Priority Focus Area for Jackson Blue Spring

Division of Environmental Assessment and Restoration

Florida Department of Environmental Protection

October 2017

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More Information

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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* [DEP] *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 the 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, including 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, including roads, natural boundaries, and political jurisdictions.

Steps in Delineating the PFA for Jackson Blue Spring

The PFA boundary for Jackson Blue Spring, including related springs downstream, 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 both water quality restoration and protection perspectives. The steps listed below were taken to develop a draft PFA for review and input by stakeholders. The consideration of mapped characteristics that express high vulnerability, a high potential for pollutant mobility, and likely pollutant sources provides the best assurance that the PFA includes the areas of greatest concern for water quality restoration and protection.

Step 1. Establish the springshed for the priority spring(s). The Northwest Florida Water Management District (NWFWMD) delineated the springshed boundary for Jackson Blue Spring in 2007 using the methodology described in Bartel et al. (2011).[1] The aquifer potentiometric surface and groundwater flow gradients were the main basis for the delineation of the springshed.

The expanded Jackson Blue Spring Springshed, representative of the contributing area for Jackson Blue plus the downstream springs along Merritt's Mill Pond (Shangri-La, Indian Washtub, Twin Caves, Hole-In-The-Wall, Heidi Hole, and Gator Hole Springs) was used for this assessment. Also considered was the Jackson Blue Spring/Merritt's Mill Pond Basin Management Action Plan (BMAP) restoration area boundary. **Figure 1** shows the springshed, BMAP area, and PFA boundaries.

Step 2. Identify regions in the contributing area where the greatest recharge occurs. Several GIS coverages developed by the U.S. Geological Survey (USGS), water management districts, and others 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 PFA delineation are the areas of highest recharge to the aquifer, which 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 the 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.

Unfortunately, water management district or USGS recharge coverages are not currently available for the Jackson Blue Springshed. However, another GIS coverage is available to help define the recharge regime for priority setting and provide recharge information for the springshed. This layer, developed by the Florida Natural Areas Inventory (FNAI) for state land acquisition priority ranking, identifies areas of potential recharge important for natural systems

[1] Bartel, R.L., K Barrios, M. Pritzl, and K. Coates. June 2011. *Jackson Blue Spring water resources assessment.* NWFWMD Water Resources Assessment 11-01.

and human use based on features that contribute to aquifer vulnerability, as well as areas in springshed protection zones near public water supply wells.[2] In this coverage, higher priority areas are those with the greatest recharge to the Floridan aquifer. **Figure 2** shows the FNAI recharge coverage for the Jackson Blue Spring region in Florida.

[2] FNAI. December 2000. *Florida Forever conservation needs assessment summary report to the Florida Forever Advisory Council*.

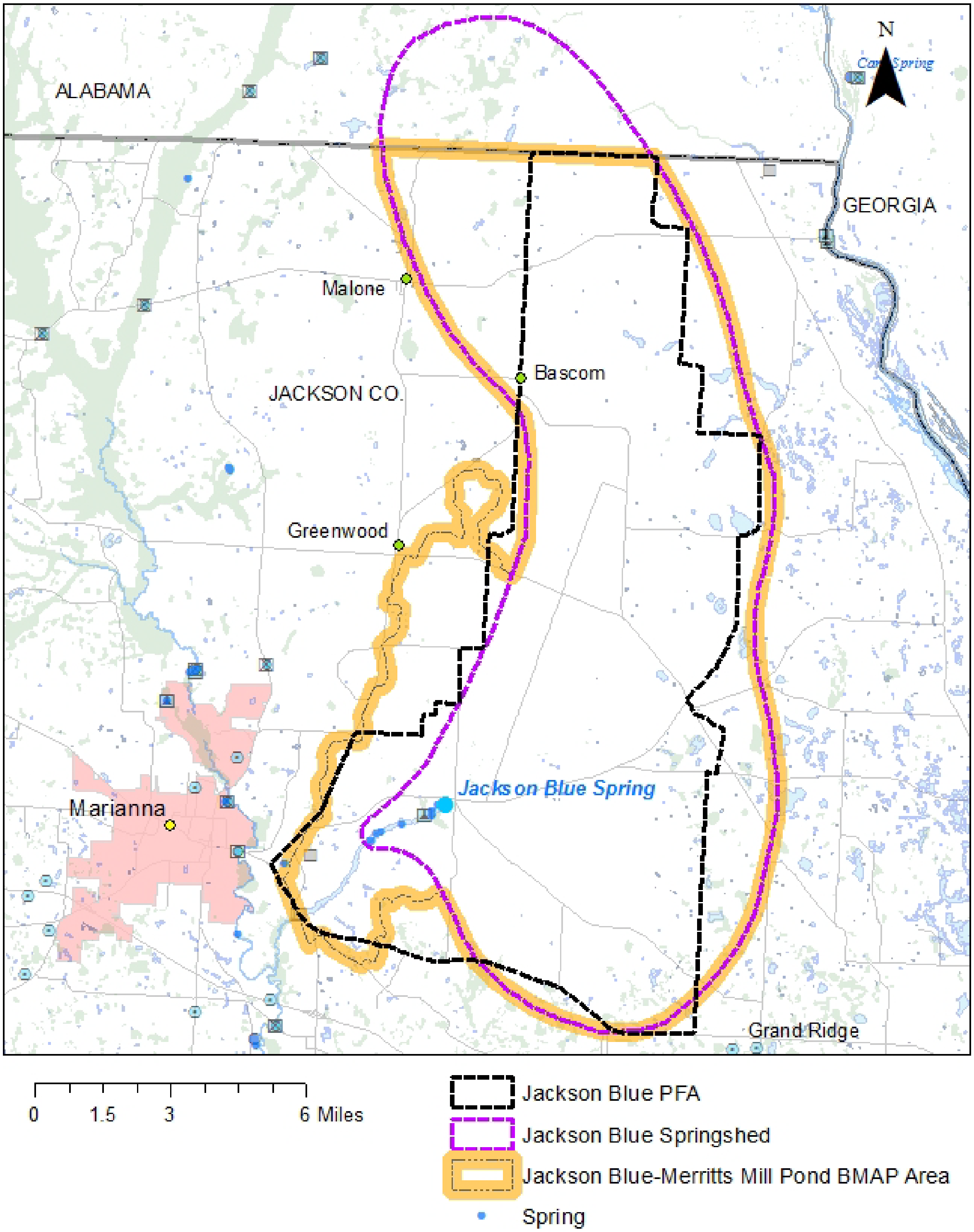

Figure 1. Jackson Blue Springshed, Jackson Blue/Merritt's Mill Pond BMAP area, and PFA boundary

