-- PASCOAG RESERVOIR UPPER DAM #16--
VISUAL
INSPECTION / EVALUATION REPORT

Main Dam

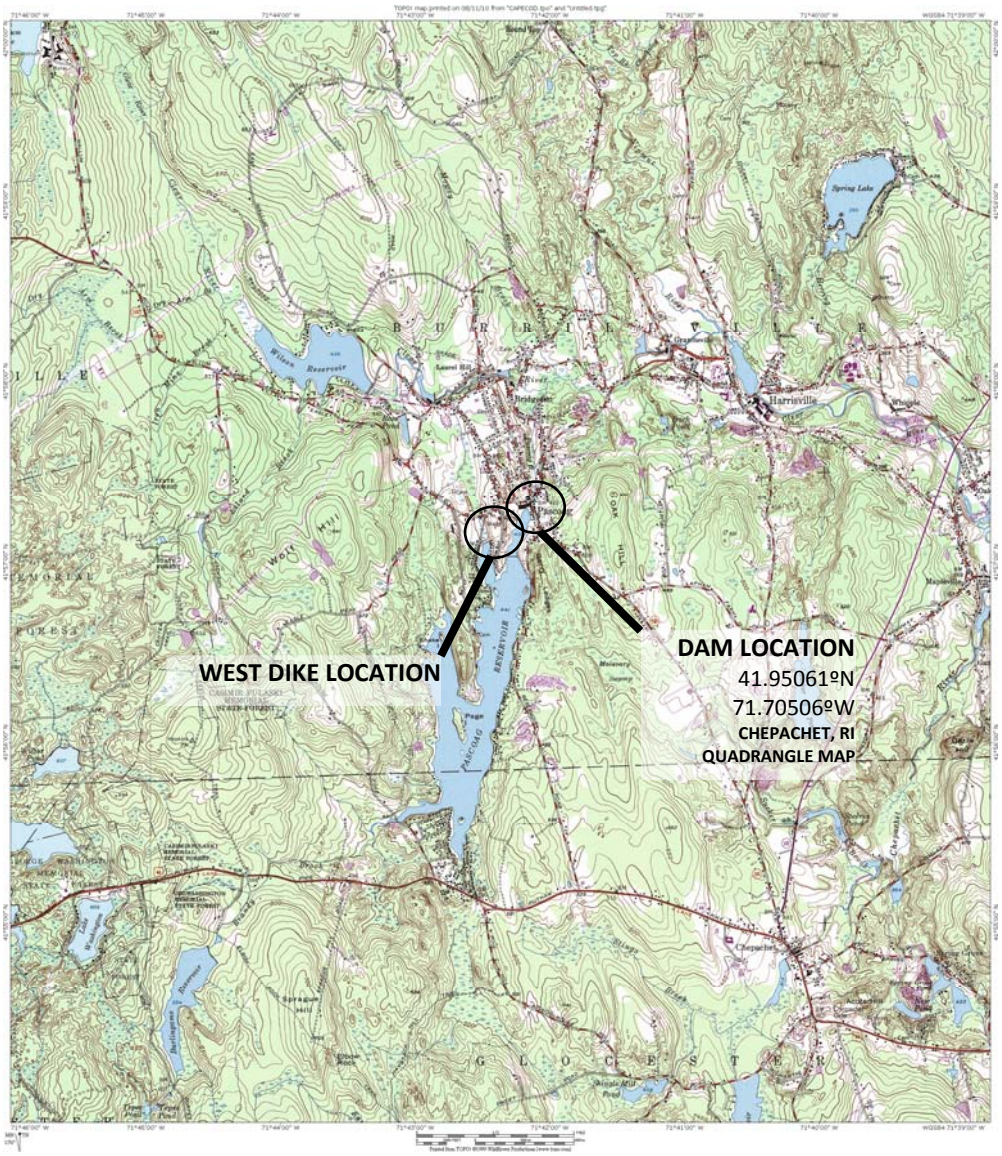
West Dike

Dam Name:	***Pascoag Reservoir Upper Dam***
State Dam ID#:	***16***
Owners:	***Colleen Conley (Main Dam); Leo Plouffe (West Dike)***
Town:	***Burrillville***
Consultant:	***Pare Corporation***
Date of Inspection:	***May 14, 2010***

PARE CORPORATION

INSPECTION SUMMARY

Dam Name (No):	Pascoag Reservoir Upper Dam (#16)
Location:	Burrillville
Hazard Classification:	High
Inspector:	David M. Matheson, P.E., Pare Corporation
Inspection Date:	May 14, 2010



When describing the dam and dike, "left" and "right" refer to the respective sides of the dam or dike as viewed when facing downstream (with normal flow of water).

PREFACE

The assessment of the general condition of the dam and West Dike 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 and West Dike 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 and West Dike 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 and West Dike will continue to represent the condition of the dam and West Dike at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

J.Matthew Bellisle, P.E.
PARE CORPORATION
Senior Vice President

9/27/10

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1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The RIDEM Office of Compliance and Inspection has retained Pare Corporation of Foxboro, Massachusetts and Lincoln, Rhode Island to perform a visual inspection and develop a report of conditions for the dam and West Dike at Pascoag Reservoir Upper along Brandy Brook in Burrillville, Rhode Island. This inspection and report were performed in accordance with current Rhode Island laws.

RIDEM will develop an overall condition rating based upon the data presented herein. It is understood that this rating will consider operational and structural deficiencies and will be presented under a separate cover.

1.1.2 Purpose of Work

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

The investigation was divided into three parts: 1) obtain and review reports, investigations, and data pertaining to the dam and West Dike and appurtenant structures available within the Rhode Island Department of Environmental Management files; 2) perform a visual inspection of the site; and; 3) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions.

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 B. 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) hazard classification; 4) general; and 5) condition rating.

