Appendix E: Other Supporting Information

- **Existing Conditions Tech Memo**
- **Design Criteria Tech Memo**
- **Hydrology Tech Memo**
- **Hydraulic Modeling & Flood Inundation Tech Memo**
- **Dam Rehabilitation Design Tech Memo**
- **Economic Investigations & Analysis (I&A) Report**
- **PR&G Alternative Formulation & Screening Matrix**
- **Ecosystem Services Framework Worksheet**
- **Biological Assessment of the Preferred Alternative**
- **Biological Assessment for Geotechnical Clearance**
- **Geotechnical Tech Memo – Gerhart Cole, Inc.**
- **Ute Ladies'-tresses Survey Memoranda**
- **Yellow-billed Cuckoo Survey Memoranda**
- **Wetlands Field Determination Report**
- **NRCS WebSoil Survey Custom Soil Resource Report**
- **USFWS IPaC Official Species List**
- **Utah Natural Heritage Online Species Search Report**
- **Redacted Cultural Resources Inventory Report**

Existing Conditions Tech Memo

Technical Memorandum 001
Existing Conditions

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1.0 Introduction

The purpose of Technical Memorandum 001, Existing Conditions (TM001), is to identify and document the existing conditions, existing records, document work previously performed, and present information gathered from site visits. Weber County (Weber) is the project sponsor. Weber owns and operates Utaba Retarding Dam (Utaba) (see Figure 1). The Soil Conservation Service precursor to the National Resource Conservation Service (NRCS) originally designed and built the Utaba Retarding Dam. The 1959 Watershed Work Plan for the Northfork Ogden River Watershed indicates the purpose of the retarding structure is to "reduce sediment yields and flood flows." This document also indicates the Utaba Retarding Dam will reduce the daily fluctuations in flow during the snowmelt runoff and control sediment and summer rainstorm floods. The structure was designed to reduce peak flows to non-damaging levels for storm events up to 100-year events. No mention is made of potential influences on Pineview Reservoir. NRCS is providing funding for this project. Weber is committed to developing a Watershed Plan-Environmental Assessment (Plan-EA) for the rehabilitation of the Utaba Dam.

Utaba is adjacent to North Fork Park in Weber County, Utah, about 10 miles northwest of Pineview Reservoir. The dam is located in the North Fork Ogden River watershed. The main objective of the project is to address concerns about potential failure due to extensive damage and degradation of the auxiliary spillway, potential failure due to seepage that is occurring in the outlet works, and bringing the embankment, principal spillway, and auxiliary spillway up to current Utah and NRCS Dam Safety Standards.

Liberty is located four miles southeast of Utaba and was settled beginning in 1859. According to 2020 census data, the town has a population of 1,522 people. Historically, Liberty has been a farming community, but it has recently developed into a recreational community for the Ogden area. The Utaba Dam was built by the Soil Conservation Service in 1962 to provide flood control for the downstream area. It sits at an elevation of approximately 5,700 feet and covers about nine acres. Several private camps are located just downstream of the dam, including Camp Utaba, which is located immediately below the dam. Many homes have also been built along the North Fork Ogden River since the Utaba Dam was built.



Figure 1: Utaba Retarding Dam, June 2024

2.0 Background and Existing Conditions

The Utaba watershed is the area that drains into Utaba Reservoir and is part of the larger North Fork Ogden River watershed, which is an area that drains into Pineview Reservoir. Cutler Creek and North Fork Ogden River enter from the west and northwest respectively and converge at Utaba Reservoir. The North Fork Ogden River travels from Utaba to Pineview Reservoir through Liberty, Utah. Water from Pineview Reservoir funnels into the Ogden River and makes its way west through Ogden Canyon. Figure 2 maps out the location of these features. The Ogden River then joins the Weber River, and the Weber River flows towards the Great Salt Lake, which is the lowest point in the area.

