VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

# Dam Safety Inspection Report

Dam Safety Program
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Name: **Hardwick Lake Dam**
State ID: **93.01** NID ID: VT00186
Hazard Class: Significant

Town: **Hardwick**
Watershed: Lamoille River
Stream: Lamoille River

## Inspection Details

| | |
|---|---|
| **Inspection date:** 05/29/2024 08:36 | **Last inspection date:** 7/15/2019 |
| **Inspection type:** Periodic | **Weather:** Cloudy, 60F |
| **Inspected by:** Benjamin Green, Russell McGinnis | |

## Dam Safety Recommendations

*The following recommendations and remedial measures describe the recommended approach to address current deficiencies at the dam. Maintenance level activities can be performed by the Owner, while Studies and Analyses and Remedial Repair Recommendations will require the services of a qualified professional engineer registered in the State of Vermont who is experienced in dam safety engineering design, permitting, and construction. Remedial repairs recommended within this report will likely require obtaining a Dam Order from the Dam Safety Program (DSP).*

***It is always recommended to communicate with the DSP about any planned repairs to evaluate if the planned work requires obtaining a Dam Order. Additionally, any remedial repairs recommended within this report will likely require obtaining a Dam Order from the Dam Safety Program (DSP) prior to performing the repairs.***

**Overall dam condition:**

☐ Satisfactory ☐ Fair ☑ Poor ☐ Unsatisfactory ☐ Not Rated

**See General Information section at the end of report for further details*

| **Maintenance level recommendations** | |
|---|---|
| *General* | On a regular basis and following the application of unusual or extreme loading conditions, perform monitoring of the dam and its appurtenances. Report any unsafe condition to the Dam Safety Program. |
| | Establish and maintain vegetation clearing limits a minimum of 15 feet from all portions of the dam. Annually cut and remove grass, weeds, brush, and woody vegetation (but leave stumps) from the dam crest, upstream and downstream walls, spillways, abutments, and downstream areas to near ground surface. |
| *Crest* | Monitor the dam crest for signs of settlement, particularly to the left of the principal spillway along the non-overflow weir. Report any change of conditions to the DSP. |
| *Upstream Wall* | Monitor the area near the principal spillway structure where the small whirlpool was observed. Determine location of leakage discharge and monitor for changes in flow, turbidity, or size. |

| **Maintenance level recommendations** | |
|---|---|
| *Spillways* | Continue to maintain the principal and/or auxiliary spillway free of debris to ensure free-flow conditions. |
| | Monitor and repair minor concrete cracking and deterioration, as well as the condition of the concrete joints. |
| *Low-Level Outlet* | Inspect, lubricate, perform maintenance, and test operate the mechanical components on a yearly basis to ensure operability. |

| **Studies and analysis:** | |
|---|---|
| *General* | Perform necessary analyses to support either the design of repairs to bring the dam into compliance with current dam safety rules and guidelines, or alternately, dam removal. |
| *Hydrology and Hydraulics (H&H)/Hazard Classification* | Perform updated hydrologic and hydraulic analyses of the dam to determine hydraulic adequacy and also to confirm the hazard potential classification of the dam. |
| | Identify alternatives to make the dam hydraulically adequate or capable of being safely overtopped during the Inflow Design Flood (IDF). |
| | Evaluate the condition of all gate mechanisms and identify repair, maintenance, or replacement alternatives. |
| *Structural* | During low flow conditions or winter drawdown, inspect the principal spillway weir for any deficiencies and perform stability analyses. |
| | Once vegetation is removed from the left non-overflow wall, perform a thorough structural inspection and analyses |
| | Evaluate the condition of the gate structures and determine repair or replacement requirements. |
| *Emergency Action Planning* | Develop an Emergency Action Plan for the dam included updated dam failure analyses and flood inundation maps and provide to the Dam Safety Program. |
| *Operation & Maintenance (O&M)* | Develop an Operations and Maintenance Manual for the dam and provide a copy to the Dam Safety Program for record keeping purposes. |

| **Remedial repair recommendations** |
|---|
| Based on the studies and analysis recommended above, repair, rehabilitate, or replace the dam to bring it into compliance with current dam safety rules and guidance. Alternatively, consider pursing dam removal.<br><br>An alternative to reduce loading and improve hydraulic adequacy of the dam would be to evaluate whether the dam can be operated year-round at the lowered reservoir pool that is currently maintained during winter months. This may provide the dam with more available storage during flooding events and serve as a reasonable risk reduction measure until a permanent solution can be pursed. |

