APPENDIX D WETLANDS VEGETATION STUDY

TETRA TECH

June 18, 2019

Technical Memorandum

To: Scituate Department of Public Works (DPW)
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From: Ken Deshais, Senior Project Scientist, Tetra Tech

Re: DEIR Appendix D – Wetlands Vegetation Study
Reservoir Dam – NID# MA 000478
Reservoir Dam Water Storage and Fish Passage Improvement Project

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1.0 INTRODUCTION

The Certificate of the Secretary of Executive Office of Energy and Environmental Affairs (EOEEA #15711) (the Certificate) for the Environmental Notification Form (ENF) for Reservoir Dam Water Storage and Fish Passage Improvement Project (EOEEA 2017) requires the Draft Environmental Impact Report (DEIR) to identify impacts of the proposed project on the wetland vegetation surrounding the Reservoir Dam impoundment and Tack Factory Pond. The Wetlands Vegetation Study includes:

Wetlands delineation and permit level design was completed in 2017 to determine impacts on wetlands surrounding Reservoir Dam and Tack Factory Pond for preparation of a Notice of Intent (NOI) and the MEPA ENF (Tetra Tech 2017).

An assessment of the proposed project's potential impacts on wetlands surrounding the Reservoir Dam impoundment and Tack Factory Pond was completed in 2019 for preparation of the DEIR as described in this memorandum and is summarized in DEIR Section 5.3.

2.0 PROJECT OVERVIEW

Reservoir Dam was first constructed in the early 1960s to serve as a storage reservoir for the Town of Scituate's public water supply. The dam is an earthen embankment with a concrete core wall that supplements well water to the Old Oaken Bucket Dam water treatment plant. Current conditions are similar to the original design, with the spillway structure repaired in 1994. Existing structures include an ogee-shaped concrete spillway, a low-level outlet, and a pool and weir fishway. The dam and structures are routinely maintained as needed.

The existing ogee spillway crest elevation is 38.9 feet (ft.).) North American Vertical Datum 1988 (NAVD88) and length is 38.9 feet (ft.). All elevations in this document refer to NAVD88. The spillway has a total discharge capacity of 1,751 cubic feet per second (cfs) at the top of dam Elevation (El.) 45 ft. The low-level outlet is a 12-inch diameter pipe through the dam with an inlet structure at the bottom of the reservoir and a flow control valve at the downstream side of the dam. The low-level outlet flow control valve has an electric motor and is operated through a supervisory control and data acquisition (SCADA) system. The fishway has 21 weirs approximately 3 ft. wide creating pools that are approximately 3.5 ft. long. The channel downstream of the fishway has a slope of 1V:30H. Reservoir Dam has a 4.3 square mile watershed located on both sides of Chief Justice Cushing Highway (CJCH, or Route 3A) in the Town of Scituate. The Town currently owns Conservation Land around the reservoir on the east side of CJCH and Tack Factory Pond on the west side of CJCH. First Herring Brook feeds into Tack Factory Pond and water passes through the Reservoir Dam impoundment, flowing south/southeast toward Old Oaken Bucket Pond.

The results of a preliminary assessment conducted by the DPW in January 2013 indicated that providing more storage in the Reservoir Dam impoundment by maintaining a higher normal pool level could allow the existing fishway to function during the spring upstream migration and fall out-migration periods while providing additional storage for the Town's water demand. A subsequent feasibility study conducted in 2013 indicated that management of the reservoir in the spring to store more water would help meet the Town's water demands throughout the summer, while also providing adequate flow for fish passage and stream habitat in the fall. The study indicated that a 1.5 ft. increase in normal pool elevation would add 113 acre-feet (ac-ft.) of storage capacity, (an equivalent of 37.0 million gallons of additional storage), by installing a bottom-hinged crest gate on the spillway and lowering the fishway exit channel. In 2014, the DPW completed preliminary design of the spillway and fishway modifications needed to implement the

selected management plan for expanding storage capacity of the Reservoir Dam impoundment to improve water supply, maintain BIOQ90 flows for stream habitat (the natural streamflow that occurs 90% of the time), and provide both upstream and downstream fish passage at Reservoir Dam. This should allow re-establishment of a healthy anadromous fish population in First Herring Brook for the first time in 60 years.

3.0 PROPOSED PROJECT

The purpose of the Reservoir Dam Water Storage and Fish Passage Improvement Project (Reservoir Dam Project) is to provide water storage for the Town of Scituate's public water supply while providing BIOQ10 flows to maintain aquatic habitat downstream of the Reservoir Dam impoundment and Old Oaken Bucket Pond and effective fish passage at the Reservoir Dam fishway. Since the dam is classified as a Class I high hazard dam, modifications to the spillway are included in this project to increase the discharge capacity for the design flood equal to one-half the Probable Maximum Flood (1/2 PMF) in accordance with Massachusetts General Law c.253, Section 46 and 301 Code of Massachusetts Regulations (CMR) 10.07. Modifications to the dam, spillway, and fishway conform to the dam safety regulations and will be approved by the Department of Conservation and Recreation (DCR), Office of Dam Safety (ODS).

The Scituate DPW will continue to perform the Interim Operational Plan (IOP) developed by the North and South Rivers Watershed Association (NSRWA) until the spillway and fishway modifications are implemented and a new operating plan is developed. The proposed improvements to reservoir storage capacity will be maximized through modifications to the spillway and fishway without affecting dam safety. Higher pool levels will have minimal impact on CJCH and properties adjacent to the reservoir.

The proposed plans for the project are to raise the Reservoir Dam impoundment to El. 40.4 ft which is 1.5 feet (ft.) above the existing maximum normal pool El. 38.9 ft. and 1.1 ft above the Tack Factory Pond existing maximum normal pool El. 39.3 ft. The spillway will be modified to lower the crest to El. 36.4 ft. and install a bottom-hinged crest gate. The existing fishway at Reservoir Dam will also be modified to lower the fishway exit channel into the impoundment and incorporate a removable weir to provide passage of anadromous species (alewife and blueback herring) at all reservoir water levels during the spring and fall migration periods. The Project will add 113 ac-ft. of storage, which is approximately 25 days of water supply at the Town's average annual daily withdrawal rate. The Project will also allow for more robust stream flow releases in order to enhance overall ecological habitat in the Reservoir, First Herring Brook and Old Oaken Bucket Pond. The overall ecological modeling results indicate that proposed modifications and reservoir operation could have adequate fishway flow for successful passage 98% of the time during the spring in-migration and 88% of the time during the fall outmigration. In addition, an unintended benefit of the project is the deeper impoundment will help equalize and balance long-term temperature variability within the newly expanded pool.

4.0 EXISTING WETLAND PROTECTION ACT INLAND RESOURCE AREAS

Resource Area Delineation

The existing wetland resource areas within and near the Reservoir Dam project area were evaluated during the 60% Design and Initial Permitting phase of the project for preparation of the NOI (Tetra Tech 2017). There are five types of wetland resource areas regulated under the Massachusetts Wetlands

Protection Act (MGL, Chapter 131, Section 40, WPA) and Regulations (310 CMR 10.00) within the project area. These include Bank, Bordering Vegetated Wetlands (BVW), Land under Water Bodies and Waterways (LUW), Bordering Land Subject to Flooding (BLSF), and Riverfront Area (RA).

Tetra Tech wetland scientists identified wetland resource areas within and near the Reservoir Dam project area in March and April 2016. Wetland resource area boundaries were demarcated with alpha-numerically labeled blue surveyor's tape. Wetland flags were located using the real-time, high submeter accuracy iSXBlue II+ GNSS receiver and are shown on the plans provided in DEIR Appendix F. The wetland lines were delineated using vegetation type, abundance, and soil characteristics determined using sampling and inspection methods. Wetland resources areas present on the project site include the following.

Bank. As defined in the WPA, a Bank is the portion of the land surface which normally abuts and confines a water body. A Bank can occur between a water body and a vegetated bordering wetland and adjacent floodplain, or if these are not present, a Bank can occur between a water body and an upland area. A Bank may be partially or totally vegetated, or it may be comprised of exposed soil, gravel or stone. The lower boundary of Inland Bank is the Mean Annual Low Flow (MALF) level, the upper boundary of the Inland Bank is the first break in slope or the Mean Annual Flood Level (MAFL), whichever is lower.

Bank of Reservoir Dam is based on the MAFL, El. 39.8 ft and MALF, El. 35.9 ft. Bank of Tack Factory Pond is based on the Mean Annual Flood Level MAFL, El. 39.8 ft and MALF, El. 39.3 ft. For both the Reservoir Dam impoundment and Tack Factory Pond, MAFL is either below the first break in slope or generally coincident with it. Bank along First Herring Brook, the unnamed perennial stream on the south side of Tack Factory Pond, and the two intermittent streams flowing into the Reservoir Dam Impoundment are derived from field flagging.

Flag series KBKA (Flags KBKA1 – KBKA10) and KBKD (Flags KBKD1 – KBKD14) denote the Bank of First Herring Brook, flowing into Tack Factory Pond. Flag series R and S (Flags R1 – R9 and S1 – S9) denote the Bank of an intermittent stream on the northeast side of the reservoir; and flag series H (Flags H1 – H8) denote the Bank of an intermittent stream on the northwest side of the reservoir. Flag series KBKB (Flags KBKB1 – KBKB17) and KBKC (Flags KBKC1 – KBKC15) denote the Bank of an unnamed perennial stream on the south side of Tack Factory Pond.

Bordering Vegetated Wetland. Under the MA WPA, Bordering Vegetated Wetlands are defined as freshwater wetlands which border on creeks, rivers, streams, ponds and lakes. Bordering Vegetated Wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. Several areas of BVW border on Tack Factory Pond, the Reservoir Dam impoundment, and associated waterways.

Flag series B (Flags B1 – B11) denotes an area of BVW on the south side of the reservoir, north of Sherman Drive. This wetland is a forested wetland dominated by red maple (*Acer rubrum*).

Wetland flag series D (Flags D1 – D35) is a forested, scrub shrub, and emergent wetland located in the southwest corner of the reservoir on the east side of Route 3A. This wetland is dominated by red maple, sweet pepperbush (*Clethra alnifolia*), and cat briar (*Smilax* sp.). Common reed (*Phragmites australis*) dominates the reservoir edge in this area.

Wetland flag series F (Flags F1 – F15), G (Flags G1 – G22), I (Flags I1 – I36), J (Flags J1 – J20), K (Flags K1 – K14), L (Flags L1 – L7), M (Flags M1 – M4), and O (Flags O1 – O18) denote a forested wetland complex on the northwest side of the reservoir on the east side of Route 3A. This complex is a

forested wetland dominated by red maple, sweet pepperbush and cat briar, with fringes of common reed along the edge of the reservoir in some areas.

Flag series N (Flags N1 – N7 and N100 – N108) and P (Flags P1 – P8) demarcate the boundary of a forested wetland along the northern edge of the reservoir. Dominant species include red maple, sweet pepperbush, and cat briar.

Flags Q (Q1 – Q10 and Q100 – Q121), T (Flags T1 – T19), U (Flags U1 – U10) and V (Flags V1 – V36) identify the boundaries of a forested wetland complex on the northeastern and eastern sides of the reservoir. Dominant species include red maple and sweet pepperbush. Common reed is clustered in areas along the reservoir edge and along the T series flags.

Flag series W (Flags W1 – W7) denotes a fringe forested wetland along the southeast corner of the reservoir, just north of the dam that is dominated by red maple and sweet pepperbush.

Flag series X (Flags X1 – X14) and Y (Flags Y1 – Y16) show the boundary of a forested wetland along the banks of First Herring Brook, just south of the Reservoir Dam impoundment that is dominated by red maple and sweet pepperbush.

Flag series KA (Flags KA1 – KA33), KB (Flags KB1 – KB30), KC (Flags KC1 – KC10), and KD (Flags KD1 – KD14) represent the boundary of a forested wetland complex that borders the north, west, and south sides of Tack Factory Pond on the west side of Route 3A. Dominant wetland vegetation in this complex includes red maple, sweet pepperbush, cat briar, and spicebush (*Lindera benzoin*).

Land Under Water Bodies and Waterways. The MA WPA defines Land under Water Bodies and Waterways (LUW) as the land beneath any creek, river, stream, pond or lake. This land may be composed of organic muck or peat, fine sediments, rocks or bedrock. The land beneath Tack Factory Pond, the Reservoir Dam impoundment, First Herring Brook, the unnamed stream flowing into Tack Factory Pond, and the two intermittent streams flowing into the Reservoir Dam impoundment contain LUW. The landward boundary of LUW is the MALF level which is El. 35.9 feet for the Reservoir Dam impoundment and El. 39.3 ft for Tack Factory Pond. Due to the steepness of the banks associated with First Herring Brook, the unnamed stream flowing into Tack Factory Pond, and the two intermittent streams flowing into Reservoir Dam impoundment, the landward limit of LUW is the flagged locations of Bank.

