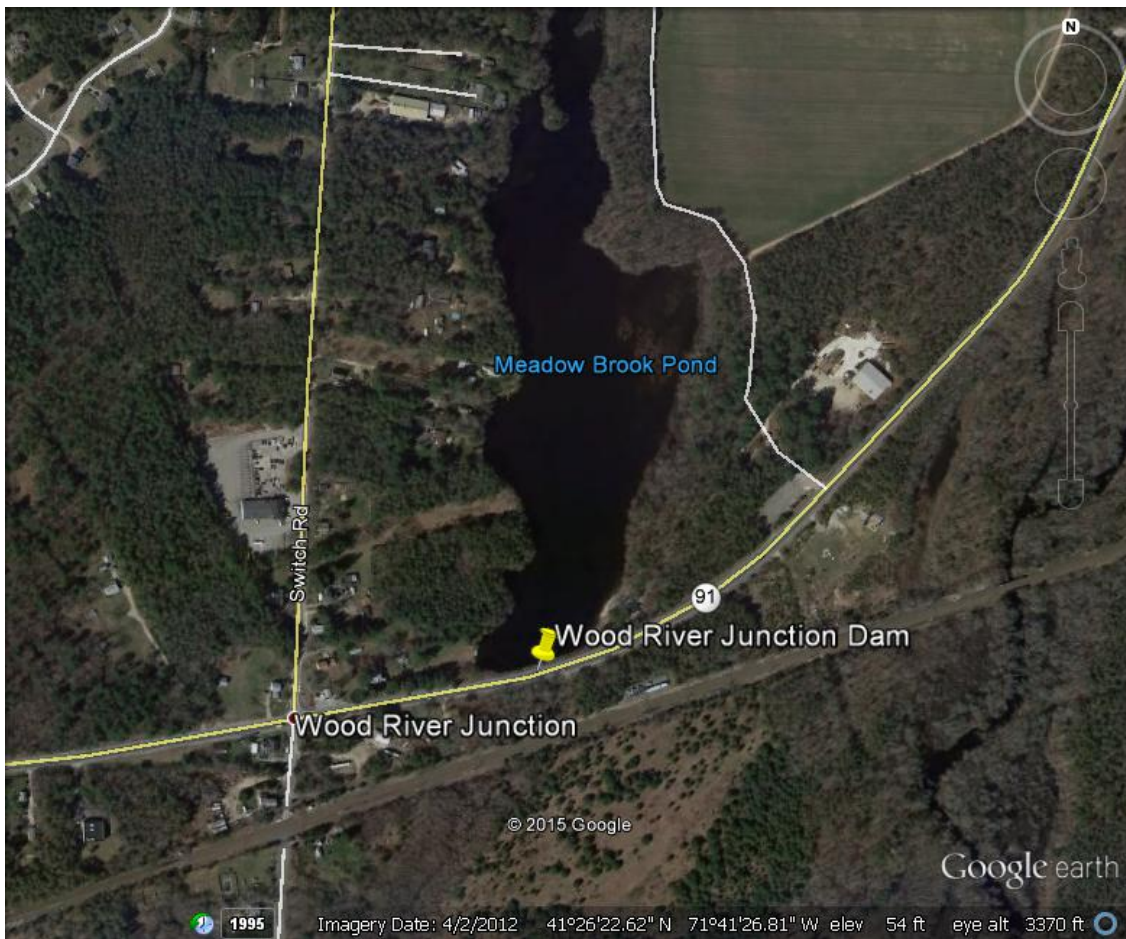


WOOD RIVER JUNCTION DAM VISUAL INSPECTION / EVALUATION REPORT



Dam Name:	<i>Wood River Junction Dam</i>
State Dam ID #:	<i>273</i>
Owner:	<i>Unknown</i>
Town:	<i>Richmond</i>
Consultant:	<i>Fairbanks Engineering Corporation</i>
Date of Inspection:	<i>October 5, 2014</i>

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ATTACHMENTS:

- Figure 1 – Vicinity Map
- Figure 2 – Site Sketch
- Appendix A – Photographs
- Appendix B – Definitions

PREFACE

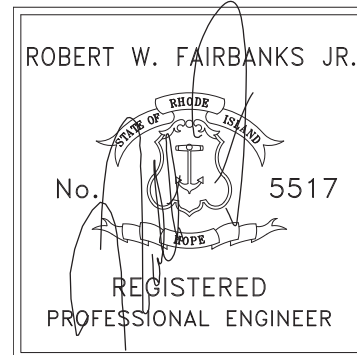
The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team. In cases where and impoundment is lowered or drained prior to inspection, such action, while improving the stability and safety of the dam & dike, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

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 present 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.



