

FACTORY POND DAM
PHASE I
INSPECTION / EVALUATION REPORT



Dam Name: **Factory Pond Dam**
State Dam ID#: **7-12-123-2**
NID ID#: **MA00391**
Owner: **Town of Hanover / Town of Hanson**
Town: **Hanover / Hanson**
Consultant: **Amory Engineers, P.C.**
Date of Inspection: **December 22, 2011**

EXECUTIVE SUMMARY

- Factory Pond Dam, Hanover/Hanson, MA
- Inspected December 22, 2011
- Inspected by Amory Engineers, P.C., Duxbury, MA
- Dam Condition: Poor
- The following deficiencies were observed during the inspection:
 1. The primary spillway concrete walls have significant cracks, spalled concrete and exposed aggregate.
 2. Trees, dense brush and roots on the dam crest, the upstream and downstream embankment slopes and along the toe of the embankment left of the auxiliary spillway.
 3. Riprap has dislodged from the downstream face of the auxiliary spillway at its right embankment contact.
 4. The upstream slope of the left embankment has significant erosion resulting in vertical and undercut areas. The vertical fieldstone masonry wall along the downstream face has collapsed in a couple of locations causing erosion of the downstream slope and sinkholes in the crest.
 5. The vertical alignment of the left embankment crest is irregular with depressions caused by erosion and a worn walking path.
 6. Seepage was observed approximately five to ten feet downstream of the vertical fieldstone masonry wall (left embankment).
- Amory Engineers recommends the following to address deficiencies:
 1. Remove all trees, brush and root systems from the embankment. Fill all voids with impervious fill material.
 2. Fill sinkholes with impervious fill.
 3. Reconstruct the upstream slope of the left embankment to provide a consistent, sloped face. Armor the slope with riprap stone.
 4. Fill/re-grade the crest to provide a consistent vertical alignment along the embankment. Loam and seed to provide grass cover on the crest and embankment slopes.
 5. Repair cracks and spalls in concrete.
 6. Replace and/or reset riprap stone on downstream face of the auxiliary spillway right contact.
 7. Repair downstream vertical fieldstone retaining wall.

Dam Evaluation Summary Detail Sheet

1. NID ID:	MA00391	4. Inspection Date:	December 22, 2011
2. Dam Name:	Factory Pond Dam	5. Last Insp. Date:	February 9, 2007
3. Dam Location:	Hanover, MA	6. Next Inspection:	December 22, 2016
7. Inspector:	Patrick G. Brennan, P.E.		
8. Consultant:	Amory Engineers, P.C.		
9. Hazard Code:	Significant	9a. Is Hazard Code Change Requested?:	No
10. Insp. Frequency:	5 Years	11. Overall Physical Condition of Dam:	POOR
12. Spillway Capacity (% SDF)	0-50% of the SDF or Unknown		
E1. Design Methodology:	1	E7. Low-Level Discharge Capacity:	2
E2. Level of Maintenance:	2	E8. Low-Level Outlet Physical Condition:	1
E3. Emergency Action Plan:	2	E9. Spillway Design Flood Capacity:	1
E4. Embankment Seepage:	3	E10. Overall Physical Condition of the Dam:	2
E5. Embankment Condition:	2	E11. Estimated Repair Cost:	\$130,000
E6. Concrete Condition:	2		

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

PREFACE

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

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

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



Licensed Professional's Signature

Patrick G. Brennan, P.E.
Associate
Amory Engineers, P.C.

Massachusetts License No.: 41489
License Type: Civil

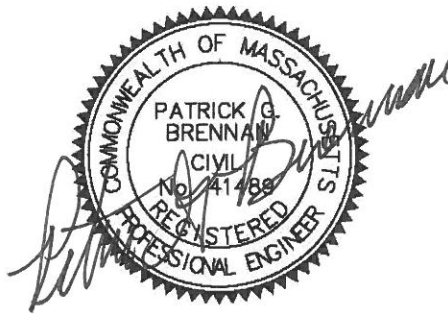


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SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The Town of Hanover, Massachusetts retained Amory Engineers, P.C. to perform a visual inspection and develop a report of conditions for the dam at Factory Pond in the Towns of Hanover and Hanson, Plymouth County, Massachusetts. The 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 our 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

Factory Pond Dam is located in the Towns of Hanover and Hanson, Plymouth County, in eastern Massachusetts on Factory Pond (see Figure 1).

MassGIS coordinates are 42.08892 latitude and 70.86697 longitude. To get to the dam from Hanover Town Hall, drive west on Hanover Street (Route 139) for about 340 feet, turn left onto Center Street for 1.8 miles, Center Street becomes Broadway, continue on Broadway for about 0.3 miles, Broadway becomes Winter Street, follow Winter Street for about 0.1 miles, the dam will be located on the right, behind 901 Winter Street.

1.2.2 Owner/Caretaker

Factory Pond Dam is jointly owned by the Hanover and Hanson Conservation Commissions. Contact information is as follows:

Hanover	Dam Owner	Dam Caretaker
Name	Conservation Commission	Victor Diniak, DPW Director
Street Address	550 Hanover Street	40 Pond Street
Town, State, Zip	Hanover, MA 02339	Hanover, MA 02339
Phone	781-826-6505	781-826-3189
Fax	781-826-5950	781-826-8915
Email		vdiniak@hanoverdpw.org
Hanson	Dam Owner	Dam Caretaker
Name	Conservation Commission	Robert Brown
Street Address	542 Liberty Street	795 Indianhead Street
Town, State, Zip	Hanson, MA 02341	Hanson, MA 02341
Phone	781-294-4119	781-293-2822
Fax	781-294-0884	
Email	bnehiley@hanson-ma.gov	highwaydept@hanson-ma.gov

1.2.3 Purpose of the Dam

The current purpose of the dam is to impound water for recreation and flood control. Factory Pond Dam was originally constructed to provide power first for a sawmill and subsequently for a machine shop.

1.2.4 Description of the Dam and Appurtenances

Factory Pond Dam consists of an earth and stone masonry embankment, approximately 310 feet long. The maximum height above upstream toe is approximately 9 feet (hydraulic height) and above downstream toe is about 10.8 feet (structural height). The dam consists of an open channel, concrete primary spillway at the right abutment, then approximately 40 feet of earth embankment to a concrete and stone masonry auxiliary spillway, approximately 175 feet long and finally to another earth embankment, extending about 85 feet to the left abutment.

The primary spillway, reportedly constructed circa 1942 to 1943, is a concrete channel with a wood stop-log weir. Upstream of the weir are concrete training walls which are parallel to flow for about 4.5 feet and then open out approximately 45 degrees to a point where they turn parallel to the dam. The channel downstream of the weir is about 29 feet long, 8 feet wide and 8.5 feet deep with one foot wide concrete training walls. The channel flows into an approximately 10 foot square concrete stilling basin which is about 9.5 feet deep. Discharge from the stilling basin is through a 20 foot long, 36-inch diameter high density polyethylene (HDPE) culvert. The culvert is surrounded with riprap stone between the stilling basin and the natural stream channel to which it discharges. The spillway is surrounded by a chain link security fence.

The crest along the earth embankment between the spillways varies in width from about 20 to 25 feet. The upstream face is sloped earth with some riprap protection. Dense brush growth

obscures most of the upstream slope and crest of the embankment. The downstream face is riprap with a slope of about 3:1.

The auxiliary spillway consists of a concrete broad crested weir on a grouted granite block and stone masonry foundation. The downstream face is grouted stone masonry, sloped at about 1:1. The weir is about ten feet above the downstream toe which consists of a stone lined channel parallel to the dam with flow going from left to right (west to east). According to a Weston & Sampson Inspection and Evaluation Report dated February 9, 2007, the auxiliary spillway was repaired in 1996. One of the repairs included installing a pair of 2-in. diameter PVC drain pipes about every 20 feet along the spillway. The intake of the drain pipes is reportedly wire mesh clamped over filter fabric. There was little to no flow observed from the drain pipes at the time of inspection.

The crest along the earth embankment left of the auxiliary spillway averages about 5 feet in width. The upstream face is nearly vertical in some areas and undermined in others with significant erosion. The downstream face is a vertical dry-set fieldstone masonry retaining wall ranging in height from about four to eight feet. The wall has collapsed in two areas causing erosion and there is much tree and brush growth adjacent to the wall (top and toe) which makes access to portions of the wall difficult.

1.2.5 Operation and Maintenance

There are no formal operation and maintenance procedures in place for Factory Pond Dam. Mr. Victor Diniak, Hanover DPW Director, advised that his department routinely inspects the dam for damage after major storm events.

1.2.6 DCR Size Classification

Factory Pond Dam has a height of dam of approximately 10.8 feet and a maximum storage capacity of 265 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, Factory Pond Dam is an Intermediate size structure.

