SOUTHWEST DISTRICT • SPRINGS COAST BASIN

FINAL TMDL Report

Nutrient TMDLs for Weeki Wachee Spring and Weeki Wachee River (WBIDs 1382B and 1382F)

James Dodson and Kristina Bridger
Ground Water Management Section
Division of Environmental Assessment and Restoration
Florida Department of Environmental Protection

June 2014

2600 Blair Stone Road
Mail Station 3575
Tallahassee, FL 32399-2400

Acknowledgments

This analysis could not have been accomplished without significant contributions from Kirstin Eller, Edgar Wade, and Paul Lee in the Florida Department of Environmental Protection's Water Quality Evaluation and Total Maximum Daily Loads Program, Ground Water Management Section. The authors also appreciate the assistance provided by the Southwest Florida Water Management District in obtaining information on historical studies and in their review of this report.

Map production was provided by Ron Hughes in the Department's Office of Watershed Services.

Editorial assistance was provided by Linda Lord in the Department's Watershed Planning and Coordination Section.

For additional information on the watershed management approach and impaired waters in the Springs Coast Basin, contact:

Terry Hansen
Florida Department of Environmental Protection
Watershed Restoration Program
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
terry.hansen@dep.state.fl.us
Phone: (850) 245–8561
Fax: (850) 245–8434

Access to all data used in the development of this report can be obtained by contacting:

Richard Hicks, P.G.
Florida Department of Environmental Protection
Water Quality Evaluation and TMDL Program
Ground Water Management Section
2600 Blair Stone Road, Mail Station 3575
Tallahassee, FL 32399-2400
richard.w.hicks@dep.state.fl.us
Phone: (850) 245–8229
Fax: (850) 245–8236

Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

Identification of Impaired Surface Waters Rule

Florida STORET Program

2014 Integrated Report

Criteria for Surface Water Quality Classifications

Florida Springs

U.S. Environmental Protection Agency, National STORET Program

Region 4: TMDLs in Florida

National STORET Program

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads for nitrate nitrogen (NO_3N), which was determined to contribute to the ecological imbalance at Weeki Wachee Spring and the freshwater segment of its receiving water, the Weeki Wachee River. These waterbodies are located in the Middle Coastal Planning Unit of the Springs Coast Basin. Weeki Wachee Spring and River were verified by the Florida Department of Environmental Protection as impaired by nutrients, which contribute to the excessive growth of algae. They were included on the Verified List of impaired waters for the Spring Coast Basin adopted by Secretarial Order in May 2009. The TMDLs establish the allowable level of nutrient loadings to Weeki Wachee Spring and River that would restore these waterbodies so that they meet the applicable water quality criterion for nutrients. This report will be used as the basis for discussions during the development of the Basin Management Action Plan.

1.2 Identification of Waterbodies

Weeki Wachee Spring is located in western Hernando County, approximately 500 feet southwest of the U.S. Highway 19 and State Highway 50 intersection (**Figure 1.1**), inside Weeki Wachee Springs State Park. Weeki Wachee Spring is the headwaters of the Weeki Wachee River, which flows westward seven miles to the Gulf of Mexico. Weeki Wachee Spring and the Weeki Wachee River support a complex freshwater aquatic ecosystem and together are an important cultural and economic resource for the state. **Figure 1.2** shows an aerial photograph of this system.

For assessment purposes, the Department has divided the waters of the state into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Weeki Wachee Spring is WBID 1382B, and the freshwater portion of the Weeki Wachee River is WBID 1382F. The freshwater portion of the Weeki Wachee River immediately adjoins the tidal/estuary portion of the river. **Figure 1.3** contains a map of the two impaired WBIDs. The nutrient enrichment of springs within the estuarine segment of the Weeki Wachee River will be addressed in a future TMDL.

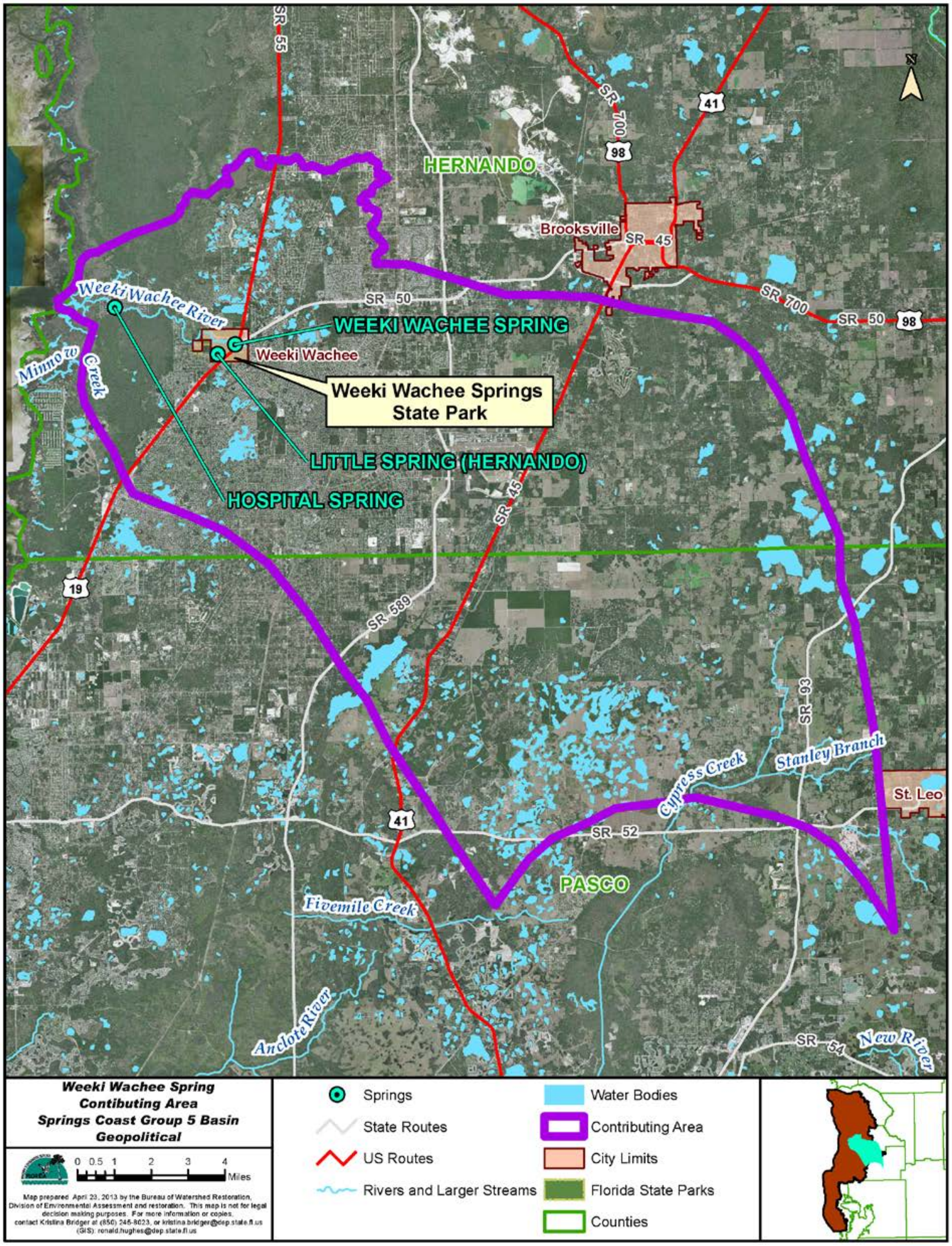

Figure 1.1. Major Geopolitical and Hydrologic Features in the Estimated Contributing Area of the Two Impaired WBIDs in Hernando and Pasco Counties

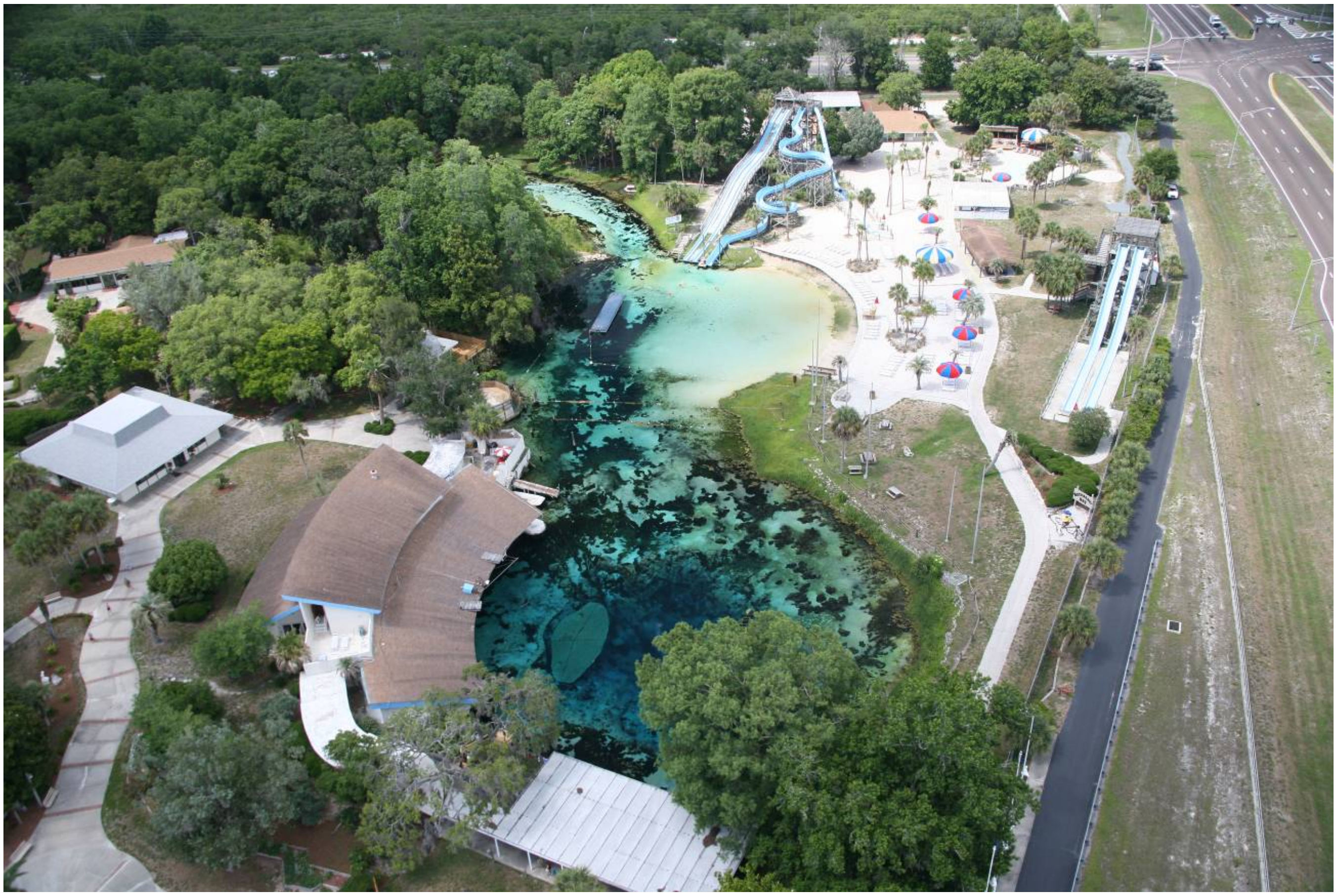

Figure 1.2. Aerial Photograph of Weeki Wachee Spring and the Headwaters of the Weeki Wachee River (Department photo)

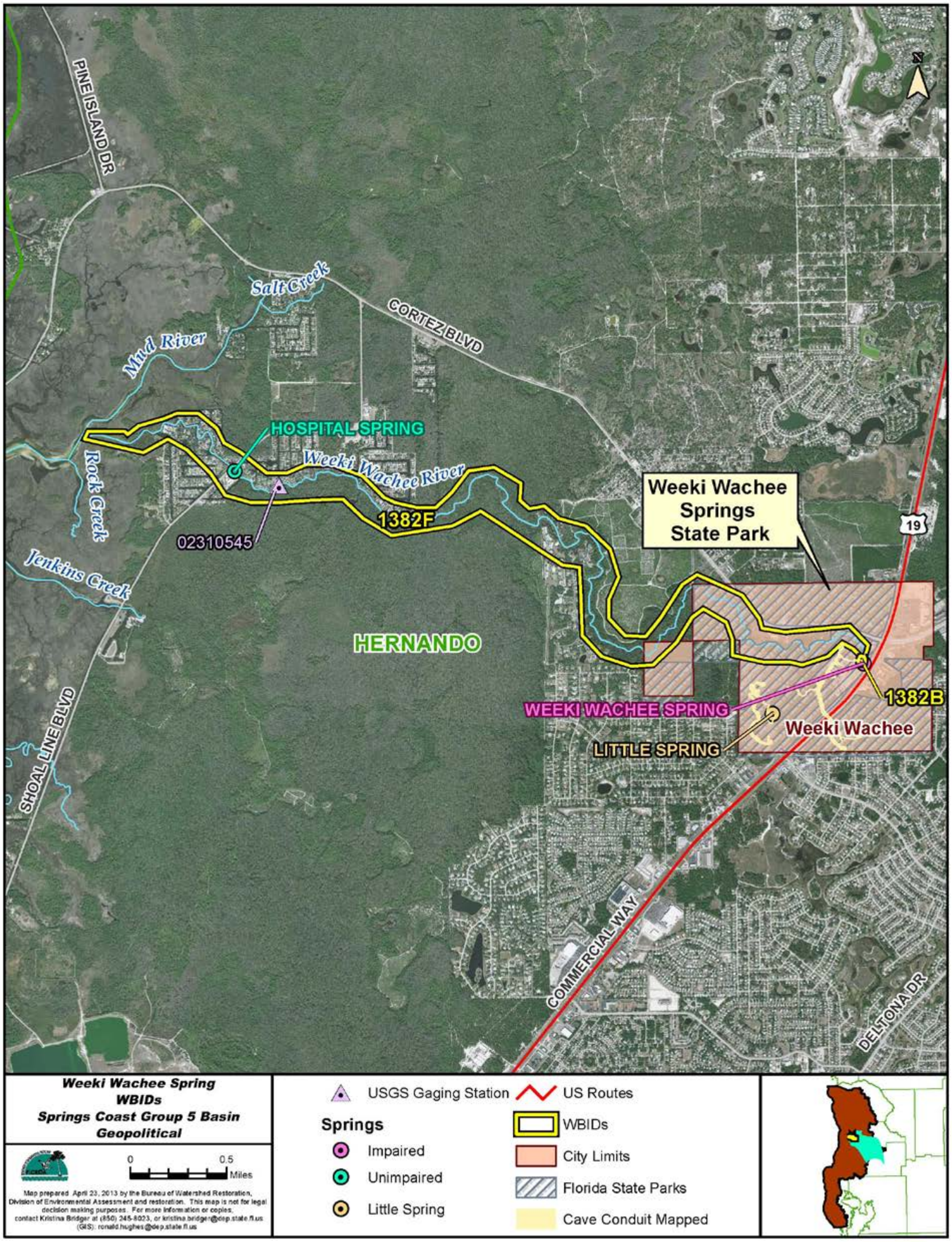

Figure 1.3. Named Springs and Impaired WBIDs in the Weeki Wachee Spring Area (Cave Conduit image courtesy of Karst Underwater Research)

The Weeki Wachee Spring Group is composed of a single, large main spring and numerous smaller springs spread over an area of nearly 5 square miles. Weeki Wachee Spring is the primary source of the Weeki Wachee River and the largest spring (by discharge) in the group. The spring pool is 165 feet by 210 feet and 45 feet deep over the vent (Scott *et al.* 2004). Weeki Wachee Spring is consistently a first-magnitude spring with discharge greater than 100 cubic feet per second (cfs).

Another much smaller, intermittent spring named Little Spring (also known as Twin Dees) is located half a mile southwest of Weeki Wachee Spring. The Weeki Wachee River WBID also includes one other named spring, Hospital Spring, also known locally as Hospital Hole. The other named springs in the system, Mud Spring and Salt Spring, are much farther downstream and very close to the river mouth at the Gulf of Mexico. These two springs, which discharge to the Mud River, are saltwater influenced and do not affect the impaired waterbody segments.

In physiographic terms, Weeki Wachee Spring and its associated receiving waters are located in a karst plain region, where the landforms and surface water features depend on the underlying geology. In general, the topographic features and internal drainage in karst regions are caused by the underground dissolution, erosion, and subsidence of near-surface carbonate rocks. Within the rock, slightly acidic rainwater causes the limestone to dissolve, and further dissolution along zones of fractured rock and bedding planes causes the development of caves and interconnected openings known as conduits. **Figure 1.3** shows the conduits in the Weeki Wachee Spring area that have been mapped by Karst Underwater Research. Ground water migrates within these zones, and springs occur where hydraulic head differences in the aquifer coincide with openings in the earth.

The entire area that contributes water to a spring via ground water and surface water inflows is known as a springshed. Springsheds are bounded by ground water divides rather than topographic divides because the principal drainage is by way of ground water flow in the Upper Floridan Aquifer (UFA) (Knochenmus and Yobbi 2001). The Southwest Florida Water Management District (SWFWMD) created a generalized springshed boundary for Weeki Wachee Spring based on an analysis of ground water elevation maps, called potentiometric surface maps (Jones 1997). Delineation based on potentiometric surface maps provides a good general description of springshed boundaries but is limited by the date and resolution of the potentiometric surface map, the climatic conditions that existed when the map was created, and the assumption of uniform drainage over the mapped area.

The Weeki Wachee River is within the 24.5-square-mile Tooke Lake watershed (Carr *et al.* 2013). In evaluating the potential sources of nutrients impacting Weeki Wachee Spring and River, the Department considered the springshed as well as the surface watershed of the impaired receiving waters. The estimated combined contributing area of water to Weeki Wachee Spring and River includes the springshed of Weeki Wachee Spring and the surface water watershed of the Weeki Wachee River. Together this combined contributing area encompasses an area of 254 square miles. **Figure 1.1** shows the estimated contributing area and its major geopolitical and hydrologic features. This area includes 149 square miles in Hernando County and 105 square miles in Pasco County.

The geology of the Springs Coast Basin includes thick sequences of limestone exposed at or very near to (10 to 20 feet) the land surface in the eastern and western portions of the basin. Where the limestone is near the land surface, the thin veneer of sediment covering the limestone consists of unconsolidated deposits of primarily quartz sand. The limestone units include the Suwannee Limestone of Oligocene age and the Ocala Limestone of Eocene age. Underlying these exposed limestone units is the Avon Park Formation of Eocene age. The Avon Park Formation is the deepest formation containing potable water (based on total dissolved solids, which represent salinity). The Suwannee and Ocala Limestones and the Avon Park Formation comprise the UFA system in the basin, and the UFA is the source of water that discharges from springs (Jones *et al.* 1997).

In the Brooksville Ridge area (which includes the eastern part of the Weeki Wachee Spring contributing area), undifferentiated quartz sand and sediments of the Hawthorn Group overlie the UFA. The Hawthorn Group sediments were deposited in a variety of environments and consist of sand, silty sand, and waxy green clay. Phosphorite pebbles and fossil oyster bars are common. West of the Brooksville Ridge, the Hawthorn Group sediments are essentially absent, and limestone is near the surface and covered only by sand. These conditions are prevalent in the Coastal Lowlands, which include Weeki Wachee Spring and the Weeki Wachee River (Jones *et al.* 1997).