Robert W. Fairbanks, P.E.
President/Chief Geotechnical Engineer
Fairbanks Engineering Corporation





Fairbanks Engineering Corporation
Geotechnical & Marine Engineers

SECTION 1

1.0 DESCRIPTION OF PROJECT

The Rhode Island Department of Environmental Management (RIDEM) Office of Compliance and Inspections has retained Fairbanks Engineering Corporation (FEC) to perform an inspection of the Wood River Junction Dam on October 5, 2014. This work is performed per FEC's contract with RIDEM, Office of Compliance and Inspection, dated September 9, 2014, and FEC's proposal dated April 21, 2014. This inspection and report were performed in accordance with generally accepted visual type dam inspection procedures. An H&H analysis has not been undertaken to review the spillway adequacy to pass the spillway design flood (SDF).

1.1 General

1.1.2 Purpose of Work

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

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are attached in Appendix B. Many of these terms may be included in this report.

1.1.4 Previous Inspection Reports

This report is based on our visual inspection and information contained in the following previous inspection reports:

- Visual Inspection/Evaluation Report, November 29, 2011, by Pare Corporation

1.2 DAM INFORMATION

1.2.1 Location

The Wood River Junction Dam is located in the Town of Richmond, approximately 30.3 miles southwest of the center of the City of Providence. The dam impounds water along the Meadow Brook to form Meadow Brook Pond. The dam is located at the southern end of the



impoundment area near coordinates 41.43787°N/71.69109°W. Please refer to the inspection summary for a locus plan depicting the area of the dam and its immediate surroundings.

The dam is accessible from Rt. 91, which runs along the crest of the dam. The dam is also accessible from the RI Division of Fish & Wildlife parking lot on the upstream left abutment. To reach the dam from I-95, take Exit 3A for RI-138 East. Follow RI-138E/Kingston Road for approximately 2.0 miles. Turn right onto RI-112S/Richmond Townhouse Road and follow for 3.3 miles. Turn right onto RI-91W/Alton Carolina Road and follow for 1.9 miles. A gravel parking lot will be on the right immediately before the impoundment on the right.

1.2.2 Owner/Operator

The owner of the dam is currently unknown. Previous reports have indicated that the dam is owned and operated by the Rhode Island Department of Transportation; however, ownership was not confirmed as part of the preparation of this report.

1.2.3. Purpose of the Dam

The dam currently impounds water for recreational purposes. It appears that the dam may have been originally constructed as a water supply structure from a mill building formerly located at the left end of the dam. The original date of construction and purpose of the dam is not known; however, a plan dated 1886 (which refers to the dam as Ennis Reservoir Dam) appears to show the configuration of the dam at the site.

1.2.4 Description of the Dam & Appurtenances

The following description, paraphrased from previous reports and based on observations made during inspection, is believed to be an accurate depiction of the dam and appurtenances.

The Wood River Junction Dam is an approximately 475-foot long earthen embankment dam with a reported maximum structural height of approximately 10-feet. The upstream side of the dam embankment consists of an approximately 2H:1V slope protected by a layer of 15-inch diameter stone riprap. The crest is approximately 45-feet wide and supports the 38-foot wide asphalt roadway with vegetated shoulders having an average width of 4 feet and bordered by upstream and downstream guardrails. The downstream side consists of steep vegetated slope averaging near roughly 1.25H:1V.

The spillway structure, located near the center of the dam embankment, consists of a rectangular control structure extending upstream of a headwall along the upstream slope. The control structure extends approximately 18.5-feet upstream of the dam and is approximately 8-feet wide. The sides of the structure provide uncontrolled overflow weirs with an effective length of approximately 15.67 feet. The upstream side of the control structure formerly supported two 3.5-foot wide timber gates; however, the gates have been removed and replaced with a reinforced concrete weir with an 18-inch low level outlet pipe installed through the bottom of the weir.



1.2.5 Operations and Maintenance

It appears that the Rhode Island Department of Transportation completes routine maintenance to cut brush along the shoulders of the roadway. However, ownership of the dam is currently unknown. There were no reported operational procedures.

1.2.6 Hazard Potential Classification

In accordance with current classification procedures under State of Rhode Island dam safety rules and regulations, Wood River Junction Dam is currently classified as a SIGNIFICANT hazard potential dam.



SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Wood River Junction Dam was inspected on October 5, 2014. At the time of the inspection, the weather was sunny with a temperature of about 60 degrees. Photographs to document the current condition of the dam were taken during the inspection and are included in Appendix A. The level of impoundment appeared to be near normal operating levels. Underwater areas were not inspected as part of the field activity. FEC's inspection findings were in agreement with previous inspection findings, so the following was paraphrased from previous reports.

2.1.1 General Findings

In general, Wood River Junction Dam was found to have significant growth of vegetation along the downstream side of the dam, other areas of unwanted vegetation, areas of seepage along the downstream toe and within apparent former outlet channels, and an apparently inoperable low level outlet. The specific concerns are identified in more detail in the sections below:

2.1.2 Dam Embankment

The dam embankment consists of an earthen section that is in fair condition. It appears that the brush along the sides of the roadway is periodically cut by RIDOT; however, no maintenance is completed on the remainder of the dam. The following was noted during the inspection:

Upstream Side

- The riprap along the upstream slope is typically overgrown with brush and several trees. The riprap generally appears to be stable and suitably sized.
- Some displacement of riprap was noted in areas, apparently the result of public use of the area to access the pond.
- Several significant trees (larger than 6-inches in diameter) were noted along the length of the upstream slope.
- The slope/riprap is covered with leaves and small woody vegetation. Slope conditions partially limited inspection, particularly left of spillway.
- Approximately 210-feet right of the left abutment, some of the riprap appears to be displaced, possibly by public use of the area.
- Upstream slope protection ends approximately 50-feet left of the right abutment. A stone bound was noted in this area.
- From approximately 50-feet left of the right abutment to the right abutment, the slope is generally wooded and irregular with erosion present along the waterline. Access to this area for inspection is limited by a chainlink fence.



Crest

- The surface of the roadway is asphalt in good condition appearing to have been recently paved.
- The downstream side of the crest is eroded at isolated areas above the downstream end of the culvert. The shoulder of the roadway in this area is very steep immediately above the culvert headwall.

Downstream Side

- From approximately 70 to 200-feet right of the left abutment, the slope consists of a well maintained grass surface averaging near 2.5H:1V. The tree line in this area extends up to the downstream toe of the slope.
- From approximately 160 to 180-feet right of the left abutment, an asphalt driveway extends from the downstream edge of the roadway towards the downstream area. The asphalt appears in good condition with no indication of unusual movement noted.
- The downstream slope is overgrown and steeper from approximately 200 to 230-feet right of the left abutment. The steep slopes result from the transition to the downstream left training wall at the spillway.
- From the right side of the spillway to right abutment, the downstream slope is steep with an average approximate slope of 1.25H+/-:1V estimated during the inspection. The slope is typically vegetated with unmaintained grass and brush. The top 6-feet of the slope appears to be regularly cut as part of roadway maintenance procedures. Sloughing was typical within the bottom foot of the slope.
- According to previous reports, an area of standing discolored water and saturated surrounding soils was noted at the toe of the slope approximately 290-feet right of the left abutment. This water could not be observed at the time of the inspection due to heavy vegetation.
- According to previous reports areas at the toe of the slope approximately 300-feet right of the left abutment appeared to be wet and may occasionally collect water. This observation was not made at the time of the inspection due to heavy vegetation.
- According to previous reports an approximately 5-foot wide excavated channel was noted extending from the toe of the slope approximately 390-feet right of the left abutment to the downstream channel downstream of the embankment. The channel appeared to have been excavated. Staining and an apparent flow rate of less than 1 gpm were noted in this channel. An accumulation of sand was noted at the convergence of this channel with the downstream channel; however, the sediment appears to be the result of scour in the downstream channel as opposed to sediment transported by seepage through the embankment. This area could not be observed at the time of the inspection due to heavy vegetation.
- Approximately 10-feet left of the right abutment, an approximately 10-foot wide channel with apparent remnants of stonewalls along the sides was noted extending from the toe of the downstream slope to the downstream channel. Seepage was noted in the channel.



