Tarbox Pond Dam

Dam Assessment Report

West Greenwich, Rhode Island

Dam Name: **Tarbox Pond Dam**
NID ID#: **RI 183**
Owner: **State of Rhode Island**
Town: **West Greenwich**
Consultant: **Pare Corporation**
Date of Report: **February 2024**

EXECUTIVE SUMMARY

At the request of the Rhode Island Department of Administration, Pare Corporation (Pare) performed a visual inspection, developed conceptual designs, and prepared this assessment report for Tarbox Pond Dam located within the Big River Management Area in the Town of West Greenwich, Kent County, Rhode Island. It is Pare's understanding that the purpose of this work is to identify deficiencies at Tarbox Pond Dam and develop concepts to reduce the frequency of flooding of Hopkins Hill Rd.

Tarbox Pond Dam (National ID RI03701/State ID 183) is classified by the Rhode Island Department of Environmental Management (RIDEM) as a low hazard structure consisting of an approximately 200-foot-long earthen embankment dam with a maximum structural height of approximately 16 feet. Appurtenant structures at the dam include a 7-foot-wide concrete spillway controlled by wooden stoplogs and discharging flows through two 36-inch diameter culverts, and a former water supply outlet consisting of four 18-inch diameter culverts. The dam is currently owned, operated, and maintained by the Rhode Island Water Resources Board, an executive agency of state government under the RI Division of Statewide Planning under the Department of Administration.

The preparation of the conceptual designs included conducting a file review with the RIDEM Office of Compliance and Inspection, a visual field inspection including a relative elevation survey using GPS, a conduit inspection of the two 36-inch diameter primary spillway culverts and the four 18-inch diameter historic water supply outlets, a hydrologic and hydraulic review of the drainage area to the impoundment, and other inspection and analysis as stated within this report. Using notes and pictures from the site visit in conjunction with the relative elevation survey and available LiDAR data, Pare prepared a site sketch for Tarbox Pond Dam including preliminary topographic data for the site and noting the locations of observed deficiencies.

In general, the overall condition of Tarbox Pond Dam is **Poor.** The dam was found to have the following deficiencies:

1. Dense woody brush, trees, and other unwanted vegetation growing on the upstream and downstream slopes and within close proximity to downstream stone masonry walls.
2. Spillway with limited capacity and susceptible to clogging resulting in roadway overtopping.
3. Deteriorated concrete at the primary spillway intake.
4. Scour and headcutting erosion at the primary spillway discharge.
5. Inadequate scour protection at the primary spillway and water supply outlet discharge areas
6. An inoperable water supply outlet system.
7. Deteriorated stone masonry walls.
8. Steep downstream slopes.
9. Evidence of seepage at the historic water supply outlet discharge and isolated areas along the toe of the downstream slope.
10. Reported beaver activity periodically disrupting dam operations.

If left uncorrected, the conditions at Tarbox Pond dam will continue to deteriorate. Pare notes that further deficiencies may be identified should the vegetation be cleared off the dam or a follow-up site visit be made in the Fall or Winter when more of the dam will be visible.

The recommended conceptual design to repair observed deficiencies and improve the overall stability of the dam generally consisted of the following items:

1. Removing unwanted vegetation from on and around the dam.
2. Flattening the downstream slope of the dam.
3. Flattening and armoring the upstream slope of the dam.
4. Installing erosion and scour protection at the primary spillway discharge.
5. Conducting a concrete repair program at the primary spillway.
6. Restoring / modifying the primary spillway.
7. Restoring flow and operability of the former water supply pipes and intake.
8. Armoring the discharge of the former water supply.
9. Installing new guardrails at the dam site.

Given the condition of the dam and the extensive effort required to bring the dam into compliance with dam safety regulations and current dam safety practices, the estimated cost to complete the recommended repairs is **$1,202,000 – $2,169,000**. Cost ranges presented are a reflection of the potential range of scope associated with the work items (which heavily depend on the findings of studies and analyses completed during a full design) and fluctuations within the construction/bidding climate.

As Tarbox Pond is not used as a water supply resource, one option to reduce the rate of flooding of Hopkins Hill Road and address safety and stability concerns at Tarbox Pond Dam is to breach the dam. While this will result in elimination of yearly operating and maintenance expenses, permitting activities and construction costs associated with dam removal are estimated at **$1,500,000 – $3,000,000**. Cost ranges are based on Pare's experience with dam removal projects in the state of Rhode Island. When completing a dam removal, additional efforts such as sediment classification, sediment management, downstream flood impacts must be considered. Additionally, removal of the dam at this location will require the installation of a bridge or culvert to allow the roadway to remain in place.

Given the high cost of the recommended rehabilitation or dam removal approaches, Pare recognizes that capital funding will need to be acquired and it may take some time to do so. To address the recurrent flooding of Hopkins Hill Road, Pare recommends that the State enter a contract with a company that installs beaver deterrent fencing and flow devices, as an interim maintenance approach. Such devices will allow water levels to remain at the prevailing level while also passing base and storm flows into the spillway. Cost for the design and installation of such a system are estimated at **$24,000- $26,000**. Maintenance of such a system would likely require the use of a diver to remove debris on an at least yearly basis. Costs for maintenance are estimated at **$3,000 - $5,000** per year.

Pare notes that prior to undertaking the proposed repair work, additional studies, design, and permitting considerations are required as stated in the report. Design of the repairs, analyses to confirm the extent of the work, and observation to verify materials/methods used should be completed by a qualified engineer experienced in the design and rehabilitation of earthen dams throughout the evaluation, design, and construction process. Additionally, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of the local conservation commission, RIDEM, or other regulatory agencies.

PREFACE

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team and other information collected as part of the evaluation.

It is critical to note that the condition of the dam is evolutionary in nature and depends on numerous and constantly changing internal and external conditions. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

David R. Caouette, P.E.	*Allen R. Orsi, P.E.*
Managing Engineer	*Senior Vice President*
Pare Corporation	*Pare Corporation*
Rhode Island License No.: 0011698	*Rhode Island License No.: 0008982*
License Type: Civil	*License Type: Civil*

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1.0 PROJECT INFORMATION

1.1 General

1.1.1 Authority

The Rhode Island Department of Administration has retained Pare Corporation (Pare) to perform a visual inspection and develop conceptual designs to address observed deficiencies for the Tarbox Pond Dam located within the Big River Management Area in the Town of West Greenwich, Kent County, Rhode Island.

1.1.2 Purpose of Work

The purpose of this investigation is to inspect and evaluate the present condition of the dam and appurtenant structures and to provide conceptual designs to address observed deficiencies at the Tarbox Pond Dam and reduce the frequency of flooding of Hopkins Hill Rd.

The investigation is divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the dam and dam site; 3) perform a visual inspection of the conduits; 4) develop a preliminary assessment of the existing spillways' ability to handle a variety of storm events; 5) prepare conceptual designs for alternatives to address observed deficiencies; and 6) prepare and submit a final report presenting the evaluation of the structure, conceptual designs, and opinions of probable costs.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix E. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; 5) general; and, 6) condition rating.

1.2 Description of Project

1.2.1 General

Sections of this report are based upon available documentation, including previous inspection reports and other available information as identified in Appendix D. Other historical information obtained during the inspection, including information provided by the caretaker has also been incorporated into this report. This material is intended to provide general information. The accuracy of this referenced information was not verified as it was outside the scope of work for this inspection.

Subsurface investigation and underwater investigations are beyond the scope of this evaluation.

1.2.2 Location

Tarbox Pond Dam is located within the Big River Management Area within Kent County in the Town of West Greenwich, Rhode Island. The dam impounds water from the Carr River to create Tarbox Pond. The structure and impoundment are shown on the Crompton, Rhode Island USGS quadrangle map at coordinates 41.63638ºN/71.57352ºW. The dam is accessible via Hopkins Hill Road. The dam is located at the western side of the impoundment along Hopkins Hill Rd as indicated on Figure 1: Locus and Drainage Area Plan.

The dam is accessible from Interstate 95 as follows: From I-95, take Exit 19 and merge onto Hopkins Hill Rd heading southbound. Continue for approximately 1.3 miles, then park at the gravel parking lot marked “Tarbox Pond Fishing Access” located along the crest of the dam.

1.2.3 Owner/Operator

The dam is currently owned, operated, and maintained by the Rhode Island Water Resources Board[1], an executive agency of state government under the RI Division of Statewide Planning under the Department of Administration.

Table 1-1: Owner/Operator Information

	Dam Owner/Caretaker
Name	Rhode Island Water Resources Board
Mailing Address	235 Promenade Street, Suite 230
Town	Providence, RI 02908
Daytime Phone	401-222-7901
Email Address	DOA.Water@doa.ri.gov

1.2.4 Purpose of the Dam

The dam was originally built to supply water to support mill operations. The mill was located on the downstream right side of the dam, but has since been demolished, with only limited foundation walls remaining. The dam currently impounds the Carr River to create the Tarbox Pond. The Rhode Island Water Resources Board, owner of the Big River Management Area, is charged with maintaining the water quality within the management area as a potential source of drinking water. The impoundment also serves as a passive recreational facility.

1.2.5 Description of the Dam and Appurtenances

Tarbox Pond Dam (National ID RI03701/State ID 183), as shown in Figure 3: Site Sketch, consists of an approximately 200-foot-long earthen embankment dam with a maximum structural height of approximately 16 feet. The dam is comprised of 3 primary components including an earthen embankment section, the spillway, and a former water supply outlet. Tarbox Pond Dam was originally constructed circa 1885[2].

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[1] As listed in the National Inventory of Dams Database

[2] As indicated in RIDEM RI Dam Safety Maps https://dem.ri.gov/online-services/data-maps

The upstream slope of the dam consists of generally shallow slopes, 4H:1V or less from the right abutment to the primary spillway and then steep slopes, 1.5H:1V, left of the spillway. The surface is primarily exposed sand and gravel, with areas of woody brush and tree growth throughout the upstream side. The crest of the dam ranges in width from approximately 24 to 30 feet, and consists of Hopkins Hill Rd, a 2-lane asphalt roadway with a crown along the centerline. Along the wider areas of the crest, gravel covered shoulders are present. The crest generally slopes downward from the abutments to the area of the primary spillway. The downstream slope of the dam is densely wooded with a variable slope. Maximum slopes on the order of 1 to 1.5H:1V are present adjacent to the primary spillway and historic water supply outlet. The remainder of the downstream slope varies between 2 and 3H:1V. Sporadic placed stones and boulders are present along the toe of the slope. Dry set stone masonry walls support the downstream side of the dam around the historic water supply outlet, and steep stone slopes abut the primary spillway discharge.

The spillway is located thru the left half of the dam and consists of one 7-foot-wide bay with wooden stoplogs. Flows over the spillway drop approximately 5 feet into a concrete stilling basin before continuing under Hopkins Hill Road through two, 3-foot diameter HDPE culverts and discharging to the Carr River.

The historic water supply outlet is located through the right half of the dam. On the upstream side of the dam, the intake is marked by a 3-sided flared concrete headwall protruding approximately 2 feet above the shoreline. Flows through the outlet were conveyed through four, 18-inch diameter vitrified clay (VC) pipes under Hopkins Hill Rd before discharging through a dry set stone masonry headwall and feeding back into the Carr River. Per a 1946 inspection report, the intakes for these pipes are reportedly plugged.

1.2.6 Operations and Maintenance

Routine maintenance at the dam is limited to the periodic removal of debris from the spillway caused by beaver activity to address periodic roadway flooding. No formal Operations and Maintenance manual is known to exist for this structure.

1.2.7 RIDEM Hazard Classification

Tarbox Pond Dam has a maximum structural height of approximately 16 feet and a reported maximum storage capacity of 255[1] acre-feet and an estimated normal pool storage volume of 190 acre-feet[2]. The dam is located within the Big River Management Area, and the downstream area is wooded and undeveloped apart from the New London Turnpike which runs over the Carr River approximately 800 feet downstream of the dam. It is estimated that a failure of the Tarbox Pond Dam at maximum pool may result in overtopping of the downstream New London Turnpike, increased pool levels and potential overtopping of Capwell Pond Dam (#281)/Burnt Sawmill Road, and flooding within downstream wetlands and wooded area. As such it appears that the Tarbox Pond Dam is accurately classified as a **Low** hazard structure.

[1] As indicated in the National Inventory of Dams Database. Note the RIDEM RI Dam Safety Maps https://dem.ri.gov/online-services/data-maps reports a conflicting storage volume of 210 acre-feet.

[2] Based on available LiDAR and an assumed normal pool level of 288.78

SECTION 2

2.0 ENGINEERING DATA

2.1 General

2.1.1 Drainage Area

As determined by the USGS StreamStats application, the drainage area for Tarbox Pond Dam is estimated to be 1.66 square miles and includes 3.0 miles of stream channel. Forested land comprises 73.6% of the drainage area, Tarbox Pond and Carr Pond comprise 9.23% of the drainage area, and 11.3% of the drainage area is comprised of wetlands.[2] 6.72% of the drainage area is developed (urban) land, and 0.99% of the drainage area is impervious.[2] The drainage area is shown in Figure 1: Locus Plan.

The drainage area extends approximately 1.2 miles north of the dam, 1 mile south of the dam, and 1.3 miles west of the dam. The entire drainage area is within the Town of West Greenwich, with the majority within the Big River Management Area with the exception of a small area of the northwestern portion that consists of a residential development. The drainage area is typically undeveloped wooded terrain.

Carr Pond Dam (RI Dam #184) is the only other apparent jurisdictional dam structure located within the drainage area of Tarbox Pond Dam. This dam impounds the Carr River upstream of Tarbox Pond Dam to create the Carr Pond.

2.1.2 Reservoir

Table 2-1 Reservoir Properties

	Length[2] (ft)	Width[2] (ft)	Surface Area[1] (acres)	Storage Volume[2] (acre-feet)
Normal Pool	300 ±	300 ±	40 ±	190±
Maximum Pool	350 ±	400 ±	50 ±	255 ±

2.1.3 Discharges at the Dam Site

No records of discharges from the dam site were made available during the preparation of this report.

2.1.4 General Elevations (feet)

Elevations are based upon GPS data approximately establishing NAVD88 vertical elevations; data is intended to establish general elevation only. As part of the survey work, a temporary benchmark was set by Pare at the top of the boulder located at the downstream left abutment, approximately NAVD88 El. 269.58, as indicated on Figure 3: Site Sketch.

[1] Normal pool values scaled from available aerial imagery. Maximum pool values scaled from available LiDAR. Values Estimated from GPS Mapping of the Site

[2] Maximum pool storage volume based on the reported storage within the National Inventory of Dams Database. Normal pool storage volume estimated by subtracting the pool storage from the assumed normal pool elevation (288.78 feet) based on calculated stage-storage values from available LiDAR surfaces.

A.	Top of Dam (Hopkins Hill Road)	290.9 ft ±
B.	Normal Pool	288.8 ft ±
C.	Spillway Crest (Stop logs)	288.75 ft ±
D.	Upstream Water during Inspection	289.3 ft ±
E.	Downstream Channel (Primary Spillway)	279.0 ft ±
F.	Downstream Water during Inspection	280.1 ft ±

2.1.5 Spillway

A.	Type	Controlled Concrete Spillway with Stoplogs
B.	Length of Weir	7 feet (1 bay)
C.	Top of Stoplogs	288.75 feet ±
D.	Invert Elevation	Unavailable
E.	Conduit	
	a. Type	2x HDPE Double Wall Corrugated Pipes
	b. Size	36-inch diameter
	c. Invert	Upstream – 285.0 ±, Downstream – 284.2 ±

2.1.6 Water Supply Outlet

A.	Type	4x Vitrified Clay Pipes
B.	Control	Intakes Plugged
C.	Size	
	a. Vitrified Clay Pipes (all four)	18-inch dia
D.	Elevations	
	a. Intake	Unavailable (buried)
	b. Outlet	280 ft ± (approximate invert of outlet)
	c. Downstream Channel	275.0

2.1.7 Design and Construction Records

Tarbox Pond Dam was reportedly originally constructed circa 1885[1]. The current concrete primary spillway and stilling basin structure was originally constructed in 1938 and has been repaired multiple times since. The historic water supply outlet was abandoned and the intake was backfilled sometime prior to 1946 and has since become silted in.

No historic design or construction records were available at the time of this report, nor were any records of operations or maintenance other than repairs to the primary spillway and stoplogs in 1986.

2.1.8 Operating Records

No operating records were made available or indicated to exist during the inspection and preparation of this report.

[1] As indicated in RIDEM RI Dam Safety Maps https://dem.ri.gov/online-services/data-maps

2.2 Hydraulic/Hydrologic Data

Tarbox Pond Dam is currently classified as a **Low** hazard potential structure. Currently, the RIDEM Rules and Regulations for Dam Safety do not specify a design storm for any dams and while Spillway Design Flood regulations. Therefore, Pare has deferred to the Natural Resources Conservation Service Technical Release 210-60 Earth Dams and Reservoirs to assume a design storm for comparison purposes. Per this NRCS document, Low Hazard dams with existing upstream dams are recommended to be designed to withstand the 100-year storm at minimum.

