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Acronyms

Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
ASTM	American Society for Testing and Materials
BMP	Biological Monitoring Plan
dbh	diameter at breast height
ERP	Environmental Resource Permit
et al.	and others
FDEP	Florida Department of Environmental Protection
GPS	Global Positioning System
JAXPORT	Jacksonville Port Authority
km	kilometer
LABINS	Land Boundary Information System
LSJR	Lower St. Johns River
m	meter
NRCS	Natural Resources Conservation Service
ORP	oxidation-reduction potential
POC	Point of Contact
ppt	parts per thousand
SAV	Submerged Aquatic Vegetation
SOP/SOPs	Standard Operating Procedure(s)
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture

1.0 Introduction

As a condition of contract W91278-16-D-0062 between Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) and the U.S. Army Corps of Engineers (USACE) to provide Submerged Aquatic Vegetation (SAV) and Freshwater Wetlands Monitoring in Support of Jacksonville Harbor Deepening Project, a Biological Monitoring Plan (BMP) for required freshwater forested wetlands monitoring must be submitted. The following is the BMP that describes the wetlands monitoring methodology and data analysis for five locations within the Lower St. Johns River (LSJR). This Wetlands BMP identifies wetland plot locations within five tributaries of the LSJR.

2.0 Background

Jacksonville's federal navigation channel is a 21-mile reach of the LSJR extending from the Atlantic Ocean at Mayport, Florida to the Jacksonville Port Authority (JAXPORT) Talleyrand Marine Terminal just north of downtown Jacksonville, Florida. In accordance with the Water Resources Reform Development Act of 2014, the USACE has been authorized to deepen the channel from 40 to 47 feet between river miles 0 and 13. This will allow Post-Panamax vessels to access the JAXPORT marine terminals near Blount Island.

Hydrodynamic modeling conducted by the USACE indicates the proposed deepening would result in a minor upstream shift in salinity. The authorized deepening plan, as well as the State permit, requires monitoring of selected freshwater forested wetlands within five tributaries of the LSJR. The data will be used to document community trends over time.

3.0 Objectives

The primary objective of this plan is to describe the freshwater wetlands monitoring approach, outlined in USACE Contract No. W91278-16-D-0062 and FDEP ERP Number: 0129277-017-BI, which will be used to identify potential adverse secondary impacts that may occur due to salinity stress to freshwater wetland vegetation, due to the deepening of the LSJR as identified above. The freshwater wetland monitoring results will be used to support the results of the hydrodynamic and ecological modeling performed by the USACE. This BMP describes the methods that will be used to assess freshwater wetlands within the LSJR to document the pre-dredge status and post-dredge status site conditions.

4.0 Methodology

4.1 Freshwater Wetlands Monitoring Station Locations

Freshwater wetland monitoring stations will be established adjacent to the following five tributaries of the LSJR (see Figure 1):

- Pottsburg Creek
- Ortega River
- Julington Creek
- Black Creek
- Six Mile Creek

Tributary Descriptions

Pottsburg Creek, located in Duval County, is approximately 8.2 miles long, and drains an area of about 9.1 square miles within the Jacksonville city limits (southeast portion of Duval County). The Creek is located on the east side of the St. Johns River, and is the most northern tributary in the project area. Pottsburg Creek is a second-order stream that flows directly into the Arlington River, a tributary to the St. Johns River. Interstate 95 passes through this densely-urbanized watershed (FDEP 2009a).

The Ortega River is also located in Duval County, on the west side of the St. Johns River, in a densely urban area west of the Jacksonville Naval Air Station. It drains an approximately 88.6 square mile area. The Ortega River watershed is located entirely within the highly-urbanized Jacksonville city limits, in the southern portion of Duval County. The Cedar River flows approximately 2.5 miles from northwest to southeast and then converges with the north-flowing Ortega River. From that convergence, the river flows approximately 1.5 miles eastward to the St. Johns River (FDEP 2009b).

Julington Creek, located on the east side of the St. Johns River in Duval County, is approximately 9.1 miles and drains approximately 20.4 square miles. Julington Creek flows into Durbin Creek, which is also a tributary to the St. Johns River. The Julington Creek watershed is located within the Jacksonville city limits, in the southeast portion of Duval County (FDEP 2009a).

Black Creek is a major tributary of the St. Johns River. It is 13 miles long, and drains an approximately 479-square-mile area. Black Creek is located on the west side of the St. Johns River, and the majority of Black Creek is in Clay County, Florida. Tributaries to Black Creek include North Fork Black Creek, South Fork Black Creek, Little Black Creek, Greens Creek, Peters Creek, and Grog Branch. The West Indian manatee, a federally endangered species, is found in the St. Johns River (FDEP 2009c).

Six Mile Creek is located on the east side of the St. Johns River, in St. Johns County, and is the most upstream tributary to the St. Johns River for this monitoring project area. The Six Mile Creek watershed covers an area approximately 122 square miles in size. Mill Creek and Turnbull Creek are tributaries of Six Mile Creek. Land in the Six Mile Creek watershed is primarily undeveloped; upland forests and wetlands. Urban and agricultural land comprise about 21% of the watershed land use (USEPA 2013).

Location of Wetland Monitoring Stations

Adjacent to each tributary, three freshwater wetland monitoring stations will be permanently established and repeatedly surveyed as reflected in the monitoring timeline (Section 4.2). Vegetation and soil/sediment data will be collected from each monitoring station. The monitoring stations will be established in locations that meet the criteria below:

- The wetland will be forested;
- The wetland (and wetland monitoring plot) will be located adjacent to the designated tributaries, to ensure the site is representative to detect potential salinity effects;

- The stretch of tributary will be tidally influenced; and
- The stretch of tributary will have prior salinity measurements less than 0.5 parts per thousand (ppt).

The first wetland monitoring station adjacent to each tributary will be located the furthest downstream in a tidally influenced stretch of the tributary where previous data indicates there was no prior salinity measurements greater than 0.5 ppt. The second and third monitoring stations will be located upstream of the first station, approximately one kilometer (km) apart, and on the same side of the tributary, if practicable. Wetland stations will be ground-truthed to ensure the wetlands do not have any visible signs of salinity intrusion or salt-stress. Some of the areas adjacent to the tributaries are urban or upland, and the wetland plot locations may need to be adjusted to locations within a freshwater forested wetland community. Justification for deviation from the wetland plot criteria and plot distances will be documented and reported.

Using the criteria above, wetland monitoring stations have been identified for each of the tributaries (Figure 1). The location of each wetland monitoring station is shown on Figures 2 through 6. A 10m x 20m monitoring plot was established at each station; the long side (20m) of the monitoring plot is oriented parallel to the tributary. Global Positioning System (GPS) coordinates for the corners of each monitoring plot are reflected in Table 1. Photographs of representative views of each wetland monitoring plot are provided in the Appendix.

Deviations from Wetland Plot Criteria

Deviations from the monitoring station criteria were made on four of the five tributaries: Pottsburg Creek, Julington Creek, Black Creek, and Six Mile Creek. The explanation and justification for these wetland plot criteria deviations are provided below.

1) Pottsburg Creek: The plots for the freshwater wetland monitoring stations are approximately 0.7 km apart. Locations for these monitoring stations was limited due to the presence of businesses and parking lots on both sides of the Pottsburg Creek (stormwater runoff) and the limited areas with habitat consistent with a freshwater forested wetland.

2) Julington Creek: The plots for the freshwater monitoring stations adjacent to Julington Creek were limited due to the short stretch of the Creek (approximately 1.1 km) that met both of the following conditions: tidally influenced and with salinities below 0.5 ppt. The three plots proposed are evenly spaced apart within this 1.1 km stretch of Julington Creek.

