PARR AND MONTICELLO RESERVOIR FLUCTUATION STUDY

PARR HYDROELECTRIC PROJECT

FERC NO. 1894

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtGroup.com

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PARR AND MONTICELLO
RESERVOIR FLUCTUATIONS STUDY

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FERC NO. 1894

SOUTH CAROLINA ELECTRIC & GAS COMPANY

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is the Licensee of the Parr Hydroelectric Project (FERC No. 1894) (Project). The Project consists of the Parr Shoals Development and the Fairfield Pumped Storage Development. Both developments are located along the Broad River in Fairfield and Newberry Counties, South Carolina.

The Project is currently involved in a relicensing process which involves cooperation and collaboration between SCE&G, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals. SCE&G established several Technical Working Committees (TWCs) comprised of interested stakeholders with the objective of identifying Project-related resource issues and impacts.

During issue scoping meetings, the Fisheries TWC identified the need for a Reservoir Fluctuation Study on the Parr and Monticello Reservoirs. The operating regime for the Project consists of a lowering and a refilling of the Project's two reservoirs on a daily basis. Parr Reservoir is currently permitted by the FERC license to fluctuate up to 10 feet and Monticello Reservoir can fluctuate up to 4.5 feet. However, the amount that the Project reservoirs fluctuate will vary dependent on load demands and system needs. The magnitude of daily fluctuations also varies seasonally in both impoundments, with the largest average daily fluctuations generally occurring in June, July, and August in both reservoirs (see Table 1-1 and Table 1-2).

TABLE 1-1 PARR RESERVOIR MONTHLY AVERAGE ELEVATIONS: 2005-2013

MONTHLY AVERAGE RES. ELEV.			
	MAX	MIN	RANGE
Jan	263.04	259.96	3.08
Feb	262.88	260.01	2.87
Mar	263.44	260.32	3.13
Apr	263.81	259.61	4.20
May	264.22	258.79	5.43
June	264.59	258.09	6.49
Jul	264.72	257.96	6.75
Aug	264.74	257.71	7.03
Sep	264.17	258.27	5.90
Oct	263.60	259.14	4.46
Nov	263.53	259.97	3.56
Dec	263.38	260.11	3.28
AVERAGE	**263.84**	**259.16**	**4.68**

TABLE 1-2 MONTICELLO RESERVOIR MONTHLY AVERAGE ELEVATIONS: 2005-2013

MONTHLY AVERAGE RES. ELEV.			
	MAX	MIN	RANGE
Jan	423.92	422.32	1.60
Feb	423.93	422.45	1.49
Mar	423.82	422.18	1.66
Apr	424.08	421.88	2.22
May	424.42	421.64	2.80
June	424.74	421.42	3.33
Jul	424.69	421.38	3.29
Aug	424.71	421.31	3.40
Sep	424.53	421.45	3.06
Oct	424.02	421.83	2.18
Nov	423.61	422.00	1.61
Dec	423.86	422.28	1.58
AVERAGE	**424.19**	**421.84**	**2.35**

During February through April, when many fish species are spawning in shallow water habitat, average daily fluctuations range from 2.9-4.2 feet in Parr Reservoir and from 1.6-2.4 feet in Monticello Reservoir (TWC meeting presentation 12-19-13). Resource agencies and stakeholders expressed concerns that these daily and seasonal fluctuations may be affecting aquatic habitat along the shorelines of the reservoirs and fish spawning and recruitment.

2.0 STUDY OBJECTIVES

2.1 PARR RESERVOIR STUDY OBJECTIVES

Study objectives with regards to Parr Reservoir include providing a qualitative and quantitative assessment of the potential effects of operational reservoir fluctuations on aquatic habitat and navigation within the reservoir. This study provides information to characterize habitat types that are exposed during lake-level fluctuations as well as identify areas with potential navigation issues caused by fluctuations. Data collected will characterize the degree to which reservoir fluctuations affect navigation in the reservoir and identify portions of the reservoir which are potentially influenced through dewatering of aquatic habitat and/or constricted channel.

2.2 MONTICELLO RESERVOIR STUDY OBJECTIVES

The objective of this study with regards to Monticello Reservoir is two-fold. First, SCE&G will provide a qualitative assessment of the potential effects of operational reservoir fluctuations on aquatic habitat within the reservoir. Areas of shoreline are exposed during impoundment fluctuations, but the type and quality of those areas are not currently documented. This study provides information on areas of the reservoir identified by the TWC that are eligible for habitat enhancements that will promote or enhance fish spawning and recruitment.

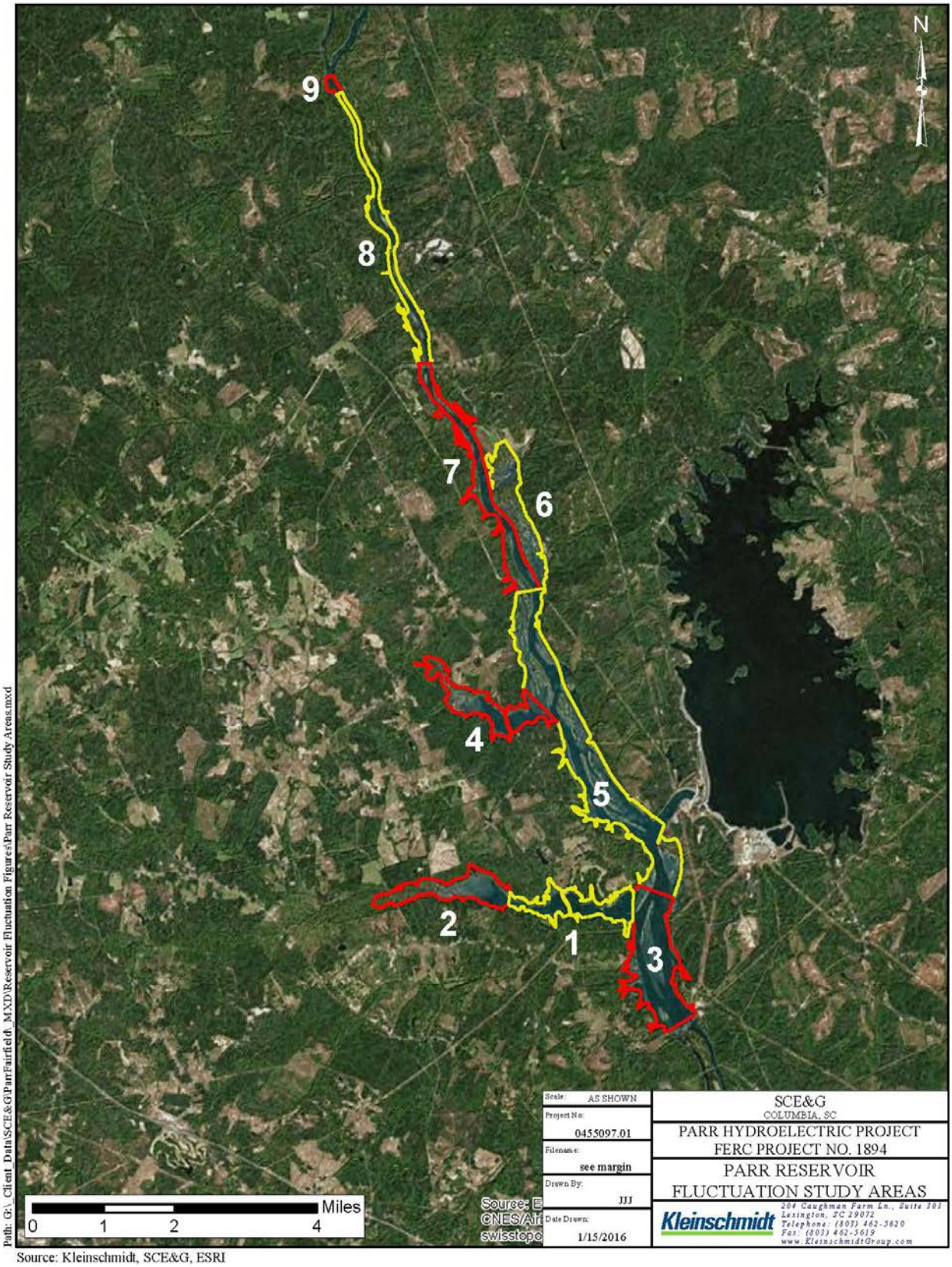
3.0 METHODS AND MATERIALS

The study area includes both Parr and Monticello Reservoirs. TWC members performed field observations of the reservoirs during 2015 to assess the variety of existing aquatic habitat types. In addition to the TWC observations, digital imagery of the reservoirs was collected during a drawdown period (9.9 foot down from full pool on Parr and 2.25 foot down from full pool on Monticello) so that substrate types could be observed. SCE&G used photogrammetry to convert the digital imagery to a Digital Elevation Model (DEM) for both reservoirs at 2 foot contours (Orbis 2015).

3.1 PARR RESERVOIR FLUCTUATION

The Parr Reservoir DEM covered the shoreline from elevation 266' msl down to 256.1' msl. Initially, Parr Reservoir was separated into 9 Study Areas based on reservoir characteristics and TWC input (Figure 3-1). Using GIS, a grid system was then applied to each Study Area and approximately 10 percent subsample of each Study Area was selected by random sample. Based on the digital imagery and personal observation/photographs collected during the drawdown, the subsampled shoreline area substrates were classified as mud/silt, sand, or gravel/cobble. Areas of structure (trees, stumps, stream channels and submerged vegetation) were also identified.

After classifications were completed, 2 foot contours for the entire Study Area were established using GIS and photogrammetry. The total acreage of the subsample and the entire Study Area was also determined. The substrate and structure type was summed for each 2 foot contour within the subsample area. The subsample breakdowns of substrate by 2 foot contour were then converted to percent composition based on the total area of the subsample within each 2 foot contour. The subsample percentages were then multiplied by the area within each 2 foot contour for the entire Study Area to determine the breakdown of substrate acreage for each 2 foot contour for each Study Area.

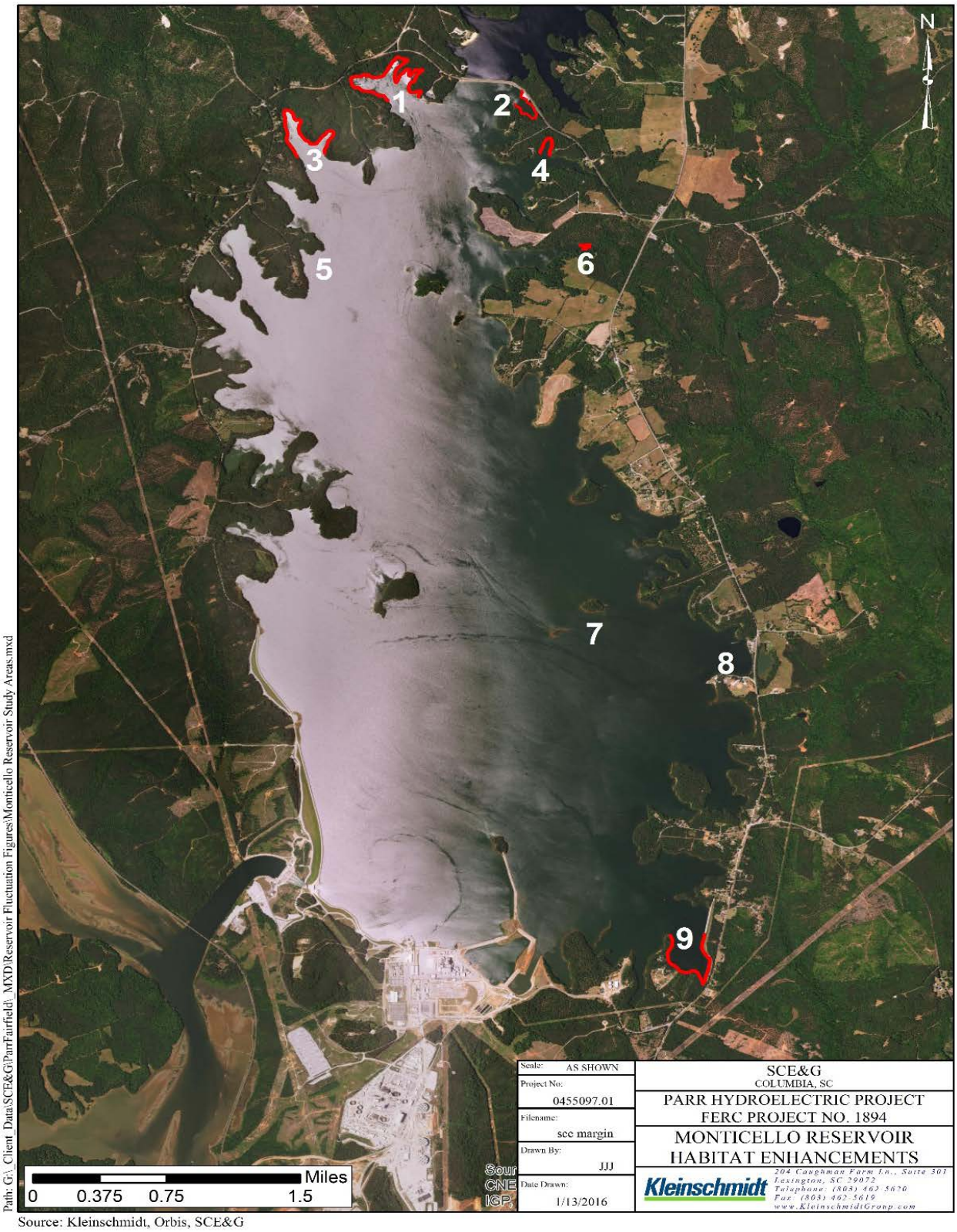


Source: Kleinschmidt, SCE&G, ESRI

FIGURE 3-1 PARR RESERVOIR STUDY AREA SECTIONS

3.2 MONTICELLO RESERVOIR FLUCTUATION

On Monticello Reservoir, SCE&G also collected digital imagery during a partial drawdown (425' msl to 422.75' msl) and used it to create a DEM that could be viewed and assessed using GIS. SCE&G and TWC members reviewed the DEM and digital imagery information during the September 29, 2015 TWC meeting to identify areas to consider for potential habitat enhancement measures. The TWC also identified the types of enhancement measures (spawning, fry protection, and adult fish structure) that could be incorporated (Figure 3-2). Nine enhancement areas were identified on the reservoir based on the digital imagery and TWC recommendations. At each of the nine enhancement locations, GIS was used to calculate the amount of shoreline area available (for spawning and fry protection) within the identified area. These measurements will be used to help identify the amount (linear area enhanced or number of enhancements) of habitat enhancement structures that could be installed.



