



TECHNICAL MEMORANDUM

Date: September 12, 2023

To: Shane O’Keefe, Town Administrator
Town of Londonderry, VT

From: Charles Johnston, P.E. and Hannah Pascual

Subject: Williams Dam Inspection

On Tuesday, September 5, 2023, Dubois & King, Inc. (D&K) completed a site visit of Williams Dam, located in Londonderry, Vermont. An inspection of the dam was completed by Charles Johnston, P.E. and Hannah Pascual of D&K. The purpose of this site visit was to observe the flood damages that occurred during the July 11th storm event, observe repairs of the Route 11 embankment completed by VTrans, and to determine the suitability of the temporary protection measures installed along Edge Hill Road.

The following is a summary of the observations from the inspection by D&K and recommendations for repairs associated with the Dam. Appended to this memorandum is a photolog from the site visit.

FLOOD DAMAGE AND REPAIRS

On July 10, 2023, the State of Vermont experienced significant rainfall and flooding. The Londonderry, VT area received between 6 to 9-inches of rainfall over a 48-hour period. Williams Dam is a run-of-the-river dam system, and normally discharges the West River with little to no significant storage. During the flood event, the West River backwatered and flowed over Route 11 and the abutments of the dam. This caused significant damage to the right and left dam abutment contacts.



Flooding at Williams Dam with Overtopping Flow



Damage to Right Abutment Contact



Damage to Left Abutment Contact

Subsequent to the flooding event, VTrans completed repairs in order to address the erosion on the western end of the Route 11 Bridge and the Town contracted for repairs to the erosion on Edge Hill Road. Both locations are within the limits of the abutment contact areas of the dam. Though significant erosion occurred on the right side of the dam, the river did not breach the dam due to an upstream concrete wall that connects the bridge abutment to the dam low-level outlet structure. VTrans backfilled this area with a Stone Fill, Type III material with larger stones/boulder near the toe of the slope by the river. The eroded area on Edge Hill Road was filled by the Town with a Stone Fill, Type I, and was limited to an approximate 30-ft distance downstream of the dam abutment contact area. Reportedly, a State of Vermont River Engineer suggested the repair be limited to this distance due to unknown dam limits.



Repairs to Edge Hill Road



Repairs to Right Abutment/Route 11 Bridge Abutment

DAM INSPECTION

The inspection took place on September 6, 2023 at approximately 11am. The weather at that time was sunny and in the high 80's. The D&K inspection team met with Shane O'Keefe, Londonderry Town Administrator, and Tom Cavanagh, Londonderry Selectboard Chair. FEMA staff was present to observe damage from the July 10th flooding.

D&K began the inspection on the right abutment to review repairs completed by VTrans. As noted previously, the repairs were completed with large Stone Fill, Type III – large riprap with rock diameters between 12 to 36-inches. It appears a sandy gravel mix may have been placed to fill voids in the large riprap. VTrans also completed the replacement of a 24-inch diameter corrugated metal pipe, presumably connected to the catch basin on the northern side of Route 11, west of the bridge. The rock mass appears to be stable. No leakage or seepage was noted at the bottom of the rock fill mass. The rock fill slope was measured at approximately 2.5H:1V slope.

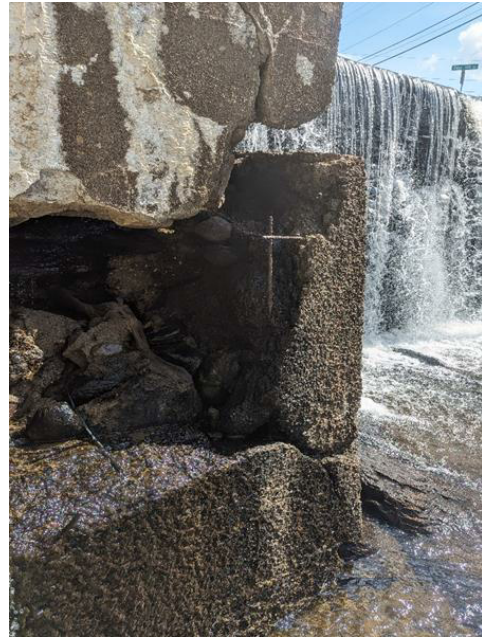
The following is a list of other notable observations and measurements made; signs of concrete deterioration may have been present during the previous inspection and further exacerbated by the recent storm event:

- Located at the bottom corner, at the intersection of the right wall and upstream wall of the low-level structure, there is a 6-inch thick spall, and leakage is flowing into the structure at the spall. (Photo No. 5)
- Efflorescence can be found throughout the low-level structure.
- Rocks are found at the outlet of the 6-foot diameter CMP (part of the low-level intake structure). It is suspected that the rocks may have been dropped into the structure during the right abutment repair. (Photo No. 7)
- The water depth flowing through the CMP is 3-inches. Pressurized leakage was observed through the metal pipe. (Photo No. 7)
- A crack is present at the intersection of the left wall of the low-level structure and the primary spillway. Previous inspections indicated a portion of the concrete to be missing in this location, however, this appears to have expanded from the flood event. This section of the structure appears to be comprised of three horizontal lifts of concrete. The concrete appears in fair condition at the top, then becomes significantly worse descending to the bottom. Rebar secured to the bedrock below is exposed and located within the divot downstream of the left wall. (Photo No. 9 and 10)
- Spalling is observed approximately 10-feet from the left corner of the spillway. (Photo No. 3)
- There appears to be a notch or even spall on the top of the spillway that was not observed during the previous inspection. (Photo No. 14)
- Water flowing around the left side of the concrete spillway on top of bedrock was measured 6 to 12-inches deep. (Photo No. 15)
- Observations of the downstream face of the dam are difficult due to flow over the dam. Pressurized leakage and spalling of the downstream face continues to be noted. (Photo No. 11)

- Water was clear in front of the outlet gate and the front of the gate could be observed. The silt level in front of the gate is slightly lower than the silt level behind the dam. The gate stem however, as noted in previous inspection, is bent making the gate system inoperable. (Photo No. 12 and 13)



2021 Inspection



2023 Inspection



2021 Inspection



2023 Inspection

The concrete spillway ends at a 90-degree bend on the left abutment within the river. Water flows over and around the end of the concrete spillway on to bedrock ledge outcrops. It is suspected that the original grade extended to the concrete spillway, however, past flooding eroded this section. Upstream of the left

abutment contact area are large riprap to stabilize the bank of the river. This portion does not exhibit signs of damage from the July 11th flood event.

A temporary repair of a portion of the eroded section at the left abutment contact and downstream has been completed. This repair is comprised of a small stone size, Stone Fill Type I, compared to the right abutment. The flood event appears to have eroded the downstream channel, exposing a new portion of bedrock outcrop. A stormwater pipe was noted to be crushed by large stones extending toward the Edge Hill Road and Route 11 intersection. (Photo No. 3 and 4)

DAM SAFETY CONCERNS AND RECOMMENDATIONS

The purpose of the site visit was to observe the condition of the dam, and provide recommendations on repairs to the dam and for stabilizing Edge Hill Road. The primary dam safety concern is the damage to the left abutment contact area that occurred during the flood event. Significant flow through the earthen/stone embankment is occurring and continued erosion of sand/silt earthen material could continue to occur. In addition, the current condition is vulnerable to further erosion in a future flood event.

Based on conversations with the Town, a repair is intended to stabilize the embankment with a stone fill revetment system to allow for the reconstruction of Edge Hill Road. The following are recommendations for this repair:

- The maximum slope of the system should be 2H:1V slope, a 3H:1V slope is suggested.
- Create a key trench or utilize large stones (36-inch diameter or larger) to create a key to build the revetment upon. The toe of the repair should extend to the 90-degree bend in the concrete spillway.
- Calculate the revetment stone size and depth utilizing 100-year flood velocities in the channel. (FEMA FIS reports 10,335 cfs during the 1% or 100-year event upstream of Williams Dam)
- Extend the repair from the downstream side of the dam to 20-feet upstream of the spillway. The goal of this is to tie the repair into stable embankment that appears to be undamaged from the storm event.
- Excavate and replace the section of stormwater pipe that is crushed. Extend pipe to discharge downstream of the dam spillway.
- Following the completion of the revetment system, it is suggested that grubbings are used to fill voids within the stones.
- Below the stone fill, the embankment should be backfilled with a VTrans 703.04 Granular Borrow.
- Subbase of Edge Hill Road should be comprised of a minimum of:
 - 15-inches of 704.05A Crushed Gravel for Subbase, fine graded, on top of
 - 36-inches of 704.05B Crushed Gravel for Subbase, coarse graded, on top of
 - Rock fill material filled with granular material.