Karst processes play a dominant role in the rates and directions of ground water movement through the UFA in the basin. In karst areas, the dissolution of limestone creates and enlarges cavities along fractures in the limestone that eventually collapse and form sinkholes. Sinkholes capture surface water drainage and funnel it underground, promoting further dissolution of the limestone. This leads to the progressive integration of voids beneath the surface and allows larger and larger amounts of water to be funneled into the underground drainage system. Dissolution is most active at the water table or in the zone of water table fluctuation, where carbonic acid contained in atmospheric precipitation and generated by reaction with carbon dioxide in the soil reacts with limestone and dolostone. Over geologic time the elevation of the water table has shifted in response to changes in sea level, and many vertical and lateral paths have developed in the underlying carbonate strata in the basin. Many of these paths or conduits lie below the present water table and greatly facilitate ground water flow.

In evaluating the potential sources of nutrients impacting the springs and their impaired receiving waters, the Department considered the Weeki Wachee springshed as well as the surface watershed of the Weeki Wachee River. With the exception of surface water drainage near the river corridor, most of the drainage in this area is internal, either directly into closed depressions or by seepage through overlying sediments into the unconfined limestone of the UFA.

Figure 1.4 shows the vulnerability of the Floridan aquifer in the area contributing to Weeki Wachee Spring. This map is based on the Florida Aquifer Vulnerability Assessment (FAVA) model that was developed using conditions such as soil characteristics, depth to ground water, recharge rate, and the prevalence of sinkhole features (Arthur *et al*. 2007). The map shows that most of the area around Weeki Wachee Spring is more vulnerable to ground water contamination compared with other regions of the state.

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

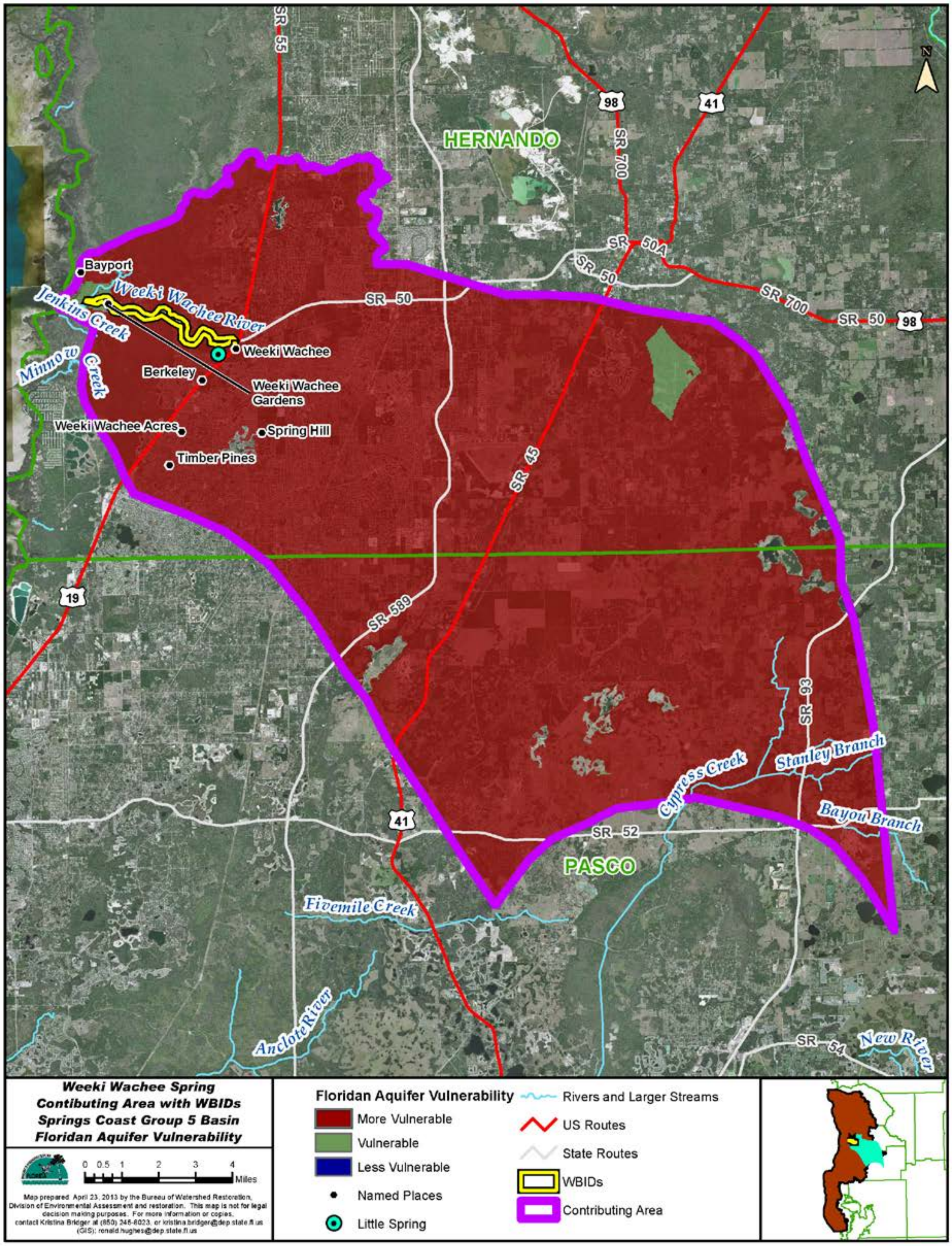

Figure 1.4. FAVA Map in the Contributing Area for Weeki Wachee Spring and Weeki Wachee River (Arthur 2007)

The adoption of nutrient TMDLs for Weeki Wachee Spring and River will be followed by the development and implementation of a BMAP to reduce the levels of nutrients that contribute to the ecological imbalance in Weeki Wachee Spring and River. The restoration of these waterbodies will depend heavily on the active participation of stakeholders in the contributing area, including Hernando County, Pasco County, other local governments, landowners, businesses, and private citizens. The SWFWMD, the Florida Department of Transportation (FDOT), and the Florida Department of Agriculture and Consumer Services (FDACS) will also play important roles in the implementation of restoration activities.

Weeki Wachee Spring and River are located in southwestern Hernando County, but their estimated contributing area includes part of northern Pasco County as well. The area includes the large unincorporated communities of Spring Hill, Shady Hills, and North Weeki Wachee, and the town of Weeki Wachee Springs, as well as smaller communities, and extends as far as Brooksville to the northeast and San Antonio to the southeast.

The Weeki Wachee Springs park opened as an underwater tourist attraction in 1947. In 2001, the SWFWMD negotiated a three-party agreement with the city of St. Petersburg, and its lessee, Weeki Wachee Spring, LLC, to purchase the 442 acres surrounding the spring. With the concurrence of the SWFWMD, on January 24, 2008, Weeki Wachee Springs, LLC, and the Department entered into an Asset Purchase Agreement to bring the Weeki Wachee Springs attraction under management as a unit of Florida's state park system. On November 1, 2008, the Department and the SWFWMD signed a 50-year lease giving the Department authority to manage the Weeki Wachee Springs attraction and additional SWFWMD land surrounding the attraction.

The Department began managing the property in 2008 to preserve the unique and historic roadside attraction that has existed since the early days of Florida's tourism industry. Weeki Wachee Springs and a small segment of the Weeki Wachee River are within Weeki Wachee Springs State Park. Downstream portions of the river corridor are within or on the boundary of the Chassahowitzka Wildlife Management Area and the Weeki Wachee Preserve.

Weeki Wachee Spring and River are economically valuable to the state and local communities. In 2012, 209,000 people visited Weeki Wachee Springs State Park. The park employs approximately 80 people who are either state employees or private concessionaires (Brewer 2013a).

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1. Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 22 waterbodies in the Springs Coast Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The IWR was modified in 2006 and 2007.

2.2. Information on Verified Impairment

Rule 62-303, F.A.C., includes a methodology for listing nutrient-impaired surface waters based on documentation that supports the determination of a waterbody's imbalance in flora or fauna attributable to nutrients. In 2009, the Department used available water quality data from the SWFWMD, the Department's Springs Initiative, and other sources to document elevated nitrate concentrations and the excessive growth of algae in Weeki Wachee Spring and the upper segments of the Weeki Wachee River. Water quality data collected by the SWFWMD and the Department comprised the bulk of the nitrate data used in the evaluation. Biological assessment documents prepared by researchers (Stevenson *et al.* 2004; Stevenson *et al.* 2007) also provided evidence of algal smothering.

These spring-related waters were listed as impaired by nutrients because of their consistently elevated concentrations of nitrate (above 0.6 milligrams per liter [mg/L]) and the corresponding evidence of imbalance in flora and fauna caused by algal smothering. This information, documented by Hicks *et al.* (2009), supplemented the determination of impairment for the 2009 Verified List of impaired waters. **Table 2.1** lists the waterbodies in the Springs Coast Basin on the Cycle 2 Verified List that are addressed in this report.

Table 2.1. Verified Impaired Spring-Related Segments in the Weeki Wachee Spring Basin

WBID	Waterbody Segment	Parameters Assessed Using the IWR	Priority for TMDL Development	Projected Year of TMDL Development
1382B	Weeki Wachee Spring	Nutrients (Algal Mats)	Medium	2013
1382F	Weeki Wachee River	Nutrients (Algal Mats)	Medium	2013

2.3 Nutrients

Nutrient overenrichment contributes to the impairment of many surface waters, including springs. The two major nutrient parameters monitored are nitrogen (N) and phosphorus (P). These are essential nutrients to plant life, including algae. For aquatic vegetation and algae to grow, both nutrients have to be present. In fact, one can be present in excess, but if the other is absent, the overgrowth of vegetation or algae is unlikely to occur. Historically, many spring systems have had sufficient naturally occurring phosphorus to trigger an imbalance, but it did not occur because there was very little nitrogen in the water.

Nitrogen is found in several forms and is ubiquitous in the environment. Nitrate (NO_3) is the form of nitrogen that occurs in the highest concentrations in ground water and springs. Nitrite-nitrogen (NO_2), an intermediate form of nitrogen, is almost entirely converted to nitrate in the nitrogen cycle. While nitrate and nitrite are frequently analyzed and reported together as one concentration (nitrate + nitrite-nitrogen), the nitrite contribution is always insignificant.

Historically, nitrogen was only a minor constituent of spring water, and typical nitrate concentrations in Florida were less than 0.2 mg/L until the early 1970s. Since then, elevated concentrations of nitrate have been found in many springs. With sufficient phosphorus in the water column, seemingly low nitrogen concentrations can actually cause a significant shift in the balance of spring ecological communities, leading to the degradation of biological systems due to the overgrowth of algae and sometimes aquatic plants (Harrington *et al.* 2010).

2.3.1 Nitrate

In this report nitrate is NO_3 as nitrogen (NO_3N) and, unless otherwise stated, the sum of NO_3 and NO_2 is used to represent NO_3 due to minimal contributions of NO_2. **Chapter 5** discusses the NO_3 nutrient impairment and the setting of the target concentration for NO_3.

The UFA's vulnerability to contamination can be observed in the nitrate concentrations at the springs and wells in the contributing area (Jones *et al.* 1997), where concentrations increased as land use transitioned from natural land to urban development. Anthropogenic sources of nitrate in the contributing area include atmospheric deposition, fertilizers, and human and animal wastes.

The NO_3 concentration measured at Weeki Wachee Spring has increased from 0.07 mg/L in 1974 to approximately 0.90 mg/L in 2013.

2.3.2 Phosphorus

Phosphorus is naturally abundant in the geologic material in much of Florida and is often present in significant concentrations in both surface water and ground water. The most common form of phosphorus in geologic material is orthophosphate. Total phosphorus (TP) includes both orthophosphate and organic forms of phosphorus. Neither orthophosphate nor TP has shown an increasing temporal trend in Weeki Wachee Spring or River, and concentrations remain close to those levels found in the early 1970s. These levels most likely represent natural background conditions due to phosphate in the geologic material. Therefore, phosphorus was not considered a target nutrient for the TMDL. In general, only the inorganic form of phosphorus, orthophosphate, is found in ground water in Florida.

2.4 Ecological Issues Related to Nutrients

2.4.1 Algal Mats

Evidence of an increasing trend in algal coverage, especially *Lyngbya spp.*, and algal smothering has been documented in both Weeki Wachee Spring and River.

The earliest documentation of observed algal mats was recorded in the 1991 SWFWMD document, *Resource Evaluation of the Weekiwachee Riverine System Proposed Water Management Land Acquisition.* The report stated, "*On the river bottom Lyngbya forms mats which eventually rise to the surface hindering boat passage and presenting an unsightly appearance because of its resseblance (sic) to floating sewage.*" In later studies, indicators of eutrophic conditions related to elevated nitrate in the water column were noted. A survey of 29 first- and second-magnitude springs in 2006 noted that, of all surveyed springs, Weeki Wachee Spring had the thickest *Lyngbya wollei* mats (Stevenson *et al.* 2007). Until 2008, a dense growth of *L. wollei* smothered the spring bottom, preventing the growth and establishment of aquatic plants. In 2008, the SWFWMD initiated an effort to remove the algae and sediments and replanted native vegetation in the main spring vent area (Department 2011a); it continues to combat the reinfestation of *Lyngbya* in this area.

The response of algae to nutrient enrichment in Weeki Wachee Spring and River is not unique to this system. It is similar to the conditions documented in the nutrient TMDLs for the Suwannee and Santa Fe Rivers (Hallas and Magley 2008), Wekiva River and Rock Springs Run (Gao 2007), Wakulla River (Gilbert 2012), Silver Springs and River (Holland and Hicks 2012), and Rainbow Springs and River (Holland and Hicks 2013). Unfortunately the overgrowth of algae in response to nutrient enrichment has also been documented in many other spring systems. Frazer *et al.* (2006) documented these conditions in Weeki Wachee as well as two other spring-run river systems in the Springs Coast region: Homosassa and Chassahowitzka (for which TMDLs are also being developed).

Photographic evidence of increased algal coverage in Weeki Wachee Spring and River also documents the shift from healthy stands of native vegetation during the early days of the Weeki Wachee Springs attraction to smothered benthic conditions that became prevalent in more recent years. Early underwater still photographs documented healthy populations of submersed aquatic vegetation (SAV) and crystalline water clarity with little to no algal smothering. Recent photographs, taken within the past five years, contrast with historical photographs and document the change that has occurred to the aquatic community in Weeki Wachee Spring and River (**Figures 2.1** through **2.5**). **Figure 2.6** shows the conditions in 2009.

2.4.2 Other Ecological Issues

Nearly all of the natural land cover around the Weeki Wachee head spring and upper river has been extensively altered. The spring pool and adjacent areas underwent significant development with the construction of the historic tourist attraction, which includes buildings and sea walls adjacent to the waterbody and a large asphalt-paved parking area. In addition, the head spring is approximately 500 feet from the U.S. Highway 19 corridor, which includes a multilane divided highway and commercial development along the highway frontage.

Figure 2.1. Archives Underwater Photo of Weeki Wachee Spring Shows Native Vegetation (Florida Archives photo)

Figure 2.2. Archives Underwater Photo of Weeki Wachee Spring Shows Native Vegetation and Water Clarity (Florida Archives photo)

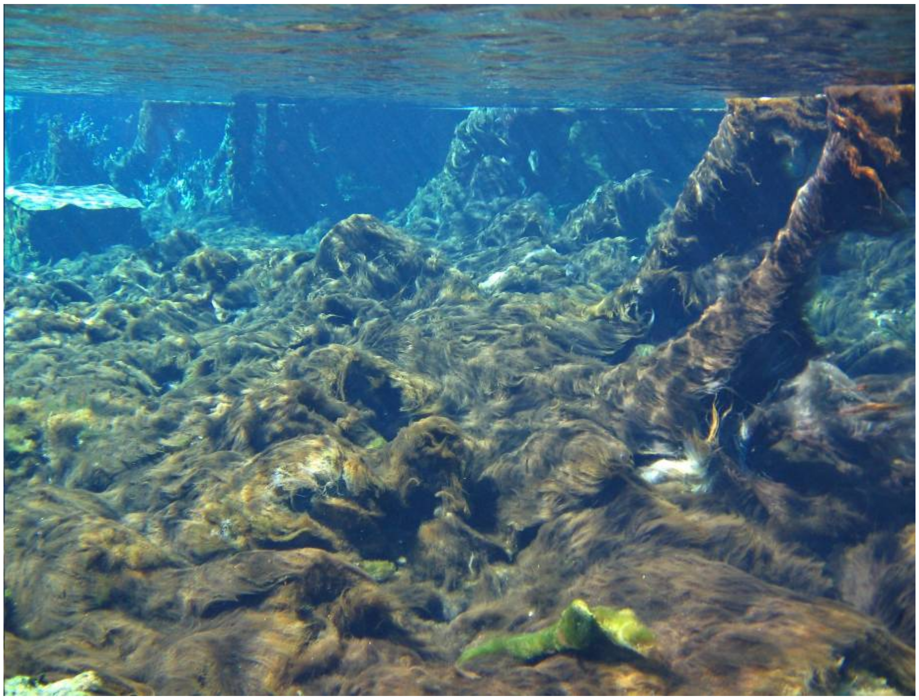

Figure 2.3. Algae on Tape Grass and Dead Logs in Weeki Wachee Spring, WBID 1382B, in 2006 (Department photo)

Figure 2.4. Algal Smothering at Weeki Wachee Spring, WBID 1382B, in 2009 (photo by Gary Maddox, Department)

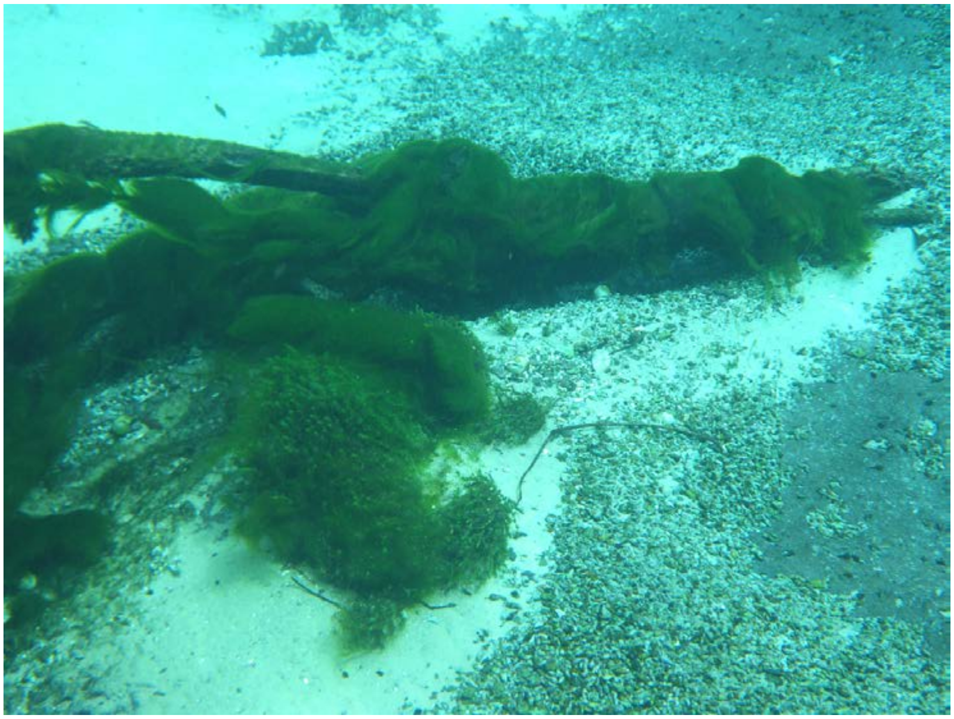

Figure 2.5. Algal Growth on Fallen Logs, Weeki Wachee Spring, WBID 1382B, in 2009 (photo by Gary Maddox, Department)

Figure 2.6. Algae Coating Macrophytes, Weeki Wachee River, WBID 1382F, in 2009 (photo by Gary Maddox, Department)

The bank of the upper river below the head spring also includes a water park, Buccaneer Bay, which has a large sandy beach and bathing area for park visitors. Some of these activities have resulted in sediment erosion and deposition in the spring basin and upper river. Accumulated sediments and algal growth in the spring pool were removed by a SWFWMD dredging project in 2009.

