-- FOSTER'S POND DAM --

PHASE I

INSPECTION / EVALUATION REPORT

Dam Name:	Foster's Pond Dam
NID ID#:	MA00153
Owner:	Foster's Pond Corporation
Town:	Andover
Consultant:	GEI Consultants, Inc.
Date of Inspection:	December 6, 2016

GEI Consultants

EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the inspection and evaluation of Foster's Pond Dam located in Andover, Massachusetts. The inspection was conducted on December 6, 2016 by Lee Wooten, P.E., of GEI Consultants, Inc. Foster's Pond Dam is classified as an Intermediate size, Significant (Class II) hazard potential dam.

In general, the overall condition of Foster's Pond Dam is Satisfactory. The dam was found to have the following minor deficiency:

1. The left embankment has a history of sinkholes due internal erosion of embankment material caused by seepage through the upstream face carrying soil out through the downstream masonry wall. The owner, Foster's Pond Corporation (FPC) has undertaken repairs on several occasions (2010, 2014, and 2015) to seal the backside of the upstream masonry with concrete and to place clay fill in the eroded areas to reduce seepage. Seepage appeared to have been reduced at the time of our visit, but we could not judge if it had been eliminated as a potential issue. The FPC should continue to monitor for seepage erosion (sediment in the seepage) and sinkholes.

In addition to the seepage repair noted above, FPC has performed regular remedial maintenance on the dam on a regular, typically annual basis. Maintenance since the 2011 inspection has included:

- Upgrading of the left stone masonry spillway training wall. The training wall was backed with a thick concrete section to provide a better seepage barrier.
- Clay backfill was placed behind the training wall, also to reduce seepage.
- The stoplog brackets / slots were recently replaced in the sluiceway with stainless steel slots that allow a padlock to prevent unauthorized removal or placement of stoplogs.
- Large gravel has been placed to cover over geotextile across the entire upstream face as erosion protection.
- Grass cover on the crest has been maintained.

The following table summarizes the deficiencies reported in the 2011 Phase I report and the status of those deficiencies:

Previously Identified Deficiency	***Resolution or Current Condition***
The EAP section of the O&M Manual should be expanded as described in Section 3.2.	The EAP section of the O&M Manual has been expanded as recommended.
A small area of geotextile on the right embankment is exposed.	The exposed geotextile has been covered with either seeded topsoil or gravel.

We recommend that the FPC continue its conscientious monitoring and maintenance of Foster's Pond Dam.

Dam Evaluation Summary Detail Sheet

1. NID ID:	**MA00153**	**4. Inspection Date:**	**December 6, 2016**
2. Dam Name:	**Foster's Pond Dam**	**5. Last Insp. Date:**	**November 18, 2011**
3. Dam Location:	**Andover, MA**	**6. Next Inspection:**	**December 6, 2021**
7. Inspector:	**Lee Wooten, P.E.**		
8. Consultant:	**GEI Consultants, Inc.**		
9. Hazard Code:	**Significant**	**9a. Is Hazard Code Change Requested?:**	**No**
10. Insp. Frequency:	**5 Years**	**11. Overall Physical Condition of Dam:**	**SATISFACTORY**
12. Spillway Capacity (% SDF)	**>100% SDF w/ no actions by Caretaker**		

E1. Design Methodology:	**1**	**E7. Low-Level Discharge Capacity:**	**1**
E2. Level of Maintenance:	**5**	**E8. Low-Level Outlet Physical Condition:**	**1**
E3. Emergency Action Plan:	**4**	**E9. Spillway Design Flood Capacity:**	**5**
E4. Embankment Seepage:	**4**	**E10. Overall Physical Condition of the Dam:**	**4**
E5. Embankment Condition:	**5**	**E11. Estimated Repair Cost:**	**$1500 to $3,500**
E6. Concrete Condition:	**5**		

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

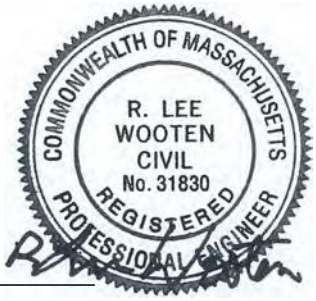
Structural, hydraulic height changes based on measurement after major maintenance activities
Impoundment volumes changes based on bathymetric surveys (normal pool) and calculated volumes above normal pool
Spillway capacities changes based on calculations after major maintenance activities

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.



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Principal
GEI Consultants, Inc.

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SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

Foster's Pond Corporation retained GEI Consultants, Inc. to perform a visual inspection and develop a report of conditions for the Foster's Pond Dam in Andover, MA, Essex 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

Foster's Pond Dam is located off Rattlesnake Hill Road within Essex County in the Town of Andover, Massachusetts. The dam impounds water that flows into wetlands immediately downstream of the dam and eventually into the Shawsheen River above the Ballardvale Dam and into an urban area. The structure and the impoundment are shown on the Google Earth website at 42.61361°N latitude and 71.14146°W longitude. The dam can be reached from I-93 in Wilmington via:

- Exit 41 – Route 125 East to
- Andover Street, north (left) to
- Woburn Street, north (straight), to
- Rattlesnake Hill Road, north (right).

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

The dam, reportedly constructed in the 1850's, was originally under joint control of mill owners on the Shawsheen River and was used to store water for generating power for the mills. The purpose of Foster's Pond Dam today is to provide a recreational impoundment (Foster's Pond).

1.2.4 Description of the Dam and Appurtenances

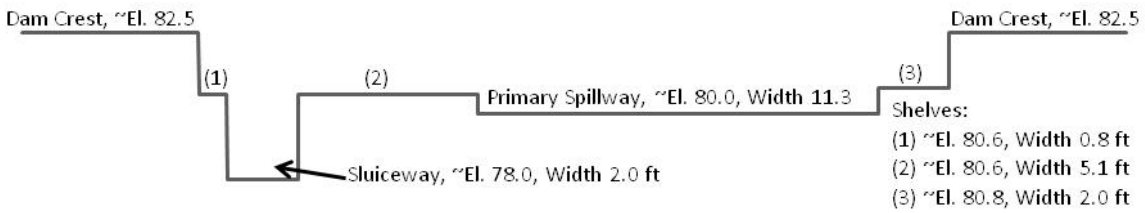
Foster's Pond Dam impounds water to form Foster's Pond, which discharges to wetlands downstream and eventually flows into the Shawsheen River. The reservoir is irregularly shaped, with a maximum length (north to south) of approximately 5,000 feet and a maximum width (east to west) of approximately 4,000 feet. The dam impoundment is shown in Fig. 1, Site Location Map and in Fig. 2, an aerial photograph of the pond area.

Foster's Pond Dam is an earthfill dam with a sloped embankment on the upstream side and a mostly unmortared stone masonry wall on the downstream side. As shown in the Dam Site Plan Sketch, Fig. 5, the dam incorporates a main spillway structure, a sluiceway (primary outlet structure), and a swale along its right abutment that serves as an auxiliary spillway. The dam has a structural height of approximately 10.1 feet, a hydraulic height of approximately 7.6 feet, and an overall length of approximately 150 feet.

The upstream side of the embankment appears to be a very flat slope. Previous inspection records indicate slopes as flat as 6H:1V. Large gravel and cobble-sized (3 inch to 6 inch) riprap covers the slope with the top of the slope being grass covered. The crest of the embankment is approximately 10 feet wide at its narrowest point and grass covered.

The downstream side of the dam consists of a mostly unmortared stone masonry wall. Outside the plunge pool, the area at the toe of the masonry wall area is covered with large rounded gravel. Rattlesnake Hill Road runs approximately parallel and approximately 20 feet downstream of the stone masonry wall. Large boulders along the edge of Rattlesnake Hill Road and a metal chain gate at the access path near the right abutment prevent access of unauthorized vehicles to the dam.

The main spillway for the dam is a stone masonry and concrete broad-crested weir overflow structure located approximately 50 feet from the right abutment. The main spillway has a total width of about 21.2 feet with an approximate weir profile as shown below:



Normal outflows are conveyed by the primary spillway section of the main spillway profile shown above, except during the winter drawdown, when outflows are through the sluiceway. High flows will extend over the three shelves shown in the profile and over any stoplogs in place in the sluiceway. The spillway is flanked and contained by training walls, which are constructed of mortared granite curb stones. The stone masonry of the training walls is backed by a section of mass concrete about 1- to 2-feet thick, which was placed in 2010. The approach to the spillway is a slope covered with geomembrane and overlaid by clay, extending approximately 6 feet upstream into the basin. Discharges flow over the concrete spillway apron onto a pile of grouted riprap within the plunge pool downstream. A mortared stone masonry training wall surrounds the plunge pool and prevents flows from impacting Rattlesnake Hill Road. Flows entering the plunge pool are carried under the road through two 42-inch concrete pipe culverts to the wooded wetlands downstream.

The primary lower outlet for the dam is a sluiceway controlled with stoplogs and located on the left side of the main spillway. Based on review of inspection reports dating back to 1913, the sluiceway was originally constructed in 1937 and has been backfilled and restored several times since then. A valve-controlled 8-inch cast-iron low-level outlet pipe was installed through the sluiceway sometime in the past to provide a means of lowering the pond water level. The low-level outlet was reportedly last used in 1973 and has since corroded and is now filled with concrete and abandoned.

The sluiceway was restored in October of 2005 to accommodate winter drawdowns and provide excess freeboard to the dam. As shown on Fig. 2, the sluiceway varies in width and depth from approximately 3 feet wide and 2.5 feet deep on the upstream side to a 2-foot width and a depth of 4.5 feet on the downstream side. The 2-foot width by 2.5-foot depth at the stoplogs controls the maximum flow capacity. There are two sets of offsets behind which stoplogs can be set. Three stoplogs, each 10 inches deep, can currently be set in the middle offset. Stainless steel brackets or slots for the stoplogs were installed in 2015. The new brackets allow for installation of a padlock to prevent unauthorized removal or installation of the stoplogs. Flows through the sluiceway enter the downstream plunge pool and are carried under Rattlesnake Hill Road through the two 42-inch concrete pipe culverts.

At the right abutment, a swale extending from the pond to Rattlesnake Hill Road serves as the emergency spillway. Flows from the emergency spillway would cross over the road. The emergency spillway has a 1.5-foot-deep channel with a base width of 9 feet and a top width of 18 feet. The spillway channel surface has been finished with cobbles upstream and topsoil with grass or mulch cover from the spillway crest downstream. Geotextile has been placed under all portions of the emergency spillway cover.