## Dam Information

| | | |
|---|---|---|
| **Type:** Concrete<br>**Purpose:** Hydroelectric | **Status:** In Service<br>**Height:** 20 ft<br>**Length:** 523 ft | **Construction date:**<br>1920 |
| **Owner/Contact/Operator:** Hardwick Electric Department *email:* bessary@hardwickelectric.com *phone:* (802) 472-5201 *Address:* PO Box 516 Hardwick, VT 05843 | | |
| **Normal storage:**<br>900 ac-ft | **Max storage:**<br>2,000 ac-ft | |
| **Normal surface area:**<br>180 ac | **Drainage area:**<br>78,144 acres | **Max surface area:**<br>Not determined |
| **Pool elevation during inspection:** Slightly above normal | **Tailwater elevation during inspection:** Within normal ranges | **Normal pool elevation:**<br>Not determined |
| Dam **has** been breached or overtopped. **Date:** July 11, 2023- Overtopped | | |
| Dam **does not** have public road on crest. | Dam **does not** have public bridge. | Dam **does not** have associated dike. |
| **Inspection history:** This dam was last inspected on December 23, 2019, and was rated in POOR condition. After the July 10, 2023, Flooding Event, a Rapid Inspection was performed and it was found the dam had overtopped as a result of the event. | | |

| **Access road to dam** | | |
|---|---|---|
| **Type:**<br>Maintained paved road | **Road name:**<br>Route 14 | **Distance from access road to dam:** 50 ft |
| **Seasonal access:**<br>☑ Plowed winter ☐ Sanded winter ☐ Maintained in mud season ☑ Passable in all weather conditions ☐ Need high clearance vehicle | | |
| **Access of emergency/construction equipment:** Good access for large construction equipment. | | |
| Action required: ☑ None ☐ Monitor ☐ Maintenance ☐ Engineer | | |

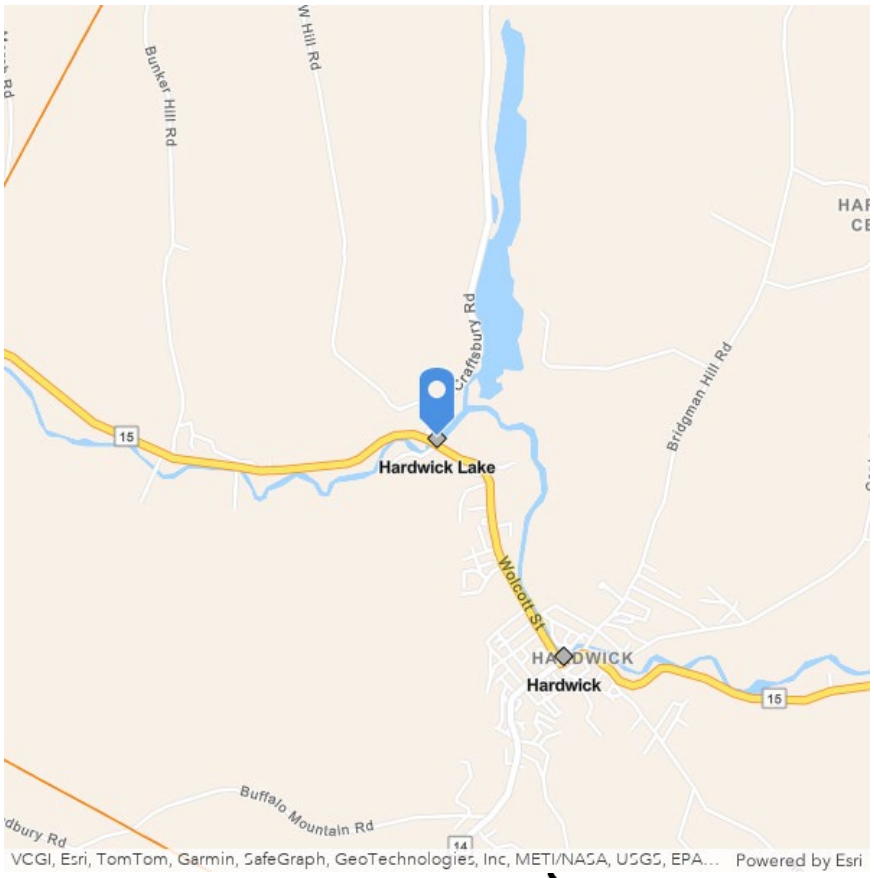
| **Security** |
|---|
| **Device type(s):** Spillway access bridge secured. |
| Action required: ☑ None ☐ Monitor ☐ Maintenance ☐ Engineer |

