Priority Focus Area for Wekiwa and Rock Springs

Division of Environmental Assessment and Restoration
Florida Department of Environmental Protection

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Additional Information

The following individuals can provide additional information about the priority focus area for Wekiwa and Rock Springs:

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Introduction

Under the Florida Springs and Aquifer Protection Act, the Florida Department of Environmental Protection (DEP) is required to delineate priority focus areas (PFAs) for all Outstanding Florida Springs identified as impaired. According to the Florida Springs and Aquifer Protection Act, adopted by the Florida Legislature in 2016 (Chapter 373, Part VIII, Florida Statutes [F.S.]), *" Priority focus area' means the area or areas of a basin where the Floridan Aquifer is generally most vulnerable to pollutant inputs where there is a known connectivity between groundwater pathways and an Outstanding Florida Spring, as determined by the department in consultation with the appropriate water management districts, and delineated in a basin management action plan. . . . Using the best data available from water management districts and other credible sources, the department, in coordination with the water management districts, shall delineate priority focus areas for each Outstanding Florida Spring or group of springs that contains one or more Outstanding Florida Springs and is identified as impaired in accordance with s. 373.807. In delineating priority focus areas, the department shall consider groundwater travel time to the spring, hydrogeology, nutrient load, and any other factors that may lead to degradation of an Outstanding Florida Spring. The delineation of priority focus areas must be completed by July 1, 2018, shall use understood and identifiable boundaries such as roads or political jurisdictions for ease of implementation, and is effective upon incorporation in a basin management action plan."*

Factors to consider in establishing these geographically bounded areas include the following:

- Groundwater travel time to the spring, which could be based on empirical data from tracer studies and/or predicted travel time from modeling, if such data or studies are available.

- Hydrogeology, which includes the spring's groundwater contributing area (or springshed), the amount of confining material protecting the Floridan aquifer, the aquifer recharge characteristics, the capacity for the aquifer to transmit water, and other characteristics that help determine the aquifer vulnerability and the likelihood of adverse water quality impacts to springs.

- Nutrient load to the spring, which includes actual measured load in the water discharging from the spring as well as the potential nutrient load based on land uses in specific regions that would most probably influence water quality in the spring.

- Other factors, which include soil characteristics that are favorable for pollutant leaching to the aquifer in the springshed and the presence or absence of pollutant sources in the area.

- Identifiable boundaries, which include roads, natural boundaries, and political jurisdictions.

The following section describes the method used to delineate the proposed PFA for both Wekiwa and Rock Springs (which were combined due to their proximity to one another).

Steps in Delineating the Proposed Wekiwa–Rock Springs PFA

The proposed PFA for Wekiwa and Rock Springs was developed using geographic information system (GIS) tools, spring-specific data, and published information to help identify the portion of the springs' contributing area that is most important from the perspectives of both water quality restoration and protection. The steps discussed below were taken to develop a draft PFA for review and input by stakeholders. The overlapping of mapped characteristics that express high vulnerability, high potential for pollutant mobility, and likely pollutant sources provides the best assurance that the proposed PFA includes the areas of greatest concern for water quality restoration and protection.

Step 1. Establish the springshed for the priority spring(s)

The estimated combined springshed for Wekiwa and Rock Springs was developed by the St. Johns River Water Management District (SJRWMD) based on a flow path analysis of potentiometric surface contour maps developed by the U.S. Geological Survey (USGS) and the Florida Geological Survey (FGS) in cooperation with the water management districts. Flow pathways were compared for multiple dates to identify contributing areas that account for seasonal variation in flow direction. **Figure 1** shows the combined Wekiwa–Rock Springs springshed and the proposed PFA.

Step 2. Identify regions in the contributing area where the greatest recharge occurs

Several GIS coverages developed by the USGS and water management districts delineate areas of high, medium, and low recharge to the Floridan aquifer system as well as areas of aquifer discharge. The areas to be considered in the proposed PFA delineation are the areas of highest recharge to the aquifer. These could occur as diffuse infiltration through permeable geological material, as well as focused recharge to sinkholes that breach confining layers. Pollutant sources in high-recharge areas have the greatest potential for causing adverse impacts to groundwater and springs because water is impeded the least as it infiltrates to the aquifer from the surface. In high-recharge areas, recharge is 10 inches per year (in/yr) or greater.

The areas of high recharge shown in **Figure 2** are from a composite of two recharge coverages. Recharge for most of the area was included in a 2015 GIS coverage developed by the SJRWMD methodology.[1] However, a portion of the area shown in **Figure 2** was not included in the 2015 product, and thus the GIS coverage developed for a 2002 USGS model was also overlain.[2] The high-recharge areas represented in both coverages represent recharge of 10 in/yr or greater.

[1] Boniol, D., and K. Mouyard. 2016. *Recharge to the upper Floridan aquifer in the St. Johns River Water Management District.* Technical Fact Sheet SJ2016-FS1.

[2] Sepulveda, N. 2002. *Simulation of ground-water flow in the intermediate and Floridan aquifer systems in peninsular Florida.* USGS Water Resources Investigation Report 02-4009.