Frazer *et al.* (2006) found that SAV coverage had significantly decreased in the Weeki Wachee River between 1998–2000 and 2003–05. He noted a 75% reduction in SAV coverage in the river between these two sampling intervals.

In a 2008–09 study of the ecological conditions of 12 Florida springs, Wetland Solutions, Inc. (WSI) (2010) found some changes at Weeki Wachee Spring, including flow reductions and nitrate increases. This study also found that Weeki Wachee Spring had a 45% increase in gross primary productivity compared with measurements taken in 1955. WSI stated that the time of year could explain some of the difference between the two studies and that another possible cause was an increase in nitrate nitrogen concentrations (WSI 2010).

Limestone outcroppings are exposed throughout the river. The higher flow velocities in the narrow segments of the river and the resultant scouring of the bottom account for a loss of SAV (Heyl 2008). Eroded sediment can also cause the smothering of vegetation and a loss of SAV.

2.5 Monitoring Sites and Sampling

Historical water quality data for Weeki Wachee Spring are limited, but they do provide a glimpse of current versus "background" water quality. Water quality data have been collected from various locations around the springs and in the river since 1961, and the EPA Storage and Retrieval (STORET) and U.S. Geological Survey (USGS) National Water Information System (NWIS) databases contain many of these data. **Figure 2.7** shows the locations of the current and past routine water quality sampling stations and biological stations that are represented by data collected by or provided to the Department. The water quality data used in this TMDL evaluation include nitrate data collected from January 2004 through December 2012, and most were obtained from SWFWMD studies and routine monitoring.

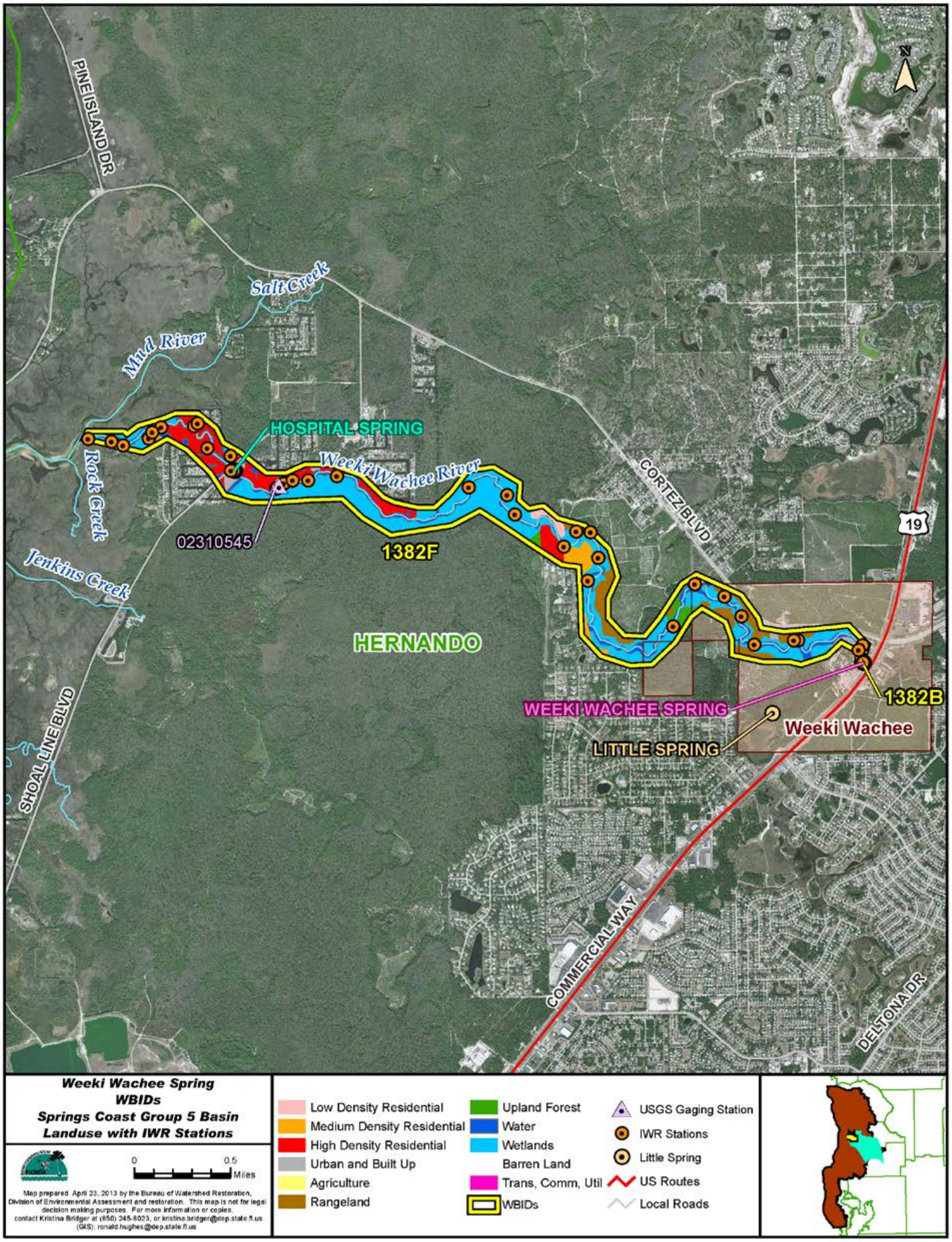

Figure 2.7. Surface Water Monitoring Sites Associated with Impaired WBIDs 1382B and 1382F (based on Department dataset)

2.6 Rainfall and Temperature Data

The climate in the Weeki Wachee Spring area is humid subtropical, with hot, rainy summers and cool, generally dry winters. Recharge to ground water and flow in springs depend on rainfall. Rainfall and temperature data were reviewed for the 30-year period of record from 1982 to 2012 (**Table 2.2**). Annual rainfall amounts average approximately 47.76 inches per year (in/yr), with an average air temperature of about 70.9^{o} F. (National Oceanic and Atmospheric Administration [NOAA] 2013).

Table 2.2. Temperature and Precipitation at NOAA Station (Weeki Wachee - 089430), 1982–2012

Analysis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
30-Year Mean–Maximum Temperature (°F.)	70.3	72.8	76.8	82	87.4	90.4	91.5	91.5	90.1	85.1	79	72.4	82.5
30-Year Mean–Minimum Temperature (°F.)	44.4	47.6	52	56.6	63.6	70.6	71.8	71.9	69.8	62.1	54	47.1	59.3
30-Year Mean–Average Temperature (°F.)	57.4	60.2	64.4	69.3	75.5	80.5	81.7	81.6	79.9	73.6	66.5	59.7	70.9
30-Year Mean–Precipitation (inches)	3.6	3.17	4.32	2.3	2.18	7.42	8.43	7.13	6.62	2.52	1.78	2.3	53.31

Figure 2.8 shows the 30-year historical rainfall trend measured at the Weeki Wachee station. Over the 30-year period, the lowest annual rainfall of 24.24 inches occurred in 2007, and the highest annual rainfall of 74.62 inches occurred in 1983. The NOAA annual average rainfall from 1982 to 2012 is 47.76 inches.

2.7 Discharge Data

The USGS has collected flow measurements from Weeki Wachee Spring since 1904 and manual discharge measurements for the Weeki Wachee River since 1917 from two river gauge stations (Station 02310500 prior to 1995 and 02310545 post-1995), shown in **Figure 2.9**. River discharge estimates are based on a series of manual discharge measurements compared with the water level in the nearby Weeki Wachee well (283201082315601). The discharge measured at these stations includes contributions from Weeki Wachee Spring, Little Spring, a smaller unnamed spring, and the bed of Little Spring Run (Heyl 2008). According to data from the USGS website, the mean discharge from annual discharges over the entire period of record (1917–2012) is 170.7 cfs. From 2000 to 2012, the mean discharge was 156.6 cfs. **Table 2.3** lists the adjusted annual mean discharge for each year from 1917 to 2012.

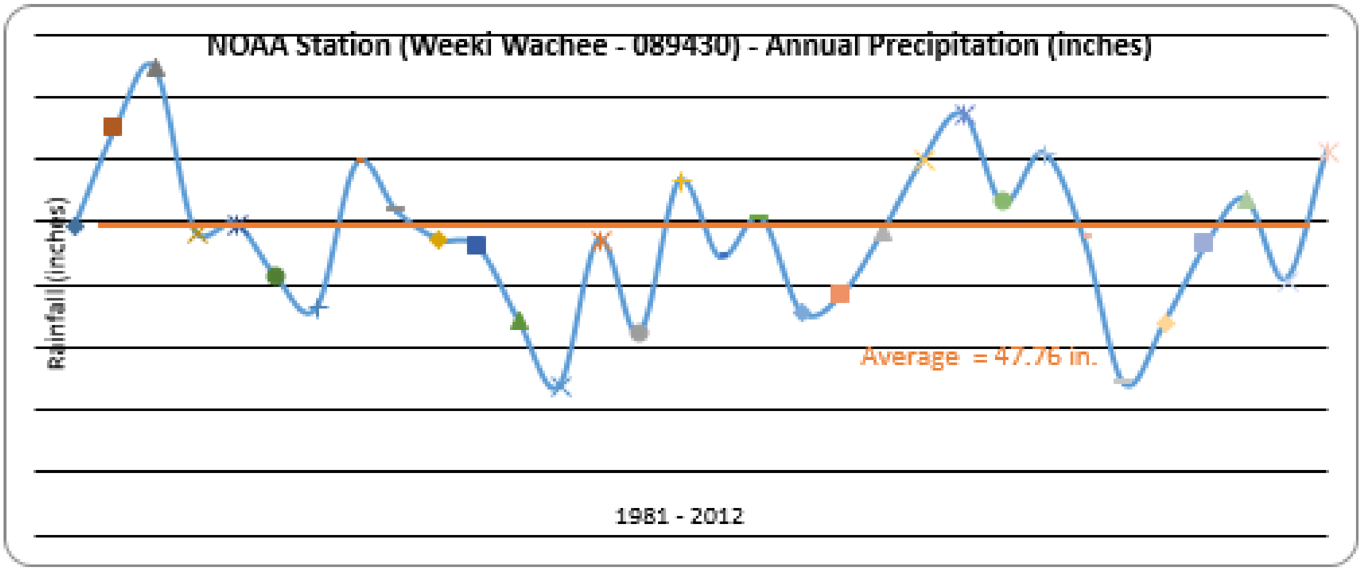

Figure 2.8. Precipitation for Weeki Wachee - 089430, 1981–2012 (NOAA Climate Information for Management and Operational Decisions [CLIMOD] product, May 6, 2012)

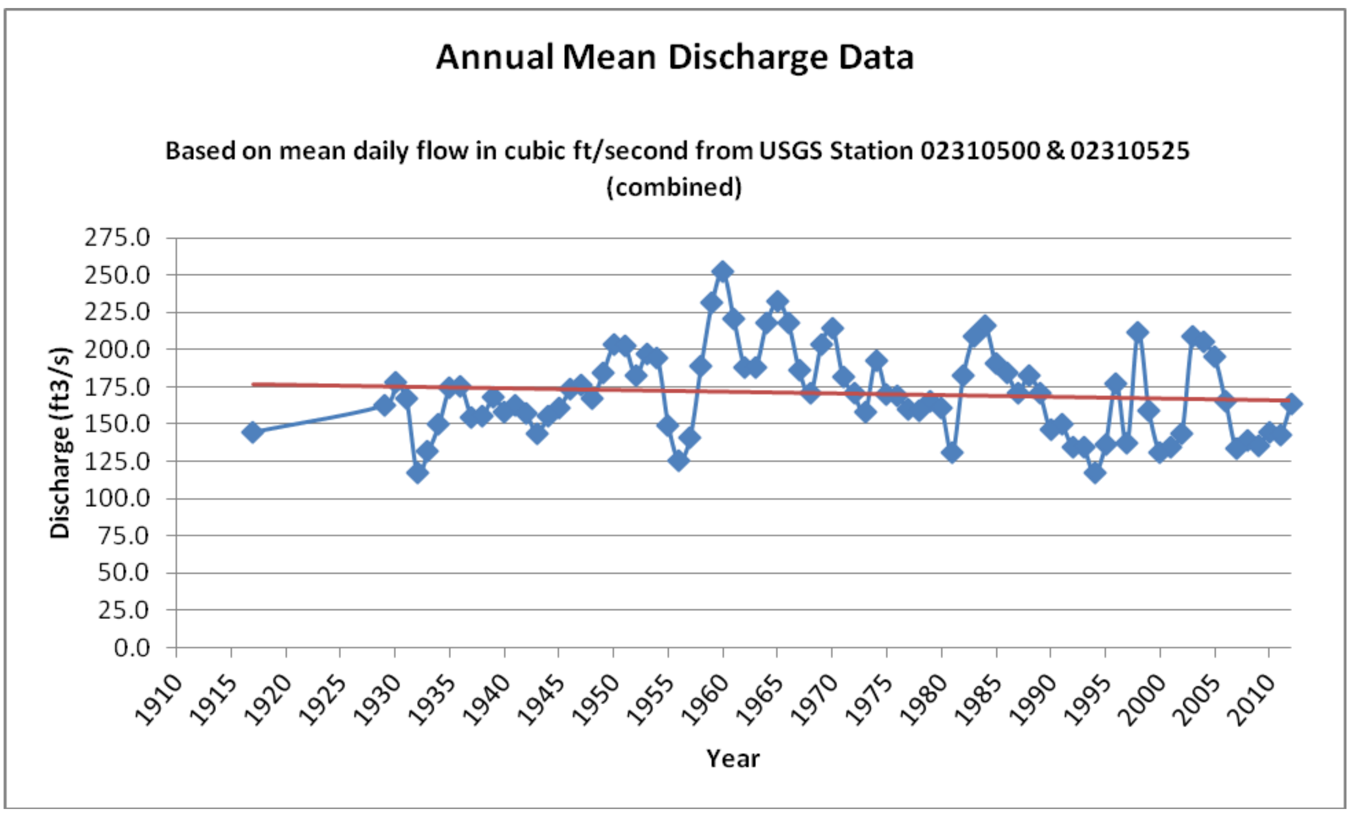

Figure 2.9. Adjusted Annual Mean Discharge Data for Weeki Wachee River, 1917–2012

Table 2.3. Adjusted Annual Mean Discharge for Weeki Wachee River, 1917–2012

* Values with an asterisk and in red represent years with the highest and lowest discharge during the period of record.
** Includes USGS October, November, and December 2012 provisional data.

Year	Mean	Year	Mean	Year	Mean	Year	Mean	Year	Mean
1917	145.0	1945	160.5	1962	188.0	1979	165.2	6	177.5
1929	163.0	1946	173.4	1963	188.4	1980	160.8	1997	137.3
1930	178.0	1947	176.7	1964	217.6	1981	131.0	1998	211.6
1931	167.2	1948	167.2	1965	232.6	1982	182.6	1999	159.4
1932	117.8	1949	184.2	1966	217.6	1983	209.2	2000	131.3
1933	131.5	1950	203.0	1967	185.8	1984	216.0	2001	134.7
1934	150.2	1951	202.8	1968	170.4	1985	191.0	2002	143.3
1935	174.9	1952	183.0	1969	203.4	1986	184.3	2003	208.7
1936	175.8	1953	197.3	1970	214.7	1987	171.2	2004	204.9
1937	154.9	1954	194.7	1971	181.5	1988	182.4	2005	195.5
1938	155.4	1955	149.4	1972	170.4	1989	170.7	2006	165.8
1939	168.5	1956	125.4	1973	157.7	1990	146.4	2007	133.7
1940	158.5	1957	141.3	1974	192.6	1991	149.8	2008	138.8
1941	162.7	1958	189.3	1975	170.3	1992	134.7	2009	135.6
1942	156.9	1959	231.3	1976	169.4	1993	134.9	2010	144.4
1943	144.0	1960*	252.0*	1977	160.3	1994*	117.1*	2011	142.7
1944	155.6	1961	220.4	1978	159.3	1995	136.0	2012	163.3**

Statistical analyses of discharge data have indicated that declines in discharge are related to both rainfall and ground water withdrawal (Heyl 2008). The decline in discharge and a target for protection for flows in the Weeki Wachee River system were addressed in the SWFWMD's 2008 minimum flows and levels (MFL) document (Heyl 2008).

2.8 Monitoring Results

2.8.1 Nitrogen

The USGS, SWFWMD, and Department have measured nitrate concentrations at Weeki Wachee Spring since 1961. Publications by each of these entities have documented increasing trends in nitrate levels over time (Harrington *et al.* 2010; Rosenau *et al.* 1977). Elevated nitrate in the spring may also correlate with ground water concentrations. From a compilation of well data from various sources, the Department found that over 41% of the 153 wells in the springshed with data had nitrate concentrations greater than 1 mg/L, and the highest nitrate concentrations in ground water of the contributing area (from private well monitoring by the Florida Department of Health [FDOH]) were detected in wells in the central and western regions (Harrington *et al.* 2010).

Figures 2.10 and **Table 2.4**, and **Figure 2.11** and **Table 2.5,** depict total nitrogen (TN) and nitrate data for Weeki Wachee Spring and River, respectively. The sum of nitrate ($NO_{3)}$ and nitrite (NO_2) is used in this report to represent nitrate due to minimal concentrations of nitrite. In all cases, the comparative data show that nitrate is the predominant form of nitrogen. The nitrate data in **Tables 2.4** and **2.5** are for the period of record used in developing the TMDLs.

Plotted data from Weeki Wachee Spring (**Figure 2.10**) show that nitrate levels have steadily increased from 1984 to the present. The mean nitrate level at Weeki Wachee Spring for 2010 was 0.91 mg/L.

The data in **Figure 2.11** indicate that median nitrate levels in 2010 in the Weeki Wachee River (WBID 1382F; 0.82 mg/L median) were lower than those in Weeki Wachee Spring (WBID 1382B; 0.90 mg/L median).

