REVISED DRAFT

Priority Focus Area for Kings Bay Springs

Division of Environmental Assessment and Restoration

Florida Department of Environmental Protection

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2600 Blair Stone Road, MS 3575
Tallahassee, Florida 32399-2400
www.dep.state.fl.us

More Information

The following individuals can provide more information about the priority focus area for the Kings Bay Springs Group:

Terry J. Hansen, P. G.

Basin Coordinator

DEP Watershed Planning and Coordination Section

terry.hansen@dep.state.fl.us

850-245-8561

Richard Hicks, P. G.

Professional Geologist Administrator

DEP Groundwater Management Section

richard.w.hicks@dep.state.fl.us

850-245-8229

Introduction

Under the Florida Springs and Aquifer Protection Act, the Florida Department of Environmental Protection (department) is required to delineate priority focus areas (PFA) for all Outstanding Florida Springs that are identified as impaired. According to the Florida Springs and Aquifer Protection Act, adopted by the Florida Legislature in 2016 (Chapter 373, Part VIII, 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:

- 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.

Delineation of the PFA for the Kings Bay Springs Group, which has been documented as impaired by nitrate nitrogen, is described in the following section.

Steps in Delineating the Kings Bay Springs PFA

The PFA for the Kings Bay Springs was developed using geographic information system (GIS) tools, spring-specific data, and published information to help identify the portion of the spring contributing area that is most important from both the water quality restoration and protection perspectives. The following steps were taken to develop a draft PFA for review and input by stakeholders. The overlap of mapped characteristics that express high vulnerability, high potential for pollutant mobility, and likely pollutant sources provide 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 estimated springshed was developed by the Southwest Florida Water Management District (SWFWMD) based on U. S. Geological Survey (USGS) potentiometric surface contour maps. The springshed, the Kings Bay Basin Management Action Plan (BMAP) area, and the proposed PFA are is shown in **Figure 1**.

Step 2. Identify regions within the contributing area where 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 PFA delineation are the areas of highest recharge to the aquifer, which could occur as uniform 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 or greater based on a GIS coverage developed by the USGS in 2002 and later refined by SWFWMD. **Figure 2** shows the area of greatest recharge (≥10 inches per year).

Step 3. Identify regions within the springshed where the Floridan Aquifer is most vulnerable. The aquifer vulnerability assessment (AVA) for Citrus County, based on the Florida Aquifer Vulnerability Assessment (FAVA) model for the Floridan Aquifer, was used to map aquifer vulnerability in the Kings Bay Springs Group springshed (**Figure 3**). Higher vulnerability areas exist where the upper Floridan Aquifer is unconfined or semiconfined, and/or where there is a strong vertical gradient and potential for water to move vertically between the surficial aquifer and the underlying Floridan Aquifer. This modeling tool was developed by the Florida Geological Survey to provide a spatial coverage of aquifer vulnerability ranges across an area.[1] Often, areas of greatest aquifer vulnerability occur where aquifer recharge is also greatest. According to the Citrus County AVA model, the central and eastern regions of the Kings Bay Springs contributing area is in the “most vulnerable” and “more vulnerable” categories, most of which should be included in the PFA.

[1] Arthur, J. D., Wood, H. A. R., Baker, A. E., Cichon, J. R., Raines, G. L., 2007, Development and Implementation of a Bayesina-based Aquifer Vulnerability Assessment in Florida: Natural Resources Research, Vol. 16, No. 2., P. 93-107. Also for more information go to http://www.dep.state.fl.us/geology/programs/hydrogeology/fava.htm.