3) Black Creek: The distance between the plots for the first (most downstream) and second freshwater wetland monitoring stations is approximately 0.9 km, and the distance between the second and third (most upstream) monitoring station is approximately 1.4 km. A second deviation is that the third plot is located on the opposite side of Black Creek from the first and second monitoring plots. These distance-between-plot and location deviations were unavoidable due to a lack of freshwater forested wetlands that meet the project criteria on lands that were approved for access by landowners.

4) Six Mile Creek: The distance between the plots for the first (most downstream) and second freshwater wetland monitoring stations is approximately 1 km, and the distance between the second and third (most upstream) monitoring stations is approximately 0.6 km. The third monitoring station is the furthest upstream possible on land with permission to access. The landowner for the adjacent (upstream) land did not authorize land access. The first plot is located on the opposite side of the Six Mile Creek from the second and third plots. This location deviation was unavoidable due to land access permission.

Table 1. Wetland Monitoring Stations - Plot Corner Coordinates

Tributary Name	Wetland Station Name	Longitude (DD)	Latitude (DD)
Pottsburg Creek	PC1A	-81.586010	30.271924
	PC1B	-81.586214	30.271953
	PC1C	-81.586239	30.272045
	PC1D	-81.586035	30.272066
	PC2A	-81.590613	30.266840
	PC2B	-81.590632	30.266662
	PC2C	-81.590720	30.266653
	PC2D	-81.590717	30.266842
	PC3A	-81.586819	30.261147
	PC3B	-81.586615	30.261140
	PC3C	-81.586613	30.261053
	PC3D	-81.586832	30.261055
Ortega River	OR1A	-81.744427	30.188555
	OR1B	-81.744619	30.188624
	OR1C	-81.744648	30.188513
	OR1D	-81.744436	30.188469
	OR2A	-81.753341	30.188238
	OR2B	-81.753324	30.188059
	OR2C	-81.753244	30.188044
	OR2D	-81.753247	30.188196
	OR3A	-81.764291	30.188615
	OR3B	-81.764058	30.188689
	OR3C	-81.764103	30.188759
	OR3D	-81.764242	30.188691
Julington Creek	JC1A	-81.555952	30.146161
	JC1B	-81.555912	30.145979
	JC1C	-81.556028	30.146007
	JC1D	-81.556020	30.146191
	JC2A	-81.555624	30.150199
	JC2B	-81.555595	30.150017
	JC2C	-81.555702	30.149988
	JC2D	-81.555717	30.150179
	JC3A	-81.556845	30.154174
	JC3B	-81.556893	30.153978
	JC3C	-81.556982	30.153988
	JC3D	-81.556929	30.154182
Black Creek	BC1A	-81.828377	30.067111
	BC1B	-81.828390	30.067285
	BC1C	-81.828508	30.067278
	BC1D	-81.828469	30.067089
	BC2A	-81.829553	30.074626
	BC2B	-81.829736	30.074717
	BC2C	-81.829781	30.074663
	BC2D	-81.829616	30.074559
	BC3A	-81.841675	30.082537
	BC3B	-81.841835	30.082444
	BC3C	-81.841915	30.082497
	BC3D	-81.841736	30.082603
Six Mile Creek	SMC1A	-81.538431	29.952256
	SMC1B	-81.538599	29.952349
	SMC1C	-81.538666	29.952253
	SMC1D	-81.538493	29.952156
	SMC2A	-81.532923	29.945029
	SMC2B	-81.532835	29.944822
	SMC2C	-81.532738	29.944870
	SMC2D	-81.532821	29.945035
	SMC3A	-81.528287	29.941141
	SMC3B	-81.528272	29.940975
	SMC3C	-81.528191	29.940988
	SMC3D	-81.528202	29.941153

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Legend:

Example: Ortega River

OR1A, where 1 = most downstream station and A = one of four station corners

OR3B, where 3 = most upstream station, and B = one of four station corners

4.2 Freshwater Wetlands Monitoring Timeline

The wetland monitoring timeline will be in accordance with the State permit. Each of the pre-dredge freshwater wetland monitoring stations will be monitored at least one time prior to the start of construction during the peak growing season. During the dredging phase of the project, the freshwater wetland stations will be monitored twice per year for the duration of the dredging. After the dredging is complete and the last construction contract is complete, monitoring of the freshwater wetland stations will be conducted twice a year for at least 10 years. The bi-annual freshwater wetland monitoring events will be conducted in April-May and September-October, the beginning and ending of the growing season, respectively.

In the calendar year 2017, data will be collected at the wetland monitoring stations in October 2017, prior to commencement of the harbor deepening.

4.3 Freshwater Wetlands Survey Methods

The rationale for the methodology outlined in this Freshwater Wetlands BMP was stipulated by, and will be performed in accordance with, the USACE Contract No. W91278-16-D-0062, and FDEP permit (ERP Permit No.: 0129277-017-BI). For temporal consistency, wetland monitoring assessments will be conducted at the same approximate, representative tide phase for each monitoring site location, to the extent practicable. Logistics, field efficiency, site conditions, and the monitoring assessment date could affect achievement of this goal. The potential effects of tide heights from lunar cycles, rainfall, or offshore weather conditions will also be considered when selecting the assessment date, to the extent practicable. The field notes/forms will include information regarding tide stage and direction at the time of the assessment.

4.3.1 Freshwater Wetlands Vegetation Data Collection Method

Data collection will occur within the wetland monitoring plots identified in Section 4.1. The corners of each 10m x 20m wetland monitoring plot will be marked in the field with fiberglass posts. A nested plot design will be established to include 1m x 1m sub-plots (quadrats). At least 20 quadrats will be identified; the corners of each quadrat will be marked in the field with a pin flag. Quadrats will be selected randomly, but may be modified in the field to ensure a representative sample of ground layer vegetation is included. A grid showing monitored quadrats will be reported and used in conjunction with GPS plot coordinates to reestablish the quadrats during subsequent monitoring events.

Vegetation monitoring will be conducted for living plants at three vegetative strata:

- Canopy;
- Sub-canopy/understory; and
- Ground layer.

For purposes of this study, the canopy will be defined as woody vegetation, 20 feet or more in height and three inches or larger at diameter breast height (dbh); the sub-canopy/understory will be defined as plants below the canopy and includes woody plants between approximately 3 and 20 feet in height and less than 3 inches dbh; and the ground layer will be defined as herbaceous (non-woody) vegetation less than approximately three feet in height (USACE 2010).

All plants observed within the 10m x 20m wetland plot will be identified to the lowest possible taxonomic level, and all plant taxa present within each plot will be recorded and reported on field data forms and/or a tablet device (presence/absence). Data will also indicate if the identified plant is observed in the canopy, sub-canopy/understory, and / or ground layer.

The same visual census technique(s) identified below for quantifying percent cover of wetland plants in each vegetative stratum will be used over time and across sites.

The Contractor will assess the condition / health of the plants within each plot. Any visually conspicuous signs of salt stress will be noted during each survey, such as yellowing needles / leaves, loss of needles / leaves, and dying limbs or trees, at a minimum.

Canopy Monitoring

The abundance (i.e., percent cover) of plant taxa in the canopy will include the total percent canopy cover of all canopy plants, and the percent cover for each of the dominant tree taxa (i.e., the top five most abundant plants [by cover] or those plants that constitute greater than 20% cover) within each monitoring plot. Canopy cover will be visually estimated using a spherical densiometer. If trees are rooted outside of the monitoring plot, and the tree canopy extends into the monitoring plot space, then that tree(s) will be included in the canopy percent cover estimates. If an upland tree species rooted outside of the monitoring plot is part of the monitoring plot canopy cover, and the upland tree species cannot be avoided, field personnel will document and record this anomalous site condition. Canopy plants will be defined as woody vegetation, 20 feet or more in height and three inches or larger dbh (USACE 2010).

