

Limited Dam Safety Inspection Report

Pascoag Reservoir Upper Dam

Pascoag, Rhode Island

Town of Burrillville, RI

Job No. 1018649 Nov 16,2006

Prepared by Jacques Whitford, Lincoln, RI

1.0 INTRODUCTION

Jacques Whitford Company Inc. (Jacques Whitford) has completed a limited dam safety inspection and this report for the subject dam per request of Mr. Richard Bernardo of the Town of Burrillville (Client) in October 2006. This scope of service was completed in accordance with our proposal, dated October 13, 2006, and our subsequent conversations with the Client. The recommendations contained in this report are subject to the limitations in Section 6.

The report presents our findings of the site observations and provides recommendations for the improvement of dam safety for the Pascoag Reservoir Upper Dam located in Pascoag, Rhode Island (see Figure 1). This report was prepared by Ronald Daignault, with the assistance of Gary R. McAllister, P.E., both of Jacques Whitford Company.

The purpose for the Limited Dam Safety Inspection is to provide the Town of Burrillville with a baseline document regarding the current general condition of the Pascoag Reservoir Upper Dam. Jacques Whitford researched existing documentation for the Pascoag Reservoir Upper Dam including readily available plans, reports, and maintenance records on file with the State of Rhode Island and the Pascoag Reservoir Dam Association. Copies of these documents are appended to this report. In addition, historical aerial photos were reviewed and included in Appendix A. Sanborn Fire Insurance Maps were not available for the area of the Pascoag Reservoir Upper Dam.

Features of the dam and appurtenant structures, including the upstream and downstream slopes above the water line, the crest, left and right abutments, spillway, and outlet works, were visually observed to identify current dam safety deficiencies. cursory field measurements and photos were taken to support documentation of our observations. Due to dense brush and seasonal ground cover, visual observations were somewhat limited in certain locations.

This Limited Dam Safety Inspection Report presents our observations and findings, and presents an opinion regarding the need for repairs, and whether or not further investigations and/or analysis is warranted.

2.0 SITE DESCRIPTION

Our understanding of existing conditions is based on review of information obtained from the Town of Burrillville, Rhode Island Department of Environmental Management (RIDEM) and the Pascoag Reservoir Dam Association (Mr. Leo Plouffe). In addition, Jacques Whitford performed a site visit on October 25, 2006 to visually observe the general condition of the dam features. Plans and surveys reviewed by Jacques Whitford are included in Appendix C.

The State of Rhode Island identifies the subject dam as the Pascoag Reservoir Upper Dam, located approximately 2,000 feet from Pascoag, RI and at the northern end of Brandy Brook. The water impounded by this dam is located partially in the Town of Burrillville and partially in the Town of Glocester and is known as Pascoag Reservoir in Burrillville and as Echo Lake in Glocester. The dam is bordered to the north by Union Pond, to the south by Pascoag

Reservoir, to the east by a residential property and Rock Avenue, and to the west by residential property.

The State of Rhode Island identification number for the Pascoag Reservoir Upper Dam is 016 and the National identification number is RI00304. The Town of Burrillville Tax Assessor's office lists the current owner of the dam as Colleen Conley of East Providence, Rhode Island, as of September 20, 2005. According to RIDEM records and the Phase I Inspection Report by the Department of the Army New England Division, Corps of Engineers (USCOE), dated April 1979, the dam is an earth embankment, gravity dam used for recreation. The Pascoag Reservoir Dam Association indicated that attempts have been made to utilize the dam for limited flood control. The total dam length is approximately 475 feet in length, with a spillway length of 22 feet. The dam is 27 feet in height, with a crest width averaging 21 feet. The impoundment is recorded as 500 acres, with a storage of 5,000 acre-feet, at normal pool. The drainage area is noted as 8.42 square miles. At maximum pool, discharge is 1,020 cubic feet per second (cfs) over the spillway and 180 cfs through the Gated Outlet. The 2005 Annual Report to the Governor, on the Activities of the Dam Safety Program gave the Pascoag Reservoir Upper Dam a hazard rating of HIGH.