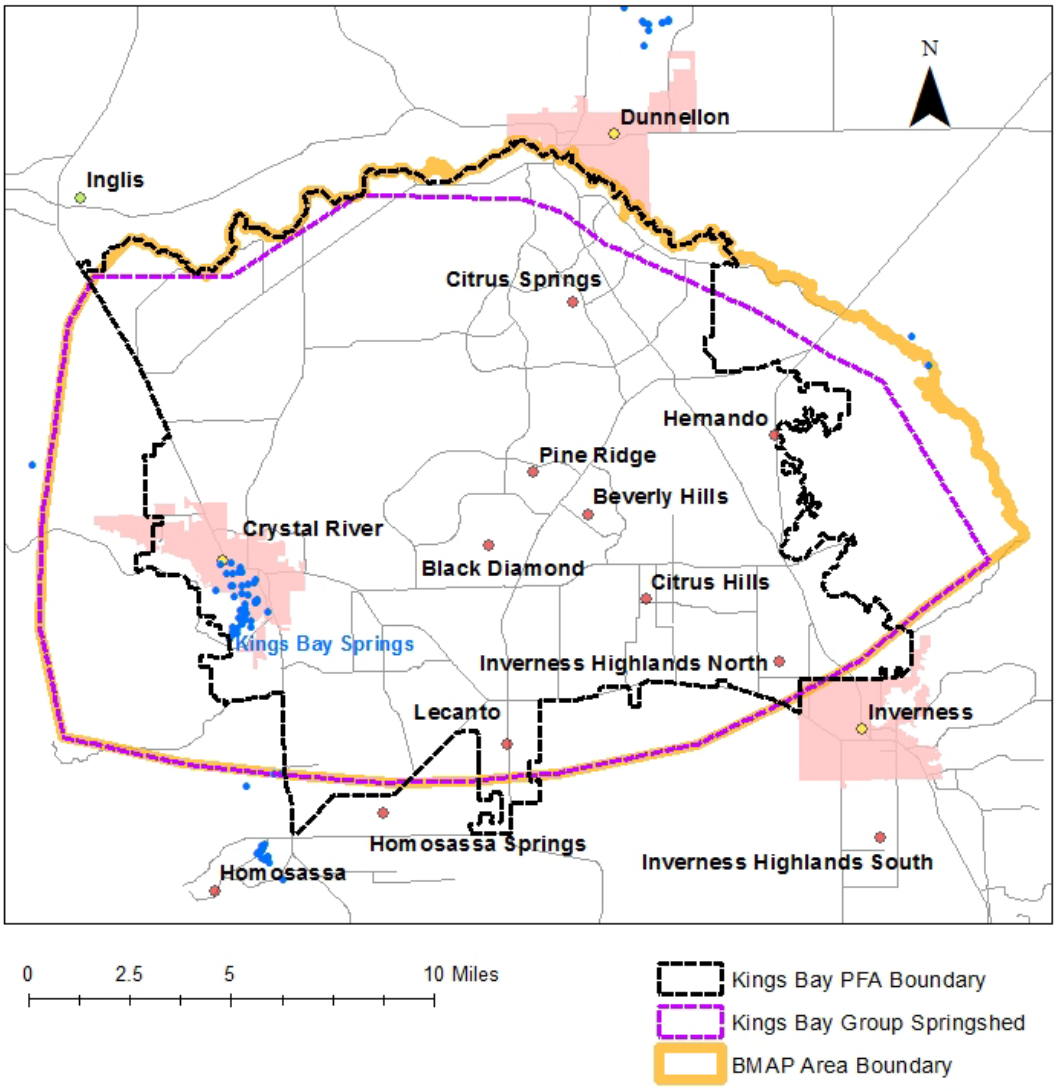

Figure 1. Kings Bay Springs Group springshed, basin management action plan boundary and proposed priority focus area

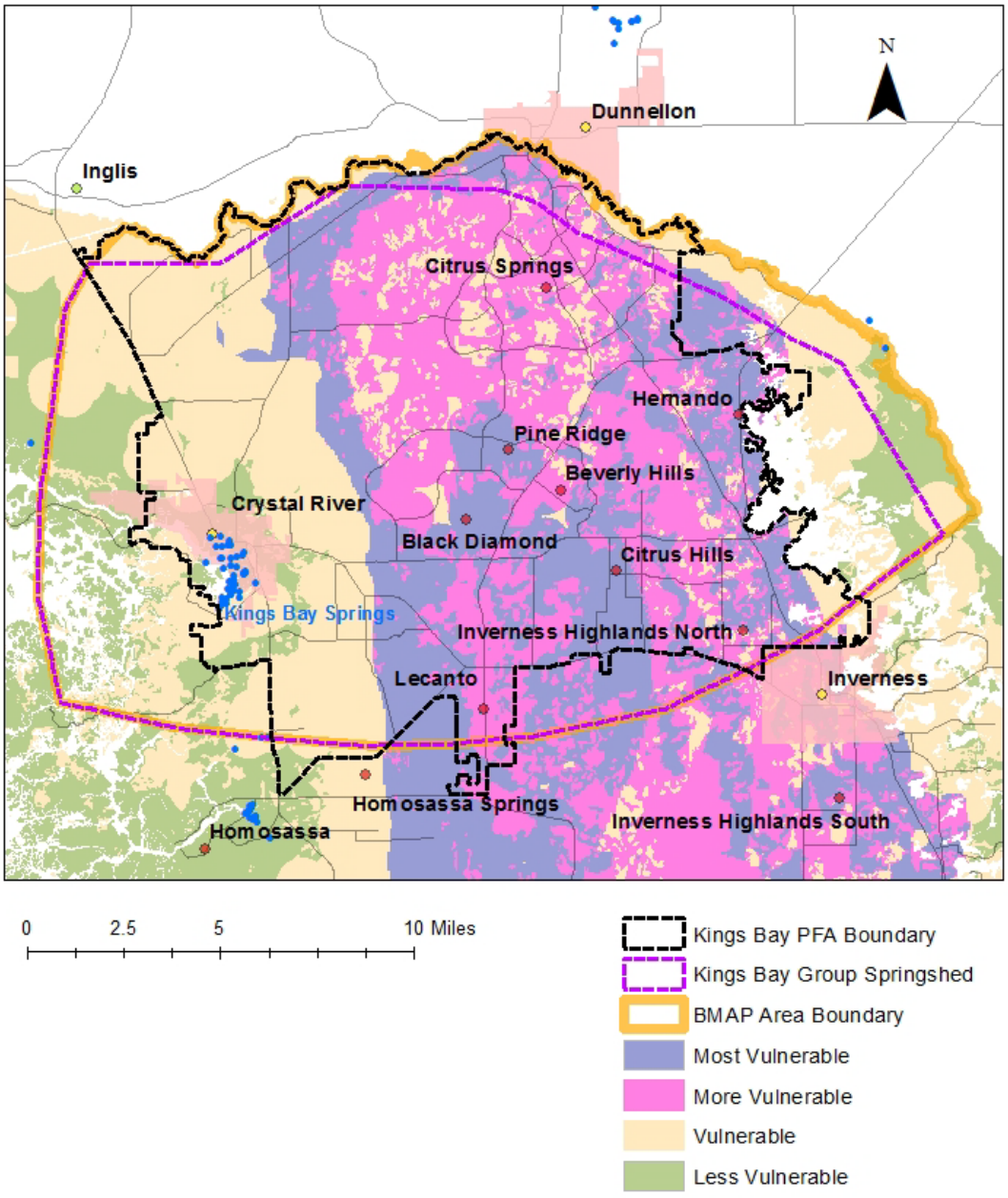

Figure 2. Citrus County aquifer vulnerability assessment area and proposed priority focus area

