

# Biennial Biological Monitoring Report for Hilton Head Plantation and Palmetto Hall Recycled Water Projects

## Hilton Head Public Service District Hilton Head Island, SC

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**March 2020**



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Prepared for

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HILTON HEAD ISLAND, SOUTH CAROLINA

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Athens, Georgia

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## **1.0 INTRODUCTION**

The following report details the results of biological monitoring conducted during the 2019 annual period at four recycled water discharge wetlands on Hilton Head Island, South Carolina. The Hilton Head Public Service District (PSD) discharges advanced treated dechlorinated recycled water to the wetlands as part of a sustainable water reuse program during low recycled water demand periods. The PSD water reuse program discharges to receiving wetlands under the National Pollution Discharge Elimination System (NPDES) permit Number SC0046191, administered by the S.C. Department of Health and Environmental Control (SCDHEC). The permit, as modified October 24, 2005, requires quantitative and qualitative biological monitoring of vegetation and benthic macroinvertebrates conducted annually with reports submitted to SCDHEC biennially or once every two years.

The recycled water discharge wetlands include the Whooping Crane Conservancy wetland and Cypress Conservancy wetland in the Hilton Head Plantation neighborhood, and the grassy wetland and wooded wetland within the Palmetto Hall Golf Course (Figure 1). The PSD ceased discharging recycled water to the Palmetto Hall grassy wetland during 2019. Despite the cessation of discharge, a permanent monitoring station was monumented and sampled within the Palmetto Hall grassy wetland during the 2019 monitoring period.

Monitoring was conducted by Nutter and Associates, Inc. (NAI) during the 2019 monitoring period. This was the first year that NAI biologists have participated in the project. Baseline documentation and monitoring during all previous years was completed by Ballantine Environmental Resources. NAI utilized the same methodology and protocols employed during previous monitoring events. Overall site conditions were similar to those described in past monitoring reports. However, previous monitoring reports did not include quantifiable metrics of existing conditions. Quantifiable comparisons could not be made between the 2019 monitoring period and past monitoring events. Results for the 2019 monitoring year are listed in this report and provide a record of existing conditions during the 2019 monitoring year that can be compared during subsequent monitoring events.

## **2.0 METHODS**

As stipulated by the NPDES permit, the discharge wetlands were monitored semiannually in 2019. Field data collection consisted of quantitative assessments of hydrology, vegetation, and benthic macroinvertebrates at discrete stations established along transects within the four wetlands in the Hilton Head Plantation and the Palmetto Hall Golf Course. Monitoring protocols followed the criteria listed in the NPDES permit. Additional qualitative observations of birds and other wildlife, and any significant impacts such as tree mortality and blow downs were documented. Based upon previously identified monitoring schedules, semiannual monitoring consisted of one monitoring event during the dormant season and one monitoring event during the growing season. The dormant season monitoring event was conducted in early March of 2019 and the growing season monitoring event was conducted in August of 2019. Tables 1 and

2 below detail the sample locations, sample size, protocols, and metrics employed during the 2019 monitoring period. The locations and of each fixed monitoring station are provided in Figures 2 through 5.

## **2.1 Vegetative Cover Methods and Metrics**

Previous scientists relied upon local knowledge to locate monitoring stations without the benefit of GPS waypoints. It was therefore necessary to establish new monitoring stations in 2019. Each monitoring station was located as close as possible to the locations that were identified on the hand drawn maps that were included in previous reports. The new 2019 monitoring stations and plots were recorded using a GPS and were monumented by latitude and longitude. All monumented point locations had an error of less than 1-meter. The new monitoring stations and plots will continue to be utilized during subsequent annual monitoring periods and will serve as a replicable sample set to assess changes in vegetative structure and potential wetland impacts (Figures 2-5).

At each monitoring station, a 1/100-acre circular plot was established, and all canopy and sapling/shrub species were identified (Figure 6). Tree species included any species that was greater than 10-feet tall with a DBH greater than 3-inches. Diameter at breast height (DBH) was measured for each canopy tree species equal to or greater than 3-inch DBH. Percent coverage estimates were conducted for canopy and shrub strata within each 1/100-acre plot. Shrub species included any species that was less than 10-feet tall and had a DBH of less than 3-inches. In the middle of the 1/100 plot, a 1/1,000-acre sub-plot quadrat was established to document groundcover species. Groundcover species included any species that was rooted within the quadrat and was less than 6-feet tall. Additionally, a general search for all plant species that occurred within the larger wetland area was completed for each discharge wetland.

Tree density was calculated as the total number of an individual species per acre. Basal area (BA) was calculated as the sum of the cross-sectional area of each tree species, measured at breast height above ground. Importance values were calculated as the sum from (i) the relative frequency; (ii) the relative density; and (iii) the relative dominance. Importance values for trees can range between 0 (absent) and 300 (highly frequent with high density).

For shrub and herbaceous ground cover plots, mean coverage was calculated as the total coverage divided by the number of stations in each wetland. Relative dominance was calculated as the sum of total coverage of a given species divided by the overall ground coverage and multiplied by 100 to calculate the percentage. Frequency was calculated as the total recorded occurrences by transect station. Relative frequency was calculated as the frequency of occurrence by species divided by the total number of occurrences multiplied by 100. Counting individual stems of shrub and ground cover would have been impractical. Many species exist as colonies of multiple stems or clonal extensions of rhizomes. Because of the difficulty in quantifying density, importance values for shrub and ground cover were calculated

as the sum from (i) the relative frequency; and (ii) the relative dominance. Importance values for shrub and herbaceous cover can range between 0 (absent) and 200 (highly frequent with high density).

## **2.2 Benthic Macroinvertebrate Methods and Metrics**

Where appropriate, macroinvertebrate sampling was adapted using protocols outlined in the SCDHEC Standard Operating and Quality Control Procedures for Macroinvertebrate Sampling (SCDHEC, 2012). However, the SCDHEC SOP was specifically written for stream sampling, so adaptations were made to accommodate wetland sampling. The grassy wetland at Palmetto Hall was not sampled for benthic macroinvertebrates due to a lack of water. At each monitoring transect, multiple habitats were targeted for sampling using D-frame dip net samplers. Targeted habitats included undercut banks and root wads, aquatic vegetation, and submerged logs. Submerged logs were rinsed within the D-frame dip net. All samples were composited for each wetland and stored in a 70% ethanol solution. Identification and enumeration of macroinvertebrates was performed by Wendell Pennington of Pennington and Associates, Inc., Cookeville, TN. Results were evaluated using the biotic index and commonly used diversity metrics including taxa richness.

## **3.0 MONITORING RESULTS**

Overall site conditions are described for tree, shrub, and groundcover classes. Previous monitoring reports did not include empirical data of existing conditions. Results for the 2019 monitoring year are listed in Table 3 through 15 below and provide a record of existing conditions during the 2019 monitoring year. These results can be used to make direct comparisons during subsequent monitoring events.

### **3.1 Tree Canopy Results**

The Cypress Conservancy, Whooping Crane Conservancy, and the Palmetto Hall wooded wetlands were heavily forested and dominated by swamp tupelo (*Nyssa biflora*). Cypress Conservancy and Whooping Crane Conservancy supported mature forest and had the highest basal area per acre as compared to The Palmetto Hall wooded wetland and Palmetto Hall grassy wetlands. The Palmetto Hall wooded wetlands had similar tree composition to Cypress Conservancy and Whooping Crane Conservancy but the forest was younger and had lower stem density and basal area. The Palmetto Hall grassy wetlands were largely herbaceous and contained the lowest overall tree cover.

#### **3.1.1 Basal Area of Trees**

The Cypress Conservancy, Whooping Crane Conservancy, and the Palmetto Hall wooded wetlands were dominated by even-aged stands of large swamp tupelo (*Nyssa biflora*) (Tables 3-5). Within the Cypress Conservancy, several other sub-dominant species contributed to the total tree taxa richness including bald cypress (*Taxodium distichum*), loblolly pine (*Pinus taeda*), wax

myrtle (*Morella cerifera*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and large gallberry (*Ilex coriacea*) (Table 3). However, sub-dominates contributed little to the total basal area of the Cypress Conservancy which was dominated by swamp tupelo. Total basal area in the Cypress Conservancy was 70 ft<sup>2</sup>/acre. Sub-dominants occurring in the Whooping Crane Conservancy included loblolly pine, wax myrtle, Carolina willow (*Salix caroliniana*), and red maple (*Acer rubrum*) (Table 4). Total basal area in the Whooping Crane Conservancy was 75 ft<sup>2</sup>/acre. Within the Palmetto Hall wooded wetlands, the only sub-dominant was wax myrtle (Table 5). Total basal area in the wooded wetlands was 14 ft<sup>2</sup>/acre. The Palmetto Hall grassy wetlands contain few canopy species and was dominated by loblolly pine, with sub-dominants including swamp tupelo and Chinese tallow (*Triadica sebifera*) (Table 6). Total basal area in the grassy wetland was 2 ft<sup>2</sup>/acre.

### **3.1.2 Density of Canopy Trees**

As with basal area, the density of canopy trees in the Whooping Crane Conservancy, Cypress Conservancy, and the Palmetto Hall wooded wetlands was highest for swamp tupelo (Tables 3-5). The Palmetto Hall grassy wetland had higher densities of loblolly pine. The highest density of trees occurred at the Whooping Crane Conservancy (227 trees per acre) with the next highest total density of canopy trees occurring at the Cypress Conservancy (166 trees per acre) (Table 3-4). Tree density at the Palmetto Hall wooded wetlands was 101 trees per acre (Table 5). The grassy wetlands contained 50 trees per acre (Table 6).

### **3.1.3 Importance Value of Canopy Tree Species**

Forested communities were dominated by swamp tupelo at the Cypress Conservancy, Whooping Crane Conservancy, and the Palmetto Hall wooded wetlands, and importance values for swamp tupelo were greater than 200 for all three wetlands. Loblolly pine was the most important species in the grassy wetland (Table 3-6). Bald cypress occupied secondary importance only in the Cypress Conservancy where several large bald cypress were observed.

## **3.2 Shrub and Groundcover Results**

Shrub and groundcover diversity were highest in the Cypress Conservancy and Whooping Crane Conservancy. Both sites represented the most mature forest cover as compared to the other discharge wetlands. Overall the diversity of shrub cover and herbaceous groundcover within the discharge wetlands was limited by several factors including shade from mature canopy trees that limits shrub and herbaceous growth. Additionally, the largest factor affecting herbaceous diversity in all wetlands except Palmetto Hall grassy wetland was the percent of stations with standing water and the average depth of water. Deeper waters preclude substantial herbaceous growth. It should be noted that diversity and abundance increased during the summertime growing season monitoring event. A list of all plant species recorded within the larger general search area of each wetland is included in Appendix B.