Pare conducted a preliminary review of the spillway's ability to pass a variety of storm events utilizing s simplified HydroCAD model assuming steady state inflow to the site based upon regressions equations utilized with USGS StreamStats for a variety of storm events. The primary spillway, discharge conduits and low-level outlet structure were included in the model. Pare notes that modeling the design storm flow as a steady-state flow over the spillway is a simplified and conservative estimation of spillway performance, as it does not take into account the hydrograph of the storm event nor attenuating effects of the impoundment, but rather applies a constant flow of water into the impoundment and thru the dam structure. This preliminary model also assumed that the former water supply pipes were non-operational and further evaluated the primary spillway discharges assuming unclogged, and partially clogged conditions (assumes clogging lower portion of the intake pipes with 12 inches of debris, as observed during the July 3, 2023 site visit). The results of this assessment are presented in the following table:

Table 2-2 Preliminary Hydrologic and Hydraulic (H&H) Analysis Results

Spillway Condition		Storm Event				
		5 yr	**10 yr**	**25 yr**	**50 yr**	**100 yr**
	24-hr Rainfall (in)	4.29	5.04	6.07	6.84	7.65
	Peak Inflow/Outflow (cfs)	34.5	43.7	59.7	72.3	87.2
	Starting Water Surface Elevation (ft)	289				
Unclogged Spillway Pipes	Peak water surface Elevation (ft)	290.05	290.25	290.46	290.6	290.73
	Freeboard (-) / **Overtopping Depth (+)** (ft)	-0.65	-0.45	-0.24	-0.1	**+0.03**
Clogged Spillway Pipes – 12 inches	Peak water surface Elevation (ft)	290.05	290.25	290.8	290.88	290.97
	Freeboard (-) / **Overtopping Depth (+)** (ft)	-0.65	-0.45	**+0.1**	**+0.18**	**+0.27**

The model results indicate that the existing spillway weir at the dam is adequate to accommodate up to the 50-year storm without overtopping the dam. However, in the event the spillway discharge pipes are clogged, spillway capacity can be significantly reduced and result in roadway/dam overtopping events at smaller return interval storms. As shown in Table 2-2, clogging the intake pipes would result in the overtopping of the dam during the 25-year event. Additional clogging would result in overtopping during smaller rain events.

2.3 Operation and Maintenance Procedures

2.3.1 Operational Procedures

The only operable component to the dam is the stoplogs at the primary spillway. Based on the current understanding operations are not typically performed at this structure.

2.3.2 Maintenance of Dam and Operating Facilities

Maintenance procedures at the dam are limited to the periodic removal of miscellaneous and beaver related debris from the spillway.

2.4 Emergency Warning System

The dam is classified as a low hazard potential structure; therefore, the development and maintenance of an Emergency Action Plan (EAP) is not required unless deemed necessary by RIDEM. An EAP is not known to exist for this structure.

SECTION 3

3.0 INSPECTION

3.1 Visual Inspection

The Tarbox Pond Dam was inspected on July 3, 2023. At the time of the inspection, temperatures were near 85ºF with fair skies. Photographs to document conditions were taken during the inspection and are included in Appendix A. The level of the pool at the time of inspection was approximately 8-inches above the spillway stoplog crest, following 0.92 inches of precipitation in the preceding 7 days. Note that vegetative debris on the stoplogs also contributed to pool levels above normal operating conditions. Underwater areas were not evaluated during this inspection beyond that which could be evaluated visually from the surface.

During the inspection, a baseline was established along the top of the dam structure with station 1+00 located at a large boulder along the downstream shoulder of Hopkins Hill Rd just beyond the left abutment (the benchmark for the site survey) and extending to station 3+20.

The limits of the dam extend from approximately Station 1+20 (approximately 20 feet left of the left wall of the primary spillway stilling basin) and Station 3+20 (approximately marked by the start of a footpath on the upstream side of the dam). Observations were referenced to the baseline where appropriate.

3.1.1 General Findings

In general, the Tarbox Pond Dam was found to be in **Poor** condition, which indicates significant structural, operational, and maintenance deficiencies. The specific concerns are identified in more detail in the sections below.

3.1.2 Dam

The following was noted along the earthen embankment portion of the dam during the inspection.

Abutments

- The structural contact between the earthen embankment and the left abutment appeared good with no signs of movement, cracking, or leakage.
    - A 3-foot wide by 6- to 12-inch-deep erosion channel was present within the downstream left groin. The erosion appeared to be likely due to surface runoff from the roadway concentrated to a path/hiking trail. The erosion resulted in a vertical headcut adjacent to the roadway. The surface of the erosion channel was exposed gravels and cobbles.
    - Several large boulders up to 5 feet in diameter were observed along the downstream shoulder and slope at the left abutment.

- The contact between the earthen embankment and the right abutment appeared good with no signs of movement or cracking.

Upstream Side

- The upstream slope between STA 1+00 through 1+30 and STA 2+50 through 3+20 was covered by dense woody brush up to 1 inch in diameter. Trees up to 8-inches diameter were present within the brush.
- In general the upstream slope was shallow, 10H:1V from the roadway to the waterline.
  - Left of the spillway the slope was shallow for a distance of 5 to 10 feet from the roadway and then sloped down at 2.5H:1V.
  - Vertical scarping ranging from 0.5 to 2.5 feet was typical along the upstream waterline from STA 1+00 - 1+30 and STA 2+50 - 3+20. The slope along the waterline in these areas generally appeared to be supported by tree and woody brush roots, as most of the soil had eroded.
  - Shallow slopes generally extended 5 to 10 feet beyond the waterline and then a steep drop off was observed.
- The slope in this area ranged from 2.5H:1V to 3H:1V upstream of the noted vertical scarping.
- An erosion channel approximately 3.5 feet wide and 0.5 feet deep extending from the roadway to the waterline was observed at STA 0+12.
- From STA 1+30 – 1+50, the upstream area consisted of the spillway.
- Trees up to 16 inches in diameter were observed growing along the upstream slope between the spillway and the left abutment.
- An approximately 7’ by 7’ by 5’ pile of dead tree branches and other beaver related debris was observed on the upstream slope at STA 1+30.
- The upstream slope from STA 1+50 – 2+25 consisted of a sand / gravel beach with a typical slope of 4:1. Trees up to 10” in diameter and tree stumps up to 6” in diameter were typical in this area.
- From STA 2+25 – 2+50, the upstream slope consisted of a concrete headwall for the historic water supply outlet.
  - The bottom of Tarbox Pond in front of the headwall was probed to a depth of approximately 1.8 feet. Pare notes that the bottom of the pond in this area felt and sounded like rock when probed but was unable to be visually inspected due to the dense vegetation in this area.
- From STA 2+50 – 3+20, trees up to 16 inches in diameter were typical along the upstream slope. The slope in this area ranged from 1:1 to 4:1 upstream of the noted vertical scarping.

Crest

- The crest of Tarbox Pond Dam consists of Hopkins Hill Rd, a two-lane crowned asphalt roadway.
- From STA 1+00 – 1+30, the upstream and downstream shoulders of the roadway range in width from 3 – 6 feet and consist of exposed soil.
- From STA 1+30 – 1+50, wooden guardrails are present on the upstream and downstream shoulders to provide a limited barrier to the spillway channel.
  - These guardrails appear in poor condition, with deterioration to the timber and broken stanchions.
  - The guardrails were less than 24-inches high and would provide limited fall or barrier protection.
  - The downstream guardrail appears to have sank / collapsed and was touching the ground.
  - Both the upstream and downstream guardrails were able to be moved with limited force applied by the inspectors.
- From STA 1+50 – 3+20, the upstream shoulder is approximately 8 feet wide and consists of gravel. It appears that this area is used for parking for the Tarbox Pond Fishing Access.
- From STA 2+00 – 3+20, the downstream shoulder is approximately 8 feet wide and consists of gravel. It appears that this area is used for parking for the Tarbox Pond Fishing Access.

Downstream Side

- Dense woody brush, vegetation, and trees up to 24 inches in diameter were typical throughout the downstream side of the dam.
- The downstream slope observed during the inspection varied between 1 and 1.5H:1V.
- Sporadic sections of stacked stone up to 24 inches in diameter were typical along the downstream slope of the dam. It appeared that the stones may have previously formed a system of walls, but the purpose of the walls is unknown. Vegetation density along the downstream slope and area prevented a clear assessment of the purpose of any walls.
- From STA 2+75 through 3+00, the downstream slope consisted of a system of dry set stone masonry walls forming the discharge structure for the former water supply outlet. The walls had a maximum height of approximately 10.7 feet. A short, steep slope, approximately 1.5H:1V and 3-feet high, was present above the stone masonry wall to extend the slope to the crest elevation.
  - Trees up to 18-inches in diameter were growing from the stone masonry wall and in close proximity to the top of the wall. Sections of the left side of the wall were displaced by tree growth.
- Several areas of seepage were noted throughout the downstream area:
  - Clear seepage was emanating from the left side of the discharge channel for the historic water supply outlet, approximately 3-feet downstream of the stone masonry headwall. Flow was estimated at 0.25 to 0.5 gpm; however, the presence of a tailwater made estimating flow difficult. No signs of sediment transport were apparent at the time of the inspection.
  - A 2-foot wide by 1-foot-deep channel was present near the toe of the dam between STA 2+30 and 2+75. The ground within the channel was saturated and had iron flocculant staining. Standing water was present. Flow, estimated at less than 0.1 gpm was present at the point of confluence with the historic water supply outlet discharge channel, but no areas of concentrated flow were observed along the length of the channel.

3.1.3 Appurtenant Structures

The appurtenant structures at the dam include the spillway and the four historic water supply outlet pipes. The general condition of each of these structures is noted below.

Spillway

- At the time of this inspection, the water level was approximately 8 inches above the top of stoplogs.
- The mudline immediately upstream of the spillway was densely vegetated and was probed to 2.3 feet below the water surface.
- The spillway weir was partially choked by dense vegetation growing up to the water surface.
- The stilling basin contained 1.55 feet of water at the time of the inspection, and dense vegetation within the basin was observed growing up to the water surface.
- The left concrete wall of the stilling basin contained a spall just above the waterline measuring approximately 1 foot wide, 3.5 feet long, and 4 inches deep.
- The right concrete wall of the stilling basin was eroded with approximately 3 inches of exposed masonry extending from the waterline to approximately 1 foot above the waterline.
- The two 3’ diameter culverts under Hopkins Hill Road appeared in good condition. The inlets to both culverts were partially clogged by aquatic vegetation, sticks, rock, and other debris. In all, approximately 12-inches of debris was blocking the bottom of each of the discharge culverts.

- The spillway culverts daylighted just downstream of Hopkins Hill Road through a concrete headwall located approximately 4 feet above the downstream waterline.
  - While the concrete forming the downstream headwall appeared in good condition the ground surface below the headwall was beginning to undermine, resulting in about 2-3 inches of stone loss beneath the headwall.
  - Pare observed evidence of erosion in the riverbed at the outlet of the culverts, however the extent of the erosion could not be estimated due to the area being inaccessible from the high flow through the outlets.
  - The pipes appeared to be two sections of double wall corrugated HDPE. The pipes appeared to be maintaining a good circular section with no holes or breaks observed; however, the downstream pipe section, in both the left and right pipes, appeared to have settled and/or rotated at the pipe joint. Settlement on the left pipe is estimated at 4 inches, while settlement on the right pipe was estimated at 2 inches. Estimates were based on viewing the pipe from the downstream discharge. Inspection of the pipes with camera equipment was not possible due to flow through the pipes at the time of the inspection.

Historic Water Supply Outlet

- The former Historic Water Supply Outlet consisted of four vitrified clay pipes under Hopkins Hill Road
  - The wall thickness of the pipes was approximately 0.11 feet.
  - The inside diameters of the pipes from left to right were as follows: 1.5’, 1.4’, 1.6’, 1.55’.
  - Leakage of approximately 0.1 gpm was observed through the rightmost historic water supply outlet pipe.
  - Leakage of approximately 3 drips per second was observed through the second historic water supply pipe from the left side.
- The concrete headwall for the historic water supply intake extended approximately 2 feet above the shoreline and consisted of three concrete sections, each approximately 5’ long and 1’ thick.
  - The concrete headwall appeared in good condition with no signs of instability.
- The dry set stone masonry headwall for the historic water supply outlets was approximately vertical and measured approximately 10.7’ high.
  - The stone masonry appeared in poor condition with trees and woody vegetation growing through the masonry, displaced / missing stones, and signs of settlement.
- The historic water supply outlets were plugged and abandoned around 1946 and are reportedly inoperable.
  - The area of the historic water supply intakes was backfilled or silted in, and the intakes could not be viewed during the inspection.
  - No controls for any of the historic water supply outlet pipes were observed during the inspection.
- A conduit inspection of the historic water supply outlet pipes was conducted using a GoPro camera and LED light. The results of this inspection were as follows:
  - Each of the historic water supply outlet pipes were inspected. Three of the four pipes were probed to a depth of up to 45 feet upstream of the discharge headwall. In general the following was noted:
    - The vitrified clay pipes appeared in good condition with no signs of structural instability or major leakage.
    - Slight displacement, ¼ to ½ inches, at the joints was noted however the joints appeared sealed and no signs of recent movement were observed.
    - Rocks up to 5 inches in diameter were observed within the pipes approximately 30 feet upstream of the headwall. The source of these rocks was unclear.

- The following was noted at the right most pipe:
  - The pipe was open with few obstructions (several stones) and some iron oxide bacterial formation along the base of the pipe.
  - Approximately 0.05 to 0.01 gpm of flow was in the pipe.
  - Probed to 45 feet.

- The following was noted at the right center pipe:
  - A thin layer of mud and iron oxide bacteria was present at the bottom of the pipe.
  - No flow was noted in the pipe.
  - More cobbles were present in the pipe than the right most pipe.
  - Probed to 45-feet. from about 35-45 feet of depth many of the joints had a heavy build-up of iron oxide bacteria from the sides and base of the pipe, with trace leakage noted.
- The following was noted at the left center pipe:
  - Approximately 2-inches of sediment was present at the base of the pipe within the downstream 10-feet of the pipe preventing the pushing of the camera up the pipe.
  - No flow was observed in this pipe
- The following was noted at the left most pipe:
  - Numerous rocks, broken bottles and other debris were present in the first 15-feet. With the exception of these obstructions, the pipe appeared in a similar condition to the other pipes.
  - The pipe was probed to approximately 32 feet.
- Each of the pipes led to a shared concrete chamber. The interior of the chamber could not be observed due to limitations on the inspection equipment.

3.1.4 Downstream Area

The area immediately downstream of the dam is densely wooded apart from the New London Turnpike, which runs over the Carr River approximately 800 feet downstream of the dam.

3.1.5 Pond Area

The impoundment is located within the Big River Management Area within the Town of West Greenwich. The dam is located at the westernmost point of the pond. Wind fetch normal to the dam is approximately 1700 feet in an easterly direction. The pond's slopes are generally shallow and generally consist of soil.

3.2 Awareness of Potential Dam related Hazards at, near, and on Dams

The following section identifies a list of potential dam related hazards which may be present in the vicinity of a dam. As part of the field inspection, the site was reviewed for the presence of these potential hazards. This list may be incomplete, and it is the responsibility of the Dam Owner to ensure compliance with Local, State, and Federal Laws, inclusive of OSHA, ADA, RIDOH, and other applicable regulators. It is the intent of this section to inform the Dam Owner of potential safety risks that may be present.

It should be noted that the scope of the safety assessment is limited to observations noted during the inspection. Pare recommends that the Owner consider completing a comprehensive site assessment by trained risk reduction and hazard assessment specialists.

Table 3-1 Potential Related Hazards At, Near, and On Dams

Hazard Category Checked	Hazard Present?		Comments
	Yes	No	
Fall Hazard	X		Potential fall hazard from Hopkins Hill Rd into spillway or downstream channel due to insufficient guardrails, potential fall hazard from upstream shoulder into stilling basin.
Submerged Inlet		X	Not applicable.
Boater Safety	X		No signs to warn boaters of spillway.
Roll Dam		X	Not applicable.
Sudden Releases		X	Not applicable.
Confined Space		X	None observed.
Ergonomic	X		No means of ergonomically removing debris from the stilling basin or stop logs from the primary spillway.
Others	X		The ground under the primary spillway discharge headwall is unprotected with signs of headcutting. Headcutting has the potential to undermine the roadway.

Implementation of any recommendations may require local, state, or federal permits as well as securing property rights if subject areas are not owned by the dam owner. Securing such permits and/or land rights is the sole responsibility of the dam owner.

3.3 Structural and Seepage Stability

No structural or seepage stability analyses are known to exist for this structure.

3.3.1 Embankment Structural Stability

The upstream and downstream slopes of the earthen embankment are overgrown in many areas with dense woody brush and large trees. While tree roots may support the earth in which they are rooted, the resulting hole that can result during a tree blowover/uprooting event can be extremely detrimental to overall dam stability. Additionally, when trees die the deteriorating root systems can create preferential seepage pathways through a dam that may result in reduced internal piping stability.

Throughout most of the dam the downstream slope is steeper than 2.5H:1V and is steeper than 1.5H:1V adjacent to the primary spillway and historic water supply outlet discharge areas. The upstream slope at the left abutment also exceeds 2H:1V. 3H:1V slopes are generally considered the maximum steepness of an earthen slope without additional evaluation and design considerations. Steep slopes may not have adequate factors of safety against slope failures that may result in a loss of the dam and or roadway along the top of the dam. There are also several areas where steep slopes are located adjacent to the roadway and/or parking areas on the roadway shoulder. It is unclear if the slopes are able to maintain adequate factors of safety as a result of additional traffic loading.