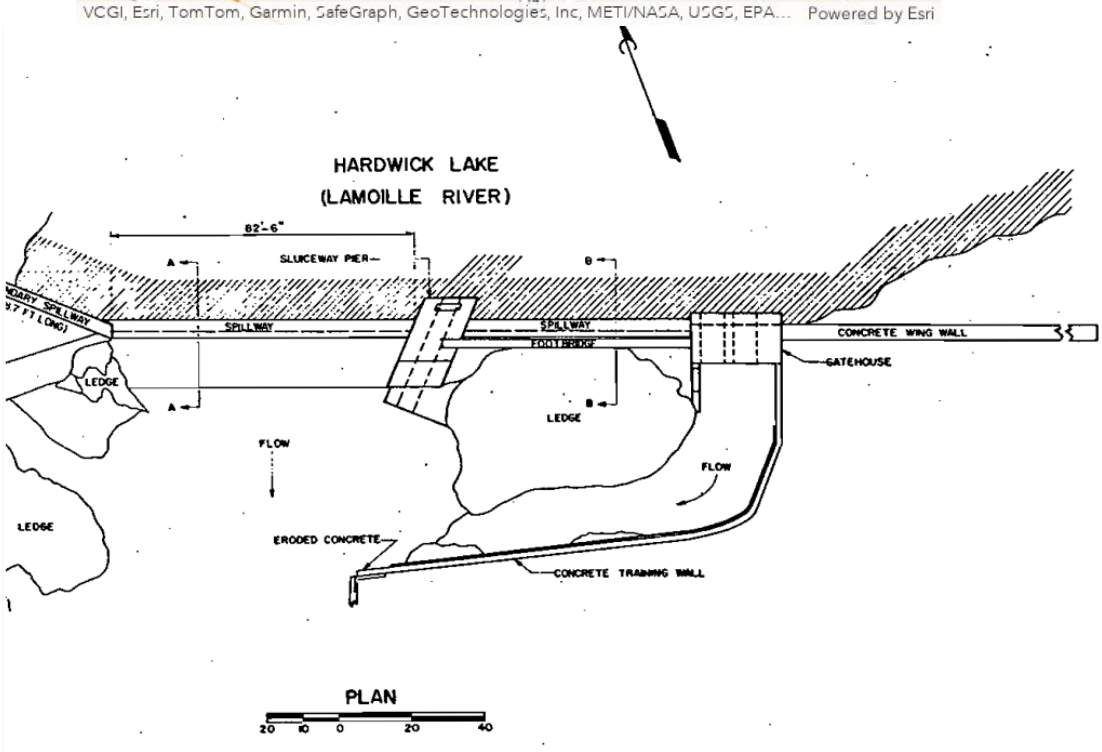
| **Public/Inspection team safety at dam** | |
|---|---|
| Confined space entry required: No | Fall protection required: No |
| Other safety required: No | Public safety consideration: None observed |
| Action required: ☑ None ☐ Monitor ☐ Maintenance ☐ Engineer | |

