FINAL
AS-BUILT BASELINE
MONITORING REPORT (MY0)

ARABIA BAY WETLAND MITIGATION SITE

Hoke County, North Carolina

DMS Project ID No. 100061
Full Delivery Contract No. 7529
USACE Action ID No. SAW-2018-01151
DWR Project No. 2018-0784
RFP No. 16-007332

Cape Fear River Basin
Cataloging Unit 03030004

Data Collection: January 30, 2020
Submission: March 2020

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699-1652

Restoration Systems, LLC
1101 Haynes St. Suite 211
Raleigh, North Carolina
Ph: (919) 755-9490
Fx: (919) 755-9492

March 23, 2020

Lindsay Crocker
NC DEQ – Division of Mitigation Services
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

Subject: Arabia Bay, Project ID #100061, DMS Contract #0007529
Response to DMS Comments on the Draft Baseline Monitoring Document & As-built Survey

Lindsay - Below are the responses from Restoration Systems to all comments received on the draft Baseline Monitoring Document & As-built Survey. DMS comments are in black, and RS responses are in blue. Please do not hesitate to reach out if you would like to discuss.

Sincerely,

Raymond Holz
Restoration Systems

Comments Received & Responses

1. Page 4, Table 5 and/or As-Built survey. Include information on permanent and/or temporary seed mix and any soil amendments.
   A bullet point was added to the "Project Components and Structure" section indicating that "A permanent seed mix was applied across the Site." A species list of the seed mix was added as Table 8 in Appendix C.

2. Page 4, 1.3. In section about constructed road, please provide information about elevation of road above outer rim. Option to put this information in the drawings if preferred.
   The following was added to the discussion of the road: "The road was built according to the construction plans at an average elevation of 222 feet."

3. Page 4, 1.3 in section about depressions, please provide information about the average depths.
   The following was added to the discussion of the depressions: "The depths of the pools average between 6 and 12 inches."

4. Page 5. Update success criteria table to match mitigation plan
   Success criteria were updated to match mitigation plan.

5. Page 6. Update monitoring summary table to match mitigation plan
   Monitoring summary was updated to match mitigation plan.

6. Table 1. Update table to match mitigation plan area (16.000). Credits and areas for wetlands should go out 3 significant digits. Please utilize 5/2019 DMS updated template for reporting areas and credits.
   The wetland credits and areas were updated to reflect the 5/2019 DMS template (3 significant digits).

7. Table 2. Mitigation plan was completed/final on 4/30/2019 date.
   The "Completion or Delivery" date of the Mitigation Plan was updated to "April 30, 2019".

8. Table 6. Please consider field conversations about vegetation and update if necessary for only one line of bald cypress or merge with pond cypress (Taxodium spp) if ID is not possible between the two. Update to remove white oak spp (may be swamp white oak mis-ID).
   Upon review and through discussion with the planting contractor, it was determined that Taxodium ascendens (Pond Cypress) was planted exclusively in the Cypress Savanna (Habitat Pools) and, likewise, that Taxodium distichum (Bald Cypress) was planted exclusively in the remaining Riverine Wet Hardwood Forest. Tables 5 and 6 were updated to reflect this. Additionally, the Quercus alba was misidentification was changed to Quercus bicolor.

9. If possible, please provide a shapefile and/or map of the two planting areas (hardwood forest and habitat pools).
   A shapefile of the planting areas has been included in the digital submittal.

10. Figure 2. Provide the area of the habitat pools in the legend.
    The area (1.6 acres) was added to the legend of Figure 2.

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Prepared by:

Restoration Systems, LLC
1101 Haynes Street, Suite 211
Raleigh, North Carolina 27604
Contact: Worth Creech
919-755-9490 (phone)
919-755-9492 (fax)

And

Axiom Environmental, Inc.
218 Snow Avenue
Raleigh, North Carolina 27603
Contact: Grant Lewis
919-215-1693 (phone)

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APPENDICES

1.0 PROJECT SUMMARY

Restoration Systems, LLC has established the North Carolina Division of Mitigation Services (NCDMS) Arabia Bay Wetland Restoration Site (Site).

1.1 Project Goals & Objectives

Project goals were based on the *Cape Fear River Basin Restoration Priorities* (CFRBRP) report (NCEEP 2009) goals are addressed by project objectives as follows.

1. CFRBRP Goal – Reduce and control sediment inputs
   Site specific objective – Cessation of row crop production and conversion of a ditched Carolina Bay to a depressional wetland, removal of agricultural sediment outputs from the Site, and control of sediments within the Site.

2. CFRBRP Goal – Reduce and manage nutrient inputs
   Site specific objective – Cessation of row crop production may result in a direct reduction of 160 pounds of nitrogen and 280 pounds of phosphorus per year (based on the nutrient model) from the elimination of agricultural nutrient inputs/fertilizer application at the Site.

Site specific mitigation goals and objectives have been developed through the use of North Carolina Wetland Assessment Method (NC WAM) analyses of preconstruction and reference wetland systems (NC WFAT 2010) as outlined in the following table.

Wetland Targeted Functions, Goals, and Objectives

Targeted Functions	Goals	Objectives
(1) HYDROLOGY		
(2) Surface Storage & Retention	• Minimize downstream flooding to the maximum extent possible.	• Filled agriculture ditches to restore jurisdictional hydrology • Planted native woody vegetation • Ceased row crop production within the easement • Plowed soils (6-8 inches) to reduce surface compaction and increase surface roughness • Protected the Site with a perpetual conservation easement
(2) Sub-surface Storage & Retention		
(1) WATER QUALITY		
(2) Pollution Change	• Remove direct nutrient, sediment, and pollutant inputs from the Site.	• Removed agricultural land uses and agricultural inputs from the Site • Filled the ditch network to restore ground and surface hydrology within the Site • Planted woody vegetation • Restored jurisdictional wetlands
(1) HABITAT		
(2) Physical Structure	• Improve wildlife habitat within and adjacent to the Site.	• Planted woody vegetation to provide organic matter and shade • Filled ditches to provide groundwater hydrology and plant woody native vegetation • Protected the Site with a perpetual conservation easement • Restored jurisdictional wetlands
(2) Landscape Patch Structure		
(2) Vegetation Composition		

1.2 Project Background

The Site is situated in a Carolina bay that was historically cleared, drained, and farmed. In the NC Geological Survey 1956 aerial photograph for Hoke County the Site was in agricultural production indicating the area was cleared prior to 1956. The bay is an isolated depression surrounded by sand rims along the northwest and southeast margins. Land use adjacent to the bay includes rural residential properties, timber tracts, and additional row crops. Prior to construction, the Site land use was characterized entirely by agricultural row crops. Herbaceous vegetation and a few shrubby species were growing within the ditches, which were regularly maintained by bush hogging and herbicide application.

The 1956 NC Geological Survey aerial photograph and 1974 aerial photograph included in the Hoke and Cumberland Counties Soil Survey show a historic ditch that is no longer present (USDA 1984). The ditch was placed in the middle of the field and ran from the southeast to the northwest where it connected the primary present-day ditches. The historical ditch appeared to be a secondary

ditch that was not necessary for agricultural production and was therefore filled in during the 1980's. A field investigation was performed using hand tools to locate the historic ditch location and determine if the subsurface clay layer was intact. Based on the field investigation it appears the clay layer within the footprint of the historic ditch is intact.

A Detailed Restoration Plan was prepared for the Site that outlined the backfilling of agricultural ditches and planting with native forest vegetation. In addition, an outlet structure was designed as an emergency spillway if the bay filled during major storm events. The detailed plan was approved by the NCDMS and Interagency Review Team (IRT) and implemented during the summer of 2019.

1.3 Project Components and Structure

Proposed Site restoration activities generated 16.1 Non-riparian Wetland Mitigation Units (WMUs) as the result of 16.1 acres of riparian wetland restoration.

Additional activities that occurred at the Site included the following.

