VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Dam Safety Inspection Report

Dam Safety Program
One National Life Drive
Montpelier, VT 05620-3510
(802) 622-4093
benjamin.green@vermont

Name: **Lake Paran Dam**
State ID: **17.01** NID ID: **VT00006**
Hazard Class: **High Hazard Potential**

Town: **Bennington**
Watershed: **Walloomsac River**
Stream: **Paran Creek**

Inspection Details

Inspection date: 11/23/2022 14:29

Inspection type: Periodic **Weather:** Cloudy, 45F

Inspected by: Andrew Sampsell

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 will likely require obtaining a Dam Order from the Dam Safety Program.

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	• Perform an update to the Emergency Action Plan at least every other year and provide the updates to all key contacts. • 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.
Embankment	• Continue mowing the grass surfaces of the embankment and auxiliary spillway once to twice annually. • Remove pond vegetation from the upstream riprap slope. Supplement riprap with smaller stone to fill large voids. • Add topsoil, seed, and mulch bare spots on the embankment to reduce the risk of erosion. • Clean out the toe drain vault/manhole structure and start to track the rate of sediment/fines deposition.

Maintenance level recommendations	
Crest area	• Fill ruts, depressions, and or puddles on the dam crest with compacted granular fill to match surrounding grades. Topsoil, seed, and mulch to establish grass cover. • Repair eroded areas and promote drainage on the dam crest. • Place erosion stone at the end of the dam crest storm water culvert.
Downstream slope area	• Regularly monitor seepage, leakage, and/or wet areas for changes in flow, turbidity, or size. • Monitor and fill holes on the downstream slope after removing deleterious materials with compacted granular fill to match surrounding grades. Seed and mulch repaired areas. If necessary, remove nuisance animals from the dam and surrounding area or otherwise address the cause of the holes.
Spillways	• Monitor and repair minor concrete cracking and deterioration. • Monitor vandalism and graffiti.
Stoplog Channel	• Remove debris as needed to maintain free flow conditions. • Regularly monitor stoplogs and take measures to reduce leakage.
Upstream Wall	• Monitor minor concrete deterioration, hairline cracking, and efflorescence. Replace failing joint sealant as needed.

Studies and analysis	
Hydrology and hydraulics/hazard classification	• Perform updated hydrologic and hydraulic analyses of the dam to confirm hydraulic adequacy. • Identify alternatives to make the dam hydraulically adequate or capable of safely being overtopped during the Spillway Design Flood. • Determine the best approach to replacement of the deteriorated stoplogs.
Operation and maintenance	• Develop an Operations and Maintenance Manual for the dam and provide a copy to the Dam Safety Program for record keeping purposes.
Geotechnical	• Perform necessary cleaning and a remote video inspection of seepage collection system to assess condition. Design repairs/replacement as needed.
Utilities	• Determine if the buried waterline near the right abutment of the dam runs through the embankment. If it is determined that the water line runs through the dam embankment, identify the condition of the waterline, and evaluate appropriate measures to reduce associated risks. • While camera inspecting the toe drain system, also evaluate the condition of the storm water basin and corrugated outlet pipe which runs through the embankment. Identify any repair or replacement needs if required.

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.

Dam Information

Type: Earth **Purpose:** Recreation	**Status:** In Service **Height:** 25 ft **Length:** 720 ft	**Construction dates:** 1851, 1980
Owner/Contact/Operator: Vermont Agency of Transportation		
Normal storage: 285 ac-ft	**Max storage:** 535 ac-ft	Dam has capability to impound **more than** 500k cubic feet (11.48 ac-ft)
Normal surface area: 38 ac	**Drainage area:** 15.3 sq. mi.	**Max surface area:** Not Measured
Pool elevation during inspection: ~El. 647.0 (NGVD29, ft)	**Tailwater elevation during inspection:** Normal, water flowing below surface of riprap.	**Normal pool elevation:** El. 647.0 (NGVD29, ft)
It's unknown if the dam in its current configuration has been breached or overtopped.		
Dam **does not** have public road on crest. Dam does have an active railroad, a spur of the Vermont Rail System across the dam crest.	Dam **does not** have public road bridge. Dam does have a steel railroad bridge that spans the spillway.	Dam **does not** have associated dike.
Reservoir shape: Irregular	**Reservoir average depth (ft):** Unknown	**Reservoir observations:** None
Shoreline development: ☐ Undeveloped ☑ Semi-developed ☐ Developed ☐ Unknown		
Reservoir slopes: ☑ Mild ☐ Moderate ☐ Steep ☐ Unknown		
Inspection history: The dam was last inspected by the Dam Safety Program on October 12, 2020. The previous inspection found the dam to be in FAIR condition.		

