--WOODBURY POND DAM--

PHASE I

INSPECTION / EVALUATION REPORT

Dam Name:	Woodbury Pond Dam
NID ID#:	MA01179
Owner:	Town of Sutton
Town:	Sutton, Massachusetts
Consultant:	Weston & Sampson Engineers, Inc.
Date of Inspection:	November 22, 2019

Weston & Sampson

EXECUTIVE SUMMARY

This report documents observations and evaluation of Woodbury Pond Dam located in Sutton, Massachusetts based on a visual dam safety inspection conducted by Weston & Sampson Engineers, Inc. of Reading, Massachusetts on November 22, 2019. The dam is classified as an **INTERMEDIATE** size, **SIGNIFICANT** hazard potential structure. The overall physical condition of the dam was found to be **POOR** based on the existence of several dam safety deficiencies. The deficiencies listed below are considered to be those most significant to the overall condition rating. Additional deficiencies observed during the inspection are described in **Section 2** and **Section 3** of this report.

- Prior hydrologic and hydraulic analyses indicate the dam (embankment) overtops by about 1-ft. during the spillway design flood, which is the 100-year storm event.
- Significant portions of the upstream and downstream slopes are covered with woody vegetation and brush that prevented a thorough inspection. Trees up to approximately 18 inches in diameter are present along the downstream toe and in the immediate downstream area. Vegetation on the upstream slope is generally limited to brush, tall grasses, and occasional saplings.
- An erosional scarp is present along the upstream slope at the normal pool elevation. Up to 12 inches of bank undercutting along the scarp was observed in several areas.
- Two isolated slope failures have occurred on the upstream slope below the normal pool elevation between the spillway and left abutment. Transported embankment soils were observed downslope of both areas. It appears these failures are the result of surface drainage from the roadway directed onto the slope. Continued drainage of stormwater onto the slope and surges in the impoundment stage could worsen this condition.
- Slow seepage (less than 0.5 gpm) was observed emerging from the left downstream groin upstream of a small area of ponded water. Slow seepage and standing water in this area have been observed previously. Prior inspections noted a seepage rate between 3 to 5 gpm. The source/origin of the seepage has not been confirmed.
- A bituminous coating lining the interior of the CMP culverts is cracked at the top of the pipes and mostly missing along the inverts. The pipe inverts are corroded where the coating is missing. Continued corrosion and deterioration could result in leakage into the embankment.

In addition to the above deficiencies, the timber gate at the upstream end of the low-level outlet (LLO) conduit failed in July 2019. The gate was subsequently removed by the Town. The pond level has been drawn down since failure and removal of the gate and is currently controlled by a small sandbag and cobble check dam constructed at the LLO inlet. Base flow is currently discharged through the LLO, but pond levels will fluctuate with stream flow and storm events that exceed the LLO discharge capacity. According to Mr. Matthew Stencel, Superintendent of the Town Highway Department and the dam's caretaker, there are currently no plans to repair the LLO and restore the impoundment to the normal pool elevation.

Section 3 of this report provides recommendations for remedial modifications to bring the structure into compliance with current dam safety regulations and includes a discussion of dam removal as a potential alternative to rehabilitation. Recommendations for recurrent maintenance activities and minor repairs are also provided. Continued monitoring and regular maintenance are critical for preserving the integrity and functionality of dams and other hydraulic structures. Maintenance personnel familiar with the dam should routinely observe the condition of the dam for changes relative to those identified in this report. Observations should be made at least quarterly, as well as during and following significant rainfall events.

Dam Evaluation Summary Detail Sheet

1. NID ID:	**MA01179**	**4. Inspection Date:**	**November 22, 2019**
2. Dam Name:	**Woodbury Pond Dam**	**5. Last Insp. Date:**	**July 13, 2009**
3. Dam Location:	**Sutton, MA**	**6. Next Inspection:**	**November 22, 2024**
7. Inspector:	**Timothy Blair, P.E.**		
8. Consultant:	**Weston & Sampson Engineers, Inc.**		
9. Hazard Code:	**Significant**	**9a. Is Hazard Code Change Requested?:**	**No**
10. Insp. Frequency:	**5 Years**	**11. Overall Physical Condition of Dam:**	**POOR**
12. Spillway Capacity (% SDF)	**0-50% of the SDF or Unknown**		

E1. Design Methodology:	**2**	**E7. Low-Level Discharge Capacity:**	**4**
E2. Level of Maintenance:	**2**	**E8. Low-Level Outlet Physical Condition:**	**1**
E3. Emergency Action Plan:	**5**	**E9. Spillway Design Flood Capacity:**	**1**
E4. Embankment Seepage:	**3**	**E10. Overall Physical Condition of the Dam:**	**2**
E5. Embankment Condition:	**2**	**E11. Estimated Repair Cost:**	**$650k to $850k**
E6. Concrete Condition:	**3**		

Evaluation Description

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post design analysis show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR, annual training

E4: SEEPAGE (Embankments, Foundations, & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (See Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

E6: CONCRETE CONDITION (See Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low level outlet, no provisions (e.g. pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 50-90% of the SDF
3. 90 - 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g. open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF DAM
1. UNSAFE – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. POOR - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. 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
4. SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. GOOD - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST

Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Changes/Deviations to Database Information since Last Inspection

The overall physical condition of the dam has changed from FAIR to **POOR** based on the ranking (2) given to evaluation code E5 (embankment condition), which is considered a 'high important category' and therefore governs the overall physical condition rating (code E10). Deficiencies most significant to the Embankment Condition rating include excessive brush and woody vegetation, two isolated slope failures on the upstream slope below the normal pool elevation, and significant erosion and undercutting of the upstream slope along the normal pool elevation.

PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

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

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the reported 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.

Licensed Professional's Signature

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Geotechnical Engineering & Dam Safety
Weston & Sampson Engineers, Inc.

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SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The Town of Sutton, Massachusetts retained Weston & Sampson Engineers, Inc. (Weston & Sampson) to perform a visual inspection and develop a report of conditions for the dam at Woodbury Pond along Cold Spring Brook in Sutton, Worcester County, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR10.07 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was 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 site; 3) evaluate the status of an emergency action plan for the site and; 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions, and opinion 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 D**. 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; and 5) miscellaneous.

1.2 Description of Project

1.2.1 Location

Woodbury Pond Dam is located in Sutton in Worcester County, Massachusetts. The dam impounds Woodbury Pond along its northern shoreline and is located at the following coordinates referencing the North American Datum of 1983 (NAD 83): 42.1651 North (latitude) and 71.7311 West (longitude). The location of Woodbury Pond Dam relative to surrounding physical features is shown in **Figure 1**. An aerial photograph of the dam and surrounding area is provided as **Figure 2**.

The crest of the dam supports an approximately 480-ft. long segment of Boston Road. To access the dam from the Sutton Town Hall located at 4 Uxbridge Road, begin travelling northwest on Uxbridge Road toward Boston Road. Turn right onto Boston Road at the first intersection and travel for approximately 2.0 miles. Woodbury pond will appear on the right. Limited parking is available along the shoulder of the westbound travel lane near the left abutment.

1.2.2 Owner/Caretaker

See **Table 1.1** for current owner and caretaker data (names and contact information).

1.2.3 Purpose of the Dam

Woodbury Pond Dam was originally used to impound water for mill power and ice harvesting. The dam is now used for recreation.

1.2.4 Description of the Dam and Appurtenances

Woodbury Pond Dam is an approximately 480-ft. long earthen embankment dam with a structural height of approximately 20 ft. Boston Road, a two-lane paved public roadway, is present along the dam crest. Appurtenances include a primary spillway consisting of six (6) 5-ft. diameter corrugated metal pipe (CMP) culverts located near the center of the embankment and a low-level outlet (LLO) that extends beneath the spillway culverts.

The upstream face of the dam is formed by an earthen slope generally inclined at approximately 2H:1V, although slightly steeper inclinations exist in some areas including along the normal pool elevation. Riprap armoring exists around spillway headwall and occasionally in other areas on the slope. A stone drainage culvert daylights onto the upstream slope at the left abutment contact but the purpose of the culvert is unknown. The downstream face of the dam is also formed by an earthen slope inclined at approximately 2H:1V. Steeper inclinations (up to 1H:1V) exist in the vicinity of the spillway endwall and discharge area where the slope is armored with large boulders for scour and erosion protection. Weeds, brush, and woody vegetation are present on the downstream slope.

The dam crest (Boston Road) is approximately 40 ft. wide. The shoulder areas along the upstream and downstream sides of the crest are lined with steel guardrails. The road surface is crowned to promote stormwater runoff to catch basins located in the gutter lines. Outfall pipes from the catch basins daylight on the upstream and downstream slopes. Sewer manholes also exist on the crest.

The CMP culverts comprising the spillway extend approximately 45 ft. through the embankment from an upstream reinforced concrete headwall to a downstream reinforced concrete endwall. The pipes are spaced at approximately 7.5 ft. center to center (2.5 ft. clear distance between pipes). The invert of all six pipes is approximately 7.5 ft. below the top of the headwall. Flow through the culverts discharges onto a cascading, boulder-lined slope to the natural streambed in Cold Spring Brook, which is a tributary of the Blackstone River.

The LLO is a 2.5-ft. wide by 3-ft. tall rectangular concrete conduit that extends under the primary spillway between the second and third pipes (from left). The conduit outlet is an opening in the cascading, boulder-lined slope at the spillway discharge area. The LLO was formerly controlled by a timber gate at the inlet. The gate failed in July 2019 and was subsequently removed by the Town. The pond level has been drawn down since failure and removal of the gate and is currently controlled by a small sandbag and cobble check dam constructed at the LLO inlet. Base flow is currently discharged through the LLO, but pond levels will fluctuate with stream flow and storm events that exceed the LLO discharge capacity. According to Mr. Matthew Stencel, Superintendent of the Town Highway Department and the dam's caretaker, there are currently no plans to repair the LLO and restore the impoundment to the normal pool elevation.

1.2.5 Operations and Maintenance

The Town of Sutton Highway Department Superintendent, Matthew Stencel, is responsible for operation and maintenance of this dam. Regular maintenance includes brush cutting on the upstream and downstream slopes at least once per year. The site is visited at least weekly. Refer to **Section 2.3** for additional information related operations and maintenance.

1.2.6 DCR Size Classification

According to Department of Environmental Management (DEM) emergency dam inspection report prepared by SFC Engineering Partnership, Inc. in 1999 (SFC, 1999), Woodbury Pond Dam has a structural height of 20 ft. and a maximum storage capacity of 111 acre-feet (SFC, 1999). Refer to **Appendix D** for definitions of height of dam and storage. In accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Woodbury Pond Dam is an **INTERMEDIATE** size structure.

1.2.7 DCR Hazard Potential Classification

The crest of Woodbury Pond Dam supports Boston Road and is located upstream of Route 122A, several residential properties, and the Blackstone River. It appears that a failure of the dam at maximum pool may cause loss of life and damage to homes, commercial facilities, secondary highways, or cause interruption of use of service of relatively important facilities. Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Woodbury Pond Dam should be classified as a **SIGNIFICANT** hazard potential dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Woodbury Pond Dam is approximately 6.3 square miles (4,045 acres) and extends through the community of Sutton to the south and west of Woodbury Pond. The drainage area is generally wooded with residential development, a golf course, and fields. The drainage area contains Girard Pond, Aldrich Pond, Marble Pond, Sibley Reservoir, Clark Reservoir, Bond Hollow Swamp, Cogan Pond, Cedar Swamp, and several wetland areas located upstream of Woodbury Pond. The drainage area for Woodbury Pond Dam was delineated using the USGS Streamstats program (https://streamstats.usgs.gov/ss/). A map of the drainage area for Woodbury Pond Dam is provided as **Figure 3**.