Source: Kleinschmidt, Orbis, SCE&G

FIGURE 3-2 MONTICELLO SHORELINE HABITAT ENHANCEMENT AREAS IDENTIFIED BY TWC

4.0 RESULTS

4.1 PARR RESERVOIR

Parr Reservoir results are provided below in tabular format. Substrate and structure acreage estimates are provided for each of the Study Areas on Parr Reservoir. Results are separated by both habitat and substrate types along with the associated elevation range. A 95% confidence interval (CI) was also calculated for each estimate to demonstrate the GIS accuracy for each estimate. In some cases total acreage by elevation does not equal the sum of the substrate or structure breakdowns, because there are slight errors in using GIS. These variances were not significant. The area at 256' was also provided to show how much of the reservoir was still wetted. Note that the reservoir drawdown level was 256.1', yet DEM labeled some areas that had shallow depressions on mud flats as 256'. This created an anomaly when GIS analysis counted some areas below the 256' elevation as "dewatered" (Figure 4-1). This GIS artifact appeared in Areas 2, 5 and 6 but were not a significant number or amount of area. Figures for each Parr Study Area are included in Appendix A.

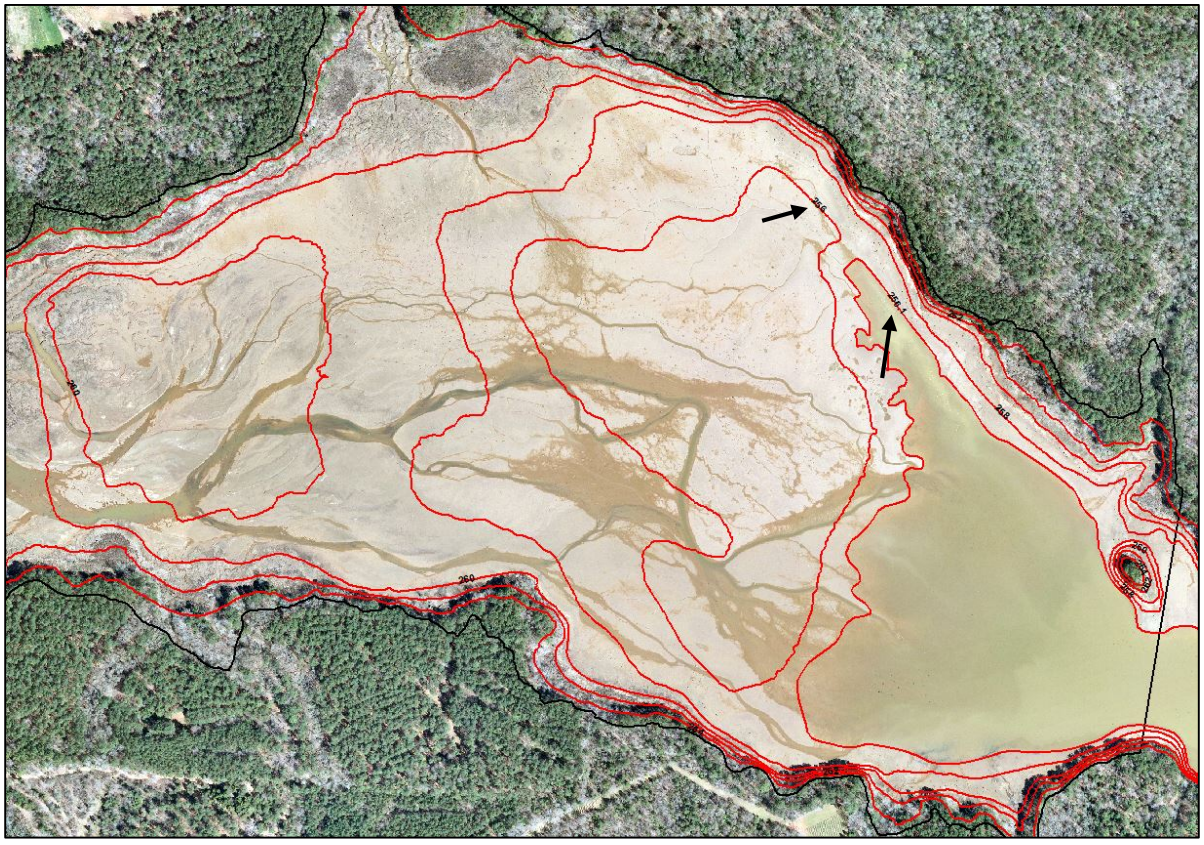


FIGURE 4-1 PARR RESERVOIR - EXAMPLE OF ELEVATION 256 ANOMALY

4.1.1 PARR STUDY AREA 1

Study Area 1 is located in Cannons Creek near the mainstem of the reservoir. The study area is primarily made up of silt and sand substrates with stumps representing the primary structure. Elevations 256-258’ and 258-260’ contain the largest portions of the study area that are periodically exposed by reservoir fluctuations. This elevation band also contains the most structure used by typical warmwater species present within the Reservoir (SCANA 2016). Substrate composition shifts from silt at 256-260’ to sand at 260-264’. The elevation band from 264-266’ is dominated by terrestrial plants with unknown substrates due to tree cover.

TABLE 4-1 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 1 OF PARR RESERVOIR

SS1 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	19.60	0.00	0.00	0.00	0.00	1.11	0.12	18.40	0.26	0.00	0.00
262-264	19.19	9.62	0.40	0.00	0.00	0.80	0.07	8.77	0.10	0.00	0.00
260-262	15.97	13.63	0.08	1.51	0.04	0.83	0.07	0.00	0.00	0.00	0.00
258-260	23.09	2.82	0.08	19.59	0.26	0.61	0.06	0.00	0.00	0.00	0.00
256-258	25.38	2.54	0.33	22.08	0.24	0.76	0.08	0.00	0.00	0.00	0.00
< 256	223.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.03	2.18

SS1 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	19.60	17.63	0.29	0.00	0.00	0.00	0.00	0.00	0.00
262-264	19.19	5.70	0.14	0.13	0.00	5.37	0.80	0.00	0.00
260-262	15.97	1.06	0.50	3.07	0.27	2.08	0.13	0.00	0.00
258-260	23.09	0.02	0.00	0.06	0.00	9.42	0.39	0.00	0.00
256-258	25.38	0.01	0.00	0.00	0.00	11.65	0.24	0.00	0.00
< 256	223.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.2 PARR STUDY AREA 2

Study Area 2 is located in the upper portion of Cannons Creek and offers more backwater rather than mainstem habitat characteristics. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. The study area as a whole displays significant dewatering during reservoir fluctuation, exposing creek channels in the upper portion of the study area. Substrate composition shifts from silt at 256-260' to sand at 260-264'. Elevation 264-266' is dominated by terrestrial plants with unknown substrates due to tree cover and contains the most area exposed by fluctuations in the reservoir. Note: There were a few spots below the 256' elevation line that showed up as "dewatered" despite the reservoir height being at 256', which is an artifact of the GIS analysis.

TABLE 4-2 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 2 OF PARR RESERVOIR

SS2 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	114.65	13.40	0.89	0.00	0.00	0.00	0.00	100.86	5.03	0.39	0.00
262-264	45.81	34.63	0.63	0.00	0.00	0.00	0.00	9.58	0.48	1.60	0.36
260-262	49.69	33.06	0.62	12.70	0.72	0.00	0.00	0.00	0.00	3.93	0.20
258-260	34.68	4.07	0.27	29.08	1.01	0.00	0.00	0.00	0.00	1.52	0.92
256-258	35.48	0.00	0.00	31.37	1.00	0.00	0.00	0.00	0.00	4.10	0.35
< 256	55.90	0.00	0.00	5.35	3.41	0.00	0.00	0.00	0.00	50.52	3.86

SS2 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	114.65	54.20	1.55	60.09	7.03	0.00	0.00	0.00	0.00
262-264	45.81	6.49	0.62	35.34	0.79	0.15	0.03	0.00	0.00
260-262	49.69	0.00	0.00	28.96	0.83	0.06	0.04	1.46	0.78
258-260	34.68	0.00	0.00	2.67	1.75	15.71	2.63	0.00	0.00
256-258	35.48	0.00	0.00	0.00	0.00	14.91	2.04	2.37	0.81
< 256	55.90	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00

4.1.3 PARR STUDY AREA 3

Study Area 3 is the downstream most study area along the mainstem reservoir adjacent to the dam. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-260' to sand at 260-264'. The upper two feet affected by fluctuations is dominated by terrestrial plants with unknown substrates due to tree cover. Elevation 258-260' contains the most area exposed by fluctuations in the reservoir. Note: This study area also contains some small areas that showed up as dewatered below elevation 256'.

TABLE 4-3 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 3 OF PARR RESERVOIR

SS3 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	15.33	0.00	0.00	0.00	0.00	0.00	0.00	15.33	9.81	0.00	0.00
262-264	22.29	22.17	0.50	0.09	0.00	0.03	0.00	0.00	0.00	0.00	0.00
260-262	31.80	25.36	0.14	6.41	0.06	0.00	0.00	0.00	0.00	0.00	0.00
258-260	159.41	6.07	0.18	152.95	1.11	0.00	0.00	0.00	0.00	0.40	0.00
256-258	66.95	1.67	0.22	68.16	1.04	0.00	0.00	0.00	0.00	0.00	0.00
< 256	405.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	399.36	2.26

SS3 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	15.33	14.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
262-264	22.29	0.63	0.00	21.27	0.50	0.66	0.00	0.00	0.00
260-262	31.80	0.00	0.00	17.35	0.36	0.33	0.03	0.00	0.00
258-260	159.41	0.00	0.00	0.00	0.00	17.37	4.07	0.00	0.00
256-258	66.95	0.00	0.00	0.00	0.00	9.27	0.23	0.00	0.00
< 256	405.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.4 PARR STUDY AREA 4

Study Area 4 is the located in Hellers Creek off the mainstem of the reservoir. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-260’ to sand at 260-264’. The upper two feet (264-266’) of the fluctuation zone is dominated by terrestrial plants with unknown substrates due to tree cover. Elevation 256-258’ contains the most area exposed by fluctuations in reservoir elevation.

TABLE 4-4 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 4 OF PARR RESERVOIR

SS4 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	57.85	7.96	0.00	0.00	0.00	8.42	1.84	41.47	9.40	0.00	0.00
262-264	36.54	34.73	1.27	0.00	0.00	0.76	0.15	1.05	0.62	0.00	0.00
260-262	33.72	24.69	0.99	1.07	0.47	0.79	0.14	0.00	0.00	7.06	0.53
258-260	32.77	3.69	0.42	28.07	1.03	1.01	0.20	0.00	0.00	0.00	0.00
256-258	89.40	0.85	0.11	88.03	1.49	0.52	0.04	0.00	0.00	0.00	0.00
< 256	105.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	105.66	3.02

SS4 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	57.85	49.44	3.71	0.00	0.00	0.00	0.00	0.00	0.00
262-264	36.54	1.05	0.62	31.79	1.32	2.94	0.00	0.00	0.00
260-262	33.72	0.00	0.00	18.19	5.58	0.00	0.00	0.00	0.00
258-260	32.77	0.00	0.00	0.00	0.00	2.26	1.50	0.00	0.00
256-258	89.40	0.00	0.00	0.00	0.00	17.81	0.29	0.00	0.00
< 256	105.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.5 PARR STUDY AREA 5

Study Area 5 is the located along the mainstem of the reservoir. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-260' to sand at 260-264'. The upper two feet of the fluctuation zone (264-266') is dominated by terrestrial plants with unknown substrates due to tree cover. The study area becomes more riverine as water levels drop with the channel becoming more defined. Elevation 258-260' contains the most area exposed by fluctuations in the reservoir. Note: This study area also contains some small areas that showed up as dewatered below elevation 256'.