Dam Information

The previous inspection report made several recommendations. Recommendations that do not appear to have been addressed are summarized below.

- Establish clearing limits for brush and trees a minimum of 15 feet from all areas of the dam including the downstream toe.
- Fill gaps in riprap with smaller rip rap to create a more uniform surface on upstream slope.
- Re-caulk concrete joints in the upstream wall.
- Fill animal burrows with compacted granular fill.
- Remove vegetation and sediments from the collection manhole.
- Perform stormwater repairs to the dam crest including: remove silt and debris from the catch basin grate on the dam crest, adding stone to armor the outlet to the catch basin at the downstream toe of the dam, and promoting positive stormwater drainage on the crest of the dam to prevent the formation of puddles.
- The alignment of the water main located near the right abutment should be determined to see if it extends onto or though the embankment fill of the dam.
- Perform an update to the Emergency Action Plan (EAP).
- Develop a brief Operations and Maintenance Manual for the dam that documents operable works and regular maintenance procedures.
- Perform updated hydrologic and hydraulic analyses to confirm the hydraulic adequacy of the dam and identify alternatives to bring the dam into compliance with current dam safety standards.
- Retain a professional engineer qualified in dam safety to design and construct repairs to the dam to make it hydraulically adequate.

Access road to dam		
Type: Maintained gravel road	**Road name:** State Fishing Access	**Distance from access road to dam:** 25 ft
Seasonal access: ☐ Plowed winter ☐ Sanded winter ☐ Maintained in mud season ☑ Passable in all weather conditions ☐ Need high clearance vehicle		
Access of emergency/construction equipment: Accessibility of equipment is fair, may need to ford stream to get large equipment to the main section of dam unless railroad grants access.		
Action required: ☑ None ☐ Monitor ☐ Maintenance ☐ Engineer		

Security	
Device type(s): None	Dam **has** sign of vandalism, trespass or unauthorized operation. **Description:** Graffiti, trash and swimming despite no swimming signage.
Action required: ☐ None ☑ Monitor ☑ Maintenance ☐ Engineer	

Public/Inspection team safety at dam	
Confined space entry required: No	Fall protection required: Yes, when inspecting concrete features, or operating stoplogs.
Other safety required: Active railroad across dam crest poses safety risk. Railroad includes a bridge over the spillway. Bridge has no railings.	Public safety consideration: Dangerous swimming location. Swimming occurs despite signage advising against.
Action required: ☐ None ☑ Monitor ☑Maintenance ☐ Engineer	

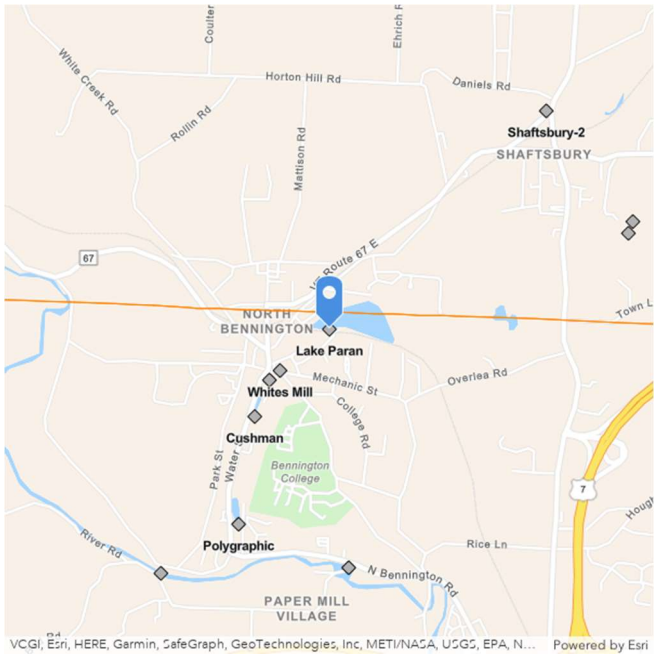
Dam Description/Background

Lake Paran Dam is an earth embankment dam with a principal spillway and stoplog channel. The dam is currently classified as a HIGH hazard potential. According to file information, the dam has a total length of 720 feet and a structural height of 25 to 30 feet. The upstream face of the dam consists of an approximately 3H:1V slope with an embedded, vertical concrete wall to the right and left of the spillway. The crest of the dam is at approximately El. 653 (National Geodetic Vertical Datum, NGVD in feet) and supports an active railroad that crosses over the spillway discharge channel via a steel bridge. The downstream slope of the dam is approximately 2.5H:1V. The principal spillway consists of a three-sided, concrete ogee-style weir that is approximately 126 feet in length and at El. 647.