1.2 Description of Project

1.2.1 Location

The Pascoag Reservoir Upper Dam is located at the end of Lake Drive in the Town of Burrillville. The dam is located along the north edge of the pond near coordinates 41.95061°/71.70506° and is privately owned. The West Dike is located approximately 0.17 miles northwest of the dam along the same impoundment.

The dam can be reached from I-295 as follows: At exit 9B on I-295, take ramp right onto Route 146 North / Eddie Dowling Highway. Follow Route 146 for 6.1 miles then take the ramp right towards School Street. At the end of the ramp, take a right onto School Street then take a quick left

onto Route 146A / Great Road. Follow Great Road for 1.5 miles then keep straight onto Route 102 / Victory Highway. Follow Route 102 for 6.2 miles then take a right onto Lapham Farm Road. Follow Lapham Farm Road for 1.8 miles then bear right onto Route 100 / Main Street. Follow Route 100 for 1 mile then keep straight onto High Street. After 0.1 miles, High Street becomes Eagle Peak Road then immediately bear left onto Rock Avenue. Follow Rock Avenue for 0.4 miles and turn left onto Lake Drive. The dam is located at the end of the road. The West Dike is located at the end of Shore Road, which is located off of Rock Avenue about 0.1 miles north of the intersection with Lake Drive.

1.2.2 Owner/Caretaker

The dam and West Dike are respectively owned by Colleen Conley and Leo Plouffe. The Pascoag Upper Dam Association has responsibility for the operations and maintenance of the dam and dike.

1.2.3 Purpose of the Dam and West Dike

The dam currently provides an environmental and recreation resource. As stated in previous reports, the dam was originally constructed to provide a continuous supply of process water and hydropower to downstream mills. Since the closing of the mills, the dam no longer serves this purpose.

1.2.4 Description of the Dam, West Dike, and Appurtenances

The following description of the dam and West Dike is paraphrased from the 1979 USACE Phase I Inspection Report:

> The Pascoag Reservoir Dam is an earth embankment structure approximately 475 feet long, 27 feet in height, with an average crest width of 22 feet. The upstream face is sloped at 1.5H to 1V and is protected by stone armor. The downstream slope is approximately 1.5H to 1V.
>
> The outlet control structure (i.e., Low Level Outlet) is located on the upstream face of the dam adjacent to the overflow spillway. The intake inlet is constructed of cut stone masonry. The control mechanism for the 36-inch diameter outlet pipe is a vertical slide sluice gate and is housed within a timber frame gatehouse atop the inlet structure. Water is withdrawn from the upper reservoir through the 36-inch diameter pipe and is discharged through the submerged outlet on the downstream slope of the dam to Pascoag Lower Reservoir.
>
> The overflow spillway structure (i.e., Primary Spillway) is located at the left abutment of the embankment and is constructed of cut stone masonry. The spillway overflow weir is a broad crested section, 22 feet long. Spillway discharges flow into the lower reservoir. A timber service bridge spans the spillway training walls and provides access to the embankment.
>
> An earth dike (i.e., The West Dike) approximately 240[1] feet long is located in an adjacent cove formed by the reservoir west of the main embankment, a distance of 1,000 feet. The

[1] The USACE report stated the length of the dike was 310 feet. Based on measurements during the current inspection, a length of approximately 240 feet was determined.

upstream and downstream faces are vertical with stone facing. The average crest width is 25 feet.

1.2.5 Operations and Maintenance

Operation and maintenance responsibilities have been assigned to the Pascoag Upper Dam Association. Operation and maintenance activities include clearing of vegetation from the dam embankment, maintaining and operating the low level outlet gate, and partial clearing of the West Dike. Based on discussions with the caretakers, the primary spillway's training walls were recently re-mortared.

1.2.6 Hazard Potential Classification

In accordance with current classification procedures under State of Rhode Island dam safety rules and regulations, Pascoag Reservoir Upper Dam and associated West Dike have been classified as a HIGH hazard potential dam.

2.0 INSPECTION

2.1 Visual Inspection

Pascoag Reservoir Upper Dam was inspected on May 14, 2010. At the time of the inspection, the weather was 60° F and mostly cloudy. Photographs to document the current conditions of the dam and West Dike were taken during the inspection and are included in Appendix A. The level of the impoundment was about 1-inch above the crest of the spillway. Underwater areas were not inspected as part of the field activity.

For reference purposes, a baseline was established along the crest of the dam during the inspection. Station 0+00 was located at the left abutment and extended to station 4+75 on the right abutment. A baseline was established along the West Dike with station D0+00 located at the left abutment and station D2+40 on the right abutment. Observations were made in relation to their location along the baseline as appropriate and as noted herein.

2.1.1 General Findings

In general, the Pascoag Reservoir Upper Dam was found to animal burrows within the dam crest, rotted stumps, eroded and bare areas throughout the embankment, an irregular vertical alignment of the crest, sporadic upstream and downstream slope protection, a large hole on the downstream slope left of the primary spillway, a deteriorated timber footbridge over the primary spillway, and missing and shifted stones within the downstream training walls to the low level outlet.

In general, the West Dike was found have an irregular vertical alignment of the crest, bulging upstream and downstream walls, tree growth over most of the dike, and a collapsed section of downstream wall near the left abutment.

The specific concerns are identified in more detail in the sections below:

2.1.2 Main Dam

Dam Crest

- The horizontal alignment appears okay with no unusual movement observed.
- The vertical alignment is irregular (i.e., wavy and uneven).
- The vegetation consists of several stumps (up to 24” diameter) of various ages of decay, grass and weed growth, and various bare areas. It was apparent that the caretaker kept the vegetation trimmed. Tree growth has been removed since the previous inspection in 2001.
- The crest in the area of the low level outlet is eroded down up to 12 inches, most likely from pedestrian traffic to the upstream waterline and outlet structure.
- No cracking or rutting was observed.
- Some animal burrows were observed near the left abutment and near the low level outlet structure.
- Abutment contact areas at the right abutment appears okay with no unusual movement observed.