A simplistic illustration of a 10m x 20m wetland plot with representative canopy plants can be seen in Diagram 1. The canopy data depicted in Diagram 1 is an illustration only for this BMP.

Diagram 1. Example of Canopy Percent Cover in Wetlands Monitoring Plot

<table>
<tr><td rowspan="3">30% Taxodium distichum</td><td colspan="3">10% Quercus laurifolia</td></tr>
<tr><td rowspan="2">8% Acer rubrum</td><td rowspan="2">8% open canopy</td><td>2% Pinus elliottii</td></tr>
<tr><td>2% Gordonia lasianthus</td></tr>
<tr><td>20% Fraxinus caroliniana</td><td colspan="3">20% Betula nigra</td></tr>
</table>

For this diagrammed example, the following data would be reported in tabular form:

1) A list of each species observed and percent cover of each species observed (30% *Taxodium distichum*, 10% *Quercus laurifolia*, 8% *Acer rubrum*, 2% *Pinus elliottii*, 2% *Gordonia lasianthus*, 20% *Fraxinus caroliniana*, and 20% *Betula nigra*).
2) The total canopy cover: 92% cover
3) The percent cover of each dominant species in the canopy: 30% *T. distichum*, 20% *F. caroliniana*, 20% *B. nigra*.

Sub-canopy/Understory Monitoring

Sub-canopy and understory vegetation will be combined for purposes of this survey. The monitoring methodology for this stratum is the same as the canopy vegetation monitoring. The abundance (i.e., percent cover) of plant taxa in the sub-canopy/understory stratum will include the total percent canopy cover of all sub-canopy/understory vegetation, and the percent cover for each of the dominant plant taxa (i.e., the top five most abundant plants [by cover], or those plants that constitute greater than 20% cover) within each 10m x 20m monitoring plot. If sub-canopy/understory plants are rooted outside of the monitoring plot, and this plant cover extends into the monitoring plot space, then that plant (s) will be included in the sub-canopy/understory percent cover estimates. The sub-canopy/understory will include plants below the canopy; woody plants between approximately 3 and 20 feet in height and less than 3 inches dbh (USACE 2010).

Ground Layer Monitoring

In the ground layer vegetative stratum, the total percent plant cover and percent cover of each dominant plant taxa (i.e., the top five most abundant plants [by cover] or those plants that constitute greater than 20% cover) will be quantified within each 10m x 20m monitoring plot. Additionally, at least 20 randomly placed quadrats will be permanently established in each 10m x 20m plot. The Contractor will also determine the abundance (i.e. percent cover) of all vegetation in each of these 20 (1m x 1m) quadrats in the ground layer. Percent cover will be estimated by visual assessment as precisely as possible, and will be reported to at least the nearest 10%. The ground layer vegetation will be defined as herbaceous (non-woody) vegetation less than approximately three feet in height (USACE 2010).

4.3.2 Freshwater Wetlands Soil Data Collection Method

Soils in the freshwater wetland monitoring stations will be evaluated qualitatively and quantitatively, as described in the following subsections and shown in Table 2 following this discussion. Two soil/sediment samples will be collected from each monitoring station. For sample collection, the soil/sediment sample material will be collected at a uniform depth, between 12 and 24 inches, in all monitoring plots. Although not anticipated, in the event the uniform sampling depth is not possible at a monitoring station, the sampling depth and the reason for the non-uniform sampling depth will be documented in the field (and provided in the annual report). To the extent practicable, the non-uniform sampling depth will be implemented for all three (3) monitoring plots in that tributary. Tidally-influenced groundwater effects will also be considered when identifying the sample location.

The methods and instrumentation used for the soil/sediment quantitative measurements will meet FDEP criteria as described in the FDEP Standard Operating Procedures (SOPs) for field measurements. At a minimum, field instruments will be calibrated before use each day and verified at the end of each day with appropriate standards; and the instrument calibration/verification documentation will be recorded. Additional field records will include date and time of measurement, source and location of measurement test sample, analyte or parameter measured, measurement value and unit, field staff initials, and identification number for the instrument.

4.3.2.1 Qualitative Description of Soils

A qualitative description of soil/sediment conditions and characteristics based on field observation (e.g., soil texture, saturation, coloration) will be determined in the field at each wetland monitoring plot. The soil texture will be determined in the field by the “Feel Method” (modified from Thien 1979). To determine soil/sediment texture, a small grab sample of the wet soil material will be gently rubbed between the forefinger and thumb; the type of soil ribbon formed will determine if the soil/sediment is coarse, moderately coarse, medium, or fine textured (Thien 1979, and USDA-NRCS 2017). Soil/sediment saturation will be qualitatively determined based on the soil/sediment moisture by feel and appearance approach [U.S. Department of Agriculture (USDA) - Natural Resources Conservation

Service (NRCS) 1998]. A small (approximately one tablespoon) grab sample of soil/sediment will be firmly squeezed in the hand into a ball shape; characteristics such as texture, ability to ribbon, water staining, water glistening, etc. will be noted and compared with photographs/charts to estimate the percent saturation of the soil/sediment (USDA-NRCS 1998). Soil/sediment color will be determined by comparison of moistened soil color with Munsell soil color charts (Munsell 1990[1]), and the soil color hue, chroma, and value will be documented and reported.

4.3.2.2 Quantitative Field Measurements of Soils

Soil/Sediment Oxidation – Reduction Potential (ORP)

To help determine if methanogenic or sulfate-reducing conditions are present, soil oxidation-reduction potential (ORP) will be measured in two soil/sediment samples collected within each monitoring plot using an ORP probe and meter (Hanna® Instruments HI1297D and HI36183, respectively) in accordance with the instrument manufacturer's instructions, and in general accordance with ASTM G200-09 Standard Test Method for Measurement of Oxidation-Reduction Potential (ORP) of Soil (ASTM 2014). Briefly, additional soil samples will be collected at two locations as described above and placed in labeled plastic bags. The cleaned and calibrated ORP probe will be inserted into the soil, and a reading is recorded. This process is conducted a total of three times at different locations in the soil sample; three ORP readings will be reported for each sample. The Contractor's field personnel will also note if the soil/sediment sample exudes a sulfur (rotten egg) odor, which is indicative of the conversion from sulfate to hydrogen sulfide gas (USDA-NRCS 2017).

Porewater pH and Salinity

If water fills the borehole created by the collection of the two soil/sediment cores discussed below (Section 4.3.2.3), pH and salinity of the water filling each sampling borehole will be immediately measured in situ with appropriate field instruments/field probes (e.g. multi probe instrument). Measurement of these water quality parameters will be conducted in accordance with the instrument manufacturer's instructions, and in general accordance with FT1100, Field Measurement of Hydrogen Ion Activity (pH) and in general accordance with the Conductivity Method identified in FDEP SOP FT1300, Field Measurement of Salinity (FDEP SOPs 2014), respectively.

In the event the wetland monitoring station is inundated with surface water at the time of monitoring, this site condition will be documented in the field (and included in the annual report). Under this circumstance, the pH and salinity in the surface water will be measured and recorded as same.

NOTE: If the borehole does not fill with water, field personnel will dig up to 24-inches total for water in the borehole. If water is still not observed within the borehole, another random location within the plot will be chosen and the process repeated.