### **3.2.1 Shrub Cover Results**

Shrub cover within the Cypress Conservancy was dominated by dwarf palmetto (*Sabal minor*), tallow tree (*Triadica sebifera*), Red Bay (*Persea borbonia*), and wax myrtle (*Morella cerifera*) with each species represented by roughly equal importance values (Table 7). Of note among these is the presence the invasive-exotic tallow tree. Previous monitoring reports do not include any data in relation to the overall coverage of tallow tree so no direct comparisons were able to be concluded to past monitoring events. Tallow tree is a common component of many wetlands within the coastal plain of South Carolina. Previous monitoring reports do indicate that tallow tree was present in past years.

The Whooping Crane Conservancy shrub cover was dominated by wax myrtle with swamp loosestrife (*Decodon verticillatus*), Carolina willow (*Salix caroliniana*), and red bay serving as important secondary shrub species (Table 8). Notable among these is the presence of swamp loosestrife, an invasive-exotic subshrub. Previous monitoring reports do not mention swamp loosestrife. As with tallow tree, swamp loosestrife is a common component of inundated wetlands in the coastal plain of South Carolina.

The Palmetto Hall wooded wetland shrub cover was dominated by tallow tree and wax myrtle with dwarf palmetto, red bay, buttonbush (*Cephalanthus occidentalis*), and red maple (*Acer rubrum*) serving as secondary species (Table 9). Again, the presence of tallow tree is of note because it is an invasive-exotic species. However, the 2019 results can only serve as baseline for the monitoring period for the reasons discussed above.

The Palmetto Hall grassy wetlands were dominated by wax myrtle and persimmon with persimmon occupying dry monitoring stations (Table 9). Tallow tree, dwarf palmetto, red bay, and Dahoon (*Ilex cassine*) were closely represented as secondary species. Again, no direct comparisons between the coverage of tallow tree could be made with past monitoring reports.

### **3.2.2 Groundcover Results**

Groundcover composition was similar between the March and August monitoring events of 2019. As expected, overall cover and species richness increased during the growing season. The Cypress Conservancy had slightly less species richness with 15 total species recorded among the sampling stations. Overall species composition was similar to Whooping Crane Conservancy monitoring stations. Species composition in the Cypress Conservancy was dominated by lizard's tail (*Saururus cernuus*) and swamp smartweed (*Polygonum hydropiperoides*), with sub-dominates composed of pennywort (*Hydrocotyle* spp.), creeping primrose (*Ludwigia palustris*), maidencane (*Panicum hemitomon*), and Virginia chainfern (*Woodwardia virginiana*) occupying a significant portion of the species composition (Table 11).

The highest diversity occurred at the Whooping Crane Conservancy where 16 total species were recorded. A higher percentage of stations within the Whooping Crane Conservancy had standing water with slightly higher depths than Cypress Conservancy (Table 12). Species

composition in Whooping Crane was dominated by pennywort and creeping primrose. Important secondary species were Virginia iris (*Iris virginica*), lizard's tail, Carolina willow (*Salix caroliniana*), cone-cup spikerush (*Eleocharis tuberculosa*) and buttonbush (*Cephalantha occidentalis*). Species diversity and total cover increased during the growing season. Total cover of lizard's tail and creeping primrose increased the most between the dormant season and growing season monitoring events.

The Palmetto Hall wooded wetlands contained the least amount of groundcover, and all stations had water with average depths greater than other wetlands (Table 13). The species composition in the wooded wetlands was dominated by lizard's tail. Young sprouts of tallow tree, smartweed, and creeping primrose were also recorded and represented minor and nearly equivalent importance among monitoring stations.

There was no water discharged to the grassy wetland and the taxonomic profile of plant species was less hydrophytic than the other wetlands (Table 14). Species composition in the grassy wetland was dominated by smartweed, with sub-dominants of Virginia iris, and plume grass (*Setaria magna*) occupying most of the rest of the species composition (Table 14).

### **3.3 Macroinvertebrate Results**

The macroinvertebrate communities in the discharge wetlands are typical of many freshwater wetland systems in the coastal plain (Table 15). The soft sediments and naturally low dissolved oxygen concentrations in these wetlands are conducive for a community dominated by midge larvae in the family Chironimidae. Generally, wetlands will sustain a more tolerant suite of macroinvertebrate taxa than do freshwater streams. However, the receiving wetlands had several species with mid-tolerance values including, *Neoporus* sp., *Anax junius*, *Ferrissia fragilaris*, *Planorbella* sp., *Tanytarsus* sp., which would indicate that water quality conditions can support more sensitive species. Tolerance values were similar across all of the wetlands sampled. Taxa richness was lowest in the Whooping Crane Conservancy likely due to sampling inefficiencies related to abundant floating duckweed (*Lemna* sp.) which limits the ability to target habitats. Several long-lived species were collected, including species from the order Odonata, or dragonflies, and several beetle species from the order Coleoptera. The presence of long-lived species indicates a lack of chronic water quality stressors and the presence of long-term surface water hydrology. There is a good mix of functional feeding groups in these wetlands indicating good habitat conditions and presence of long-term surface water inundation.

### **3.4 Threatened and Endangered Species**

A literature review of potential threatened and endangered (T&E) species listed for Beaufort County, SC was completed prior to the first monitoring event in March 2019. The U.S. Fish and Wildlife Service lists 20 species as either federally threatened or endangered in the County. In addition to those species that have federal listing status, the South Carolina Department of Natural Resources lists 4 additional species as state threatened or endangered. American

alligators were a common inhabitant of the Cypress Conservancy and Whooping Crane Conservancy. With this exception no other T&E species were observed during the 2019 annual monitoring period. Many species listed for the county occupy marine habitats and have no potential to occupy habitats within the discharge wetlands. A complete list of both state and federally listed species that are known to occur either presently or historically within the county is included in Appendix D. A discussion of those species that have the potential to occur in the project area are included below.

#### **3.4.1 American Alligator (*Alligator mississippiensis*)**

The American alligator is a common and well-known inhabitant of Hilton Head Island and throughout the coastal plain of South Carolina. The American alligator is listed as a federally threatened species by both the USFWS and the SCDNR. This status is due to a restricted habitat within the coastal plain and due to the species similarity in appearance to the critically endangered American crocodile (*Crocodylus acutus*) which is known to still occur in southern Florida. The discharge wetlands likely enhance and augment the alligator habitat that occurs on the island. Winter dormitories occur in both Whooping Crane Conservancy and Cypress Conservancy.

#### **3.4.2 Spotted Turtle (*Clemmys guttata*)**

The spotted turtle has been recently listed as a state threatened species by the SCDNR and is noted as an at-risk species by the USFWS. Spotted turtles occupy shallow wetlands with soft substrates. This type of habitat occurs within the Whooping Crane Conservancy and Cypress Conservancy; however, no spotted turtles were observed during the 2019 monitoring period. Little is known of the distribution and long-term habitat requirements of the species within the state. Whooping Crane Conservancy and Cypress Conservancy offer some of the only available natural habitat on the island. The many water features and ponds associated with the many golf courses on the island also offer a secondary potential habitat. There are no perceived threats to spotted turtles due to the discharge wetlands.

#### **3.4.3 Southern Hognose Snake (*Heterodon simus*)**

The southern hognose snake is another species that has been in decline throughout the state and is listed as a state threatened species by the SCDNR and an at-risk species by the USFWS. Very little potential habitat exists for the southern-hognose snake within the project area. The species is most likely to occur in sandy habitats associated with pine-oak sandhills. No sandhill habitat occurs. Some dry upland sites do border some of the discharge wetlands with the most prominent upland habitat occurring near the recently dried Palmetto Hall grassy wetland. Regardless, the presence of southern hognose is unlikely in the project area and there is no perceived risk to potential habitat from the discharge wetlands.

### **3.4.4 Pondberry (*Lindera melissifolia*)**

Where it occurs, pondberry can be found in Carolina bays and seasonally wet depressions. Pondberry was not observed during the 2019 annual monitoring period and has not been recorded within the project area during any of monitoring events of the last 20 years. Although limited potential habitat does occur within the Whooping Crane Conservancy, Cypress Conservancy, and Palmetto Hall wooded wetland, the occurrence of pondberry is unlikely. There is no perceived risk to the species from the discharge wetlands.

### **3.4.5 Wood Stork (*Mycteria Americana*)**

The wood stork is listed as a federally threatened and state endangered species. Wood stork was not observed during the 2019 monitoring period, however, the species was recorded for the Cypress Conservancy in the 2017 monitoring report (Ballantine 2018). Mature forest within the Cypress Conservancy and Whooping Crane Conservancy provide potential foraging and roosting habitat for the species. Both sites are probably too small to support nesting habitat and no rookeries are known to occur in either wetland. There is no perceived risk to the species from the discharge wetlands and mature habitats within the project area have the potential to benefit the species.

### **3.4.6 Northern Long-eared Bat (*Myotis septentrionalis*)**

Like many bat species, populations of the northern long-eared bat are in steep decline. The species is currently listed as threatened by the USFWS but has not been listed by the SCDNR. No northern-long eared bats were observed during the 2019 monitoring period. Identification of the species is difficult and requires either mist netting, audio-acoustic identification, or a combination of both. The species occupies a broad geographical range and utilizes mature forests with standing dead trees and live trees with exfoliated bark as summer roost sites. Some potential summer habitat for the species occurs within the Whooping Crane Conservancy and Cypress Conservancy. There is no perceived risk to the species from the discharge wetlands and mature habitats within the project area have the potential to benefit the species.

## **4.0 CONCLUSIONS AND RECOMMENDATIONS**

The primary concern Ballentine Environmental Resources raised in their 2018 report were the substantial number of trees that had blown down along the edges of the wetlands and the required dry down periods in the Palmetto Hall wetlands. It is our understanding that discharge to the Palmetto Hall grassy wetlands has ceased due to concerns from local residents. The grassy wetlands are transitioning to a pine forest. Ballentine suggests that the rigid dry down periods make the trees more susceptible to blow down. However dry-down periods can be beneficial in the swamp tupelo swamps, including the Palmetto Hall wooded wetlands and the Hilton Head Plantation conservancies. Most of the swamp forest wetlands contained an even age of mature trees and very few younger swamp tupelos or bald and pond cypress. Carefully implemented dry downs can help with recruitment of younger tree species in these forests and

increase overall plant diversity. It is apparent that with the exception of the Palmetto Hall grassy wetland, the receiving wetlands are benefiting from the PSD water reuse program. The macroinvertebrate assemblage indicates long-term hydrology conditions, and good water quality conditions conducive for supporting a diverse assemblage of aquatic invertebrates.