TABLE 4-5 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 5 OF PARR RESERVOIR

SS5 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	106.88	69.77	2.02	0.00	0.00	0.00	0.00	37.11	1.58	0.00	0.00
262-264	159.03	158.64	0.16	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00
260-262	118.77	66.86	0.08	51.89	0.14	0.00	0.00	0.00	0.00	0.00	0.00
258-260	265.78	6.79	0.22	258.99	0.62	0.00	0.00	0.00	0.00	0.00	0.00
256-258	185.72	3.57	2.13	182.15	0.88	0.00	0.00	0.00	0.00	0.00	0.00
< 256	506.27	0.00	0.00	60.91	3.46	0.00	0.00	0.00	0.00	445.36	6.15

SS5 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	106.88	73.75	1.55	32.61	1.71	0.00	0.00	0.00	0.00
262-264	159.03	2.06	0.21	153.05	0.19	0.46	0.00	0.00	0.00
260-262	118.77	0.35	0.00	24.39	0.17	0.00	0.00	0.00	0.00
258-260	265.78	0.00	0.00	0.00	0.00	62.52	4.40	0.00	0.00
256-258	185.72	0.00	0.00	0.00	0.00	23.35	0.83	0.00	0.00
< 256	506.27	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00

4.1.6 PARR STUDY AREA 6

Study Area 6 is a backwater area located off the mainstem of the reservoir near the Broad River WMA. The study area is dominated by silt and sand substrates with stumps and aquatic vegetation representing the primary structure. Substrate composition shifts from silt at 256-262' to sand at 262-266'. The area is dominated by aquatic vegetation throughout the study area, with stumps most common below elevation 262'. Elevation 264-266' contains the most area exposed by fluctuations in reservoir elevation. Note: This study area also contains some small areas that showed up as dewatered below elevation 256'.

TABLE 4-6 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 6 OF PARR RESERVOIR

SS6 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	101.31	101.27	0.99	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
262-264	100.98	100.98	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
260-262	89.20	32.52	0.26	56.66	0.35	0.00	0.00	0.00	0.00	0.00	0.00
258-260	53.50	0.07	0.00	53.43	1.01	0.00	0.00	0.00	0.00	0.00	0.00
256-258	14.60	0.00	0.00	14.60	1.05	0.00	0.00	0.00	0.00	0.00	0.00
< 256	12.35	0.00	0.00	0.42	0.14	0.00	0.00	0.00	0.00	11.93	0.67

SS6 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	101.31	90.09	1.27	7.84	2.46	0.00	0.00	0.00	0.00
262-264	100.98	11.14	1.20	67.97	0.80	0.00	0.00	0.00	0.00
260-262	89.20	0.00	0.00	20.08	1.07	18.63	1.13	0.51	0.05
258-260	53.50	0.00	0.00	0.00	0.00	6.85	1.27	4.78	1.20
256-258	14.60	0.00	0.00	0.00	0.00	9.81	1.72	0.00	0.00
< 256	12.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.7 PARR STUDY AREA 7

Study Area 7 is located along the mainstem of the reservoir adjacent to Study Area 6. The area is long and narrow with a well-defined channel with sparse sandbars and backwater areas. The study area is dominated by silt and sand substrates with aquatic and riparian vegetation representing the primary structure. Substrate composition shifts from silt at 256-262' to sand at 262-266'. Elevation 264-266' contains the most area exposed by fluctuations in reservoir elevation.

TABLE 4-7 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 7 OF PARR RESERVOIR

SS7 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	52.98	37.84	1.42	0.00	0.00	0.00	0.00	15.14	0.32	0.00	0.00
262-264	36.54	33.85	0.83	0.51	0.14	0.00	0.00	2.17	0.13	0.00	0.00
260-262	46.39	6.97	0.11	38.97	1.65	0.00	0.00	0.44	0.14	0.00	0.00
258-260	27.04	15.78	2.95	10.78	0.13	0.00	0.00	0.44	0.10	0.05	0.01
256-258	21.88	6.66	0.69	15.05	0.23	0.00	0.00	0.14	0.00	0.03	0.00
< 256	223.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.95	1.98

SS7 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	52.98	29.01	1.13	8.54	0.00	1.76	0.00	0.00	0.00
262-264	36.54	2.72	0.12	20.29	0.00	0.00	0.00	0.00	0.00
260-262	46.39	0.00	0.00	0.00	0.00	6.31	0.37	4.51	0.45
258-260	27.04	0.00	0.00	0.00	0.00	4.13	0.06	3.09	0.79
256-258	21.88	0.00	0.00	0.00	0.00	1.74	0.16	0.00	0.00
< 256	223.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.1.8 PARR STUDY AREA 8

Study Area 8 is located along the mainstem in the upper portion of the reservoir. The area is long and narrow with a well-defined channel and steep banks. The study area is dominated by silt and sand substrates with riparian vegetation and channels representing the primary structure. Substrate composition shifts from silt at 258-260' to sand at 260-266'. Elevation 262-264' contains the most area exposed by fluctuations in the reservoir.

TABLE 4-8 SUBSTRATE AND STRUCTURE COMPOSITION OF EXPOSED SHORELINES IN STUDY AREA 8 OF PARR RESERVOIR

SS8 EXTRAPOLATED		SUBSTRATE									
		SAND		SILT		GRAVEL/COBBLE		UNKNOWN		UNEXPOSED	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	23.87	15.74	1.17	0.00	0.00	0.00	0.00	8.13	0.09	0.00	0.00
262-264	152.60	5.23	0.62	3.47	0.07	0.00	0.00	1.14	0.06	142.73	1.56
260-262	79.86	3.32	1.58	13.68	0.78	0.00	0.00	0.00	0.00	62.85	3.13
258-260	12.89	0.00	0.00	12.89	8.93	0.00	0.00	0.00	0.00	0.00	0.00
256-258	0.77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
< 256	0.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SS8 EXTRAPOLATED		STRUCTURE							
		TREES		SUBMERGED VEGETATION		STUMPS		STREAM CHANNELS	
Elev Range	Acreage	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI	Acreage	95% CI
264-266	23.87	23.11	0.28	0.00	0.00	0.00	0.00	0.00	0.00
262-264	152.60	0.15	0.10	0.00	0.00	0.08	0.00	3.58	0.00
260-262	79.86	0.00	0.00	0.00	0.00	1.56	0.31	3.95	0.00
258-260	12.89	0.00	0.00	0.00	0.00	0.00	0.00	12.89	0.00
256-258	0.77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
< 256	0.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

4.1.9 PARR STUDY AREA 9

No substrate and structure data could be collected in Study Area 9 due to the riverine nature of the study area. This Study Area did not exhibit any measurable habitat dewatering resulting from reservoir fluctuations at the flow experienced on the day of data collections. The area does contain ledges that offer significant riverine habitat but none of these were exposed even at the lowest observed reservoir elevations of 256.1' msl at the dam.

4.1.10 TOTAL PARR RESERVOIR AREAS

The total amount of shoreline exposed at each two foot drawdown is shown in Table 4-9. The estimated acreage exposed was calculated by subtracting unexposed area estimates from the total area within each contour interval.

TABLE 4-9 TOTAL AREA OF SHORELINES EXPOSED IN ALL STUDY AREAS OF PARR RESERVOIR COMBINED

ELEVATION	ESTIMATED ACREAGE EXPOSED	ESTIMATED TOTAL CUMULATIVE ACREAGE EXPOSED
264-266	492.08	492.08
262-264	428.63	920.71
260-262	391.54	1312.25
258-260	607.20	1919.44
256-258	436.05	2355.49

4.1.11 PARR RESERVOIR NAVIGATION

Navigation restrictions were noted during the TWC field observations at elevation 256.1 msl. Navigation in the mainstem of the reservoir did not appear to be restricted as a definite channel was observed throughout the reservoir. During the observations, a navigation channel was most restricted in the mouth of Heller's and Cannon's creeks. Heller's Creek had both sediments and stumps that reduced or prevented boat traffic at the lowest level of drawdown. Cannon's Creek was restricted mostly by the presence of stumps. However, a navigation channel was navigable between the stumps from the mouth upstream to the Cannon's Creek boat access (Mealing pers. com. 2015).

4.2 MONTICELLO RESERVOIR

During the September 29, 2015 Fisheries TWC meeting, critical habitat areas on Monticello Reservoir were identified to be analyzed for potential enhancement measures. Because the reservoir experiences several feet of fluctuation each day and it is not a natural stream bank, the shoreline diversity is very limited. There is a general lack of structure and stable substrates in shallow areas that would be used by typical warmwater species present in the reservoir. TWC discussions identified three types of aquatic enhancements that would be beneficial primarily to the Centrarchid (and secondarily to the Ictalurid) populations in the reservoir. These enhancements included: shallow water spawning areas, fry rearing structures to be positioned near the identified spawning areas, and deep water structures to attract adult fishes and enhance recreational fishing. The TWC noted that any enhancements installed should be located below elevation 420' msl to ensure that they would not be exposed during reservoir fluctuations or serve as a navigation hazard.

TWC discussions indicated that spawning area enhancements should be located in cove areas with stable sloped banks, which include Areas 1, 2, 3, 4, 6, and 9 (Table 4-10). Table 4-10 also included the total length of shoreline for each Area to give a relative understanding of the amount of proposed spawning enhancements. In Areas where shoreline spawning enhancements were proposed, fry rearing structures were also proposed to help protect swim up fry as they migrate from the spawning area enhancement.

Deep water structures were identified for Areas 1, 3, 4, 5, 7, 8, and 9. These structures were positioned in open cove areas, cove mouth areas, or in open water areas adjacent to islands in Monticello Reservoir. The proposed habitat enhancements are also included within the table and illustrated in Figures 1-9 in Appendix B.

A preliminary list of costs for the various habitat enhancement structures (not including labor for installation) is provided in Appendix C (Mossback 2015). These prices are based on the Mossback company designs and price list available at http://www.mossbackrack.com/. These structures were selected as a basis for costs because of the product durability and presence and use in southeastern reservoirs. Initial contacts with Mossback have indicated the company's ability to work as a contractor for installation and design of habitat enhancements for specific reservoir applications. Unit costs for spawning areas is not as definitive at this point and will require additional discussions with the TWC on final length and location, design, and type of product used to build and maintain them.

TABLE 4-10 POTENTIAL MONTICELLO HABITAT ENHANCEMENTS

MONTICELLO RESERVOIR CRITICAL HABITAT AREAS		POTENTIAL HABITAT ENHANCEMENTS			
Area Number	Shoreline Length (ft)	Spawning Habitat (ft)	Percent of Shoreline (%)	Fry Rearing	Deepwater Attractor
1	8947	450	5.0	3	3
2	2422	100	4.1	1	0
3	5966	225	3.8	2	2
4	1434	150	10.5	2	1
5	deep water	0	0	0	2
6	629	50	7.9	1	0
7	deep water	0	0	0	3
8	deep water	0	0	0	2
9	4936	150	3.0	0*	1
TOTALS	**24334**	**1125**		**9**	**14**

*Fry habitat was not proposed for Area 9 due to the extensive amount of rip-rap areas adjacent to the proposed spawning enhancement.

5.0 DISCUSSION

The Parr Reservoir results will be reviewed and discussed with the TWC[1]. The study results will provide a basis for the TWC to identify the magnitude of impact associated with reservoir fluctuations and develop potential alternatives to reduce the impacts, as well as aid in the identification of priority areas for potential PM&E measures that could be considered as part of the Settlement Agreement.

The Monticello Reservoir results will also be presented to the TWC for review and discussion. The proposed habitat enhancements should provide a basis for discussion and recommendation of the types and amounts of habitat enhancements that could be proposed for the Settlement Agreement. The proposed enhancements should provide benefits to various life stages of Centrarchids (spawning and fry rearing) within Monticello Reservoir. The deep-water structures should provide habitat for several types of adult fish and enhance fishing opportunities in the reservoir. While Centrarchids are the primary focus of the listed aquatic habitat enhancements, the stable structures may provide additional benefits to other species of fish and aquatic biota (mussels and macroinvertebrates).

[1] A Fisheries TWC meeting was held on March 3, 2016 to discuss this report. Meeting notes are included in Appendix D.

6.0 REFERENCES

Orbis. 2015. Contractor for collection of Photogrammetry data and conversion to a Digital Elevation Model for Parr and Monticello Reservoirs, March 2015.

Kleinschmidt. 2013. *Baseline Fisheries Resources Report: Parr Hydroelectric Project*. Prepared for SCE&G by Kleinschmidt Associates, Lexington, SC. November 2013.