Soil/Sediment Conductivity

Using a direct soil conductivity instrument with automatic temperature compensation (e.g. Soil Test™ Direct Soil EC Tester, Hanna® Instruments), conductivity will be measured in the soil/sediment temporarily collected at three random locations within each wetland monitoring plot. Methodology for performing this field analysis will be in accordance with the instrument manufacturer's instructions, and in general accordance with FDEP SOP FT1200, Field Measurement of Specific Conductance (Conductivity) (FDEP SOPs 2014).

[1] Munsell has produced a newer version (2015) of the Munsell Soil Color Book. The revised edition features the same colors available in previous books (e.g. 1990), plus additional color charts. These additional color charts in the 2015 version include adding soil charts for Australia, Southeast Asia, and a specific soil type found in New Jersey,

4.3.2.3 Quantitative Laboratory Measurements of Soils - Salinity and pH

Two soil/sediment samples will be collected as described in section 4.3.2, using a sample scoop (e.g. garden shovel) constructed of stainless steel, Teflon, Teflon-coated, polyethylene, polypropylene, or plastic. The sediment material will be temporarily placed on the ground, on clean plastic sheeting to collect the sample material and to perform other in situ measurements in the soil/sediment. A sub-sample of approximately 250 grams from each sample will be placed in a sample container for analysis of conductivity/salinity in the Contractor's laboratory. A sub-sample of approximately 50 grams of each sample will be placed in a sample container for analysis of pH in the Contractor's laboratory. In unusual situations where the site is denuded with water (such as following a tropical storm, nor'easter, etc.), sampling with a shovel may not be possible. In that case, sediment sampling using a sediment core sampler will be conducted. Collected sediment will be extruded so that only the sediment between 12 and 24 inches in depth is captured for analysis.

Sample containers will be plastic (e.g. sealed plastic bag, Teflon, polypropylene, polyethylene, polyvinyl chloride, neoprene, or tygon), or glass (FDEP SOP FS1000, *General Sampling Procedures*) (FDEP SOPs 2014). Methodology for collecting the two soil/sediment samples will be in general accordance with FDEP SOP FS4000, *Sediment Sampling* (FDEP SOPs 2014). The labeled samples will be preserved on ice and transported to the Contractor's laboratory. Sample chain-of-custody will be maintained and documented. All activities related to the sampling event will be documented, including sample collection, equipment calibration, equipment cleaning, and sample transport.

In the Contractor's laboratory, processing of the soil/sediment sample material for measurement of pH using a 5:1 water-to-soil mix method (USDA-NRCS 2011). Measurement of pH is time sensitive, and the sample processing for pH will begin on the date of sample collection. Salinity of the collected soil/sediment will be measured using the saturated paste method (Miller et al. 2013, and USDA 1969). The measurement of salinity is not time sensitive; the collected soil/sediment will be analyzed for salinity in the Contractor's laboratory within two weeks of sample collection.

Table 2 summarizes the soil/sediment sampling, data collection, sample handling, and associated methods.

Table 2. Summary of Soil/Sediment Data Collection per Monitoring Plot

Soil/Sediment Analysis or Characterization	Sample Location Identification	Quantity	Sample Retained	Sample Transported to Laboratory	Analysis or Characterization Method
Soil texture, Saturation, coloration (In situ)	1 and 2	2	No	No	Munsell 1990; Thien 1970; USDA-NRCS 1998, 2017;
ORP (In situ)	3 and 4	2	No	No	ASTM G200-09 2014; USDA-NRCS 2017
pH and salinity (In situ)	1 and 2	2	No	No	FDEP SOPs FT1110 and FT1300
Conductivity (In situ)	1, 2 and 5	3	No	No	FDEP FT1200
pH and salinity (Laboratory)	1 and 2	2	Yes	Yes	Miller et al. 2013; USDA-NRCS 2011

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4.4 Spatial Distribution and Plant Community Delineation

Plant communities located within and between wetland monitoring plots shall be mapped to document spatial distribution and to delineate distinct plant community types using the most recent high resolution and infrared aerial photographs. Aerial photographs may be obtained from public sources such as Land Boundary Information System (LABINS), Department of Revenue, Department of Transportation, or NRCS, whichever is the most recent. The Contractor will photo-interpret plant communities to document the spatial distribution and delineate distinct plant community types.

5.0 Data Analysis and Reporting

The primary goal of the freshwater wetlands monitoring is to determine changes in vegetation/ vegetation condition throughout time at each wetland monitoring plot. Changes in condition will primarily be defined as changes in taxonomic vegetation composition or abundance. The primary null hypotheses to be tested are that no long-term changes occur in condition of the wetland communities at each site, in excess of natural variation, beginning with pre-construction data. Changes in community composition will be assessed by comparing species composition (species richness), total plant densities, and the densities of individual taxa.

5.1 Data Analysis - Rationale

The use of non-parametric (distribution-free) statistical methods is preferred because the great majority of the monitoring data (percentages and ratios of percentages) will not be normally distributed. Further, environmental data frequently contains outliers due to uncontrolled factors such as weather. Distribution-free methods are powerful and less sensitive to outliers, and they avoid the problems associated with transforming data to meet normality requirements of parametric methods.

The following statistical methods will be employed: Multiple-site Sørensen similarity metric (Jost *et al*. 2011) and the Seasonal Kendall test (Helsel & Hirsch 2002). The Sørensen similarity metric will highlight wetland monitoring plots where long-term changes in species richness were unusually large or small. The Seasonal Kendal tests will show any significant, monotonic trends in wetland species cover over time and provide slopes (rate of change) for these trends.

Calculations and statistical tests will be done separately for each of the three structural categories for wetland vegetation: canopy, subcanopy/understory, and ground layer.

5.2 Statistical Analyses

The Sørensen similarity metric will be used to quantify variation in annual species composition (richness) for each wetland monitoring plot across sampling years. Annual aggregate species data are used for this calculation to avoid effects of seasonality. Ground cover species identified in individual sub-plots will be aggregated for this measurement to give a single ground cover species list for the entire plot. At least two samples are needed for comparison, but two full years of sampling are needed to avoid effects of seasonality.

Tests for significant temporal trends and calculations of slopes will be done for the following variables at each wetland monitoring plot using the non-parametric regression Seasonal Kendall Test. If this test shows significant seasonal effects, then trends will be evaluated separately for each season. A minimum of two full years of data are needed for this test, and three years are needed to test seasonal effects.

- Species richness (number of taxon) for each structural category
- Total percent cover for each structural category
- Percent cover and percent composition of dominant plant taxa for each structural category. Percent composition is the percent cover for each taxon divided by the total percent cover for that structural category. For ground cover species, percent cover and percent composition measured in individual sub-plots will be averaged to characterize the entire plot.

5.3 Tabular and Graphical Representations

Results from statistical analyses will be presented in tabular or graphic formats. Graphical representations of the data and the trend analyses will be complementary in examination of changes in wetland vegetation through time. Time-series graphs will illustrate the degree and direction of changes and the variability in the data.

Summary tables will include a matrix of wetland species present for each wetland monitoring plot by year for each of the three structural categories. Summary graphs will include point plots of annual data by site for the following metrics:

- Species richness for each vegetative structural category,
- Total percent cover for each structural category,
- Percent cover of dominant wetland taxa for each structural category, and
- Percent composition of dominant plant taxa for each structural category.

A summary table showing the soil data measured in the field and the laboratory will be provided for each monitoring event and the annual report. The table will include:

- Field data for soil and water parameters: conductivity and ORP in soil; pH and salinity in water filling the soil borehole, and
- Laboratory data for soil: pH and salinity.