1.3.2 Reservoir

See **Table 1.1** for data about normal, maximum, and spillway design flood (SDF) volumes and flow rates.

1.3.3 Discharges at the Dam Site

No data documenting discharges at the site were available at the time of this inspection. The capacity of the primary spillway culverts is approximately 1,200 cfs when the water surface elevation in the pond is at the crest of the dam (SFC, 1999).

1.3.4 General Elevations (feet)

Elevations listed below are based on the plan titled, "Plan of Boston Road in the Town of Sutton," by the County Commissioners, dated August 30, 1967, sheet 4 of 4. The elevations appear to reference the National Geodetic Vertical Datum (NGVD), but this was not confirmed. A current survey of the dam is not available and is recommended. The elevations listed below are approximate and have not been verified by survey. The elevations are useful for understanding relative differences between components of the dam but should not be used for design or construction purposes.

A.	Top of Dam	El. 384.2
B.	Spillway Design Flood Pool (SFC, 1999)	El. 385.4
C.	Normal Pool	El. 377.8
D.	Upstream Water at Time of Inspection	El. 373.0±
E.	Downstream Water at Time of Inspection	El. 365.5±
F.	Streambed at Toe of the Dam	El. 364.2

1.3.5 Primary Spillway

A.	Type	(6) Circular CMPs
B.	Size	5-ft. Diameter CMPs
C.	Invert In Elevation	El. 377.8
D.	Invert Out Elevation	Not Determined

1.3.6 Low-Level Outlet

A.	Type	Concrete Conduit
B.	Size	2.5-ft. by-3 ft.
C.	Invert In Elevation	Not Determined
D.	Invert Out Elevation	Not Determined

1.3.7 Design and Construction Records and History

The original dam was reportedly constructed prior to 1900 to impound Spring Brook for mill power and ice harvesting. The current configuration of the dam was reportedly constructed circa 1971 as part of improvements to Boston Road. Plans titled, "Plan of Boston Road in the Town of Sutton," by the County Commissioners, dated August 30, 1967 show a plan view of the improvements to Boston Road and the dam. Additional detail drawings of the primary spillway culverts and LLO are also available.

As described above, the timber gate at the LLO inlet failed in July 2019. As a result, pond levels fell to several feet below the normal pool elevation by the end of July. Attempts to stop the leakage through the gate were unsuccessful and the gate was subsequently removed by the Town. A cobble

and sandbag check dam was constructed just upstream of the LLO inlet to permit observation of the LLO inlet and maintain some water in the impoundment.

At the present time, the LLO does not have a closure mechanism and the impoundment remains drawn down during normal inflows. According to Mr. Matthew Stencel, Superintendent of the Town Highway Department and the dam's caretaker, there are currently no plans to repair the LLO and restore the impoundment.

1.3.8 Operating Records

No operating records for this dam were available at the time of this report.

1.4 Summary Data Table

1.1 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA01179
Dam Name	Woodbury Pond Dam
Dam Name (Alternate)	Millers Pond Dam
River Name	Tributary to Blackstone River
Impoundment Name	Woodbury Pond
Hazard Class	Significant
Size Class	Intermediate
Dam Type	Earthen Embankment
Dam Purpose	Recreation
Structural Height of Dam (feet)	20
Hydraulic Height of Dam (feet)	13.6
Drainage Area (sq. mi.)	6.4
Reservoir Surface Area (sq. mi.)	0.011 (7.2 Acres)
Normal Impoundment Volume (acre-feet)	35 (SFC, 1999)
Max Impoundment Volume ((top of dam) acre-feet)	111 (SFC, 1999)
SDF Impoundment Volume* (acre-feet)	Not Determined
Spillway Type	CMP Culverts (6 Total)
Spillway Length (feet)	Varies with Pond Elevation
Freeboard at Normal Pool (feet)	6.4
Principal Spillway Capacity* (cfs)	1,200 (SFC, 1999)
Auxiliary Spillway Capacity* (cfs)	N/A
Low-Level Outlet Capacity* (cfs)	Unknown
Spillway Design Flood* (flow rate - cfs)	100-year / 2,962 (SFC, 1999)
Winter Drawdown (feet below normal pool)	N/A
Drawdown Impoundment Vol. (acre-feet)	N/A
Latitude	42.1651 N
Longitude	71.7311 W
City/Town	Sutton
County Name	Worcester
Public Road on Crest	Boston Road
Public Bridge over Spillway	No
EAP Date (if applicable)	Will be Finalized in May 2020
Owner Name	Town of Sutton
Owner Address	4 Uxbridge Road
Owner Town	Sutton, MA 01590

Owner Phone	(508) 865-8743
Owner Emergency Phone	(508) 865-8747 (Police)
Owner Type	Municipality or Political subdivision
Caretaker Name	Matthew Stencel/Highway Superintendent
Caretaker Address	4 Uxbridge Road
Caretaker Town	Sutton, MA 01590
Caretaker Phone	(508) 865-8743
Caretaker Emergency Phone	(508) 865-8747 (Police)
Date of Field Inspection	11/22/2019
Consultant Firm Name	Weston & Sampson Engineers, Inc.
Inspecting Engineer	Timothy Blair, P.E.
Engineer Phone Number	(978) 532-1900

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Woodbury Pond Dam was inspected on November 22, 2019. At the time of the inspection, the temperature was 45°F and the weather was cloudy. Photographs to document the current conditions of the dam were taken during the inspection and are included in **Appendix A**. At the time of this inspection, the impoundment level was several feet below the normal pool elevation and about 1.5 ft. below the top of the LLO entrance opening due to failure and removal of the timber gate as described above. Underwater areas and inaccessible areas including the LLO conduit were not inspected. A copy of the inspection checklist is included in **Appendix B**.

2.1.1 General Findings

In general, Woodbury Pond Dam was found to be in **POOR** condition based on current dam safety guidelines for the overall physical condition rating of embankment dams. As such, the overall condition rating of the dam has declined from the previously reported condition in 2009. The primary deficiencies contributing to the changed condition rating include:

- excessive brush and woody vegetation on the embankment slopes, abutment contacts, and in the immediate downstream area;
- two slope failures on the upstream slope below the normal pool elevation between the spillway and left abutment, which appear to have been caused by surface drainage from the roadway directed onto/down the slope during a low impoundment stage; and
- an erosional scarp line and associated undercutting (up to 12 inches into the embankment) along the upstream slope at the apparent normal pool elevation.

As described in **Section 2.5**, prior hydrologic and hydraulic analyses conducted by SFC Engineering Partnership, Inc. in 1999 also indicate that the dam crest overtops by about 1.2-ft. during the spillway design flood (100-year storm event). While an updated analysis is recommended, the results of the previous study appear consistent with historical accounts (from the previous caretaker) of Boston Road (the dam crest) 'washing out' in 1955. No further details of this reported event were available or provided.

In addition to the above deficiencies, and as described in **Section 1.3.7**, the timber gate at the upstream end of the low-level outlet (LLO) conduit failed in July 2019. The gate was subsequently removed by the Town. The pond level has been drawn down since failure and removal of the gate and is currently controlled by a small sandbag and cobble check dam constructed at the LLO inlet. Base flow is currently discharged through the LLO, but pond levels will fluctuate with stream flow and storm events that exceed the LLO discharge capacity. According to Mr. Matthew Stencel, Superintendent of the Town Highway Department and the dam's caretaker, there are currently no plans to repair the LLO and restore the impoundment to the normal pool elevation.

2.1.2 Dam

Abutments

The following conditions were observed at the abutment contacts:

- The abutment/crest contacts appeared sound with no evidence of unusual movement or transverse cracking. General pavement distress in the vehicle wheel paths including occasional longitudinal and alligator cracking was observed in the vicinity of the abutment contacts and along other portions of the crest. See **Photo 1** and **Photo 2**.
- Woody vegetation including brush and occasional trees is growing along the upstream and downstream groins (abutment to slope contacts). A thick layer of leaf litter and other plant debris covered the surface and prevented a thorough visual inspection of these areas.
- Slow seepage (less than 0.5 gpm) was observed emerging from the left downstream groin upstream of a small area of ponded water. Refer to the *Downstream Slope* section below for additional information.
- A small stone arch drainage culvert daylights from the left upstream groin. The culvert was dry at the time of the inspection and partially filled with sediment and debris. The culvert alignment appears to continue west along the southern edge of Boston Road but available plans titled "Plan of Boston Road in the Town of Sutton," by the County Commissioners and dated August 30, 1967 show the apparent culvert alignment trending diagonally northwest under/across Boston Road towards the left downstream groin.

Upstream Slope

The following conditions were observed on the upstream slope:

- Dormant vegetation including weeds, tall grasses, brush, and occasional saplings are growing on the upstream slope above the normal pool elevation. Vegetation was generally sparse below the normal pool elevation. See **Photo 3** and **Photo 4** for an overview of the upstream slope and vegetation.
- Occasional riprap is present in the vicinity of the spillway but the majority of the upstream slope does not have consistent erosion protection. An erosional scarp line exists along the normal pool elevation for most of the slope length with a maximum scarp height of approximately 8 inches. Up to 12 inches of bank undercutting along the scarp line was also observed in several areas. Cobbles within the embankment fill are exposed in the undercut areas. See **Photo 5**.
- Two slope failures (referred to as slope failure #1 and slope failure #2) were observed on the upstream slope below the normal pool elevation between the spillway and left abutment. The head scarp of slope failure #1 (leftmost failure) was approximately 6 ft. wide, 1 ft. deep, and 9 ft. long. The scarp resulting from slope failure #2 (rightmost failure) was less pronounced and measured 4 ft. wide. 0.5 ft. deep, and 5 ft. long. Debris fans consisting of transported embankment soil (sand and fine gravel) were observed downstream of both slope failures. Both failures appear to be the result of stormwater runoff onto/down the slope during a low impoundment stage. See **Photo 6** and **Photo 7**.
- A catch basin located in the upstream gutter line of Boston Road contains a 12-inch diameter corrugated metal stormwater outfall pipe that daylights through the upstream

slope between the spillway and left abutment. A scour hole and small erosion gully were observed on the slope beneath the pipe outfall. See **Photo 8**.

- Occasional footpaths are present in isolated locations on the upstream slope. The paths are poorly defined and were largely obscured by dormant weeds and other vegetation.

Crest

The following conditions were observed on the crest:

- Evidence of pavement distress including longitudinal cracking and occasional alligator cracking is present in the vehicle wheel paths of both travel lanes of Boston Road. See **Photo 9** and **Photo 10**.
- The dam crest (Boston Road) is crowned along its centerline, which appears to direct stormwater runoff onto the upstream and downstream slopes. The vertical alignment of the roadway also appears to form a high point above the spillway and low points to the left and right of the high point. Two catch basins located between the spillway and left abutment in the roadway gutter lines discharge into corrugated metal outfall pipes that daylight through the upstream and downstream slopes. See **Photo 10** and **Photo 11**. Observations related to the outfall pipes are provided in the *Upstream Slope* and *Downstream Slope* sections above and below, respectively.