The outlet works and water level of the reservoir are currently controlled by the Pascoag Reservoir Dam Association. The sluice gate is generally operated and maintained by Mr. Leo Plouffe. A log is kept within the gate house to record water levels and gate operation.

It is important to note that the USCOE study assumes a spillway at El. 441 (NGVD 29) and embankment crest of El. 449. Some earlier records indicate the spillway crest is El. 445 and top of dam is El. 452±. This difference is believed to be attributed to a differing vertical datum and the loss of the top course of stone at the spillway crest.

3.0 HISTORICAL RESEARCH AND DATA REVIEW

In addition to the files obtained from RIDEM and Town of Burrillville offices, historic aerial photos (Appendix A) of the area were obtained from the RI Department of Administration, Division of Statewide Planning. Copies of previous reports from RIDEM and the Pascoag Reservoir Dam Association can be found in Appendix B.

Constructed in 1860 for the Pascoag Woolen Company under the direction of Gushing & DeWitt, Civil Engineer, the dam was used to provide water and hydro power to downstream mills. The dam changed ownership in 1928 and was acquired by the Uxbridge Woolen Company.

Although no records were available of the original design of the dam, annual reports of the Commission of Dams and Reservoirs (CDR), obtained from RIDEM, indicate that the dam is an earth embankment dam constructed on "hardpan" and lined with chestnut plank sheetpiling for the entire length.

The annual reports of the CDR from 1883 to 1934 were reviewed for the Pascoag Reservoir Dam. Initial reports indicate that the Pascoag Reservoir Upper Dam was in good condition. In 1890, the CDR report stressed that "the water from these combined sources flows through a populous community, where life and property would be endangered by their sudden escape. Positive security of both structures is matter of paramount importance". •

Many of the annual CDR inspections during this time indicated that the dam was in poor or unsatisfactory condition. The CDR reports indicate a history of crest and embankment erosion, heavy vegetative growth on the embankment, settlement, seepage, and insufficient spillway capacity. Recommendations during this time included repair of the embankment, removal of trees and brush, and lowering of the water level within the reservoir. In 1934, a new schedule for the water level of the reservoir was instituted that allowed the reservoir to be held at a maximum of 3.0 feet below the spillway during the summer months.

In 1939, an application was filed on behalf of the Uxbridge Woolen Company to repair the masonry inlet and outlet structures. A suggestion to widen the spillway to 40 feet was made at that time.

A large gap in information, from 1947 to 1978, indicates that either dam inspections or maintenance were not performed during this time or that records were not kept at RIDEM. In the following years, inspection of the dam was conducted by The RI Department of Public Works,

Division of Harbors and Rivers and the RI Department of Natural Resources (RIDNR). The United States Army Corps of Engineers (USAGE) performed a Phase I Inspection as part of the National Dam Inspection Program in April 1979. The findings of the report were based on a historical review of past performance and visual inspection of the dam and its appurtenances. The USAGE indicated several items of concern including apparent seepage through the embankment, overgrowth of vegetation, areas of settlement and bulging, erosion, and inadequate spillway capacity. The USAGE recommended installation of embankment armor, erosion repair, removal of overgrown vegetation, a limited subsurface investigation, topographic survey, regular maintenance program, development of an emergency action plan, seepage monitoring, and lowering of the reservoir. Subsequent letters to the Pascoag Reservoir Association in 1981 and 1982 indicated that action had not yet been taken on the recommendations of the USAGE report.

In 1983, the Pascoag Reservoir Association replaced the trash rack, cleared trees and brush, and repaired rip-rap on the upstream slope. A subsequent inspection in 1984 indicated that some large trees still existed on the slopes and brush from the tree removal was still on the slopes. Erosion was noted on both slopes and seepage was evident at the downstream toe of the embankment.

A revised Plan of Work for the Flood Plain Management Study was submitted in September 1987, finalized in December 1987 and completed in March 1989.

Subsequent inspections indicate continued varying water levels in the reservoir and continuing recommendations to remove trees and brush, repair the embankment, clearing the spillway and address seepage and erosion problems.