5.4 Data Reporting

Raw wetlands monitoring data will be provided to the USACE in Excel format and as copies of scanned field forms no later than three days after each wetland monitoring event.

Upon completion of annual surveys, a draft and final Annual Wetlands Monitoring Report will be submitted that will contain:

- Detailed descriptions of the methods used to collect and analyze data
- Summary of all biological data collected (vegetation, aerial photo interpretation, soils)
- Descriptions of current condition of the biological communities
- Statistical comparisons as described in Section 5.2 (Data Analysis)
- Representative photos from each wetland monitoring 10m x 20m plot
- A statement that the monitoring results indicate, or do not indicate, a change in the condition of the freshwater wetlands vegetation/vegetative condition that exceeds the natural variation in these systems.

The draft report submittal shall include draft electronic files in native Microsoft Word format and a draft PDF format. The final report submittal shall include a final electronic document in PDF format and three (3) hard copies. The Contractor shall provide the draft and final submittals to the USACE Technical Point of Contact.

6.0 References

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FS4000, Sediment Sampling
FT1100, Field Measurement of Hydrogen Ion Activity (pH)
FT1300, Field Measurement of Salinity
FT1200, Field Measurement of Specific Conductance (Conductivity)

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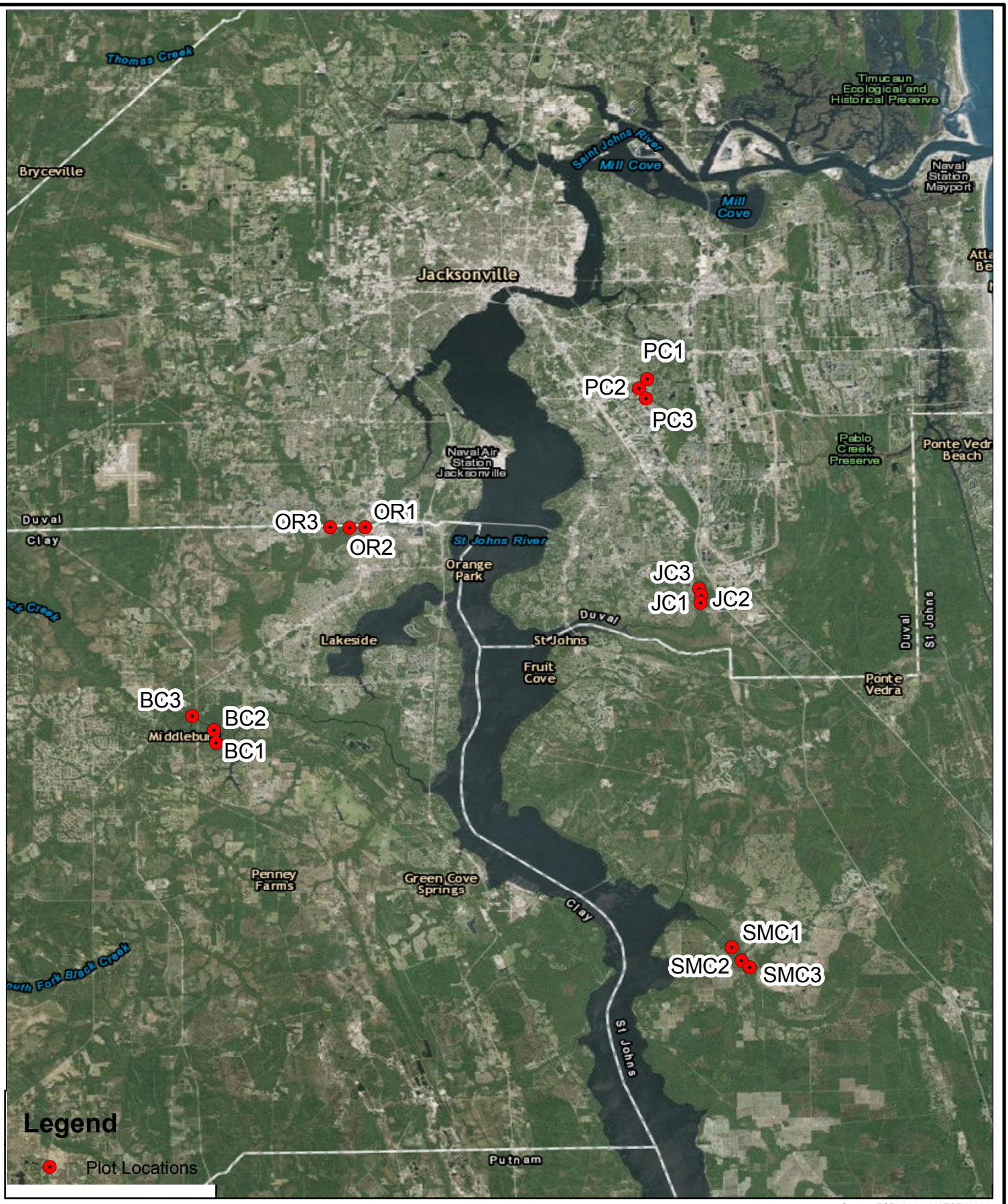
Figures



Source: ESRI 2014; AMECFW 2017

N

1 inch = 5 miles

0 2.5 5 Miles

USACE - SAV and Wetlands Monitoring Project

Freshwater Wetland Monitoring Plots - All Tributaries

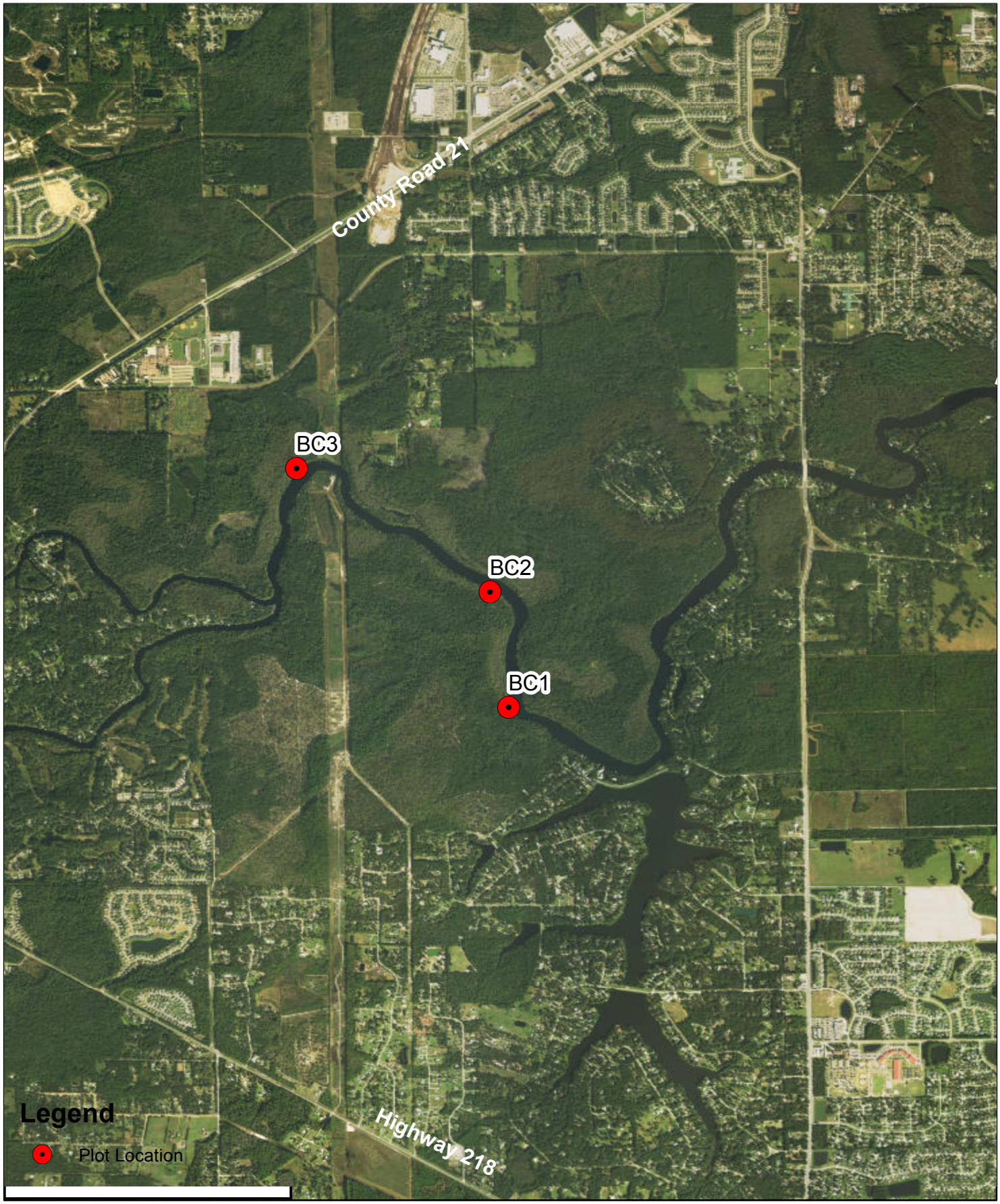
Drawn	Date
SEB	10/30/2017
Checked	Date
JMR	10/30/2017