Bordering Land Subject to Flooding. The Federal Emergency Management Agency (FEMA) is responsible for establishing the flood zone elevation or height of water during certain flood events. FEMA publishes Flood Insurance Rate Maps (FIRMs) showing flood hazard areas. The Flood Maps showing the project site are Maps 25023C0109K and 25023C0117K, both dated November 4, 2016. The 100-year flood is an event that has a 1% probability of occurring in any given year. For Tack Factory Pond and the Reservoir Dam impoundment, FEMA has determined that floodwater will rise to El. 44.0 ft. and El. 42.0 ft., respectively, during the 100-year event. Under the MA WPA, the boundary of Bordering Land Subject to Flooding (BLSF) is the estimated maximum lateral extent of flood water which will result from the 100-year event. The lower boundary of BLSF is the MAFL (aka Top of the Inland Bank) or the landward limit of BVW; and the upper boundary is the limit of the 100-year flood, El. 44.0 ft. and El. 42.0 ft. (NAVD88) for Tack Factory Pond and the Reservoir Dam impoundment, respectively.

Riverfront Area. Under the Massachusetts Wetlands Protection Act, First Herring Brook and the unnamed stream flowing into Tack Factory Pond qualify as perennial streams, a naturally flowing body of water that flows throughout the year. Because they are considered perennial streams, the Riverfront Area designation applies. Under the MA WPA, Riverfront Area is the area of land between a river's mean

annual highwater line and a parallel line measured horizontally 200 feet away. Due to the steep banks of First Herring Brook and the unnamed stream, the Riverfront Area extends 200 feet from the flagged Bank line of these waterways.

Soils

Based on a review of the Plymouth County Soil Survey, flag series B and D along the south side of the reservoir are shown as "Water," (Map Symbol 1) on the soil map. Water areas are listed as containing areas of the hydric Freetown and Swansea soils in bogs, kettles, marshes and swamps.

The Freetown series consists of deep, very poorly drained organic soils that formed in more than 51 inches of highly decomposed organic material. These soils are in bogs that are on lake plains, outwash plains, till plains and moraines. Typically, they have a dark reddish-brown muck surface layer about 2 inches thick over black and dark reddish-brown muck to a depth of 60 inches. The Swansea series consists of very poorly drained organic soils that formed in 16 to 51 inches of highly decomposed organic material over sandy mineral material. These soils are in bogs that are on outwash plains, till plains and moraines. Typically, they have a dark reddish-brown muck surface layer about 2 inches thick over black muck to a depth of 26 inches. The substratum from 26 to 32 inches is light olive gray, loamy coarse sand and from 32 to 60 inches is light olive gray, gravelly coarse sand.

Wetland flag series F, G, I, J, K, L, M, and O are shown to be in an area of Woodbridge Fine Sandy Loam (Map Symbol 311B) on the northwest side of the reservoir, east of Route 3A. The Woodbridge soil series is not considered a hydric or wetland soil but does contain inclusions of the hydric Ridgebury soil in depressions.

The Ridgebury series consists of very deep, poorly and somewhat poorly drained soils on uplands. They formed in glacial till. Typically, these soils have a black sandy loam surface layer 6 inches thick. The mottled subsoil from 6 to 16 inches is olive gray sandy loam. The mottled substratum from 16 to 60 inches is light olive brown and olive sandy loam.

Wetland flag series N and P are located in an area of Freetown Muck (Map Symbol 53A) and Swansea Muck (Map Symbol 51A) on the northern edge of the reservoir. As described above, both of these soil series consist of deep, very poorly drained organic soils that formed in highly decomposed organic material.

Wetland flag series Q, T, and U are located in an area of Brockton Sandy Loam (Map Symbol 48A) on the northeast side of the reservoir. The Brockton series consists of very deep, very poorly drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark brown, organic surface layer 3 inches thick. The subsurface layer from 3 to 14 inches is a mottled, black sandy loam. The upper substratum from 14 to 20 Inches is a gray gravelly loamy sand.

Wetland flag series V and W are located in an area of Norwell Mucky Fine Sandy Loam (Map Symbol 49B) on the eastern edge of the reservoir. The Norwell series consists of very deep, poorly drained soils on uplands. They formed in sandy glacial till. Typically, these soils have a very dark grayish-brown, gravelly sandy loam surface layer 8 inches thick. The mottled subsoil from 8 to 20 inches is mainly dark grayish- brown loamy sand or loamy coarse sand.

Wetland flag series X and Y are located south of the Reservoir Dam impoundment on the west and east sides of First Herring Brook, respectively. Flag series X is located within an area of Newfields Fine Sandy Loam (Map Symbol 427A). The Newfields series consists of very deep, moderately well drained soils and is not considered a hydric soil, but contains inclusions of the hydric Norwell series, described above, in

depressions and drainageways. Flag series Y, located on the east side of First Herring Brook, is located in an area of the hydric Norwell Mucky Fine Sandy Loam (Map Symbol 49B).

Wetland flag series KA is located on the northern side of Tack Factory Pond on the west side of Route 3A in an area of Woodbridge Fine Sandy Loam (Map Symbol 311B) and extends to the west to an area of Brockton Sandy Loam (Map Symbol 47A). As described above, the Woodbridge soils are not considered hydric soils, but contain inclusions of the hydric Ridgebury soil in depressions. The Brockton series consists of very deep, very poorly drained soils on uplands. The Brockton series formed in glacial till. Typically, these soils have a very dark brown, organic surface layer 3 inches thick. The subsurface layer from 3 to 14 inches is a mottled, black sandy loam. The upper substratum from 14 to 20 inches is a gray gravelly loamy sand.

Wetland flag series KB, KC, and KD extend from east to west along the south side of Tack Factory Pond, west of Route 3A. Soils in this area include Brockton Sandy Loam (Map Symbol 47A), Freetown Muck (Map Symbol 53A), Norwell Mucky Fine Sandy Loam (Map Symbol 49A) and Ridgebury Fine Sandy Loam (Map Symbol 71A). All these soils are considered hydric or wetland soils.

5.0 INUNDATION AND WATER LEVEL DATA

A summary of expected water levels in the Reservoir Dam impoundment and Tack Factory Pond with the existing and proposed project operations based on the Water Evaluation and Planning (WEAP) model is presented in Tables D-1 and D-2, respectively.

Table D-1. Reservoir Levels with Existing Project Operation (DEIR Appendix C, Table C-5)

Condition	Reservoir Dam Level (ft. NAVD88)	Tack Factory Pond Level (ft. NAVD88)
Mean Annual Low Flow (MALF)	35.9	39.3
Mean Annual Flood Level (MAFL)	39.8	39.8
100-year Flood (HEC-HMS)	43.6	44.0
100-year Flood (FEMA)	42.0	44.0

Table D-2. Reservoir Levels with Proposed Project Operation (DEIR Appendix C, Table C-6)

Condition	Reservoir Dam Level (ft. NAVD88)	Tack Factory Pond Level (ft. NAVD88)
WEAP Mean Annual Low Flow (MALF)	36.4	39.3
WEAP Mean Annual Flood Level (MAFL)	40.4	40.4
100-year Flood (HEC-HMS)	41.0	43.7
100-year Flood (FEMA)	42.0	44.0

The FEMA 100-year flood level was used to determine BLSF since the HEC-HMS model predicted 100-year flood close to the FEMA levels for the existing conditions in Tack Factory Pond.

Water level and annual inundation frequency data for existing and proposed conditions are presented in DEIR Appendix C. A comparison of Reservoir Dam DPW measured water levels for the 2011-2016 period to the proposed conditions is presented on Figure D-1 with a similar comparison for wet, dry and average hydrologic conditions shown on Figures D-2A, D-2B, and D-2C, respectively. The mean annual flood level for the existing conditions in the Reservoir Dam impoundment and Tack Factory Pond is El. 39.8 ft.

Growing season inundation frequency data for existing and proposed conditions is also provided in DEIR Appendix C. A comparison of the growing season (April 18 – September 30 [165 days]) water level frequency curves from the WEAP model and DPW measurements for existing conditions over 2011-2016 period is presented on Figure D-3A for Reservoir Dam and Figure D-3B for Tack Factory Pond. Water level frequency data for Reservoir Dam and Tack Factory Pond with existing and proposed conditions are summarized in Table D-3 for the growing season and Table D-4 and Table D-5 for each of the April-September growing season months. Changes in the submergence frequency of bordering vegetated wetland impacted by the proposed higher water levels are color coded on Figure D-4 and the enlarged figure of Tack Factory Pond shown on Figure D-5).

Table D-3. Growing Season Water Level Frequency Data

Reservoir/Pond El. ft NAVD 1988	April 18-September 30 2011-2016 Hydrologic Conditions					
	Reservoir Dam			Tack Factory Pond [1)]		
	% Time water level higher than Reservoir		% Change in Submergence	% Time water level higher than Pond Level		% Change in Submergence
	Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions	
40.4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.2	0.00%	16.10%	16.10%	0.00%	16.10%	16.10%
40.0	0.00%	24.76%	24.76%	0.00%	24.76%	24.76%
39.8	0.27%	37.67%	37.39%	0.28%	37.67%	37.39%
39.6	0.46%	47.80%	47.33%	0.47%	47.80%	47.33%
39.4	1.37%	55.15%	53.76%	1.39%	55.15%	53.76%
39.2	7.14%	61.78%	21.43%	100.00%	100.00%	0.00%
38.9	35.16%	71.16%	44.05%	100.00%	100.00%	0.00%

1) Impacted BVW area between El. 39.8 ft – El. 40.0 ft is 206.556 sq. ft.
2) Impacted BVW area between El. 40.0 ft – El. 40.2 ft is 102,953 sq. ft.
3) Impacted BVW area between El. 40.2 ft – El. 40.4 ft is 29,406 sq. ft.
4) Total impacted BVW area (El. 39.8 ft – El. 40.4 ft) around Tack Factory Pond is 338,925 sq. ft.

Table D-4. Monthly Water Level Frequency Data, 2011-2016 Hydrologic Conditions – Reservoir Dam

Reservoir El. ft NAVD 1988	April 18-31			May			June		
	% Time water level higher than Reservoir Elevation		% Change in Submergence Time	% Time water level higher than Reservoir Elevation		% Change in Submergence Time	% Time water level higher than Reservoir Elevation		% Change in Submergence Time
	Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions	
40.4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.2	0.00%	66.11%	66.11%	0.00%	12.90%	12.90%	0.00%	12.22%	12.22%
40.0	0.00%	79.44%	79.44%	0.00%	32.26%	32.26%	0.00%	25.00%	25.00%
39.8	1.68%	84.44%	82.77%	0.00%	54.84%	54.84%	0.00%	51.67%	51.67%
39.6	2.23%	87.22%	84.99%	0.00%	69.35%	69.35%	0.56%	62.78%	62.22%
39.4	5.59%	92.78%	87.19%	0.00%	76.88%	76.88%	2.78%	66.67%	63.89%
39.2	25.70%	95.56%	69.86%	6.99%	88.71%	81.72%	8.89%	75.56%	66.67%
38.9	74.86%	98.89%	24.03%	52.15%	97.31%	45.16%	42.22%	91.67%	49.44%

Reservoir El. ft NAVD 1988	July			August			September		
	% Time water level higher than Reservoir Elevation		% Change in Submergence Time	% Time water level higher than Reservoir Elevation		% Change in Submergence Time	% Time water level higher than Reservoir Elevation		% Change in Submergence Time
	Existing Conditions	Existing Conditions		Existing Conditions	Existing Conditions		Existing Conditions	Existing Conditions	
40.4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.2	0.00%	5.38%	5.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.0	0.00%	8.60%	8.60%	0.00%	3.23%	3.23%	0.00%	0.00%	0.00%
39.8	0.00%	23.66%	23.66%	0.00%	7.53%	7.53%	0.00%	3.89%	3.89%
39.6	0.00%	44.62%	44.62%	0.00%	15.05%	15.05%	0.00%	7.78%	7.78%
39.4	0.00%	62.90%	62.90%	0.00%	17.20%	17.20%	0.00%	14.44%	14.44%
39.2	1.64%	70.43%	35.46%	0.00%	20.43%	20.43%	0.00%	20.00%	20.00%
38.9	25.14%	80.65%	71.90%	4.86%	29.57%	24.71%	12.29%	28.89%	16.60%

Table D-5. Monthly Water Level Frequency Data, 2011-2016 Hydrologic Conditions – Tack Factory Pond

