MBA ENGINEERS, INC.
STRUCTURAL CIVIL GEOTECHNICAL

MBA Engineers Inc – Geotechnical Department
2717 6th Avenue South, Birmingham, AL 35233

December 17, 2021

Mayor Donna Hanby
Town of Highland Lake
612 Lakeshore Drive
Highland Lake, AL 35121

Subject: Informal Dam Inspection
Highland Lake Dam
Town of Highland Lake, Alabama
MBA Reference Number: G21-047.00

Dear Mayor Hanby:

MBA Engineers has completed the authorized Informal Dam Inspection of the Highland Lake Dam located at the Town of Highland Lake in Blount County, Alabama. Our services were performed in general accordance with the scope of services outlined in our Proposal Number G9059-21R dated June 1, 2021.

We understand there is very little design or inspection information on the Highland Lake Dam. A number of informal inspections were conducted in the past; however, the Town of Highland Lake does not have access to the majority of these reports. The purpose of our geotechnical study was to provide an informal inspection in the event structural issues with the dam or spillway have been exposed. We understand the Town of Highland Lake is also attempting to organize accurate records of the dam for the future.

1.0 SCOPE OF SERVICES

The objective of the exploration is a visual inspection of the Highland Lake Dam and Spillway. The visual and informal inspection were conducted based on industry guidelines from a typical Dam Safety Program. Based on the objectives, the following is our proposed scope of services.

1. Existing Documentation Review: Prior to the site visit, previous inspection documentation was reviewed. Documentation review included an informal inspection from Malcolm Pirnie (in 2008) and Bhate Geosciences (2005). However, we understand a formal exploration was conducted by the Army Corp of Engineers in 1978; however, we do not have access to the existing 1978 document.

2. Visual Dam Inspections – The Visual Dam Inspection Checklist has been included in the appendix. Informal inspections of the dam and spillway typically include but are not limited to the following:

    1. Visual inspection of the dam crest including documentation of settlement, subsidence, and tension cracks.
    2. Document water level of lake at the time of the inspection. The elevation will be estimated if possible.
    3. Document upstream slope cover and protection.
    4. Document upstream slope anomalies such as erosion, settlement, or cracking
    5. Document any erosion or water seepage on downstream slope.
    6. Document evidence of slope sloughing or slides on downstream slope.

7. The informal inspection will not include a formal slope stability analysis. A formal slope stability analysis will require soil test borings and a survey of the existing slope conditions and geometry.
8. Document flow of Principal and Emergency Spillway. Note any obstructions or debris altering the flow of the spillways.
9. Document leaks around Principal and Emergency Spillway.
10. Inspection of structural defects of the Spillway system including the presence of cracks or holes.

2.0 REFERENCE MATERIALS

A formal survey and dam inspection was not provided during our informal report; however, the following referenced materials were utilized during the observation and report:

1. Highland Lake Field Visit by Kevin Ruswick with Malcolm Pirnie dated September 19, 2009

2. Limited Dam Inspection by David Johnson, P.E. with Bhate Geosciences dated July 25, 2005

3. Quarterly Dam Inspection by John Hand with Town of Highland Lake dated October 2, 2021

4. Discussions with Joe Hayden – Resident on Highland Lake from 1963 to 1970 and 1985 to 2021.

5. National Inventory of Dams - https://nid.usace.army.mil/

6. Federal Guidelines for Dam Safety by Interagency Committee on Dam Safety, FEMA, April 2004

2.0 INFORMAL DAM INSPECTION AND KNOWN HISTORY

The Highland Lake Dam is located to the southwest of the Town of Highland Lake in Blount County, Alabama. Highland Lake is located on the Blackburn Fork of the Little Warrior River to the south of Oneonta, Alabama. The Blackburn Fork/ Little Warrior flows north to south at the dam location.