- Move access road off the Carolina bay bed and onto the adjacent sand rim. The road was built according to the construction plans at an average elevation of 222 feet.
- Install an overflow drop structure to release water from the Carolina bay during excessive storm events (at a water depth of approximately 2.5 feet in the Carolina bay bottom).
- Excavation of shallow, elliptical depressions to form hummocks and pools for habitat variation across the Site. The depths of the pools average between 6 and 12 inches.
- Plant 16.1 acres of the Site with 10,600 stems (planted species and densities by zone are included in Table 5 [Appendix C]).
- A permanent seed mix was applied across the Site. A species list is included in Table 8 (Appendix C).

Site design was completed in November 2018. Construction started on August 5, 2019 and ended within a final walkthrough on August 22, 2019. The Site was planted on January 24, 2020. Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 1-4 (Appendix A).

1.4 Success Criteria

Project success criteria have been established per the October 24, 2016 NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring and success criteria relate to project goals and objectives. From a mitigation perspective, several of the goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement. Other goals and objectives will be considered successful upon achieving success criteria. The following table summarizes Site success criteria.

Success Criteria

Wetland Hydrology
• Saturation or inundation within the upper 12 inches of the soil surface for, at a minimum, 10 percent of the growing season, during average climatic condition based on the Wilmington District Stream and Wetland Compensatory Mitigation Update (USACE 2016), Table 1, for a Typic Paleaquult (Rains).
Vegetation
• Within planted portions of the site, a minimum of 320 stems per acre must be present at year 3; a minimum of 260 stems per acre must be present at year 5; and a minimum of 210 stems per acre must be present at year 7. • Trees must average 7 feet in height at year 5, and 10 feet in height at year 7 in each plot. • Planted and volunteer stems are counted, provided they are included in the approved planting list for the site; natural recruits not on the planting list may be considered by the IRT on a case-by-case basis. Volunteer Loblolly pine which is not included on the planting list is a desirable species for the restoration of the vegetative community and will count towards vegetative success. • Any single species can only account for 50% of the required stems within any vegetation plot. o Ephemeral pool "habitat areas" are a normal component of Carolina bays. Areas of freshwater marsh are expected to be comprised of herbaceous emergent vegetation and not forested woody vegetation. Ephemeral pool "habitat areas" are expected to encompass approximately 20% of the bay area and should not be held to the above vegetative success criteria.

2.0 METHODS

Monitoring requirements and success criteria outlined in this plan follow the October 24, 2016 NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring will be conducted by Axiom Environmental, Inc. Annual monitoring reports of the data collected will be submitted to the NCDMS by Restoration Systems no later than December 31 of each monitoring year data is collected. The monitoring schedule is summarized in the following table.

Monitoring Schedule

Resource	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Wetlands							
Vegetation							
Visual Assessment							
Report Submittal							

2.1 Monitoring

The monitoring parameters are summarized in the following table.

Monitoring Summary

Wetland Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Wetland Restoration	Groundwater gauges	As-built, Years 1, 2, 3, 4, 5, 6, and 7 throughout the year with the growing season defined as March 1-November 12	14 gauges spread throughout restored wetlands	Soil temperature* at the beginning of each monitoring period to verify the start of the growing season, groundwater and rain data for each monitoring period
	Visual Assessment	As-built, Years 1, 2, 3, 5, and 7	Terracell outlet structure and ditch plugs	Visually inspect features to ensure they are performing as designed and retaining hydrological inputs
Vegetation Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acre (100 square meters) in size; *CVS-EEP Protocol for Recording Vegetation, Version 4.2* (Lee et al. 2008)	As-built, Years 1, 2, 3, 5, and 7	14 plots spread across the Site	Species, height, planted vs. volunteer, stems/acre
	Annual random vegetation plots, 0.0247 acre (100 square meters) in size	As needed	As needed	Species and height

*Soil Temperature will be measured with a continuous recording soil probe. Temperatures will be measured from February to the end of April in each monitoring year.

3.0 REFERENCES

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation. Version 4.2. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.

North Carolina Ecosystem Enhancement Program (NCEEP). 2009. Cape Fear River Basin Restoration Priorities 2009 (online). Available : http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329

North Carolina Wetland Functional Assessment Team. (NC WFAT 2010). N.C. Wetland Assessment Method (NC WAM) User Manual. Version 4.1.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

United States Department of Agriculture (USDA). 1984. Soil Survey of Cumberland and Hoke Counties, North Carolina. United States Department of Agriculture, Soil Conservation Service.

United States Department of Agriculture (USDA). 2017. Web Soil Survey (online). Available: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm [May 8, 2018]. United States Department of Agriculture.

Appendix A
Background Tables

Table 1. Project Components and Mitigation Units
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Attributes Table

Table 1. Project Components and Mitigation Credits
Arabia Bay Restoration Site

Reach ID	Wetland Type	Existing Acreage	Restoration Acreage	Restoration Level	Restoration or Restoration Equivalent	Mitigation Ratio	Mitigation Credits
Wetland Restoration	Non-riparian	--	16.000	Restoration	16.000	1:1	16.000

Length & Area Summations by Mitigation Category	
Restoration Level	**Non-riparian Wetland (acreage)**
Restoration	16.000

Overall Assets Summary	
Asset Category	**Overall Credits**
Non-riparian Wetland	**16.000**

Table 2. Project Activity and Reporting History
Arabia Bay Restoration Site

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Technical Proposal (RFP No. 16-007332)	February 8, 2018	February 8, 2018
Institution Date (NCDMS Contract No. 7529)	--	April 4, 2018
Mitigation Plan	October 2018	April 30, 2019
Construction Plans	--	November 2018

Table 3. Project Contacts Table
Arabia Bay Restoration Site

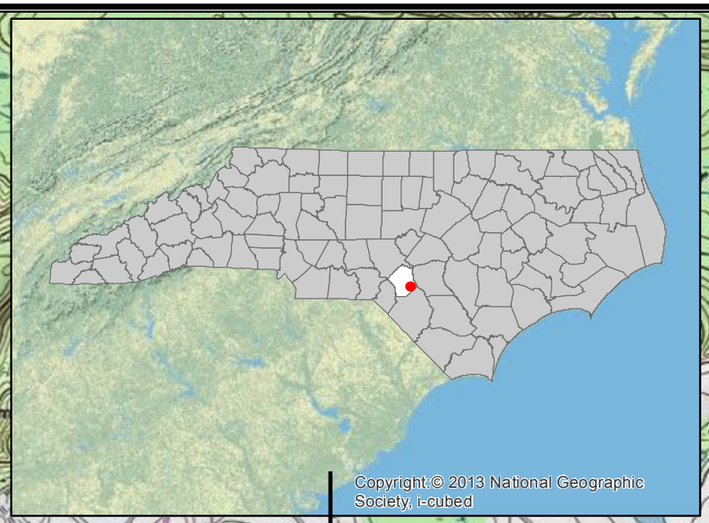
Full Delivery Provider	Restoration Systems 1101 Haynes Street, Suite 211 Raleigh, North Carolina 27604 Worth Creech 919-755-9490
Designer	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693