Gainesville Florida Project No. 6063170288

amec foster wheeler

Figure 1

Path: \\GNV-FS1\projects\EAT\2017\Projects\USACE_SAV_Wetlands\GIS\MXD\Wetland BMP\Figure 1 Project Locations.mxd joy.ryan Date Saved: 10/27/2017 4:42:30 PM



Source: ESRI 2014; AMECFW 2017

N

1 inch = 3,000 feet

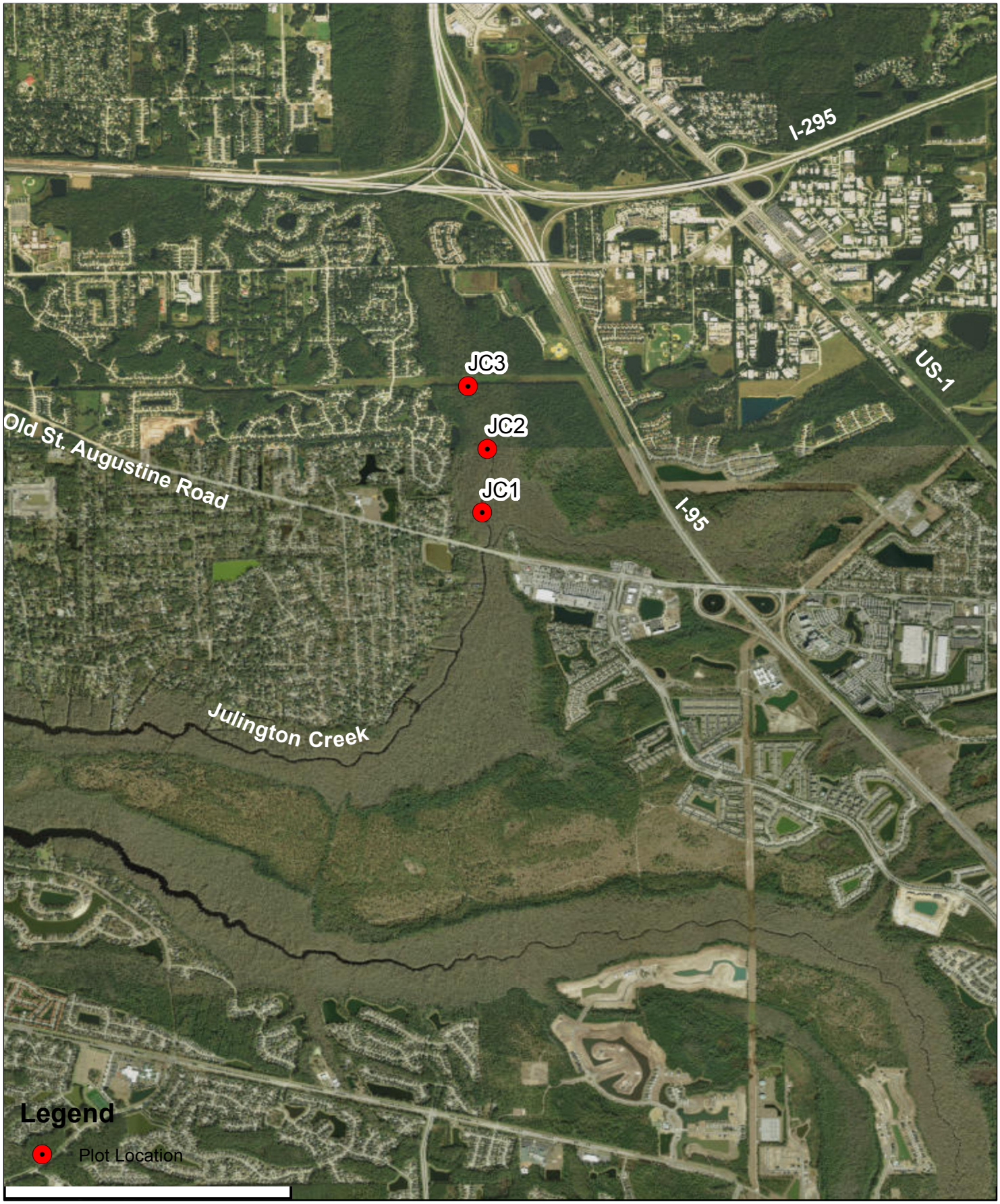
0 1,500 3,000 Feet

USACE - SAV and Wetlands Monitoring Project

Freshwater Wetland Monitoring Plots - Black Creek

Drawn	Date	*Gainesville Florida Project No. 6063170288*	amec foster wheeler	**Figure 2**
SEB	10/30/2017			
Checked	Date			
JMR	10/30/2017			

Path: \\GNV-FS1\projects\EAT\2017\Projects\USACE_SAV_Wetlands\GIS\MXD\Wetland BMP\Figure 2 Parcel Map_Black Creek.mxd joy.ryan Date Saved: 10/27/2017 4:21:55 PM