1.2.5 Operations and Maintenance

The dam is operated and maintained by Foster's Pond Corporation, a community-based non-profit organization. The Corporation was formed in 1939 to maintain, repair, and operate the dam and to regulate the flow of water from Foster's Pond. The water level control at the dam is maintained at approximately 2 inches below the bottom of the dam's primary spillway between the months of April and November. A winter drawdown to create reserve capacity for the dam commences in November. Removal of the three stoplogs, one at a time, reduces the water level gradually to no more than 18 inches below the spillway level, the maximum allowed by the Andover Conservation Commission and DEP Superseding Order of Conditions. An Operations and Maintenance Manual has been prepared for this structure.

1.2.6 DCR Size Classification

Foster's Pond Dam has a height of approximately 10.1 feet and a maximum storage capacity of 867 acre-feet. Refer to Appendix D for definitions of height of dam and storage. Therefore, 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, Foster's Pond Dam is an Intermediate size structure.

1.2.7 DCR Hazard Potential Classification

Foster's Pond Dam is located within a suburban area. Rattlesnake Hill Road crosses the downstream channel immediately downstream of the spillway. Twin pipe culverts carry flows from the dam under the road to a downstream wetlands area. Woburn Street, approximately 1,300 feet downstream of the dam, crosses the wetlands area and is reportedly prone to flooding during high storm events. Scattered residences in the downstream area appear to be at distances and elevations that would not be impacted by failure of this dam. Fig. 4 shows the area downstream of the dam on the USGS topographic map.

It appears that a failure of the dam at maximum pool could result in flooding and damage to Rattlesnake Hill Road. 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, Foster's Pond Dam should be classified as a Significant hazard potential dam. The Hazard Potential Classification recommendation is consistent with the Hazard Potential Classification on record with the Office of Dam Safety for Foster's Pond Dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Foster's Pond Dam is approximately 1.58 square miles and extends through the communities of Andover, Wilmington, and North Reading. Fig. 3 shows the drainage area estimated by the USGS Massachusetts StreamStats program for Foster's Pond. The StreamStats calculates an average area slope of 2.0%, the area of forest as 40%, and area of sand and gravel deposits as 58% for the basin. At its northeasterly point the pond is fed by Frye's Brook. The area is primarily suburban and much of it is undeveloped. The area is moderately hilly, especially west of the pond.

1.3.2 Reservoir

See Table 1.1 for data about normal, maximum, and spillway design flood (SDF) pools. The normal pool volume was provided to us and was estimated from a bathymetric survey by Aquatic Control Technology, the lake management consultant to the Foster's Pond Corporation. Maximum and spillway design flood pools were calculated based on interpolation of areas measured on topographic maps for the El. 80 pool and the El. 90 contour and using the U.S. Army Corps of Engineers Conic Method for Reservoir Values.

1.3.3 Discharges at the Dam Site

No records of discharges at the dam are maintained. The dam has been reportedly overtopped in May 1954, March of 2001, the spring of 2002, April of 2004, and May of 2006. The dam has not been overtopped since major maintenance efforts were commenced in 2006.

1.3.4 General Elevations (feet)[1]

A.	Top of Dam	~El. 82.5
B.	Spillway Design Flood Pool	~El. 82.3 with sluiceway boards in place ~El. 82.1 with sluiceway boards out
C.	Normal Pool	~El.80.0
D.	Spillway Crest	~El.80.0
E.	Upstream Water at Time of Inspection	~El.79.5
F.	Downstream Water at Time of Inspection	~El.72.1
G.	Streambed at Toe of the Dam	~El.72.1
H.	Low Point along Toe of the Dam	~El.72.1 in plunge pool

1.3.5 Main Spillway Data

A.	Type	Masonry & Concrete Broad-Crested Weir
B.	Weir Length	~21.2 feet
C.	Weir Crest Elevation	Varies, ~El.80.0 for primary spillway
D.	Upstream Channel	Unknown (underwater)
E.	Downstream Channel	~El.72.1
F.	Downstream Outlet Invert or Channel Bottom Elevation	~El.72.1

1.3.6 Additional Data – Sluiceway (Outlet Structure)

A.	Type	Sluicegate with three stoplogs
B.	Length	2 feet (at downstream side)
C.	Invert Elevation	~78.0 feet

Additional Data - Auxiliary/Emergency Spillway

A.	Type	Swale
B.	Length	18 feet at ~El.82.5, 9 feet at ~El. 81.0
C.	Invert Elevation	~81.0 feet

1.3.7 Design and Construction Records and History

The Foster's Pond Corporation has performed major maintenance efforts on the dam since the 2006 Phase I Report. The first effort corrected deficiencies identified in the 2006 report and was performed in 2007 and reported in our May 8, 2008 "Foster's Pond Dam Follow-Up Inspection / Evaluation Report." Specific maintenance activities in 2007 included:

[1] Survey information is not available for this structure. Elevations are referenced to an assumed spillway crest of El. 80.0. This elevation is consistent with elevation contours in the area depicted in the USGS maps.

- Mortared stone masonry wingwalls, about 1.7 feet high, were constructed out of granite curbstones on both sides of the spillway to protect the dam crest from spillway flows and to allow the dam crest to be maintained at a level grade. The effect of the wingwalls has been to increase the safe flow capacity of the primary spillway.
- The dam crest was rehabilitated to a level, grassed surface on both sides of the spillway. Trees and brush were removed from the crest, upstream slope, and areas immediately downstream. Sinkholes were filled. Fill was placed across the crest to create the level grade. A geotextile layer was placed under the seeded loam on the right embankment. Grass growth was established on both embankments.
- The emergency spillway at the right abutment was cleaned up with minor regrading to form a 1.5-foot-deep channel with a base width of 9 feet and a top width of 18 feet. The spillway channel surface was finished with cobbles upstream, grass cover across the spillway crest, and mulch cover downstream of the spillway. Geotextile was placed under all portions of the emergency spillway prior to placing both the upstream cobble cover and the downstream seeded loam.
- Cobble cover over geotextile was placed across the entire upstream face of the embankment as erosion protection.
- Riprap was placed in the plunge pool across the width of the primary spillway and sluice way as scour protection.

Significant damage to the spillway and crest adjacent to the spillway was observed following large storms in March of 2010. The damage was described in our letter of April 6, 2010 as:

- Several sinkholes had formed on the crest of the left / southwest embankment of the dam immediately adjacent to the mortared masonry wingwall (see Photos 3 & 4). The deepest sinkhole was at least 3.5 feet deep. The sinkholes extended through the upper embankment soil, which appeared to consist of sandy silt / silty sand.
- The mortared masonry blocks of the upstream part of the left spillway wingwall had moved out (away from the embankment) and had gaps of up to about ¾ inch at joints between the masonry blocks. The movement may be the result of frost action pushing on the wingwall.
- At least two holes appeared in the concrete crest of the spillway, which opened into voids that extended 1 to 2 feet into the crest structure. The voids appeared to be formed in a cobble, gravel, and soil matrix.

To repair the damage, the FPC lowered the pond using the sluiceway and performed the following remedial maintenance in 2010:

- Much of the concrete cover of the spillway was removed to expose the full extent of voids in the masonry below. Flowable mortar mix and concrete were placed into the cavities that formed in the spillway. About 2 tons of concrete were placed and the surface of the spillway was restored.
- Soil behind the two spillway training walls was excavated down to the drawdown pool level and 1- to 2-foot-thick mass concrete sections were constructed behind the walls. About 7 tons of concrete were placed in the sections. The excavations were backfilled and the embankment crest was re-loamed and re-seeded.

- With the pond lowered, the area upstream of the left training wall and the sluiceway was exposed to reveal wall undercuts and water entry holes. Concrete was placed over the entire exposed area to plug holes, fill in undercuts, and cover the sloped area upstream of the sluiceway.
- Several tons of large crushed stone gravel were added to the upstream slopes of the dam.

The FPC undertook minor repair in 2012 to place additional crushed stone on the upstream face of the dam and to place load fill in areas of the crest to provide a level profile with grass for erosion protection.

The FPC has monitored and repaired seepage-related sinkholes on the left abutment several times since the 2010 repairs. In 2013, the FPC placed additional gravel on the upstream face and excavated and backfilled part of the left embankment to install clay fill in areas where seepage had been observed. In 2014, in response to the development of a sinkhole behind the sluiceway wall, the FPC again excavated and backfilled part of the left embankment to install clay fill in the area of the sinkhole. These efforts were repeated in 2015, with the excavation extending to a depth of about 8 feet and with the clay backfill placement of about 500 pounds (dry) of bentonite clay.

1.3.8 Operating Records

Operating records such as winter drawdown schedules and notifications are maintained by the Foster's Pond Corporation President, Stephen Cotton, at 19 Pomeroy Road in Andover. Significant maintenance activities at the dam are reported by Stephen Cotton on the Foster's Pond Corporation web site.

1.4 Summary Data Table

Refer to the following Table 1.1 for the DCR formatted tabulation of the data required for the Phase I reporting.

1.1 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA00153
Dam Name	Foster's Pond Dam
Dam Name (Alternate)	0
River Name	Frye's Brook (inflow) to Shawsheen River about 1 mi
Impoundment Name	Fosters Pond
Hazard Class	Significant
Size Class	Intermediate
Dam Type	Earthfill w/ downstream stone masonry
Dam Purpose	Recreational
Structural Height of Dam (feet)	~10.1
Hydraulic Height of Dam (feet)	~7.6
Drainage Area (sq. mi.)	1.58
Reservoir Surface Area (sq. mi.)	0.19
Normal Impoundment Volume (acre-feet)	~538
Max Impoundment Volume ((top of dam) acre-feet)	~867
SDF Impoundment Volume* (acre-feet)	~838
Spillway Type	Broad crested weir
Spillway Length (feet)	21.2
Freeboard at Normal Pool (feet)	5
Principal Spillway Capacity* (cfs)	~194
Auxiliary Spillway Capacity* (cfs)	~57
Low-Level Outlet Capacity* (cfs)	~33 with full pool
Spillway Design Flood* (flow rate - cfs)	100-year / 191 cfs
Winter Drawdown (feet below normal pool)	2.5 0
Drawdown Impoundment Vol. (acre-feet)	~200 0
Latitude	42.61361 N
Longitude	71.14146 W
City/Town	Andover
County Name	Essex
Public Road on Crest	None
Public Bridge over Spillway	None
EAP Date (if applicable)	December 6, 2016 - see Note 1 Misc page
Owner Name	Foster's Pond Corporation
Owner Address	19 Pomeroy Road
Owner Town	Andover, MA 01810
Owner Phone	978-475-5679
Owner Emergency Phone	978-475-5679
Owner Type	Private Association or other non-profit
Caretaker Name	David Brown - Treasurer
Caretaker Address	31 Glenwood Road
Caretaker Town	Andover, MA 01810
Caretaker Phone	978-470-0454
Caretaker Emergency Phone	978-470-0454
Date of Field Inspection	12/6/2016
Consultant Firm Name	GEI Consultants, Inc.
Inspecting Engineer	Lee Wooten, P.E.
Engineer Phone Number	

*In the event a hydraulic and hydrologic analysis has not been completed for the dam, indicate "No H&H" in this table, recommendation section shall include specific recommendation to hire a qualified dam engineering consultant to conduct analysis to determine spillway adequacy in conformance with 302 CMR 10.00.