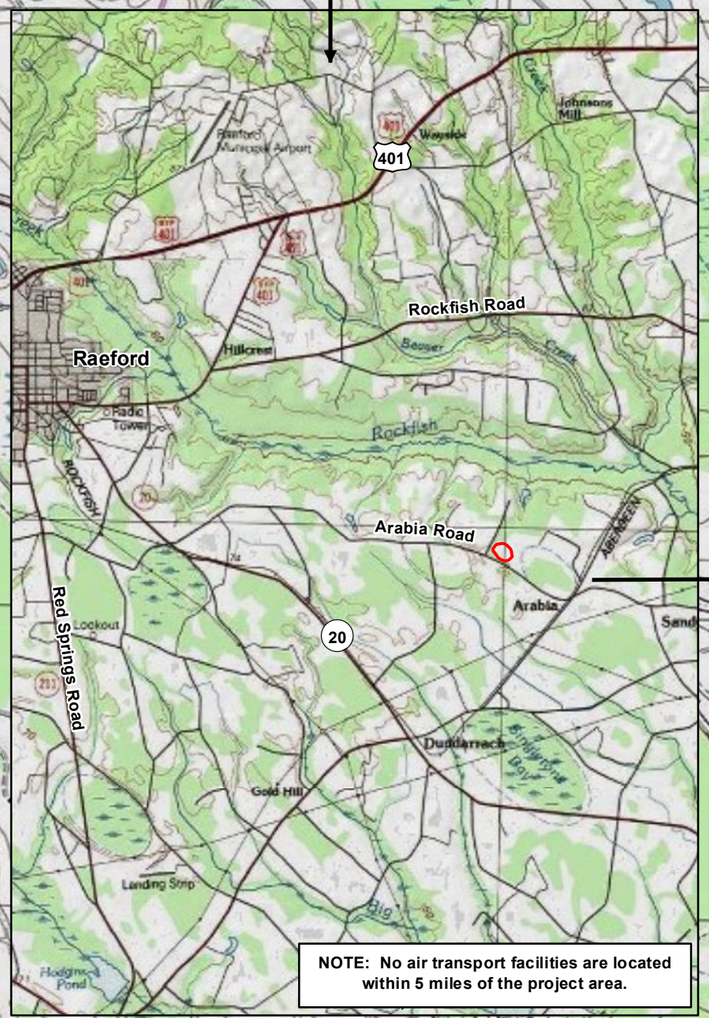
Table 4. Project Attribute Table
Arabia Bay Restoration Site

Project Information			
Project Name	Arabia Bay Restoration Site		
Project County	Hoke County, North Carolina		
Project Area (acres)	16.1		
Project Coordinates (latitude & latitude)	34.9570ºN, 79.1379ºW		
Planted Area (acres)	16.1		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
Project River Basin	Cape Fear		
USGS HUC for Project (14-digit)	03030004150011		
NCDWR Sub-basin for Project	03-06-15		
Project Drainage Area (acres)	NA		
Percentage of Project Drainage Area that is Impervious	<5%		
CGIA Land Use Classification	Cultivated		
Wetland Summary Information			
Parameters	**Wetlands**		
Wetland acreage	16.1 acres drained		
Wetland Type	Non-riparian		
Mapped Soil Series	McColl		
Drainage Class	Poorly drained		
Hydric Soil Status	Hydric		
Source of Hydrology	Precipitation, groundwater		
Hydrologic Impairment	Ditched and drained		
Native Vegetation Community	Bay Forest/Small Depression Pocosin		
% Composition of Exotic Invasive Vegetation	0%		
Restoration Method	Hydrologic, vegetative		
Enhancement Method	NA		
Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States-Section 401	Yes	Yes	Approved JD (App D)
Waters of the United States-Section 404	Yes	Yes	Approved JD (App D)
Endangered Species Act	Yes	Yes	CE Document (App E)
Historic Preservation Act	Yes	Yes	CE Document (App E)
Coastal Zone Management Act	No	--	CE Document (App E)
FEMA Floodplain Compliance	No	--	CE Document (App E)
Essential Fisheries Habitat	No	--	CE Document (App E)

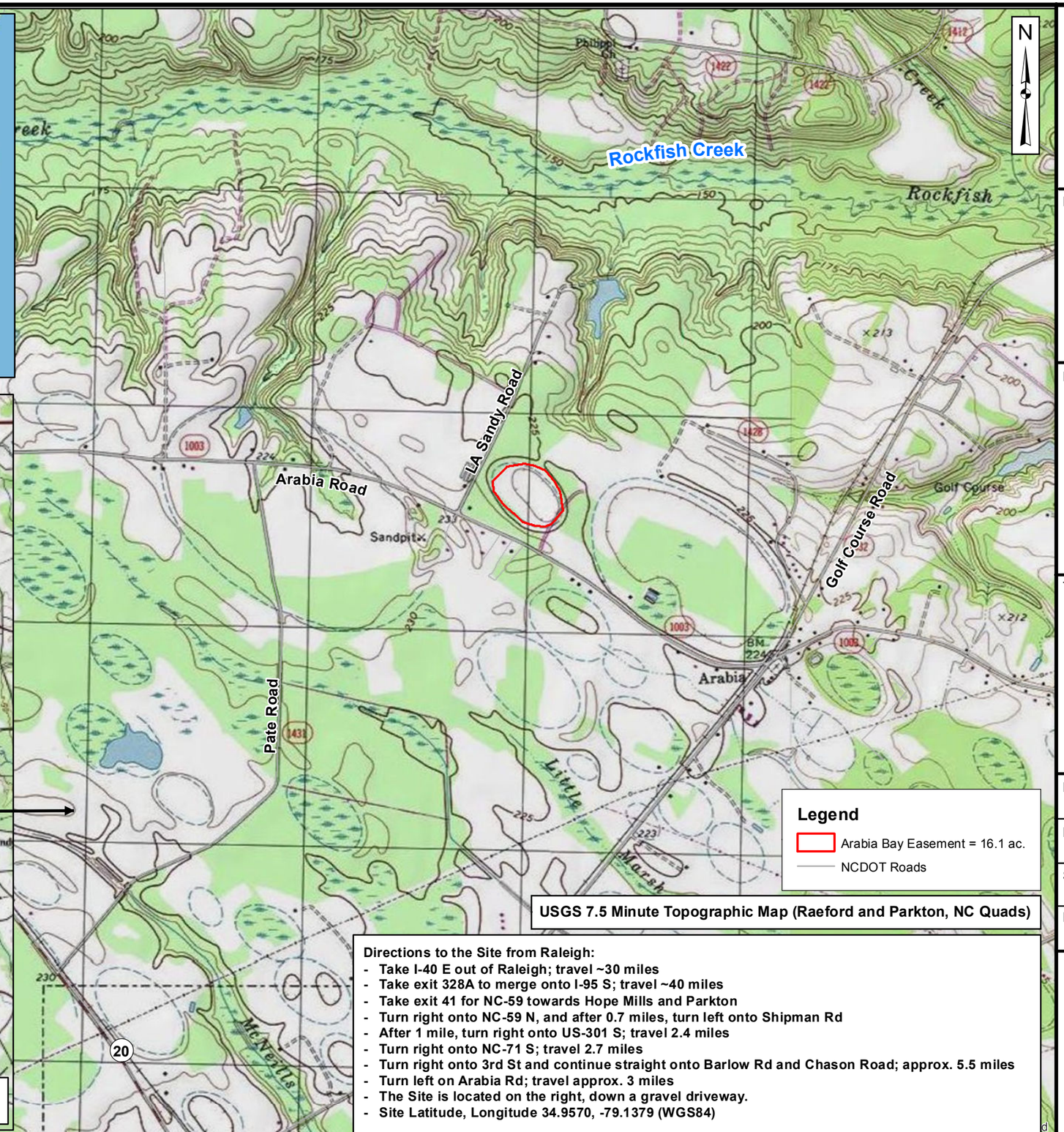
Appendix B
Visual Assessment Data

Figure 1. Project Location
Figure 2. Current Conditions Plan View
Vegetation Plot Photographs





NOTE: No air transport facilities are located within 5 miles of the project area.



