all applicable standards and performance measures of the Sustainable Forestry Initiative Program, Forest Stewardship Council, American Tree Farm System, and Forest Stewardship Program. The complete *Austin Cary Memorial Forest Resource Management Plan* (Long et al., 2004) is available from UF.

CHAPTER 4: NUTRIENT TMDLS—BASELINE POLLUTANT LOADINGS AND MANAGEMENT ACTIONS BY SUB-BASIN

Including the basinwide management activities described in Chapter 3, over 50 projects have been identified that will achieve nutrient load reductions in specific sub-basins in the Orange Creek Basin. For each sub-basin, this chapter identifies the background pollutant loading by source and highlights specific projects intended to reduce nutrient loads. The benefits of individual projects have been quantified to the greatest extent possible.

Table 4.1 provides a detailed summary of the relative contribution of various sources to pollutant loading, by sub-basin. Data for this table were taken directly from the Newnans Lake, Orange Lake, and Lake Wauberg TMDL documents. These values form the basis of the sub-basin specific baseline pollutant loading discussions in this chapter (see **Sections 4.1.1, 4.2.1, 4.3.1, and 4.4.1**).

Due to the deferment of the TMDL, quantitative source data were not considered valid to include Lochloosa Lake in **Table 4.1**; background loading estimates for Lochloosa Lake were also not included in the table. However, management actions will be implemented to reduce nutrient loading to Lochloosa Lake (see **Section 4.5**).

4.1 Newnans Lake Sub-basin

4.1.1 Baseline Pollutant Loadings

In the Newnans Lake TMDL, the internal recycling of nutrients stored in lake sediments contributed a significant proportion of the TN and TP load and to the subsequent observed degree of eutrophication (see **Section 5.1 of the Newnans Lake TMDL**).

Figures 4.1 and 4.2 reflect the dominance of internal recycling as a nutrient source: 71.8% of the TN load and 52.4% of the TP load. Tributary inflows from Hatchet and Little Hatchet Creeks are the next significant source, contributing 17.1% of the TN load and 22.1% of the TP load into Newnans Lake. Atmospheric deposition is also a significant contributor of TP loading (12.4%).

In the TMDL document, TN loading from on-site wastewater systems (septic tank systems and package plants) was estimated to be 0.3% of the TN load to Newnans Lake. On-site wastewater loading in the TMDL was based on an estimate of the number of failing septic systems and load contributed by each. However, on-site systems that are designed, installed, and functioning properly contribute nutrient loading to ground water, primarily TN. This TN loading can then enter surface waters through baseflow.

Given the BWG's concern about on-site systems, a wastewater analysis was conducted for the BMAP (**Appendix I**). This analysis estimated TN loading from functioning and failing on-site systems (septic tank systems and package plants) in close proximity to Orange Creek Basin lakes. TN loading from on-site wastewater systems into Newnans Lake was estimated at 2.6% (see **Appendix I**). The primary contribution was from functioning septic tank systems (**Figure I-1, Appendix I**). Although this is greater than the 0.3% estimate from the TMDL, on-site wastewater systems are a small portion of the anthropogenic TN load to Newnans Lake.

Table 4.1. TMDL baseline pollutant loading and percent contribution for TMDL development period

SOURCES OF POLLUTANTS (TMDL baseline loading in lbs/yr)	NEWNANS LAKE (TP)		NEWNANS LAKE (TN)		ORANGE LAKE (TP)		LAKE WAUBERG (TP)		LAKE WAUBERG (TN)		ALACHUA SINK (TN)	
	TMDL baseline loading	%	TMDL baseline loading	%	TMDL baseline loading	%	TMDL baseline loading	%	TMDL baseline loading	%	TMDL baseline loading	%
Point sources	145	0.6%	655	0.2%								
Municipal plant discharges												
Main Street WRF											88,748	19.2%
Kelly Power Plant											802	0.2%
Stormwater runoff												
Natural area runoff							21	2.8%	123	3.0%		
Silviculture												
Forest/rural	329	1.3%	5,335	1.7%	602	2.2%					928	0.2%
Rangeland	95	0.4%	657	0.2%	24	0.1%					98	0.0%
Water/wetland	1399	5.4%	14,037	4.4%	3,338	12.0%					2,308	0.5%
Stormwater runoff/developed uses												
Urban open	33	0.1%	347	0.1%	97	0.3%					2,166	0.5%
Low-density residential	145	0.6%	1,340	0.4%	439	1.6%					673	0.1%
Medium-density residential	204	0.8%	1,702	0.5%	185	0.7%					21,700	4.7%
High-density residential	31	0.1%	200	0.1%	4	0.0%					850	0.2%
Transportation/communications	34	0.1%	313	0.1%	209	0.7%					681	0.1%
Agriculture	209	0.8%	1,450	0.5%	5,987	21.5%					599	0.1%
Atmospheric deposition (wet/dry)	3,197	12.4%	6,393	2.0%	2,941	10.5%	486	65.0%	2,642	65.0%	23	0.0%
Tributary inflows												
Hatchet Creek	4,259	16.6%	42,132	13.4%								
Little Hatchet Creek	1,424	5.5%	11,622	3.7%								
Camps Canal					10,346	37.1%						
Cross Creek					3,327	11.9%						
Alachua Lake											338,307	73.1%
Seepage/ground water	540	2.1%	1,993	0.6%								
Septic tank systems	108	0.4%	800	0.3%	390	1.4%	241	32.2%	1,299	32.0%	4,667	1.0%
Internal nutrient recycling	13,478	52.4%	226,515	71.8%								
Adjustment	102	0.4%	19	0.0%								
Loading information												
TMDL baseline phosphorus/nitrogen (P/N) loading and % (lbs/yr)	25,732	100%	315,510	100%	27,889	100%	748	100%	4,064	100%	462,550	100%
TMDL (lbs/yr)	10,924		85,470		15,262		374		2,062		256,322	
Reduction needed in loading and % (lbs/yr)	14,808	57.5%	230,040	72.9%	12,627	45.3%	375	50.1%	2,002	49.3%	206,228	44.6%
Concentration information												
TMDL baseline average chlorophyll a	249 µg/L		249 µg/L		59.2 µg/L		76.9 µg/L		76.9 µg/L			
TMDL baseline TP/TN	160 µg/L		4.34 mg/L		53µg/L		111 µg/L		1.62 mg/L			
TMDL target for TP/TN	62 µg/L		0.97 mg/L		31 µg/L		56 µg/L		1.01 mg/L			
TMDL target for chlorophyll a	57.6 µg/L		57.6 µg/L		24.1 µg/L		29.2 µg/L		29.2 µg/L			

Figure 4.1. Baseline TN loading to Newnans Lake

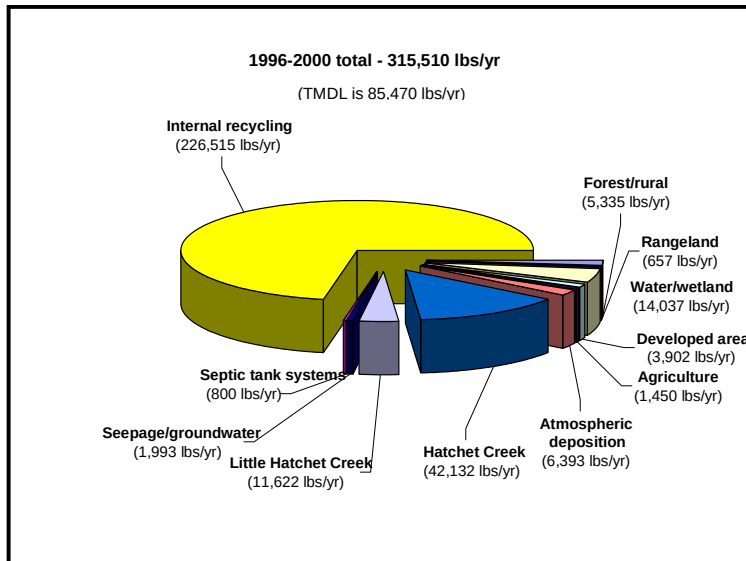
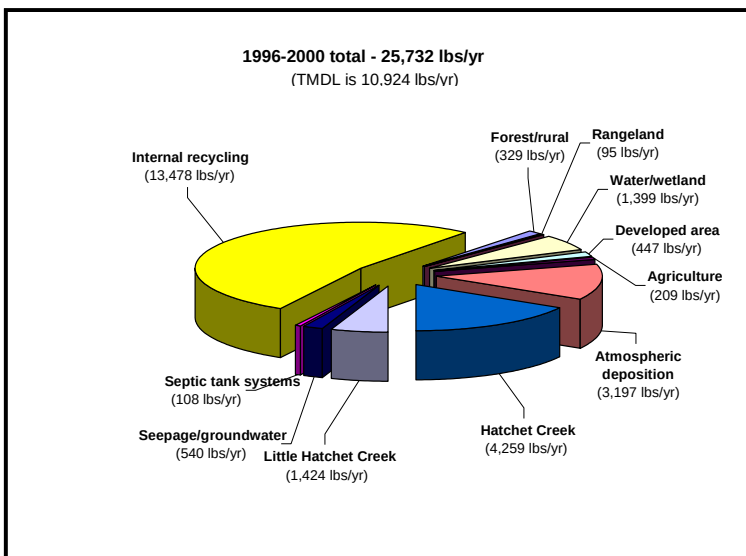


Figure 4.2. Baseline TP loading to Newnans Lake



4.1.2 Management Actions To Reduce Nutrient Loading

Significant uncertainties remain regarding the sources of nutrient loading to Newnans Lake. Despite the precision with which the TMDL was calculated, a significant portion of the allocation was assigned to internal recycling, based primarily on a lack of data. As stated in the TMDL, “No data were available on sediment TN and TP levels during the verified period or on how the rate of translocation of TN and TP from the sediment into the water column correlate with sediment TN and TP in this lake over this period. Given the lack of this information, the importance of the TN and TP internal recycling was examined by comparing the current TSI to the TSI calculated under the situation that the internal recycling of TN and TP was completely eliminated” (DEP, 2003). In the absence of quantitative data, the nutrient recycling allocation was based on the assumption that recycling is responsible for the difference between nutrient loads from stormwater runoff versus in-lake concentrations. Although the BWG does not question that Newnans Lake is nutrient impaired, BWG members have questioned the validity of this assumption.

The extent to which nutrient recycling acts as a nutrient load in Newnans Lake could significantly affect the selection of individual nutrient load reduction projects. However, stakeholders have proposed a variety of projects to decrease nutrient loading into Newnans Lake because of the general consensus that the lake is nutrient impaired.

Management actions have been proposed to address specific nutrient sources in Newnans Lake. **Table 4.2** outlines the anticipated results of these actions. **Appendix E** provides details on all projects. Where possible, load reductions from management actions were quantified. However, limited data were available to quantify anticipated phosphorus loading reductions in the Newnans Lake sub-basin. Regardless of the BWG’s ability to quantify the benefits of proposed management actions, these projects will help decrease nutrient inputs and meet stakeholders’ TMDL obligations.

Table 4.2. Anticipated results of management actions to reduce nutrient loading to Newnans Lake

NUTRIENT SOURCE	MANAGEMENT ACTION CATEGORY	ANTICIPATED RESULTS	COMMENTS
Internal recycling	Restoration and Water Quality Improvement Projects	Reduce nutrient loadings through vegetative uptake.	Planting of maidencane, knotgrass, and giant bulrush.
	Special Studies and Planning Efforts	Improve scientific understanding of nutrient loadings due to recycling; better understanding of ground water nutrient inputs.	Examples: PLRG development, ground water–surface water interaction study.
Hatchet and Little Hatchet Creeks	Land Acquisition	Minimize future loading increases by controlling future land development.	Example: Newnans Lake Conservation Area.
	Silviculture BMPs	Reduce nutrient loadings.	All large industrial silviculture operators are participating in the BMP program, covering the majority of silviculture property in the watershed.
	Agricultural BMPs	Reduce nutrient loadings.	Rowcrop BMPs being implemented; BMP manuals for cow/calf, nursery, sod, and equine operations under development.
	Stormwater Permit Program Implementation	Reduce nutrient loadings.	Includes education and outreach and other components of MS4 Program implementation.
	Structural Stormwater BMPs	Reduce nutrient loadings.	Example: Dry detention ponds installed during SR 20 widening.
Direct stormwater discharge	Stormwater Permit Program Implementation	See above.	See above.
	Silviculture BMPs	See above.	Not applicable
	Agricultural BMPs	See above.	Not applicable
Atmospheric deposition	Not applicable	Not applicable	Considered an uncontrollable source.

A number of projects are also planned but currently unfunded. The primary example is the Brittany Estates Mobile Home Park Wastewater Upgrade, which would reduce nutrient concentrations in the treated wastewater currently being discharged into Hatchet Creek, the primary tributary to Newnans Lake. Alachua County, in partnership with the GCWP, DEP, and SJRWMD (Project ALACHUA06), has proposed the implementation of a basinwide shoreline buffer restoration program that has the potential for significant

water quality and habitat improvements. Alachua County has also proposed a project to restore disturbed wetlands basinwide to improve the function of wetland areas in improving water quality (Project ALACHUA08). These projects should be considered a high priority when they are being evaluated by funding agencies.

To address the broader issue of the unknowns associated with pollutant loads into Newnans Lake, including nutrient recycling, the SJRWMD is conducting two projects. The results will form the basis on which future project selection will be based through the adaptive management approach outlined later in this BMAP. The projects are as follows:

- **Spatial nutrient loading dynamics in the Newnans Lake watershed:** The purpose of this project, which is being conducted for the SJRWMD by Dr. Matt Cohen at UF, is to examine the spatial distribution and transport of nutrients into Newnans Lake. The primary objectives are to quantify the exogenous sources of nutrients, characterize the spatial distribution of loads, delineate cultural from geological enrichment, and identify pathways for nutrients fluxes to the lake. Tasks include developing a GIS-based screening system to strategically select the sample sites, evaluating the effects of land use on water quality in the basin, quantifying the spatial pattern of watershed loading of critical water quality parameters, examining the spatial distribution of stream sediment quality, and quantifying event-based loading at regional hot spots using high-resolution temporal sampling. These data will be incorporated into models to improve the estimates of watershed nutrient loading that are critical to PLRG development. Completion is scheduled for September 2008.
- **Stormwater nutrient loading into Newnans Lake and Lochloosa Lake:** The purpose of this project, being conducted for the SJRWMD by Environmental Consulting and Technology, Inc., is to measure nutrient loading into Newnans Lake and Lochloosa Lake via five selected tributaries during storms. Additionally, monthly base flow samples will be collected from two of the five tributaries. These data will be incorporated into models to improve the estimates of watershed nutrient loading that are critical to PLRG development. Completion is scheduled for September 2008.

4.1.3 Anticipated Reductions in Nutrient Loading

When implemented, all of the Newnans Lake and Hatchet/Little Hatchet Creek projects outlined in **Appendix E** are expected to decrease TN and TP loading to Newnans Lake. The BWG expects to see improvements in TSI values as a result. However, the degree of TSI improvement is difficult to predict, as insufficient data are available to quantify nutrient reductions. Project benefits will be evaluated through data collected during project implementation and the application of the basin monitoring strategy (see *Chapter 6*).

4.2 Orange Lake Sub-Basin

The Orange Lake nutrient TMDL targets were based on reductions in TP (Gao and Gilbert, 2003). As such, management strategies for Orange Lake also focused on TP.

4.2.1 Baseline Pollutant Loadings

Inflow from Newnans Lake via Camps Canal was the most significant TP source in Orange Lake, contributing 37.1% of the TP load (**Table 4.3**). Together with inflow from Lochloosa via Cross Creek (11.9%), loading from upstream lakes contributes 49% of the TP load into Orange Lake. Management actions proposed for Newnans and Lochloosa will help achieve the necessary TP load reductions to promote downward trends in TSI values in Orange Lake.

Figure 4.3 reflects the dominance of tributary inflows as a TP source. Orange Lake is unique in the dominance of agriculture as a TP source (21.5%). Loading from water and wetland areas as well as atmospheric deposition (“uncontrollable” sources) comprises 32% of the TP load into Orange Lake. Given the uncertainties associated with TP attenuation, TP load from on-site systems into Orange Lake was not included in the BMAP-specific wastewater analysis provided in **Appendix I**.

4.2.2 Management Actions To Reduce Phosphorus Loading

Management actions have been proposed to address specific nutrient sources in Orange Lake. **Table 4.3** outlines the anticipated results of these actions. **Appendix E** provides details on all projects. Regardless of the BWG’s ability to quantify the benefits of proposed management actions, these projects will help decrease nutrient inputs and meet stakeholders’ TMDL obligations.

The unfunded projects discussed in **Section 4.1.2** also apply to the Orange Lake sub-basin. These projects should be considered a high priority when they are being evaluated by funding agencies.

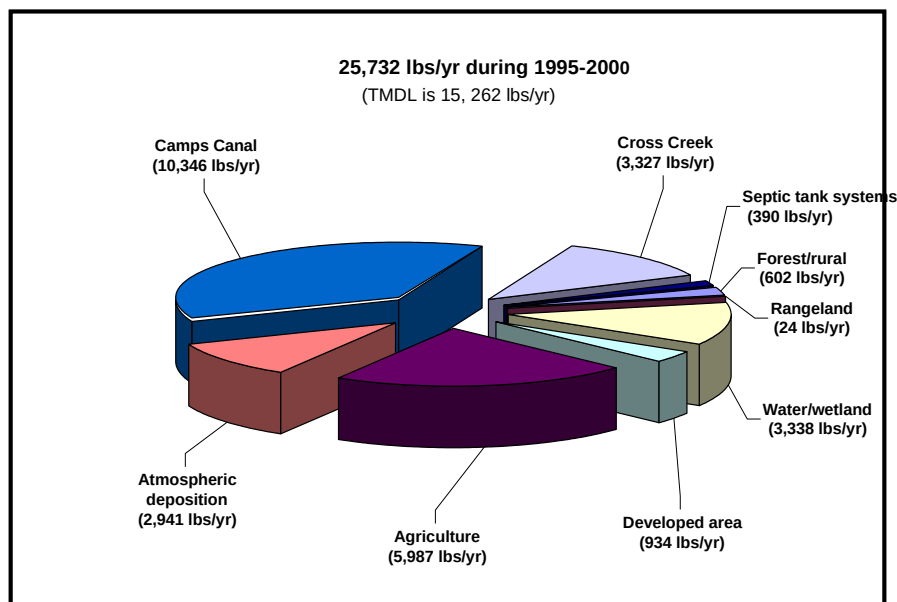
4.2.3 Anticipated Reductions in Phosphorus Loading

Where possible, load reductions from management actions were quantified. However, limited data were available to quantify anticipated phosphorus loading reductions in the Orange Lake Sub-basin. When implemented, all Orange Lake projects outlined in **Appendix E** are expected to decrease TN and TP loading. Because Orange Creek receives water from both Lochloosa Lake and Newnans Lake, projects implemented in these two sub-basins will also benefit Orange Creek by decreasing nutrient loading through Cross Creek and Camps Canal. The BWG expects to see improvements in Orange Lake TSI values as a result. However, the degree of TSI improvement is difficult to predict, as insufficient data were available to quantify nutrient reductions from the majority of projects. As with Newnans Lake, project benefits will be evaluated through data collected during project implementation and application of the basin monitoring strategy (see the monitoring strategy outlined in Chapter 6).

Table 4.3. Anticipated results of management actions to reduce nutrient loading to Orange Lake

NUTRIENT SOURCE	MANAGEMENT ACTION CATEGORY	ANTICIPATED RESULTS	COMMENTS
Inflow from Newnans Lake via Camps Canal/River Styx	See Newnans Lake Management Actions	Reduce TP inflow from Camps Canal/River Styx.	Not applicable
Silviculture and other agricultural sources	Silviculture BMPs	Reduce nutrient loadings.	All large industrial silviculture operators are participating in the BMP Program, covering the majority of silviculture property in the watershed.
	Agricultural BMPs	Reduce nutrient loadings.	Rowcrop BMPs being implemented; BMP manuals for cow/calf, nursery, sod, and equine operations under development.
	Land Acquisition	Minimize future loading increases by controlling future land development.	Example: Longleaf flatwoods preserve.
Water/wetlands	Restoration and Water Quality Improvement Projects	Reduce nutrient loadings through natural nutrient uptake and attenuation.	Not applicable
Inflow from Lochloosa Lake via Cross Creek	Land Acquisition	Minimize future loading increases by controlling future land development.	Example: Lochloosa Wildlife Conservation Area.
	Silviculture BMPs	Reduce nutrient loadings.	All large industrial silviculture operators are participating in the BMP Program, covering the majority of silviculture property in the watershed.
	Agricultural BMPs	Reduce nutrient loadings.	Rowcrop BMPs being implemented; BMP manuals for cow/calf, nursery, sod, and equine operations under development.
	Special Studies and Planning Efforts	Improve understanding of ground water nutrient inputs in PLRG and future iterations of the TMDL.	Examples: PLRG development, ground water–surface water interaction study.
Other identified sources	Stormwater Permit Program Implementation	Reduce nutrient loadings.	Includes education and outreach and other components of MS4 Program implementation.
	Public Education and Outreach	Not applicable	Not applicable
Atmospheric deposition	None	Not applicable	Considered an uncontrollable source.

Figure 4.3. Baseline TP loading to Orange Lake

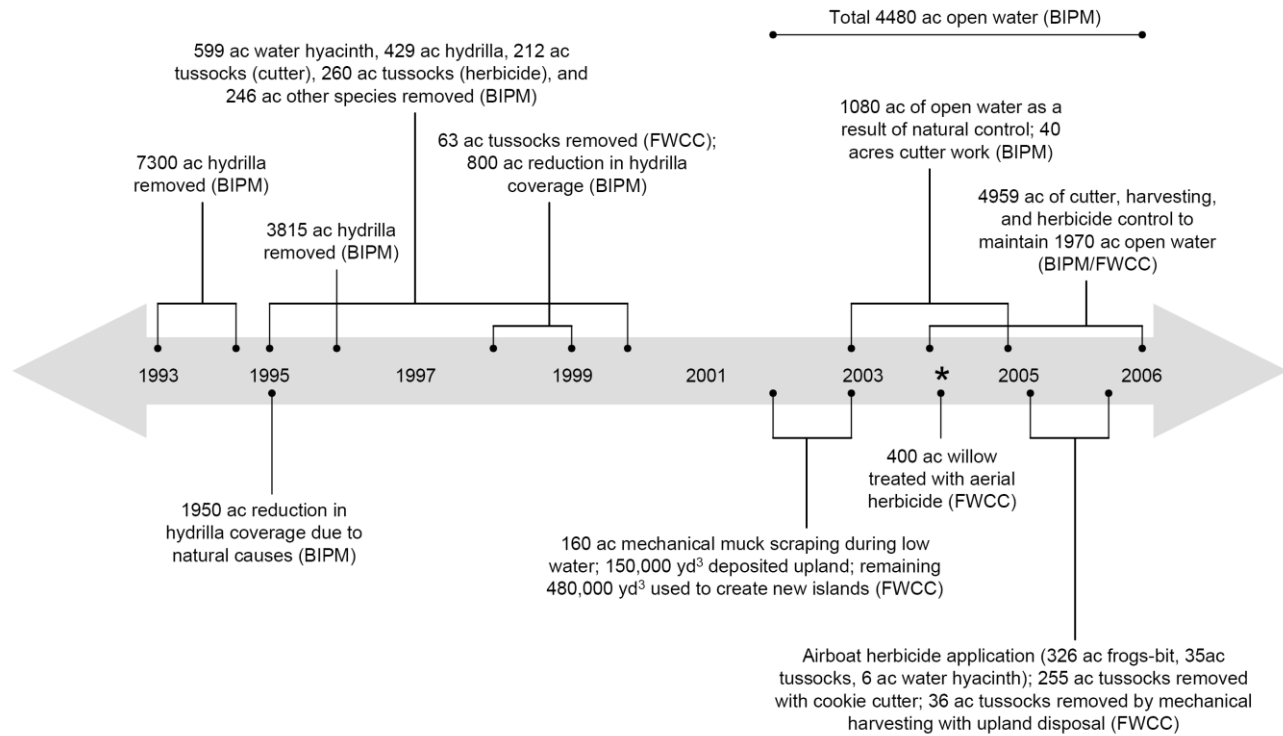


4.2.4 Aquatic Plant Management

DEP conducts aquatic plant management under Subsection 369.20 (2), F.S. (see **Appendix K** for more information on related agency responsibilities and the aquatic plant management review process). Orange Lake has been the site of aquatic plant management activities extending back many decades. The lake is very popular for recreation (especially fishing), but the proliferation of both native and invasive aquatic plants often interferes with navigation and creates localized areas with very low oxygen. “Floating islands,” also known as tussocks, have at times occupied thousands of acres of Orange Lake and are especially abundant after abrupt rises in water level. Activities undertaken to control the accumulation of aquatic plants in the lake have included herbicide treatment, tussock removal and cutting, muck scraping, and mechanical harvesting.

The BWG questioned whether some of the pollutant loading attributed to external sources resulted from aquatic plant management activities in Orange Lake. **Figure 4.4** identifies the key aquatic plant management activities that occurred in the lake between 1993 and 2006.