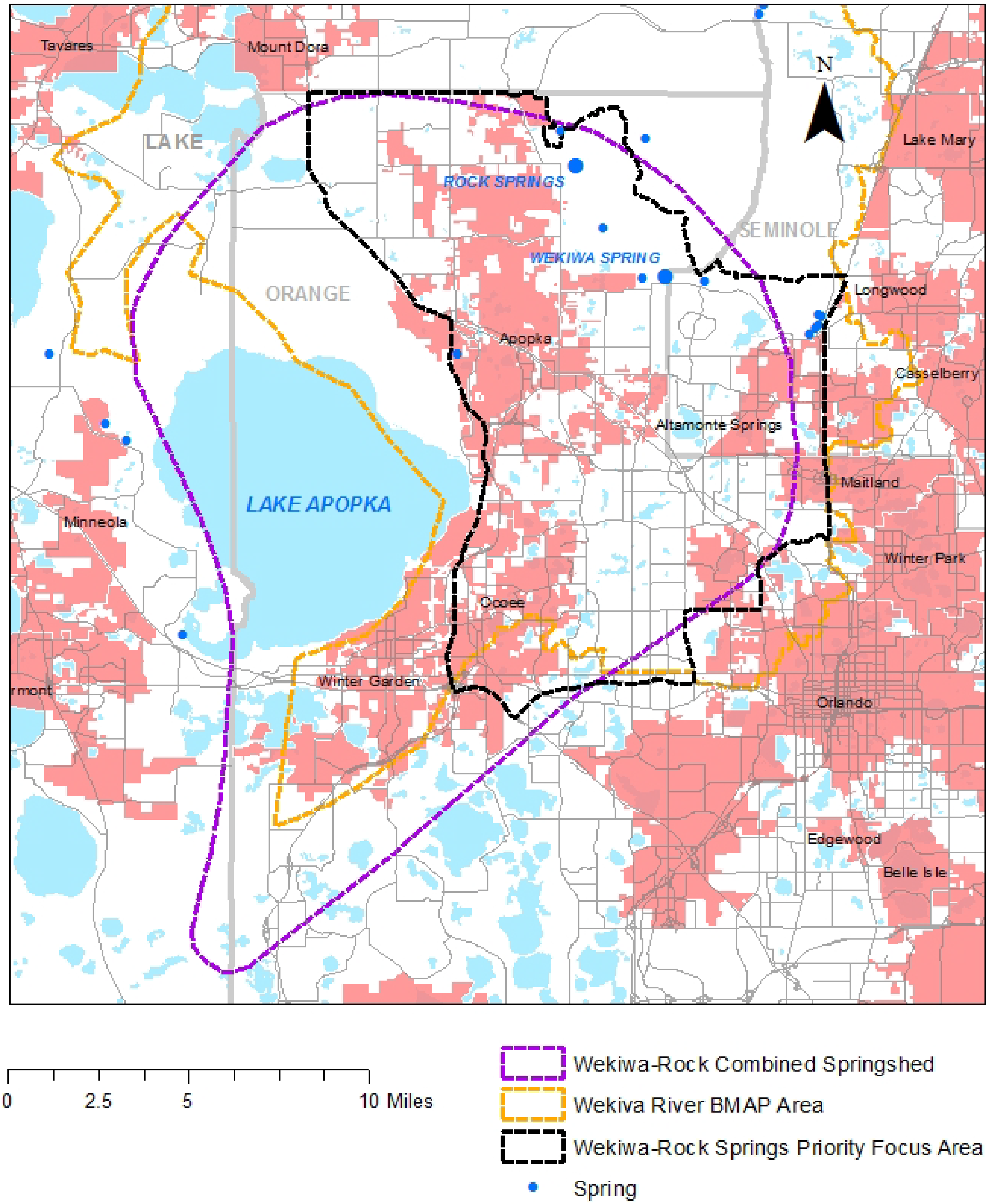

Figure 1. Combined Wekiwa–Rock Springs springshed and proposed PFA

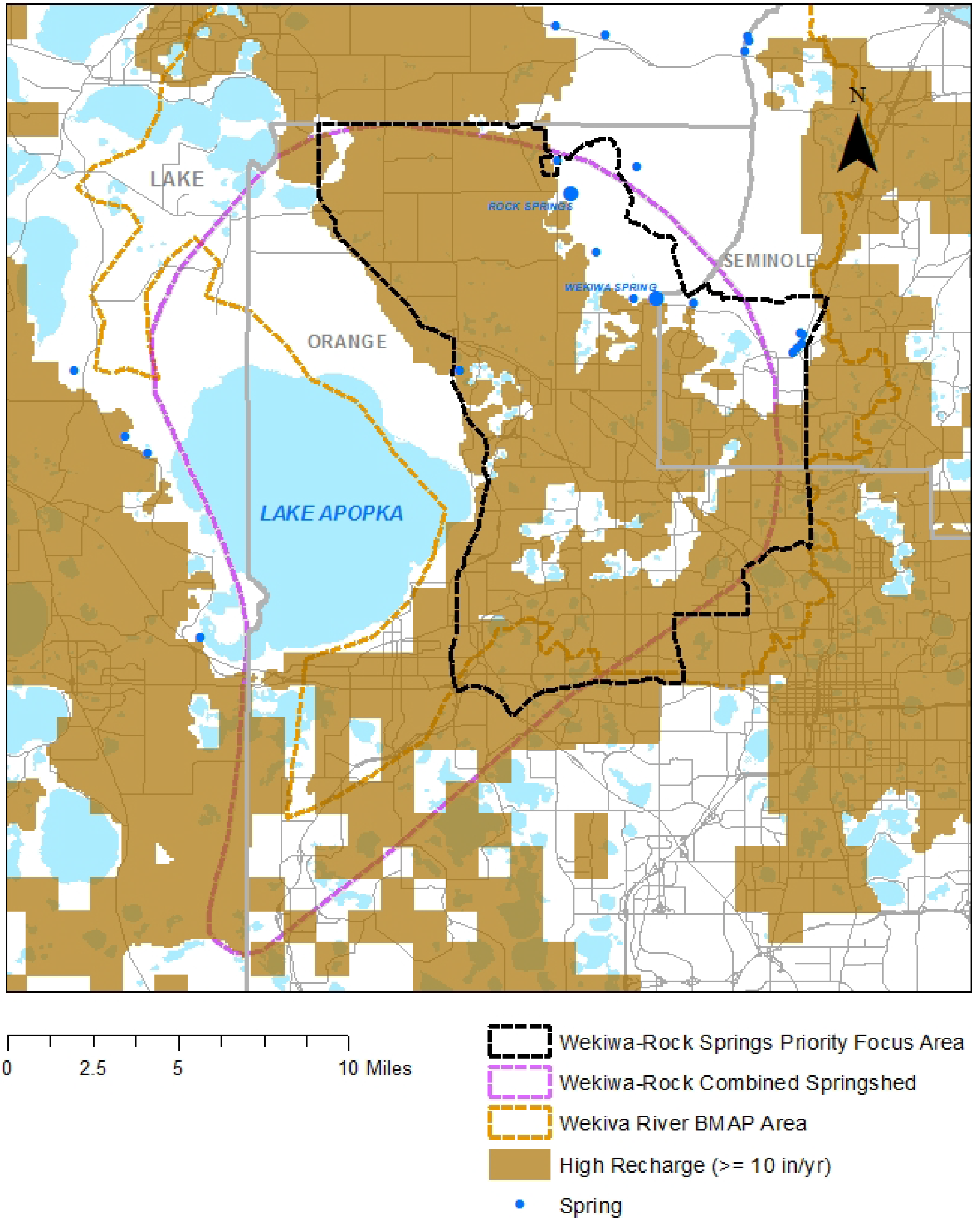

Figure 2. Areas of high recharge to the Floridan aquifer (≥10 in/yr) and proposed PFA based on SJRWMD 2015 and USGS 2002 methodologies

Step 3. Identify regions in the springshed where the Floridan aquifer is most vulnerable

In 2005 the FGS assessed the vulnerability of the Floridan aquifer in the Wekiva River Basin.[3] The map in **Figure 3** summarizes the modeling results. The model was based on the methodology developed for the Florida Aquifer Vulnerability Assessment (FAVA) model created by the FGS to provide spatial coverage of aquifer vulnerability ranges across an area.[4] Often, the areas of greatest aquifer vulnerability occur where aquifer recharge is also greatest. The Wekiva Area Vulnerability Assessment (WAVA) shows that most of the Wekiwa–Rock Springs springshed is in the "vulnerable" and "more vulnerable" categories.

Step 4. Consider nitrogen load

The Wekiva River and Rock Springs Run were verified as impaired due to total phosphorus (TP) and nitrate-nitrogen, based on evidence of an imbalance of aquatic flora. The major source of flow and nutrients in the upper reaches of these 2 waterbodies is groundwater discharged from Wekiwa and Rock Springs. In the basin management action plan (BMAP), recent median nitrate concentrations in Wekiwa Spring and Rock Springs Run were reported as 0.92 and 0.98 milligrams per liter (mg/L), respectively.[5] Recent TP concentrations for the 2 springs (from the BMAP) were 0.113 and 0.083 mg/L, respectively.

It is generally understood that the natural geological material contains phosphorus, which is imparted to groundwater and springs. The natural contribution of phosphorus to concentrations in the springs is thought to be significant. In the Middle St. Johns Basin, median background phosphorus concentrations (as orthophosphate) in groundwater were as high as 0.105 mg/L.[6] Nitrate-nitrogen has become the major nutrient of concern in Florida's spring systems due to its pervasive nature in groundwater, its mobility, and its availability for uptake by aquatic flora when it is discharged from springs.