Chinese tallow was recorded throughout the project area and was a significant component of the shrub strata within the Cypress Conservancy, the Palmetto Hall wooded wetlands, and the Palmetto Hall grassy wetlands. The presence of the species is anecdotally referenced in the 2018 monitoring report but no quantitative data is listed. Because of this no conclusions can be drawn regarding changes in overall coverage from earlier reporting. Populations of tallow tree should be monitored in the future. Multiple factors can make tallow tree management difficult. It produces large numbers of fruits, which are spread by water and are consumed and spread by many species of birds. Bottomlands subject to periodic flooding may be repeatedly re-infested from upstream seed sources. Tallow tree is also an aggressive sprouter and rapidly regenerates from both stumps and lateral roots, so mechanical control methods frequently exacerbate the problem. Several effective herbicides do exist for tallow tree control. At this time, no prescriptive action is recommended. Tallow tree is a common component of wetlands throughout the coastal plain of South Carolina. The spread of tallow tree is not necessarily a result of discharge of RW within the project area. Interpreting the spread of tallow could be elucidated by the establishment of an appropriate reference site on the Island, if such a resource exists. For all of the same reasons listed for Chinese tallow, the spread of swamp loosestrife should also be monitored closely in subsequent monitoring periods. The following specific recommendations are proposed for the Hilton Head Plantation and Palmetto Hall Recycled Water Projects:

1. Subsequent monitoring reports should provide data results in tabular form.
2. The spread of tallow tree should be monitored closely, and if the species is deemed problematic as compared to similar communities on the island prescriptive action may be required.
3. The spread of swamp loosestrife should be monitored closely, and if the species is deemed problematic as compared to similar communities on the island prescriptive action may be required.
4. Establishing an appropriate reference site, if one exists, would provide a more informative interpretation of the spread of exotic-invasive species.
5. Hilton Head PSD should continue its successful outreach program to educate customers and the general public about the valuable Recycled Water Program pioneered on Hilton Head Island.

## **5.0 REFERENCES**

Ballantine Environmental Resources, Hilton Head Plantation Recycled Water Project, Biennial Biological Monitoring Report, March 2018.

Ballantine Environmental Resources, Palmetto Hall Recycled Water Project, 2016-2017 Biennial Biological Monitoring Report, March 2018.

# ***TABLES***

Table 1. Recycled water discharge wetlands and associated monitoring effort conducted during the 2019 biological monitoring period.

<b>Recycled Water Project (RWP) Site / Wetland Areas</b>	<b>Monitoring Locations / Type</b>
<i>Palmetto Hall RWP</i>	
Grassy Wetland	5 Transects / 1 stations per transect
Wooded Wetland	4 Transects / 1 stations per transect
<i>Hilton Head Plantation RWP</i>	
Cypress Conservancy	3 Transects / 3 stations per transect
Whooping Crane Conservancy	3 Transects / 3 stations per transect

Table 2. Biological monitoring sampling parameters and methods conducted for the Hilton Head PSD at four recycled water discharge wetlands.

<b><i>Vegetation</i></b>	
Canopy	One (1) 1/100-acre plot per station
Shrub and groundcover	1/1,000-acre plot per station
Nuisance species	Plot sampling and/or qualitative assessment
<b><i>Benthic Macroinvertebrates</i></b>	
Grab Samples	One composite sample per wetland*
<b><i>Significant Impact</i></b>	
Observations of disease, insects, hurricanes, tornados, etc.	Qualitative observations within each monitoring unit

\* Benthic macroinvertebrates were not collected at the Palmetto Hall grassy wetlands due to a lack of water.

Table 3. Quantitative analysis of tree cover at the Cypress Wetland as observed in 2019.

Species Name	Common Name	Density (Trees per acre)	Basal Area (ft <sup>2</sup> /ac)	Importance Values
<i>Nyssa biflora</i>	Swamp tupelo	124	56.9	213.3
<i>Taxodium distichum</i>	Bald cypress	23	3.5	39.5
<i>Pinus taeda</i>	Loblolly pine	2	0.1	11.3
<i>Morella cerifera</i>	Wax myrtle	1	0.0	5.6
<i>Liquidambar styraciflua</i>	Sweetgum	10	0.4	16.6
<i>Acer rubrum</i>	Red maple	2	0.1	6.3
<i>Ilex coriacea</i>	Large gallberry	4	0.0	7.4
<b>Total</b>		<b>166</b>	<b>61</b>	<b>300</b>

Table 4. Quantitative analysis of tree cover at the Whooping Crane Wetland in 2019.

Species Name	Common Name	Density (Trees per acre)	Basal Area (ft <sup>2</sup> /ac)	Importance Values
<i>Nyssa biflora</i>	Swamp tupelo	172	71.5	214.3
<i>Pinus taeda</i>	Loblolly pine	22	2.8	37.5
<i>Morella cerifera</i>	Wax myrtle	10	0.1	23.4
<i>Salix caroliniana</i>	Coastal plain willow	22	0.3	19.6
<i>Acer rubrum</i>	Red maple	1	0.0	5.2
<b>Total</b>		<b>227</b>	<b>75</b>	<b>300</b>

Table 5. Quantitative analysis of tree cover at the Palmetto Hall wooded wetland in 2019.

<b>Species Name</b>	<b>Common Name</b>	<b>Density (Trees per acre)</b>	<b>Basal Area (ft<sup>2</sup>/ac)</b>	<b>Importance Values</b>
<i>Nyssa biflora</i>	Swamp tupelo	98	14.3	277.0
<i>Morella cerifera</i>	Wax myrtle	3	0.0	23.0
<b>Total</b>		<b>101</b>	<b>14</b>	<b>300</b>

Table 6. Quantitative analysis of tree cover at the Palmetto Hall grassy wetland in 2019.

<b>Species Name</b>	<b>Common Name</b>	<b>Density (Trees per acre)</b>	<b>Basal Area (ft<sup>2</sup>/ac)</b>	<b>Importance Values</b>
<i>Pinus taeda</i>	Loblolly pine	24	1.6	192.8
<i>Nyssa biflora</i>	Swamp tupelo	16	0.0	59.2
<i>Triadica sebifera</i>	Chinese tallow tree	10	0.1	48.0
<b>Total</b>		<b>50</b>	<b>2</b>	<b>300</b>

Table 7. Shrub coverage metrics and taxa richness recorded for the Cypress Conservancy as observed in 2019.

Species	Common Name	Mean Cover	Relative Dominance	Relative Frequency	IVI
<i>Sabal minor</i>	Dwarf palmetto	10.56	27.22	20.59	47.81
<i>Triadica sebifera</i>	Tallow tree	8.89	22.92	23.53	46.45
<i>Persea borbonia</i>	Red bay	7.89	20.34	23.53	43.87
<i>Morella cerifera</i>	Wax myrtle	8.22	21.20	17.65	38.85
<i>Liquidambar styraciflua</i>	Sweet gum	0.78	2.01	5.88	7.89
<i>Lyonia lucida</i>	Fetterbush	1.11	2.87	2.94	5.81
<i>Vaccinium corymbosum</i>	Highbush blueberry	1.11	2.87	2.94	5.81
<i>Decodon verticillata</i>	Swamp loosestrife	0.22	0.57	2.94	3.51
<b>Total</b>		<b>38.78</b>	<b>99.99</b>	<b>100.00</b>	<b>199.99</b>

Table 8. Shrub coverage metrics and taxa richness recorded for the Whooping Crane Conservancy as observed in 2019.

Species	Common Name	Mean Cover	Relative Dominance	Relative Frequency	IVI
<i>Morella cerifera</i>	Wax myrtle	22.78	47.23	33.33	80.57
<i>Decodon verticillata</i>	Swamp loosestrife	11.33	23.50	22.22	45.73
<i>Salix caroliniana</i>	Carolina willow	9.44	19.59	11.11	30.70
<i>Persea borbonia</i>	Red bay	2	4.15	11.11	15.26
<i>Ilex cassine</i>	Dahoon	0.89	1.84	7.41	9.25
<i>Lyonia lucida</i>	Fetterbush	0.67	1.38	7.41	8.79
<i>Triadica sebifera</i>	Tallow tree	0.78	1.61	3.70	5.32
<i>Cephalanthus occidentalis</i>	Buttonbush	0.33	0.69	3.70	4.39
<b>Total</b>		<b>48.22</b>	<b>100.00</b>	<b>100</b>	<b>200.00</b>

Table 9. Shrub coverage metrics and taxa richness recorded for the Palmetto Hall wooded wetland as observed in 2019.

<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Triadica sebifera</i>	Tallow tree	16.25	57.52	36.36	93.89
<i>Morella cerifera</i>	Wax myrtle	7.5	26.55	27.27	53.82
<i>Cephalanthus occidentalis</i>	Buttonbush	2.5	8.85	9.09	17.94
<i>Sabal minor</i>	Dwarf palmetto	1	3.54	9.09	12.63
<i>Acer rubrum</i>	Red maple	0.5	1.77	9.09	10.86
<i>Persea borbonia</i>	Red Bay	0.5	1.77	9.09	10.86
<b>Total</b>		<b>28.25</b>	<b>100.00</b>	<b>100.00</b>	<b>200.00</b>

Table 10. Shrub coverage metrics and taxa richness recorded for the Palmetto Hall grassy wetland as observed in 2019.

<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Morella cerifera</i>	Wax myrtle	5.00	41.67	14.29	55.95
<i>Diodia virginiana</i>	Persimmon	1.60	13.33	28.57	41.90
<i>Triadica sebifera</i>	Tallow tree	2.00	16.67	14.29	30.95
<i>Persea borbonia</i>	Red bay	1.40	11.67	14.29	25.95
<i>Sabal minor</i>	Dwarf palmetto	1.00	8.33	14.29	22.62
<i>Ilex cassine</i>	Dahoon	1.00	8.33	14.29	22.62
<b>Total</b>		<b>12.00</b>	<b>100.00</b>	<b>100.00</b>	<b>200.00</b>

Table 11. Ground coverage metrics and species richness recorded for the Cypress Conservancy, during the 2019 annual monitoring period.