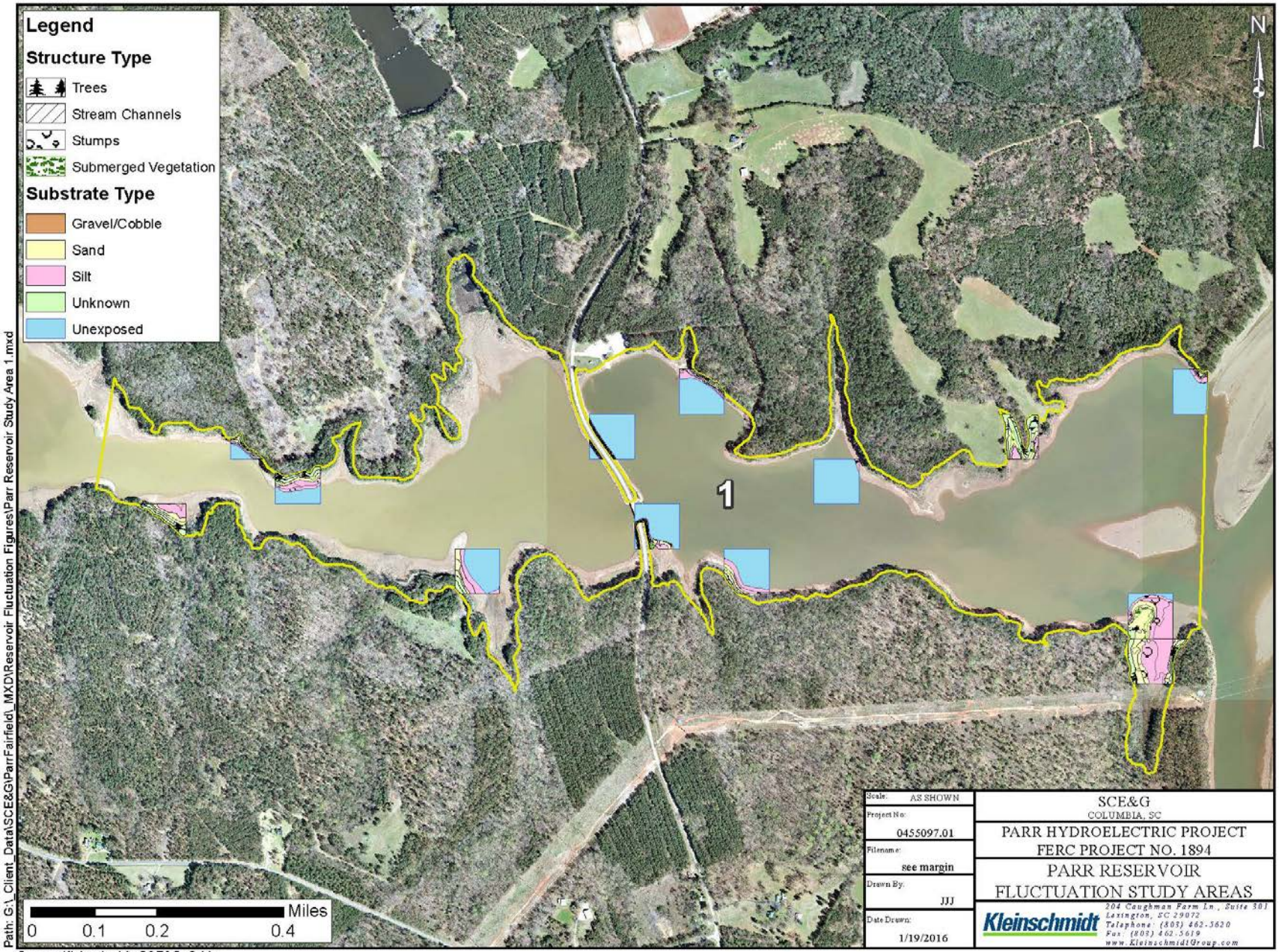
Mossback Fish Habitat. www.mossbackrack.com. Web. January 2015.

Mealing, H. (December 2015). Personal Communication. Parr Reservoir Fisheries TWC Site Visit, March 2015.

SCANA Services, Inc. 2016. Fish Community Assessment of Parr Reservoir 2015. Summary of fish collections in Parr Reservoir from 2012-2015.

APPENDIX A

PARR RESERVOIR STUDY AREAS



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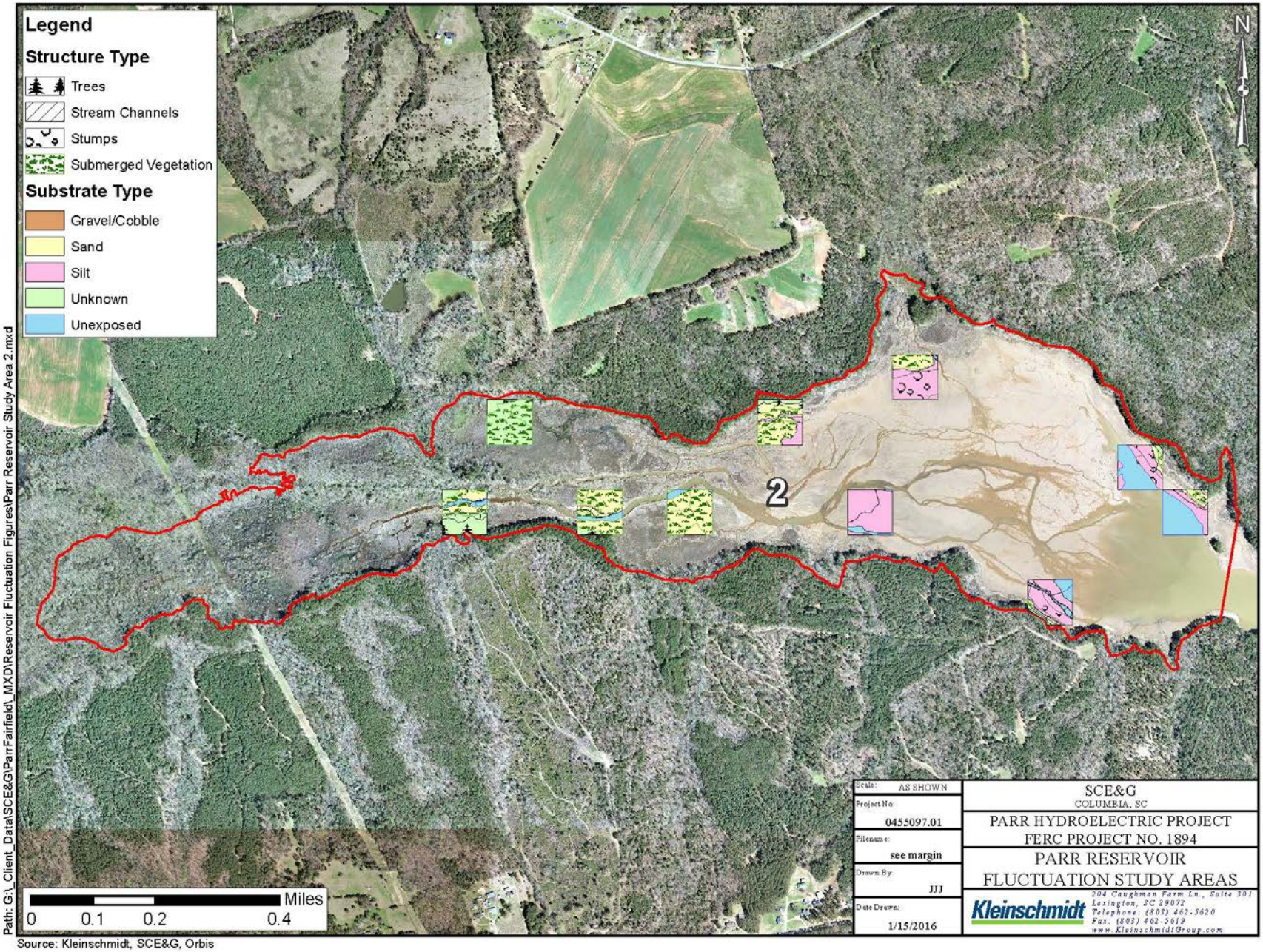

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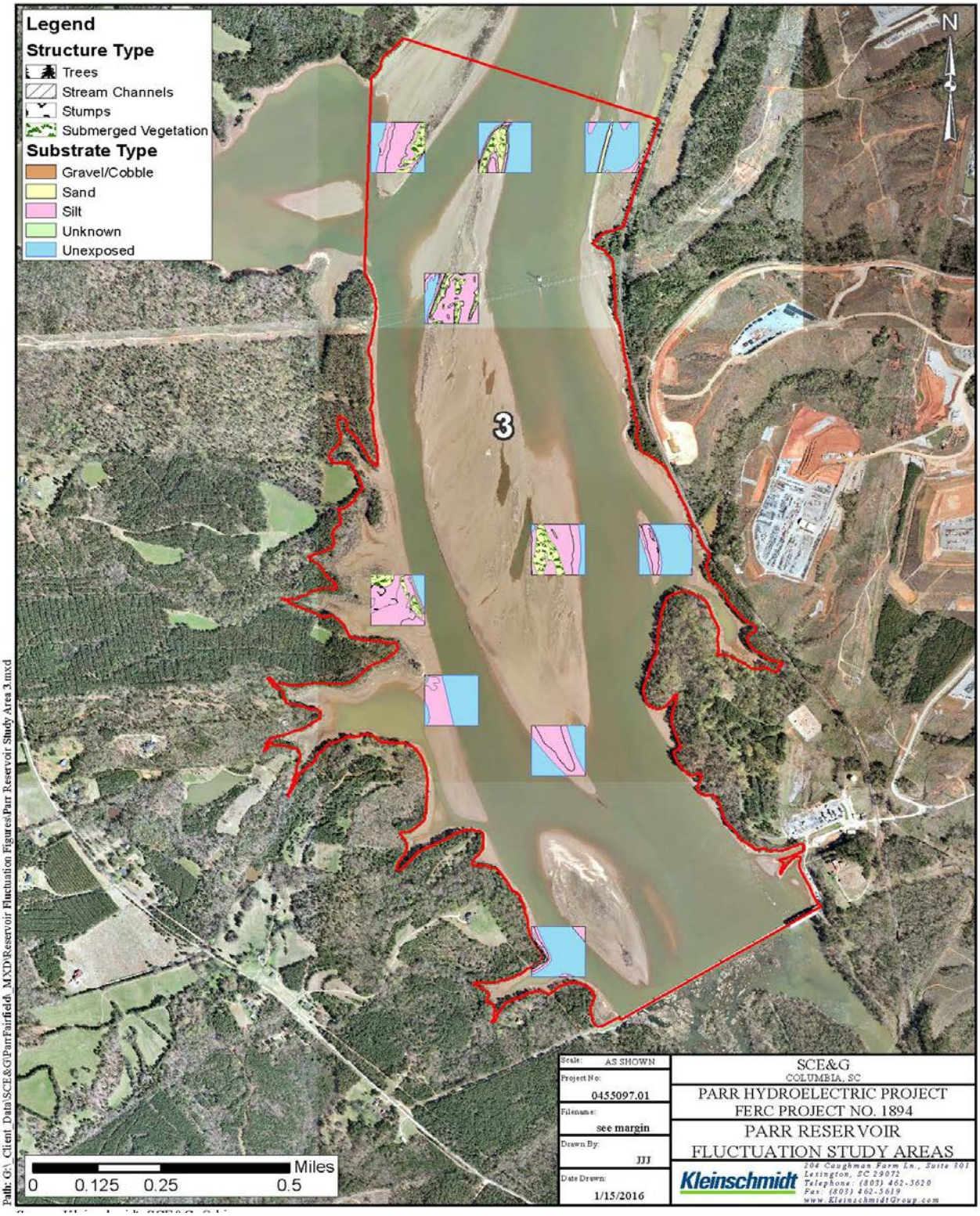