**Dam Description/Background**

Harwick Lake Dam is a concrete gravity dam with a principal spillway, auxiliary spillway, and outlet works founded on bedrock. The dam is currently classified as a SIGNIFICANT hazard potential. According to our files, the dam has a total length of approximately 523 feet and a structural height of 23 feet. The principal spillway consists of a divided ogee weir with a total length of about 144 feet with a crest at El. 794.8 (all elevations in this report reference the National Geodetic Vertical Datum, NGVD, in feet). The divided ogee weir spillway is fitted with slots and receivers on both sections for flashboards, although no flashboards were installed at the time of our inspection. In the center of the two principal spillway sections is a structure containing a 6-foot diameter, gate operated low-level outlet (LLO) with an invert of El. 780.0. On the right side of the principal spillway is an approximately 40-foot-long, auxiliary spillway at El. 797.3. To the left of the principal spillway is a structure containing two 6-foot diameter gate operated mid-level outlets with inverts at El. 786.0. It is our understanding that the right outlet is plugged and abandoned. To the left of this structure is an approximately 300-foot-long non-overflow concrete wall that extends to the left abutment with a crest at El. 801.0. The upstream and downstream faces of the left abutment structure are vertical. The dam impounds Hardwick Lake, which has a surface area of 180 acres, a drainage area of 78,144 acres, and normal and maximum storage of 900 acre-feet and 2,000 acre-feet, respectively. The dam was constructed in 1920 and reportedly was rebuilt in 1952. The Department of Environmental Conservation was given jurisdiction on this dam from the Public Service Board (now called the Public Utility Commission) circa 2008. The dam was formerly used to store water for hydroelectric production downstream but has not been used for that purpose in many years.

## Dam Location



## Emergency Action Plan

| EAP **on** file | **EAP date:** April 30, 1993 |
|---|---|
| *If dam is a SIGNIFICANT or HIGH Hazard dam, an up-to-date EAP with dam failure flood hazard inundation map is highly recommended.* | |

| What issues are present with the EAP? | Action |
|---|---|
| ☐ None<br>☑ Revisions required<br>☐ Not approved<br>☐ No plan available<br>☐ Inundation study required<br>☑ Format out of date<br>☐ Under review | ☐ None<br>☐ Monitor<br>☐ Maintenance<br>☑ Engineer |

## Operation & Maintenance Manual

| O&M Manual **not on** file | |
|---|---|
| **Accessibility to outlets or low-level outlet (LLO):** Good | **Frequency of outlet or LLO discharge:** Winter drawdown |
| **Frequency of mowing:** Not often. | **Seasonal drawdown?** ☑ Yes ☐ No<br>**Amount lowered:** Partially drained. |
| **Frequency of dam owner surveillance:** Unknown. No known monitoring program. | **Owner surveillance during storm events:** ☐ Yes ☑ No |
| **Operating problems since last inspection:** None reported | **History of repairs since last inspection:** Not known. |

| What issues are present with the O&M Manual? | Action |
|---|---|
| ☐ None<br>☐ Revisions required<br>☐ Not approved<br>☑ No plan available<br>☐ Format out of date<br>☐ Under review | ☐ None<br>☐ Monitor<br>☐ Maintenance<br>☑ Engineer |

## Downstream Hazard Classification

**Current classification:** Significant

The hazard potential classification of the dam informs dam design standards and requirements. There are no records on file indicating how the hazard potential classification of the dam was assigned. Therefore, it is currently unknown if this hazard potential classification is appropriate, and an updated Hazard Classification/Dam Failure Analysis should be performed. It also does not appear that an inundation map was used to determine the hazard potential classification.

A desktop review of the potential downstream impacts was performed and it appears that there could be potential impacts to downstream roads and properties, including 175 McAllister Farm Rd, which appears to be a residential property/commercial farm.

## Hydrologic/Hydraulic Data

Since Hardwick Lake dam is currently rated as SIGNIFICANT hazard potential, the Inflow Design Flood (IDF) is the 1,000-yr storm event according to Federal Guidance currently applied in the State of Vermont.

According to State requirements, the dam must provide a minimum of 3.0 feet of freeboard between the normal water level and the dam crest. Based on visual observation this requirement appears to be met. Similarly, the dam is required to provide a minimum of 1.5 feet of freeboard between the peak water surface elevation during the IDF and the dam crest. Based on the dams performance in July 2023, it is unlikely that this condition is met.

Based on file review, there are information and calculations available in the 1980 Phase I Report produced by the USACE. However, these analyses used outdated methods and did not consider the current IDF. Accordingly, the hydraulic adequacy of the dam is considered unknown.

