



Proactive by Design

GEOTECHNICAL
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ECOLOGICAL
WATER
CONSTRUCTION
MANAGEMENT

DRAFT



MEMORANDUM

To: Mr. Vincent Godino (Ledyard Historical District Commission)

From: James F. Davis, P.E, David M. Leone, P.E. (GZA GeoEnvironmental, Inc)

Date: May 15, 2025

File No.: 05.0047451.00

Re: Visual Dam Evaluation
Lee Brook Pond Dam (CT Dam ID #7219)
Ledyard, Connecticut

GZA GeoEnvironmental, Inc. (GZA) has prepared this Memorandum in accordance with our February 25, 2025 Contract for the Ledyard Historical District Commission (Client) regarding the Lee Brook Pond Dam (Site). The purpose of this memorandum is to summarize available information, discuss observations from a Site visit, and provide recommendations for improvements and next steps. This memorandum is subject to the Limitations in **Appendix A**. References to left and right assume an orientation looking downstream.

BACKGROUND

Lee Brook Pond Dam (also known as Horace Main Dam) is located on Lee Brook in Ledyard, Connecticut, and impounds Lee Brook Pond. Lee Brook Pond Dam is classified as a Hazard Class A dam (Low Hazard Potential). Lee Brook Pond Dam was reportedly built in the mid-19th century with no known original construction date. The dam has a total length of approximately 150 feet and a maximum height of about 4.5 feet. The non-overflow section of the dam consists of an earthen embankment with a downstream masonry wall. A building housing an active sawmill is located about 40 feet from the left abutment. The downstream embankment masonry wall also serves as the upstream building wall.

The spillway is located at the right abutment and consists of an approximate 16.5-foot long, stone masonry broad crested weir with stone steps on the downstream side. At the time of the inspection, approximately 5.5-inches of wooden flashboards were installed. There was approximately 8 and 12 inches of freeboard between the top of the boards and the top of embankment to the left and right of the spillway, respectively.



Photograph 1- Spillway and Typical Embankment Section

A penstock with a wooden gate is located about 40 feet from the left abutment. The penstock consists of an approximate 32-inch-tall and 24-inch-wide rectangular concrete conduit that extends from the inlet to the edge of building. The penstock transitions at the building to a 2-foot diameter steel pipe and discharges to a vertical holding tank with a lower port to operate the turbine. Water from the turbine flows to the spillway downstream channel via a tailrace with masonry walls or sloped channel sides. A former intake structure consisting of a stone masonry manhole was located at the left abutment and has been filled in. The abandonment reportedly consisted of filling the interior with soil and placed stones on top of the structure. A 36-inch diameter reinforced concrete pipe (RCP), which is reportedly the outlet pipe for the former intake structure, is located at the downstream end of the stone masonry walls at the tailrace.



Photograph 2- Wooden gate at penstock



Photograph 3- Tailrace with former outlet pipe



Photograph 4- Abandoned intake at the left abutment (where the rocks are stacked).

Known improvements to the dam are summarized below:

1970s

- Pond drained and bottom cleared with bulldozer.
- Spillway and head race rebuilt.
- Bypass pipe/valve added to intake structure.
- Sawmill was restored.

1983

- Sawmill stone foundation damaged due to overtopping in June 1982.
- A buried concrete wall added to the upstream edge of embankment near sawmill.
- Wall about 6-feet-deep and 18-inches wide at top.
- Wall extends about 24 feet to the left of the penstock intake and 32 feet right of the intake.
- Penstock and gate were reconfigured.

2025

- A permit has been issued to reline the penstock piping. The Project is currently scheduled for summer of 2025.