2.1.3 Appurtenant Structures

Primary Spillway

The spillway generally appeared to be in fair condition. The following was noted during the inspection:

- The spillway is a reinforced concrete, open box structure with a fixed, sharp crested weir. There is a concrete deck/walkway extending from a headwall along the upstream slope to access the end of the spillway. The concrete structure is generally in fair condition.
 - A hairline crack was noted through the concrete slab at the end of the access deck; at the upstream end of the spillway structure.
 - It appears that minor scour/spalling of the concrete is present along the waterline. However, slightly elevated pool conditions obstructed complete inspection.
 - Several small cracks with efflorescent staining were noted on the construction joint along the downstream face of the piers supporting the access deck and also at the apparent concrete joint at the top of the weir.
 - Spillway discharges flow through the dam via a concrete box culvert which is in good condition. There is deterioration of the first construction joint (as located from the downstream end) in the left wall of the culvert.
- Stone masonry training walls extend from the downstream end of the culvert. The training walls extend approximately 10-feet from the culvert before transitioning to flared wing walls.
 - The stone masonry training walls are generally in fair condition with mortar typically in place.
 - Several 4-inch diameter trees are present along the top of the downstream left training wall.
 - The downstream right and left wing walls are missing several capstones. The wing walls also has more missing mortar than the training walls.
 - An 8-inch diameter tree is growing from the downstream toe of the wall near the approximate midpoint of the length of the wall.
 - The downstream left wing wall is generally in fair condition. However, a significant percent of mortar is missing from this section of wall.
- The channel downstream of the dam is generally poorly defined with accumulated debris and trash resulting in the stream overflow the banks of the channel.

Low Level Outlet

Low Level Outlet

The outlet end of a pipe was noted in the upstream wall of the control structure. However, no controls to regulate flow through this outlet were noted.



2.1.4 Downstream Area

As noted above the downstream channel is clogged with debris, resulting in erosion and overflow of the banks of the channel with flow occurring outside the natural channel limits.

The area downstream of the embankment right of the spillway is generally flat and wooded.

Approximately 200-feet downstream of the dam, Meadow Brook flows beneath the Amtrak railroad tracks. Approximately 1000-feet downstream of the railroad tracks, Meadow Brook reaches its confluence with the Pawcatuck River.

2.1.5 Reservoir Area

The dam is located at the southern end of the impoundment. The shape of the impoundment is generally a widening of the river channel; however, the surrounding topography only provides limited shelter to the dam to limit the surface area over which waves may develop.

The eastern shoreline of the impoundment is undeveloped and wooded. The western shoreline includes several residential structures with occasional docks. The slopes surrounding the impoundment are generally flat.

2.2 Caretaker Interview

The current owner of the dam is unknown; therefore, no caretaker interview was conducted as part of this report.

2.3 Operations and Maintenance Procedures

There was no formal operations and maintenance manual for the dam available at the time of the inspection.

2.3.1 Operational Procedures

There were no operable components at the dam at the time of the inspection. It appears that the spillway includes a low level outlet; however, the operator for this structure was not observed during the inspection. It does not appear that any operations are completed. No operational plan was indicated to exist at the time of the inspection.

2.3.2 Maintenance of Dam and Operating Facilities

There was no maintenance manual for the dam available at the time of the inspection. Maintenance appears to be limited to cutting of vegetation along the top of the slopes. The slope maintenance appears to be part of a roadway maintenance program as opposed to a program for maintenance of the dam.



SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

The Wood River Junction Dam was found to have the following deficiencies:

1. Growth of trees and other unwanted vegetation along the length of the dam
2. Steep downstream slopes
3. Areas of seepage through apparent former outlets and the embankment.
4. Deterioration of stone masonry wall section

A detailed inspection of the dam, inclusive of recommendations for repairs, was completed by Pare Engineering Corporation (PARE) in 2011. FEC's assessment, recommendations and alternatives were in agreement with previous inspection reports; therefore, the following is paraphrased from previous reports. A comparison of current conditions to those previously reported indicates routine maintenance is completed at the dam to control vegetation.

3.2 Recommendations

The following recommendations and remedial measures generally describe the recommended approach to address 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.

The following presents 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 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.

1. Determine the current Owner of the dam.
2. Complete a slope stability evaluation upon the embankment section. Evaluate the need to regrade the embankment slopes, particularly the downstream slope right of the spillway. Completion of a subsurface investigation will likely be required to determine the soil properties of the in-situ embankment fill.
3. Develop and implement a monitoring program to assess the areas of observed seepage along the downstream side of the dam. The monitoring program should track observed flow rates, presence of sediment transport, and other observations in the two channels and one area of apparent standing water along the downstream side of the dam, as well as in any areas of future noted seepage.