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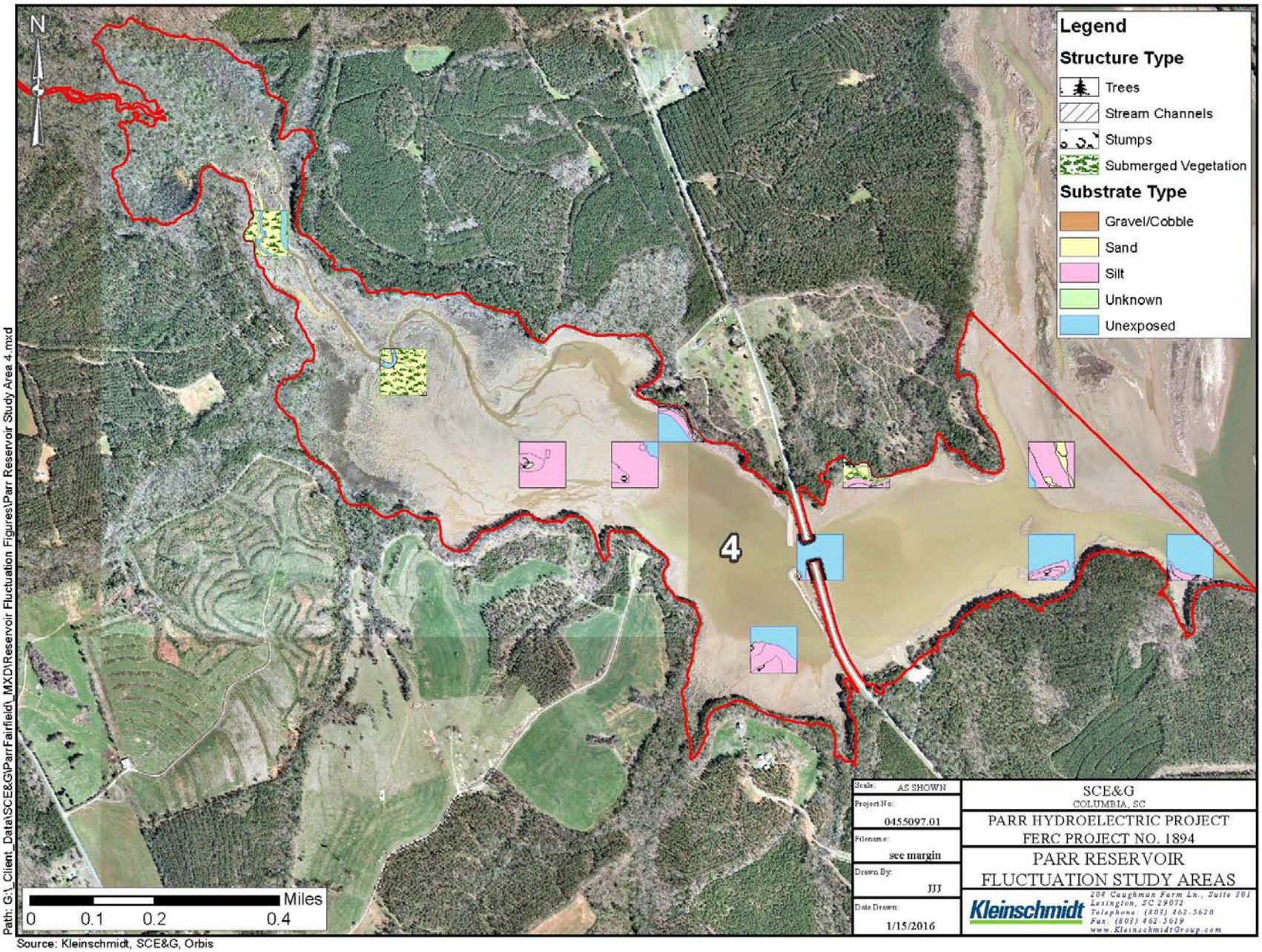
Drawn By: JJJ	
Date Drawn: 1/15/2016	Kleinschmidt 204 Caughman Farm Ln., Suite 301 Lexington, SC 29072 Telephone: (803) 462-3620 Fax: (803) 462-3619 www.KleinschmidtGroup.com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Legend
Structure Type
Trees
Stream Channels
Stumps
Submerged Vegetation
Substrate Type
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Sand
Silt
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Unexposed
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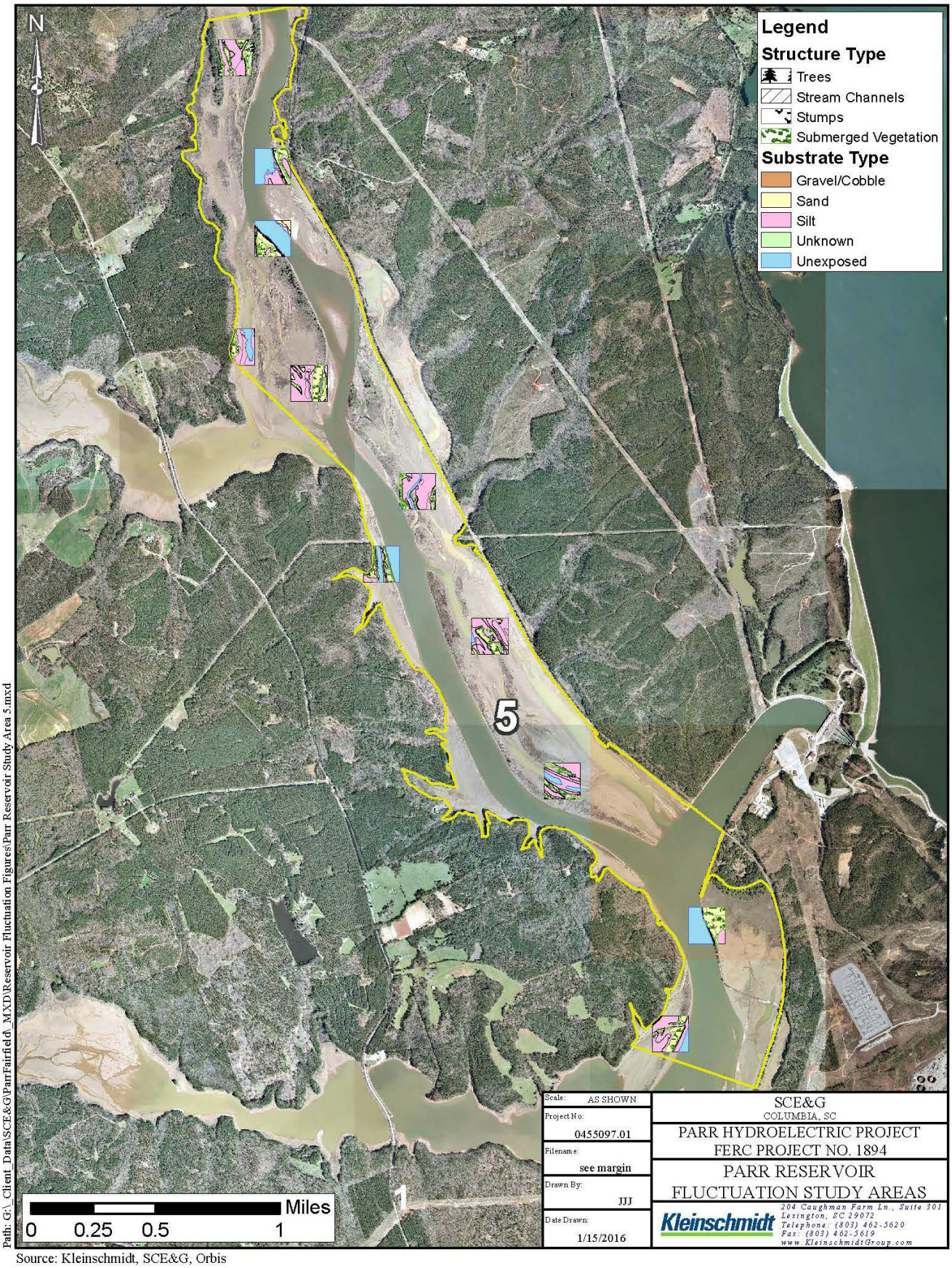

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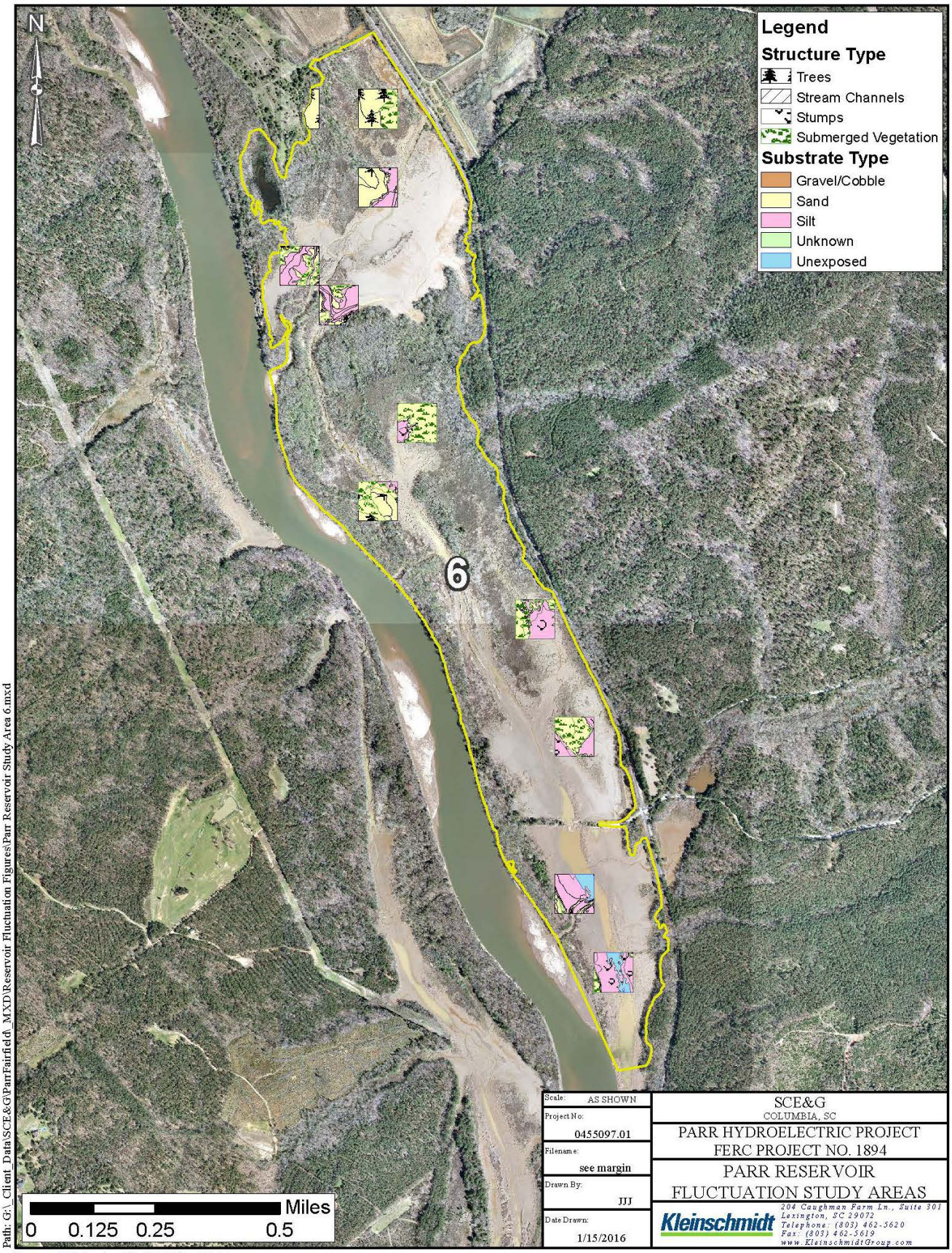

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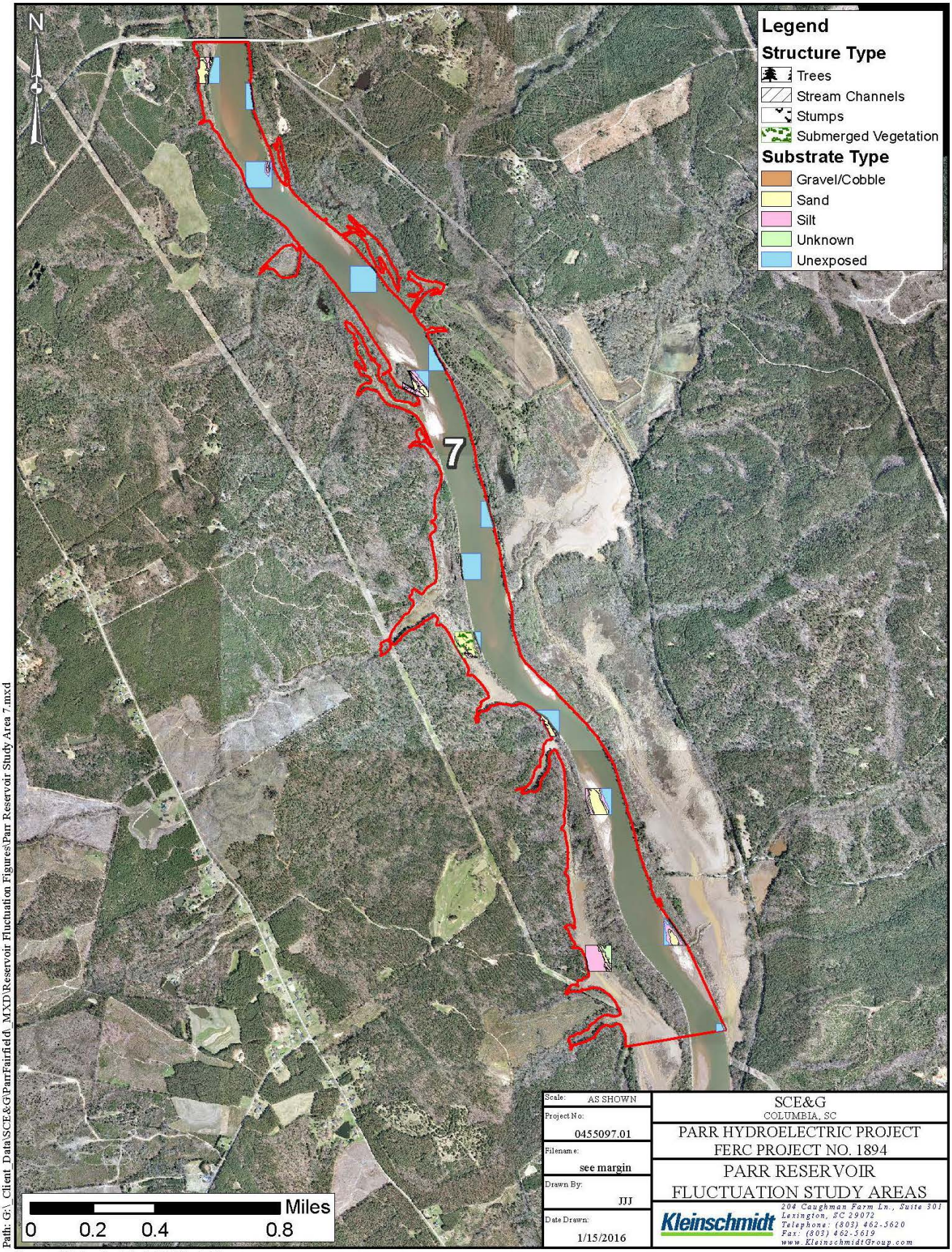