DuBois & King is not completing the slope repair design, however was requested to complete an opinion of probable construction costs for planning purposes. The following information was used:

- The repair is expected to be 60-feet in length along the river bank, and approximately 15-feet tall.
- Excavation will be required to expose natural grade to construct upon. The quantity of excavation is estimated to be 140 CY. Pricing for this type of work fluctuates depending on availability, however, VTrans historic pricing for excavation is \$12 per cubic yard; or approximately \$2,000 total.
- Utilizing a 3-ft depth of stone fill, the estimated quantity to complete the repair is approximately 320 cubic yards. Pricing of this material has fluctuated in the past few months due to demand, however, historic pricing provides a range of \$55 to \$65 per cubic yard, or approximately \$21,000 for the stone fill material.
- Total estimated quantity for both grades of Crushed Gravel for Subbase is 210 yards at \$40 per cubic yard; or approximately \$9,000 total.
- Additional costs such as Erosion Prevention and Sediment Controls, Control of Water, Restoration of Surfaces, and Mobilization/Demobilization will be required. Recommend a contingency of 50% for these costs. With this contingency, the repair is estimated to be approximately \$50,000.

Other immediate repairs that are recommended:

- Remove the stones from the outlet section of the low-level outlet structure.
- Consider completing a camera inspection of the new stormwater pipe or request from VTrans an after action report outlining the repair.

As outlined in the Williams Dam Study, dated March 24, 2022, the dam is experiencing a number of issues that require action by the Town. These deficiencies include the integrity of the concrete structures, inadequate dam operating controls, and insufficient hydraulic capacity. Repairs to the concrete of the structure and low-level gate are recommended but damage to these systems appears to be on-going and not only caused by the recent flood event.

The flood event appears to have caused additional concrete damage to the dam, specifically on the spillway crest and the low-level outlet structure. The dam structure appears to be constructed of a stone/concrete cyclopean wall with a concrete facing. In locations that spalling is occurring, there is exposed rebar in poor condition. It is recommended that analysis of the dam structure be completed and if the dam is to remain in place, concrete repairs be completed.

During the site visit, the river was clear enough to observe the upstream side of the low-level gate. It appears that sediment is trapped behind the gate but not to same depth as behind the dam. It is recommended that the Town completes repairs to the bent gate stem to make the gate system operable. The Town should operate this gate a minimum of once a year.

Project Name: Williams Dam	Site Location: Londonderry, Vermont	Project No.: 827442
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Photo No.: 1	Date: 9/05/2023
Description: View looking at right abutment.	

A photograph showing a concrete dam structure with a small waterfall. The dam is situated in a river, and the water is dark and reflects the surrounding greenery. A bridge is visible in the background, spanning the river. The dam is surrounded by lush green trees and vegetation. The view is from the right abutment.

Photo No.: 2	Date: 9/05/2023
Description: View looking at left abutment.	

A photograph of a dam and waterfall structure. In the foreground, there is a concrete dam with a small waterfall cascading over it. To the left, a wooden utility pole stands with electrical equipment. In the background, a white house is visible on a hillside surrounded by dense green trees. The sky is blue with scattered white clouds.

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Photo No.: 3	Date: 9/05/2023
Description: Crushed 24-inch dia corrugated metal pipe along the left abutment. (1/2)	

A photograph showing a crushed 24-inch diameter corrugated metal pipe partially buried among large, grey, layered rocks. Some green vegetation is growing on the rocks above the pipe. The pipe is dark and appears to be broken or flattened. The rocks are large and angular, with some green plants growing on top. The scene is outdoors, likely near a water body or a drainage system.

Photo No.: 4	Date: 9/05/2023	
Description: Crushed 24-inch dia corrugated metal pipe along the left abutment. (2/2)		

Project Name: Williams Dam	Site Location: Londonderry, Vermont	Project No.: 827442
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Photo No.: 5	Date: 9/05/2023	
Description: 6-inch thick spall at the bottom corner of the low-level structure (at the intersection of the right wall and upstream wall).		

Photo No.: 6	Date: 9/05/2023	
Description: 3-inch scour along the bottom of the right wall of the low-level structure.		

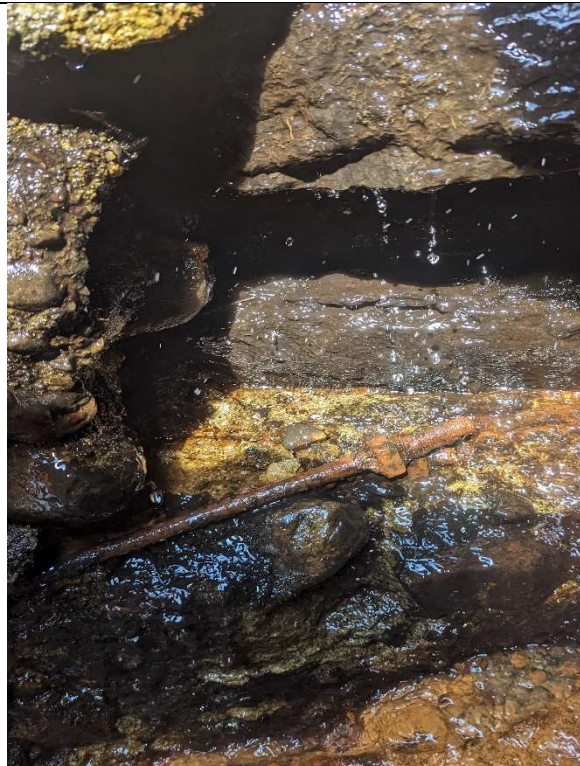
Project Name: Williams Dam	Site Location: Londonderry, Vermont	Project No.: 827442
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Photo No.: 7	Date: 9/05/2023			
Description: Fallen rocks at the outlet of the 6-foot dia corrugated metal pipe (that is part of the low-level structure).				