Downstream Slope

The following conditions were observed on the downstream slope:

- With the exception of the cascading boulder-lined spillway discharge channel, the downstream slope is moderately overgrown with woody brush. Trees up to 18 inches in diameter are present along the downstream toe and in the immediate downstream area. The vegetative cover and associated layer of dead plant debris on the slope surface prevented a thorough visual inspection. Wetland vegetation was present at the slope toe near the left abutment. See **Photo 12** through **Photo 15** for an overview of the downstream slope and extent of vegetation.
- A catch basin located in the downstream gutter line of Boston Road contains an 18-inch diameter corrugated metal stormwater outfall pipe that daylights through the downstream slope along the toe between the spillway and left abutment. The exposed end of the pipe was partially buried and obscured by vegetation. The pipe was dry at the time of the inspection. No evidence of erosion was observed downstream of the outfall, but as noted above, a thick layer of dead plant debris covering the area could have obscured this condition. See **Photo 16**.
- Slow seepage (less than 0.5 gpm) was observed emerging from the left downstream groin upstream of a small area of ponded water. Reportedly, seepage and standing water have always been an issue near the left abutment on the downstream side of the dam and in the immediate downstream area. Prior inspections (with the impoundment at normal pool elevation) noted a seepage rate between 3 to 5 gpm. See **Photo 17**.
- Surface drainage from the crest onto the downstream slope has resulted in slight 'oversteepening' and surficial erosion near the top of the slope in a few locations, particularly in line with the crest low points to the right and left of the spillway.

Drains

A subsurface utility stormwater drainage system is present within the embankment (beneath the crest) based on the presence of catch basins in the roadway. No other drains were observed or are reported to exist at the dam.

Instrumentation

Instrumentation was not observed and is not reported to exist at the dam.

Access Roads and Gates

The dam supports a two-lane paved public roadway (Boston Road), which appears to be in satisfactory condition based on the observations described above. There are no gates or other designated access roads associated with the dam.

2.1.3 Appurtenant Structures

Primary Spillway

The following conditions were observed at the primary spillway and its associated features:

- There are transverse cracks in the reinforced concrete headwall above the second and sixth CMP culverts (from the left) and a longitudinal crack between the third and fourth CMP culvert (from the left). See **Photo 18** and **Photo 19**.
- The protective bituminous coating lining the interior of the CMP culverts is cracked at the top of the pipes and mostly missing along the inverts. The pipe inverts are corroded where the bituminous coating is missing. See **Photo 20**.
- Cracking and general concrete deterioration were observed at the reinforced concrete endwall (downstream side of spillway) along an apparent construction joint between the endwall and bedding slab or footing beneath the CMP culverts. No evidence of wall movement was observed. See **Photo 21** and **Photo 22**.

Low-Level Outlets

As described in **Section 1.3.7**, the timber gate at the LLO inlet failed in July 2019. As a result, pond levels fell to several feet below normal pool elevation by the end of July. The gate and debris at the inlet were removed on August 15, 2019 and the Town constructed a stone and sandbag check dam immediately upstream of the conduit entrance to permit observation of the LLO and prevent complete drainage of the impoundment. The following conditions were observed at the LLO:

- The stone and sandbag check dam installed by the Town was still in place and functioning as intended. The approach area upstream of the check dam was generally free of pond debris. See **Photo 23**.
- The timber guide/bearing boards mounted to the left and right side of the conduit entrance appeared to be in generally fair condition but the concrete at the conduit entrance (against which the former push gate 'sealed') is eroded to the point where individual pieces of aggregate are exposed. See **Photo 23** and **Photo 24**.
- When viewed from the downstream end, the LLO conduit appeared to be in generally fair condition and flowing freely. See **Photo 25**.

Auxiliary/Emergency Spillway

There is no auxiliary or emergency spillway at this dam.

Dikes

There are no dikes associated with this dam.

2.1.4 Downstream Area

As described above, slow seepage (less than 0.5 gpm) was observed emerging from the left downstream groin upstream of a small area of ponded water located in the immediate downstream area near the left abutment. Prior inspections noted similar findings and reported higher seepage rates (3 to 5 gpm) as well as exposed sand and gravel. The source/origin of the seepage is unknown. Monitoring of seepage rates during fluctuation of the impoundment level may provide insight as to whether or not this condition is directly tied to the impoundment.

The immediate downstream area is heavily wooded and accessible only by foot. The downstream channel (Cold Spring Brook) appears to flow freely for several hundred feet downstream of the dam. See **Photo 26**.

2.1.5 Reservoir Area

Based on observations from the dam crest, the reservoir shoreline is generally undeveloped and wooded with mild to moderate slopes and occasional apparent bedrock outcrops. Some residential properties are present along the southeastern shoreline. See **Photo 27**.

2.2 Caretaker Interview

Matthew Stencel, Superintendent of the Sutton Highway Department, is the caretaker for Woodbury Pond Dam. Mr. Stencel provided the following information on the dam:

- Brush is cut on the upstream and downstream slopes at least once per year.
- Town Highway personnel drive by the site three times per week and walk the site at least once per week.
- Mr. Stencel estimated that the highest water level he has observed at the dam prior to the LLO gate failure was approximately 1 ft. over the CMP inverts.
- Since removal of the LLO gate, Mr. Stencel has observed a maximum water level equal to the CMP invert elevation.

According to the previous caretaker, Mr. Mark Brigham, the dam crest (Boston Road) reportedly 'washed out' in 1955. No further details of this reported event were provided or available.

2.3 Operation and Maintenance Procedures

A formal operations and maintenance (O&M) plan has not been developed for Woodbury Pond Dam.

2.3.1 Operational Procedures

The LLO gate was the only operational appurtenance at the dam, and according to Mr. Stencel, it had not been operated for many years prior to failure and removal.

2.3.2 Maintenance of Dam and Operating Facilities

Brush growing on the embankment slopes is cut at least once per year and inspected periodically. The CMP culverts comprising the spillway are also checked for debris periodically.

2.4 Emergency Warning System

Weston & Sampson is currently finalizing an Emergency Action Plan (EAP) for the dam. The finalized EAP will be dated May 2020.

2.5 Hydrologic/Hydraulic Data

Woodbury Pond Dam is an **INTERMEDIATE** size, **SIGNIFICANT** hazard potential structure. Therefore, according to 302 CMR 10.14 (6), the Spillway Design Flood (SDF) for the structure is the 100-year storm event.

A comprehensive hydrologic and hydraulic (H&H) study was performed by SFC as part of the 1999 DEM Emergency Dam Inspection Report for Woodbury Pond Dam. The inputs and results of this analysis were reviewed at part of this study and the drainage area used by SFC was 6.4 square miles. The analysis was conducted assuming Woodbury Pond was at normal pool and available capacity of the LLO was neglected. SFC developed an inflow hydrograph to Woodbury Pond utilizing HydroCAD V.5.01 for the 100-year storm event. Refer to SFC's report more information on the study. SFC reported the following findings:

Peak Inflow to Woodbury Pond	2,962 cfs
Peak Outflow from Woodbury Pond	2,945 cfs
Peak Depth of Dam Crest Overtopping	1.16 ft.
Duration of Overtopping	3.5 hours

Based on this analysis, the dam cannot safely pass the SDF. Modifications to the dam are therefore necessary to bring the structure into compliance with current dam safety guidelines and practices. Prior to any modifications, an updated H&H should be completed using current rainfall data.

2.6 Structural and Seepage Stability

2.6.1 Embankment Structural Stability

Engineering analyses of static and dynamic stability were not available for review and were not completed as part of this study. Based on visual observation, Woodbury Pond Dam appears structurally stable, but may not meet the minimum factors of safety against slope instability included in the current state dam safety guidelines. The downstream slope is graded at approximately 1.5H:1V to 2H:1V, which generally exceeds the maximum slope inclination recommended for earthen dams. Flattening of slopes may be required to meet minimum factors of safety against instability.

Until necessary repairs can be made, deficiencies noted on the upstream slope including scarps and areas of slope failures should be monitored for additional movement and erosion. Utility poles along the downstream edge of the crest (which were observed to be tilted in the downstream direction) should also be monitored for additional movement.

2.6.2 Structural Stability of Non-Embankment Structures

Based on visual observation, the non-embankment elements of the dam including the spillway headwall and endwall appear stable. As noted above, there is a crack along an apparent construction joint near the base of the endwall but no evidence of wall movement/rotation was observed. Continued monitoring of the endwall is recommended and any evidence of wall movement should be documented and reported.

2.6.3 Seepage Stability

As described above, slow seepage (less than 0.5 gpm) was observed emerging from the left downstream groin upstream of a small area of ponded water. Reportedly, seepage and standing water have always been an issue near the left abutment on the downstream side of the dam and in the immediate downstream area. Prior inspections noted similar findings and reported higher seepage rates (3 to 5 gpm) as well as exposed sand and gravel. The source/origin of the seepage is unknown. Monitoring of seepage rates during fluctuation of the impoundment level may provide insight as to whether or not this condition is directly tied to the impoundment and/or influenced by the impoundment level.

At the present time, the observed seepage does not appear to present an imminent dam safety concern or an unsafe condition; however, it is recommended that the seepage be regularly monitored and any increases in rates or the presence of transported soil fines be noted and reported. Monitoring of the seepage prior to, during, and immediately following significant precipitation events or upstream reservoir releases that raise the impoundment level is especially important and may provide insight as to the source/origin of the seepage.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

The overall physical condition of the dam is considered to be **POOR** based on the deficiencies observed during this inspection and guidelines provided by the Office of Dam Safety. This represents a condition downgrade from the (fair) condition rating assigned during the last Phase I Inspection/Evaluation completed by Weston & Sampson in 2009. The primary reasons for the downgrade include significant woody vegetation, brush, and trees on the slopes, abutments, and in the immediate downstream areas; slope failures and erosion on the upstream slope that could be exacerbated by fluctuating water levels caused by the open LLO conduit; and overtopping potential during the SDF.

A complete list of dam safety deficiencies observed during this inspection is as follows:

1. The timber gate (closure mechanism) at the LLO inlet failed in July 2019 and was subsequently removed. At the present time, the LLO does not have a closure mechanism and the impoundment remains drawn down under normal inflows. The concrete at the LLO conduit entrance (against which the former gate 'sealed') is eroded to the point where individual pieces of aggregate are exposed, creating a very rough surface. Improvements to the LLO inlet will be required as part of gate replacement.
2. Significant portions of the upstream and downstream slopes are covered with vegetation including brush, dormant weeds, tall grasses, and occasional saplings. Vegetation on the upstream slope is generally limited to brush and saplings, but trees up to 18 inches in diameter are present along and within approximately 20 feet of the downstream toe. A thick layer of leaf litter and other plant debris covering the downstream slope prevented a thorough visual inspection and may have obscured specific deficiencies.
3. The majority of the upstream slope does not have consistent erosion protection. A scarp line exists along the normal pool elevation for most of the slope length with a maximum vertical height of approximately 8 inches. Up to 12 inches of bank undercutting along the scarp was observed in several areas.
4. Two slope failures have occurred on the upstream slope below the normal pool elevation between the spillway and left abutment. The head scarp from leftmost failure was approximately 6 ft. wide, 1 ft. deep, and 9 ft. long. The scarp resulting from the adjacent (rightmost) failure was smaller and less pronounced. Debris fans consisting transported embankment soil were observed downslope of both areas. It appears these isolated slope failures are the result of surface drainage from the roadway directed onto/down the slope during a low impoundment stage. Continued drainage of stormwater onto the slope and surges in the impoundment stage could worsen this condition.
5. A catch basin located in the upstream gutter line of Boston Road contains a 12-inch diameter corrugated metal stormwater outfall pipe that daylights through the upstream slope between the spillway and left abutment. A scour hole and small erosion gully were observed on the slope beneath the pipe outfall.
6. Slow seepage (less than 0.5 gpm) was observed emerging from the left downstream groin upstream of a small area of ponded water. Prior inspections noted a seepage rate between 3 to

5 gpm as well as exposed sand and gravel. Evidence and suspicion of piping or transport of embankment material was not described in prior inspection reports.