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Drawn By: JJJ	
Date Drawn: 1/15/2016	Kleinschmidt 204 Caughman Farm Ln., Suite 301 Lexington, SC 29072 Telephone: (803) 462-5620 Fax: (803) 462-5619 www.KleinschmidtGroup.com

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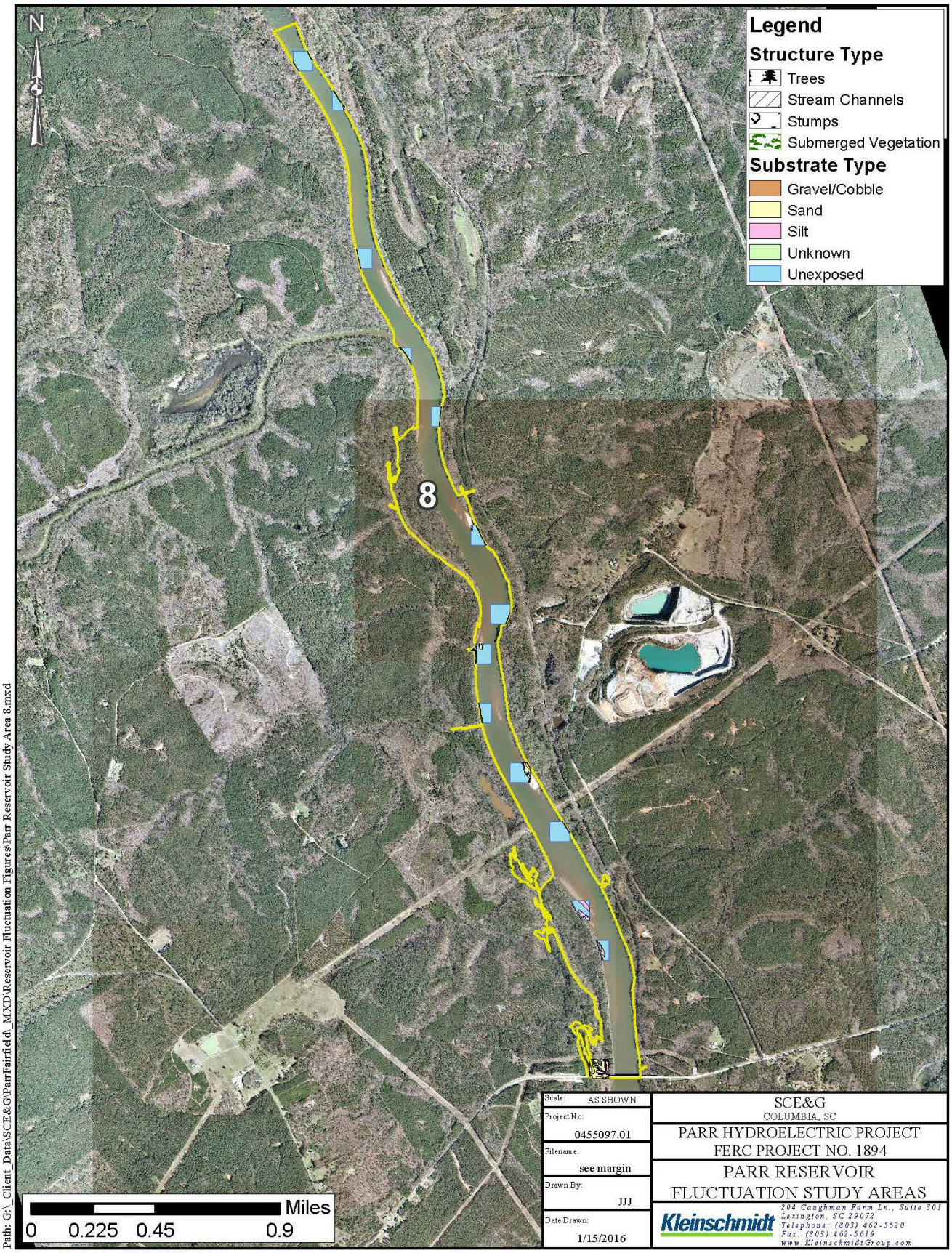

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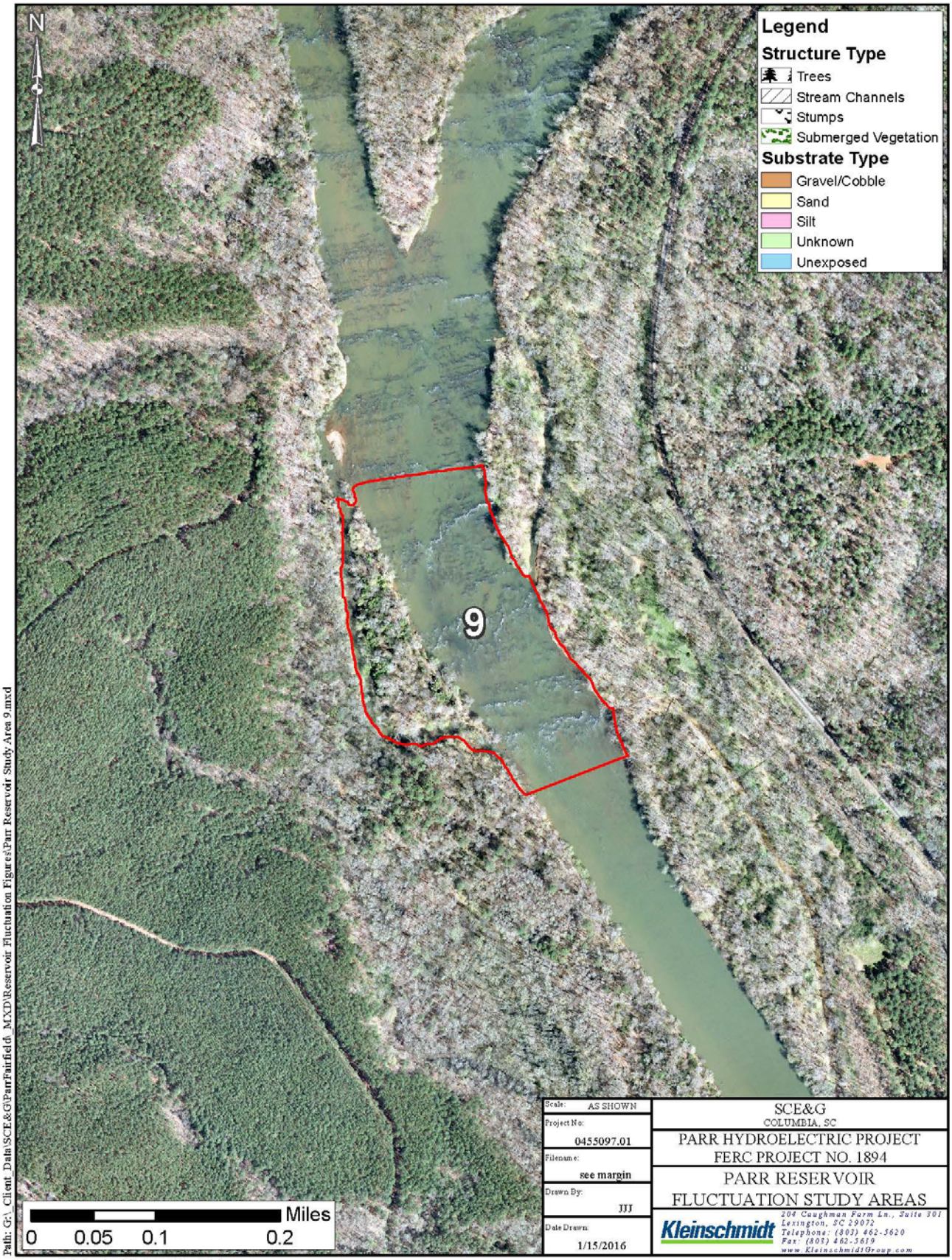

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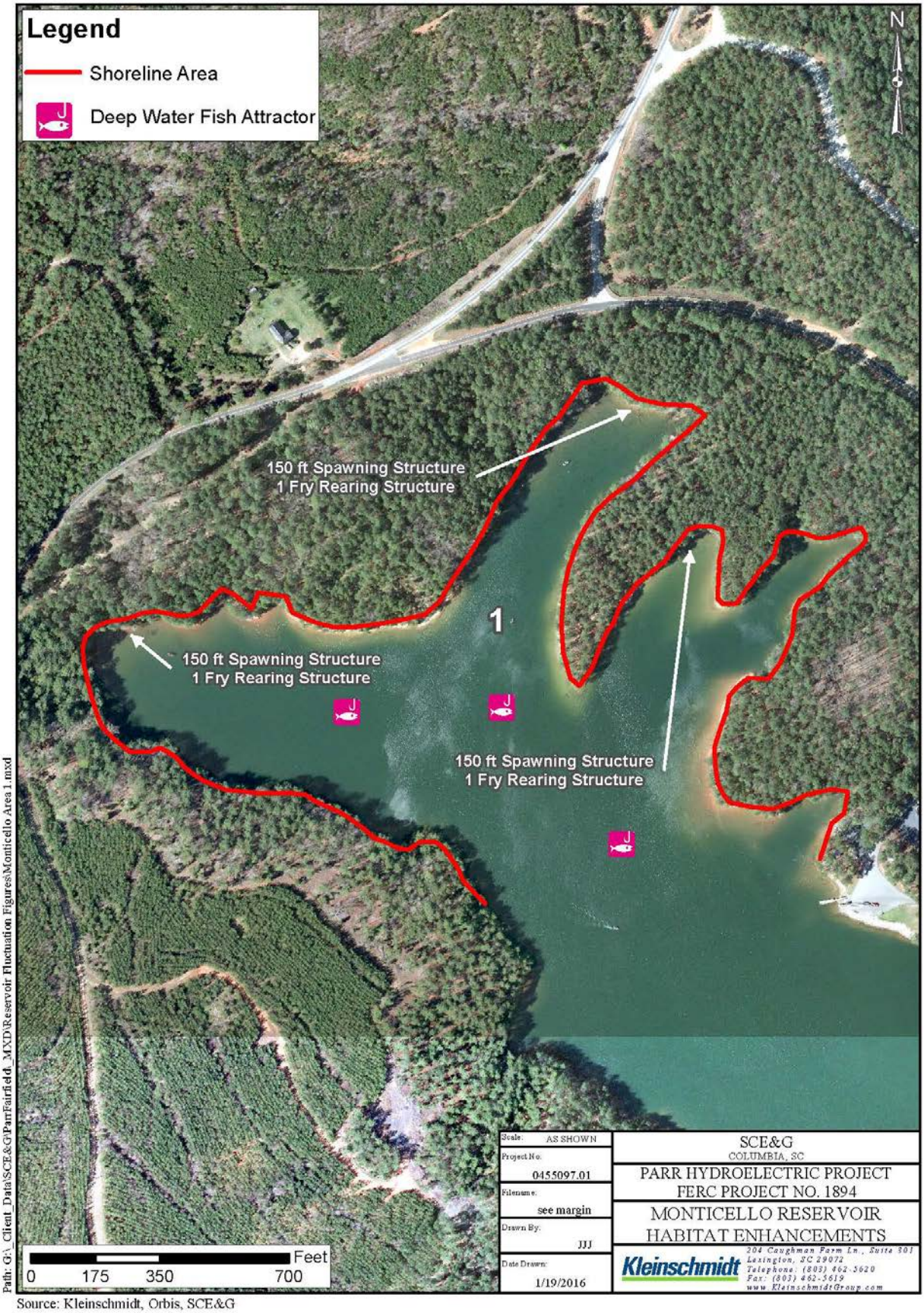
APPENDIX B