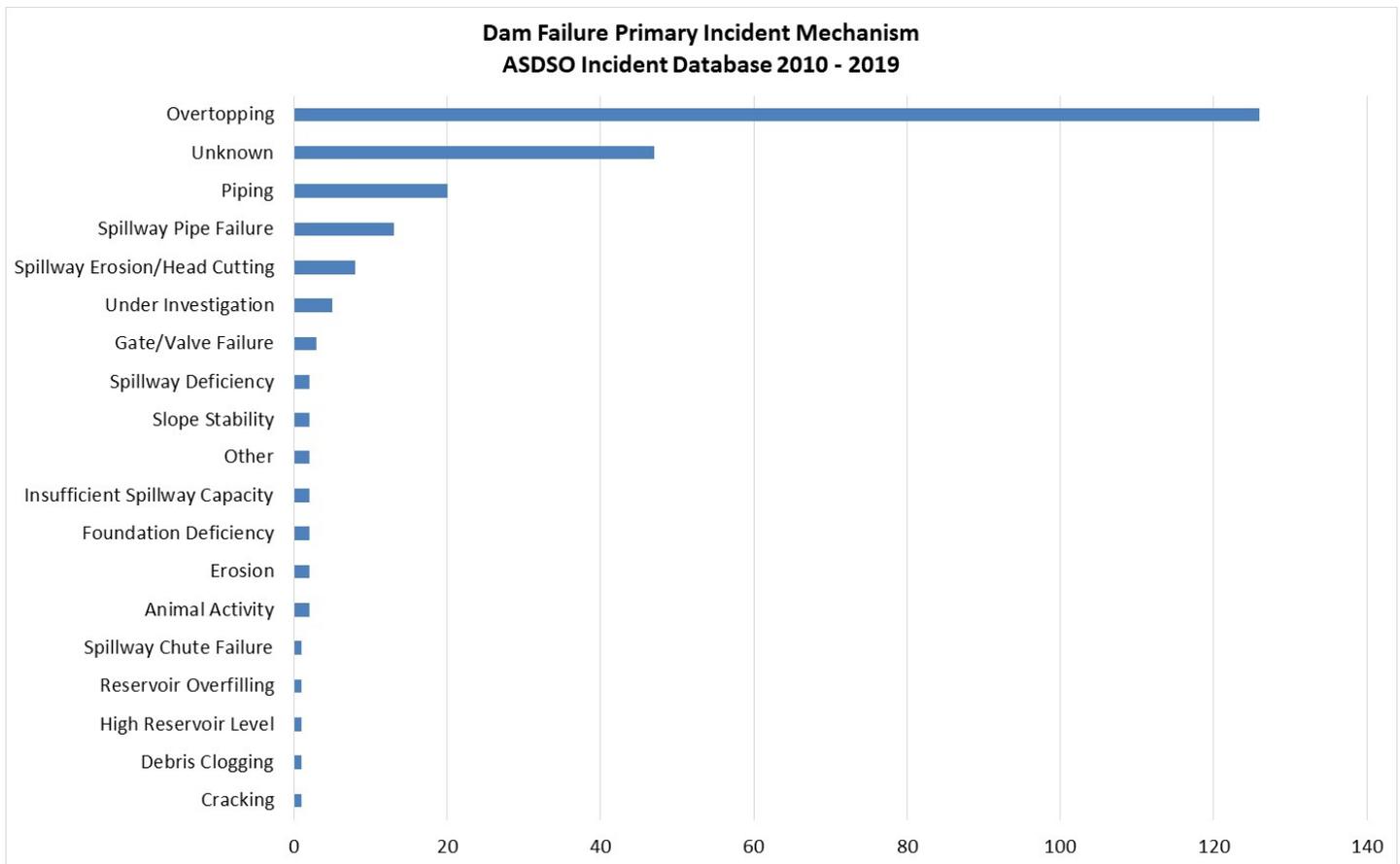


OVERTOPPING

The dam has reportedly overtopped 8 to 10 times in the past 25 years, including twice during the winter of 2023-2024. At least 3 times since 2000, the overtopping water has flowed through the foundation of the mill building which has resulted in voids in the downstream embankment wall / building foundation. During an overtopping event in March 2010, water reached the door of the sawmill building.

Overtopping of an earthen and stone masonry dam is a serious dam safety concern that, left unaddressed, is likely to lead to dam failure. The Association of State Dam Safety Officials (ASDSO) states the following¹:

“Overtopping of a dam is often a precursor of dam failure. National statistics show that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures.”