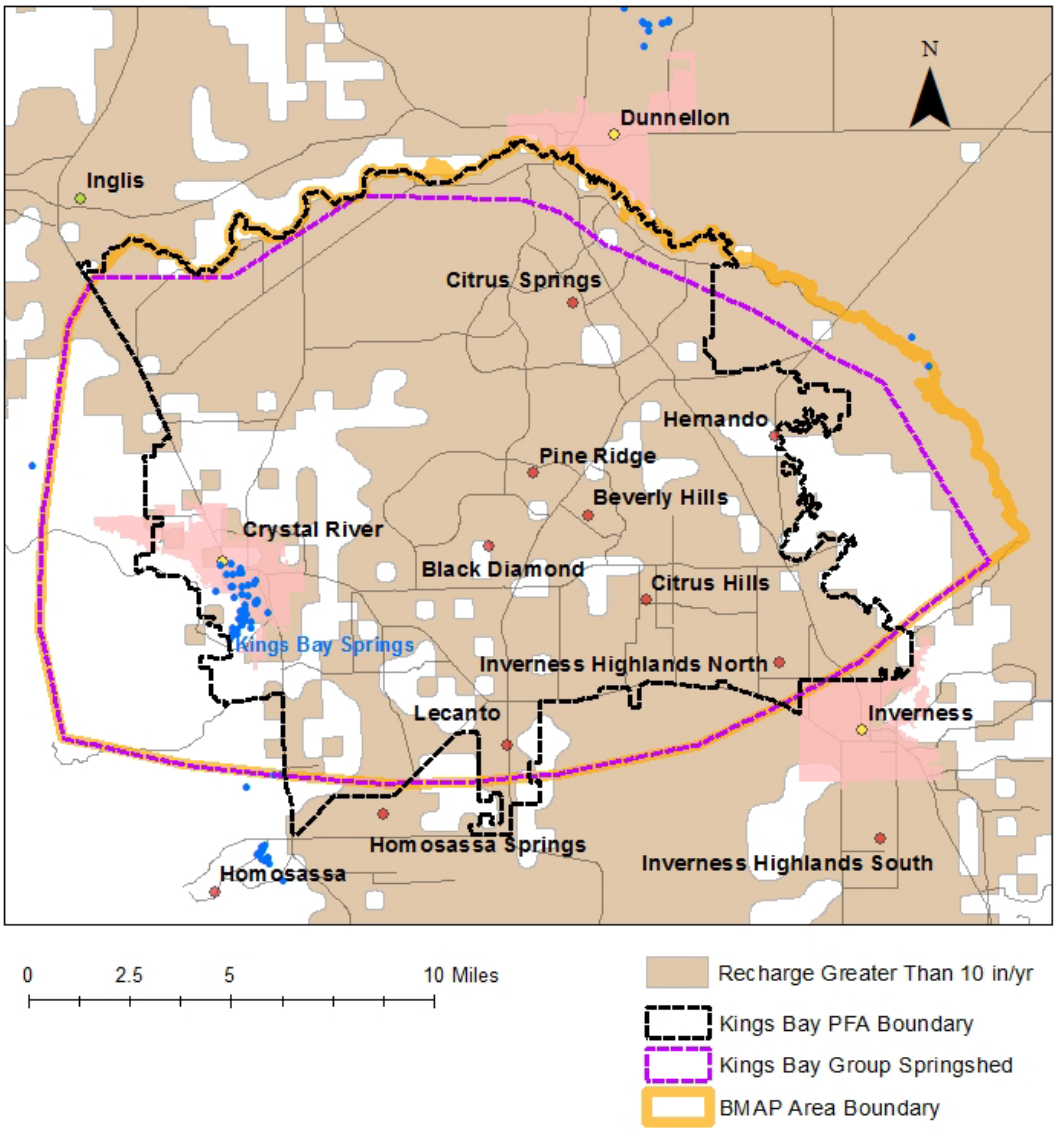

Figure 3. Areas of high recharge to Floridan aquifer (≥10 inches/year) and proposed priority focus area

Step 4. Consider nitrogen load. Several of the springs in the Kings Bay group that are monitored on a routine basis were listed by the department as impaired by nitrate, and a total maximum daily load (TMDL) was developed for them as well as the bay. The TMDL report can be found at this link: http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp5/KingsBay-1341-nutr-tmdl.pdf .