<b>Cypress Conservancy March 2019</b>					
<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Saururus cernuus</i>	Lizard's tail	16.22	39.78	23.53	63.31
<i>Polygonum hydropiperoides</i>	Swamp smartweed	6.83	16.76	17.65	34.41
<i>Hydrocotyle sp.</i>	Pennywort	7.44	18.26	11.77	30.03
<i>Panicum hemitomon</i>	Maidencane	3.56	8.72	8.82	17.54
<i>Ludwigia palustris</i>	Creeping primrose	1.78	4.36	8.82	13.18
<i>Iris virginica</i>	Virginia iris	2.44	5.99	5.88	11.87
<i>Scirpus cyperinus</i>	Woolgrass	0.78	1.91	5.88	7.79
<i>Liquidambar styraciflua</i>	Sweetgum	0.33	0.82	5.88	6.7
<i>Woodwardia virginiana</i>	Virginia chainfern	1.11	2.72	2.94	5.66
<i>Toxicodendron radicans</i>	Poison ivy	0.22	0.55	2.94	3.49
<i>Acer rubrum</i>	Red maple	0.11	0.27	2.94	3.21
<i>Nyssa biflora</i>	Swamp tupelo	0.06	0.14	2.94	3.08
<b>Species Richness</b>					<b>12</b>
<b>Percent of Station with Water</b>					<b>55</b>
<b>Average Depth of Water in Inches</b>					<b>3.3</b>
<b>Cypress Conservancy August 2019</b>					
<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Saururus cernuus</i>	Lizard's tail	26	43.90	21.88	65.78
<i>Polygonum hydropiperoides</i>	Swamp smartweed	18.44	31.15	18.75	49.90
<i>Hydrocotyle sp.</i>	Pennywort	4.56	7.69	18.75	26.44
<i>Woodwardia virginiana</i>	Virginia chainfern	6.67	11.26	3.13	14.38
<i>Ludwigia palustris</i>	Creeping primrose	0.78	1.31	6.25	7.56
<i>Acer rubrum</i>	Red maple	1.11	1.88	3.13	5.00
<i>Liquidambar styraciflua</i>	Sweetgum	0.56	0.94	3.13	4.06
<i>Mikania scandens</i>	Climbing hempvine	0.22	0.38	3.13	3.50
<i>Setaria magna</i>	Plume Grass	0.22	0.38	3.13	3.50
<i>Dichanthelium sp.</i>	Rosette grass	0.11	0.19	3.13	3.31
<i>Parthenocissus quinquefolia</i>	Virginia creeper	0.11	0.19	3.13	3.31
<i>Pinus taeda</i>	Loblolly pine	0.11	0.19	3.13	3.31
<i>Pontederia cordata</i>	Pickrelweed	0.11	0.19	3.13	3.31
<i>Sabal minor</i>	Dwarf palmetto	0.11	0.19	3.13	3.31
<i>Toxicodendron radicans</i>	Poison ivy	0.11	0.19	3.13	3.31
<b>Species Richness</b>					<b>15</b>
<b>Percent of Station with Water</b>					<b>77</b>
<b>Average Depth of Water in Inches</b>					<b>6</b>

Table 12. Ground coverage metrics and species richness recorded for the Whooping Crane Conservancy, during the 2019 annual monitoring period.

Whooping Crane March 2019					
Species	Common Name	Mean Cover	Relative Dominance	Relative Frequency	IVI
<i>Hydrocotyle sp.</i>	Pennywort	12.44	56.85	25	81.85
<i>Polygonum hydropiperoides</i>	Smartweed	0.89	4.06	12.5	16.56
<i>Iris virginica</i>	Virginia iris	2.22	5.08	6.25	16.4
<i>Cephalanthus occidentalis</i>	Buttonbush	0.78	3.55	12.5	16.05
<i>Eleocharis tuberculosa</i>	Cone-cup spikerush	1.67	7.61	6.25	13.86
<i>Decodon verticillatus</i>	Swamp loosestrife	1.11	5.08	6.25	11.33
<i>Ludwigia palustris.</i>	Creeping primrose	1.11	5.08	6.25	11.33
<i>Salix caroliniana</i>	Carolina willow	1.11	5.08	6.25	11.33
<i>Scirpus cyperinus</i>	Woolgrass	0.33	1.52	6.25	7.77
<i>Nyssa biflora</i>	Swamp tupelo	0.11	0.51	6.25	6.76
<i>Saururus cernuus</i>	Lizard's tail	0.11	0.51	6.25	6.76
<b>Species Richness</b>					<b>11</b>
<b>Percent of Station with Water</b>					<b>88</b>
<b>Average Depth of Water in Inches</b>					<b>4.9</b>
Whooping Crane August 2019					
Species	Common Name	Mean Cover	Relative Dominance	Relative Frequency	IVI
<i>Ludwigia palustris.</i>	Creeping primrose	6	16.57	14.29	30.85
<i>Hydrocotyle sp.</i>	Pennywort	4.56	12.58	11.43	24.01
<i>Iris virginica</i>	Virginia iris	4.78	13.19	8.57	21.76
<i>Saururus cernuus</i>	Lizard's tail	3.56	9.82	11.43	21.25
<i>Panicum hemitomon</i>	Maidencane	3.67	10.12	5.71	15.84
<i>Polygonum hydropiperoides</i>	Smartweed	1.89	5.22	5.71	10.93
<i>Typha latifolia</i>	Cattail	1.89	5.22	5.71	10.93
<i>Decodon verticillatus</i>	Swamp loosestrife	1.44	3.99	5.71	9.70
<i>Eleocharis tuberculosa</i>	Cone-cup spikerush	1.44	3.99	5.71	9.70
<i>Lycopus rubellus</i>	Water horehound	1.11	3.07	5.71	8.78
<i>Cephalanthus occidentalis</i>	Buttonbush	0.89	2.45	5.71	8.17
<i>Rhynchospora inundata</i>	Horned beaksedge	1.67	4.60	2.86	7.46
<i>Tridens sp.</i>	Tridens	1.67	4.60	2.86	7.46
<i>Woodwardia virginiana</i>	Virginia chainfern	0.89	2.45	2.86	5.31
<i>Cyperus virens</i>	Green flatsedge	0.56	1.53	2.86	4.39
<i>Mikania scandens</i>	Climbing hempvine	0.22	0.61	2.86	3.47
<b>Species Richness</b>					<b>16</b>
<b>Percent of Station with Water</b>					<b>100</b>
<b>Average Depth of Water in Inches</b>					<b>9.4</b>

Table 13. Ground coverage metrics and species richness recorded for the Palmetto Hall wooded wetland, during the 2019 annual monitoring period.

<b>Palmetto Hall Wooded Wetland March 2019</b>					
<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Saururus cernuus</i>	Lizard's tail	28.75	93.50	57.14	150.64
<i>Triadica sebirifera</i>	Tallow tree	1.25	4.07	14.29	18.35
<i>Polygonum hydropiperoides</i>	Smartweed	0.5	1.63	14.29	15.91
<i>Ludwigia repens</i>	Creeping primrose	0.25	0.81	14.29	15.10
<b>Species Richness</b>					<b>4</b>
<b>Percent of Station with Water</b>					<b>100</b>
<b>Average Depth of Water in Inches</b>					<b>7.6</b>
<b>Palmetto Hall Wooded Wetland August 2019</b>					
<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Saururus cernuus</i>	Lizard's tail	61.67	76.4	37.50	113.94
<i>Carex</i> sp.	Carex	9.00	11.16	25.00	36.16
<i>Rhynchospora inundata</i>	Horned beaksedge	6.67	8.26	12.5	20.76
<i>Polygonum hydropiperoides</i>	Smartweed	2.33	2.89	12.5	15.39
<i>Cephalanthus occidentalis</i>	Buttonbush	1.00	1.24	12.5	13.74
<b>Species Richness</b>					<b>6</b>
<b>Percent of Station with Water</b>					<b>100</b>
<b>Average Depth of Water in Inches</b>					<b>7.5</b>

Table 14. Ground coverage metrics and species richness recorded for the Palmetto Hall grassy wetland, during the 2019 annual monitoring period.

<b>Palmetto Hall Grassy Wetland March 2019</b>					
<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Polygonum</i> sp.	Smartweed	35	63.64	25	88.64
<i>Setaria magna</i>	Plume Grass	7.2	13.09	18.75	31.84
<i>Iris virginica</i>	Virginia iris	9	16.36	6.25	22.61
<i>Erechtites hieracifolia</i>	Burnweed	0.8	1.45	12.5	13.95
<i>Juncus effusus</i>	Soft rush	1	1.82	6.25	8.07
<i>Eupatorium</i> sp.	Eupatorium	0.6	1.09	6.25	7.34
<i>Woodwardia virginiana</i>	Virginia chainfern	0.6	1.09	6.25	7.34
<i>Pinus taeda</i>	Loblolly pine	0.4	0.73	6.25	6.98
<i>Scirpus cyperinus</i>	Wool grass	0.2	0.36	6.25	6.61
<i>Toxicodendron radicans</i>	Poison ivy	0.2	0.36	6.25	6.61
<b>Species Richness</b>					<b>10</b>
<b>Percent of Station with Water</b>					<b>0</b>
<b>Average Depth of Water in Inches</b>					<b>0</b>
<b>Palmetto Hall August 2019</b>					
<b>Species</b>	<b>Common Name</b>	<b>Mean Cover</b>	<b>Relative Dominance</b>	<b>Relative Frequency</b>	<b>IVI</b>
<i>Polygonum hydropiperoides</i>	Smartweed	52	63.57	30.77	94.34
<i>Erechtites hieracifolia</i>	Burnweed	8	9.78	23.08	32.86
<i>Setaria magna</i>	Plume Grass	4	4.89	7.69	12.58
<i>Iris virginica</i>	Virginia iris	2	2.44	7.69	10.13
<i>Panicum hemitomon</i>	Maidencane	2	2.44	7.69	10.13
<i>Pinus taeda</i>	Loblolly pine	1.4	1.71	7.69	9.40
<i>Toxicodendron radicans</i>	Poison ivy	0.4	0.49	7.69	8.18
<b>Species Richness</b>					<b>7</b>
<b>Percent of Station with Water</b>					<b>0</b>
<b>Average Depth of Water in Inches</b>					<b>0</b>

Table 15. Macroinvertebrate assemblages collected from the Hilton Head Island PSD recycled water discharge wetlands, in 2019.