The spillway discharges into a concrete lined channel that passes through the embankment and discharges to Paran Creek. The stoplog channel is about 4 feet wide, embedded in the right side of the principal spillway, and consists of a dual set of timber stoplogs. The dam does not appear to have a low-level outlet and it does not have an auxiliary spillway.

Lake Paran at normal pool is approximately 38 acres and the normal and maximum storage capacities of the dam are approximately 285 acre-feet and 535 acre-feet, respectively. The drainage area of the dam is estimated to be 9,312 acres. The dam was originally constructed in 1851 for water storage for downstream mills. In 1955 the timber spillway was replaced with a concrete spillway. The dam was deemed unsafe by the United States Corps of Engineers in 1978 and was reportedly reconstructed circa 1979.

Dam Location



Emergency Action Plan

EAP **on** file
EAP type: High hazard EAP, complete template

EAP date:
September 15, 2011

If dam is a SIGNIFICANT or HIGH Hazard dam, an up-to-date EAP with dam failure flood hazard inundation map is highly recommended.

Has the EAP been exercised? ☐ Yes ☑ No

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

Operation & Maintenance Manual

O&M Manual **not on** file.

Operation & Maintenance Manual

Accessibility to outlets or low-level outlet (LLO): Right end of principal spillway weir, requires climbing down or up a ladder.	**Frequency of outlet or LLO discharge:** Not operated, stoplogs.
Frequency of mowing: As needed.	**Seasonal drawdown?** ☐ Yes ☑ No
Frequency of dam owner surveillance: Unknown	**Owner surveillance during storm events:** ☐ Yes ☑ No
Operating problems since last inspection: Unknown	**History of repairs since last inspection:** Unknown

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

Downstream Hazard Classification

Current classification: High Hazard Potential
Current classification appears appropriate, and an inundation map was used to determine the classification.

Hydrologic/Hydraulic Data

Since Lake Paran Dam is a HIGH hazard potential dam, the spillway design flood (SDF) is the probable maximum flood (PMF) based on Federal Guidance currently used in the State of Vermont. The most recent hydrologic/hydraulic analysis was performed by Dubois & King, Inc. as part of the 2011 dam failure analysis work. The 2011 D&K study provided the following information:

Drainage Area = 15.3 square miles
Principal Spillway/Normal Pool Elevation = El. 647.0 (NGVD29, ft)
Dam Crest Elevation = El. 653.0 (NGVD29, ft)

Storm Event*	Precip (in)	Inflow (cfs)	Outflow (cfs)	Peak WS El.	Freeboard (+) or Overtopping (-) (ft)
100-yr	6.72	3,312	3,270	650.8	2.2
1/4 PMF	-	4,324	4,268	651.5	1.5
1/2 PMF	-	12,465	12,432	654.8	- 1.8
PMF	30.00	29,794	29,772	657.5	- 4.5

Based on the above results, the dam appears to have 6 feet of freeboard between the normal pool elevation and the dam crest, which exceeds the lower allowable freeboard threshold of 3 feet according to State requirements. However, the dam is overtopped by 4.5 feet during the SDF which does not meet the State requirement of providing 1.5 feet of freeboard. Since the dam cannot safely pass the SDF, the dam is considered hydraulically inadequate.

Upstream Slope

The upstream slope of the dam is inclined at approximately a 3H:1V slope and is surfaced with large riprap. Pond vegetation grows on the upstream slope, and the majority of the slope is below the water at normal pool elevation. From the normal pool elevation to the dam crest is a concrete upstream wall. Since the majority of the upstream slope is covered by vegetation, or below the normal water line, inspection of the upstream slope was limited.

Upstream slope protections	Action
Riprap armoring	☐ None ☐ Monitor ☑ Maintenance ☐ Engineer

Upstream slope issues	Action
The riprap on the upstream slope is very large in diameter and not well graded, voids should be filled in with smaller stone. The upstream slope to the right of the principal spillway is covered in brush/cattails/reeds which makes it difficult to inspect. There appears to be a few locations used as fishing spots which have accumulated trash/debris.	☐ None ☐ Monitor ☑ Maintenance ☐ Engineer

Upstream slope images

Crest

Length: 720 ft **Width:** 50 ft

Freeboard:
Principal spillway to crest: 6 ft

Additional comments: Minor rutting from mowing operations. Crest behind concrete upstream wall is lower than the top of concrete wall. Earthen portion of crest is not level and minor erosion from stormwater runoff observed. A stormwater catch basin is located between in the concrete upstream wall and railroad tracks to help drain ponding stormwater. Active railroad bed on dam crest, timber ties set in crushed stone ballast.