1.2.7 DCR Hazard Potential Classification

Factory Pond Dam is located upstream of Winter Street, Indian Head Dam, Curtis Crossing Dam and residential properties. It appears that a failure of the dam at maximum pool may cause damage to public roads, downstream dams, residential properties and possible loss of life. 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, Factory 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 Factory Pond Dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Factory Pond Dam is approximately 22.66 square miles and extends through the communities of Hanover, Hanson, Whitman, Rockland, Abington, Weymouth, Hingham and Norwell (see Figure 3). The drainage area was delineated using the USGS StreamStats program which is based on USGS topographic quadrangle maps.

The drainage area includes dense residentially and commercially developed areas, woodlands and wetlands. Upstream tributaries to Factory Pond include the Drinkwater River, French Stream, Cushing Brook, Ben Mann Brook, Shinglemill Brook and Longwater Brook. Ponds located along the tributaries include Forge Pond, Studley's Pond, Hackett's Pond and Shinglemill Pond. Beech Hill Swamp, Hell Swamp and the Abington/Rockland Reservoir are also located in the drainage area to Factory Pond Dam. The topography is relatively flat with the tributaries flowing primarily north to south.

1.3.2 Reservoir

See Table 1.1 for data about normal, maximum, and spillway design flood (SDF) pools. No hydraulic / hydrologic analysis was performed as part of this inspection and there are no existing data related to spillway or dam design. Data related to normal pool volume were taken from Phase I Inspection/Evaluation Report performed by Weston & Sampson, dated February 9, 2007. Data pertaining to maximum pool volume were calculated by interpolating contour information from USGS topographic quadrangle maps. Data pertaining impoundment pool and tributary drainage areas were calculated from USGS topographic maps, USGS StreamStats program and MassGIS digital orthophotos.

1.3.3 Discharges at the Dam Site

There are no known records of discharges at Factory Pond Dam.

1.3.4 General Elevations

Elevations, in feet, are based on the assumption that the pond was at normal pool at the time of inspection. Based on USGS topographic maps normal pool is El. 48.0, NGVD 1929 datum.

A.	Top of Dam	49.0
B.	Spillway Design Flood Pool	Unknown
C.	Normal Pool	48.0
D.	Primary Spillway Crest (at time of inspection)	46.95
E.	Auxiliary Spillway Crest	47.85
F.	Upstream Water at Time of Inspection	48.0
G.	Downstream Water at Time of Inspection	39.25
H.	Streambed at Toe of the Dam	37.1
I.	Low Point along Toe of the Dam	37.1

1.3.5 Primary Spillway Data

A.	Type	Wood stop-log
B.	Weir Length	7.3 feet
C.	Weir Crest Elevation	46.95
D.	Upstream Channel Elevation	43.0
E.	Downstream Channel Elevation	40.8
F.	36-in. HDPE Inlet Invert	40.2
G.	36-in. HDPE Outlet Invert	38.0
H.	Top of Training Walls (at weir)	49.65

1.3.6 Auxiliary Spillway Data

A.	Type	Broad-crested concrete weir
B.	Weir Length	175 feet
C.	Weir Breadth	1.25 – 1.5 feet
C.	Weir Crest Elevation	47.85
D.	Downstream Channel Elevation	38.6 – 40.5

1.3.7 Design and Construction Records and History

There are no design or construction records available for Factory Pond Dam. The following information was obtained from the Weston & Sampson 2007 report:

- A 1995 DEM Report indicated that a dam was originally constructed at this location in 1712.
- In the 1800's a dam similar to the present configuration was built to provide power for a mill.
- A 1987 DEM report indicated that the dam was rebuilt circa 1942 to 1943 including addition of the concrete primary spillway.
- The Town of Hanson acquired the dam in 1976 and it is now jointly owned by the Hanson and Hanover Conservation Commissions.
- Weston & Sampson prepared design plans and in 1996 repairs were made to the dam including adding the concrete cap to the auxiliary spillway; rebuilding the downstream face of the auxiliary spillway; filling of sinkholes on the upstream side of the auxiliary spillway; installation of weep drains through the auxiliary spillway; armoring of the downstream embankment slope between the spillways and installation of the 36-in. HDPE outlet culvert.

1.3.8 Operating Records

There are no operating records for Factory Pond Dam.

1.4 Summary Data Table

See next page for Table 1.1 – Summary Data Table.

1.1 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA00391
Dam Name	Factory Pond Dam
Dam Name (Alternate)	N/A
River Name	Drinkwater River (upstream) / Indian Head River (downstream)
Impoundment Name	Factory Pond
Hazard Class	Significant
Size Class	Intermediate
Dam Type	Earth and stone masonry
Dam Purpose	Originally power for mill, now recreation/flood control
Structural Height of Dam (feet)	10.75
Hydraulic Height of Dam (feet)	9
Drainage Area (sq. mi.)	22.66
Reservoir Surface Area (sq. mi.)	0.08 (51.19 acres)
Normal Impoundment Volume (acre-feet)	200
Max Impoundment Volume ((top of dam) acre-feet)	265
SDF Impoundment Volume* (acre-feet)	No Hydraulic / Hydrologic Analysis
Spillway Type	Wooden weir - stop logs
Spillway Length (feet)	7.3
Freeboard at Normal Pool (feet)	5
Principal Spillway Capacity* (cfs)	533
Auxiliary Spillway Capacity* (cfs)	No hydraulic / hydrologic analysis
Low-Level Outlet Capacity* (cfs)	No hydraulic / hydrologic analysis
Spillway Design Flood* (flow rate - cfs)	Unknown
Winter Drawdown (feet below normal pool)	None
Drawdown Impoundment Vol. (acre-feet)	N/A
Latitude	42.08892
Longitude	70.86697
City/Town	Hanover
County Name	Plymouth
Public Road on Crest	No
Public Bridge over Spillway	No
EAP Date (if applicable)	0
Owner Name	Towns of Hanover / Hanson
Owner Address	550 Hanover St. / 542 Liberty St.
Owner Town	Hanover, 02339 / Hanson, 02341
Owner Phone	781-826-6505 / 781-294-4119
Owner Emergency Phone	0
Owner Type	Municipality or Political subdivision
Caretaker Name	Victor Diniak / Robert Brown
Caretaker Address	40 Pond St. / 795 Indianhead St.
Caretaker Town	Hanover, MA 02339 / Hanson, MA 02341
Caretaker Phone	781-826-3189 / 781-293-2822
Caretaker Emergency Phone	0
Date of Field Inspection	12/22/2011
Consultant Firm Name	Amory Engineers, P.C.
Inspecting Engineer	Patrick G. Brennan, P.E.
Engineer Phone Number	781-934-0178

*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

Factory Pond Dam was inspected on December 22, 2011. At the time of the inspection, the weather was sunny and a seasonably warm 50 degrees. Approximately 0.14 inches of rain had fallen in the area within the previous 24 hours but there had been no significant rainfall events which would impact normal pool and flow conditions. Photographs to document the current conditions of the dam were taken during the inspection and are included in Appendix A. The level of the impoundment appeared to be at normal pool, El. 48.0 (NGVD 1929). Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Factory Pond Dam was found to be in Poor condition. Specific concerns are described in more detail in the sections below:

2.1.2 Dam

- **Abutments** are in fair condition.
- **Upstream Face** is in poor condition along the embankment left of the auxiliary spillway. There is severe erosion which has left the face vertical and undercut in some areas. There is no sign of riprap slope protection.

The upstream face on the embankment between the primary and auxiliary spillways is obscured by heavy brush growth. There was evidence of some riprap slope protection but the extent of it could not be determined.

- **Crest** of the embankment left of the auxiliary spillway is in poor condition. The width of the crest is fairly narrow due to 1) erosion along the upstream face and 2) erosion due to collapse of the fieldstone retaining wall in a couple of locations along the downstream face. Trees, brush and exposed roots are present on the crest as are sink holes due to the erosion. The crest is not level due to a worn walking path and erosion. There are three large trees on the crest near the left abutment (>24-in. diameter).

The embankment crest between the spillways is in fair condition. The crest in this area is about 20 to 25 feet wide but it is overgrown with brush. The ground surface under the brush appeared to be a boney gravel with no loam or grass vegetation. There were no signs of erosion.

- **Downstream Face** of the embankment left of the auxiliary spillway is a vertical dry-set fieldstone retaining wall in poor condition. Heavy brush and tree growth obscures much of the face. There were two areas of the wall which have partially collapsed causing erosion of the face and crest above the wall in those locations. Other areas of

the wall appear to be bulged and out of alignment. It appears that roots from large trees adjacent to the toe of the wall may be contributing to movement in the wall. There was no seepage observed through the wall but seepage was observed in some locations 5 to 10 feet from the toe of the wall.

Downstream face of the embankment between the spillways is in fair condition. It is armored with riprap and there does not appear to be any seepage. Small trees and brush cover the slope.

- **Drains.** The 2-in. PVC drains through the auxiliary spillway had very little if any flow. With water flowing over the spillway it was difficult to determine if there was any discharge. Because they were not flowing full we suspect that the inlets are at least partially blocked or clogged.
- **Access Roads and Gates.** There is a chain link fence with locked gates at the primary spillway. The fence is in fair condition. Aside from the chain link fence there is clear access to the right side of the dam via Winter Street and the parking lot for Country Ski and Sports. Clear access to the left side of the dam is via Waterford Drive through a walking path between residential properties.