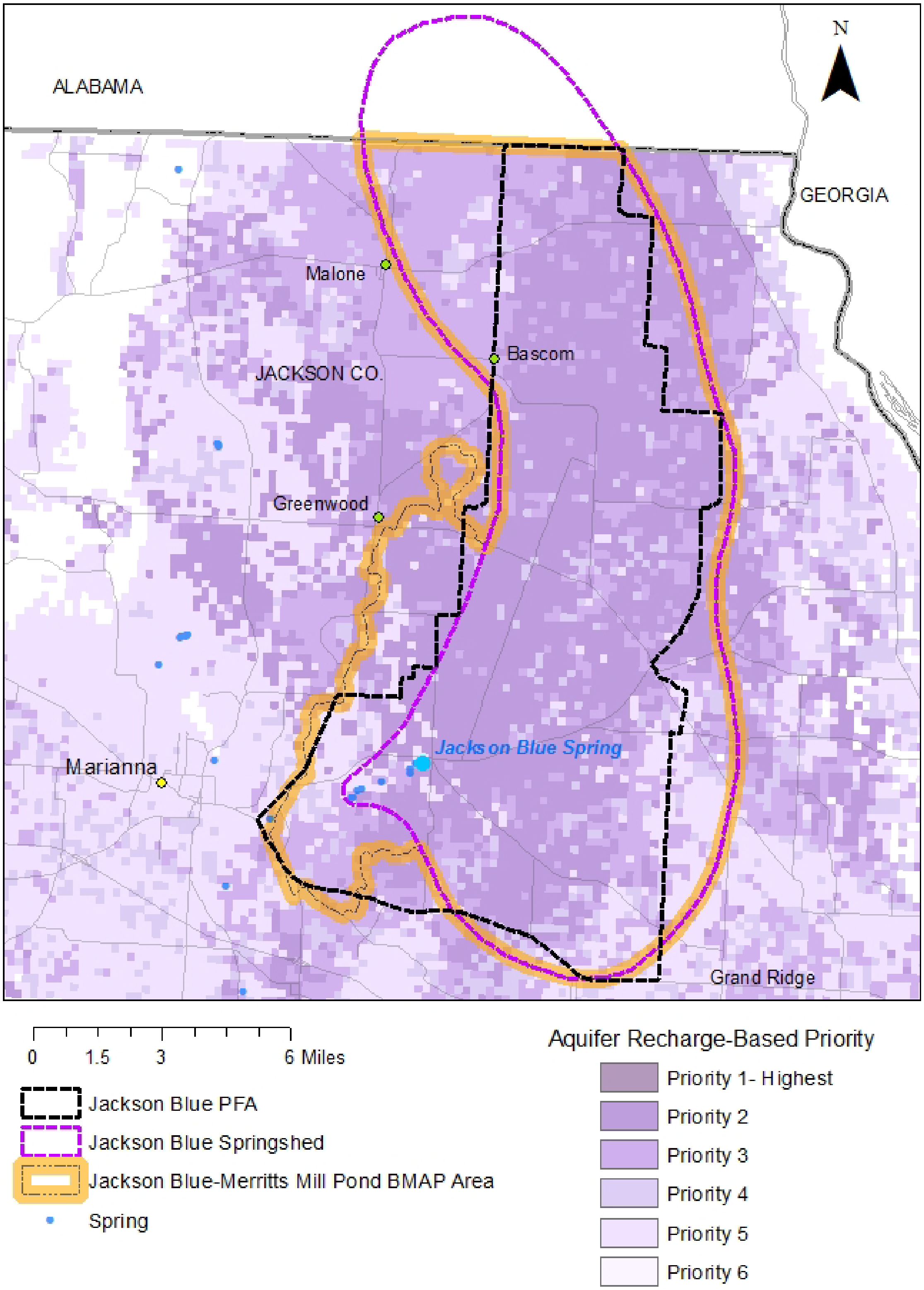

Figure 2. Florida state lands recharge-based prioritization coverage and PFA boundary

Step 3. Identify regions in the springshed where the Floridan aquifer is most vulnerable. The Florida Geological Survey (FGS) developed the Florida Aquifer Vulnerability Assessment (FAVA) model to provide spatial coverage of aquifer vulnerability ranges across an area of interest.[3] According to the statewide FAVA model for the Floridan aquifer system, the entire Jackson Blue Springshed in the "more vulnerable" category (**Figure 3**).

As a further refinement, the vulnerability of the aquifer to local points of recharge through sinkholes and linear karst features was evaluated by evaluating closed depressions and swallets, which represent localized areas of high vulnerability. In this area, which is in a karst plain, most closed topographic depressions form as solution or collapse sinkholes, and water flowing into these features can more rapidly reach the aquifer. Dry or intermittent stream traces, shown in the coverage, can have associated subterranean conduit networks. Swallets, which are sinkholes that capture stream flow, can provide a direct conduit for surface water discharge into the aquifer. In 2007, the FGS completed a project to map all known swallets in the state and produced a GIS layer that includes their locations. **Figure 4** shows the outlines of closed depressions and swallets in the Jackson Blue Spring area in Florida.

Step 4. Consider nitrogen load. Nitrate-nitrogen is the major nutrient of concern in Florida's spring systems because of its extensive use and presence on the ground surface, its mobility, and its availability for uptake by aquatic flora when it is discharged from springs. Excess concentrations of nitrate nitrogen in the spring water have contributed to biological impairment in Jackson Blue Spring and Merritt's Mill Pond. The source of flow from the springs is groundwater from the Floridan aquifer system that comes mainly from local precipitation recharging the aquifer in the springshed area. The nitrate originates from atmospheric deposition and anthropogenic sources in the springshed.