Pond El. ft NAVD 1988	April 18-31			May			June		
	% Time water level higher than Reservoir Elevation		% Change in Submergence Time	% Time water level higher than Pond Elevation		% Change in Submergence Time	% Time water level higher than Pond Elevation		% Change in Submergence Time
	Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions	
40.4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.2	0.00%	66.11%	66.11%	0.00%	12.90%	12.90%	0.00%	12.22%	12.22%
40.0	0.00%	79.44%	79.44%	0.00%	32.26%	32.26%	0.00%	25.00%	25.00%
39.8	1.68%	84.44%	82.77%	0.00%	54.84%	54.84%	0.00%	51.67%	51.67%
39.6	2.23%	87.22%	84.99%	0.00%	69.35%	69.35%	0.56%	62.78%	62.22%
39.4	5.59%	92.78%	87.19%	0.00%	76.88%	76.88%	2.78%	66.67%	63.89%
39.3	100.00%	100.00%	0.00%	100.00%	100.00%	0.00%	100.00%	100.00%	0.00%

Pond El. ft NAVD 1988	July			August			September		
	% Time water level higher than Pond Elevation		% Change in Submergence Time	% Time water level higher than Pond Elevation		% Change in Submergence Time	% Time water level higher than Pond Elevation		% Change in Submergence Time
	Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions		Existing Conditions	Proposed Conditions	
40.4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.2	0.00%	5.38%	5.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40.0	0.00%	8.60%	8.60%	0.00%	3.23%	3.23%	0.00%	0.00%	0.00%
39.8	0.00%	23.66%	23.66%	0.00%	7.53%	7.53%	0.00%	3.89%	3.89%
39.6	0.00%	44.62%	44.62%	0.00%	15.05%	15.05%	0.00%	7.78%	7.78%
39.4	0.00%	62.90%	62.90%	0.00%	17.20%	17.20%	0.00%	14.44%	14.44%
39.3	100.00%	100.00%	0.00%	100.00%	100.00%	0.00%	100.00%	100.00%	0.00%

6.0 WETLAND PROTECTION ACT RESOURCE AREA IMPACT ASSESSMENT

Tetra Tech's assessment of the five types of wetland resource areas around the Reservoir Dam impoundment and Tack Factory Pond is presented as follows and depicted on Figure D-1.

Bank. Bank lengths were obtained using CAD to measure the length of the Mean Annual Flood Level (MAFL) around the Reservoir Dam impoundment and Tack Factory Pond. The length of Bank along the unnamed perennial stream on the south side of Tack Factory Pond and the two intermittent streams flowing into the Reservoir Dam impoundment are derived from field flagging. The Bank of First Herring Brook upstream of Tack Factory Pond is based on field flagging. The existing Bank length is 12,348 linear feet (ft.) long. Since the proposed MAFL (El. 40.4) will be above the first break in slope associated with all but the western and southern side of Tack Factory Pond, there will be no change in the upper limit of Bank in those areas. Along the western and southern side of Tack Factory Pond the upper limit of Bank will move to the proposed MAFL, elevation 40.4 ft. This will result in a decrease of 169 ft. of Bank for a total Bank length of 12,179 ft.

Bordering Vegetated Wetlands. The existing BVW resource area was calculated using CAD techniques to determine the area between top of Bank and the delineated wetlands flags. The existing BVW area is 1,599,660 sq. ft. At locations where the top of Bank will move into existing BVW with the proposed project, the BVW resource will be reclassified as Bank. The area of BVW to be reclassified as Bank for the proposed project was calculated using CAD techniques to determine the difference in area between the existing top of Bank and the proposed top of Bank. The BVW area to be converted to Bank is 338,925 sq. ft. resulting in a proposed BVW resource area of 1,260,735 sq. ft.

Land under Water Bodies and Waterways. The landward boundary of the existing LUW is the MALF level, which is approximately El. 35.9 ft. for the Reservoir Dam impoundment, with approximately 52.1 acres of LUW below that elevation. Tack Factory Pond has an existing MALF El. 39.3 ft., or 7.9 acres of LUW for a total existing LUW of 60.0 acres. Under proposed conditions the MALF level of the Reservoir Dam impoundment would be El. 36.4 ft. resulting in 60.8 acres of LUW, or a net gain of 8.7 acres. The proposed project would not change the Tack Factory Pond MALF and LUW. The total proposed LUW would be 68.7 acres, or an increase of 8.7 acres. Land Underwater of First Herring Brook, the unnamed perennial stream associated with Tack Factory Pond, and the intermittent streams of Reservoir Dam would not be impacted due to no change to the current lower limits of Bank.

Bordering Land Subject to Flooding. The Bordering Land Subject to Flooding (BLSF) around the Reservoir Dam impoundment has been estimated using CAD techniques to determine the area between the lower and upper boundaries. The lower boundary of BLSF is the MAFL (aka Top of Inland Bank) or landward limit of BVW, whichever is higher; the upper boundary is the limit of the 100-year flood, El. 44.0 ft. and El. 42.0 ft. for Tack Factory Pond and the Reservoir Dam impoundment, respectively. The BLSF would not be affected by the proposed Project and would be 301,814 sq. ft. for Tack Factory Pond and 93.569 sq. ft. for Reservoir Dam (432,494 sq. ft. total) for existing and proposed conditions.

Riverfront Area (RA). The Riverfront Area was measured using CAD techniques as the area of the 200 ft. setback from Bank associated with perennial streams, which is coincident with the Mean Annual High Water (MAHW) line of First Herring Brook upstream of Tack Factory Pond and downstream of the Reservoir Dam spillway as well as the unnamed perennial stream flowing into Tack Factory Pond. The existing Riverfront Area within the project area is 455,736 sq. ft. Raising the MAFL to El. 40.4 decreases RA by 108,622 sq. ft.

Figures D-4 and D-5 show the existing and proposed wetland resource area limits with labels identifying CAD measurements and changes in the wetland resources resulting from the proposed project.

Other Resource Areas

The project area is not located within Natural Heritage and Endangered Species Program (NHESP) mapped Priority Habitat of Rare Species or Estimated Habitat of Rare Wildlife. No evidence of vernal pools was observed during our site investigation of the project area.

Conclusion

Wetland Resource Area Impacts. WPA resource areas will change. Most significantly this will involve; the conversion of BVW to Bank, a minimal reduction of Bank and RA, and an increase in LUW; the functionality of the resource areas will be maintained.

Although a substantial area of BVW will be technically converted to Bank during certain operational scenarios, this area is anticipated to remain vegetated and will effectively continue to function as BVW. The area will maintain functions of BVW although a portion that is inundated more frequently may change to "wetter" plant species (see discussion in Section 8).

Bank will technically be reduced, however, the "lost" Bank is associated with the waterways of Tack Factory Pond. These Banks do not contain significant habitat characteristics and during low flow periods will be present as it is now

The reduction of RA will occur within areas of existing BVW and/or protected open space, therefore no alteration to the interests of RA will be affected.

The increase in LUW is associated with the increased storage of Reservoir Dam thus raising the lower limit of Bank. The area proposed for conversion from Bank to LUW is gently sloping and due to public water supply demand, regularly exposed during the later portion of the growing season. The increase in LUW will provide additional habitat for aquatic species and is expected to have a beneficial ecological impact.

7.0 WETLAND TRANSECT VEGETATION ASSESSMENT METHODOLOGY

Development of Methodology

In response to the Certificate and DEP comments Tetra Tech developed a proposed vegetation impact analysis methodology and submitted it to DEP for comments. DEP provided comments and Tetra Tech responded to the comments (refer to Attachment 1). As a result, Tetra Tech proceeded with the following methodology:

- Establish one transect along a low gradient wetland area at the Reservoir Dam impoundment and Tack Factory Pond (light blue lines shown on Figure D-6). Low gradient transects are proposed because this is where the greatest alterations of wetland resource areas are likely to occur.
- Inventory trees within approximately five-feet of transect between El. 45.0 ft [Upper limit of El. 45.0 ft is proposed because the proposed normal pool is El. 40.4 ft, changes are not anticipated above El. 45.0 ft] and existing open water. The inventory includes species identification, diameter

at breast height, approximate height (clinometer based), general health, and attachment of aluminum ID tags for future reference.

- Inventory shrubs growing within approximately five-feet of transect El. 45.0 ft and existing open water, record species, approximate height, general health, and attach aluminum ID tag for future reference. [Note: effort to identify water community (e.g. buttonbush) characteristics will occur during frozen conditions.] Due to the sheer numbers of sweet pepperbush (*Clethra alinfolia*) and button bush (*Cephalanthus occidentalis*) within portions of the transects, individuals were not inventoried, only general conditions were noted, and the areas depicted on the figures.
- Inventory ground cover within a five-foot radius plot at the approximate midway point between upper and lower one-foot contours based on LIDAR data along transect between El. 45.0 ft and existing open water, record species and percent cover, and mark plot locations with pin flags for future reference. [Note: effort to identify water community (e.g. deep marsh) characteristics will occur during frozen conditions.]
- Inventoried trees, shrubs, and ground cover center point of plots will be GPS located, groundcover plots will be photographed.
- Identify existing community types (forested, scrub/shrub, etc.) based on aerial photographs and site visits.
- Using monthly intervals during the growing season (Growing season is presumed to be between April 18 and October 30, based on NOAA mean date of last and first occurrence of 28 degrees F at Plymouth.), correlate existing mapped vegetation communities to inundation durations and proposed inundation duration, both on a foot to foot basis.
- Review inundation data and provide a narrative on anticipated changes in habitat types and resource impacts. This will be based on the presumption of consistent soil types of USDA NRCS loamy very fine sand and finer within the "altered" area.
- Provide the mean annual flood level and the mean annual low flow level based on modeling data for the existing Reservoir Dam impoundment and Tack Factory Pond as well as for proposed conditions.

Results of Wetland Vegetation Transect Assessment

The wetland vegetation transect assessment was conducted to document existing vegetation between "water" limit of woody vegetation and the proposed upper MAFL. This information not only documents existing conditions but will serve as a baseline for comparison of changes that may occur associated with the Project's potential effects that increased inundation may have on plant communities. Tetra Tech wetland scientists conducted the vegetation/habitat inventory on 2018-DEC-17, 2019-JAN-14, and 2019-JAN-23. During the December site visit; tree, shrub, and groundcover inventories were conducted along the Reservoir Dam transect and approximately the "upper" half of the Tack Factory Pond transect, the "lower" half of the Tack Factory Pond transect could not be accessed due to deep unfrozen muck soil and water.

The January 14th site visit was conducted after a hard freeze with the anticipation of being able to safely access the areas of deep muck and water, however, site conditions were not adequately stable to access the remaining "lower" portion of the Tack Factory Pond transect. Because of January 14th field conditions, efforts were redirected to locating the representative boundary between forested, scrub/shrub, and/or emergent wetland habitats along the southern portion of Tack Factory Pond. On the January 23rd site visit, the vegetation inventory of the "lower" portion of the Tack Factory Pond transect was completed.

The species, general health condition, height, wetland indicator status, diameter at breast height (for trees) of the trees and shrubs inventoried along the transects are presented in Attachment 2. Inventory results of groundcover plots are presented in Attachment 3.

In total 40 trees were inventoried along the two transects, 24 along the Reservoir Dam transect and 16 along the Tack Factory Pond transect. Along the approximately upper 230 feet of the Tack Factory Pond transect uniform coverage of sweet pepperbush exists, due to the number of shrubs those sweet pepperbushes were not inventoried. Similarly, along the approximately lower 90 feet of the Tack Factory Pond transect individual buttonbushes were also not surveyed due to uniform coverage. However, other shrub species encountered along those segments were inventoried. In addition, due to deep water/thin ice several buttonbushes were not inventoried at the lower limit of the Reservoir Dam transect.

Tree and shrub species along with their wetland indicator status along the transects are shown in Figures D-7 and D-8, as are groundcover plot locations. Vegetated wetland cover type mapping developed using the transects information along with aerial photo interpretation and limited ground truthing are depicted on Figure D-9 for Tack Factory Pond and Figures D-10A through D-10D for Reservoir Dam. These cover types are classified according to the USFWS Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979).

8.0 WETLAND HABITAT IMPACT ASSESSMENT

Reservoir Dam Impoundment. The Reservoir Dam impoundment is bound by a relatively narrow band of vegetated wetland along the northwestern and eastern areas. In contrast, the northeastern portion is bound by a relatively wide sloping wetland. The wetlands adjacent to the reservoir typically include a band of buttonbush at the lower elevations (below existing MAFL) and abruptly grade into forested wetland dominated by red maple (*Acer rubrum*) trees with an understory dominated by sweet pepperbush and based on transect data highbush blueberry (*Vaccinium corymbosum*). The southwestern and southern areas are generally bound by upland forest with a few discrete areas of forested wetland habitat and common reed (*Phragmites australis*) dominated wetlands.