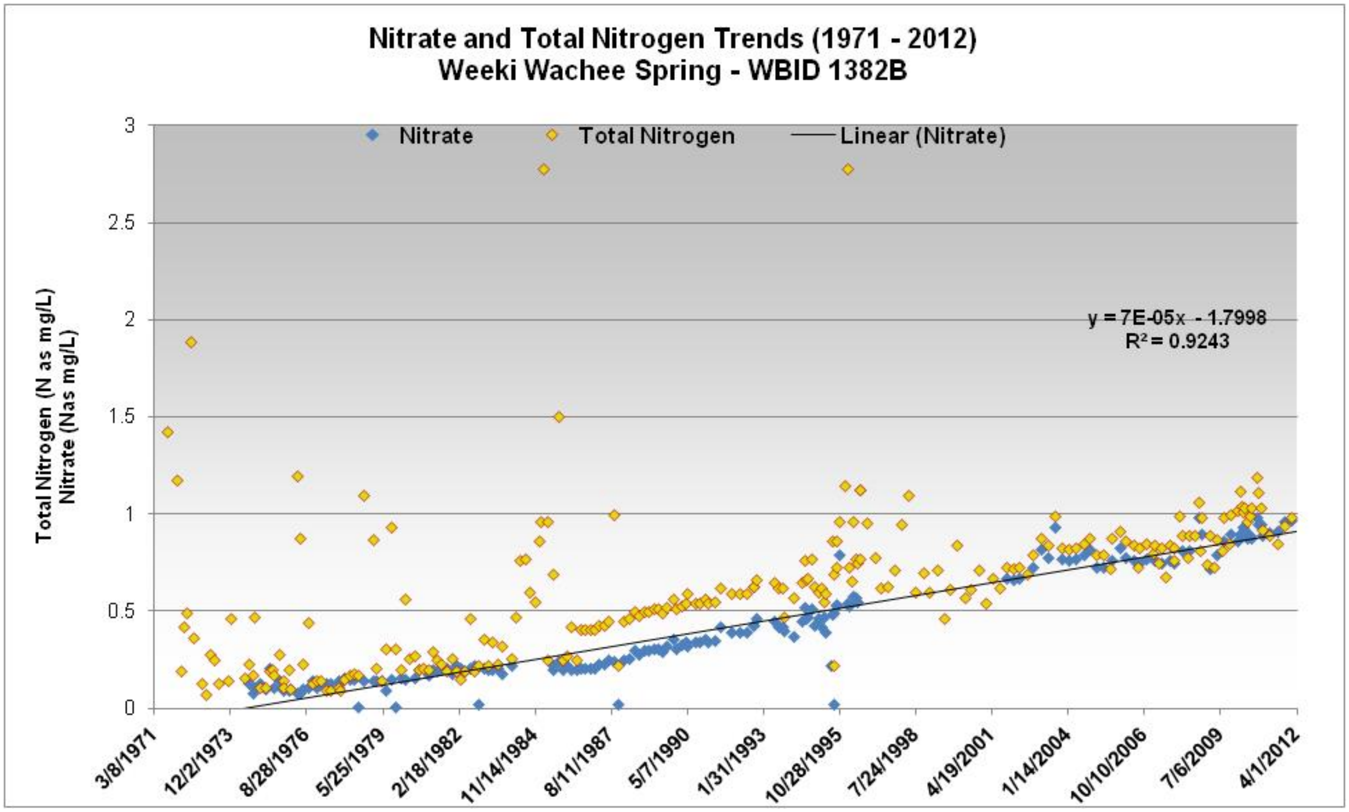

Figure 2.10. Nitrate and TN Trends for Weeki Wachee Spring, WBID 1382B, 1971–2012

Table 2.4. Nitrate and TN Concentrations for Weeki Wachee Spring, WBID 1382B, 2004–2012

Min = Minimum
Max = Maximum

Year	NO_3NO_2-N *n*	NO_3NO_2-N Mean	NO_3NO_2-N Median	NO_3NO_2-N Min	NO_3NO_2-N Max	TN *n*	TN Mean	TN Median	TN Min	TN Max
2004	8	0.79	0.78	0.76	0.82	4	0.85	0.84	0.82	0.88
2005	5	0.76	0.76	0.73	0.83	5	0.79	0.82	0.72	0.91
2006	5	0.76	0.76	0.72	0.78	5	0.82	0.84	0.73	0.86
2007	8	0.75	0.75	0.69	0.77	8	0.79	0.82	0.68	0.84
2008	8	0.83	0.81	0.75	0.98	8	0.91	0.89	0.78	1.06
2009	8	0.81	0.81	0.72	0.90	8	0.86	0.86	0.73	1.00
2010	14	0.91	0.90	0.85	0.98	11	1.05	1.03	0.96	1.19
2011	4	0.92	0.91	0.89	0.96	4	0.90	0.91	0.85	0.94
2012	4	0.97	0.98	0.90	1.04	4	0.99	0.99	0.87	1.10

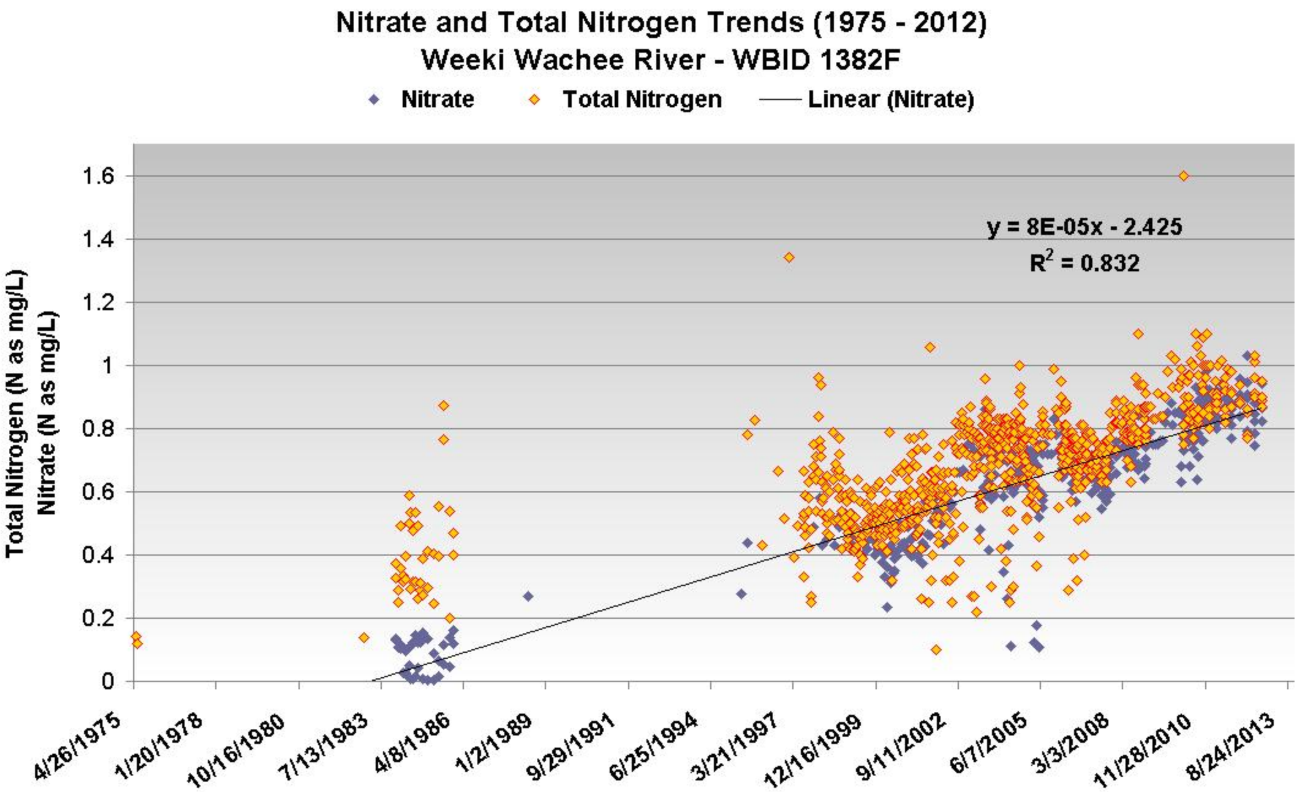

Figure 2.11. Nitrate Trends for Weeki Wachee River, WBID 1382F, 1975–2012

Table 2.5. Nitrate and TN Concentrations for Weeki Wachee River, WBID 1382F, 2000–12

Min = Minimum
Max = Maximum

Year	NO_3NO_2-N *n*	NO_3NO_2-N Mean	NO_3NO_2-N Median	NO_3NO_2-N Min	NO_3NO_2-N Max	TN *n*	TN Mean	TN Median	TN Min	TN Max
2004	41	0.637	0.660	0.111	0.770	78	0.716	0.758	0.250	1.000
2005	34	0.605	0.671	0.106	0.830	32	0.701	0.730	0.366	0.990
2006	41	0.688	0.692	0.568	0.790	77	0.709	0.730	0.290	0.950
2007	42	0.666	0.670	0.545	0.758	77	0.694	0.700	0.410	0.890
2008	40	0.749	0.741	0.644	0.860	86	0.778	0.790	0.390	1.100
2009	41	0.763	0.760	0.591	0.880	79	0.788	0.780	0.410	1.110
2010	47	0.809	0.820	0.630	0.970	47	0.927	0.920	0.750	1.600
2011	29	0.869	0.87	0.769	0.99	29	0.909	0.910	0.800	1.016
2012	20	0.878	0.887	0.747	1.03	20	0.898	0.895	0.77	1.03

2.8.2 Phosphorus

Tables 2.6 and **2.7** depict TP data for Weeki Wachee Spring and River, respectively. In general, median phosphorus levels have not varied greatly over the period of record and remain relatively consistent with background ground water concentrations in the region. There was no correlation between phosphorus and nitrate concentrations from 2004 through 2012.

Table 2.6. TP Concentrations for Weeki Wachee Spring, 2004–2012

Min = Minimum
Max = Maximum

Year	TP *n*	TP Mean	TP Median	TP Min	TP Max
2004	10	0.008	0.009	0.004	0.010
2005	5	0.005	0.004	0.004	0.010
2006	5	0.006	0.005	0.004	0.010
2007	8	0.007	0.007	0.004	0.010
2008	8	0.005	0.005	0.004	0.007
2009	8	0.006	0.006	0.004	0.008
2010	15	0.008	0.008	0.004	0.011
2011	4	0.008	0.008	0.007	0.009
2012	4	0.009	0.009	0.005	0.012

Table 2.7. TP Concentrations for Weeki Wachee River, 2004–2012

Max = Maximum
Min = Minimum

Year	TP *n*	TP Mean	TP Median	TP Min	TP Max
2004	78	0.0104	0.0110	0.0040	0.0250
2005	36	0.0110	0.0100	0.0070	0.0292
2006	78	0.0108	0.0100	0.0050	0.0230
2007	77	0.0094	0.0018	0.0050	0.0220
2008	86	0.0096	0.0090	0.0060	0.0170
2009	77	0.0136	0.0100	0.0070	0.2500
2010	47	0.0101	0.0090	0.0070	0.0140
2011	29	0.0102	0.0100	0.0060	0.0260
2012	20	0.0103	0.0100	0.0080	0.0150

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

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 (there are no state waters currently in this class)**

Weeki Wachee Spring (WBID 1382B) and the freshwater segment of the Weeki Wachee River (WBID 1382F) are Class III fresh waterbodies (with designated uses of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife). The Class III freshwater quality criterion applicable to the impairment addressed by this TMDL is nutrients, which have been demonstrated to adversely affect flora or fauna.

3.2 Applicable Water Quality Standards and Numeric Water Quality Targets

3.2.1 Nutrients

Thresholds of nutrient impairment for streams have been interpreted in the IWR, Section 62-303.351, F.A.C. (*Nutrients in Streams*), to include stream segments with imbalances of flora or fauna due to nutrient enrichment. These causes of imbalance include algal blooms, changes in alga species richness, excessive macrophyte growth, a decrease in the areal coverage or density of SAV, and excessive diel oxygen variation.

For Weeki Wachee Spring and River, benthic macroalgae mats and epiphytic algae growing on macrophytes were shown to be a significant problem. Algal growth causes a variety of ecological impairments, including, but not limited to, habitat smothering, the provision of nutrition and habitat for pathogenic bacteria, the production of toxins that may affect biota, the reduction of oxygen levels, and an increase in diurnal swings of the dissolved oxygen (DO) regime in the stream. Macroalgal mats can produce human health problems, foul beaches, inhibit navigation, and reduce the aesthetic value of clear springs or stream runs.

Research on Florida springs, including Weeki Wachee, has provided ample evidence that algal growth responds to the introduction of phosphorus and nitrate in spring water (Stevenson *et al*. 2007). In Weeki Wachee Spring, elevated nitrogen is the nutrient of concern because phosphorus is at natural background. As nitrate is the dominant form of nitrogen in the Weeki Wachee River system based on concentration, the nutrient linked to the excessive algal growth in WBIDs 1382B and 1382F is nitrate nitrogen.

The Department's numeric nutrient criterion (NNC) of 0.35 mg/L nitrate for spring vents was adopted in Rule 62-302, F.A.C., by the Environmental Regulations Commission on December 8, 2011. Following legal challenges and federal rulemaking actions on November 30, 2012 the EPA approved the Department's NNC for spring vents. The NNC for springs is 0.35 mg/L nitrate-nitrite as an annual geometric mean, not to be exceeded more than once in any 3 calendar year period. The Department has published a complete technical support document on how it calculated the NNC.

Paragraph 62-302.530(47) (b), F.A.C., states that "in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." This narrative criteria is still applicable statewide, but the Department's hierarchal approach gives preference to the numeric nutrient value of 0.35 mg/L nitrate-nitrite for springs based on quantifiable stressor-response relationships between nutrients and biological response. In addition, if there are sufficient site-specific data for a particular spring, a site-specific alternative criterion can be set. The Department found sufficient algal growth response data to support a different site specific criterion for these impaired waters. **Chapter 5** discusses the nitrate impairment and the setting of the TMDL target concentration of nitrate.

3.2.2 Outstanding Florida Water Designation

The Outstanding Florida Water (OFW) criterion in Section 62-302.700, F.A.C., allows no degradation in water quality for Special Waters, which include the Weeki Wachee riverine system. The Weeki Wachee River was designated as an OFW in 2003, meaning that it is worthy of special protection because of its natural attributes.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Population and Land Use in the Weeki Wachee Spring Contributing Area

4.1.1 Population

In spring areas, elevated concentrations of nitrate in the springs often correlate with population growth. **Figure 4.1** shows the relationship between population growth in Hernando County and nitrate concentrations in Weeki Wachee Spring from 1960 to 2010. In this area, there appears to be about a 15-year lag between population and spring nitrate increases.

The total population of Hernando County is 172,778 and the population of Pasco County is 464,697, according to the U.S. Census Bureau's 2010 Census. There are 71,745 households (HH) and 84,504 housing units (HU) in Hernando County, and 189,612 HH and 228,928 HU in Pasco County. Hernando County contains 365.6 people per square mile of land and 178.8 HU per square mile; while Pasco County contains 622.2 people per square mile of land and 306.5 HU per square mile. A little over 27% of the contributing area for Weeki Wachee Spring is residential, and the areas of highest population are in Hernando County close to the spring, mainly lying between U.S. Highways 19 and 41 (**Figure 4.2**).

The largest residential area within this area of Hernando County is Spring Hill, founded in 1967. The original subdivision within the community, Spring Hill Unit 1, was platted in February 1967. Beginning in 1974, the part of Spring Hill in the immediate vicinity of Weeki Wachee Spring began to experience significant residential growth with the development of the Spring Hill Unit 25 subdivision. Today, the unincorporated community of Spring Hill contains 44,435 dwellings, which is more than half of the housing units in the entire county (Hernando County 2012).

4.1.2 Land Uses

Information on the distribution of different land use categories in the Weeki Wachee Spring contributing area was obtained from the 2009 SWFWMD land use Geographic Information System (GIS) coverage, which is the most recent land use data available. **Table 4.1** and **Figure 4.3** show the breakdown of the various land use categories from the GIS data. In 2009, residential, forest, and agricultural areas were the predominant land uses in the contributing area, covering 27%, 23%, and 23%, respectively. Wetlands were fourth, with 15% of the contributing area for Weeki Wachee Spring.

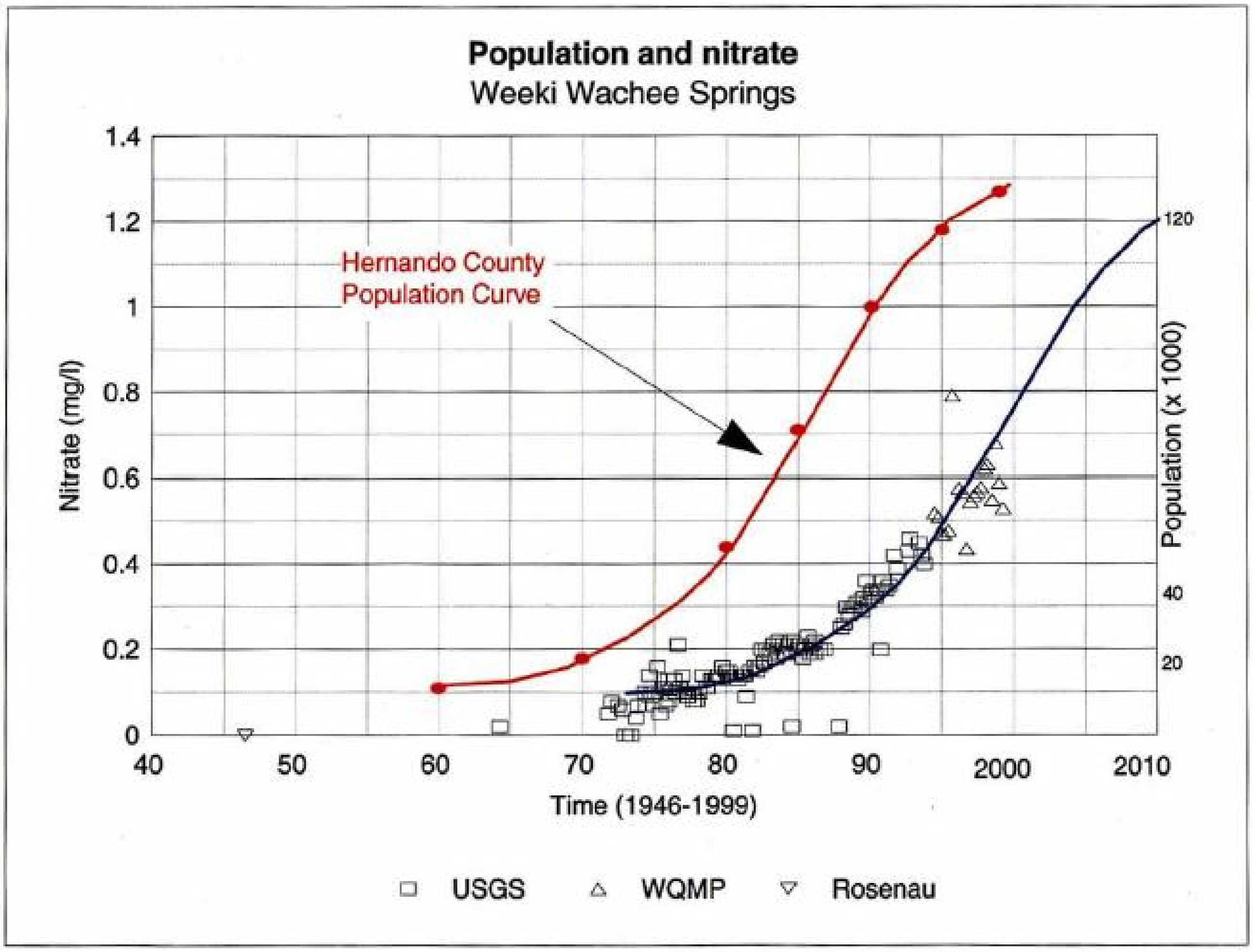

Figure 4.1. Hernando County Population Growth vs. Nitrate Concentration in Weeki Wachee Spring, 1960–2010

