Eagle Dam Removal
Technical Feasibility Study Report Addendum

Wrentham, MA

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and

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WSE Project No. ENG22-14330

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REPORT AMENDMENT

TO:	Charles River Watershed Association and Town of Wrentham
FROM:	Weston & Sampson
DATE:	June 30, 2023
SUBJECT:	Eagle Dam Removal Phase II
	Sub-task 3.5: Amendment to Eagle Dam Removal Technical Feasibility Study, prepared by ESS Group Inc., April 19, 2021

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Introduction

During Fiscal Year 2019, the Town of Wrentham partnered with Charles River Watershed Association (CRWA) and ESS Group Inc. (ESS) to undertake an initial feasibility assessment to identify any major barriers to removing Eagle Dam. The results of this effort are documented in a report titled Eagle Dam Removal Technical Feasibility Study prepared by ESS Group Inc., dated April 19, 2021 ("2021 Eagle Dam Removal Study"). The 2021 Eagle Dam Removal Study documented the following:

- Field Data Collection - site inspection, limited topographic survey, bathymetric survey, wetland delineation, review of potential rare or endangered species.
- Sediment Assessment and Management Recommendations - due diligence review, sediment sampling plan, sample collection and analysis, and management recommendation, if necessary.
- Cultural Assessment - review of the historic significance of the dam within the community.
- Hydrology and Hydraulics - hydrologic and hydraulic modeling of the site, dam impoundment, and the portion of Eagle Brook affected by either dam removal or a lowered spillway elevation.
- Conceptual Renderings – oblique aerial renderings of the impoundment under several water surface lowering scenarios.
- Description of Dam Removal Concept and Cost Estimate.
- Discussion of next steps necessary to inform subsequent project phases.

Since the 2021 Eagle Dam Removal Study was prepared, additional study and evaluation has been completed. This report documents the additional study and evaluation regarding the removal of Eagle Dam supported through the Fiscal Year (FY) 2023 MVP Action Grant for the Town of Wrentham related to the Phase II Feasibility Assessment and Community Outreach for Eagle Dam. This report serves as an addendum to show the work completed that supplements the 2021 Eagle Dam Removal Study related to the following sections:

- 2.0 Field Data Collection
- 4.0 Cultural Resources
- 5.0 Hydrologic and Hydraulic Analysis
- 7.2 Permit Identification
- 8.0 Next Steps

Note that sections 3.0, Sediment Assessment, 6.0 Conceptual Renderings, and 7.1 Description of Dam Removal Alternative and Conceptual Design and 7.3 Cost Estimate, were not part of the FY23 MVP Action Grant scope.

2.0 Field Data Collection

Summary of Previous Work

The 2021 Eagle Dam Removal Study reviewed the topography of the area, which was determined to be steeply sloping, well sorted glacial gravel and sand deposits. The 2021 Eagle Dam Removal Study also included a bathymetric survey of the dam impoundment to determine the elevations in the

impoundments and the water depth. Additionally, a site visit and dam site review were conducted to further evaluate the area and dam.

The 2021 Eagle Dam Removal Study also included a habitat assessment and wetland delineation in the anticipated work zone. Wetlands identified in the impoundment include one small, forested wetland. No Bordering Vegetative Wetlands were identified in the anticipated work sone due to steep slopes and presence of retaining walls. A 100-ft buffer from the Bank and a 200-ft Riverfront Area were identified associated with Eagle Brook. The anticipated work zone area is also contained within the 100-year floodplain. The habitat assessment showed evidence of beaver presence, reported populations of 10 warm water fish of interest to anglers, and a diverse selection of warmwater species including Bridle Shiner, which is a species of special concern in Massachusetts. A part of the anticipated work zone is within Priority Habitat 814 (PH 814) and Estimated Habitat 667 (EH 667) as confirmed by the Natural Heritage and Endangered Species Program. One aquatic invasive plant, non-native common reed (*Phragmites australis)* was found to dominate the marsh downstream of the dam and would likely expand with a drawdown of the impoundment. Sampling suggests that the warmer water temperatures in the impoundment negatively affect aquatic habitat quality upstream of the dam.

During Phase I, previously completed, discrepancies between the structural height of Eagle Lake Dam (MA02263)[1] listed in the Inspection/Evaluation Report and the structural height observed in the field were identified. An increase in the structural height can influence both the size and hazard potential classification of the dam.

Update

To supplement this work, additional field work was conducted in February 2023 as a part of the FY 23 MVP Action Grant. On February 24, 2023, Weston & Sampson observed existing conditions and collected relevant elevations. The goal of this work was to verify discrepancies identified in Phase I, update information accordingly, and collect additional information necessary to update the hydraulic and hydrologic model (H&H). Handheld GPS equipment[2] was used to collect the elevations of relevant and accessible structures between Lake Archer in Wrentham and the Main Street crossing in Norfolk. A total of 11 sites along this reach were visited (listed upstream to downstream):

1. The outlet to Lake Archer
2. The outlet to a small pond downstream of Lake Archer
3. Creek Street culvert
4. Red Dam (MA00170)
5. Eagle Lake Dam (MA02263)
6. Route 140 bridge
7. The unnamed dam at Mill Pond
8. The culvert immediately downstream of unnamed dam at Mill Pond
9. Lawrence Street bridge
10. Bush Pond Dam #2 (MA01158)
11. City Mills Pond Dam (MA00818)/Main Street

[1] National Inventory of Dams (NID) Identification Numbering

[2] Trimble TDC600 Handheld Data Collector, used in coordination Trimble R780 Integrated GNSS System, set to U.S. Survey Feet, accurate to 3" +/- (most data points were accurate to 1.2" or better)

The Field Data Collection Index Sheet in Attachment C provides an overview of these sites. Figures 1 through 6 in Attachment C show the specific locations where elevations were collected with the handheld GPS equipment.

At culverts and bridges, where safe, the height and width were measured along with height from invert to road crest. At dams, where safe, height and width of openings were measured and relevant elevations were collected at each structure. For Eagle Lake Dam, several points were collected along the crest of the dam and two points were collected to estimate the spillway elevation as it could not safely be accessed due to flow over the spillway. Elevational data collected at Eagle Dam will be shared with the Office of Dam Safety for their consideration regarding the dam's current classification.

To further support improving the Charles River Flood Model (CRFM) in the Eagle Lake Dam area, elevations were also obtained for one cross section of the channel between Eagle Lake Dam and Route 140. This cross section is located approximately halfway between the dam and Route 140. These spot elevations will be used to add detail to the downstream channel for more reliable model simulation results.

During the site visit, Weston & Sampson also collected Finished Floor Elevations (FFEs) of buildings that could potentially be impacted by flooding caused by larger storm events. These buildings were identified by reviewing the FEMA 100-year flood zones as well as the CRFM model simulation results of the 2070 100-year storm event. Buildings located within or near the flooding extents were visited. The elevation at ground surface was collected using the handheld GPS unit and the FFE was estimated by measuring from the ground surface.

The field data collected will be used to confirm and improve the accuracy of the CRFM. FFEs were used to estimate impacts to a building during a variety of storm events under existing conditions and potential dam removal conditions.

4.0 Cultural Resources

On June 21, 2023, CRWA met with a representative from the Mashpee Wampanoag tribe to discuss the potential for dam removal or dam repairs, and the associated cultural significance of the dam and potential nearby cultural resources. The following summarizes key input from that discussion:

- The dam is not culturally associated with the tribe.
- It is unclear if native Americans helped construct the dam.
- The tribe generally encourages river restoration projects due to positive experience with prior projects.
- The tribe is supportive of fish ladders and natural fish passage.
- Historic and Archaeological Records Investigation (including Underwater) will likely be required in the permitting process per standard practice.
- Tribe would like to be kept in contact with as project progresses into review by the Massachusetts Historical Commission and by the tribe in the formal Section 106 process.
- River restoration has the opportunity to plant culturally significant plant species in former impoundment area.

- Concern about loss of mature trees in the dam-repair scenario.
- Design should include native culturally significant plantings into any planting plans (sweet grass, bullrush, cat and nine tails, etc.)
- Any land disturbance in either scenario should avoid any significant indigenous cultural resources and be subject to Section 106 permitting of National Historic Preservation Act.

In addition, there are Cultural and Historical Considerations that have been clarified during FY23:

- Depending on additional information gathering, archeological survey in the form of shovel tests may be recommended in areas where ground disturbance or excavation is required in both dam repair and dam removal scenarios.
- Archaeologists may be recommended to be on-site during construction in both dam repair and dam removal scenarios.

Note that this section was primarily authored by CRWA.