Species	Tolerance Values	Functional Feeding Groups	Whooping Crane Conservancy	Cypress Conservancy	Palmetto Hall Wooded Wetlands
<b>MOLLUSCA</b>					
<b>Bivalvia</b>					
<b>Veneroidea</b>					
Sphaeriidae		FC			1
<i>Musculium sp.</i>	7.5	FC		2	
<b>Gastropoda</b>					
<b>Basommatophora</b>					
Ancylidae		SC			
<i>Ferrissia fragilaris</i>	6.55	SC	8	9	11
Lymnaeidae		SC			
<i>Pseudosuccinea columella</i>	7.7	CG		1	
Physidae					
<i>Physella sp.</i>	8.7	CG		17	54
Planorbidae		SC			
<i>Menetus dilatatus</i>	7.6	SC	7	1	55
<i>Planorbella sp.</i>	6.82		3		7
<b>ANNELIDA</b>					
<b>Clitellata</b>					
<b>Oligochaeta</b>		CG			
<b>Tubificida</b>					
Naididae		CG			
Naidinae		CG			52
<i>Dero sp.</i>	9.8	CG		2	3
Tubificinae w.h.c.	7.11	CG		1	
Pristininae					
<i>Pristina sp.</i>	7.7	CG			10
<b>Lumbriculida</b>					
Lumbriculidae	7.03	CG	52		
<b>ARTHROPODA</b>					
<b>Arachnoidea</b>					
<b>Acariformes</b>	5.53			1	
<b>Crustacea</b>					
<b>Cladocera</b>					
Daphnidae					
<i>Ceriodaphnia sp.</i>			1	3	20

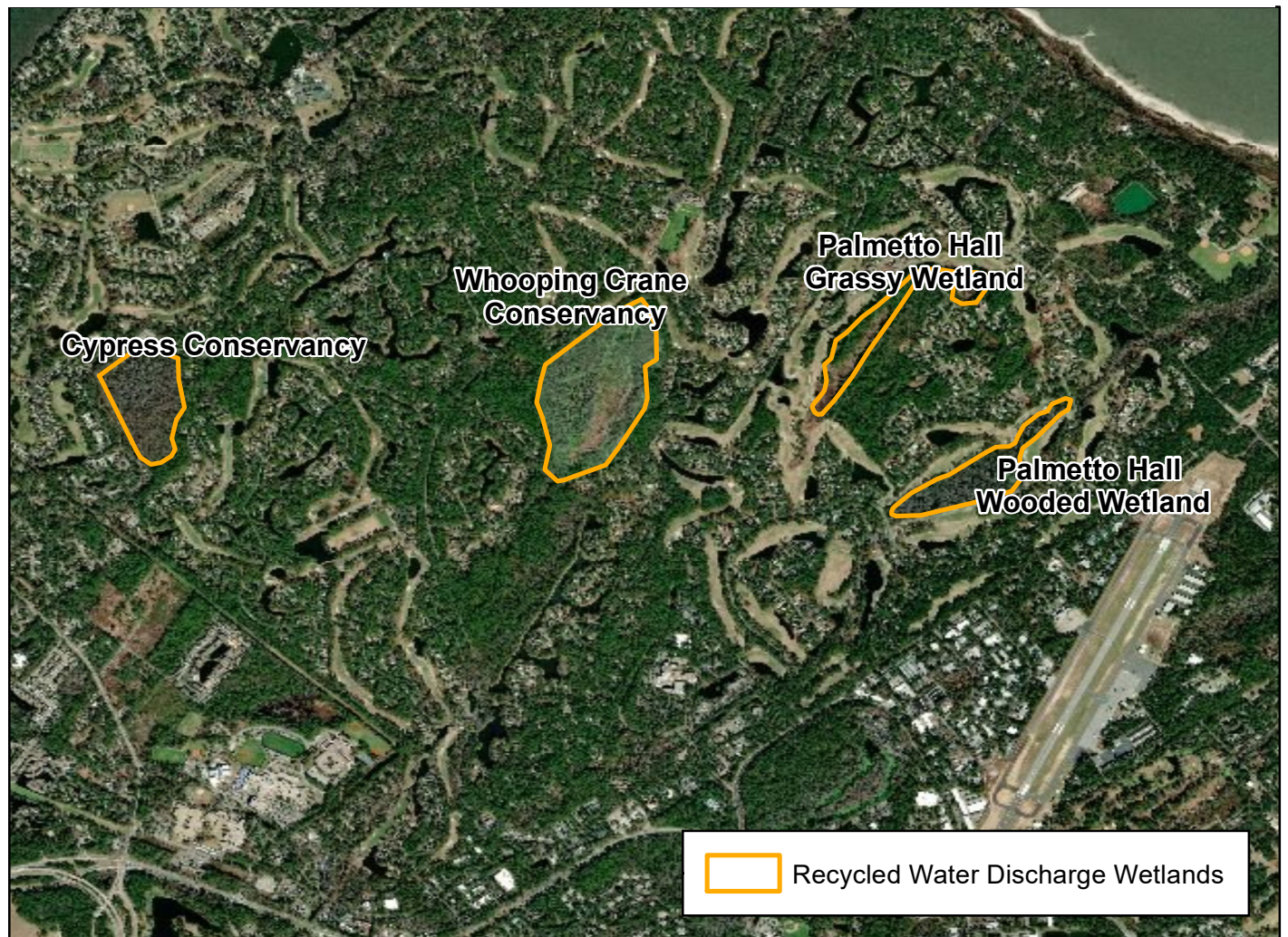
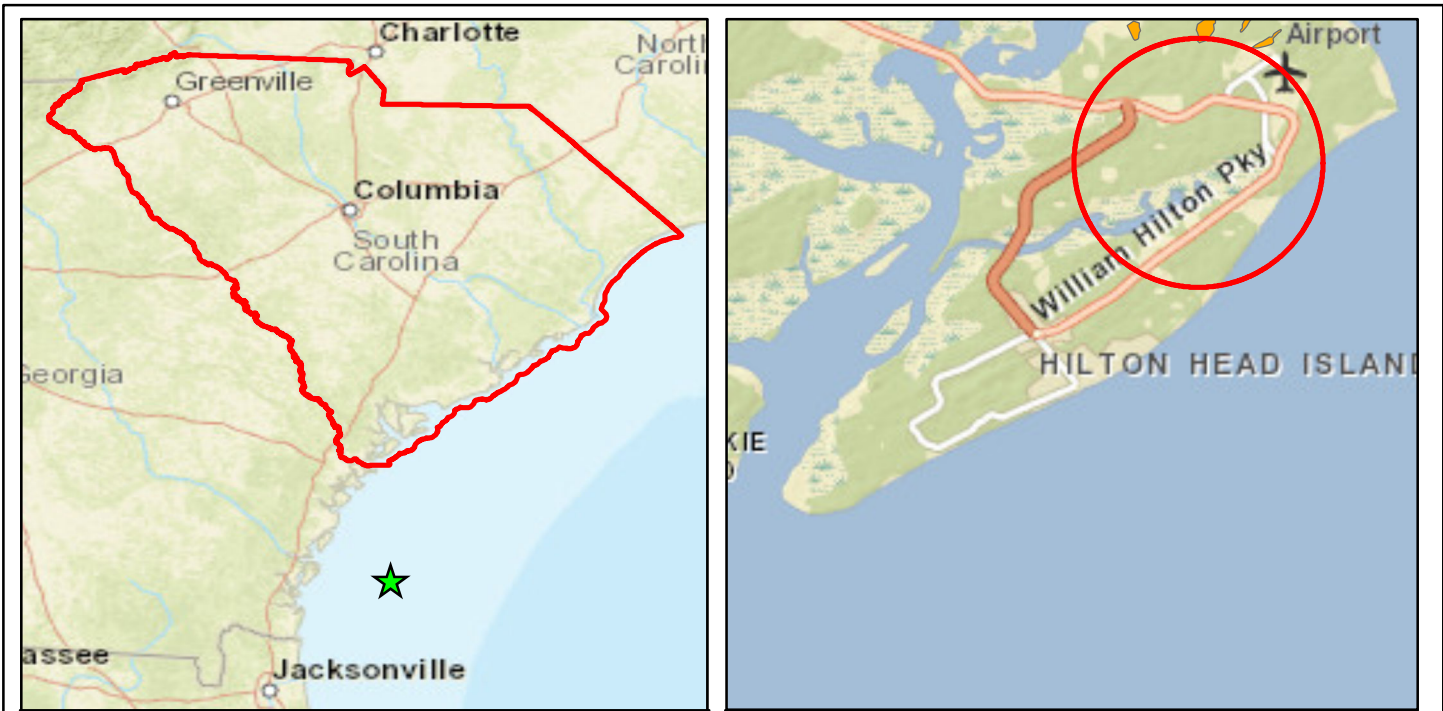
Table 15. Continued, Macroinvertebrate assemblage from the Hilton Head Island PSD recycled water discharge wetlands, March 2019.

Species	Tolerance Values	Functional Feeding Groups	Whooping Crane Conservancy	Cypress Conservancy	Palmetto Hall Wooded Wetlands
<b>Copepoda</b>					
<b>Cyclopoida</b>					
Cyclopidae					
<i>Acanthocyclops sp.</i>			2	2	4
<i>Macrocyclops albidus</i>			6		
<b>Ostracoda</b>				6	27
<b>Isopoda</b>					
Asellidae		<b>SH</b>			
<i>Caecidotea sp.</i>	<b>8.4</b>	<b>CG</b>	9	53	56
<b>Amphipoda</b>		<b>CG</b>			
Hyalellidae					
<i>Hyalella azteca</i>	<b>7.75</b>	<b>CG</b>	57	4	2
<b>Insecta</b>					
<b>Collembola</b>					
Sminthuridae			2		1
<b>Odonata</b>					
Aeshnidae		<b>P</b>			
<i>Anax junius</i>		<b>P</b>			2
<i>Nasiaeschna pentacantha</i>	<b>6.6</b>			2	
Coenagrionidae		<b>P</b>			
<i>Ischnura sp.</i>	<b>9.5</b>				1
Libellulidae		<b>P</b>			
<i>Pachydiplax longipennis</i>	<b>9.6</b>			1	
<b>Hemiptera</b>					
Belostomatidae					
<i>Belostoma sp.</i>	<b>9.5</b>	<b>P</b>		1	
Corixidae	<b>9</b>	<b>PI</b>		1	
Naucoridae					
<i>Pelocoris sp.</i>	<b>7.01</b>		1		
<b>Neuroptera</b>					
Sisyridae		-			
<i>Climacia sp.</i>	<b>8.4</b>			1	
<b>Coleoptera</b>					
Curculionidae			10		
Dytiscidae		<b>P</b>			

Table 15. Continued, Macroinvertebrate assemblage from the Hilton Head Island PSD recycled water discharge wetlands, March 2019.