USGS 7.5 Minute Topographic Map (Raeford and Parkton, NC Quads)

Directions to the Site from Raleigh:

- Take I-40 E out of Raleigh; travel ~30 miles
- Take exit 328A to merge onto I-95 S; travel ~40 miles
- Take exit 41 for NC-59 towards Hope Mills and Parkton
- Turn right onto NC-59 N, and after 0.7 miles, turn left onto Shipman Rd
- After 1 mile, turn right onto US-301 S; travel 2.4 miles
- Turn right onto NC-71 S; travel 2.7 miles
- Turn right onto 3rd St and continue straight onto Barlow Rd and Chason Road; approx. 5.5 miles
- Turn left on Arabia Rd; travel approx. 3 miles
- The Site is located on the right, down a gravel driveway.
- Site Latitude, Longitude 34.9570, -79.1379 (WGS84)

Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

ARABIA BAY WETLAND MITIGATION SITE

Hoke County, NC

Title:

SITE LOCATION

Drawn by: KRJ

Date: JAN 2019

Scale: 1:20,000

Project No.: 18-016

FIGURE

1

Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

ARABIA BAY WETLAND MITIGATION SITE

Hoke County, NC

Title:

CURRENT CONDITIONS PLAN VIEW

Drawn by: KRJ

Date: MAR 2020

Scale: 1:1200

Project No.: 18-016

FIGURE

2

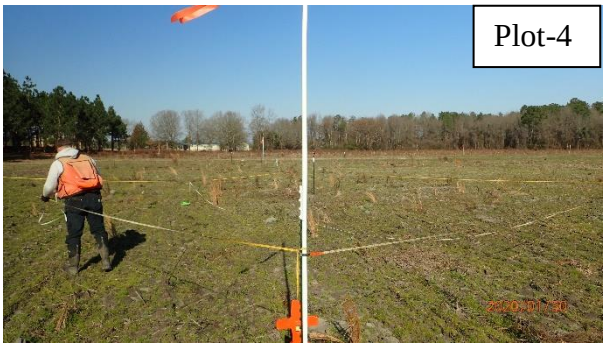
Arabia Bay As-built Vegetation Plots
Photos Taken January 30, 2020

Plot-1

Plot-2

Plot-3

Plot-4



Plot-5

Plot-6

Plot-7

Plot-8

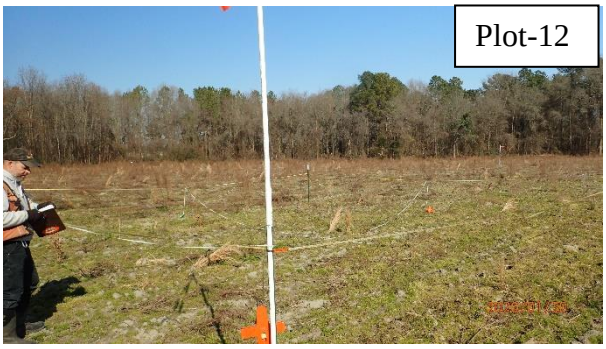
Arabia Bay As-built Vegetation Plots
Photos Taken January 30, 2020
(continued)

Plot-9

Plot-10

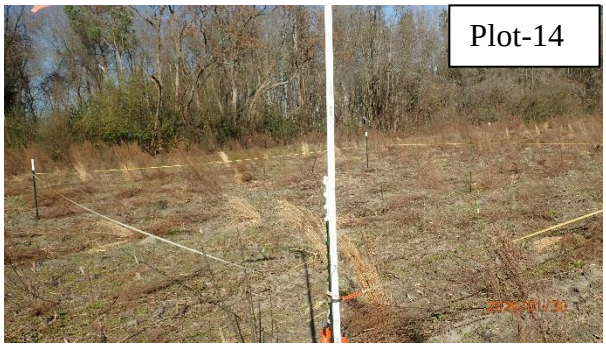
Plot-11

Plot-12



Plot-13

Plot-14



Appendix C
Vegetation Data

Table 5. Planted Bare Root Woody Vegetation
Table 6. Total Stems by Plot and Species
Table 7. Planted Vegetation Totals
Table 8. Permanent Seed Mix

Table 5. Planted Bare Root Woody Vegetation
Arabia Bay Restoration Site

Nonriverine Wet Hardwood Forest		
Species	**Quantity**	**Percentage**
Cephalanthus occidentalis	100	1%
Fraxinus pennsylvanica	600	6%
Magnolia virginiana	1,000	10%
Nyssa sylvatica v sylvatica	1,000	10%
Quercus bicolor	600	6%
Quercus laurifolia	1,000	10%
Quercus michauxii	600	6%
Quercus nigra	1,000	10%
Quercus pagoda	600	6%
Taxodium distichum	800	8%
	7,300	71%

Cypress Savanna (Habitat Pools)		
Species	**Quantity**	**Percentage**
Nyssa sylvatica v biflora	1,000	10%
Taxodium ascendens	2,000	19%
	3,000	29%

Totals =	**10,300**

Table 6. Total Stems by Plot and Species
NCDMS Project Code 18016. Project Name: Arabia Bay

			Current Plot Data (MY0 2020)																						
			18016-01-0001			18016-01-0002			18016-01-0003			18016-01-0004			18016-01-0005			18016-01-0006			18016-01-0007			18016-01-0008		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Celtis occidentalis	common hackberry	Tree																						1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub																						1	1	1
Fraxinus pennsylvanica	green ash	Tree	1	1	1	1	1	1	7	7	7							3	3	3						
Magnolia virginiana	sweetbay	Tree	1	1	1	3	3	3	2	2	2	2	2	2	1	1	1				1	1	1			
Nyssa	tupelo	Tree				1	1	1				2	2	2				4	4	4	3	3	3	5	5	5
Nyssa sylvatica	blackgum	Tree							1	1	1	2	2	2												
Quercus	oak	Tree				1	1	1										1	1	1						
Quercus bicolor	swamp white oak	Tree	1	1	1	1	1	1																		
Quercus lyrata	overcup oak	Tree	2	2	2	3	3	3	2	2	2	1	1	1	2	2	2	1	1	1	1	1	1			
Quercus michauxii	swamp chestnut oak	Tree				1	1	1													4	4	4	2	2	2
Quercus nigra	water oak	Tree	3	3	3				2	2	2	2	2	2	1	1	1	3	3	3	5	5	5	1	1	1
Quercus pagoda	cherrybark oak	Tree	3	3	3	10	10	10	1	1	1	1	1	1	5	5	5	1	1	1				1	1	1
Taxodium distichum	bald cypress	Tree	1	1	1				5	5	5	4	4	4	4	4	4				1	1	1	1	1	1
Unknown		Shrub or Tree																								
		Stem count	12	12	12	21	21	21	20	20	20	14	14	14	13	13	13	13	13	13	15	15	15	12	12	12
		size (ares)	1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	7	7	7	8	8	8	7	7	7	7	7	7	5	5	5	6	6	6	6	6	6	7	7	7
		Stems per ACRE	485.6	485.6	485.6	849.8	849.8	849.8	809.4	809.4	809.4	566.6	566.6	566.6	526.1	526.1	526.1	526.1	526.1	526.1	607	607	607	485.6	485.6	485.6

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

Table 6. Total Stems by Plot and Species (continued)
NCDMS Project Code 18016. Project Name: Arabia Bay

			Current Plot Data (MY0 2020)																	Annual Means		
			18016-01-0009			18016-01-0010			18016-01-0011			18016-01-0012			18016-01-0013			18016-01-0014			MY0 (2020)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Celtis occidentalis	common hackberry	Tree																			1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub				1	1	1													2	2	2
Fraxinus pennsylvanica	green ash	Tree				3	3	3										2	2	2	17	17	17
Magnolia virginiana	sweetbay	Tree	1	1	1							1	1	1	6	6	6	2	2	2	20	20	20
Nyssa	tupelo	Tree				1	1	1	5	5	5	3	3	3				2	2	2	26	26	26
Nyssa sylvatica	blackgum	Tree							1	1	1	1	1	1	1	1	1				6	6	6
Quercus	oak	Tree							1	1	1							1	1	1	4	4	4
Quercus bicolor	swamp white oak	Tree	1	1	1	4	4	4										1	1	1	8	8	8
Quercus lyrata	overcup oak	Tree	8	8	8							2	2	2							22	22	22
Quercus michauxii	swamp chestnut oak	Tree																2	2	2	9	9	9
Quercus nigra	water oak	Tree										2	2	2				1	1	1	20	20	20
Quercus pagoda	cherrybark oak	Tree				3	3	3	2	2	2	2	2	2							29	29	29
Taxodium distichum	bald cypress	Tree	1	1	1	3	3	3	2	2	2				3	3	3	1	1	1	26	26	26
Unknown		Shrub or Tree	2	2	2																2	2	2
		Stem count	13	13	13	15	15	15	11	11	11	11	11	11	10	10	10	12	12	12	192	192	192
		size (ares)	1			1			1			1			1			1			14		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.35		
		Species count	5	5	5	6	6	6	5	5	5	6	6	6	3	3	3	8	8	8	14	14	14
		Stems per ACRE	526.1	526.1	526.1	607	607	607	445.2	445.2	445.2	445.2	445.2	445.2	404.7	404.7	404.7	485.6	485.6	485.6	555	555	555