Figure 4.4. Timeline of aquatic plant management activities in Orange Lake, 1993–2006



* 1500 acres new open water as a result of storms (BIPM)

BIPM = Department of Environmental Protection Bureau of Invasive Plant Management
FWCC = Fish and Wildlife Conservation Commission

In some waterbodies, the internal recycling of nutrients is a significant source of impairment that needs to be addressed, along with external discharges, to achieve and/or maintain reduced nutrient concentrations. In the course of the model calibration process, a significant omission of a nutrient source (such as internal loading) in the model creates a discrepancy between modeled and actual water quality. This discrepancy was not seen during the model calibration for Orange Lake, leading to the conclusion that internal nutrient loading was not significant in the period from 1995 to 2000. Based on this information, neither aquatic plant management activities nor the existence of aquatic plants were considered significant components of the TMDL (DEP, 2003). While internal loadings were considered in this way during TMDL development, allocations in the Orange Lake TMDL were assigned only to external point and nonpoint sources, with a margin of safety.

Some questions remain as to whether large-scale aquatic plant management activities conducted after the TMDL data period may have contributed to lowered water quality in Orange Lake, especially with regard to TP. Such a determination is complicated by a significant rise in water level and a large influx of water from Camps Canal, among other observed events in 2004 and 2005. The ability to distinguish between internal recycling sources is also technically elusive.

In addition to water quality concerns, excessive aquatic plant growth can interfere with navigation and recreation. Thus, it is important to consider the impacts of nonmanagement when balancing the benefits and drawbacks of aquatic plant management.

The BWG concluded the following:

- Coordination and communication are needed among the agencies with state, regional, or local water management responsibilities in the basin (DEP, the FWC, the SJRWMD, Alachua County, and Marion County), to minimize the potential adverse water quality impacts associated with aquatic plant management activities.
- There is a need in the Orange Creek Basin for public education on invasive aquatic plants and their management, including the potential impacts of aquatic plant management and nonmanagement on water quality.

4.3 Lake Wauberg Sub-basin

4.3.1 Baseline Pollutant Loadings

In the Lake Wauberg TMDL, the atmospheric deposition of nutrients contributed 65% of both of the TN and TP load and is considered an uncontrollable source (**Table 4.4**). **Figures 4.5** and **4.6** reflect the dominance of atmospheric deposition as a nutrient source. The other primary source was on-site wastewater, contributing 32%% of the TN load and 32.2% of the TP load into Lake Wauberg. This reflects the character of the Lake Wauberg watershed as largely undeveloped, with limited rural residential and university-owned recreation areas near the lake, all of which rely on on-site systems for wastewater management.

Table 4.4. Anticipated results of management actions to reduce nutrient loading to Lake Wauberg

NUTRIENT SOURCE	MANAGEMENT ACTION CATEGORY	ANTICIPATED RESULTS	COMMENTS
Septic tank systems (on-site wastewater)	Special Studies and Planning Efforts	Identify priority locations for on-site wastewater rehabilitation.	Septic tank systems identified as the primary controllable nutrient source for Lake Wauberg; UF Lake Wauberg South Shore facility septic tank system upgraded in 2000; Additional resources may be needed to rehabilitate failing tanks.
Atmospheric deposition	None	Not applicable	Considered an uncontrollable source.

Figure 4.5. Baseline TN loading to Lake Wauberg

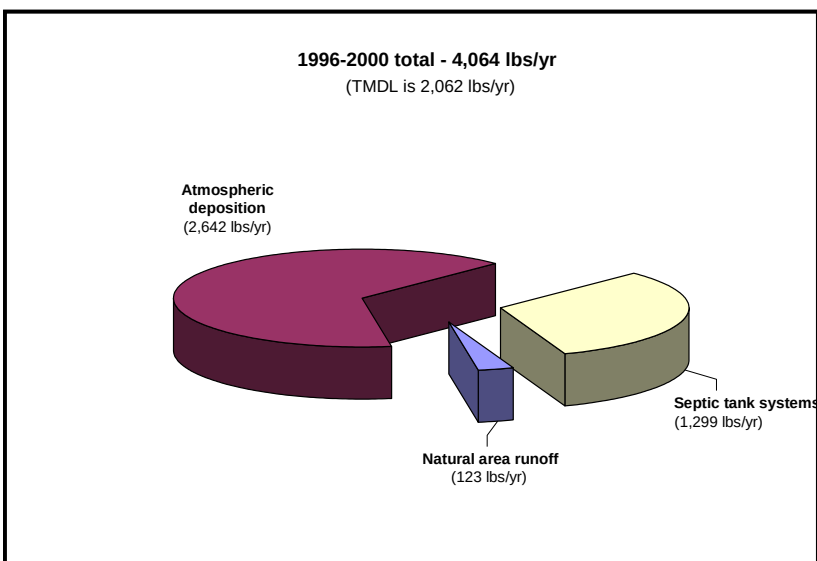
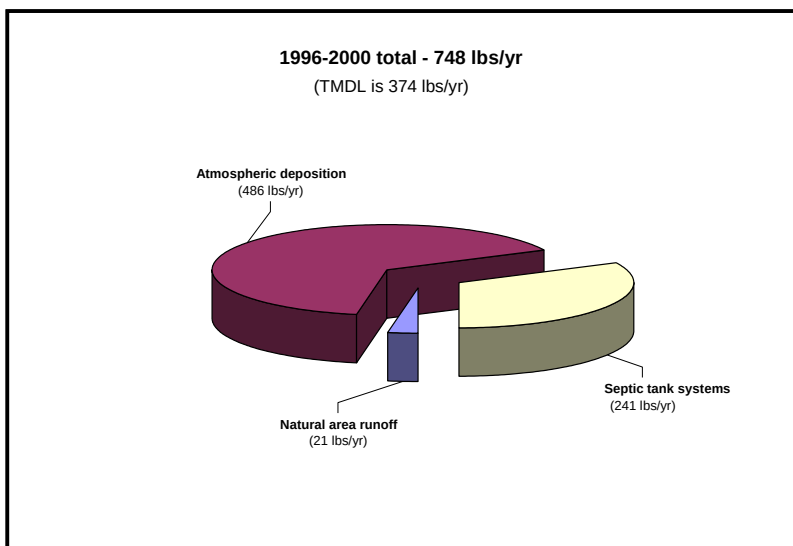


Figure 4.6. Baseline TP loading to Lake Wauberg



Using the alternative assumptions of the BMAP-specific wastewater analysis, TN loading from on-site wastewater systems was estimated to be 10% (see **Appendix I**), compared with the 32% estimate in the TMDL. Despite this difference, the management of on-site wastewater systems remains the primary controllable factor for nutrient load reduction in the Lake Wauberg watershed.

4.3.2 Management Actions To Reduce Nutrient Loading

Management actions have been implemented to address septic tank system nutrient loading in the Lake Wauberg watershed. **Table 4.4** outlines the anticipated results of these actions. Additional projects proposed by the BWG also affect Lake Wauberg (see **Appendix L**).

The primary project being implemented in the Lake Wauberg sub-basin is an evaluation of on-site wastewater systems (i.e., septic tank systems) (Project WAU01). In cooperation with UF and Paynes Prairie State Park staff, the ACHD is completing a study of these systems for parcels along the shore of Lake Wauberg to identify the potential water quality impacts. Although the study is focused on identifying coliform sources, it will also inform the evaluation of septic tank systems as nutrient sources.

In late September/early October 2006, UF, park, and ACHD staff reviewed septic tank systems and drainfields at the recreation areas near the lake that are managed by UF. The drainfields appeared to be in compliance with state standards. Discussions are ongoing regarding the possibility of upgrading these systems. ACHD staff are continuing their evaluation of drainfields for restrooms and the camping area at Paynes Prairie State Park. They have also contacted private landowners along the lake shore (**Figure**

4.7). Their primary evaluation criteria are focused on coliform. However, systems that have potential coliform impacts may also have nutrient impacts. Thus far, ACHD has had difficulty accessing private property. **Figure 4.8** shows the current results of this effort. The ACHD, Paynes Prairie Park, and UF will continue with the project as resources allow.

The unfunded projects discussed in **Section 4.1.2** also apply to the Lake Wauberg sub-basin. These projects should be considered a high priority when they are being evaluated by funding agencies.

Figure 4.7. Form used by the ACHD to contact private landowners for on-site wastewater evaluation



Jeb Bush
Governor

M. Rony François, M.D., M.S.P.H., Ph.D.
Secretary

Date - _____

To - Current Resident

From - Alachua County Health Department

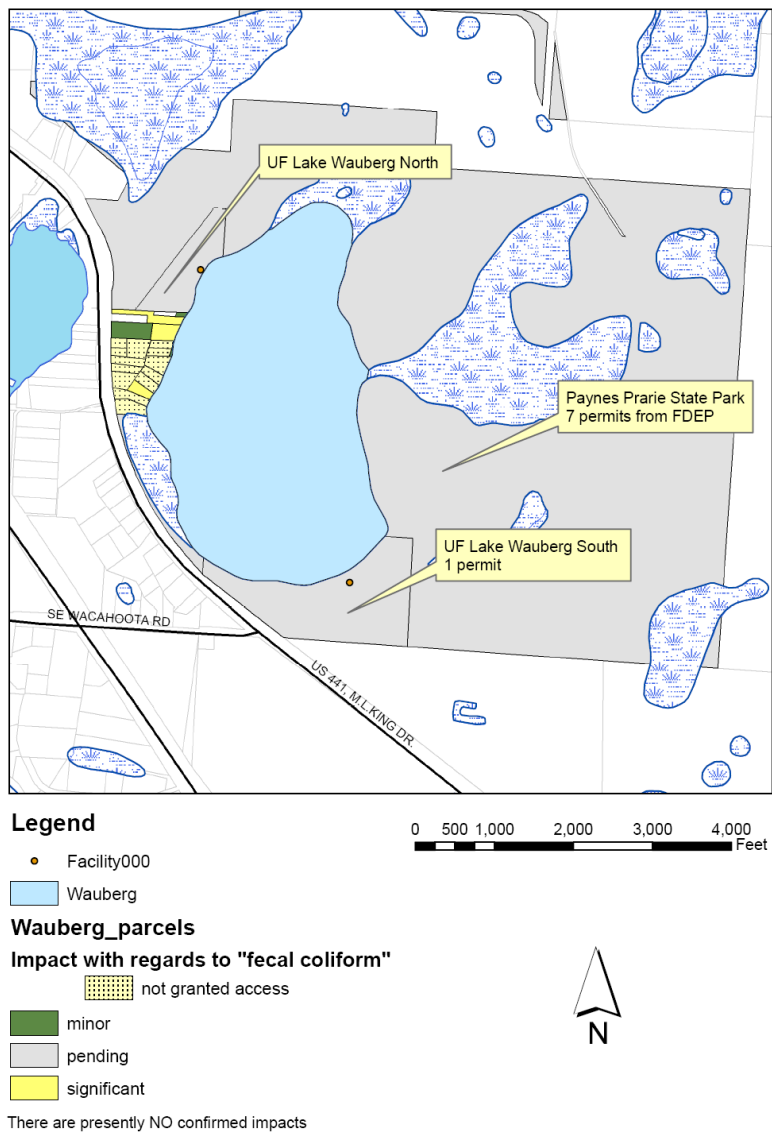
RE - Septic System Study

The Alachua County Health Department is currently conducting a study of septic systems that border certain impaired surface waters. The Lake Wauberg watershed is considered an impaired surface water, and as such, we need your help in establishing the level of impact on this pollution due to septic systems. A staff agent visited your property today, and we have left this flier to ask that you contact the Alachua County Health Department to receive further information in regards to this important study. Please contact us at your earliest convenience, and please note that your participation in this study is imperative to its success. We offer several testing services that can offer you peace of mind for the quality of your drinking water, and all testing and monitoring will be given to you free of charge if you agree to participate in this study.

Please contact Paul Myers or Anthony Dennis at 352-334-7930, to grant access to our staff or for further information on this study. Thank you in advance for contacting the Alachua County Health Department.

Alachua County Health Department
Environmental Health Division
224 SE 24th St
Gainesville, FL 32641

Figure 4.8. Parcels with on-site wastewater systems potentially affecting water quality in Lake Wauberg



4.3.3 Anticipated Reductions in Nutrient Loading

As UF, Paynes Prairie Park, and the ACHD continue to identify and upgrade on-site wastewater systems, nutrient inputs to Lake Wauberg should decrease. Although no data are available to quantify the anticipated nutrient loading reductions associated with Lake Wauberg management actions, it is expected that enhanced septic tank system management will limit nutrient loading into Lake Wauberg.

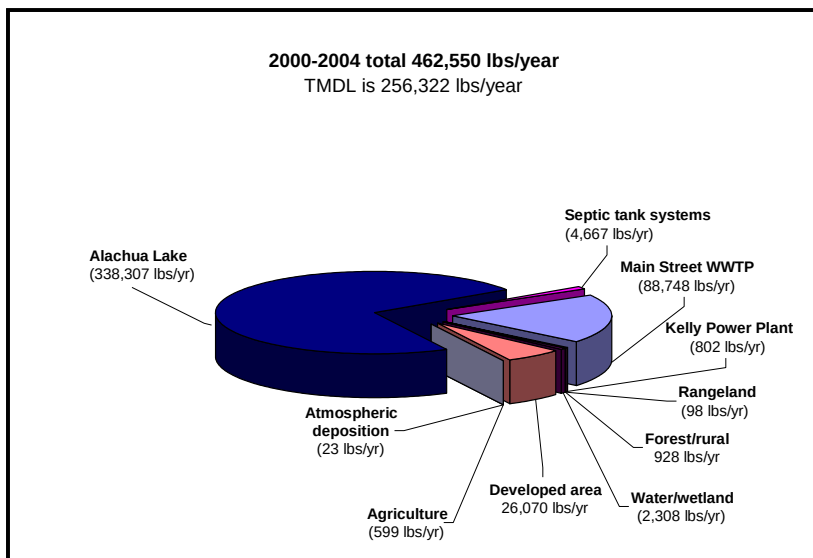
4.4 Alachua Sink Sub-basin

4.4.1 Baseline Pollutant Loadings

Nutrient inflows from Sweetwater Branch include point source discharges from the Main Street WRF and J.R. Kelly Power Plant. Sweetwater Branch also conveys stormwater to Alachua Sink from portions of the urban watershed of east Gainesville. The point source nutrient loadings from Sweetwater Branch are conveyed to Alachua Sink through Paynes Prairie within the Sweetwater Canal. This canal prevents Sweetwater Branch flow from becoming a more diffuse sheetflow, as it did before canal construction. Prior to canal construction, unaltered sheet flow provided more opportunity for water and nutrient uptake to occur as water from Sweetwater Branch made its way to Alachua Sink.

The Main Street WRF currently contributes 88,748 lbs/yr of TN to Alachua Sink, representing about 23% of the total loading. Nonpoint sources make up most of the remaining TN load (**Figure 4.9**). Near the Alachua Sink waterbody, discharge from the Sweetwater Canal combines with a large volume of flow from Alachua Lake, the inundated portion of Paynes Prairie (**Figure 2.6** in Chapter 2). Alachua Sink and Alachua Lake are separate waterbodies during periods of drought and/or low rainfall, but in wet years the entire prairie is flooded and these two waterbodies coalesce. Even if the loading from wastewater sources were completely eliminated, nonpoint source reductions would be needed in order to achieve the TMDL, particularly for those loadings that are contributed through Paynes Prairie/Alachua Lake. It is estimated that the complete removal of the wastewater sources will only result in an 11% reduction in TN in Alachua Sink (ATM, 2005).

Figure 4.9. Baseline TN loading to Alachua Sink



4.4.2 Management Actions To Reduce Nutrient Loading

Potential management actions to reduce TN loading to Alachua Sink are complicated by the hydrology of Paynes Prairie and Alachua Sink, which periodically undergo extreme water level changes over relatively short periods. During prolonged wet periods, high water levels in Paynes Prairie create ecological conditions that are similar to a shallow lake, rather than the freshwater marsh system that is seen during more dry conditions. Water levels at Paynes Prairie during TMDL development were relatively low, although this changed in the latter half of 2004.

Despite this uncertainty, management actions were proposed to address known nutrient sources in Alachua Sink. **Table 4.5** outlines the anticipated results of these actions. Further details are provided below and in **Appendix E**.

Table 4.5. Anticipated results of management actions to reduce nutrient loading to Alachua Sink

NUTRIENT SOURCE	MANAGEMENT ACTION CATEGORY	ANTICIPATED RESULTS	COMMENTS
Stormwater from developed areas (including nutrient load in Alachua Lake)	Restoration and Water Quality Improvement	Reduce TN loadings through nutrient uptake and attenuation.	Sweetwater Branch/ Paynes Prairie Sheetflow Restoration Project
	Land Acquisition	Minimize future loading increases by controlling future land development.	Sweetwater Preserve.
	Structural Stormwater BMPs	Reduce TN loadings	Example: Hydrodynamic separators.
	Special Studies and Planning Efforts	Improve scientific understanding of nutrient loadings due to recycling; better understanding of ground water nutrient inputs	PLRG development for nearby waterbodies will improve understanding of Alachua Sink hydrology as well.
	Stormwater Permit Program Implementation	Reduce nutrient loadings	Includes education and outreach and other components of MS4 Program implementation.
Main Street WRF	Wastewater Infrastructure Maintenance	Inspect and rehabilitate infrastructure to decrease wastewater exfiltration and spills.	GRU has achieved a 99.999% wastewater delivery efficiency rate (based on volume) and has maintained a spill rate of less than 25% of the national average (2004–06).
	Special Studies and Planning Efforts	Facilitate use of reclaimed water to minimize discharges to Sweetwater Branch; improve scientific understanding of nutrient loadings due to recycling; improve understanding of ground water nutrient inputs	Reclaimed Water Master Plan; PLRG development.
Atmospheric deposition	None	Not applicable	Considered an uncontrollable source.

Sweetwater Branch/Paynes Prairie Sheetflow Restoration

Much of Paynes Prairie, a 16,000-acre watershed, was drained in the 1920s to expand cattle ranching. As a result, two highways were constructed across the prairie, SR 441 and I-75. A railroad line across the prairie was abandoned in the 1980s. The legacy of these drainage and transportation activities is 38 miles of dikes and 50 miles of canals in wetlands within Paynes Prairie Preserve State Park. To restore sheetflow across portions of Paynes Prairie, the state park during 2000–04 removed 7 miles of dikes and

filled 10 miles of canals. Dikes and canals channelize water, preventing the sheetflow of shallow water across wetlands. Sheetflow is beneficial because it increases the water residence time in the prairie, thus increasing sediment retention and the uptake of nutrients by wetland plants and the soil before the water reaches Alachua Sink and the Floridan aquifer. Sheetflow also increases the water storage capacity of the watershed.

The restoration of Sweetwater Branch's sheetflow discharge to Payne's Prairie has been contemplated since the early 1970s. Sweetwater Branch is a natural stream that drains what is now the Gainesville urban area and flows into Paynes Prairie. Tumblin' Creek is a tributary to Sweetwater Branch, which also drains the Gainesville urban area. In its natural state, Sweetwater Branch discharged via sheetflow onto Paynes Prairie into the area of the prairie known as Alachua Lake, which is actually a wet prairie. The natural sheetflow of Sweetwater Branch onto the prairie was disrupted by a man-made ditch constructed by ranchers to drain portions of the prairie. The ditch diverts the Sweetwater Branch flow directly to Alachua Sink and has resulted in the dehydration of over 1,000 acres of wetlands in Paynes Prairie. In addition, the direct connection of Sweetwater Branch to Alachua Sink provides a more direct conduit into the Floridan aquifer.

Since most of the urban development in the Sweetwater Branch drainage area occurred long before modern stormwater management and other pollution control regulations, Sweetwater Branch, and in turn the prairie, have been heavily impacted by stormwater runoff. The Main Street WRF also discharges treated effluent to Sweetwater Branch and is the main contributor of nutrients (nitrogen and phosphorus) to the stream. Sweetwater Branch also receives inputs of nutrients, sediments, and other contaminants from stormwater runoff, septic tank systems, and other nonpoint sources from the Gainesville urban area.

During the course of TMDL adoption and BMAP development, a stakeholder group was formed to rekindle the prospects of restoring Sweetwater Branch sheetflow to Paynes Prairie. The primary stakeholders include DEP, the SJRWMD, City of Gainesville Public Works Department (COGPWD), GRU, and DOT. From this stakeholder group, a number of intensive studies were recently conducted to evaluate the alternatives for restoring Sweetwater Branch sheetflow to Payne's Prairie. These efforts included the following:

- **Offline Sweetwater Branch Stormwater Wetland Analysis:** An evaluation of stormwater BMPs for improving water quality in Sweetwater Branch, and specifically, a stormwater management and water quality improvement wetland to be located near the point where Sweetwater Branch flows onto the prairie basin (Jones Edmunds & Associates, Inc., 2003),
- **Sweetwater Branch Sheetflow Restoration Feasibility Analysis:** An evaluation of the sheetflow concept for distributing higher quality Sweetwater Branch flows over a larger area of Paynes Prairie to minimize hydrologic and water quality impacts as well as identification of the level of pretreatment needed to adequately protect and restore the area of the prairie receiving the inflow (Wetland Solutions, Inc. [WSI], 2006a),
- **Main Street WRF Upgrade Analysis:** An evaluation of technically and economically feasible alternatives for additional upgrades at the Main Street WRF to achieve additional nutrient removal prior to discharge into Sweetwater Branch (CH2M HILL, 2006), and

- **Detailed Water Quality Performance Assessment:** Modeling of the effects of the Main Street WRF upgrade alternatives on Sweetwater Branch enhanced wetland sizing and ultimately on water quality (WSI, 2006b).

Based on these studies, stakeholders have developed a conceptual approach to implementing the Sweetwater Branch/Paynes Prairie Sheetflow Restoration Plan. **Appendix M** provides the full Conceptual Plan. The plan will include the following four primary components (**Figure 4.10**):

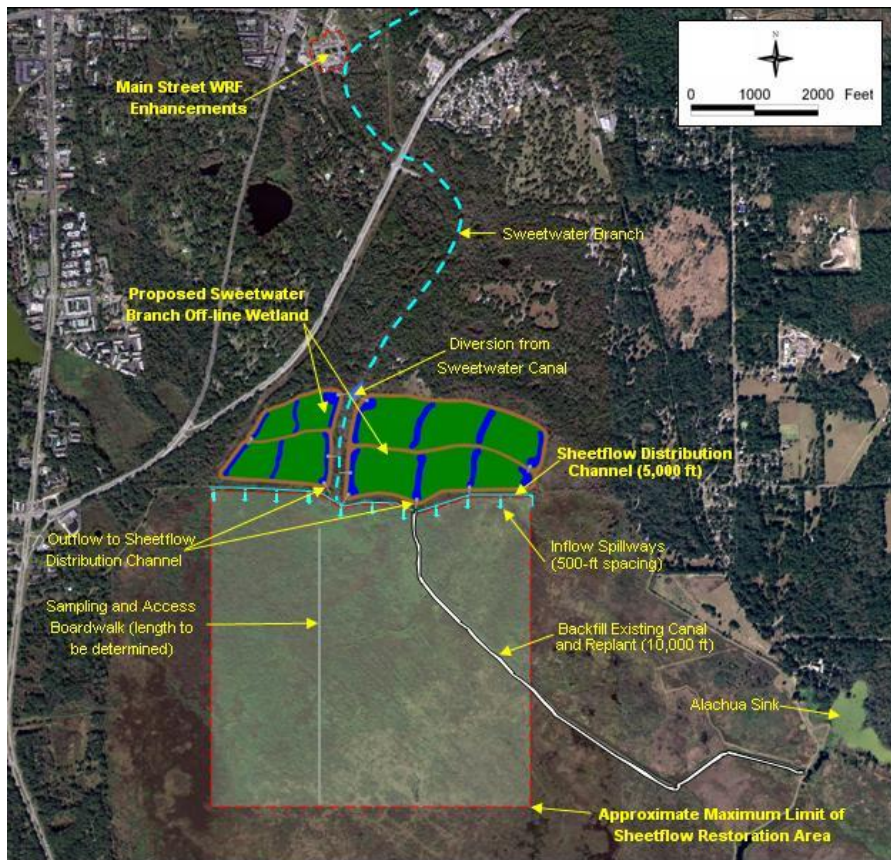
1. The Main Street WRF will be upgraded for optimized nitrogen removal and enhanced phosphorus removal,
2. An enhanced stormwater management and water quality improvement wetland (Sweetwater Branch Wetland) will be constructed, which will reduce levels of nitrogen, phosphorus, suspended solids and other pollutants from Sweetwater Branch to produce a high-quality, low-nutrient water source to Paynes Prairie,
3. Water from the Sweetwater Branch Wetland will be distributed to the Sweetwater Branch/Paynes Prairie Sheetflow Restoration Area, to restore the natural sheetflow to Paynes Prairie, and
4. Approximately 10,000 feet of existing canals and berms in Paynes Prairie Preserve State Park will be removed, and the area will be regraded to predevelopment conditions and replanted with natural wetland vegetation.