Tack Factory Pond. In general, except for the eastern shore and a portion of the northern shore, Tack Factory Pond is bordered by a broad and relatively flat vegetated wetland. The water side of the wetland consists of scrub shrub habitat with a uniform stand of buttonbush grading to a mix of red maple (*Acer rubrum*), gray birch (*Betula populifolia*) saplings, alder (*Alnus incana*), highbush blueberry, and sweet pepperbush. Beyond the scrub shrub habitat, the wetland consists of forested habitat dominated by red maple trees with a predominant understory of sweet pepperbush.

As presented in Tables D-3 and depicted on Figures D-11 and D-12, the total growing season submergence period for areas between elevation 40.0 and 40.4 will increase between 16 to 25 percent or 26 to 41 days. This area generally consists of forest habitat growing on poorly drained or very poorly drained soils and meet the saturated water regime modifier (Cowardin *et al.* 1979). Areas between 39.8 and 40.0 will experience an increased growing season submergence period of 37 percent or 61 days (Table D-3 and Figures D-11 and D-12). This area is generally dominated by scrub shrub habitat, along with a minor component of forest habitat, both growing on poorly to very poorly drained soil meeting the Cowardin *et al.* (1979) saturated water regime modifier. Vegetated areas below El. 39.8 ft is generally dominated by stands of buttonbush along with relatively minor amounts of sweet pepperbush, alder, and red maple.

Discussion

It is generally accepted that increased inundation during the non-growing season (the dormant period) has no or little impact on the survivability of existing wetland woody plant species (Klimas, 1982, Frye and Grosse, 1992), therefore, this habitat impact assessment is focused on the growing season (April 18 – September 30 [165 days]).

As documented by Garssen et al. (2015), increased periods of inundation and/or periods of soil saturation (for discussion purposes this will be referred to as "submergence period") can result in a shift of plant species and/or habitats. As presented in the Section 5.0, some currently vegetated habitats will be subject to anincrease in a submergence period, others will experience an increase in submergence period of a much shorter duration and may have little or no effect on habitat. The total areas of submergence are identified onFigure D-5 and Table D-3,and subjectively indicate areas that may or may not have changes in habitat.

Community Structure – Forest Habitat. Water levels in red maple swamps are known to fluctuate considerably in elevation as well as duration. In one study of red maple swamps of Rhode Island, levels were as high as 7.8 inches above the ground surface and remained at the soil surface for a significant portion of the growing season (Golet *et al.* 1993). In Lowry's study (Lowry, 1984) most of the red maple swamps met the definition of seasonally flooded as defined by Cowardin et al. (1979) and had surface water present through June of most years. Golet *et al*. (1993) also note that in a study by Malecki et al. (1983) that after increasing inundation depths by 27-30 cm from mid-March through late June or early July, the frequency of major tree species did not change over a 12-year study period. In addition, according to the New Hampshire Department of Environmental Services (NHDES, 2005) red maple swamps occur where soils are saturated or flooded through early summer. Thunhorst (1993) states that appropriate growing conditions for red maple include areas that are irregularly to seasonally inundated or saturated up to 25 percent of the growing season. Klimas (1982) notes in a study by Gill (1970) that flooding a site for up to 40 percent of the growing seasons does not affect the establishment of woody species. For water levels above El. 39.8 ft in Tack Factory Pond, inundation will not be greater than 40 percent of the growing season (see Table D-3). Therefore, a significant impact on the recruitment of woody species above El. 39.8 ft is not anticipated.

Proposed submergence period above El. 40.0 ft is not anticipated to exceed 25 percent of the total growing season. Although significant increases in total submergence duration will occur during the early portion of the growing season on a monthly basis (Table D-5), submergence will not necessarily occur continuously, but rather periodically based on climatic conditions (storm events).

Community Structure – Scrub Shrub Habitat. Scrub shrub habitat associated with the reservoir is generally limited to a relatively narrow band and generally dominated by buttonbush. In Tack Factory Pond relatively large expanses of scrub shrub habitat occur, including significant stands of buttonbush. Areas vegetated with buttonbush will experience the greatest increase in submergence periods, however, buttonbush has been shown capable of surviving seasonal to permanent inundation of up to three feet (Slaughter, et al., 2010 and Thunhorst, 1993). As discussed above, a shift in plant species can result due to increased periods of inundation and/or soil saturation. As mentioned by Golet *et al.*'s (1993) review of Malecki et al.'s (1983) study, certain shrubs, including spicebush (*Lindera benzoin*) and winterberry (*Ilex verticillata*) showed decline with increasing inundation periods during the early growing season, however, other species were favored by the lengthened hydroperiod. Thunhorst (1993) states that swamp azalea (*Rhododendron viscosum*) is suited to areas that are seasonally to regularly inundated or saturated up to 75 percent of the growing season. The lower portions of the non-buttonbush dominated scrub shrub habitat are dominated by red maple saplings, alder, and sweet pepperbush, grading to red maple saplings and highbush blueberry.

The upper portions of the scrub shrub habitat, above elevation 39.8, are not anticipated to exceed 40 percent submergence, so woody species recruitment is not expected to be affected. Elevations below 39.8 are anticipated to exceed 40 percent submergence period, however, these areas are primarily dominated by buttonbush which is a species capable of growing and becoming established in areas with longer inundation periods.

Community Structure – Emergent Habitat. Emergent habitat subject to increased submergence is limited to a relatively small area in the southwest portion of Reservoir Dam that is dominated by cattail (*Typha* sp.) and common reed and a relatively small area of common reed along the reservoir's eastern shore. Increased submergence time may affect the ability of common reed to survive.

Conclusion

Considering the above, the increased submergence period is not anticipated to have a significant effect on the forested habitat. However, it may have an effect on the scrub shrub habitat by shifting it towards plant species more tolerant of deeper, longer duration or more frequent inundation.

9.0 SUMMARY

The Reservoir Dam Water Storage and Fish Passage Improvement Project will result in the conversion of WPA regulated wetland resource areas to other resource areas, and an increase or decrease in the amount of specific wetland resource areas along with potential changes in species presence, specifically:

- Bank will be reduced by 169 linear feet.
- 338,925 sq. ft. of Bordering Vegetated Wetland will be reclassified as Bank.
- Land under Water Bodies and Waterways will increase by 8.7 acres.
- No change in Bordering Land Subject to Flooding will occur.
- Riverfront Area will be reduced by 108,622 sq. ft.
- The increase in the spring submergence period is likely to result in a shift toward "wetter" species within scrub shrub habitat.
- WPA resource functions will be similar to existing conditions.

10.0 REFERENCES

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List of Figures

Attachments

Attachment 1	Proposed Vegetation Impact Analysis Methodology
Attachment 2	Transect Inventoried Trees and Shrubs Details
Attachment 3	Transect Groundcover Plot Details

Figure D-1 Comparison of Reservoir Dam DPW Measured Water Levels During 2011-2016 to WEAP Model Proposed Conditions

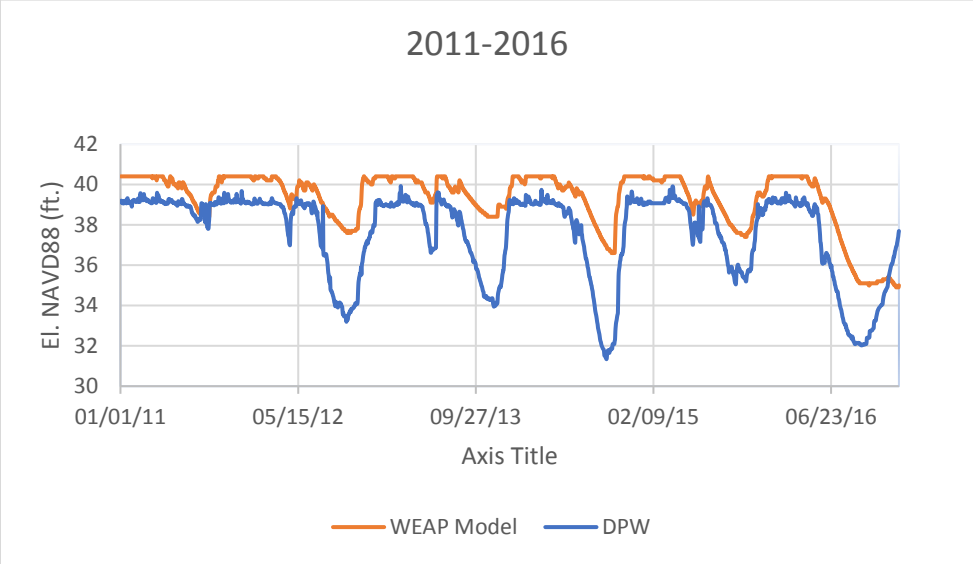


Figure D-2A Comparison of Reservoir Dam DPW Measured Water Levels to WEAP Model Proposed Conditions During 2016 Wet Conditions

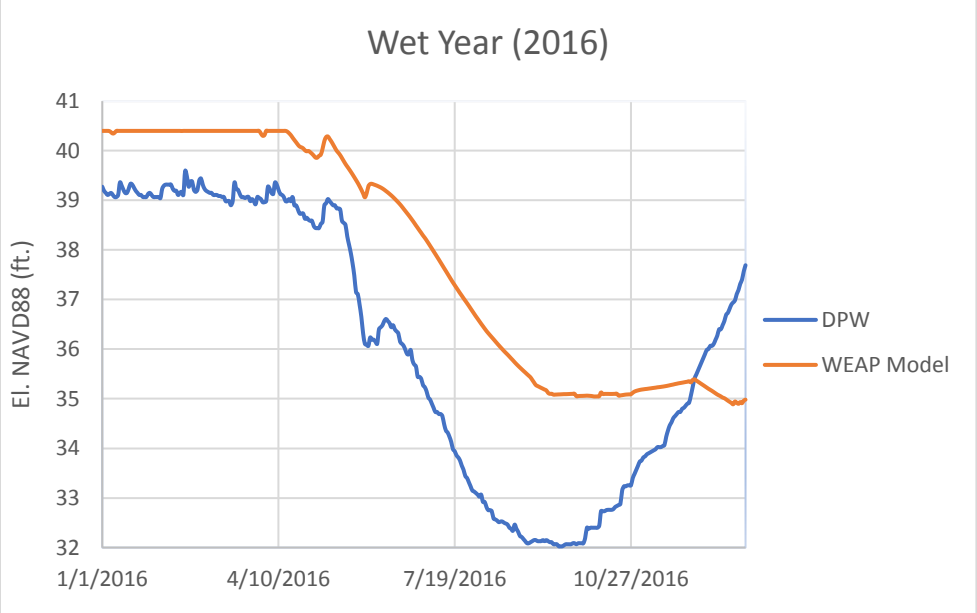


Figure D-2B Comparison of Reservoir Dam DPW Measured Water Levels to WEAP Model Proposed Conditions During 2015 Dry Conditions

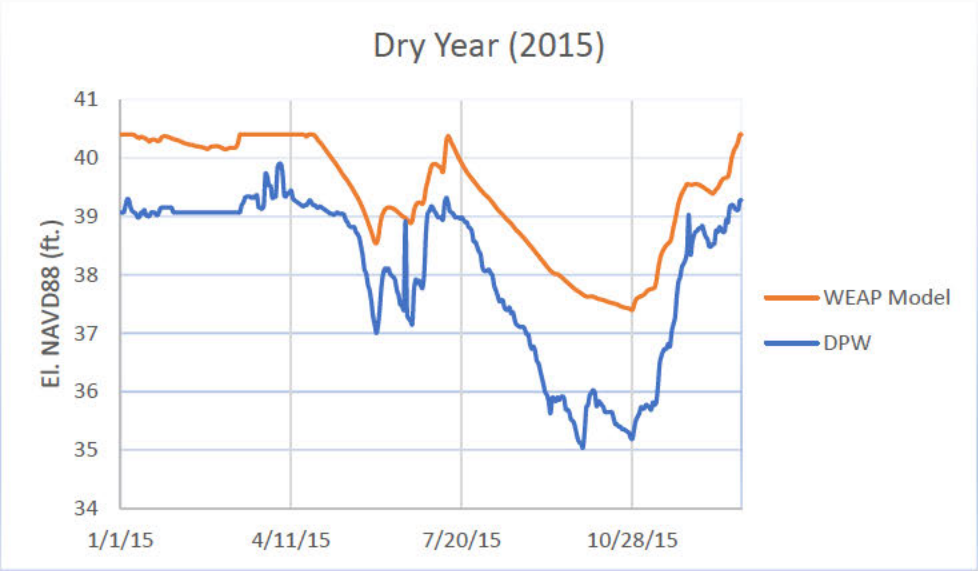


Figure D-2C Comparison of Reservoir Dam DPW Measured Water Levels to WEAP Model Proposed Conditions During 2013 Average Conditions