5.0 Hydrologic and Hydraulic Analysis

Summary of Previous Work

The 2021 Eagle Dam Removal Study included a feasibility study level hydrologic and hydraulic analysis of Eagle Dam, its impoundment, and watershed. The modeling analyzed the upstream effects at Red Dam and downstream effects at the Route 140 stream crossing of two alternatives to existing conditions. The two alternatives analyzed were:

1) lowering the dam crest and spillway to reduce water depth by 2 ft, changing the dam designation to non-jurisdictional, and
2) removing the dam.

The flood impacts of these two alternatives were analyzed using two different design rainfall depth datasets, including "Historic precipitation" data, which was derived from a 1992 report titled "Hydrology & Hydraulic Calculations for the Restoration of Red Dam" provided by the Massachusetts Department of Conservation & Recreation (DCR) Office of Dam Safety and "Current precipitation" data, derived from the Northeast Regional Climate Center (NRCC) and the Natural Resources Conservation Service's (NRCS) web tool "Extreme Precipitation in New York and New England." As shown in Table 1, the current rainfall data consists of higher design depths for the same recurrence interval storm events.

Table 1 – Precipitation Data

Storm Event	Historical Data 24 Hour Precipitation (inches)	Current Data 24 Hour Precipitation (inches)
25-year	5.50	6.27
50-year	6.10	7.51
100-year	6.80	9.01

We note that while the "historical precipitation" data cited in the 2021 study was commonly used for many years, its use has faded significantly over the past ten years. The "current precipitation" data has even become largely outdated over the past five years with the publication of NOAA Atlas 14, although

we note that the "current" NRCC design rainfall depths are generally similar to their NOAA14 counterparts, except for some of the most extreme storm events. For the sake of comparing how the latest H&H analyses compare to those conducted in support of the 2021 study, 2021 model results derived from simulations of the "current precipitation" are most relevant. Tables 2 and 3 show the peak discharge rates and maximum water surface elevations (WSEs) identified in the 2021 H&H analyses with "current precipitation," using the HydroCAD modeling software.

Table 2 – Current Precipitation Model Discharge (cfs) Results				
	Storm Event	Existing Model Conditions	Lowered Eagle Dam by 2 ft	Removed Eagle Dam
Red Dam	25-Year Storm	341	415	415
	50-Year Storm	471	626	668
	100-Year Storm	669	848	1,013
Eagle Dam	25-Year Storm	341	414	414
	50-Year Storm	470	625	720
	100-Year Storm	641	848	1,012
Route 140 Stream Crossing	25-Year Storm	341	414	414
	50-Year Storm	470	625	720
	100-Year Storm	641	848	1,012

Table 3 – Current Precipitation Model Water Surface Elevation (ft) Results				
	Storm Event	Existing Model Conditions (ft)	Lowered Eagle Dam by 2 ft (ft)	Removed Eagle Dam (ft)
Red Dam	25-Year Storm	200.43	200.68	200.38
	50-Year Storm	201.15	201.01	200.99
	100-Year Storm	202.09	201.88	201.78
Eagle Dam	25-Year Storm	199.99	198.47	195.75
	50-Year Storm	200.82	199.88	198.25
	100-Year Storm	201.81	201.10	199.86
Route 140 Stream Crossing	25-Year Storm	193.02	193.90	193.90
	50-Year Storm	194.73	**196.75**	**197.00**
	100-Year Storm	**196.80**	**197.25**	**197.53**

*The **red, bolded** values indicate modeled water elevations that do not meet the MassDOT Principal Arterial freeboard design criteria, which would require a maximum water surface elevation no higher than 196.0 feet at the Route 140 stream crossing location.*

As Tables 2 and 3 indicate, the 2021 H&H models resulted in increased discharge rates upstream at Red Dam and downstream at the Route 140 stream crossing under both dam alternatives. This analysis also indicated that neither the two alternatives nor the existing conditions fail to meet MassDOT Principal Arterial freeboard design criteria, requiring a maximum water surface elevation no higher than 196.0 feet, for the Route 140 stream crossing under 100-year storm event modeled conditions. Note that the maximum water surface elevations reported in Table 3 are based on a representation of Eagle Brook based on estimated rather than surveyed elevations. The resulting simulated water surface elevations

cannot be directly compared to more recent model results presented in subsequent sections, which were based on a survey-based model.

In the 2021 Eagle Dam Removal Study report, it was recommended that further analysis should be conducted to confirm results and coordinate with MassDOT as the project moves further in design.

Model Updates for Eagle Dam

To supplement that work completed in 2021, more data was collected, model updates using the updated data were completed, and model scenarios were run as a part of the FY 23 MVP Action Grant. This work used the Charles River Flood Model (CRFM), which is a computer flood model of the upper and middle Charles River watershed that identifies where and when flooding will occur under various present day (baseline) and future rainfall scenarios. The CRFM uses a software called PCSWMM to simulate flooding across the study area. The cities of Boston and Cambridge, which border the Lower Charles River Basin, already had detailed models demonstrating the impacts of both freshwater and coastal flooding in their communities prior to the launch of this initiative. The CRFM geographic extent covers the whole or part of 33 municipalities and a total area of 273 square miles. The technical details of developing, calibrating and validating the CRFM are available in the Charles River Flood Model report found on the CRWA website[3].

On February 24, 2023, Weston & Sampson observed existing conditions and used a GPS unit[4] to collect relevant elevations at hydraulic features between Lake Archer in Wrentham, MA and Main Street in Norfolk, MA. The goal of this work was to verify discrepancies identified in Phase I documented in the 2021 Eagle Dam Removal Study, update information accordingly, and collect additional information necessary to update the H&H model. See Section 2.0 of this memorandum for more detail on the field effort.

Data collected in the field during February 2023 were used to update the CRFM:

- Dam and roadway heights were modified in the CRFM based on the information collected.
- Dimensions measured were used to represent dam outlets and culverts more accurately along Eagle Brook in the CRFM.
- Lake Archer's outlet was previously modeled assuming the outlet was flowing west from Lake Archer through the Rowell Road, Creek Street, and Gilmore Road neighborhoods. Field work verified the outlet flows southwest between Rowell Road and Welcome Lane before entering the Creek Street culvert. This observation was reflected in updates to the CRFM.
- Previously, the CRFM did not explicitly model the unnamed dam at Mill Pond and the stream crossing immediately downstream. Based on field measurements, this area was incorporated into the updated model.
- Since the CRFM was developed at a watershed scale, the reach from Lake Archer to Main Street was modeled with moderate detail. The two dimensional (2D) mesh in this area had a very

[3] https://www.crwa.org/watershed-model
[4] Trimble TDC600 Handheld Data Collector

coarse resolution. This section of the CRFM was updated to include a 2D mesh with a much finer resolution to provide more detailed estimates of flooding extents and elevations in Eagle Brook. See Figure 1 below for a comparison of the old and new 2D mesh resolutions.

Design rainfall depths and distributions in the CRFM were also updated to reflect the latest guidance on present day climate (i.e., National Oceanic and Atmospheric Administration (NOAA) Atlas 14[5]) and future climate scenarios using the Resilient Massachusetts Action Team (RMAT) Climate Resilience Design Standards Tool[6]. Updated total precipitation depths for 24-hour design storms were made available in the latest version of the RMAT Tool released in April 2022. These are considered the best available climate science data for the project area, and therefore the CRFM was updated to reflect these rainfall projections. The rainfall distribution was also updated to the NOAA Atlas 14 temporal rainfall distribution. Table 4 lists the recurrence internals and associated 24-hour design storms under baseline (present day) conditions and future conditions (year 2070).