Crest issues	Action
Minor erosion, and rutting.	☐ None ☐ Monitor ☑ Maintenance ☐ Engineer
Un-even crest, poor drainage.	☐ None ☐ Monitor ☑ Maintenance ☐ Engineer

Crest images

Downstream Slope

General slope inclination: 2.5 H:1V (slopes **are** within generally accepted stable inclinations). Downstream slope appears stable based on visual observation under current loading conditions. There are **no** isolated areas where the slope is over steepened.

Additional comments: There are areas of soil loss on the downstream slope primarily near the right abutment. It is unclear if these are the results of vandalism or an active dam safety deficiency such as animal burrowing or sinkholes that have developed. Some of the holes appear to be filled in with rocks/junk. Further investigation should be performed to determine the cause of these holes and repair by removing placed boulders/trash/debris and filling in with embankment compatible granular fill, topsoil, seed & mulch. The stormwater culvert which discharges at the toe of the downstream slope does not have any stone placed around it to prevent erosion.

Downstream slope protections			**Action**
Vegetation			
Condition:			☑ None
☑ Adequate	☐ Bare	☐ Too tall	☐ Monitor
☐ Improper	☐ Sparse	☐ Too short	☐ Maintenance
			☐ Engineer
Comments: Continue to mow at least once to twice annually.			

Downstream slope issues	**Action**
Depressions/Sinkholes Approximate width: 4 ft x 4 ft (varies by location) Approximate depth: 1 to 1.5 ft (varies by location) Location: Right End, Center	☐ None ☐ Monitor ☑ Maintenance ☐ Engineer

Seepage Collection Systems	**Number**
Toe drains	1

Toe drains					
Tag: Collection Weir					
Flow Depth:	1-inch	Measure method:	Ruler	Location:	Near center of embankment.
Action required: ☐ None ☑ Monitor ☐ Maintenance ☐ Engineer					
Comments: Toe drain is a 12” pipe which flows into a manhole and then outflow passes over a v-notch weir. The weir had 1 inch of flow depth. The manhole was partially filled with loose fines (assumed from toe drains/embankment), some iron-colored deposits.					

Downstream slope images

Downstream slope images

Toe drain images

Principal Spillway

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

Spillway location: Left abutment

Water level measured against principal spillway crest: 1-inch **Erosion control structures**: End Sill

Spillway components:

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

Additional comments: Did not inspect upstream face of Ogee (submerged). The concrete chute and downstream training walls appear to be in satisfactory condition. Vertical alignment appeared satisfactory. There was a small section along the left side of the chute that had peeled/spalled.

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
Location: Entire Surface			
Deteriorating stop logs Comments: Leakage observed through gaps between stoplogs, and around ends of stoplogs (between interface with steel channel the stoplogs sit in).			☐ None ☑ Monitor ☑ Maintenance ☐ Engineer

Principal spillway drains	Number
No drains were observed during inspection.	0

Principal spillway images

Upstream Wall

Wall type: Concrete
Length: 650 ft

Wall height (exposed):	**Horizontal wall alignment:**	**Vertical wall alignment:**
6 ft	Fair/Satisfactory	Fair/Satisfactory

Unusual wall movement: ☐ Yes ☑ No

Additional comments: None

Surface condition: Crest of wall has hairline cracking in various locations. Left of principal spillway wall the horizontal alignment is not straight.

Joint condition: Joint filler starting to fail in some locations. Most joints are in satisfactory condition.

Abutment contact condition: Satisfactory

Upstream wall issues	**Action**
Joints Joint filler is failing in some locations.	☐ None ☑ Monitor ☑ Maintenance ☐ Engineer
Deteriorating concrete Issues: ☐ Bug holes ☐ Popouts ☐ Isolated crack ☑ Hairline crack ☐ Honeycombing ☐ Exposed rebar ☑ Efflorescence ☐ Scaling ☐ Disintegration ☐ Spalling ☐ Crazed/Map cracks ☐ Other: Location: Hairline cracks along top of wall, minor efflorescence on upstream face of wall.	☐ None ☑ Monitor ☐ Maintenance ☐ Engineer

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.
Spillway Design Flood or "SDF": 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 SDF'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 SDF 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