The nitrogen load from Wekiwa and Rock Springs depends on concentration and flow. Using recent median nitrate concentrations from the BMAP and recent flows of 58 and 55 cubic feet per second (cfs) for Wekiwa and Rock Springs, respectively, from the SJRWMD springs data portal, an estimated total nitrogen (TN) load (as nitrate) from the 2 springs is about 200,000 pounds per year (lb/yr).

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[3] Cichon, J.R., A.E. Baker, A.R. Wood, and J.D. Arthur. 2005. *Wekiva aquifer vulnerability assessment.* FGS Report of Investigation 104.

[4] Arthur, J.D., A.R. Wood, A.E. Baker, J.R. Cichon, and G.L. Raines. 2007. Development and implementation of a Bayesian-based aquifer vulnerability assessment in Florida. *Natural Resources Research* 16(2): 93–107. Additional information is available on the DEP FAVA website.

[5] DEP. October 2015. *Basin management action plan for the implementation of total maximum daily loads for nutrients in the Middle St. Johns River Basin for Wekiva River, Rock Springs Run, and Little Wekiva Canal.* Tallahassee, FL: Division of Environmental Assessment and Restoration Watershed Restoration Program.

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

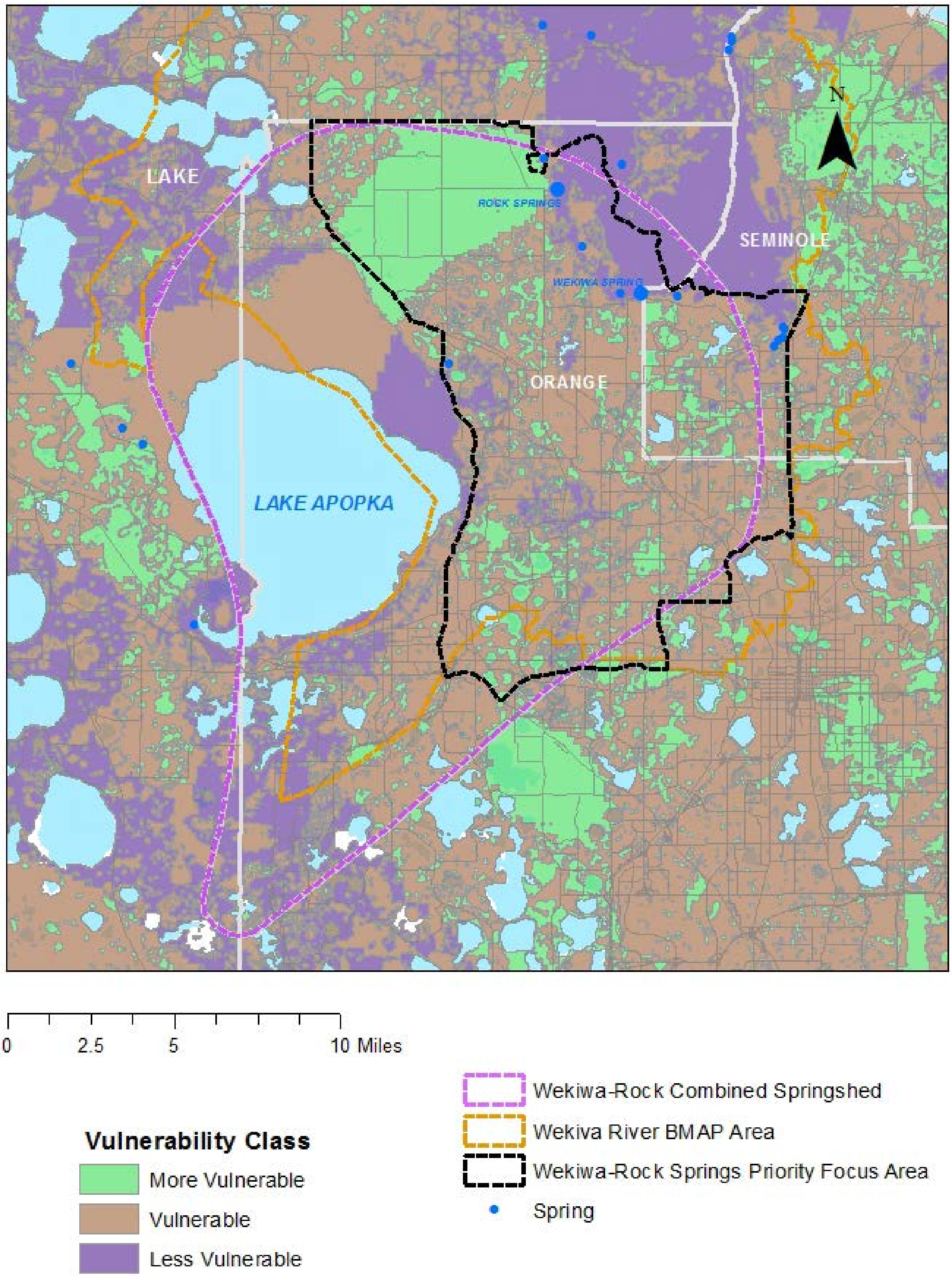

Figure 3. Wekiva-area aquifer vulnerability assessment and proposed PFA

A nitrogen source inventory will be developed in 2017 for the Wekiwa–Rock Springs contributing area to serve as a tool for developing remediation strategies and projects for reducing loads to the springs and river. Until that inventory is complete, an existing tool can provide general information. The nitrogen source loading inventory developed in 2010 by a SJRWMD contractor for the entire Wekiva River Basin includes an estimate of 1,800 metric tons per year (4 million lb/yr) of nitrogen to groundwater and the river system.[7] This inventory identified agricultural fertilizer, onsite treatment and disposal systems (OSTDS) (septic systems), residential fertilizer, and wastewater treatment facilities (WWTFs) as the sources contributing the highest percentages of the total estimated load to the groundwater and river system in the basin.

In a recent modeling effort, the SJRWMD used the Soil Treatment Unit Model for Florida (STUMOD-FL), developed as part of the Florida Department of Health (FDOH) Florida Onsite Nitrogen Reduction Strategies study to estimate nitrogen loading to the vadose zone from OSTDS in the Wekiwa–Rock Springs contributing area.[8] Coupling this result with recharge data, the SJRWMD simulated OSTDS-related loading to the Floridan aquifer and identified potential "hot spots" in the springshed where loads from OSTDS were shown by the model to be greatest. Higher loads occur where the combination of high OSTDS density, soils favorable for nitrogen leaching, and high-recharge conditions exist. **Figure 4** shows the modeled results for an area including the proposed PFA.

Step 5. Consider groundwater travel time in creating the PFA boundaries

To the extent possible, the proposed PFA should include parts of contributing areas with demonstrated or anticipated short travel times to the springs. Springs occur in areas of karst terrain where surface and subsurface erosion of the limestone can result in the development of complex networks of solution channels and conduits in the aquifer material. In these areas, groundwater can potentially move rapidly from points where the water enters the aquifer to the spring vents. The Wekiwa–Rock Springs springshed includes areas of more dynamic flow where infiltrating water has caused the dissolution and erosion of conduits in the limestone matrix and areas where the limestone is confined by layers of lower permeability material that inhibit the erosion of limestone by percolating water. In areas where conduits do not exist, groundwater movement occurs within intergranular pore spaces in the limestone and is slower.