Source: Florida Department of Community Affairs 2002

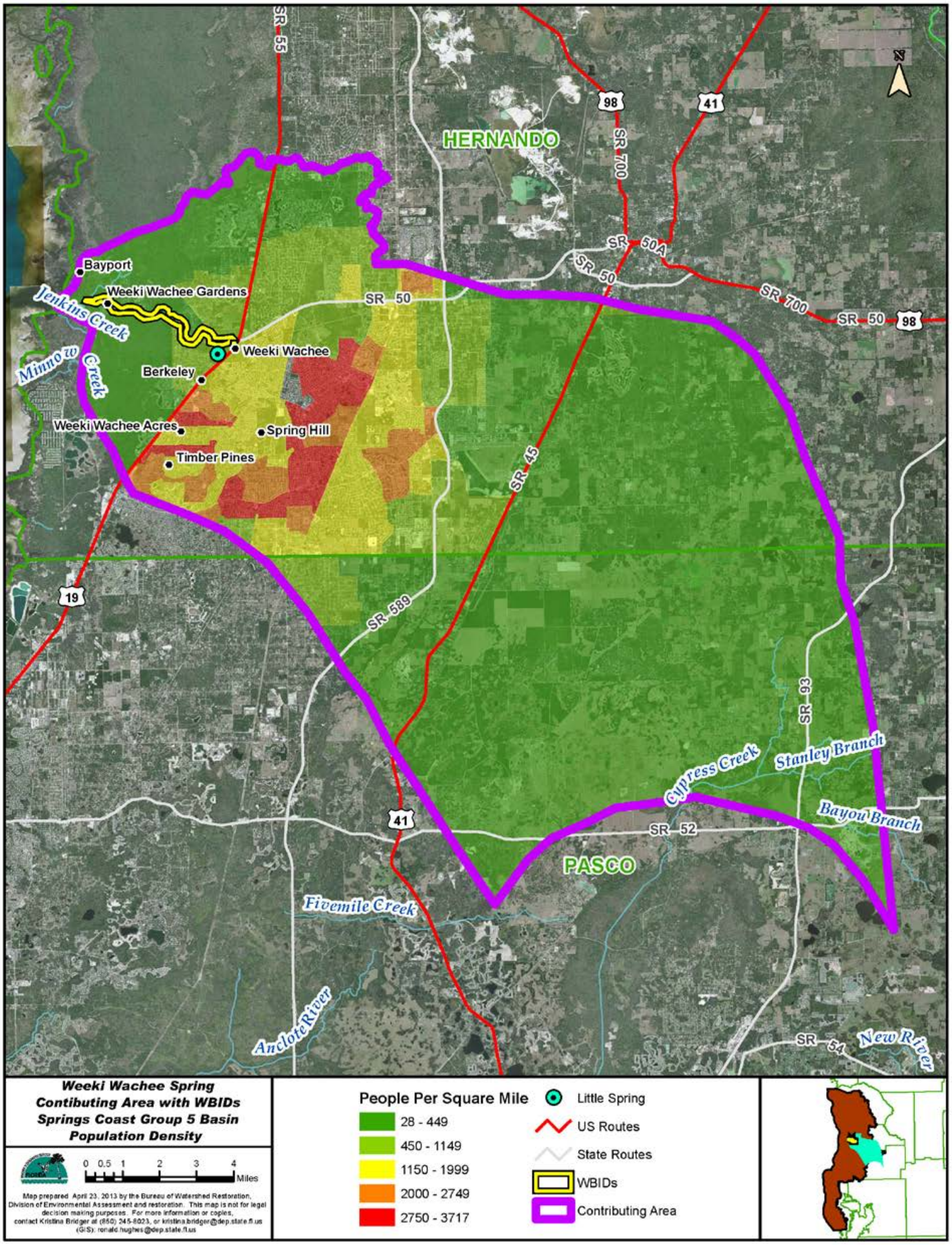

Figure 4.2. Population Density for the Weeki Wachee Spring Contributing Area in Hernando and Pasco Counties (based on 2010 Census data)

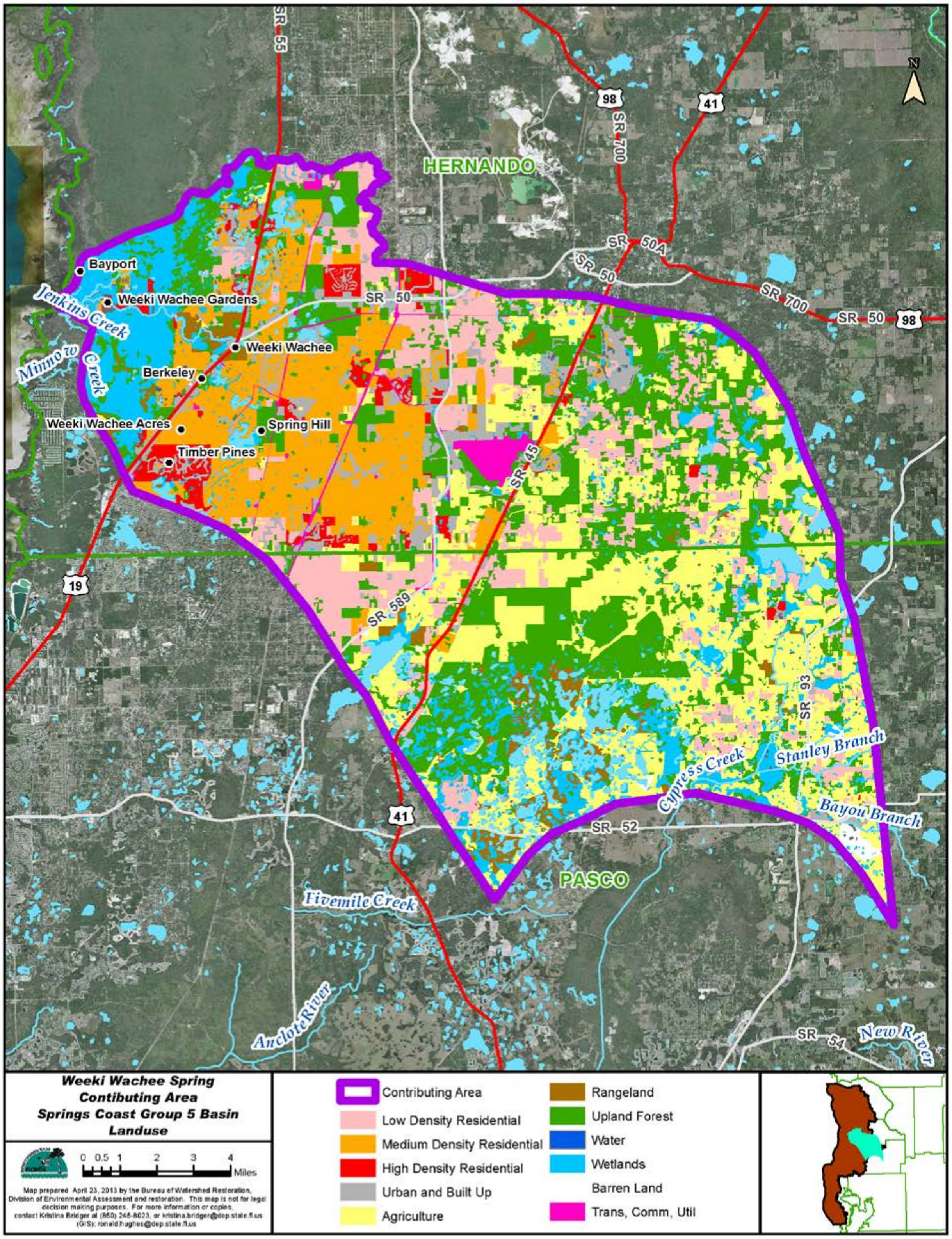

Figure 4.3. Land Uses in the Weeki Wachee Spring Contributing Area in 2009

Table 4.1. Percentages of Major Land Uses in the Weeki Wachee Spring Contributing Area in 2009

- = Empty cell/no data

Code	Land Use	Square Miles	Acreage	% of Contributing Area
1000	Urban Open	0.00	0.00	0.00%
1100	Low-Density Residential	32.34	20,695.55	12.72%
1200	Medium-Density Residential	31.24	19,990.48	12.29%
1300	High-Density Residential	5.95	3,810.89	2.35%
1400	Commercial	3.73	2,390.32	1.47%
1500	Light Industrial	0.54	345.40	0.21%
1600	Extractive/Quarries/Mines	0.00	0.00	0.00%
1700	Institutional	1.33	851.06	0.52%
1800	Recreational (Golf Courses, Parks, Marinas, etc.)	3.48	2,226.63	1.37%
1900	Open Land	5.93	3,796.83	2.33%
2000	Agriculture	57.50	36,800.31	22.62%
3000+7000	Rangeland	7.03	4,499.99	2.77%
4000	Forest/Rural Open	58.94	37,721.89	23.18%
5000	Water	2.42	1,548.87	0.95%
6000	Wetlands	38.58	24,688.87	15.17%
8000	Communication and Transportation	5.23	3,346.65	2.06%
-	**Total**	**221.90**	**162,713.72**	**100%**

4.2 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of nutrients in the watershed and the magnitude of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernible, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) discharging directly to surface waters are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities and those sources that do not directly discharge to an impaired surface water, including runoff from urban land uses, wastewater treatment sites, stormwater drainage wells, agriculture, silviculture, mining, discharges from failing septic systems, and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of surface water pollution as point sources subject to regulation under the EPA's National Pollutant Discharge

Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges to surface water, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges to surface water) and stormwater system discharges to surface water that require an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.3 Potential Sources of Nitrate in the Weeki Wachee Spring Contributing Area

While nitrate occurs naturally in the environment through nitrogen fixation, bacterial processes, and lightning, the elevated and increasing levels of nitrate in the contributing area are attributed to anthropogenic sources. These include point sources such as domestic wastewater and residuals, as well as nonpoint sources that discharge to ground water, such as septic tanks; fertilizers from residential landscaping and lawns, golf courses, and agricultural operations; the land application of permitted wastewater effluent; livestock waste; and atmospheric deposition. While not a nitrate source *per se*, stormwater runoff is an important pathway for nitrate to reach an impaired waterbody.

4.3.1 Wastewater and Stormwater Sources

None of the permitted wastewater and stormwater facilities in the vicinity discharges directly to the impaired surface waters addressed in this TMDL analysis. However, some of these may still influence nitrate concentrations in the ground water and springs as nonpoint sources.

Domestic Wastewater

Figure 4.4 shows the locations of the 23 domestic and industrial wastewater facilities and 1 residuals facility in the Weeki Wachee Spring contributing area. **Appendix B** lists the facilities and their permit numbers. None of these domestic WWTFs has NPDES-permitted discharges to surface water. All of them discharge to ground water via spray irrigation, rapid infiltration basins (RIBs), drainfields, or percolation ponds.

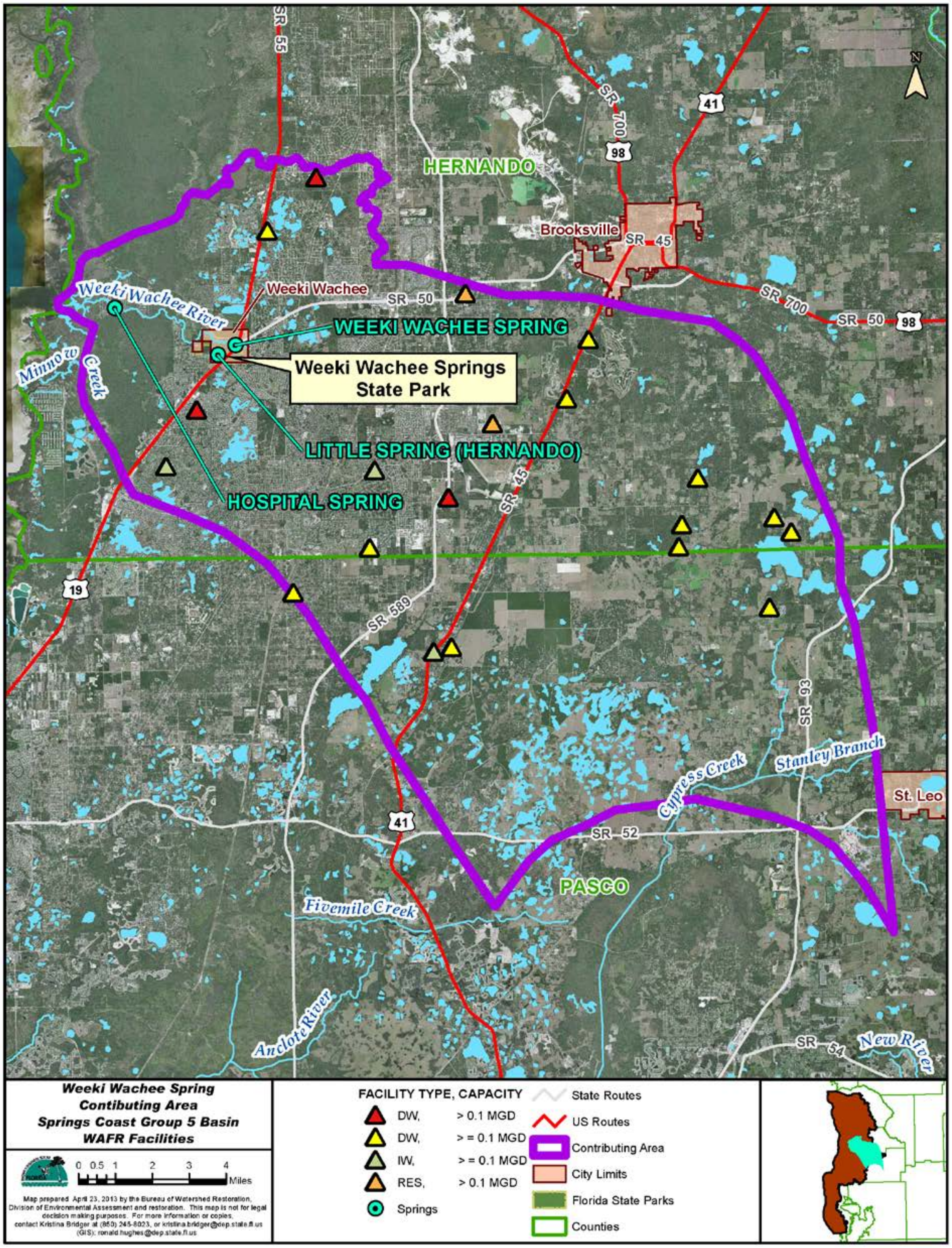

Figure 4.4. Domestic Wastewater Facilities in the Weeki Wachee Spring Contributing Area

Table 4.2 includes the 4 largest domestic facilities in the contributing area with permitted discharges of 0.1 million gallons per day (MGD) or greater. The contributing area also has 2 residuals management facilities (RMFs), AAA White Septic Tank Service and Appalachian Materials; the latter has a permit to discharge domestic wastewater residuals up to a maximum of 320 dry tons per year.

A wastewater treatment plant located near the Weeki Wachee River at 5568 Cofer Road during the 1970s has been converted to a sewer lift station. In April 2013, flow to the Berkeley Manor Subregional Wastewater Treatment Plant was diverted to the Spring Hill Water Reclamation Facility, located in the eastern portion of the contributing area.

Table 4.2. Domestic Wastewater Facilities with Permitted Capacity over 0.1 MGD and RMFs in the Vicinity of Weeki Wachee Spring and River

[a] Dry tons

Facility Name	Permit Number	County	Facility Type	Owner Type	Design Capacity (MGD, unless otherwise stated)	Disposal Method	Facility Status
Glen Water Reclamation Facility	FLA012069	Hernando	Domestic Wastewater	County	1.0000	Extended Aeration	Active
Hernando Airport Subregional WWTF	FLA017223	Hernando	Domestic Wastewater	County	0.7500	Extended Aeration, Screening, and Grit Removal	Active
Berkeley Manor WWTF	FLA012060	Hernando	Domestic Wastewater	County	0.7500	Extended Aeration	Active
Appalachian Materials Systems	FLA280348	Hernando	Residuals	Private	1,652.00[a]	Lime Stabilization	Active
Traveler's Rest RVP WWTF	FLA012831	Pasco	Domestic Wastewater	Private	0.1000	Extended Aeration	Active
AAA White's Septic Tank Service RMF	FLA012052	Hernando	Residuals	Private	320.0000[a]	Lime Stabilization	Active

Permitted Stormwater Discharges

A municipal separate storm sewer system (MS4) under the federal NPDES Program is a publicly owned conveyance or system of conveyances (*i.e.,* ditches, curbs, catch basins, underground pipes, etc.) that is designed or used for collecting or conveying stormwater and that discharges directly to surface waters of the state. Three MS4 permits have been issued near the Weeki Wachee Spring area: Pasco County (FLS000032), Hernando County (FLR04E040), and the city of Brooksville (FLR04E119). Hernando County and the city of Brooksville both have Phase II permits, while Pasco County is covered under a Phase I permit.

A Phase II MS4 is defined as a system of publicly owned conveyance(s)—including roads, curbs, gutters, swales, or ditches—that discharges to surface waters of the state (outfalls), and is designed or used solely for collecting or conveying stormwater, and is not a Phase I MS4. **Figure 4.5** depicts the boundaries of the various MS4 permit holders. In addition, FDOT District 7 is a co-permittee. Load allocations may be assigned to MS4 entities under their permits if their discharges affect impaired surface waters.

A number of facilities in the springshed have industrial stormwater permits. Of the 23 domestic and industrial wastewater facilities in the contributing area, 8 facilities own and operate stormwater collection systems. These facilities, all concrete batch plants (CBPs), include CEMEX Construction Materials FL LLC (FLG110331), Prestige AB Ready Mix LLC (FLG110397), Evans Septic Tanks and Ready Mix (FLG110232), and SCI Concrete Batch Plant (CBP) (FLG110461). State permit numbers beginning with FLG are specifically issued for CBPs to identify them as operations that reuse their water rather than discharge to surface waters. Concrete batch plants are not considered significant sources of nutrients.

While these existing NPDES entities are not currently being assigned a specific allocation or reduction, some of them may still be included in the BMAP process because of their nonpoint source contributions. The potential involvement of MS4 entities in this area may not be limited to the typical discharges of urban stormwater to surface water. They also include nonpoint source discharges of stormwater to ground water via ponds, sinkholes, and drainage wells. There are no permitted drainage wells in the contributing area.