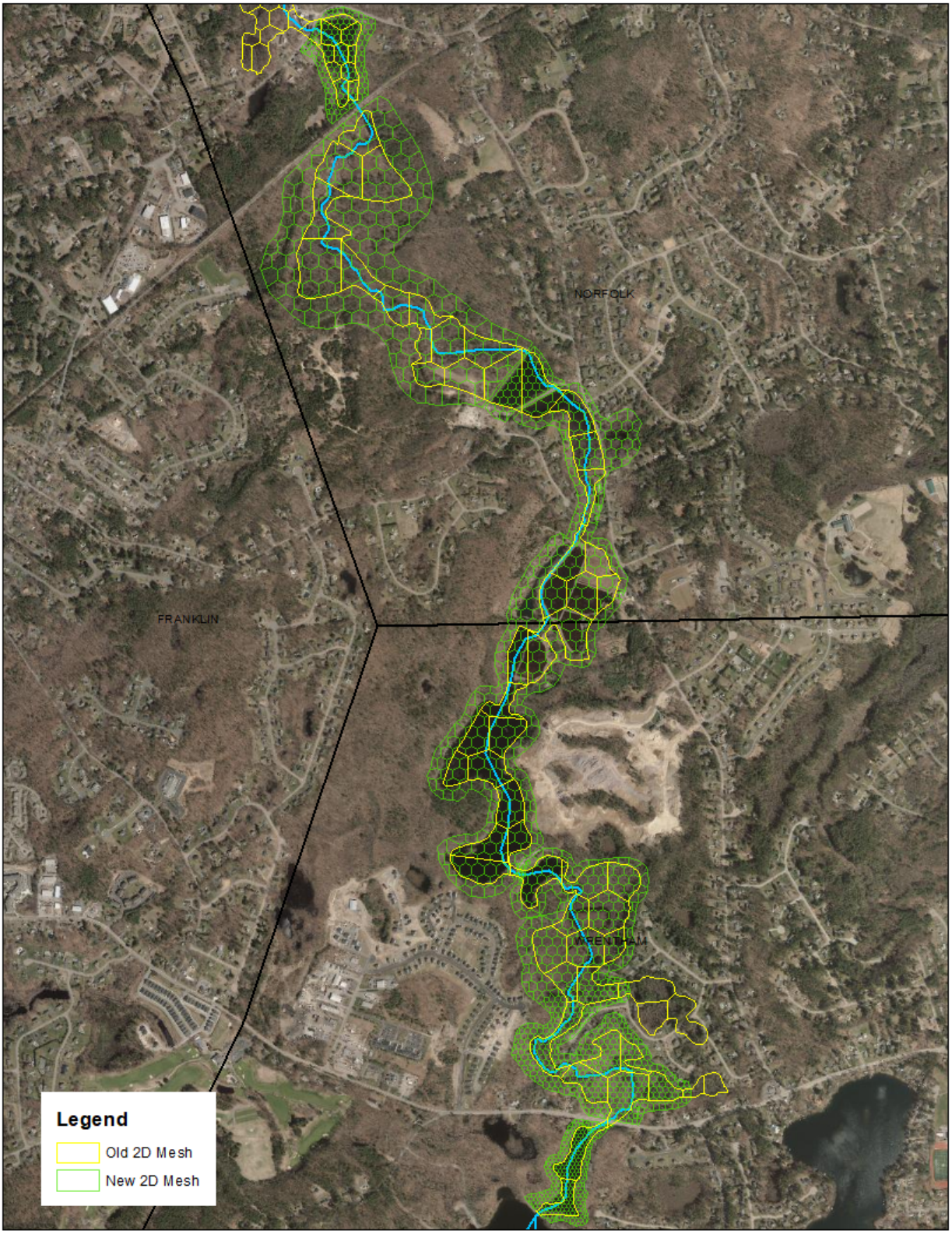
Table 4 – 24-Hour Storm Event Recurrence Intervals and Precipitation Amounts

Recurrence Interval	Baseline Conditions (inches of precipitation in 24 hours, NOAA Atlas 14)	2070 Conditions (inches of precipitation in 24 hours, RMAT Tool)
2-year	3.4	4.6
10-year	5.2	7.1
50-year	7.2	9.8
100-year	8.2	11.1
500-year	11.0	14.9

It is important to note that the updated CRFM uses a different rainfall distribution – how the rainfall occurs over time during the simulated design storm – than the 2021 Eagle Dam Removal Study. While the NOAA Atlas14 design rainfall depths are somewhat similar to the "current precipitation" values used in the 2021 study, the NOAA14 rainfall distribution is significantly different than the older Soil Conservation Service (SCS) Type III distribution used in 2021 Eagle Dam Removal Study. The SCS distributions have much sharper peak intensities, resulting in higher estimated peak runoff rates and higher peak streamflow values. Weston & Sampson continues to use the SCS curves (among others) for critical infrastructure design (e.g., dam rehabilitation projects), however, for projects related to dam removal, stream restoration, transportation, stormwater management, green infrastructure design, and more, Weston & Sampson typically uses NOAA Atlas14 or other distributions with lower and more realistic peak intensities as was done in support of this project.

[5] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html
[6] https://resilientma.mass.gov/rmat_home/designstandards/

Figure 1: Comparison of 2D Mesh Resolutions



Dam Removal Model Results

The updated CRFM model was used to perform a preliminary evaluation of the potential changes to the expected peak flood level and velocities downstream of the dam during a range of design storm conditions, as a result of dam removal. The ultimate goal of these analyses is to understand the dam removal's potential impact on the hydraulic performance of the Rte. 140 stream crossing immediately downstream and any impacts to flood risk at several homes in and near the floodplain between the Route 140 stream crossing and Main Street in Norfolk.

Dam removal was evaluated by creating a "dam-out" version of the PCSWMM-based model and comparing its output to the corresponding results of the existing conditions model. To create the dam-out geometry, the dam's existing 15-foot-wide spillway was replaced by a deeper and wider channel. The width of the dam-out channel geometry was estimated from field observations of approximate bankfull width, and the bottom elevation of the new channel was assumed to match that of the upstream and downstream reaches of Eagle Brook, representing a free flowing state. The roughness of the channel was also increased to a value typical of the channel conditions immediately downstream as opposed to that of a concrete spillway.

Ten simulations were conducted of the dam-out model, representing the 2-, 10-, 50-, 100-, and 500-year, 24-hour design storms under both present day and 2070 climate scenarios. The dam-out peak water levels were compared to their existing condition, dam-in counterparts at five locations, including Lake Pearl, the current Eagle Dam location, the upstream face of Route 140, the downstream face of Route 140, and at an unnamed dam behind 160 Mill Street in Wrentham. Those comparisons are summarized in Tables 5 through 9, respectively, below. These locations are shown in Figure 2.

FIGURE 2
TOWN OF WRENTHAM MASSACHUSETTS

H&H ANALYSIS POINTS

Weston & Sampson

Table 5 – Impacts of Eagle Dam Removal on Maximum Water Levels in Lake Pearl				
Climate Scenario	Recurrence Interval (yrs)	Max Water Level (ft. NAVD88)		Change* (ft.)
		Dam In	Dam Out	
Present	2	197.55	197.55	0.00
	10	198.07	198.07	0.00
	50	198.78	198.78	0.00
	100	199.14	199.14	0.00
	500	200.10	200.10	0.00
2070	2	197.86	197.86	0.00
	10	198.75	198.75	0.00
	50	199.70	199.70	0.00
	100	200.14	200.14	0.00
	500	201.34	201.34	0.00

**Note: positive change values are increases in water level while negative values are decreases in water level.*

Maximum water levels in Lake Pearl are not expected to be impacted by the removal of Eagle Dam, as shown in Table 5.

Table 6 – Impacts of Eagle Dam Removal on Maximum Water Levels in Old Mill Pond				
Climate Scenario	Recurrence Interval (yrs)	Max Water Level (ft. NAVD88)		Change* (ft)
		Dam In	Dam Out	
Present	2	196.77	196.65	-0.12
	10	197.17	196.86	-0.31
	50	197.73	197.43	-0.29
	100	198.05	197.70	-0.34
	500	198.90	198.45	-0.46
2070	2	196.95	196.74	-0.21
	10	197.69	197.41	-0.29
	50	198.55	198.14	-0.41
	100	198.93	198.47	-0.46
	500	199.95	199.36	-0.58

**Note: positive change values are increases in water level while negative values are decreases in water level.*

Naturally, the removal of Eagle Dam is expected to lower the maximum water level in Old Mill Pond under all design storms and climate scenarios, as shown in Table 6. Those reductions generally increase with the size of the design storm, ranging from a 0.12-foot reduction during the Present Day 2-year event to a 0.58-foot reduction during a 2070 500-year storm.

Table 7 – Impacts of Eagle Dam Removal on Maximum Water Levels Upstream of Route 140				
Climate Scenario	Recurrence Interval (yrs)	Max Water Level (ft. NAVD88)		Change* (ft.)
		Dam In	Dam Out	
Present	2	188.70	188.69	0.00
	10	188.94	188.94	0.00
	50	190.26	190.26	0.00
	100	190.61	190.61	0.00
	500	191.56	191.56	0.00
2070	2	188.77	188.77	0.00
	10	190.22	190.22	0.00
	50	191.15	191.15	0.00
	100	191.60	191.60	0.00
	500	192.87	192.88	0.02

**Note: positive change values are increases in water level while negative values are decreases in water level.*

As shown in Table 7, model simulations indicate no change in the maximum water level at the upstream face of Route 140, with the exception of the 500-year event under a 2070 climate scenario, which indicates an increase of between 0.01 and 0.02 feet. Normally, such an increase could represent an obstacle to obtaining a “No Rise” certification to remain in compliance with the Federal Emergency Management Agency (FEMA) and Massachusetts Department of Transportation (MassDOT) standards. However, because the design storm represents a future climate scenario, it is not applicable.