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

Table 7. Planted Vegetation Totals
Arabia Bay Restoration Site

Plot #	Planted Stems/Acre	Success Criteria Met?
1	486	Yes
2	850	Yes
3	809	Yes
4	567	Yes
5	526	Yes
6	526	Yes
7	607	Yes
8	486	Yes
9	526	Yes
10	607	Yes
11	445	Yes
12	445	Yes
13	405	Yes
14	486	Yes
Average Planted Stems/Acre	**555**	**Yes**

Table 8. Permanent Seed Mix
Arabia Bay Restoration Site

Wetland Seed Mix			
Species	**Percentage**	**Species**	**Percentage**
Agrostis alba	20%	*Chamaecrista nictitans*	1%
Tridens flavus	20%	*Cosmos bipinnatus*	1%
Agrostis hyemalis	5%	*Desmodium canadense*	1%
Agrostis stolonifera	5%	*Helianthus angustifolius*	2%
Chrysanthemum leucanthemum	5%	*Heliopsis helianthoides*	1%
Coreopsis lanceolata	5%	*Hibiscus moscheutos*	1%
Coreopsis tinctoria	5%	*Lespedeza capitata*	1%
Elymus virginicus	5%	*Lespedeza virginica*	1%
Panicum clandestinum	5%	*Liatris spicata*	1%
Rudbeckia hirta	5%	*Verbena hastata*	1%
Echinacea purpurea	3%	*Eupatorium perfoliatum*	0.5%
Lespedeza stipulacea	3%	*Monarda fistulosa*	0.3%
Chamaecrista fasciculata	2%	*Pycnanthemum tenuifolium*	0.3%
			100%

Habitat Pool Seed Mix			
Seasonally Flooded Wildlife Food Mix		**NC Coastal Plain FACW Mix**	
Species	**Percentage**	**Species**	**Percentage**
Panicum clandestinum	21.5%	*Panicum rigidulum*	30%
Elymus virginicus	20%	*Panicum anceps*	25.9%
Andropogon gerardii	16.6%	*Carex albolutescens*	13%
Echinochloa crusgalli var. *frumentacea*	15%	*Elymus riparius*	10.5%
Carex vulpinoidea	10%	*Carex lupulina*	5%
Panicum virgatum	8%	*Rhynchospora globularis*	4%
Chamaecrista fasciculata	4%	*Hibiscus moscheutos*	2%
Verbena hastata	1.5%	*Juncus effusus*	2%
Heliopsis helianthoides	1%	*Ludwigia linearis*	1.3%
Juncus effusus	1%	*Ludwigia maritima*	1.3%
Agrostis perennans	0.8%	*Eupatorium fistulosum*	1%
Asclepias incarnata	0.1%	*Helenium flexuosum*	1%
Aster novae-angliae	0.1%	*Juncus tenuis*	1%
Eupatorium fistulosum	0.1%	*Scirpus cyperinus*	1%
Eupatorium perfoliatum	0.1%	*Vernonia noveboracensis*	1%
Monarda fistulosa	0.1%		
Pycnanthemum tenuifolium	0.1%		
	100%		**100%**

Appendix D
Groundwater Gauge Soil Profiles

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

Axiom Environmental, Inc.

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.956784, -79.136755

Investigator: Perkinson/Axiom

Notes: GW-1

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-8	10yr 3/1	100			Loam
8-25	10yr 4/1	80	10yr 4/6	20	Clay
25-33	10yr 4/1	70	10yr 4/6	30	Sandy Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/ Coordinates: 34.955849, -79.136857

Investigator: Perkinson

Notes: GW-2; Gauge located on the outer margins at the request of the IRT

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-15	10yr 3/1	100			Loam
15-20	10yr 6/1	80	10yr 6/6	20	Clay
20-36	10yr 6/6	100			Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.714, -79.137481

Investigator: Perkinson

Notes: GW-3

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-12	10yr 3-2	100			Loam
12-20	10yr 6/2	100			Loam
20-36	10yr 6/2	80	10yr 5/6	20	Clay Loam

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.9956345, -79.137134

Investigator: Perkinson

Notes: GW-4

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-10	7.5yr 4/1	100			Silt Clay Loam
10-18	7.5yr 6/2	80	7.5yr 4-6	20	Clay
18-25	7.5yr 5/1	95	7.5yr 4-6	5	Clay
25+	7.5y 5/1	90	7.5yr 4-6	10	Silty Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

Axiom Environmental, Inc.

SOIL BORING LOG

Notes: GW-5

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.956345, -79.137134

Investigator: Perkinson

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-8	10r 3/1	100			Loam
8-25	10yr 4/1	80	10yr 4/6	20	Clay
25-34	10yr 4/6	60	10yr 4/1	40	Sandy Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.957257, -79.136835

Investigator: Perkinson

Notes: GW-6

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-8	10yr 3/1	100			Loam
8-15	10yr 3/1	90	10yr 4/6	10	Sandy Clay
15-35	10yr 3/1	60	10yr 4/6	40	Sandy Clay
35+	10yr 3/1	40	10yr 4/6	60	Sandy Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.957627, -79.137412

Investigator: Perkinson

Notes: GW-7

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-12	10yr 3/1	100			Loam
12-15	10yr 3/1	90	10yr 4/6	10	Sandy Clay
16-19	10yr 3/1	60	10yr 4/6	40	Sandy Clay
20+	10yr 3/1	50	10yr 4/7	50	Sandy Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

Axiom Environmental, Inc.

SOIL BORING LOG

Notes: GW-8

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.957216, -79.137869

Investigator: Perkinson

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-8	10yr 3/1	100			Loam
8-16	10yr 3/1	85	10yr 4/3	15	Clay
16-20	10yr 3/1	75	10yr 4/3	25	Clay
20-24	10yr 3/1	50	10yr 4/3	50	Clay
24+	10ye 4/3	80	10yr 3/1	20	Sandy Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

Axiom Environmental, Inc.

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.956741, -79.137735

Investigator: Perkinson

Notes: GW-9

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-14	10yr 3/1	100			Loam
14-22	10yr 4/1	85	10yr 4/6	15	Clay Loam
22-30	10yr 5/1	70	10yr 4/6	30	Clay Loam
30+	10yr 5/1	60	10yr 4/6	40	Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.9956538, -79.138735

Investigator: Perkinson

Notes: GW-10

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-10	7.5yr 4/1	100			Silt Clay Loam
10-110	7.5yr 6/2	80	7.5yr 4-6	20	Clay
20-30	7.5yr 5/1	95	7.5yr 4-6	5	Silty Clay
30+	7.5y 5/1	90	7.5yr 4-6	10	Silty Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/ Coordinates: 34.956990, -79.139482

Investigator: Perkinson

Notes: GW-11; Gauge installed at edge of site at the request of the IRT

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-10	10yr 3/1	100			Loam
10-16	10yr 5/1	90	10yr 4/6	10	Sandy Clay
16-33	10yr 4/6	80	10yr 5/1	20	Sandy Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

Axiom Environmental, Inc.