2.1.3 Appurtenant Structures

- **Primary Spillway:** The primary spillway is a concrete channel with wood stop-logs. The condition of the spillway is poor. The training walls and discharge channel walls are spalled and cracked with weathered concrete (exposed aggregate). The top of the left outlet channel wall has extensive spalling. The right channel wall has structural cracks and a couple of holes. The beam spanning the weir and the center support column for the weir have severely weathered concrete with exposed aggregate. At the time of the inspection there was 0.95 feet of water flowing over the stop-logs. Deterioration of the walls was evident at the water level but the condition of the walls below the waterline could not be determined. Also, the condition of the wood stop-logs could not be determined due to water flow. There was debris (branches and weeds) stuck against the center support column for the weir at the time of inspection. No other obstructions were observed. The beam spanning the outlet channel at the stilling basin had exposed aggregate and some exposed rebar on the underside. The stilling basin was in fair condition with some minor concrete weathering. There were no apparent physical deficiencies with the HDPE discharge culvert. However, the upstream end of the culvert was submerged and the water depth was only 1.2 feet flowing out of the end of the culvert, indicating there may be an obstruction.
- **Low-Level Outlets:** There is no low-level outlet, however, the pond could be lowered and possibly emptied by removing all of the stop-logs. The bottom of the pond (sediment level) against the stop-logs was at El. 43.0 and the bottom of the concrete channel behind the stop-logs is El. 40.8.
- **Auxiliary Spillway:** The auxiliary spillway is in fair condition. The concrete cap appeared to be in good condition with no observed deficiencies. The grouted stone downstream face appeared to be in fair condition but the flow of water over the spillway prevented a thorough inspection of the entire face. A portion of the

downstream face does not appear to have been grouted at the contact with the embankment at the right end of the spillway. This portion of the face does not have the same profile as the grouted portion and it appears that some of the riprap may have fallen down the slope. The contact with the embankment left of the spillway is eroded on both the upstream and downstream faces. The upstream face of the embankment is severely eroded and is undercut adjacent to the spillway. Stones have dislodged from the downstream face of the embankment causing erosion and sink holes adjacent to the spillway. The approach to the spillway is reportedly stone-lined pond bottom but the stones were covered with sediment which sloped from the weir back into the pond. The approach was clear at the time of inspection. Discharge from the spillway flows through a stone-lined channel that parallels the toe of the spillway. The channel was clear at the time of inspection with no evidence of sediment in the channel. See observations in Section 2.1.2 regarding the spillway drains.

2.1.4 Downstream Area

The downstream area consists of the Indian Head River which flows through woods for about 750 feet where it crosses under Winter Street. The channel is a stone- and cobble-lined stream with trees, brush and remnants of old stone walls along the banks.

2.1.5 Reservoir Area

The 51.2-acre reservoir is surrounded by woodland except for about a dozen residential homes around the southern end. Factory Pond Dam is located at the southeastern end of the reservoir. The reservoir has a “dogleg” shape and an average width of about 500 feet with the northern 2,800 feet oriented in a north-south direction and the southern 2,100 feet oriented in an east-west direction. Adjacent terrain consists of relatively flat slopes and potential for slides is low.

The February 9, 2007 Weston & Sampson Inspection/Evaluation Report referenced a 1995 DEM report which indicated that fishing is prohibited in the pond due to high levels of mercury found in the fish. We understand that there is concern of possible contamination of the pond sediments due to three upstream hazardous waste sites and a former munitions factory.

2.2 Caretaker Interview

Mr. Victor Diniak, Hanover DPW Director, and Mr. Curt MacLean, Hanover DPW Deputy Director, were interviewed on January 6, 2012. Hanover DPW acknowledged joint responsibility for operation and maintenance of the dam with the Town of Hanson. We discussed the history, construction, operation and maintenance (O&M) and emergency action procedures for the dam.

2.3 Operation and Maintenance Procedures

2.3.1 Operational Procedures

No written records are available for O&M. However, Hanover DPW routinely inspects the dam for erosion and damage during and following large storm events and is planning to develop a written O&M Plan/Manual.

2.3.2 Maintenance of Dam and Operating Facilities

There is no formal maintenance plan for Factory Pond Dam. In 1996 improvements to the dam were completed and are described in Section 1.3.7 of this report.

2.4 Emergency Warning System

There is no written Emergency Action Plan (EAP) for Factory Pond Dam.

2.5 Hydrologic/Hydraulic Data

No hydrologic/hydraulic analysis has been performed.

2.6 Structural and Seepage Stability

2.6.1 Embankment Structural Stability

Based on visual observation, structural stability of Factory Pond Dam is fair. Erosion of the embankment left of the auxiliary spillway (left embankment) is a concern and should be closely monitored. Trees on the left embankment could damage the embankment if uprooted by storm wind.

2.6.2 Structural Stability of Non-Embankment Structures

Cracks in the right concrete wall of the discharge channel are a concern. The extent of the cracks should be investigated and the wall should be monitored for movement.

2.6.3 Seepage Stability

Seepage was observed at a number of locations five to ten feet downstream of the left embankment. The seepage does not appear to be significant but should be monitored. Because of the discharge channel along the toe of the auxiliary spillway, primary spillway and the embankment between the spillways, seepage at these locations could not be determined.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

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

1. The primary spillway concrete walls have significant cracks, spalled concrete and exposed aggregate.
2. Trees, dense brush and roots were observed on the dam crest, the upstream and downstream embankment slopes and along the toe of the embankment left of the auxiliary spillway.
3. Riprap has dislodged from the downstream face of the auxiliary spillway at its right embankment contact.
4. The upstream slope of the left embankment has significant erosion resulting in vertical and undercut areas. The vertical fieldstone masonry wall along the downstream face has collapsed in a couple of locations causing erosion of the downstream slope and sinkholes in the crest.
5. The vertical alignment of the left embankment crest is irregular with depressions caused by erosion and a worn walking path.
6. Seepage was observed approximately five to ten feet downstream of the vertical fieldstone masonry wall (left embankment).

Most of the deficiencies noted above were observed by Weston & Sampson (W&S) during their inspection on February 9, 2007. Item 3 was not reported by W&S but this may be due to ice on the downstream face of the auxiliary spillway during their inspection. W&S reported leakage at several locations through the downstream face of the auxiliary spillway during their inspection, however, water flowing over the spillway during our inspection did not allow for observation of any potential leakage. The erosion on the left embankment appears to be at the same locations as reported by W&S, however, there appeared to be additional erosion and sinkholes during our inspection.

It does not appear that any work has been done to the dam since the 2007 inspection.

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

The following studies and analyses should be performed to ensure compliance with applicable regulations and to ensure stability and proper operation and maintenance of the dam:

1. An Operation and Maintenance Manual (O&M) should be prepared which outlines frequency of inspections and tasks that will need to be completed to ensure the safe operation of the dam. The plan should describe each required task, list recommended materials and formalize operational responses to anticipated conditions (e.g. predicted significant precipitation events).
2. Investigate the extent and severity of the cracks in the concrete at the primary spillway.
3. Investigate the extent and severity of the seepage to determine how best to control it.
4. The owner should consider developing an emergency action plan to facilitate emergency response.

3.3 Recurrent Maintenance Recommendations

The following recommendations should be performed on an annual basis to maintain the dam in satisfactory or good condition:

1. Control tree and brush growth on embankment crest and slopes.
2. Monitor embankment erosion.
3. Monitor concrete condition.
4. Monitor stop-log condition.
5. Monitor seepage.
6. Monitor auxiliary spillway condition.

3.4 Minor Repair Recommendations

The following items are recommended to improve the overall condition of the dam and would not alter the current design of the dam. These recommendations may require design by a professional engineer and construction by a contractor experienced in dam repair. These activities may require filing of permit applications with the local Conservation Commissions and a DCR Chapter 253 Permit:

1. Cut and remove all small trees and brush from embankment.
2. Repair cracks and spalls in concrete.
3. Replace and/or reset riprap stone on downstream face of the auxiliary spillway right contact.
4. Repair downstream vertical fieldstone retaining wall.

5. Fill sinkholes with impervious fill.
6. Replace stop-logs (if necessary).

3.5 Remedial Modifications Recommendations

The following remedial design and construction measures are recommended to bring the dam into compliance with current Dam Safety Regulations. The remedial measures will require securing permits from the local Conservation Commissions and DCR (Chapter 253 Permit). The following remedial measures are recommended:

1. Remove all large trees, brush and root systems from the embankment. Fill all voids with impervious fill material.
2. Reconstruct the upstream slope of the left embankment to provide a consistent, sloped face. Armor the slope with riprap stone.
3. Once vegetation is removed, inspect the upstream slope of the embankment between the spillways to determine if adequate stone armoring exists. Supplement armoring as necessary to protect the face of the embankment.
4. Fill/re-grade the crest to provide a consistent vertical alignment along the embankment. Loam and seed to provide grass cover on the crest and embankment slopes.
5. Once repairs to the left embankment are complete, monitor seepage to determine if further investigation is required.