3.3.2 Structural Stability of Non-Embankment Structures

The spillway channel walls exhibited severe erosion, spalling, and cracking; however, no indications of immediate structural instability were noted. Additionally, the ground under the primary spillway discharge headwall is unprotected, with signs of headcutting. Headcutting has the potential to undermine the roadway and/or destabilize the discharge pipes headwall.

The downstream wall supporting the embankment at the historic water supply outlet appears to be deteriorated, with areas of missing/collapsed stone masonry, areas of missing chinking and load bearing stones within the face of the wall, woody brush and trees growing within gaps/joints in the stone masonry, trees growing in close proximity to the top of the headwall, and inadequate scour protection at the pipe outfall. While no immediate signs of instability were observed, continued development of the stated deficiencies could result in an unsafe condition developing. Failure of any portion of this wall would likely result in a loss of a portion of the roadway.

3.3.3 Seepage Stability

Based upon the visual inspection, limited seepage through the dam is occurring. However, Pare noted that all seepage flows appear clear with no signs of sediment transport.

SECTION 4

4.0 CONDITION ASSESSMENT

4.1 General Assessments

In general, the overall condition of Tarbox Pond Dam is **Poor.** The dam was found to have the following deficiencies:

1. Dense woody brush, trees, and other unwanted vegetation growing on the upstream and downstream slopes and within close proximity to downstream stone masonry walls.
2. Spillway with limited capacity and susceptible to clogging resulting in roadway overtopping.
3. Deteriorated concrete at the primary spillway intake.
4. Scour and headcutting erosion at the primary spillway discharge.
5. Inadequate scour protection at the primary spillway and water supply outlet discharge areas
6. An inoperable water supply outlet system.
7. Deteriorated stone masonry walls.
8. Steep downstream slopes.
9. Evidence of seepage at the historic water supply outlet discharge and isolated areas along the toe of the downstream slope.
10. Reported beaver activity periodically disrupting dam operations.
11.

If left uncorrected, the conditions at Tarbox Pond dam will continue to deteriorate. Pare notes that further deficiencies may be identified should the vegetation be cleared off the dam or a follow-up site visit be made in the Fall or Winter when more of the dam will be visible.

4.2 Dam Deficiencies

4.2.1 Unwanted Vegetation

Unwanted vegetation at the Tarbox Pond Dam consists of dense woody brush and vegetation along the upstream and downstream slopes of the dam, as well as trees and tree stumps up to 24 inches in diameter growing on the upstream and downstream slopes of the dam. Trees and woody brush growing on the slopes of a dam can be detrimental to a dam's safety in the following ways: Root systems can generate preferential pathways for seepage flows to travel through the dam (e.g. water flows along the roots, causing a hydraulic short-circuit around embankment soils). Root systems can create gaps in the embankment if the tree / brush dies and the roots decompose, resulting in preferential seepage pathways and weak points within the embankment. Uprooted root systems can cause failures of large sections of the embankment should a tree fall (e.g. if storm winds uproot a tree, it leaves a large gap behind in the embankment soils). Root systems can cause increased deterioration of appurtenant structures (e.g. roots growing through masonry walls, putting pressure on conduits, etc.). Finally, the presence of dense woody brush and vegetation along the slopes of a dam inhibit thorough inspection of the dam and may cause other dam deficiencies to go unnoticed.

4.2.2 Spillway Capacity

Preliminary review of the Tarbox Pond Dam spillway's ability to accommodate a variety of storm events indicate that the existing spillway system at the dam cannot accommodate storms larger than and including the 100-year event, assuming the spillway is maintained. Based on previous Owner reports and based on the condition of the dam at the time of the site visit, it is noted that the spillway is frequently subject to clogging from aquatic vegetation and beaver generated debris; hydraulic analysis incorporating 12 inches of debris at the spillway pipes indicates that the dam would overtop during storms equivalent to the 25-year event or larger. Note that additional debris within the spillway structure or outlet pipes would further reduce the spillway capacity and increase the frequency of roadway flooding and dam overtopping.

Insufficient spillway capacity indicates that a dam is unable to safely pass flows associated with larger storm events without overtopping. In the case of Tarbox Pond Dam, this overtopping typically results in flooding of Hopkins Hill Road. Overtopping of the dam is both disruptive to the local community who relies on this roadway, and detrimental to the safety of the structure. Overtopping during larger storm events can cause significant flows of water over the downstream slope, resulting in scour and erosion of the slope. This scour and erosion weakens the downstream slope of the dam, reducing the overall strength of the structure and could lead to the development of a breach through the embankment.

4.2.3 Deteriorated Concrete

Spalling and significant concrete erosion is present within the walls of the spillway stilling basin. The bottom of the stilling basin was obstructed by turbulent flow and collected debris/. Spalls and erosion allow water to further penetrate into the concrete structure during freeze-thaw cycles, applying significant additional internal forces to the concrete in the area of the erosion or spalling. This can result in additional deterioration of the concrete over time leading to the failure of the concrete if left unaddressed. Therefore, it is advantageous to repair spalling and erosion damage when observed to increase the service life of the concrete and maintain its structural integrity.

4.2.4 Erosion at the Primary Spillway Outlet

The primary spillway culverts at Tarbox Pond Dam daylight on the downstream side of Hopkins Hill Road approximately 4 feet above the Carr River bed. Pare observed evidence of erosion to the riverbed in this area, as well as erosion of the vertical section of the embankment beneath the headwall supporting the culvert discharge. Erosion is likely as a result of discharge flows through the spillway culverts. Allowing flow to discharge without energy dissipation will likely result in further erosion and scour at the spillway outlet and lead to further undermining of the downstream slope and potentially the loss of the embankment and/or undermining and collapse of portions of Hopkins Hill Road.

4.2.5 Inoperable Historic Water Supply Outlet

The former water supply outlets at Tarbox Pond Dam were inoperable at the time of the site visit, and the inlets on the upstream side of the dam appeared to have been backfilled or silted in at some point in the past. These outlets appear to be at a lower elevation than the primary spillway and could be an important tool for a dam operator to lower the level of the impoundment in the event of an emergency, to provide additional impoundment storage ahead of a large precipitation event, or allow for inspection of or repair to portions of the dam. With these outlets inoperable, the dam operator is left with far less control over the impoundment level.

4.2.6 Deteriorated Stone Masonry Walls

Significant deterioration to the system of stone masonry walls around the discharge structure for the former water supply outlets was observed. Missing stones and unchecked tree and woody brush growth within the stone masonry and within close proximity to the stone masonry walls result in questionable overall stability of the system. These stone masonry walls act as a support system for the downstream slope of the dam and prevent erosion to the downstream slope as a result of flows through the historic water supply outlets. When trees and woody brush are allowed to grow through the walls unchecked, rapid deterioration of the masonry occurs. This reduces the structural stability of the walls, which in turn reduces the stability of the downstream slope of the dam.

4.2.7 Steep Downstream Slopes

Downstream slopes as steep as 1H:1V are present along areas of the Tarbox Pond Dam. Steep slopes are detrimental to a dam’s safety as they have limited ability to resist the loads of the embankment soils and can be further destabilized by a high phreatic surface due to embankment seepage. Furthermore, slopes steeper than 2.5H:1V are difficult to mow and maintain, resulting in the development of unwanted vegetation and reduced access.

4.2.8 Seepage

Two areas of seepage were observed along the downstream slope of the dam: one left of the historic water supply outlets, and one through the historic water supply outlet headwall. Seepage alone is not necessarily a cause for concern, but it must be monitored to understand changes in the nature of the seepage (i.e. flow quantity, discharge location, turbidity) to further determine the effects the seepage may be having on the overall structure. Sediments in seepage flows may be indicative that soil is being transported from the inside of the embankment, which significantly reduces the strength of the embankment and increases the risk of a piping failure. Changing seepage flow rates indicate changing conditions within the embankment, such as settlement or redistribution of internal soils, which can be detrimental to overall dam stability.

4.2.9 Beaver Activity

As stated by the Rhode Island Department of Administration in the Request for Quote, beaver activity is a concern at the Tarbox Pond Dam. Beavers are attracted to the sounds of running water produced by the dam’s spillway, and stack debris in front of the spillway in an attempt to stop the flow. This decreases the capacity of the spillway and increases the pool elevation, resulting in decreased performance of the dam during storm events. The decreased capacity of the spillway increases the risk of flooding and overtopping of the dam, which can result in significant damage to the dam structure and temporary loss of the roadway service.

SECTION 5

5.0 Conceptual Design

5.1 Conceptual Design Approach

Several options for restoring the functionality of the Tarbox Pond Dam were considered. When evaluating options for dam restoration, Pare considered economic feasibility, constructability, impact to current uses of the impoundment, impact to wildlife, safety, and long term operations and maintenance.

The following remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs and remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, RIDEM, or other regulatory agencies.

5.2 Conceptual Design Recommendations

The following recommendations are actions that should be taken at the dam to improve the overall stability and functionality of the dam.

<u>Removal of Unwanted Vegetation</u>

The dam embankment and areas within 10 feet of the abutments and within 10 feet of the upstream/downstream slope toes should be cleared of unwanted vegetation and trees. Trees and existing stumps should be removed from along the upstream and downstream slopes and from the left and right abutments. Root systems with a diameter greater than 0.5 inches should be grubbed, and resulting holes filled with an engineered fill material suitable for use on a dam embankment and compacted in accordance with common dam safety practices.

<u>Flattening of the Downstream Slope</u>

Once vegetation has been cleared from the downstream slope, appropriate dam materials should be utilized to fill as necessary to reduce the maximum downstream slope of Tarbox Pond Dam to 3H:1V, or other slope angle determined to be required/allowable thru detailed slope stability analyses. Once backfilling is complete, appropriate surface treatments, such as loam treated with an embankment appropriate seed mix should be planted along the upstream and downstream slopes and crest shoulders to mitigate potential future erosion damage.

<u>Flattening / Armoring of the Upstream Slope</u>

Once vegetation has been cleared from the upstream slope, appropriate dam materials should be utilized to fill as necessary to reduce the maximum unprotected upstream slope of Tarbox Pond Dam to 3H:1V or other slope angle determined to be required/allowable thru detailed slope stability analyses. A wave run up analysis should be conducted for the dam to determine the design wave for the structure, and appropriate riprap armoring should be designed for the upstream slope to reduce erosion from wave damage.

New Guardrails

The guardrails between the primary spillway and Hopkins Hill Road should be replaced to restore rail functionality to protect the spillway and meet current traffic protection guidelines. Considerations to install additional guardrails along the entirety of the roadway should be made.

Erosion/Scour Protection at the Primary Spillway Discharge

To address scour and undermining at the primary spillway discharge, a reinforced concrete wall should be cast to extend the existing discharge headwall to the base of the dam and underpin undermining of the existing headwall. Existing erosion damage to the riverbed should be filled with appropriate materials and riprap scour protection should be placed at the outlets of the spillway culverts to buttress the downstream headwall and provide energy dissipation to protect the Carr Riverbed from scour associated with discharges from the spillway culverts. Scour protection may consist of large diameter riprap, grouted riprap, or other appropriate materials capable of dissipating the energy associated with storm flows through the spillway culverts.

Concrete Repairs at the Primary Spillway

Deteriorated concrete at the primary spillway should be removed to sound concrete and repaired. As there are approximately 6-inches between the edge of the discharge pipes and the wall face within the spillway approach, it may be beneficial to cast new reinforced concrete walls in this space to increase the strength of the spillway approach. The concrete can be designed to withstand erosive forces of entering water.

Restoration / Modification of the Primary Spillway

The primary spillway intake should be dredged to allow for the free passage of water into the discharge conduits. The intake can then be improved by extending the concrete training walls so that new stop log slots and stop log controls can be installed. The width of the intake would have to be such that flows over the stop logs are enough to meet the capacity of the discharge pipes.

The wall extensions at the primary spillway can be installed at a lower elevation than the current walls, such that if beavers dam the stoplog system these new walls can act as additional weirs until the beaver blockage is able to be removed. Should both the stoplogs and wall extensions be dammed, the original spillway walls will act as a third weir at a higher elevation to allow flows to be passed.

Restoration of Former Water Supply Outlet Pipes

As presented above, a conduit inspection of the four former water supply outlet pipes was completed and found that the pipes extend approximately to the upstream end of the roadway before a blockage occurred. The pipes are vitrified clay which may have limited capacity to withstand erosive forces from discharge flows over time. Given the good structural condition of the pipes it would likely be sufficient to slipline the pipes with a liner, which can better withstand water flow.

Restoration of Former Water Supply Intake

The former water supply intake should be dredged to allow for the free passage of water into the discharge conduits. The intake can then be improved by casting a new concrete slab along the approach to the intake and extending the flared concrete training walls so that stop log slots and stop log controls can be installed. The width of the intake would have to be such that flows over the stop logs are enough to meet the capacity of the discharge pipes.

The wall extensions at the former water supply intake can be installed at a lower elevation than the current walls, such that if beavers dam the stoplog system these new walls can act as additional weirs until the beaver blockage is able to be removed. Should both the stoplogs and wall extensions be dammed, the original spillway walls will act as a third weir at a higher elevation to allow flows to be passed.

<u>Restoration of Former Water Supply Discharge</u>

To address safety concerns with the proximity of this headwall to the crest roadway and parking areas, it is recommended that a new stone masonry or concrete wall be installed at the downstream end of the existing masonry walls in the downstream area of the former water supply outlet. Then the discharge pipes can be extended 20-feet +/- to discharge through this new wall and the space between the new wall and the existing headwall can be backfilled with earthen materials and sloped at 3H:1V to buttress the existing discharge headwall and remove the vertical drop from close proximity to the roadway. A chimney and blanket drain can be installed adjacent to existing stone masonry components to allow for seepage waters to be collected and conveyed away from the dam.

Alternative to using earthen materials, the area downstream of the discharge headwall could be buttressed with riprap and the discharge pipes extended slightly to discharge onto a riprap stilling basin. If no buttressing is completed then it would likely be recommended to install guardrails on the crest of the dam to limit the proximity of traffic loading to the downstream wall.

<u>Maintenance Associated with New Design</u>

Maintenance associated with this new design would include clearing the former water supply intake and primary spillway quarterly of debris to ensure beaver activity does not disrupt dam performance. Additionally, the valves for the historic water supply outlets and spillway bypass pipes would need to be exercised quarterly to ensure their continued operability. Pare notes that this design approach would not impact current recreational uses of the impoundment.

5.3 Interim Maintenance

As requested by the RIDOA, this section provides recommendations for interim maintenance actions that can be taken while funding for a larger project aimed at dam rehabilitation is developed.

<u>Previous Recommendations</u>

Previous recommendations to address safety concerns at the dam including frequent overtopping of Hopkins Hill Road are presented in the March 2022 Natural Resources and Implementation Report for the Big River Management Area report prepared by EA Engineering. Recommendations within this report include the removal of several stoplogs at the main spillway and installation of a trash rack. While these recommendations remain valid, they may present several issues dealing with maintenance and use of the impoundment.

Removal of stoplogs will lower the operating elevation of the impoundment. While this will provide for additional storage in the impoundment, it will also result in the exposure of additional bank around the impoundment. This exposed bank overtime will likely fill in with vegetation and could add to the organic load within the impoundment. Reduction of the water level may also affect the aquatic animal species within the impoundment by changing the extent and type of habitable zones. Additionally, simply removing stoplogs and installing a trash rack does not necessarily address or deter beaver activity, nor does it lessen the need to complete debris related maintenance as the narrow restriction caused by the spillway geometry will remain, and the trash rack will continue to catch debris at the spillway.

Current Recommendation

Pare recommends that the RIDOA enter into an agreement with a contractor that specializes in beaver deterrence and the installation of beaver resistant flow devices. Systems installed by these types of contractors can be effective at maintaining the existing reservoir elevations and ecology and allow for similar flows to reach the spillway.

Appendix C provides additional details on the fence and pipe intake construction. While beavers will continue to dam the area in front of the fence; the larger effective length of the fence compared to the spillway opening, allows for similar flows to enter the discharge culverts, during a storm event. The addition of the domed intake fence and pipe allows for base flows to continue through the upstream fenced area during periods of normal flow. Additional pipes can be added to accommodate varying quantities of base and/or flood flows.

This system is fairly inexpensive and can be easily installed. Maintenance of the system and clearing of debris can be extremely difficult given the location of the barriers within the impoundment and may require the use of a diver. However, given the longer length of the flow area, the number of maintenance trips per year can likely be lessened than current requirements. Also, having a submerged intake could become a hazard for boaters or swimmers and it is therefore recommended that such a device be clearly marked by signage or buoys.

Typically, the materials used in the construction of beaver deceiver devices (as presented in the appendix) last approximately 5 to 10 years before requiring replacement.

SECTION 6

6.0 Design Alternatives

6.1 Alternative Design Approach

Pare evaluated several options for reducing the frequency of flooding of Hopkins Hill Road without fully restoring the functionality of the Tarbox Pond Dam. When evaluating alternative options, Pare considered economic feasibility, constructability, impact to recreational uses of the impoundment, safety, impact to wildlife, and long term operations and maintenance.

Pare recommends that the removal of unwanted vegetation, armoring of the upstream slope, flattening of the downstream slope, concrete repairs at the primary spillway, masonry repairs at the historic water supply outlet headwall, erosion/scour protection at the primary spillway discharge, and new guardrails from the Conceptual Design section be implemented in addition to the alternative designs presented below.

Prior to undertaking recommended maintenance, repairs and remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, RIDEM, or other regulatory agencies.