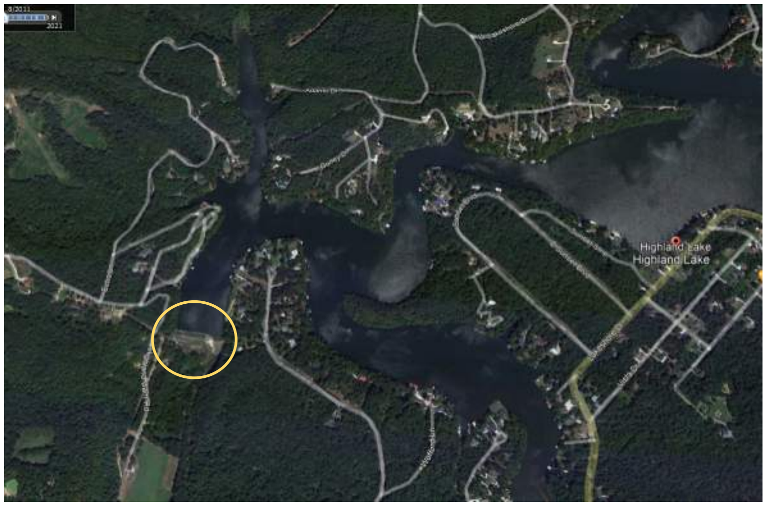

Figure 1: Location of Highland Lake Dam

The following was noted regarding visual observation of the dam. All measurements were conducted with a tape measure and measuring wheel, and should be considered approximate. We recommend a formal survey to verify elevations and measurements:

- The Highland Lake Dam is a rockfill/ earth dam primarily used for recreation. According to National Inventory of Dams, the dam is considered a "High[1] hazard category". A hazard category has not been applied in accordance with Hazard Potential Classification System Guidelines from FEMA; however, we estimate at least a "Significant hazard risk. If the dam failure would potential damage the Inland Lake Dam, the Highland Lake Dam would be considered "high".

- According to Mr. Joe Hayden, the dam was operational by March 1955, and the foundations of the dam were constructed by excavating to underlying rock. The area of the existing spillway was an existing hillside that was blasted/ excavated. According to Mr. Hayden, the interior of the dam consists of a clay core, and the blasted sandstone rock from the spillway was used on the exterior of the clay core. We recommend borings to verify the material components of the dam.

- The exterior embankment/ dam material appears to consist of boulder fill (shot sandstone); however, riprap sized limestone boulders were observed at the east and west wings of the dam.

- Dam Crest: The dam length at the crest is approximately 516' long (including concrete spillway), and the crest is approximately 16' wide. The crest consisted of limited grass and a dirt roadway. No notable signs of settlement or surface cracks were observed.

- Upstream Slope: The estimated slope inclination of the upstream slope was on the order of 3.5 H to 1 vertical, and the slope was approximately 25' in height to the existing water height. The upstream slope primarily consisted of maintained grass; however, limestone riprap boulders were located on the east and west wing of the slope and the toe of the slope (near the water) to prevent erosion from wave action. According to Mr. Hayden, the riprap was placed in 2009. No major slope issues were observed in the upstream slope.

[1] "High" Classification indicates probable loss of life and large economic and environmental damages. "Significant" risk indicates no loss of life but significant economic damages.

- Downstream Slope: The estimated slope inclination of the downstream slope was on the order of 1.2 H to 1 vertical, and the slope was approximately 75' in height. The following was noted along the downstream slope:

  - The downstream slope primarily consisted of sandstone boulders; however, limestone riprap boulders were located on the west wing of the slope.

  - Thick shrubs were observed in the southwest corner that need to be cleared to observe potential issues in the area. This area of the downstream slope could not be visually observed.

  - No evidence of surficial slope stability issues including sloughing, subsidence, depressions or movement at the toe were observed. However, a 1.2 horizontal to 1 vertical slope would be considered very steep and potentially unstable, even for rock/ boulder fill.

  - Seepage was not observed in the downstream slope; however, seepage was observed at the toe of the slope (see toe area).

- Slope Berm/ Abutment: An abutment/ berm feature is located to the west of the concrete spillway, and based on conversations with Mr. Hayden, the berm likely consists of sandstone boulders excavated during construction of the dam. The berm creates a road/ access to the creek that is formed at the base of the dam spillway apron. The berm appears to consist of rock fill and sub-mature trees.

- Downstream Toe Area: The toe area of the downstream slope primarily consisted of large sandstone boulders and no erosion was observed at the slope/ toe contact. No signs of movement or depressions were observed at the toe. Water seepage was observed at three (3) locations (See Figure 2), and the following was noted:

  - Seepage 1 observed in the Southwest corner at the toe of the general area of the limestone riprap. Flow at Seepage 1 consisted of approximately 0.5 gals/min. Mr. Hayden stated the seepage from Seepage 1 appears to be a result of water from the western hillside and not from the lake. Prior to installing the riprap, an erosion ditch had been created between the dam and the natural grade due to the constant seepage from the western hillside. In 2009, the drainage ditch at the base of the dam and along the slope were backfilled with limestone riprap by Mr. Hayden to prevent additional erosion.

  - Seepage 2 was observed at the location of the abutment corner in the middle length of the downstream slope. Estimated flow consisted 3 gal/min.

  - Additional seepage (Seepage 3) was observed between Seepage 1 and 2. Seepage flow appears to be less than 1.0 gal/min.