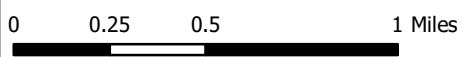
Species	Tolerance Values	Functional Feeding Groups	Whooping Crane Conservancy	Cypress Conservancy	Palmetto Hall Wooded Wetlands
<i>Neoporus sp.</i>	5		4	2	5
Haliplidae					
<i>Haliplus sp.</i>	8.71	SH		2	3
Hydrophilidae		P			
<i>Enochrus sp.</i>	8.5	CG	3		
<i>Tropisternus sp.</i>	9.3	P		2	
Noteridae					
<i>Suphisellus sp.</i>			1		
Scirtidae		SC			
<i>Scirtes sp.</i>				1	
<b>Diptera</b>					
Ceratopogonidae		P		4	
Chironomidae					
<i>Chironomus sp.</i>	9.3	CG			2
<i>Conchapelopia sp.</i>	8.43	P		1	
<i>Dicrotendipes neomodestus</i>	7.9	CG		15	
<i>Kiefferulus sp.</i>				3	
<i>Kiefferulus dux</i>	8			72	
<i>Limnophyes sp.</i>	7.43	CG			2
<i>Nanocladius crassicornus</i>	7.4				1
<i>Polypedilum illinoense gp.</i>	8.7	SH		57	
<i>Tanytarsus sp.</i>	6.6	FC		1	1
<i>Tanypus sp.</i>	9.19	P		7	1
Simuliidae		FC			
<i>Simulium sp.</i>	4.9	FC	2		
Stratiomyidae		CG			
<i>Myxosargus sp.</i>			2		1
<b>TOTAL NO. OF ORGANISMS</b>			<b>170</b>	<b>275</b>	<b>322</b>
<b>TOTAL NO. OF TAXA (Richness)</b>			<b>17</b>	<b>30</b>	<b>24</b>
<b>EPT INDEX</b>			<b>0</b>	<b>0</b>	<b>0</b>
<b>BIOTIC INDEX Assigned Values</b>			<b>7.21</b>	<b>8.18</b>	<b>7.79</b>

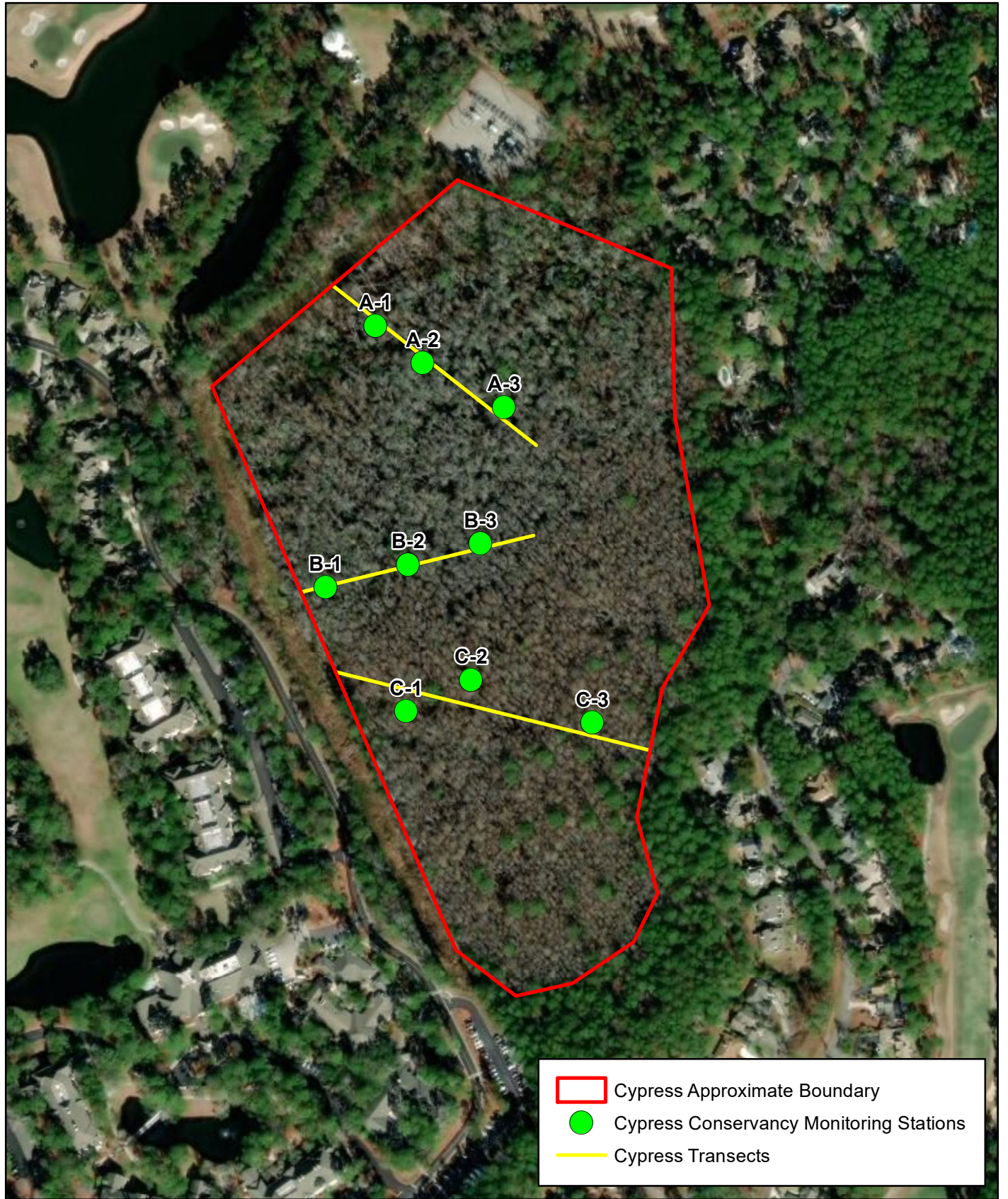
# ***FIGURES***



Data Source: ESRI GIS Data Server: February 19, 2017

Figure 1. Vicinity map for the Hilton Head Island PSD Recycled Water Discharge Wetlands.



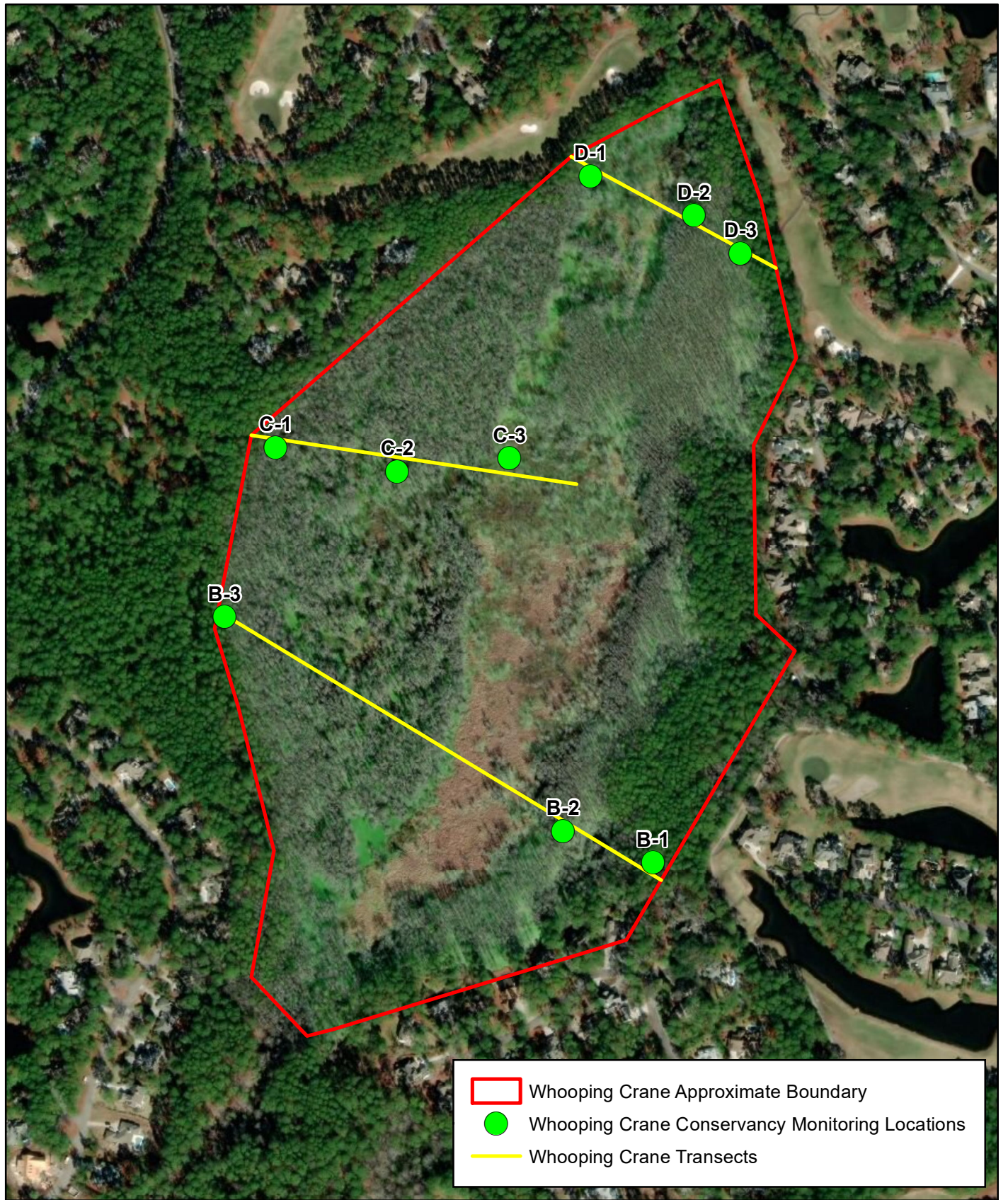


Data Source: Esri World Imagery

0 150 300 600 Feet



Figure 2. Cypress Conservancy Biological Monitoring Stations for the Hilton Head PSD Recycled water project.