3.6 Alternatives

Because of the possible contamination of pond sediments, breaching the dam is not considered a viable alternative. No other alternatives have been identified at this time.

3.7 Opinion of Probable Construction Costs

1. Studies and Analyses: \$ 15,000
2. Recurrent Maintenance Recommendations: \$ 3,000 (yearly)
3. Minor Repair Recommendations: \$ 25,000
4. Remedial Modification Recommendations: \$ 90,000

FIGURES

Figure 1 – Locus Plan

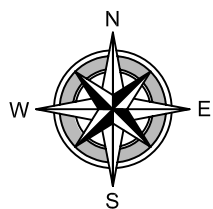
Figure 2 – Aerial Photograph Plan

Figure 3 – Drainage Area Plan

Figure 4 – Dam and Area Downstream Plan

Figure 5 – Site Plan

FIGURE 1



2000' 1000' 0 2000'



SCALE IN FEET
1" = 2000'

LATITUDE: 42° 05' 20", LONGITUDE -70° 52' 01"

NOTE: BASE MAP TAKEN FROM MASS GIS SCANNED USGS
QUADS 5-CD SET - JULY 1996 - CD's 4&5

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Figures.dwg

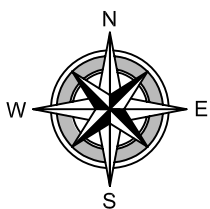
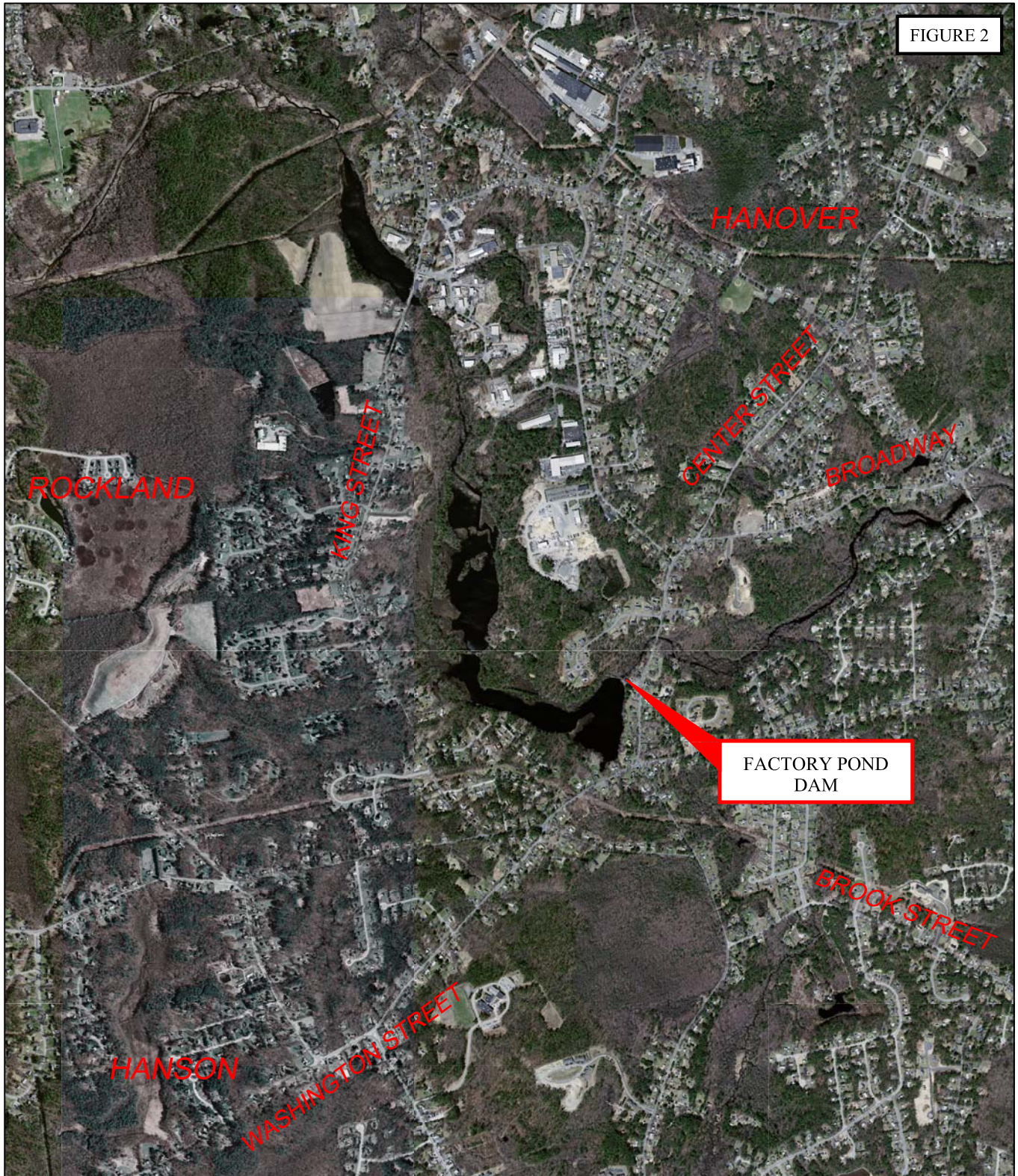
DEPARTMENT OF PUBLIC WORKS
HANOVER, MASSACHUSETTS
FACTORY POND DAM
LOCUS PLAN

NID# MA00391 HANOVER/HANSON, MA

DECEMBER 2011

AMORY ENGINEERS, P.C.
DUXBURY, MASSACHUSETTS

FIGURE 2



2000' 1000' 0 2000'



SCALE IN FEET
1" = 2000'

LATITUDE: 42° 05' 20", LONGITUDE -70° 52' 01"

NOTE: BASE MAP TAKEN FROM MASS GIS SCANNED USGS
QUADS 5-CD SET - JULY 1996 - CD's 4&5

P:\Clients\Hanover\3557 Hanover Factory Pond Dam Inspection\
Figures.dwg

DEPARTMENT OF PUBLIC WORKS
HANOVER, MASSACHUSETTS

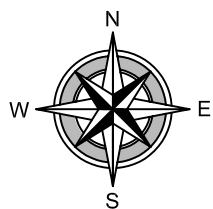
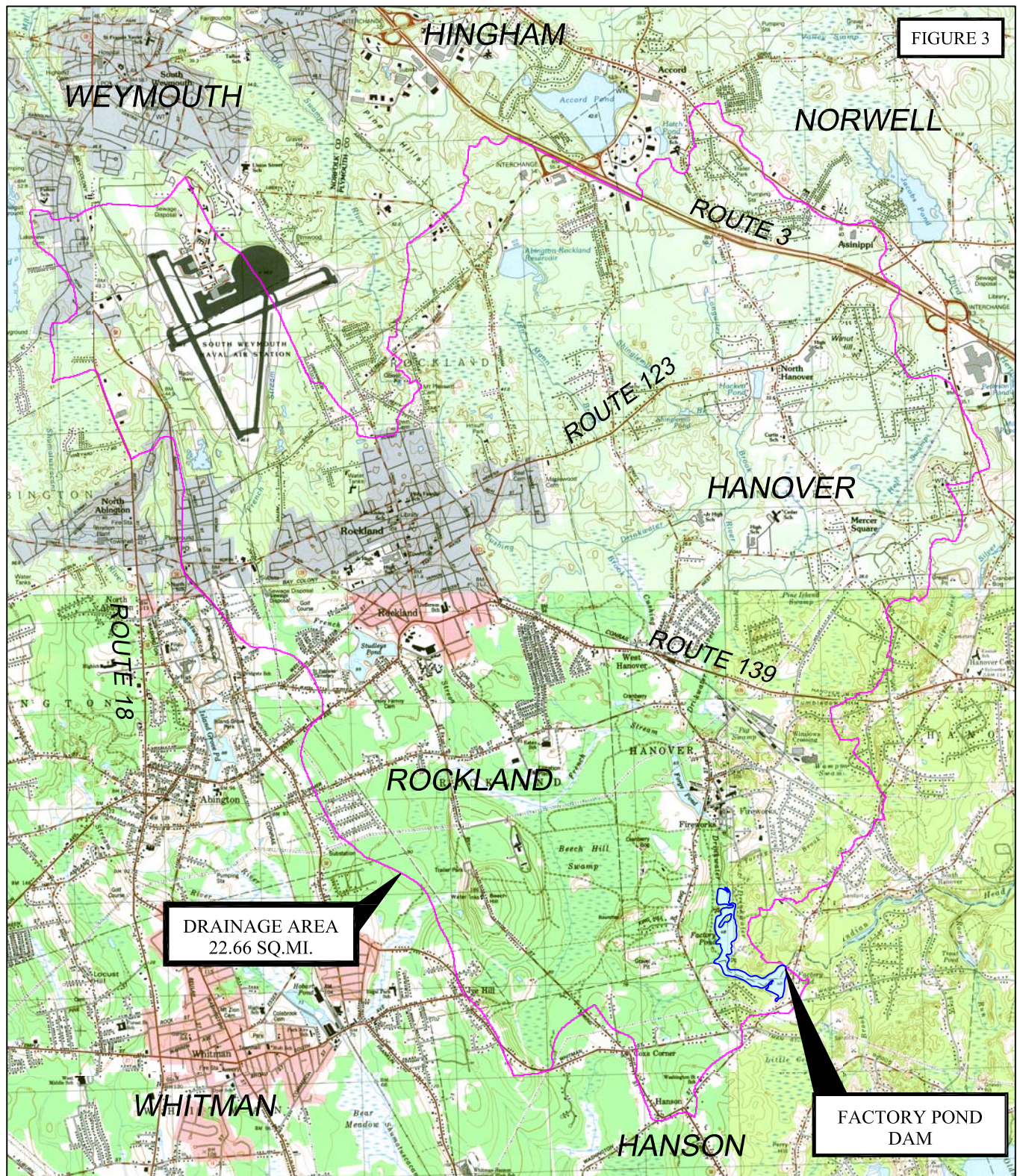
FACTORY POND DAM
AERIAL PHOTOGRAPH PLAN