- The concrete abutment end walls had some surface spalling. But appear structurally sound. According to the 1979 USACE Phase I Report, these walls were identified as "concrete vehicular barriers".
- The area left of the concrete wall at the left abutment appeared lower than the crest.
- The area right of the concrete end wall appears to follow the shape of the dam for about 50 feet right; therefore, the right abutment of the dam may be located 50 feet right of the concrete barrier. Additional survey work is recommended before this can be confirmed.

Upstream Side

- No sloughs or slides were observed; however, eroded 18-inch wide and 6-inch deep gullies, most likely due to surface runoff, were observed about 20 and 30 feet right of the low level outlet structure, respectively.
- Erosion was noted along the waterline between the low level outlet and primary spillway with approximate IV:IH to near vertical slopes observed.
- No animal burrows were observed.
- Slope protection consisted of sporadic boulders with several bare areas. Erosion protection had more coverage in the area of the low level outlet structure.
- Abutment contacts looked good with no unusual movement observed.
- The vegetation consists of several stumps of various ages of decay, grass and weed growth, and various bare areas.

Downstream Side

- Eroded areas, most likely due to surface runoff, were observed along the upper slope approximately 30 feet right of the low level outlet and about 20 feet left of the primary spillway.
- A large hole about 8 feet long, 3 feet wide and 3 to 4 feet deep was observed left of the primary spillway near the base of the slope. The caretaker said this was reported as a former animal burrow in previous inspections.
- The vegetation consists of several stumps of various ages of decay, grass and weed growth, and various bare areas. Some stumps were almost completely rotted with holes forming within the embankment along the toe of the dam.
- It appears that the water level at the pond downstream had once been higher based on the flatness observed at the toe of the downstream slope that is above water. The caretaker stated that this had been like this for some time.
- Sporadic riprap areas were observed at the base of the downstream slope for protection against wave action from the adjacent downstream waterbody.
- No animal burrows were observed.
- Abutment contacts appeared okay with no unusual movement observed.
- The lower quarter of the slope was damp and wet in some areas with no staining or seepage areas observed.

2.1.3 Appurtenant Structures

Primary Spillway

- As observed, the caretaker reported that the granite block training walls have been re-pointed since the previous inspection in 2001. The re-pointing appears okay with no cracks or missing mortar.
- Approximately 0.5-inches of water was flowing over the crest.
- The training walls' vertical and horizontal alignment appears okay.
- The approach and discharge areas were clear.
- The caretaker informed the inspector that the crest of the spillway was lowered by one block height during previous work. The removed blocks remain in the downstream area of the channel.
- The timber deck of the footbridge had one broken board and several aged boards in place but was still able to support foot traffic.
- No leakage was observed.

Low Level Outlet

- The approach and discharge areas were underwater and could not be viewed.
- The caretaker stated that the gate was opened 2-inches.
- The caretaker opened the gate another inch to demonstrate its operability. The opening mechanism appeared to operate smoothly.
- The low level outlet concrete structure appeared in satisfactory condition with no major cracking, settlement, or movement observed.
- The downstream headwall was observed with missing chinking stones, missing mortar and tree stumps protruding out some joints with shifted stones.
- No leakage was observed.

2.1.4 West Dike

Dike Crest

- The vertical alignment appears okay with no unusual movement observed.
- The horizontal alignment is irregular.
- The vegetation consists of several small (6-inch) to medium (12-inch) trees with grass and weed growth, and various bare areas.
- No animal burrows were observed.
- Soil sloughing was noted about 15 feet right of the left abutment on the downstream side due to a failed downstream wall section.
- No depressions or rutting was observed.
- The area left of the dike was about three feet lower than the dam.
- The right abutment contact appears okay.

Upstream Side

- The upstream walls have a poor vertical and horizontal alignment with bulging observed, apparent sunken tops of walls, and an irregular vertical alignment; however, no holes were observed behind the walls or soil discharge in front of the wall
- Some stones were missing within the joints.
- Small to medium trees were observed growing in front of the wall.
- Abutment contacts looked good with no unusual movement observed.

Downstream Side

- The downstream walls have a poor vertical and horizontal alignment with bulging observed, apparent sunken tops of walls, and an irregular vertical alignment.
- Some stones were missing within the joints.
- Small to medium trees were observed growing along the toe of the wall.
- A failed section of wall was observed about 30 feet right of the left abutment. Soil has sloughed at this location at about a 1.5H:1V slope.
- Wet areas were observed along the wall.
- Abutment contacts looked good with no unusual movement observed.

2.1.5 Downstream Area

The area downstream of the dam consists of Pascoag Reservoir Lower (immediately downstream), two (2) residential structures on the right bank of the lower reservoir (100 and 370 feet downstream), and commercial, residential structures, and roadways within the center of Pascoag[2] (starting at approximately 1,500 feet downstream).

2.1.1 Reservoir Area

According to existing plans, the bottom of the pond near the low level outlet is approximately 12 feet deep; however, this was not confirmed during the inspection. The perimeter of the impoundment is generally lined with residential houses and roadways.

2.2 Caretaker Interview

Kevin Menard, President of the Pascoag Upper Dam Association (PUDA), and Leo Plouffe, member of the PUDA and owner of the West Dike met the undersigned at the dam during the inspection. Information provided by Mr. Menard and Mr. Plouffe was incorporated into this report.

2.3 Operation and Maintenance Procedures

There is no formal operations and maintenance manual for the dam.

[2] Pascoag is a village located within the Town of Burrillville.

2.3.1 Operational Procedures

The PUDA reportedly keeps a log of the low level gate operations and exercises the gate during storm flows to control impoundment levels. The log is kept on a clipboard within the control structure.

2.3.2 Maintenance of Dam and Operating Facilities

Maintenance on the dam includes vegetation removal, grass cutting, periodic masonry work, and maintaining the low level outlet controls. Maintenance on the west dike is limited to partial tree removal and cutting of grass on the crest.