7. Surface drainage from the crest onto the downstream slope has resulted in slight 'oversteepening' and surficial erosion near the top of the downstream slope in a few locations, particularly in line with the crest low points to the right and left of the spillway.
8. Transverse cracks in the reinforced concrete headwall were observed above the second and sixth CMP culverts from the left. A longitudinal crack was observed between the third and fourth CMP culvert from the left.
9. A bituminous coating lining the interior of the CMP culverts is cracked at the top of the pipes and mostly missing along the inverts. The pipe inverts are corroded where the coating is missing. Continued corrosion and deterioration could result in leakage into the embankment.
10. Cracking and general concrete deterioration were observed at the reinforced concrete endwall along an apparent construction joint between the endwall and bedding slab or footing beneath the CMP culverts.

In addition to the above deficiencies, the timber gate at the upstream end of the low-level outlet (LLO) conduit failed in July 2019. The gate was subsequently removed by the Town. The pond level has been drawn down since failure and removal of the gate and is currently controlled by a small sandbag and cobble check dam constructed at the LLO inlet. Base flow is currently discharged through the LLO, but pond levels will fluctuate with stream flow and storm events that exceed the LLO discharge capacity. According to Mr. Matthew Stencel, Superintendent of the Town Highway Department and the dam's caretaker, there are currently no plans to repair the LLO and restore the impoundment to the normal pool elevation.

While the lowered impoundment level associated with the open LLO reduces hydraulic loads on the dam and the risks associated with many of the identified deficiencies, inflows associated with significant storms and/or upstream dam releases will exceed the LLO capacity and can significantly raise the impoundment for short periods. Drawdown from such conditions (i.e. rapid drawdown) could destabilize portions of the upstream slope and exacerbate existing failures and erosion.

Previously identified deficiencies described in the 2009 Phase I Inspection/Evaluation Report prepared by Weston & Sampson are summarized in the following table. The table also presents the current condition or resolution of the deficiencies.

Previously Identified Deficiency	**Resolution or Current Condition**
The upstream and downstream slopes are vegetated with long grass, weeds, and brush that prevented a thorough inspection.	Condition appears generally unchanged since the previous inspection.
An erosional scarp was observed along the upstream slope near the normal water line.	Condition appears generally unchanged since the previous inspection, but may have worsened slightly.
Eroded footpaths and an eroded surface water drainage swale were observed along upstream slope.	Condition appears generally unchanged since the previous inspection.

Seepage of approximately 3 gpm to 5 gpm was observed at the top of the slope near the left abutment.	Seepage was observed but at a slower rate (less than 0.5 gpm). The reduced seepage may be associated with the lower impoundment level.
The downstream slope appears to be relatively steep. Utility poles along the top of the downstream slope are tilted downstream, which could be an indication of slope movement and should be monitored over time.	Condition appears generally unchanged since the previous inspection. Continued monitoring is still recommended.
The interior coating of the primary spillway CMPs is deteriorating.	Condition appears generally unchanged since the previous inspection, but may have worsened slightly.
The LLO is likely not operable and the push gate appears to be silted in place.	The LLO push gate failed in 2019 and has not been replaced or repaired.
The dam cannot safely pass the SDF.	No modifications have been made to address this deficiency.

As defined by current dam safety guidelines, an overall condition rating of **POOR** means that significant structural, operation, and maintenance deficiencies are clearly recognized under normal loading conditions. The deficiencies described above are considered to be both structural deficiencies as well as operation and maintenance deficiencies, but do not appear to create an immediate unsafe condition at the dam under normal loading conditions. If not addressed, however, an unsafe condition could develop over time or become exacerbated by unusual or extreme loading conditions.

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs, or 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, MADEP, or other regulatory agencies. A Chapter 253 Dam Safety Permit application filed with the Office of Dam Safety will be required for repairs and alternations to the dam, including replacement of the LLO gate.

3.2 Studies and Analyses

It is recommended that the Town of Sutton engage the services of a Registered Professional Engineer as defined in 302 CMR 10.03 to complete the following studies and analyses in accordance with current dam safety regulations:

- Prepare an Operations and Maintenance (O&M) Plan for the dam to include maintenance to the primary spillway, embankment, and LLO.
- Perform a stability analysis of the downstream slope of the dam. The analysis should include the collection of the necessary physical properties, section geometry, and determination of design loading conditions.

- Perform a H&H study of the dam to check the results from the 1999 DEM Emergency Dam Inspection Report prepared by SFC and for use in design of modifications to the dam to make it hydraulically adequate.

3.3 Recurrent Maintenance Recommendations

It is recommended that the Town of Sutton conduct the following routine observation and maintenance activities:

- Observe the condition of the dam for changes from those identified in this report. Observations should be made quarterly, as well as during and following rainfall events that exceed the 25-year, 24-hour storm (approximately 6.2 inches of rain in 24 hours).
- Observe the approach and discharge areas of the primary spillway and LLO and clear debris if observed to maintain free flow through the system.
- Monitor the seepage at the toe of the downstream slope near the left abutment. Keep written and photographic records of the area and note any changes to rate or clarity of flow.
- Monitor the tilted utility poles on the downstream slope of the dam to assess if slope movement is occurring.
- Cut vegetation on and around the upstream and downstream slopes of the embankment to within 6 inches of the ground surface. Develop and maintain a healthy stand of grass on the slopes of the embankment and inspect the slopes for any deficiencies not detected during this inspection.

3.4 Minor Repair Recommendations

It is recommended that the Town of Sutton conduct the following minor repair activities as soon as practicable to improve conditions and reduce the risk of dam failure until appropriate dam rehabilitation is designed and constructed. These activities may require design by a Registered Professional Engineer and/or permit application filing with the local conservation commission, Office of Dam Safety, and/or DEP.

- Fill any eroded paths with compacted granular fill. Seed and mulch the paths to promote a healthy stand of grass.
- Repair the two slope failures on the upstream slope by restoring to grade with compacted granular fill. Loose material in the failure areas should be removed prior to fill placement. These areas and the catch basin pipe outfalls should be armored with riprap for erosion protection.
- Fill the scarped and undercut areas on the upstream slope with compacted granular fill and armor with riprap.
- Patch and repair the cracks and voids observed in the primary spillway culvert headwall and endwall.

3.5 Remedial Modifications Recommendations

The following remedial modifications are recommended to bring the dam into compliance with current dam safety regulations and will require permit application filing from the local conservation commission, Office of Dam Safety, DEP, and the US Army Corps of Engineers.

- Remove trees and root masses from the embankment and backfill resulting voids with compacted granular fill.
- Regrade the embankment slopes to a mild, consistent geometry in accordance with current best practices for dam design and install an engineered seepage filter on the downstream slope designed to control seepage while retaining the existing embankment soils.
- Install riprap slope protection along the upstream slope to reduce erosion and undercutting. Extend the riprap to within 1 ft. of the crest elevation and at least 2 ft. below the normal pool elevation.
- Reconfigure or reconstruct the primary spillway to safely discharge the SDF, or surface the entire downstream slope with an erosion resistant treatment to provide overtopping protection. Reconfiguration of the spillway should include replacement or re-lining of the CMP culverts.
- Repair or permanently decommission the LLO. If repaired, install a mechanically operated gate on the upstream end. Installation of a mechanically operated gate would likely require construction of a riser-type intake structure connected to the upstream end of the conduit and accessible via a catwalk from the crest. The catwalk and riser structure would need to be gated to prevent unrestricted access and vandalism. If the LLO is permanently decommissioned, upstream slope improvements should be made to reduce the potential for instability caused by impoundment fluctuations and rapid drawdown conditions.
- Resurface the regraded portions of the downstream slope with loam and seed the areas to promote a healthy stand of grass.
- Institute an O&M Plan consistent with the new design features of the dam.

3.6 Alternatives

A possible alternative to dam rehabilitation is dam removal. Dam removal would involve making a controlled breach of the dam to revert the impoundment area to a smaller, natural (non-impounded) stream channel. Maintaining the existing road and roadway embankment could be accomplished by replacing the existing primary spillway culverts with a culvert system that has an invert set at the natural streambed elevation. A preliminary assessment is recommended to evaluate the feasibility and effects of dam removal.

The advantages of dam removal include eliminating the liability, cost, and risk associated with dam ownership, as well as eliminating the need for long-term maintenance and operational effort and cost. There are several State and Federal agencies that advocate and provide funding for dam removal. The opportunities for funding would need to be evaluated during the design and permitting process.

Removal of the dam would require a Registered Professional Engineer to design the method and sequence of breaching and establishing a new channel. Dam removal will require significant

environmental permitting and public opposition is likely depending on perceived changes in recreational opportunities or aesthetic value of the structure or impoundment. A historical review of the site would be recommended to determine the type and expanse of wetland resources present at the site prior to dam construction. Also, additional pond bathymetry may be required to determine the original pond area and stream inlet and outlet channels. There could also be impacts to groundwater supply wells in the area if the impoundment level is permanently reduced. These issues would have to be evaluated as part of the design, but could be less complicated due to the existing drawn down condition created by the open LLO. A comprehensive hydraulic and hydrologic assessment of the upstream and downstream areas should be performed during the preliminary evaluation.

The extent and cost of environmental permitting for dam removal is not clear and would depend on how the local conservation commission, City, public, and permitting agencies view a dam removal proposal. A full environmental impact evaluation would be required to identify the extent of environmental impacts of dam removal.

3.7 Opinion of Probable Construction Costs

The following opinion of probable construction costs have been developed for the recommended recurrent maintenance, minor repair, and remedial modification recommendations identified in **Section 3.3** through **Section 3.5**, and for the dam removal alternative described in **Section 3.6**.

Recurrent Maintenance Recommendations (Annual Cost)…….. $8,000 to $10,000

Minor Repair Recommendations……. $30,000 to $50,000

Remedial Modification Recommendations…….. $650,000 to $850,000

Alternatives (Dam Removal)……$300,000 to $450,000

The above costs are based on limited investigation and are provided for general information only; the costs should not be considered an engineer's estimate or be used for capital planning or budgeting purposes. Actual construction costs may be less or considerably more than indicated. Costs associated with the dam removal alternative may vary depending on the environmental engineering assessment described in **Section 3.6**.