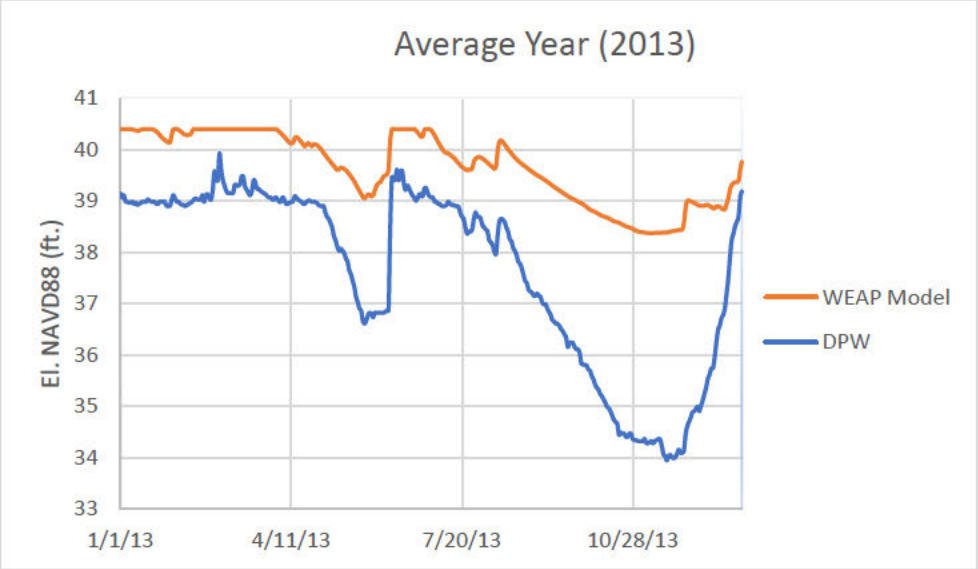


Figure D-3A
Reservoir Dam Growing Season Water Level Frequency Curve with Existing and Proposed Conditions (2011-2016)

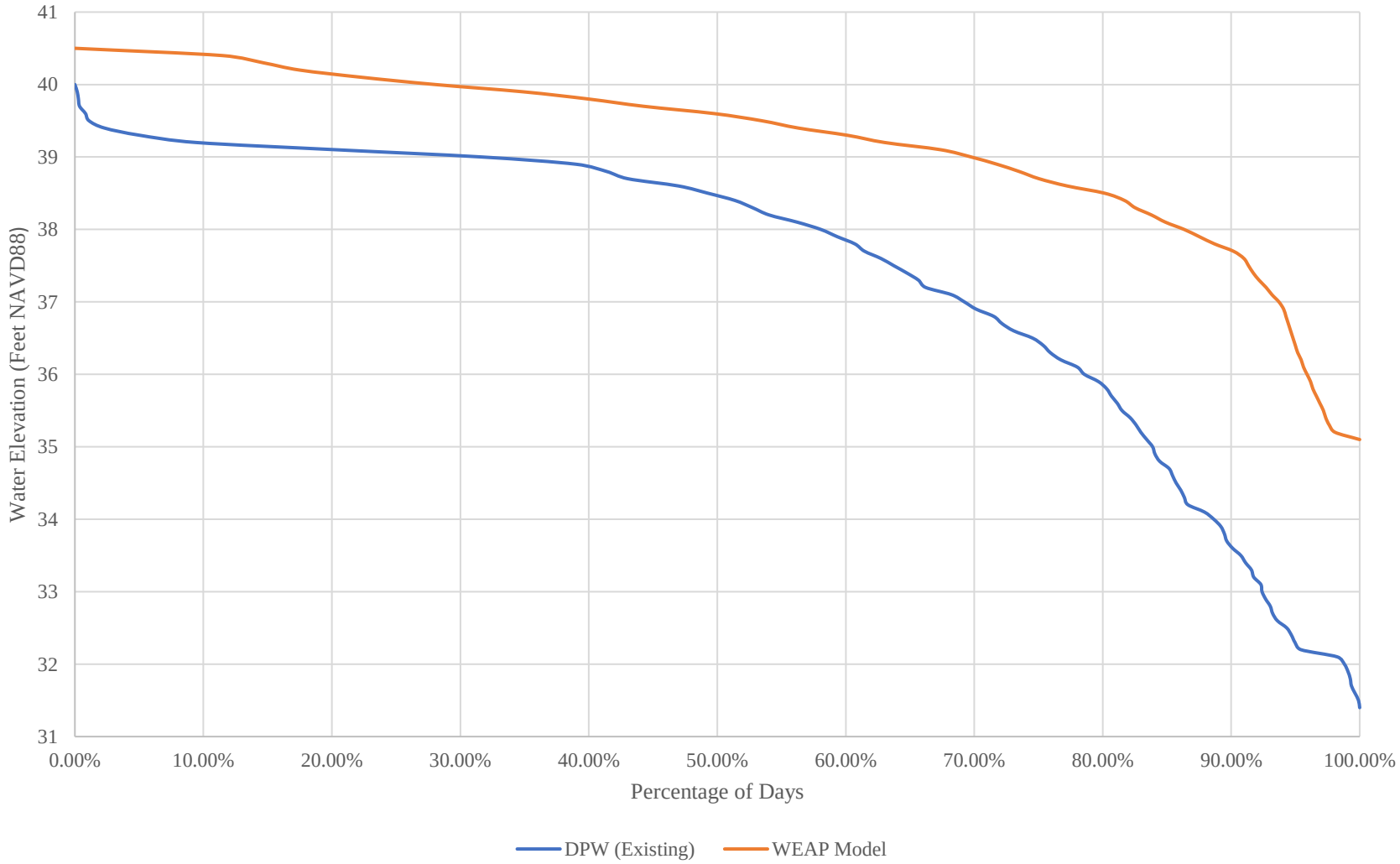
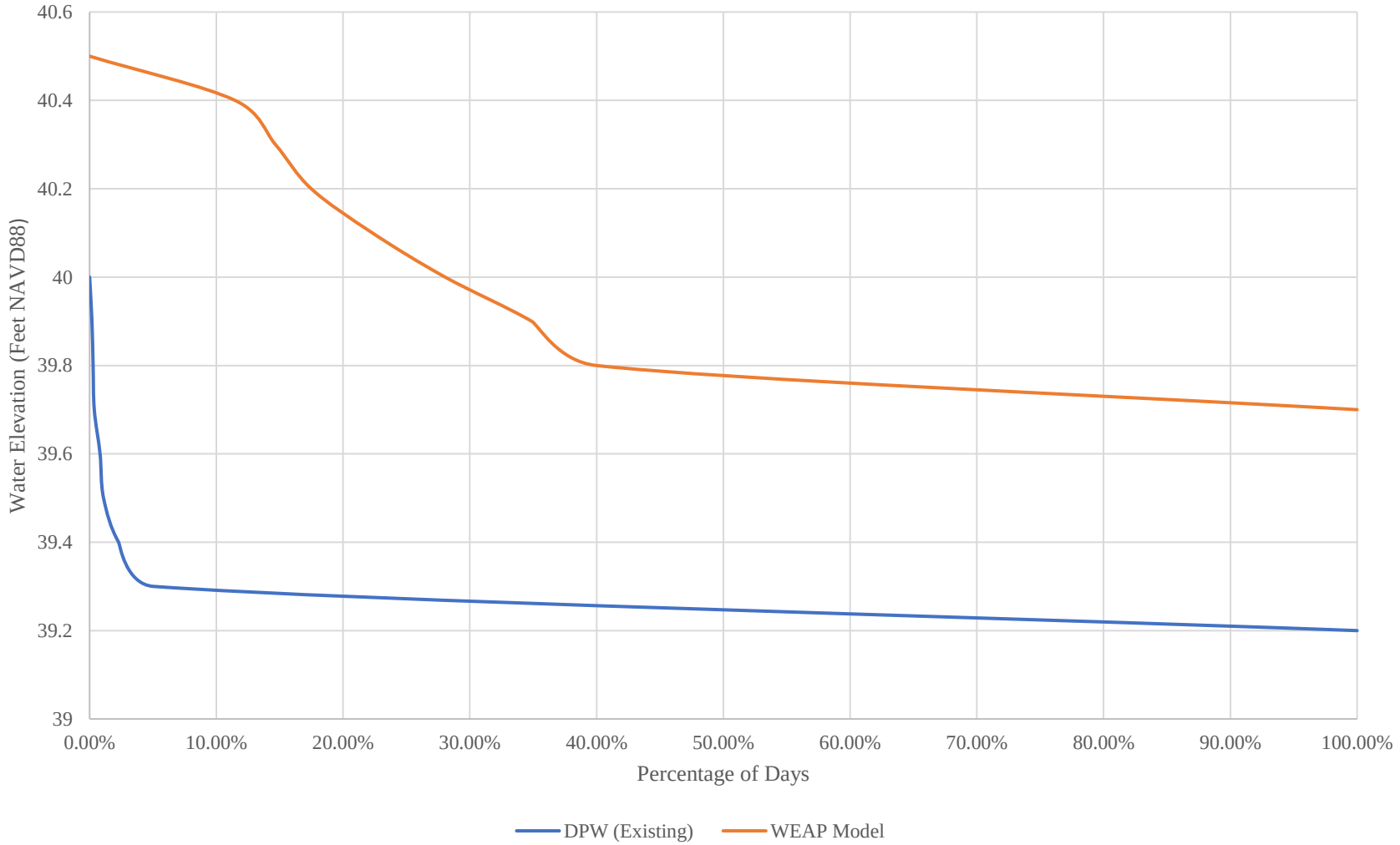


Figure D-3B
Tack Factory Pond Growing Season Water Level Frequency Curve with Existing and Proposed Conditions



LEGEND:

TOTAL EXISTING BVW - 1,599,660 SQ. FT

- TACK FACTORY POND BVW - 695,111 SQ. FT.
- RESERVOIR DAM BVW - 904,549 SQ. FT.
- EXISTING BVW CONVERTED TO BANK - 338,925 SQ. FT.

PROPOSED BVW - 1,260,735 SQ. FT.
(Tack Factory Pond & Reservoir Dam)

	0%	16%	25%	37%
CONTOUR EL. FT. NAVD88	40.4'	40.2'	40.0'	39.8'

EXISTING BVW PERCENT CHANGE IN SUBMERGENCE TIME DURING GROWING SEASON

TOTAL BLSF AREA:

BLSF - 432,494 SQ. FT.