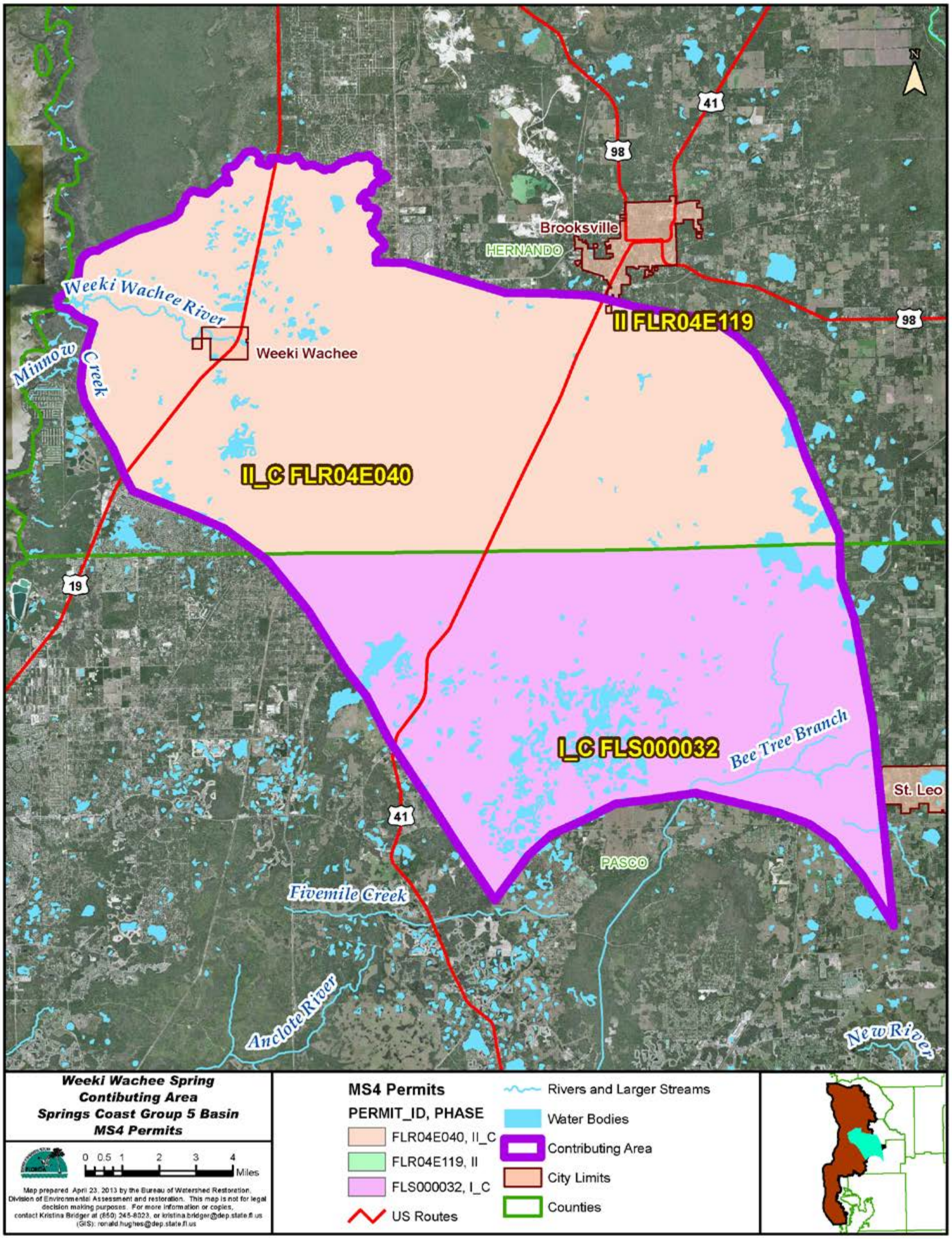

Figure 4.5. MS4 Permit Boundaries in the Weeki Wachee Spring and River Contributing Area

Onsite Sewage Treatment and Disposal Systems

Onsite sewage treatment and disposal systems (OSTDS) are used for the disposal of domestic wastes at homes that are not on central sewer, often because providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDS are a sanitary means of disposing of domestic waste. The effluent from a well-functioning OSTDS is generally higher in total nitrogen concentration than secondarily treated wastewater from a sewage treatment plant, although the wastewater profile can vary from home to home.

On average, the TN concentration in the effluent from a typical OSTDS is 57.7 mg/L (Hazen and Sawyer 2009), although this concentration is reduced further as the effluent is discharged to the drainfield and percolates to ground water. Under a low-density residential setting, nitrogen loadings from OSTDS may not be significant, but under a higher density setting, one could expect the nitrogen input to be approximately 129 pounds per acre per year (lb/ac/yr) (Harrington *et al.* 2010). There has been a growing concern over the abundance and continuing use of septic tanks as the primary sanitary sewer disposal method within the contributing areas of springs, particularly those in higher density areas close to the springs.

As of 2010, Hernando County had approximately 22,094 OSTDS, and Pasco County had approximately 25,320 OSTDS. Approximately 16,662 of these OSTDS are in the contributing area of Weeki Wachee Spring, with approximately 37% of the Spring Hill area within sewer service areas. Data for septic tanks are based on the FDOH statewide OSTDS inventory (Hall and Clancy 2009) GIS layer (**Figure 4.6**). These values are estimates only, as the dataset includes an estimate of unrecorded permits and current digitized locations, resulting in an overestimation of septic tanks.

Fertilizer

The nitrogen component of nitrate in ground water is composed of two stable isotopes, ^{14}N and ^{15}N, of which the vast majority of naturally occurring elemental nitrogen is ^{14}N. The difference between the two isotopes involves an extra neutron present in the nucleus of the ^{15}N isotope. The ratio of the two isotopes in the atmosphere is constant; however, the additional weight conveyed by the presence of the neutron in ^{15}N causes isotope fractionation in natural systems. Due to its lighter weight, ^{14}N is preferentially returned to the atmosphere during denitrification. Because animal and plant tissue is ^{15}N

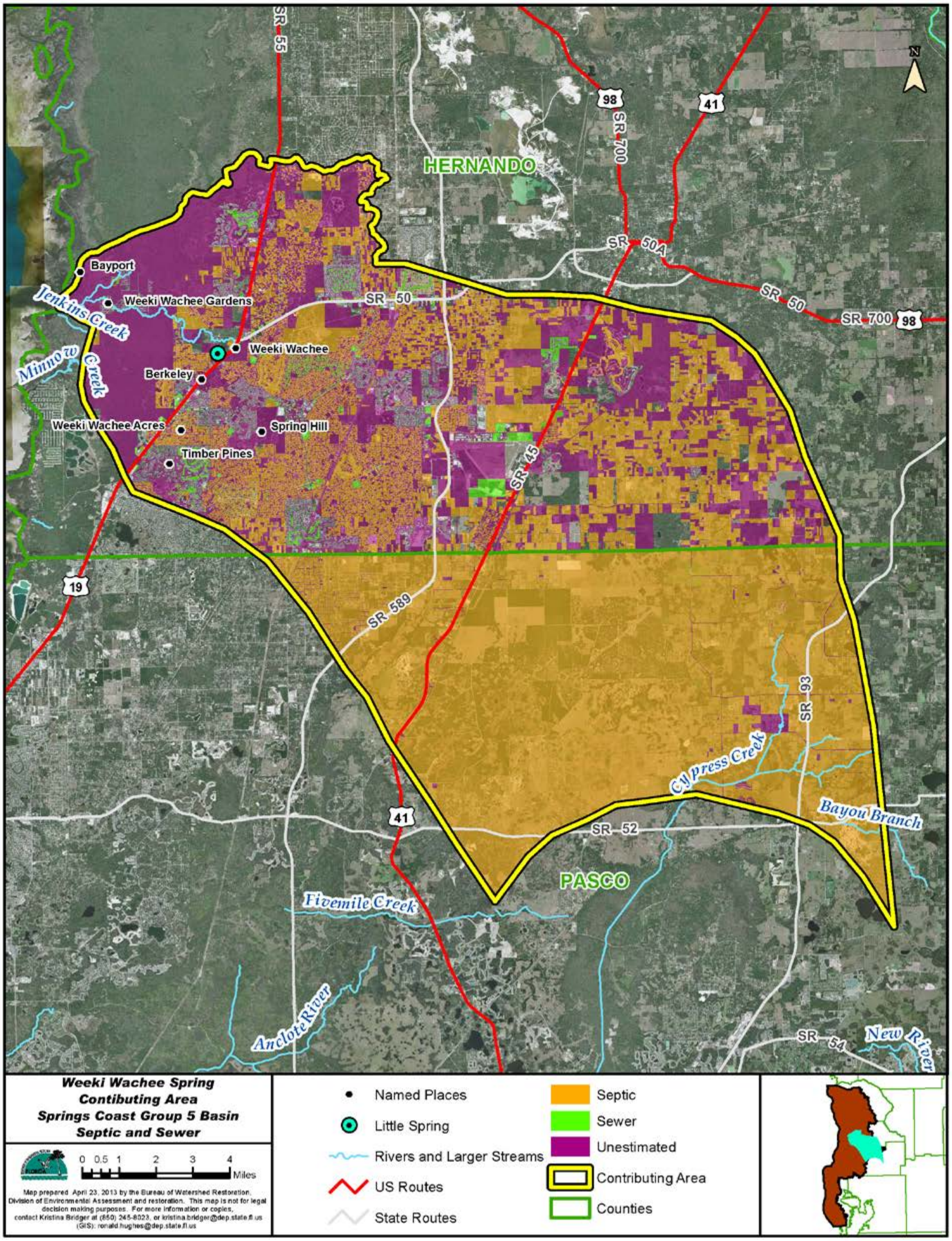

Figure 4.6. Density of OSTDS (Septic Tanks) in Hernando and Pasco Counties and in the Weeki Wachee Spring Contributing Area

enriched, nitrogen in ground water can be traced to an organic or inorganic source. Typically, nitrate in ground water with an enrichment of over 10 parts per thousand ($^{0}/_{00}$) ^{15}N is considered representative of septic tank discharge and animal waste. Levels below 3 $^{0}/_{00}$ ^{15}N are representative of sources of nitrogen not entrained in the natural system, such as inorganic fertilizer. Levels between 3 and 10 $^{0}/_{00}$ indicate mixed inorganic and organic sources (Katz *et al.* 1999). The anthropogenic sources of inorganic nitrate include fertilizer applied to agricultural fields, yards, and golf courses. Anthropogenic sources of nitrate derived from organic material include domestic wastewater and residuals, septic tank effluent, and animal waste derived from equine, poultry, and cow/calf operations.

Previous studies (Champion and Starks 2001) indicate that inorganic fertilizer is a significant source of nitrate to springs in the Springs Coast area, based on the measured ratios of the two stable isotopes of nitrogen (^{14}N and ^{15}N). The SWFWMD isotope data collected indicate that the source of the water from Weeki Wachee Spring was consistent with the inorganic fertilizer signature. The Department also collects samples for nitrogen isotope analysis. A 2013 sample collected by the Department from Weeki Wachee Spring had a ^{15}N value of 4.54‰, which may indicate that the nitrate is from a mixture of inorganic and organic sources, but with a significant contribution from inorganic fertilizer.

The high potential for fertilizer leaching through the well-drained sandy soils typical of spring areas is a major reason that inorganic fertilizer is such a prevalent source of nitrate in ground water and springs. **Table 4.3** provides the estimated ranges of inorganic nitrogen use as fertilizer for the types of land uses common to the contributing area. In addition to residential lawns and landscaping, land uses with fertilizer that could potentially contribute nitrate to Weeki Wachee Spring and River include golf courses and agriculture. The 2009 land use map shows 13 golf courses in the contributing area, 7 of which are within 5 miles of Weeki Wachee Spring. Harrington *et al.* (2010) reported that 21% of the springshed area comprises row crops, field crops, and pasture, and that there are approximately 34 ornamental nurseries in the springshed.

Best management practices (BMPs) and local ordinances and programs have been designed to encourage the conservative use of fertilizers and where implemented can make a difference. Examples include the *Florida Golf Course BMP Manual* developed by the Department; row crop, cow-calf, equine, and container nursery BMP manuals produced by FDACS; and ordinances and programs implemented by Hernando and Pasco Counties.

Table 4.3. Potential Fertilizer Application Ranges for Selected Land Uses in the Weeki Wachee Spring Contributing Area

Note: Estimated loadings from fertilization are conservative, based on recommended agronomic rates and not actual field data.
[1] Lb/ac/yr = Pounds per acre per year

Nitrogen Source	Estimated Nitrogen Inputs Per Year (lb/ac/yr unless otherwise noted)[1]	Comments
Hayfield	320	Bahia grass, assume 4 cuttings (Mylavarapu *et al.* 2009)
Fertilized pasture	50–160	Bahia grass (Mylavarapu *et al.* 2009)
Container nursery, controlled- release fertilizer	17-472	Based on 2 to 3 pounds of controlled-release fertilizer per cubic yard of potting mix, ranging from pot size #1 to pot size #25 spacing (Yeager 2009; Garber *et al.* 2002)
Golf course, turf or lawn, bermudagrass–central Florida	174-261	4 to 6 pounds/1,000 square feet (Sartain *et al.* 2009)
Golf course, turf or lawn, St. Augustine grass–central Florida	87-131	2 to 3 pounds/1,000 square feet (Sartain *et al.* 2009)

Atmospheric Deposition

Atmospheric deposition was also identified as an important potential nitrogen source (about 17% of the total input) (Jones *et al.* 1997). Wet nitrogen deposition from rainfall was estimated from the closest National Atmospheric Deposition Program (NADP) monitoring station, located at the Chassahowitzka National Wildlife Refuge. This station has been in operation since August 1996 (data are available on the NADP website).

Wet deposition is computed by multiplying the precipitation-weighted mean ion concentration (mg/L) for valid samples by the total precipitation amount in centimeters for the summary period and dividing by 10. Records indicate an annual average input of nitrogen from wet deposition to be 2.92 kilograms per hectare (kg/ha) at the station from 2004 to 2012, or about 2.61 lb/ac/yr, which results in 185 tons of nitrogen/year contributed to the 254-square-mile Weeki Wachee Spring contributing area. The wet deposition and dry deposition of nitrogen are not proportional, with dry deposition sometimes exceeding wet deposition in arid regions or in urban areas where air emissions are high. Dry deposition data were not available for this area.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

The Department often uses hydraulic and water quality models to simulate loading and the effects of the loading in a given waterbody. However, there are other appropriate methods to develop a TMDL that are just as credible as a modeling approach. Such an alternative approach was used to estimate existing conditions and calculate the TMDLs for Weeki Wachee Spring and the Weeki Wachee River.

5.1 Determination of Loading Capacity

Typically, the target loading and existing loading for a stream or watershed are based on hydrologic and water quality modeling. Many of these models depend on the relationship between flow and surface water drainage area, as well as the relationship between land use and soils and pollutant delivery.

The predominant source of nitrate loading to Weeki Wachee Spring and the Weeki Wachee River is ground water. Ground water discharges from Weeki Wachee Spring and to a minor extent, Little Spring. Thus, a direct relationship between surface water loadings in the watershed is not appropriate. This atypical situation requires the use of an alternative approach for establishing the nutrient TMDLs.

Existing stream loading can be estimated by multiplying the measured stream flow by the measured pollutant concentrations in the stream. To estimate the pollutant loading this way, synoptic flow and concentration data measured at the outlet of each stream segment under question are required. These data were not available for all sources covering the same period.

The Department considered the feasibility of using the available flow measurements to estimate the flow at each segment outlet based on the drainage area ratio among these stream segments. This method would normally provide an approximation of flow estimates at the stream segment outlets. However, because the contributing area of Weeki Wachee Spring and the Weeki Wachee River is internally drained, most surface drainage tends to flow toward sinkholes and closed depressions, where it infiltrates and discharges at Weeki Wachee Spring and River. Thus flow estimation based on surface drainage area ratio is not possible.

Estimates of current nutrient loads from the ground water of Weeki Wachee Spring and River could still be made based on spring flow and concentration. However, as both current and TMDL loads would be generated from the same flow data, there would be a linear or proportional relationship based on current and target concentrations. Therefore, the loads of nitrate were not explicitly calculated.

Instead, the percent load reduction required to achieve the nitrate concentration target was calculated assuming the percent loading reduction would be the same as the percent concentration reduction. The percent reduction required to achieve the water quality target was calculated using the following formula:

[(existing mean concentration – target concentration)/existing mean concentration] x 100

5.2 TMDL Development Process

5.2.1 Use of Site-Specific Information

For freshwater spring vents, the applicable numeric interpretation of the numeric nutrient criteria in Paragraph 62-301.530(47)(b), F.A.C., is 0.35 mg/L of nitrate-nitrite (NO_3 + NO_2) as an annual geometric mean, not to be exceeded more than once in any three consecutive calendar years. In many cases, this criterion can serve as the concentration-based TMDL for spring waters. However, TMDLs can also serve as site specific alternative criteria where an alternative threshold is more appropriate based on waterbody-specific data. To develop the nitrate target concentration for Weeki Wachee Spring and River, the Department used site-specific historical evidence of algal mats instead of a value based on the statewide criterion.

Historical Evidence from the Weeki Wachee Springs Attraction

Initially, it was believed that the documentation of algal growth would be available from records maintained by the Weeki Wachee Springs underwater attraction, which has operated continuously since 1947. Unfortunately, however, these records were lost or were not consistently maintained over the course of changes in ownership and concession management. Weeki Wachee Springs State Park does not have operational records prior to the establishment of the state park, and no maintenance records exist that would provide information on algal nuisance issues (Brewer 2013b). In particular, it was hoped that there would be records documenting when algae had to be routinely removed from the viewing area of the underwater theater.

Historical photographs of Weeki Wachee Spring were also reviewed in an effort to establish a record of algal issues. The authors examined hundreds of photographs from the tourist attraction for evidence of algal mats. Most of these photos were taken near the underwater theater and the spring vent. These were professional photographs taken for tourism and marketing purposes and did not include problem conditions such as algal smothering. As a result, the photographs were of little use in documenting the algal smothering conditions that may have been present during those times. In addition, the online photographs at the State Archives consisted of images from the 1930s through the 1970s that were also taken for promotional purposes; these also did not provide useful information on the presence of algae. Archivists said they had no additional photos in reserve.

Historical Environmental Issues

The authors found several accounts of environmental impacts to Weeki Wachee Spring and River that included information from the 1960s, 1970s, and 1980s, but none of these provided insight into algal growth. They did, however, provide information on occurrences of bacterial contamination in the river and turbidity in the spring vent.

Historical Documentation of Algae

The earliest documentation of observed algal mats was recorded in the May 1991 SWFWMD document, *Resource Evaluation of the Weekiwachee Riverine System Proposed Water Management Land Acquisition,* which stated, *"On the river bottom Lyngbya forms mats which eventually rise to the surface hindering boat passage and presenting an unsightly appearance because of its resseblance (sic) to floating sewage."* The SWFWMD later mapped the area in greater detail on October 9, 1991, for its 1994 report, *Weeki Wachee River Diagnostic/Feasibility Study: Section V, Submerged Aquatic Vegetation*.

During this study, a visual survey of the submersed vegetation was conducted to determine the species composition and coverage of plants. Twenty-six locations (identified as "A" through "Z") were observed from the headspring to the confluence of the Mud River. These segments are shown in **Figure 5.1**, which is adapted from the SWFWMD (1994) report figures. The SWFWMD researchers reported that *Lyngbya* occurred predominantly within the first mile of the headspring (Segments A through E), where it covered about 25% of the river bottom. *Lyngbya* also dominated Segment U, which is part of the 0.5-mile stretch of the river that was dredged and widened when Weeki Wachee Gardens was created. At this location, where the river channel was deeper and wider, *Lyngbya* covered about 98% of the river bottom, most likely due to the reduced stream velocity. The study also identified other areas prone to *Lyngbya* development and identified areas completely absent of *Lyngbya*. Several areas where *Lyngbya* was completely absent were where the river channel was narrow and water velocity was high.