4.0 FIELD OBSERVATIONS

Mr. Gary R. McAllister, P.E. and Mr. Ronald A. Daignault, E.I.T., of Jacques Whitford completed the visual field observation of the dam on October 25, 2006. The observations included the earth embankment, spillway, raceway, and outlet works. Photographs and limited measurements of the site were taken. Mr. Leo Plouffe, Pascoag Reservoir Dam Association, provided historical insight regarding maintenance of the dam, and provided access into the gate structure.

4.1 Outlet Works Structure

The outlet works is housed in a fenced concrete block structure located on the upstream face of the dam and approximately 70± feet east of the spillway. The inlet structure appears to be cast-in-place concrete. Trash racks were observed below a plank deck constructed of 2 x 6-inch boards. There appeared to be minor trash accumulation on the trash racks at the time of the inspection and as deep as could be observed from the surface. The gate chamber beyond the trash racks was not visible.

Water from the upper reservoir, south of the dam, is directed through a 36-inch diameter outlet pipe and discharged through a submerged outlet into Union Pond on the downstream slope (north side) of the dam. Flow through the outlet pipe is controlled by a hand operated, gear driven vertical slide sluice gate operated from within the gate house. A large cast iron wheel connected to the gear assembly facilitates movement of the sluice gate. A wooden lever has been fabricated and attached to the wheel to assist in raising and lowering the sluice gate. On October 24, 2006, Mr. Leo Plouffe operated the sluice gate in the presence of Mr. Ron Daignault. The screw of the sluice gate was raised a total of 2.75± inches and slight flow was observed from the submerged 36-inch outlet pipe.

The fence, entry door to the gate house, and the door to the upstream platform of the gatehouse were all locked and the gatehouse appears to be well maintained. A gage for recording the water level within the reservoir is painted on the western side of the concrete inlet structure. A handwritten log is kept within the gatehouse to record water levels and maintenance of the gatehouse and sluice gate, although posted operating instructions were not observed.

4.2 Spillway

The overflow spillway structure is located on the west abutment and approximately 70± feet west of the outlet works structure. The reservoir level at the time of the observation was 9'-3" according to the water level gage and the sluice gate was open approximately 2.75± inches. Upon arrival at the dam location, an aluminum flat bottomed boat was stuck across the opening of the spillway. After removal of the boat, flow over the spillway at the time of the observation was approximately 1± inches. The spillway crest elevation appears to have been approximately 2± feet higher at one time. Two courses of stone block were missing from the top of the spillway and appeared to be below the spillway on the downstream side, apparently removed at some earlier date or pushed over by natural causes such as ice action.

The cut stone masonry spillway appeared in generally good alignment. The spillway crest consisted of cut stone masonry with the east and west sides of the spillway crest being approximately 2± feet higher, and extending for approximately 3-feet from the training walls. The east and west training walls consisted of wet laid cut stone block walls that stepped up from the natural bed of the upstream side of the dam and downstream side of the spillway. The blocks have experienced significant loss of mortar. A steel truss footbridge with metal railings and wood plank decking spans the spillway between the east and west training walls.

The impoundment bottom upstream of the spillway and between the training walls consisted predominantly of granular soil for an approximate depth of 1.5 to 2 feet. The water depth was uniform and ranged between 6± inches closest to the spillway crest to 2± feet deep at the extent of the upstream training walls at the time of the observation. Bedrock outcrop was observed at the bottom of the reservoir beyond the training walls on the upstream side of the dam.

The spillway empties into a raceway with no observed stilling basin. The raceway was of uniform spillway width within 20± feet of the base of the spillway and narrows somewhat, winding west then east, eventually emptying into Union Pond below the dam. The basin bottom consists of bedrock and the topography sloped to the north from the spillway to Union Pond. Hydraulic obstructions included loose cut stone blocks, rocks and vegetation within the raceway. Scouring was noted at the base of the eastern side of the raceway just below the spillway. Dense vegetation was established within both the east and west sides of the raceway with some mature trees located on the west side of the raceway.