LIMITS OF RIVERFRONT AREA:

RESERVOIR DAM - 144,865 SQ. FT. (EXISTING & PROPOSED)

TACK FACTORY POND - (SEE FIGURE D-9)
310,871 SQ. FT. (EXISTING)
202,249 SQ. FT. (PROPOSED)

TOTAL BANK LENGTHS:

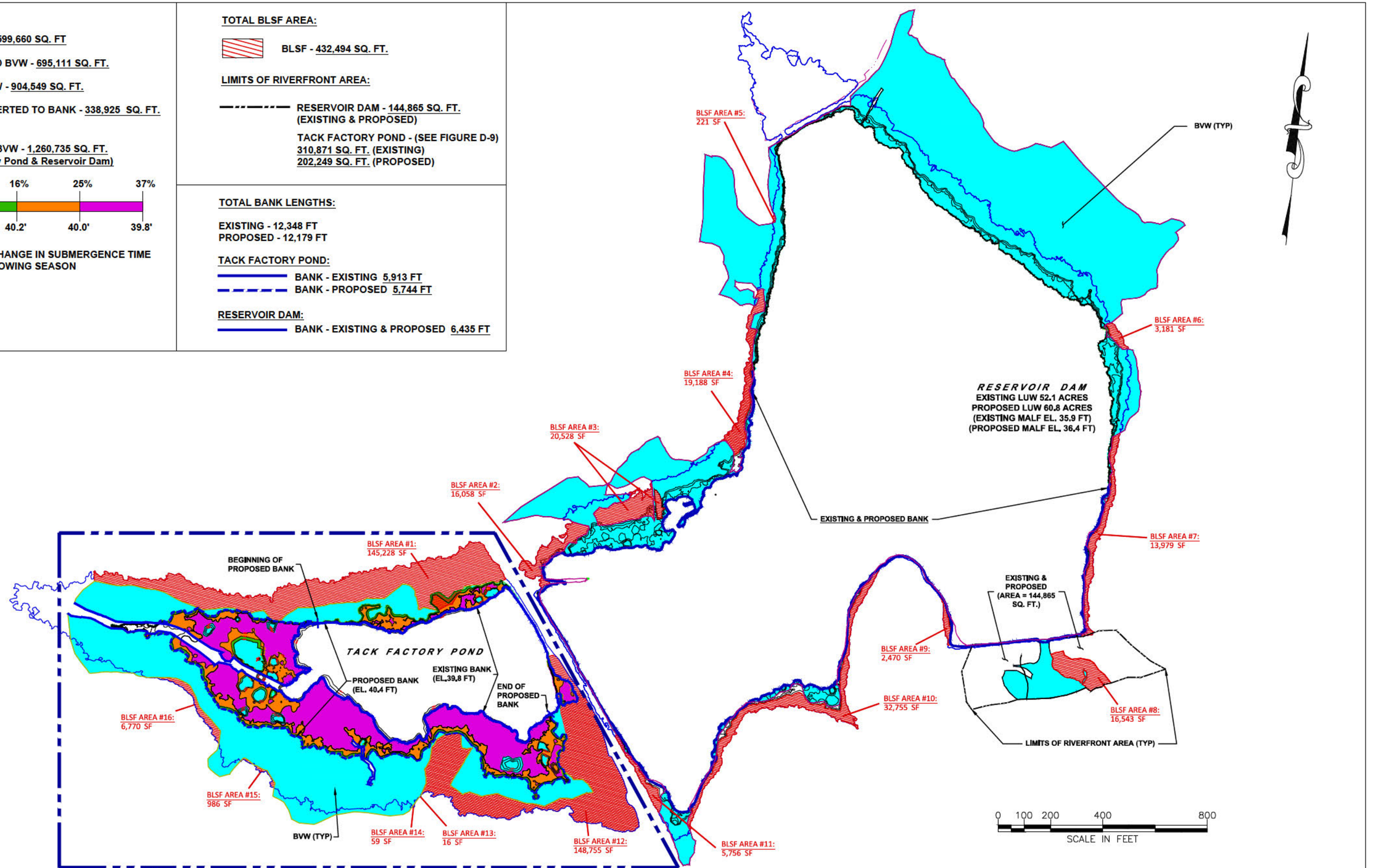
EXISTING - 12,348 FT
PROPOSED - 12,179 FT

TACK FACTORY POND:

BANK - EXISTING 5,913 FT
BANK - PROPOSED 5,744 FT

RESERVOIR DAM:

BANK - EXISTING & PROPOSED 6,435 FT



SEE FIGURE D-5 FOR ENLARGED DETAIL OF TACK FACTORY POND

TETRA TECH
www.tetratech.com
160 FEDERAL STREET, 3RD FLOOR
BOSTON, MA 02110
TEL: (617) 443-7500 FAX: (617) 737-3480

MARK	DATE	DESCRIPTION	BY
-	-	-	-

Reservoir Dam Water Storage and Fish Passage Improvement Project
Scituate, Plymouth County, Massachusetts

WETLANDS RESOURCE AREA LIMITS AND SUBMERGENCE FREQUENCY CHANGES

Date:	06/17/2019
Project No.:	194-6444
Designed by:	TC/FGM
Drawn by:	FGM
Checked by:	TC

Figure D-4

CAD FILE: WRA Limits_REV A.dwg

LIMITS OF RIVERFRONT AREA (TYP)

PROPOSED (AREA = 62,495 SQ. FT.)

EXISTING (AREA = 76,772 SQ.FT.)

EXISTING & PROPOSED (AREA = 90,370 SQ. FT.)

BEGINNING OF PROPOSED BANK

BLSF AREA #1: 145,228 SF

TACK FACTORY POND
(MALF EL. 39.3 FT, LUW = 7.9 ACRES EXISTING & PROPOSED)

PROPOSED BANK (EL. 40.4 FT)

EXISTING BANK (EL.39.8 FT)

END OF PROPOSED BANK

BLSF AREA #16: 6,770 SF

BVW (TYP)

BLSF AREA #15: 986 SF

LIMITS OF RIVERFRONT AREA (TYP)

EXISTING (AREA = 39,489 SQ.FT.)

EXISTING (AREA = 41,745 SQ.FT.)

PROPOSED (AREA = 21,171 SQ.FT.)

PROPOSED (AREA = 28,213 SQ.FT.)

BLSF AREA #14: 59 SF

BLSF AREA #13: 16 SF

BLSF AREA #12: 148,755 SF

0 100 200
SCALE IN FEET

LEGEND:

EXISTING BVW - 695,111 SQ. FT
EXISTING BVW CONVERTED TO BANK - 338,925 SQ. FT.

PROPOSED BVW - 356,186 SQ. FT.

CONTOUR EL. FT. NAVD88

0%	16%	25%	37%
40.4'	40.2'	40.0'	39.8'

EXISTING BVW PERCENT CHANGE IN SUBMERGENCE TIME DURING GROWING SEASON

BLSF - 301,814 SQ. FT.

BANK - EXISTING 5,913 FT
BANK - PROPOSED 5,744 FT

LIMITS OF RIVERFRONT AREA
310,871 SQ. FT. (EXISTING)
202,249 SQ. FT. (PROPOSED)

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MARK	DATE	DESCRIPTION	BY
-	-	-	-

Reservoir Dam Water Storage and Fish Passage Improvement Project
Scituate, Plymouth County, Massachusetts

TACK FACTORY POND WETLANDS RESOURCE AREA LIMITS AND SUBMERGENCE FREQUENCY CHANGES

Date:	06/17/2019
Project No.:	194-6444
Designed by:	TC/FGM
Drawn by:	FGM
Checked by:	TC

Figure D-5

CAD FILE: WRA Limits_Tack Pond_REV A.dwg

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D6_Wetland_Transect_Locations.mxd

Legend
- Transect Location
- Town Boundary (Survey)

1 inch = 350 feet

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Reservoir Dam Water Storage
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Scituate, Plymouth County Massachusetts

WETLAND TRANSECT LOCATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D6

Date: 7/1/2019
Path: P:\67639\143-67639-17004\GIS\Fig_D7_Reservoir_Transect_Results.mxd

Legend

- Data Plots
- **Vegetation Survey Results - January 29, 2019**
- Shrub, FACU
- Shrub, FAC
- Shrub, FACW
- Shrub, OBL
- Tree, FACU
- Tree, FAC
- Town Boundary (Survey)

1 inch = 30 feet

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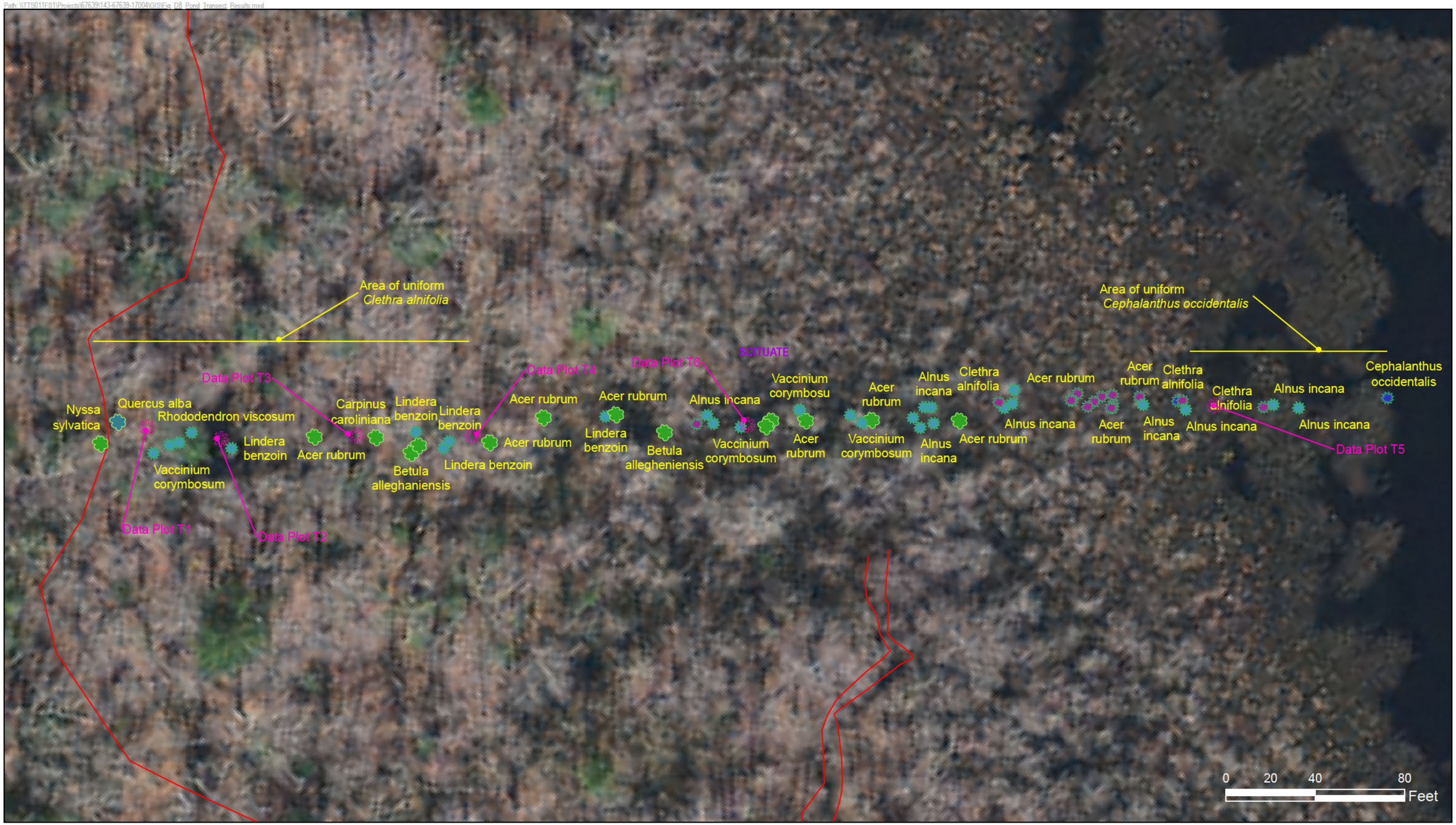
RESEROIVR DAM TRANSECT RESULTS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-7

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D8_Pond_Transect_Results.mxd



Legend

Data Plots

Vegetation Survey Results - January 29, 2019

Shrub, FAC

Shrub, FACW

Shrub, OBL

Tree, FACU

Tree, FAC

Edge of Wetland

Town Boundary (Survey)

1 inch = 40 feet

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TACK FACTORY POND TRANSECT RESULTS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-8

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D9_Pond_Existing_Habitat_Classifications.mxd

Legend

- Forested Wetland
- Emergent Wetland
- Scub Shrub We land
- Town Boundary (Survey)
- Buttonbush (Subset of scrub shrub)