Recent data from the USGS real-time monitoring station at Jackson Blue Spring were used to estimate the nitrogen load from the spring. A nitrate concentration of 3.63 milligrams per liter (mg/L) was measured on July 13, 2017, by a sensor at the spring.[4] This concentration is more than 10 times greater than Florida's numeric nitrate criterion (NNC) for spring vents and the nitrate threshold established as the total maximum daily load (TMDL) for Jackson Blue Spring (0.35 mg/L).[5] The nitrogen load from the spring vent depends on concentration and flow. Using the July 13, 2017 real-time flow value of 77 cubic feet per second (cfs) measured at the USGS station and the nitrate concentration on the same date, the nitrogen load from the Jackson Blue Spring vent was more than 1,500 pounds per day (lbs/day), or more than 548,000 pounds per year (lbs/yr).

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[3] Arthur, J.D., H.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. For additional information, see the DEP FAVA website.

[4] USGS National Water Information System web interface for water quality and discharge.

[5] Dodson, J. January 2013. *Nutrient TMDL for Jackson Blue Spring and Merritts Mill Pond (WBIDs 180Z and 180A)*. Tallahassee, FL: DEP.

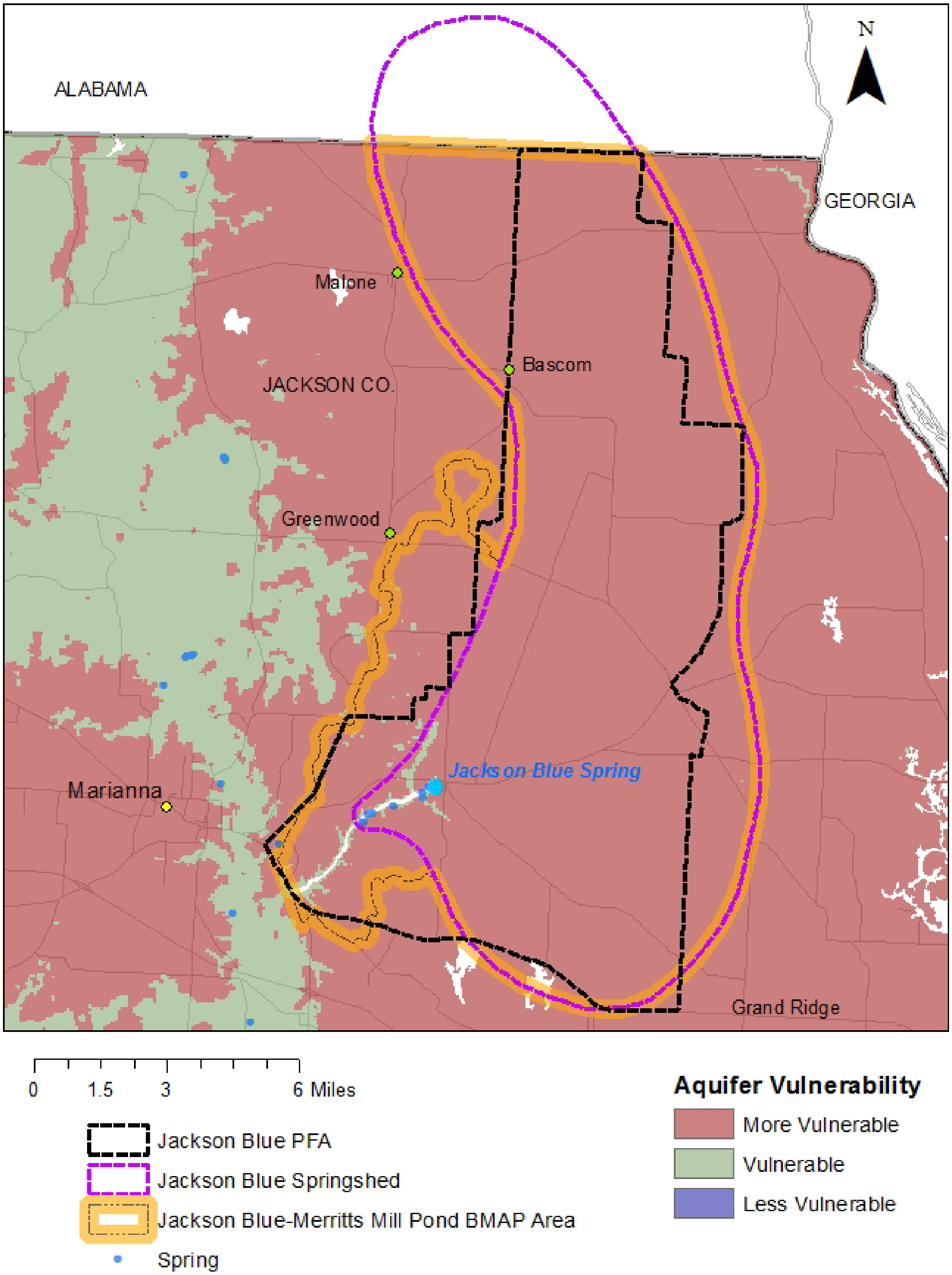

Figure 3. Floridan aquifer vulnerability based on the statewide FAVA results

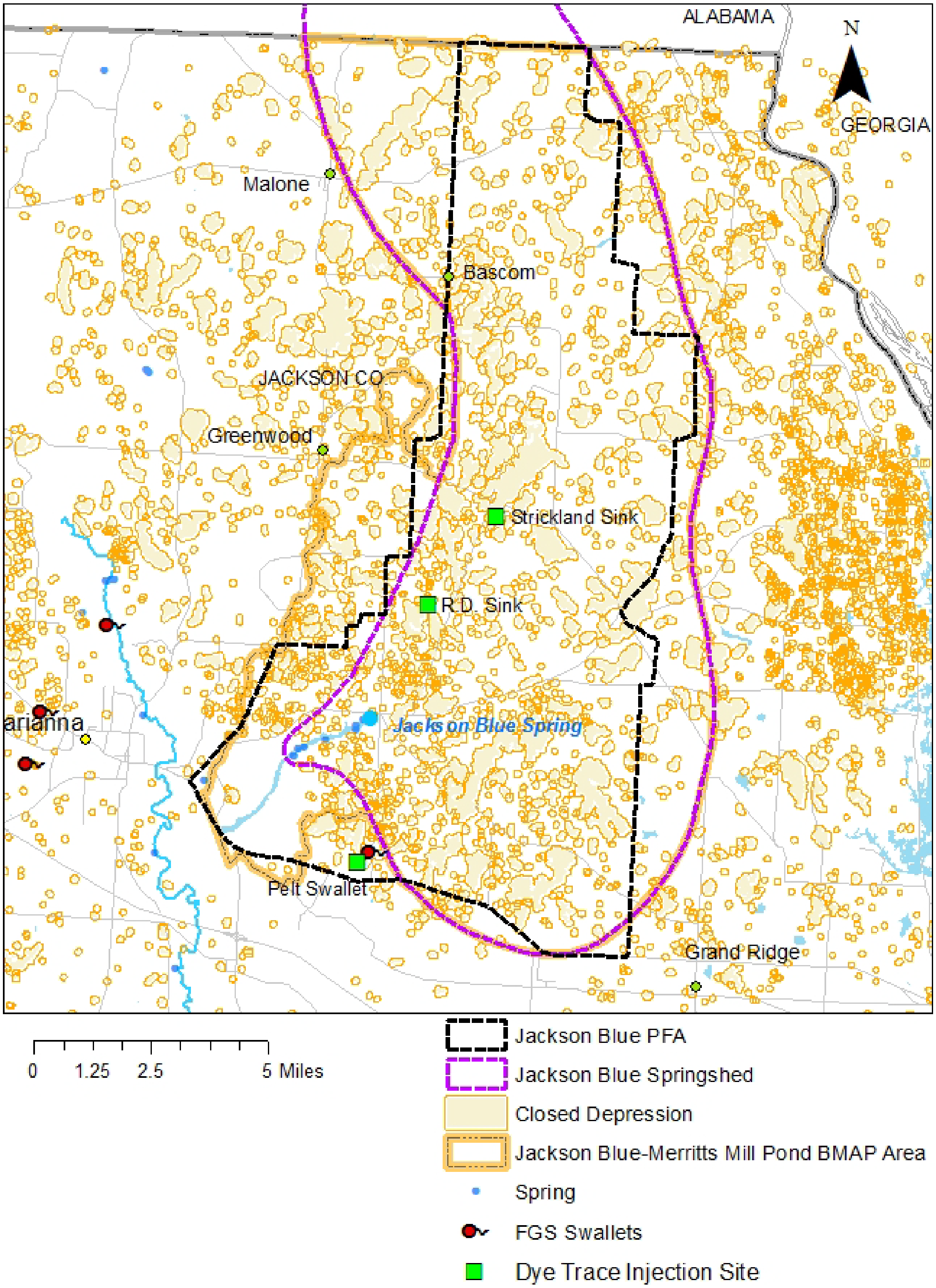

Figure 4. Closed depressions, swallets, and dye trace injection sites and PFA boundary

DEP developed a draft nitrogen source inventory in 2016 for the Jackson Blue Spring/Merritt's Mill Pond BMAP area as a tool for restoration planning to reduce nitrogen loads to the springs and pond.[6] The inventory results showed that most of the nitrogen loads to groundwater in the BMAP area were from inorganic fertilizer used on farms. Fertilizer applied to irrigated and nonirrigated farmlands constituted 79 % of the nitrogen load to groundwater in the area.

Step 5. Consider groundwater travel time in creating PFA boundaries. To the extent possible, PFAs should include parts of contributing areas that have 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 create complex networks of solution channels and conduits in the aquifer material. In these areas, groundwater can move rapidly from points where the water enters the aquifer to the spring vents.