FIGURES

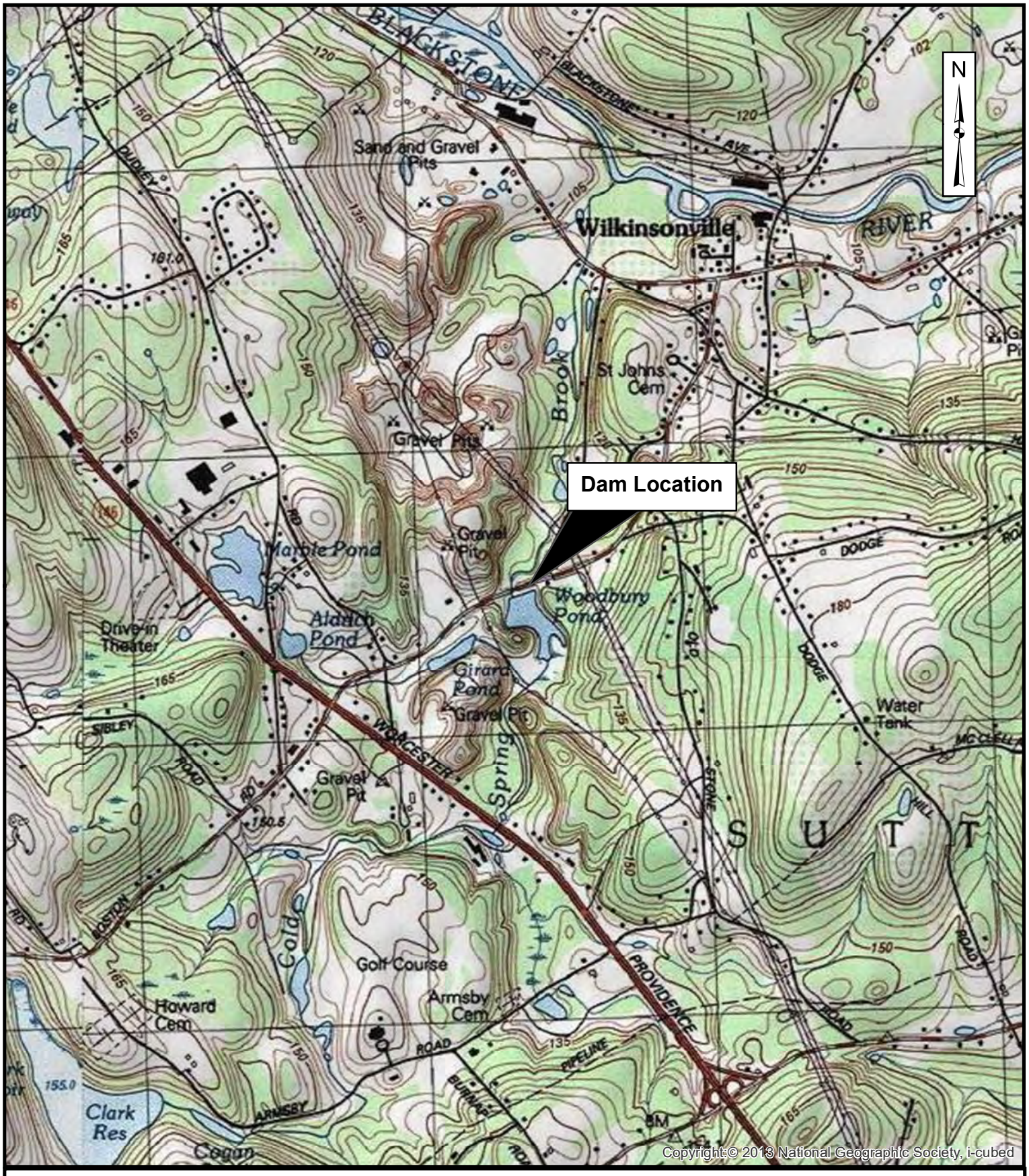


FIGURE 1- LOCUS PLAN
WOODBURY POND DAM

TOWN OF SUTTON, MASSACHUSETTS

NID ID#: MA01179
Longitude ±: 71.7311 W
Latitude ±: 42.1651 N
USGS Quad: Sutton, MA

0 550 1,100 2,200 3,300 4,400 Feet

Weston & Sampson

FIGURE 2- AERIAL PHOTOGRAPH
WOODBURY POND DAM
TOWN OF SUTTON, MASSACHUSETTS
NID ID#: MA01179
Longitude ±: 71.7311 W
Latitude ±: 42.1651 N
USGS Quad: Sutton, MA

0 100 200 400 600 800 Feet

Weston & Sampson

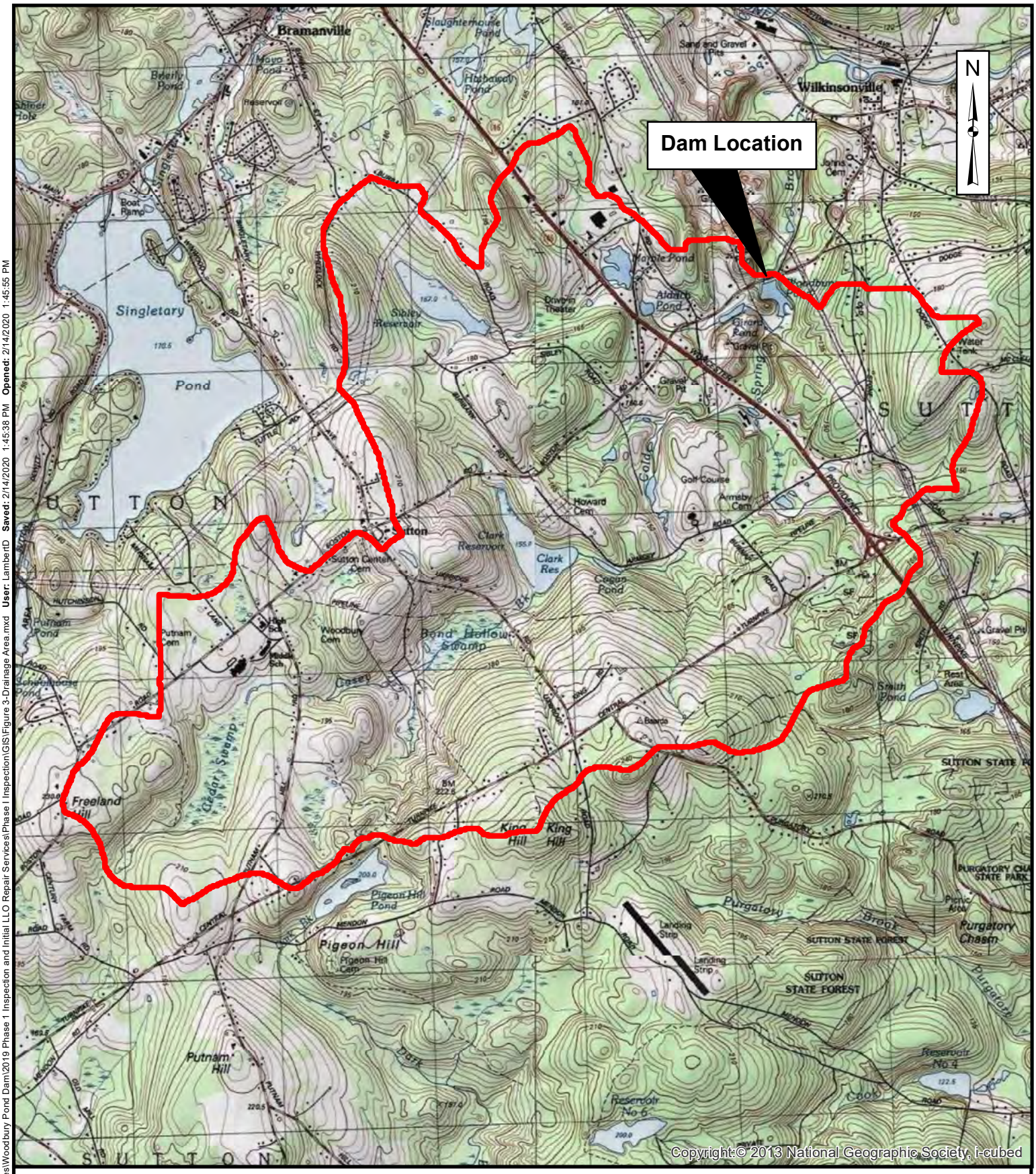


FIGURE 3- DRAINAGE AREA
WOODBURY POND DAM

TOWN OF SUTTON, MASSACHUSETTS

NID ID#: MA01179
Longitude ±: 71.7311 W
Latitude ±: 42.1651 N
USGS Quad: Sutton, MA

Legend

Drainage Area (6.3 Sq. Mi.)