NID# MA00391 HANOVER/HANSON, MA

DECEMBER 2011

AMORY ENGINEERS, P.C.
DUXBURY, MASSACHUSETTS

FIGURE 3



5000' 2500' 0 5000'



SCALE IN FEET
1" = 5000'

LATITUDE: 42° 05' 20", LONGITUDE -70° 52' 01"

NOTE: BASE MAP TAKEN FROM MASS GIS SCANNED USGS
QUADS 5-CD SET - JULY 1996 - CD's 4&5

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Figures.dwg

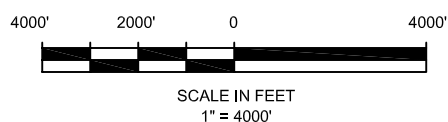
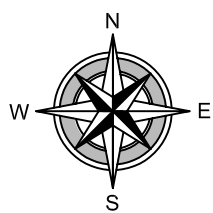
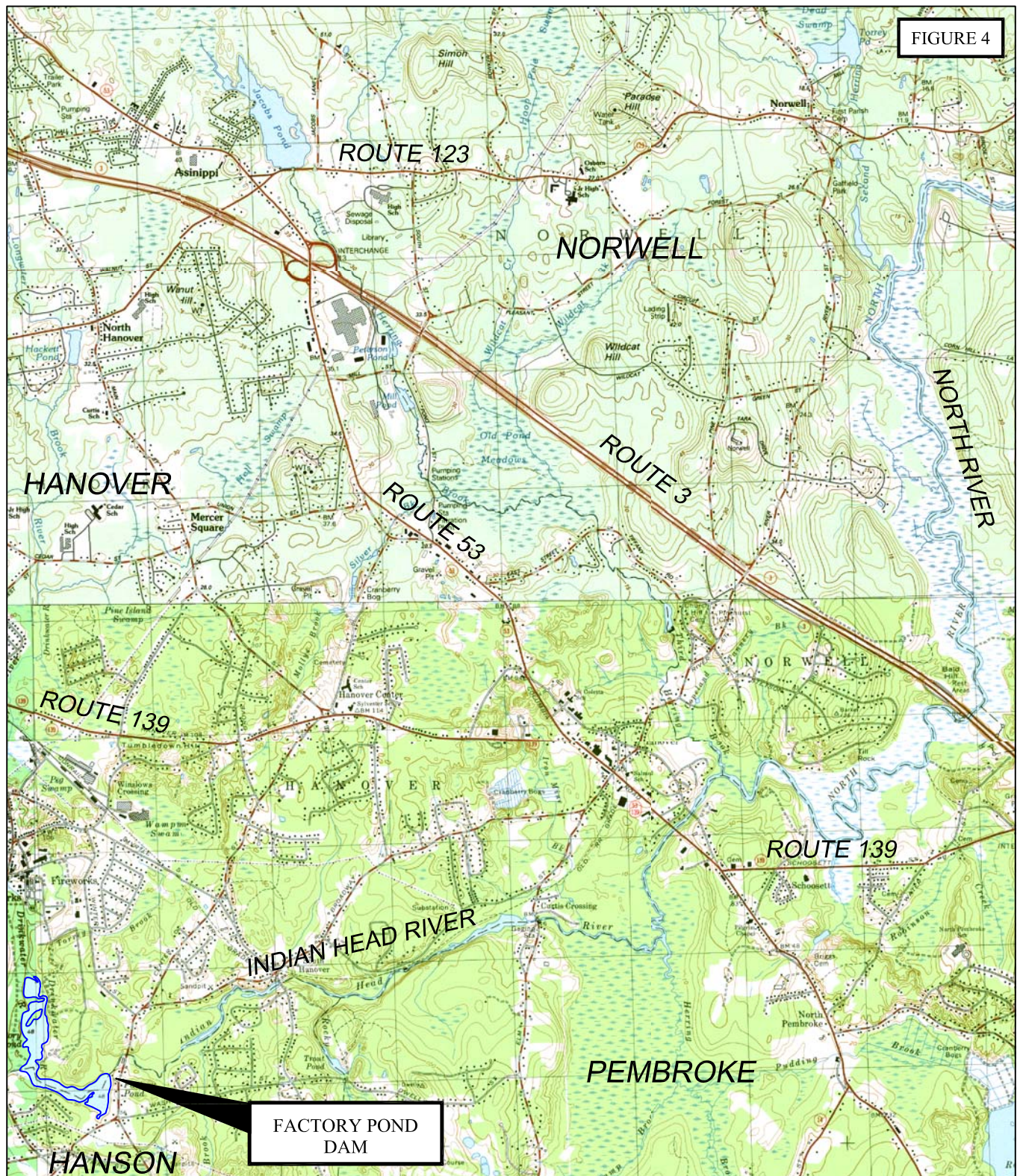
DEPARTMENT OF PUBLIC WORKS
HANOVER, MASSACHUSETTS
FACTORY POND DAM
DRAINAGE AREA PLAN

NID# MA00391 HANOVER/HANSON, MA

DECEMBER 2011

AMORY ENGINEERS, P.C.
DUXBURY, MASSACHUSETTS

FIGURE 4



LATITUDE: 42° 05' 20", LONGITUDE -70° 52' 01"

NOTE: BASE MAP TAKEN FROM MASS GIS SCANNED USGS
QUADS 5-CD SET - JULY 1996 - CD's 4&5

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Figures.dwg

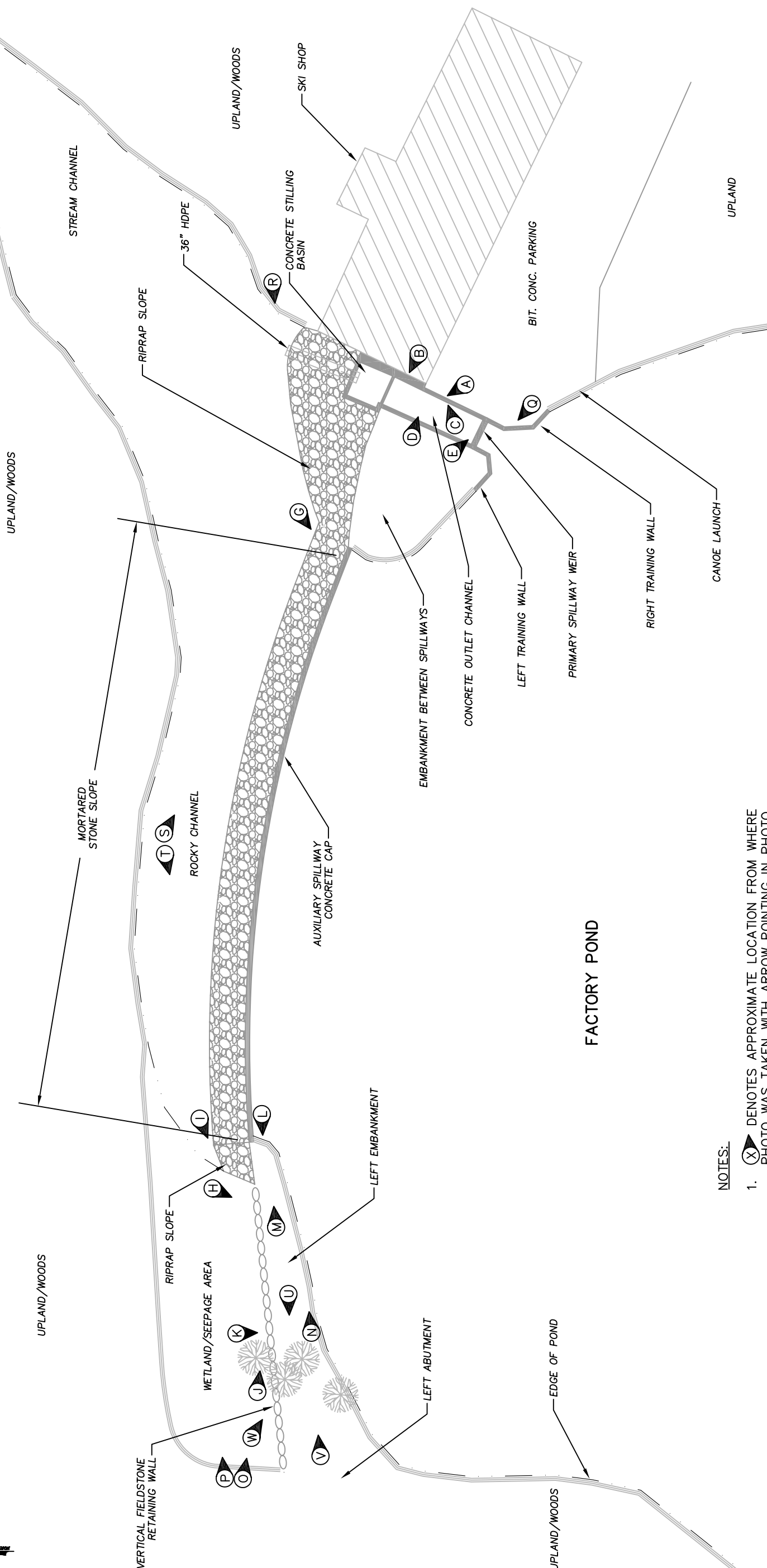
DEPARTMENT OF PUBLIC WORKS
HANOVER, MASSACHUSETTS
FACTORY POND DAM
DAM & AREA DOWNSTREAM PLAN
NID# MA00391 HANOVER/HANSON, MA