At a minimum, this proposed project is expected to provide the following benefits:

1. Restore (rehydrate) over 1,000 acres of formerly impacted wetlands in Paynes Prairie Preserve State Park,
2. Attain regulatory TMDL requirements for the reduction of total TN discharges to Alachua Sink from the city of Gainesville and DOT stormwater runoff and from the Main Street WRF,
3. Create over 100 acres of high-quality wetland wildlife habitat and a public use area for bird watching and nature study in the Sweetwater Branch Wetland,
4. Naturally assimilate other nutrients, sediments, and other pollutants in the Sweetwater Branch flow to protect the Sheetflow Restoration Area, Alachua Sink, and the Floridan aquifer, and
5. Restore part of the overall water balance to Paynes Prairie, which has been impacted by the diversion of water from the prairie at other locations.

A comprehensive monitoring and evaluation program will be part of project implementation and will be used to quantitatively assess the project's environmental benefits.

Figure 4.10. Illustration showing proposed conceptual plan for the Sweetwater Branch/Paynes Prairie Sheetflow Project
(Including upgrades at the Main Street WRF, Sweetwater Branch Wetland, and Sweetwater Branch/Paynes Prairie Sheetflow Restoration Area)



The proposed Sweetwater Branch/Paynes Prairie Sheetflow Restoration Project will require several years and considerable political resolve to implement. Given the complexities that remain and the need for approvals from multiple governmental agencies, all dates noted are tentative. The following key milestones remain for this project to become a reality:

- Preliminary engineering, including surveys and geotechnical assessments to refine project assumptions, determine land requirements, and revise cost estimates. Anticipated completion date: April 2008.

- The purchase of land adjacent to Paynes Prairie, and approval by the Governor and Cabinet to exchange this parcel for state parkland needed by for the Sweetwater Branch Wetland. Anticipated completion date: June 2008.
- Funding will be provided by a combination of the project partners. However, given the significant burden on GRU, rate increases for its customers may be required. Anticipated completion date: Ongoing throughout project permitting and design phases.
- The preparation of detailed construction plans for the wetland system that are compatible with extensive site clearing and earthwork in a sensitive environment. Anticipated completion date: April 2009.
- The preparation of detailed construction plans for upgrades to the Main Street WRF. Anticipated completion date: April 2009.
- Negotiations for environmental permits and reviews allowing project construction. Anticipated completion date: April 2010.
- Final design and contractor procurement for multiple project components. Anticipated completion date: July 2010.
- Project construction at the Main Street WRF and at the base of Sweetwater Branch that will accommodate existing wastewater flows and anticipated wet conditions, while protecting the environmental resources of Paynes Prairie, which is an OFW. Anticipated completion date: July 2012.
- Development and implementation of a thorough monitoring program to quantify project benefits to water quality and ecological structure and functions on Paynes Prairie. Anticipated completion date: July 2013.

The proposed Sweetwater Branch/Paynes Prairie Sheetflow Restoration Project is ambitious and will require focused efforts and commitment from multiple organizations. However, the many valuable benefits that the project will provide to the environment and to the citizens of the state make it well worthwhile.

Other Nutrient Load Reduction Activities

Appendix N provides details on selected additional projects that will reduce nutrient loads to Alachua Sink.

4.4.3 Anticipated Reductions in Nutrient Loading

The Sweetwater Branch/Paynes Prairie Sheetflow Restoration Project holds significant potential for reducing nutrient loads. If the project goes forward as designed, Alachua Sink is expected to meet its nitrogen TMDL. Although few data are available to quantify the anticipated nutrient loading reductions associated with additional Alachua Sink management actions, it is expected that these actions will limit nitrogen loading into Alachua Sink.

4.5 Lochloosa Lake Sub-basin

DEP has deferred the development of the Lochloosa Lake/Cross Creek TMDLs because of a lack of data to establish whether the impairment is due to human impacts, either in whole or in part. Because of this, specific management actions were not developed for this sub-basin. However, several of the basinwide management activities and programs

mentioned in Chapter 3 will help decrease nutrient loads into Lochloosa Lake. This anticipated decrease in nutrient loading will promote water quality enhancement in downstream waterbodies, specifically Orange Lake.

CHAPTER 5: COLIFORM AND IRON TMDLS—BASELINE POLLUTANT LOADINGS AND MANAGEMENT ACTIONS

Coliform bacteria are fecal pollution indicators used for monitoring water quality. The “indicator concept” is not new and has been used to assess the sanitary condition of drinking water, recreational waters, and waters for shellfish propagation since the early part of the 20th century (Griffin et al., 2001; Scott et al., 2002). Fecal coliform bacteria originate from the digestive tracts of warm-blooded animals; therefore their presence in water is indicative of fecal pollution. The presence of these organisms indicates that other disease-causing pathogens may also be present.

Fecal coliform are a subset of the total coliform group and are distinguished by their ability to grow and ferment lactose under incubation at 44.5° C. (Griffin et al., 2001; American Public Health Association [APHA], 1998). **Appendix O** contains additional detail on coliform bacteria characteristics and analyses.

Some total coliform organisms can live and reproduce in soil and water without a warm-blooded host, and so their presence is not necessarily indicative of fecal pollution. Currently, there are state water quality standards for recreational waters for fecal coliform bacteria. Due to the lack of specificity of the total coliform group, DEP has withdrawn the standard for total coliform.

The use of fecal coliform bacteria to indicate microbial water quality is a nationwide standard. However, in the relatively warm waters of the southeast, fecal coliform bacteria can persist and regrow in the environment, thus breaking the direct link between fecal coliform levels and coliform sources. Solo-Gabriele et al. (2000) reported the regrowth of *Escherichia coli* (*E. coli*) bacteria in subtropical coastal waters. *E. coli* is a subset of the fecal coliform group and is another common indicator of fecal pollution.

Potential regrowth may limit the use of fecal coliform and *E. coli* as indicators of recent microbial contamination. Due to the limitations of the standard methods and the indicator concept, advanced scientific methods that trace microbes to their sources are being developed. These emerging methods are showing promise in helping communities understand the sources of bacteria pollution in surface waters. They have been applied in the Orange Creek Basin alongside more traditional approaches for source identification, assessment, and the remediation of elevated coliform levels in Tumblin and Hogtown Creeks and Sweetwater Branch.

5.1 Use of Source Identification To Guide Management Actions

Significant resources have been dedicated to identify sources and reduce bacteria levels in the basin’s urban creeks. However, several key unknowns remain, including quantified source identification. As such, it will be necessary to use a combination of source prevention and additional data-gathering efforts under a phased approach to address coliform reductions. The basic approach, outlined in this chapter in more detail, is as follows:

- Existing monitoring data and source identification projects were used to identify “hot spots,”

- Primary coliform sources will be investigated in each of these hot spots through the coordinated effort of Alachua County, GRU, the city of Gainesville, and other affected parties to address all controllable sources of coliform in one hot spot in a short time before moving onto another priority area,
- At the same time, individual coliform load management projects will continue to be implemented, and
- Coliform monitoring will continue to help assess progress and guide the selection of future management actions.

Through the use of this approach, Orange Creek Basin stakeholders are using the best information available from their source identification activities (e.g., the GRU microbial source tracking project) to identify priority areas. In these areas, stakeholders are using a comprehensive approach to address the known sources of coliform. Uncertainties regarding precise sources remain to be resolved. However, resource commitments associated with individual projects and the cooperative “hot spot” project are expected to result in decreased coliform levels in the urban creeks over the next one to two years. Upon completion of these projects, the ongoing water quality monitoring results will be evaluated to identify the benefits achieved by these projects and guide the selection of future projects.

5.2 Background on the Waterbodies

Fecal coliform bacteria continue to be found at elevated levels in the Orange Creek Basin’s streams and rivers. Elevated coliform bacteria levels occur in both rural and urban areas of the county, though the sources may be quite different.

In the basin, DEP designated three streams in urban Gainesville as impaired waters due to elevated levels of fecal coliform bacteria: Tumblin Creek, Sweetwater Branch, and Hogtown Creek. As shown in **Table 1.3** in Chapter 1, Tumblin Creek, Sweetwater Branch, and Hogtown Creek each have TMDLs for fecal coliform requiring reductions in loading of 74%, 70%, and 51%, respectively. An iron TMDL was also developed for Hatchet Creek. **Section 5.5** at the end of the chapter discusses this TMDL in detail.

5.2.1 Fecal Coliform Levels in Urban Creeks

Fecal coliform levels vary widely in Alachua County’s waters under differing hydrologic conditions. Typically, baseflow levels in streams are one or more orders of magnitude lower than samples collected under stormflow conditions (R. Hallbourg, ACEPD, unpublished data).

Quarterly median baseflow levels of fecal coliform concentrations in the urban creeks from 2001 through 2005 (**Table 5.1**) ranged from less than 200 to 5,000 colony-forming units per 100 milliliters (CFU/100 mL). Samples collected under stormflow conditions can exceed 100,000 CFU/100 mL. Both baseflow and stormflow levels often greatly exceed the one-time allowable maximum of 800 CFU/100 mL for the Class III water quality standard for recreational waters.

The median value is a useful measure of central tendency for comparing results. The median value has the advantage of not being as influenced by the extreme values as the

mean or average value. In a detailed analysis of 2004–05 fecal coliform data conducted by the ACEPD, the median value compared favorably with the geometric mean.

For the purpose of summary statistics, the ACEPD has combined data for all stations along each of the three creeks. Data (Table 5.1 and Figure 5.1) show a decreasing trend of fecal coliform levels in all three creeks from January 2001 to July 2005. There are a number of possible reasons for the decline, including the extremely high rainfall events that occurred with the hurricanes in August and September 2004. These rains raised water levels and scoured the creeks, moving and redistributing sediments that but have been a persistent source for the elevated levels of fecal coliform bacteria in some areas.

Table 5.1. Median fecal coliform bacteria levels for the Hogtown Creek, Sweetwater Branch, and Tumblin Creek watersheds, 2001–05

YEAR	HOGTOWN CREEK		SWEETWATER BRANCH		TUMBLIN CREEK		RAINFALL (INCHES)
	FECAL COLIFORM (CFU/100mL)	N	FECAL COLIFORM (CFU/100mL)	N	FECAL COLIFORM (CFU/100mL)	N	
2001	290	42	1,700	47	1,300	27	44.55
2002	700	81	1,700	54	2,400	47	47.10
2003	1,300	52	1,110	30	2,000	18	43.04
2004	540	160	565	102	920	33	55.73
2005	685	46	720	29	800	13	25.94

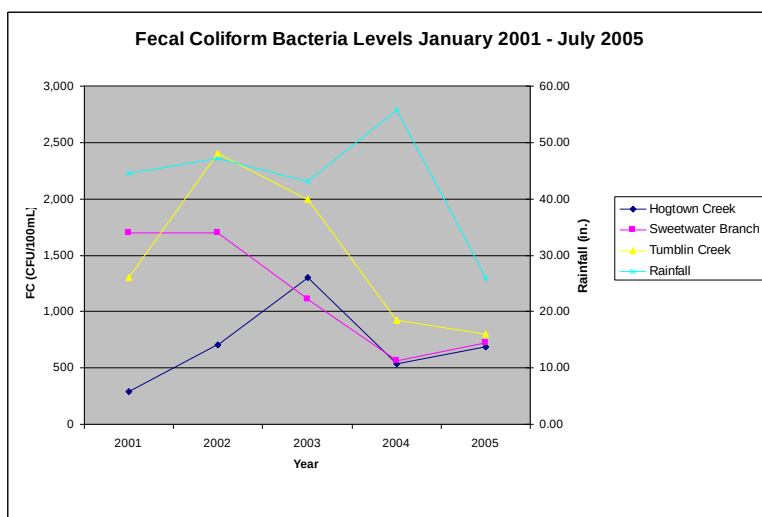
Notes:

Median values for all stations on creeks.

N = Count of samples in median.

2005 data up to June only.

Figure 5.1. Median fecal coliform bacteria levels for the Hogtown Creek, Sweetwater Branch, and Tumblin Creek watersheds, January 2001–July 2005



5.2.2 Coliform Load Allocations

Due to the uncertainties and limitations with conventional testing methods for coliform, detailed load allocations were not established in the adopted TMDLs and will not be developed in the initial BMAP cycle, except for the Main Street WRF. Detailed load allocations will not be possible until additional studies are performed that better identify the sources of coliform. Until such studies are completed, each stakeholder will need to develop and implement management strategies that provide reasonable assurances that the potential sources of coliform under their respective control are being mitigated or eliminated in a prudent and cost-effective manner. The implementation of the coliform TMDLs will require a phased approach that will continually consider historical efforts and new water quality and source-tracking data.

For the Main Street WRF, the TMDL for Sweetwater Branch allows for coliform counts based on the surface water standard permitted limits, which allow an average monthly arithmetic mean of 200 CFU/100mL and a single sample maximum of 800 CFU/100mL. These limits are based on the facility average daily permitted flow of 7.5 mgd. The effluent from the Main Street WRF typically shows nondetectable or near nondetectable levels for fecal coliforms, and the daily permitted compliance monitoring data are submitted to DEP in the monthly discharge monitoring reports. As discussed in Chapter 3, the Main Street WRF is not considered a source of coliform impairment in Sweetwater Branch under the TMDL, and no reductions are required in the TMDL for this facility.

5.3 Coliform Sources—The Urban Creeks

Before and during the initial TMDL and BMAP cycle, local stakeholders dedicated significant resources to gather water quality data, conduct source-tracking efforts, and verify the system integrity of centralized and on-site wastewater systems to reduce coliform levels in the Gainesville urban creeks. This section highlights the key source identification projects, including two intensive microbial source tracking projects.

5.3.1 Completed Source Identification Projects

The following three projects provided the foundation for the current and future approach to coliform load management in the Orange Creek Basin. The results of these projects were considered alongside source information gathered during TMDL development to guide the type of activities and geographic priorities for the management actions identified in **Section 5.4**.

1. Alachua County Environmental Protection Department Coliform Monitoring and Microbial Source Tracking

ACEPD has historically monitored fecal coliform bacteria in the urban creeks and Newnans Lake tributaries in the basin. In 2000, ACEPD contracted with the University of South Florida and Biological Consulting Services, Inc. to conduct antibiotic resistance analyses (ARA) and DNA ribotyping, respectively. This work was conducted in an effort to determine the sources of fecal coliform bacteria present in Tumblin Creek and Sweetwater Branch (Harwood, 2003a and 2003b). The results of these studies were inconclusive, likely in part due to the small number of sampling events and the lack of

specificity in the techniques employed at the time. The use of ARA has not proven successful and has been replaced by more sophisticated testing.

In an effort to find a reliable microbial indicator, the ACEPD is evaluating analytical techniques for analyses of *E. coli*. The results from the initial samplings do not indicate that these data will be more useful than fecal coliform for source tracking. The ACEPD continues to monitor the levels of fecal coliform bacteria in the urban creeks and the tributaries to Newnans Lake. The urban creek sampling is currently conducted bimonthly, and the Newnans Lake tributaries are sampled at least quarterly. In addition to the baseline monitoring, the ACEPD will conduct source-tracking studies at locations where elevated fecal coliform bacteria have been found over the past two years. It will also evaluate storm event-related fecal coliform levels in the urban watersheds of Tumbler Creek, Sweetwater Branch, and Hogtown Creek.

2. GRU Microbial Source Tracking Study

The GRU Microbial Source Tracking Study is of particular significance. Using previous conventional testing studies and land use coverages in tandem with advanced scientific microbial source tracking methods, the study provides an initial understanding of the relative contributions of various sources to coliform levels in the creeks, and applies genetic markers to identify locations where human fecal pollution is present. The study was conducted in three phases, with the third phase applying advanced microbial source tracking methods to 40 samples taken over 4 events under wet and dry conditions.

Appendix P provides additional details on the study.

The presence or absence of three different DNA markers was evaluated: **human polyoma virus DNA marker** (found in urine), **human enterococcus DNA marker**, and **human bacteroides marker**. These markers are found under different conditions, in different proportions of the human population, and have different regrowth potential, and so the **pattern** of presence/absence markers in a sample can provide clues to the source and timing of the fecal contamination.

The variables representing bacteria count data will be converted to presence/absence variables by using the EPA thresholds of counts used to fail or pass a waterbody for human use (high counts indicate failure and presence, and vice versa). Using these regulatory thresholds of passing or failing waterbodies to convert the bacteria counts to categorical variables provides an indication of how well the conventional guidelines indicate a human source of contamination.

To determine the relative contribution of potential sources, DNA fingerprinting of *E. coli*, known as ribotyping, was performed. The ribotyping analysis involved isolating *E. coli* from a number of sample sites in the study and comparing their genetic fingerprint with a database of over 5,000 human and nonhuman *E. coli* isolates. An initial analysis was performed to predict the primary animal source of an isolate (human, bird, wildlife, etc.). A second analysis examined the ability of ribotype profiles, or genetic fingerprinting, to predict the specific source of an isolate from a comparison of the animal and human-derived isolates collected in the study to the pre-existing ribotype database. This second analysis resulted in either a direct match to a source isolate or an "indeterminate" classification in which the DNA profile matched several source isolates contained in the database. A broad classification of "indeterminate animal" was also assigned to a fingerprint that was shared by two or more animal sources in the library but was not observed in human isolates. Finally, a classification of "human/animal" was assigned to

isolates that matched both human and animal sources. **Figure 5.2** summarizes the results of the ribotyping analysis performed at 20 locations. The figure shows that the nonhuman categories were the dominant sources found in the study.

To narrow in on the human contribution, the presence or absence of 4 different DNA markers was evaluated: **human enteric virus DNA marker**, **human polyoma virus DNA marker** (found in urine), **human enterococcus DNA marker**, and **human bacteroides marker**. These markers are found under different conditions, in different proportions of the human population, and have different regrowth potential, and so the **pattern** of presence/absence markers in a sample can provide clues to the source and timing of the fecal contamination. **Table 5.2** summarizes the human markers and their characteristics, and **Table 5.3** describes the interpretative “toolbox” applied to determine whether the human markers present in an area are recent or a residual remnant of a past event. After 40 samples taken during 4 different events, the study identified 7 areas that have persistent sources of human contamination and warrant further investigation by local stakeholders.

Figure 5.2. Results of GRU microbial source tracking ribotyping analysis

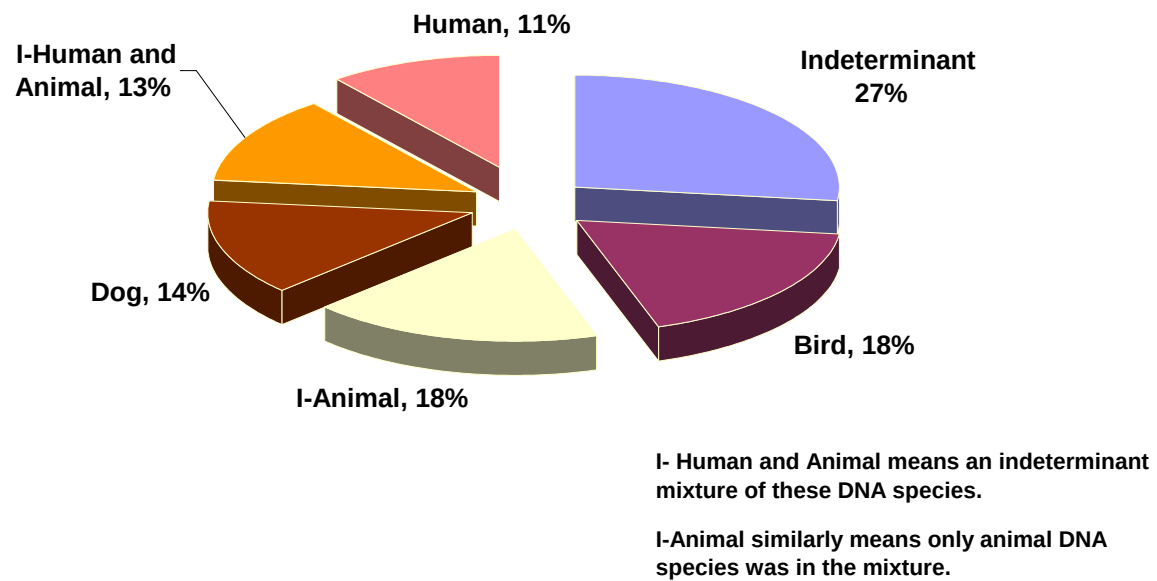


Table 5.2. Summary characteristics for genetic markers used in tracking and investigation of microbial sources

TYPE OF GENETIC MARKER	TYPE OF ANALYSIS	OCCURRENCE	MARKER SPECIFICITY	TEST SENSITIVITY	FATE IN THE ENVIRONMENT	POTENTIAL FOR REGROWTH
Human enteric virus	Reverse Transcriptase Polymerase Chain Reaction (RT-PCR)	Digestive system	Very highly specific	Moderate	Persists in ground water and surface water for 30 to 60 days	Does not regrow in environment due to lack of host
Human polyoma virus	Polymerase Chain Reaction (PCR)	Urinary tract	Very highly specific	Moderate	Persistence in ground water and surface water unknown	Does not regrow in environment due to lack of host
Human enterococcus	PCR	Digestive system	Very highly specific	High	Can persist in surface water for 10 to 20 days	Regrowth in surface waters and sediments has been documented
Bacteroides	PCR	Digestive system	Very highly specific	High	Rapid die-off in aerobic surface waters	Will not regrow in aerobic environments
E. coli	Ribotyping	Digestive system	Moderate	Moderate	Can persist in surface water and sediments for extended periods	Regrowth in surface waters and sediments has been documented

Table 5.3. Signature pattern of four genetic markers used in tracking and investigation of microbial sources

CATEGORY	ENTERIC VIRUS	POLYOMA VIRUS	ENTEROCOCCUS	BACTEROIDES	CHARACTERISTICS OF SIGNATURE			COMMENTS
					STRENGTH OF HUMAN SIGNATURE	RECENT OR RESIDUAL SOURCE	OTHER	
Quadruple Positive	Positive	Positive	Positive	Positive	Very strong positive	Recent		
Triple Positive	Negative	Positive	Positive	Positive	Very strong positive	Recent		
	Positive	Negative	Positive	Positive	Very strong positive	Recent		
	Positive	Positive	Negative	Positive	Very strong positive	Recent	Possible septic tank systems	
	Positive	Positive	Positive	Negative	Very strong positive	Residual		
Double Positive	Negative	Negative	Positive	Positive	Strong positive	Recent	Strong signature based on realistic method sensitivity	Most common result
	Positive	Negative	Negative	Positive	Strong positive	Recent	Possible septic tank systems	
	Positive	Positive	Negative	Negative	Strong positive	Residual	Possible wastewater discharge	
	Positive	Negative	Positive	Negative	Strong positive	Residual		
	Negative	Positive	Negative	Positive	Strong positive	Recent		
	Negative	Positive	Positive	Negative	Strong positive	Residual		
Single Positive	Positive	Negative	Negative	Negative	Strong positive	Residual		Rare event
	Negative	Positive	Negative	Negative	Moderate positive	Residual	No evidence of human fecal contamination	
	Negative	Negative	Positive	Negative	Weak positive	Residual	Low evidence of human fecal contamination; resample	
	Negative	Negative	Negative	Positive	Weak/moderate positive	Recent	Possible septic tank systems; resample	
No Positive	Negative	Negative	Negative	Negative	Very strong negative	No human source		

3. Alachua County Health Department OSTDS Surveys and Coliform Monitoring

To address coliform TMDLs, the Alachua County Health Department (ACHD) sought to determine what role septic systems play in the fecal coliform loading of Sweetwater Branch and Tumblin and Hogtown Creeks. Of the eight watersheds in urban Gainesville, these three were considered a priority due to data indicating poor water quality.

In July 2004, the State Health Office, Bureau of Onsite Sewage Programs, awarded the ACHD \$20,000 to implement a project titled, *Fecal Coliform Loading Attributed to Onsite Sewage Treatment and Disposal Systems in the Hogtown, Tumblin, and Sweetwater Branch Systems in Gainesville, Florida*. Project tasks included the following:

- a. Identification of parcels not served by GRU that abut creeks.
- b. Development of digital map of parcels identified in (a).
- c. Recruitment, selection, and training of staff.
- d. Requisition and procurement of necessary equipment.
- e. GPS location of OSTDSs on parcels abutting creek system in the study area; development and generation of accurate GIS maps of OSTDS locations in the watershed.
- f. Qualitative evaluation of OSTDS functionality:
 1. Are there visible signs of system failure? (Y/N)
- g. Evaluation of on-site soils to six feet below natural grade:
 1. Soil series identification per soil survey of Alachua County,
 2. Textural soils assessment using the U.S. Department of Agriculture (USDA) methodology to six feet below natural grade, and
 3. Seasonal high water table (SHWT) identification.
- h. Setback measurements of infiltrative absorption surface of drainfield:
 1. Horizontal setback determination to creek, and
 2. Vertical separation to SHWT.
- i. Water quality assessment of creek at selected intervals measuring fecal coliform levels.

Figure 5.3 shows the ACHD sampling points for Hogtown Creek. **Table 5.4** shows the data resulting from this sampling effort. **Figure 5.4** shows the ACHD sampling points for Tumblin Creek and Sweetwater Branch, and **Table 5.5** shows the sampling data from these waterbodies.