Source: ESRI 2014; AMECFW 2017

N

1 inch = 3,000 feet

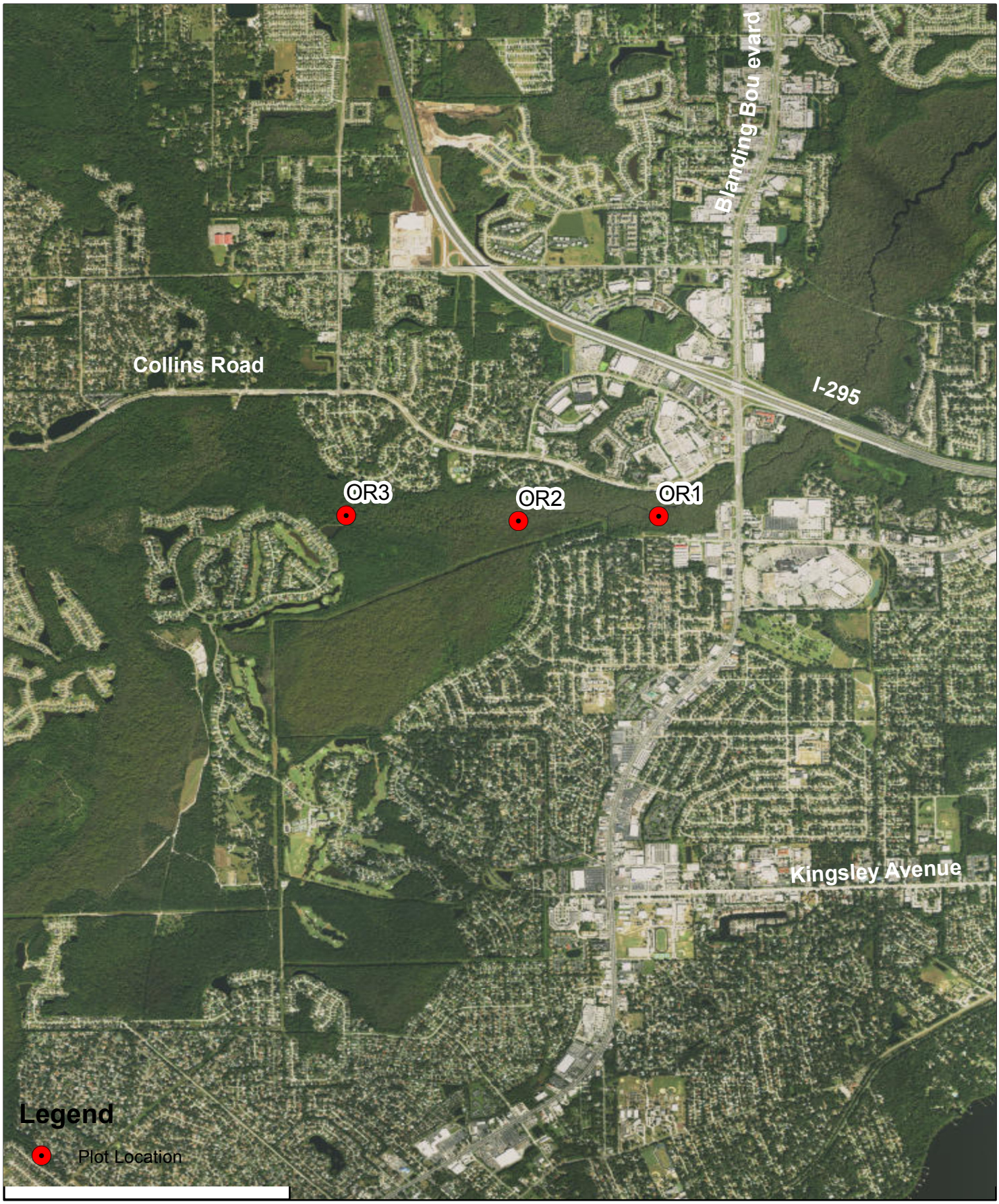
0 1,500 3,000 Feet

USACE - SAV and Wetlands Monitoring Project

Freshwater Wetland Monitoring Plots - Julington Creek

Drawn	Date	Gainesville Florida Project No. 6063170288	amec foster wheeler	Figure 3
SEB	10/30/2017			
Checked	Date			
JMR	10/30/2017			

Path: \\GNV-FS1\projects\EAT\2017\Projects\USACE_SAV_Wetlands\GIS\MXD\Wetland BMP\Figure 3 Parcel Map Julington Creek.mxd joy.ryan Date Saved: 10/27/2017 4:22:37 PM



Source: ESRI 2014; AMECFW 2017

N

1 inch = 3,000 feet

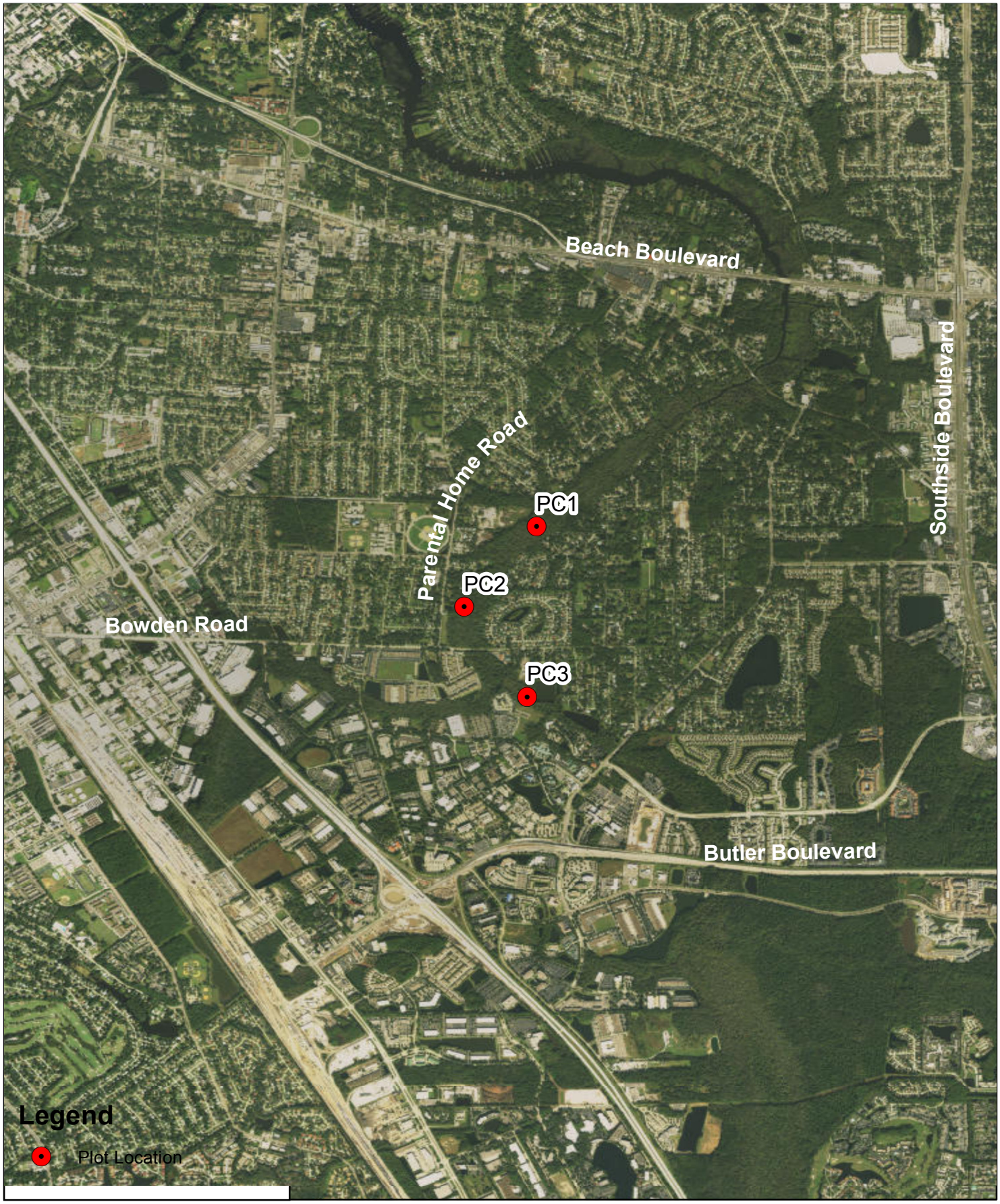
0 1,500 3,000 Feet

USACE - SAV and Wetlands Monitoring Project

Freshwater Wetland Monitoring Plots - Ortega River

Drawn	Date	Gainesville Florida Project No. 6063170288	amec foster wheeler	Figure 4
SEB	10/30/2017			
Checked	Date			
JMR	10/30/2017			