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

CONDITION SUMMARY

Embankment	Sporadic upstream and downstream slope protection, rotted stumps, surface erosion, animal burrows, and irregular vertical alignment of the crest.
Primary Spillway	Deteriorated timber footbridge and a hole behind the left downstream training wall (see embankment above).
Low Level Outlet	Shifted downstream training walls.
West Dike	Overgrown, bulging upstream and downstream walls, irregular vertical alignment of the crest, and a collapsed section of downstream wall near the left abutment.

In general, the Pascoag Reservoir Upper Dam was found to have the following deficiencies:

1. Animal burrows within the dam crest
2. Rotted stumps, eroded and bear areas throughout the embankment
3. An irregular vertical alignment of the crest
4. Sporadic upstream and downstream slope protection
5. A large hole on the downstream slope left of the primary spillway
6. A deteriorated timber footbridge over the primary spillway
7. Missing and shifted stones within the downstream training walls to the low level outlet.

In general, the West Dike is **Poor** was found to have the following deficiencies:

1. Tree growth over most of the dike
2. An irregular vertical alignment of the crest
3. Bulging upstream and downstream walls
4. A collapsed section of downstream wall near the left abutment.

The most recent inspection available for review at the time of this report was completed in June 2001, at which time the dam embankment, primary spillway, and low level outlet were respectively found to be in fair, fair, and good condition while the West Dike was found to be in poor to fair condition. In general, the dam and dike appear to have similar deficiencies that may have progressed overtime; however, trees and heavy vegetation have been removed since the time of the previous inspection.

Previously Identified Deficiency	***Resolution or Current Condition***
Main Dam: Heavy brush growth over the upstream and downstream dam slopes with scattered brush growth along the crest.	The brush has been cut since the previous inspection.

Main Dam: Some surface erosion was noted along the upstream slope, including notable area to the left of the gatehouse and about 40 feet right of the gatehouse.	No Change
Main Dam: Horizontal alignment of the upstream and downstream dam slopes, including the crest is somewhat irregular.	No Change
Main Dam: Some surface erosion was present along the dam crest, including a worn pedestrian path.	No Change
Main Dam: The joints within the training walls are missing mortar with displaced stones along the bottom of the walls near the waterline.	The joints have been re-pointed since the previous inspection.
Main Dam: Brush was growing in the downstream headwall to the low level outlet.	The brush has been cut since the previous inspection.
Main Dam: Recommendation to continue to assure proper operation of the dam's low level outlet gate.	Gate is reportedly routinely operated.
Main Dam: The vegetation on the embankment should be removed rather than cut.	Root systems still remain.
West Dike: Displaced stones were observed displaced throughout the walls, including at least one area were the earthen dike was also displaced.	No Change
West Dike: Brush and trees (up to about 8" in diameter) were present along the dike.	Some trees have been removed (with stumps remaining) near the right upstream side and some brush has been cut.
West Dike: Horizontal alignment of the upstream and downstream walls and the crest is somewhat irregular.	No Change
West Dike: Erosion was present throughout the dike.	Bare and thin grassed areas were noted along the crest due to pedestrian traffic
West Dike: There was ponded water near the toe of the dike, presumably due to seepage, extending to a wet area farther downstream.	No Change; however, it is unclear whether or not this is seepage.
West Dike: The resulting low areas along with areas of erosion should be filled and compacted.	Low areas still exist but erosion (above the waterline) was not notable.

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 RIDEM or other regulatory agencies.

3.2 Recommendations

The following present additional studies, routine and recurrent operations and maintenance activities, and repairs recommended to address deficiencies noted during the inspection and the completion of this report. The minor repairs presented below should be implemented to maintain the integrity of the structure. If deferred these maintenance items could develop into larger deficiencies that are more costly to address.

Main Dam

1. Trap and remove burrowing animals from the embankment of the dam. Properly fill any burrows with compacted fill material.

2. Stumps with diameters in excess of 6-inches need to be cut, the root systems grubbed from the embankment, and the resulting holes promptly filled with suitable compacted material. Depending upon the type of stumps to be removed, the procedure for removing the root system may vary. Some trees have taproots while other have a shallow network of roots that cover a large area. ***Impacts to the embankment should be evaluated by an engineer prior to grubbing roots from the dam. Given the location of the stumps on the embankment and the conditions prevalent at the time of the work, instability, seepage or piping conditions could develop if not undertaken in a controlled manner.***

3. Properly fill in depressions and regrade the upstream and downstream slopes with compacted engineered fill.

4. Properly fill and regrade the dam crest to a level section with compacted engineered fill.

5. Subsequent to clearing, tree and stump removal, and regrade the upstream and downstream slope, provide slope protection along the upstream and downstream sides of the dam to protect the embankment from erosion due to wave action from both the impoundment and the downstream reservoir. Slope protection would likely consist of stone riprap with properly designed bedding stone and geotextile fabric.

6. Perform a structural evaluation of the left training wall to the primary spillway involving the cause of the formation of the large hole behind the downstream side of this wall. As a minimum, the hole should be backfilled with a compacted structural fill with any necessary mitigation measures to help prevent this hole from forming, based on the findings of the evaluation.

7. Complete stability analyses to evaluate the current condition of the upstream and downstream slopes. In order to complete these analyses, completion of subsurface investigations will likely be required to assess the current conditions of the embankment soils. Based on the results of the analyses, rehabilitation recommendations could include flattening the upstream and downstream slopes in order to provide a stable section.

8. Regrade the embankment of the dam to uniform, stable sections. Establish a maintainable grass cover along the sloped portions of the upstream slope, the crest, and the downstream slope. If properly maintained, grass is not only an effective means of controlling erosion, it also enhances the appearance of a dam and provides a surface that can be easily inspected. Grass roots and stems tend to trap fine sand and soil particles, forming an erosion resistant layer once the plants are well established. Grass is least effective in areas of concentrated runoff or in areas subjected to wave action or pedestrian traffic. In these areas, a more durable protection such as stone may be more desirable.