0 1,050 2,100 4,200 6,300 8,400 Feet

Weston & Sampson

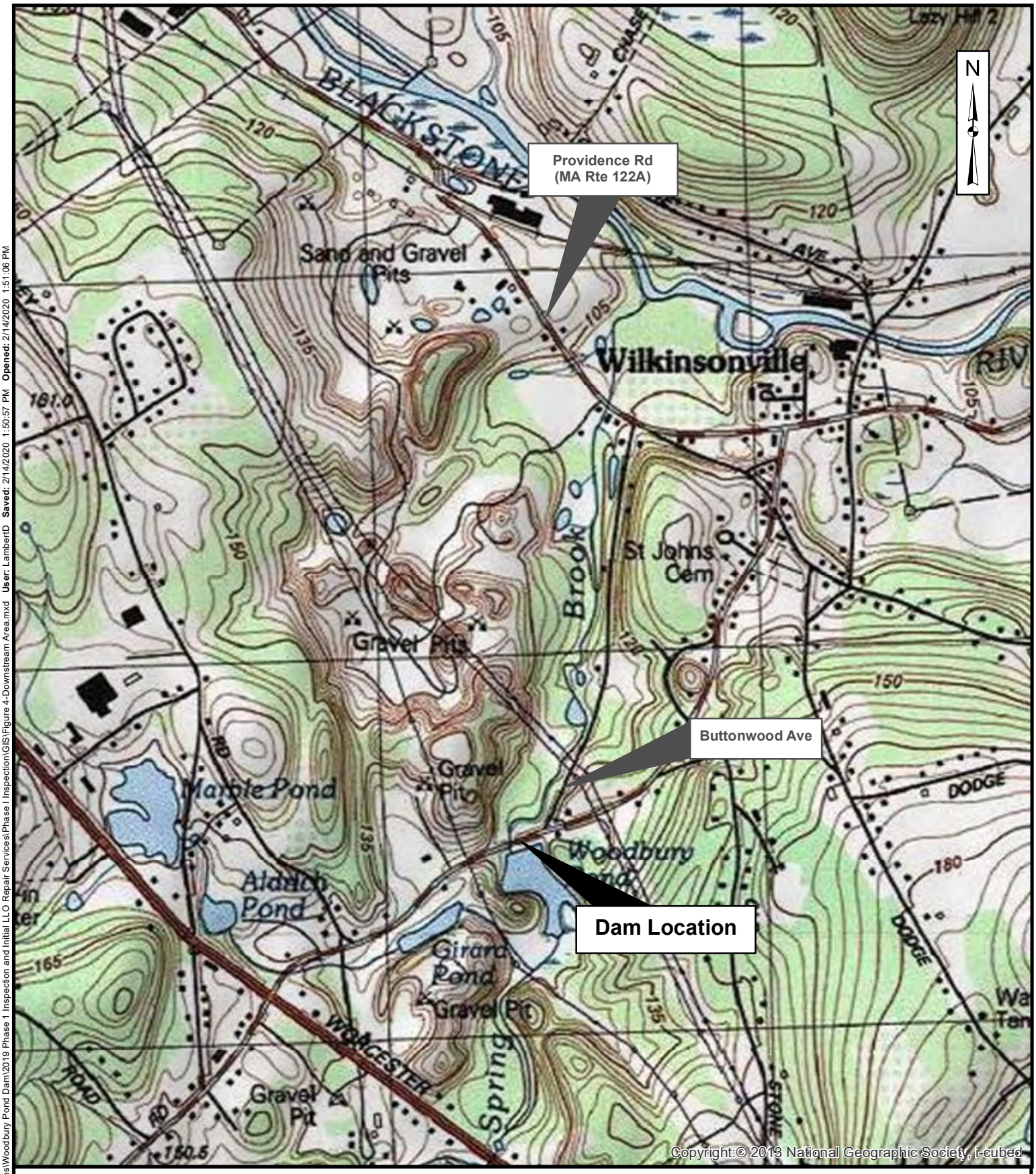


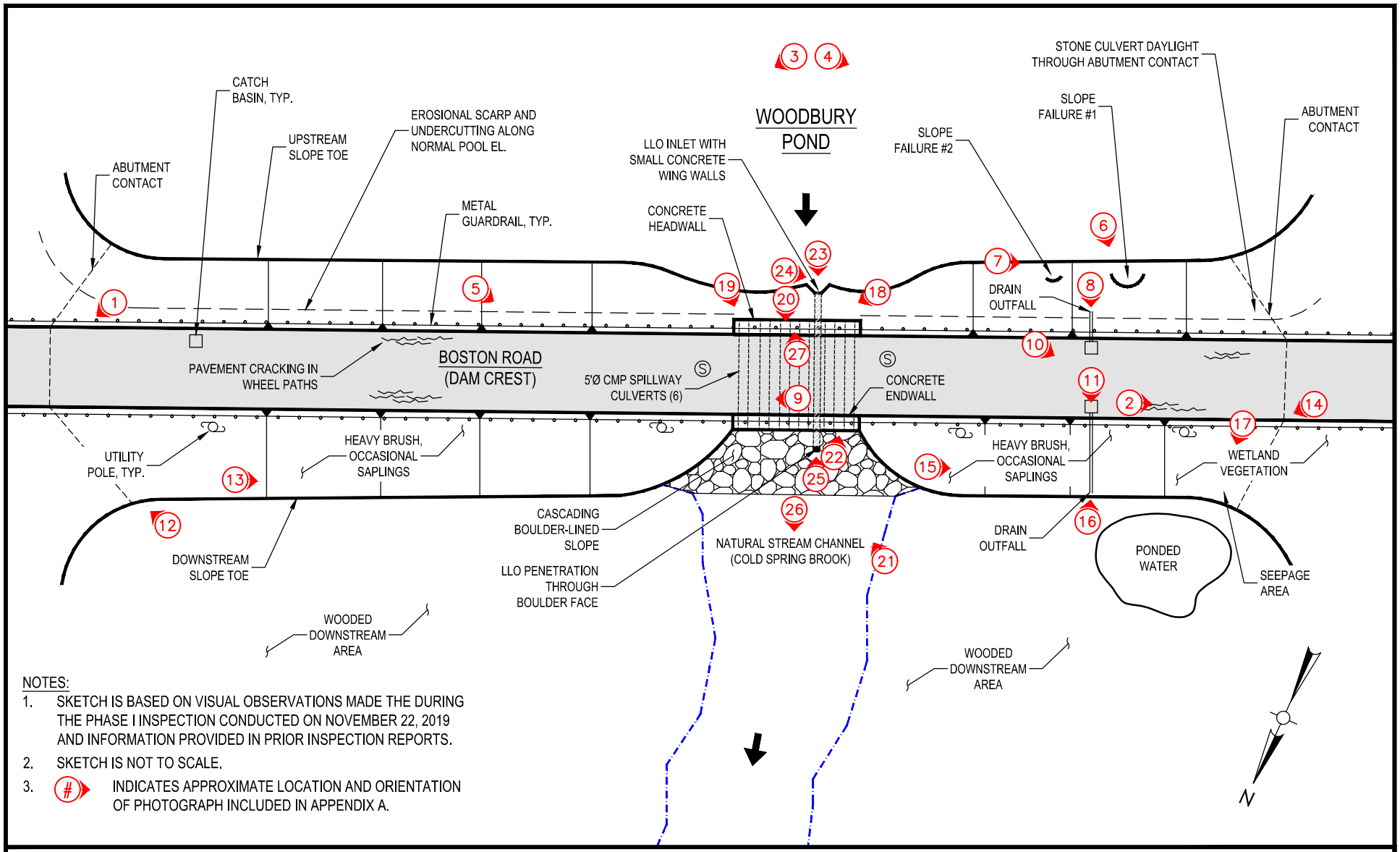
FIGURE 4- DAM & DOWNSTREAM AREA
WOODBURY POND DAM

TOWN OF SUTTON, MASSACHUSETTS

NID ID#: MA01179
Longitude ±: 71.7311 W
Latitude ±: 42.1651 N
USGS Quad: Sutton, MA

0 430 860 1,720 2,580 3,440 Feet

Weston & Sampson



NOTES:

1. SKETCH IS BASED ON VISUAL OBSERVATIONS MADE THE DURING THE PHASE I INSPECTION CONDUCTED ON NOVEMBER 22, 2019 AND INFORMATION PROVIDED IN PRIOR INSPECTION REPORTS.
2. SKETCH IS NOT TO SCALE.
3. (#) INDICATES APPROXIMATE LOCATION AND ORIENTATION OF PHOTOGRAPH INCLUDED IN APPENDIX A.

FIGURE 5 - SITE SKETCH
WOODBURY POND DAM
TOWN OF SUTTON, MASSACHUSETTS

NID ID#: MA01179
Longitude ±: 71.7311 W
Latitude ±: 42.1651 N

NOT TO SCALE

Weston & Sampson

APPENDIX A
Photographs

Photo 1 - The right end of the dam where the embankment crest contacts the right abutment.

Photo 2 - The left end of the dam where the embankment crest contacts the left abutment.

Photo 3 - Overview of the upstream slope (right of the spillway). Note the presence of dormant brush and saplings on the upper portion of the slope above the normal pool elevation.

Photo 4 - Overview of the upstream slope (left of the spillway). Two isolated slope failures were observed below the normal pool elevation. Vegetation conditions were similar to those described in Photo 3.

Photo 5 - The upstream slope near the spillway. As noted in Photos 3 and 4, an erosional scarp is present on the upstream slope along the normal pool elevation. The maximum height of the scarp was approximately 8 inches. Up to 12 inches of slope undercutting along the scarp was observed in several areas.

Photo 6 - Close-up view of slope failure #1 shown in Photo 4. An apparent erosion gully or drainage ditch is located above and in-line with the scarp.

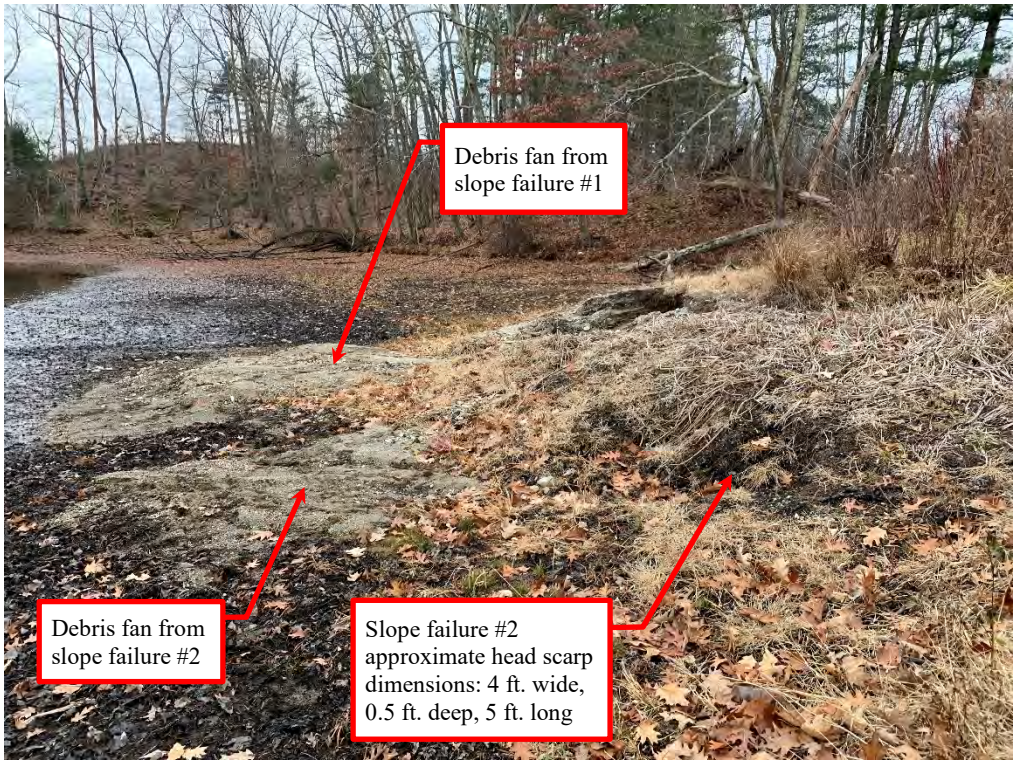


Photo 7 - Overview of two slope failures observed on the upstream slope between the spillway and left abutment.

Photo 8 - The outfall of a 12-inch corrugated metal stormwater drain pipe connected to a catch basin on the dam crest. This outfall is located on the upstream slope between the spillway and left abutment.

Photo 9 - Overview of the dam crest (Boston Road) from the spillway, facing the right abutment.

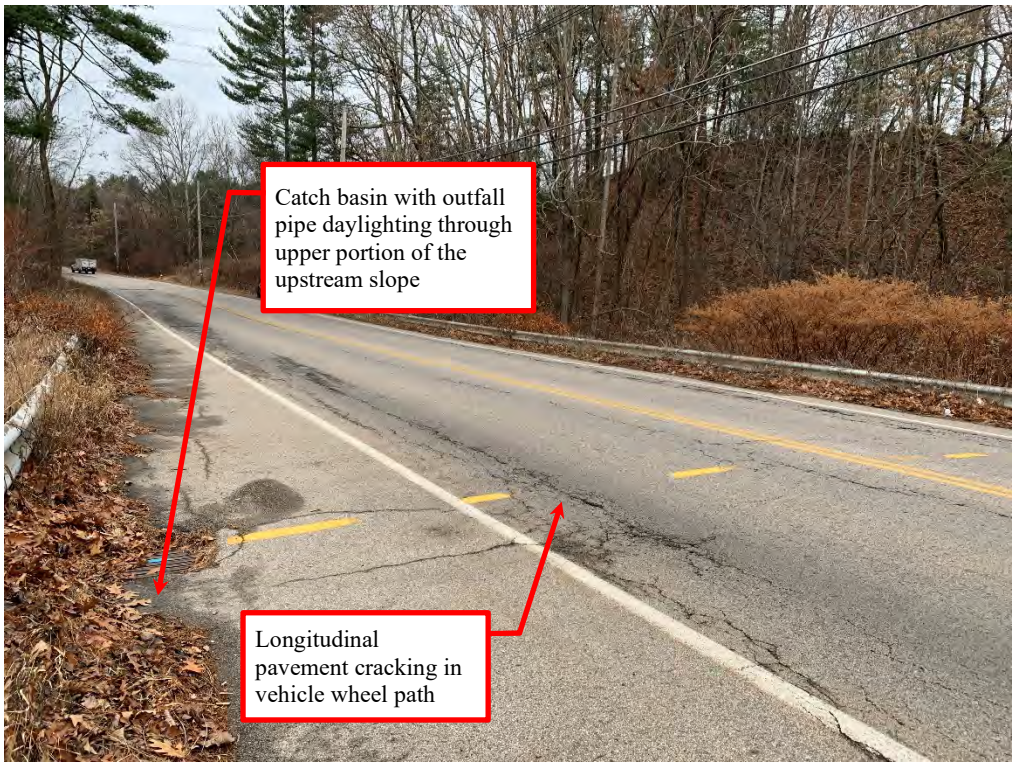


Photo 10 - Overview of the dam crest (Boston Road) from the spillway, facing the left abutment.

Photo 11 - Catch basin at the edge of pavement on the downstream side of the crest (opposite the catch basin shown in Photo 10). This catch basin discharges into an 18-inch diameter corrugated metal outfall pipe that daylights through the toe of the downstream slope (see Photo 16).

Photo 12 - The right end of the downstream slope where it contacts the right abutment (right downstream groin). Woody vegetation and large trees are present.

Photo 13 - The downstream slope between the spillway and right abutment. Woody vegetation and a thick cover of leaves and plant debris made inspection difficult and may have obscured deficiencies.

Photo 14 - The downstream slope where it contacts the left abutment (left downstream groin). Thick brush and wetland vegetation is present in this area.

Photo 15 - The downstream slope between the spillway and left abutment. Woody vegetation and a thick cover of leaves and plant debris made inspection difficult and may have obscured deficiencies.

Photo 16 - The partially buried outfall of an 18-inch corrugated metal stormwater drain pipe connected to a catch basin on the dam crest. This outfall is located on the downstream slope between the spillway and left abutment.

Photo 17 - Ponded water in a depression along the toe of the downstream slope near the left abutment. A wet area with slow seepage was observed upstream of the ponded water along the lower portion of the left downstream groin. Seepage has been observed in this area previously, but the origin/source is unknown.

Photo 18 - Overview of the spillway and reinforced concrete headwall. Transverse cracks were observed above the second and sixth CMPs from the left and a longitudinal crack was observed between the third and fourth CMPs from the left.