1 inch = 150 feet

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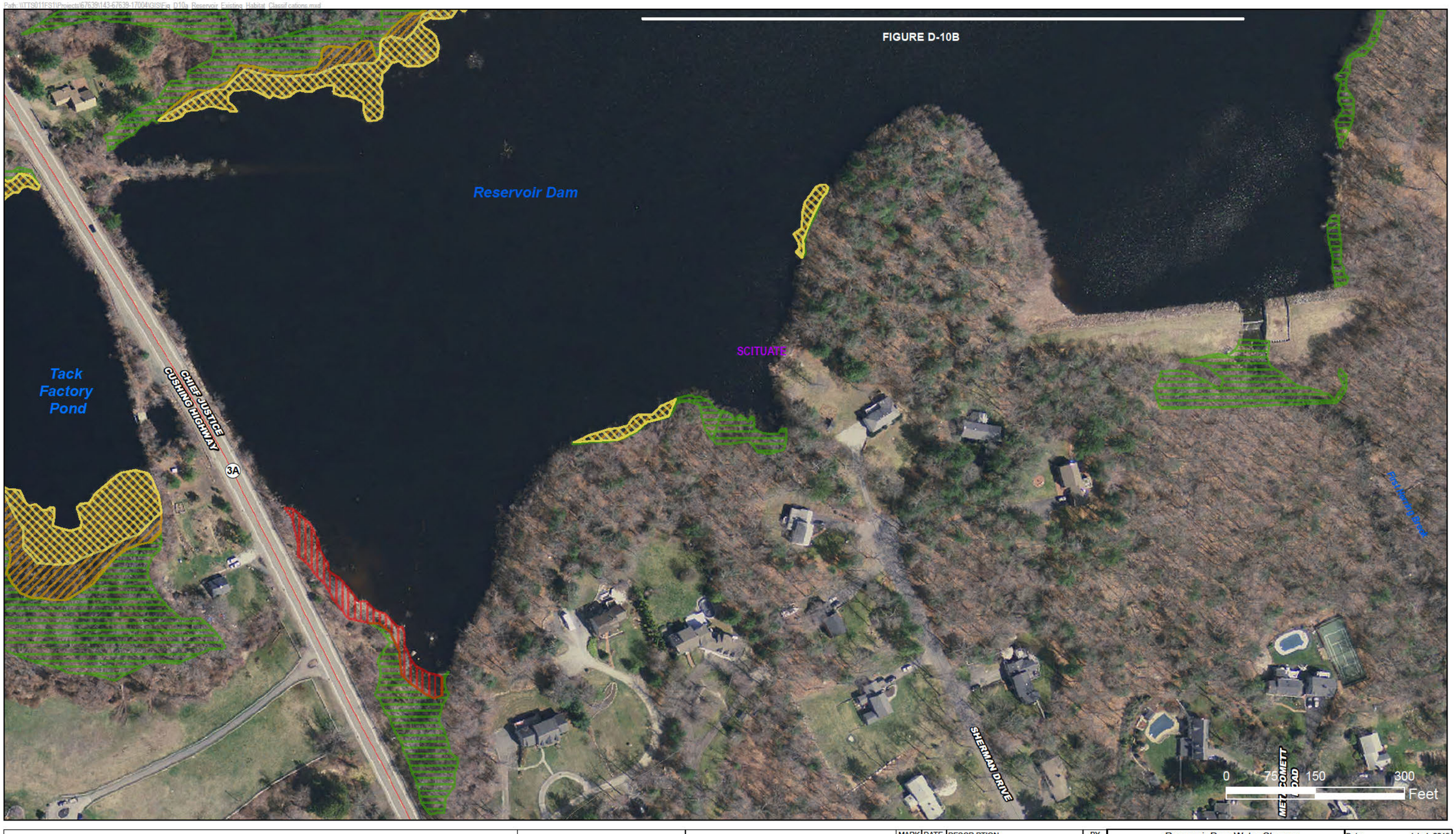
TACK FACTORY POND
EXISTING WETLAND HABITAT CLASSIFICATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-9

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D10a_Reservoir_Existing_Habitat_Classifications.mxd

FIGURE D-10B



Legend

- Forested Wetland
- Emergent Wetland
- Scub Shrub Wetland
- Town Boundary (Survey)
- Buttonbush (Subset of scrub shrub)

1 inch = 150 feet

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RESERVOIR DAM EXISTING WETLAND HABITAT CLASSIFICATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-10A

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D10b_Reservoir_Existing_Habitat_Classifications.mxd

Legend

- Forested Wetland
- Emergent Wetland
- Scub Shrub Wetland
- Town Boundary (Survey)
- Buttonbush (Subset of scrub shrub)

1 inch = 150 feet

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RESERVOIR DAM
EXISTING WETLAND HABITAT
CLASSIFICATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-10B

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D10c_Reservoir_Existing_Habitat_Classifications.mxd

FIGURE D-10B

Legend

- Forested Wetland
- Scub Shrub Wetland
- Buttonbush (Subset of scrub shrub)
- Emergent Wetland
- Town Boundary (Survey)

1 inch = 150 feet

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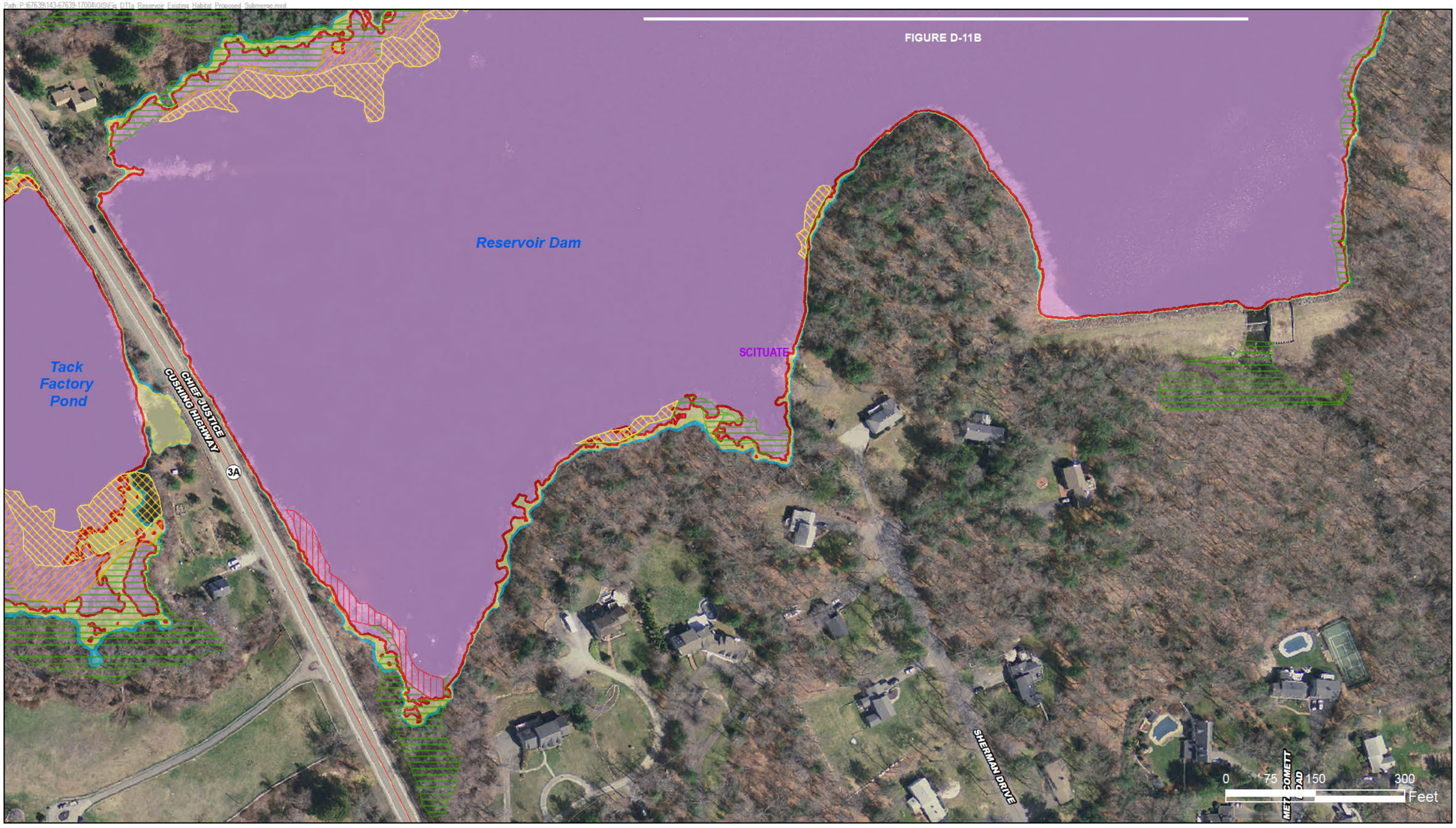
RESERVOIR DAM
EXISTING WETLAND HABITAT CLASSIFICATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-10C

Date: 7/1/2019
Path: P:\67639\143-67639-17004\GIS\Fig_D11a_Reservoir_Existing_Habitat_Proposed_Submerge.mxd

FIGURE D-11B



Legend

Submergence Duration
- 40.4
- 40.2
- 40

- Forested Wetland
- Scub Shrub Wetland
- Buttonbush (Subset of scrub shrub)
- Emergent Wetland
- Town Boundary (Survey)

1 inch = 150 feet

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RESERVOIR DAM
EXISTING WETLAND HABITATS AND PROPOSED SUBMERGENCE DURATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-11A

Date: 7/1/2019
Path: P:\67639\143-67639-17004\GIS\Fig_D11b_Reservoir_Existing_Habitat_Proposed_Submerge.mxd

Legend

Submergence Duration
- 40.4
- 40.2
- 40

- Forested Wetland
- Scub Shrub Wetland
- Buttonbush (Subset of scrub shrub)
- Emergent Wetland
- Town Boundary (Survey)

1 inch = 150 feet

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RESERVOIR DAM
EXISTING WETLAND HABITATS AND PROPOSED SUBMERGENCE DURATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-11B

Date: 7/1/2019
Path: P:\67639\143-67639-17004\GIS\Fig_D11c_Reservoir_Existing_Habitat_Proposed_Submerge.mxd

FIGURE D-11B

Legend

Submergence Duration
- 40.4
- 40.2
- 40

- Forested Wetland
- Scub Shrub Wetland
- Buttonbush (Subset of scrub shrub)
- Emergent Wetland
- Town Boundary (Survey)

1 inch = 150 feet

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RESERVOIR DAM
EXISTING WETLAND HABITATS AND PROPOSED SUBMERGENCE DURATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
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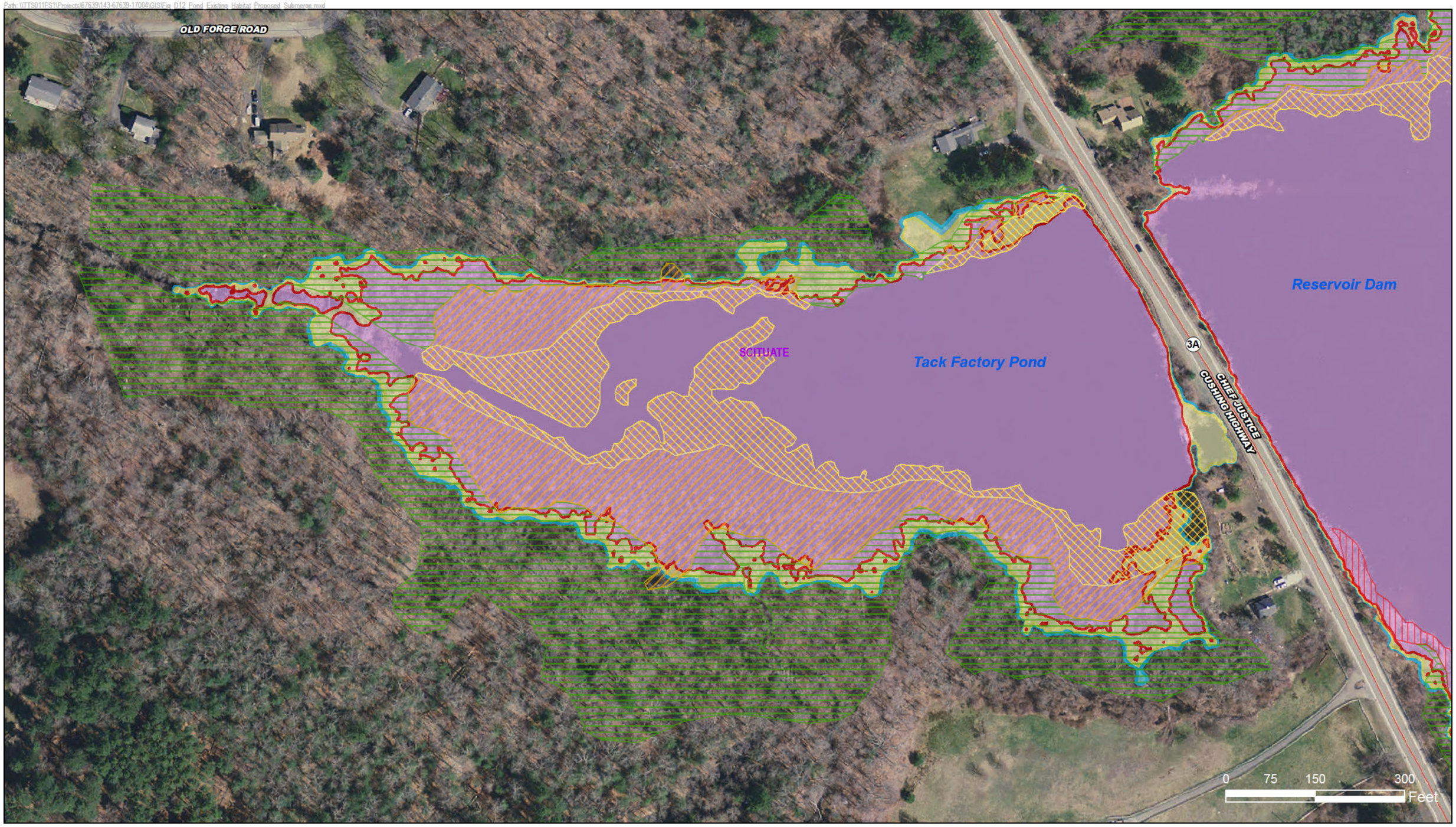
Checked By:	KD