  - The majority of the toe area consisted of soft, saturated clay. The depth of soft clay is unknown; however, based on probing with a steel rod, the soft conditions extended to at least 3' below the existing surface.

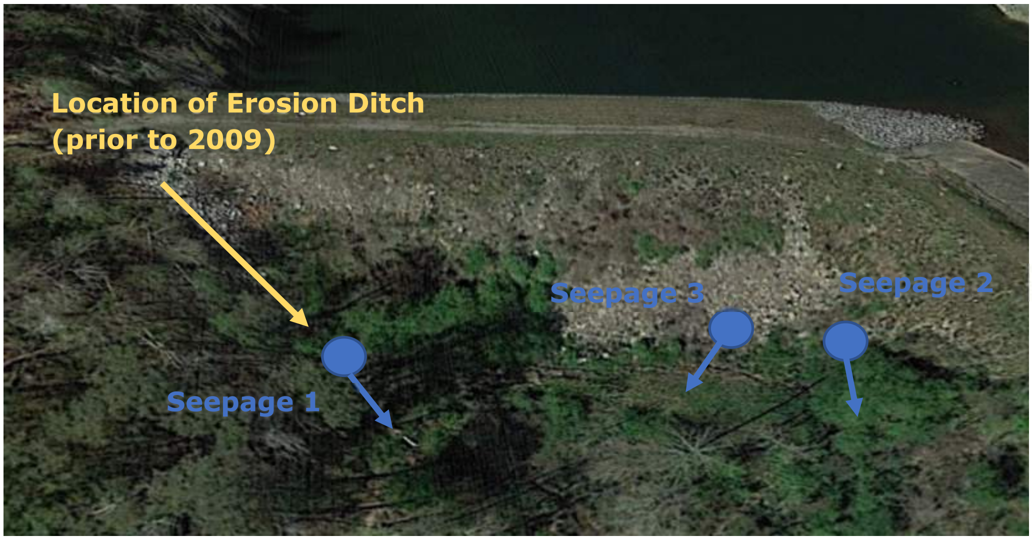

Figure 2: Approximate Location of Observed Seepage at Toe of Downstream Slope

- Dam Spillways: The dam flow is maintained primarily by a 36″ drawdown pipe (primary spillway) and concrete spillway (secondary). The 36″ drawdown pipe is typically open after October, and the concrete spillway is typically used during the warmer months. A rusted pipe was observed in the southwest corner of the downstream toe; however, we understand this pipe has been abandoned.

- 36″ Drawdown Pipe Entrance Channel: The entrance channel for the 36″ pipe consists of a 12″ wide concrete channel. The bottom of the channel could not be viewed during the site visit due to flowing water; however, no noticeable debris or vegetation was observed. The walls/ slopes of the channel are concrete and appear to be stable.

    - According to Mr. Hayden, the concrete entrance channel for the 36″ Pipe was constructed in 2015. The entrance channel additions were constructed to help prevent water from flowing under and undermining the spillway apron.

    - A slide gate is used at the entrance of the 36″ reinforced pipe to control water through the primary spillway. The slide gate has some wearing including rusty bolts.

- Spillway Entrance Channel: The spillway entrance channel consists of boulders and soil. We observed a geofabric lining beneath the boulders and soil material, and according to Mr. Hayden, the fabric is an impermeable rubber lining that was installed in 2015. The wings of the entrance channel consist of concrete (from Pipe Channel) on the easter portion and riprap to the west.

- Concrete Spillway History: According to Mr. Hayden, we understand the following in regards to the history of the Concrete Spillway:

1. When initially constructed, the spillway was only 12′ wide, and the spillway was constructed by blasting into the side of the mountain. Sandstone is exposed on the eastern walls of the spillway and apron.

2. A flood occurred in the late 1970′s where water rose to within 5′ or 6′ of the top of the dam. Based on a Phase 1 Inspection by the Mobile District of the U.S. Army Corps of Engineers between June 1977 and March 1978, the report concluded the

dam was in "potentially unsafe condition due to insufficient spillway capacity, embankment stability concerns, seepage issues, lack of low level outlet, and substantial vegetal growth."

3. As a result of the damage of the flood and the Phase I inspection, the spillway was reconstructed in October of 1977. The 1977 reconstruction consisted of the following:

    a. Installation of the 36" reinforced concrete pipe (primary) at an elevation of 887.8' (according to Malcolm Pirnie report).

    b. The fixed spillway was widened into the mountain side which required heavy blasting of sandstone rock. The current length is 162'. According to Mr. Hayden, the blasted rock was used to build-up and level the downstream apron.

    c. The spillway was poured with a new reinforced concrete slab.