Path: \\GNV-FS1\projects\EAT\2017\Projects\USACE_SAV_Wetlands\GIS\MXD\Wetland BMP\Figure 4 Parcel Map_Ortega River.mxd joy.ryan Date Saved: 10/27/2017 4:37:50 PM



Source: ESRI 2014; AMECFW 2017

N

1 inch = 3,000 feet

0 1,500 3,000 Feet

USACE - SAV and Wetlands Monitoring Project

Freshwater Wetland Monitoring Plots - Pottsburg Creek

Drawn	Date	Gainesville Florida Project No. 6063170288	amec foster wheeler	Figure 5
SEB	10/30/2017			
Checked	Date			
JMR	10/30/2017			

Path: \\GNV-FS1\projects\EAT\2017\Projects\USACE_SAV_Wetlands\GIS\MXD\Wetland BMP\Figure 5 Parcel Map Pottsburg Creek.mxd joy.ryan Date Saved: 10/27/2017 4:28:16 PM

Source: ESRI 2014; AMECFW 2017

N

1 inch = 4,000 feet

0 2,000 4,000 Feet

USACE - SAV and Wetlands Monitoring Project

Freshwater Wetland Monitoring Plots - Six Mile Creek

Drawn	Date	Gainesville Florida Project No. 6063170288	amec foster wheeler	Figure 6
SEB	10/30/2017			
Checked	Date			
JMR	10/30/2017			

Path: \\GNV-FS1\projects\EAT\2017\Projects\USACE_SAV_Wetlands\GIS\MXD\Wetland BMP\Figure 6 Parcel Map_Six Mile Creek.mxd joy.ryan Date Saved: 10/27/2017 4:34:40 PM

Appendix

Photographic Record of Freshwater Wetland Monitoring Plots

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District

Project Number: 6063170288

Project Name: Jacksonville Harbor Deepening

Site Location: Pottsburg Creek

Photographer:
Joy Ryan

Date:
June 6, 2017

Photo #: 1

Description:

Representative View into plot PC1, from PC1a corner (view to NW)

Photographer:
Joy Ryan

Date:
June 6, 2017

Photo #: 2

Description:

Representative View of plot PC2 with Pottsburg Creek on left, from PC2a corner (view to N).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District

Project Number: 6063170288

Project Name: Jacksonville Harbor Deepening

Site Location: Pottsburg Creek

Photographer:
Joy Ryan

Date:
June 6, 2017

Photo #: 3

Description:

Representative View into plot PC2, from corner PC2a (view to NW).

Photographer:
Joy Ryan

Date:
September 21, 2017

Photo #: 4

Description:

Representative View into plot PC3, from near corner PC3a (view to SE).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District

Project Number: 6063170288

Project Name: Jacksonville Harbor Deepening

Site Location: Ortega River

Photographer:
Joy Ryan

Date:
June 7, 2017

Photo #: 5

Description:

View of Ortega River adjacent to plot OR1, from corner OR1b (view to N).

Photographer:
Joy Ryan

Date:
June 7, 2017

Photo #: 6

Description:

Representative View into plot OR1, from corner OR1b (view to S).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District **Project Number:** 6063170288

Project Name: Jacksonville Harbor Deepening **Site Location:** Ortega River

Photographer:
Joy Ryan

Date:
June 9, 2017

Photo #: 7

Description:

Representative View of plot OR2, from corner OR2d. Bank is underwater; downed tree on right, in background, represents Ortega River location. (view to W).

Photographer:
Joy Ryan

Date:
June 7, 2017

Photo #: 8

Description:

Representative View into plot OR3, from corner OR3d (view to SE).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District

Project Number: 6063170288

Project Name: Jacksonville Harbor Deepening

Site Location: Julington Creek

Photographer:
Joy Ryan

Date:
June 5, 2017

Photo #: 9

Description:

Representative View into plot JC1, from corner JC1b (view to NW).

Photographer:
Joy Ryan

Date:
June 5, 2017

Photo #: 10

Description:

Representative View of plot JC2 with Julington Creek in background, from corner JC2d (view to E), corner flag for JC2a in photo.

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District **Project Number:** 6063170288

Project Name: Jacksonville Harbor Deepening **Site Location:** Julington Creek

Photographer:
Joy Ryan

Date:
June 5, 2017

Photo #: 11

Description:

Representative View into plot JC2, from corner JC2b (view to S).

Photographer:
Joy Ryan

Date:
June 5, 2017

Photo #: 12

Description:

Representative View into plot JC3, from corner JC3d (view to SE).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District **Project Number:** 6063170288

Project Name: Jacksonville Harbor Deepening **Site Location:** Black Creek

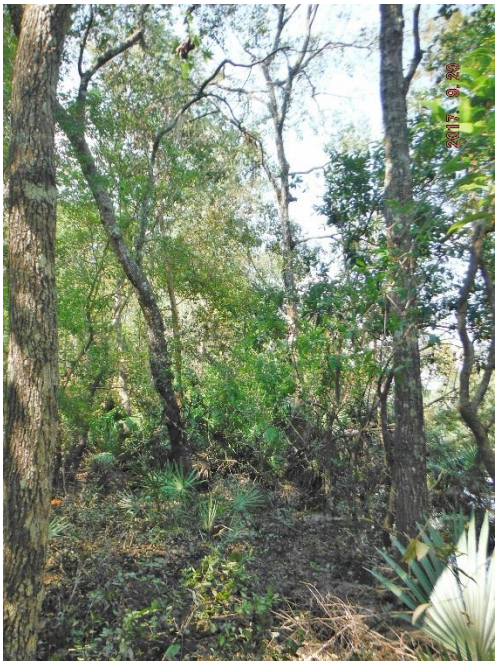
Photographer:
Joy Ryan

Date:
September 20, 2017

Photo #: 13

Description:

Representative View into plot BC1 (view to N).



Photographer:
Joy Ryan

Date:
September 20, 2017

Photo #: 14

Description:

Standing water near plot BC1 (view to S).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District **Project Number:** 6063170288

Project Name: Jacksonville Harbor Deepening **Site Location:** Black Creek

Photographer:
Joy Ryan

Date:
June 9, 2017

Photo #: 15

Description:

Representative View into plot BC2, from corner BC2a (view to NW).

Photographer:
Joy Ryan

Date:
September 20, 2017

Photo #: 16

Description:

Representative View into plot BC3, from corner BC3a (view to NNE).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District **Project Number:** 6063170288

Project Name: Jacksonville Harbor Deepening **Site Location:** Six Mile Creek

Photographer:
Joy Ryan

Date:
June 8, 2017

Photo #: 17

Description:

Representative View into plot SMC2, from corner SMC2a (view to E).

Photographer:
Joy Ryan

Date:
October 13, 2017

Photo #: 18

Description:

Representative View into plot SMC3, from corner SMC3b (view to NE).

Photograph Record - Wetland BMP

Client: USACE - Jacksonville District

Project Number: 6063170288

Project Name: Jacksonville Harbor Deepening

Site Location: Six Mile Creek

Photographer:
Joy Ryan

Date:
October 13, 2017

Photo #: 19

Description:

Representative View of plot SMC3, from corner SMCb (view to NE)

Photographer:
Joy Ryan

Date:
October 13, 2017

Photo #: 20

Description:

Representative View of plot SMC3, from corner SMC3d (view to SW). Large dark area on right side of photo is root base of downed tree. Can see boat and field personnel in background, on Six Mile Creek.