Table 8 – Impacts of Eagle Dam Removal on Maximum Water Levels Downstream of Route 140				
Climate Scenario	Recurrence Interval (yrs)	Max Water Level (ft. NAVD88)		Change* (ft.)
		Dam In	Dam Out	
Present	2	188.46	188.46	0.00
	10	188.91	188.91	0.00
	50	190.23	190.23	0.00
	100	190.54	190.54	0.00
	500	191.38	191.38	0.00
2070	2	188.55	188.55	0.00
	10	190.18	190.18	0.00
	50	191.01	191.01	0.00
	100	191.41	191.41	0.00
	500	192.58	192.58	0.00

**Note: positive change values are increases in water level while negative values are decreases in water level.*

Maximum water levels at the downstream face of the Route 140 stream crossing are not expected to be impacted by the removal of Eagle Dam, as shown in Table 8. In addition, the bridge is expected to maintain sufficient freeboard to satisfy MassDOT design criteria under all simulated design storms.

Velocities at the Route 140 stream crossing were also compared to existing conditions to provide an understanding of how velocities, which are a critical component of estimating bridge scour potential, might change at the crossing. A comparison of peak velocities is provided in Table 9.

Table 9 – Impacts of Eagle Dam Removal on Peak Velocities Beneath the Route 140 Stream Crossing					
Climate Scenario	Recurrence Interval (yrs)	Velocity (ft./sec.)		Change* (ft./sec.)	Change (%)
		Dam In	Dam Out		
Present	2	0.6	0.8	0.2	27%
	10	1.7	2.0	0.3	17%
	50	3.7	3.7	0.0	0%
	100	5.4	5.4	0.0	0%
	500	9.9	9.9	0.0	0%
2070	2	1.2	1.4	0.2	17%
	10	3.5	3.5	0.0	0%
	50	8.1	8.1	0.0	0%
	100	10.0	10.0	0.0	0%
	500	14.8	14.8	0.0	0%

**Note: positive change values are increases in velocity while negative values are decreases in velocity.*

As shown in Table 9, maximum velocities are shown to increase modestly during three of the ten simulated design storms, specifically the Present Day 2- and 10-year events and the 2070 climate 2-year events. While the relative size of those increases ranges from 17 to 27%, the absolute magnitude of the increases is quite modest, ranging from 0.2 to 0.3 feet per second. In addition, these increases are short-lived, lasting for up to approximately one hour over the course of the 24-hour event.

Comparison of 2021 Eagle Removal Study and 2023 MVP Action Grant H&H

This significant change in findings between the 2023 analysis and the 2021 study are largely due to the use of different rainfall distributions in the two models. As noted above, the current project used a rainfall distribution developed from NOAA14 data as opposed to the significantly older SCS Type III distribution, which has a much higher peak intensity that is widely regarded as overly conservative. As a result, the updated CRFM indicates that the peak flow rates at Eagle Dam and the Route 140 stream crossing are two to four times lower than the 2021 Eagle Dam Removal Study model outputs, resulting in the 2023 modeling effort indicating sufficient freeboard at the Route 140 stream crossing under both existing and dam removal conditions where the 2021 analysis did not. This approach is consistent with MassDOT-accepted hydrologic methods, although ultimately a detailed hydraulic model will be needed to confirm what the CRFM has shown in terms of hydraulics (e.g., freeboard at the Route 140 stream crossing, flooding depths, scour rates, etc.).

MassDOT Requirements

While removal of Eagle Dam is not a bridge design project, its impact on the hydraulic performance of the Route 140 bridge immediately downstream is a key finding of this study. As discussed above, model results indicate that the removal of Eagle Dam will have no significant impact on the peak water surface upstream and only a minor impact on maximum velocities at the Route 140 stream crossing. These findings were reviewed in light of the relevant MassDOT and FEMA requirements.

The MassDOT LRFD Bridge Manual, Section 1.3, provides Hydraulic Design Criteria for MassDOT bridge design. For example, the analysis evaluated the 10%, 2%, 1%, and 0.2% (i.e., 10-year, 50-year, 100-year, and 500-year) storm events consistent with Section 1.3.3.3.C of the manual. Those design storms were modeled specifically, along with the 2-year storm, and summarized in previous sections of this report. Route 140 or Franklin Street as it is called locally, is classified as a rural minor arterial. The impacts of dam removal were assessed at the 50-year return period among others.

According to Section 1.3.2 Hydraulic Design Criteria of the Bridge Manual, the Route 140 stream crossing should have a minimum clearance of two feet between the design approach water surface and the low chord of the bridge. GPS elevations collected in the field show the low chord of the bridge to be at approximately El. 193.1 NAVD88. According to model results presented in Table 8, during the present day 50-year design storm, the water surface immediately upstream of the bridge reaches a peak level of El. 190.3, representing approximately 2.8 feet of clearance. If Eagle Dam were removed, that minimum clearance would remain the same as no increase is anticipated to the maximum water level.

Section 1.3.5 of the Bridge Manual provides guidelines for “No Rise” Encroachment reviews for MassDOT bridges in regulatory floodways. Eagle Brook is classified as Zone A and is not a Regulatory Floodway. According to the effective FEMA Flood Insurance Study, flood risk in Eagle Brook has only been evaluated with “approximate methods” as there is no effective model for Eagle Brook. However, the results presented above are consistent with the results that would be expected by a formal “no rise” analysis using HEC-RAS or similar software. As described, anticipated increases in peak flood level are not expected to increase under present day climate conditions for any of the five design storms evaluated.

On June 20, 2023, Weston & Sampson, CRWA, and Town staff met with Hanan Fouad, MSCE, PE – Hydraulic Engineer, MassDOT/Highway Division, Bridge Section/Hydraulics. During that meeting, CRWA provided a project overview and Weston & Sampson provided a review of the H&H approach undertaken to date. The following documents the presentation to MassDOT staff:

- Weston & Sampson utilized EPA Stormwater Management Model (SWMM), combination of open channel and piped infrastructure.
- Used model to assess potential impact on flooding downstream to residents and abutters.
- If significant impacts were identified in the H&H model, the Town may have wished to proceed with an alternative to dam removal. However, significant impacts were not identified by the modeling effort.

- The Charles River Flood Model (CRFM) was updated specifically for this project. Additions included improved 2D mesh, cross sections, connectivity between Lake Archer and Eagle Lake, 50-year storm event and 500-year storm event.

- A "mini" model was created for the Project Area. Used the output from the larger CRFM watershed model to create downstream boundary conditions .

- We found that with dam removal, there are almost no impacts to peak flooding in 1D or 2D cells including depth of flooding. Not only is peak flooding not shown to change but peak discharge rate is not shown to change so there is no change in velocity or scour rate in a dam-out condition.

Based on the presentation, MassDOT staff offered the following:

- Need a detailed HEC-RAS model from upstream dam to Arlene Drive. This small-scale H&H model will show the effect on Route 140 stream crossing. Start from Red Dam at Lake Pearl outlet and go downstream from the route 140 bridge to Arlene Drive.

- Need to know maximum flow from spillway on Red Dam and use in this model – with dam in and dam out and need to know about erosion around the area .

- The existing bridge downstream of Eagle Dam on Route 140 is a closed bottom culvert. MassDOT is not extremely worried about abutment scour, but more worried about streambank erosion.

- Downstream of culvert, MassDOT will need to know the scour hole dimension with dam in and dam out conditions.

- Need to do a sediment transport analysis as part of design to remove the dam – will it deposit before the Route 140 stream crossing or what will happen? MassDOT will request dimensions.

- MassDOT will want a copy of the model and report when completed in future phases.

- Discussion regarding permits: what permit(s) would the Town need from MassDOT?
    - MassDOT will need to know the effect of the project on the bridge and will need to review the model.
    - Contact others in MassDOT as next steps (including right of way for any potential future work on the current bridge and road corridor, Environmental Division, as well as Alexander Bardow State Bridge Engineer for information on MassDOT Access Permits).

- MassDOT had a question on hydrology: design flow is 50-year, scour is 100- and 200-year storm events. Weston & Sampson confirmed that we did not evaluate scour directly and will need 50-, 100-, and 200-year flood evaluation in the next phase of work.

Note that Weston & Sampson clarified:

- The existing model is a "small model" but was focused on peak flows, similar to HydroCAD.
- We are in full agreement that a HEC-RAS model would be a future phase of the work and be needed in the early stages of a removal design and permitting process.

7.2 Permit Identification

The 2021 Eagle Dam Removal Study identified the following regulatory reviews are necessary to remove Eagle Dam. In addition to the previously identified list, the Project will require:

- Review under the Massachusetts Endangered Species Act (MESA)[7];
- Project Notification Form (PNF) and Section 106 Review with the Massachusetts Historic Commission (MHC) and with the Mashpee Wampanoag Tribe; and
- Letter of Map Revision with the Federal Emergency Management Agency (FEMA).