4. Because the shot-rock (sandstone) was used beneath the concrete apron slab, water was allowed to percolate under the concrete spillway and through the underlying voided shot rock. Heavy water seepage was observed at the toe of the apron between the concrete and the underlying sandstone; therefore, a clay cutoff trench was installed in the entrance channel to slow the water seepage. According to Mr. Hayden, the trench was excavated to rock and backfilled with clay.

5. The clay cutoff trench prevented seepage for a number of years; however, around the year 2000, heavy seepage was observed at the toe of the apron between the concrete and underlying sandstone. In 2007, Mr. Hayden stated the clay cutoff trench was excavated and replaced with a concrete cutoff trench.

- <u>Concrete Spillway Crest and Apron</u>: The following was observed on the concrete spillway crest and apron:

    - The spillway is currently concrete lined. The concrete has some weathering with a number of aggregate pieces missing.

    - The spillway length at the crest is approximately 162'. The downstream apron is approximately 128' long from the crest to the end of the concrete.

    - One concrete joint is located 12' below the crest of the spillway. The joint has noticeable erosion, and the joint is the approximately the same elevation as the 36" drawdown pipe. The joints needs to be sealed.

    - Relief valves were observed in the concrete at a 14' to 18' grid spacing. We are unaware if the relief valves are working as the water was not flowing over the crest of the spillway.

    - Water seepage was observed between the toe of the concrete apron and the underlying sandstone. The seepage appeared to be flowing at approximately 5.0 gpm.

- <u>Spillway Wing Walls</u>: The eastern wings consist of a natural sandstone wall. The western wing walls consist of the slope of the abutment/ berm feature. The western wing wall has been capped with concrete, and no notable slope issues were observed along either wing wall.

- Abandoned Emergency Pipe: An abandoned spillway pipe was observed in the southwest corner of the downstream slope. According to Mr. Hayden, the 36” pipe was originally installed with the construction of the dam as a relief valve; however, the pipe had significant seepage issues from the start. According to Mr. Hayden, the seepage persisted from 1958 to 1970. Eventually, the pipe was welded shut in the early 1970’s at the entrance of the pipe on the upstream side. In addition to welding the entrance of the pipe, the dam operator’s were concerned the pipe may collapse under the weight of the dam; therefore, the pipe was backfilled and sealed with gunite in the early 1970’s.

3.0 DAM CONSIDERATIONS AND RECOMMENDATIONS

In view of the observations from the dam, the following should be considered in regards to the health of the dam:

3.1 SEEPAGE AT TOE OF DOWNSTREAM SLOPE

As previously discussed, water seepage was observed at three (3) locations at the toe of the downstream slope. During our site visit, the water seepage was minor and does not appear to be affecting the lake level. However, the soils at the base of the downstream slope appear to be saturated as a result of the seepage.

Potential Slope Stability Issues: Based on the height, size, and estimated geometry (1.2 H to 1.0 V) of the downstream slope, we recommend the downstream slope be analyzed for potential stability issues. In addition, the presence of saturated soils at the toe would increase the potential risk of slope stability failure at the dam. As a minimum, the subsurface conditions at the toe of the slope should be explored to determine the potential slope stability risk. If the downstream slope was determined to have an elevated risk of global failure, the downstream slope would likely require an a rock buttress and abutment to increase stability and decrease the risk of a global slope (and dam) failure.

Controlling Water Seepage: As a minimum, water seepage should be controlled so the foundation soils at the toe of the slope do not continue to be saturated. Trench drains should be considered to collect water from the toe of the slope to the existing creek in order to control the water.

Continue Monitoring Water Seepage: As previously discussed, we are unaware of the origin of the water seepage, and the location in the southwest corner maybe seepage from the western hills. We recommend continuously monitoring the seepage to determine if seepage flow is increasing. If seepage flow increases, additional stabilization measures would have to be considered.

3.2 CONCRETE SPILLWAY/APRON COMMENTS

Since 1977, the concrete spillway has been patched and reconstructed a number of times. The following defects were noted during our informal visit:

1. The concrete joint located along the concrete apron has noticeable erosion and likely has water seepage during summer months. We recommend the joint to be sealed.

2. Water Seepage at Apron Toe: Water seepage was observed between the apron toe and the underlying sandstone. The water seepage is low and does not appear to be affecting the lake elevation. We understand larger water seepage issues have been observed in this area that required stabilization measures such as installing the concrete cutoff trench. The cutoff trench appears to be working effectively; however, we recommend monitoring the water seepage to determine if the seepage is increasing.