## Upstream Wall Face (Left Non-Overflow Wall)

**Wall type:** Concrete
**Length:** 300 foot left non-overflow wall

| **Wall height (exposed):** | **Horizontal wall alignment:** |
|---|---|
| ~5 ft. (left non-overflow wing wall section) | Straight |

**Unusual wall movement:** ☐ Yes ☑ No

| **Additional comments:** | **Surface condition:** |
|---|---|
| Largely overgrown with brush and trees which prevented a thorough inspection. | Overall fair with several isolated areas with minor damage. |

## Upstream Wall Face (Left Non-Overflow Wall)

| | |
|---|---|
| **Joint condition:** Where inspectable, appeared fair. | **Abutment contact condition:** Some undermining and noticeable water flowing around the cavity where the left wall meets the principal spillway section. Additional investigation of this area is recommended. |

| Upstream wall issues | Action |
|---|---|
| Could not inspect, brush covering areas preventing a thorough inspection. Several areas of minor damage. | ☐ None<br>☐ Monitor<br>☑ Maintenance<br>☐ Engineer |

**Upstream wall images**

Tree growing out of upstream wall about 150 feet down left wall.

## Crest (Left Non-Overflow Wall)

| | |
|---|---|
| **Length:** ~300 feet | **Width:** Approximately 2.5 feet width for the 300-foot-long left non-overflow wall. |

**Freeboard lengths:** There is approximately 6 feet of freeboard between the principal spillway crest/normal water level and the crest of the wall.

**Additional comments:** Abutment contact is overgrown and difficult to access which prevented a thorough inspection. Signs of overtopping throughout the entire length of the left downstream wall were observed.

| Crest issues | Action |
|---|---|
| • The crest is covered in brush and debris that prevented a thorough inspection.<br>• An area of deteriorated concrete was observed resulting in a low point in the crest.<br>• Just to the left of the structure that contains the two (2) 6-foot diameter outlet pipes, there was a small whirlpool observed on the upstream side and settlement on the crest be indicative of developing issue in this portion of the dam. | ☐ None<br>☐ Monitor<br>☑ Maintenance<br>☑ Engineer |

**Crest images**

**Crest images**

Debris and tree growth preventing a thorough inspection

Part of left wall showing visible concrete deterioration and vegetation about 150 feet to the left of the principal spillway. Due to concrete deterioration, the crest elevation is lower than the rest of the wall at this location.

## Downstream Wall (Left Non-Overflow Wall)

**Wall type:** Concrete
**Length:** 300 foot left non-overflow wing wall

| **Wall height (exposed):** | **Horizontal wall alignment:** |
|---|---|
| ~5 ft. (left non-overflow wing wall) | Straight |

**Unusual wall movement**: ☐ Yes ☑ No

| | |
|---|---|
| **Additional comments**: Largely overgrown with brush and trees which prevented a thorough inspection. Original wall appears to be encased in concrete which is delaminating in areas resulting in material loss on much of the downstream face. | **Surface condition:** Section loss to a depth of 3 to 5 inches is prevalent. |
| **Joint condition:** Fair | **Abutment contact condition:** Needs investigation where the left non-overflow wing-wall contacts the concrete structure containing the two (2) 6-foot outlets. As previously described in the crest section, this area had observed settlement on the crest, that may be indicative to subsurface damage to the structure. A small whirlpool was observed just upstream of this area, but the outlet of the leakage was not found. |

| **Downstream wall issues** | **Action** |
|---|---|
| • Wall obscured by brush that prevented a thorough inspection.<br>• Concrete section loss observed in large areas of the downstream wall. | ☐ None<br>☐ Monitor<br>☑ Maintenance<br>☑ Engineer |

**Downstream wall images**

Example of concrete deterioration and delamination on the downstream face.

Vegetation obscuring downstream wall face.

## Instrumentation

*No instrumentation found*

## Principal Spillway

**Spillway type:** Weir **Primary material:** Concrete **Weir:** Ogee

**Spillway location:** Spills the full length of the channel. One weir section on right side of gate structure and one on left side.