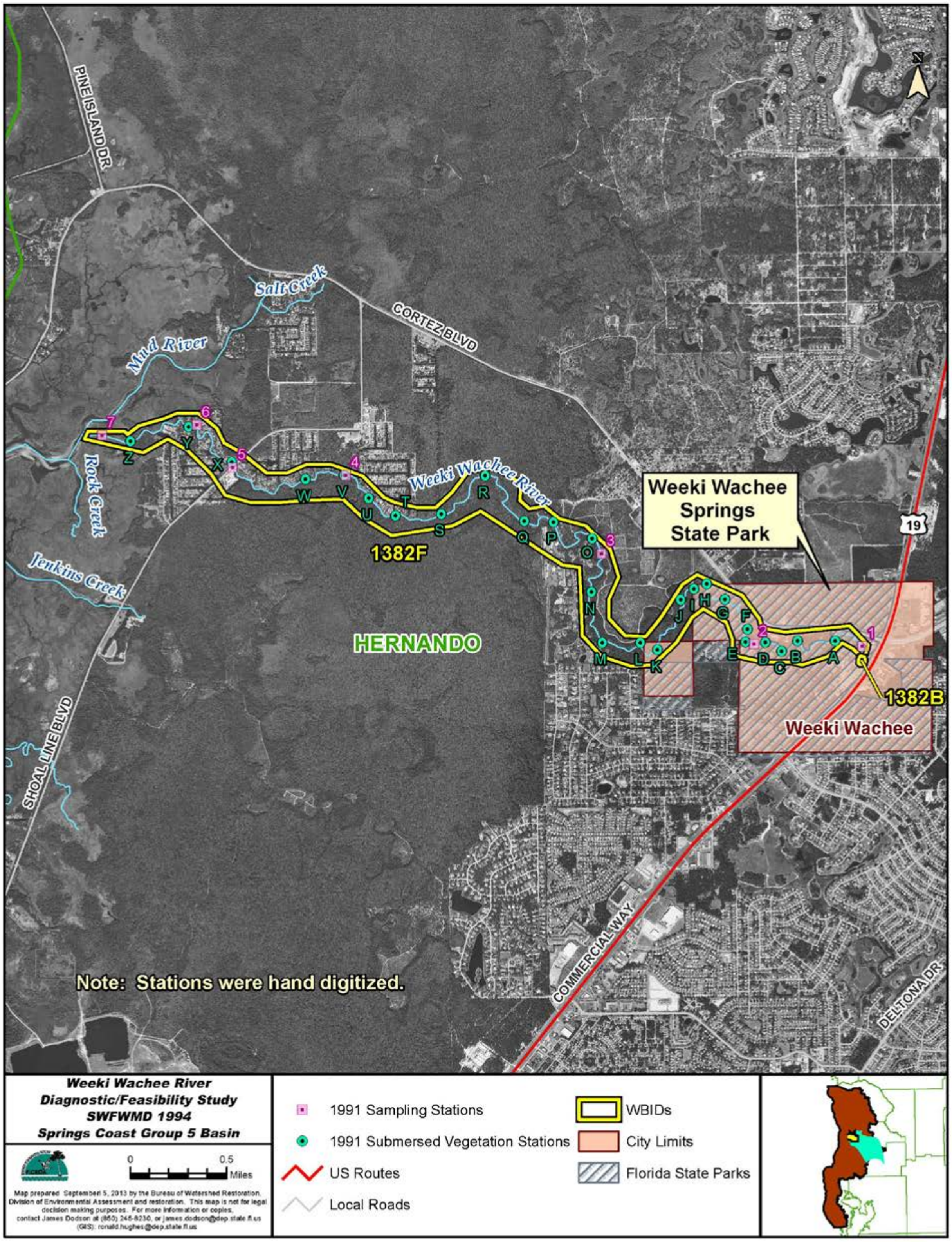

Figure 5.1. Submersed Vegetation Stations Observed by the SWFWMD in October 1991 Adjacent to Water Quality Stations Sampled in 1991 (SWFWMD 1994)

In addition to the visual survey of SAV, water quality samples were collected monthly. These locations were identified as 1 through 6, and their locations are translated to the vegetation stations in **Table 5.1**. At the location nearest the spring vent (Submersed Vegetation Station A, Water Quality Station 1), algae covered approximately 30% of a 9-acre area of river bottom, and there was a corresponding annual mean nitrate concentration of 0.38 mg/L. At the next downstream location with *Lyngbya* coverage (SV Sta C, WQ Sta 2), algae covered 50% of a 1-acre area, and there was a corresponding annual mean nitrate concentration of 0.3 mg/L. *Lyngbya* coverage was lower and sometimes absent farther down the river until the waterway reached the canals constructed at Weeki Wachee Gardens. Here (SV Sta U, WQ Sta 4) there was 98% *Lyngbya* coverage of a 2.8-acre area of river bottom, and the corresponding annual mean nitrate concentration was 0.28 mg/L.

Water quality stations located in the 1991 *Lyngbya*-dominated areas had nitrate concentrations ranging from 0.28 to 0.38 mg/L. Based on the Diagnostic/Feasibility Study results from 1991 (SWFWMD 1994), nitrate concentrations equal to or greater than 0.28 mg/L resulted in *Lyngbya* growth. Therefore the maximum allowable nitrate target concentration limit for Weeki Wachee Spring is 0.28 mg/L. The Department believes that reducing the growth rate of macroalgae (including *Lyngbya*) through nutrient reduction (nitrogen) will cause filamentous algae biomass to decrease. Additional restoration activities will thus become more effective and efficient. As a result of this information, the Department believes that nitrate concentrations lower than 0.28 mg/L are needed to reduce *Lyngbya* biomass.

To estimate a corresponding nitrate target concentration appropriate for the Weeki Wachee River (WBID 1382F), the nitrate concentrations for Weeki Wachee Spring were plotted against the nitrate concentrations for the nearby water quality station station, 21FLSWFD20926.

The relationship of Station A (Weeki Wachee Spring Station 21FLSWFD20919) and Station C (Weeki Wachee River Station 21FLSWFD20926) to nitrate concentrations over time shows the dilution and attenuation of nitrate as nitrate-enriched water migrates from the spring vent through the water column to a nearby station in the river. Once the water leaves the spring vent, nitrate is readily available for uptake by benthic organisms (Woods Hole Group 2007). Also, the effects of dilution from surface water runoff and denitrification processes further reduce nitrate concentrations.

In 1991 the nitrogen attenuation and dilution factor between Station A and Station C was approximately 0.08 mg/L. The distance between these stations is 0.5 miles. Using data collected from 2004 to 2012, the nitrogen attenuation and dilution rate remains between 0.07 and 0.08 mg/L.

Table 5.1. SAV Occurrence during 1991 (adapted from SWFWMD 1994)

= Empty cell/no data
Min = Minimum
Max = Maximum

Section V SAV Study Oct 1991 STA Number	Surface Acres	*Lyngbya* % Covered	Acres Covered with *Lyngbya*	Filamentous % Covered	Acres Covered with Filamentous	Section I WQ Jan – Dec 1991 STA Number	Min	Mean	Max
A	9.19	30%	2.76	0%	0	1	0.32	0.38	0.44
B	1.31	10%	0.13	0%	0	0	-	-	-
C	1.15	50%	0.57	0%	0	2	0.24	0.3	0.37
D	1.54	20%	0.31	0%	0	0	-	-	-
E	0.86	1.65%	0.17	0%	0	0	-	-	-
F	2.06	7%	0.14	0%	0	0	-	-	-
G	1.55	3%	0.05	0%	0	0	-	-	-
H	1.77	2%	0.04	0%	0	0	-	-	-
I	0.33	19%	0.03	0%	0	0	-	-	-
J	1.65	4%	0.07	0%	0	0	-	-	-
K	1.65	2%	0.03	0%	0	0	-	-	-
L	1.25	0%	0	0%	0	0	-	-	-
M	1.14	0%	0	0%	0	0	-	-	-
N	2.96	5%	0.15	0%	0	0	-	-	-
O	1.46	0%	0	0%	0	3	0.18	0.29	0.37
P	2.33	0%	0	0%	0	0	-	-	-
Q	2.58	0%	0	0%	0	0	-	-	-
R	4.34	0%	0	0%	0	0	-	-	-
S	2.29	0%	0	0%	0	0	-	-	-
T	1.41	2%	0.03	0%	0	0	-	-	-
U	2.81	98%	2.75	0%	0	4	0.21	0.28	0.35
V	0.82	1%	0.01	0%	0	0	-	-	-
W	2.24	0%	0	2%	0.04	0	-	-	-
X	5.83	0%	0	8%	0.47	5	0.21	0.28	0.35
Y	4.5	0%	0	10%	0.45	6	0.19	0.29	0.47
Z	4.52	0%	0	30%	1.36	0	-	-	-

Using the nitrate attenuation and dilution factor, a nitrate target concentration of 0.28 mg/L for Weeki Wachee Spring translates to a nitrate concentration of 0.20 mg/L for the Weeki Wachee River station, 21FLSWFD20926 (Station C). Based on the results of the regression equation (N [results] = 14, RSquare 0.90, p-value 0.0001) shown in **Figure 5.2,** the maximum allowable nitrate target concentration limit for the Weeki Wachee River, WBID 1382F, is therefore 0.20 mg/L.

21FLSWFD20919 = 0.1284808 + 0.9016329*Weeki Wachee River

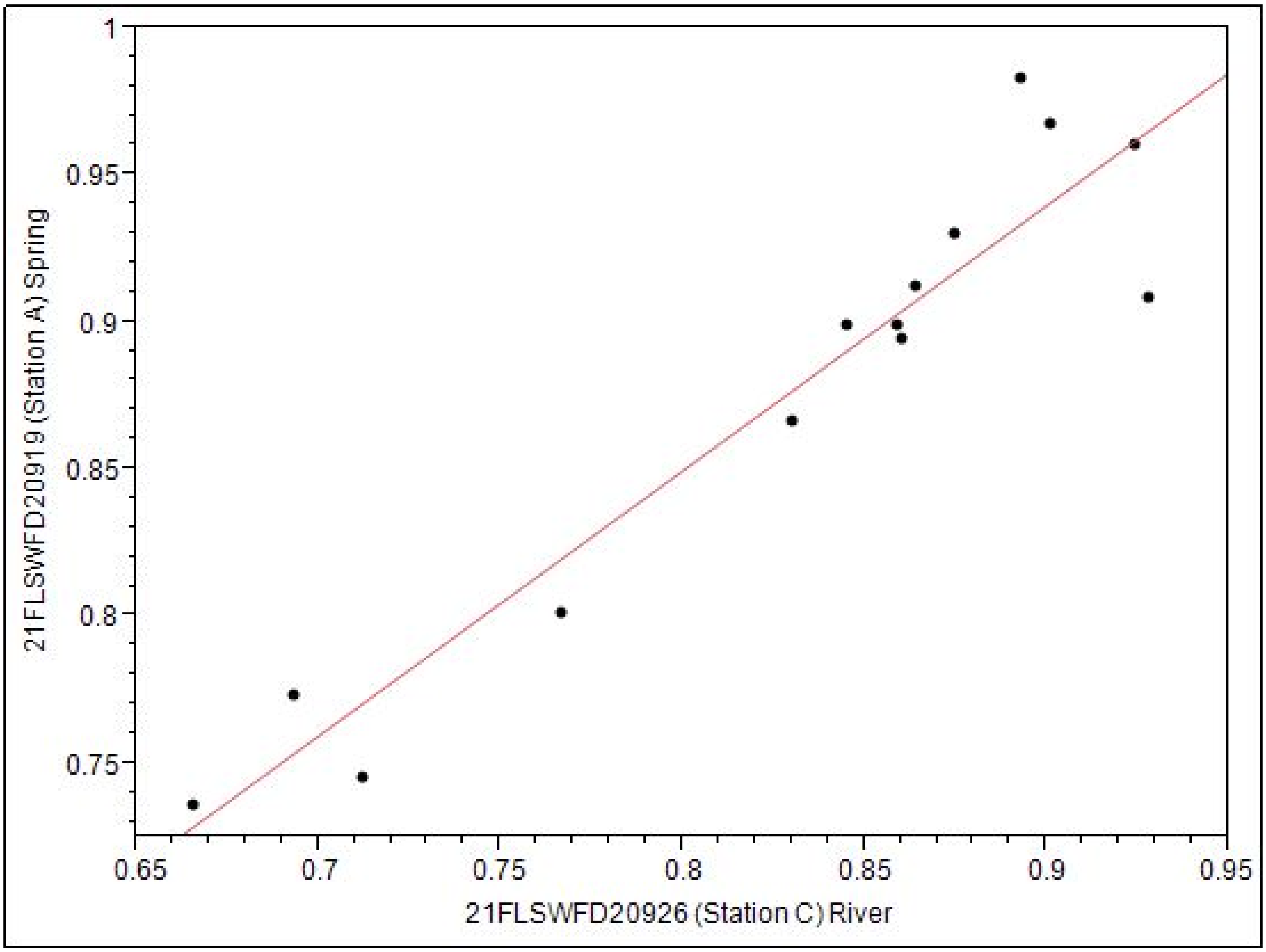

Figure 5.2. Nitrate Attenuation and Dilution of Weeki Wachee Spring vs. Weeki Wachee River

5.3 Setting the Annual Average Concentration for Nitrate

The Department believes that 0.28 mg/L nitrate (nutrient) as the TMDL for Weeki Wachee Spring and 0.20 mg/L nitrate (nutrient) as the TMDL for the Weeki Wachee River as annual averages are appropriate and conservative targets . Annual average targets are most appropriate because algal growth does not respond to the instantaneous changes in nutrient concentration. Therefore, a short-term exceedance of the target concentration may not produce negative or positive biological or ecological effects.

In addition, the majority of the water supply for the river originates from the spring. However, monthly data from the spring are not available for all months. Therefore, long-term annual average concentrations were calculated for each year based on measured concentrations over a reasonable period that is representative. To ensure that the annual average concentrations will meet the concentration target even under the worst-case scenario, the highest annual average nitrate concentrations were used to calculate the percent reduction required to achieve the nitrate targets. This approach adds to the margin of safety of the TMDLs.

For Weeki Wachee Spring (WBID 1382B) and the Weeki Wachee River (WBID 1382F), the percent reductions required to meet their TMDLs were calculated using the annual values for nitrate averaged over the most recent verified period (January 1, 2004, through June 30, 2011) with recent data added through December 2012. The maximum annual average for each WBID was then considered in calculating a target for the percent reduction (**Table 5.2**).

Table 5.2. Yearly Average Nitrate Concentrations for Weeki Wachee Spring and River (2004–12)

= Empty cell/no data

Year	Weeki Wachee Spring (WBID 1382B) Verified Period Average (mg/L)	Weeki Wachee River (WBID 1382F) Verified Period Average (mg/L)	Annual Rainfall (inches)
2012	0.97	0.88	61.27
2011	0.92	0.87	40.76
2010	0.91	0.81	53.61
2009	0.81	0.76	46.06
2008	0.83	0.75	33.98
2007	0.75	0.67	24.24
2006	0.76	0.69	47.35
2005	0.76	0.62	60.89
2004	0.79	0.64	53.08
Maximum Annual Average	**0.97**	**0.81**	**-**

5.4 Critical Conditions/Seasonality

Establishing the critical conditions for algal growth in a given watershed depends on many factors. For typical surface waters, the critical conditions exist when there is an extended dry period followed by a rainfall runoff event. During the wet weather period, rainfall washes off nutrients that have built up on the land surface under dry conditions. Similar correlations have also been noted for some spring systems, but they may not be as dramatically influenced by rain events.

The water discharged from Weeki Wachee Spring comes from infiltrating precipitation somewhere in the springshed that migrated within the UFA system to the spring vent. Water discharged from the vent is from a mixture of sources and may range from days to decades in age. At Weeki Wachee Spring, fluctuations in spring water quality have been observed, and these could be a response to flushing from seasonal rainfall events or to seasonal nonpoint impacts such as fertilization. However, throughout the year, nitrate concentrations remain above the threshold for algal growth.

One potential seasonal influence on the growth of some forms of algae may be stream velocity, which is based on spring discharge, which is in turn influenced by precipitation. For the TMDLs established for Weeki Wachee Spring and River, there appears to be a correlation between annual average nitrate concentrations and flow, such that increased flow in Weeki Wachee Spring can result in increased nitrate concentrations (Heyl 2012). Stevenson *et al.* (2007) noted a positive correlation between the current and the growth of *Vaucheria*. In addition, sediments that have accumulated for months may provide a flux of nutrients to the water column under certain weather or DO conditions.

5.5 Calculation of TMDL Percent Reduction

Based on an examination of the data depicted in **Table 5.1**, the percent reductions were based on the data from 2012, the year with the highest annual average nitrate concentration for both the spring and river.

The maximum annual average nitrate concentrations for Weeki Wachee Spring (WBID 1382B) and the Weeki Wachee River (WBID 1382F) are 0.97 and 0.88 mg/L, respectively. These were calculated from data available between January 1, 2004, and December 31, 2012.

As discussed in **Chapter 3**, these TMDL target concentrations for Weeki Wachee Spring and the Weeki Wachee River will be submitted to EPA for approval as site specific hierarchal interpretations of the narrative nutrient criteria for these water bodies as stated in Rule 62-302.531, F.A.C.

To obtain percent reductions that are reasonably representative of the two WBIDs and will be adequately protective by using the largest datasets, the maximum annual average nitrate concentrations were used. The percent reductions required to achieve the water quality targets were calculated using the following formula:

[(existing mean concentration – target concentration)/existing mean concentration] x 100

For Weeki Wachee Spring (WBID 1382B):

[(0.97 mg/L – 0.28 mg/L) / 0.97 mg/L] * 100

Equals a 71.1% reduction in nitrate.

For the Weeki Wachee River (WBID 1382F):

[(0.88 mg/L – 0.20 mg/L) / 0.88 mg/L] * 100

Equals a 77.3% reduction in nitrate.

Reductions in nitrate concentrations of 71.1% in Weeki Wachee Spring and 77.3% in the Weeki Wachee River are proposed because they are protective values that, when achieved, will satisfy the nutrient reduction requirements for the system. Once the target concentrations are consistently achieved, each WBID will be re-evaluated to determine if nitrogen continues to contribute to an imbalance of flora or fauna as a result of algal smothering. If such a condition still exists, the TMDLs will be reassessed as part of the Department's watershed assessment cycle. The target concentrations may be changed if the Department determines that further reductions in the nitrogen concentrations are needed to address the imbalance. The purpose of a TMDL is to set a pollutant reduction goal that, if achieved, will result in attainment of the designated uses for that waterbody.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The percent load reductions were established to achieve the annual average nitrate concentrations of 0.28 mg/L for Weeki Wachee Spring and 0.20 mg/L for the Weeki Wachee River. While these percent reductions are the expression of the TMDLs that will be implemented, the EPA recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard. Maximum daily concentration (MDC) targets for nitrate were established using the equation below, established by the EPA (2006). In the following equation, it is assumed that the nitrate data distributions are lognormal:

$MDL = LTA * \exp(Z_p \sigma_y – 0.5 \sigma y^2)$

$\sigma y = \mathrm{sqrt}(\ln(CV^2 + 1))$

Where:

LTA = long-term average (0.28 mg/L for spring, 0.20 mg/L for river)
Z_p = p^{th} percentage point of the standard normal distribution, at 95% (Z_p = 1.645)
σ = standard deviation
CV = coefficient of variance

6.1.1 Calculation of MDC for Nitrate for Weeki Wachee Spring and River

For the daily maximum nitrate concentration, it was assumed that the average annual target concentration should be the same as the average daily concentration. Also, assuming the target dataset will have the same CV as the existing measured dataset (**Table 6.1**) and allowing a 5% exceedance (EPA 2007, pp. 19 and 20), the daily maximum nitrate concentrations for Weeki Wachee Spring and the Weeki Wachee River are 0.284 mg/L and 0.245 mg/L, respectively.