Figure 5.3. ACHD coliform sampling points in Hogtown Creek

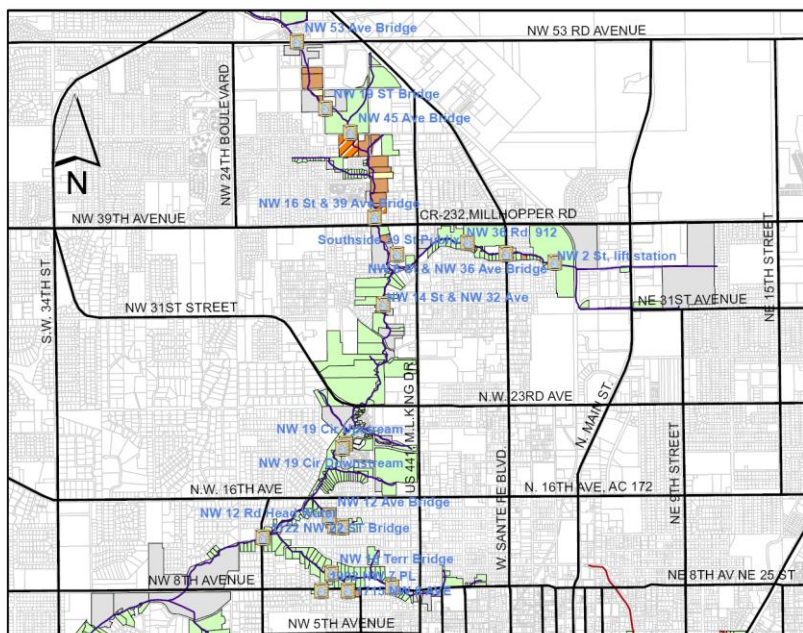


Table 5.4. Results from ACHD coliform sampling in Hogtown Creek (fecal coliform/100mL using most probable number [MPN])

Location	9/6/2005	11/29/2005	1/17/2006	1/30/2006	2/7/2006	2/21/2006	4/4/2006	5/1/2006	ArithMean
NW 53 AVE bridge	1400	14000					170	110	3920.00
NW 19 ST bridge	700	2800					230	20	937.5
NW 45 AVE	1100						70	140	436.6667
NW 39 AVE	1700						500	500	900
NW 36 PL, Publix	5000						50	1400	2150
NW 36 RD, 912	2200						140	9000	3780
NW 6 ST & NW 36 AVE	800						140	2800	1246.667
NW 36 AVE, 426	2200						220	3500	1973.333
NW 2 ST, lift station							300	20	160
NW 14 ST & NW 32 AVE	900						20		460
NW 18 TERR bridge			1300						1300
NW 22 ST, 1122, bridge			700	2200					185
NW 7 PL, 1902			300	70					185
NW 15 ST & NW 8 AVE				1300					1300
NW 18 TERR, 1230					1700	1700			1700
NW 12 RD, 1748					900	2400			1650
NW 19 CIR, DS					220	700			460
NW 19 CIR, US					800	300			550
NW 12 Ave, 1800, bridge					900	3000			1950
NW 8 AVE, 1715			2800	11000		500			4766.667
SE 10 TERR bridge		28000	800	3000					10600
Rosewood		50000	1700	2200					17966.67
Rosewood footbridge			1100	1100					1100
Sweetwater WWTP		30000	110	500					10203.33
Depot Park					300	300			300
Oakbrook Walk					800	800			800

Figure 5.4. ACHD sampling points in Tumblin Creek and Sweetwater Branch

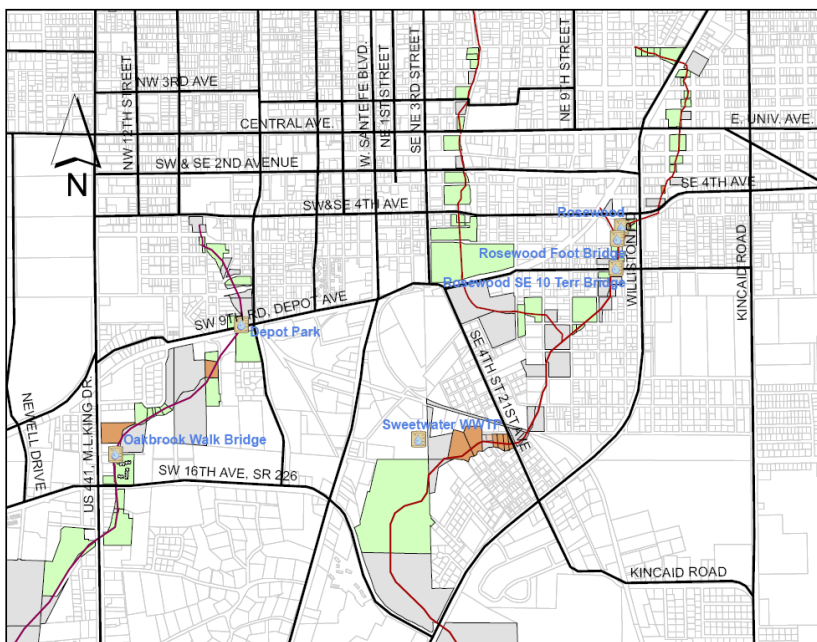


Table 5.5. Results from ACHD coliform sampling in Tumblin Creek and Sweetwater Branch (fecal coliform/100mL using MPN)

Location	9/6/2005	11/29/2005	1/17/2006	1/30/2006	2/7/2006	2/21/2006	4/4/2006	5/1/2006	ArithMean
NW 53 AVE bridge	1400	14000					170	110	3920.00
NW 19 ST bridge	700	2800					230	20	937.5
NW 45 AVE	1100						70	140	436.6667
NW 39 AVE	1700						500	500	900
NW 36 PL, Publix	5000						50	1400	2150
NW 36 RD, 912	2200						140	9000	3780
NW 6 ST & NW 36 AVE	800						140	2800	1246.667
NW 36 AVE, 426	2200						220	3500	1973.333
NW 2 ST, lift station							300	20	160
NW 14 ST & nw 32 AVE	900						20		460
NW 18 TERR bridge			1300						1300
NW 22 ST, 1122, bridge			700	2200					185
NW 7 PL, 1902			300	70					185
NW 15 ST & NW 8 AVE				1300					1300
NW 18 TERR, 1230					1700	1700			1700
NW 12 RD, 1748					900	2400			1650
NW 19 CIR, DS					220	700			460
NW 19 CIR, US					800	300			550
NW 12 Ave, 1800, bridge					900	3000			1950
NW 8 AVE, 1715			2800	11000		500			4766.667
SE 10 TERR bridge		28000	800	3000					10600
Rosewood		50000	1700	2200					17966.67
Rosewood footbridge			1100	1100					1100
Sweetwater WWTP		30000	110	500					10203.33
Depot Park					300	300			300
Oakbrook Walk					800	800			800

Based on the data results of items (f) through (i) above, the characteristics of the investigated OSTDSs in terms of their potential impact to each creek were categorized as follows:

- **Confirmed impact to creek** – There are visible signs of untreated effluent impacting the creek.
- **Significant potential for adverse impact to creek** – There are no visible signs of impacts to the creek but there is a horizontal setback to the creek of less than 75 feet and/or a vertical setback to the SHWT of less than 24 inches.
- **Minor potential for adverse impact to creek** – There are no visible signs of impacts to the creek and there is a horizontal setback of greater than 75 feet and a vertical setback to the SHWT of greater than 24 inches.

The setbacks for fecal coliform loading are supported by the following references:

Vertical Setback:

- Lewis, A.L., and L.M. Stark. 1993. *Florida OSTDS Research Project*.
- EPA. 2002. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008.

Horizontal Setback:

- Canter, L.W., and R.C. Knox. 1985. *Septic Tank System Effects on Groundwater Quality*.
- EPA. 2002. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008.

The survey results were as follows:

- The Sweetwater Branch survey found 9 parcels on OSTDSs, 8 with a **significant potential**, and 1 with a **confirmed impact** that subsequently was connected to GRU central sewer (see the map for Sweetwater Branch).
- The Tumblin' Creek survey found 3 possible parcels on OSTDSs, as the ACHD was unable to gain access to 1 parcel, none with **minor potential**, 2 with **significant potential**, and none with a **confirmed impact** (see the map for Tumblin Creek).
- The Hogtown Creek Survey found 25 parcels on OSTDSs, 3 to which the ACHD was unable to gain access, 2 with **minor potential**, 20 with **significant potential**, and none with a **confirmed impact** (see the map for Hogtown Creek).
- The combined results of the Hogtown Creek, Tumblin Creek, and Sweetwater Branch surveys yielded the following summary: of the 455 total parcels that abut the 3 creeks, 301 are on GRU sewer (66%), 36 on OSTDS (8%), and 118 are unimproved (26%).

The ACHD is still in the process of sampling the surface water of the creeks for fecal coliform using the MPN (SM9221E) standard in areas upstream and downstream of the identified systems. To date the ACHD has taken 64 surface water samples. Thirty-six additional sampling events are planned and will be reported when completed. A preliminary analysis of the data indicates that the methodology is limited in its usefulness

with this particular project. Rainfall events and associated stormwater runoff seem to influence the results.

The ACHD and GRU are further evaluating each of the properties identified as either having a confirmed or significant potential for adverse impacts, to determine on a case-by-case basis the most feasible approach for eliminating the potential impact. Alternatives include relocating and/or upgrading the property's OSTDS to meet current standards, or abandoning the OSTDS and connecting the property to GRU's centralized sewer system. The study will develop an overall plan and estimated costs. GRU and the ACHD are seeking funding sources to assist in paying the costs to implement the program. As of FY2007, \$225,000 has been requested through the SJRWMD SWIM Program. Funds are also being sought through the EPA Section 319 funding program.

The \$225,000 that was requested through the SJRWMD SWIM Program was based on the assumption that approximately 15 residences would be connected to sanitary sewer, at an average cost of \$15,000 each. The requested funds would pay for extending the sanitary sewer line to each residence, establishing plumbing connections, and abandoning the septic system. As the detailed feasibility study described above is completed, costs and funding amounts requested will be refined as appropriate.

The ACHD is also in the process of completing a similar study of parcels along the shore of Lake Wauberg to identify the potential of individual parcels to contribute coliform to surface waters. Although this study is focused on identifying coliform sources, Lake Wauberg is verified as impaired for nutrients only, not coliform. However, given the potential for septic systems to contribute elevated nutrients, this study will also inform source identification for nutrient impacts to Lake Wauberg. **Section 4.3** above provides more details.

5.3.2 Known Coliform Sources in Urban Creeks

Fecal coliform in surface waters originate from warm-blooded animals. Where animals such as raccoons, possums, and rodents congregate along streams, their feces may be a major source of fecal coliform pollution. The anthropogenic sources in the area include leaking central sewer lines and lateral connections to homes, failing septic tank systems, untreated or inadequately treated stormwater, livestock operations, pet waste, and the homeless. Once the bacteria are in a stream, the warm Florida climate may allow them to persist or increase in number.

Known fecal coliform sources in the urban creeks are categorized as primary and secondary. Primary sources include the following:

- Exfiltration and releases from public and private centralized wastewater collection and treatment systems,
- Malfunctioning on-site wastewater treatment facilities, such as septic tank systems,
- The direct use of creeks for human sanitation,
- Runoff from urban campsites near creeks,
- Domestic animal waste (e.g., dogs), and
- Wildlife animal waste.

These sources can be delivered directly to a stream or can be delivered through accumulation on the land surface and subsequent transport to a stream via stormwater.

Fecal coliform bacteria are known to persist and reproduce in conducive environments outside of warm-blooded animals (Solo-Gabriele et al., 2000; Griffin et al., 2001). This secondary source can become a dominant load from nonpoint sources during rain events.

Based on the results of the projects discussed above and analyses conducted as part of TMDL development, each of these sources appears to be present in the urban creeks. Based on the detailed microbial source tracking analysis completed by GRU (**Figure 5.2**), roughly 50% of the coliform in the urban creeks sampled are from nonhuman sources and 11% from human sources. The remaining 40% could not be classified clearly as human or animal. Markers of human coliform contamination were found throughout the urban creek system.

Wastewater

GRU maintains an extensive centralized wastewater infrastructure in the city of Gainesville and nearby areas (*see the summary in Chapter 3*). The system consists of 705 miles of piping, 160 lift stations, and 13,888 manholes covering a service area of 115 square miles with over 160,000 people. Exfiltration from the centralized sewer infrastructure and infrastructure failures are a potential source of coliform in urban creeks. Significant resources have been and continue to be used to minimize direct and indirect wastewater leakage into these creeks.

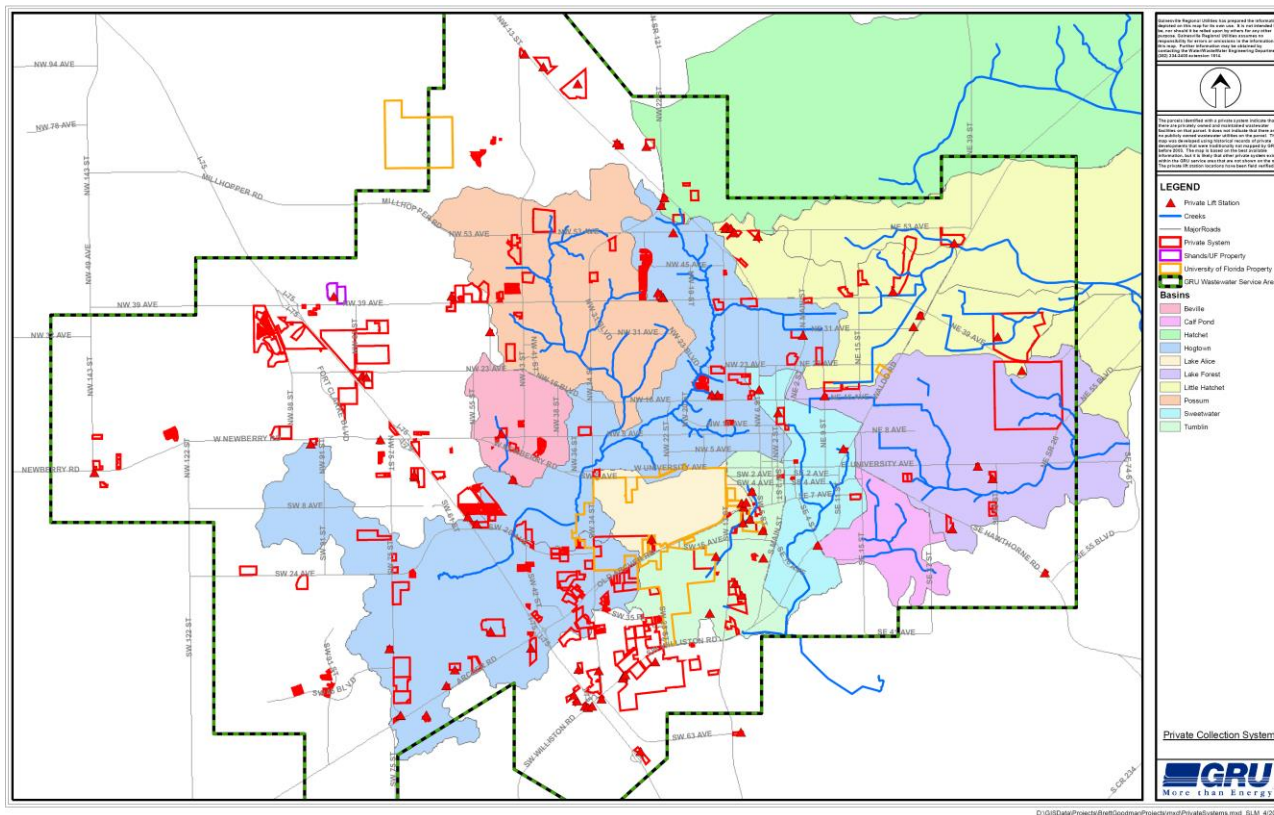
Leaking sewer lines on private property are a potentially significant source of coliform (and nutrients). **Figure 5.5** shows private collection systems connected to the GRU wastewater system that are of concern for the following reasons:

- They may have had limited to no inspection since they were installed,
- They may not be built to GRU's standards,
- They may only be "maintained" during emergency response situations,
- They may not report spills, and
- There are no regulatory constraints on operating and maintaining these systems beyond the DEP certificate of construction.

Residential plumbing could also be a potential source near creeks. If not properly installed or maintained, these systems—although they are less concentrated—have issues that are similar to those of private collection systems.

Based on the results of the ACHD on-site wastewater surveys discussed above, parcels that use septic tank systems for wastewater disposal can represent a source of coliform to urban creeks (e.g., eight parcels with a significant potential for coliform discharge and one parcel with confirmed coliform discharge in the Sweetwater Branch watershed).

Figure 5.5. Private lift stations connected to the GRU wastewater system



Urban Campsites

Although data were unavailable to quantify the effects of this source, individuals living in campsites along the urban creeks are likely to be contributing coliform to the creeks, given that sanitation facilities in these areas are limited.

Animal Waste

Improperly managed agricultural and domestic animal waste can lead to elevated coliform levels. In addition, heavy wildlife populations can contribute a majority of the coliform load in streams, even in areas with intensive human and domestic animal populations (Somarelli et al., 2007). As demonstrated by the GRU microbial source tracking study results (**Figure 5.2**), each of these coliform sources is a factor in the Gainesville urban creeks. Human markers were found consistently throughout the urban creek system. However, 50% of coliform loads were attributed to nonhuman sources.

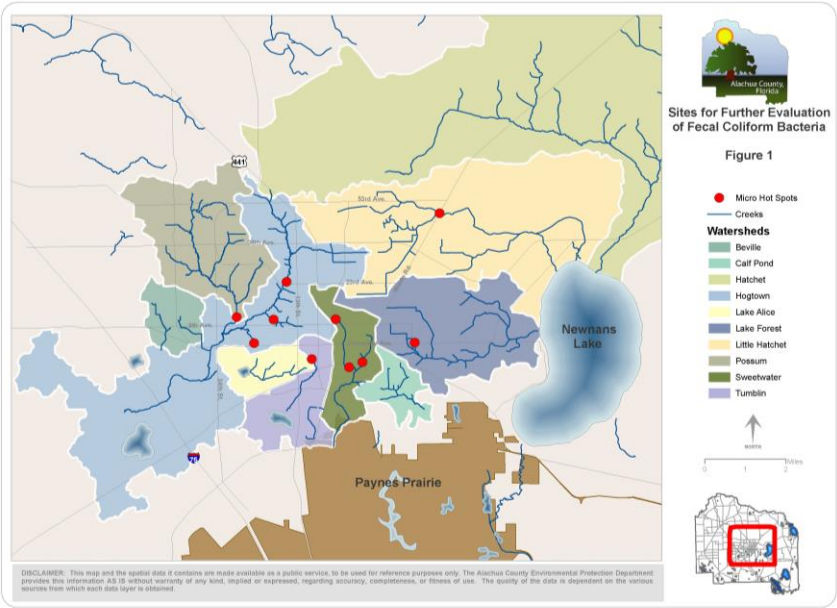
In addition to identifying the degree to which human sources contribute to coliform loads in the urban creeks, the GRU microbial source tracking study identified 10 areas with persistent sources of human contamination that warrant further investigation by local stakeholders. These priority areas form the foundation of the ongoing cooperative coliform reduction "hot spot" project discussed in **Section 5.4.2**. **Figure 5.6** identifies the priority areas that will be the focus of stakeholder efforts to reduce coliform.

5.3.3 Unknowns Regarding Urban Creek Coliform Sources

As mentioned above, once bacteria enter a waterbody they can persist and regrow in conducive environments (Solo-Gabriele et al., 2000; Griffin et al., 2001). This secondary source can become a dominant load from nonpoint sources during rain events. Conventional testing methods for coliform bacteria do not distinguish between primary sources and secondary sources (Scott et al., 2002; Bitton, 2005; Harwood, 2006). This lack of specificity is problematic when attempting to use coliform source identification information to guide the implementation of management actions.

The GRU microbial source tracking study provided a level of detail about coliform sources that was not previously available. It provided a good direction for a path forward in the management of elevated coliform levels and identified areas of high priority for management actions. However, at the completion of the project, roughly 40% of the coliform load in the urban creeks remained of indeterminate or mixed human/animal origin. Thus, even with the level of detail provided by the study, the quantification of coliform sources in the watershed was not achievable. Although the general source categories and minimum contributions have been identified, the relative magnitude of these sources remains unknown.

Figure 5.6. Priority areas for further evaluation of fecal coliform bacteria, based on GRU microbial source tracking study



Watershed	Location ID	Area
Hogtown Creek	ELIZNW7DS	Headwaters near University Avenue
Hogtown Creek	HOGNW23	NW23 Avenue to 8th NW Avenue
Hogtown Creek	POSNW16	NW 16th Avenue to confluence with Hogtown Creek
Hogtown Creek	RATTLESNAKE	Entire creek
Sweetwater Branch	SWBNE10	NE 10th Avenue to SE 1st Avenue
Sweetwater Branch	SWBSE8	SE 8th Avenue
Sweetwater Branch	ROSEWOOD	Mid-point in the watershed to confluence with Sweetwater
Tumblin Creek	TUMBLIN	SW 5th Avenue to PK Yonge School
Little Hatchet Creek	LHTWALDO	Vicinity of Waldo Road
Lake Forest Creek	LFCNE25	NE 25th Street north of University Avenue

5.4 Fecal Coliform Management Actions and Expected Outcomes

The ability to apply advanced scientific methods to accurately distinguish between sources of coliform in the urban creeks will be critical in developing appropriate management strategies and measuring progress for meeting the TMDLs in each impaired waterbody. Until these advanced methods become more cost-effective, local stakeholders will continue to develop and implement management strategies using a blend of conventional testing data and advanced microbial source tracking information. Federal, state, and local support of the research and development of cost-effective advanced microbial source tracking methods will benefit all stakeholders in reducing coliform levels in Gainesville's urban creeks.

A significant number of management actions have been completed and are in progress to address fecal coliform in the Orange Creek Basin urban creeks. This section highlights the key individual management actions, the cooperative coliform remediation project, further research, and the expected outcomes of these activities. These activities are based on the known sources identified above and local knowledge of the urban creeks.

5.4.1 Individual Management Actions To Decrease Coliform Loads

Coliform management actions in the Orange Creek Basin fall into four primary categories: septic tank system management, centralized wastewater system management, stormwater management, and public education. The stakeholders involved and their general areas of responsibility are as follows:

ACHD

- On-site wastewater system permitting program
- Septic tank system evaluation near major urban creeks
- Incident response

ACEPD

- Public education/outreach
- Ambient water quality monitoring
- County water quality code implementation and enforcement
- Stormwater illicit connection elimination program
- Microbial source tracking studies

DEP

- Public education/outreach
- Ambient water quality monitoring
- Funding support

GCWP

- Public education/outreach
- Illicit connection elimination program
- Pet waste management

GRU/City of Gainesville

- Public education/outreach
- Inflow and Infiltration Program
- Wastewater collection system repair and restoration
- Force main integrity program
- Water quality sampling near facilities
- Microbial source tracking study
- Private collection system identification
- Incident response
- “Connect Free” program

SJRWMD

- Public education/outreach
- Ambient water quality monitoring
- Funding support

Table 5.6 provides highlights of specific management actions to reduce coliform loads in the urban creeks. **Appendix E** contains full details of all management actions.

Table 5.6. Highlights of management actions to reduce coliform loads in urban creeks

Note: Additional management actions have been proposed to decrease coliform loads.

Appendix E provides details of all management actions.

PROJECT NAME	PROJECT NUMBER	DESCRIPTION	PRIMARY PROJECT PARTNERS	ANTICIPATED BENEFITS
MS4 Permit Implementation	MSPERMIT01 MSPERMIT02 MSPERMIT03	Implementation of the 6 primary control measures: public outreach, illicit discharge detection and elimination, mapping and modeling efforts, construction site pollution prevention programs, and municipal operations pollution prevention programs.	City of Gainesville Alachua County DOT	Reduce coliform loads in stormwater runoff.
SW 11 th Avenue Storm Sewer	TUM02	Improvements to storm sewer system and creek outfall stabilization.	City of Gainesville	Reduce coliform load associated with suspended sediment
Street Sweeping	URBAN01 URBAN04 URBAN08	Routine street sweeping and additional sweeping during special events.	City of Gainesville DOT Alachua County	Prevent debris, sediment, trash, and other pollutants from entering the storm sewer system.
Public Education and Outreach, Including Community-based Social Marketing Workshop	ALACHUA02 OCB01	Written materials, public service announcements, workshops, and a wide variety of other forms of public outreach.	Alachua County City of Gainesville DOT (GCWP) SJRWMD Sustainable Alachua County GRU DEP	Reduce coliform loads in stormwater runoff.
Vegetative Enhancement Projects	SWT22 TUM18 HOG26	Public education workshop and enhancement of stormwater pond and seepage wetland buffers.	City of Gainesville Alachua County DOT (GCWP)	Reduce coliform loads in stormwater runoff.
Alachua County Water Quality Code Implementation	ALCODE01	Alachua County/Alachua County Water Quality Code Implementation for Tumblin Creek, Sweetwater Branch, and Hogtown Creek. Public education, outreach, and enforcement.	Alachua County City of Gainesville DOT (GCWP)	Reduce coliform loads in stormwater runoff.
Duck Pond Restoration	SWT03	Creek restoration project, installation of two CDS units, pond rehabilitation, and removal of ducks.	City of Gainesville	Reduce coliform load associated with suspended sediment and reduce direct discharge of coliform associated with wildlife.