The TMDL report documents maximum annual average nitrate concentrations in the impaired springs that range from 0.31 to 0.64 milligrams per liter during the period of record used for the TMDL. The load of nitrogen from these springs depends on flow. For the Kings Bay springs, it is not possible to accurately estimate flow or calculate the nitrogen load because of the hydrology of the bay and the tidal nature of the springs. However, it is possible to estimate the load to ground water in the springshed, which will influence the springs.

The recent nitrogen inventory developed by the department for the Kings Bay BMAP area, which is very similar to the springshed area, shows that during recent years, the estimated load of nitrogen to the ground water is estimated at more than 600,000 pounds per year.[2] The most significant nitrogen source categories identified in the evaluation were onsite treatment and disposal systems (septic tanks), urban turf fertilizer, and farm fertilizer. The areas where septic tanks are present in high numbers and density and the urban and agricultural areas where fertilizer would be applied were considered in delineation of the PFA. The nitrogen inventory report for Kings Bay can be found at this link:
http://publicfiles.dep.state.fl.us/DEAR/NSILT/Kings%20Bay/

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 result in the development of 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 some Outstanding Florida Spring areas, dye traces have been conducted by researchers to measure the travel times and information from these studies can be incorporated into the PFA development. In some other areas, models have been used to estimate travel times and define protection zones and can also be used to help define PFAs. In the absence of modeled or demonstrated travel times, best professional judgement of groundwater professionals experienced in the spring area may be considered.

In the Kings Bay area, there are no past dye traces or models that could be used in refining the PFA. Most of the Kings Bay springshed is an area of karst, with limestone close to land surface and numerous karst erosional features. Therefore, tt is assumed that groundwater travel times could be quite rapid within the area, but specific areas of potentially rapid transport of ground water are not known and none have been mapped for this purpose. It is, however, understood that proximity to the springs has to be a consideration in creating the PFA boundary. **Figure 4** shows a 5-mile radius surrounding the springs group.

[2] Eller, K. and Katz, B. 2016. Nitrogen Source Inventory and Loading Estimates for the Kings Bay Springs Basin Management Action Plan Area, August 2016 Update. DEP Groundwater Management Section.

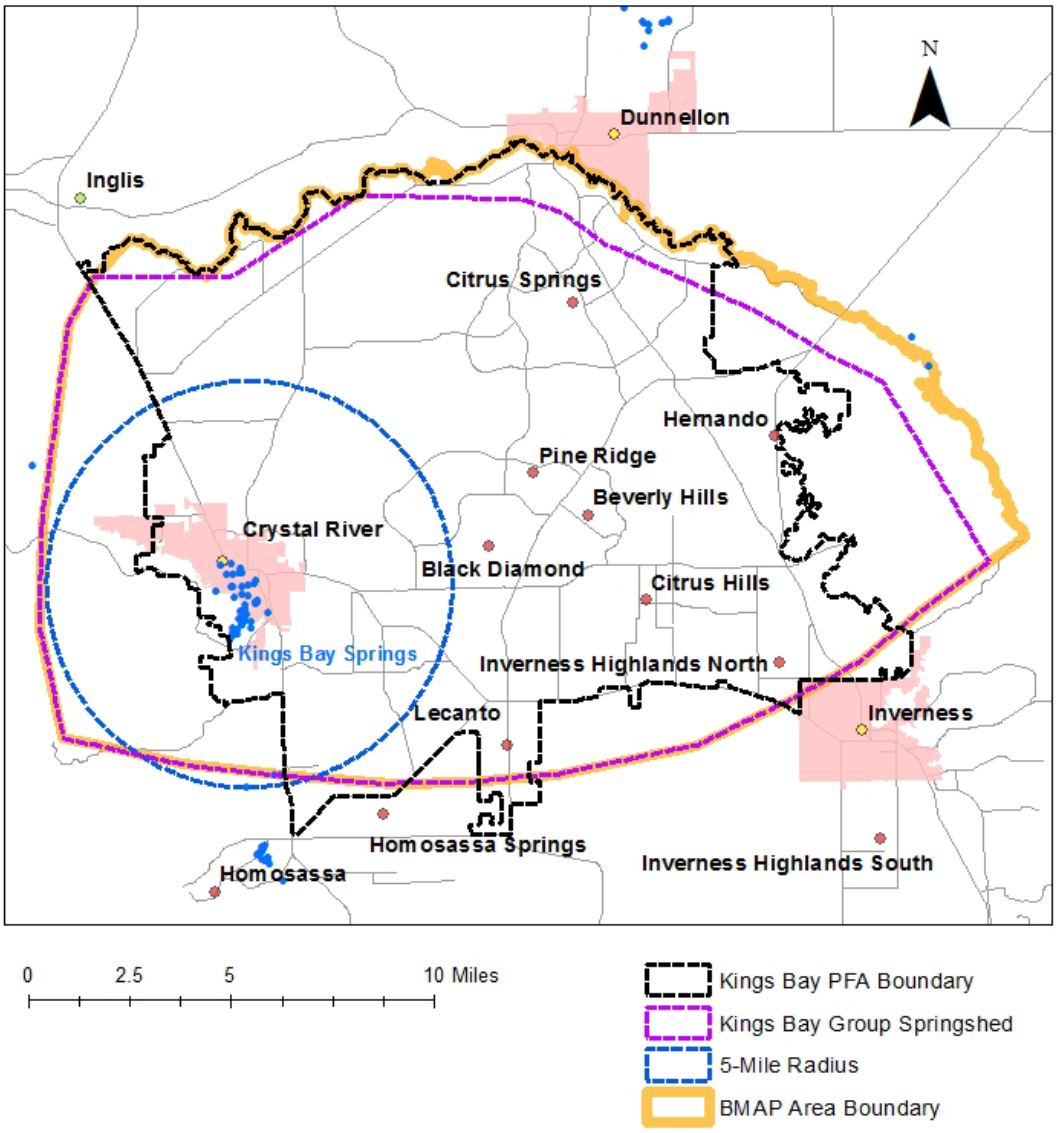

Figure 4. Kings Bay Springs Group, surrounding 5-mile radius, and proposed priority focus area