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Foster's Pond Dam was inspected on December 6, 2016. At the time of the inspection, the weather was sunny with temperatures in the 40's °F. Photographs to document the conditions at the dam were taken during the inspection and are included in Appendix A. The level of the impoundment was about 0.5 foot below the primary spillway crest and one board had been removed from the sluiceway to start the winter drawdown. Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Foster's Pond Dam was found to be in Satisfactory condition with no major dam safety deficiencies. The observations and specific concerns are identified in more detail in the sections below:

2.1.2 Dam

- Abutments (Photographs 1- 9, 11)

  The left and right abutments appear to be in good condition with no evidence of seepage, erosion, or cracking.

- Upstream Face (Photographs 1, 2, 7-11)

  The upper part of the upstream face of the embankment was visible at the time of our visit and was covered with gravel and small cobble / crushed stone to within about a ½ foot of the crest. Grassed topsoil on the top of the upstream face was visible under the snow. The geotextile that underlies the riprap and cover soils was covered by the gravel and topsoil.

- Crest (Photographs 1-13)

  The crest of the embankment was grass-covered (under the snow) and approximately 8 feet wide at its narrowest point. The crest has a relatively consistent grade along its entire length with a slight slope upstream and downstream from its center. A small stone bench has been constructed on the right embankment.

- Downstream Face (Photographs 3-6, 11, 13)

  The downstream face of the dam consists of a masonry stone wall with an irregular profile. The masonry is largely unmortared except for below the spillway. It was not obvious if the seepage at the dam toe within the plunge pool area, a few feet southwest of the sluiceway, as noted in our 2011 report, was still active. The seepage, if present was less than observed in 2011. Based on discussions with Mr. Stephen Cotton, we understand that the seepage is probably still present, but at a lower flow rate than before the various repairs were undertaken (refer to section 1.3.7).

- Drains

  There are no design records available for the dam. However, it does not appear that the embankment contains a filtered collection drain system.

- Instrumentation

  There are no instruments installed at this dam.

- Access Roads and Gates (Photographs 1-12)

  The dam is accessed from Rattlesnake Hill Road. A guard rail and boulders along most of the frontage on Rattlesnake Road prevent vehicle access to the dam. Vehicle access to the right embankment is possible at the emergency spillway on the right abutment and is blocked off with a metal chain strung between boulders.

2.1.3 Appurtenant Structures

- Primary Spillway (Photographs 1-6, 8-13)

  The primary spillway is in generally good condition. Major repairs as described in Chapter 1 have upgraded the structural condition of the spillway and provided containment for flood flows.

- Sluiceway Low-Level Outlet (Photographs 3, 10, 12, 13)

  The sluiceway is in good condition. An 8-inch cast-iron pipe, described as being installed through the sluiceway and serving as the low-level outlet, has reportedly corroded and been abandoned. The pipe was reportedly filled and covered with concrete when the sluiceway was restored in 2005. Flows through the sluiceway are directed into the same plunge pool as flows from the main spillway. New stainless steel brackets / slots provide a secure means of securing the stoplogs.

- Auxiliary/Emergency Spillway (Photographs 1, 2, 4, 6, 7, 9)

  The swale along the right abutment of the dam serves as an emergency spillway and is in good condition. The emergency spillway channel is lined with a geotextile, which is covered with cobbles upstream, grass cover across the spillway crest, and mulch cover downstream of the spillway.

2.1.4 Downstream Area (Photographs 1-12)

Rattlesnake Hill Road is located approximately 20 feet downstream of the dam. Flow from the primary spillway and the sluiceway passes under Rattlesnake Hill Road through two 42-inch-diameter concrete pipe culverts. Downstream of Rattlesnake Hill Road, water flows through wooded wetlands towards Woburn Street and eventually flows into the Shawsheen River upstream of the Ballardvale Dam.

2.1.5 Reservoir Area

Foster's Pond orientation is shown in Figs. 1 and 2. The impoundment is located within a suburban area with private homes located along the shoreline. The shoreline is primarily wooded with generally gentle to moderate slopes around the pond perimeter. The slopes along portions of

the west side of the impoundment are hilly. The pond has several branches with the deepest areas located away from the dam. The shallow channel to the dam would constrain the release of much of the pond if the dam were to fail.

2.2 Caretaker Interview

Foster's Pond Corporation, is responsible for the operation and maintenance of the Dam. Mr. Stephen Cotton, the Corporation President, was present during the inspection. Information provided by Mr. Cotton on this and previous visits, along with the information from the website for the Corporation, has been incorporated into this report.

2.3 Operation and Maintenance Procedures

Mr. Cotton provided us with the Operation and Maintenance (O&M) Manual, which consists of a three page document that includes Emergency Action Plan (EAP) procedures. The document is suitable for the size and hazard of the dam. See Section 2.4 for comments relative to the EAP.

2.3.1 Operational Procedures

The pond level is annually drawn down a maximum of 18 inches during the winter months. The maximum drawdown is mandated by the Andover Conservation Commission and DEP Superseding Order of Conditions. The sluiceway has the capacity to drawdown the water a maximum of 24 inches. The drawdown is performed to allow for reserve storage capacity of the dam during snow melt and storm events in the spring. Advance written notification of the drawdown is provided annually to the Andover Conservation Commission and the Massachusetts Division of Fisheries & Wildlife. The annual drawdown commences on or after November 1. It is performed by sequentially removing stoplogs from the sluiceway to lower the water by approximately 1 inch per day to the maximum of 18 inches by December 1. This level is maintained through the winter months. Depending on weather conditions, stoplogs are installed and the water level is allowed to rise on about March 15 with a target refill of early April. The water level is maintained within a few inches of the primary spillway invert elevation for the remainder of the year. Announcements of significant operational events are posted and preserved on the FPC website.

2.3.2 Maintenance of Dam and Operating Facilities

According to the O&M manual, the FPC monitors the dam semiannually for:

- Evidence of seepage or leaks on the downstream face (with note to notify the Office of Dam Safety in the event of change in amount or color of water seepage).
- Voids, cracks, sinkholes, and erosion on the upstream face and crest.
- Cracks and voids in the concrete spillway and sluiceway.
- Debris and blockages in the stilling basin and Rattlesnake Hill Road culverts (notify the Andover Public Works Department of any culvert blockages that the FPC is unable to remove).
- Sinkholes in Rattlesnake Hill Road in the area of the culverts (notify the Andover Public Works Department).

- Brushy growth on the slopes and crest.
- Damage to the stoplogs and sluiceway.

Annually, the Foster's Pond Corporation will:

- Patch, grade and fill areas and repair eroded areas as needed.
- Repair cracks and voids in concrete surfaces of the spillway and sluiceway, as needed.
- Remove brushy growth from slopes and crest.
- Replace stoplogs, as needed.
- Add clay as needed to repair erosion.
- Remove debris from plunge pool and culverts.
- Weed and re-seed grass cover on crest.

2.4 Emergency Warning System

The O & M Manual includes an "Emergency Procedures" section that describes:

- Emergency monitoring and stoplog removal for severe weather conditions.
- Emergency notifications to make in the event of (1) auxiliary spillway flow, (2) overtopping, piping, or high seepage with sediment, (3) any other signs of distress to the dam, (4) sinkholes in the vicinity of the culverts.
- Emergency contacts – state and municipal agencies and phone numbers with recommended assistance that each contact may provide.

2.5 Hydrologic/Hydraulic Data

Following the major maintenance performed in 2007 and 2008, we evaluated the Spillway Design Flood (SDF) and the capacities of the main spillway (with and without the stoplogs in the sluiceway) and of the emergency spillway. The SDF for Foster's Pond Dam, as an Intermediate size, Significant hazard potential dam, is the 100-year-return-period flood (100-year flood).

We estimated the 100-year flood flow to be 191 cubic foot per second (cfs) using a regression equation for eastern Massachusetts streams from the USGS Water Supply Paper 2214 (Wandle, 1983). We note that the 100-year flood has an annual probability of exceedance of 1%, a 50% probability of exceedance in any 69-year period, a 63.5% probability of exceedance in a 100-year period, and a 26% chance of exceedance during a 30-year period of a typical mortgage. We also note that watershed changes, especially increased urbanization, and climate change affect actual storm frequencies and that the pond watershed characteristics may differ from those of the watersheds used as the basis for the estimate.

We estimated capacities for the main and emergency spillways using weir equations for broad-crested weirs. We used a sharp-crested weir equation for flow over the sluiceway stoplogs. Our capacity estimates are summarized below for the maximum flood pool (~El.82.5) at the top of the dam.

Feature	Flow Capacity
Main spillway with stoplogs in place	194 cfs
Main spillway without stoplogs	227 cfs
Emergency spillway	57 cfs
Total capacity with stoplogs in place	251 cfs
Total capacity without stoplogs in place	284 cfs

Based on our calculations, the combined spillways have the capacity to pass the SDF without overtopping except by waves. Wave action on the pond should be limited by the narrow reach of the pond near the dam and the height of the hills on either side of this section of the pond. The height of water that would cause the weir equation flow estimates to match the SDF were about 0.2 foot below the top of the dam with the stoplogs in place or about 0.4 foot below the top of the dam with the stoplogs removed.

2.6 Structural and Seepage Stability

2.6.1 Embankment Structural Stability

No stability analyses were available for review. The downstream masonry stone wall face of the dam has exhibited some signs of distress with some missing and misaligned stones. The condition of the embankment and wall has improved since the 2006 inspection with the major maintenance, which included removal of trees and brush, placement of geotextile across the dam, establishment of a grassed soil cover, and identification and elimination of areas of seepage. The upstream dam slope appears to be very flat. Based on the above, the dam structural stability appears satisfactory but should be monitored.