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[7] MACTEC. March 2010. *Final report, Wekiva River Basin nitrate sourcing study.* MACTEC Project No. 6063090160A. Prepared for the SJRWMD.

[8] Canion, A. December 16, 2016. *Spatial OSTDS load estimates for Wekiwa and Rock Springs using STUMOD-FL.* SJRWMD Interoffice memorandum to Casey Fitzgerald.

Hazen and Sawyer. June 2014. *Task D.10. Validate/refine complex soil model.* FDOH Contract CORCL. Prepared for FDOH Onsite Sewage Programs.

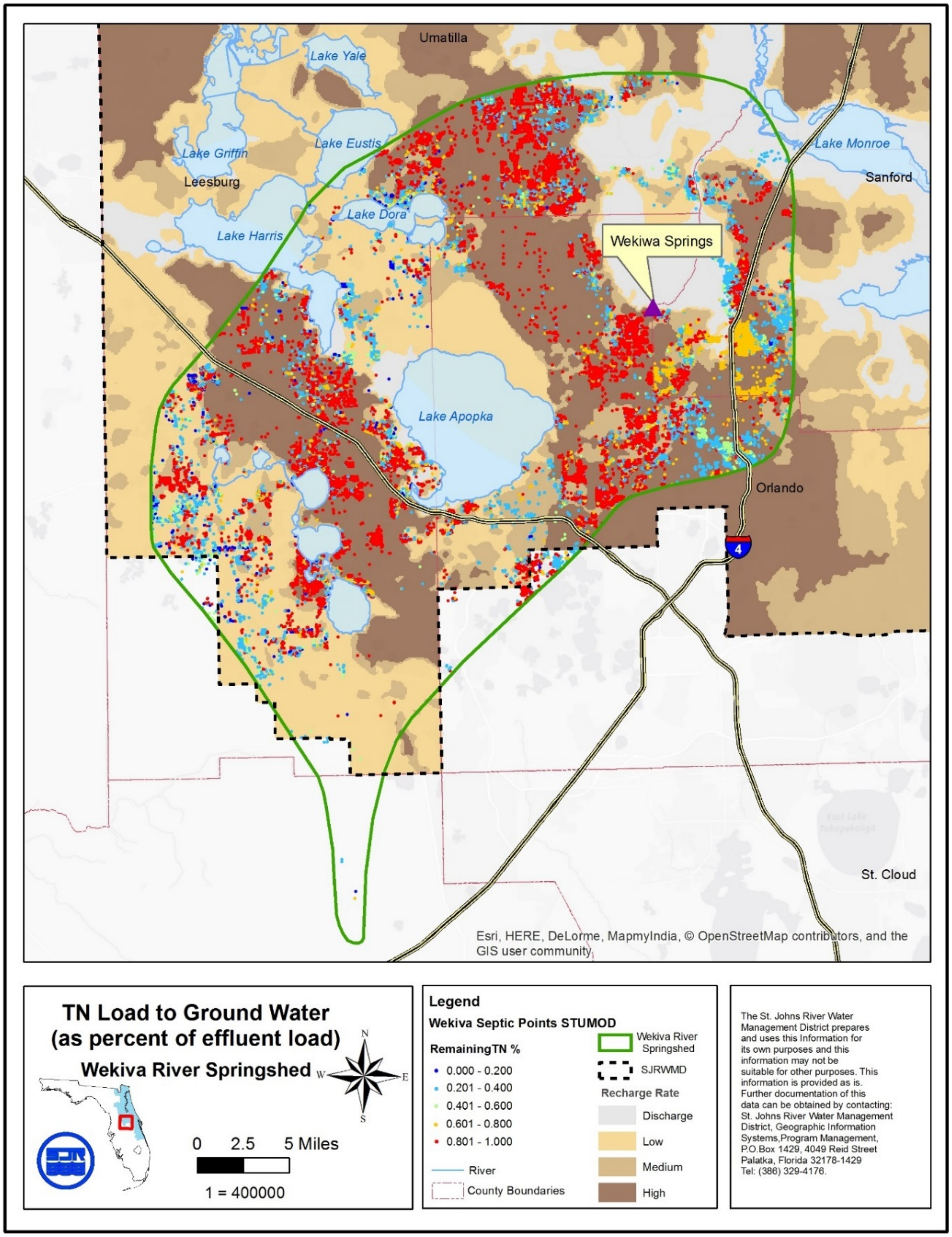

Figure 4. SJRWMD TN load to groundwater from OSTDS, expressed as percent of original effluent load (incorporates STUMOD-FL model runs and recharge weighting of load)

In 2014 and 2015, DEP conducted 2 tracer tests to evaluate groundwater flow rates to Rock and Wekiwa Springs.[9] In each test, a gaseous tracer (sulfur hexafluoride) was introduced into a well installed specifically for that purpose. The tracer was introduced into the Floridan aquifer limestone at a well located 1.5 miles west (upgradient) of Rock Springs and arrived at the springs in less than 1 week, traveling at an estimated velocity of 980 feet per day. The tracer was also introduced into the limestone at a well located 1.5 miles southwest (also upgradient) of Wekiwa Spring and arrived at the spring within 50 days, traveling at a significant but somewhat lower velocity (137 feet per day).

The difference between travel times at these two locations may be related to the development of conduits and level of confinement of the aquifer at the two locations. At the site near Rock Springs (located in a "more vulnerable" area) (**Figure 3**), the aquifer is unconfined and there is significant development of conduits and enlarged pore spaces in the aquifer material. However, at the tracer injection site southwest of Wekiwa Spring, the aquifer is confined, the limestone has been subjected to less erosion, and there are fewer and smaller conduits to allow the rapid movement of water.

Regardless, the rate of groundwater transport from both traces indicate that once nitrate reaches the aquifer, migration to either spring can be rapid. Based on the lower value, which is likely to be more representative of the aquifer throughout the springshed, groundwater transport could be more than 10 miles per year. **Figure 5** shows a 10-mile radius surrounding both springs and a shaded region that is a very simplified representation of the area from which groundwater could travel to the springs within a year's time.

Step 6. Identify regions in the contributing area where soil conditions are most favorable for the leaching of nitrogen from surface sources

Nitrogen is the target nutrient for spring restoration. Research has shown that the removal of nitrogen in the soil zone through denitrification and its tendency to leach is related to soil drainage class.[10] Denitrification is lowest and nitrogen leaching is highest in areas with soils that are excessively drained, somewhat excessively drained, or well drained. Leaching may occur in areas with moderately well-drained soils and is least likely to occur in soils that are poorly drained, somewhat poorly drained, or very poorly drained because of their greater potential for denitrification.

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[9] DEP. June 30, 2016. *Summary report Wekiva Basin groundwater tracer study for Rock and Wekiwa Springs.* Tallahassee, FL: Division of Environmental Assessment and Restoration.

[10] Otis, R.J. 2007. *Estimates of nitrogen loadings to groundwater from onsite wastewater treatment systems in the Wekiva Study Area, Task 2 report, Wekiva onsite nitrogen contribution study.* Prepared by Otis Environmental Consultants for FDOH.