MONTICELLO RESERVOIR STUDY AREA HABITAT ENCHANTMENTS



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Drawn By: JJJ	FERC PROJECT NO. 1894
Date Drawn: 1/13/2016	MONTICELLO RESERVOIR HABITAT ENHANCEMENTS

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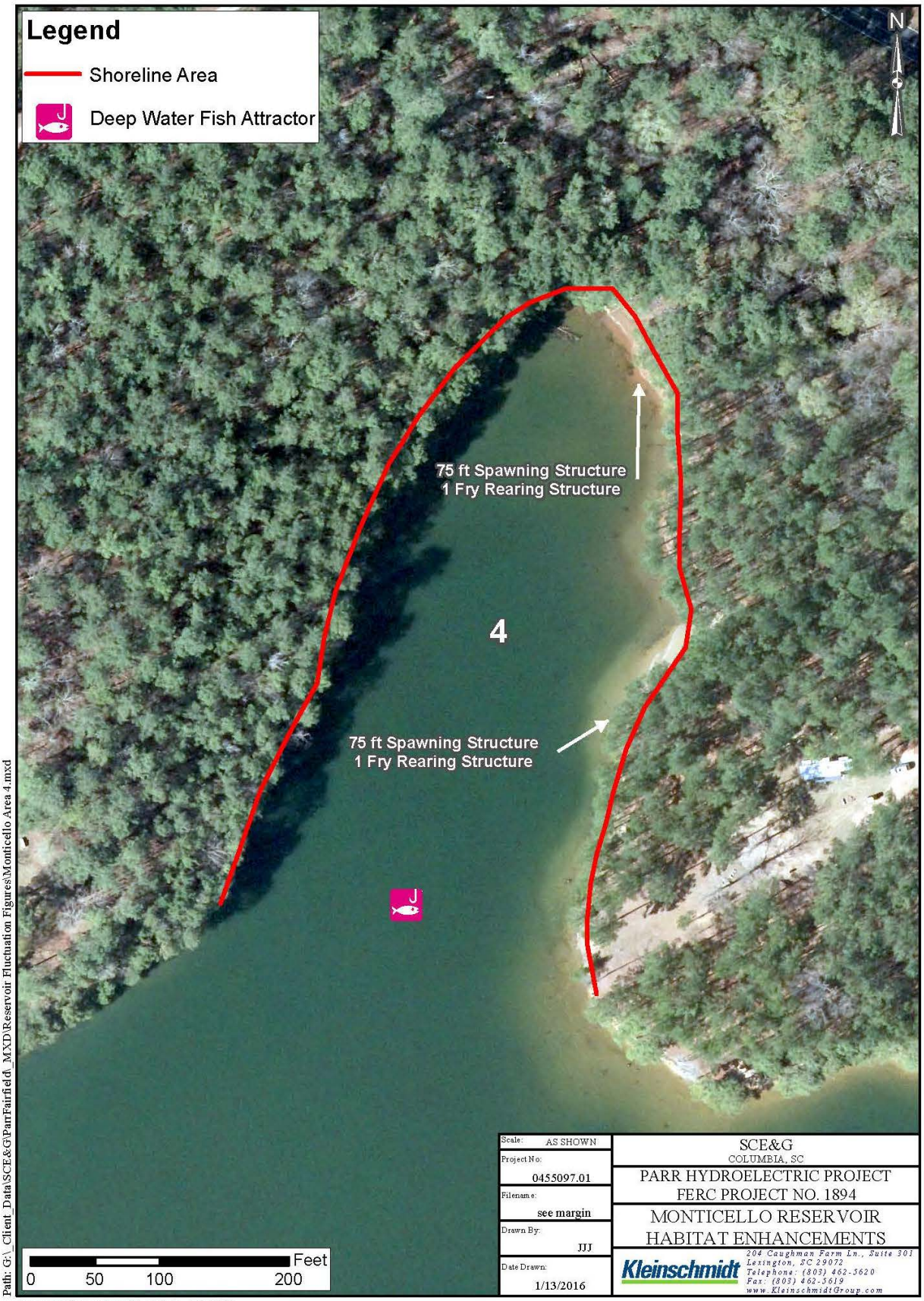

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Drawn By: JJJ	
Date Drawn: 1/13/2016	Kleinschmidt 204 Caughman Farm Ln., Suite 301 Lexington, SC 29072 Telephone: (803) 462-5620 Fax: (803) 462-5619 www.KleinschmidtGroup.com

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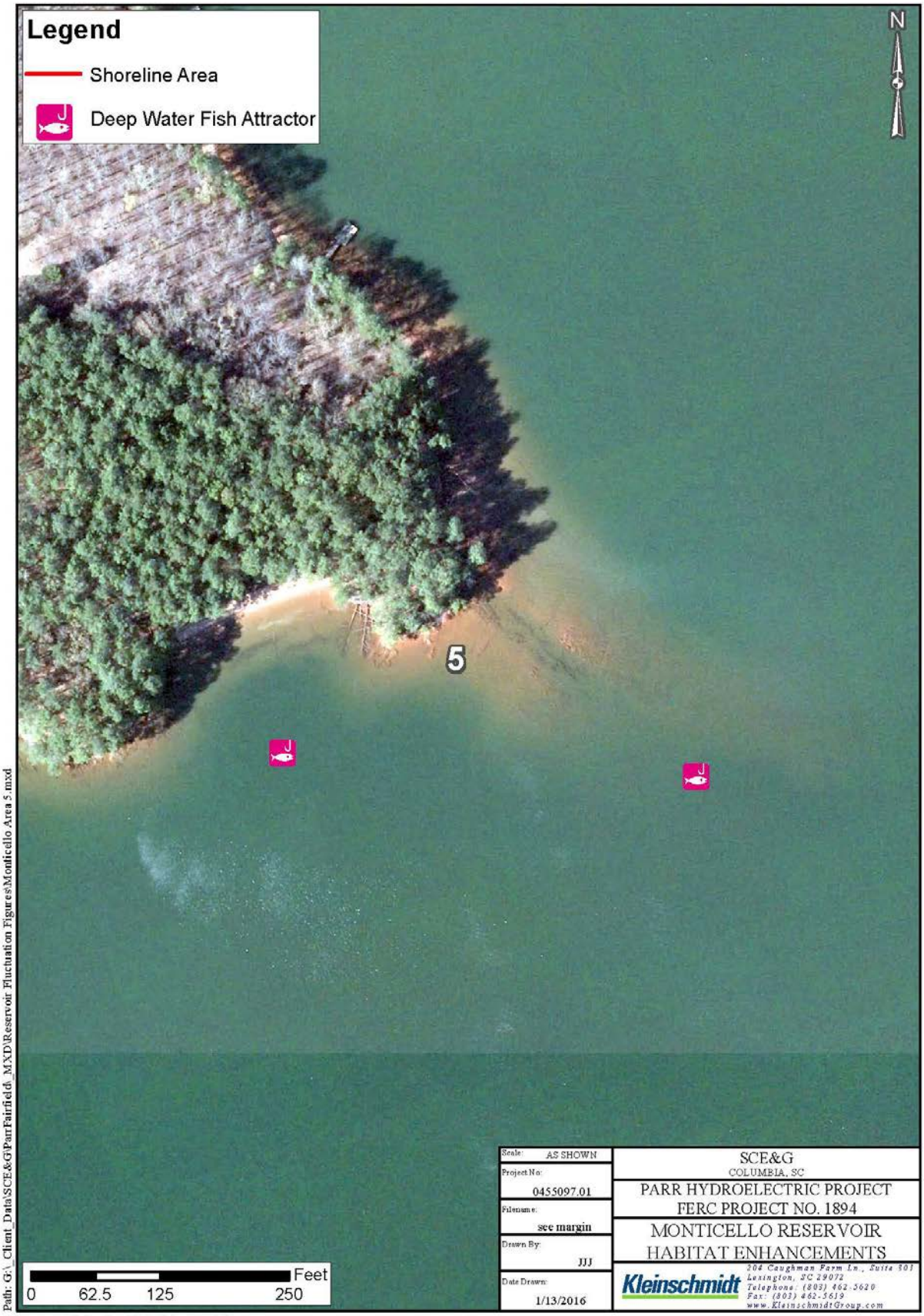

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Drawn By: JJJ	
Date Drawn: 1/13/2016	Kleinschmidt 204 Caughman Farm Ln., Suite 301 Lexington, SC 29072 Telephone: (803) 462-5620 Fax: (803) 462-5619 www.KleinschmidtGroup.com

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Project No: 0455097.01	PARR HYDROELECTRIC PROJECT FERC PROJECT NO. 1894
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Drawn By: JJJ	
Date Drawn: 1/13/2016	Kleinschmidt 204 Caughman Farm Ln., Suite 301 Lexington, SC 29072 Telephone: (803) 462-3620 Fax: (803) 462-3619 www.KleinschmidtGroup.com

Source: Kleinschmidt, Orbis, SCE&G

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Scale: AS SHOWN	SCE&G COLUMBIA, SC
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Source: Kleinschmidt, Orbis, SCE&G

APPENDIX C

MOSSBACK FISH HABITAT STRUCTURE COSTS

TABLE 4-1 MOSSBACK FISH HABITAT STRUCTURE COSTS

MOSSBACK FISH ATTRACTOR KITS	
Juvenile Structure	Cost
Fry Cage	$499.95
Safe Haven 5-Post	$224.95
Safe Haven 9-Post	$529.95
Adult Structure	Cost
MB1 Trophy Tree	$324.95
MB2 Trophy Tree	$599.95
Reef Kit	$499.95
Mega Reef Kit	$1,129.95

APPENDIX D

FISHERIES TWC MEETING NOTES
MARCH 3, 2016

MEETING NOTES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
Fisheries TWC Meeting

March 3, 2016

Final KMK 03-07-16

ATTENDEES:

Bill Argentieri (SCE&G)
Ray Ammarell (SCE&G)
Randy Mahan (SCE&G)
Brandon Stutts (SCANA)
Caleb Gaston (SCANA)
Tom McCoy (USFWS) via conf. call
Fritz Rohde (NOAA) via conf. call
Dick Christie (SCDNR)
Bill Marshall (SCDNR)
Alex Pellett (SCDNR) via conf. call
Henry Mealing (Kleinschmidt)
Kelly Kirven (Kleinschmidt)
Jordan Johnson (Kleinschmidt)

These notes serve as a summary of the major points presented during the meeting and are not intended to be a transcript or analysis of the meeting.

Henry opened the meeting with introductions and told the group the purpose of the meeting was to review the Reservoir Fluctuation Report and identify any Protection, Mitigation and Enhancement (PM&E) measures that might be associated with fluctuation of Parr and Monticello reservoirs.

Parr Reservoir

Henry explained the methodology included in the study, where Parr Reservoir was divided into nine segments and 10% of each segment was analyzed to determine how much and what type of habitat was dewatered at each 2 foot increments from 266 down to 256.1 msl.

TWC members had expressed concern over the fluctuation of Parr Reservoir, and so the group tried to identify ways to improve habitat and navigation in the reservoir.

Bill M. asked for ways that navigation could be improved when the reservoir was low. Henry said that at Heller's Creek, stumps could be removed, however this would also remove important fish habitat. Bill M. suggested that only some stumps be removed, to allow for better navigation, but to still provide some fish habitat. Henry said that improving access from Heller's Landing could be considered as a PM&E measure.

Dick said another idea would be to limit fluctuations on both Parr and Monticello reservoirs during spring fish spawning. He understands that this is a difficult issue to address and that this could be something that is done only when conditions allow. Bill A. asked if it's more important to keep the habitat wetted or dry and Dick said that it's more important for the reservoir level to remain stable. Ideally, both reservoirs would be full and stable during spawning, however if the reservoir can't be full, then they should be stable, so fish nests aren't left dry when the water level drops. Bill A. and

Ray said they would talk with operators to see if this is possible. It would also depend on how much water is coming from upstream, although in the spring, generally there is excess water, which may make it easier to hold the reservoir at a steady level.

Henry said that Ron Ahle (SCDNR) had mentioned in a previous TWC meeting that it would be nice to stabilize one of the side channels as a small impoundment in Parr Reservoir, similar to the Recreation Lake at Monticello Reservoir, as a PM&E measure. The group discussed the possibility of this and how the US Army Corps of Engineers (USACE) might handle it. The group looked at maps of Parr and identified a small side channel area as the potential site for an impoundment. Brandon said it would likely be difficult to obtain a permit, plus mitigation would need to be done to account for the loss of wetlands or streams. The railroad would also need to be contacted to see how this would possibly affect their operations, since the railroad tracks run close to the area in question. Caleb also mentioned that duck hunters would need to be considered, since this proposed area for the impoundment is a heavily used location for duck hunting. Navigation into and out of this area could become an issue.