In 2007, the USGS used two anthropomorphic age-dating tracers, chlorofluorocarbon-113 and sulfur hexafluoride, to calculate an average age of 19 years for water flowing from Jackson Blue Spring.[7] However, the average age of water is not necessarily the same as travel time, since water flowing from a spring can include a mixture of recently recharged precipitation and older water. The USGS used the age dating of groundwater and water from springs to help calibrate a regional-scale model groundwater transport model to evaluate travel time in the Jackson Blue Spring groundwater contributing area. Particle endpoint travel times ranged from 25 to 50 years in areas of the springshed near the Florida–Alabama state line to less than 2 years closer to the spring. This regional-scale modeling does not take into account travel times within karst features but does give a general idea of transport in the aquifer matrix.

To provide information for the Jackson Blue/Merritt's Mill Pond BMAP, a DEP contractor conducted a multiple dye tracer study in the area in 2016 to develop a better understanding of the connection between potential source areas and the travel times of groundwater to the springs.[8] Dyes were introduced into three natural sinkhole features shown in **Figure 4**: Pelt Swallet (2.5 miles southeast of the springs), Strickland Sink East (5.1 miles northeast of the springs), and R.D.'s Sink (2.5 miles north-northeast of the springs). The dye injected in Pelt Swallet (eosine) reached Twin Caves Spring and Hole-In-The-Wall Spring in 14 to 21 days, indicating travel times ranging from 999 to 1,413 feet per day. The dye injected into R.D.'s Sink (rhodamine) arrived at Jackson Blue Spring in 3 to 7 days and at Shangri-La and Indian Washtub Springs 7 to 14 days after injection. The rate of travel from R.D.'s Sink to Jackson Blue Spring was 1,847 to 4,310 feet per day. The dye injected into Strickland Sink East (fluorescein) was not detected during the study because of two complications: a soil plug in the sinkhole bottom that attenuated the dye, and the pumping of nearby irrigation wells that could have captured the released dye.

[6] Eller, K.T., B.G. Katz, and Y. Escribano. October 2016. *Draft Nitrogen Source Inventory and Loading Tool estimates for the Jackson Blue Spring and Merritt's Mill Pond Basin Management Action Plan area.* Tallahassee, FL: DEP, Division of Environmental Assessment and Restoration, Groundwater Management Section.

[7] Crandall, C.A., B.G. Katz, and M.P. Berndt. 2013. *Estimating nitrate concentrations in groundwater at selected wells and springs in the surficial aquifer system and upper Floridan aquifer, Dougherty Plain and Marinanna Lowlands, Georgia, Florida, and Alabama, 2002–50.* USGS Scientific Investigations Report 2013-5150.

[8] AECOM. February 20, 2017. *Multiple dye groundwater tracer study, Jackson Blue Spring and Merritt's Mill Pond Spring Group.* DEP Contract WM946, Project No. 60493736.