3. Valve Gate: We did not monitor the valve gate when it was closed to determine the effectiveness. However, a number of components were rusty including some of the valve bolts. Consideration should be given to replacing rusty parts of the valve structure.

3.3 FORMAL DAM INSPECTION

Dam Safety Guidelines: The State of Alabama has no guidelines for Dam Safety Programs or the frequency of dam inspections. However, based on the *Federal Guidelines for Dam Safety* (2004), the following is recommended for federal dams:

- *A formal inspection is required periodically to verify the safety and integrity of the dam and appurtenant structures. Formal inspections should include a review to determine if the structures meet current accepted design criteria and practices. Formal inspections should be made periodically at intervals not to exceed 5 years. Depending on past experience or the project history, some dams may require more frequent formal inspections.*

Based on the 2008 Malcolm Pirnie Report, a formal Phase I inspection has not been conducted since 1978, and the Phase I inspection report concluded that "the dam was in a potentially unsafe condition due to insufficient spillway capacity, embankment stability concerns, seepage issues, lack of low level outlet and substantial vegetal growth". Based on our visual inspection and discussions with Mr. Hayden, many of these issues have been addresses since 1978; however, there are still embankment stability concerns and seepage issues.

Additionally, the Phase I report also indicated potential capacity issues during a Probable Maximum Flood (PMF) with the spillway in 1978; however, we understand adjustments were made to the spillway shortly after the noted issues in 1978. Regardless of the reconstruction of the dam and spillway, a formal inspection has not been conducted to determine if the reconstructed dam structure meets current attempted design criteria and practices.

Formal Dam Inspection: We recommend conducting a formal inspection to determine if the current dam conditions meet design criteria and practices. Formal dam inspections typically require the following:

1. The inspection should include a review of all pertinent documents including instrumentation, operation, and maintenance and, to the degree necessary, documentation on investigation, design, and construction.
2. The formal inspection would review possible stream runoff scenarios and calculate the PMF for the dam area. The dam and spillway would be analyzed to determine if the structure can handle the estimated PMF capacity.
3. The stability of the downstream slope would be analyzed.
4. All formal inspections should be conducted by a team of highly trained specialists.
5. To assure that a dam and its appurtenant facilities are thoroughly inspected, checklists should would cover the condition of struc tural and mechanical features.
6. This inspection should also verify that operating instructions are available and understood, instrumentation is adequate and data is assessed to assure structures are performing as designed, and there are emergency provisions for access to and communication with all project operating facilities.
7. Formal and special inspections should be conducted under the direction of licensed professional engineers experienced in the investigation, design, construction, and operation of dams.

4.0 GENERAL REMARKS AND LIMITATIONS

This report has been prepared for the exclusive use of **Mayor Donna Hanby with the Town of Highland Lake** for specific application to the subject project and is non-transferable to any third party without prior consent from MBA Engineers. All recommendations contained in this report have been made in accordance with generally accepted soil engineering practices in the area where the services were performed. No other warranties are implied or expressed.

An article published by the Geoprofessional Business Association (GBA), titled Important Information About Your Geotechnical Report, has been included in the Appendix. We encourage all individuals to become familiar with the article to help manage risk.

We appreciate the opportunity to work with you and we look forward to assisting you through the design and construction phase of this project. If you have any questions or need any additional information, please call us.

Respectfully submitted,
MBA ENGINEERS, INC

Drew Thornbury, P.E.
Geotechnical Principal Engineer

MBA Engineers Inc – Geotechnical Department
2717 6th Avenue South, Birmingham, AL 35233

VISUAL DAM INSPECTION CHECKLIST

TYPE OF INSPECTION: (formal, regular, informal): Informal

DAM NAME: Highland Lake Dam

MBA PROJECT NO.: G21-047.00

LOCATION: Town of Highland Lake

OWNER: Bill Towns (According to National Inventory of Dams)

OPERATOR: None

DATE OF INSPECTION: 11-19-21

RESERVOIR INFORMATION

Normal Reservoir Elevation (ft): Estimated 895.0' full pool (according to quarterly dam inspection dated 10-2-21 provided by John Hand. The actual normal reservoir elevation is unknown.)

Reservoir Elevation at time of inspection (ft): Measured approximately 5.5' lower than crest of spillway elevation.

WEATHER CONDITIONS (including recent rainfall): Closest weather station is Oneonta, AL.