4. Complete a seepage evaluation for the embankment to determine if they are problematic. Evaluation of seepage at the right end of the dam may require research to determine the history of the dam and the potential for remnants of historic structures through the embankment.
5. Complete an underwater inspection to assess the presence and condition of an operable low level outlet. Evaluate means to restore operability to the outlet.
6. Reset displaced riprap and extend the limits of riprap to provide protection along the entire length of the dam.
7. Remove trees, brush and unwanted vegetation less than 6-inches in diameter from the dam slopes and within 10-feet of the downstream slope. Removal of trees larger in size is not recommended due to the potential negative impacts to the embankment. Removal of the large trees will require complete re-construction of the embankments due to the need to excavate and remove the root systems which is necessary to avoid piping concerns in the future. If there is a concern about stability of the larger trees the canopies may be trimmed to reduce the area and corresponding wind forces.
8. Regrade the downstream slope to a stable cross section. Loam and seed the embankment to provide a surface that can be easily maintained and inspected.
9. Clear the downstream channel of accumulated debris.
10. Repoint the stone masonry walls along the downstream channel. Remove all trees from the vicinity of the walls.
11. Complete detailed hydrologic and hydraulic (H&H) analyses to evaluate the capacity of the structure to accommodate various storm events that would be typical for the watershed. It is recommended that the analysis consider flows associated with the 100-year through one half probable maximum flood (1/2 PMF) storm events. 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.
12. Continue to implement inspection and monitoring of the dam as needed. The dam is currently classified as significant hazard potential, and as such it must be inspected and a report prepared every 5 years by a RI registered professional engineer familiar with dam engineering.
13. A formal Operations and Maintenance Manual should be developed for this structure. The manual should include the 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 wetter months. Additionally, the manual should provide 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 canal spillway and monitoring areas of potential movement and deterioration. The manual should include a schedule for regular maintenance activities to be continued to control and prevent growth of unwanted vegetation.