SOIL BORING LOG

Notes: GW-12

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.957323, -79.138667

Investigator: Perkinson

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-6	10yr 3/1	100			Loam
6-25	10yr 4/6	50	10yr 4/1	50	Sandy Clay
25-30	10yr 4/6	70	10yr 4/1	30	Sandy CLay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

SOIL BORING LOG

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.957883, -79.138368

Investigator: Perkinson

Notes: GW-13

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-12	10yr 3/1	100			Loam
12-20	10yr 4/6	60	10yr 4/1	40	Clay
20-30	10yr 4/6	70	10yr 4/1	30	Sandy Clay
30-40	10yr 4/6	75	10yr 4/1	25	Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

AXIOM ENVIRONMENTAL, INC
218 Snow Avenue
Raleigh, North Carolina 27603
919-215-1693

Axiom Environmental, Inc.

SOIL BORING LOG

Notes: GW-14

Project/Site: Arabia Bay Wetland Restoration

County, State: Hoke, North Carolina

Sampling Point/
Coordinates: 34.957672, -79.1139089

Investigator: Perkinson

Depth (inches)	Matrix		Mottling		Texture
	Color	%	Color	%	
0-8	10yr 3/1	100			Loam
8-15	10yr 4/1	70	10yr 4/6	30	Sandy Clay
15-25	10yr 4/6	70	10yr 4/1	30	Clay
25+	10yr 4/6	85	10yr 4/1	15	Clay

North Carolina Licensed Soil Scientist

Number: 1233

Signature: W Grant Lewis

Name/Print: W. Grant Lewis

Appendix E
As-built Plan Sheets

AS-BUILT SURVEY
ARABIA BAY
HOKE COUNTY, NORTH CAROLINA

DMS PROJECT ID No. 100061
SPO FILE NUMBER 47-AA
DWR PROJECT # 2018-0784

VICINITY MAP
NOT TO SCALE

NORTH
NC GRID
NAD'83(2011)

INDEX OF SHEETS

LEGEND

- CONSERVATION EASEMENT CORNER
- CONSERVATION EASEMENT
- PARCELS
- HABITAT AREAS
- GRAVEL ROAD REMOVED
- NEW GRAVEL ROAD
- FILLED IN DITCHES
- TCE — TOP OF CAP ELEVATION
- GSE — GROUND SHOT ELEVATION
- EL + XX.XX' — ELEVATION / SPOT ELEVATION
- NONRIVERINE WET HARDWOOD FOREST - 14.28 ACRES±
- CYPRESS SAVANNA (HABITAT POOL) - 1.80 ACRES±
- VEGGIE PLOT
- WETLAND GAUGE
- RAIN GAUGE
- OUTFALL

SURVEYORS CERTIFICATION(S)

Surveyor's disclaimer: No attempt was made to locate any cemeteries, wetlands, hazardous material sites, underground or aboveground utilities or any other features above, or below ground other than those shown.

I certify that the survey is of another category (as-built survey), such as the recombination of existing parcels, a court-ordered survey, or other exception to the definition of subdivision.

I certify that this plat does not meet G.S. 47-30 as amended.

I, John A. Rudolph, certify that this map was drawn under my direct supervision from an actual survey made under my supervision. That the ratio of precision is 1:10,000±, that this map was prepared in accordance with the standards of practice for land surveyors in North Carolina, witness my hand and seal, this 20th day of March, 2020.

NORTH CAROLINA PROFESSIONAL SEAL L-4194 LAND SURVEYOR JOHN ASHLEY RUDOLPH

"PRELIMINARY PLAT"
NOT FOR RECORDATION, CONVEYANCES OR SALES

Professional Land Surveyor — L-4194 License Number

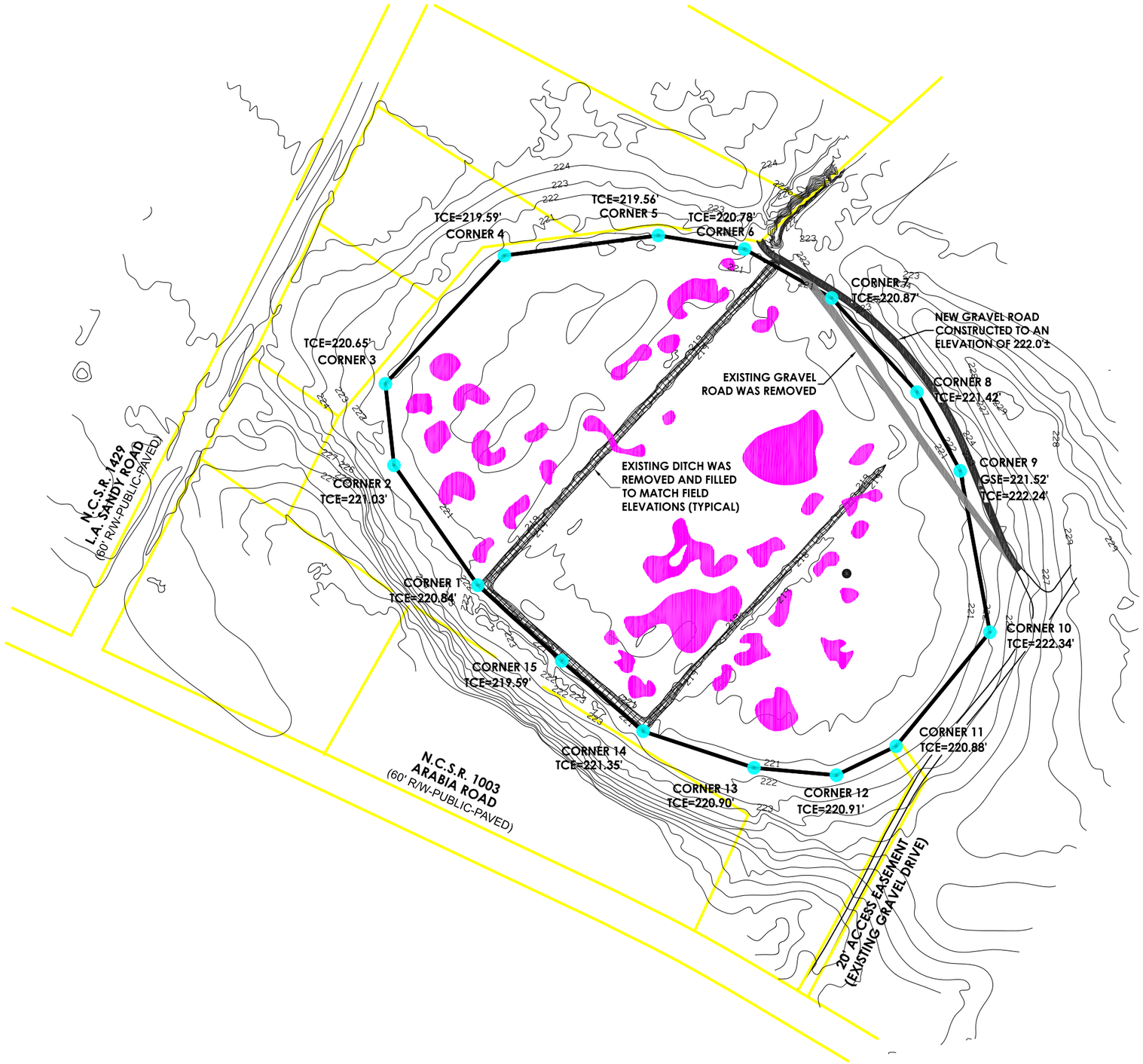
DRAWN BY: FGR
DATE: 03/20/20
SURVEYED BY: J.A.R.
DWG. NO. RSS351AB20
SHEET 1 OF 4

Axiom Environmental, Inc.
Axiom Environmental
218 Snow Avenue
Raleigh, NC 27603
919-215-1693