6.2 Alternative Designs

Restoration / Modification of the Primary Spillway – Alternative B

The primary spillway intake should be dredged to allow for the free passage of water into the discharge conduits. The intake can then be improved by casting a new concrete slab along the approach to the intake and extending the concrete training walls to install an arched concrete ogee weir. The elevation of the weir would be designed to match that of the existing stop logs and maintain the current normal pool elevation. The arched weir would have a longer overall length than the existing spillway to reduce the effects that beaver debris may have on the overall capacity of the spillway.

An optional addition to Alternative A or B would be to include a bypass pipe with a valve installed into the headwall extension below the normal pool level such that the pool level within Tarbox Pond could be drawn down by dam operators when required.

Restoration of Former Water Supply Intake – Alternative B

The former water supply intake should be dredged to allow for the free passage of water into the discharge conduits. The intake can then be improved by casting a new concrete slab along the approach to the intake and extending the flared concrete training walls to install an arched concrete ogee weir. The elevation of the weir would be designed to be slightly higher than the primary spillway weir to deter beaver activity at the former water supply intake. This would allow the former water supply intake to operate as an auxiliary spillway in the event beaver debris reduced the capacity of the primary spillway.

An optional addition to Alternative A or B would be to include a bypass pipe with a valve installed into the headwall extension below the normal pool level such that the pool level within Tarbox Pond can be drawn down by dam operators when required.

Restoration of Former Water Supply Intake – Alternative C

The former water supply intake should be dredged to allow for the free passage of water into the discharge conduits. The intake can then be improved by installing riprap scour protection between the existing flared concrete walls and installing control gates at the upstream end of the discharge pipes to control flow.

Historic Water Supply Outlet as Primary Spillway

Based on the USGS StreamStats report, the 50% duration base flow at Tarbox Pond Dam is estimated at approximately 2 cfs. This flow could easily be accommodated through the historic water supply outlets. Therefore, an alternative option available to the dam owner when restoring operability to these outlets is to design the crest height at the historic outlets slightly lower than that at the current primary spillway, routing the majority of flows through the historic outlets.

The benefit to routing the base flows through the historic outlet is that this would focus the majority of the beaver activity at the smaller historic outlets, leaving the larger primary spillway clear to pass larger storm flows. The disadvantage to this design is that the historic water supply outlet culverts are significantly smaller than the primary spillway culverts, making them easier to clog and harder to clean.

It should be noted that if the primary spillway and historic water supply outlets are restored as recommended in Alternative A with a stoplog system, the routing of base flows could be alternated by manipulating the stoplogs at either location. If Alternative B is selected instead, the routing of base flows will have to be decided upon before construction is commenced.

Restoration of Former Water Supply Discharge

Alternative to using earthen materials, the area downstream of the former water supply outlet discharge headwall could be buttressed with riprap and the discharge pipes extended slightly to discharge onto a riprap stilling basin. If this alternative is pursued then it would be recommended to install guardrail along the top of the discharge headwall to keep traffic away from the steep riprap slope and to keep traffic loading off of the discharge headwall.

Upstream Floodwall

An alternative option to reduce the frequency of flooding on Hopkins Hill Road without significant redesign of the spillway or repair to the historic water supply outlets is to install a floodwall on the upstream side of the road. This would effectively increase the height of the dam, in turn increasing the maximum capacity of Tarbox Pond. Further H&H analysis would be required to determine the required height of this floodwall and design the floodwall such that the dam could withstand the 100-year storm without flooding Hopkins Hill Road.

Maintenance associated with this new design would include clearing the spillway of debris to ensure beavers are unable to dam it.

As this solution would not require redesign of the spillway or historic water supply outlets, it may be significantly cheaper to implement than other designs presented. The installation of an upstream floodwall may present a challenge to retain the current accessibility of Tarbox Pond for fishing and recreational boating; however, as boating is not a desired activity within the Big River Management Area, the presence of a flood wall may be a beneficial deterrent. In addition, this solution would require analysis of Tarbox Pond to ensure that raising the maximum pool elevation at Hopkins Hill Road would not result in overflow or flooding elsewhere along the shoreline.

Increase Spillway Capacity

Another alternative option to reduce the frequency of flooding on Hopkins Hill Road without restoring operability to the historic water supply outlets is to increase the capacity of the primary spillway such that it can pass 100-year storm flows. This would consist of designing a new spillway and stilling basin, as well as a bridge and box culvert under Hopkins Hill Road to carry the additional flows. Pare notes that this could be constructed either in the area of the current spillway or in the area of the historic water supply outlets. If this was constructed in the area of the historic water supply outlets, the current spillway could pass normal flows during construction to avoid the construction of a temporary bypass culvert.

As this solution would require the design of a large box culvert and bridge for Hopkins Hill Road, it is likely significantly more expensive than other available options.

Lower the Normal Pool Level of Tarbox Pond

As Tarbox Pond is not used as a water supply resource, another option to reduce the rate of flooding of Hopkins Hill Road is to lower the spillway crest elevation, lowering the normal pool level of Tarbox Pond. This would effectively increase the height of the dam and increase the freeboard available during the SDF. Pare would conduct further H&H analysis to determine the required drop in pool elevation required to withstand the 100-year storm without flooding Hopkins Hill Road. In addition, the weir would be extended into the impoundment or widened into a large horseshoe to mitigate beaver activity at the dam.

Maintenance associated with this new design would include clearing the spillway quarterly of debris to ensure beavers are unable to dam it.

As this solution would not require major redesign of the spillway or historic water supply outlets, it may be significantly cheaper to implement than other designs presented. That being said, the lowering of the pool elevation may reduce the usability of Tarbox Pond for recreational purposes and may impact wildlife.

Beaver Fencing

Alternate to or in combination with the proposed spillway improvements a “beaver deceiver” fence and/or intake pipe could be installed upstream of one or both (if restored) spillways at the dam structure. See Appendix C for additional details on the fence and pipe intake construction. These devices allow for beavers to continue to dam the area in front of the culvert; however given the fences large effective length, enough flow is allowed to overtop the beavers dammed area to enter the discharge culverts. The addition of the domed intake fence and pipe would allow for base flows to continue through the upstream fenced area in the event the beaver damming gets to high. Additional pipes can be added to accommodate varying base flows.

This system is fairly inexpensive and can be easily installed; however, maintenance of the system and clearing of debris can be extremely difficult given the location of the barriers within the impoundment. Also having a submerged intake fence could become a dangerous obstacle for boaters or swimmers.

Typically the materials used in the construction of beaver deceiver devices (as presented in the appendix) last approximately 5 to 10 years before requiring replacement.

Accept Flood Risk

Alternate to restoring the historic water supply outlet, or completing other improvements that increase overall spillway capacity, the State can accept the risk of flooding over Hopkins Hill Road. This will result in the loss of service of the roadway for the duration of flooding, as well as during the completion of any necessary repairs. Allowing overtopping of the dam embankment may also result in full or partial failure of the dam, which would result in downstream flooding, sediment release, and a loss of service of the roadway, and loss of the impoundment as a recreational resource.

Removal of Tarbox Pond Dam

As Tarbox Pond is not used as a water supply resource, one option to reduce the rate of flooding of Hopkins Hill Road and address safety and stability concerns at Tarbox Pond Dam is to breach the dam. While this alternative will address the safety concerns, it will result in the loss of the recreational, flood attenuation, and environmental resource created by the dam. Further, while this will result in elimination of yearly operating and maintenance expenses, permitting activities and construction costs associated with dam removal may exceed those of rehabilitation and maintenance.

SECTION 7

7.0 Additional Considerations

7.1 Additional Studies

The following additional studies are proposed to gather adequate information to complete a final design at this structure.

7.1.1 Subsurface Exploration

A subsurface exploration and laboratory testing program for the Tarbox Pond Dam site would allow Pare to determine the composition and in-situ compaction of embankment materials and native site soils, determine the depth to bedrock at the site, complete in-field permeability tests to evaluate hydraulic conductivity of embankment materials and native site soils, and provide the data needed to complete a detailed seepage and slope stability analysis for the embankment.

7.1.2 Seepage and Slope Stability

A seepage and slope stability analysis is recommended for completion to assess the existing embankment for compliance with common dam safety stability criteria. While the RIDEM Dam Safety program does not currently require compliance with any specific stability criteria, it is common practice in the event of a lack of State requirements, to default to a suitable federal standard, such as the Army Corps, Natural Resources Conservation Service, or Bureau of Reclamation.

7.1.3 Hydraulic & Hydrologic Analysis

A Hydraulic & Hydrologic Analysis of the Tarbox Pond Dam site would allow for the evaluation of the performance of Tarbox Pond Dam during a variety of potential storm events, determine the additional flow capacity required to reduce flooding of Hopkins Hill Road, account for the attenuation effects of the dam, and allow for a more detailed evaluation of the effects of increasing the dam's capacity by restoring operability of the historic water supply outlets and / or expanding the spillway. This analysis would also allow for the evaluation of the potential flooding risk to downstream areas associated with potential increases in flow capacity through the dam and evaluate the risk of downstream flooding in the occurrence of a dam failure.

7.1.4 Topographic and Partial Bathymetric Survey

While a limited topographic survey was performed as part of this conceptual evaluation, a detailed topographic survey of the dam and partial bathymetric survey of the Pond is required to provide accurate representation of current site conditions and support required analyses and design. A partial bathymetric survey would aid in determining the capacity of Tarbox Pond and increase the understanding of how operations at the dam may be able to affect the ability of the dam to pass a variety of storm events. Limits of a topographic survey should extend a minimum of 50-feet beyond the abutments and 50-feet beyond the toe of the downstream slope/proposed limits of work (whichever is further). A partial bathymetric survey should be completed extending at least 30-feet beyond the toe of the upstream slope. Beyond the limits of the survey, ground surfaces can be estimated using available RIGIS LiDAR surfaces.

7.1.5 Wetland Delineation & Tree Count

A wetland delineation will be required to apply for permits that will be required to complete the recommended work items. Wetlands will need to be flagged and the flag locations surveyed to be included on an existing condition plan to determine the impacts of the proposed improvements. Wetland reports in conformance with Army Corps standards should be prepared in support of permit applications. A count of trees larger than 3-inches diameter at breast heigh subject for removal should be completed to assess potential impacts to the northern long eared bat. Such a tree count will be required for any Army Corps permits.

7.2 Permitting Considerations

Given the nature of the site and adjacent resource areas, impacts to freshwater wetlands and other jurisdictional areas are unavoidable. As such, a number of permit will be required prior to implementing any repair work. The following sections describe the permits that should be anticipated.

7.2.1 RIDEM Dam Safety Permit

Tarbox Pond Dam is a low hazard potential structure and may be exempt from requiring a Rule 10 Approval under 250-RICR-130-05-1, however the proposed repairs to the dam will still require the review and approval of the RIDEM Director under the Dam Safety Regulations. It is likely that the Dam Safety Program will require that the repairs keep the dam consistent with previous dam operations and may require a review of the hazard classification of the dam.

7.2.2 RIDEM Freshwater Wetlands

A RIDEM Freshwater Wetlands permit will be required before conducting activities at the dam which will result in alterations to freshwater wetlands, alterations in the volume of water flowing into or draining away from wetlands, or other activities as defined by RI Rules and Regulations Governing the Administration and Enforcement of the Fresh Water Wetlands Act (250-RICR-150-15-1).

7.2.3 Floodplain Management Coordination

Coordination with floodplain management may be required before increasing the discharge capacity of the Tarbox Pond Dam to evaluate the impacts to downstream stakeholders.

7.2.4 Army Corps of Engineers

A permit from the US Army Corps of Engineers will be required before conducting any work at Tarbox Pond Dam which will impact wetlands or other waterbodies. Depending on the quantity of temporary and permanent impacts to land under water, bank, and river/stream channel, the Army Corps permitting process could vary from a self-verification permit to requiring an individual permit.

7.3 Construction Considerations

7.3.1 Control of Water

As the Tarbox Pond Dam is currently operational and must remain so throughout the duration of the work, temporary dewatering of areas of the dam and temporary diversion of flows around the dam may be required during construction. This may consist of temporary installation of cofferdams and dewatering around appurtenant structures, temporary installation of pumps and pipelines to divert flows around the dam, temporary lowering of Tarbox Pond, or other water control methods not listed here.

If the former water supply outlet is restored this will likely require the installation of an upstream cofferdam to allow for the dredging of the intake and installation of new controls. Once this outlet is restored, then the restored outlets could be utilized for base flow diversion while repairs are completed at the primary spillway, limiting the need for additional flow diversion measures during repairs at the primary spillway.

7.3.2 Traffic Control

Due to the location of Tarbox Pond Dam and the geometry of the dam site, it is likely that construction at the dam will temporarily impact traffic flows and normal use of Hopkins Hill Rd. These impacts may include reduced parking along the shoulders of the roadway near Tarbox Pond Dam, reduction of traffic along the road to one lane, or temporary road closures and detours. One potential detour via Division Street, Carrs Pond Road, and Bates Trail has been identified and is approximately 5-miles long.

7.3.3 Available Borrow Materials

It is likely that the nearby Hopkins Hill Sand and Stone gravel pit could blend materials suitable for use on the dam. Alternatively, Richmond Sand and Stone has experience in blending materials for use in dam/levee construction.

7.3.4 Construction Schedule

The construction schedule of work at Tarbox Pond Dam should be considered to reduce the impacts of construction to current dam uses. Typically dam construction is performed during the drier months of mid-summer to early fall; however, , the time of year for construction will have to be balanced with the temporary loss of use of the recreational facility.

SECTION 8

8.0 OPINIONS OF PROBABLE COSTS

8.1 Opinions of Probable Costs

The following conceptual opinions of probable costs have been developed for the conceptual and alternative designs noted above. The costs shown herein are based on a visual investigation and are provided for general information only. This should not be considered an engineer's estimate, as actual construction costs may be somewhat less or considerably more than indicated based upon additional information gathered during the design phase.

8.1.1 Conceptual Design

Interim Maintenance

1. Beaver Fencing & Piping - Design	$	4,000	-	$	6,000
2. Beaver Fencing & Piping - Installation	$	10,000	-	$	20,000
3. Debris Maintenance (Per 5 years)	$	15,000	-	$	30,000
Subtotal	**$**	**29,000**	**-**	**$**	**56,000**

Studies and Analyses[1]

1. Subsurface Exploration	$	15,000	-	$	30,000
2. Seepage and Slope Stability	$	7,000	-	$	15,000
3. Hydraulic & Hydrologic Analysis	$	15,000	-	$	25,000
4. Topographic and Partial Bathymetric Survey	$	10,000	-	$	25,000
5. Wetland Delineation, Tree Count, and Reporting	$	7,000	-	$	15,000
Subtotal	**$**	**54,000**	**-**	**$**	**110,000**

Conceptual Design – Base Dam Repairs[2]

1. Removal of Vegetation from Dam	$	75,000	-	$	110,000
2. Flattening of Downstream Slope	$	300,000	-	$	500,000
3. Flattening / Armoring of Upstream Slope	$	20,000	-	$	50,000
4. Guardrail Replacement	$	30,000	-	$	50,000
5. Installation of Spillway Outlet Scour Protection	$	40,000	-	$	60,000
6. Concrete Repairs at Primary Spillway	$	10,000	-	$	30,000
7. Control of Water	$	50,000	-	$	100,000
8. Traffic Control	$	30,000	-	$	75,000
Subtotal	**$**	**555,000**	**-**	**$**	**975,000**
Engineering & Design	$	40,000	-	$	75,000

[1] Costs ranges presented in the Studies and Analysis section are a reflection of the potential range of scope associated with the stated item.
[2] Cost ranges presented in the Base Dam Repairs section are a reflection of the potential range of scope associated with the work items (which heavily depend on the findings of the Studies and Analyses) and experienced fluctuations within the construction/bidding climate.

	Permitting	$	20,000	-	$	30,000
	30% Contingency	$	167,000	-	$	293,000
	Subtotal	**$**	**782,000**	**-**	**$**	**1,373,000**

Conceptual Design – Alternative Repairs[1]

1.	Restoration of Primary Spillway Alt. A*	$	50,000	-	$	100,000
	Restoration of Primary Spillway Alt. B	$	75,000	-	$	125,000
2.	Restoration of Former Water Supply Outlet Pipes*	$	50,000	-	$	75,000
	Accept Flood Risk/Lower Design Storm	$	0	-	$	0
3.	Restoration of Former Water Supply Intake Alt. A*	$	50,000	-	$	100,000
	Restoration of Former Water Supply Intake Alt. B	$	125,000	-	$	175,000
	Restoration of Former Water Supply Intake Alt. C	$	80,000	-	$	100,000
	Accept Flood Risk	$	0	-	$	0
4.	Restoration of Former Water Supply Discharge - Earthen*	$	50,000	-	$	90,000
	Restoration of Former Water Supply Discharge - Riprap	$	30,000	-	$	60,000
5.	Upstream Floodwall	$	300,000	-	$	400,000
6.	Increase Primary Spillway Capacity	$	900,000	-	$	1,250,000
7.	Beaver Fencing*	$	20,000	-	$	30,000
	Beaver Piping	$	30,000	-	$	50,000
	Subtotal (Recommended Alternative)	**$**	**220,000**	**-**	**$**	**395,000**
	Engineering & Design	$	50,000	-	$	75,000
	Permitting	$	30,000	-	$	70,000
	30% Contingency	$	66,000	-	$	119,000
	Subtotal (Recommended Alternatives)	**$**	**366,000**	**-**	**$**	**684,000**

***** Indicates the recommended alternative.

Grand Total (Studies, Base Dam Repairs, & Rec. Alt. Repairs) $1,202,000 – $2,169,000

Note that the above stated total only includes the price range for the recommended alternative work items.