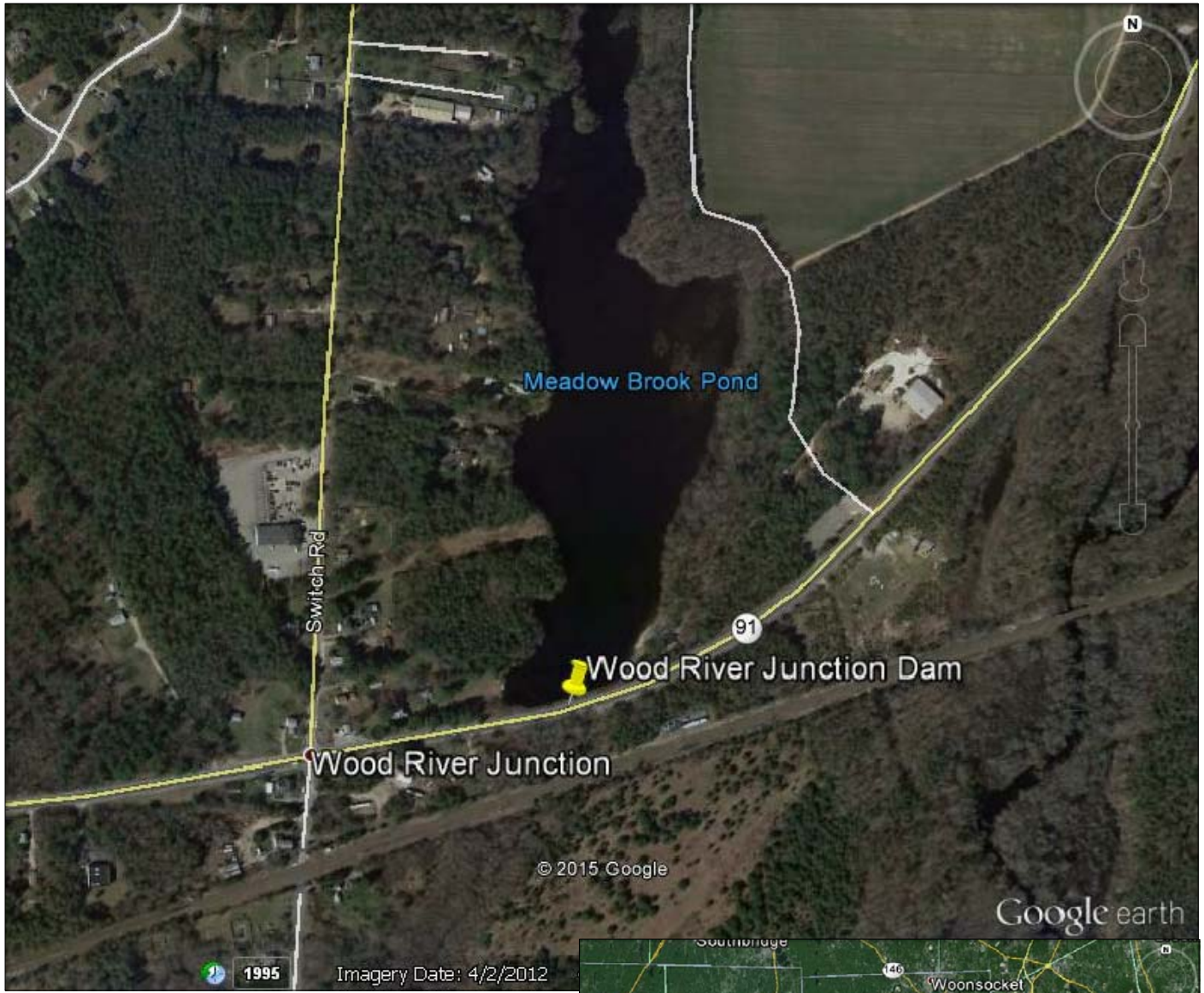
3.3 Alternatives

The following alternatives are presented based on a review of the concerns. Additional studies should be performed to determine if the following options are suitable for this dam site. Appropriate environmental permits will be required to complete both of the alternatives presents.

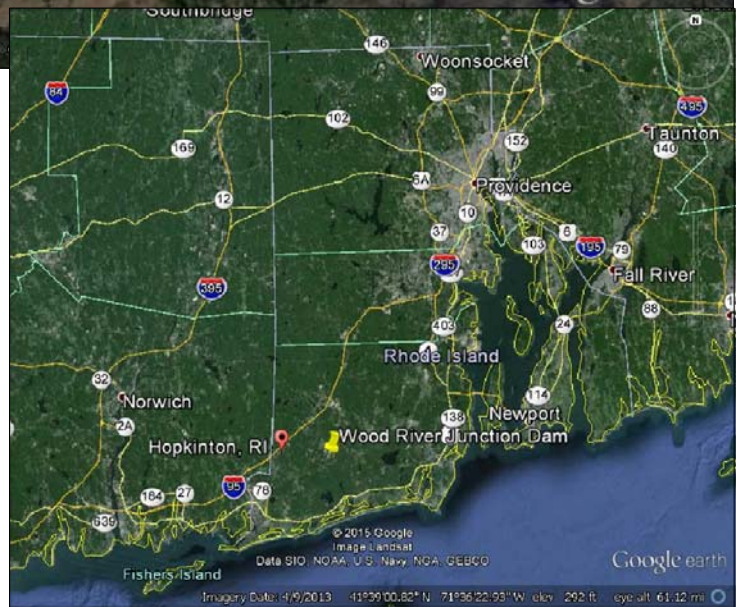
Dam Removal/Breaching: An alternative to making the repairs recommended above is to breach the dam to address safety and stability concerns at the structure. It should be considered that breaching the dam will result in the loss of the recreational and environmental resource and reduce the potential flood control capacity provided by the dam and impoundment. While removal of the dam will eliminate yearly operating and maintenance expenses, permitting activities and demolition costs associated with dam removal may exceed the cost of rehabilitating the dam and performing appropriate operations and maintenance procedures. The cost of both options should be evaluated.

Lower the Dam: Modifications can be made to the dam to reduce the overall height of the dam, which would result in a reduction in the maximum height and volume of water that the dam would be capable of impounding. If lowering the dam is a consideration, the impact on the hazard potential should be evaluated. If the dam is lowered, the recommendations made in this report will still apply and should be implemented in accordance with general dam safety practice. The cost of lowering the dam may exceed the cost of performing repairs and operating and maintaining the structure. The cost of both options should be evaluated.