Step 6. Identify regions within the contributing area where soil conditions are most favorable for leaching of nitrogen from surface sources. Nitrogen has been identified as the target nutrient for spring restoration. Research has shown that removal of nitrogen in the soil zone through denitrification and its tendency to leach can be related to soil drainage class.[3] Denitrification is lowest and leaching of nitrogen is highest in areas with soils that are excessively drained, somewhat excessively drained, or well drained. Leaching may occur in areas with moderately

[3] 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 Florida Department of Health.
Hofstra, N. and Bowman, 2005. Denitrification in Agricultural Soils: Summarizing Published Data and Estimating Global Annual Rates. Nutrient Cyclieing in Agroecosystems (2005) 72: 267-278.

well drained soils and leaching of nitrogen 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. 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 Natural Resources Conservation Service soil survey geographic (SSURGO) database for Florida. 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. This includes soils in the excessively drained, somewhat excessively drained and well drained SSURGO drainage classes. This area is very similar to the "most vulnerable" and "more vulnerable" areas in the Citrus County AVA map.

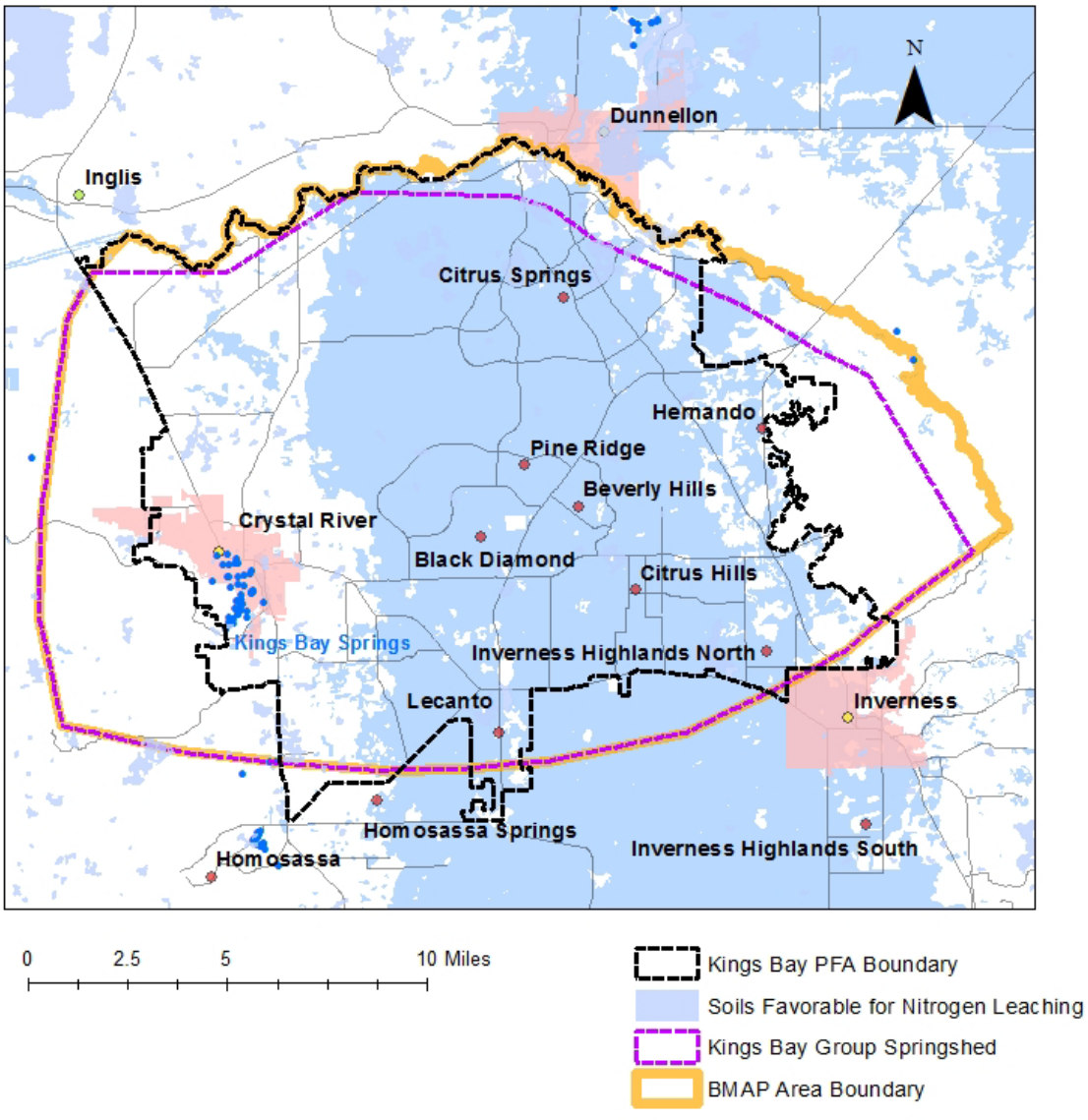

Figure 5. Areas of high nitrogen leaching potential soils and proposed priority focus area