Photo 19 - Close up view of a transverse crack above rightmost CMP.

Photo 20 - Close up view of two of the CMPs. The protective bituminous coating on the CMPs is cracked at the top of the pipes and is missing along the inverts. The bottom of the CMPs are corroded where the bituminous coating is missing.

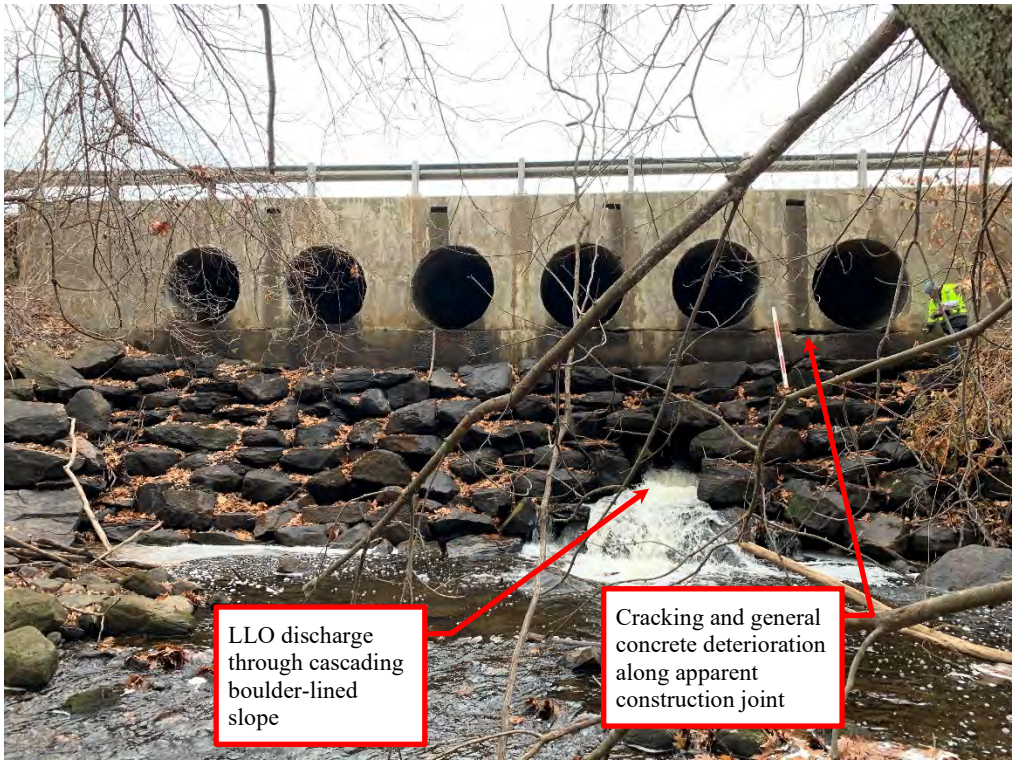


Photo 21 - Overview of the downstream side of the spillway and cascading boulder-lined discharge slope. The spillway's reinforced concrete endwall is cracked and deteriorated in several locations.

Photo 22 - Close-up view of cracked and deteriorated concrete at the spillway endwall along an apparent construction joint.

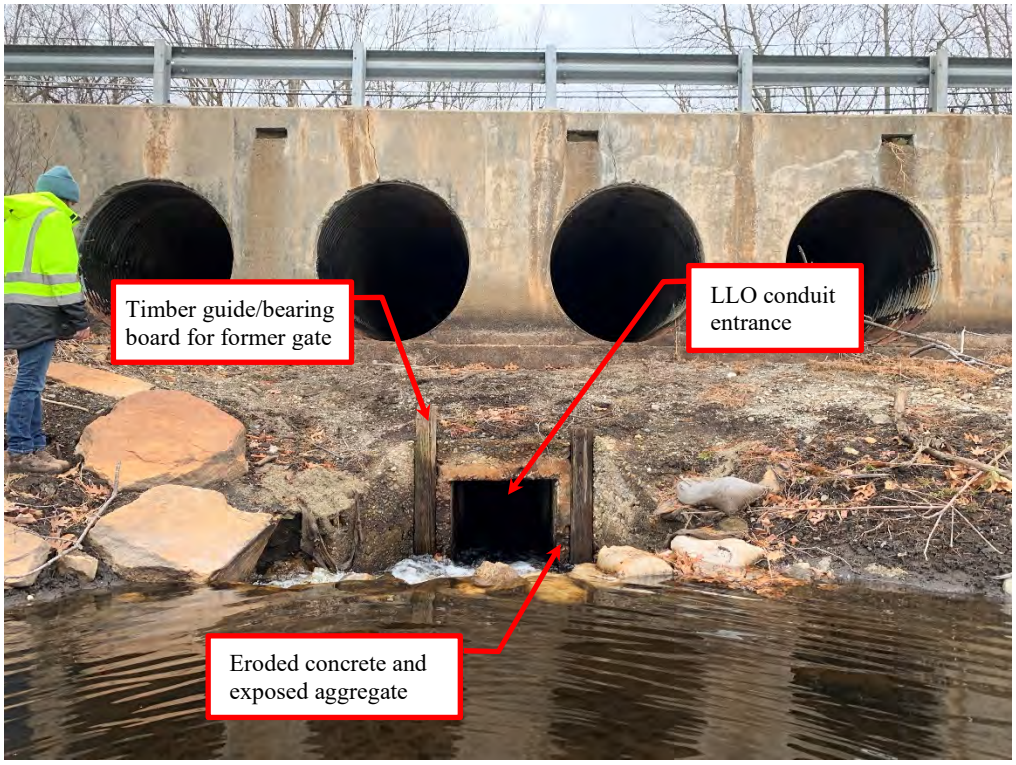


Photo 23 - Overview of the LLO approach area. The LLO control mechanism (timber gate) failed and was removed in July 2019. A stone and sandbag check dam is present upstream of the LLO inlet.

Photo 24 - Close up view of the LLO approach area and eddy at the end of the left LLO training wall. The eddy appears to be eroding a small cavity behind the training wall. Erosion of the concrete at the conduit entrance has resulted in exposed aggregate.

Photo 25 - The LLO conduit viewed looking upstream from the downstream end where the conduit daylights through the cascading boulder-lined slope. The conduit appeared to be flowing freely.

Photo 26 - Overview of the immediate downstream area and banks of the downstream channel (Cold Spring Brook). The immediate downstream area is heavily wooded. Access to the downstream area is possible by foot only. The downstream channel appears to flow freely.

Photo 27 - Overview of the impoundment from the dam crest.

APPENDIX B
Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: Woodbury Pond Dam
STATE ID #: 3-14-290-12

REGISTERED: ☑ YES ☐ NO
NID ID #: MA01179

STATE SIZE CLASSIFICATION: Intermediate
STATE HAZARD CLASSIFICATION: Significant
CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Sutton
COUNTY: Worcester

DAM LOCATION: Boston Road
(street address if known)
ALTERNATE DAM NAME: Millers Pond Dam

USGS QUAD.: Milford
LAT.: 42.1651 N
LONG.: 71.7311 W

DRAINAGE BASIN: Blackstone
RIVER: Tributary to Blackstone River

IMPOUNDMENT NAME(S): Woodbury Pond

GENERAL DAM INFORMATION

TYPE OF DAM: Earthen Embankment
OVERALL LENGTH (FT): 480

PURPOSE OF DAM: Recreation
NORMAL POOL STORAGE (ACRE-FT): 35 (SFC, 1999)

YEAR BUILT: Prior to 1900 (SFC, 1999)
MAXIMUM POOL STORAGE (ACRE-FT): 111 (SFC, 1999)

STRUCTURAL HEIGHT (FT): 20
EL. NORMAL POOL (FT): El. 377.8±

HYDRAULIC HEIGHT (FT): 13.6
EL. MAXIMUM POOL (FT): El. 384.2±

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO
CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: Woodbury Pond Dam | STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 | NID ID #: MA01179

INSPECTION SUMMARY

DATE OF INSPECTION: November 22, 2019 | DATE OF PREVIOUS INSPECTION: July 13, 2009

TEMPERATURE/WEATHER: 45°F, Overcast | ARMY CORPS PHASE I: ☐ YES ☑ NO | If YES, date

CONSULTANT: Weston & Sampson Engineers, Inc. | PREVIOUS DCR PHASE I: ☑ YES ☐ NO | If YES, date July 13, 2009

BENCHMARK/DATUM: Crest of dam assumed to be El. 384.2 based on plan titled, "Plan of Boston Road in the Town of Sutton," by the County Commissioners, dated August 30, 2009, Sheet 4 of 4.

OVERALL PHYSICAL CONDITION OF DAM: POOR | DATE OF LAST REHABILITATION: 1970±

SPILLWAY CAPACITY: 0-50% of the SDF or Unknown

EL. POOL DURING INSP.: Estimated at El. 373.0± | EL. TAILWATER DURING INSP.: Estimated at El. 365.5±

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
Timothy Blair, P.E.	Project Engineer	Weston & Sampson Engineers, Inc.
Deanna Lambert, E.I.T.	Engineer	Weston & Sampson Engineers, Inc.

EVALUATION INFORMATION

	Click on box to select E-code
E1) TYPE OF DESIGN	2
E2) LEVEL OF MAINTENANCE	2
E3) EMERGENCY ACTION PLAN	5
E4) EMBANKMENT SEEPAGE	3
E5) EMBANKMENT CONDITION	2
E6) CONCRETE CONDITION	3
E7) LOW-LEVEL OUTLET CAPACITY	4

	Click on box to select E-code
E8) LOW-LEVEL OUTLET CONDITION	1
E9) SPILLWAY DESIGN FLOOD CAPACITY	1
E10) OVERALL PHYSICAL CONDITION	2
E11) ESTIMATED REPAIR COST	$650k to $850k
ROADWAY OVER CREST	YES
BRIDGE NEAR DAM	NO

NAME OF INSPECTING ENGINEER: Timothy Blair, P.E. | SIGNATURE: T. J. Blair

NAME OF DAM:	Woodbury Pond Dam	STATE ID #:	3-14-290-12
INSPECTION DATE:	November 22, 2019	NID ID #:	MA01179

OWNER:		CARETAKER:	
ORGANIZATION	Town of Sutton	ORGANIZATION	Highway Department
NAME/TITLE		NAME/TITLE	Matthew Stencel/Highway Superintendent
STREET	4 Uxbridge Road	STREET	4 Uxbridge Road
TOWN, STATE, ZIP	Sutton, MA 01590	TOWN, STATE, ZIP	Sutton, MA 01590
PHONE	(508) 865-8743	PHONE	(508) 865-8743
EMERGENCY PH. #	(508) 865-8747 (Police)	EMERGENCY PH. #	(508) 865-8747 (Police)
FAX	(508) 865-9533	FAX	(508) 865-9533
EMAIL	mstencel@town.sutton.ma.us	EMAIL	mstencel@town.sutton.ma.us
OWNER TYPE	Municipality or Political subdivision		

PRIMARY SPILLWAY TYPE	(6) 5-ft. dia. corrugated metal pipe (CMP) culverts		
SPILLWAY LENGTH (FT)	Varies with pond elevation	SPILLWAY CAPACITY (CFS)	1,200 (SFC, 1999)
AUXILIARY SPILLWAY TYPE	N/A	AUX. SPILLWAY CAPACITY (CFS)	N/A
NUMBER OF OUTLETS	1	OUTLET(S) CAPACITY (CFS)	Unknown
TYPE OF OUTLETS	Low-Level	TOTAL DISCHARGE CAPACITY (CFS)	1,200 with LLO closed (SFC, 1999)
DRAINAGE AREA (SQ MI)	6.4	SPILLWAY DESIGN FLOOD (PERIOD/CFS)	100-year / 2,962 (SFC, 1999)

HAS DAM BEEN BREACHED OR OVERTOPPED ☐ YES ☑ NO IF YES, PROVIDE DATE(S) Prior caretaker stated that the road reportedly washed out in 1955. No further details provided.