FIGURES



NOTE: THESE FIGURES OBTAINED FROM GOOGLE EARTH IMAGES



PROJECT NO. 14021.00

INSPECTION DATE: OCTOBER 5, 2014

FIGURE 1

VICINITY MAP

WOOD RIVER JUNCTION DAM ID #273

RICHMOND, RHODE ISLAND

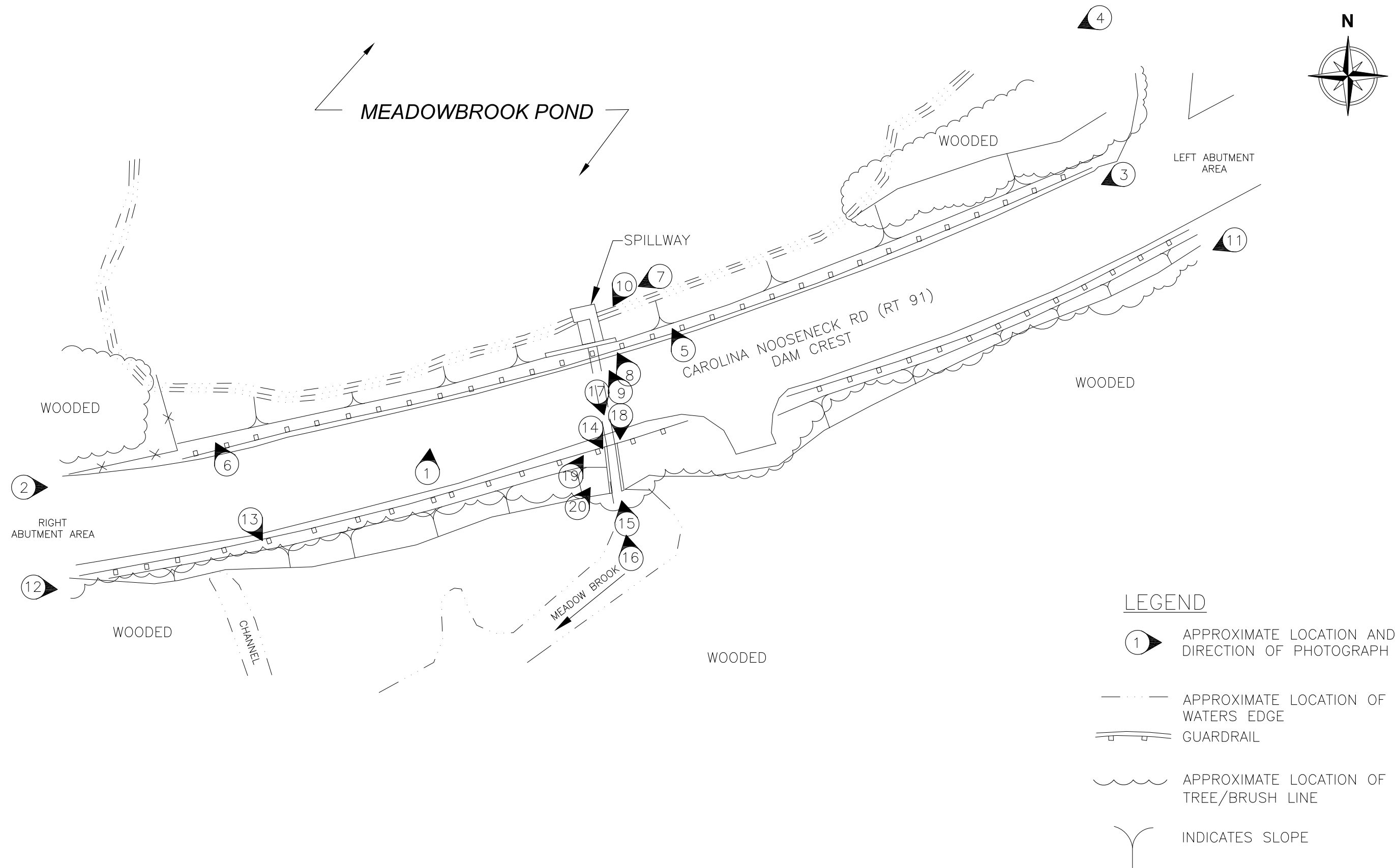


FAIRBANKS ENGINEERING CORP.

42 COBBLESTONE HILL ROAD
 EXETER, RHODE ISLAND 02822
 (401) 294-3484 OFFICE
 (401) 474-2361 CELL
 rfairbanks@fairbankseng.com

(CAD FILE: 14021.00, FIGURE 2.DWG)

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LEGEND

- APPROXIMATE LOCATION AND DIRECTION OF PHOTOGRAPH
- APPROXIMATE LOCATION OF WATERS EDGE
- GUARDRAIL
- APPROXIMATE LOCATION OF TREE/BRUSH LINE
- INDICATES SLOPE

NOTE: THIS PLAN CREATED FROM FIELD OBSERVATIONS, AERIAL IMAGERY, AND THE SITE SKETCH PROVIDED IN THE 2011 INSPECTION REPORT. IT IS PROVIDED FOR INFORMATION ONLY AND IS NOT A SURVEY PLAN.