Hofstra, N., and A.F. Bouwman. 2005. Denitrification in agricultural soils: Summarizing published data and estimating global annual rates. *Nutrient Cycling in Agroecosystems* 72: 267–278.

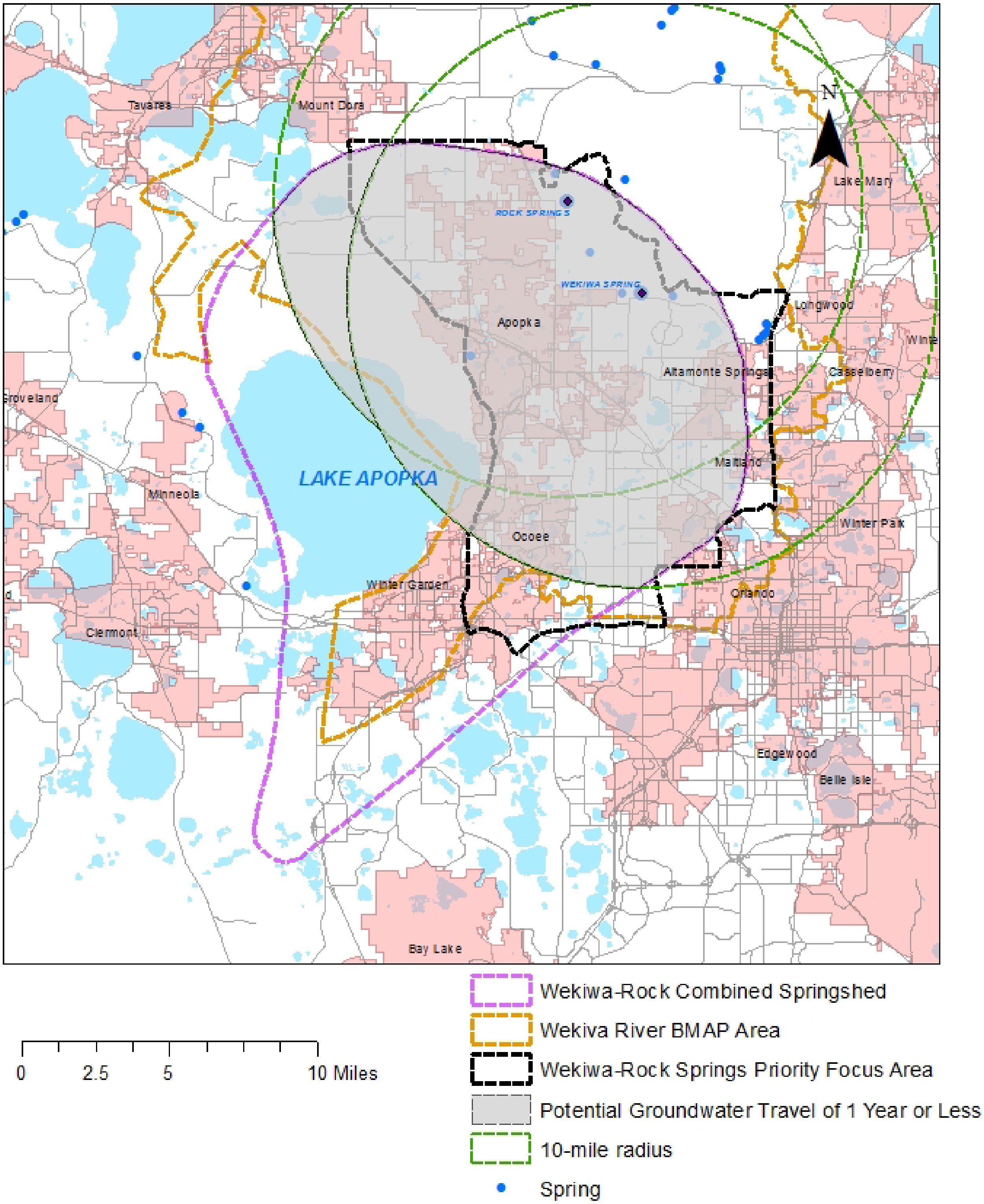

Figure 5. Wekiwa and Rock Springs, estimated area of potential one-year groundwater travel, and proposed PFA

The portions of the contributing area where soil conditions are more favorable for nitrogen leaching can be mapped using the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database for Florida.[11] These excessively to well-drained soils tend to occur in areas where aquifer recharge is highest and vulnerability is greatest. **Figure 6** shows the area where soil conditions are most favorable for nitrogen leaching. This includes soils in the excessively drained, somewhat excessively drained, and well-drained SSURGO drainage classes. The areas of higher soil drainage are similar to the higher groundwater recharge areas.

Step 7. Identify regions in the contributing area to exclude or include based on land use and potential pollutant sources

Conservation lands, wetlands, and undeveloped open lands protected from development may be excluded from the PFA if there is no expectation that they would include pollutant sources affecting springs in the foreseeable future and are under protection. The most significant conservation areas within or adjacent to the Wekiwa–Rock Springs springshed include the state-managed Wekiwa Springs State Park, Rock Springs Run State Reserve, and Lake Apopka Restoration Area. The springshed also includes Orange County's Kelly Park, as well as other smaller parks. **Figure 7** shows conservation lands from the Florida Natural Areas Inventory Conservation Lands (FNAI Managed Areas) GIS layer. The proposed PFA boundary includes Wekiwa Springs State Park and Kelly Park, which include Wekiwa and Rock Springs, respectively.

Most of the Wekiwa–Rock Springs contributing area is in urban land uses, but the area also includes scattered areas of agricultural land use. The proposed PFA delineation also includes the consideration of areas with significant potential for nitrogen leaching to groundwater based on the sources of nitrogen that occur there. In its nitrogen source inventory, MACTEC reported that the main sources of nitrogen loading in the Wekiva River Basin (which includes most of the Wekiwa–Rock Springs springshed) were agricultural fertilizer, OSTDS, urban fertilizer, and wastewater facilities. These occur in urban and agricultural land use areas. **Figure 8** shows mapped urban and agricultural lands (based on the 2009 SJRWMD land use–land cover GIS coverage).

Figure 9 shows the locations of OSTDS in the area, based on GIS coverage developed as part of the FDOH Florida Water Management Inventory Project.

[11] The SSURGO Database is a digital soil survey developed by the National Cooperative Soil Survey. The dataset includes georeferenced digital map data and computerized attribute data. Metadata are available online.