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PROJECT NAME	PROJECT NUMBER	DESCRIPTION	PRIMARY PROJECT PARTNERS	ANTICIPATED BENEFITS
Hydrodynamic Separators	HOG29 HOG30 HOG31 URBAN02 URBAN03 URBAN09 URBAN10	Installation and operation of a Stormceptor unit.	City of Gainesville	Prevent debris, sediment, trash, and other pollutants from entering the storm sewer system.
Stormwater Parks	SWT02 SWT04 TUM01	Improved stormwater treatment through wet detention.	City of Gainesville SJRWMD DOT	Reduce sediment load and associated bacteria.
Centralized Wastewater Infrastructure Inspection and Rehabilitation	BACTERIA07 BACTERIA08 BACTERIA09 BACTERIA10 BACTERIA11 BACTERIA12 BACTERIA13 BACTERIA15	Intensive wastewater collection system integrity testing, closed-circuit TV camera inspection, visual inspection, lift station maintenance, and other efforts to identify problem areas and rehabilitate the centralized wastewater collection system.	GRU	Minimize the possibility of wastewater releases.
Sanitary Sewer System Geodatabase	URBAN12	Maintain a comprehensive geodatabase for all GRU sanitary sewer system data.	GRU	Minimize the possibility of wastewater releases by better identifying infrastructure location.

5.4.2 Cooperative Coliform Reduction “Hot Spot” Project

Based on the results of ambient fecal coliform monitoring, microbial source tracking, alternative bacteriological monitoring, and optical brightener analyses, a number of sites warrant further evaluation. There are 10 sites with consistently high levels of fecal coliform bacteria, 8 of which have shown the presence of human markers in microbial source tracking samples. The evidence of human markers is a specific concern, as a continuing source of fecal coliform bacteria from humans, such as failing infrastructure, may be impacting the creeks. These sources of bacteria may be preventable and must be defined to develop strategies for reducing fecal pollution in the creeks.

The ACEPD, ACHD, COGPWD, DOT, GRU, and DEP have initiated a cooperative project (BACTERIA16) to evaluate and remediate coliform sources.

The work of evaluating the fecal coliform “hot spots” may cover large portions of individual watersheds. Approximately 30 to 40% of the Hogtown Creek watershed, including Elizabeth Creek and Rattlesnake Branch and excluding Possum Creek), will be evaluated. The lower 10% of the Possum Creek watershed is of concern; the upper 90% will be screened to further identify the area(s) of concern and the percentage of the watershed to evaluate further. Approximately 30% of the Tumblin Creek watershed will be evaluated. An estimated 50% of the Sweetwater Branch watershed will be evaluated, including Rosewood Branch. The area of concern on Lake Forest Creek includes approximately 15% of the watershed. The area of concern on Little Hatchet Creek is downstream of approximately 40% of the watershed; this area will also be refined based on additional baseflow monitoring. All of these percentages are estimates and will be refined during GIS field mapping.

The Orange Creek Basin TMDL stakeholders propose a series of tasks to further evaluate elevated fecal coliform bacteria levels and infrastructure in the Gainesville urban creek watersheds. Tasks include the following:

- Performing initial confirmatory baseflow fecal coliform sampling,
- Assessing existing programs and activities focused on reducing coliform in the creeks and identifying areas needing improvement,
- Mapping infrastructure components into a GIS format within specific study areas,
- Conducting coordinated field evaluations of public and private sanitary sewer lines (including connection and laterals), septic systems, and storm sewer lines,
- Repairing infrastructure as necessary, and
- Performing postevaluative sampling to document water quality improvements.

These tasks will be conducted in the high-priority areas identified in **Figure 5.6** above. Each cooperating entity will attempt to conduct its portion of these tasks concurrently with the other entities in a specific watershed. When the coliform issues in a specific watershed are resolved, the focus will then turn to the next priority. With this approach, the responsible parties will address all controllable coliform sources within an individual watershed at roughly the same time before shifting priorities to other areas. This cooperative approach is expected to yield significant decreases in coliform levels in the urban creeks. The project scope provides additional detail on this approach (**Appendix P**).

5.4.3 Further Research and Source Tracking

In addition to the “hot spot” project discussed in detail above, a number of additional research and source tracking projects are in progress (**Table 5.7**) to investigate the unknowns regarding coliform sources in the urban creeks. The BWG expects that these projects will provide further guidance for continued coliform load reduction actions. Additional research and source tracking efforts may be conducted, pending the outcome of current research, current management actions, the “hot spot” coliform load reduction project, and funding availability. The need for additional coliform management actions and studies will be evaluated during the BMAP follow-up meetings.

Table 5.7. Current coliform assessments and research projects

PROJECT NAME	PROJECT NUMBER	DESCRIPTION	PRIMARY PROJECT PARTNERS	ANTICIPATED BENEFITS
Coliform Wet and Dry Season Assessment	BACTERIA03	Assessment of wet and dry season fecal coliform concentrations in surface waters at selected stations.	Alachua County City of Gainesville DOT (GCWP)	Provide data for use in determining baseline conditions and achievable load reductions.
Expanded Fecal Coliform Bacteria Monitoring	BACTERIA04	Expanded baseflow fecal coliform monitoring to better identify stream segments with high bacterial counts.	Alachua County	Improve the understanding of current conditions.
Inlet Protection Pilot Projects	HOG24 SWT29	Assessment of stormwater drop inlet geotextile filtering devices.	Alachua County City of Gainesville DOT (GCWP)	Determine the effectiveness of drop inlet protection devices to determine the utility of expanded use throughout the city.

5.4.4 Expected Outcomes

Extensive management actions have been completed, are under way, and are planned for the future to decrease coliform loads into Tumblin Creek, Sweetwater Branch, and Hogtown Creek. Through these efforts, the BWG anticipates that coliform loads in the urban creeks will decrease over time. Given the often erratic behavior of fecal coliform bacteria in the environment, the detailed quantification of load reductions is not possible at this time. However, the BWG will continue to evaluate coliform levels in these streams to track progress. Depending on the results achieved through implementation of the above management actions, an approach such as the cooperative coliform reduction “hot spot” project may be expanded to other parts of the watershed. This adaptive management approach will be used to evaluate and select additional management actions in future iterations of the BMAP.

5.5 Hatchet Creek Iron TMDL

The Hatchet Creek watershed encompasses approximately 65 square miles in northeastern Alachua County. Major tributaries into Hatchett Creek are Forest Creek and Bee Tree Creek. Forest Creek is in the western part of the basin, and Bee Tree

Creek drains the entire eastern part of the watershed. Bee Tree Creek joins the main channel of Hatchet Creek upstream of SR 26 in the vicinity of the Gumroot Swamp Conservation Area. The primary site for water quality monitoring is on the north side of SR 26. The SJRWMD selected this site, which is downstream of the confluence with Bee Tree Creek, to evaluate the entire watershed and its contribution to the water quality of Newnans Lake.

Hatchet Creek is a blackwater stream, with approximately 70% of the watershed forested, 20% in natural forest habitat, and 50% in silviculture. Relief is low in much of the watershed, and wetlands are numerous. The baseline water quality in Hatchet Creek reflects its land use and physiography. As such, the waters of Hatchet Creek at the SR 26 sampling site are high in organic carbon and iron and relatively low in specific conductance, DO, and pH. The median total organic carbon (TOC) concentration is 36.9 mg/L (n= 107) (ACEPD, 2004). The median total iron concentration is 0.987 mg/L (n=77) (SJRWMD, 2006a). The median specific conductance is 99 microsiemens/square centimeter (cm²) (n=107) (ACEPD, 2004). TSS, chloride, and sulfate are very low or nondetectable in these waters. The median pH concentration is 6.12 Standard Units (SU) (n=108) (ACEPD, 2004). The median DO concentration is 5.46 mg/L (n=108) (ACEPD, 2004). TN is relatively high, with a median concentration of 1.120 mg/L, likely due to the abundance of wetlands and the forested nature of the watershed (ACEPD, 2004).

The SJRWMD routinely monitors Hatchet Creek for nutrients and general chemical characteristics (SJRWMD, 2006). The ACEPD conducted both baseflow and stormwater monitoring of Hatchet Creek from February 1998 through September 2004 through a contract with the SJRWMD (ACEPD, 2004). The analyses primarily focused on nutrients and inorganic and organic indicator constituents. The SJRWMD currently monitors Hatchet Creek.

The ACEPD sampled sites through out the Hatchett Creek watershed from September 2005 to August 2006 for fecal coliform bacteria and iron. Samples were collected at four to nine sites during each sampling event. Manganese, another naturally occurring trace metal, TOC, total coliform, fecal coliform, *E. coli*, and field parameters (pH, DO, temperature, specific conductance, and turbidity) were also added to the analyte list. The average iron concentration for all sites ranged from 570 to 1,240 ug/L, with the highest concentrations observed during September 2005. Manganese concentrations, though lower than iron, followed a similar trend. Additional monitoring for iron is not planned. Fecal coliform bacteria levels were generally low, with only 3 of 33 samples collected exceeding the daily maximum of 800 CFU/100mL. Fecal coliform counts were typically highest in the summer when rainfall was greatest. ACEPD continues to monitor for bacteria.

DEP adopted a TMDL for iron for Hatchet Creek in 2003. The standard for iron in Class III surface waters is 1.0 mg/L (DEP, 2002).

Iron is commonly occurring and is typically found associated with the oxyhydroxide coatings on the quartz sands and as a cation associated with silicate clays that comprise the surficial sediments in the watershed. It is typically present in its reduced or ferric (Fe³⁺ as Fe [OH]₃) form in oxyhydroxides, such as Goethite and Limonite. When oxidized, iron is found in its ferrous form (Fe²⁺).

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The chemical behavior of iron in the surficial aquifer and associated wetlands (the primary sources of water to Hatchet Creek) is complex. Microbial activity controls the oxidation and reduction of iron in soils and in the shallow aquifer (Cullimore, 1992). The growth of iron bacteria, a common natural occurrence, can create a “biofilm” that allows the accumulation of metals such as iron and increases iron mobility (Cullimore, 1992). Hem (1992) describes two processes in which bacteria may make iron more available in natural waters: (1) the oxidation of dissolved ferrous iron and (2) microbial mediated reactions that alter the iron concentration.

The fact that Hatchet Creek is a blackwater stream is significant because the humic substances from the decay of organic matter (in the form of humic and fulvic acids) have sites available in their structure to hold cations, such as iron (Fe^{2+}). The analyses for TOC and color are measures of these humic and fulvic acids in surface waters. Iron that is released from sands and clays in the surficial aquifer is available to form complexes with these large organic molecules. The analysis of iron measures “total iron,” which is iron present in any form in the water. Since the samples are acidified in the field, the laboratory results include any particulate iron present in the water sample.

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The iron concentrations that ACEPD found in Hatchet Creek appear to be related to the occurrence of iron in the natural environment. The concentrations were similar upstream and downstream of the potential pollution sources in the watershed, such as the Fairbanks Sand Pit, the Alachua County Northeast and Northeast Auxiliary landfills, and the Airport Landfill. These data are consistent with the results from the surficial aquifer monitoring well off CR 225, where iron concentrations in ground water range from 0.70 to 2.20 mg/L (n=3) (DEP, 2006).

There are many other blackwater streams in Alachua County. Little Hatchet Creek, a tributary (LHAT26) has a median iron concentration of 1.47 mg/L (n=14) and a median TOC value of 37.0 mg/L (n=101) (SJRWMD, 2006). Little Hatchet Creek (LHAT26E) has a median iron concentration of 0.67 mg/L (n=13) and a median TOC value of 37.6 mg/L (n=140) (SJRWMD, 2006a).

The instream aquatic ecosystem of Hatchet Creek is in excellent condition. Two rapid bioassessments (BioRecons) conducted in 1997 and 2001 reported that Hatchet Creek was healthy, passing all three metrics (ACEPD, 2004). Hatchet Creek at CR 225 had the highest Florida Index and Ephemeroptera, Plecoptera and Tricoptera (EPT) metrics of any stream site assessed in Alachua County from 2000–03 (Water and Air Research, Inc., 2004).

CHAPTER 6: MONITORING, PROJECT TRACKING, AND ADAPTIVE MANAGEMENT

This chapter outlines the steps stakeholders will take to track progress in implementing projects and observe the results of those projects in BMAP waterbodies. It also outlines a process for communicating this information among stakeholders.

6.1 Monitoring Water Quality and Pollutant Loads

The development of a surface water monitoring network is a critical element in the assessment, restoration, and protection of stream water quality. The Orange Creek BWG developed a strategy for monitoring water quality and measuring pollutant loads that builds on existing programs being conducted by DEP, the SJRWMD, Alachua County, GRU, and others. The elements of the strategy include the objectives and anticipated benefits, contributing entities, ambient station and parameter information, performance-based monitoring details, quality assurance/quality control (QA/QC) mechanisms, data management, and data analysis and reporting. Using an adaptive management approach, the BWG will continue to develop the details of the strategy based on conditions and monitoring results.

6.1.1 Monitoring Objectives and Anticipated Benefits

The overall purpose of this monitoring strategy is to support the implementation of the BMAP. The objectives below reflect the BWG's priorities and provide further detail on the application of water quality monitoring data to support the BMAP. Both the primary and secondary objectives apply to waterbodies included as part of the BMAP.

Primary Objectives

1. Identify and track water quality trends in BMAP waterbodies to determine if water quality standards are being achieved, and
2. Where feasible, measure the effectiveness of specific BMPs in reducing external loadings of target pollutants.

Secondary Objectives

1. Measure reductions in watershed loadings of TMDL target pollutants, and
2. Refine understanding of the type and relative magnitude of pollutant loading sources.

Use of Monitoring Activities and Data

- Evaluate progress toward achieving objectives,
- Demonstrate stakeholders' progress toward meeting their individual TMDL obligations,
- Facilitate comparisons of water quality before and after BMP implementation, and
- Inform the selection of future BMPs.

6.1.2 Water Quality Indicators and Resource Responses

To achieve the objectives above, the monitoring strategy focuses on two types of indicators: core and supplemental. Both types are used to track water quality trends. **Table 6.1** lists these indicators and their anticipated trends, if any. Core indicators are the minimum parameters that will be tracked. These relate directly to the parameters causing impairment in lakes and creeks. Supplemental indicators support the interpretation of water quality data and broader waterbody health.

As BMAP implementation moves forward, changes in the core indicators are expected. Changes in supplemental indicators may or may not be observed.

Table 6.1. Anticipated trends in core and supplemental water quality indicators

CORE INDICATORS	LAKES	CREEKS
Chlorophyll a	Decrease in concentration	Not applicable
Phosphorus (as P)	Decrease in concentration	Not applicable
Nitrogen, Nitrite (NO ₂) and Nitrate (NO ₃) as N	Decrease in concentration	Not applicable
Nitrogen, Kjeldahl (TKN)	Decrease in concentration	Not applicable
Fecal coliform	-	Decrease in concentration
SUPPLEMENTAL INDICATORS	LAKES	CREEKS
Specific conductance	Monitored to support interpretation of core indicators	Not applicable
DO	Monitored to support interpretation of core indicators	Not applicable
Alkalinity	Monitored to support interpretation of core indicators	Not applicable
pH	Monitored to support interpretation of core indicators	Not applicable
Temperature	Monitored to support interpretation of core indicators	Not applicable
Color	Monitored to support interpretation of core indicators	Not applicable
Turbidity	Monitored to support interpretation of core indicators	Monitored to support interpretation of core indicators
TSS	Monitored to support interpretation of core indicators	Monitored to support interpretation of core indicators
TOC	Monitored to support interpretation of core indicators	Monitored to support interpretation of core indicators

These water chemistry indicators reflect the primary goal of the TMDL Program—to restore waterbodies so that they meet state water quality standards. However, broader resource responses are also important when evaluating waterbody health. **Table 6.2** lists the anticipated resource responses, by waterbody type, that will be tracked for the

BMAP waterbodies. The anticipated changes in resource responses may not be observed during BMAP implementation. A significant amount of time may be needed for the changes in water chemistry to be translated into resource responses such as shifts in algae species. However, these responses represent the achievement of long-term goals to demonstrate improvements in the ecological health of Orange Creek Basin lakes.

Table 6.2. Anticipated resource responses to impairment for nutrients and coliform, by waterbody type

RESOURCE RESPONSES	LAKES (NUTRIENTS)	CREEKS (COLIFORM)
Changes in the TSI	X	
Shifts in algae species	X	
Shifts in zooplankton populations	X	
Fewer than 10% exceedances of fecal coliform water quality standards		X

6.1.3 Monitoring Programs

This section outlines existing monitoring programs in the Orange Creek Basin. Several of these programs will provide significant resources to meet the monitoring strategy objectives outlined in **Section 6.1.1**. Other programs may contribute to tracking water quality improvements in BMAP waterbodies but will not be significant. **Table 6.3** lists these primary and secondary monitoring resources, which are described in more detail below.

Table 6.3. Monitoring programs to track water quality in BMAP waterbodies

PROGRAM/ENTITY	PRIMARY RESOURCE TO TRACK PROGRESS ON MONITORING OBJECTIVES	SECONDARY RESOURCE TO TRACK PROGRESS ON MONITORING OBJECTIVES
DEP – Tier I		X
DEP – Tier II		X
DEP – Tier III		X
SJRWMD	X	
ACEPD	X	
GRU (permit compliance monitoring)		X
WAV		X
LakeWatch		X

DEP

DEP's Integrated Water Resource Monitoring Network (IWRM) Program is composed of three tiers. Tier I monitoring comprises status and trend monitoring designed to answer statewide to regional questions. Tier II monitoring includes basin assessments and monitoring required for TMDL development. It is more localized in nature than Tier I monitoring, yet may encompass a broader area than Tier III. Tier III includes all monitoring tied to regulatory permits issued by DEP. In general, Tier I addresses statewide and regional (within Florida) questions, Tier II addresses basin-specific to stream segment-specific questions, while Tier III answers site-specific questions.

Tier I: Florida has a random sample (probabilistic)-based status monitoring network and a fixed station "trend" or temporal variability monitoring program. The Status Monitoring Network is used to characterize the environmental conditions of Florida's freshwater resources and determine how these conditions change over time. The overall statewide sample design provides for the sampling of the entire state within a five-year period. Status network data are primarily designed for use in evaluating statewide water quality conditions present during the period of sampling. The monitoring sites are randomly assigned statewide, and thus they may or may not fall within the Orange Creek Basin in a given year.

Tier II: Fixed network stations are sampled on the basin rotation cycle. As a Group 1 basin, the Orange Creek Basin will be in the first group to be revisited under the five-year basin rotation cycle. The focus of this sampling is to meet the minimum data requirements to evaluate potentially impaired waterbodies on the Planning List. This sampling program is not intended to track water quality in waterbodies that are verified impaired.

Tier III: Investigating site-specific water quality is a priority for the BMAP. However, for DEP, this type of sampling is a lower priority than Tier I and Tier II sampling. As such, DEP cannot make firm commitments to Tier III sampling in the Orange Creek Basin. This sampling will occur on an as-needed basis if resources are available after the Tier I and Tier II sampling are completed.

SJRWMD

The SJRWMD has an extensive surface water quality monitoring program. Monitoring activities in the Orange Creek Basin are managed to achieve multiple goals, as follows:

- Analyze the water-quality status and trends for major lakes and streams,
- Calibrate and verify water quality models for the development of PLRGs,
- Design projects to improve water quality and aquatic habitats, and
- Monitor the success of projects implemented to improve water quality and aquatic habitats.

To a great extent, these goals overlap with the BMAP monitoring objectives outlined above. From October 1, 2006, through September 30, 2007, the SJRWMD will collect monthly field data, as well as water quality and plankton samples, at approximately 22 stations in the Orange Creek Basin.

Data generated under the SJRWMD program are uploaded to the EPA's National Water Quality Database (STORET) and used by DEP for Florida's biennial 305(b) report and the development of TMDLs. The program provides support for modeling efforts involving surface water quality and produces a biennial districtwide assessment of surface water quality status and trends, sediments, and benthic community health. It also participates in DEP's IWRM Tier 1 Network.

ACEPD

The ACEPD monitors water quality in selected streams and lakes throughout Alachua County. The current program includes monitoring for nutrients, coliform bacteria, and inorganic indicators throughout the Gainesville urban area and in the northern and western portions of the county.

The ACEPD has been the primary agency monitoring water quality in the Gainesville urban area since 1972. It focuses on the smaller streams and lakes that are not currently monitored by the SJRWMD. These efforts help protect water quality by establishing trends and allow the ACEPD to assess problem areas in more detail. These sites are monitored for a number of field and lab parameters, including temperature, pH, conductivity, DO, nutrients, inorganic ions, and selected metals. The ACEPD, in conjunction with Water and Air Research, Inc. and the Alachua County WAV Program, conducts instream biological monitoring to investigate ecosystem health.

Between 1998 and 2004, the ACEPD partnered with the SJRWMD and local governments to conduct monthly baseflow sampling and storm event monitoring in the urban creeks and Newnans Lake tributaries. Since that time, the ACEPD has continued focus on Gainesville urban creek water quality. The SJRWMD now concentrates its efforts on the large lakes in the Orange Creek Basin (Newnans and Orange Lakes and Lochloosa Lake) and the tributaries to Newnans Lake (Hatchet, Little Hatchet, and Lake Forest Creeks). The ACEPD's fecal coliform monitoring program includes Newnans Lake tributaries as well as the Gainesville urban creeks. The ACEPD continues to regularly monitor approximately 31 sites in the Hogtown Creek, Sweetwater Branch/Alachua Sink, Tumbler Creek, and Newnans Lake sub-basins, as well as targeted monitoring at selected sites on an as-needed basis.⁴ All of the ACEPD's water quality data are uploaded to STORET.

ACHD

To date the ACHD has taken 64 surface water samples in these creeks, using the MPN (SM9221E) standard, upstream and downstream of areas where fecal coliform has been detected. Thirty-six additional sampling events are planned and will be reported when completed. The results of this sampling have been reported individually and as the arithmetic mean (see Figures 5.3 and 5.4 and Tables 5.4 and 5.5). A preliminary analysis of the data indicates that the methodology has limited usefulness with this particular project. Rainfall events and associated stormwater runoff seem to influence the results.

LakeWatch and WAV

Several volunteer monitoring programs are also in place in the Orange Creek Basin. These include LakeWatch and WAV.

⁴ The number of sites monitored by the ACEPD depends on water levels in Paynes Prairie and other weather conditions.

Florida LakeWatch, a volunteer citizen lake monitoring program, facilitates "hands-on" citizen participation in the management of Florida lakes through monthly monitoring activities. Coordinated through the UF–IFAS Department of Fisheries and Aquatic Sciences, the program has been in existence since 1986. In 1991 the Florida Legislature recognized the importance of the program and established Florida LakeWatch in the state statutes (Section 1004.49, F.S.).

LakeWatch is now one of the largest lake monitoring programs in the nation, with over 1,800 trained citizen volunteers monitoring more than 600 lakes in more than 40 counties. Volunteers collect water quality samples for laboratory analyses of TN, TP, and chlorophyll. They also measure Secchi depth, a measure of water clarity, in the field. At some locations samples are also obtained for laboratory analyses of pH, total alkalinity, specific conductance, color, chloride, and coliform bacteria.

Throughout the Orange Creek Basin, Florida LakeWatch volunteers monitor many lakes. The 2005 LakeWatch data report lists the following lakes in the basin: Lake Alice, Bivens Arm Lake, Little Orange Lake, Lochloosa Lake, Newnans Lake, Orange Lake, and Lake Wauberg. Typically, samples are obtained from three or four stations in each lake to account for water quality variability. Sample collection frequency varies, but many lakes are sampled monthly. Currently, data from Florida LakeWatch constitute the primary dataset for Bivens Arm Lake and Lake Wauberg. This program serves a vital function to fill in the gaps remaining between formal monitoring programs. Florida LakeWatch data will be used to the greatest extent possible; these data may be obtained at <http://lakewatch.ifas.ufl.edu/>.

The Alachua County WAV Program has a participant water quality monitoring component. WAV water quality monitors collect monthly baseline data for DO, alkalinity, chloride, pH, and temperature at approximately 10 sites in the Orange Creek Basin. These data are verified by the water management district, and are available on the SJRWMD WAV web database at <http://www.sjrwmd.com/wav/>. In 2007, WAV water quality monitors will begin collecting nutrient and fecal coliform samples quarterly from sites in the Hogtown Creek, Sweetwater Branch, and Little Hatchet Creek watersheds. These data will supplement water quality data collected by the ACEPD. The same certified laboratories used by the ACEPD will be used for WAV Program water quality monitoring.

WAV participants also assist with stream habitat assessments and the collection of benthic macroinvertebrates (BMIs) to determine the overall ecological health of the aquatic system. Between 2000 and 2003, volunteers assisted biologists and environmental scientists with over 30 instream ecological assessments. Beginning in late 2007 or early 2008, additional biological assessments are planned for over 20 sites in the Gainesville urban creeks.

GRU

GRU samples Gainesville's urban creeks as necessary to evaluate the effectiveness of its wastewater collection system integrity programs. Monitoring is not typically on a routine frequency and is typically project related or is a part of a focused study.