**Gate:** Low-Level slide gate in structure between spillway sections, see below for more information.

**Water level measured against principal spillway crest:** Approximately 3 inches flowing over

**Erosion control structures**: None

**Spillway components:**

| | | |
|---|---|---|
| ☐ Anti-vortex plate | ☐ Filter Diaphragm | ☑ Training Walls |
| ☐ Flashboard | ☐ Trashrack | ☐ Other: |

Additional comments: During the July 2023 Storm the spillway experienced heavy flows and debris. Flow over the spillway on day of inspection prevented thorough inspection. It is recommended to inspect the spillway during low flows or winter drawdown conditions.

| Principal spillway issues | | | Action |
|---|---|---|---|
| **Deteriorating concrete** | | | |
| Issues: | | | |
| ☐ Bug holes | ☐ Popouts | ☐ Isolated crack | ☐ None |
| ☑ Hairline crack | ☐ Honeycombing | ☐ Exposed rebar | ☐ Monitor |
| ☑ Efflorescence | ☐ Scaling | ☐ Disintegration | ☑ Maintenance |
| ☐ Spalling | ☐ Crazed/Map cracks | ☐ Other: | ☑ Engineer |
| Impacted area: Throughout | | | |
| Location: Entire Surface | | | |

**Principal spillway images**

Ogee weir section on right side of dam.

Weir section on left side.

**Principal spillway images**

Effervescence and cracks above the two (2) 6-foot-diameter principal spillway outlet structure.

Bulging of the training wall on the left side of where the two (2) 6-foot-diameter principal spillway outlet barrels discharge.

## Outlet Structures

Total number of outlet structures: **2**

| **LLO Gate in Center of Principal Spillway** | |
|---|---|
| **Elevation:** El. 780.0 (feet) | **Location:** Center of the divided ogee spillway, accessible by the suspension bridge |
| **Drain size and configuration:** Slide gate. Electric motor operated. | **Access:** Access is only possible if the suspension bridge is intact and well maintained. |
| **Additional comments:** Outlet was not test operated during inspection. Reportedly in working condition. | |

| **LLO Gate Issues** | **Action** |
|---|---|
| **Description:** Condition is Poor. Described as still operable, but the condition of the steel is in a deteriorating state that requires some maintenance. There were some observed cracks in the steel at mounting points for the mechanisms. The condition of the gate itself could not be determined. | ☐ None<br>☐ Monitor<br>☑ Maintenance<br>☑ Engineer |

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| **Main Principal Outlet Structure** | |
|---|---|
| **Elevation:** El. 786.0 (feet) | **Location:** Left side of principal spillway. |
| **Drain size and configuration:** Two (2) 6-foot-diameter outlet barrels with a manually operated gate. Left of the two outlet pipes is nonfunctional and reportedly abandoned. | **Access:** Good. |
| **Additional comments:** Outlet was not operated during inspection. The lake is reportedly lowered using this outlet works in the winter. Leakage through this gate was observable. | |

| **Main Principal Outlet Structure Issues** | **Action** |
|---|---|
| The mechanism and visible condition of the gate operator appears poor. The condition of the gate itself could not be determined. | ☐ None<br>☐ Monitor<br>☑ Maintenance<br>☑ Engineer |

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**Outlet images**

Gate across wooden spillway cable bridge.

On left gate at the entrance of the spillway. Both gates are closed but are heavily leaking.

**Outlet images**

Inside of the housing where the gate operator is located for the left main gate.

**Outlet images**

Crack observed in gate support.

## Auxiliary Spillway

| | | |
|---|---|---|
| **Spillway type:** Broad Crested Weir with concrete splash pad. | **Primary material:** Concrete | |
| **Spillway location:** Right abutment | | |
| **Auxiliary Spillway Freeboard:** Approximately 2.5 feet above the principal spillway crest. | | **Erosion control structures**: None |
| **Spillway components:** | | |
| ☐ Anti-vortex plate | ☐ Filter Diaphragm | ☑ Training Walls |
| ☐ Flashboard | ☐ Trashrack | ☐ Other: |
| **Additional comments:** Underdrain present under auxiliary. 2 pipes 4” in diameter observed. | | **Number of auxiliary spillways:** 1 |

| **Auxiliary spillway issues** | **Action** |
|---|---|
| Debris and vegetation buildup was observed in the approach to the auxiliary spillway. | ☐ None<br>☑ Monitor<br>☑ Maintenance<br>☐ Engineer |

| **Auxiliary Spillway Drains** | **Number** |
|---|---|
| *Two (2) 4” auxiliary spillway underdrains were present.* | 2 |

**Auxiliary spillway images**

Auxiliary spillway at the right abutment.