2.6.2 Structural Stability of Non-Embankment Structures

The spillway is the only non-embankment structure on the dam, and it appears to be in good structural condition after the 2010 major maintenance. The spillway's low height, broad base, and the placement of grouted riprap downstream of the spillway all contribute to its overall stability. The recent placement of flowable mortar mix and concrete into structural voids appears to have rehabilitated the condition of the masonry.

2.6.3 Seepage Stability

The numerous efforts to reduce seepage flow from the sluiceway into the stone masonry on the left embankment appear to have been partially successful. However, the dam does not have a filtered seepage collection system and may be vulnerable to seepage at either higher pond levels or if the embankment degrades (e.g., frost heave). We judge the current seepage stability to be satisfactory but we recommend continued regular monitoring for new seepage with sediment and for sinkholes.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of Foster's Pond Dam is Satisfactory. The dam was found to have the following minor deficiency:

1. The left embankment has a history of sinkholes due internal erosion of embankment material caused by seepage through the upstream face carrying soil out through the downstream masonry wall. The owner, Foster's Pond Corporation (FPC) has undertaken repairs on several occasions (2010, 2014, and 2015) to seal the backside of the upstream masonry with concrete and to place clay fill in the eroded areas to reduce seepage. Seepage appeared to have been reduced at the time of our visit, but we could not judge if it had been eliminated as a potential issue. The FPC should continue to monitor for seepage erosion (sediment in the seepage) and sinkholes.

The following table summarizes the deficiencies reported in the 2011 Phase I report and the status of those deficiencies:

Previously Identified Deficiency	***Resolution or Current Condition***
The EAP section of the O&M Manual should be expanded as described in Section 3.2.	The EAP section of the O&M Manual has been expanded as recommended.
A small area of geotextile on the right embankment is exposed.	The exposed geotextile has been covered with either seeded topsoil or gravel.

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.

3.2 Studies and Analyses

No studies or analyses appear to be needed at this time.

3.3 Recurrent Maintenance Recommendations

Continue with the maintenance activities described in the O&M Manual and as practiced over the past few years.

3.4 Minor Repair Recommendations

No minor repairs appear to be needed at this time.

3.5 Remedial Modifications Recommendations

No remedial modifications appear to be needed at this time.

3.6 Alternatives

No alternative remedial measures are needed at this time.

3.7 Opinion of Probable Construction Costs

The following conceptual opinions of probable construction costs have been developed for continued regular maintenance. The costs shown herein are based on a limited analysis and are provided for general information only. This should not be considered an engineer's estimate, as actual costs may vary from the costs indicated.

Yearly Recommendations

1.	Maintaining grassed cover on dam	$500 - $1,000
2.	Monitoring and inspection of dam (seepage, erosion, etc.)	$0 - $500
3.	Removal of debris from plunge pool and culverts	$500 - $1,000
4.	Other regular maintenance activities	$500 - $1,000
	TOTAL	$1,500 - $3,500

SECTION 4

4.0 LIMITATIONS

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no other warranty, express or implied, is made. Limitations on our recommendations are contained in the attached "Important Information about your Geotechnical Engineering Report."

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed*. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

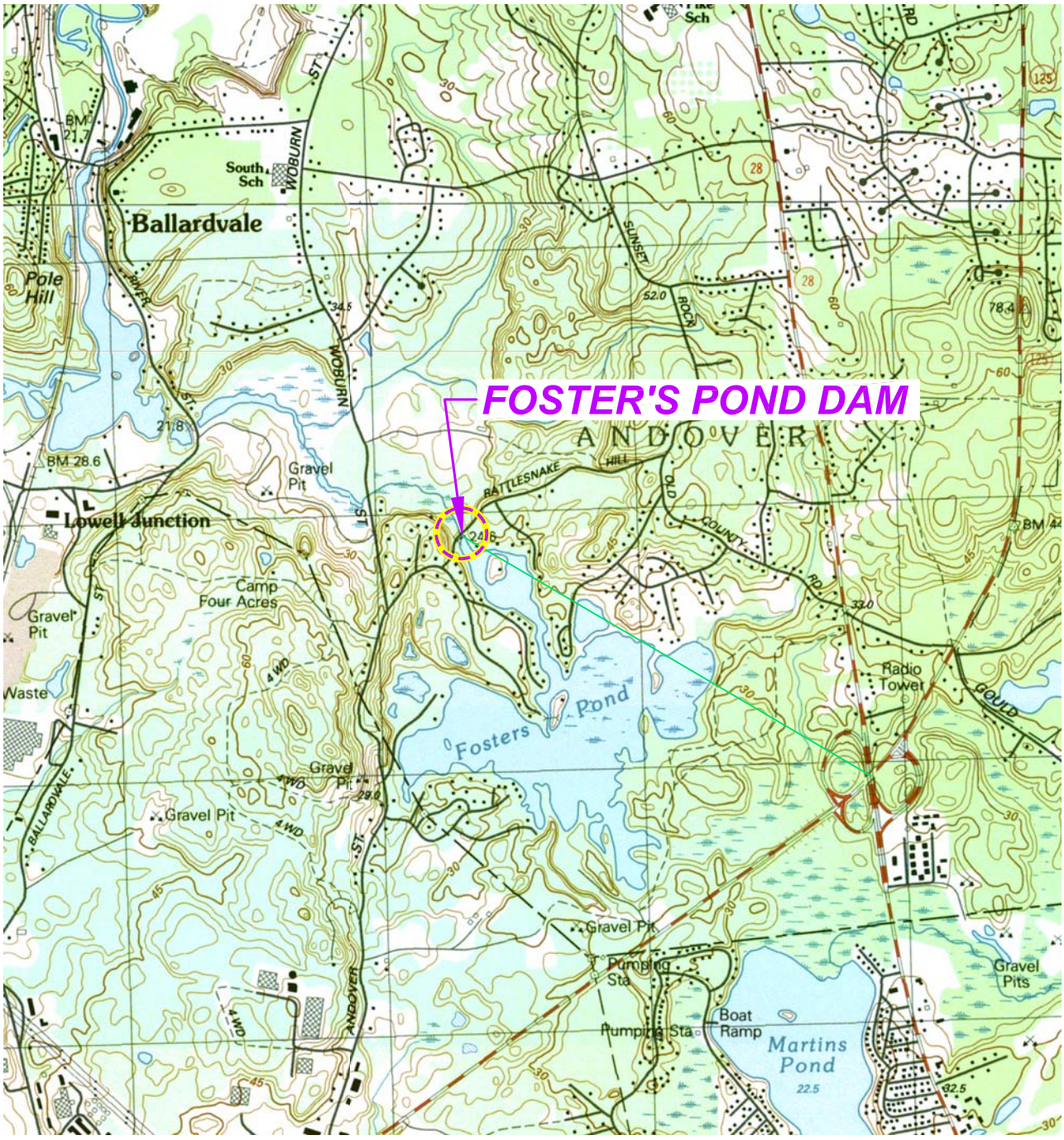
Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

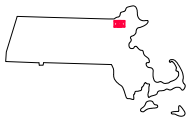
FIGURES



0 1000 2000 4000 6000

APPROXIMATE SCALE, FEET

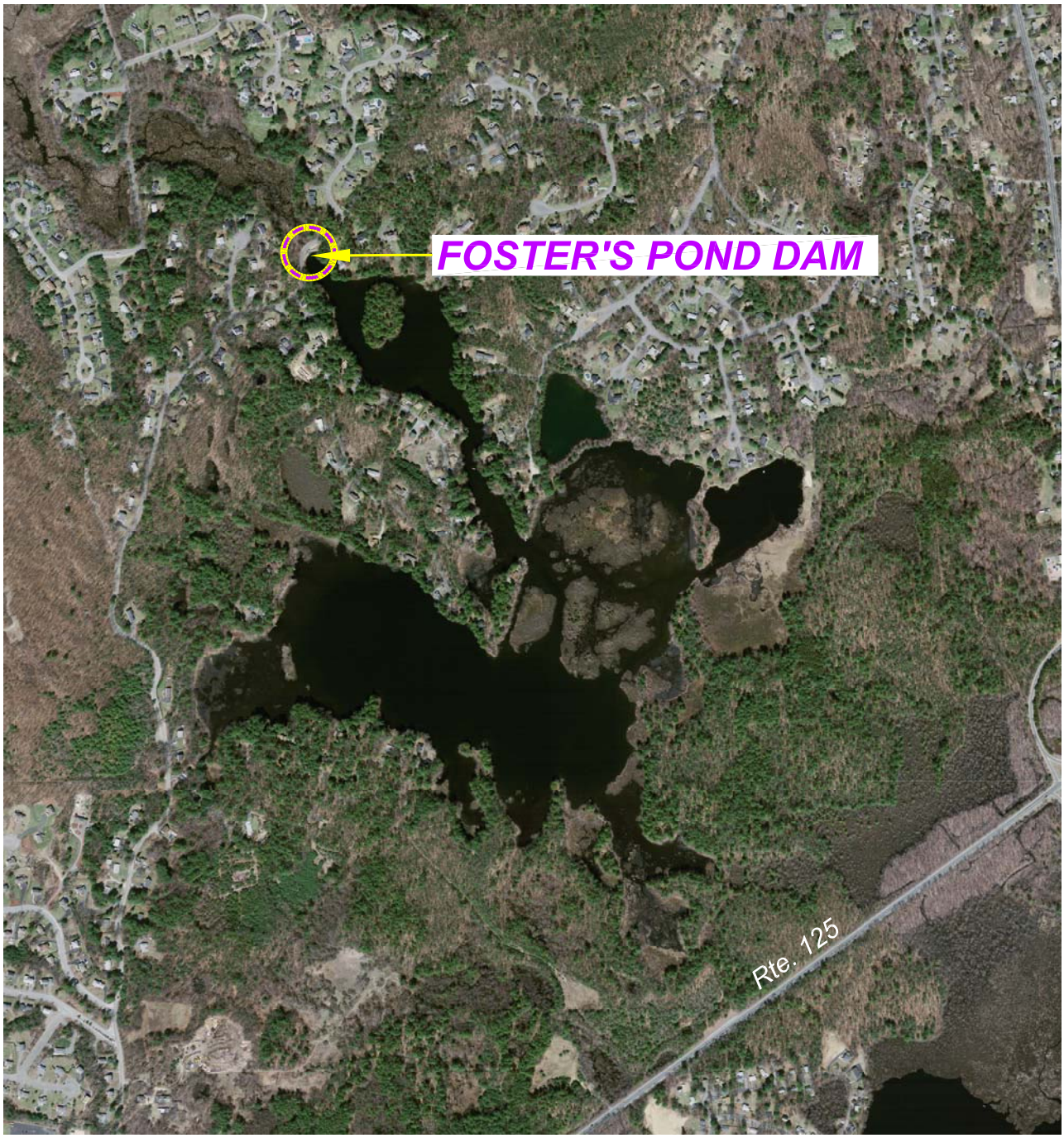
FOSTER'S POND DAM
NID ID# MA00153
ANDOVER, MA
READING & LAWRENCE, MA QUADRANGLES
SOURCE: MassGIS
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W