Step 7. Identify regions within the contributing area to exclude or include based on land use and potential for pollutant sources to occur. Conservation lands, wetlands, and undeveloped open land that are protected from development are land areas that 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. Large land areas within the Kings Bay Springs Group contributing area and along the coast are designated conservation lands. These areas are shown in **Figure 6** and the PFA boundary aligns with several conservation area boundaries.

Most of the Kings Bay Springs contributing area not designated for conservation is in urban land uses, with a smaller percentage in agricultural land uses. Development of the PFA also includes consideration of areas with significant potential for nitrogen leaching to groundwater based on the presence of land uses or activities that have been documented in the nitrogen inventory as potentially significant pollutant sources. The nitrogen inventory for the Kings Bay BMAP area suggests that these potential source areas include areas of intensive urban development and high densities of septic systems and areas of farmland. Mapped urban and agricultural lands are in **Figure 7.** Septic tanks are shown in **Figure 8**. Existing domestic wastewater facilities with design flows greater than 0.1 million gallons per day (mgd) are also shown in **Figure 8** because they also have potential for contributing nitrogen to groundwater.

Step 8. Create PFA boundaries that correspond with understood and identifiable boundaries. For stakeholders to implement restoration and protection actions described in the ones within the PFAs, the boundaries have to be clearly defined and associated with features easily recognizable on a map. For that reason, the actual boundaries of PFAs that are used for planning and restoration will be made to conform to easily recognizable natural features, roads and demographic boundaries.

Development of the PFA for the Kings Bay Springs Group included several conservation area boundaries, the Withlacoochee River, the Tsala Apopka Lakes, Lake Rouseau, county lines, and major roads that will provide readily identifiable boundaries. The Kings Bay BMAP area boundary was also considered in refinement of the PFA.