For comparison purposes the estimated cost for design, permitting, and construction of a dam removal is presented below.

Dam Removal[2] **$1,500,000 – $3,000,000**

When comparing costs, the total cost including design, engineering, permitting, construction and long-term maintenance should be considered.

[1] Cost ranges presented in the Base Dam Repairs section are a reflection of the potential range of scope associated with the work items (which heavily depend on the findings of the Studies and Analyses) and experienced fluctuations within the construction/bidding climate.

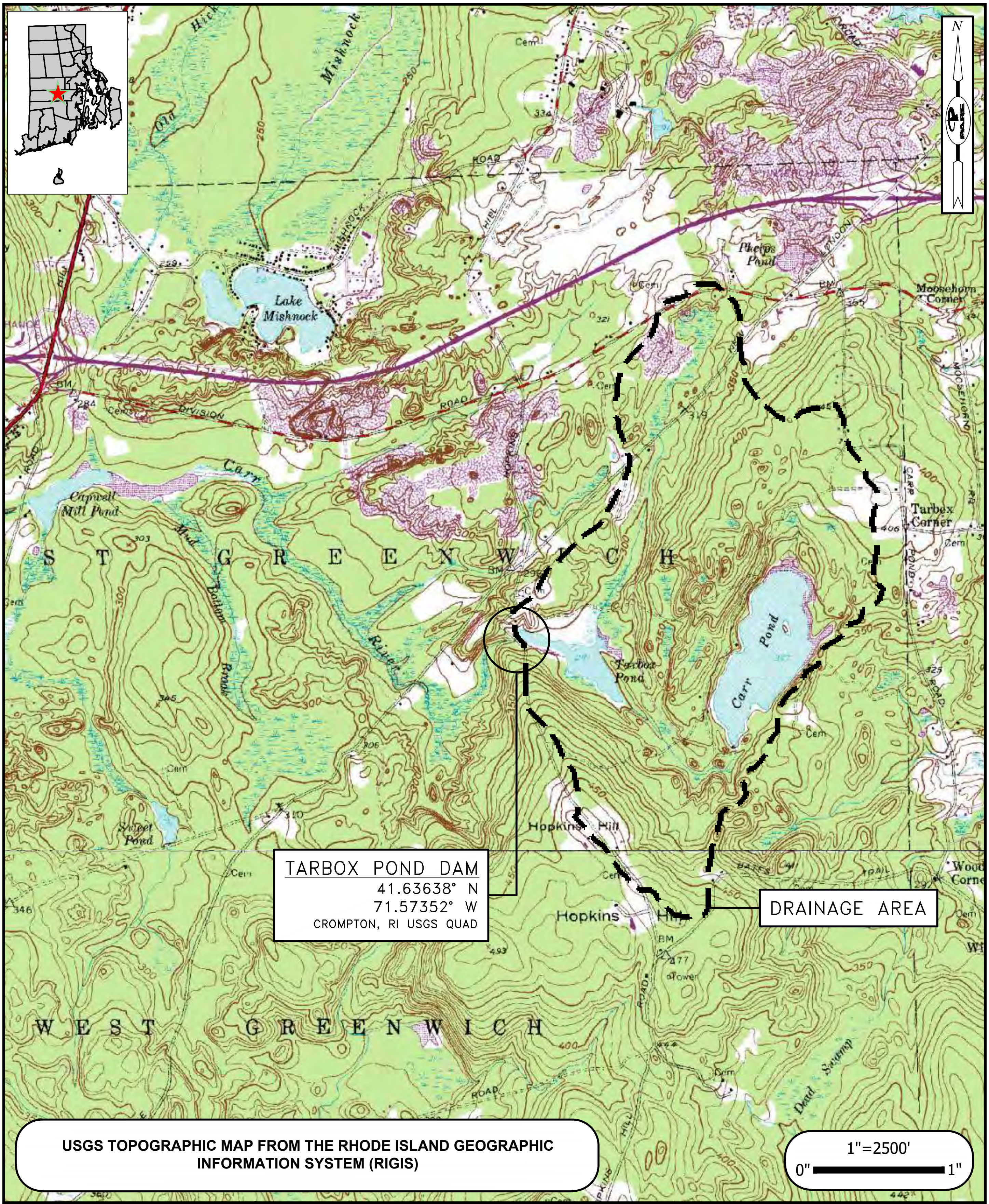
[2] This estimated cost is based on recent dam removals completed by Pare. When completing a dam removal, additional efforts such as sediment classification, sediment management, downstream flood impacts must be considered. Additionally removal of the dam at this location will require the installation of a bridge or culvert to allow the roadway to remain in place.

The applicability of other environmental permits (ie., Freshwater Wetlands, Dam Safety, PGP, Water Quality Certificate, ACOE etc.) needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of RIDEM, or other regulatory agencies.

Tarbox Pond Dam

West Greenwich, RI

FIGURES



PARE CORPORATION

TARBOX POND DAM ASSESMENT

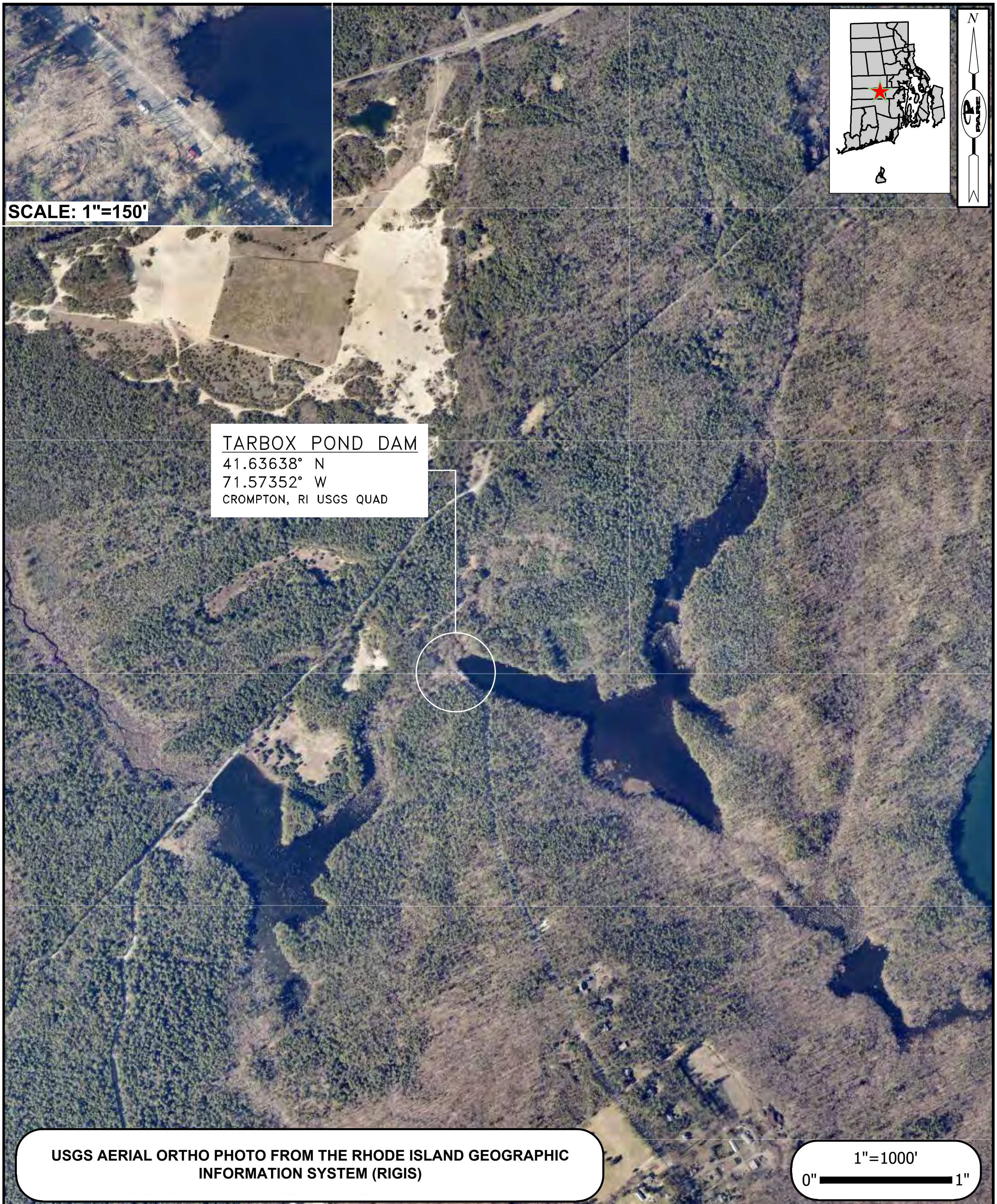
RI DAM #183

WEST GREENWICH, RHODE ISLAND

LOCUS PLAN

NOVEMBER 2023

FIGURE 1



PARE CORPORATION

TARBOX POND DAM ASSESMENT

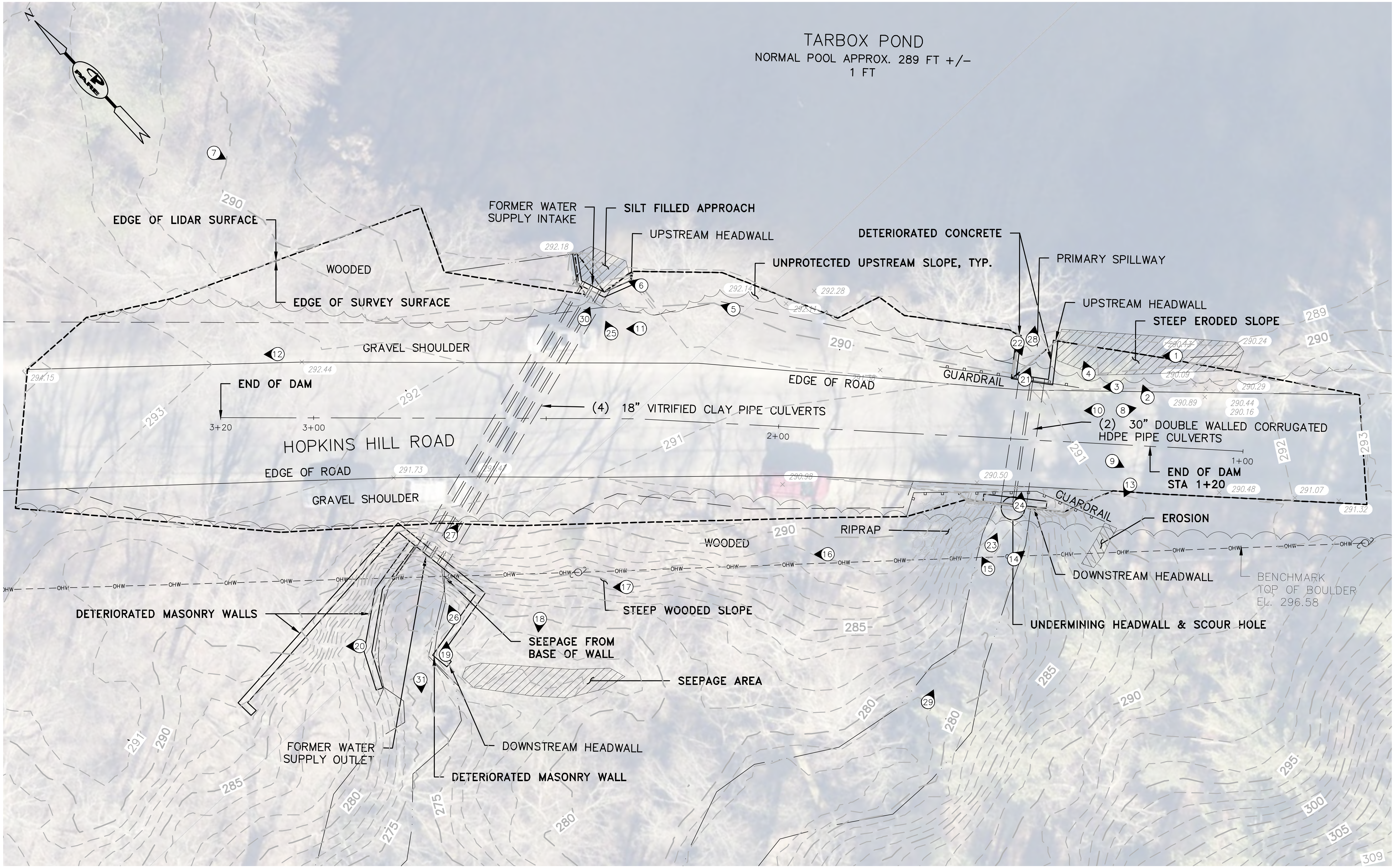
RI DAM #183

WEST GREENWICH, RHODE ISLAND

AERIAL PLAN

SEPTEMBER 2023

FIGURE 2



NOTES AND LEGEND

1. PLAN DEVELOPED GPS SURVEY TAKEN DURING THE INSPECTION AND SUPPLEMENTED WITH AVAILABLE RIGIS LiDAR. INFORMATION IS PROVIDED FOR REFERENCE PURPOSES ONLY.

(#) DENOTES APPROXIMATE LOCATION AND DIRECTION OF PHOTOGRAPH.

SITE SKETCH

SCALE: 1"=20'±

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SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

TARBOX POND DAM ASSESMENT
RI DAM #183
WEST GREENWICH, RHODE ISLAND

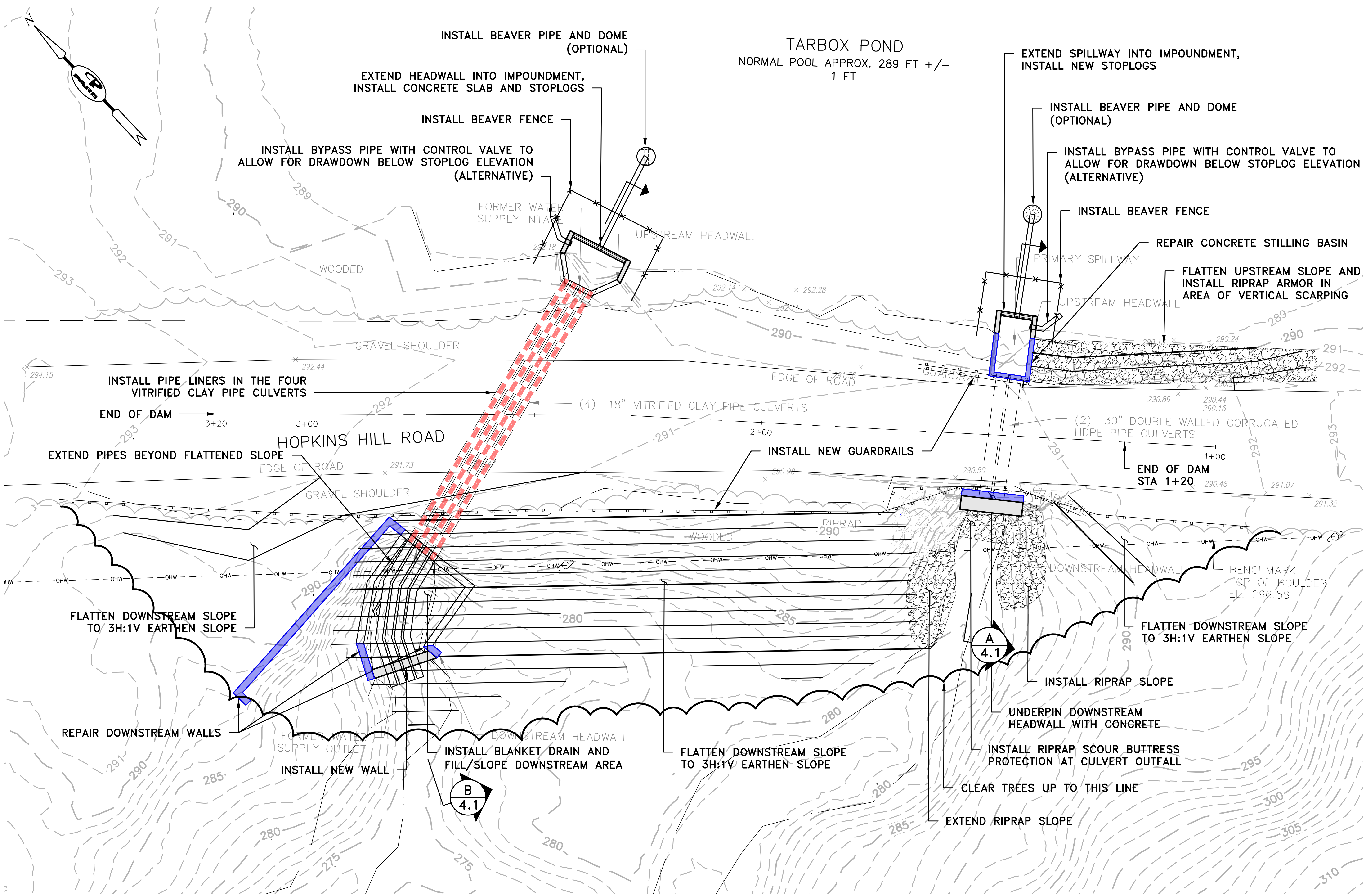
REVISIONS:

PROJECT NO.:	23116.00
DATE:	SEPTEMBER 2023
SCALE:	AS NOTED
DESIGNED BY:	DM
CHECKED BY:	ARO
DRAWN BY:	LMC
APPROVED BY:	ARO

SITE SKETCH

FIGURE NO.: 3.0

X:\JOBS\23_Jobs\23116.00 RIDOA - TarboxPondDamAssessment - RI\DWG\Fig 3.0 - Site Sketch.dwg



ALTERNATIVE A

SCALE: 1"=20'±

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TARBOX POND DAM ASSESMENT

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ALTERNATIVE A

FIGURE NO.: 4.0

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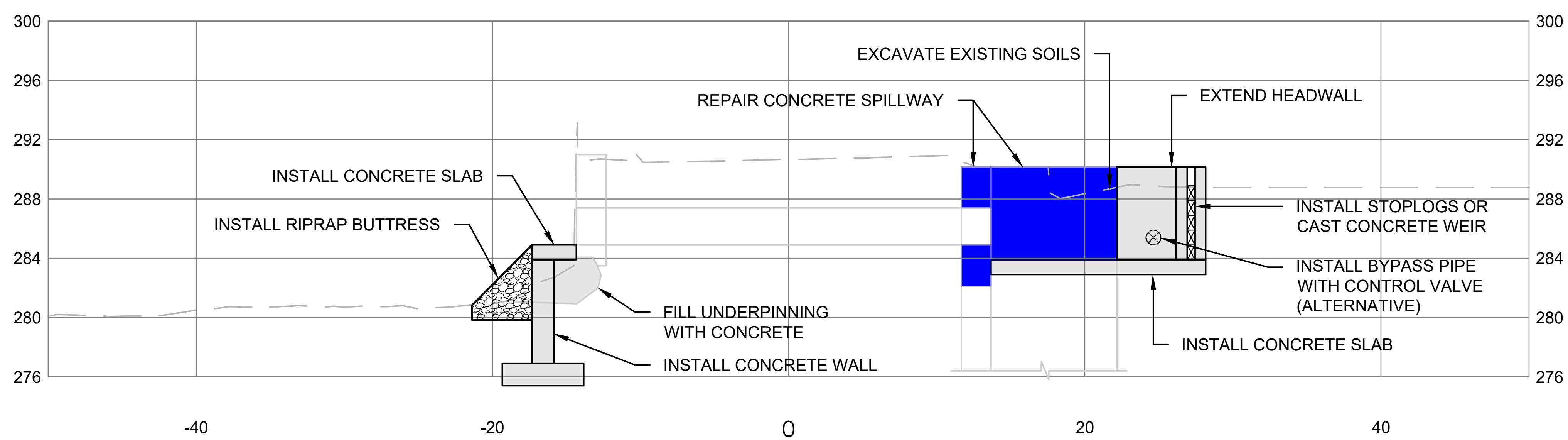

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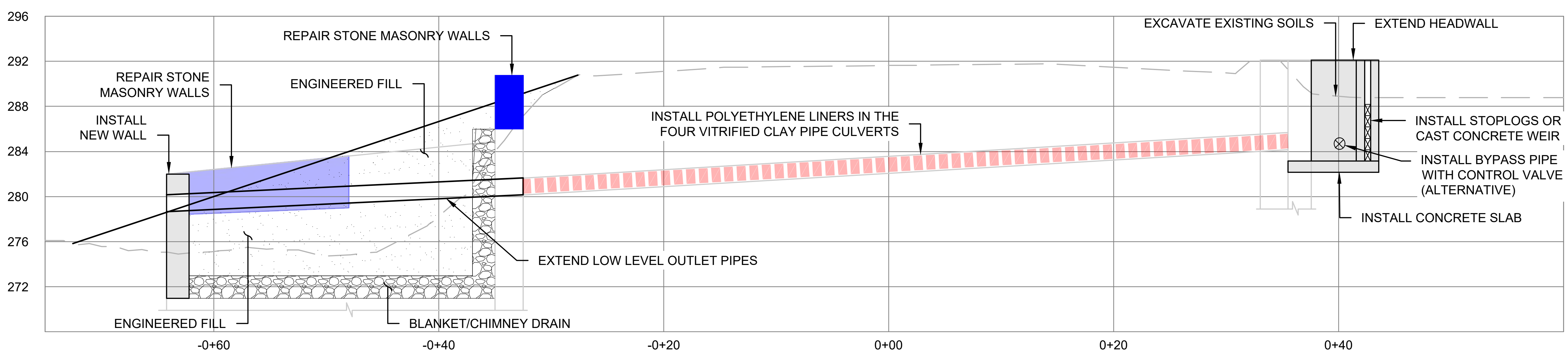

B / 4.0 SECTION B
SCALE: 1"=10'

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TARBOX POND DAM ASSESMENT
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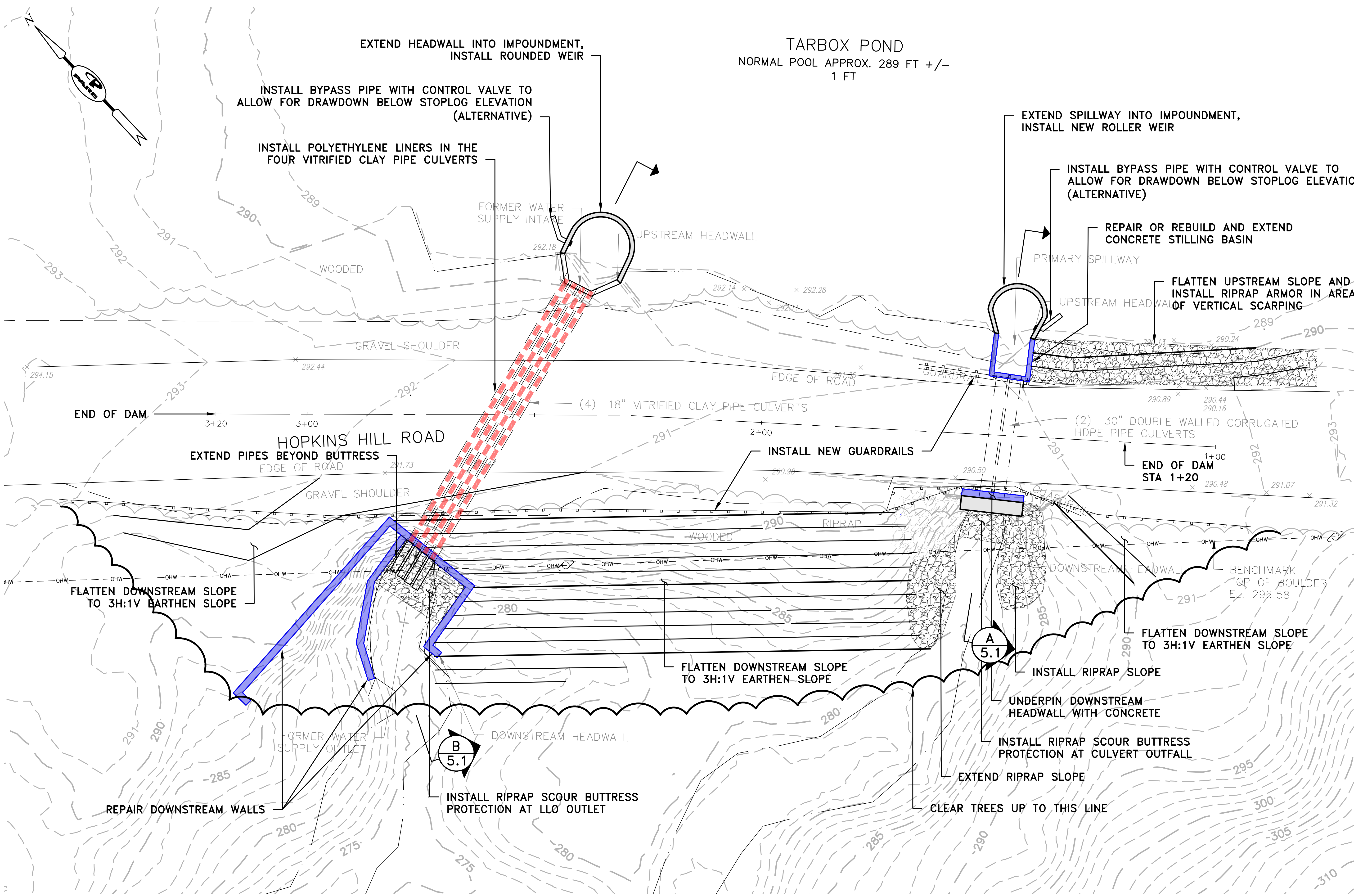
ALTERNATIVE A SECTIONS

FIGURE NO.: 4.1

Y:\JOBS\23 Jobs\23116.00 RIDOA - TarboxPondDamAssessment - RI\DWG\FIG 4.1 ALT A SECTIONS.dwg



ALTERNATIVE B

SCALE: 1"=20'±

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TARBOX POND DAM ASSESMENT
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ALTERNATIVE B

FIGURE NO.: 5.0

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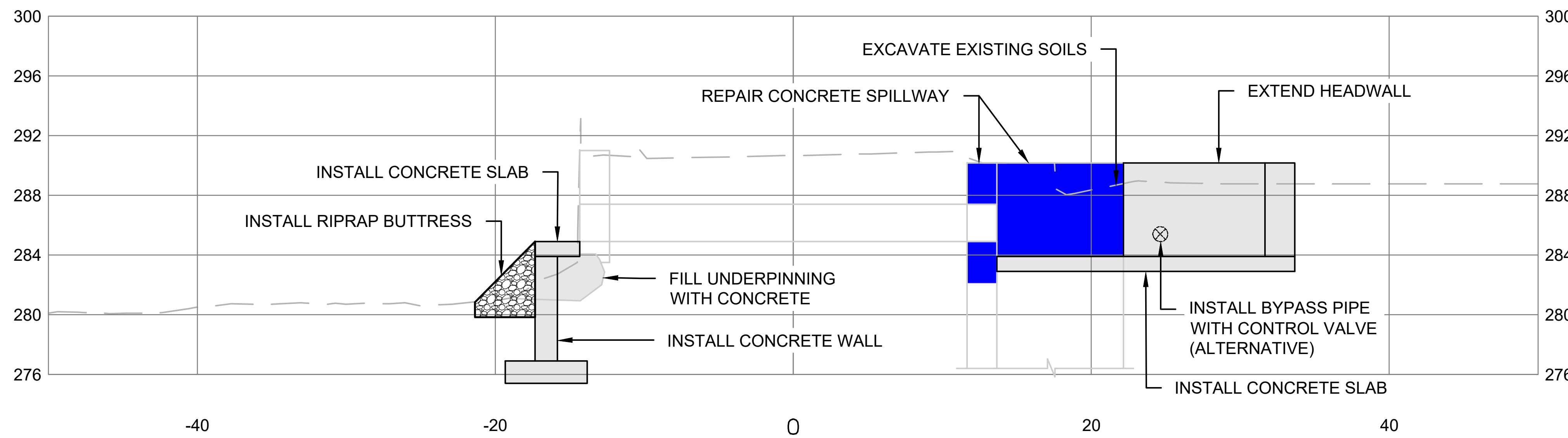

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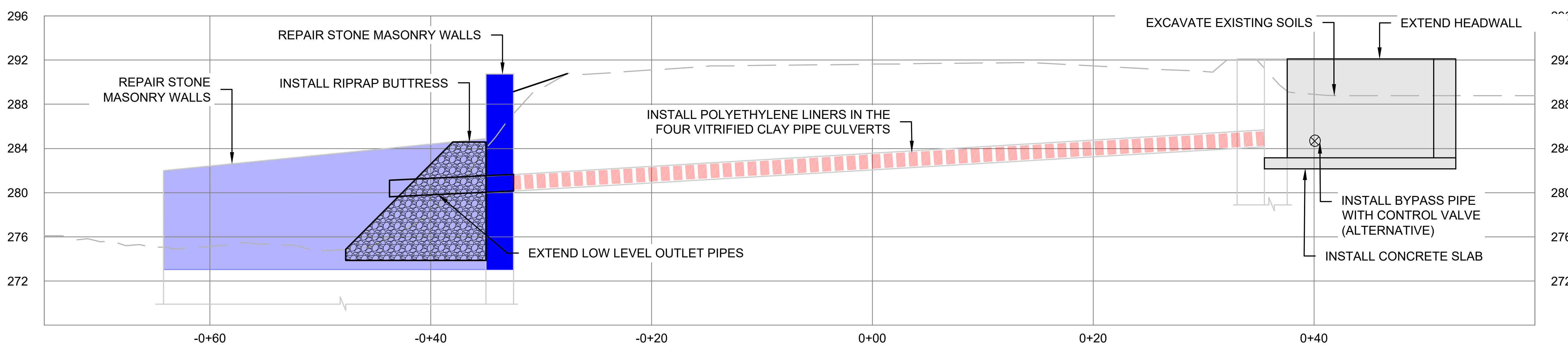

B 5.0 **SECTION B**

SCALE: 1"=10'

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SCALE ADJUSTMENT GUIDE

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TARBOX POND DAM ASSESMENT

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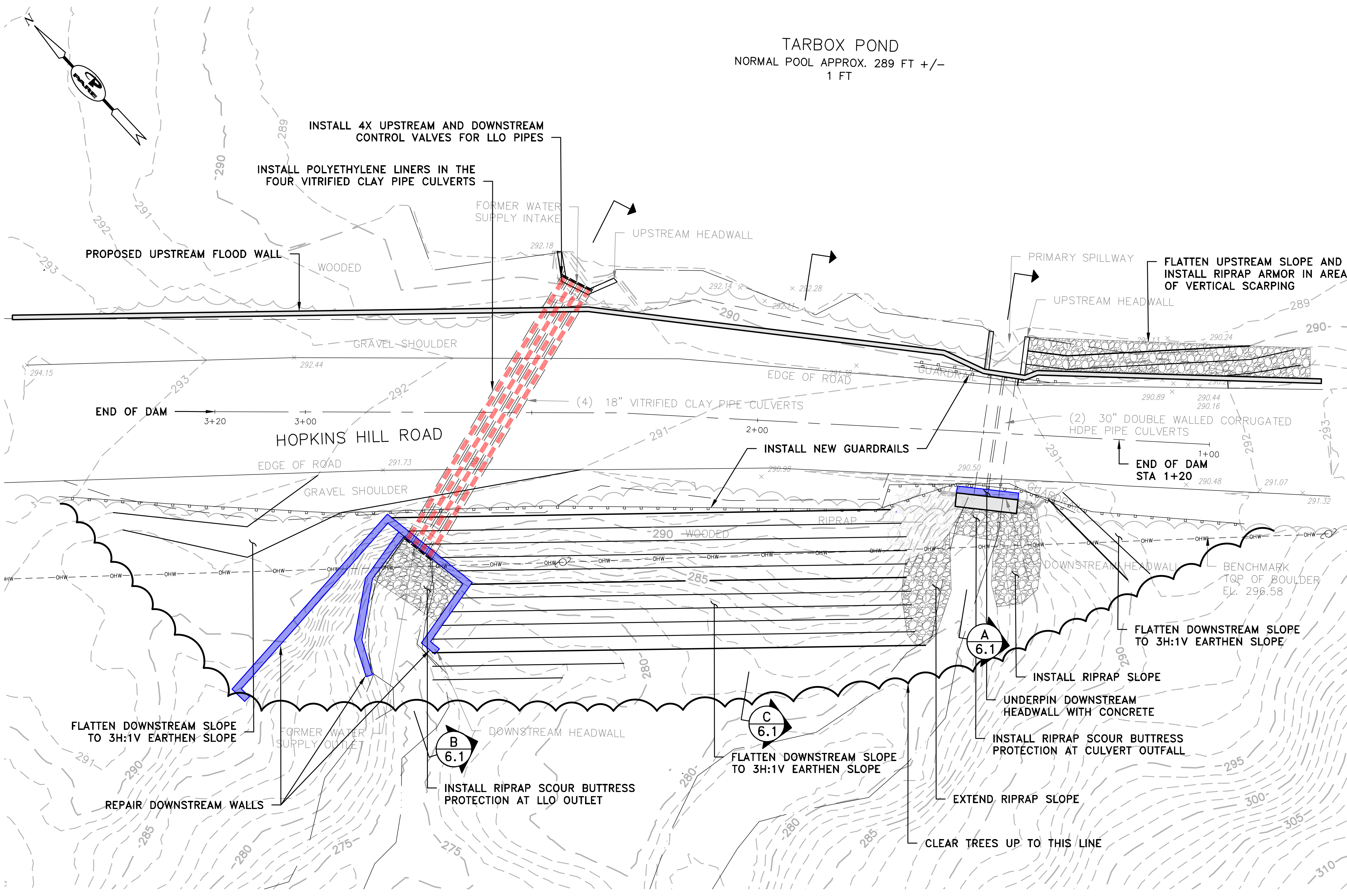
ALTERNATIVE B SECTIONS

FIGURE NO.: 5.1

Y:\JOBS\23 Jobs\23116.00 RIDOA - TarboxPondDamAssessment - RI\DWG\FIG 5.1 ALT B SECTIONS.dwg