MASSACHUSETTS
QUADRANGLE LOCATION

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	SITE LOCATION MAP
Foster's Pond Corporation Andover, Massachusetts	Project 06463-3	December 6, 2016 Fig. 1

M:\DRAFTING\2006\064630 Fosters Pond Dam\064633\064633-05



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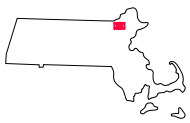
APPROXIMATE SCALE, FEET

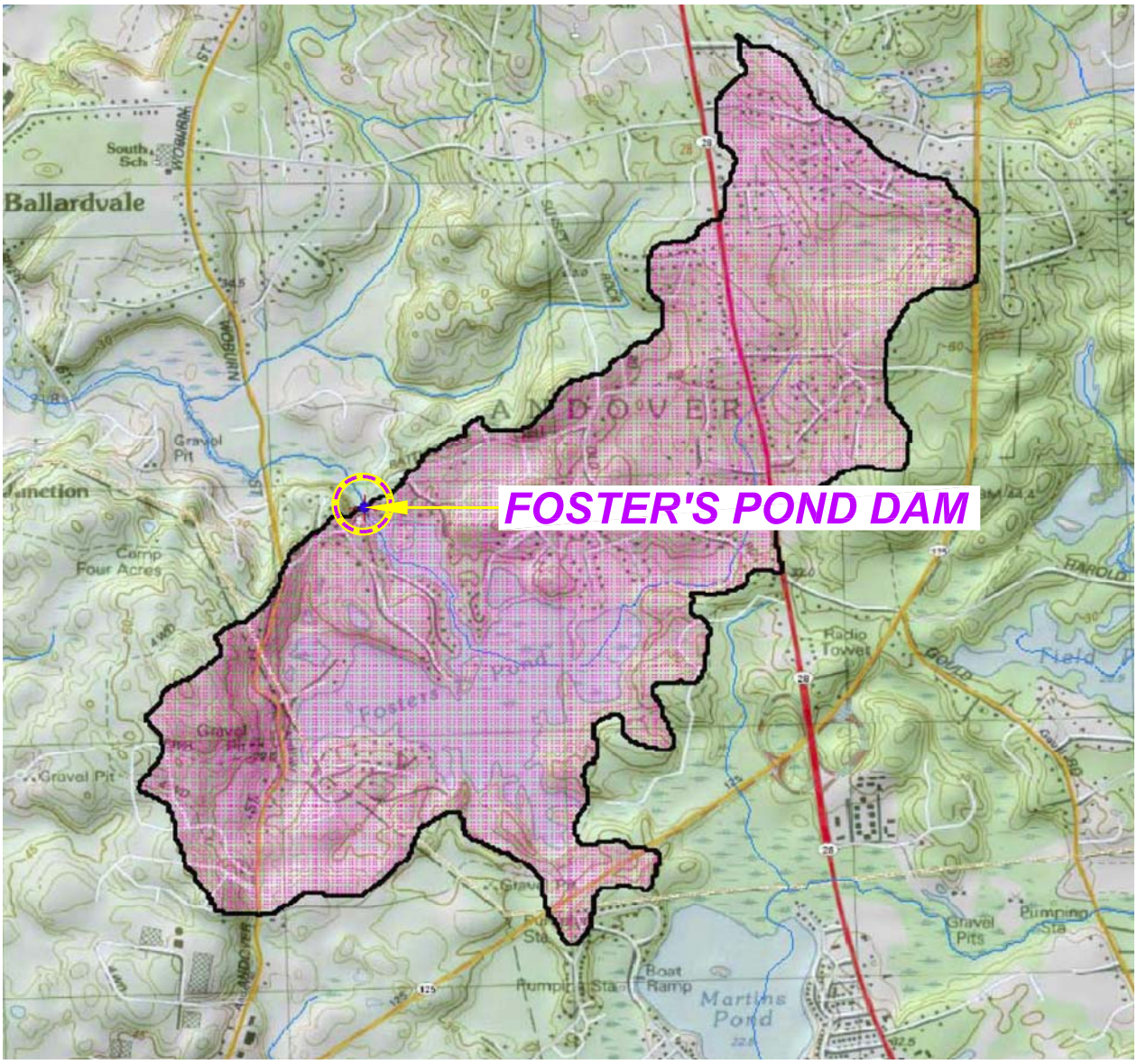
FOSTER'S POND DAM
NID ID# MA00153
ANDOVER, MA
READING & LAWRENCE, MA QUADRANGLES
SOURCE: MassGIS
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W



MASSACHUSETTS
QUADRANGLE LOCATION

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	AERIAL PHOTOGRAPH
Foster's Pond Corporation Andover, Massachusetts	Project 06463-3	December 6, 2016 Fig. 2

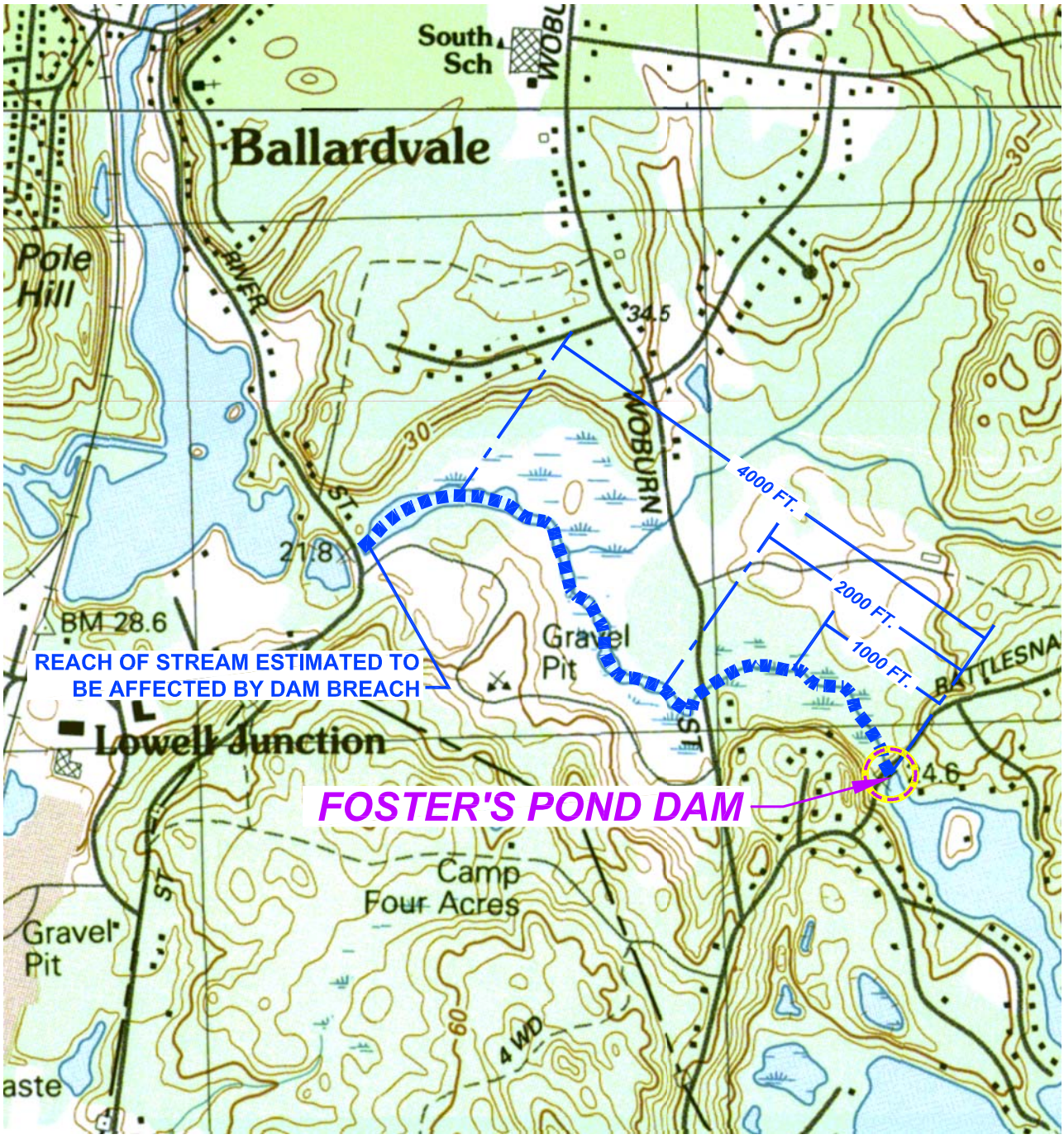
M:\DRAFTING\2006\064630 Fosters Pond Dam\064633\064633-05



FOSTER'S POND DAM
NID ID# MA00153
DRAINAGE AREA = 1.58 SQUARE MILES
ANDOVER, MA
READING & LAWRENCE, MA QUADRANGLES
SOURCE: USGS PROGRAM MASSACHUSETTS STREAMSTATS
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	DRAINAGE AREA
Foster's Pond Corporation Andover, Massachusetts	Project 06463-3	December 6, 2016 Fig. 3

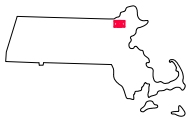
M:\DRAFTING\2006\064630 Fosters Pond Dam\064633\064633-06