DECEMBER 2011

AMORY ENGINEERS, P.C.
DUXBURY, MASSACHUSETTS



FIGURE 5



NOTES:

1. (X) DENOTES APPROXIMATE LOCATION FROM WHERE PHOTO WAS TAKEN WITH ARROW POINTING IN PHOTO DIRECTION. THE LETTER CORRESPONDS TO THE LETTER SUFFIX OF PHOTOS 21X IN THE REPORT.
2. NOT ALL PHOTO LOCATIONS ARE SHOWN.



FACTORY POND DAM
HANOVER/HANSON, MASSACHUSETTS
SITE PLAN

APPENDIX A

Photographs

1. Overview of dam from upstream
2. Overview of dam from downstream
3. Overview of upstream face from right abutment
4. Overview of upstream face from left abutment
5. Overview of dam crest from right abutment
6. Overview of dam crest from left abutment
7. Overview of downstream face from right abutment
8. Overview of downstream face from left abutment
9. Overview of spillway from upstream
10. Overview of spillway from downstream (tailrace or channel area)
11. Overview of right training wall
12. Overview of left training wall
13. Overview of weir
14. Overview of stilling basin
15. Overview of downstream channel
16. N/A
17. N/A
18. N/A
19. Outlet inlets and discharge points
20. Overview of reservoir
21. Areas of specific deficiencies (e.g., cracks, erosion, displacement, seeps, deterioration, etc.)



Photo 1 – Overview of dam from upstream



Photo 2 – Overview of dam from downstream



Photo 3 – Overview of upstream face from right abutment



Photo 4 – Overview of upstream face from left abutment



Photo 5 – Overview of crest face from right abutment



Photo 6 – Overview of crest face from left abutment



Photo 7 – Overview of downstream face from right abutment



Photo 8 – Overview of downstream face from left abutment



Photo 9A – Overview of primary spillway from upstream



Photo 9B – Overview of auxiliary spillway from upstream



Photo 10A – Overview of primary spillway from downstream



Photo 10B – Overview of auxiliary spillway from downstream



Photo 11 – Overview of right training wall



Photo 12 – Overview of left training wall



Photo 13 – Overview of weir



Photo 14 – Overview of stilling basin



Photo 15A – Overview of downstream channel at primary discharge



Photo 15B – Overview of downstream channel at auxiliary discharge



Photo 19A – Primary discharge point



Photo 19B – Primary spillway discharge channel



Photo 20 – Overview of reservoir



Photo 21A – Spalled concrete on left outlet channel wall



Photo 21B – Exposed aggregate/deteriorated concrete on left outlet channel wall



Photo 21C – Cracks in right outlet channel wall



Photo 21D – Cracks in right outlet channel wall



Photo 21E – Crack in wall at right of weir (note spalled concrete on beam)

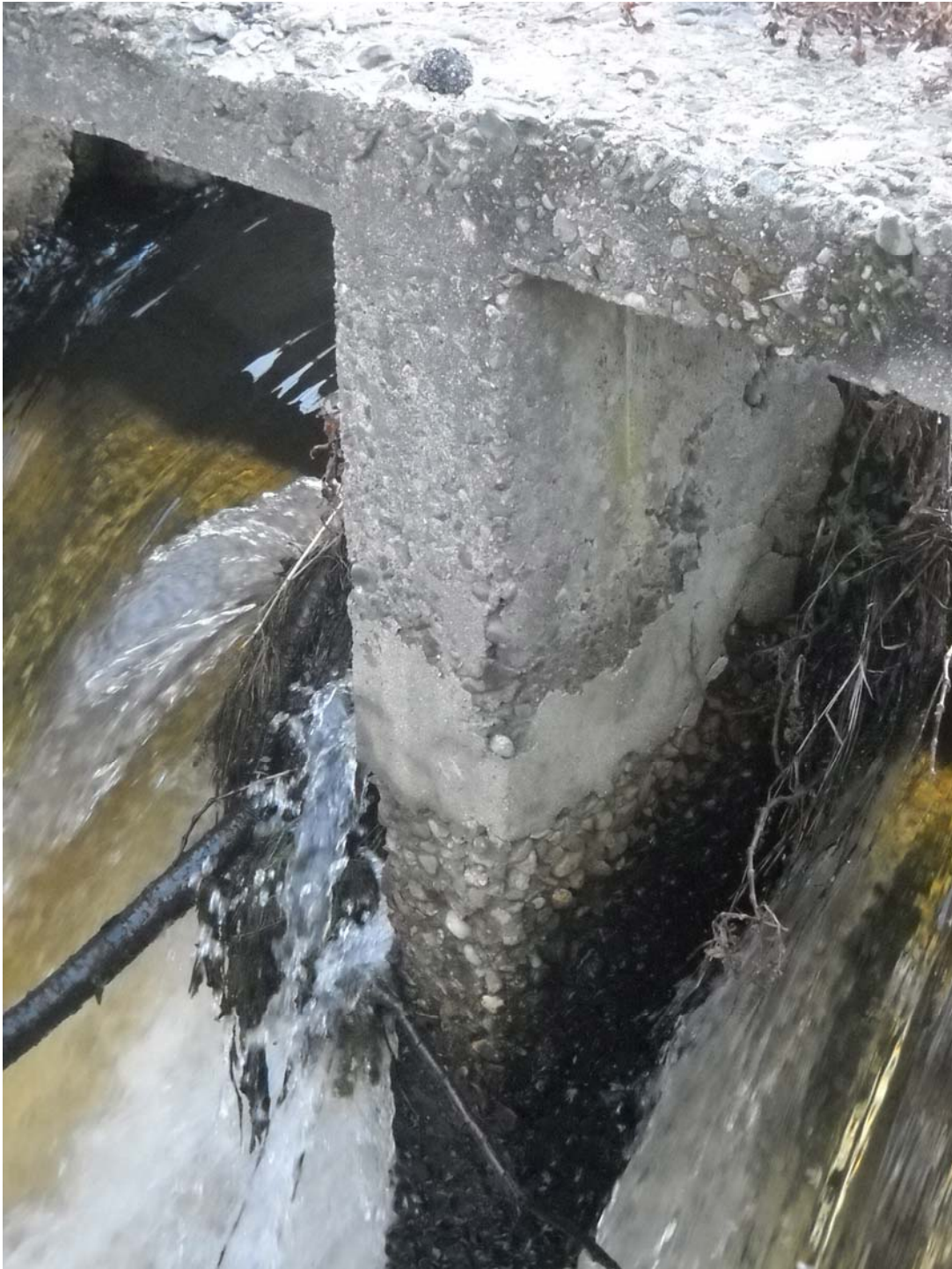


Photo 21F – Exposed aggregate and deteriorated concrete at weir support column



Photo 21G – Area of missing/fallen riprap at right auxiliary spillway contact



Photo 21H – Collapsed vertical wall near auxiliary spillway



Photo 21I – Collapsed vertical wall near auxiliary spillway



Photo 21J – Collapsed vertical wall approximately 50 feet from left abutment



Photo 21K – Collapsed vertical wall approximately 50 feet from left abutment



Photo 21L – Exposed roots, erosion and sinkholes upstream face and crest near left auxiliary spillway contact



Photo 21M – Exposed roots and sinkholes downstream face and crest near left auxiliary spillway contact



Photo 21N – Eroded upstream face left of the auxiliary spillway



Photo 21O – Seepage downstream of left embankment



Photo 21P – Seepage downstream of left embankment



Photo 21Q – Brush on embankment between spillways (from right abutment upstream)



Photo 21R – Brush on embankment between spillways (from right abutment downstream)