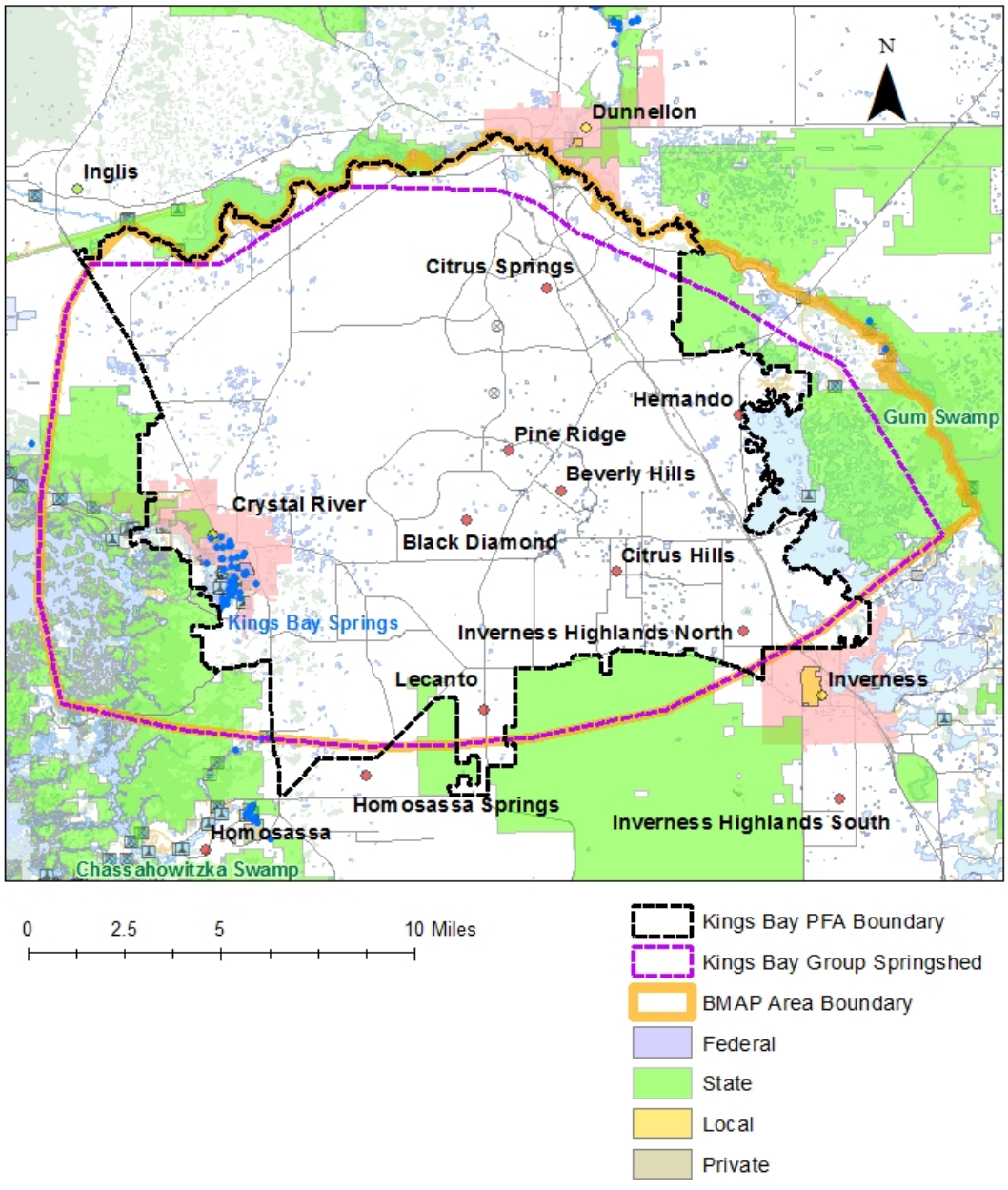

Figure 6. Conservation lands and proposed priority focus area

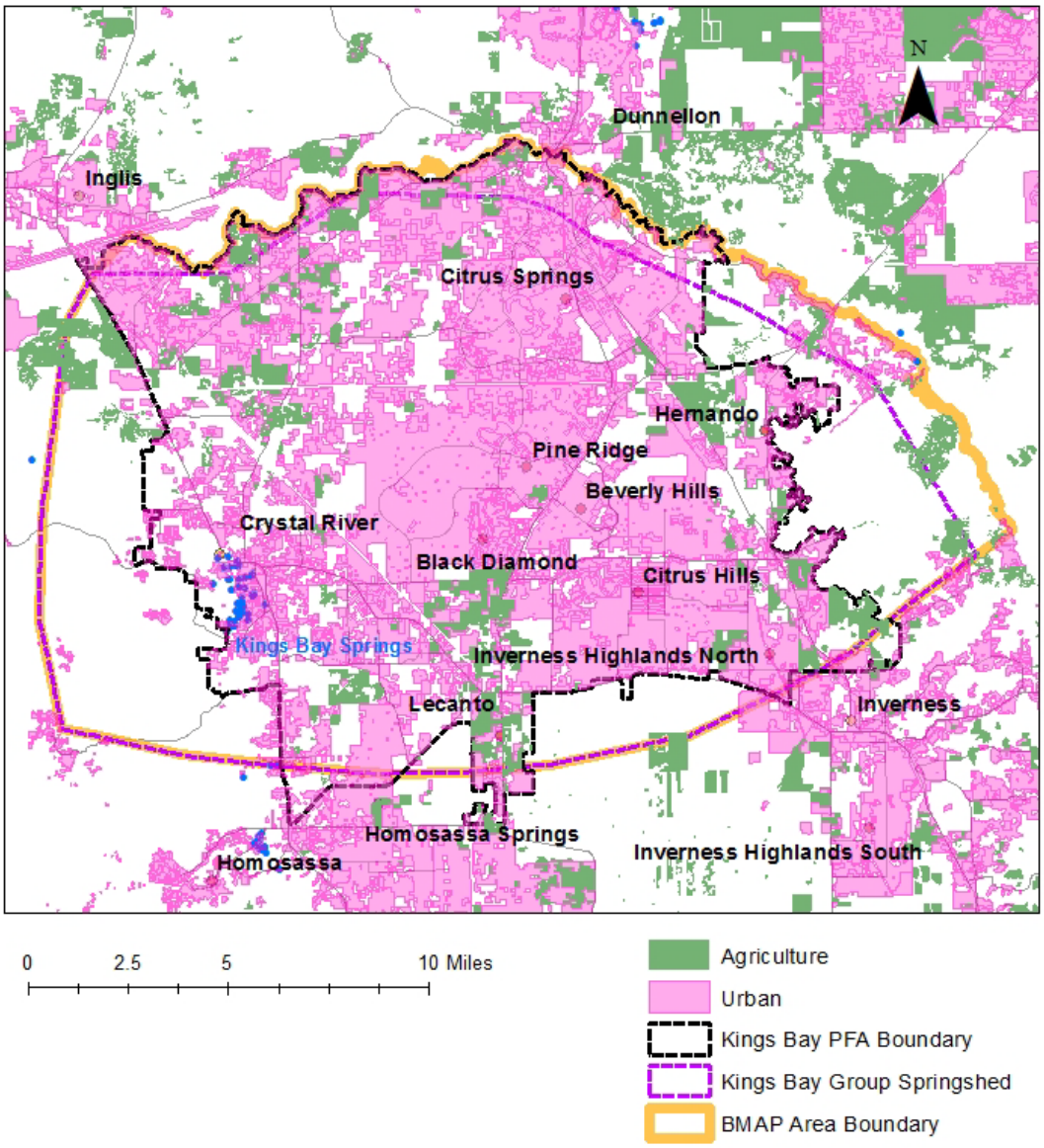

Figure 7. Urban and agricultural lands and proposed priority focus area

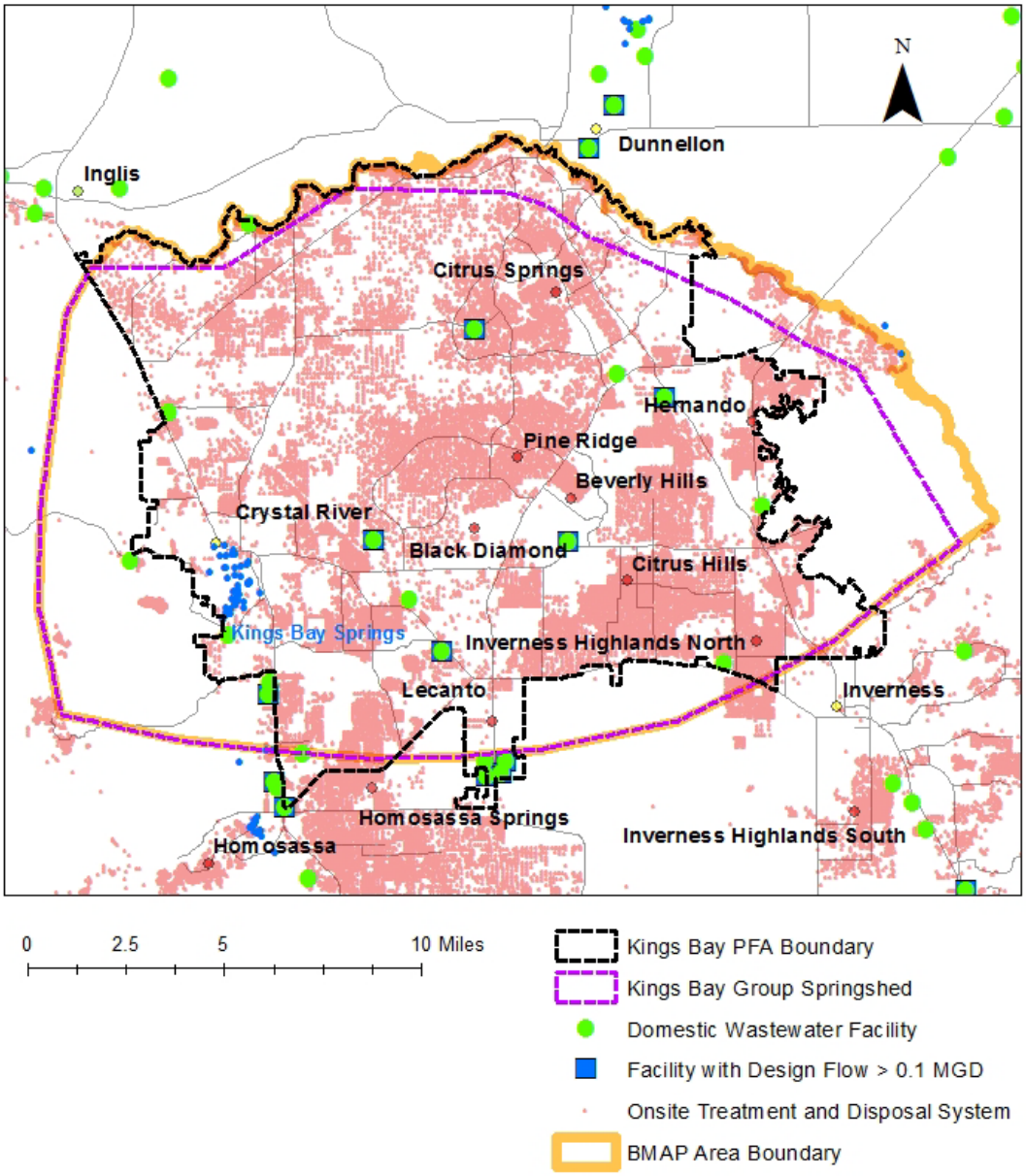

Figure 8. Onsite treatment and disposal systems, domestic wastewater treatment facilities and proposed priority focus area

PFA Boundary for Kings Bay Springs Group

The PFA boundary shown in **Figure 1** was developed by overlaying GIS coverages of recharge, vulnerability, soils, conservation lands, and potential contaminant nitrogen source information. The PFA includes most of the springshed for the Kings Bay Springs Group as well as the Kings Bay BMAP area because high groundwater recharge/vulnerability conditions and soil conditions that tend to leach nitrogen occur in most of these two areas. No information on actual or modeled travel time exists for the Kings Bay contributing area and most of this area has karst geology, so travel time could not be used to help determine the size or area of the PFA. However, the PFA boundary was drawn to include land areas close to the springs because of the potential for adverse impacts from near-field sources. The PFA also includes extensive areas of urban development, high densities of septic tanks, several larger wastewater treatment facilities, and agricultural lands which can all contribute to nitrogen enrichment in the aquifer and springs.

Conservation land boundaries, natural features, county lines and major roadways in the area were also considered in the development of a readily identifiable boundary. The proposed PFA is bounded to the north by the Witlacoochee River and Lake Rousseau, to the east by conservation lands and the Tsala Apopka Chain of Lakes; to the south by conservation lands, the Inverness city limit boundary, and Department of Transportation (DOT) roads; and to the west by conservation lands and other DOT local roads. The proposed PFA includes most of the city of Crystal River plus all or part of several unincorporated population centers that include Lecanto, Citrus Springs, Hernando, Pine Ridge, Beverly Hills, Black Diamond and Inverness Highlands North. The springshed of the Kings Bay Springs Group adjoins the springshed of Homosassa Springs, and a portion of the southern Kings Bay Springs PFA boundary will also serve as the northern PFA boundary for Homosassa Springs.