0 500 1000 2000 3000

APPROXIMATE SCALE, FEET

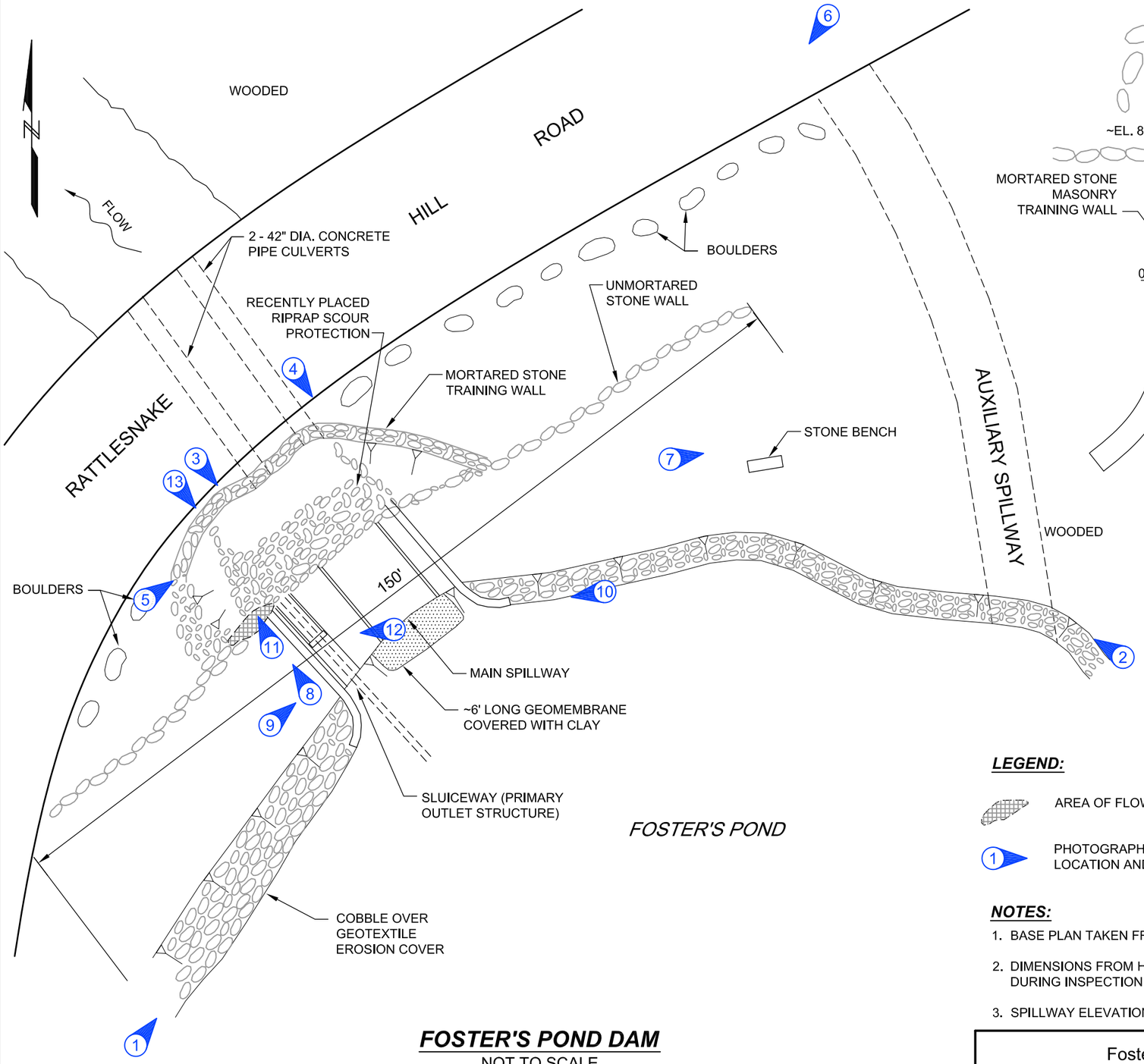
FOSTER'S POND DAM
NID ID# MA00153
ANDOVER, MA
READING & LAWRENCE, MA QUADRANGLES
SOURCE: MassGIS
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W



MASSACHUSETTS
QUADRANGLE LOCATION

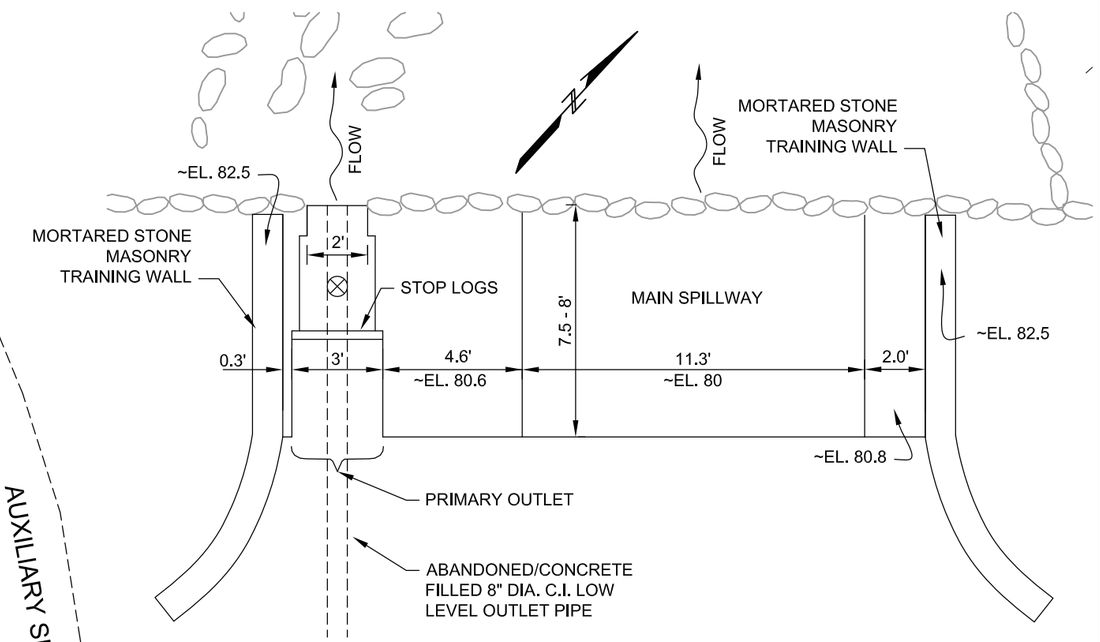
Foster's Pond Dam Andover, Massachusetts	GEI Consultants	DAM AND AREA DOWNSTREAM FROM POND
Foster's Pond Corporation Andover, Massachusetts	Project 06463-3	December 6, 2016 Fig. 4

M:\DRAFTING\2006\064630 Fosters Pond Dam\064633\064633-07



FOSTER'S POND DAM

NOT TO SCALE



MAIN SPILLWAY AND PRIMARY OUTLET DETAIL

0 5 10

SCALE, FEET

LEGEND:

AREA OF FLOW FROM WALL

1 PHOTOGRAPH NUMBER LOCATION AND DIRECTION

NOTES:

1. BASE PLAN TAKEN FROM SITE PLAN PREPARED BY FOSTER'S POND CORP. MEMBERS.
2. DIMENSIONS FROM HISTORIC INSPECTION RECORDS AND MEASUREMENTS TAKEN DURING INSPECTION ON NOVEMBER 10, 2006 AND MAY 8, 2008.
3. SPILLWAY ELEVATIONS ASSUME SPILLWAY CREST AT EL. 80.0.

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	DAM SITE PLAN SKETCH
Foster's Pond Corporation Andover, Massachusetts	Project 06463-3	December 6, 2016 Fig. 5

M:\DRAFTING\2006\064630 Fosters Pond Dam\064633\064633-08

APPENDIX A
Photographs

Photo 1 – Upstream slope and crest from left*

Photo 2 – Upstream slope and crest from right*

*Note: Distortions and color or light irregularities in panoramic composite photos are due to discontinuities between individual photographic images used to create panoramic composites.

Photo 3 – Downstream side of dam at spillway*

Photo 4 – Downstream side, right embankment*

Photo 5 – Downstream side, left embankment*

Photo 6 – Right embankment and auxiliary spillway*

Photo 7 – Right abutment and auxiliary spillway*

Photo 8 – View downstream from dam crest, Rattlesnake Road*

Photo 9 – Right embankment and right spillway training wall*

Photo 10 – Spillway and sluiceway upstream side*

Photo 11 – Spillway plunge pool from upstream*

Photo 12 – Sluiceway stoplogs and new metal slots

Photo 13 – Sluiceway from downstream

APPENDIX B
Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST INSTRUCTION PAGE

The checklist (Excel file) includes sections applicable to a variety of dam structure types. Carefully follow the instructions on the first tab of the checklist. Complete those pages pertaining to each structure and omit pages that are not relevant or mark them "Not Applicable." The Checklist must be signed by the inspecting engineer and a clean, neat copy included in the final inspection report. Use the checklist to generate the Dam Evaluation Summary Detail Sheet (should immediately follow the Executive Summary) and Table 1.1 (should immediately follow Section 1.0).

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 analyses 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, filed with MADCR, annual training

E4: EMBANKMENT SEEPAGE (Embankment, Foundation & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but monitored 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 mis-alignment 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. 51- 90% of the SDF
3. 91- 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 THE 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 for 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

Guidelines and Notes for Evaluations

Each of the evaluation categories has 5 rating levels. In general, the rating levels in each category are intended to reflect the following conditions:
1. Unsafe
2. Poor
3. Fair
4. Satisfactory
5. Good

<u>E10-Overall Safety Rating Guideline</u>

Unless the inspecting engineer presents compelling data, analyses, and observations that justify a higher rating, E10-Overall Safety Rating of the Dam shall not be higher than the lowest ranking in these high importance categories:
-E4-Seepage,
-E5-Embankment Condition (for embankment dams), and
-E6-Concrete Condition (for dams where concrete structures retain water).

Note 1 - Embankment Condition Factor of Safety Criteria

In addition to the inspection conditions listed, the embankment condition rating should consider the slope stability Factor of Safety (FS) according to the following guidelines for downstream (D/S) and upstream slopes (U/S).

	Normal Pool	**SDF**	**Seismic**	**Rapid Drawdown**
Rating	**D/S & U/S FS**	**D/S FS**	**D/S & U/S FS**	**U/S FS**
1	<1.3	<1.1	<1.0	<1.0
2	<1.5	<1.4	<1.0	<1.1
3	>1.5	<1.5	<1.1	<1.2
4	>1.5	>1.5	>1.1	>1.2
5	>1.5	>1.5	>1.1	>1.2

In the absence of stability analyses, use the following factors to evaluate the stability component of the embankment rating. The inspecting engineer will need to consider all factors in combination as the exact combination of conditions listed will rarely occur. For slopes, > indicates "steeper than."