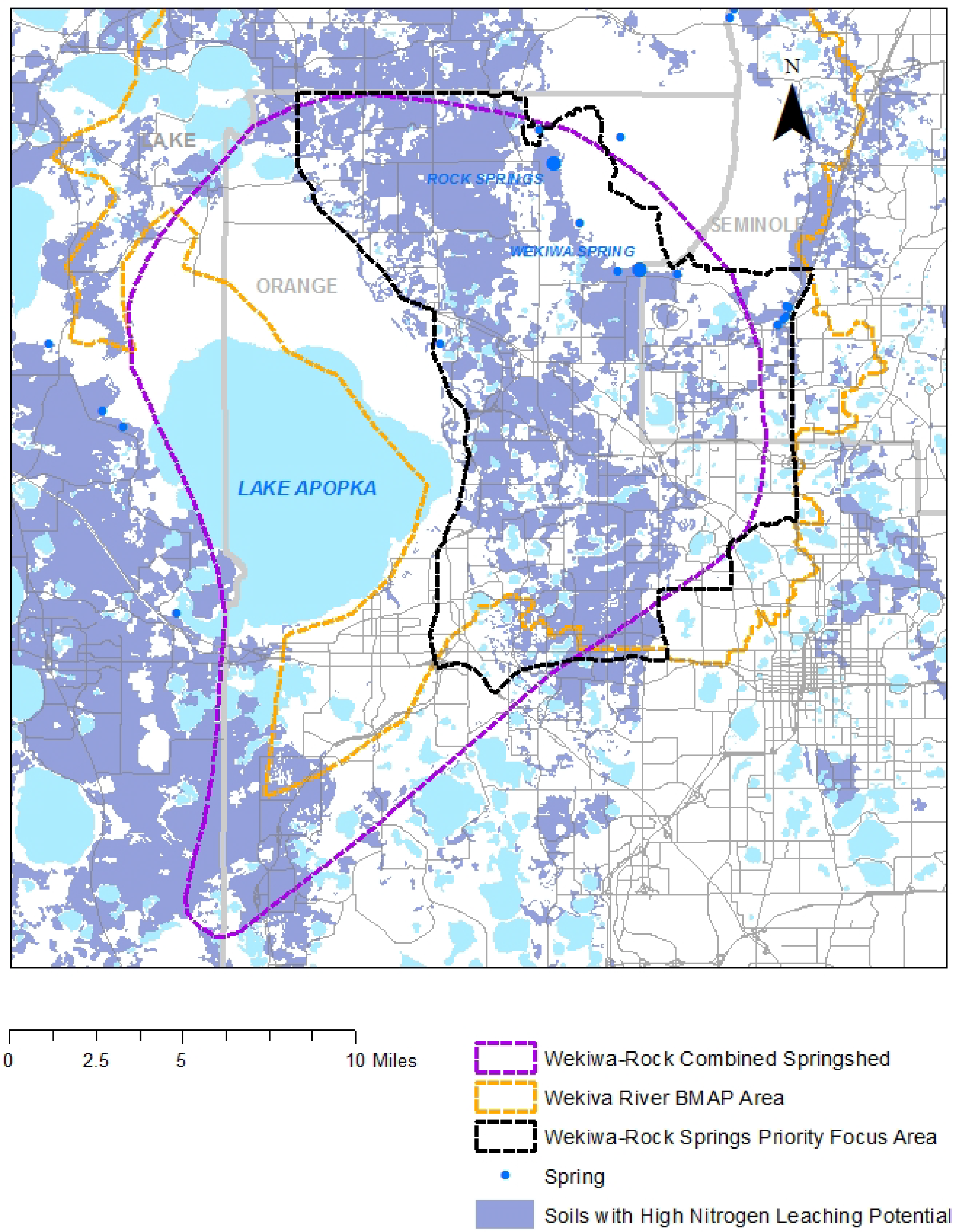

Figure 6. Areas with potential high nitrogen leaching in soils and proposed PFA

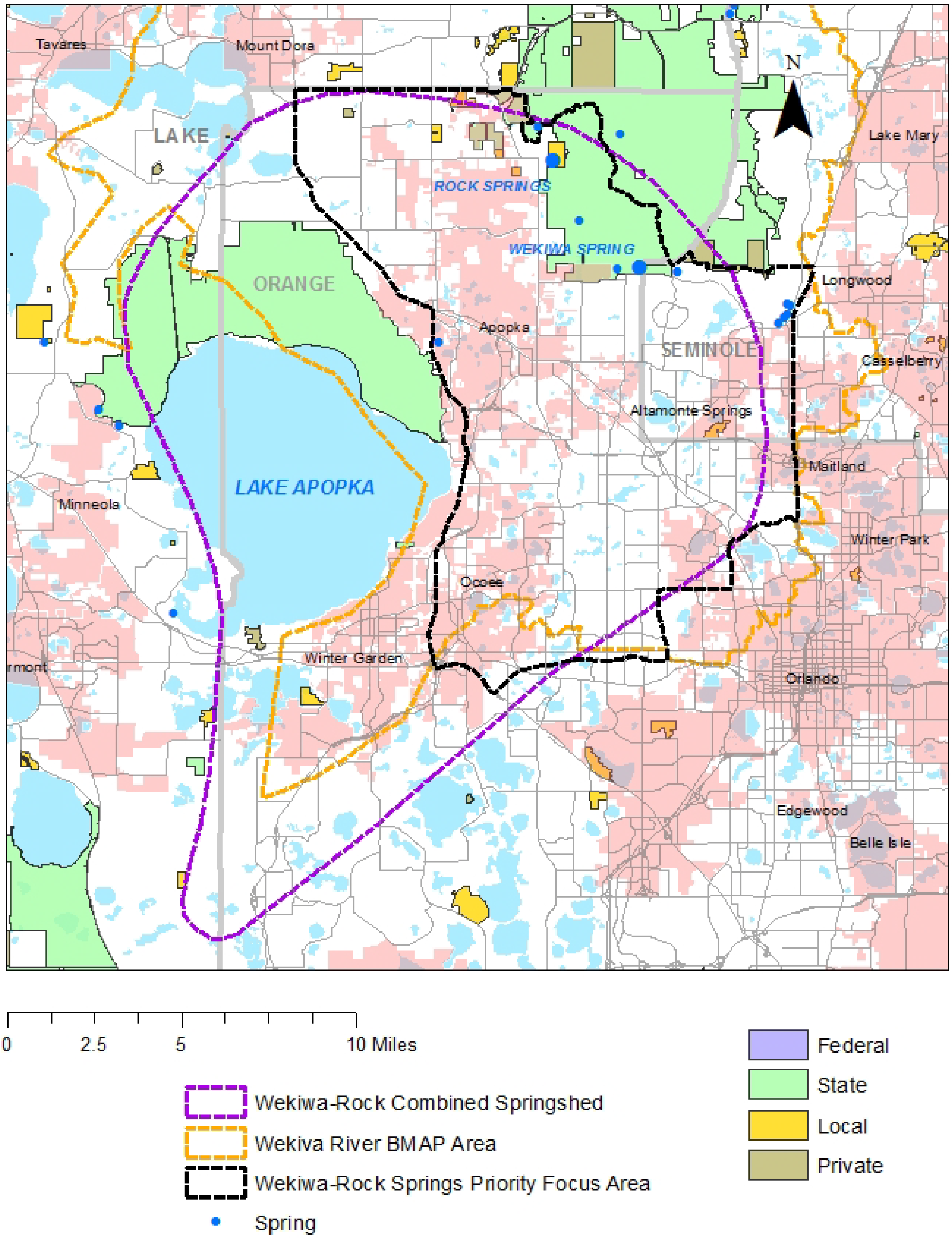

Figure 7. Conservation lands and proposed PFA

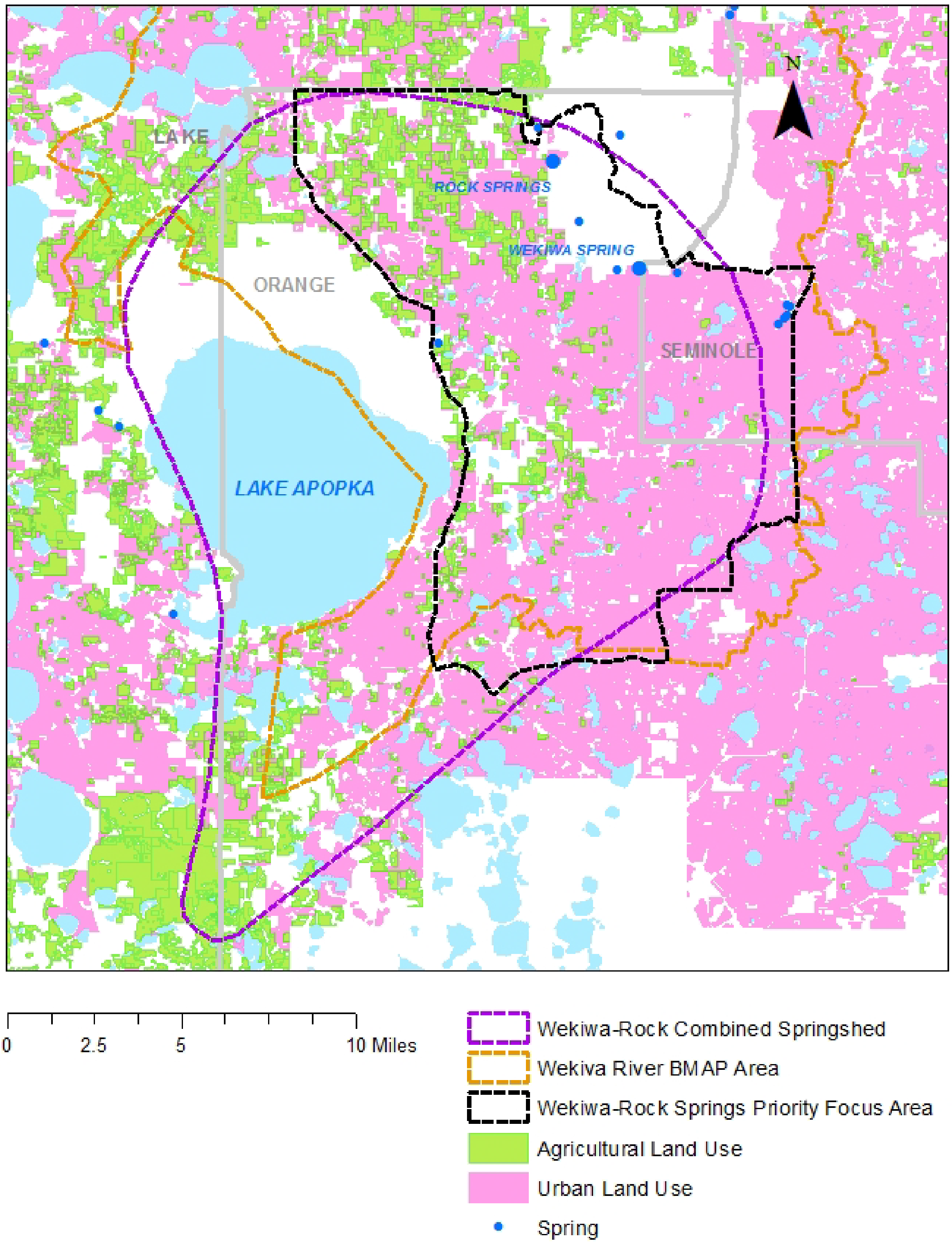

Figure 8. Urban and agricultural land use areas and proposed PFA

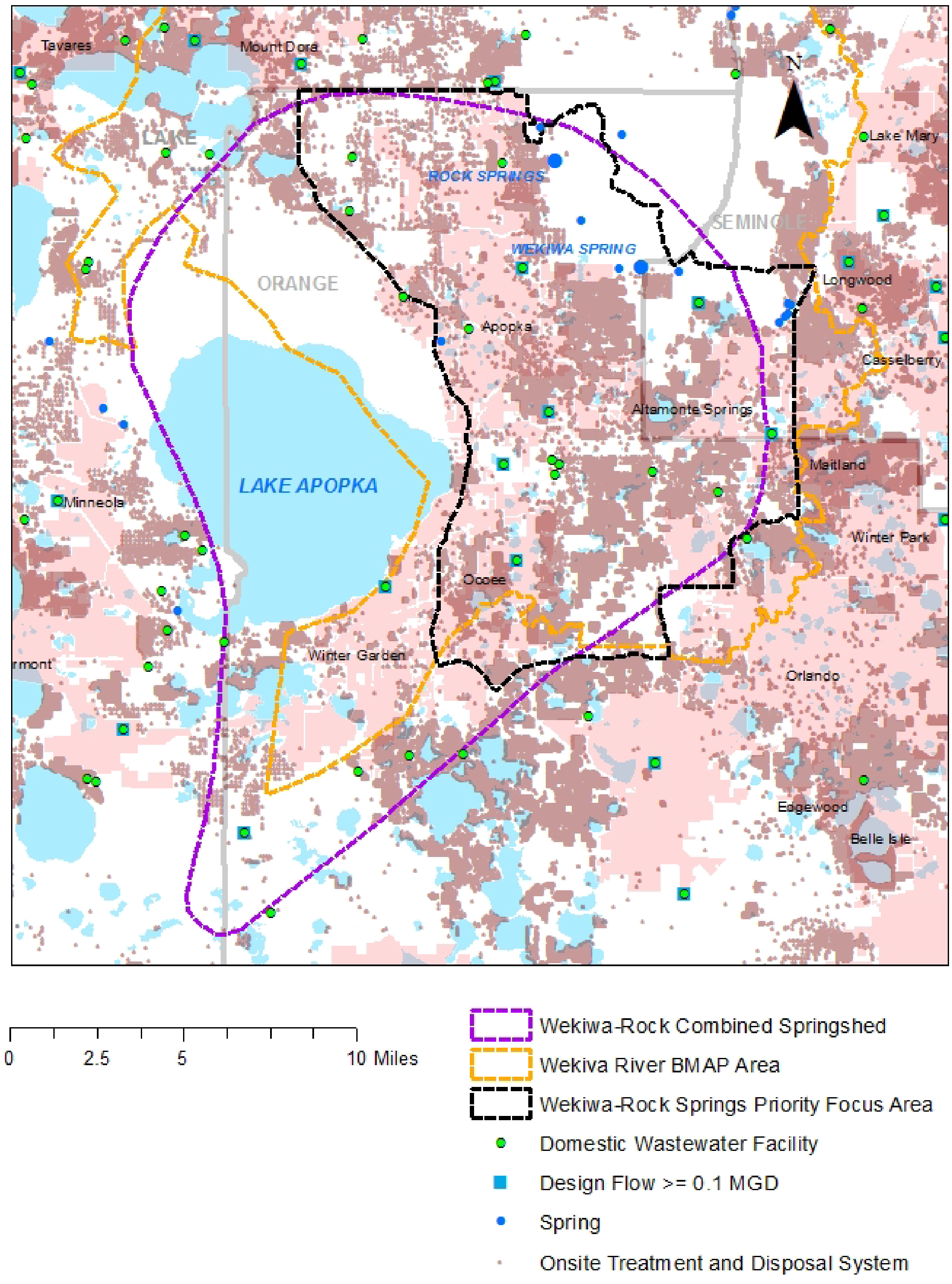

Figure 9. OSTDS, domestic WWTFs, and proposed PFA

Existing domestic wastewater facilities, including those with design flows greater than or equal to 0.1 million gallons per day (mgd), are also shown in **Figure 9** because they also have the potential to contribute nitrogen to groundwater. However, many of the wastewater facilities have upgraded and provide better treatment of nitrogen than they did when the basinwide nitrogen inventory was developed. Domestic wastewater facility information for the two springsheds was obtained from the DEP Wastewater Facility Regulation (WAFR) Database.