- High Temp = 61 degrees
- Low Temp = 33 degrees
- Precipitation (Day of) = 0.03"
- Precipitation from Week Prior = 0.72"

INSPECTION PERSONNEL

- Drew Thornbury, P.E – MBA Engineers
- John Hand – Town of Highland Lake

GENERAL INFORMATION

Name of Dam: Highland Lake Dam

Fed. I.D. No. AL01168 AL Dam No.: AL01168

River Basin: Blackburn Fork/ Little Warrior River

Town: Highland Lake Community County: Blount County

Nearest Downstream City-Town: Inland Junction

Stream Name: Blackburn Fork/ Little Warrior River Tributary of: Locust Fork

Latitude (N): 33.881234 Longitude (W): -86.434252

Type of Dam: Rockfill, Earth

Purpose of Dam: Recreation

Hazard Category: High (according to National Inventory of Dams) Class III or IV Estimated

Drainage Area (sqr mls): unknown

Height (ft): 75' downstream (estimated) Length (ft): 516' (measured with wheel measurement)

Normal Surface (ac): N/A Normal Capacity (af): N/A

Maximum Capacity (af): N/A Spillway Capacity (cfs): N/A

HISTORY

Date Constructed: estimated 1953 Dates(s) Reconstructed: N/A

Designer: Unknown Constructed By: Unknown

Owner & Address: Town of Highland Lake – 612 Lakeshore Drive, Highland Lake, AL 35212

Owner/Operator present during inspection (yes or no): John Hand (representive)

PREVIOUS INSPECTIONS (date of)

Last Inspection: 10-2-21 Last Regular Inspection: 10-2-21

Phase I Inspection: March 1977 Last Formal Inspection: Unknown

EMERGENCY ACTION PLAN: (Required for all Class I and Class II dams)

No Emergency Action Plan has been implemented.

DOWNSTREAM HAZARD CLASSIFICATIONS

Present Hazard Classification: No official classification. Estimated "Significant" Hazard

Changes in Downstream Land Use and Habitation: none

Is present classification appropriate? Need formal investigation to determine hazard classification.

OPERATION AND MAINTENANCE

Date of Operation and Maintenance Plan: No operation or maintenance plan

Are instructions adequate? N/A

Do operating personnel follow instructions? N/A

What are operating personnel capabilities? N/A

EXAMINATION OF EMBANKMENT DAMS AND DIKES

DESCRIPTION OF STRUCTURE

Embankment Material: Boulder Fill (Sandstone). Limestone riprap located on wings of the dam

Cutoff Type: Concrete cutoff at spillway entrance (according to Mr. Joe Hayden)

Impervious Core: Clay core (according to Mr. Joe Hayden)

Internal Drainage System: Unknown. Abandoned/ sealed emergency valve pipe in southwest corner

Movement (Horizontal and Vertical Alignment): Stream flows North to South

Junctions with Abutments or Embankments: A large (narrow) abutment feature is located between the apron and the downstream slope. The abutment separates the apron from the remaining downstream areas (See Figure 1 for location). The abutment may have been constructed as a roadway to access the bottom of the dam.

Figure 1: Abutment Feature between Apron and Downstream Slope

Miscellaneous:

NOTE: ALL MEASUREMENTS ARE TAKEN BY MEASUREMENT WHEEL AND SHOULD BE CONSIDERED APPROXIMATE.

CREST

Vertical Alignment: 16' wide

Horizontal Alignment: 520' long

Surface Cracks: None observed

Settlement: None observed

Unusual Conditions: Steep drop off on downstream slope. Crest can be accessed with a vehicle.

UPSTREAM SLOPE

Slope (Estimate) (H:V): 3.5 horizontal to 1 vertical (estimated)

Trees, Undesirable Growth or Debris, Animal Burrows: minor shrubs

Sloughing, Subsidence or Depressions: None observed

Slope Protection: Majority consists of maintained grass. Riprap is located along the shoreline for wave protection. Riprap is located on western wing, and 30’ of riprap is located adjacent to the concrete spill way. No major slope protection issues were observed.

Figure 2: Location of Rip-Rap located on Upstream Slope

Surface Cracks or Movement at Toe: None observed. Could not be viewed clearly due to the presence of rip rap.

Unusual Conditions:

DOWNSTREAM SLOPE

Slope (Estimate) (H:V): 1.2 Horizontal to 1 Vertical

Trees, Undesirable Growth or Debris, Animal Burrows: No animal burrows. Thick shrubs were observed in the southwest corner that need to be removed. This area could not be observed due to thick shrubs and steep slope.

Sloughing, Subsidence or Depressions: No evidence of sloughing

Surface Cracks or Movement at Toe: None observed

Seepage: None along slope. All seepage was observed at the toe of the slope. (See Toe Area below)

External Drainage System (Ditches, Trenches, Blanket): None observed

Condition Around Outlet Structure: N/A

Unusual Conditions:

 

Figures 3 and 4: Downstream Slope Conditions

ABUTMENTS AND TOE AREA

Erosion at Contact: None. Consisted of large sandstone boulders.