SITE VISIT

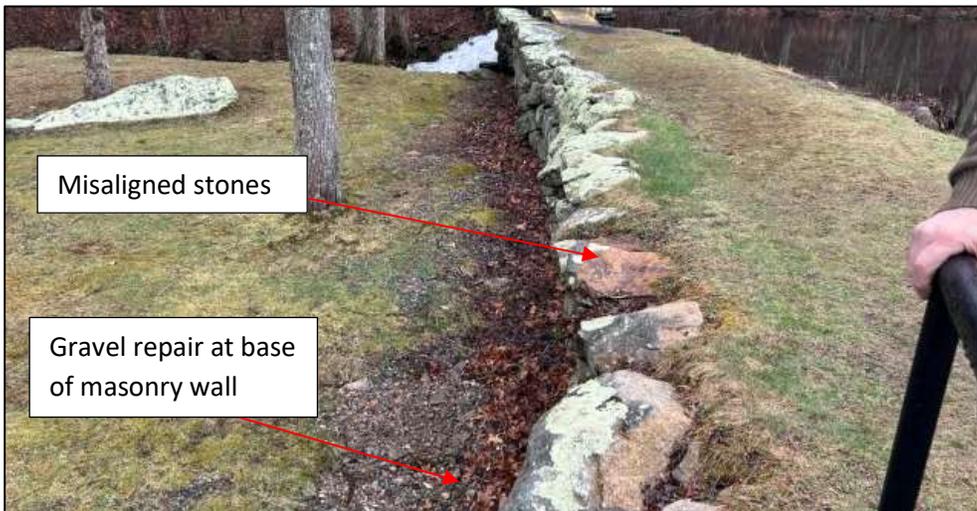
James Davis, P.E. (GZA) visited the dam on April 7, 2025 to view the existing conditions of the dam. In general, the dam appeared well maintained with signs of overtopping damage which are summarized below.

¹ “The Causes of Dam Failure”, Association of State Dam Safety Officials, <https://damsafety.org/dam-failures>

The crest of the embankment was uneven with apparent settlement along the downstream slope of the masonry wall. The downstream masonry wall had displaced stones, which caretakers during the Site visit indicated was progressively worsening and likely a result of overtopping. Gravel repair areas were observed at the toe of the masonry wall from overtopping scour. The tailrace and tailrace masonry walls were in good condition. The spillway appeared in good condition. Caretakers indicated the concrete training walls on either side of the spillway appeared to be shifting downstream, which could be a result of ice damage or excessive flow over the spillway.



Photograph 5- Embankment crest from the Left side of the Spillway



Photograph 6- Downstream Masonry Wall Looking from the Right side of the Penstock

CONCEPTUAL DAM REPAIR ALTERNATIVES EVALUATION

For a Hazard Class A dam, Connecticut Department of Energy and Environmental Protection (DEEP) expects the spillway design flood (SDF) to consist of the 100-year flood with 1 foot of freeboard. On similar projects, GZA has also used the 500-year flood with no freeboard.

GZA performed a cursory and preliminary hydraulic and hydrology (H&H) analysis to estimate the overtopping water levels during the 100- and 500-year flood using the USGS StreamStats online application. Note that the results of this preliminary analysis are subject to change, including a significant increase in estimated flood flows, after a detailed H&H analysis is performed. The peak-flows during the 100-year and 500-year flood are approximately 400 and 600 cubic feet per second

(cfs)², respectively. The spillway capacity with and without the flashboards in place is approximately 32 cfs and 63 cfs, respectively. Table 1 below summarizes the estimated overtopping depth during the various storms:

Table 1- Estimated Overtopping Depths

Design Storm	Inflow (cfs)	Overtopping with flashboards	Overtopping without Flashboards
100-year	400	1.3 feet	1.2 feet
500-year	600	1.7 feet	1.6 feet

In addition to overtopping of the dam, deficiencies included an uneven crest, erosion at the masonry wall downstream toe, misaligned stones in the wall, and voids in portions of the downstream wall at the sawmill building. GZA has developed two repair concepts consisting of overtopping protection and constructing an auxiliary spillway, as described below. GZA also initially evaluated raising the embankment to pass flood flows through the current spillway only. The embankment would have to be raised approximately 4 feet, which includes 1 foot of freeboard for the 100-year storm, which does not appear feasible based on access limitations such as the door to the sawmill building.