ALTERNATIVE C

SCALE: 1"=20'±

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TARBOX POND DAM ASSESMENT
RI DAM #183
WEST GREENWICH, RHODE ISLAND

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ALTERNATIVE C

FIGURE NO.: 6.0

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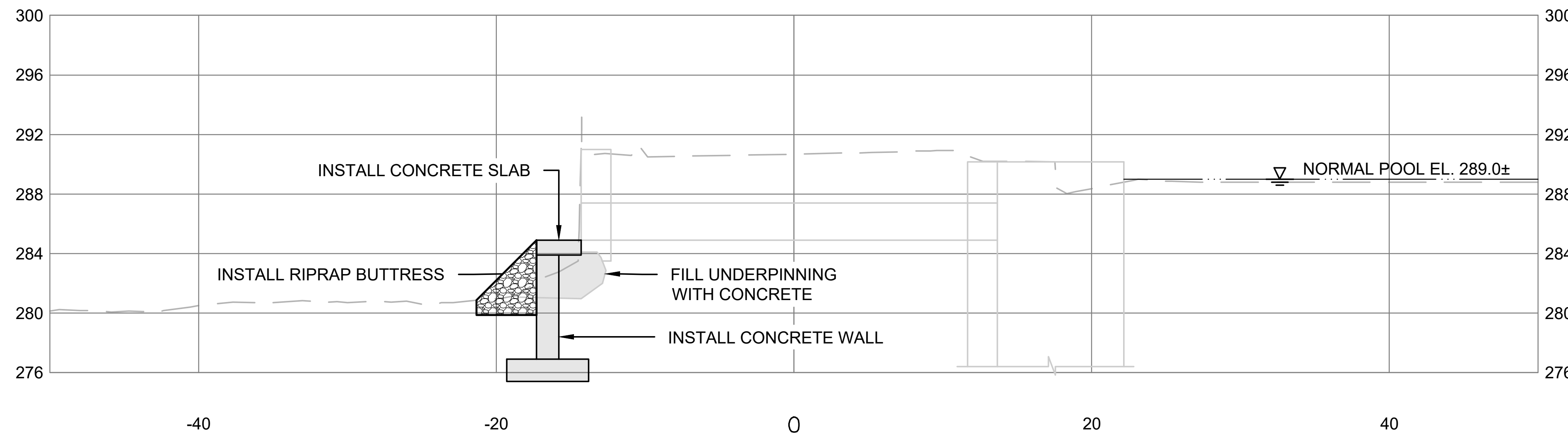

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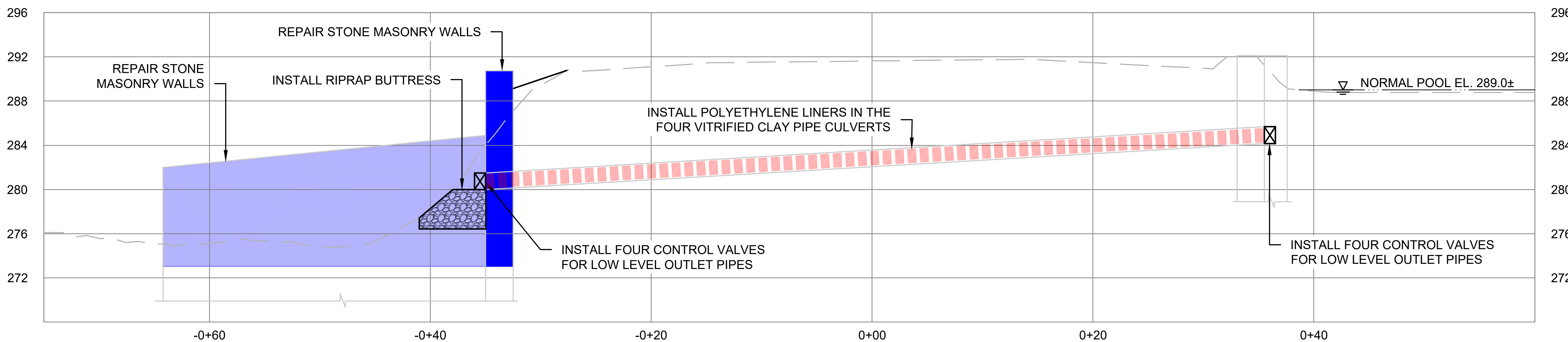

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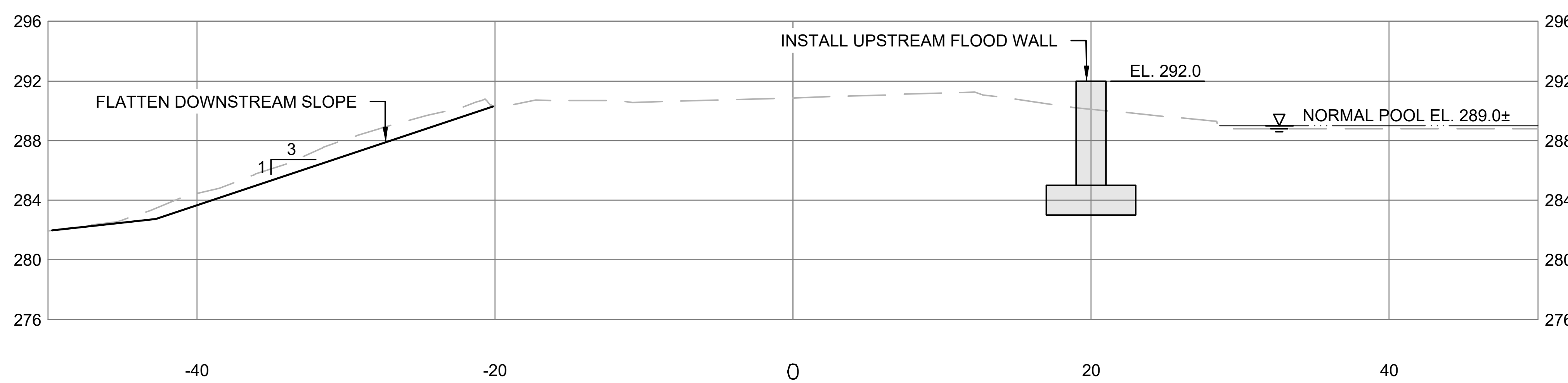

C 6.0 SECTION C
SCALE: 1"=10'

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TARBOX POND DAM ASSESMENT
RI DAM #183
WEST GREENWICH, RHODE ISLAND

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ALTERNATIVE C SECTIONS

FIGURE NO.: 6.1

Y:\JOBS\23 Jobs\23116.00 RIDOA - TarboxPondDamAssessment - RI\DWG\FIG 6.1 ALT C SECTIONS.dwg

Tarbox Pond Dam

West Greenwich, RI

APPENDIX A

PHOTOGRAPHS

Photo No. 1. Upstream slope from STA 1+20 looking right. Note the dense woody vegetation growing on the upstream slope.

Photo No. 2. Upstream slope at STA 1+32. Note the erosion channel extending from Hopkins Hill Rd to Tarbox Pond (circle).

Photo No. 3. Upstream shoulder from STA 1+50 looking right. Note the trees up to 16 inches in diameter growing through the upstream slope and the pile of debris adjacent to the spillway.

Photo No. 4. Upstream slope looking upstream at STA 1+50. Note the vertical scarping and dense woody vegetation.

Photo No. 5. Upstream slope from STA 2+20 looking right. Note the trees up to 10 inches in diameter growing through the upstream slope.

Photo No. 6. Upstream slope from STA 2+40 looking right. Note the historic LLO intake concrete headwall and the dense woody brush along the upstream slope.

Photo No. 7. Upstream slope from STA 3+25 looking left. Note the dense woody brush and trees growing along the upstream slope.

Photo No. 8. Upstream crest contact with the left abutment.

Photo No. 9. Downstream crest contact with the left abutment. Note the large boulder roughly marking STA 1+00.

Photo No. 10. Crest at STA 1+45 looking right. Note the gravel upstream shoulder parking area containing the red and silver cars (arrow).

Photo No. 11. Crest and upstream shoulder from STA 2+45 looking right. Note the gravel upstream shoulder used as a parking area.

Photo No. 12. Upstream crest contact with right abutment. Note the upstream footpath roughly marking STA 3+20 (arrow) and the right abutment.

Photo No. 13. Downstream slope at STA 1+32. Note the erosion channel extending from Hopkins Hill Rd to Carr River.

Photo No. 14. Downstream slope at STA 1+50 looking left.

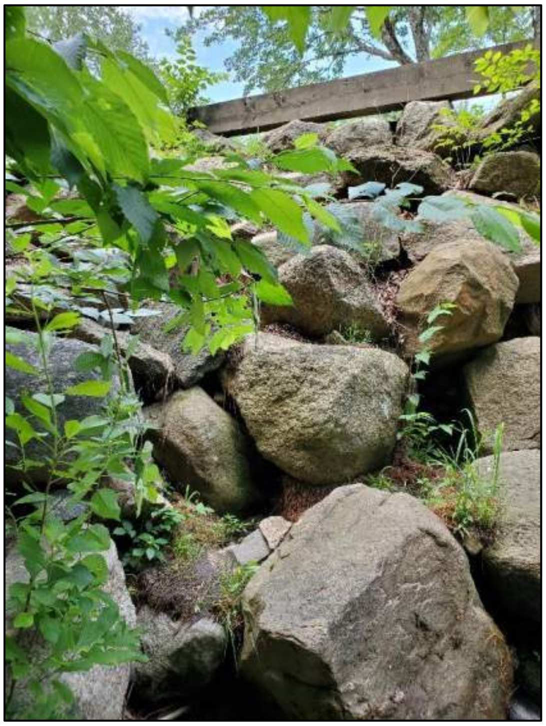


Photo No. 15. Downstream slope at STA 1+70 looking right. Note the large placed stones along the downstream slope.

Photo No. 16. Downstream slope at STA 1+95 looking right. Note the dense vegetation and woody brush.

Photo No. 17. Downstream slope at STA 2+50 looking right. Note the dense vegetation and woody brush.

Photo No. 18. Downstream slope at STA 2+75 looking downstream. Note the seepage channel (arrow).

Photo No. 19. Downstream slope at STA 1+75 looking upstream. Note the deterioration of the dry set stone masonry LLO outlet headwall and the tree growing through the headwall.

Photo No. 20. Downstream slope at STA 3+00 looking right. Note the dry set stone masonry wall.

Photo No. 21. Spillway and stilling basin. Note the vegetation choking the spillway weir.

Photo No. 22. Spillway stilling basin and spillway culvert inlets. Note the vegetation and garbage choking the culvert intakes. Note the spall in the stilling basin left wall (arrow).

Photo No. 23. Spillway culvert outlets. The red line indicates the bottom of the concrete headwall. Below this elevation the headwall is partially supported by stone, but is beginning to undermine.

Photo No. 24. Interior of the left outlet pipe. Note the pipe is clear of debris, except for the entrance. Also note the displacement at the pipe joint midway up the pipe.

Photo No. 25. Historic LLO intake structure. Note the vegetation growing in the area of the historic intake.

Photo No. 26. Historic LLO outlet structure. Note the woody brush growing through the headwall and downstream channel walls.

Photo No. 27. Interior of the vitrified clay LLO pipe approximately 40 feet upstream of the outlet as viewed during the conduit inspection. Note the apparent blockage at the end of the pipe.

Photo No. 28. Overview of the impoundment from the spillway.

Photo No. 29. View of the Carr River from primary spillway discharge channel looking upstream, about 70-feet downstream of the dam.

Photo No. 30. Overview of the impoundment from the historic LLO inlet.

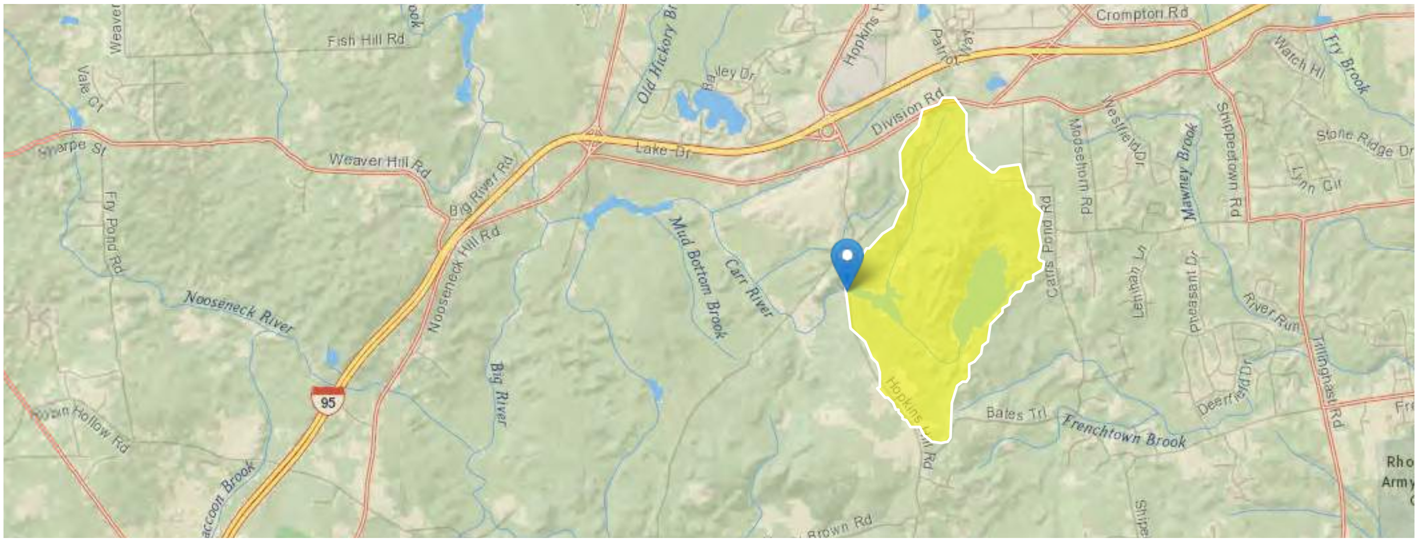
Photo No. 31. Overview of the downstream channel from the LLO outlet.

APPENDIX B

STREAMSTATS REPORTS

StreamStats Report

Region ID: RI
Workspace ID: RI20230705132521812000
Clicked Point (Latitude, Longitude): 41.63615, -71.57325
Time: 2023-07-05 09:25:42 -0400



Collapse All

Basin Characteristics

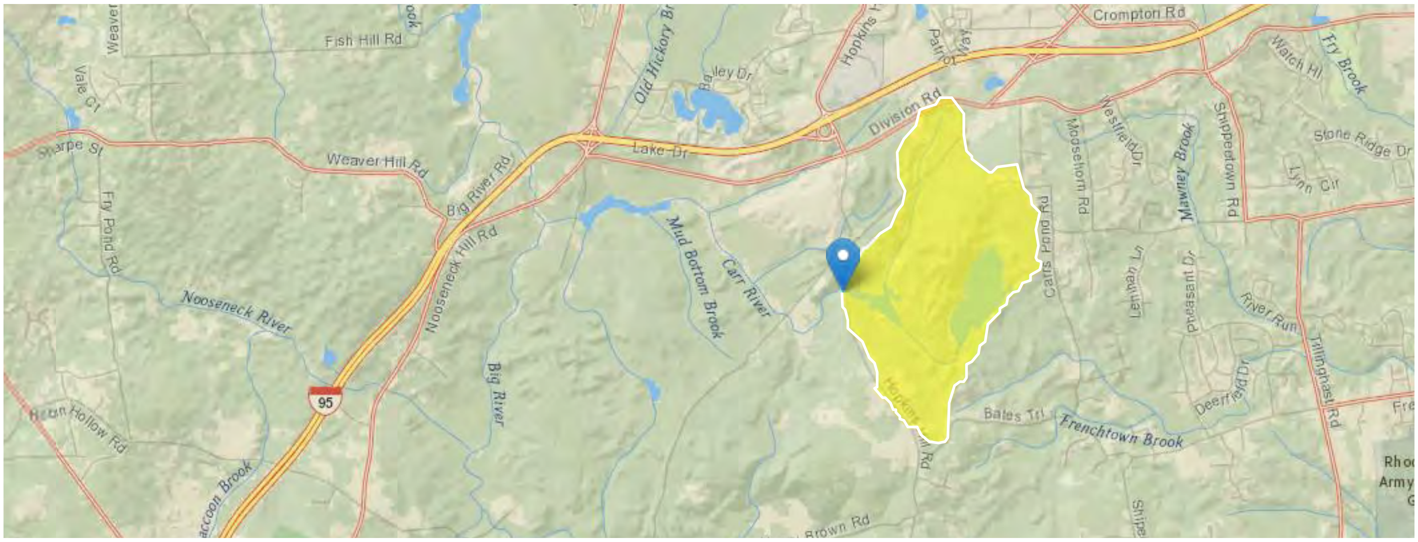
Parameter Code	Parameter Description	Value	Unit
CAT1ROADS	Length of interstates lmtd access highways and ramps for lmtd access highways, includes cloverleaf interchanges (USGS Ntl Transp Dataset)	0	miles
CAT2ROADS	Length of sec hwy or maj connecting roads; main arteries & hwys not lmtd access, usually in the US Hwy or State Hwy systems (USGS Ntl Transp Dataset)	0	miles
CAT3ROADS	Length of local connecting roads; roads that collect traffic from local roads & connect towns, subdivisions & neighborhoods (USGS Nat Transp Dataset)	0.25	miles
CAT4ROADS	Length of local roads; generally paved street, road, or byway that usually have single lane of traffic in each direction (USGS Ntnl Transp Dataset)	2.23	miles
CROPS	Percent of area covered by agriculture	1.8	percent
CROSCOUNT1	Number of intersections between streams and roads, where the roads are interstate, limited access highway, or ramp (CAT1ROADS)	0	dimensionless
CROSCOUNT2	Number of intersections between streams and roads, where the roads are secondary highway or major connecting road (CAT2ROADS)	0	dimensionless
CROSCOUNT3	Number of intersections between streams and roads, where roads are local conecting roads (CAT3ROADS)	0	dimensionless
CROSCOUNT4	Number of intersections between streams and roads, where roads are local roads (CAT4ROADS)	1	dimensionless
CRSDFT	Percentage of area of coarse-grained stratified drift	36.1	percent
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	52.1	feet per mi
DRNAREA	Area that drains to a point on a stream	1.66	square miles
ELEV	Mean Basin Elevation	360	feet
FOREST	Percentage of area covered by forest	73.6	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	6.72	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.99	percent