Photo 21S – Brush on embankment between spillways



Photo 21T – Brush on left embankment



Photo 21U – Large trees on crest near left abutment



Photo 21V – Trees and brush on left embankment (from left abutment)



Photo 21W – Trees on crest of left embankment and adjacent to downstream vertical fieldstone masonry wall

APPENDIX B

Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>	
REGISTERED: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		NID ID #: <u>MA00391</u>	
STATE SIZE CLASSIFICATION: <u>Intermediate</u>		STATE HAZARD CLASSIFICATION: <u>Significant</u>	
		CHANGE IN HAZARD CLASSIFICATION REQUESTED?: <u>No</u>	
<u>DAM LOCATION INFORMATION</u>			
CITY/TOWN: <u>Hanover</u>		COUNTY: <u>Plymouth</u>	
DAM LOCATION: <u>Winter Street, Hanson</u> (street address if known)		ALTERNATE DAM NAME: <u>N/A</u>	
USGS QUAD.: <u>Hanover</u>		LAT.: <u>42.08892</u>	LONG.: <u>70.86697</u>
DRAINAGE BASIN: <u>South Coastal</u>		RIVER: <u>Drinkwater River (upstream) / Indian Head River (downstream)</u>	
IMPOUNDMENT NAME(S): <u>Factory Pond</u>			
<u>GENERAL DAM INFORMATION</u>			
TYPE OF DAM: <u>Earth and stone masonry</u>		OVERALL LENGTH (FT): <u>310</u>	
PURPOSE OF DAM: <u>Originally power for mill, now recreation/flood control</u>		NORMAL POOL STORAGE (ACRE-FT): <u>200</u>	
YEAR BUILT: <u>Originally 1712, rebuilt 1943, repaired 1996</u>		MAXIMUM POOL STORAGE (ACRE-FT): <u>265</u>	
STRUCTURAL HEIGHT (FT): <u>10.8</u>		EL. NORMAL POOL (FT): <u>48.0</u>	
HYDRAULIC HEIGHT (FT): <u>9</u>		EL. MAXIMUM POOL (FT): <u>49.0</u>	
<u>FOR INTERNAL MADCR USE ONLY</u>			
FOLLOW-UP INSPECTION REQUIRED: <input type="checkbox"/> YES <input type="checkbox"/> NO		CONDITIONAL LETTER: <input type="checkbox"/> YES <input type="checkbox"/> NO	

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>	
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>	
<u>INSPECTION SUMMARY</u>			
DATE OF INSPECTION: <u>December 22, 2011</u>		DATE OF PREVIOUS INSPECTION: <u>February 9, 2007</u>	
TEMPERATURE/WEATHER: _____		ARMY CORPS PHASE I: <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO If YES, date _____	
CONSULTANT: <u>Amory Engineers, P.C.</u>		PREVIOUS DCR PHASE I: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If YES, date <u>9-Feb-07</u>	
BENCHMARK/DATUM: <u>Water surface elevation based on USGS Quadrangle map. NGVD 1929.</u>			
OVERALL PHYSICAL CONDITION OF DAM: <u>POOR</u>		DATE OF LAST REHABILITATION: <u>1996</u>	
SPILLWAY CAPACITY: <u>0-50% of the SDF or Unknown</u>			
EL. POOL DURING INSP.: <u>48</u>		EL. TAILWATER DURING INSP.: <u>39.25</u>	
<u>PERSONS PRESENT AT INSPECTION</u>			
<u>NAME</u>	<u>TITLE/POSITION</u>	<u>REPRESENTING</u>	
Patrick G. Brennan, P.E.	Associate	Amory Engineers, P.C.	
Alex J. Richards	Project Engineer	Amory Engineers, P.C.	
<u>EVALUATION INFORMATION</u>			
<div style="display: flex; justify-content: space-between;"> <div> E1) TYPE OF DESIGN E2) LEVEL OF MAINTENANCE E3) EMERGENCY ACTION PLAN E4) EMBANKMENT SEEPAGE E5) EMBANKMENT CONDITION E6) CONCRETE CONDITION E7) LOW-LEVEL OUTLET CAPACITY </div> <div> Click on box to select E-code <div style="border: 1px solid black; padding: 2px;">1</div> <div style="border: 1px solid black; padding: 2px;">2</div> <div style="border: 1px solid black; padding: 2px;">2</div> <div style="border: 1px solid black; padding: 2px;">3</div> <div style="border: 1px solid black; padding: 2px;">2</div> <div style="border: 1px solid black; padding: 2px;">2</div> <div style="border: 1px solid black; padding: 2px;">2</div> </div> </div>		<div style="display: flex; justify-content: space-between;"> <div> E8) LOW-LEVEL OUTLET CONDITION E9) SPILLWAY DESIGN FLOOD CAPACITY E10) OVERALL PHYSICAL CONDITION E11) ESTIMATED REPAIR COST ROADWAY OVER CREST BRIDGE NEAR DAM </div> <div> Click on box to select E-code <div style="border: 1px solid black; padding: 2px;">1</div> <div style="border: 1px solid black; padding: 2px;">1</div> <div style="border: 1px solid black; padding: 2px;">2</div> <div style="border: 1px solid black; padding: 2px;">\$130,000</div> <div style="border: 1px solid black; padding: 2px;">NO</div> <div style="border: 1px solid black; padding: 2px;">NO</div> </div> </div>	
NAME OF INSPECTING ENGINEER: Patrick G. Brennan, P.E.		SIGNATURE: _____	

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>	
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>	
OWNER:	ORGANIZATION	CARETAKER:	ORGANIZATION
	<u>Towns of Hanover / Hanson</u>		<u>Hanover DPW / Hanson Highway Dept.</u>
	<u>NAME/TITLE</u>		<u>Victor Diniak / Robert Brown</u>
	<u>STREET</u>		<u>40 Pond St. / 795 Indianhead St.</u>
	<u>TOWN, STATE, ZIP</u>		<u>Hanover, MA 02339 / Hanson, MA 02341</u>
	<u>PHONE</u>		<u>781-826-6505 / 781-294-4119</u>
	<u>EMERGENCY PH. #</u>		<u>781-826-3189 / 781-293-2822</u>
	<u>FAX</u>		<u>781-826-5950 / 781-294-0884</u>
	<u>EMAIL</u>		<u>781-826-8915 / n/a</u>
	<u>OWNER TYPE</u>		<u>vdiniak@hanoverdpw.org</u>
	<u>Municipality or Political subdivision</u>		
PRIMARY SPILLWAY TYPE		<u>Wooden weir - stop logs</u>	
SPILLWAY LENGTH (FT)		<u>7.3</u>	
AUXILIARY SPILLWAY TYPE		<u>Broad crested masonry weir</u>	
NUMBER OF OUTLETS		<u>2</u>	
TYPE OF OUTLETS		<u>Concrete flume to culvert & earth channel</u>	
DRAINAGE AREA (SQ MI)		<u>22.66</u>	
HAS DAM BEEN BREACHED OR OVERTOPPED		<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO IF YES, PROVIDE DATE(S) _____	
FISH LADDER (LIST TYPE IF PRESENT)		<u>N/A</u>	
DOES CREST SUPPORT PUBLIC ROAD?		<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO IF YES, ROAD NAME: _____	
PUBLIC BRIDGE WITHIN 50' OF DAM?		<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO IF YES, ROAD/BRIDGE NAME: _____	
		MHD BRIDGE NO. (IF APPLICABLE) _____	