Broad crested auxiliary spillway weir from right abutment.

**Auxiliary spillway images**

Auxiliary Spillway discharges onto a splash pad that appears to be founded on bedrock.

GENERAL INFORMATION

Website: https://dec.vermont.gov/water-investment/dam-safety

The Dam Safety Program conducts periodic safety inspections of non-federal, non-power dams to determine their condition and the extent to which they pose a potential or actual threat to life, property, and the environment. The condition rating reported herein was based on available data and visual inspection. Detailed investigations/analyses were beyond the scope of this report. It should be realized that the reported condition was based on observations of field conditions at the time of inspection, along with data available to the inspection team. The condition of the dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam in the future. Only through continued care and inspection can there be any chance that unsafe conditions are detected.

**Hazard Potential Classifications:**

HIGH: Dams where failure or mis-operation will probably cause loss of human life.
SIGNIFICANT: Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
LOW: Dams where failure or mis-operation results in no probable loss of human life and low economic and environmental losses.
MINIMAL: A dam that meets the LOW hazard definition, above, but is only capable of impounding less than 500,000 cubic feet.

**Condition Ratings:**

SATISFACTORY: No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
FAIR: No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
POOR: A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.
UNSATISFACTORY: A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
NOT RATED: The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

**Definitions:**

Upstream: The side of the dam that borders the impoundment located up gradient of the dam.
Downstream: The side of the dam opposite the upstream side, located down gradient of the dam.
Right: The area to the right when looking in the downstream direction (also known as “river right”).
Left: The area to the left when looking in the downstream direction (also known as “river left”).
Structural Height-of-Dam: The vertical distance from the lowest point in the stream bed or native ground surface at the downstream toe of the dam to the elevation of the lowest non-overflow section of the dam crest.
Embankment: An artificially constructed feature usually consisting of earth and rock with sloping sides and a flat crest, intended to provide a permanent barrier that impounds or is capable of impounding water.
Dam Crest: The top of the non-overflow portion of the dam.
Abutment: The part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed at the interface with a concrete gravity section.
Normal Pool: The water elevation, reservoir surface area, and reservoir storage capacity that is prevalent at the site or typical under normal, non-storm conditions. Typically, this level is controlled by the principal spillway.

Maximum Pool: The highest water elevation, reservoir surface area, and reservoir storage capacity that could be impounded by the dam, including accumulated sediments, with the water or liquid level at the top of the lowest non-overflow part of the structure or dam crest.
Principal spillway: A structure that maintains normal pool conditions and over which daily non-storm related and flood flows are discharged. Also called a primary or service spillway.
Auxiliary Spillway: The secondary spillway not in use under normal conditions but used when needed to pass flood flows that exceed the capacity of the principal spillway.
Low-level outlet or "LLO": An installed pipe and operable gate or valve typically located in or near the foundation of a dam that can be used to alter water levels, drain the reservoir, or otherwise meet operational or safety needs. Also called a pond drain.
Inflow Design Flood or "IDF": The storm event which the hydraulic capacity of the spillway structure and dam is designed and required to safely pass. Dam safety rules under development are considering the following prescriptive IDF's, Low and Minimal = 100-year Storm, Significant = 1,000-year storm, High = PMF. The use of incremental consequence analysis or risk-informed decision making to evaluate the potential of selecting a smaller/site specific IDF is permitted.
Emergency Action Plan (EAP): A written plan that identifies the area that would likely be inundated by the failure of a dam and identifies the actions that should be taken by the Owner to protect life, property, lifelines, and the environment in the event of a dam failure or threatening condition at the dam. The plan is usually implemented in cooperation with the local, regional, and state emergency personnel.
Operation and Maintenance Plan or "O&M": A plan that provides guidelines for the necessary, regular operation and maintenance activities at a dam.

**Complete list of definitions from the Vermont Dam Safety Rule:**
**https://anrweb.vt.gov/DEC/IronPIG/DownloadFile.aspx?DID=185352&DVID=0**