Rating	**Slopes**	**Seepage**	**Material**	**Compaction**
1	>2H:1V	>5' above toe	SP, ML*, SM*	Loose or unknown
2	>2.5H:1V	>2' above toe	ML**, MH	Loose or unknown
3	>3H:1V	at toe	SM**, SW, CH	Likely compacted
4	<3H:1V	DS of toe	SC, CL	Compacted
5	<3H:1V	None	Suitably Zoned	Compacted

ML* - Non-plastic silt or any silt or clay susceptible to dispersion
ML** - Silt with some plasticity (non-dispersive)
SM* - Uniform silty fine sand
SM** - Widely graded silty sand

Note 2 - Concrete Condition Factor of Safety Criteria

In addition to the inspection conditions listed, ratings should consider the sliding stability Factors of Safety (FS) for any concrete structures that retain water according to the following guidelines.

FS Criteria for Dams with Limited Structure and Foundation Information and Testing

Rating	**Normal Pool FS**	**SDF FS**	**Ice Loading FS**	**Seismic FS**
1	<2.0	<1.3	<1.3	<1.0
2	<3.0	<2.0	<2.0	<1.3
3	>3.0	>2.0	>2.0	<1.5
4	>3.0	>2.0	>2.0	>1.5
5	>3.0	>2.0	>2.0	>1.5

FS Criteria for Dams with Well Defined Structure and Foundation Information and Testing

Rating	**Normal Pool FS**	**SDF FS**	**Ice Loading FS**	**Seismic FS**
1	<1.5	<1.3	<1.3	<1.0
2	<2.0	<1.7	<1.7	<1.0
3	<3.0	<2.0	<2.0	<1.1
4	>3.0	>2.0	>2.0	<1.3
5	>3.0	>2.0	>2.0	>1.3

See Appendix D for a complete listing of dam orientation and terminology definitions.

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.

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.

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.

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: Foster's Pond Dam

STATE ID #: 5-5-9-10

REGISTERED: ☑ YES ☐ NO

NID ID #: MA00153

STATE SIZE CLASSIFICATION: Intermediate

STATE HAZARD CLASSIFICATION: Significant

CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Andover

COUNTY: Essex

DAM LOCATION: Off Rattlesnake Hill Road
(street address if known)

ALTERNATE DAM NAME:

USGS QUAD.: Reading

LAT.: 42.61361°N

LONG.: 71.14146°W

DRAINAGE BASIN: Shawsheen

RIVER: Frye's Brook (inflow) to Shawsheen River about 1 mile downstream

IMPOUNDMENT NAME(S): Fosters Pond

GENERAL DAM INFORMATION

TYPE OF DAM: Earthfill w/ downstream stone masonry

OVERALL LENGTH (FT): ~150

PURPOSE OF DAM: Recreational

NORMAL POOL STORAGE (ACRE-FT): ~538

YEAR BUILT: ~1850s

MAXIMUM POOL STORAGE (ACRE-FT): ~867

STRUCTURAL HEIGHT (FT): ~10.1

EL. NORMAL POOL (FT): ~78.5-79.8 (assumed spillway El.=80 ft)

HYDRAULIC HEIGHT (FT): ~7.6

EL. MAXIMUM POOL (FT): ~82.5

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO

CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: Foster's Pond Dam | STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 | NID ID #: MA00153

INSPECTION SUMMARY

DATE OF INSPECTION: December 6, 2016 | DATE OF PREVIOUS INSPECTION: November 18, 2011

TEMPERATURE/WEATHER: Sunny, ~40 degrees F | ARMY CORPS PHASE I: ☐ YES ☑ NO | If YES, date

CONSULTANT: GEI Consultants, Inc. | PREVIOUS DCR PHASE I: ☐ YES ☑ NO | If YES, date 18-Nov-11

BENCHMARK/DATUM: Not available; 80 ft used as a reference datum equal to the main spillway crest elevation

OVERALL PHYSICAL CONDITION OF DAM: SATISFACTORY | DATE OF LAST REHABILITATION: Annual maintenance in 2007-2008, 2010-2015

SPILLWAY CAPACITY: >100% SDF w/ no actions by Caretaker

EL. POOL DURING INSP.: ~79.5 | EL. TAILWATER DURING INSP.: ~72.2

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
Lee Wooten, P.E.	Principal	GEI Consultants, Inc.
Stephen Cotton	FPC President	Foster's Pond Corporation - (FPC)

EVALUATION INFORMATION

	Click on box to select E-code		Click on box to select E-code
E1) TYPE OF DESIGN	1	E8) LOW-LEVEL OUTLET CONDITION	1
E2) LEVEL OF MAINTENANCE	5	E9) SPILLWAY DESIGN FLOOD CAPACITY	5
E3) EMERGENCY ACTION PLAN	4	E10) OVERALL PHYSICAL CONDITION	4
E4) EMBANKMENT SEEPAGE	4	E11) ESTIMATED REPAIR COST	$1500 to $3,500
E5) EMBANKMENT CONDITION	5	ROADWAY OVER CREST	NO
E6) CONCRETE CONDITION	5	BRIDGE NEAR DAM	YES
E7) LOW-LEVEL OUTLET CAPACITY	1		

NAME OF INSPECTING ENGINEER: Lee Wooten, P.E. | SIGNATURE: Lee Wooten

NAME OF DAM: Foster's Pond Dam | STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 | NID ID #: MA00153

OWNER:		CARETAKER:	
ORGANIZATION	Foster's Pond Corporation	ORGANIZATION	Foster's Pond Corporation
NAME/TITLE	Stephen E. Cotton - President	NAME/TITLE	David Brown - Treasurer
STREET	19 Pomeroy Road	STREET	31 Glenwood Road
TOWN, STATE, ZIP	Andover, MA 01810	TOWN, STATE, ZIP	Andover, MA 01810
PHONE	978-475-5679	PHONE	978-470-0454
EMERGENCY PH. #	978-475-5679	EMERGENCY PH. #	978-470-0454
FAX		FAX	978-470-2066
EMAIL	scotton@fosterspond.org	EMAIL	davebrown@alum.mit.edu
OWNER TYPE	Private Association or other non-profit		

PRIMARY SPILLWAY TYPE: Broad crested weir

SPILLWAY LENGTH (FT): 21.2 | SPILLWAY CAPACITY (CFS): ~194

AUXILIARY SPILLWAY TYPE: Grass covered swale | AUX. SPILLWAY CAPACITY (CFS): ~57

NUMBER OF OUTLETS: 1 sluiceway | OUTLET(S) CAPACITY (CFS): ~33 with full pool

TYPE OF OUTLETS: Suiceway with stoplogs (operational) | TOTAL DISCHARGE CAPACITY (CFS): ~284

DRAINAGE AREA (SQ MI): 1.58 | SPILLWAY DESIGN FLOOD (PERIOD/CFS): 100-year / 191 cfs

HAS DAM BEEN BREACHED OR OVERTOPPED: ☑ YES ☐ NO | IF YES, PROVIDE DATE(S): overtopped 05/54, 03/01, Sprng '02, 04/04, 05/14/06

FISH LADDER (LIST TYPE IF PRESENT): No

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

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

MHD BRIDGE NO. (IF APPLICABLE):

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Grass cover		x	
	2. SURFACE CRACKING	None observed		x	
	3. SINKHOLES, ANIMAL BURROWS	None observed		x	
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	Uniform crest elevation after recent maintenance		x	
	5. HORIZONTAL ALIGNMENT	No visible horizontal displacements	x		
	6. RUTS AND/OR PUDDLES	None observed		x	
	7. VEGETATION (PRESENCE/CONDITION)	Grass cover		x	
	8. ABUTMENT CONTACT	Good	x		

ADDITIONAL COMMENTS: The aggressive maintenance actions have restored a uniform grade to the embankment crest and established a grass cover over the crest. Geotextile was placed below seeded topsoil on embankment crest.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	None observed		x	
	2. SEEPAGE	None observed		x	
	3. SLIDE, SLOUGH, SCARP	Irregular unmortared stone masonry wall		x	
	4. EMB.-ABUTMENT CONTACT	Good	x		
	5. SINKHOLE/ANIMAL BURROWS	None observed		x	
	6. EROSION	None observed		x	
	7. UNUSUAL MOVEMENT	None observed	x		
	8. VEGETATION (PRESENCE/CONDITION)	No vegetation in masonry wall		x	

ADDITIONAL COMMENTS: A stone masonry wall retains most of the downstream side of the dam. See "Masonry Walls" page for additional information.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

EMBANKMENT (U/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	None observed	x		
	2. SLOPE PROTECTION TYPE AND COND.	Cobble (3 inch to 6 inch) & gravel placed over geotextile (Note 1)		x	
	3. SINKHOLE/ANIMAL BURROWS	None observed		x	
	4. EMB.-ABUTMENT CONTACT	Good	x		
	5. EROSION	None observed		x	
	6. UNUSUAL MOVEMENT	None observed	x		
	7. VEGETATION (PRESENCE/CONDITION)	Grass cover above cobble erosion protection (Note 1)		x	

ADDITIONAL COMMENTS: 1. Most of the upstream slope is covered with 3- to 6-inch cobbles and gravel placed over a geotextile. The upper few feet of the slope are covered with grassed soil. Geotextile was placed below seeded toposoil on right embankment crest and is covered with seeded topsoil or gravel to prevent degradation by sunlight.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	None	x		
	2. OBSERVATION WELLS	None	x		
	3. STAFF GAGE AND RECORDER	None	x		
	4. WEIRS	None	x		
	5. INCLINOMETERS	None	x		
	6. SURVEY MONUMENTS	None observed	x		
	7. DRAINS	None	x		
	8. FREQUENCY OF READINGS	N/A	x		
	9. LOCATION OF READINGS	N/A	x		

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

DOWNSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
D/S WALLS	1. WALL TYPE	Downsteam dam face is a mostly unmortared stone masonry wall			x		
	2. WALL ALIGNMENT	Irregular alignment of stones in masonry wall (probably as-built condition)				x	
	3. WALL CONDITION	Fair				x	
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: 0 ft	max: 8 ft	avg: 4 ft	x		
	5. SEEPAGE OR LEAKAGE	See comments below				x	
	6. ABUTMENT CONTACT	Good			x		
	7. EROSION/SINKHOLES BEHIND WALL	None observed				x	
	8. ANIMAL BURROWS	None observed				x	
	9. UNUSUAL MOVEMENT	None observed				x	
	10. WET AREAS AT TOE OF WALL	See note 1				x	