Step 8. Create PFA boundaries that correspond with understood and identifiable geographic, hydrologic, and political features

For stakeholders to implement restoration and protection actions, the proposed PFA boundaries must be clearly defined and associated with features and boundaries easily recognizable on a map, including geographic, hydrologic, and political features. The proposed PFA for Wekiwa and Rock Springs was developed based on several readily identifiable conservation area boundaries, political boundaries, and major roads.

Proposed PFA Boundary for Wekiwa and Rock Springs

The proposed PFA boundary shown in **Figure 10** was developed by overlaying GIS coverages of recharge, vulnerability, soils, conservation lands, and potential contaminant nitrogen source information. It includes a region in the northeastern part of the combined springshed with high groundwater recharge/vulnerability conditions and soils that tend to leach nitrogen. It includes modeled areas of higher nitrogen loading from OSTDS, as well as an area of the springshed over which groundwater travel to the springs could occur within one year or less. The proposed PFA also includes interconnected areas with urban development, OSTDS, agriculture, and WWTFs, all of which have the potential to contribute to nitrogen enrichment in the aquifer and springs. Agricultural fertilizer, OSTDS, and urban turf fertilizer were identified in a nitrogen source inventory of the Wekiva River Basin, and these may also be among the more significant sources of nitrogen loading to groundwater in the Wekiwa–Rock Springs springshed.

In addition, conservation land boundaries, natural features, political boundaries, and roads in the area were considered in the development of a readily identifiable boundary. The proposed PFA is in Orange and Seminole Counties. It includes parts of the following cities: Apopka, Ocoee, Altamonte Springs, Maitland, and Orlando. It includes the unincorporated areas of Orange and Seminole Counties, as well as all or parts of the following communities: Zellwood, South Apopka, Wekiwa Springs, Clarcona, Pine Hills, Lockhart, Forest City, Eatonville, Fairview Shores, and Paradise Heights. The area also includes Wekiwa Springs State Park and Kelly Park, which contain Wekiwa and Rock Springs, respectively.

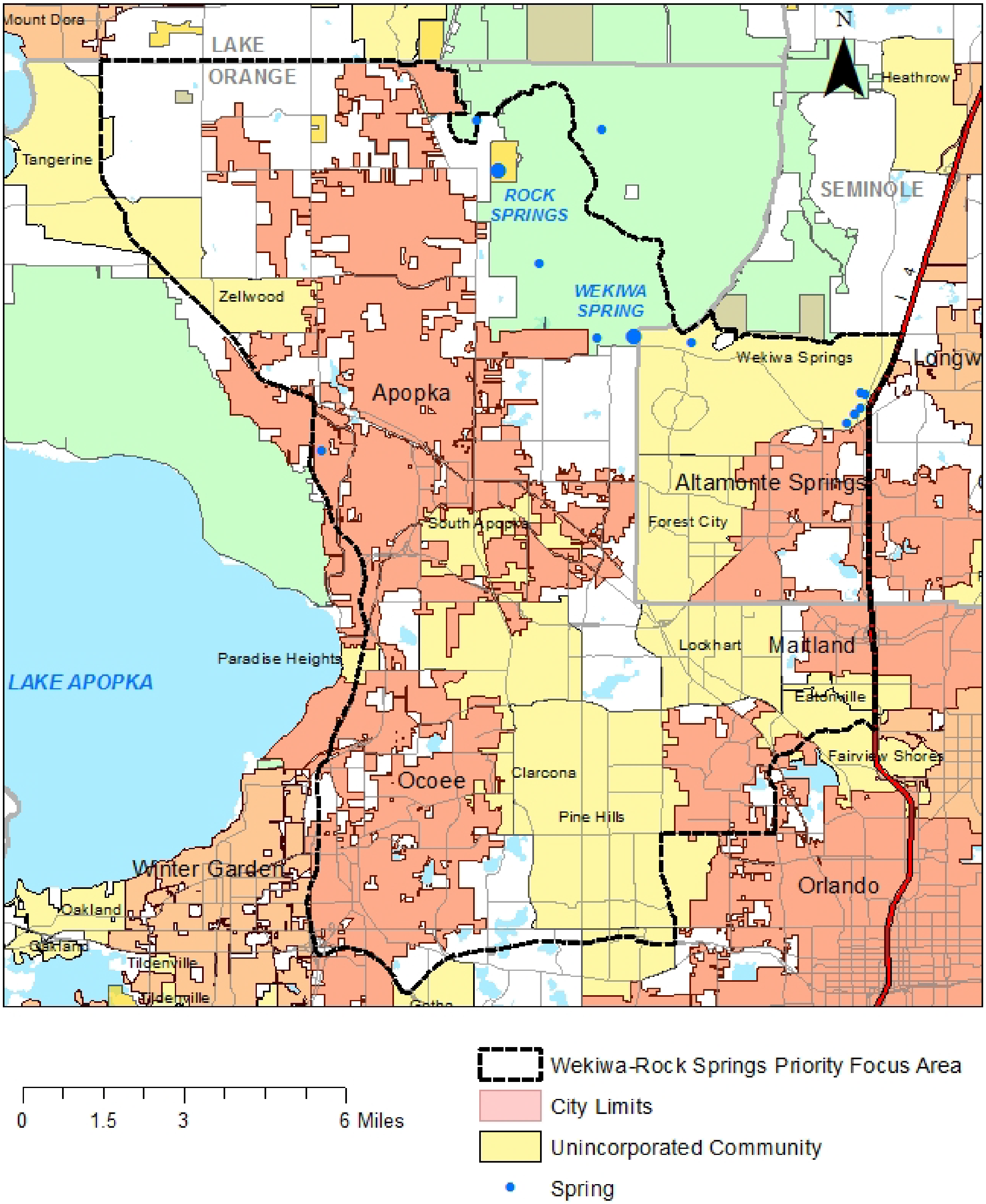

Figure 10. Proposed PFA boundary for Wekiwa and Rock Springs

Appendix A. Important Links

Cover page:
DEP home page: www.dep.state.fl.us

p. 2, Additional Information
Moira Homann email address: moira.homann@dep.state.fl.us
Richard Hicks email address: richard.w.hicks@dep.state.fl.us

p. 8, Step 4:
SJRWMD springs data portal: http://www.sjrwmd.com/springs/discharge.html

p. 8, Footnote 4:
DEP FAVA website: http://www.dep.state.fl.us/geology/programs/hydrogeology/fava.htm

p. 14, Step 7:
FDOH Florida Water Management Inventory Project:
http://www.floridahealth.gov/environmental-health/onsite-sewage/research/flwmi/index.html

p. 14, Footnote 11:
SSURGO metadata website: https://catalog.data.gov/dataset/soil-survey-geographic-ssurgo-database-for-various-soil-survey-areas-in-the-united-states-