6.1.4 Sampling Stations, Parameters, and Frequency

This section outlines details of the Orange Creek Basin monitoring plan (stations, parameters, frequency, entity, etc.). The plan is designed to meet the objectives discussed above. Additional sampling will be completed by individual entities for other projects, such as Alachua County's 2005 bacteriological monitoring to identify fecal coliform "hot spots." Additional parameters may also need to be collected to address unknowns that were highlighted during TMDL development (e.g., rates of nutrient cycling). Programs specifically aimed at individual issues or to address unknowns will be implemented outside of this monitoring strategy.

The plan comprises the stations and parameters identified below. Individual sites/parameters may be added or removed, depending on environmental conditions, resources, and other pertinent factors. Careful consideration will be given before any site or parameter is removed.

Water Chemistry and Coliform Data

Monitoring associated with the programs described above will help meet the first primary objective: identify and track water quality trends in BMAP waterbodies to determine if water quality standards are being achieved.

The SJRWMD and ACEPD's extensive sampling programs will be the key to achieving this objective. These agencies monitor at approximately 44 stations throughout the Orange Creek Basin.

Table 6.4 and **Figure 6.1** provide information on the monitoring locations, parameters, and frequency of sampling for these programs. The SJRWMD and ACEPD sample at these sites regularly as part of their routine monitoring programs. The site list is consistent with the monitoring plans of the ACEPD and SJRWMD for calendar year 2007. It will be modified as needed to track changes in ambient water quality and make the best use of limited monitoring resources.

Table 6.4. Ambient water quality monitoring stations in the Orange Creek Basin

SUB-BASIN	ENTITY	STATION ID	STATION DESCRIPTION	LAT.	LONG.	STATION TYPE	SAMPLING FREQUENCY	YEAR SITE EST.	SAMPLING PARAMETERS *	WBID
Newnans Lake and Hatchet Creek	SJRWMD	NEW	Newnans Lake center	29.6453	-82.22	Ambient	Monthly	1994	Field parameters; Water chemistry; Chlorophyll-a; Light attenuation; Plankton	2705B
	SJRWMD	NEWNLN	Newnans Lake north	29.6647	-82.2197	Ambient	Monthly	1994	Field parameters; Water chemistry; Chlorophyll-a; Light attenuation; Plankton	2705B
	SJRWMD	LFC329B	Lake Forest Creek at 329B	29.6517	-82.2511	Ambient	Monthly	1998	Field parameters; Water chemistry	2709
	SJRWMD	HAT26	Hatchet Creek at SR 26	29.68783	-82.2063	Ambient	Monthly	1994	Field parameters; Water chemistry	2688
	SJRWMD	LHT26E	Little Hatchet Creek east	29.68805	-82.22063	Ambient	Monthly	1994	Field parameters; Water chemistry	2695
	SJRWMD	LHAT26	Little Hatchet Creek	29.67963	-82.23443	Ambient	Monthly	1994	Field parameters; Water chemistry	2695
	SJRWMD	LHTNB	North branch of Little Hatchet Creek, downstream of Airport Industrial Park	29.69322	-82.26565	Ambient	Monthly	1996	Field parameters; Water chemistry	2695
	SJRWMD	PC20	Prairie Creek at SR 20	29.61116	-82.24824	Ambient	Monthly	1998	Field parameters; Water chemistry	2705A
	ACEPD	LFCNE25	Upstream of University Ave on NE 25th St	29.62845	-82.30590	Ambient	Quarterly	1998	Fecal coliform; Flow	2709
	ACEPD	LFC329B	Upstream of CR 329B between SR 26 and Southeast (SE) 70th St.	29.65143	-82.24968	Ambient	Quarterly	1998	Fecal coliform; Flow	Sunland Drain/2885
	ACEPD	HAT225	West side (downstream) of CR 225.	29.73537	-82.27482	Ambient	Quarterly	1998	Fecal coliform; Flow	Hatchet Creek/2688
	ACEPD	HAT26	North side of SR 26 at bridge.	29.68783	-82.20663	Ambient	Quarterly	1994	Fecal coliform; Flow	Hatchet Creek/2688

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SUB-BASIN	ENTITY	STATION ID	STATION DESCRIPTION	LAT.	LONG.	STATION TYPE	SAMPLING FREQUENCY	YEAR SITE EST.	SAMPLING PARAMETERS *	WBID
	ACEPD	LHATWALDO	East of Waldo Rd (SR 24) on Little Hatchet Creek, between NE 47th Ave and 49th Ave.	29.69827	-82.27998	Ambient	Quarterly	1998	Fecal coliform; Flow	Little Hatchet Creek/2695
	ACEPD	LHAT26	North side of SR 26 before SR 26 intersects with SR 222 (39th Avenue).	29.67963	-82.23443	Ambient	Quarterly	1998	Fecal coliform; Flow	Newnans Lake Outlet/2705
Orange Lake	SJRWMD	OLC	Orange Lake center (between Cow Hammock & Samsons Point)	29.465	-82.1775	Ambient	Monthly	1994	Field parameters; Water chemistry; Chlorophyll-a; Light attenuation; Plankton	2749A
	SJRWMD	OLN	Orange Lake north	29.4867	-82.2008	Ambient	Monthly	1994	Field parameters; Water chemistry; Chlorophyll-a; Light attenuation; Plankton	2749A
	SJRWMD	OLSW	Orange Lake, southwest	29.4342	-82.205	Ambient	Monthly	1994	Field parameters; Water chemistry; Chlorophyll-a	2749A
	SJRWMD	OC301	Orange Lake outlet west of US 301	29.4433	-82.1086	Ambient	Monthly	1994	Field parameters; Water chemistry	2749A
	SJRWMD	CCN325	Cross Creek about 50 feet north of CR 325 bridge	29.4911	-82.1661	Ambient	Monthly	1994	Field parameters; Water chemistry	2754
	SJRWMD	STX346	River Styx at CR 346	29.5172	-82.2222	Ambient	Monthly	1994	Field parameters; Water chemistry	2744
	SJRWMD	CC234	Camps Canal at CR 234	29.57662	-82.24972	Ambient	Monthly	2003	Field parameters; Water chemistry	2705
Lake Lochloosa	SJRWMD	LOL	Lochloosa Lake center	29.52	-82.1247	Ambient	Monthly	2003	Field parameters; Water chemistry; Chlorophyll-a; Light attenuation; Plankton	2738A
	SJRWMD	LOCHLN	Lochloosa Lake north-center	29.5256	-82.1272	Ambient	Monthly	1994	Field parameters; Water chemistry; Chlorophyll-a; Light attenuation; Plankton	2738A

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SUB-BASIN	ENTITY	STATION ID	STATION DESCRIPTION	LAT.	LONG.	STATION TYPE	SAMPLING FREQUENCY	YEAR SITE EST.	SAMPLING PARAMETERS *	WBID
	SJRWMD	CELC	Tributary on north shore of Lochloosa Lake, east of Lochloosa Creek	29.5637	-82.1248	Ambient	Monthly	2003	Field parameters; Water chemistry	2728
	SJRWMD	LC1LB	Lochloosa Creek about 2 miles north of Lochloosa Lake	29.565	-82.1406	Ambient	Monthly	2003	Field parameters; Water chemistry	2693
	SJRWMD	LLS	Lochloosa Slough	29.4823	-82.1073	Ambient	Monthly	2003	Field parameters; Water chemistry	2738A
	SJRWMD	LOCH20	Lochloosa Creek at SR 20	29.60022	-82.14468	Ambient	Monthly	1994	Field parameters; Water chemistry	2693
Lake Wauberg	ACEPD	LWAUBERG	Center of Lake Wauberg east of US 441	29.55034	-82.61136	Ambient	Semi-annually	2007	Field; Fecal Coliform; Surface Water; Chlorophyll	Lake Wauberg/ 2741
Sweetwater Branch Hogtown Creek	ACEPD	HOGNW45	South side of NW 45th Ave at Hogtown Creek.	29.69558	-82.34520	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water; Flow	Hogtown Creek/2698
	ACEPD	HOGNW16	Ring Park, north of NW 16 th Avenue	29.66703	-82.34863	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water	Hogtown Creek/2698
	ACEPD	HOG30US	North side of CR 30 (SW 20 th Ave) upstream of bridge	29.63839	-82.39219	Ambient	Quarterly	1999	Field; Fecal Coliform; Surface Water	Hogtown Creek/2698
	ACEPD	HOGSINK	Hogtown Creek approx. 100 meters upstream of Haile Sink	29.62973	-82.41117	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water ; Flow	Haile Sink/2717A
	ACEPD	POSNW16	South of NW 16th Ave west of NW 27th Terr.	29.66662	-82.36423	Ambient	Quarterly	1996	Field; Fecal Coliform; Surface Water	Possum Creek/2696
	ACEPD	SWBNE10	Site is in the median at NE 10th Ave between N Main St NE 2nd Street.	29.66107	-82.32348	Ambient	Quarterly	2002	Field; Fecal Coliform; Surface Water ; Flow	Sweetwater Branch/2711
	ACEPD	ROSESE9	Upstream of SE 9th St between SE 9th Ave and SE 10th Ave.	29.64292	-82.31505	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water ; Flow	Sweetwater Branch/2711
	ACEPD	SWBSE4	Site is east of SE 4th St between SE 13th Lane and SE 11th Place.	29.63805	-82.31809	Ambient	Quarterly	2003	Field; Fecal Coliform; Surface Water ; Flow	Sweetwater Branch/2711

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SUB-BASIN	ENTITY	STATION ID	STATION DESCRIPTION	LAT.	LONG.	STATION TYPE	SAMPLING FREQUENCY	YEAR SITE EST.	SAMPLING PARAMETERS *	WBID
	ACEPD	SWB331	West of SR 331 (Williston Rd) just north of SE 16th Ave.	29.63040	-82.32242	Ambient	Quarterly	1994	Field; Fecal Coliform; Surface Water; Chlorophyll (if also sampling on Paynes Prairie)	Sweetwater Branch/2711
	ACEPD	SWBALACH**	Upstream (at culvert) of the confluence of SWB and Alachua Lake.	29.60319	-82.30272	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water; Chlorophyll	Alachua Sink Outlet/2720
	ACEPD	ALACHLAKE**	Lake/marsh upstream of inlet to Alachua Sink.	29.60261	-82.30286	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water; Chlorophyll	Alachua Sink Outlet/2720
	ACEPD	ALACHSINK**	Large waterbody east of the Primary Sink Feature at Alachua Sink on Payne's Prairie.	29.60553	-82.30064	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water; Chlorophyll	Alachua Sink Outlet/2720
Tumblin Creek	ACEPD	TUMSW5	South of SW 5th Ave between SW 8th St and SW 10th St.	29.64705	-82.33366	Ambient	Quarterly	2001	Field; Fecal Coliform; Surface Water ; Flow	Tumbling Creek/2718A
	ACEPD	TUM441	West of SW 13th Street end of concrete channel.	29.63317	-82.34058	Ambient	Quarterly	1998	Field; Fecal Coliform; Surface Water ; Flow	Tumbling Creek/2718A
	ACEPD	BIVARM	Center of Bivens Arm Lake west of US 441	29.62361	-82.34389	Ambient	Semi-annually	1998	Field; Fecal Coliform; Surface Water; Chlorophyll	Tumbling Creek South/2718C

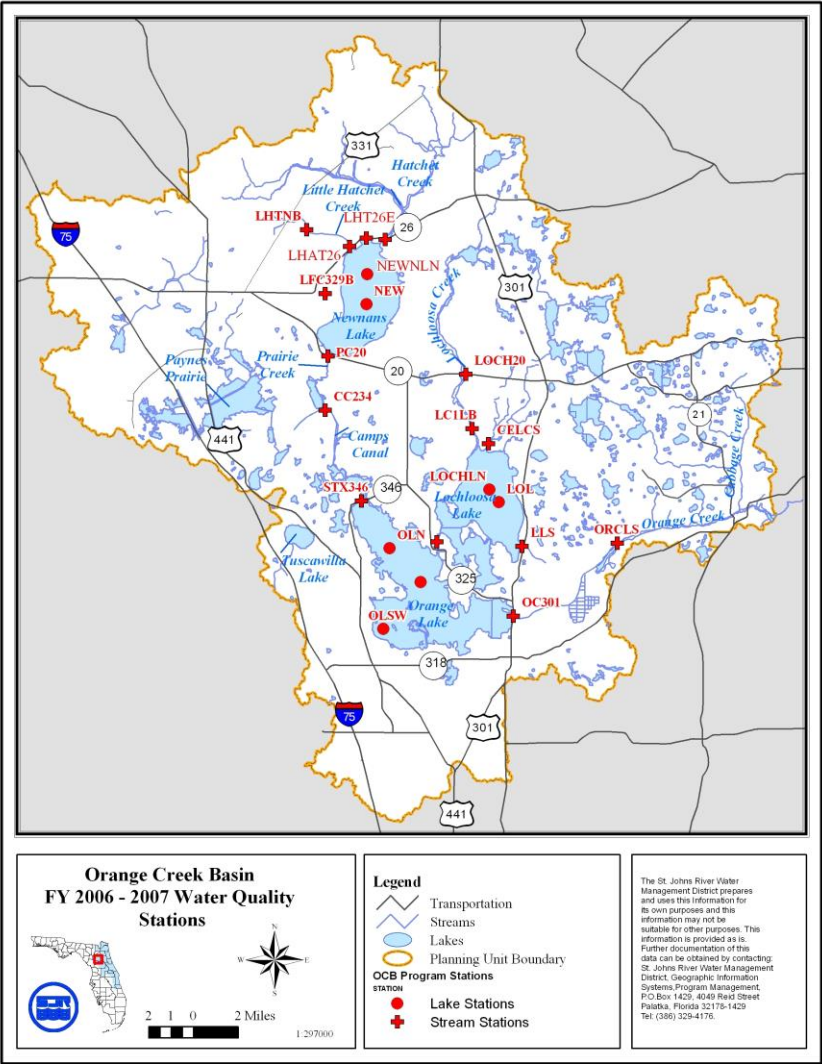
* ACEPD field parameters: pH, DO, conductivity, turbidity, Secchi depth, depth of collection, depth of water column, air temperature, weather, cloud cover (lakes only), wind speed (lakes only), wind direction (lakes only), water temperature.

** Sampled during low water when the prairie is not flooded. When the prairie is flooded, sample ALACHPSF. ACEPD sampling will cease if and when the SJRWMD takes over sampling these stations.

ACEPD Surface Water Chemistry: The full suite of surface water parameters will be analyzed in the winter and summer quarters (Alk, Ca, Mg, K, Fe, TP, field filtered ORP, Cl, color, SO₄, TSS, TDS, NH₄, NO_x, TKN, TN, TOC, Chlorophyll a at SWB331 and ALACH sites on Paynes Prairie). Partial parameters alternating quarters (TP, field filtered ORP, NO_x, TKN, TN, NH₃, and K).

SJRWMD Plankton: Zooplankton and phytoplankton (identification, counts, biovolume/biomass).

Figure 6.1. SJRWMD water quality sampling stations, 2006–07



Author: godfrey, Source: V:\ocb\all\projects\Water_Quality\FY0607\mxd\ocb_fy0607_stations_8.5x11_April06.mxd

In addition to sites monitored by Alachua County and the SJRWMD, WAV and LakeWatch program volunteers routinely monitor at the locations listed in **Table 6.5**. Sampling parameters for the WAV sites include nutrients and fecal coliform. LakeWatch volunteers currently sample for TN, TP, chlorophyll, and Secchi depth. Currently, LakeWatch is the only program that routinely samples Lake Wauberg.

Table 6.5. Stations monitored by WAV and LakeWatch volunteers

SAMPLING PROGRAM	LOCATION	FREQUENCY OF WATER QUALITY SAMPLING
WAV	Rosewood SE 3 rd Ave.	Quarterly
	LFCSE43	Quarterly
	Springstead at NW 39 th and 6 th St.	Quarterly
	HogSW2	Quarterly
	SWBSE1	Quarterly
	Bouleware Springs	Quarterly
	PosNW39	Quarterly
	ElizArbor	Quarterly
LakeWatch	Lake Alice	Quarterly
	Lake Alto	Monthly
	Bivens Arm	Monthly
	Hidden Lake	January
	Holden Pond	6 to 8 times/year
	Kingswood	2 times/year
	Little Orange Lake	Monthly
	Little Santa Fe Lake	Monthly
	Melrose Bay	Monthly; Annual Vegetation Survey
	Lochloosa Lake	Monthly March–November; Annual Vegetation Survey
	Lake Mize	5 times/year
	Moss Lake	5 times/year
	Newnans Lake	Monthly; Annual Vegetation Survey
	Orange Lake	Monthly March–November
	Lake Wauberg	Monthly

Note: Not all of these locations directly affect BMAP waterbodies.

Any station modifications or presence of unusual conditions should be noted in the field notes associated with specific sampling events. Every effort should be made to communicate this information to other stakeholders to support the accuracy of future trend analyses.

A secondary objective of this monitoring strategy is to refine the source identification provided in the initial TMDL document. One way in which this will be achieved is by locating new sampling sites in areas that have a high probability of causing excessive pollutant loads. Areas where human fecal contamination has been documented are a high priority for new sampling sites. Confirming these source areas through further investigation is a key step in refining TMDL source identification. Specific locations for this additional coliform sampling will be identified on an as-needed basis.

Flow and Rain Data

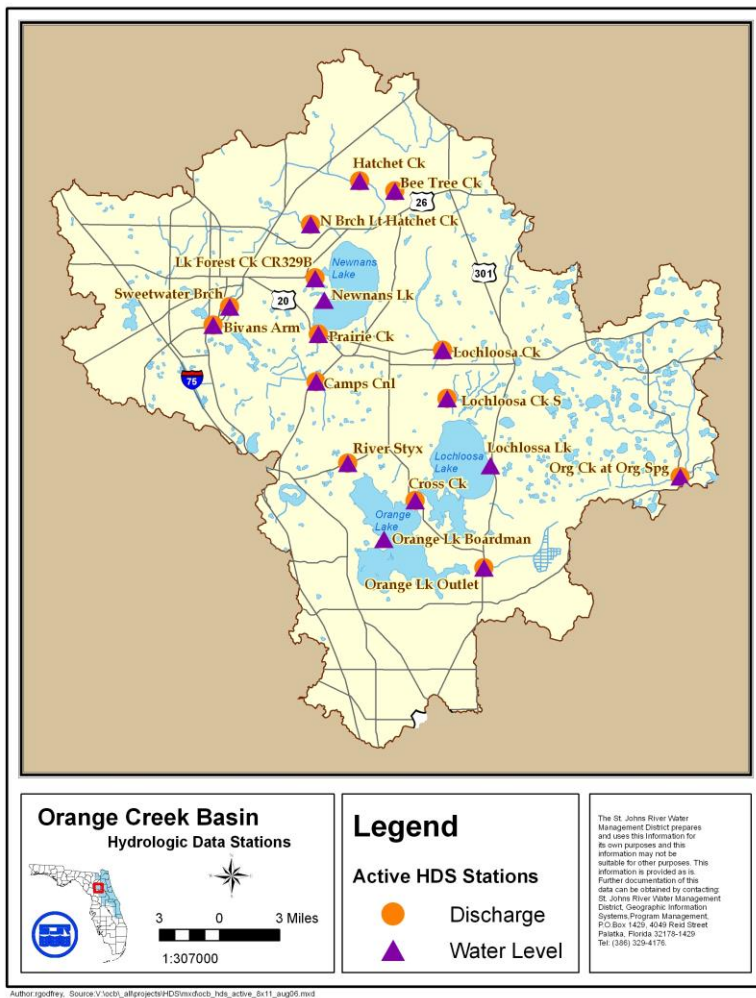
Measuring reductions in watershed loadings of TMDL target pollutants is another secondary objective of the strategy. To achieve this, flow data are needed in conjunction with the water quality parameters listed above. The SJRWMD's Hydrologic Data Services Section monitors water levels and flows throughout the district, including the Orange Creek Basin. The section gathers continuous level data for the three large lakes and flow data for the larger tributaries that discharge into these lakes. **Table 6.6** and **Figure 6.2** identify the locations of discharge and water level monitoring stations maintained by the SJRWMD with support from ACEPD.

Two rain gauges are regularly monitored in the basin: Kelly Generating Station (GRU) and Gainesville Regional Airport (SJRWMD). In addition to these stations, Next-generation Radar (NEXRAD) data are also available to track rainfall amounts. These are compiled in 15-minute time increments and are available basinwide. This dataset may be the most reliable for use in future trend analyses.

Table 6.6. Discharge and water level monitoring stations in the Orange Creek Basin

SUB-BASIN	ENTITY	STATION ID	STATION DESCRIPTION	LATITUDE	LONGITUDE	STATION TYPE	FREQUENCY	WBID
Sweetwater Branch	SJRWMD		Sweetwater Branch	29.63021	-82.32223	Discharge		
	SJRWMD		Bivens Arm	29.61658	-82.33581	Discharge		
Newmans Lake	SJRWMD		Bee Tree Creek	29.716	-82.18561	Discharge		
	SJRWMD		Lake Forest Creek CR329B	29.65194	-82.25139	Discharge		
	SJRWMD		North Branch Little Hatchet Creek	29.69078	-82.25568	Discharge		
	SJRWMD		Prairie Creek	29.61094	-82.24815	Discharge		
	SJRWMD		Newmans Lake	29.63584	-82.24365	Water Level		
	SJRWMD		Camps Canal	29.5763	-82.24944	Discharge		
Orange Lake	SJRWMD		Orange Lake Outlet	29.44178	-82.10851	Discharge		
	SJRWMD		Cross Creek	29.4852778	-82.16527778	Discharge		
	SJRWMD		River Styx	29.5171083	-82.2225472	Discharge		
	SJRWMD		Orange Lake Boardman	29.46198	-82.19181	Water Level		
	SJRWMD		Lochloosa Creek	29.60022	-82.14468	Discharge		
Lake Lochloosa	SJRWMD		Loochloosa Creek South	29.565	-82.14056	Discharge		
	SJRWMD		Lochloosa Lake	29.51639	-82.10389	Water Level		
	SJRWMD		Hatchet Creek	29.72292	-82.21499	Discharge		

Figure 6.2. SJRWMD discharge and water level sampling stations



Environmental Condition Data

The appropriate interpretation of water quality data depends on an understanding of the conditions under which the samples were taken. Conditions such as extreme weather events can significantly affect the utility of a particular sample to represent ambient conditions. **Table 6.7** outlines the specific types of environmental condition data that should be considered when water quality data analyses are conducted in the Orange

Creek Basin. The collection and use of environmental condition data will justify the use or elimination of unusual water quality datapoints.

Table 6.7. Environmental condition data for the Orange Creek Basin

DATA TYPE	DESCRIPTION/EXAMPLE
Extreme Weather Events	Hurricanes, droughts.
Aquatic Plant Management Activities	2003: 400 acres of willow treated by aerial herbicide (FWC). LakeWatch annual vegetation surveys on Lochloosa Lake and Newnans Lake will contribute to this dataset.
Changes in Consumptive Use	Significant changes in consumptive use could increase the demand for reclaimed water
Storm Event Samples	Samples taken during or shortly after storm events are not considered representative of ambient conditions. The ACEPD identifies these as storm event data.
Significant Land Use Changes	Permitting of a large recreational vehicle park in McIntosh.
Locations of Significant Bird Colonies	Large cattle egret colony on southwest shore of Lake Wauberg.

Performance-Based Monitoring

Measuring the effectiveness of specific BMPs in reducing target pollutant loads is the second primary objective of this monitoring strategy. As part of the BMAP implementation and follow-up process, BWG members will identify opportunities for BMP-specific monitoring. This will involve individual entities monitoring the impacts of one of the BMPs included in their management actions identified in the BMAP. Although this might not be feasible for every BMAP partner, even a few monitoring efforts would provide important data on the effectiveness of individual BMPs. Performance-based monitoring will occur on an as-needed basis as resources allow, as determined by the project sponsor. The data collected through this type of targeted monitoring will be used during BMAP evaluations to analyze the effectiveness of specific BMPs and adjust the implementation strategy, as appropriate. All performance-based monitoring that involves the collection of water quality samples will be collected in accordance with DEP's SOPs for water quality sampling and analysis.

Ability of Monitoring Network To Meet Objectives of Strategy

The monitoring network outlined in this strategy includes stations at the primary tributaries, outlets, and regions of the three large BMAP lakes: Newnans and Orange Lakes and Lochloosa Lake (**Table 6.4**). A number of stations are also located on the urban tributaries (**Table 6.4**). These sampling efforts are conducted primarily by Alachua County and the SJRWMD. In addition, LakeWatch volunteers sample Lake Wauberg monthly (**Table 6.5**). Given the parameters listed in **Table 6.1** and the monthly sampling frequency, this station network is considered sufficient for the purposes of future water quality trend analyses.

The current network of water quality and flow stations will provide sufficient data to calculate pollutant loading trends on a monthly basis. When trend analyses are being

conducted in the future, stakeholders and staff will determine which stations are best suited to represent long-term trends. This includes consideration of the station locations, sampling frequency, and station tenure. Future BMAP trend analyses will focus on stations with previous years of record. This will provide additional context and statistical confidence in apparent water quality trends.

Stakeholders may also choose to conduct performance-based monitoring for specific projects. Given the short duration of such sampling, it is unlikely that this will contribute to the calculation of long-term water quality trends. However, these data will help individual stakeholders demonstrate the success of specific projects through the collection of flow and water quality data before and after project completion. This type of information is vital to the evaluation of past BMPs and the selection of future BMPs in the basin.