9. Perform an evaluation of the wet areas along the downstream side to determine the source of these wet areas. Based on the results of this evaluation, install a toe drain designed to control embankment seepage and/or install a steel sheet pile or grout-injected cutoff wall along the crest.

10. Repair the deteriorated deck to the footbridge over the primary spillway.

11. Repair the downstream headwall and training walls of the low level outlet, including resetting stones, chinking wall joints, and repointing.

12. Clear the vegetation from the island developing within the downstream channel to increase the current outflow capacity of the primary spillway.

West Dike

1. Remove the trees and other woody vegetation from along the upstream slope, crest, and downstream wall. Significant root systems should also be pulled and the resulting holes properly filled and grassed. Trees and stumps with diameters in excess of 6-inches need to be cut, the root systems grubbed from the embankment, and the resulting holes promptly filled with suitable compacted material. Depending upon the type of trees to be removed, the procedure for removing the root system may vary. Some trees have taproots while other have a shallow network of roots that cover a large area. ***Impacts to the embankment should be evaluated by an engineer prior to grubbing roots from the dam. Given the location of the stumps on the embankment and the conditions prevalent at the time of the work, instability, seepage or piping conditions could develop if not undertaken in a controlled manner.***

2. Properly fill and regrade the dam crest to a level section with compacted engineered fill.

3. Complete stability analyses to evaluate the current condition of and the movement occurring at the upstream and downstream walls, including the failed section of downstream wall near the left abutment. In order to complete these analyses, completion of a subsurface investigation consisting of soil borings will likely be required to assess the current conditions of the embankment soils and pressures applied to the stone masonry walls. Based on the results of the analyses, rehabilitate the walls in order to provide a stable section. This could include partially or fully rebuilding the walls or installing a buttress against the backside of the existing wall sections.

4. Perform an evaluation of the wet areas along the downstream side to determine the source of these wet areas. If necessary, based on the results of this evaluation, install a toe drain designed to control embankment seepage and/or install a steel sheet pile or grout-injected cutoff wall along the embankment.

5. Survey/evaluate the low area at the left abutment.

General

1. Complete detailed hydrologic and hydraulic (H&H) analyses to evaluate the capacity of the structures to accommodate various storm events that would be typical for the watershed. The analysis should account for the routed inflow that utilizes the full storage capacity within the impoundment and drainage area. A structure that cannot discharge the inflow associated with normal storm events will be overtopped in an uncontrolled manner that could damage the structure and threaten downstream areas.

2. Regular maintenance activities should be implemented to control and prevent growth of unwanted vegetation, including brush and trees from the embankment, abutments, and spillway areas.

3. A formalized Operations and Maintenance Manual should be developed for this structure. This manual should include procedures for maintaining the level of the impoundment, including adjusting the level of the impoundment in anticipation of rain events to provide additional free board during the wetter months. Additionally, the manual should include periodic inspection schedules and operational and maintenance procedures required to ensure satisfactory operation and minimize deterioration of the facility. The manual should also provide record keeping procedures for ongoing inspection and monitoring, including the periodic inspection of the culvert at the low level outlet, monitoring of the hole forming behind the left downstream training wall to the primary spillway, the bulging upstream and downstream walls to the West Dike, and other areas of potential movement and deterioration.

   The manual should include schedule for regular maintenance activities to be continued to control and prevent growth of unwanted vegetation, including brush and trees from the embankment, abutments, and spillway areas. Mowing/clearing should be performed at least twice per year. Mowing at longer intervals will likely require that the clippings be bagged and disposed of offsite, or fully mulched to limit the build-up of thatch and the potential for choking of the grass.

4. Implement a program of regular inspection and monitoring of the dam and West Dike. As the dam is currently classified as a high hazard potential, the completion of a formal visual inspection by a RI registered professional engineer familiar with dam engineering is required every 2 years.

3.3 Alternatives

The following alternatives are presented based upon a conceptual review of the concerns. Additional studies and or considerations may indicate that some or all of the options presented below are not suitable for the conditions specific to this dam and dam site. In addition to the general activities, appropriate environmental permits will be required to complete many of the alternatives presented below.

Dam Removal/Breaching: Alternative to implementing any of the repairs noted above, breaching of the dam is a viable alternative for addressing safety and stability concerns at the dam. While this alternative will address the safety concerns at the dam, it will result in the loss of the recreational and environmental resource and reduce flood control capacity provided by the dam and impoundment. Additionally, while removal will result in elimination of yearly operating and maintenance expenses, permitting activities and construction costs associated with dam removal may exceed those of rehabilitation and operations and maintenance.

In evaluating the potential for dam removal several preliminary studies should be completed including:

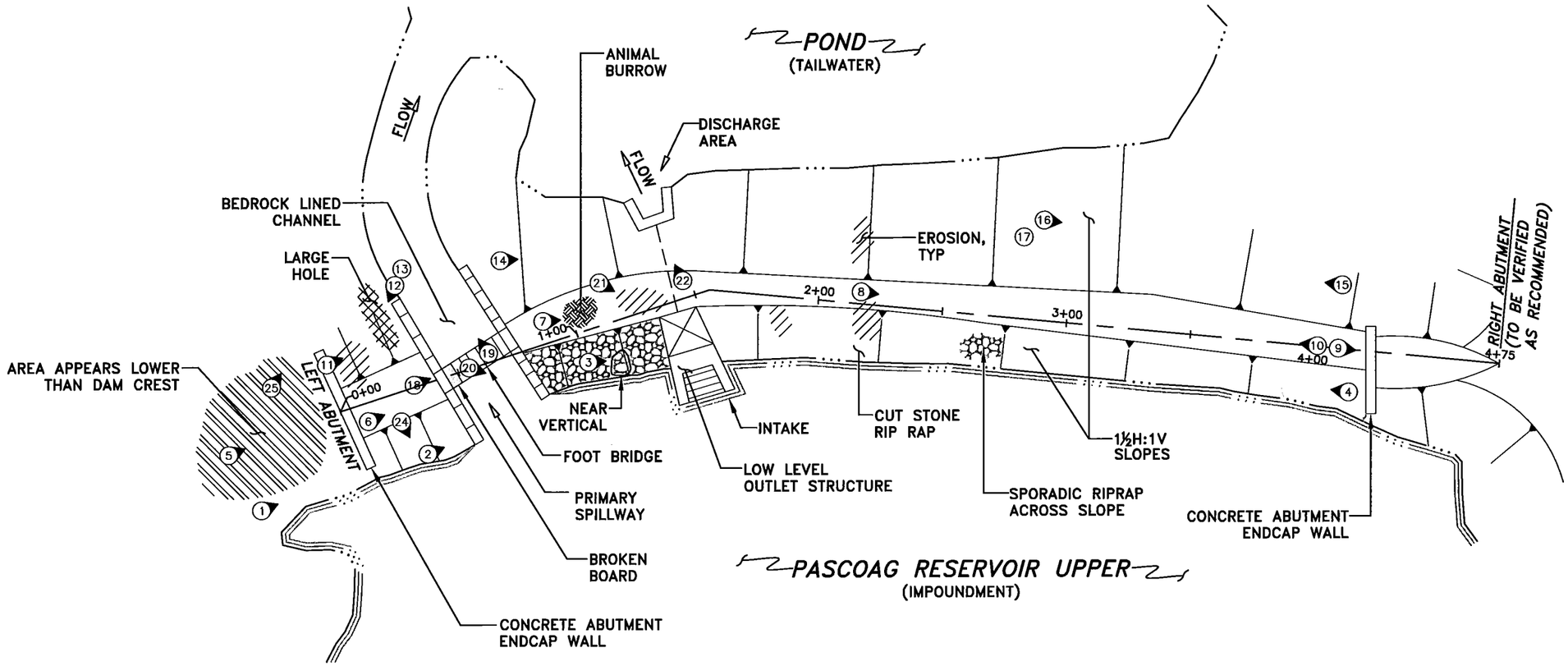
- Hydrologic/Hydraulic Analysis similar to those described above should be completed to assess any changes that may occur during routine storm events.
- A review of the historic significance that the structure may have with the community, if any. This review should include discussions with the local and state historic commissions.

- A review of rare or endangered species, which may be present in the area and dependent upon the resources created by the dam.
- An analysis of the volume, character and disposition of the sediment behind the dam. This is required to understand the amount of material to be removed or stabilize the potential for contamination within the sediment, which would require special handling, and potential scouring which would result in the migration of sediment through the downstream reaches.

Once these preliminary studies and reviews have been completed the permit requirements should be reviewed.

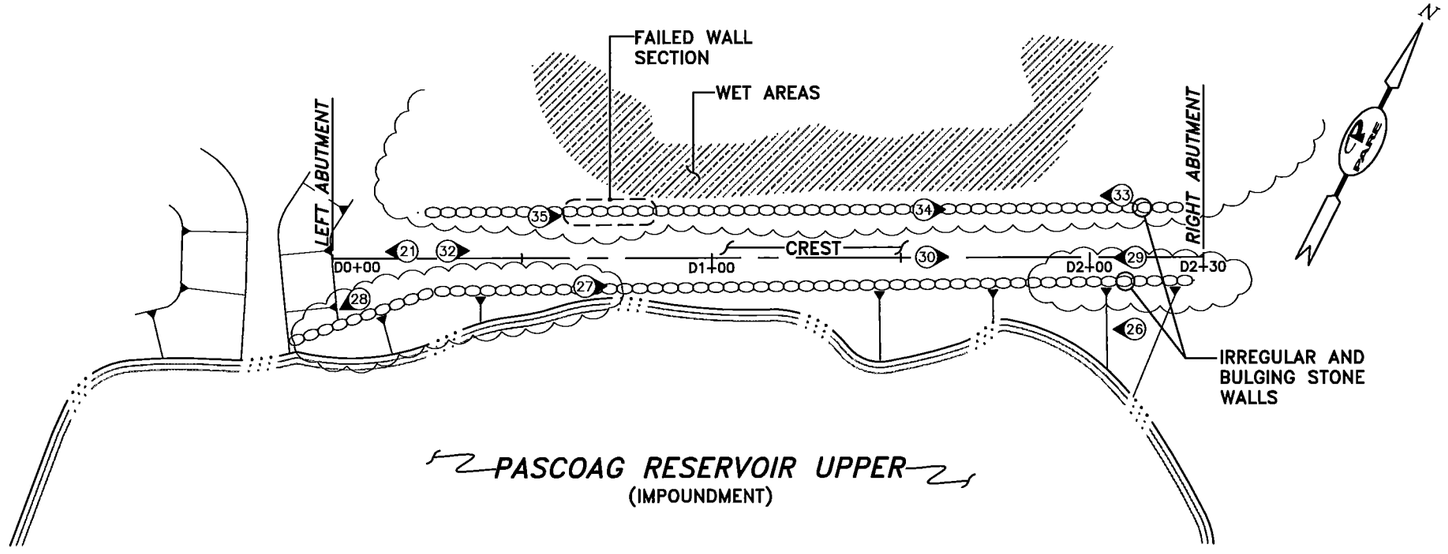
Lower the Dam and Dike: Complete modifications to the dam to reduce the dam and dike height, thereby reducing the maximum height and volume of water that may be impounded by both the dam and dike. Evaluate the impact of the lowered dam upon the hazard potential. While this alternative may result in reducing the hazard potential, recommendations listed above remain valid and should be implemented in accordance to general dam safety practice. Additionally, permitting activities and construction costs associated with reducing the dam and dike heights may exceed those of repair.