The group also listed the following items for consideration regarding the impoundment:

- build a berm or gate around the 262' or 260' mark, approximately 125 feet long
- the impoundment would need to be somewhat small, so it wouldn't affect storage in Parr (how many acre feet would this take away from operations)
- build a temporary structure that could be installed only during the spring (March, April, May), so sediment doesn't build up, hunting isn't affected, and water doesn't get stagnant
- potentially build a boat ramp that allows for access inside the impoundment (could be considered a recreation enhancement as well)

Tom was concerned about how this structure may cause navigation issues and possible sediment issues for fish and mussels when removed each year. He indicated that a permanent structure, such as a rice trunk, may be the best option. The group decided that this option needs to be discussed further, both internally for SCE&G and externally with the USACE.

Henry said the take-home message regarding Parr Reservoir fluctuations is that SCE&G doesn't bring the pond level up to 266' very often, as evidenced by the amount of vegetation growing in the upper contours. Below elevation 260', substrate is mainly sand and silt with large numbers of stumps. There is a large amount of natural structure occurring lower in the reservoir along the shorelines, while the upstream sections of the reservoir are more riverine.

<u>Monticello Reservoir</u>

One of the goals identified by the TWC in the Study Plan was to focus on identifying PM&E measures in this reservoir to enhance spawning/recruitment/and fishing to mitigate for fluctuations. Prior to the meeting, Dick prepared and distributed a document outlining potential enhancements for Monticello Reservoir, from SCDNR's perspective. This document is attached to the end of these notes.

Bill A. asked how SCE&G will show compliance with some of the enhancements that Dick proposed. Dick said that license articles could be worded to require consultation with agencies. Implementation of enhancements can be documented and agencies would send in letters of confirmation that work was completed. He is not concerned with performing creel surveys or other

studies to prove that enhancements are improving fish recruitment in the reservoir. He believes that the enhancements he is proposing have already been proven in many studies in other reservoirs to increase fish production. The installation of these enhancements should be considered successful compliance with the license article.

SCE&G said they are concerned about some of the proposed enhancements, including the amount of gravel needed and possible re-contouring of shorelines. Dick said these are just examples of some things that can be done, but SCDNR would be willing to negotiate on these items. He said that ideally, SCE&G would install all of the agreed upon enhancements versus just providing the funding for work to be done. However, SCDNR may be able to provide some assistance during installation, in the way of boats or technicians.

The group discussed the different ideas that Dick presented and agreed that a PM&E measure could address installing three different types of fish habitat: spawning, nursery, and deep water, which agrees with the report. Some of the attractors could be purchased from Mossback, or a similar company, and some could be built by SCE&G. Brandon and Caleb brought an example of a deep water attractor to the meeting that they built using scrap parts. A photo is included below.

PHOTO 1 DEEP WATER FISH ATTRACTOR BUILT BY SCE&G

The TWC and report initially identified "9 enhancement areas" on Monticello. The group discussed these and other areas of the reservoir and identified approximately 20 areas around the lake where spawning, nursery, and/or deep water fish attractors could be installed. Some of the 20 areas

included all three components, while others included only one or two. The group agreed to the following specifics for each habitat type:

- Spawning – areas will be approximately 1000ft x 10ft, and will include up to 200 spawning disks or gravel beds – spawning disks will be installed in groups of 3-5
- Nursery – areas will be paired with spawning sites above and will include approximately 15 nursery/fry structures, such as the fry cage built by Mossback or handmade stake beds or bamboo structures built by SCE&G.
- Deep water – each deep water site will be approximately 1500 square feet, with approximately 15 structures scattered around a central buoy. Structures can be constructed by SCE&G or purchased from Mossback.

SCE&G and Kleinschmidt will put together a PM&E proposal that addresses site location, cost estimation, and installation schedule. This will be brought back to the TWC for review and discussion. The group discussed several different schedules for the term of the new license, including installing enhancements in two sessions several years apart, or installing one or two sites per year for 15 years. The group also discussed prioritizing sites and installing in phases during the first 30 years of the license. Everyone agreed that at least one pause in the timeline is necessary for a check and adjust on the process.

Kleinschmidt will order a few fish attractors from Mossback to use for testing. The TWC will plan to meet at the reservoir later in the spring to field verify the sites identified and possibly install a few fish attractors to determine level of difficulty. Dick noted that Robert Stroud (SCDNR) should be involved, since he is the SCDNR representative assigned to Monticello Reservoir. Scott Collins (SCE&G) will also be consulted to ensure that the sites identified are not located in areas where docks can be permitted.

The meeting adjourned. Action items from this meeting are listed below.

ACTION ITEMS:

- SCE&G will discuss internally the option of building a berm at the site on Parr Reservoir identified in the meeting. Depending on the outcome of this discussion, they, potentially along with SCDNR, will talk with USACE about permitting this action.
- SCE&G and Kleinschmidt will put together a PM&E proposal detailing the next steps for installing fish habitat enhancement in Monticello Reservoir – types, places, timeline.
- Kleinschmidt will order some fish attractors from Mossback for testing.
- The TWC will meet later in the spring to visit the Monticello Reservoir sites identified in the meeting for fish habitat enhancement.

Aquatic habitat enhancement in Monticello Reservoir

Monticello Reservoir is a 6,800 acre impoundment associated with the Parr Shoals Hydroelectric Project (project). This project is a pump-back project that utilizes the Fairfield Pumped Storage Facility to generate electricity and refill the lake. The project has the capacity to transfer up to 29,000 acre-feet of water between Parr Shoals reservoir and Lake Monticello, and for the period 2005-2013, average daily fluctuations in Lake Monticello were 2.35 feet. However, the authorized daily operational range is 4.5 feet, which could result in a minimum reservoir level (MRL) of 420.5 feet and should be considered in the placement of any fish habitat.

When the project is operated at the minimum reservoir levels, the surface acreage is reduced from 6,800 acres to 6,467 acres, which results in the dewatering of about 333 acres or (14.5 million sq. feet) This shoreline, which is exposed on a daily basis, is generally devoid of aquatic or terrestrial vegetation, woody debris, or other structure that could provide habitat for aquatic organisms. Much of this shoreline is a silt/clay hardpan material.

To mitigate project effects on littoral habitat, the fisheries technical working committee (TWC) is developing a proposal to supplement aquatic habitat in Monticello Reservoir. The TWC recommended 1) enhancements should provide habitat for spawning, nursery area and deep water cover; 2) they should be installed in close proximity to facilitate movements from one habitat type to another; and 3) ideal spawning habitat would be located in the backs of coves protected from the wind.

Draft DNR Proposal: DNR recommends a robust fisheries enhancement program be implemented over the term of the new license. If the new license is issued for a term of 30-years, we recommend enhancement of a minimum of 15 coves on Lake Monticello. In the event a License is issued for more than 30 years, an additional 5 coves should be enhanced for each additional 10-year period. Enhancement efforts should focus on the creation of spawning, nursery and deep water cover or attraction habitats. In keeping with proposed language in the General Permit (GP) for Lake Monticello, *inshore enhancements* would include spawning and nursery habitats, and be placed in shallow water areas along shorelines and within coves, in a minimum depth of 3 feet below MRL (with the exception of felled or hinged trees). Ideal areas for inshore structures exist in areas with little to no human habitation, docks, piers or boat landings. *Open water enhancements* would be located in deep water areas away from shorelines, in water depths where the tops of the structures would be a minimum of 6 (?) feet below MRL and would not interfere with navigation. Ideal areas for open water structures exist where the absence of aquatic vegetation, submerged woody debris, or topographical depressions may provide natural fish habitat.

Spawning habitat – Cove selection is important and should be conducted in coordination with the resource agencies. Selected coves would be enhanced with structure that provides substrate suitable for spawning and cover to attract spawning fish and to provide protection for fry. Area covered (square feet) is probably more important than height (cubic feet) for spawning habitat. Spawning habitat should cover an area ranging from about 0.25 to 1 acre in each cove, which would result in a total reservoir enhancement of between 3.75 and 15 acres. Each area would be from 1000 – 2000 linear feet in length and 10-20 feet wide, depending on topography, and these areas would be located primarily in the backs of coves.

Enhancement materials could include, but are not limited to:

- gravel beds 3-4 inches in depth with aggregate ranging in size from pea gravel to crusher run (or native stone equivalent);
- spawning benches created by utilizing a 4 to 6 foot piece of log sawed lengthwise in half and attached to cinder blocks on each end; and
- spawning discs such as the Honey Hole spawning disc. Honey Hole recommends installing up to 24 discs per acre in groups of 3 to 8. We are thinking that a minimum of 200 discs/1000 linear feet of shoreline may be adequate if used alone, fewer if other spawning habitats are also used.

A combination of these various habitat types is recommended. Rock jetties less than 2 feet high and or stump fields and felled trees should be placed near the spawning habitat to provide cover for all life stages and to stabilize gravel. During periods of low water levels, exposed lake bottoms may be re-contoured to excavate a shallow depression in which to hold gravel for spawning beds. All of the structures utilized to provide spawning habitat would be generally located in water depths of 3 – 6 feet below MRL and marked with appropriate signage and/or noted with downloadable GPS data.

Nursery habitat – for each cove, several shallow water structures should be established to serve as nursery habitat. These structures should be designed to provide cover for fry and juveniles and substrate for periphyton, and would be placed near the spawning areas and in depths of water ranging from 6 -10 feet at MRL. The goal would be to establish a minimum of 2-3 “nursery areas” associated with each spawning area, each consisting of a minimum of 12 habitat units (8 feet by 8 feet) spread over an 800 -1000 square foot area. Some vertical profile is important (2-4 feet tall) for this habitat type, as is the need for numerous small interstitial spaces that exclude fish larger than 6 inches. Enhancement areas would be marked with appropriate signage and/or noted with downloadable GPS data.

Enhancement materials for nursery habitat could include:

- rock jetties 3-4 feet tall;
- stump fields;
- a combination of rock jetties and stump fields;
- concrete or corrugated culverts no greater than 24 inches in diameter;
- homemade pvc attractors;

- commercial artificial structures such as the Mossback safehaven or 9-post safehaven structures; and
- low-profile horizontal bamboo bream nursery mats.

Open water habitat - open water habitat enhancement (fish attractors) will be established at suitable locations, and would generally be located in the proximity of the spawning/nursery area enhancements but could also be located in other areas as determined by the TWC. The purpose of these areas is to enhance structure and habitat to provide cover, feeding areas and attraction for larger fish, and they would be placed in water depths between 12 and 20 feet at MRL. Vertical profile is very important for attraction habitat. The goal would be to establish at least one attractor per cove, and each attractor should cover at least 2,000 square feet (1/10 of a surface acre) and provide vertical profile (50% of water depth). All open water enhancement areas would be marked with "Coast Guard" yellow fish attractor buoys.

Enhancement materials for open water attractors could include:

- homemade PVC;
- small and large diameter corrugated and/or concrete pipe;
- concrete products or clean construction debris;
- bamboo, recycled coniferous trees and other large woody debris with concrete block anchors;
- commercially available products such as the larger Mossback safehaven structures.

Staging areas - Designated staging areas will need to be developed at Lake Monticello. These could be at existing lake access areas, or could be in areas previously used by SCDNR for Canada Geese restoration activities. Best Management Practices will be incorporated throughout the use of these areas as temporary staging for loading of materials. The proposed materials may be transported by boat or barge to a site from the designated staging areas and placed. Because of the high fluctuations in water levels, it will be necessary to use heavy materials to insure they remain where they are deployed. A mini-excavator and a skid-loader (or similar equipment) will be needed to load and off-load the material to and from the barge.

Excavation may be required in order for habitat barges to reach staging areas for load of material. Excavation is limited to the minimum necessary for access to temporary staging areas, and excavated material must be properly disposed of on an upland site. All disposed material shall be properly stabilized or contained so as to preclude entry into any surface waters, wetlands, streams or any other waters of the United States, or public property. The disposed material shall not affect cultural or historic resources or threatened or endangered species. All disposal sites must be authorized by the lake manager.

Material outlined above (ex. large rock, logs, gravel) may be used to form a temporary ramp or nosing area to load material onto boat or barge from the staging area. Stabilization of the shoreline using a rock loading ramp will prevent gouging and shoreline erosion during construction. Temporary matting may also be used where applicable. When appropriate the materials in the loading/nosing areas will be

removed, though some residual material may be left in place as bank stabilization and/or habitat enhancement (i.e. gravel beds) where applicable.

Approach – SCE&G would ultimately be responsible for conducting this work. DNR will consult with SCE&G to identify the specific areas for enhancement, to develop cove-specific descriptions of the enhancement activities, and to provide other guidance as needed for the selection of enhancement materials and deployment. We recommend that the project be phased over the term of the new license by the establishment of 10-year work periods. Annual meetings would be held to discuss the progress and accomplishments of the program and to conduct planning and coordination for annual activities. A 10-year meeting would be conducted in the last year of the work period to discuss and formulate the next 10-year work plan.