6.1.5 Quality Assurance/Quality Control Mechanisms

The collection of both ambient and performance-based water quality data will be conducted in a manner consistent with DEP's SOPs for QA/QC. The most current version of these procedures can be downloaded from www.dep.state.fl.us/labs/qa/sops.htm. All stakeholders contributing data in support of the BMAP agree to follow these SOPs.

Table 6.8 lists the primary labs used by each entity, with their National Environmental Laboratory Accreditation Conference (NELAC) certification number. Entities are free to use other labs for BMAP-related data analyses, provided that they meet the certification and other requirements outlined in the SOPs. Other labs may also be used for analyses that are not covered under the NELAC Program (e.g., advanced DNA analyses).

SJRWMD staff and contractors collect, process, and preserve samples according to the SJRWMD's *Standard Operating Procedures for the Collection of Surface Water Quality Samples and Field Data—Feb. 13, 2004*, as well as DEP's SOPs. Where the District and DEP SOP's do not correspond to one another, SJRWMD staff and contractors defer to DEP's SOPs. Sampling completed by the ACEPD is also consistent with the SOPs established by DEP. Through cooperation on TMDL-related data collection, the SJRWMD, ACEPD, and DEP have consistently used similar SOPs for field sampling and lab analyses. This consistency will continue into the future to ensure that data can be used not only for tracking BMAP progress but also for future TMDL evaluations and other purposes.

Table 6.8. Primary laboratories and NELAC certification numbers

ENTITY	LABORATORY
ACEPD and WAV	Advanced Environmental Laboratories, Inc (formerly PPB) 6815 SW Archer Road Gainesville, FL 32608
	ABC Research Corp.3437 SW 24th Ave Gainesville, FL 32607
	Severn Trent Laboratories, Inc. 2846 Industrial Plaza Drive Tallahassee, FL 3230
ACHD	Florida Department of Health Bureau of Laboratories 1217 Pearl Street Jacksonville, FL 32202
SJRWMD	Water Chemistry SJRWMD 4049 Reid St. Palatka, FL 32178 NELAC Cert. #: E42206
	Phytoplankton Department of Fisheries and Aquatic Sciences University of Florida 7922 NW 71st Street Gainesville, FL 32653
	Zooplankton Bowling Green State University 312 Life Sciences Building College Street Bowling Green, OH 43403
DEP	Florida Department of Environmental Protection 2600 Blair Stone Rd. Tallahassee, FL 32399 NELAC Cert; #: E31780

6.1.6 Data Management Mechanisms for Data Storage and Retrieval

Water Quality Data

Data collected through the above activities will need to be tracked, compiled, and analyzed for it to be useful in support of the BMAP. The Florida STORET database will serve as the primary resource for storing data and providing access for all stakeholders. The SJRWMD, ACEPD, and DEP currently store water quality data in the Florida STORET database. Stakeholders have agreed to upload data to STORET in a timely manner, after the appropriate QA/QC checks have been completed. All applicable data will be uploaded to STORET regularly, at least every six months.

STORET uploads are only appropriate for data that is representative of ambient conditions. Performance-based data collected as part of a localized source identification project, BMP investigation, or similar activity are not representative of ambient water quality conditions. These data will not be uploaded into the STORET database.

Similarly, it is inappropriate to store contextual data (discussed above) in STORET. Performance-based and contextual data will be maintained by the appropriate entity. Stakeholders agree to provide this data to other BMAP partners upon request and when appropriate for inclusion in BMAP data analyses and adaptive management evaluations.

Currently, volunteer monitoring data (WAV and LakeWatch) are not uploaded to STORET. WAV data are available from the SJRWMD WAV Water Quality Sampling Database at <http://www.sjrwmd.com/wavapp/>. Florida LakeWatch data may be obtained at <http://lakewatch.ifas.ufl.edu/>.

Flow and Discharge Data

The ACEPD currently uploads flow data into the STORET database. The SJRWMD flow data are available on the SJRWMD website at <http://sjr.state.fl.us/programs/data.html>.

6.1.7 Data Analysis and Reporting

The entities responsible for water quality monitoring in the basin will meet periodically to review water quality data and evaluate the monitoring strategy's effectiveness. These meetings will be held concurrently with the annual BMAP reporting meetings. Data analyses will be conducted before each annual BMAP status meeting. The purpose of these analyses is to identify trends in water quality conditions and the benefits of specific projects (i.e., performance-based monitoring).

A wide variety of statistical methods is available for trend analyses. The selection of an appropriate data analysis method depends on the frequency, spatial distribution, and period of record available from existing data. The BWG will use commonly accepted methods of data analysis that are appropriate for the period of record available for each BMAP waterbody.

For nutrients in Orange Creek Basin lakes, data analysis will focus on changes in the TSI. Ideally, a Mann's one-sided, upper-tail test for trends will be used (Hollander and Wolfe, 1999), with a 95% confidence level. This test is consistent with the TSI analysis methods outlined in the Impaired Surface Waters Rule. Consistency in data analysis methods will facilitate comparison with delisting criteria. Additional data analyses may be conducted, as appropriate.

For coliform in urban creeks, data analysis will focus on the number of exceedances (value greater than 800 MPN) at each sampling location. This is also consistent with the provisions of the Impaired Surface Waters Rule.

The party responsible for conducting these analyses remains to be determined.

In addition to the annual reporting meetings, DEP will update the Ocklawaha Basin Assessment Report (second cycle) by early 2009. The update will involve a significant effort to compile and evaluate data collected under this monitoring strategy and related efforts.

6.1.8 Monitoring Strategy Funding

The monitoring strategy outlined above will involve the significant investment of resources by involved stakeholders, primarily Alachua County, the SJRWMD, and the

GCWP. All stakeholders understand that resources are limited and extenuating circumstances can arise (e.g., extreme weather events).

The SJRWMD will fund the sampling program outlined in this strategy through its annual budget. The ACEPD will fund its water quality and flow monitoring through its general fund. GCWP funds will not be used for this sampling. The ACEPD may use GCWP funds for special projects and to address citizen complaints.

6.2 Tracking Project Implementation

The FWRA requires progress in achieving BMAP milestones to be evaluated every five years and the plan revised, as appropriate, in cooperation with basin stakeholders. Revised BMAPs are to be adopted by Secretarial Order.

The BWG has agreed to meet regularly after the adoption of the BMAP to follow up on plan implementation, share new information, and continue to coordinate on TMDL-related issues. This section describes implementation tracking measures developed by the BWG.

The BWG's priorities for tracking project implementation are as follows:

- All BMAP-related tracking measures are coordinated with existing reporting (e.g., discharge monitoring reports [DMRs], NPDES MS4 annual reports, etc.) to the greatest extent possible to eliminate duplication.
- BMAP tracking and reporting measures will effectively communicate the range and extent of BMAP project implementation to BWG members and other interested parties. Project information will be reported at a level of detail sufficient to meet this goal.
- BWG members will complete the form shown in **Table 6.9** by the end of each calendar year. These forms will be submitted to DEP, which will then arrange a meeting to allow all BWG members to review the information provided.
- Information gathered through project tracking will be used to guide future efforts, consistent with the principles of adaptive management.
- Only information relevant to the BMAP will be included in this reporting process. NPDES permit requirements not applicable to the BMAP will not be reported as part of BMAP project tracking.

6.3 Adaptive Management

Adaptive management involves setting up a mechanism for making course corrections in the BMAP when circumstances change or feedback mechanisms indicate that a more effective strategy is needed. Adaptive management measures include the following:

- Procedures to determine whether additional cooperative actions are needed,
- Criteria/processes for determining whether and when plan components need to be revised due to changes in costs, environmental impacts, social effects, watershed conditions, or other factors, and
- Descriptions of the role of the BMAP development group and/or individual subsequent to BMAP completion.

Tracking implementation, monitoring water quality and pollutant loads, and periodic BWG meetings to share information and expertise are key components of adaptive management. The information the BWG receives from implementation tracking and water quality monitoring will help the group decide what changes to the BMAP are needed to ensure that the TMDLs for the basin are achieved. The BWG's most immediate task is to evaluate what additional efforts are necessary to meet the TMDLs in the waterbodies that are projected to fall short under the current BMAP.

The BWG will meet annually each January to review project status and water quality conditions in the BMAP waterbodies. At this time, available information will be used to evaluate projects and monitoring for the upcoming year. Modifications from the original BMAP may occur at that time, if conditions warrant. By October of each year, DEP will populate an annual implementation report like that shown in **Table 6.9** and will distribute it to stakeholders for their review. This information and water quality trend analysis will form the basis of each annual review meeting.

Table 6.9. Draft BMAP annual reporting format

Orange Creek Basin Management Action Plan Year ____ Annual Implementation Report

REPORTING ENTITY: _____

DATE: _____

BMAP PROJECT #	WBID / WATERBODY	RELATED TO NPDES PERMIT	PROJECT PARTNERS	BRIEF DESCRIPTION	PROJECTED START/END DATES	PROJECT/ACTIVITY STATUS	PROJECT RESULTS	COMMENTS

Field Descriptions:

- **BMAP Project #:** This field will be populated by DEP with the project numbers from the BMAP project spreadsheets prior to annual form distribution. This includes projects and other management actions. New projects/activities that are not included in the BMAP can be identified on this form as well.
- **WBID/Waterbody:** This field will be populated by DEP prior to annual form distribution.
- **Related to NPDES Permit:** This field will be populated with the applicable permit number by DEP prior to annual form distribution, consistent with project and permit links identified in the BMAP.
- **Project Partners:** This field will be populated by DEP prior to annual form distribution.
- **Brief Description:** Include a brief description of the management action being reported (e.g., street sweeping - 5 miles each month).
- **Projected Start/End Dates:** If applicable, include the start and end dates for the management action. If not applicable, put "N/A" or, if it is a continuous activity, put "Continuous" and indicate how often the activity takes place (e.g., for street sweeping).
- **Project/Activity Status:** Give a clear summary of the status of the management action, in a way that makes sense for the item listed. For instance, for educational activities, list pertinent publications, events, etc., including name and/or topic for each. Include specific or general time

frames (e.g., 2 public workshops on lawn fertilizer in March 2007). Also, describe any significant changes to the management action that have taken place.

- **Project Results:** If monitoring is required as part of a management action (e.g., in a cost-share situation) or is conducted voluntarily (e.g., as part of an effort to collect BMAP effectiveness information), include the monitoring results to date, as practicable. For projects with quantifiable load reductions, these values can be reported here.
- **Comments:** Include comments on any implementation obstacles, including weather, funding, technical difficulties, etc. Identify needs for assistance from the BWG as a whole, or from individual entities represented on the BWG. Include any other comments you consider important.

CHAPTER 7: PUBLIC EDUCATION AND OUTREACH

Public education and outreach are important elements of any plan to restore water quality to the streams and lakes within the Orange Creek Basin. A wide variety of public education/outreach activities are currently implemented in this basin, many of them related to requirements for NPDES permits or local ordinances. The purpose of this chapter is outlined as follows:

- Provide a summary of current public education/outreach activities used by local governments, water management districts, silviculture industry, utilities, and nongovernmental organizations.
- Identify key issues related to implementation of TMDLs.
- Identify target audiences.
- Identify opportunities (gaps within existing programs) for creating or modifying programs to address TMDL specific issues.

7.1 Key Public Education Issues

A number of key issues were identified by the Education/Outreach Subcommittee as having importance in the overall protection of water resources in the Orange Creek Basin and in particular those waterbodies identified as impaired and with established TMDLs. They are stated in Table 7.1 as the goals of public education and outreach efforts. Main goals address either the sources or impacts from nutrients and fecal coliforms bacteria. The issues identified represent the best professional judgment of local experts. It is expected that public education and outreach efforts directed at addressing these goals will benefit impaired waters. Overall the goals focus on the reduction of stormwater runoff or management of waste to reduce the input of nutrients and fecal coliforms bacteria into waterbodies.

Table 7.1. Public Education Issues in the Orange Creek Basin

Main Goals	Reason for Importance
Minimize impacts from lawn fertilization	Excess nutrients cause problems in lakes and streams such as too much algal growth.
Increase septic system maintenance and encourage upgrades	Failing and poorly maintained septic systems can contribute bacteria and nutrients in greater quantities than design criteria allow.
Restore and maintain vegetated shoreline buffers	Shoreline vegetation and buffers protect water quality by removing sediment and pollutants.
Manage pet waste	Pet waste is a source of bacteria and nutrients.
Reduce agricultural runoff (livestock and crops)	Agricultural runoff often contains excessive nutrients, bacteria, and contaminants associated with pesticides and herbicides.
Reduce water consumption (irrigation and residential)	Overwatering of landscape plants and lawns contributes to stormwater runoff. Over consumption of water adds to the discharge of wastewater.
Reduce residential stormwater runoff	Stormwater erodes stream beds and banks and contributes pollutants.
Encourage Low Impact Development (LID) techniques	LID techniques can minimize the quantity of stormwater leaving a site and improve the quality of the stormwater.
Decrease amount of grease in wastewater collection systems	Grease can cause blockages in sewer lines and result in the release of untreated wastewater to surface waters.
Increase erosion and sediment control	Sediments clog stormwater collection systems and are deposited in surface waters. Increased nutrient and bacteria loads are often associated with sediments.

7.2 Summary of Current Activities

There are a large number of public education/outreach activities in this basin engaged in by both government and non-governmental organizations. Table 7.2 identifies the ways in which local governments, community groups, trade groups, and private businesses currently engage or plan to engage the public to address the issues identified in Section 7.1. The organizations participating in public education and outreach activities are listed in Table 7.3. More detailed descriptions of each government's or organization's programs are contained in Appendix Q.

In general most basin programs produce brochures or other informational items which are distributed through such mechanisms as workshops, mail outs, websites, special events, or when permits are issued. The Gainesville Clean Water Partnership uses an innovative "Elvis the Otter" puppet teaching tool to engage children in environmental issues.

Local governments and participating non-governmental organizations provide a diverse assemblage of materials on a wide variety of topics in a variety of media. Some of the diversity of materials is necessitated by the variety of local government responsibilities and local, state, and federal mandates, diversity of audiences, and the diversity of interests among non-governmental organizations. There is some overlap between

materials produced by different organizations. Presentations are given to groups and in the schools at their request. Workshops have also been used as another tool to inform the public about more watershed friendly actions. Some workshops are a requirement of MS4 permits, for example erosion and sediment control.

Local governments are engaged in public education and outreach activities as part of the implementation of NPDES permits, local ordinances or resolutions, Comprehensive Plans and other planning documents, or during on-site inspections. Their methods range from distribution of brochures to more personal hands on approaches such as training given at workshops or certification programs or presentations at community meetings.

Local governments may work independently of each other and state and regional agencies to meet specific agency responsibilities. The city of Gainesville, Alachua County, and FDOT also work together as members of the Gainesville Clean Water Partnership to promote water pollution prevention. Local governments do engage the services of private groups such as Current Problems, Inc, Watershed Action Volunteers, or the Florida Yards and Neighborhoods Program for specific services.

Non-governmental organizations provide an alternative mechanism of reaching the community that does not come directly from government. Volunteer groups allow people to become involved on their own terms by providing a variety of activities including litter clean-up, water quality sampling, and shoreline buffer plantings.

Most outreach efforts are information intensive. The information may be broadcast to a large audience or narrowly focused on a small audience that has expressed an interest in the topic. Examples of this last method are sediment and erosion control training and the Plant a Pond Program. Typically the people receiving information have taken an initial step in requesting that information or in participating in an event. Many of the workshops are targeted at the professional and not necessarily the average resident.

7.3 Target Audiences

The goal of public education in this basin is to achieve higher rates of participation by the community in behaviors that benefit water quality improvement of impaired waters. Though all residents within the basin would benefit from public education and outreach efforts, the TMDL Program is directed at specific impaired waterbodies. The challenge is to address the impaired waters while not neglecting the larger basin audience.

Many of the current public education/outreach efforts engage people who are already interested in the environment. These are people who are actively looking for information and are more likely to visit websites, go to festivals, or follow-up on offers for presentations. Most of the organizations have web sites where local residents can find environmental information if they are so inclined. As examples, FYN presentations are made at the request of homeowners and local governments present brochures or posters at festivals.

Members of the community who have an impact on impaired waters belong to two major groups. The first are people who live on or near the effected waterbody or live in the

watershed. The second group is those that pass through the watershed or visit the watershed to engage in a specific activity. For example, recreational boaters do not necessarily live around or even near Lakes Newnans, Wauberg, Orange, or Lochloosa. Included in this second population are service type industries such as lawn care providers. Professional service providers may require a different type of engagement than the residential home owner or recreational group. Within these two larger groups are many sub groups.

7.4 Recommended Actions

In this basin the amount of nutrients and bacteria entering streams and lakes needs to be reduced. There are best management practices that the individual can do to reduce bacteria and nutrients. Addressing the issues listed in Table 7.1 will help in meeting goals of reducing nutrients and bacteria. How to address the issues is the question.

Most local programs have taken traditional outreach approaches and have focused on distributing information in a broad manner or focused on individuals or groups who already have an interest in or are required to understand a topic. Though they provide good and timely information they too frequently do not address the barriers or reasons why people would not change their actions.

Similar information is delivered by different organizations and there is a substantial amount of information provided. One suggested change is to regionalize outreach and simplify the message. One simple consistent message delivered to all residents about what is needed to protect an impaired waterbody. A second suggestion is to more clearly identify and define the target audience and tailor outreach efforts to that group.

Two weaknesses of current programs are limited follow-up after a new approach has been introduced to an audience and none or limited identification of the barriers and benefits before an outreach program is started. The principles of community based social marketing help to address these two weaknesses by providing an alternative approach to existing outreach programs.

Community based social marketing provides a framework for creating more effective outreach and education programs. It is based upon research in the social sciences that demonstrates that activities to change behavior are most effective when initiatives delivered at the community level are focused on removing barriers to an activity while enhancing the activity's benefits (McKenzie-Mohr and Smith, 1999). Identifying barriers and benefits amounts to figuring out what question the public needs to answer or obstacles that must be removed before they will change their actions. Finding out at the start of an outreach program what the barriers and benefits are helps to define and shape the outreach program. Adding these types of investigative activities into education/outreach efforts in this basin should result in more participation by the community and provide the potential for greater water quality protection. However, incorporating community based social marketing principles into outreach programs is expensive, time consuming, and may require outside expertise from those trained in the social sciences.

7.5 Opportunities for Public Education and Outreach

Projects already implemented or planned provide opportunities for adding or changing a public education element. One such project is the investigation into bacteria hot spots. This project focuses on parts of the watershed with consistently high fecal coliform bacterial counts. As part of that project there should be opportunities to apply the principles of social marketing. One of the first steps would be to identify activities by residents around the hot spots that could be contributing to the high counts. Then select an activity and identify the barriers and benefits associated with changing actions.

There are some additional tools developed for Florida that are available. SWFWMD has contracted with Doug McKenzie-Mohr to prepare several white papers on different environmental topics (Personal communication, Morgan, 2007). These white papers provide preliminary information about potential barriers and benefits. As such they may be a useful starting point for this type of analysis.

Table 7.2 Summary of outreach approaches used in the Orange Creek Basin

Main Issues	Publication	Face to Face Contact	Workshop	Web	TV	Radio	Billboard	Direct Mail	paper ad or column	Inspection Program	Reg. Rqts	Cert. Program	Financial incentive	Benefit and Barrier Research
Minimize impacts from lawn fertilization	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	P?	Y	N	P
Increase septic tank maintenance and encourage upgrades	Y	Y	P?	Y	P	P	Y	P	N	Y	P?	Y	N	N
Restore and maintain vegetated shoreline buffers	Y	Y	Y	Y	N	Y	N	N	P	N	Y	N	N	N
Manage pet waste	P	Y	N	Y	Y	N	N	P	N	N	Y	N	N	P?
Reduce agricultural runoff (livestock and crops)	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N	N	N
Reduce water consumption (irrigation and residential)	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	P	Y	N
Reduce residential stormwater runoff	Y	Y	Y	Y	N	Y	N	Y	Y	N	N	Y	N	N
Encourage Low Impact Development (LID) techniques	Y	Y	Y	Y	N	N	N	N	N	N	Y?	Y	Y	N
Decrease amount of grease in collection systems	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N	N	N
Increase erosion and sediment control	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	Y	N	N
Y = Yes, this has been completed N= No, we do not plan on doing this, and P = We plan on doing this														

Table 7.3 Organizations implementing outreach programs in the Orange Creek Basin identified in Table 7.2

Organization Name	Organization Name
Adopt a River/Current Problems, Inc.	Florida Green Building Coalition
Alachua County	Gainesville Regional Utilities
Alachua County Health Department	Marion County Clean Water Program
Alachua County Florida Yards and Neighborhoods	Soosouthwest Florida Water Management District
City of Gainesville	St. Johns River Water Management District
Florida Dept. of Agriculture and Consumer Services	University of Florida IFAS
Florida Dept. of Environmental Protection	University of Florida CLEC
Florida Dept. of Transportation, District 1	University of Florida IFAS Program for Resource Efficient Communities
University of Florida Office of Sustainability	

CHAPTER 8: PLAN IMPLEMENTATION: FUNDING AND COMMITMENT

This chapter outlines the commitments that stakeholders have made to implement the provisions outlined in this BMAP. These commitments take the form of financial resources and political support. **Section 8.1** discusses financial resources. Political support is identified through the adoption of resolutions and development of commitment letters discussed in **Section 8.2**. The financial and political commitments alike represent a significant investment in the future health of the BMAP waterbodies.

8.1 BMAP Funding Sources

In many cases, funds from various sources are combined to implement joint projects that achieve water quality improvements. **Table 8.1** summarizes key project funding sources. These include local and regional ad valorem funds, county stormwater assessment fees, land acquisition funds, state agency funds, SJRWMD cost-share grants, National Oceanic and Atmospheric Administration (NOAA) grants, EPA grants, and others. Funding sources come with specific requirements and are often limited; therefore, it is important that information on new or unknown potential funding sources be accessible and shared.

BMAP implementation will rely on a mix of funding sources. At the same time, the voluntary efforts of individuals and groups will also play a role. The Orange Creek BWG recognizes that management actions are contingent on securing necessary funding, resources, and legislative authorizations, where required, and are subject to applicable regulations. However, signatories to this BMAP have committed to putting forward their best-faith efforts to implement the actions outlined in this plan, as shown through the commitment language at the end of this chapter.

Table 8.1. Key funding sources for Orange Creek BMAP projects

PROGRAM	SPONSOR	DESCRIPTION	FOR MORE INFORMATION	ORANGE CREEK BASIN PROJECT EXAMPLES
STATE FUNDING SOURCES				
Section 319	DEP	• Priority is given to projects or programs in impaired waters, TMDL waterbodies, SWIM watersheds, National Estuary Program waters, and watersheds with a comprehensive watershed plan, as defined by EPA. This BMAP contains the nine elements required by EPA to qualify as a comprehensive watershed plan (see Table 8.2). • A 40% nonfederal match is required. • Eligible projects include urban/agricultural BMPs, stormwater retrofits, public education, demonstration and evaluation of BMPs, ground water protection from nonpoint sources, public education programs, and other projects that help reduce nonpoint pollution. • Eligible entities include state and local governments, colleges and universities, nonprofit organizations, public utilities, and water management districts. • Project proposals are due each May. • Project partnerships are strongly encouraged.	http://www.floridadep.com/water/nonpoint/319h.htm	NW 14 th Avenue Stormwater Park Rosewood Creek Trash Trap Community-based Social Marketing Workshop (costs shared with local governments).
Surface Water Improvement and Management (SWIM)	SJRWMD	• The program focuses on designated SWIM waterbodies (including Newnans and Orange Lakes and Lochloosa Lake). • It supports a variety of water projects.	www.sjrwmd.com	The primary SWIM project is development of PLRGs for Newnans and Orange Lakes and Lochloosa Lake. PLRGs are science-based estimates of nutrient (N and/or P) external load reductions needed to restore the lakes to state water quality standards. PLRGs assist DEP in development of TMDLs.