FIGURES



SITE SKETCH

SCALE: 1"=50'±



WEST DIKE SKETCH

SCALE: 1"=40'±

NOTES AND LEGEND

1. PLAN DEVELOPED FROM NOTES TAKEN DURING THE INSPECTION AND AVAILABLE AERIAL IMAGERY FROM RIGIS. INFORMATION IS PROVIDED FOR REFERENCE PURPOSES ONLY.

(#) DENOTES APPROXIMATE LOCATION AND DIRECTION OF PHOTOGRAPH.

1+00 BASELINE AND STATIONING

PARE
PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 103
FOXBORO, MA 02035
508-543-1755

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

PASCOAG RESERVOIR UPPER DAM

RI DAM # 16

BURRILLVILLE, RHODE ISLAND

MAIN DAM OWNER: COLLEEN CONLEY
WEST DIKE OWNER: LEO PLOUFFE

DOWNSTREAM
LEFT RIGHT
UPSTREAM

REVISIONS:

PROJECT NO.:	09107.01 / 004
DATE:	September 2010
SCALE:	AS NOTED
DESIGNED BY:	DMM
CHECKED BY:	ARO
DRAWN BY:	JHG
APPROVED BY:	JMB

SITE SKETCH

FIGURE NO.: 1

APPENDIX A
Photographs

Photo No. 1: Overview of upstream slope from the left abutment.

Photo No. 2: Overview of the upstream slope in the area of the primary spillway looking right.

Photo No. 3: Erosion of the upstream slope left of the low level outlet.

Photo No. 4: Overview of upstream slope from the right abutment.

Photo No. 5: Overview of crest from the left abutment.

Photo No. 6: Overview of crest in area of the primary spillway looking right. Note eroded area possibly due to foot traffic.

Photo No. 7: Overview of crest from the primary spillway looking right.

Photo No. 8: Overview of crest from the alignment of the low level outlet looking right.

Photo No. 9: The right abutment looking right.

Photo No. 10: Overview of crest from the right abutment.

Photo No. 11: Overview of downstream slope from the left abutment.

Photo No. 12: Overview of the left downstream training wall to the primary spillway. Note location of large hole (8' L x 3' W x 4' D) observed behind wall.

Photo No. 13: Closer view of the large hole observed behind the left downstream training wall to the primary spillway. Note a root mat obstructs the true size of this hole.

Photo No. 14: Overview of downstream slope from the primary spillway looking right.

Photo No. 15: Overview of downstream slope from the right abutment.

Photo No. 16: Downstream slope as viewed from Station 2+50 looking right.

Photo No. 17: Typical rotted stump along based of downstream slope (Photo taken near Station 2+50).

Photo No. 18: Footbridge over the primary spillway looking right. Note broken board.

Photo No. 19: Downstream channel to primary spillway. The granite blocks in the channel were removed from the spillway crest as part of previous work.

Photo No. 20: Overview of the right upstream training wall to the primary spillway. Note newly mortared joints.

Photo No. 21: The control structure to the low level outlet.

Photo No. 22: The discharge end of the low level outlet as viewed from the crest looking downstream.

Photo No. 23: Left downstream training wall to low level outlet. Note gaps and movement in wall.

Photo No. 24: Overview of impoundment as viewed from the primary spillway.

Photo No. 25: Overview of the downstream area as viewed from the primary spillway.

Photo No. 26: Overview of upstream side of the west dike as viewed from the dike's right abutment.

Photo No. 27: Overview of upstream side of the west dike as viewed from Station 0+60 looking right.

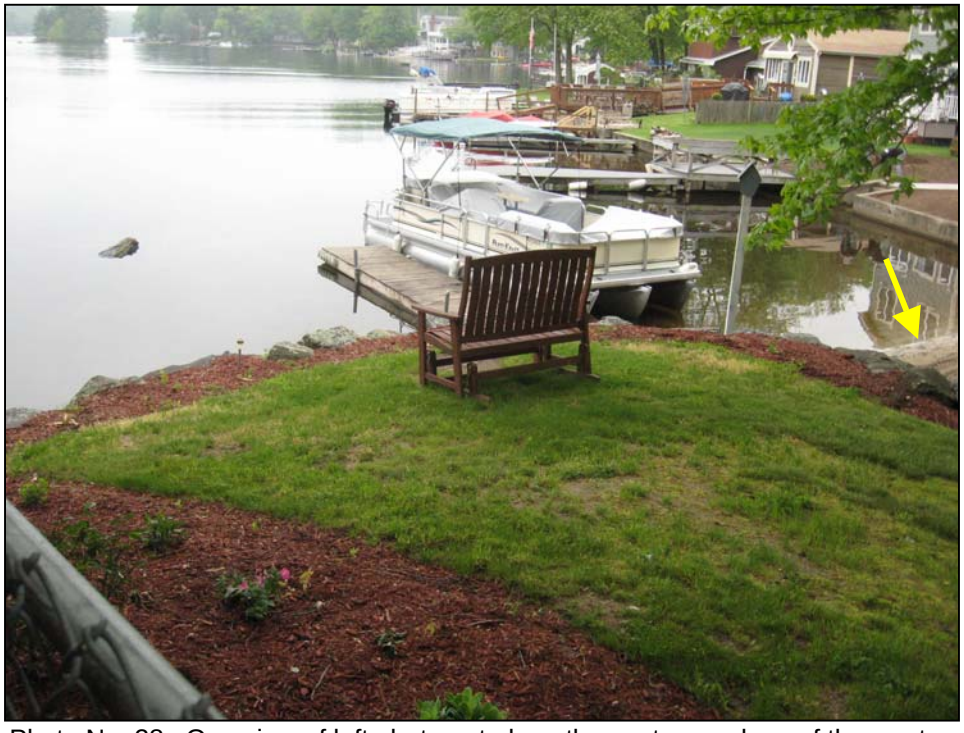


Photo No. 28: Overview of left abutment along the upstream slope of the west dike. Note lower area.

Photo No. 29: Overview of crest of the west dike as viewed from the dike's right abutment.