Seepage or Wet Area Along Contact: Figure 5 shows the location of observed seepage. The following was observed at the seepage areas:

1. Seepage 1 observed in the Southeast corner in the general area of the riprap. Estimated flow was approximately 0.5 gals/min.
2. Seepage 2 was observed at the location of the abutment corner in the middle length of the downstream slope. Estimated flow consisted 3 gal/min.
3. Additional seepage (Seepage 3) was observed between Seepage 1 and 2. Estimated flow was less than 1 gal/min
4. The majority of the toe area consisted of saturated clay. I was able to penetrate my 3' probe rod to the handle bar due to soft soils.

Signs of Movement: None observed

Depressions, Sinkholes: None observed

Unusual Conditions: N/A

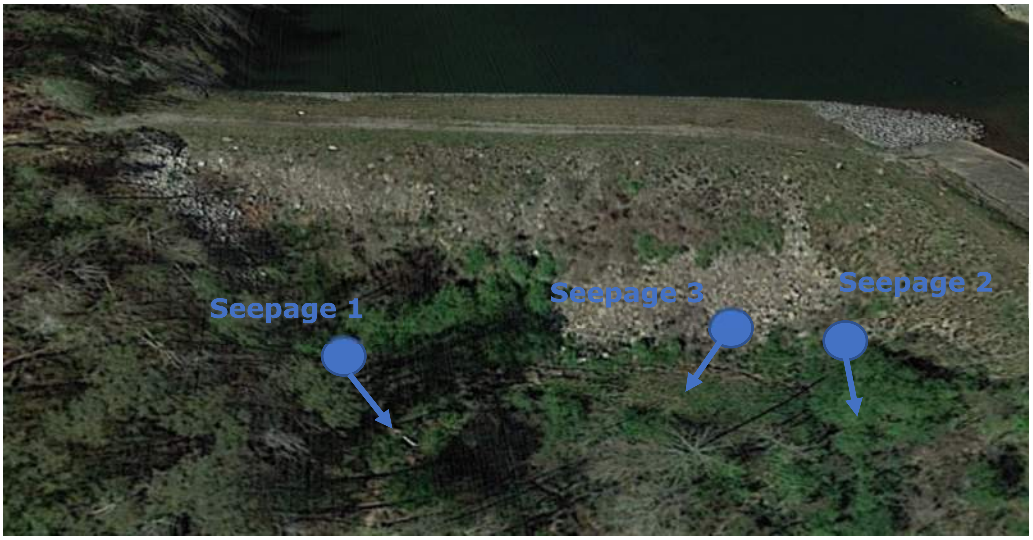

Figure 5: Approximate Location of Observed Seepage at Toe of Downstream Slope

Figures 6: Boulders Located at Toe of Downstream Slope. Picture near Seepage 1

Figures 7: Water ponding and soft soils at toe of downstream slope

SEEPAGE AND TOE DRAIN / RELIEF WELL FLOW SUMMATION

Location	Estimated Flow	Color (Turbidity)
Seepage 1	0.5 gals/min	clear
Seepage 2	3 gal/min.	clear
Seepage 3	>0.5 gals/min	clear

EXAMINATION OF SPILLWAYS AND OUTLET WORKS

TYPE(S) AND DESCRIPTION OF SPILLWAY(S)

Primary: 36" Pipe used for drawing water down

Secondary (auxiliary): Concrete Spillway

Emergency: None

Other:

FOR EACH SPILLWAY THE FOLLOWING ASPECTS MUST BE EXAMINED WHERE APPROPRIATE

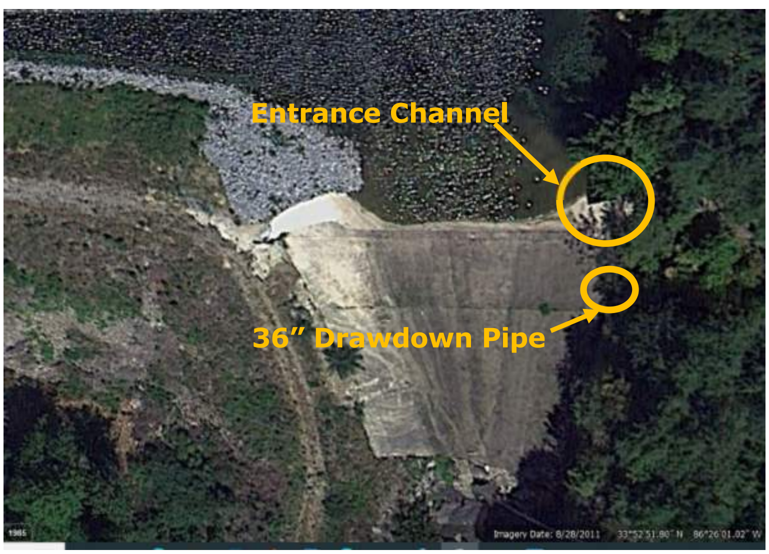

Figure 8: Concrete Spillway with Location of 36" Drawdown Pipe

Figure 9: Entrance Channel for 36" Drawdown Pipe

36” DRAWDOWN PIPE ENTRANCE CHANNEL

Description: Concrete, 12’ Wide, Cannot observe the bottom due to flowing water

Vegetation (Trees, Bushes): none

Debris: none observed

Channel Side-Slope Stability: Concrete wall so no slope issues

Slope Protection/Erosion: Concrete lined walls

Unusual Conditions: N/A

PRIMARY SPILLWAY ENTRANCE CHANNEL

Description: Material consisted of boulders and sand. Visual geofabic was observed underlying the boulders.

Vegetation (Trees, Bushes): Very little. Minor grass.

Debris: none observed

Channel Side-Slope Stability: No observed issues

Slope Protection/Erosion: Boulders and geogrid to protect from erosion

Unusual Conditions:

Figure 10: Spillway Entrance Channel

Figure 11: Downstream Apron with Secondary 36” Drawdown Pipe

SPILLWAY CREST

Description: Concrete lined. 162’ Wide. Downstream apron 128’ long

Condition of Material: Concrete is weathered. The upper portions have noticeable aggregate missing.

Signs of Movement: Not observed

Joints: One concrete joint is located 12’ below crest. The joint has noticeable erosion. The joint is at the same elevation at the exist of 36” Drawdown pipe. Joint needs to be sealed.

Unusual Conditions: Relief valves for uplift pressure were observed along the downstream concrete apron at a 14’ to 18’ grid spacing.

Seepage was observed at the toe of the downslope concrete apron between the concrete and underlying rock. Same seepage noted in October observation.

DROP VALVE FOR 36” DRAWDOWN PIPE

Description: Metal drop box

Condition of Material: Rusty. Bolts for drop box are rusted.

Signs of Movement: None

Unusual Conditions:

SPILLWAY WING WALLS – EAST WALL

Description: Cut Natural sandstone

Condition of Material: No visual issues or unstable conditions

Signs of Movement: No observed unstable conditions

Unusual Conditions: It appears the spillway was cut into rock, and I am assuming the cut material was used to construction the rock fill portion of the dam.

SPILLWAY WING WALLS – WEST WALL

Description: Concrete lined slope

Condition of Material: Good. Slight deterioration

Drains: None

Unusual Conditions:

DOWNSTREAM APRON

Description: Exposed/ Cut Sandstone

Condition of Material: Natural

Signs of Movement: none

Unusual Conditions: Seepage observed between concrete apron and sandstone apron.

Figure 12: Seepage Location between Apron and Natural Sandstone

ABANDONED EMERGENCY PIPE

Description: Abandoned Steel Pipe in SW Corner. The use is unknown.

Condition of Material: very rusty

Signs of Movement: likely collapsed under the dam

Seepage: slight seepage under the pipe. Estimated flow is 0.5 gal/min. The water was very muddy.

Unusual Conditions: Not sure of the use of the pipe. Mr. Hand mentioned it could have been installed during original construction of the dam.

Figure 13: Apparent Abondoned Pipe in the Southwest Corner

TRASH RACKS – None observed

CHUTES – No chutes observed

EXAMINATION OF OTHER FEATURES

INSTRUMENTATION (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) location, condition: NONE OBSERVED

RESERVOIR

Slopes: Exposed sandstone and soil. No observed slope issues.

OTHER ITEMS

DOWNSTREAM CONDITIONS: Although not directly affecting the dam, the stream at the base of the apron had a number of erosion issues. Based on our field observation and discussions with John Hand and Joe Hayden, the following was observed in regards to the downstream conditions:

- According to Mr. Hayden, the down stream originally was straight during initial construction.
- During the re-construction of the spillway in the late 1970's, rock was blasted from the hillside, and a lot of the rock was piled downstream.
- The rock obstacles ultimately rerouted the stream to snake to the west around the rock debris.
- Because of the sharp curvature of the stream, major erosion issues are occurring where an access road is located (See Figure 15).

Figure 14: Downstream Conditions

Figure 15: Erosion Issues Along the Stream

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/ or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

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