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PROGRAM	SPONSOR	DESCRIPTION	FOR MORE INFORMATION	ORANGE CREEK BASIN PROJECT EXAMPLES
Community Budget Issue Request (Water Project Funding)	SJRWMD and DEP	- The Legislature provides funding through the state budgeting process for stormwater, wastewater, and lake/river restoration projects. - The program focuses on implementing SWIM or other water quality improvement plans. - A 50% local match is required (may include funds from a water management district). - Solicitations occur in December through January for the following fiscal year.	Geof Mansfield DEP Division of Water Resource Management (850) 245-8339 Geofrey.Mansfield@dep.state.fl.us	
TMDL Water Quality Restoration Grants Section	DEP	- The program focuses on reducing pollutants to impaired waters. - Projects will be selected based on reduction of pollutant loading, amount of anticipated load reduction, cost per pound, amount of matching funds, and presence of a dedicated funding source such as a stormwater utility. - Most projects will require storm event monitoring. \$17 million is available annually to address water quality impacts to nonagricultural nonpoint sources. In addition, DEP receives about \$8 million per year from Documentary Stamp Tax fees for TMDL water quality restoration grants, which can be used for urban nonpoint source research or stormwater retrofit projects. - A 50% local match is required. Land acquisition, design, and permitting costs are eligible as matching. - Because the grants must be used within 3 years, they primarily are targeted to projects that are ready for construction in the next 6 to 10 months. Land acquisition, design, and permitting should be complete or nearing completion. While DEP will not fund these preliminary project elements, funds spent on these elements may be counted as local matching funds. - Applications are continually accepted.	http://www.dep.state.fl.us/Water/watersheds/tmdl_grant.htm or Eric Livingston Bureau of Watershed Management (850) 245-8430 Eric.Livingston@dep.state.fl.us	
Clean Water State Revolving Fund (SRF)	DEP	- The program provides low-interest loans for point and nonpoint pollution control activities and facilities, including wastewater management, reclaimed waster, stormwater management, and agricultural BMPs. - Eligible projects include wastewater management facilities, reclaimed wastewater reuse facilities, stormwater management facilities, BMPs associated with agricultural stormwater, and estuary protection activities and facilities.	http://www.dep.state.fl.us/water/wff/cwsrf/index.htm or Bob Holmden State Revolving Loan Program Bureau of Water Facilities	

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PROGRAM	SPONSOR	DESCRIPTION	FOR MORE INFORMATION	ORANGE CREEK BASIN PROJECT EXAMPLES
		- Eligible parties include local governments (stormwater and wastewater projects) and nongovernmental parties (agricultural BMPs). - Loan requests are accepted throughout the year.	Funding (850) 245–8358 robert.holmden@dep.state.fl.us	
Cooperative Cost-sharing Program	SJRWMD	- The program focuses on stormwater management efforts that contribute to the achievement of PLRGs or TMDLs. - It supports local government stormwater projects. - Eligible parties include local governments, special districts, and other public entities. Private utilities and nonprofit organizations may receive funds when partnering with an eligible party. - Applications are accepted May through August.	http://sjr.state.fl.us/costshare/index.html or St. Johns River Water Management District 4049 Reid Street, P.O. Box 1429 Palatka, FL 32178-1429 (386) 329–4553 http://www.dep.state.fl.us/water	Hogtown Creek Fluvial Geomorphologic Assessment and Preliminary Restoration Plan.
Water Projects Grant Program (Section 403.885, F.S.)	DEP	- The program focuses on water quality improvement, stormwater management, wastewater management, water restoration, and other water quality projects as specifically appropriated by the Legislature. - Projects must protect public health or the environment and implement plans developed under the SWIM Act or other water restoration plans. - Eligible parties include local governments and special districts with legal responsibilities for water quality improvement, water management, stormwater management, wastewater management, lake and river restoration, and drinking water projects. - No local match is required. However, projects are rarely funded by the Legislature for their full cost. Therefore, local funds will almost certainly be needed to complete projects. Funding is secured through the state budget process. - Requests for funds are solicited from about mid-December to mid-January for the next fiscal year.		
Florida Forever Land Acquisition Program	DEP DACS FWC SJRWMD (and other water management)	- The Florida Legislature established the 10-year Florida Forever program in 1999. - Under this program, the state issued bonds for \$3 billion and annually distributes about \$300 million to various agencies—the DEP, DACS, FWC, and the state's five water management districts.	DEP Division of State Lands, Office of Environmental Services (850) 245–2784 http://www.dep.state.fl.us/lands/acquisition/FloridaForever/	Lochloosa Wildlife Conservation Area and Newnans Lake Conservation Area. (Acquired under Preservation 2000, the predecessor to

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PROGRAM	SPONSOR	DESCRIPTION	FOR MORE INFORMATION	ORANGE CREEK BASIN PROJECT EXAMPLES
	t districts)	- The funds are used for land acquisition, environmental restoration, and water resource development. - Applications for acquisitions can be submitted at any time. The evaluation and selection of Florida Forever Program acquisitions is a very competitive process.		Florida Forever. Preservation 2000 was replaced by the Florida Forever Program in 2000.)
State Transportation Trust Fund; Federal Highway Trust Fund	DOT	- DOT is a public works agency responsible for the development and maintenance of Florida's transportation system. - It operates primarily from federal and state dedicated sources of funding. The State Transportation Trust Fund and the Federal Highway Trust Fund receive revenue from specific tax sources earmarked solely for transportation purposes. - DOT, working with Metropolitan Planning Organizations, local governments, and input from the public and Legislature, develops and implements a State Transportation Five-Year Work Program. The program provides a list of transportation projects (by phase) that is scheduled for implementation during the ensuing five-year period. It includes all proposed project commitments classified by major program and appropriation category. Projects are scheduled in phases (i.e., planning, design and construction) because it usually takes several years to complete a project. - The program is updated annually.	Alan Obaigbena DOT (386) 961-7064 alan.obaigbena@dot.state.fl.us	DOT is partnering with the city of Gainesville and Alachua County to fund projects committed towards meeting the TMDL goals. The amount committed by DOT towards this goal is about \$4,029,942 in projects and program funding.
General Inspection Trust Fund	DACS	The program supports the implementation and verification of agricultural BMP implementation.	DACS Office of Agricultural Water Policy http://www.floridaagwaterpolicy.com/	Cow/calf, container nursery, and sod BMP implementation and effectiveness verification.
LOCAL FUNDING SOURCES				
Local government ad valorem taxes (general fund)	Alachua County, Marion County, and city of Gainesville	- Ad valorem taxes (i.e., property taxes) are the major source of revenues for state and municipal governments. These funds support programs, capital projects, and municipal services, and are used to implement the policies of the municipality's comprehensive plan. - The SJRWMD also funds projects through the collection of ad valorem taxes.		A wide variety of programs and projects is funded with ad valorem taxes, including Alachua County's water quality monitoring, the Hogtown Creek inlet protection project,

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PROGRAM	SPONSOR	DESCRIPTION	FOR MORE INFORMATION	ORANGE CREEK BASIN PROJECT EXAMPLES
				water quality protection, and public education and outreach efforts.
GCWP	Alachua County, city of Gainesville, and DOT	See Section 3.6 for a description of the GCWP.	Sally Adkins Gainesville Clean Water Partnership Coordinator (352) 334-5072 adkinss@ci.gainesville.fl.us http://www.gainesvillecreeks.org/sponsors.htm	Water quality protection public education and outreach; Springhill Pond, Tumblin Creek, and other vegetative enhancement projects; Water quality code implementation; and Various MS4 permit requirements.
Alachua County Forever	Alachua County	- Alachua County Forever is a land conservation program to acquire and protect environmentally significant lands. Though this program, Alachua County seeks to acquire, protect and manage environmentally significant lands, protect water resources, wildlife habitat, and natural areas suitable for resource-based recreation. - As of July 2007, the Alachua County Forever Program had protected 11,120 acres, with 110 additional acres under contract. Alachua County directly manages 5,290 of these acres. Purchases through this program total more than \$56 million, with \$20 million from the county and \$36 million from partners.	http://www.co.alachua.fl.us/government/depts/epd/land/	Longleaf Flatwoods Preserve; Freddy Wood Tract; and Sweetwater Preserve.
User Fees	GRU and customers	GRU is a multiservice utility owned by the city of Gainesville. It provides electric, natural gas, water, wastewater, and telecommunications services to approximately 89,000 retail and wholesale customers in Gainesville and surrounding unincorporated areas.	http://www.gru.com/	Main Street WRF upgrades; Inflow and infiltration prevention; Sliplining; and

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PROGRAM	SPONSOR	DESCRIPTION	FOR MORE INFORMATION	ORANGE CREEK BASIN PROJECT EXAMPLES
				Ongoing infrastructure maintenance and capital projects.
Gainesville Stormwater Management Utility (SMU)	Gainesville and owners of developed properties within the city	- The Gainesville SMU Program helps maintain city stormwater conveyance systems, implement water quality and flood protection improvement projects, and protect the health of local creeks, ponds, and wetlands. - It provides an organized utility program with a revenue source to address the increasing stormwater management system requirement. - The first stormwater fees were collected in the March 1989 GRU bill. - Rates are established by ordinance by the City Commission. All residential properties are charged a fixed monthly rate that varies by the type of unit (single-family attached, duplex, condominium, apartment, or mobile home). Nonresidential properties are assessed according to the amount of impervious area on the property.	http://cityofgainesville.org/pubworks/stormwater	Depot Ave. Stormwater Park; Hogtown Creek Sediment Project; SW 11th Ave. storm sewer upgrades; Hydrodynamic separators; and Various additional MS4 permit requirements.

Table 8.2. EPA's nine elements of a comprehensive watershed management plan

WATERSHED MANAGEMENT PLAN PER EPA GUIDANCE	ORANGE CREEK BMAP
a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan.	Chapter 4 (nutrients) Chapter 5 (coliform)
b. An estimate of the load reductions expected for the management measures described under Item (c) below.	Chapter 4
c. A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under item (b) above and an identification of the critical areas in which those measures will be needed to implement the plan.	Chapters 3, 4, and 5
d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied on to implement the plan.	Appendix E (detailed project tables)
e. An information/education component that will be used to enhance public understanding of the project and encourage early and continued public participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Chapter 7
f. A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Appendix E (detailed project tables)
g. A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Chapter 6
h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a nonpoint source TMDL has been established, whether the TMDL needs to be revised.	Chapter 6
i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under Item (h) above.	Chapter 6

8.2 Statements of Commitment

Subsection 403.067(7), F.S., lays out the mechanisms for BMAP implementation (see **Appendix B**). While the BMAP is linked by statute to permitting and other enforcement processes that target individual entities, successful implementation requires that local stakeholders willingly and consistently work together to achieve adopted TMDLs. This collaboration fosters the sharing of ideas, information, and resources. The members of the Orange Creek BWG have demonstrated their willingness to confer with and support each other in their efforts.

On a very practical level, BMAP implementation also depends on adequate resources and necessary authorizations. The management actions contained in the BMAP are either under way or are planned in good faith. Both current and future actions are contingent on necessary funding and approvals for their initiation and/or continuation.

BWG members have signed individual statements of commitment to implement and/or support the management actions outlined in the BMAP. **Table 8.3** lists those groups, organizations, local governments, and agencies that signed official statements of commitment to implement provisions of the Orange Creek BMAP. Copies of these statements can be found in **Appendix R**.

Table 8.3. Signatories

ENTITY	SIGNATORY	TITLE	DATE
CITY OF GAINESVILLE GAINESVILLE REGIONAL UTILITIES ALACHUA COUNTY ENVIRONMENTAL PROTECTION DEPARTMENT ALACHUA COUNTY PUBLIC WORKS ALACHUA COUNTY HEALTH DEPARTMENT MARION COUNTY FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION ▪ <i>NORTHEAST DISTRICT</i> ▪ <i>PAYNES PRAIRIE PRESERVE STATE PARK</i> ▪ <i>INVASIVE PLANT MGT.</i> FLORIDA DEPARTMENT OF TRANSPORTATION FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES ▪ <i>DIVISION OF FORESTRY</i> ▪ <i>OFFICE OF AGRICULTURAL WATER POLICY</i> ST. JOHNS RIVER WATER MANAGEMENT DISTRICT UNIVERSITY OF FLORIDA SIERRA CLUB WOMEN FOR WISE GROWTH SUSTAINABLE ALACHUA COUNTY FLORIDA FORESTRY ASSOCIATION			

REFERENCES

- Alachua County Library District. 2003. *Alachua Sink*. Alachua County Library District Heritage Collection.
- Alachua County Environmental Protection Department. June 2007. *Gainesville creeks—A status report on baseflow water quality, stormwater and ecosystem health for the Orange Creek Basin*. Prepared for the St. Johns River Water Management District. Gainesville, Florida.
- . February 2006. *Total iron data for Hatchet Creek*.
- APHA. 1998. *Standard methods for the examination of water and wastewater*. 17th Edition. Washington, D.C.: APHA, AWWA, and WEF.
- Bitton, G. June 2005. *Microbial indicators of fecal contamination: Application to microbial source tracking*. Report submitted to the Florida Stormwater Association. University of Florida Department of Environmental Engineering Sciences.
- Canfield, D. E. Jr. 1981. Chemical and trophic state characteristics of lakes in relation to regional geology. Final report submitted to Coop. Fish and Wildlife Research Unit, University of Florida.
- Canter, L.W., and R.C. Knox. 1985. *Septic tank system effects on groundwater quality*. Chelsea, Michigan: Lewis Publishers.
- CH2M Hill. August 17, 2006. *Main Street WRF – Options for achieving TMDL in Sweetwater Branch*. Prepared for Gainesville Regional Utilities.
- . 1985. *Tumblin Creek stormwater quality evaluation*. James E. Scholl, P.E., Gainesville, Florida.
- . October 1981. *A preliminary assessment of utilizing Paynes Prairie for biological advanced treatment and wetland discharge of secondary wastewater*. Prepared for Gainesville Regional Utilities.
- Clark, W.E., R.H. Musgrove, C.G. Menke, and J.W. Cagle, Jr. 1964. *Water resources of Alachua, Bradford, Clay, and Union Counties, Florida*. Florida Geological Survey. Report of Investigations No. 35. Tallahassee, Florida.
- Coffman, L. 2000. *Low-impact development design strategies: An integrated design approach*. EPA 841-B-00-003. Prince George's County, Maryland: Department of Environmental Resources, Programs and Planning Division.
- Cullimore, R.D. 1992. *Practical manual of groundwater microbiology*. Chelsea, Michigan: Lewis Publishers.
- Deevey, E. S. 1988. Estimation of downward leakage from Florida lakes. *Limnology and Oceanography*. 33:1308-1320.
- Di, J., C. Lippinsocct, J. Huynh, and M. Martinez. 2006. *Orange Creek Basin status and trends in water quality and phytoplankton through 2003*. Palatka, Florida: St. Johns River Water Management District.
- Dyer, Riddle, Mills and Precourt. 2003. *Assessment of pollution sources in the Newnans Lake watershed*.

- Fisher, R.F. 1981. Impact of intensive silviculture on soil and water quality in a coastal lowland. In: *Tropical agriculture hydrology* (New York: J. Wiley and Sons, pp. 299–309).
- Florida Department of Environmental Protection. 2006. *Verified List of Impaired Waters for the Group 1 Basins, March 2003*. Available: (http://www.dep.state.fl.us/water/tmdl/docs/2002Update/G1CompositeVerifiedList_2-7-05.xls).
- . May 15, 2002. *Florida Administrative Code, Rule 62-302. Surface water quality standards*. Tallahassee, Florida.
- . April 3, 2006. *Watershed Monitoring Program data—Groundwater data for the surficial aquifer, Alachua County, Florida*. Tallahassee, Florida: FDEP Watershed Monitoring Section.
- . October 2003. *Water quality assessment report: Ocklawaha*.
- Florida Forestry Association. 2000. *Report to the Suwannee River Water Management District: Total nitrogen fertilization in the Suwannee River Basin*. A report submitted by the Total Nitrogen Fertilization Task Force.
- Gao, X., D. Gilbert, and W. Magley. 2006. TMDL Report. *Nutrient TMDL for Alachua Sink, WBID 2720A*. Tallahassee, Florida: Florida Department of Environmental Protection, Division of Water Resource Management, Bureau of Watershed Management.
- Gijsselaers, D. 2006. Personal Communication on November 30, 2006. GIS analysis of the SJRWMD land use and land cover (2004) vector digital data.
- Gottgens, J.F. 1993. *Assessing the feasibility of restoring Newnans Lake: Phase A, Conceptual engineering report to the Florida Game and Fresh Water Fish Commission*. Gainesville, Florida: KBN Engineering & Applied Sciences, Inc.
- Gottgens, J.F. and T.L. Crisman. 1992. *Newnans Lake, Florida: Removal of particulate organic matter and nutrients using a short-term drawdown (Phase I)*. Special Publication SJ 92-SP23. Palatka, Florida: St. Johns River Water Management District.
- Gottgens, J.F. and C. L. Montague, 1987. *Orange, Lochloosa, and Newnans Lakes: a survey and preliminary interpretation of environmental research data*. Special Publication SJ 87-SP3. St. Johns River Water Management District, Palatka, Florida, .
- Gottgens, J. F. and C. L. Montague, 1988. *Comprehensive reconnaissance profile of the Paynes Prairie Basin, Florida*. Special Publication SJ 88-SP4. St. Johns River Water Management District, Palatka, Florida.
- Griffin, D.W. September 23, 2004. Personal Communication. Microbial source tracking.
- Griffin, D.W., E.K. Lipp, M.R. McLaughlin, and J.B. Rose. October 2001. Marine recreation and public health microbiology: Quest for the ideal indicator. *BioScience*. Vol. 51, No. 10, pp. 817–824.
- Harwood, V.J. 2003a. *Final report to the Alachua County Environmental Protection Department antibiotic resistance analysis and ribotyping used to determine the source of fecal coliforms in Tumblin Creek, Gainesville, Florida, October 5, 2003; revised May 14, 2003*. Tampa, Florida: University of South Florida.
- . 2003b. *Final report to the Alachua County Environmental Protection Department antibiotic resistance analysis and ribotyping used to determine the source of fecal coliforms in Sweetwater Branch, Gainesville, Florida, May 14, 2003*. Tampa, Florida: University of South Florida.

- . 2006. *Assumptions and limitations associated with MST methods*. Tampa, Florida: Department of Biology, University of South Florida.
- Hem, J.D. 1992. *Study and interpretation of the chemical characteristics of natural water*. U. S. Geological Survey Water Supply Paper 2254. Washington, D.C.
- Jensen, J.H. 1985. *The hydrology and karst features of the Paynes Prairie Basin, Alachua County, Florida*. Thesis. University of Florida, Gainesville.
- Hollander, M., and D. Wolfe. 1999 edition. *Nonparametric statistical methods*. Wiley-Interscience Publishers.
- Jones Edmunds & Associates, Inc. December 2003. *Sweetwater Branch Watershed Management Plan*. Draft Report. Prepared for the City of Gainesville Public Works Department.
- . 2006 (draft). *Tumblin Creek Watershed Management Plan*. Gainesville, Florida.
- Lasalde, C, R. Rodriguez, and G.A. Tjoranzos. August 2005. Statistical analyses: Possible reasons for unreliability of source tracking efforts. *American Society for Microbiology. Applied and Environmental Microbiology*. Vol. 71. No.8. pp. 4690–4695.
- Lasi, M. A.. 1999. *An external nutrient budget for Orange Lake effect of sinkhole seepage on in-lake nitrogen and phosphorus stores*. St. Johns River Water Management District, Palatka, Florida.
- Langeland, K. A. 1982. *Relationships among hydrosol, water chemistry, transparency, chlorophyll a, and submersed macrophyte biomass*. Thesis. University of Florida.
- Lassiter, A., A. Schwartz, and W. Magley. September 16, 2003. *Total Maximum Daily Load for iron for Hatchet Creek, Alachua County, Florida, WBID 2688*. Tallahassee, Florida: Watershed Assessment Section, Florida Department of Environmental Protection.
- Lasi, M., and J. Shuman. 1996. *Orange Creek Basin surface water management plan*. Palatka, Florida: St. Johns River Water Management District.
- Lewis, A.L., and L.M. Stark. 1993. *Florida OSTDS research project*. State of Florida Department of Health, Tallahassee, Florida.
- Lippincott, C. June 2006. *Paynes Prairie Reservation of Water Rule: History and summary*. St. Johns River Water Management District.
- Long et al. 2004. *Austin Cary Memorial Forest resource management plan*. School of Forest Resource Conservation, Institute of Food and Agricultural Sciences, University of Florida.
- Lowrance, R., R. Todd, J. Fail, O. Hendrickson, R. Leonard, and L. Asmussen. 1984. Riparian forests as nutrient filters in agriculture watersheds. *BioScience*, Vol.34, No. 6: 374–377.
- Nagid, E.J., D.E. Canfield, and M.V. Hoyer. 2001. Wind-induced increases in trophic state characteristic of a large (27 km²), shallow (1.5 m mean depth) Florida lake. *Hydrobiologia* 455: 97-110.
- Nordlie, F. G. 1976. Plankton communities of three central Florida lakes. *Hydrobiologia*. 48 (1): 65-78.
- Oppen, S.C. 1982. *The hydrogeology of Lake Wauberg and vicinity Alachua County, Florida*. M.S. thesis. University of Florida, Gainesville, Florida.
- Phelps, G. G. 1987. *Effects of surface runoff and treated wastewater recharge on quality of water in the Floridan aquifer system, Gainesville Area, Alachua County, Florida*. Water Resources Investigations Report: 87-4099. U. S. Geological Survey, Tallahassee, Florida

- Pirkle, E.C. 1956. Notes on physiographic features of Alachua County, Florida. *Quart. J. Fla. Acad. Sci.* 19:168–182.
- Reikerk, H. 1983. Multi-resource effects of harvest, site preparation, and planting in pine flatwoods. *Southern Journal of Applied Forestry*, Vol.7, No. 1, pp. 6–13.
- Ritter, M.N. 1991. *The hydrology and origin of Alachua Sink, Alachua County, Florida*. Thesis. University of Florida, Gainesville.
- Robison, C.P., G.B. Hall, C. Ware, and R.B. Hupalo. 1997. *Water management alternatives: Effects on lake levels and wetlands in the Orange Creek Basin*. Special Publication SJ97-SP8. Prepared for the St. Johns River Water Management District.
- Rosenau, J., G. L. Faulkner, C. W. Hendry Jr., and R. W. Hull. 1977. *Springs of Florida*. Florida Geological Survey Bulletin No. 31. Prepared by the U.S. Geological Survey in cooperation with the Bureau of Geology, Division of Resource Management, and Bureau of Water Resources Management, Florida Department of Environmental Regulation.
- Scott, T.M. 1988. *The lithostratigraphy of the Hawthorn Group (Miocene) of Florida*. Florida Geological Survey. Bulletin No. 59. Tallahassee, Florida.
- Scott, T.M., J.B. Rose, T.M. Jenkins, S.R. Farrah, and J. Lukasik. December 2002. Microbial source tracking: Current methodology and future directions. *Applied and Environmental Microbiology*. Vol. 68. No. 12. pp. 5796–5803.
- Solo-Gabriele, H.M., M.A. Wolfert, T.R. Desmarais, and C.J. Palmer. Sources of *Escherichia coli* in a coastal subtropical environment. *American Society for Microbiology. Applied and Environmental Microbiology*, Vol. 66, No. 1, pp. 230–237.
- St. Johns River Water Management District. 2005. *District water management plan*. Available: http://www.sjrwmd.com/dwmp/pdfs/DWMP_2005_final.pdf.
- . 2006a. *Surface water monitoring data for Alachua County, Florida*.
- . 2006b. *Paynes Prairie reservation of water rule—History and summary*.
- . 2006c. *Orange Creek Basin status and trends in water quality and phytoplankton*.
- Somarelli, J.A., Makarewicz, J.C., R. Sia, and R. Simon. 2007. Wildlife identified as major source of *Escherichia coli* in agriculturally dominated watersheds by BOX A1R-derived genetic fingerprints. *Journal of Environmental Management*. [Volume 82, Issue 1](#), pp. 60–65.
- Thomas, B.P., E. Cummins, and W.H. Wittstruck. 1985. *Soil survey of Alachua County Florida*. U.S. Department of Agriculture, Soil Conservation Service.
- U.S. Environmental Protection Agency. 2000. *Low impact development (LID) literature review and fact sheets*. Available: <http://www.epa.gov/owow/nps/lid/lidlit.html>.
- . 2002. *Onsite wastewater treatment systems manual*. EPA/625/R-00/008.
- Vowell, J.L. 2001. Using stream bioassessment to monitor best management practice effectiveness. *Forest Ecology and Management* 143: 237–244.
- Vowell, J.L., and R. Frydenborg. 2004. A biological assessment of best management practice effectiveness during intensive silviculture and forest chemical application. *Water, Air and Soil Pollution: Focus* 4: 297–307.
- Water and Air Research, Inc. April 2004. *Stream biorecognition results, Alachua County, Florida 2000–2003*. Gainesville, Florida.

- Water Environment Research Foundation. 2003. *Effective practices for sanitary sewer and collection system operations and maintenance*. Stock No. 01CTS20T. 635 Slaters Lane, Suite 300, Alexandria, VA 22314-1177.
- Wetland Solutions, Inc.. January 9, 2006. *Tumblin Creek watershed management plan—Evaluation of wetland stormwater treatment alternatives*. Draft report prepared for Jones Edmunds & Associates, Inc.
- . 2006a. *Feasibility analysis of Sweetwater Branch Sheetflow Restoration Project at Paynes Prairie Preserve State Park, Alachua County, Florida*. Report prepared for the city of Gainesville and Florida Department of Environmental Protection. June 2006.
- . 2006b. *Effect of Main Street Water Reclamation Facility pretreatment alternatives on sizing of Sweetwater Branch off-line wetland*. Report prepared for Gainesville Regional Utilities. December 2006.
- White, W.B. 1970. *The geomorphology of the Florida peninsula*. Florida Geologic Survey Bulletin No. 41. Tallahassee, Florida.
- Wright, D.L., B. Tillman, E. Jowers, J. Marois, J. A. Ferrell, T. Katsvairo, and E. B. Whitty. February 2000, revised September 2006. *Management and cultural practices for peanuts*. SS-AGR-74. Gainesville, Florida: Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Available: <http://edis.ifas.ufl.edu/AA258>.