Table 10 – Potential Regulatory Reviews/Approval Requirements for Eagle Dam Removal

Jurisdiction	Regulatory Program	Issuing Agency	Permit Name	Dam Removal Action
Local	Massachusetts Wetlands Protection Act (State) & Wrentham Wetlands Protection Bylaw (Local)	Wrentham Conservation Commission /Massachusetts Department of Environmental Protection (MassDEP)	Order of Conditions	Required
Local	Municipal Bylaws and Ordinances	Municipal Boards and Committees	Planning, Building, Site Plan Review Permits	Required
State	Massachusetts Environmental Policy Act (MEPA) (State)	Massachusetts Executive Office of Energy and Environmental Affairs	Secretary's Certificate	Required

[7] On April 5, 2023, CRWA met with staff from MassWildlife's Natural Heritage & Endangered Species Program (NHESP) for an initial consultation to discuss the proposed project. The project is subject to consultation by their office as the design progresses and through the permitting process.

Table 10 – Potential Regulatory Reviews/Approval Requirements for Eagle Dam Removal				
Jurisdiction	Regulatory Program	Issuing Agency	Permit Name	Dam Removal Action
State	Massachusetts Dam Safety Regulations	Massachusetts Department of Conservation and Recreation - Office of Dam Safety	Jurisdictional Determination	Required
State	Massachusetts Dam Safety Regulations	Massachusetts Department of Conservation and Recreation - Office of Dam Safety	Chapter 253 Dam Safety Permit	Required
State	Section 401 of the Clean Water Act (Federal) & Massachusetts Clean Waters Act (State)	MassDEP	Section 401 Water Quality Certification	Likely Required
State	Massachusetts Endangered Species Act (MESA)	Natural Heritage & Endangered Species Program (NHESP)	Review only anticipated	Required
State	Chapter 91, the Massachusetts Public Waterfront Act	MassDEP	Chapter 91 Permit / License	Likely Required
State/ Federal	Massachusetts General Laws Chapter 9, sections 26-27C Section 106 of the National Historic Preservation Act	MHC	Project Notification Form (PNF) Section 106 Historical Review	Required

Table 10 – Potential Regulatory Reviews/Approval Requirements for Eagle Dam Removal				
Jurisdiction	Regulatory Program	Issuing Agency	Permit Name	Dam Removal Action
Federal	Section 404 of the Clean Water Act (Federal) & Section 10 of the Rivers and Harbors Act (Federal)	United States Army Corps of Engineers (USACE)	Authorization under the Massachusetts General Permit or Individual Permit Authorization	Required
Federal	National Flood Insurance Program (NFIP)	Federal Emergency Management Agency (FEMA)	Letter of Map Revision (LOMR)	Required
Federal	National Pollutant Discharge Elimination System (NPDES) (Federal)	United States Environmental Protection Agency (USEPA)	NPDES Construction General Permit	May be required

8.0 Next Steps

Summary of Previous Next Steps

The project next steps as identified in the 2021 Eagle Dam Removal Study are summarized as follows:

- Collect additional data to correctly establish existing conditions at Eagle Brook
- Perform a more detailed hydrologic and hydraulic assessment of Eagle Brook to evaluate flooding at the downstream Route 140 stream crossing.
- Engage MassDOT in the modeling efforts to ensure the appropriate scenarios are assessed.
- Build and expand stakeholder and community outreach and engagement.

Update of Next Steps

Based on the work completed during the FY23 MVP Action Grant, the following additional next steps are necessary:

- Contact MassDOT Environmental Division, Bridge Engineer, and Right-of-Way for broader discussion.
- Contact Alexander Bardow, State Bridge Engineer, at MassDOT, about permit and requirements.

- Next phase work for the Eagle Dam design/feasibility should include the following (refer to report sections above for additional detail):
    - Complete a detailed hydraulic study from Red Dam to Arlene Drive with dam in and dam out, maximum flow from Red Dam spillway, velocity, water surface elevation, shear stress around banks of channel upstream and downstream.
    - Prepare a scour analysis on Route 140 bridge and stream channel.
    - Prepare a sediment transport analysis.
    - Formally consult with NHESP on state listed species and project design.
    - Conduct further cultural and historic review, reconnaissance, research and surveys on the project location

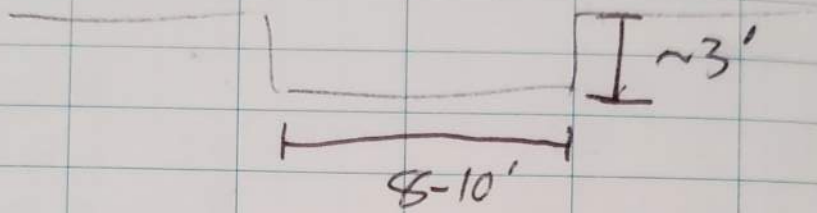
ATTACHMENT A: FIELD NOTES

Location Wrentham Date 2/24/23

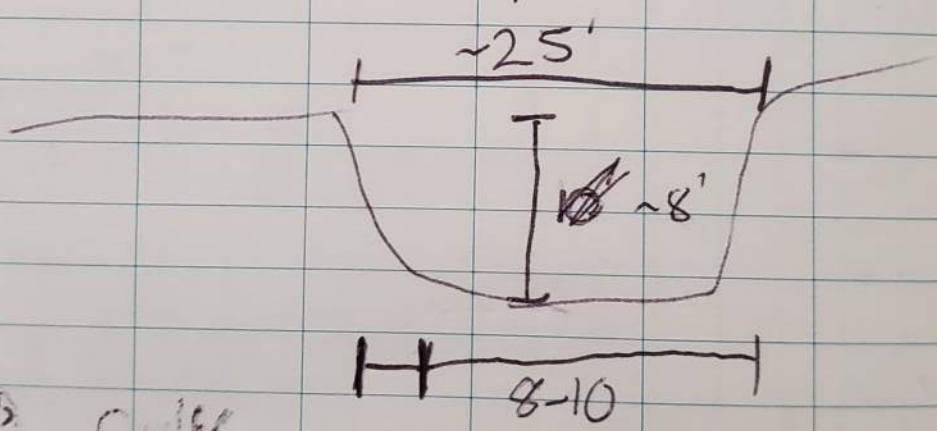
Project / Client

Lake Archer
elevations - lidar

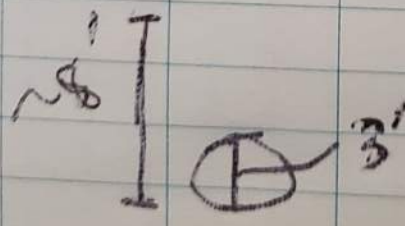
① @ lake



② outlet to d/s pond



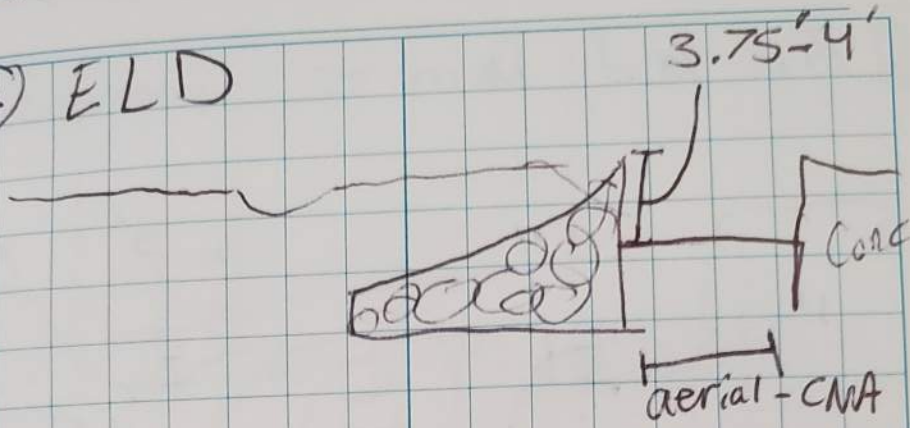
③ CMP



Location _____ Date _____

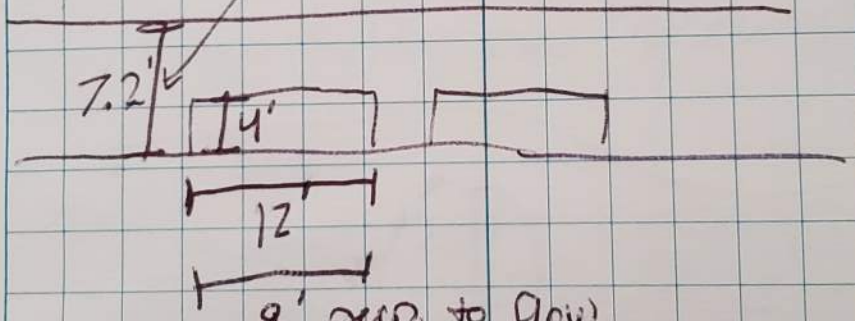
Project / Client _____

(4) ELD

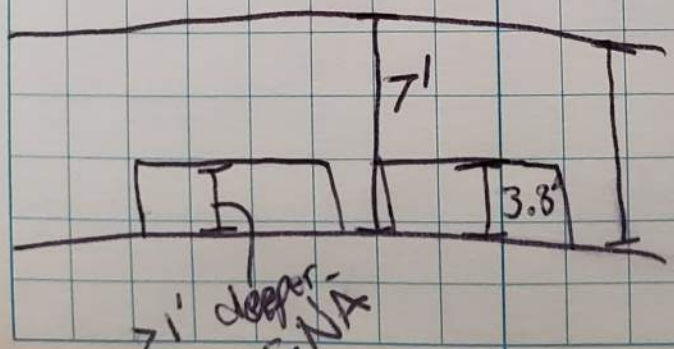


(5) Rte 140

U/S: u/s



d/s:

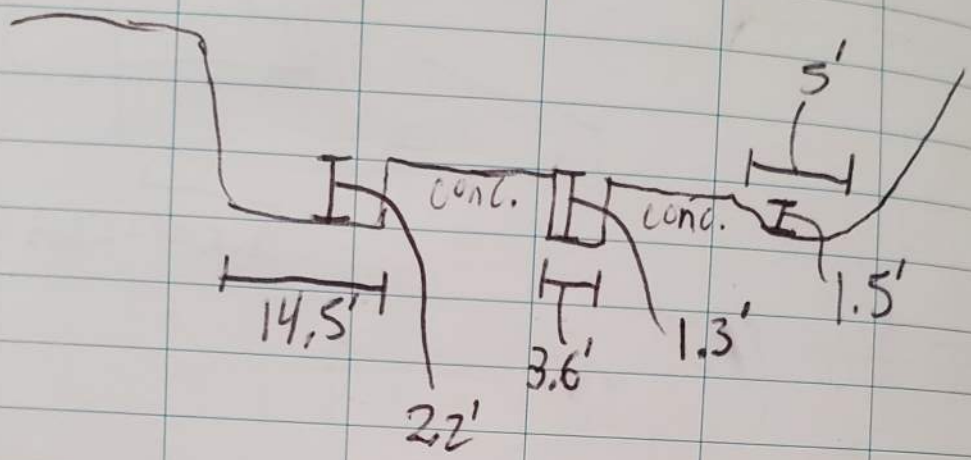


Location

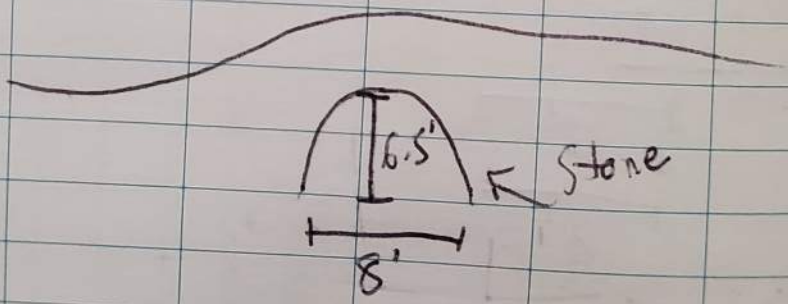
Project / Client

Date

(6) Mill Pond Dam



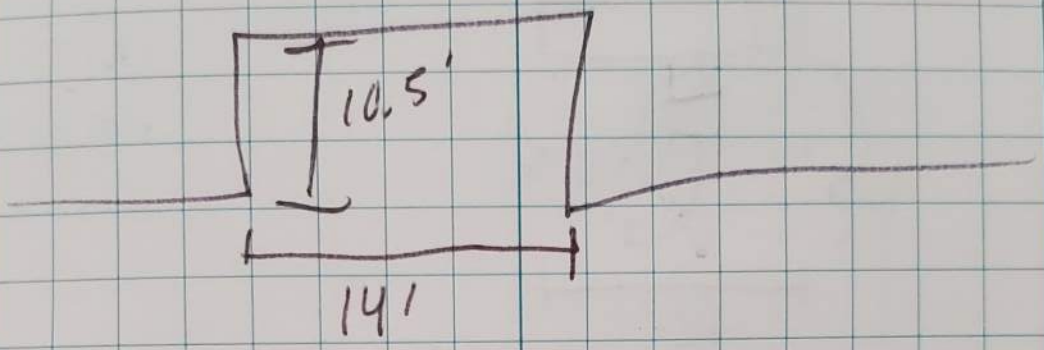
(7)



Location _____ Date _____

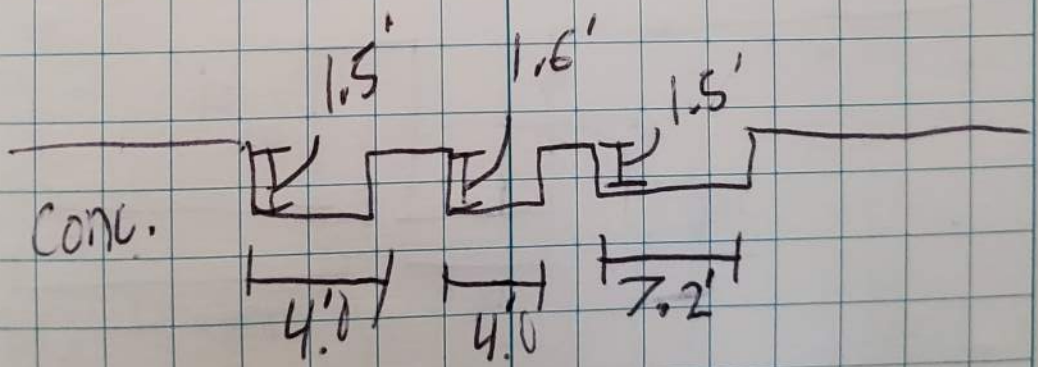
Project / Client _____

(8) Lawrence St



(9) Bush Pond Dam

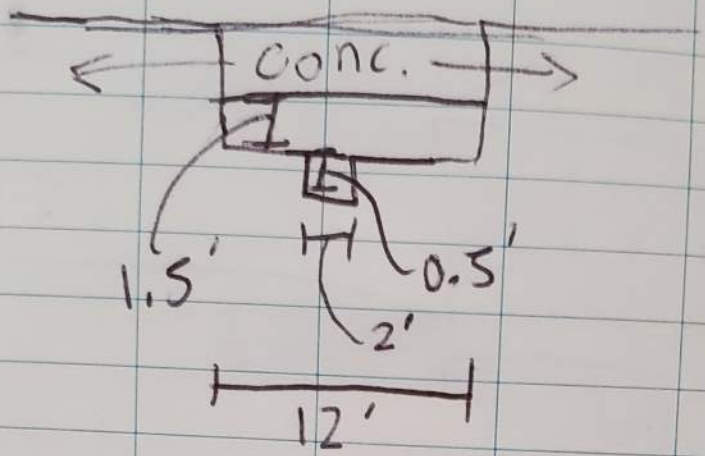
-foot bridge over spillways, 1' deck



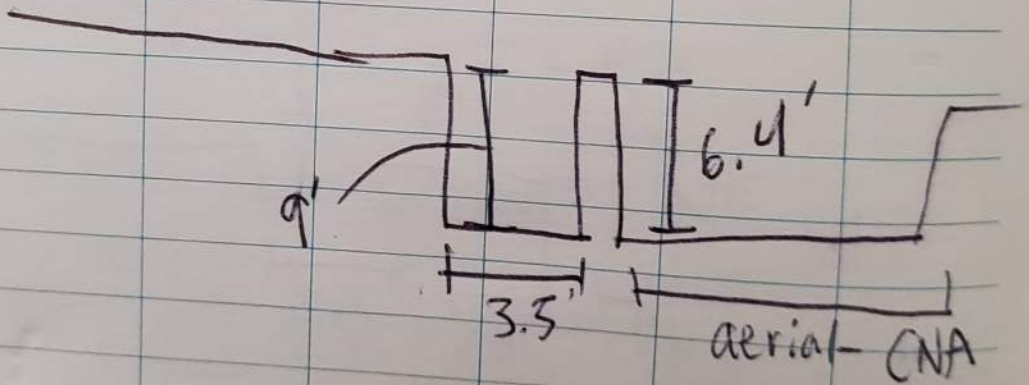
Location _____

Project / Client _____ Date _____

(10) City Mill Pond Dam



(11) Red Dam



ATTACHMENT B: FEBRUARY 24, 2023 PHOTO LOG

Photo 1: Eagle Lake Dam (MA02263) Embankment looking downstream. Eagle Lake Dam's embankment ungulates with several eroded walking paths, as seen in this photo.

Photo 2: Eagle Lake Dam (MA02263) looking upstream at the primary spillway.

Photo 3: Eagle Lake Dam's (MA02263) primary spillway looking upstream. A staff gage is located on the right training wall.

Photo 4: Unnamed dam at Mill Pond primary spillway. The primary spillway appeared to be a broad crested weir with a fixed angle iron.