It should be emphasized that these daily maximum targets were developed for illustrative purposes. The implementation of the TMDLs will be based on the annual average concentration targets.

Table 6.1. Daily Maximums for Target Nitrate Concentrations (mg/L)

Statistics	Weeki Wachee River (WBID 1382F)	Weeki Wachee Spring (WBID 1382B)
Mean (mg/L)	0.74	0.83
CV	0.129	0.097
Annual Target Concentration	0.20	0.28
Daily maximum concentration to achieve annual target concentration for nitrate	**0.245**	**0.284**

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \square \mathrm{WLAs} + \sum \square \mathrm{LAs} + \mathrm{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \square \mathrm{WLAs}_{\textbf{wastewater}} + \sum \square \mathrm{WLAs}_{\textbf{NPDES Stormwater}} + \sum \square \mathrm{LAs} + \mathrm{MOS}$$

It should be noted that the various components of a TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (2) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as a percent reduction because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the "maximum extent practical" through the implementation of BMPs.

This approach is consistent with federal regulations (40 Code of Federal Regulations § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The TMDLs for Weeki Wachee Spring and River are expressed in terms of concentration of nitrate and represent the loading the spring and river can assimilate and maintain healthy levels of algal growth that do not contribute to an ecological imbalance (**Table 6.2**). Because no target loads were explicitly calculated in this TMDL report, the TMDLs are represented as the percent reduction required to achieve the nitrate targets. The percent reductions assigned to all the nonpoint source areas (LA) are the same as those defined for the TMDL percent reductions.

Table 6.2. TMDL Components for Weeki Wachee Spring and River

N/A = Not applicable

Waterbody (WBID)	Parameter	TMDL (mg/L)	TMDL % reduction	Wasteload Allocation for Wastewater	Wasteload Allocation for NPDES Stormwater % Reduction	LA % reduction	MOS
Weeki Wachee Spring (WBID 1382B),	Nitrate as annual average	0.28	71.1%	N/A	71.1%	71.1%	Implicit
Weeki Wachee River (WBID 1382F)	Nitrate as annual average	0.20	77.3%	N/A	77.3%	77.3%	Implicit

To achieve the annual average nitrate target of 0.28 mg/L in Weeki Wachee Spring (WBID 1382B) and 0.20 mg/L in the Weeki Wachee River (WBID 1382F), the nitrate loads from the nonpoint source areas contributing to these impaired WBIDs need to be reduced by 71.1% and 77.3%, respectively. The target annual average nitrate concentrations and the percent reductions represent estimates of the maximum reductions required to meet the targets. It may be possible to meet the targets before achieving the percent reductions. It should be noted that the LA could also include loading from stormwater discharges regulated by the Department and the water management district that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.2 Wasteload Allocation

6.2.1 NPDES Wastewater Discharges

Currently, no NPDES wastewater facilities discharge directly into Weeki Wachee Spring or River. Any new potential discharger is expected to comply with the Class III criterion for nutrients and with nitrate limits consistent with this TMDL. If it is determined that any of the wastewater facilities discharges into Weeki Wachee Spring or River, they will be subject to the assigned WLA.

6.2.2 NPDES Stormwater Discharges

Currently there are no known discharges from NPDES stormwater entities to the impaired waters. If it is determined that any of the NPDES MS4 stormwater facilities identified in **Section 4.2** have direct discharges into Weeki Wachee Spring or River, they will also be subject to the assigned WLA.

6.3 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department 2001), an implicit MOS was used in the development of this TMDL, and was provided by the conservative decisions associated with a number of assumptions and the development of assimilative capacity. In addition, when estimating the required percent reduction to achieve the water quality target, the highest annual average of measured nitrogen concentration within the eight-year data period (2004–12) was used instead of the average of the annual averages. In addition, when estimating the required percent reduction to achieve the water quality target, the highest long-term monthly average of measured nitrate concentrations was used instead of the average of the monthly averages. Both of these will make estimating the required percent load reduction more conservative and therefore add to the MOS.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies. A BMAP can take into account the sources of nitrogen within the contributing area, including legacy loads from past land use activities, as well as the complexity of the aquifer system that conveys pollutants to the impaired waters.

If the Department determines that a BMAP is needed to support the implementation of these TMDLs, it will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, is technically feasible, and meets the restoration needs of the applicable waterbodies.

Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- Water quality goals (based directly on the TMDLs).
- Refined source identification.
- Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible).
- A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach.
- A description of further research, data collection, or source identification needed in order to achieve the TMDLs.
- Timetables for implementation.

- Implementation funding mechanisms.
- An evaluation of future increases in pollutant loading due to population growth.
- Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures.
- Stakeholder statements of commitment (typically a local government resolution).

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information to the management of water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

References

Albertin, A.R. 2009. *Nutrient dynamics in Florida springs and relationships to algal blooms*. Ph.D. dissertation. Gainesville, FL: University of Florida.

Arthur, J.D., H.A.R. Wood, A.E. Baker, J.R. Chichon, and G.L. Raines. 2007. Development and implementation of Baysean-based aquifer vulnerability assessment in Florida. *Natural Resources Research* 16(2): 93–107.

Bonn, M.A. 2004. Visitor profiles, economic impacts, and recreational aesthetic values associated with eight priority Florida springs located in the St. Johns River Water Management District. St. Johns River Water Management District.

Brewer, T. 2013a. E-mail from Toby Brewer to James Dodson. *Subject: Request for Weeki Wachee Springs economic numbers.* Florida Department of Environmental Protection.

———. 2013b. E-mail from Toby Brewer to James Dodson. *Subject: Algae records.* Florida Department of Environmental Protection.

Carr, D., K. Kolasa, D. Ellison, and R. Basso. 2013. *Minimum and guidance levels for Tooke Lake in Hernando County, Florida.* Brooksville, FL: Southwest Florida Water Management District, Resource Evaluation Section.

Champion, K.M., and R. Starks. 2001. *The hydrology and water quality of select springs in Southwest Florida Water Management District.* Brooksville, FL: Southwest Florida Water Management District, Water Quality Monitoring Program.

Ferguson, G.E., C.W. Lingham, S.K. Love, and R.O. Vernon. 1947. Springs of Florida. *FGS* 31: 1–197.

FitzPatrick, K. 2010 *Weeki Wachee Springs, analysis and restoration proposal.* Available: http://floridaspringsinstitute.org/Resources/Documents/Weeki_FitzPatrick.pdf.

Florida Department of Community Affairs. 2002. *Protecting Florida's springs: Land use planning strategies and best management practices.* Tallahassee, FL: Florida Department of Environmental Protection and Florida Department of Community Affairs.

Florida Department of Environmental Protection. February 2001. *A report to the Governor and the Legislature on the allocation of Total Maximum Daily Loads in Florida.* Tallahassee, FL: Bureau of Watershed Management.

———. 2006. *Water quality status report: Springs Coast*. Tallahassee, FL: Division of Environmental Assessment and Restoration.

———. 2008a. *Water quality assessment report: Springs Coast*. Tallahassee, FL: Division of Environmental Assessment and Restoration.

———. 2008b. *Standard Operating Procedure (SOP) FS7420.* Available: http://www.dep.state.fl.us/water/sas/sop/sops.htm.

———. 2011a. *Weeki Wachee Springs State Park, unit management plan.* Approved plan. Tallahassee, FL: Division of Recreation and Parks.

———. 2011b. *Florida state park system economic impact assessment for FY 2010/2011.* Tallahassee, FL: Division of Recreation and Parks.

Florida Department of Health website. 2010. Available: http://www.doh.state.fl.us/.

Frazer, T.K., S.K. Notestein, and W.E Pine, Jr. 2006. *Changes in the physical, chemical and vegetative characteristics of the Homosassa, Chassahowitzka, and Weeki Wachee Rivers.* Report submitted to the Southwest Florida Water Management District. SWFWMD Contract No. 03CON000038. Gainesville, FL: University of Florida.

Gao, X. November 15, 2007. *Nutrient TMDLs for the Wekiva River (WBIDs 2956, 2956A, and 2956C) and Rock Springs Run (WBID 2967).* TMDL report. Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration.

Garber, M.P., J.M. Ruter, J.T. Midcap, and K. Bondari. October–December 2002. Survey of container nursery irrigation practices in Georgia. *HortTechnology* 12(4).

Gilbert, D. 2012. *Nutrient (biology) TMDL for the Wakulla River, WBID 1006.* TMDL report. Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration.

Hall, P., and S.J. Clancy. 2009. *The Florida statewide inventory of onsite sewage treatment and disposal systems (OSTDS): Final draft report and database.* Prepared for the Florida Department of Health, Bureau of Onsite Sewage Programs, by EarthSTEPS and GlobalMind.

Hallas, J.F., and W. Magley. September 2008. *Nutrient and dissolved oxygen TMDL for the Suwannee River, Santa Fe River, Manatee Springs (3422R), Fanning Springs (3422S), Branford Spring (3422J), Ruth Spring (3422L), Troy Spring (3422T), Royal Spring (3422U), and Falmouth Spring (3422Z)* . TMDL report. Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration.

Hand, J. February 2009. *Florida springs assessment decision matrix.* Tallahassee, FL: Florida Department of Environmental Protection, Watershed Assessment Section.

Harrington, D., G. Maddox, and R. Hicks. February 2010. *Florida Springs Initiative Monitoring Network report and recognized sources of nitrate.* Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Protection Section.

Hazen and Sawyer, P.C. August 2009. *Florida onsite sewage nitrogen reduction strategies study: Task A.2, Final report, Literature review of nitrogen reduction technologies for onsite sewage treatment systems.* Florida Department of Health Contract CORCL.

Hernando County. 2012. *Hernando County statistical abstract: FY 2012–2013.* Population and Statistics Subject Index Webpage, Table 1.09, Cities and Communities: 2010 Census.

Heyl, M.G. October 2008. *Weeki Wachee River recommended minimum flows and levels.* Southwest Florida Water Management District.

———. April 2012. *lmpact of flow on NO3+NO2-N concentration on six Florida spring discharges.* Memo to File. Southwest Florida Water Management District.

Hicks, R., D. Harrington, and G. Maddox. March 2009. *Documentation to support listing of nutrient impaired springs and spring runs (Volusia Blue Spring and Volusia Blue Spring Run; DeLeon Spring; Jackson Blue Spring and Merritts Mill Pond; Silver Springs, Silver Springs Group, and Upper Silver River; Rainbow Springs Group and Rainbow Springs Group Run; and Weeki Wachee Spring and Weeki Wachee Spring Run.* Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Protection Section.

Holland, K., and R. Hicks. November 2012. *Nutrient TMDL for Silver Springs Group and Upper Silver River (WBIDs 2772A, 2772C, and 2772E).* Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Management Section.

———. January 2013. *Nutrient TMDL for Rainbow Springs Group and Rainbow Springs Group Run (WBIDs 1320A and 1320B).* Final report. Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Management Section.

Jones, G.W., S.B. Upchurch, K.M. Champion, and D.J. Dewitt. 1997. *Water quality and hydrology of Homosassa, Chassahowitzka, Weeki Wachee, and Aripeka Spring Complexes, Citrus and Hernando Counties, Florida. Origin of increasing nitrate concentrations.* Prepared for the Southwest Florida Water Management District.

Katz, B.G., H.D. Hornsby, J.K. Bohlke, and M.F. Mokray. 1999. *Sources and chronology of nitrate contamination in spring waters, Suwannee River Basin, Florida.* U.S. Geological Survey Water Resources Investigations Report 99-4252.

Knochenmus, L.A., and D.K. Yobbi. 2001. *Hydrology of the coastal springs ground-water basin and adjacent parts of Pasco, Hernando, and Citrus Counties, Florida.* U.S. Geological Survey Water-Resources Investigations Report 01-4230.

Miami News. June 25, 1976. Weeki Wachee is suing Deltona over pollution. Section 12A.

Mylavarapu, R., D. Wright, G. Kidder, and C.G. Chambliss. 2009. *UF/IFAS standardized fertilization recommendations for agronomic crops.* SL129. Gainesville, FL: University of Florida, Soil and

Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences.

National Oceanic and Atmospheric Administration. 2013. *Online meteorological data.*

Rosenau, J.C., G.L. Faulkner, C.W. Hendry, Jr., and R.W. Hull. 1977. *Springs of Florida.* Geological Bulletin No. 31, revised. Tallahassee, FL: Florida Geological Survey.

Sartain, J.B., L.T. Trenholm, E.F. Gilman, T.A. Obreza, and G. Toor. 2009. *Frequently asked questions about landscaping fertilization for Florida-friendly landscaping ordinances.* ENH1115. Gainesville, FL: University of Florida, Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences.

Scott,T.M., K.M. Campbell, F.R. Rupert, J.D. Arthur, and T.M. Missimer. 2001. *Geologic map of the state of Florida.* Florida Department of Environmental Protection, Florida Geological Survey Map Series 146.

Scott, T.M., G.H. Means, R.P. Meegan, R.C. Means, and S.B. Upchurch. 2004. *Springs of Florida.* Bulletin No. 66. Tallahassee, FL: Florida Department of Environmental Protection, Florida Geological Survey.

Sepulveda, N. 2002. *Simulation of ground-water flow in the intermediate and Floridan aquifer systems in peninsular Florida.* U.S. Geological Survey Water-Resources Investigations Report 02-4009.

Stevenson, R.J., A. Pinowska, and Y.K. Yang. 2004. *Ecological condition of algae and nutrients in Florida springs.* Tallahassee, FL: Florida Department of Environmental Protection.

Stevenson, R.J., A. Pinowska, A. Albertin, and J.O. Sickman. 2007. *Ecological condition of algae and nutrients in Florida springs: The synthesis report.* Submitted to the Florida Department of Environmental Protection.

Southwest Florida Water Management District. 1991. *Resource evaluation of the Weekiwachee riverine system proposed water management land acquisition.*

———. 1994. *Weeki Wachee River diagnostic/feasibility study. Section V, Submerged aquatic vegetation.*

U.S. Census Bureau website. 2010. Available: http://www.census.gov/.

U.S. District Court. August 2, 1974. *United States of America vs. John R. Underwood, W.G. Underwood, and R.W. Underwood, Jr., Case Number 70-389-CIV-T-K.*

U.S. Environmental Protection Agency. November 2006. *Memorandum establishing TMDL "daily" loads in light of the decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et al., No.05-5015 (D.C. Cir. 2006) and implications for NPDES permits.* Washington, DC.

———. June 2007. *Options for expressing daily load in TMDL (The Option).*

Wetland Solutions, Inc. 2010. *An ecosystem-level study of Florida's springs–Final report.* Florida Fish and Wildlife Conservation Commission Project Agreement No. 08010. Available: http://wetlandsolutionsinc.com/files/paper_reports/Springs_Ecosystem_Study_Final%20022610.pdf.

Wetterhall, W.S. 1964. *Geohydrologic reconnaissance of Pasco and Southern Hernando Counties, Florida.* Florida Geological Survey Report of Investigations No. 34.

Woods Hole Group. April 2007. *Final report – Natural attenuation of nitrogen in wetlands and waterbodies.* East Falmouth, MA.

Yeager, T.H. 2009. *Current fertilization practices used in container nurseries.* Unpublished manuscript. Gainesville, FL: University of Florida, Institute of Food and Agricultural Sciences.

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit (ERP) regulations.

Rule 62-40, F.A.C., also requires the state's water management districts to establish stormwater PLRGs and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and the master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and FDOT throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's Stormwater/Environmental Resource Permit programs is that the NPDES Program covers both new and existing discharges, while the state's program focus on new discharges only. Additionally, Phase II of the NPDES Program, implemented in

2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: List of Wastewater Facilities in the Weeki Wachee Spring Contributing Area

- = Empty cell/no data
[1] RMF = Residuals management facility; RV = Recreational vehicle; MHP = Mobile home park; MH = Mobile home
[2] RES = Residuals; DW = Domestic wastewater; IW = Industrial wastewater
[3] A = Active; U = Under Construction

Facility Name[1]	Permit Number	County	Facility Type[2]	Owner Type	Design Capacity (MGD)	Disposal Method	Facility Status[3]	NPDES	Latitude (DMS)	Longitude (DMS)	Datum
Appalachian Materials Systems	FLA280348	Hernando	RES	Private	1,652.0000	Lime Stabilization	A	No	28296.7271	822730.4951	HARN
AAA White's Septic Tank Service RMF	FLA012052	Hernando	RES	Private	320.0000	Lime Stabilization	A	No	283210.3708	822811.2339	HARN
Glen Water Reclamation Facility	FLA012069	Hernando	DW	County	1.0000	Extended Aeration	A	No	283456.4311	82329.2555	HARN
Berkeley Manor Subregional WWTF	FLA012060	Hernando	DW	County	0.7500	Extended Aeration	A	No	-	-	HARN
Hernando Airport Subregional WWTF	FLA017223	Hernando	DW	County	0.7500	Extended Aeration, Screening and Grit Removal	A	No	282723.1318	822842.9836	HARN
Travelers Rest WWTF	FLA012831	Pasco	DW	Private	0.2500	Extended Aeration	A	No	282442.5181	82208.7649	NAD83
Camp-A-Wyle Resort WWTF	FLA012044	Hernando	DW	Private	0.1000	Extended Aeration	A	No	283342.375	823329.379	HARN
Camper's Holiday Association WWTF	FLA012045	Hernando	DW	Private	0.0350	Extended Aeration	A	No	282746.2315	82221.3584	HARN
Topics RV Community WWTF	FLA012065	Hernando	DW	Private	0.0300	Extended Aeration	A	No	282613.7012	823050.7185	HARN
Imperial Estates MHP WWTF	FLA012059	Hernando	DW	Private	0.0250	Extended Aeration	A	No	282940.5328	822530.3336	HARN
Lakewood Retreat WWTF	FLA017033	Hernando	DW	Private	0.0200	-	A	No	282628.5098	821931.8935	HARN
Church of God of Prophecy State Campground WWTF	FLA012066	Hernando	DW	Private	0.0200	Extended Aeration	A	No	282649.2318	821959.6028	HARN

Facility Name[1]	Permit Number	County	Facility Type[2]	Owner Type	Design Capacity (MGD)	Disposal Method	Facility Status[3]	NPDES	Latitude (DMS)	Longitude (DMS)	Datum
Big Tree MH and RV Village	FLA012048	Hernando	DW	Private	0.0150	Extended Aeration	A	No	28313.3784	822454.3391	HARN
Big Oaks RV Park WWTF	FLA012756	Pasco	DW	Private	0.0135	Extended Aeration	A	No	282352.322	822840.5992	HARN
Shady Hills Elementary School WWTF	FLA012719	Pasco	DW	County	0.0100	Extended Aeration	A	No	282511.8425	823253.9245	HARN
Eckerd Academy at Brooksville WWTF	FLA012039	Hernando	DW	Private	0.0100	-	A	No	282640.8286	822228.0136	HARN
Eckerd Youth Challenge Program WWTF	FLA186830	Hernando	DW	Private	0.0075	-	A	No	28269.9275	822233.0798	HARN
Outlaw Ridge Inc. Lago Verde Mine	FLA729299	Pasco	IW	Private	0.0000	-	U	No	282545.9528	82299.4848	NAD83
Spring Hill Fast Lane Express	FLA418285	Hernando	IW	Private	0.0000	-	A	No	28282.9731	823040.6020	HARN
Timber Pines Community Association, Inc.	FLA733237	Hernando	IW	Private	0.0000	-	A	No	282811.7167	823616.7469	HARN

Appendix C: Public Comment