Photo No.: 8	Date: 9/05/2023			
Description: Missing concrete on the left wall of the low-level structure. Rebar is exposed.				

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Photo No.: 9	Date: 9/05/2023			
Description: Exposed rebar secured to the bedrock below and in proximity to the left wall of the low-level structure.				

Photo No.: 10	Date: 9/05/2023			
Description: Exposed rebar located at the right wall of the low-level structure towards the bottom corner of the right wall and upstream wall.				

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Photo No.: 11	Date: 9/05/2023
Description: Pressurized leakage of the downstream face of the dam structure.	



Photo No.: 12	Date: 9/05/2023
Description: Upstream vertical slide gate of the low-level structure.	



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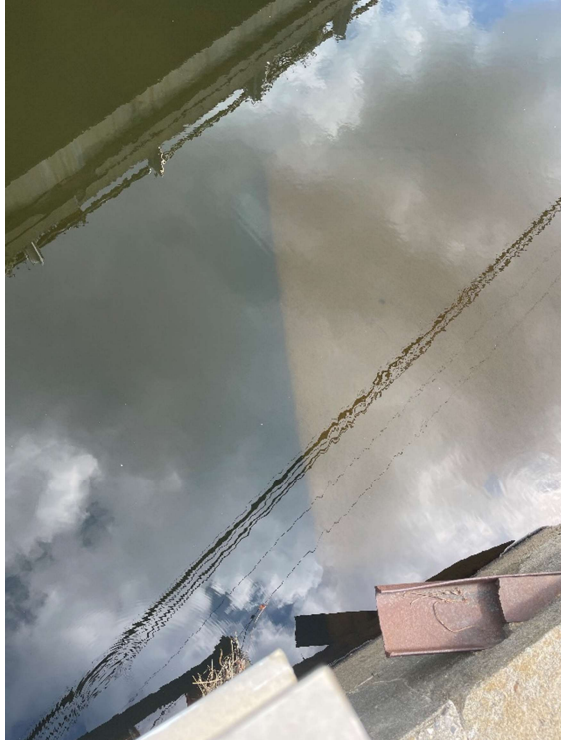
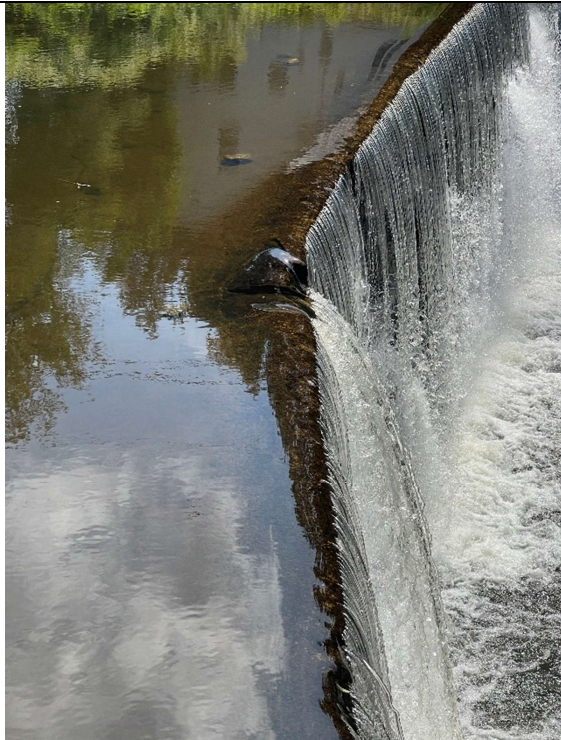
Photo No.: 13	Date: 9/05/2023			
Description: The upstream vertical slide gate of the low-level structure does not appear to be buried in silt. However, the gate stem is bent, as mentioned in the previous inspection.				

Photo No.: 14	Date: 9/05/2023			
Description: Observed notch or even spall on the top of the spillway.				

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Photo No.: 15	Date: 9/05/2023	
Description: Water flow around the left side of the concrete spillway and on top of bedrock, 6 to 12-inches deep.		