ADDITIONAL COMMENTS: Seepage from the base of the wall located a few feet to the west of the sluiceway (left looking downstream) in the past has caused internal erosion of soil in the embankment, which has resulted in sinkholes on the dam crest. FPC has repaired the sinkholes by excavating from the crest, installing concrete fill to seal seepage entry locations and to provide a non-erodible stable mass within the dam, and by backfilling with clay. FPC should continue to monitor seepage and for signs of internal erosion.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

UPSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
U/S WALLS	1. WALL TYPE	No upstream masonry walls other than spillway wing walls (good condition)			x		
	2. WALL ALIGNMENT	NA					
	3. WALL CONDITION	NA					
	4. HEIGHT: TOP OF WALL TO MUDLINE	min:	max:	avg:			
	5. ABUTMENT CONTACT	NA					
	6. EROSION/SINKHOLES BEHIND WALL	NA					
	7. ANIMAL BURROWS	NA					
	8. UNUSUAL MOVEMENT	NA					

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None observed	x		
	2. FOUNDATION SEEPAGE	None observed, but slightly obscured by ice, snow, leaves		x	
	3. SLIDE, SLOUGH, SCARP	None observed	x		
	4. WEIRS	None	x		
	5. DRAINAGE SYSTEM	Two 42-inch concrete culverts carry dam flow downstream under Rattlesnake Hill Rd	x		
	6. INSTRUMENTATION	None	x		
	7. VEGETATION	Large rounded gravel cover to Rattlesnake Hill Rd, wooded wetlands area beyond road		x	
	8. ACCESSIBILITY	Good; Rattlesnake Hill Road	x		
	9. DOWNSTREAM HAZARD DESCRIPTION	Local roads, Rattlesnake Hill Road and Woburn Street ~1300 ft downstream beyond heavily vegatated wooded wetlands area			
	10. DATE OF LAST EAP UPDATE	December 6, 2016 - see Note 1 Misc page			

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	4.5 feet (538 acre-feet / 120 acres)
	2. RESERVOIR SHORELINE	Wooded and grass, residential homes
	3. RESERVOIR SLOPES	Gentle to moderate slopes; hilly along west side of impoundment
	4. ACCESS ROADS	Adjacent to Rattlesnake Hill Road
	5. SECURITY DEVICES	Boulders along downstream side and metal chain gate at access path on right embankment
	6. VANDALISM OR TRESPASS	☐ YES ☑ NO WHAT:
	7. AVAILABILITY OF PLANS	☐ YES ☑ NO DATE:
	8. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	☐ YES ☑ NO DATE: December 6, 2016 - see Note 1 Misc page
	10. AVAILABILITY OF O&M MANUAL	☑ YES ☐ NO DATE: December 6, 2016 - see Note 1 Misc page
	11. CARETAKER/OWNER AVAILABLE	☑ YES ☐ NO DATE: December 6, 2016
	12. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS: 1. The O&M Manual is a three page document that includes EAP paragraphs, specifically directions on operation of the sluiceway during potential overtopping events and directions for emergency notifications. The document is suitable for the size and hazard of the dam.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Concrete/Masonry	x		
	WEIR TYPE	Broad-crested weir, 11.9 ft long	x		
	SPILLWAY CONDITION	Good - see note 1		x	
	TRAINING WALLS	Good - granite curbstone training walls added as erosion protection (Note 1)		x	
	SPILLWAY CONTROLS AND CONDITION	No controls other than sluiceway boards	x		
	UNUSUAL MOVEMENT	Downstream left side of spillway is slightly lower, possible past movement		x	
	APPROACH AREA	Shallow slope. Upstream slope covered w/ geomembrane & clay ~6 ft into basin.		x	
	DISCHARGE AREA	Stilling basin is enclosed by a mortared stone training wall (note 2)		x	
	DEBRIS	None observed		x	
	WATER LEVEL AT TIME OF INSPECTION	~79.5, 0.5 ft. below upstream edge of spillway (~El. 80.0 ft - reference datum)	x		

ADDITIONAL COMMENTS: 1. Taining walls originally upgraded in 2006 with the construction of the current granite block walls. In 2010, 2014, & 2015, FPC has repaired internal erosion of the embankment behind the spillway walls by excavating at sinkholes, placing concrete to seal seepage entry points, and by backfilling behind the concrete with clay.

2. Plunge pool has been maintained with the addition of dumped riprap below the spillway for erosion protection.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Grass covered swale along right abutment (Note 1)		x	
	WEIR TYPE	Earth-lined, broad-crested	x		
	SPILLWAY CONDITION	Good		x	
	TRAINING WALLS	None	x		
	SPILLWAY CONTROLS AND CONDITION	None	x		
	UNUSUAL MOVEMENT	None observed	x		
	APPROACH AREA	Clear, covered with large gravel	x		
	DISCHARGE AREA	Rattlesnake Hill Rd, wetlands beyond	x		
	DEBRIS	None observed	x		
	WATER LEVEL AT TIME OF INSPECTION	~1.0 foot below low point on swale	x		

ADDITIONAL COMMENTS: 1. Existing swale emergency spillway along the right abutment with a low point ~1 ft higher than primary spillway intake elevation, has been maintained by regrading, placement of cobble cover on upstream side and establishment of grass cover across crest. A geotextile was also placed under the cobble and seeded topsoil covered portions of the spillway.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Sluiceway contolled with stoplogs	x		
	INTAKE STRUCTURE	Concrete sluiceway, 3 ft to 2 ft wide, 2.6 feet deep (note 1)		x	
	TRASHRACK	None	x		
	PRIMARY CLOSURE	Three 10-inch deep stoplogs	x		
	SECONDARY CLOSURE	None	x		
	CONDUIT	8-inch low-level outlet pipe thru sluiceway reportedly corroded, filled w/ concrete	x		
	OUTLET STRUCTURE/HEADWALL	None	x		
	EROSION ALONG TOE OF DAM	None		x	
	SEEPAGE/LEAKAGE	None observed		x	
	DEBRIS/BLOCKAGE	None observed		x	
	UNUSUAL MOVEMENT	None observed		x	
	DOWNSTREAM AREA	Riprapped plunge pool (riprap placed as part of 2006 maintenance)		x	
	MISCELLANEOUS	Stone masonry training walls on left side of sluiceway recently repaired/upgraded		x	

ADDITIONAL COMMENTS: 1. Condition of concrete good. No cracks observed. Minor concrete patch placed in sluiceway in Dec. 2011 to cut off water flow into masonry wall. FPC installed new stainless steel stoplog brackets since the last inspection. The new brackets / slots allow the stoplogs to be locked with a bike padlock.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

CONCRETE/MASONRY DAMS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
GENERAL	TYPE	Not applicable to this structure			
	AVAILABILITY OF PLANS	Not applicable to this structure			
	AVAILABILITY OF DESIGN CALCS	Not applicable to this structure			
	PIEZOMETERS	Not applicable to this structure			
	OBSERVATION WELLS	Not applicable to this structure			
	INCLINOMETERS	Not applicable to this structure			
	SEEPAGE GALLERY	Not applicable to this structure			
	UNUSUAL MOVEMENT	Not applicable to this structure			

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

CONCRETE/MASONRY DAMS (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	TYPE	Not applicable to this structure			
	SURFACE CONDITIONS	Not applicable to this structure			
	CONDITIONS OF JOINTS	Not applicable to this structure			
	UNUSUAL MOVEMENT	Not applicable to this structure			
	HORIZONTAL ALIGNMENT	Not applicable to this structure			
	VERTICAL ALIGNMENT	Not applicable to this structure			

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

CONCRETE/MASONRY DAMS (DOWNSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S FACE	TYPE	Not applicable to this structure			
	SURFACE CONDITIONS	Not applicable to this structure			
	CONDITIONS OF JOINTS	Not applicable to this structure			
	UNUSUAL MOVEMENT	Not applicable to this structure			
	ABUTMENT CONTACT	Not applicable to this structure			
	LEAKAGE				

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: December 6, 2016 NID ID #: MA00153

CONCRETE/MASONRY DAMS (UPSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S FACE	TYPE	Not applicable to this structure			
	SURFACE CONDITIONS	Not applicable to this structure			
	CONDITIONS OF JOINTS	Not applicable to this structure			
	UNUSUAL MOVEMENT	Not applicable to this structure			
	ABUTMENT CONTACTS	Not applicable to this structure			

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. Foster's Pond Corporation, 2016, "Foster's Pond Dam Operations and Maintenance Manual & Emergency Procedures," December 6.

2. Foster's Pond Corporation, 2016, "Foster's Pond Corporation" website, http://www.fosterspond.org/.

3. GEI Consultants, Inc., 2011, "Fosters Pond Dam Phase I Inspection / Evaluation Report," November 18.

4. GEI Consultants, Inc., 2010, "Site Visit Observations and Preliminary Recommendations, Fosters Pond Dam, NID # MA00153, Andover, Massachusetts," April 6.

5. GEI Consultants, Inc., 2008, "Foster's Pond Dam Follow-Up Inspection / Evaluation Report," May 8.

6. GEI Consultants, Inc., 2006, "Fosters Pond Dam Phase I Inspection / Evaluation Report," November 10.

7. Foster's Pond Corporation, 2005, "Foster's Pond Dam, Operations and Maintenance Manual," October 12.

8. Department of Conservation and Recreation, Office of Dam Safety, 2003, Letter to Mr. Stephen Cotton with complete Foster's Pond Dam file Information including inspection reports from 1913 to 1973, dated August 12.

9. Department of Environmental Management, Office of Dam Safety, 2001, Foster's Pond Dam Notice of Inspection Letter and Inspection Summary, April 2.

10. Town of Andover, Andover, Massachusetts, 2001,Foster's Pond Dam, Letter to Department of Environmental Management, Office of Dam Safety, March 23.

11. Massachusetts Department of Public Works, 1973, Foster Pond Dam, Letter to Foster's Pond Corporation, October 29.

12. Lee Chisholm, 1973, Foster's Pond Dam, Letter to Massachusetts De Department of Public Works, October 4.

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

1. Commonwealth of Massachusetts, Department of Conservation and Recreation, 2009, "302 CMR10.00: Dam Safety," June 26.

2. Wandle, S. William, Jr., 1983, "Estimating Peak Discharges of Small Rural Streams in Massachusetts," USGS Water Supply Paper 2214.

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)