Figure D-11C

Date: 7/1/2019
Path: \\TTS011FS1\Projects\67639\143-67639-17004\GIS\Fig_D12_Pond_Existing_Habitat_Proposed_Submerge.mxd



Legend

Submergence Duration
- 40.4
- 40.2
- 40

- Forested Wetland
- Scub Shrub Wetland
- Buttonbush (Subset of scrub shrub)
- Emergent Wetland
- Town Boundary (Survey)

1 inch = 150 feet

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TACK FACTORY POND
EXISTING WETLAND HABITATS AND PROPOSED SUBMERGENCE DURATIONS

Date:	July 1, 2019
Project No.:	143-67639-17004
Designed By:	SK
Drawn By:	SK
Checked By:	KD

Figure D-12

Attachment 1 Proposed Vegetation Impact Analysis Methodology

TT-INE #143-67639-17004 Scituate Reservoir

Vegetation Impact Analysis

- Establish one transect along a low gradient wetland area at the Scituate Reservoir and Tack Factory Pond (light blue lines on pdf). Low gradient transects are proposed because this is where the greatest alterations are likely to occur.
- Inventory trees within approximately five-feet of transect between elevation 45' [Upper limit of Elevation 45 is proposed because the new Normal Pool elevation is 40.4', changes are not anticipated above 45'] and existing open water, record species, diameter at breast height, approximate height (clinometer based), general health, and attach aluminum ID tag for future reference.
- Inventory shrubs growing within approximately five-feet of transect between elevation 45' and existing open water, record species, approximate height, general health, and attach aluminum ID tag for future reference. [Note: effort to identify water community (e.g. buttonbush) characteristics will occur during frozen conditions.]
- Inventory ground cover within a five-foot radius plot at the approximate midway point between upper and lower one-foot contours based on LIDAR data along transect between elevation 45' and existing open water, record species and percent cover, and mark plot locations with pin flags for future reference. [Note: effort to identify water community (e.g. deep marsh) characteristics will occur during frozen conditions.]
- Inventoried trees, shrubs, and ground cover center point of plots will be GPS located, groundcover plots will be photographed.
- Identify existing community types (forested, scrub/shrub, etc.) based on aerial photographs and site visits.
- Using monthly intervals during the growing season (Growing season is presumed to be between April 18 and October 30, based on NOAA mean date of last and first occurrence of 28 degrees F at Plymouth.), correlate existing mapped vegetation communities to inundation durations and proposed inundation duration, both on a foot to foot basis.
- Review inundation data and provided a narrative on anticipated changes in habitat types and resource impacts. This will be based on the presumption of consistent soil types of USDA NRCS loamy very fine sand and finer within the "altered" area.
- Provide the mean annual flood level and the mean annual low flow level based on modeling data for the existing Scituate Reservoir and Tack Factory Pond as well as for proposed conditions.

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Attachment 2 Trees and Shrubs Inventoried along Transects[1]

ID[2]	SPECIES	HEIGHT (feet)	HEALTH	DBH (inches)	Indicator Status[2]	Comments
	Reservoir Transect					
S18	*Cephalanthus occidentalis*	9.6	good		OBL	
11022	*Acer rubrum*	25.0	good	2.0/3.7/1.9	FAC	clump of three
11023	*Acer rubrum*	15.5	good	2.4	FAC	
11024	*Acer rubrum*	23.5	good	3.2/2.0/1.7	FAC	clump of three
S1	*Cephalanthus occidentalis*	6	declining		OBL	
S2	*Clethra alnifolia*	10.1	good		FAC	6' x 3' patch
11020	*Acer rubrum*	27.78	good	4.5	FAC	
11021	*Acer rubrum*		good	2.5	FAC	
11018	*Acer rubrum*	25.2	good	3.1	FAC	
11017	*Acer rubrum*	32.5	good	4.7	FAC	
11019	*Acer rubrum*	34.9	good	3.3	FAC	
11016	*Betula populifolia*	33.7	good	3.5	FAC	
S3	*Clethra alnifolia*	9.8	good		FAC	10' x 10' patch
S4	*Pinus strobus*	9.6	good		FACU	
11014	*Acer rubrum*	43.3	good	5.4/5.8/4.5/3.8/3.8	FAC	clump of five
11015	*Betula populifolia*	43.1	good	5.6/5.1/5.7	FAC	clump of three
S5	*Vaccinium corymbosum*	8.3	good		FACW	
11013	*Acer rubrum*	49.3	good	5.6	FAC	
S6	*Vaccinium corymbosum*	5.5	good		FACW	
11012	*Pinus strobus*	19.7	good	3.5	FACU	
11011	*Acer rubrum*	40.5	good	6.3	FAC	
11010	*Pinus strobus*	18.2	good	2.4	FACU	

ID[2]	SPECIES	HEIGHT (feet)	HEALTH	DBH (inches)	Indicator Status[2]	Comments
S7	*Vaccinium corymbosum*	4.4	good		FACW	
11009	*Pinus strobus*	16.4	good	3.4	FACU	
11008	*Betula alleghaniensis*	31.9	good	4.0	FAC	
11007	*Nyssa sylvatica*	14.3	fair	2.3	FAC	leaning with side sucker branches
S8	*Viburnum dentatum*	6	fair		FAC	partially knocked over
11006	*Carya sp.*	31.3	good	3.1	FACU	
S9	*Vaccinium corymbosum*	6.3	good		FACW	
S10	*Pinus strobus*	7.4	good		FACU	
11005	*Acer rubrum*	35	good	3.6	FAC	
S11	*Viburnum dentatum*	5.8	fair		FAC	broken branches
S12	*Ligustrum vulgare*	5.8	good		FACU	
S13	*Viburnum dentatum*	14	good		FAC	
S14	*Viburnum dentatum*	13	good		FAC	
S15	*Viburnum dentatum*	5	fair		FAC	broken branches
S16	*Viburnum dentatum*	5	fair		FAC	broken branches
11004	*Acer rubrum*	34.2	fair	4.3	FAC	broken branches
11003	*Acer rubrum*	37.8	poor	2.7	FAC	broken top
11002	*Acer rubrum*	45.8	good	4.2	FAC	
11001	*Fraxinus americana*	28.2	good	2.9	FACU	
	Tack Transect					
T 10	*Cephalanthus occidentalis*	5 feet	Good		OBL	

ID[2]	SPECIES	HEIGHT (feet)	HEALTH	DBH (inches)	Indicator Status[2]	Comments
T 11	*Alnus incana*	7 feet	Good		FACW	
T 12	*Alnus incana*	6 feet	Good		FACW	
T 13	*Clethra alnifolia*	5 feet	Good		FAC	
T 16	*Alnus incana*	8 feet	Good		FACW	
T 15	*Clethra alnifolia*	6 feet	Good		FAC	
T 14	*Cephalanthus occidentalis*	7 feet	Good		OBL	
T 18	*Alnus incana*	9 feet	Good		FACW	
T 17	*Acer rubrum*	12 feet	Good		FAC	
T 23	*Acer rubrum*	11 feet	Fair		FAC	
T 19	*Acer rubrum*	9 feet	Fair		FAC	
T 21	*Clethra alnifolia*	6 feet	Fair		FAC	
T 22	*Clethra alnifolia*	6 feet	Fair		FAC	
T 20	*Acer rubrum*	12 feet	Fair		FAC	
T 24	*Acer rubrum*	15 feet	Fair		FAC	
T 25	*Acer rubrum*	15 feet	Fair		FAC	
T 26	*Acer rubrum*	9 feet	Good		FAC	
T 27	*Acer rubrum*	13 feet	Fair		FAC	
T 28	*Clethra alnifolia*	7 feet	Fair		FAC	
T 29	*Acer rubrum*	15 feet	Fair		FAC	
T 32	*Alnus incana*	15 feet	Good		FACW	
T 31	*Alnus incana*	14 feet	Fair		FACW	
T 30	*Alnus incana*	15 feet	Good		FACW	
T 33	*Clethra alnifolia*	8 feet	Good		FAC	
11035	*Acer rubrum*	38.5	Poor	11	FAC	
T 34	*Alnus incana*	18 feet	Fair		FACW	

ID[2]	SPECIES	HEIGHT (feet)	HEALTH	DBH (inches)	Indicator Status[2]	Comments
T 36	*Alnus incana*	20 feet	Fair		FACW	
T 35	*Alnus incana*	13 feet	Fair		FACW	
T 38	*Alnus incana*	18 feet	Good		FACW	
T 37	*Alnus incana*	16 feet	Fair		FACW	
11036	*Acer rubrum*	28	Poor	9.2/11.4	FAC	
T 39	*Vaccinium corymbosum*	12 feet	Fair		FACW	
T 40	*Vaccinium corymbosum*	13 feet	Fair		FACW	
11037	*Acer rubrum*	29.5	Fair	5.6	FAC	
T 42	*Vaccinium corymbosum*	7 feet	Fair		FACW	
T 41	*Vaccinium corymbosum*	10 feet	Fair		FACW	
11038	*Acer rubrum*	22.7	Poor	3.2	FAC	
11039	*Betula alleghaniensis*	35.1	Fair	5.0	FAC	
T 43	*Vaccinium corymbosum*	12 feet	Fair		FACW	
T 44	*Vaccinium corymbosum*	11 feet	Fair		FACW	
T 45	*Alnus incana*	22 feet	Fair		FACW	
T 46	*Acer rubrum*	15 feet	Good		FAC	
11040	*Betula alleghaniensis*	22.9	Fair	4.2	FAC	
11034	*Acer rubrum*	60.5	fair	10.5	FAC	broken top
T9	*Lindera benzoin*	11	good		FACW	
11033	*Acer rubrum*	43.9	fair	11	FAC	broken top
11032	*Acer rubrum*	59.3	fair	11.3	FAC	broken top
T7	*Lindera benzoin*	11	good		FACW	
T8	*Lindera benzoin*	12	good		FACW	
11030	*Nyssa sylvatica*	19	good	1.7	FAC	
T6	*Lindera benzoin*	15	good		FACW	
11029	*Betula alleghaniensis*	60.4	fair	8.2	FAC	broken tip

ID[2]	SPECIES	HEIGHT (feet)	HEALTH	DBH (inches)	Indicator Status[2]	Comments
11028	*Carpinus caroliniana*	18.5	poor	3.6	FAC	broken top
11027	*Acer rubrum*	94	good	21.0	FAC	
T5	*Lindera benzoin*	13	good		FACW	
T4	*Rhododendron viscosum*	9.8	good		FACW	
T2	*Vaccinium corymbosum*	4.4	declining		FACW	broken branches
T3	*Rhododendron viscosum*	8.8	fair		FACW	main stem broken
T1	*Vaccinium corymbosum*	9.9	good		FACW	
11026	*Quercus alba*	75.5	good	21.9	FACU	
11025	*Nyssa sylvatica*	60.5	good	10.1	FAC	

1 Five-digit number IDs represent trees, "S--" and "T--" represent shrubs.
2 Northcentral and Northeast 2016 National Wetland Plant List (Lichvar, R.W. et al, 2016)

Attachment 3 Groundcover of Plots along Transects[1]

Plot ID	Species	Percent Cover[2]	Indicator Status[3]	Comments
Reservoir Transect				
S1				No groundcover
S2				No groundcover
S3	*Osmundastrum cinnamomeum*	75	FACW	
	Total	**75**		
S4	*Onoclea sensibilis*	40	FACW	
	Athyrium angustum	25	FAC	
	Total	**65**		
S5	*Osmundastrum cinnamomeum*	30	FACW	
	Carex sp.	10	FACW (presumed)	
	Onoclea sensibilis	10	FACW	
	Total	**50**		
Tack Transect				
T5	*Carex stricta*	20	OBL	
	Total	**20**		
T6	*Onoclea sensibilis*	20	FACW	
	Carex stricta	20	OBL	
	Total	**40**		
T4	*Osmundastrum cinnamomeum*	50	FACW	
	Total	**50**		
T3	*Sphagnum*	50		
	Total	**50**		
T2	*Osmundastrum cinnamomeum*	40	FACW	
	Parathelypteris noveboracensis	50	FAC	
	Total	**90**		
T1	*Osmundastrum cinnamomeum*	10	FACW	
	Mitchella repens	10	FACU	
	Total	**20**		

1 Plots are presented beginning at "water's edge" and proceeds upgradient.
2 Although ground cover plots were conducted during winter, little evidence of senesced plants were observed
3 Northcentral and Northeast 2016 National Wetland Plant List (Lichvar, R.W. et al, 2016)