Option 1- Overtopping Protection

Potential overtopping protection would consist of grouted riprap or articulated concrete blocks (ACBs) on the embankment crest and extending 10 to 15 feet downstream of the masonry wall. During the construction of the overtopping protection, the embankment crest should be regraded to a consistent elevation. The portions of the embankment at the mill building could be raised higher to keep overtopping away from the building. Trees within 25 feet of the dam would be removed and the downstream masonry wall would be reset during construction. A concept plan of the overtopping protection is shown below.



Photograph 7- Proposed overtopping concept.

² USGS StreamStats Online Report accessed April 14, 2025.

Option 2- Auxiliary Spillway

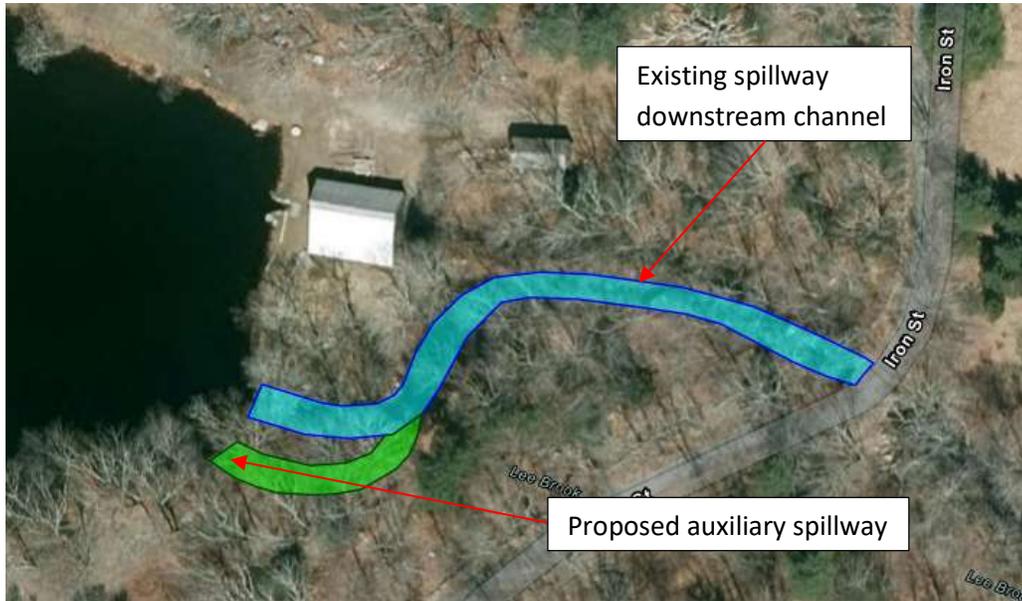
An auxiliary spillway could be constructed at the right abutment to supplement flow. The embankment crest would be regraded to a consistent elevation and the auxiliary spillway would be set approximately 6-inches above the current top of flashboards. Conceptual auxiliary spillway sizes are provided in **Table 2**. The analyses included raising the existing grade of the embankment to reduce the proposed auxiliary spillway length.

Table 2: Conceptual Auxiliary Spillway Sizes

Height Embankment Raised from existing Grade (ft)	Primary Spillway Capacity (cfs)	Auxiliary Spillway Capacity (cfs)	Auxiliary Spillway Length (ft)
1	145	460	115
1.5	200	420	65
2	250	345	37

1. Height of embankment raised as measured adjacent to the spillway. Due to uneven embankment elevation, a consistent grade raise is not anticipated.
2. Proposed auxiliary spillway length based on a 500-year spillway design flood without flashboards.