Photo No. 30: Overview of crest of the west dike as viewed from about halfway across the dike looking right.

Photo No. 31: Overview of left abutment along the crest of the west dike. Note lower area.

Photo No. 32: Overview of crest of the west dike as viewed from the dike's left abutment.

Photo No. 33: Overview of downstream side of the west dike as viewed from the dike's right abutment.

Photo No. 34: Overview of downstream wall of the west dike as viewed from about halfway across the dike looking right.

Photo No. 35: Section of failed downstream wall of the west dike as viewed from Station 0+40 looking right.

APPENDIX B
Definitions

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to State of Rhode Island Rules and Regulations for Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA.

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 – means any barrier made by humans, including appurtenant works, that impounds or diverts water.
Embankment – means the fill material, including but not limited to rock or earth, placed to provide 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 – means any ancillary feature of a dam including such structures as dikes, training walls, spillways, either in the dam or separate there from, low level outlet works, and water conduits such as tunnels, channels, pipelines or penstocks, either through the dam or its abutments.
Spillway – means a structure, a low area in natural grade or any part of the dam which has been designed or relied upon to allow normal flow or major flood flow to pass over or through while being discharged from a reservoir.

Hazard Classification

High Hazard – means a dam where failure or misoperation will result in probable loss of human life.
Significant Hazard – means a dam where failure or misoperation results in no probable loss of human life but can cause major economic loss, disruption of lifeline facilities or impact other concerns detrimental to the public's health, safety or welfare. Examples of major economic loss include but are not limited to washout of a state or federal highway, washout of two or more municipal roads, loss of vehicular access to residences, (e.g. a dead end road whereby emergency personnel could no longer access residences beyond the washout area) or damage to a few structures.
Low Hazard – means a dam where failure or misoperation results in no probable loss of human life and low economic losses.

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– means the vertical distance from the elevation of the uppermost surface of a dam to the lowest point of natural ground, including any stream channel, along the downstream toe 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 – Means the condition of a regulated dam, as determined by the Director, is such that an unreasonable risk of failure exists that will result in a probable loss of human life or major economic loss. Among the conditions that would result in this determination are: excessive vegetation that does not allow the Director to perform a complete visual inspection of a dam, excessive seepage or piping, significant erosion problems, inadequate spillway capacity, inadequate capacity and/or condition of control structure(s) or serious structural deficiencies, including movement of the structure or major cracking.*
Poor – A component that has deteriorated beyond a maintenance issue and requires repair.; the component no longer functions as it was originally intended.
Fair – Means a component that requires maintenance
Good – Meeting minimum guidelines where no irregularities are observed and the component appears to be maintained properly.

* 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)

APPENDIX C
References and Resources

REFERENCES AND RESOURCES

The following were referenced during the completion of the visual inspection and preparation of this report and the development of the recommendations presented herein:

1. "Plan of Dam at Pascoag Reservoir". Pascoag, RI. Works Progress Administration. RI Department of Public Works. 1939.

2. "Pascoag Reservoir (16)" Plan No. B-16. RI Department of Public Works. Division of Harbors and Rivers. 1940.

3. "Pascoag Reservoir. Dam No. 16 Special Inspection Report", RI Department of Public Works. Division of Harbors and Rivers. September 18, 1946.

4. "Pascoag Res./Upper, Dam No. 16. Dam Inspection Report". Department of Natural Resources. April 21, 1978.

5. "Pascoag Res. Upper Dam, Dam No. 16, Dam Inspection Report", RI Department of Natural Resources. May 7, 1984.

6. "Plan of Work. Flood Plain Study for Pascoag Reservoir Upper and Lower Dams, Burrillville, RI", U.S. Department of Agriculture Soil Conservation Service. August 1984.

7. "Pascoag Upper. Dam No. 16, Visual Inspection Checklist", RI Department of Environmental Management. May 10, 1985.

8. "Pascoag Res. Upper Dam, Dam No. 16, Dam Inspection Report", RI Department of Environmental Management. December 13, 1985.

9. "Pascoag Res. Upper Dam, Dam No. 16, Dam Inspection Report", RI Department of Environmental Management. May 6, 1987.

10. "Pascoag Res. Upper Dam, Dam No. 16, Dam Inspection Report", RI Department of Environmental Management. April 7, 1989.

11. "Pascoag Res. Upper Dam, Dam No. 16, Dam Inspection Report", RI Department of Environmental Management. April 21, 1993.

12. "Pascoag Res. Upper Dam, Dam No. 16, Dam Inspection Report", RI Department of Environmental Management. February 12, 1996.

13. "Pascoag Res. Upper Dam, Dam No. 16, Site Inspection Report", RI Department of Environmental Management. August 15, 1997.

14. "Pascoag Upper Reservoir Dam, Dam No. 16, Dam Inspection Report", RI Department of Environmental Management. February 24, 1998.

15. "Design of Small Dams", United States Department of the Interior Bureau of Reclamation, 1987

16. "ER 110-2-106 - Recommended Guidelines for Safety Inspection of Dams", Department of the Army, September 26, 1979.

17. "Guidelines for Reporting the Performance of Dams" National Performance of Dams Program, August 1994.

The following provides an abbreviated list of resources for dam owners to locate additional information pertaining to dam safety, regulations, maintenance, operations, and other information relevant to the ownership responsibilities associated with their dam.

1. RIDEM Office of Compliance and Inspection Website: http://www.dem.ri.gov/programs/benviron/compinsp/

2. "Dam Owner's Guide To Plant Impact On Earthen Dams" *FEMA L-263,September 2005*

3. "Technical Manual for Dam Owners: Impacts of Plants on Earthen Dams" *FEMA 534, September 2005*

4. "Dam Safety: An Owners Guidance Manual" *FEMA 145,December 1986*

5. Association of Dam Safety Officials – Website: www.asdso.org/

6. Dam Ownership – Responsibility and Liability", ASDSO