4.4 Earth Dam Embankment

According to current records at RIDEM and the latest Phase I Inspection Report conducted by the USAGE in 1979, no design records are available. However, earlier reports indicate the dam is an earth embankment, founded on "hardpan", and lined with chestnut plank sheetpiling for the entire length. The dam is approximately 475± feet in length, including a spillway length of approximately 22± feet. The dam is 27± feet in height with a crest width averaging 22± feet. Historically, the dam was utilized to provide water for the Pascoag Woolen Mill, and subsequently the Uxbridge Worsted Company, but is currently used for recreation. Both the east and west abutments of the embankment appear to extend to adjacent properties. According to drawings in the Town of Burrillville Tax Assessor's office, access to the west abutment is via a right-of-way off Rock Avenue. It does not appear that access exists for the east abutment, making maintenance of the embankment difficult. The Town of Burrillville should investigate the extents of the property and insure that all repairs and/or maintenance extend the full length of the dam embankment to the end of the abutment, including that of the abutting property, if necessary. Access to the east abutment should be investigated and obtained, if possible.

4.4.1 Upstream Face

The south upstream face of the embankment is overgrown with dense brush and small trees, thereby restricting observation. The face of the embankment appears to consist of granular material with loosely laid stone block rip-rap armor that has become dislodged or sloughed due to erosion of the underlying material. The majority of the embankment is at an approximate 1.5H:1V slope. The face of the eastern end of the abutment was altered by the abutting landowner and includes a retaining wall, gravel and paver patio and wooden deck. The western end of the abutment is mostly grass covered but contains a couple of mature trees and the slope is approximately 2H:1V. Animal burrows were observed within the rip-rap. Embankment erosion channels were observed at various locations along the upstream face. The outlet structure is located on the upstream face of the dam and erosion channels were , observed along the sides of the concrete training walls. Erosion was noted along both spillway training walls. Scarps or tension cracks were not observed.

4.4.2 Downstream Face

Union Pond is location downstream of the dam and is impounded by the Union Pond Dam. Therefore, the toe of the downstream slope is below the waters of Union Pond and not visible. The north downstream embankment face is overgrown with dense brush and small trees, thereby restricting observation. Bare areas, exposing the granular material on the face of the

embankment, were visible between the brush and small trees. Several large animal burrows were observed at approximately mid-height of the embankment. Erosion of the slope was visible, resulting in an erosion scarp of approximately 2± feet in height from the waterline at the base of the embankment at the time of the inspection. Seepage was observed along the entire length of the embankment at the level of the erosion scarp. The western portion of the embankment (west of the spillway) is wooded and contains mature trees. A nearly vertical, dry laid stone wall extends approximately 15± feet west of the spillway and the face of this wall appears to bulge outward. Significant seepage was observed 15-20± feet west of the spillway, resulting in a pool and running water that was discharging into Union Pond below the embankment. The discharge point for the outlet structure is a 36-inch pipe enclosed in a structure constructed of dry laid cut stone and located approximately 70± feet east of the spillway. One large stone of this. structure was dislodged at the time of the inspection. A pathway consisting of bare earth and stones was leading from the top of the embankment to the outlet structure. The slope of the downstream embankment is generally approximately 1.51-1:1 V. Scarps or tension cracks were not observed.

4.4.3 Dam Crest

The crest of the dam is covered with tall grass, brush and small trees. A sand and gravel pathway is evident along the, length of the crest. Concrete barriers are located at each end of the crest, at locations 0+00 and 3+70 of the referenced plan, to keep vehicular traffic off the dam. A steel truss footbridge with metal railings and wood plank decking spans the spillway between the east and west training walls. The crest of the dam at each end of the abutment, where the abutment appears to be part of the adjacent property, appears to be lower in elevation than that portion of the crest between the concrete barriers. One animal burrow was observed on the crest of the dam near the outlet works structure, although dense brush and vegetation may have obscured other animal burrows from view. The upstream side of the crest adjacent to the gatehouse was noticeably lower in elevation than the remaining crest, perhaps as much as 12-inches, and devoid of vegetation. The east crest of the abutment may have been altered during construction of the adjacent property. Scarps or tension cracks were not observed.