The rapid movement of the dyes injected at Pelt Swallet and R.D.'s Sink demonstrate the potentially rapid movement of water to the springs from pollutant source areas within and close to the springshed boundaries. The PFA area extends south of the springshed in the area of Pelt Swallet to include this important contributing area and includes R.D.'s Sink and similar sink features in the springshed.

Step 6. Identify regions in the contributing area where soil conditions are most favorable for nitrogen to leach from surface sources. Most nitrogen attenuation occurs in the soil zone. Research has shown that nitrogen removal in the soil zone through denitrification and the tendency of nitrogen to leach is related to soil drainage class.[9] 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 areas where soils are poorly drained, somewhat poorly drained, or very poorly drained because of the greater potential for denitrification. 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.[10] These excessively to well-drained soils tend to occur in areas where aquifer recharge is highest and vulnerability is greatest. **Figure 5** shows the area where soil conditions are most favorable for nitrogen leaching, including soils in the excessively drained, somewhat excessively drained, and well-drained SSURGO drainage classes. The figure also shows areas of moderately well-drained soils where nitrogen leaching could be significant.

Step 7. Identify regions in the contributing area to exclude or include based on land use and the potential for pollutant sources to occur. Conservation lands, wetlands, and undeveloped open land protected from development in some cases may be excluded from the PFA if there is no expectation that they would include pollutant sources affecting springs in the foreseeable future and they are under protection. In this area, conservation lands are not extensive and were not considered in delineating the PFA boundary. The PFA does include the Jackson County park containing Jackson Blue Spring. **Figure 6** shows conservation lands from the FNAI Conservation Lands (FNAI Managed Areas) GIS layer.

A large percentage of the springshed is in agricultural land uses (42 % of the area in Florida), and there are scattered areas of urban land use (6 % of the area in Florida). The delineation of the PFA includes consideration of areas with significant potential for nitrogen leaching to groundwater based on the sources of nitrogen that occur there. Agricultural lands can include fertilizer use and livestock, both of which may contribute significant amounts of nitrogen. Urban lands can include higher densities of onsite sewage treatment and disposal systems (OSTDS), domestic wastewater application sites, and areas of urban fertilizer use, all of which can be

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[9] 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.

[10] 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 can be found online.

sources of nitrogen to the aquifer and springs. **Figure 7** shows mapped agricultural and urban lands (based on the 2012–13 NWFWMD land use–land cover GIS coverage).

OSTDS are potentially significant nutrient sources to be considered in delineating the PFA. There are approximately 1,600 OSTDS in the Jackson Blue Springshed (**Figure 8**). Their locations are based on GIS coverage of parcels associated with septic tanks in the FDOH Florida Water Management Inventory Project.

DEP-regulated wastewater facilities can also be significant nutrient sources. Existing domestic wastewater facilities, including large ones with design flows greater than or equal to 0.1 million gallons per day (mgd), are shown in **Figure 8** because they have the potential to contribute nitrogen to groundwater. There are currently no DEP-permitted wastewater facilities in the Jackson Blue Springshed or BMAP area. Information on DEP-regulated wastewater facilities for this area was obtained from the DEP Wastewater Facility Regulation (WAFR) Database.

Step 8. Create PFA boundaries that correspond with understood and identifiable boundaries. For stakeholders to implement restoration and protection actions in a PFA, the boundaries must be clearly defined and associated with features easily recognizable on a map. For that reason, the proposed boundary of the PFA was made to conform to easily recognizable natural features, roads, political boundaries, and major survey boundaries.

PFA Boundary for Jackson Blue Spring

The PFA boundary shown in **Figure 9** was developed by considering GIS coverages of recharge, vulnerability, soils, dye trace information, and potential contaminant nitrogen source information. The PFA includes much of the springshed for Jackson Blue and downstream springs in Florida where recharge and soil characteristics indicate vulnerability. It also includes an area in the springshed where groundwater travel to the springs hs been documented to occur rapidly or has the potential for rapid movement. In addition, the PFA includes areas of agricultural land use and urban development, where there is the potential for significant contributions of nitrogen to the aquifer and springs based on recharge and soil characteristics. Political boundaries, roads, and major survey boundaries in the area were used in the development of a readily identifiable boundary.