During construction, a new downstream channel would be constructed between the auxiliary spillway and existing spillway downstream channel. A conceptual plan of the auxiliary spillway is shown below. In addition to the spillway construction, trees would be removed from the proposed auxiliary channel and within 25 feet of the dam and the displaced stone masonry would be reset. Note this alternative will require additional study to confirm that the auxiliary spillway does not worsen downstream flooding.



Photograph 8- Proposed auxiliary spillway concept.

PERMITTING

The full extent of the permits which may be required will depend on the results of additional analyses, pre-permitting meetings, and the final design. At this conceptual stage, GZA anticipates the following permits will be required:

- CTDEEP Dam Safety Program Individual Permit;
- State Historic Preservation Office;
- CTDEEP Fisheries; and



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- USACE GP-2 Pre-Construction Notification.

NEXT STEPS

Once a preferred alternative is selected, the following studies/coordination will be required:

- Topographic Survey of the existing dam and limits of proposed improvement;
- Wetland delineation within the Work area;
- Detailed hydrologic and hydraulic analyses;
- Coordination with DEEP regarding spillway design flood;
- Design of overtopping protection structurally and hydraulically (for the overtopping option);
- Design of auxiliary spillway structurally and hydraulically (for the auxiliary spillway option). This includes confirming that the proposed auxiliary spillway would not worsen downstream flooding;
- Pre-permitting meetings;
- Preparation of construction bid documents; and
- Preparation of permits.

CLOSING

We trust that this memorandum provides the information requested. If there are any questions or comments, please do not hesitate to contact James Davis (860-462-3016, james.davis@gza.com).

Attachments

- Appendix A - Limitations



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Appendix A
LIMITATIONS

**DRAFT****USE OF REPORT**

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of Ledyard Historical District Commission (Client) for the stated purpose(s) and location(s) identified in the Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).
3. Our services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

SUBSURFACE CONDITIONS

4. If presented, the generalized soil profile(s) and description, along with the conclusions and recommendations provided in our Report, are based in part on widely-spaced subsurface explorations by GZA and/or others, with a limited number of soil and/or rock samples and groundwater /piezometers data and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the conclusions and recommendations of this report.
5. Water level readings have been made in test holes (as described in the Report), monitoring wells and piezometers, at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the groundwater and piezometer levels, however, occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, reservoir and tailwater levels, the presence of subsurface utilities, and/or natural or artificially induced perturbations.

GENERAL

6. The observations described in this report were made under the conditions stated therein. The conclusions presented were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of described services or the time and budgetary constraints imposed by the Client.
7. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein available to GZA at the time of the evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.
8. Any GZA hydrologic analysis presented herein is for the rainfall volumes and distributions stated herein. For storm conditions other than those analyzed, the response of the site's spillway, impoundment, and drainage network has not been evaluated.



9. Observations were made of the site and of structures on the site as indicated within the report. Where access to portions of the structure or site, or to structures on the site was unavailable or limited, GZA renders no opinion as to the condition of that portion of the site or structure. In particular, it is noted that water levels in the impoundment and elsewhere and/or flow over the spillway may have limited GZA's ability to make observations of underwater portions of the structure. Excessive vegetation, when present, also inhibits observations.
10. In reviewing this Report, it should be realized that the reported condition of the dam is based on observations of field conditions during the course of this study along with data made available to GZA. It is important to note that the condition of a 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 inspection and care can there be any chance that unsafe conditions be detected.

COMPLIANCE WITH CODES AND REGULATIONS

11. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.
12. This scope of work does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

COST ESTIMATES

13. Unless otherwise stated, our cost estimates are for comparative, or general planning purposes. These estimates may involve approximate quantity evaluations and may not be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over the labor and material costs required to plan and execute the anticipated work, our estimates were made using our experience and readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

ADDITIONAL SERVICES

14. It is recommended that GZA be retained to provide services during any future: site observations, explorations, evaluations, design, implementation activities, construction and/or implementation of remedial measures recommended in this Report. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.