Photo 5: Unnamed dam at Mill Pond looking at the two auxiliary spillways from the right abutment of the primary spillway. The left auxiliary spillway is a stoplog-controlled channel, and the right auxiliary spillway is an earthen channel.

Photo 6: Unnamed dam at Mill Pond looking downstream at the stone culvert crossing downstream of the dam. The left auxiliary spillway is pictured above, with the right auxiliary spillway off-camera to the right.

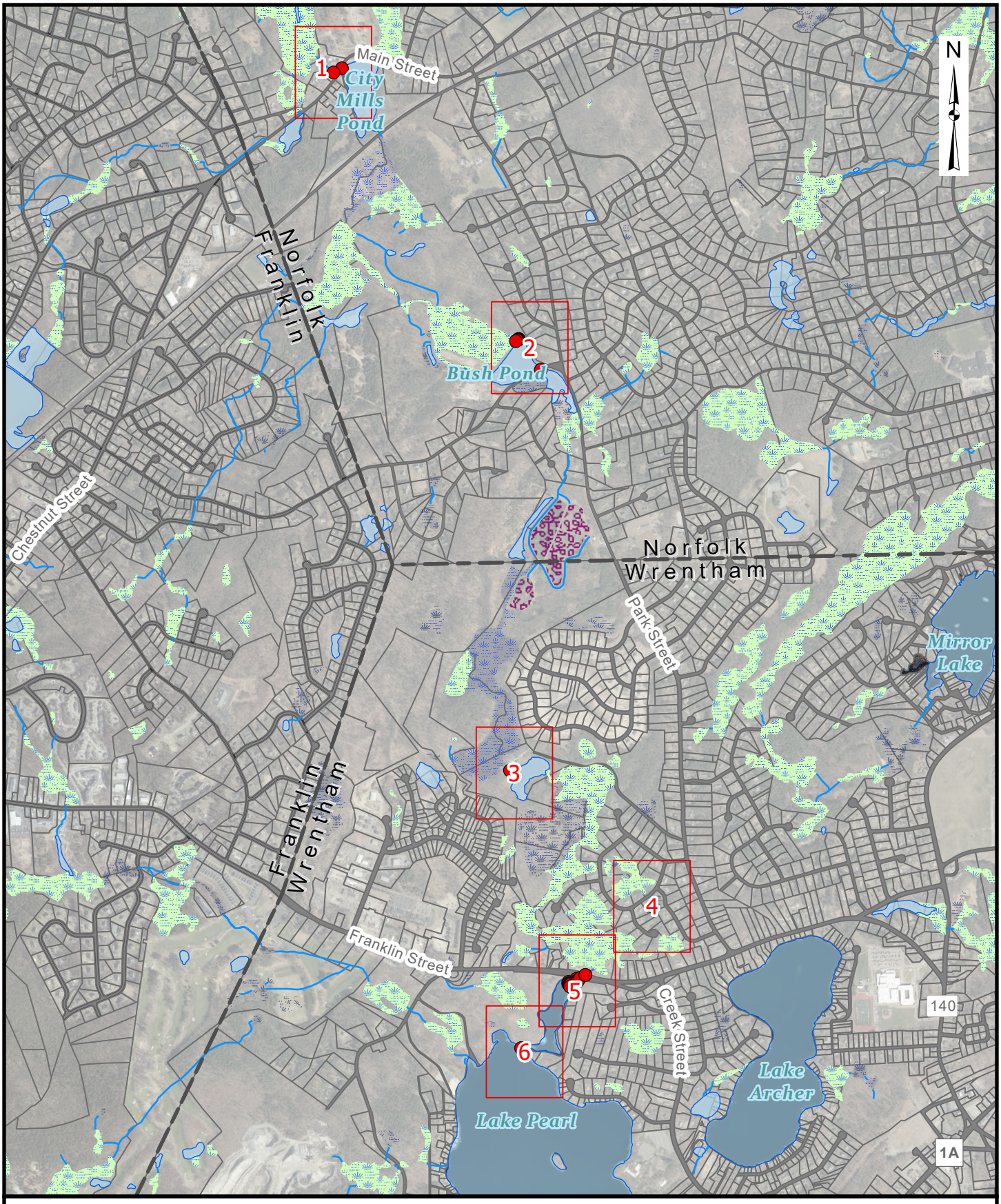
Photo 7: Bush Pond Dam (MA01158) looking at the spillways from the dam embankment. The spillways consisted of three stoplog-controlled channels.

Photo 8: Bush Pond Dam (MA01158) looking downstream at the discharge channel from the pedestrian bridge above the spillways.

Photo 9: Bush Pond Dam (MA01158) looking upstream at the spillways from the toe of the dam.

Photo 10: Bush Pond Dam (MA01158) looking at the upstream face of the spillways and dam embankment from the edge of Bush Pond.

ATTACHMENT C: MAPS



TOWN OF WRENTHAM MASSACHUSETTS
FISCAL YEAR 2023 MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) ACTION GRANT "Phase II Feasibility Assessment and Community Outreach for Eagle Dam"