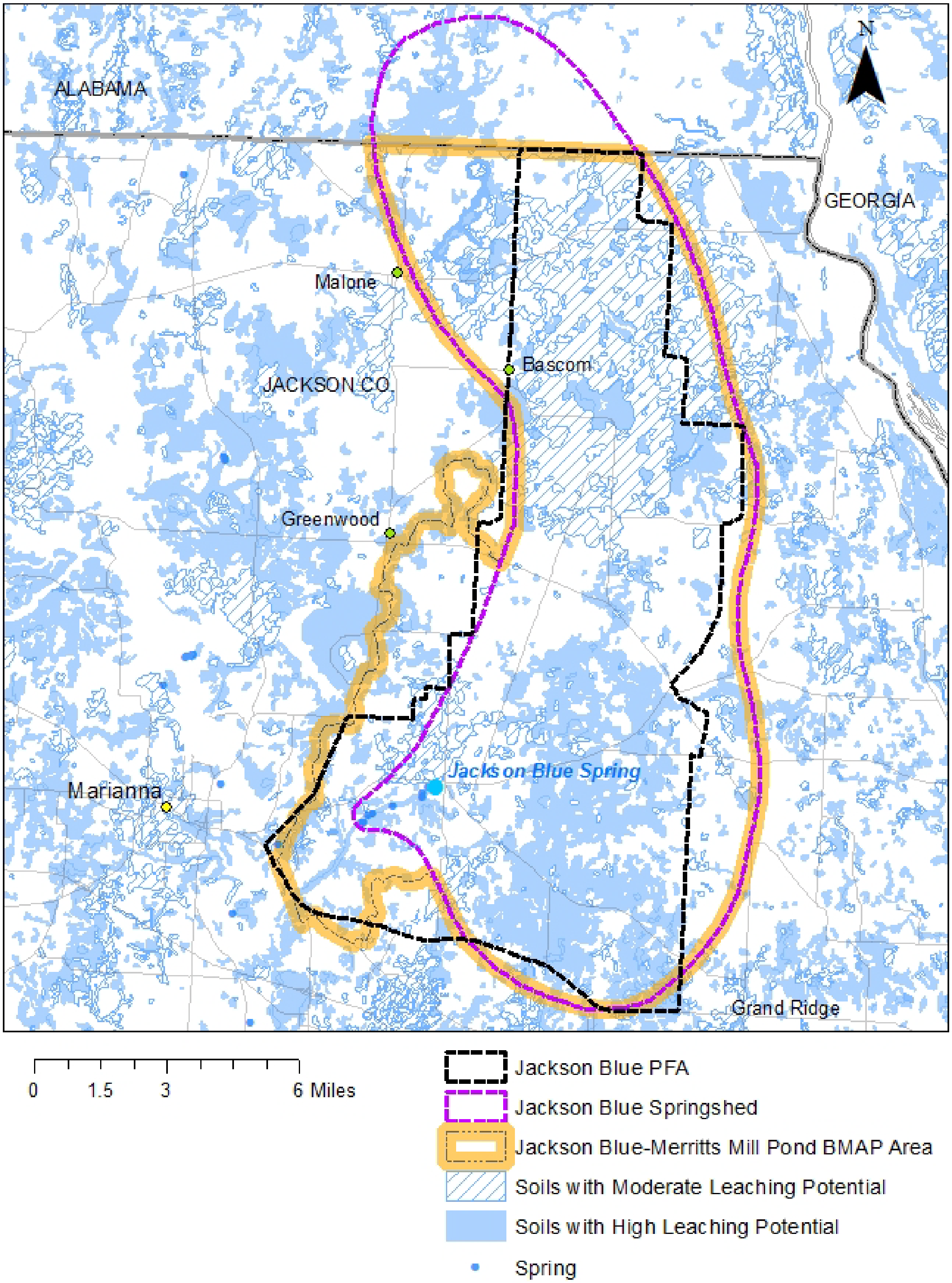

Figure 5. Areas of soils with high nitrogen leaching potential and PFA boundary

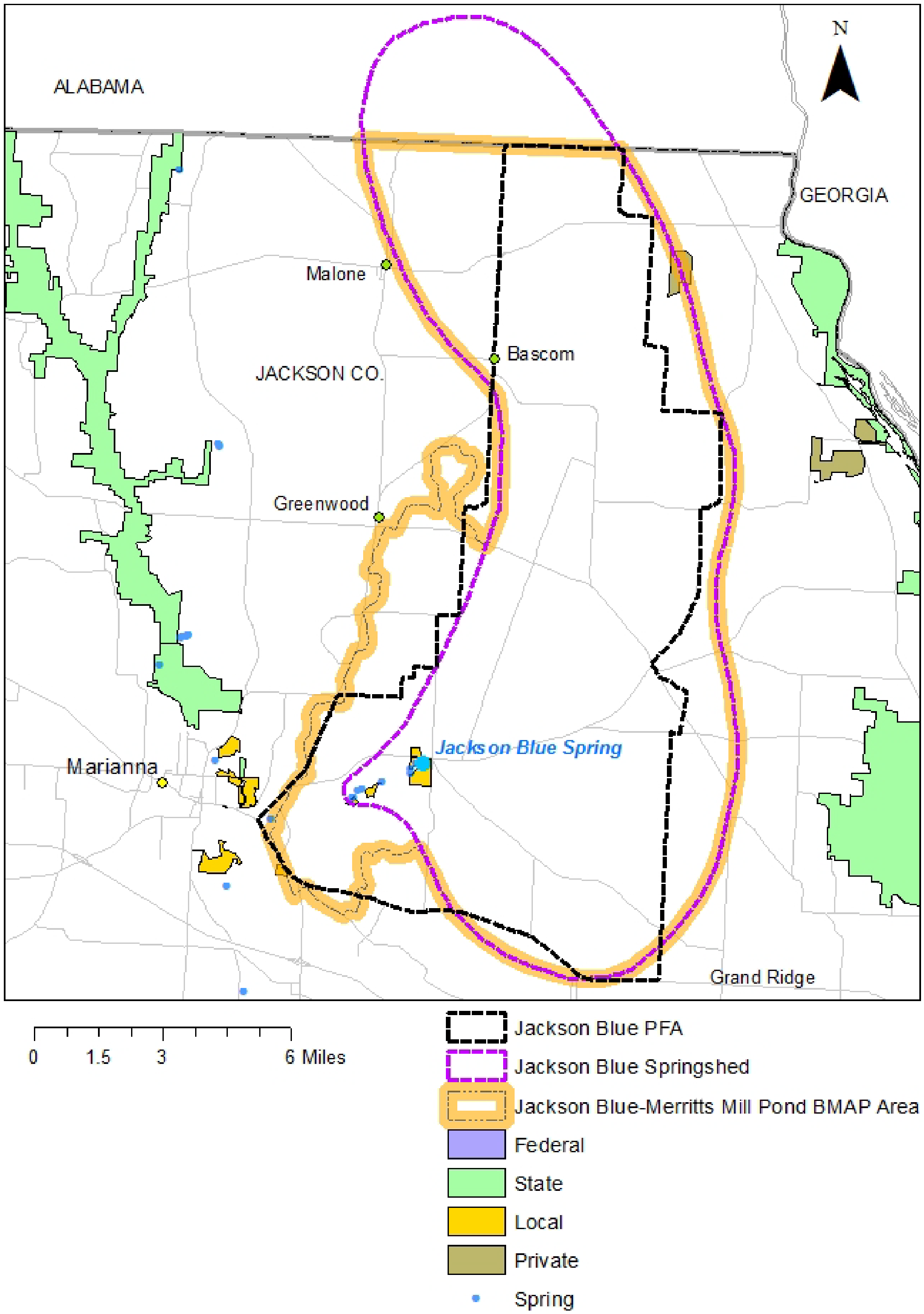

Figure 6. Conservation lands and PFA boundary

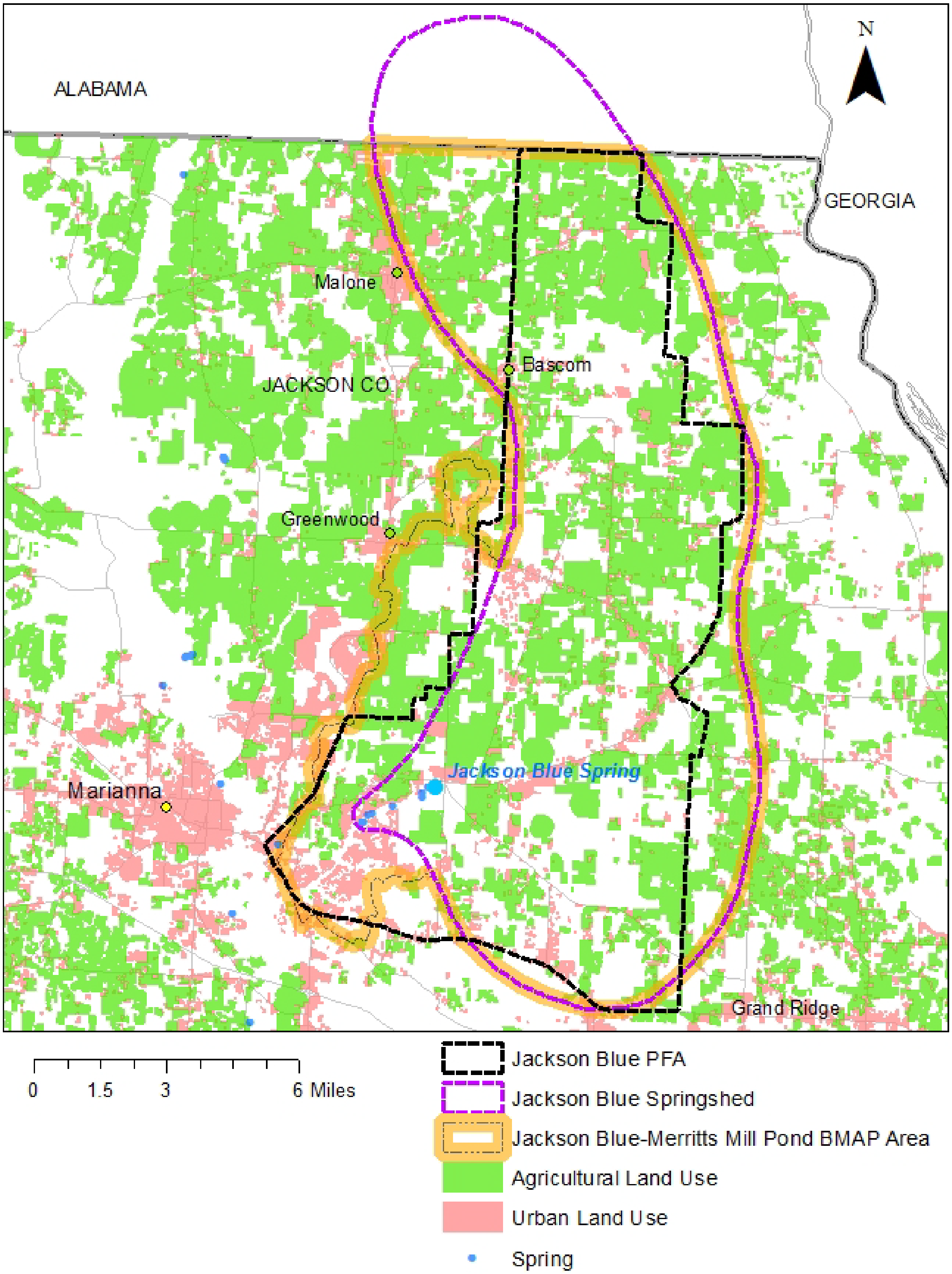

Figure 7. Agricultural and urban land use areas and PFA boundary

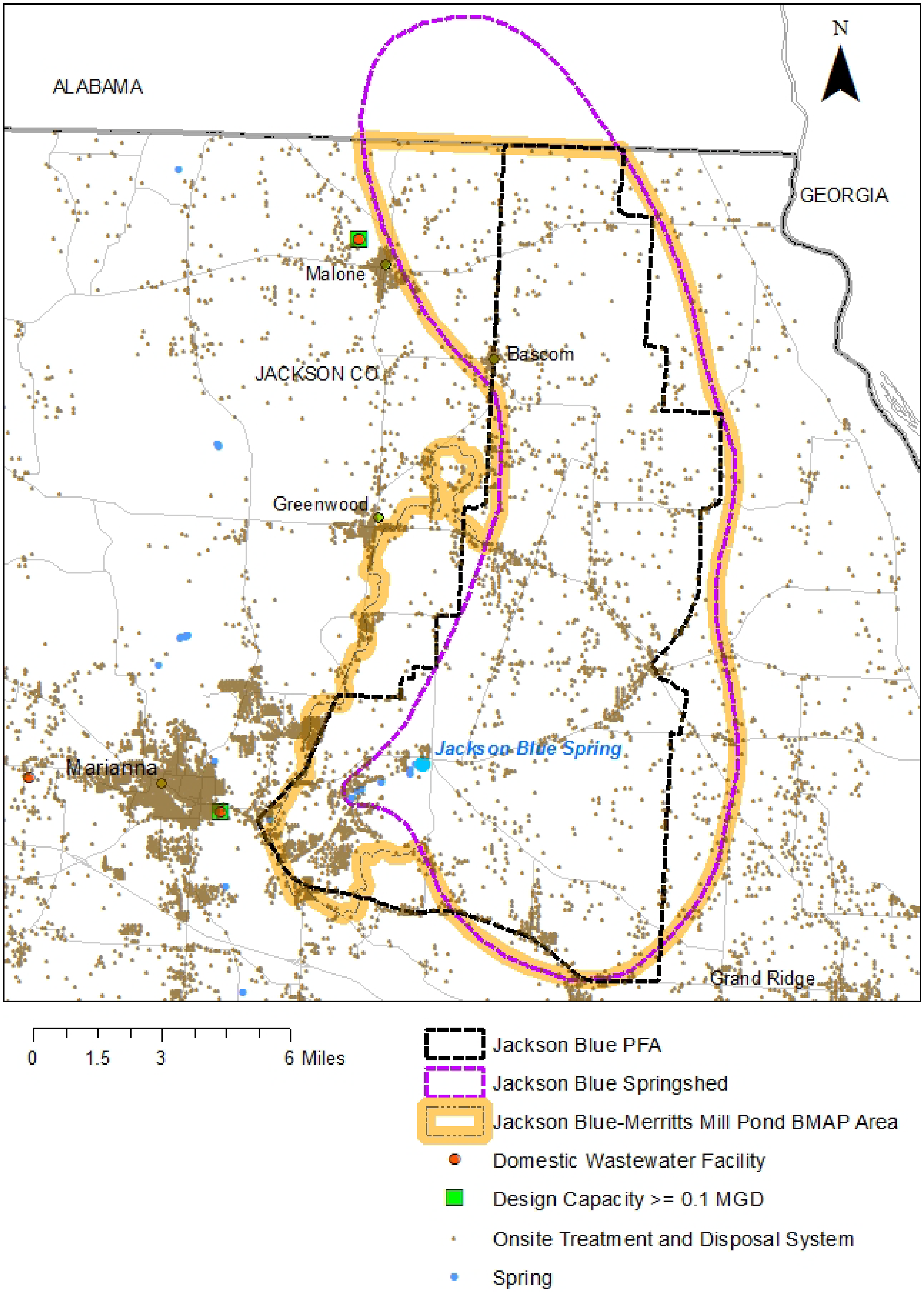

Figure 8. OSTDS, domestic WWTFs, and PFA boundary

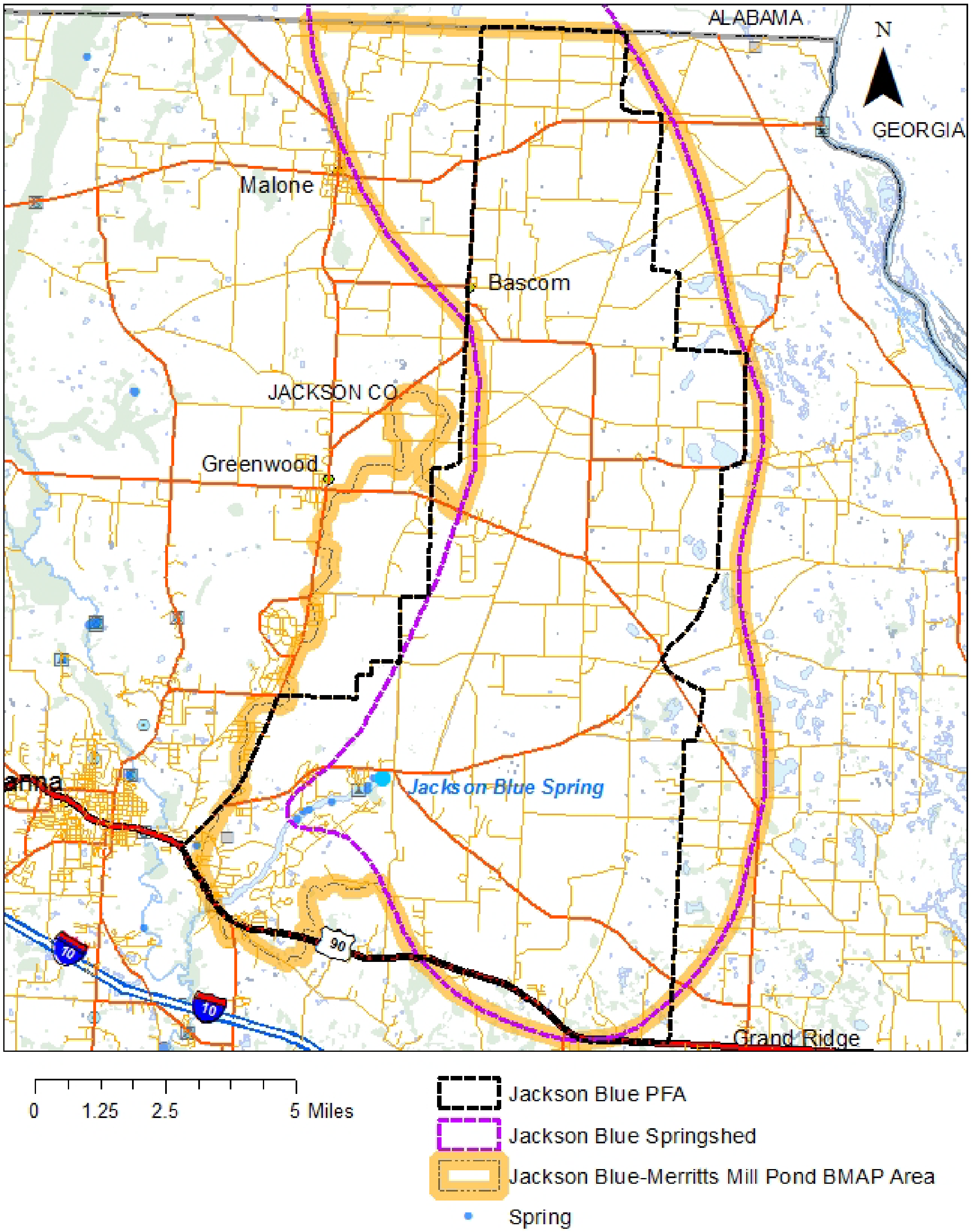

Figure 9. PFA boundary for Jackson Blue Spring that also protects related downstream springs

Appendix A: Important Links

Cover Page:
DEP website – www.dep.state.fl.us

More Information:
Email address for Terry Hansen – terry.hansen@dep.state.fl.us
Email address for Rick Hicks – richard.w.hicks@dep.state.fl.us

Step 7:
Florida Department of Health (FDOH) Florida Water Management Inventory Project website – http://www.floridahealth.gov/environmental-health/onsite-sewage/research/flwmi/index.html

Footnotes:
DEP FAVA website – http://www.dep.state.fl.us/geology/programs/hydrogeology/fava.htm

USGS National Water Information System web interface –
Water quality:
https://waterdata.usgs.gov/fl/nwis/current/?type=quality&group%20Key=basin%20cd
Discharge: https://waterdata.usgs.gov/fl/nwis/current/?type=flow

Dodson 2013 – http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp2/JacksonBlue-MerritsMill-nutr-tmdl.pdf

SSURGO Database metadata website – https://catalog.data.gov/dataset/soil-survey-geographic-ssurgo-database-for-various-soil-survey-areas-in-the-united-states-