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
EMBANKMENT (CREST)					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Earth, some grass cover, trees and brush			
	2. SURFACE CRACKING	Some observed on section between left abutment and auxiliary spillway		X	X
	3. SINKHOLES, ANIMAL BURROWS	Sinkholes observed on section between left abutment and auxiliary spillway		X	X
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	Some observed on section between left abutment and auxiliary spillway		X	X
	5. HORIZONTAL ALIGNMENT	Irregular on section between left abutment and auxiliary spillway		X	X
	6. RUTS AND/OR PUDDLES	Some observed on section between left abutment and auxiliary spillway		X	X
	7. VEGETATION (PRESENCE/CONDITION)	Small trees and brush between spillways; large trees and brush between left *		X	X
	8. ABUTMENT CONTACT	No deficiencies.			
ADDITIONAL COMMENTS: <u>* abument and auxiliary spillway.</u> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
EMBANKMENT (D/S SLOPE)					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	Yes - area downstream of the emabankment left of the auxiliary spillway.		X	
	2. SEEPAGE	Observed left of the auxiliary spillway.		X	
	3. SLIDE, SLOUGH, SCARP	There are two areas where the there is erosion due to collapse of the vertical *		X	X
	4. EMB.-ABUTMENT CONTACT	No concerns.			
	5. SINKHOLE/ANIMAL BURROWS	See comments under Item 3.		X	X
	6. EROSION	See comments under Item 3.		X	X
	7. UNUSUAL MOVEMENT	See comments under Item 3.		X	X
	8. VEGETATION (PRESENCE/CONDITION)	Small trees and brush on the embankment between the spillways and left of the **		X	X
ADDITIONAL COMMENTS: * fieldstone wall on the downstream face of the embankment left of the auxiliary spillway. ** auxiliary spillway. There are large trees and brush adjacent to the vertical fieldstone wall left of the auxiliary spillway. <hr/> <hr/> <hr/>					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
EMBANKMENT (U/S SLOPE)					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	Yes - much of the embankment left of the auxiliary spillway is eroded to the point *		X	X
	2. SLOPE PROTECTION TYPE AND COND.	None left of the auxiliary spillway. There was some riprap adjacent to the left **		X	X
	3. SINKHOLE/ANIMAL BURROWS	See comments under Item 1.		X	X
	4. EMB.-ABUTMENT CONTACT	Slope protection needed at left abutment.		X	X
	5. EROSION	See comments under Item 1.		X	X
	6. UNUSUAL MOVEMENT	See comments under Item 1.		X	X
	7. VEGETATION (PRESENCE/CONDITION)	Small trees and brush left of the auxiliary spillway, brush between spillways.		X	X
ADDITIONAL COMMENTS: * where it is either vertical or undercut. ** training wall at the primary spillway but the remainder of the upstream embankment slope between the spillways was not accessible due to overgrown brush. <hr/> <hr/> <hr/> <hr/> <hr/>					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
DOWNSTREAM MASONRY WALLS					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S WALLS	1. WALL TYPE	Dry-laid vertical fieldston and mortared, sloped riprap (along auxiliary spillway)			
	2. WALL ALIGNMENT	Two sections of the vertical wall have partially collapsed.		X	X
	3. WALL CONDITION	Sloped riprap along the auxiliary spillway is in good condition. Two sections of the *		X	X
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: 3.5 max: 9 avg:			
	5. SEEPAGE OR LEAKAGE	There is seepage and standing water approximately 5 to 10 feet from the toe of the **		X	
	6. ABUTMENT CONTACT	No concerns.			
	7. EROSION/SINKHOLES BEHIND WALL	Yes, at the locations of wall collapse.		X	X
	8. ANIMAL BURROWS	Possibly at the collapse locations.		X	
	9. UNUSUAL MOVEMENT	Yes, at the locations of wall collapse.		X	X
	10. WET AREAS AT TOE OF WALL	Stone lined stream along toe of auxiliary spillway. See comments under Item 5.		X	
ADDITIONAL COMMENTS: * vertical fieldstone wall have collapsed. The remainder of the vertical wall is in fair condition. ** vertical fieldstone wall. 					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
UPSTREAM MASONRY WALLS					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S WALLS	1. WALL TYPE	Concrete at primary spillway.			
	2. WALL ALIGNMENT	Vertical			
	3. WALL CONDITION	Satisfactory - some minor cracks and surface weathering.		X	
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: 5 max: 7 avg: 6			
	5. ABUTMENT CONTACT	Riprap placed at left end where it appears some of the embankment had previously *		X	
	6. EROSION/SINKHOLES BEHIND WALL	None.			
	7. ANIMAL BURROWS	None.			
	8. UNUSUAL MOVEMENT	None.			
ADDITIONAL COMMENTS: <u>* eroded. Right abutment contact appears to be satisfactory.</u> <div style="border-bottom: 1px solid black; height: 15px; margin-top: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-top: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-top: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-top: 5px;"></div>					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
DOWNSTREAM AREA					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None.			
	2. FOUNDATION SEEPAGE	Standing water / seepage observed approximately 5 to 10 feet from toe of *		X	
	3. SLIDE, SLOUGH, SCARP	Some erosion along the banks of the downstream channel.		X	
	4. WEIRS	None.			
	5. DRAINAGE SYSTEM	2" PVC pipes extend through the downstream slope at the auxiliary spillway.			
	6. INSTRUMENTATION	None.			
	7. VEGETATION	Trees and brush along the channel.			
	8. ACCESSIBILITY	Good.			
9. DOWNSTREAM HAZARD DESCRIPTION	New bridge at Winter Street, residences along the Indian Head River, Indian Head Dam and Curtis Crossing Dam.				
10. DATE OF LAST EAP UPDATE		0			
ADDITIONAL COMMENTS: * embankment left of auxiliary spillway. Flowing water discharged from the auxiliary spillway runs along the toe of the dam from the left end of the auxiliary spillway through a stone-lined channel to the stream at the primary discharge channel.					

NAME OF DAM: Factory Pond DamSTATE ID #: 7-12-123-2INSPECTION DATE: December 22, 2011NID ID #: MA00391**MISCELLANEOUS**

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	Unknown
	2. RESERVOIR SHORELINE	Mostly wooded with some residential development.
	3. RESERVOIR SLOPES	Relatively flat to moderate.
	4. ACCESS ROADS	Winter Street through a ski shop parking lot to the right abutment, Waterford Drive through a *
	5. SECURITY DEVICES	Locked chainlink gate and fence around the primary spillway.
	6. VANDALISM OR TRESPASS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO WHAT: Signs near ski shop.
	7. AVAILABILITY OF PLANS	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE:
	8. AVAILABILITY OF DESIGN CALCS	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE:
	10. AVAILABILITY OF O&M MANUAL	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE:
	11. CARETAKER/OWNER AVAILABLE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: January 6, 2012
	12. CONFINED SPACE ENTRY REQUIRED	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO PURPOSE:

ADDITIONAL COMMENTS: * walking path between residential properties.

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
PRIMARY SPILLWAY					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Weir and concrete flume			
	WEIR TYPE	Wooden weir - stop logs		X	
	SPILLWAY CONDITION	Poor to fair.			
	TRAINING WALLS	Spalled and weathered concrete, exposed aggregate, large cracks and some holes.		X	X
	SPILLWAY CONTROLS AND CONDITION	Wood stop logs. Appeared to be some leakage through the stop logs (difficult to *		X	
	UNUSUAL MOVEMENT	None observed.			
	APPROACH AREA	Open water.			
	DISCHARGE AREA	Concrete flume to concrete stilling basin, through 36" HDPE pipe to natural channel			
	DEBRIS	A couple of small branches hung up on the center support for the weir.		X	
	WATER LEVEL AT TIME OF INSPECTION	El. 48.0. (Top of stop logs at El. 46.95)			
ADDITIONAL COMMENTS: <u>* fully assess due to flowing water).</u> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
AUXILIARY SPILLWAY					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Concrete cap over stone masonry, 175 ft. long			
	WEIR TYPE	Concrete broad crested weir with 15 to 18 in. breadth			
	SPILLWAY CONDITION	Fair to good.			
	TRAINING WALLS	Earthen slope to the left and right of spillway. Left slope is undercut, right slope *		X	X
	SPILLWAY CONTROLS AND CONDITION	Permanent concrete weir - no controls			
	UNUSUAL MOVEMENT	Downstream riprap adjacent to the right embankment is not mortared and not in **		X	
	APPROACH AREA	Open water.			
	DISCHARGE AREA	Riprap lined channel that runs along the toe to the stream at the primary ***			
	DEBRIS	A few branches but no concerns.		X	
	WATER LEVEL AT TIME OF INSPECTION	El. 48.0 (concrete weir is at about El. 47.85)			
ADDITIONAL COMMENTS: * was not accessible. ** line with the remainder of the mortared riprap slope. Note that there was no water runiing over this portion of the spillway so it may not have been mortared with the rest of the slope. *** discharge channel.					

NAME OF DAM: <u>Factory Pond Dam</u>		STATE ID #: <u>7-12-123-2</u>			
INSPECTION DATE: <u>December 22, 2011</u>		NID ID #: <u>MA00391</u>			
OUTLET WORKS					
AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Concrete flume to concrete stilling basin through 36" HDPE pipe.			
	INTAKE STRUCTURE	Wood weir			
	TRASHRACK	None.			
	PRIMARY CLOSURE	None.			
	SECONDARY CLOSURE	None.			
	CONDUIT	36" HDPE pipe between stilling basin and natural stream channel.			
	OUTLET STRUCTURE/HEADWALL				
	EROSION ALONG TOE OF DAM	None.			
	SEEPAGE/LEAKAGE	Under water - unable to assess.			
	DEBRIS/BLOCKAGE	None.			
	UNUSUAL MOVEMENT	None.			
	DOWNSTREAM AREA	Rocky channel through woods about 850 feet to Winter Street bridge.			
	MISCELLANEOUS				
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. DCR Dam Detail Sheet, "Factory Pond Dam," April 21, 2004.
2. Design plans titled, "Spillway Emergency Repairs at Factory Pond Dam," prepared by Weston & Sampson, November 1995.
3. Department of Environmental Management Office of Dam Safety Inspection/Evaluation Report, "Factory Pond Dam," prepared by GZA Geoenvironmental, Inc., April 19, 1995.
4. Department of Environmental Management Office of Dam Safety Inspection/Evaluation Report, "Factory Pond Dam," prepared by Lee Pare & Associates, Inc., July 22, 1987.

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

1. DCR Office of Dam Safety Phase I Inspection/Evaluation Report, "Factory Pond Dam," prepared by Weston & Sampson, February 9, 2007.

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)