Data Source: Esri World Imagery

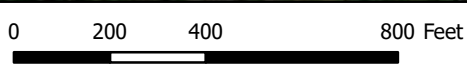
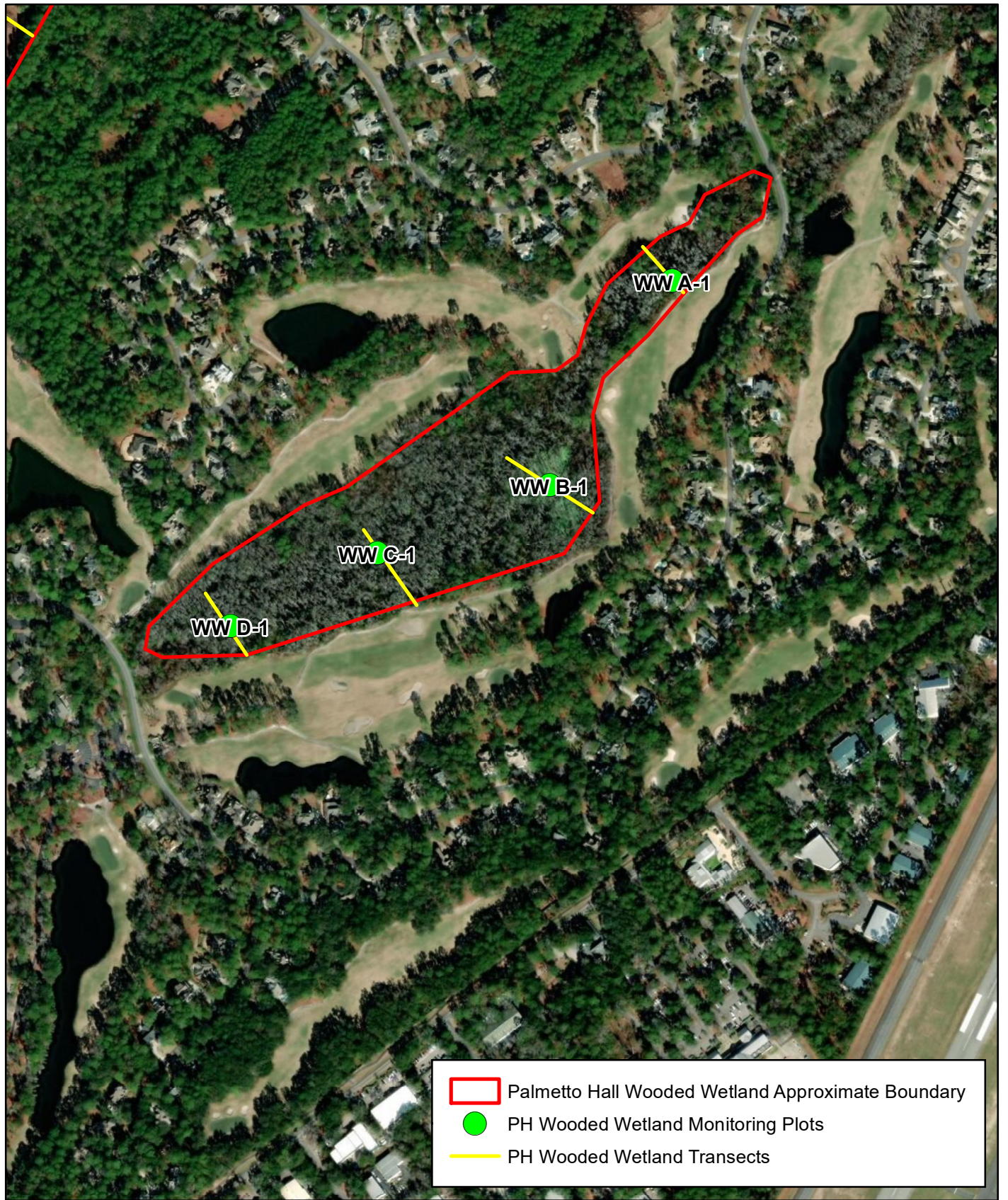


Figure 3. Whooping Crane Conservancy Biological Monitoring Stations for the Hilton Head PSD Recycled water project.



Data Source: Esri World Imagery

0 250 500 1,000 Feet



Figure 4. Palmetto Hall Wooded Wetland Biological Monitoring Stations for the Hilton Head PSD Recycled water project.

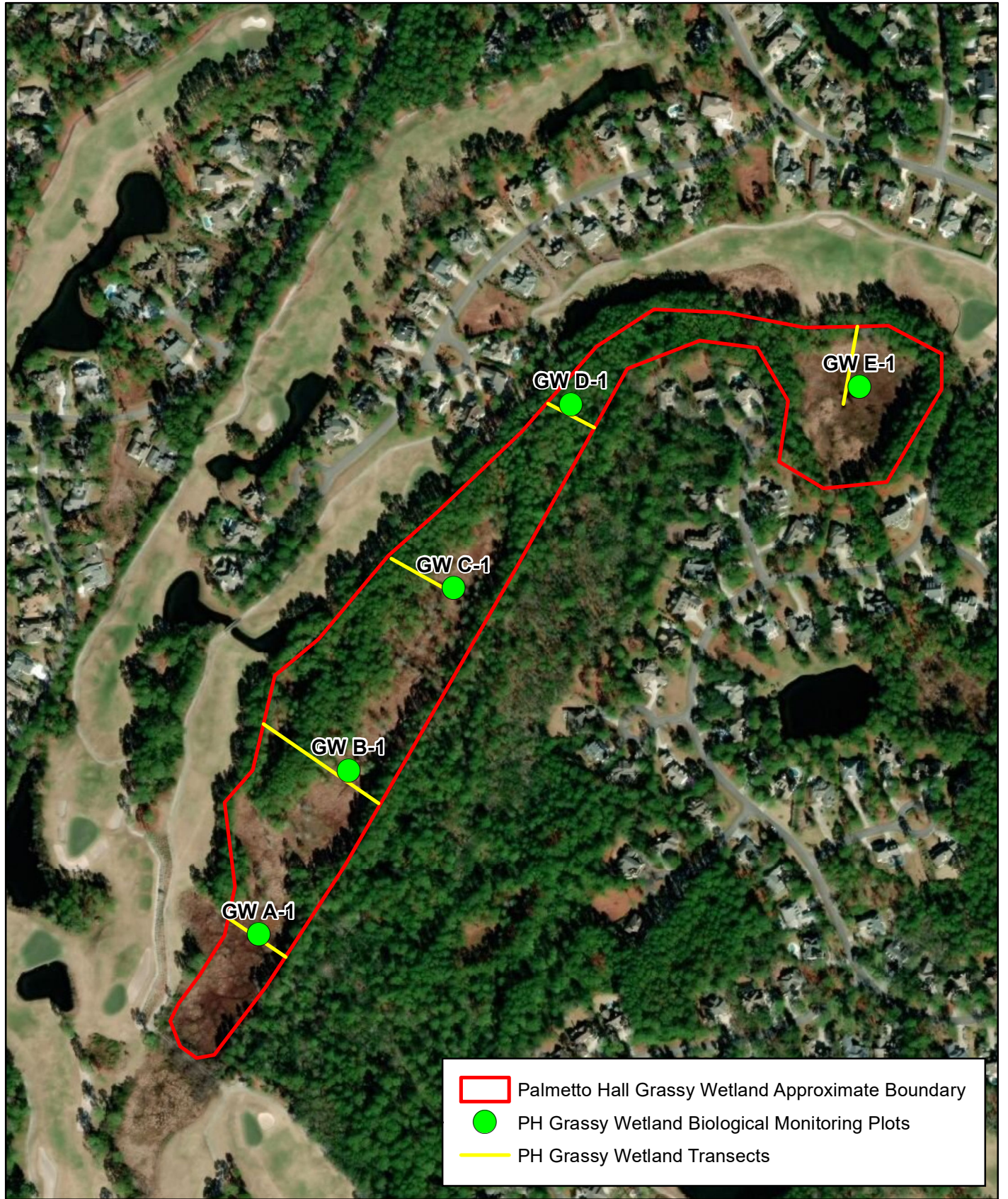


Figure 5. Palmetto Hall Grassy Wetland Biological Monitoring Stations for the Hilton Head PSD Recycled water project.

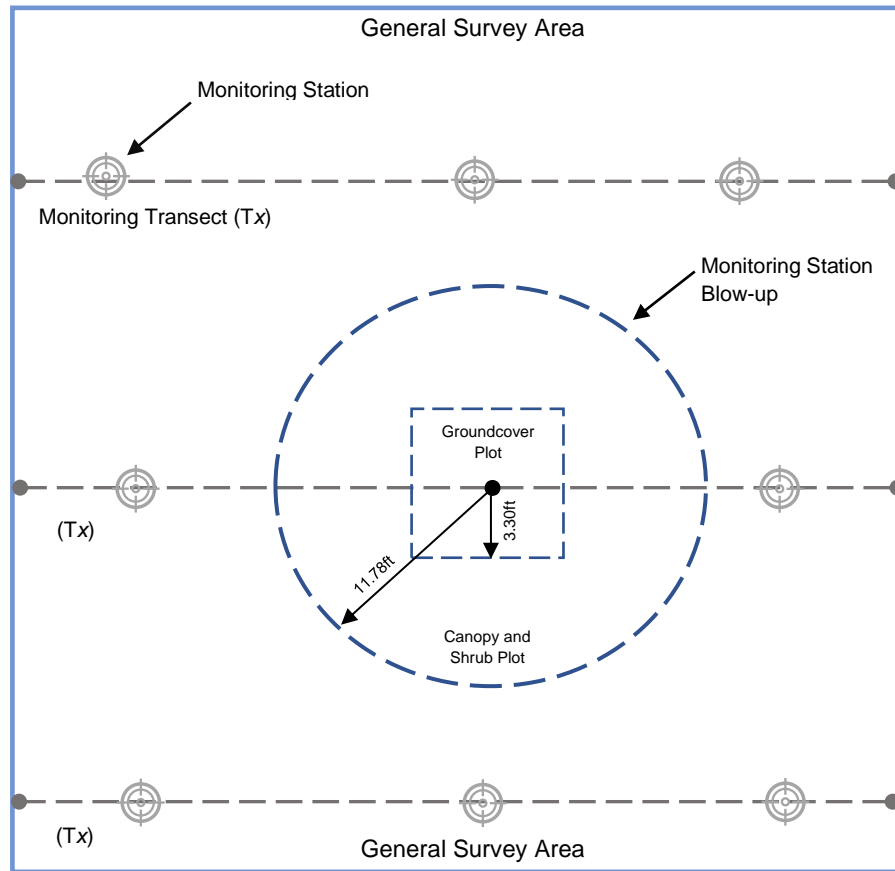


Figure 6. Wetland vegetation monitoring plot schematic.

***APPENDIX A***

***Wetland Site Photos***



Photo 1. Cypress Conservancy at station A-2, as observed during August 2019.



Photo 2. Cypress Conservancy at station B-1, as observed during August 2019.



Photo 3. Cypress Conservancy at station C-1, as observed during August 2019.



Photo 4. Whooping Crane Conservancy at station B-2, as observed during August 2019.



Photo 5. Whooping Crane Conservancy at station C-1, as observed during March 2019.



Photo 6. Whooping Crane Conservancy at station D-1, as observed during August 2019.



Photo 7. Palmetto Hall wooded wetland at station A-1, as observed during March 2019.



Photo 8. Palmetto Hall wooded wetland at station B-1, as observed during August 2019.



Photo 9. Palmetto Hall wooded wetland at station D-1, as observed during March 2019.



Photo 10. Palmetto Hall golf course wetland at station A-1, as observed during August 2019.



Photo 11. Palmetto Hall golf course wetland at station C-1, as observed during August 2019.



Photo 12. Palmetto Hall golf course wetland at station D-1, as observed during August 2019.