Parameter Code	Parameter Description	Value	Unit
LFPLENGTH	Length of longest flow path	2.53	miles
STORNHD	Percent storage (wetlands and waterbodies) determined from 1:24K NHD	14.1	percent
STRDEN	Stream Density -- total length of streams divided by drainage area	1.85	miles per square mile
STRDENED	Stream Density -- total length of streams divided by drainage area, edited from NHD	1.81	miles per square mile
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	3.07	miles
STRMTOTED	Total stream length in miles - edited NHD	3	miles
WATER	Percent of area covered by open water (lakes, ponds, reservoirs)	9.23	percent
WETLAND	Percentage of Wetlands	11.3	percent

Application Version: 4.16.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

StreamStats Report

Region ID: RI
Workspace ID: RI20230629144954789000
Clicked Point (Latitude, Longitude): 41.63613, -71.57350
Time: 2023-06-29 10:50:15 -0400



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.66	square miles
STORNHD	Percent storage (wetlands and waterbodies) determined from 1:24K NHD	14.1	percent
STRDEN	Stream Density -- total length of streams divided by drainage area	1.86	miles per square mile
STRDENED	Stream Density -- total length of streams divided by drainage area, edited from NHD	1.82	miles per square mile

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Statewide peak 2012 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	4	404
STRDEN	Stream Density	1.86	miles per square mile	1.25	3.53
STORNHD	Percent Storage from NHD	14.1	percent	3.37	19

Peak-Flow Statistics Disclaimers [Statewide peak 2012 5109]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [Statewide peak 2012 5109]

Statistic	Value	Unit
20-percent AEP flood	34.6	ft^3/s
10-percent AEP flood	43.9	ft^3/s
4-percent AEP flood	59.9	ft^3/s

Statistic	Value	Unit
2-percent AEP flood	72.7	ft^3/s
1-percent AEP flood	87.6	ft^3/s
0.5-percent AEP flood	99.9	ft^3/s
0.2-percent AEP flood	119	ft^3/s

Peak-Flow Statistics Citations

Zarriello, P.J., Ahearn, E.A., and Levin, S.B.,2012, Magnitude of flood flows for selected annual exceedance probabilities in Rhode Island through 2010: U.S. Geological Survey Scientific Investigations Report 2012–5109, 93 p. (http://pubs.usgs.gov/sir/2012/5109)

Low-Flow Statistics

Low-Flow Statistics Parameters [Statewide Low Flow 2014 5010]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	0.52	294
STRDENED	Stream Density Edited	1.82	miles per square mile	0.94	3.49

Low-Flow Statistics Flow Report [Statewide Low Flow 2014 5010]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
7 Day 2 Year Low Flow	0.0745	ft^3/s	0.0144	0.387
7 Day 10 Year Low Flow	0.0163	ft^3/s	0.00192	0.138

Low-Flow Statistics Citations

Bent, G.C., Steeves, P.A., and Waite, A.M.,2014, Equations for estimating selected streamflow statistics in Rhode Island: U.S. Geological Survey Scientific Investigations Report 2014–5010, 65 p. (http://dx.doi.org/10.3133/sir20145010)

Flow-Duration Statistics

Flow-Duration Statistics Parameters [Statewide Low Flow 2014 5010]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	0.52	294
STRDENED	Stream Density Edited	1.82	miles per square mile	0.94	3.49

Flow-Duration Statistics Flow Report [Statewide Low Flow 2014 5010]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
1 Percent Duration	20.2	ft^3/s	6.72	60.7	21.3
2 Percent Duration	15	ft^3/s	5.05	44.6	19.2
5 Percent Duration	10.1	ft^3/s	3.39	30.1	19.7
10 Percent Duration	7.25	ft^3/s	2.56	20.5	17.7
15 Percent Duration	5.79	ft^3/s	2.05	16.4	17.9
20 Percent Duration	4.62	ft^3/s	1.63	13.1	18.3
25 Percent Duration	4.07	ft^3/s	1.38	12	18
30 Percent Duration	3.46	ft^3/s	1.17	10.3	18.4
40 Percent Duration	2.66	ft^3/s	0.899	7.87	18.2
50 Percent Duration	1.99	ft^3/s	0.671	5.9	18.8

Statistic	Value	Unit	PIl	PIu	ASEp
60 Percent Duration	1.37	ft^3/s	0.457	4.1	20.8
70 Percent Duration	0.798	ft^3/s	0.26	2.45	25.4
75 Percent Duration	0.574	ft^3/s	0.18	1.83	31
80 Percent Duration	0.411	ft^3/s	0.123	1.37	38
85 Percent Duration	0.276	ft^3/s	0.0753	1.01	49.3
90 Percent Duration	0.163	ft^3/s	0.0354	0.75	75.5
95 Percent Duration	0.0725	ft^3/s	0.0126	0.418	
98 Percent Duration	0.0379	ft^3/s	0.00587	0.245	
99 Percent Duration	0.0257	ft^3/s	0.00334	0.198	

Flow-Duration Statistics Citations

Bent, G.C., Steeves, P.A., and Waite, A.M.,2014, Equations for estimating selected streamflow statistics in Rhode Island: U.S. Geological Survey Scientific Investigations Report 2014–5010, 65 p. (http://dx.doi.org/10.3133/sir20145010)

Bankfull Statistics

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	0.07722	940.1535

Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	3.799224	138.999861

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	18.8	ft
Bieger_D_channel_depth	1.3	ft
Bieger_D_channel_cross_sectional_area	24.6	ft^2

Bankfull Statistics Disclaimers [New England P Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Bankfull Statistics Flow Report [New England P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	29.1	ft
Bieger_P_channel_depth	1.54	ft
Bieger_P_channel_cross_sectional_area	44.8	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	14.8	ft
Bieger_USA_channel_depth	1.34	ft

Statistic	Value	Unit
Bieger_USA_channel_cross_sectional_area	22.5	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	18.8	ft
Bieger_D_channel_depth	1.3	ft
Bieger_D_channel_cross_sectional_area	24.6	ft^2
Bieger_P_channel_width	29.1	ft
Bieger_P_channel_depth	1.54	ft
Bieger_P_channel_cross_sectional_area	44.8	ft^2
Bieger_USA_channel_width	14.8	ft
Bieger_USA_channel_depth	1.34	ft
Bieger_USA_channel_cross_sectional_area	22.5	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages)

Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 2]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.66	square miles	0.1	3000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 2]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	7950	ft^3/s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (https://pubs.usgs.gov/wsp/1887/report.pdf)

Application Version: 4.16.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

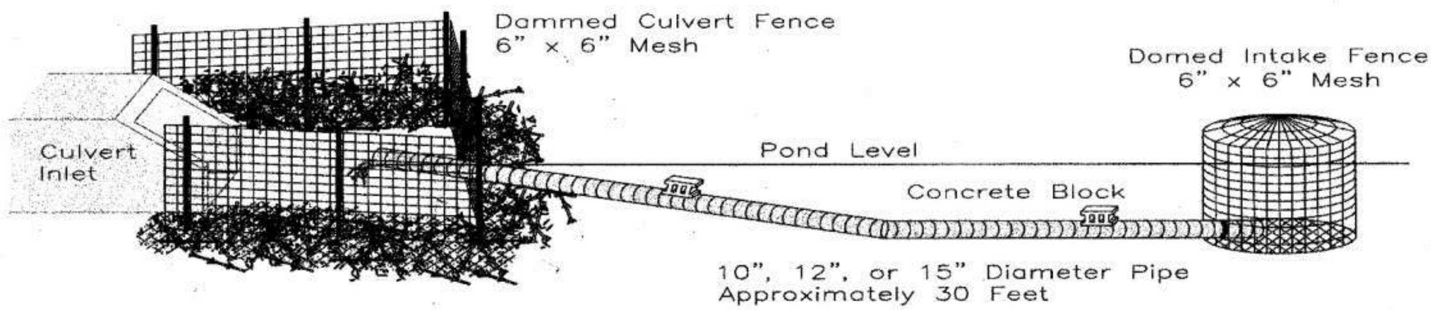
APPENDIX C

BEAVER DIVERSION REFERENCES

Fence and Pipe Flow Device

A Fence and Pipe flow device is a very effective method to protect culverts or spillways in manmade dams from beaver damming. A Flexible Pond Leveler™ pipe maintains a steady flow of water, while an exclusion fence keeps all beaver damming away from the culvert or spillway. See diagram.

Beaver damming on the culvert fence does not raise the water level due to the permanent leak created by the pond leveler pipe. The pipe system controls the pond at a safe level and prevents flooding damage to the road or manmade dam, while the fence ensures the culvert remains completely open.



FENCE AND PIPE DIAGRAM
(Side View)

The pipe outlet elevation determines the pond level. This end of the pipe can be adjusted up or down if a higher or lower pond level is desired. Water will continuously flow from the pipe outlet unless the pond level drops below the peak of the pipe.

The domed intake fence prevents beavers from hearing or feeling the flow of water into the pipe. Therefore they ignore the intake end of the pipe, and only dam on the culvert fence where they hear the water flowing.

Unlike road culverts, Flexible Pond Leveler™ pipes do not need to be sized to handle catastrophic storm events because heavy storm runoff will simply flow over the top of the dam on the fence and through the unblocked culvert or spillway. Some mild pond fluctuations are possible following very wet periods, but the pond will be controlled at a safe level.

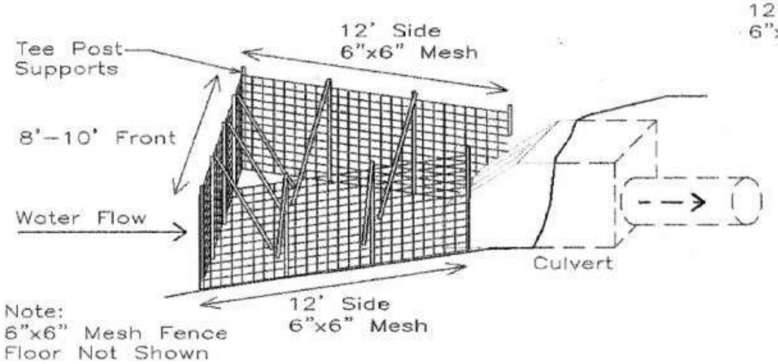
With routine maintenance this flow device will remain effective for many years. Since our customer's satisfaction and our reputation are very important to us, we offer an optional low cost Maintenance Plan. A "Worry-Free Guarantee" is included with every Maintenance Plan at no additional cost. See attached. However, if you prefer to do the maintenance, we are always available to answer any questions at no charge because we are committed to the success of our flow devices, your satisfaction and our good reputation.

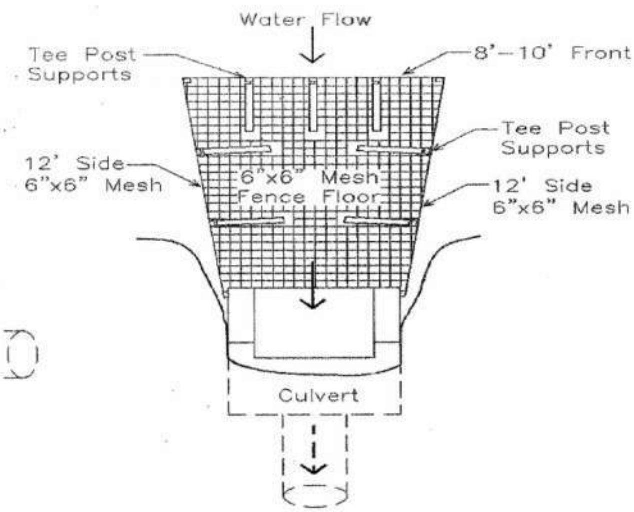
May be reproduced courtesy of Mike Callahan, Owner
Beaver Solutions LLC, "Working With Nature"

The Keystone Fence™

Road culverts are the most common beaver damming problem we encounter. Beavers often dam in culverts because with a little bit of work the entire roadbed becomes a large dam. To a beaver, a road bed with a culvert probably looks like a dam with a hole that must be repaired.

The Keystone Fence™ eliminates beaver damming of culverts. Beaver Solutions™ has installed several hundreds of these devices with a 95% success rate despite the continued presence of beavers. This device eliminates the cost of continued culvert clearing, repairs and trapping.





There are 3 reasons why the Keystone Fence™ is so effective at protecting culverts from beaver damming. First, damming 30 to 50 feet of fence is a lot more work for the beavers than simply plugging a narrow culvert. This discourages damming. See diagram. Second, if beavers begin to dam near the culvert the fence forces their damming away from the culvert which also discourages them. Third, if the beavers are determined to dam the fence, as they dam on the fence the opening that the water flows into becomes wider and wider. Therefore less water is moving through the fence where the beavers are damming. The decreasing water flow through the fence at the point of damming further decreases the damming stimulus for beavers.

Note, any device exposed to the seasons and the beavers will require some maintenance. While our Keystone Fences™ are designed to be very low maintenance, this maintenance is important. Quarterly all floated leaves and sticks should be cleared from the fence in order to keep the beavers from damming on it. When this routine maintenance is performed as recommended, the Keystone Fence™ will remain effective for many years.

Since our customer's satisfaction and our reputation are very important to us, we offer an optional low cost Maintenance Plan. A "Worry-Free Guarantee" is included with every Maintenance Plan at no additional cost. See attached. However, if you prefer to do the maintenance, we are always available to answer any questions at no charge because the success of your flow device, your satisfaction and our good reputation are very important to us.

APPENDIX D

PREVIOUS REPORTS AND REFERENCES

PREVIOUS REPORTS AND REFERENCES

The following is a list of reports that were located during the file review, or were referenced in previous reports.

1. "2022 Annual Report to the Governor on the Activities of the Dam Safety Program", Office of Compliance and Inspection, Rhode Island Department of Environmental Management, May 22, 2023.
2. "Natural Resources and Implementation Report for the Big River Management Area – Central Rhode Island." EA Engineering, Science, and Technology, Inc., March 2022.
3. "Dam Inspection Report - Tarbox Pond Dam." RIDEM, March 31, 1993.
4. "Dam Inspection Report - Tarbox Pond Dam." RIDEM, November 28, 1990.
5. "Memo – Repairs to Tarbox Pond Dam." RIDEM. September 6, 1989.
6. "Dam Inspection Report - Tarbox Pond Dam." RIDEM, June 26, 1986.
7. "Dam Inspection Report - Tarbox Pond Dam." RIDEM, April 20, 1985.
8. "Special Inspection Report - Tarbox Pond Dam." RI Department of Public Works Division of Harbors and Rivers, April 13, 1946.

The following references were utilized during the preparation of this report and the development of the recommendations presented herein:

1. "Design of Small Dams", United States Department of the Interior Bureau of Reclamation, 1987
2. "ER 110-2-106 - Recommended Guidelines for Safety Inspection of Dams", Department of the Army, September 26, 1979.
3. "Guidelines for Reporting the Performance of Dams" National Performance of Dams Program, August 1994.
4. "Technical Release 210-60 Earth Dams and Reservoirs", United States Department of Agriculture Natural Resources Conservation Service, March 2019.
5. "StreamStats v4.16.0 Web Application", United States Geological Survey, accessed June 29, 2023. StreamStats (usgs.gov)
6. "Rectangular Contracted Weir" Calculator, Washington State University, 2023. http://irrigation.wsu.edu/Content/Calculators/Water-Measurements/Rectangular-Contracted-Weir.php
7. "Rules and Regulations for Dam Safety (250-RICR-130-05-1)", Rhode Island Department of State, January 04, 2022.

Tarbox Pond Dam
West Greenwich, RI

APPENDIX E

COMMON DAM SAFETY DEFINITIONS

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR 10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exits, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; LLO works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

Size Classification
(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

Hazard Classification
(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

General

EAP – Emergency Action Plan - Shall mean a predetermined plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam break.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet

Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Condition Rating

Unsafe - Major structural, operational, and maintenance deficiencies exist under normal operating conditions.

Poor - Significant structural, operational and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

APPENDIX F

VISUAL DAM INSPECTION LIMITATIONS

VISUAL DAM INSPECTION
LIMITATIONS

Visual Inspection

1. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

2. In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team.

3. In cases where an impoundment is lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

4. It is critical to note that the condition of the dam is evolutionary in nature and depends on numerous and constantly changing internal and external conditions. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Use of Report

1. The applicability of other environmental permits (ie., NOI, PGP, Water Quality Certificate, etc.) needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of MADEP, the local conservation commission or other regulatory agency.

2. This report has been prepared for the exclusive use of the State of Rhode Island for specific application to the Tarbox Pond Dam in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

3. This report has been prepared for this project by Pare. This report is for preliminary evaluation purposes only and is not necessarily sufficient to support design or repairs or recommendations or to prepare an accurate bid.