Client

RESTORATION SYSTEMS, LLC
1101 HAYNES STREET
SUITE 211
RALEIGH, NC 27604

k2 design group
774 S Beston Road
La Grange, NC 28551
919.751.0075
www.k2designgroup.com
Firm license no.: C-2111



LEGEND

- CONSERVATION EASEMENT CORNER
- CONSERVATION EASEMENT
- PARCELS
- HABITAT AREAS
- GRAVEL ROAD REMOVED
- NEW GRAVEL ROAD
- FILLED IN DITCHES
- TCE — TOP OF CAP ELEVATION
- GSE — GROUND SHOT ELEVATION

NORTH
NC GRID
NAD'83(2011)

**"PRELIMINARY PLAT"
NOT FOR RECORDATION,
CONVEYANCES OR
SALES**

AS-BUILT SITE

0 100 200 400

1" = 200'

774 S. Beston Road
La Grange, NC 28551
919.751.0075
www.k2designgroup.com
Firm license no.: C-2111

k2 design group

Client: RESTORATION SYSTEMS, LLC
1101 HAYNES STREET
SUITE 211
RALEIGH, NC 27604

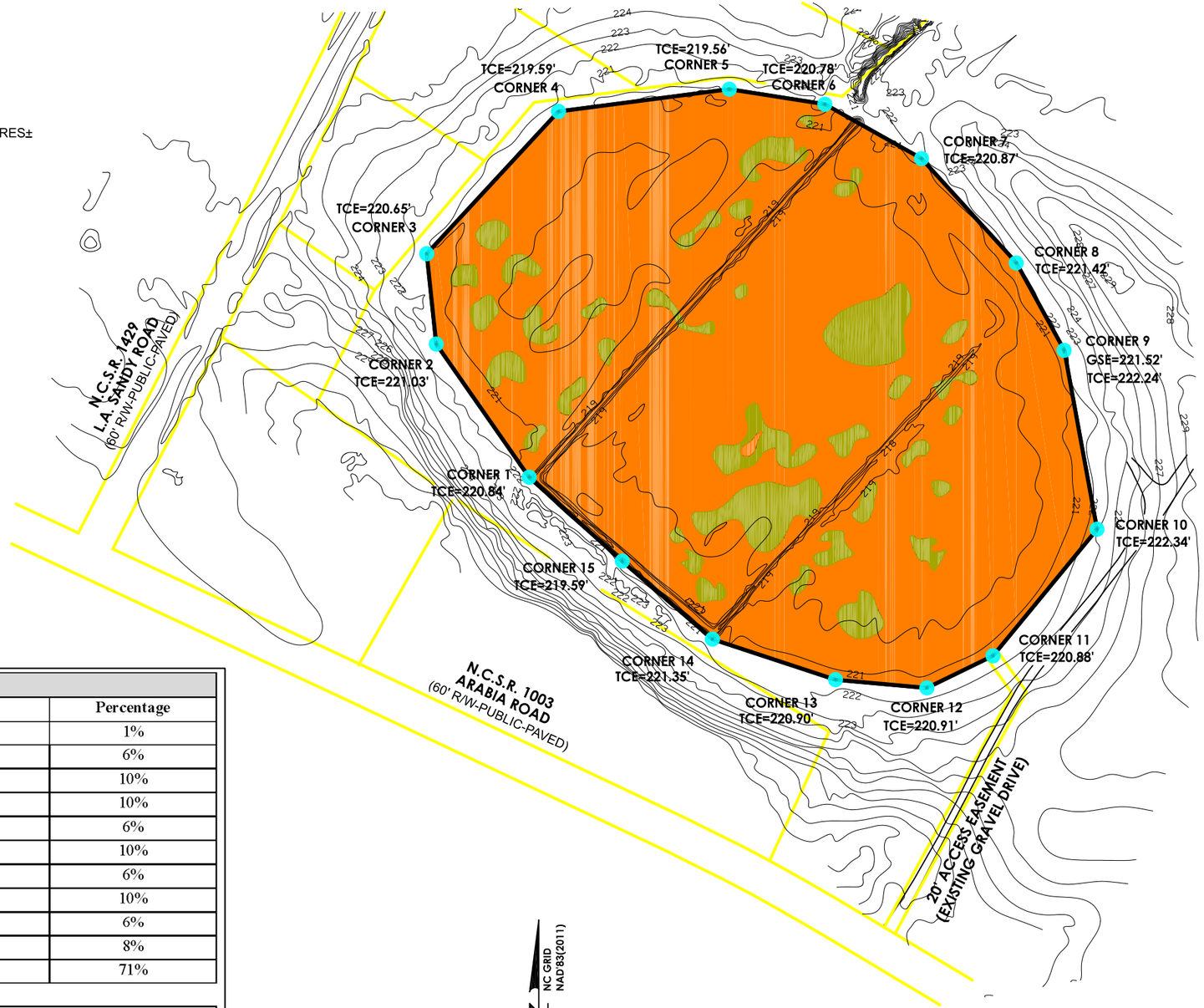
Project: ARABIA BAY
MITIGATION SITE
Hoke County,
North Carolina

Title: AS-BUILT SURVEY
FOR THE PURPOSE
OF MONITORING

DRAWN BY: FGR
DATE: 03/20/20
SURVEYED BY: J.A.R.
DWG. NO. RSS351AB20
SHEET 2 OF 4

LEGEND

- CONSERVATION EASEMENT CORNER
- CONSERVATION EASEMENT
- PARCELS
- NONRIVERINE WET HARDWOOD FOREST - 14.28 ACRES±
- CYPRESS SAVANNA (HABITAT POOL) - 1.80 ACRES±
- TCE — TOP OF CAP ELEVATION
- GSE — GROUND SHOT ELEVATION



PLANTING SCHEDULE

PLANTED BY 1-31-20

Nonriverine Wet Hardwood Forest		
Species	**Quantity**	**Percentage**
Cephalanthus occidentalis	100	1%
Fraxinus pennsylvanica	600	6%
Magnolia virginiana	1,000	10%
Nyssa sylvatica v sylvatica	1,000	10%
Quercus bicolor	600	6%
Quercus laurifolia	1,000	10%
Quercus michauxii	600	6%
Quercus nigra	1,000	10%
Quercus pagoda	600	6%
Taxodium distichum	800	8%
	7,300	71%

Cypress Savanna (Habitat Pools)		
Species	**Quantity**	**Percentage**
Nyssa sylvatica v biflora	1,000	10%
Taxodium ascendens	2,000	19%
	3,000	29%

Totals = **10,300**

(PROVIDED BY RESTORATION SYSTEMS, LLC)

"PRELIMINARY PLAT"
NOT FOR RECORDATION, CONVEYANCES OR SALES

PLANTING PLAN

0 100 200 400

1" = 200'