***APPENDIX B***

***Site Specific Plant List***

Species Name	Common Name	Whooping Crane	Cypress	Wooded Wetland	Golf Course
<i>Acer rubrum</i>	Red Maple	X	X	X	
<i>Andropogon virginicus</i>	Broomsedge Bluestem	X	X		X
<i>Arundinaria gigantea</i>	Giant Cane	X			X
<i>Asclepias incarnata</i>	Milkweed (Swamp)	X			
<i>Azolla caroliniana</i>	Mosquito Fern	X	X		
<i>Bidens laevis</i>	Bur marigold	X	X		X
<i>Bignonia capreolata</i>	Cross Vine	X			X
<i>Boehmeria cylindrica</i>	False Nettle	X	X	X	X
<i>Callitriche heterophylla</i>	Water Starwort	X			
<i>Carex striata</i>	Walter's Sedge	X			
<i>Centella asiatica</i>	Centella		X		
<i>Cephalanthus occidentalis</i>	Button Bush	X	X	X	
<i>Cladium jamaicense</i>	Sawgrass	X			
<i>Clethra alnifolia</i>	Clethra	X			
<i>Cyperus flavescens</i>	Flatsedge	X			
<i>Cyperus virens</i>	Green flatsedge	X			
<i>Decodon verticillatus</i>	Swamp loosetrife	X			
<i>Diospyros virginiana</i>	Persimmon	X		X	X
<i>Dulichium arundinaceum</i>	Three-Way Sedge	X	X		
<i>Eleocharis tuberculosa</i>	Cone-cup spikerush	X	X		
<i>Erianthus gigantea</i>	Giant Plume Grass	X	X		
<i>Erechtites hieracifolia</i>	Burnweed				X
<i>Eupatorium compositifolium</i>	Dog Fennel	X	X	X	X
<i>Habenaria repens</i>	Water Spider Orchid	X			
<i>Hydrocotyle</i> sp.	Pennywort	X	X	X	
<i>Hydrocotyle ranunculoides</i>	Water Pennywort	X			
<i>Hydrocotyle umbellata</i>	Marsh Pennywort	X	X		
<i>Ilex cassine</i>	Dahoon Holly	X	X		X
<i>Ilex glabra</i>	Gallberry	X	X		
<i>Iris virginica</i>	Virginia Iris	X	X		X
<i>Juncus effusus</i>	Soft Rush	X	X	X	X
<i>Lachnanthes caroliniana</i>	Red-root	X			
<i>Lemna</i> spp.	Duckweed	X	X		
<i>Limnobium spongia</i>	Frog's Bit	X	X		
<i>Liquidambar styraciflua</i>	Sweet Gum	X		X	
<i>Ludwigia palustris</i>	Creeping Primrose		X		
<i>Lycopus rubellus</i>	Water horehound	X			
<i>Lyonia lucida</i>	Fetterbush	X	X	X	
<i>Micranthemum umbrosum</i>	Shade Mudflower	X			
<i>Mikania scandens</i>	Climbing Hempweed	X	X	X	X
<i>Morella cerifera</i>	Waxmyrtle	X	X	X	
<i>Nymphaea odorata</i>	Water Lily - Fragrant	X			
<i>Nyssa aquatica</i>	Water Tupelo	X			
<i>Nyssa biflora</i>	Black-Gum	X	X	X	X

Species Name	Common Name	Whooping Crane	Cypress	Wooded Wetland	Golf Course
<i>Osmunda cinnamomea</i>	Cinnamon Fern	X	X	X	
<i>Osmunda regalis</i>	Royal Fern	X	X	X	
<i>Panicum hemitomon</i>	Maidencane	X	X	X	X
<i>Panicum virgatum</i>	Switch Grass	X			
<i>Parthenocissus quinquefolia</i>	Virginia Creeper	X	X	X	X
<i>Persea borbonia</i>	Red Bay	X	X	X	X
<i>Phragmites australis</i>	Giant Reed		X		
<i>Pinus taeda</i>	Loblolly Pine	X	X	X	X
<i>Polygonum densiflorum</i>	Dense-flower Smartweed	X	X		
<i>Polygonum hydropiperoides</i>	Swamp Knotweed	X	X	X	X
<i>Pontederia cordata</i>	Pickerelweed	X			
<i>Pteridium aquilinum</i>	Bracken Fern	X			X
<i>Rhynchospora inundata</i>	Horned beaksedge	X	X		
<i>Rhus copallina</i>	Winged Sumac	X			X
<i>Rubus hispidus</i>	Swamp Dewberry	X	X	X	X
<i>Sabal minor</i>	Dwarf Palmetto	X	X	X	
<i>Sacciolepis striata</i>	Baggy Knees Grass	X			
<i>Sagittaria graminea</i>	Grass-leaved Sagittaria		X		
<i>Sagittaria latifolia</i>	Duck Potato	X			
<i>Salix caroliniana</i>	Carolina Willow	X	X	X	
<i>Sapium sebifera</i>	Chinese Tallowtree	X		X	X
<i>Saururus cernuus</i>	Lizard Tail	X	X	X	
<i>Serenoa repens</i>	Saw Palmetto	X			
<i>Setaria magna</i>	Plume Grass	X			X
<i>Smilax laurifolia</i>	Bamboo Vine	X	X	X	
<i>Spirodela punctata</i>	Duckmeat	X			
<i>Taxodium ascendens</i>	Pond Cypress		X		
<i>Taxodium distichum</i>	Bald Cypress		X		
<i>Toxicodendron radicans</i>	Poison Ivy	X	X	X	X
<i>Typha latifolia</i>	Cattail (Tall)	X			
<i>Utricularia inflata</i>	Floating Bladderwort	X	X		
<i>Vaccinium corymbosum</i>	Highbush Blueberry	X	X	X	
<i>Verbesina occidentalis</i>	Wingstem	X			
<i>Wolffia punctata</i>	Wolffia (Water Meal)	X			
<i>Woodwardia areolata</i>	Netted Chainfern	X	X		
<i>Woodwardia virginica</i>	Virginia Chainfern	X	X	X	X

***APPENDIX C***

***Site Specific Bird Lists***



Common Name	Scientific Name	Cypress		Whooping Crane		Wooded Wetlands		Golf Course Wetlands	
		MAR	AUG	MAR	AUG	MAR	AUG	MAR	AUG
Red-shouldered hawk	<i>Buteo lineatus</i>	X		X	X		X		
red-winged blackbird	<i>Agelaius phoeniceus</i>								
ruby-crowned kinglet	<i>Regulus calendula</i>			X		X			
snowy egret	<i>Egretta thula</i>						X		
sora rail	<i>Porzana carolina</i>			X	X				
swamp sparrow	<i>Melospiza georgiana</i>							X	
tufted titmouse	<i>Baeolophus bicolor</i>	X	X	X		X		X	
turkey vulture	<i>Cathartes aura</i>	X		X					
white ibis	<i>Eudocimus albus</i>	X		X	X		X		
White-eyed vireo	<i>Vireo griseus</i>	X		X	X			X	
wood duck	<i>Aix sponsa</i>	X	X	X		X			
yellow-rumped warbler	<i>Setophaga coronata</i>	X		X		X			
yellow-throated warbler	<i>Setophaga dominica</i>					X		X	

***APPENDIX D***

***Threatened and Endangered Species of Beaufort County,  
South Carolina***

**Threatened and endangered species that are known to occur, in Beaufort County, SC.**

Scientific Name	Common Name	Listing Status		Preferred Habitat	Habitat Potential Within Area	Found in Project Boundaries
		Federal	State			
<i>Acipenser brevirostrum</i>	Shortnose Sturgeon	LE	SE	brackish water of large rivers and estuaries	No potential habitat exists	<b>NO</b>
<i>Acipenser oxyrinchus</i>	Atlantic Sturgeon	LE	NONE	coastal waters, estuaries, large rivers	No potential habitat exists	<b>NO</b>
<i>Aeschynomene virginica</i>	Sensitive joint-vetch	LT	NONE	freshwater to slightly brackish tidal marshes and wet ditches	Limited potential habitat exists	<b>NO</b>
<i>Alligator mississippiensis</i>	American Alligator	LT	ST	fresh to slightly brackish lakes, ponds, rivers, and marshes	Good habitat exists	<b>YES</b>
<i>Ambystoma cingulatum</i>	Frosted flatwoods salamander	LT	SE	longleaf pine-wiregrass savannahs and flatwoods	No potential habitat exists	<b>NO</b>
<i>Balaenoptera physalus</i>	Finback Whale	LE	SE	marine	Zero Potential	<b>NO</b>
<i>Calidris canutus rufa</i>	Red Knot	LT	NONE	winters on beaches and sand flats	No potential habitat exists	<b>NO</b>
<i>Caretta caretta</i>	Loggerhead	LT	ST	nests on beaches; forages in ocean and sounds	No potential habitat exists	<b>NO</b>
<i>Charadrius melodus</i>	Piping Plover	LT	SE	ocean beaches and island-end flats	No potential habitat exists	<b>NO</b>
<i>Chelonia mydas</i>	Green Sea Turtle	LT	ST	nests on beaches; forages in ocean and sounds	No potential habitat exists	<b>NO</b>
<i>Clemmys guttata</i>	Spotted Turtle	ARS*	ST	shallow waters with soft substrate and emergent and submergent vegetation	Potential habitat does exist	<b>NO</b>
<i>Dermochelys coriacea</i>	Leatherback Sea Turtle	LE	SE	oceans, rarely in sounds	No potential habitat exists	<b>NO</b>

Scientific Name	Common Name	Listing Status		Preferred Habitat	Habitat Potential Within Area	Found in Project Boundaries
		Federal	State			
<i>Eubalaena glacialis</i>	Atlantic Right Whale	LE	SE	marine	Zero Potential	<b>NO</b>
<i>Haliaeetus leucocephalus</i>	Bald Eagle	NONE	ST	mature forests near large bodies of water (nesting); rivers, lakes, and sounds (foraging)	Limited potential habitat exists	<b>NO</b>
<i>Heterodon simus</i>	Southern Hognose Snake	ARS*	ST	sandy woods, particularly pine-oak sandhills	Limited potential habitat exists at GC wetland	<b>NO</b>
<i>Lepidochelys kempii</i>	Kemp's Ridley Sea Turtle	LE	SE	marine	Zero potential	<b>NO</b>
<i>Lindera melissifolia</i>	Pondberry	LE	NONE	Carolina bays and seasonally wet depressions	Limited potential habitat exists	<b>NO</b>
<i>Megaptera novaeangliae</i>	Humpback Whale	LE	SE	marine	Zero potential	<b>NO</b>
<i>Mycteria americana</i>	Wood Stork	LT	SE	swamps, fresh or brackish ponds	Good potential foraging habitat exists in the project area	<b>NO</b>
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT	NONE	roosts in hollow trees and buildings	Limited potential habitat exists	<b>NO</b>
<i>Picoides borealis</i>	Red-cockaded Woodpecker	LE	SE	mature open pine forests, mainly in longleaf pine [	No potential habitat exists	<b>NO</b>
<i>Sterna antillarum</i>	Least Tern	NONE	ST	beaches, sand flats, open dunes, gravel rooftops	No potential habitat exists	<b>NO</b>
<i>Trichechus manatus</i>	Florida Manatee	LT	SE	marine	Zero potential	<b>NO</b>

Listing Status: Federal (LT) Listed Threatened, (LE) Listed endangered; State (ST) State threatened, (SE) State endangered