SITE SKETCH PLAN
NTS



FAIRBANKS ENGINEERING CORP.
42 COBBLESTONE HILL ROAD
EXETER, RHODE ISLAND 02822
(401) 294-3484 OFFICE
(401) 474-2361 CELL
rfairbanks@fairbankseng.com

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FIGURE 2

SITE SKETCH

WOOD RIVER JUNCTION DAM ID #273
RICHMOND, RHODE ISLAND

APPENDIX A
PHOTOGRAPHS



Photo 1: Overview of impoundment area



Photo 2: Overview of dam crest from right abutment looking left



Photo 3: Overview of dam crest from left abutment looking right



Photo 4: Overview of upstream slope looking downstream



Photo 5: Overview of rip rap on upstream slope



Photo 6: Overview of vegetation along upstream slope



Photo 7: Overview of spillway weir



Photo 8: Overview of spillway weir

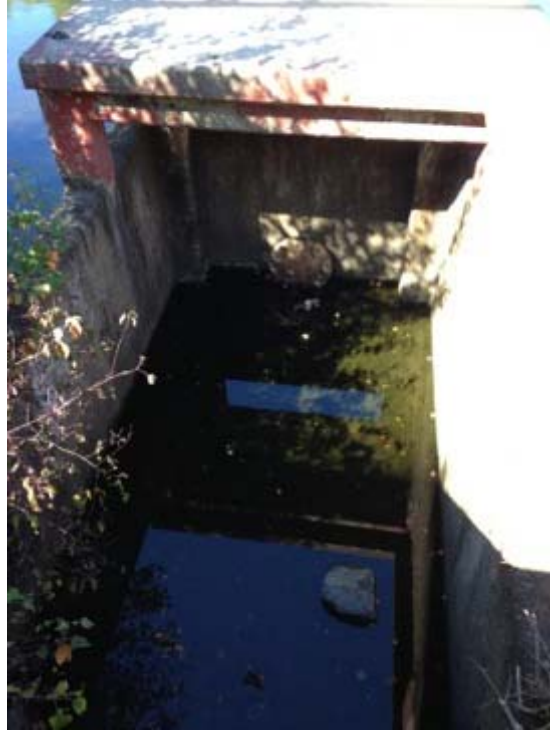


Photo 9: Overview of controls in spillway



Photo 10: Spillway concrete culvert



Photo 11: Overview of downstream slope from left abutment looking right



Photo 12: Overview of downstream slope



Photo 13: Overview of downstream area



Photo 14: Overview of downstream spillway canal

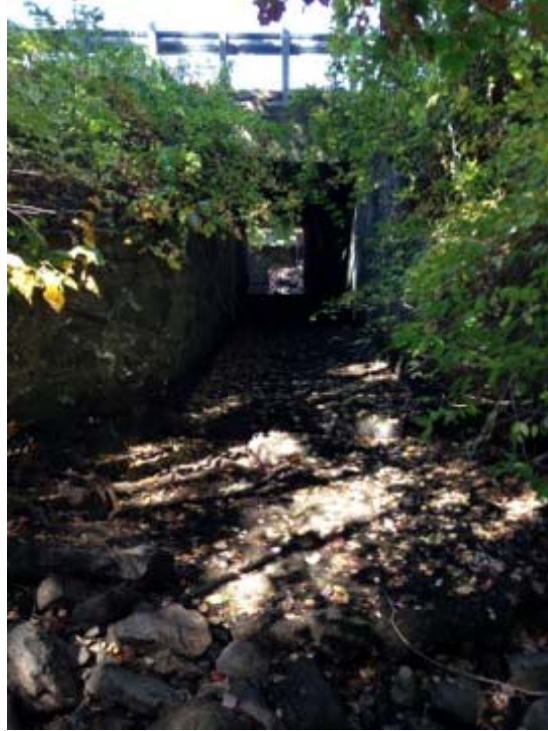


Photo 15: Primary spillway culvert



Photo 16: Primary spillway culvert



Photo 17: Primary spillway culvert



Photo 18: Primary spillway downstream channel



Photo 19: Cracking at first joint in concrete culvert at primary spillway



Photo 20: Downstream training walls

APPENDIX B
DEFINITIONS

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to Rhode Island Rules and Regulations for 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 Rhode Island's Rules govern for dams located within the Rhode Island.

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 the natural 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 there from. 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

Not used in Rhode Island

Hazard Classification

High Hazard – Shall mean dams located where failure or misoperation will result in a probable loss of human life.

Significant Hazard – Shall mean dams located 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 – Shall mean dams located 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 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 break.

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 – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

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.

Condition Rating

Unsafe – This specifically indicates 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 – This specifically indicates a component that has deteriorated beyond a maintenance issue and requires repair; the component no longer functions as it was originally intended.

Fair - This specifically indicates a component that requires maintenance.

Good - This specifically indicates a component meeting minimum guidelines, where no irregularities are observed and the component appears to be maintained properly.