FISH LADDER (LIST TYPE IF PRESENT) N/A

DOES CREST SUPPORT PUBLIC ROAD? ☑ YES ☐ NO IF YES, ROAD NAME: Boston Road

PUBLIC BRIDGE WITHIN 50' OF DAM? ☐ YES ☑ NO IF YES, ROAD/BRIDGE NAME:

MHD BRIDGE NO. (IF APPLICABLE)

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Bituminous Pavement (Boston Road).			
	2. SURFACE CRACKING	Longitudinal pavement cracking in vehicle wheelpaths. Occasional alligator cracking.			x
	3. SINKHOLES, ANIMAL BURROWS	None observed.	x		
	4. VERTICAL ALIGNMENT (DEPRESSIONS	Crest elevation slightly higher at the spillway. See additional comments below.	x		
	5. HORIZONTAL ALIGNMENT	Good, alignment is straight.	x		
	6. RUTS AND/OR PUDDLES	Slight depressions associated with cracking in vehicle wheelpaths.			x
	7. VEGETATION (PRESENCE/CONDITION)	Brush and weeds along slope contacts.			x
	8. ABUTMENT CONTACT	Appears good.	x		

ADDITIONAL COMMENTS: The road surface (crest) is crowned along the centerline, promoting drainage toward the gutter lines and onto the upstream and downstream slopes. Catch basins are present in the gutter lines and outfall pipes connected to the catch basins daylight onto the upstream and downstream slopes. Erosion was observed at the upstream outfall.

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	Small area of ponded water in downstream area near left abutment. (1)		x	
	2. SEEPAGE	Slow seepage near left abutment (origin unknown) and area of ponded water. (1)		x	
	3. SLIDE, SLOUGH, SCARP	Generally 2H:1V but steeper in some areas. No slides, sloughs, or scarps observed.		x	
	4. EMB.-ABUTMENT CONTACT	Appear good.	x		
	5. SINKHOLE/ANIMAL BURROWS	None observable but may have been obscured by vegetation and plant debris.	x	x	
	6. EROSION	Minor surface erosion noted in several areas, large stones observed near spillway.		x	
	7. UNUSUAL MOVEMENT	None observed. Utility poles on downstream slope are tilted downstream.		x	
	8. VEGETATION (PRESENCE/CONDITION)	Overgrown with brush. Occasional trees along toe. Thick layer of leaf debris coating		x	x
		surface. Wetland vegetation near left abutment around seepage and ponded water.			

ADDITIONAL COMMENTS: (1) Sand and gravel and seepage rates between 3 to 5 gpm were previously observed at seepage area. According to the caretaker, seepage and standing water have been historically present near the left abutment and in the immediate downstream area. An 18-inch diameter corrugated metal stormwater outfall pipe (connected to a catch basin on the crest) was also observed daylighting through the downstream slope along the toe.

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

EMBANKMENT (U/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	Undercutting at normal pool and two slope failures below normal pool elevation (1)		x	x
	2. SLOPE PROTECTION TYPE AND COND.	Some large riprap to the left and right of spillway, large stones set flush with slope.		x	
	3. SINKHOLE/ANIMAL BURROWS	None observed.	x		
	4. EMB.-ABUTMENT CONTACT	Appears good. Arched stone culvert daylights at left abutment.	x		
	5. EROSION	Eroded paths on slope obscured by vegetation.			x
	6. UNUSUAL MOVEMENT	Two slope failures below normal pool elevation between spillway and left abutment.		x	x
	7. VEGETATION (PRESENCE/CONDITION)	Thick vegetation, short brush and weeds, and occasional saplings. Large trees are			x
		present at both abutment contacts.			
	8. MISCELLANEOUS	Average slope inclination approximately 2H:1V above normal pool and approximately			
		2.5:1V below normal pool. Scarp along normal pool forms a vertical face.			

ADDITIONAL COMMENTS: (1) An erosional scarp line exists along the normal pool elevation for most of the slope length with a max. scarp height of approx. 8 inches. Up to 12 inches of bank undercutting along the scarp line was also observed in several areas where the slope is undercut. Two isolated slope failures have also occurred on the upstream slope below the normal pool elevation between the spillway and left abutment. The headscarp from leftmost failure was approximately 6 ft. wide, 1 ft. deep, and 9 ft. long. The scarp resulting from the adjacent (rightmost) failure was smaller and less pronounced. Transported embankment soil were observed downslope of both areas.

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS				
	2. OBSERVATION WELLS				
	3. STAFF GAGE AND RECORDER				
	4. WEIRS				
	5. INCLINOMETERS				
	6. SURVEY MONUMENTS				
	7. DRAINS				
	8. FREQUENCY OF READINGS				
	9. LOCATION OF READINGS				

ADDITIONAL COMMENTS: Instrumentation was not observed and is not reported to exist at the dam.

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

DOWNSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S WALLS	1. WALL TYPE				
	2. WALL ALIGNMENT				
	3. WALL CONDITION				
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: max: avg:			
	5. SEEPAGE OR LEAKAGE				
	6. ABUTMENT CONTACT				
	7. EROSION/SINKHOLES BEHIND WALL				
	8. ANIMAL BURROWS				
	9. UNUSUAL MOVEMENT				
	10. WET AREAS AT TOE OF WALL				

Not Applicable For This Dam

ADDITIONAL COMMENTS:

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

UPSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S WALLS	1. WALL TYPE				
	2. WALL ALIGNMENT				
	3. WALL CONDITION				
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: max: avg:			
	5. ABUTMENT CONTACT				
	6. EROSION/SINKHOLES BEHIND WALL				
	7. ANIMAL BURROWS				
	8. UNUSUAL MOVEMENT				

Not Applicable For This Dam

ADDITIONAL COMMENTS:

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	Slow seepage (less than 0.5 gpm) at left abutment. Source/origin is unknown.		x	
	2. FOUNDATION SEEPAGE	Ponded water downstream of left abutment may indicate possible foundation seepage.		x	
	3. SLIDE, SLOUGH, SCARP	None observed.	x		
	4. WEIRS	None observed.	x		
	5. DRAINAGE SYSTEM	None observed.	x		
	6. INSTRUMENTATION	None observed.	x		
	7. VEGETATION	Generally wooded.	x		
	8. ACCESSIBILITY	Accessible only by foot.	x		
	9. DOWNSTREAM HAZARD DESCRIPTION	Boston Road, Route 122A, several residential properties, Blackstone River			
	10. DATE OF LAST EAP UPDATE	Will be finalized in May 2020			

ADDITIONAL COMMENTS:

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	Not determined.
	2. RESERVOIR SHORELINE	Generally wooded.
	3. RESERVOIR SLOPES	Generally mild.
	4. ACCESS ROADS	Dam crest supports public road (Boston Road). No other designated access roads.
	5. SECURITY DEVICES	No security devices. Guardrails along edges of road for length of dam.
	6. VANDALISM OR TRESPASS	☑ YES ☐ NO WHAT: Fishing
	7. AVAILABILITY OF PLANS	☑ YES ☐ NO DATE: 1967
	8. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	☐ YES ☑ NO DATE: Will be finalized in May 2020
	10. AVAILABILITY OF O&M MANUAL	☐ YES ☑ NO DATE:
	11. CARETAKER/OWNER AVAILABLE	☑ YES ☐ NO DATE: Upon Request
	12. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS: Weston & Sampson is currently preparing and Emergency Action Plan for the dam. The EAP will be completed in May 2020.

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	(6) 5-ft. diameter corrugated metal pipe (CMP) culverts at center of embankment.			
	WEIR TYPE	Upstream end of CMP culverts.	x		
	SPILLWAY CONDITION	CMP lining deteriorated and cracks in concrete observed. See comments below.		x	x
	TRAINING WALLS	None.			
	SPILLWAY CONTROLS AND CONDITION	Uncontrolled, fixed crest.	x		
	UNUSUAL MOVEMENT	None observed.	x		
	APPROACH AREA	Clear. Water level several feet below CMP inverts.	x		
	DISCHARGE AREA	Large boulders cascading down to streambed. The LLO discharges near the toe.	x		
	DEBRIS	None observed.	x		
	WATER LEVEL AT TIME OF INSPECTION	Several feet below normal pool (CMP invert elevation) due to failed/removed LLO		x	
		gate. Stone and sandbag check dam constructed immediately upstream of the			
		LLO conduit entrance was providing limited impoundment storage, but the pond			
		appeared mostly drained.			

ADDITIONAL COMMENTS: The bituminous corrosion protection coating lining the inside of the CMP culverts is missing along the inverts near the upsteam ends and cracked along the sides and tops (possibly due to sunlight exposure). The CMP inverts are corroded where the coating is missing. Cracks in the concrete headwall were observed above the 2nd and 6th and between the 3rd and 4th culverts (from left). Continuous longitudinal cracks was observed in the downstream endwall at an apparent construction joint beneath the CMP inverts.

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Not Applicable For This Dam			
	WEIR TYPE				
	SPILLWAY CONDITION				
	TRAINING WALLS				
	SPILLWAY CONTROLS AND CONDITION				
	UNUSUAL MOVEMENT				
	APPROACH AREA				
	DISCHARGE AREA				
	DEBRIS				
	WATER LEVEL AT TIME OF INSPECTION				

ADDITIONAL COMMENTS:

NAME OF DAM: Woodbury Pond Dam STATE ID #: 3-14-290-12

INSPECTION DATE: November 22, 2019 NID ID #: MA01179

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Low-level outlet.			
	INTAKE STRUCTURE	Concrete headwall with timber gate seats and small training walls.			x
	TRASHRACK	None.			
	PRIMARY CLOSURE	Formerly a timber gate, which failed in July 2019.			x
	SECONDARY CLOSURE	None.			
	CONDUIT	2.5 ft. by 3 ft. concrete conduit under CMP spillway culverts.		x	
	OUTLET STRUCTURE/HEADWALL	None. Conduit discharges through cascading boulders on downstream side.	x		
	EROSION ALONG TOE OF DAM	None observed.		x	
	SEEPAGE/LEAKAGE	Not observable due to flow through conduit at time of inspection.		x	
	DEBRIS/BLOCKAGE	None observed. Conduit appears to flow freely.		x	
	UNUSUAL MOVEMENT	None observed.			
	DOWNSTREAM AREA	Primary spillway channel.			
	MISCELLANEOUS	A stone and sandbag check dam was placed upstream of the inlet. Eddy erosion		x	x
		at the upstream end of the left LLO training wall was observed due to flow.			

ADDITIONAL COMMENTS:

APPENDIX C
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. Report titled, "Woodbury Pond Dam Phase I Inspection/Evaluation Report," by Weston & Sampson Engineers, Inc., dated July 13, 2009.

2. Department of Environmental Management Office of Dam Safety Emergency Dam Inspection Report, "Woodbury Pond Dam," prepared by SFC Engineering Partnership, Inc., May 20, 1999.

3. "Plan of Boston Road in the Town of Sutton," by the County Commissioners, dated August 30, 1967, sheet 4 of 4.

APPENDIX D
Definitions

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exist, 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; low-level outlet 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 (and properly documented) 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 failure.

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 (Structural Height) – 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 lowest point on the crest of the dam.

Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.

Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.

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.

Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.

Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.

Condition Rating

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

Poor – Significant structural*, operation 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.

* Structural deficiencies include but are not limited to the following:

- Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
- Missing riprap with resulting erosion of slope
- Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
- Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
- Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
- Inoperable outlets (gates and valves that have not been operated for many years or are broken)