FIELD DATA COLLECTION INDEX SHEET

Weston & Sampson

1 inch = 1,000 In Feet

FIGURE 1 of 6
TOWNS OF NORFOLK AND WRENTHAM MASSACHUSETTS

GPS Points

150 75 0 150

Feet

Weston & Sampson

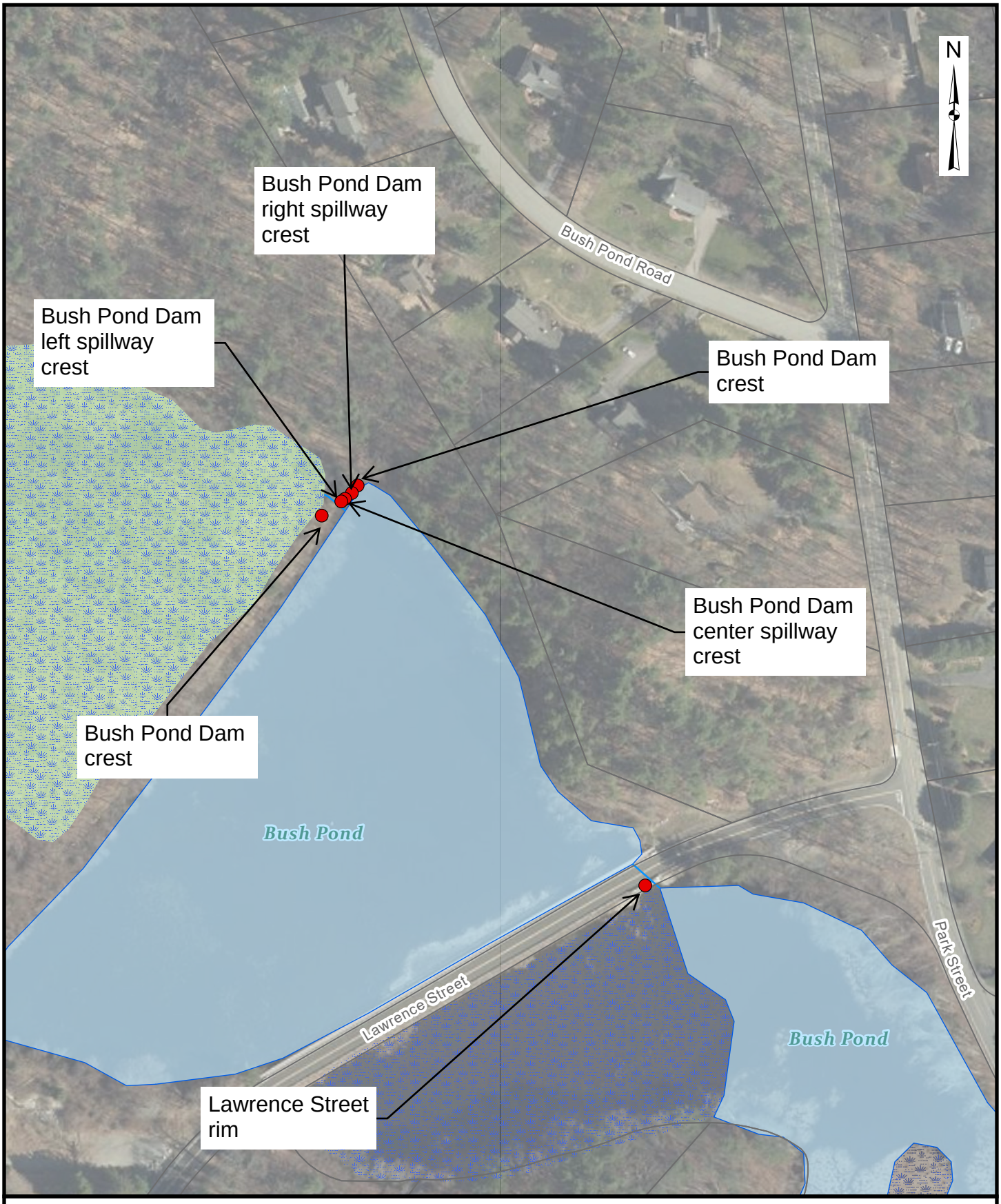


FIGURE 2 of 6
TOWNS OF NORFOLK AND WRENTHAM MASSACHUSETTS

GPS Points

150 75 0 150

Feet

Weston & Sampson

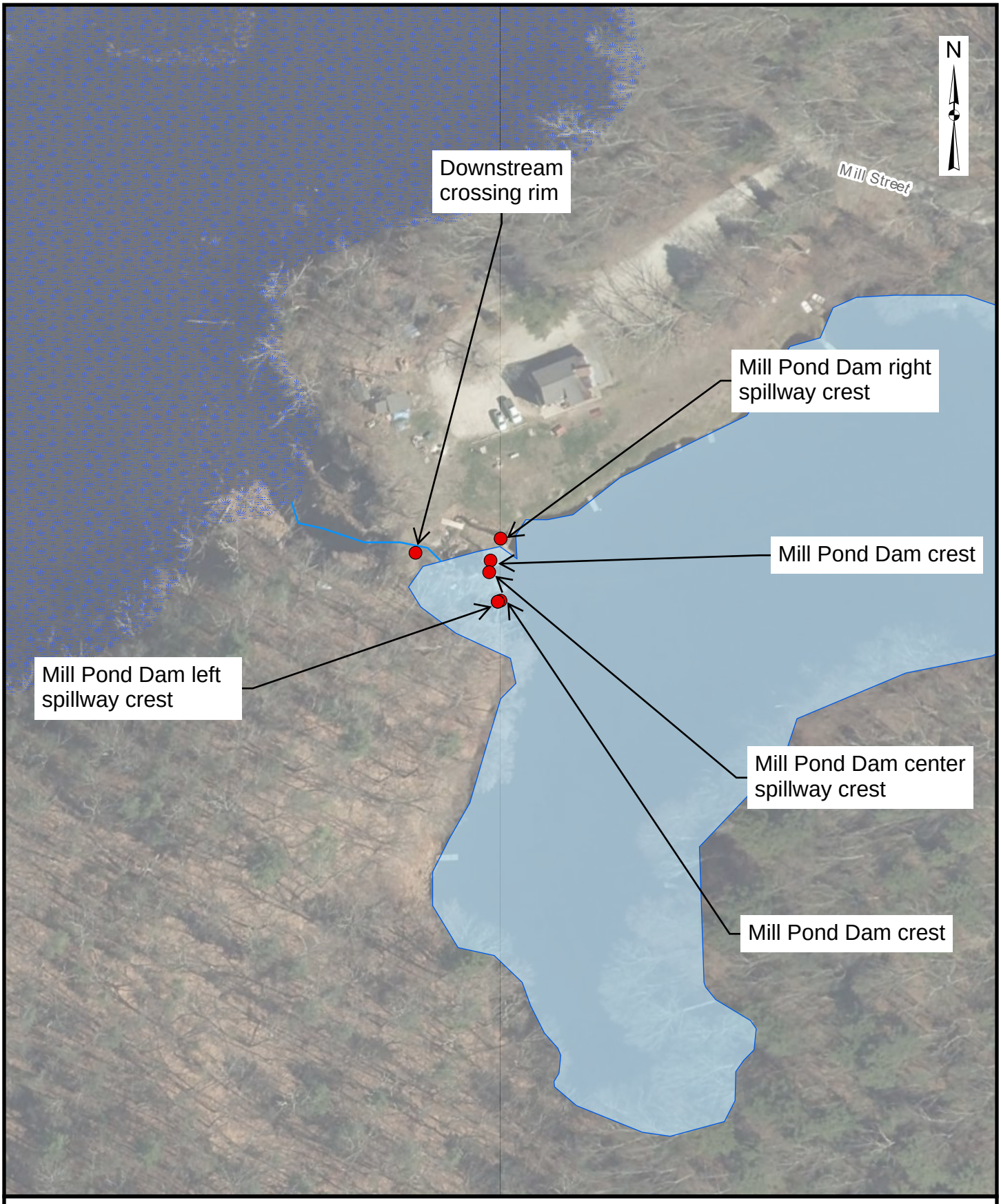


FIGURE 3 of 6
TOWNS OF NORFOLK AND WRENTHAM MASSACHUSETTS

GPS Points

100 50 0 100

Feet

Weston & Sampson

FIGURE 4 of 6
TOWNS OF NORFOLK AND WRENTHAM MASSACHUSETTS

GPS Points

150 75 0 150

Feet

Weston & Sampson

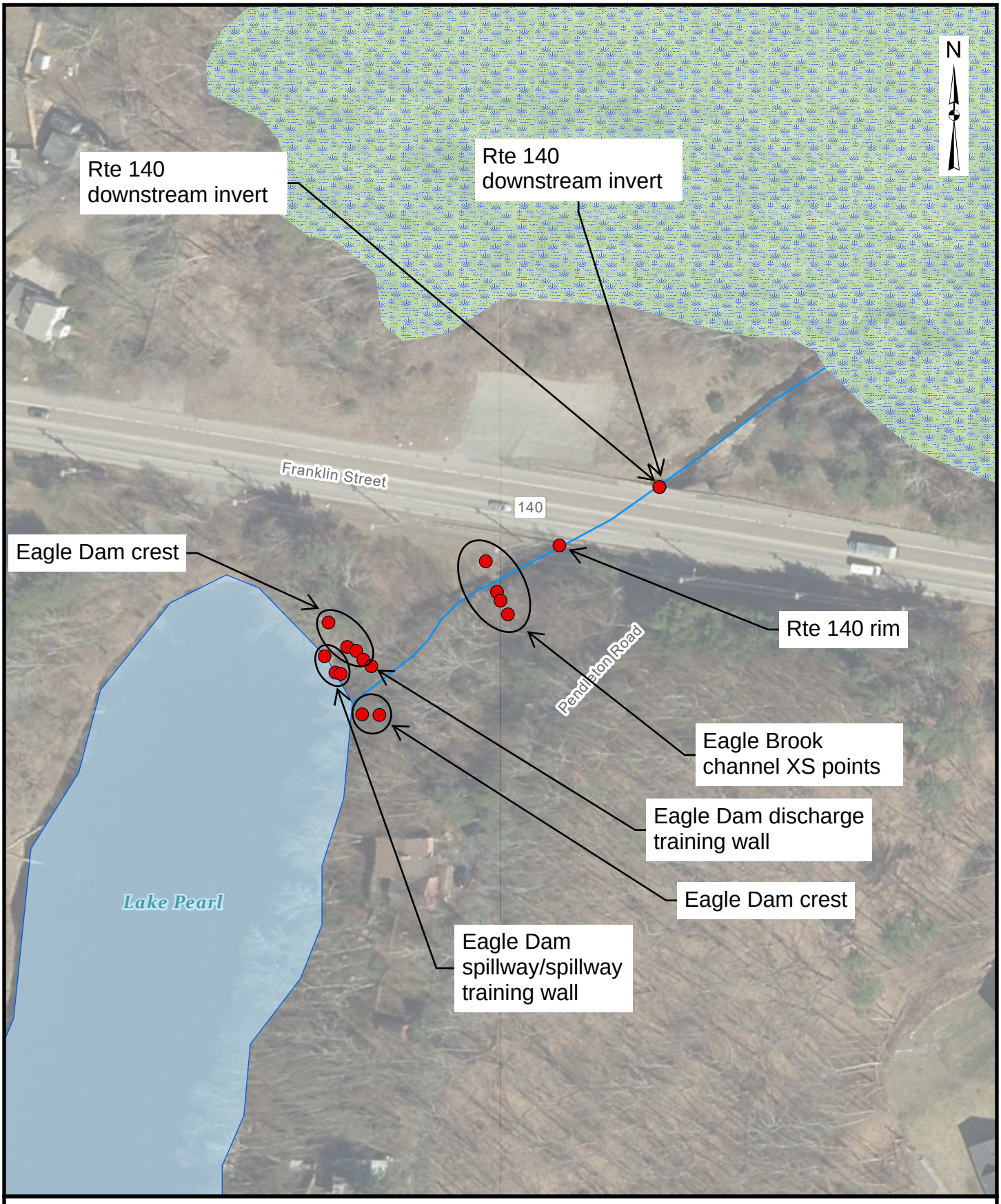


FIGURE 5 of 6
TOWNS OF NORFOLK AND WRENTHAM MASSACHUSETTS

GPS Points

100 50 0 100

Feet

Weston & Sampson

FIGURE 6 of 6
TOWNS OF NORFOLK AND WRENTHAM MASSACHUSETTS

GPS Points

150 75 0 150

Feet

Weston & Sampson