774 S. Beston Road
La Grange, NC 28551
919.751.0075
www.k2designgroup.com
Firm license no.: C-2111

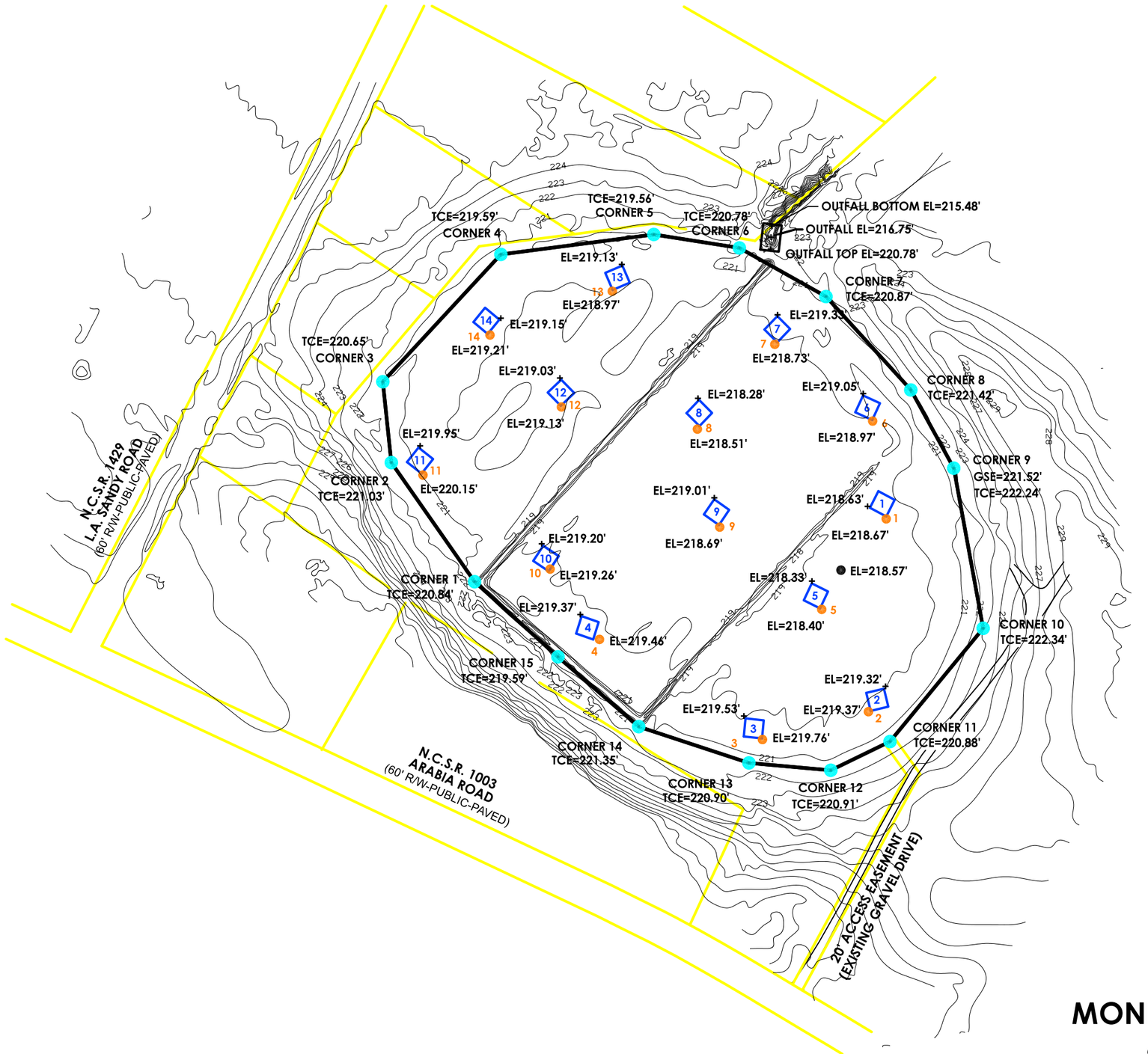
k2 design group

Client: RESTORATION SYSTEMS, LLC
1101 HAYNES STREET
SUITE 211
RALEIGH, NC 27604

Project: ARABIA BAY MITIGATION SITE
Hoke County, North Carolina

Title: AS-BUILT SURVEY
FOR THE PURPOSE OF MONITORING

DRAWN BY: FGR
DATE: 03/20/20
SURVEYED BY: J.A.R.
DWG. NO. RSS351AB20
SHEET 3 OF 4



LEGEND

- CONSERVATION EASEMENT CORNER
- CONSERVATION EASEMENT
- PARCELS
- VEGGIE PLOT
- WETLAND GAUGE
- RAIN GAUGE
- + XX.XX' SPOT ELEVATION
- EL ELEVATION
- TCE TOP OF CAP ELEVATION
- GSE GROUND SHOT ELEVATION
- OUTFALL

NORTH
NC GRID
NAD'83(2011)

**"PRELIMINARY PLAT"
NOT FOR RECORDATION,
CONVEYANCES OR
SALES**

MONITORING ELEVATIONS

0 100 200 400

1" = 200'

774 S Beston Road
La Grange, NC 28551
919.751.0075
www.k2designgroup.com
Firm license no.: C-2111

k2 design group

Client

RESTORATION SYSTEMS, LLC
1101 HAYNES STREET
SUITE 211
RALEIGH, NC 27604

Project

ARABIA BAY
MITIGATION SITE
Hoke County,
North Carolina

Title

AS-BUILT SURVEY
FOR THE PURPOSE
OF MONITORING

DRAWN BY: FGR

DATE: 03/20/20

SURVEYED BY: J.A.R.

DWG. NO.
RSS351AB20

SHEET
4 OF 4

Appendix F
Construction & Planting Photo Log

Lateral soil profile tests along existing ditches - 08/05/2019

Soil Profile, outside of Site's Boundary, North of Old Road - 08/16/2019

Soil Profile, inside of Site's Boundary, south end of the bay - 08/5/2019

Soil Profile, inside of Site's Boundary, south end of the bay - 08/5/2019

Soil from inside of Site's Boundary, south end of the bay - 08/5/2019

Filled ditch looking south near Project's outfall - 08/8/2019

Filled Ditches and habitat pools - 08/15/2019

Habitat Pool, typical - 08/08/2019

Project outfall - 08/15/2019

Project outfall looking southeast across the Site - 01/24/2020

Habitat Pools - 08/15/2019

New road, old road, looking east from Project outfall - 08/15/2019

Bare-root planting - 01/24/2020

Bare-root planting - 01/24/2020

Bare-root planting - 01/24/2020

Bare-root planting - 01/24/2020

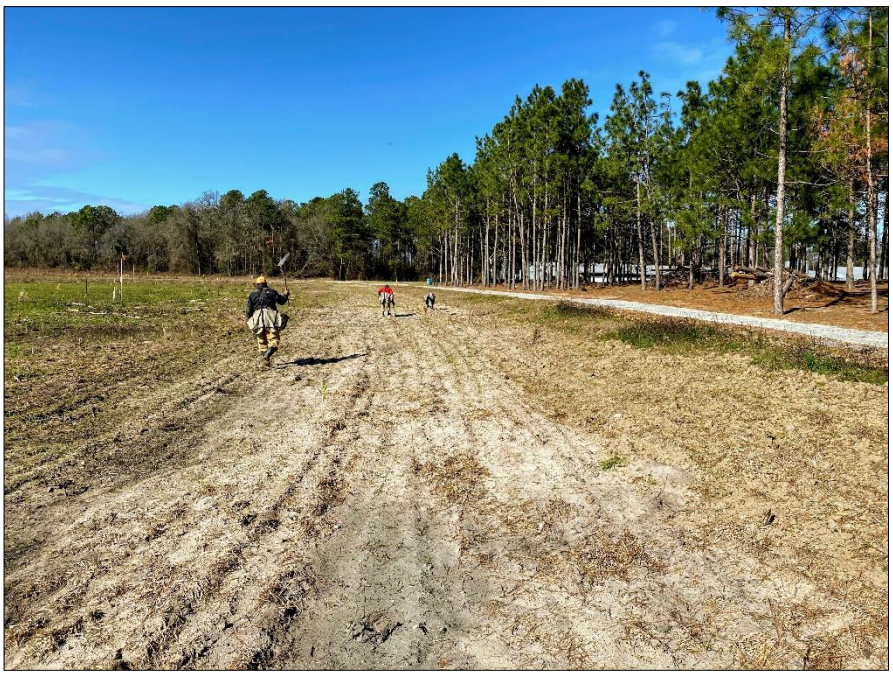
Monitoring Plot + Groundwater Gauge

Bare-root planting within ephemeral pool “habitat areas” - 01/24/2020

Bare-root planting within ephemeral pool “habitat areas” - 01/24/2020

Bare-root planting - 01/24/2020

Bare-root planting typical - 01/24/2020



Bare-root planting along old road bed - 01/24/2020