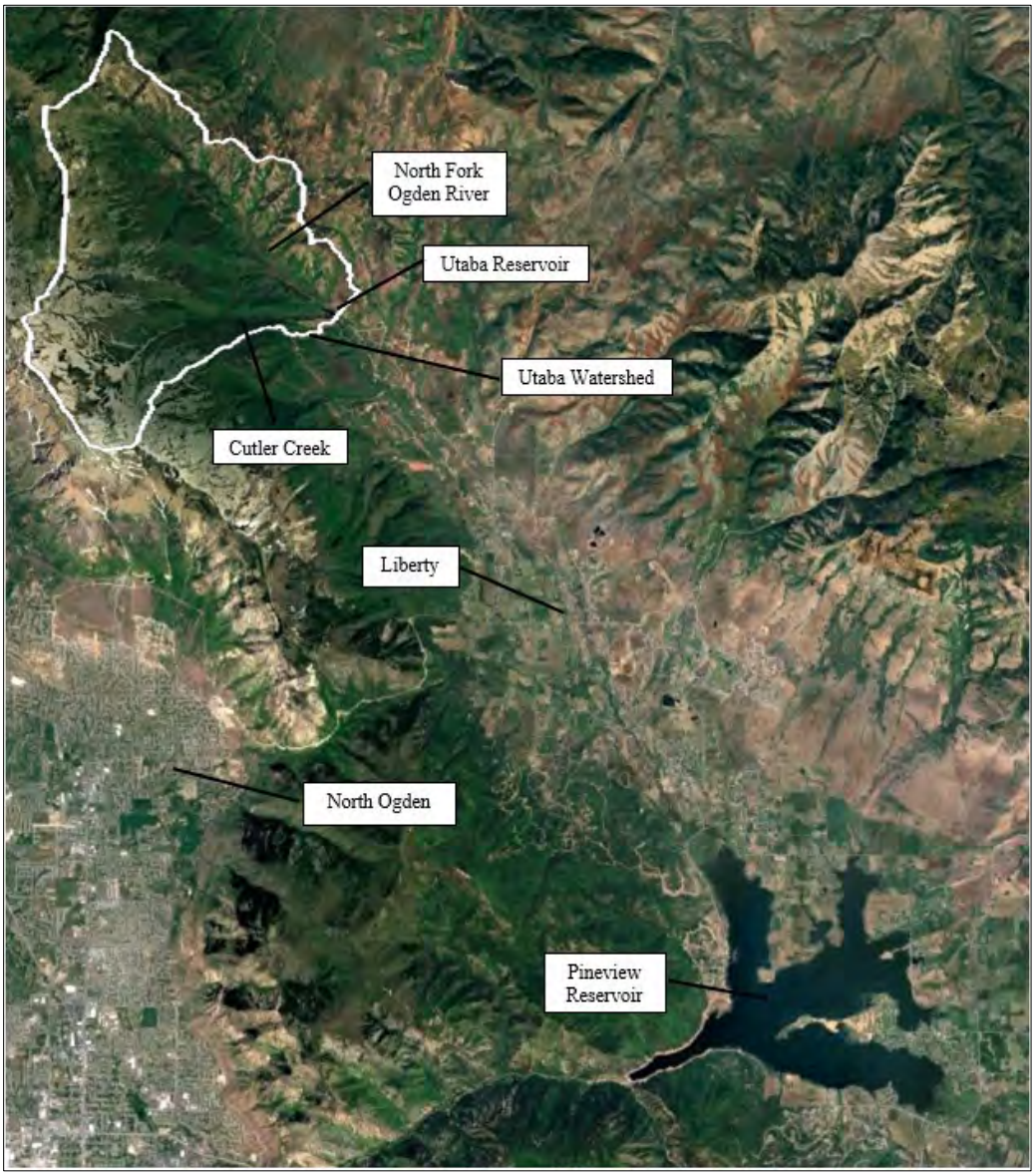

Figure 2: Map of Ogden Valley

Dams are given hazard classes when constructed. These classes reflect the likelihood of loss of human life and property damage if the dam fails. Utaba is currently considered a significant hazard class dam by NRCS; meaning that it would cause property damage and may cause loss of life if it were to fail. However, current studies and simulations indicate that Utaba should be considered a high-hazard dam because of the influx of people downstream since it was constructed. Utah Dam Safety currently identifies Utaba as a high-hazard dam. Utaba and its watershed are currently zoned as Forest Area, or areas designated for camping, outdoor recreation, and wildlife. Areas beneath Utaba are currently zoned as Low Density Residential Forest and Low Density Residential High Agriculture areas. Local census data shows that the area had 196 residents in 1950, and 2020 census data indicates 1,522 residents. If this trend continues, the area beneath Utaba is likely to

increase in permanent residents and visiting outdoor recreationalists. However, there are no official projections for populations in the area available.

Based on a dam assessment report in 2020 by Genterra Engineers and other observations, Utaba has several deficiencies that put it at risk of failure including seepage along the outside of the primary spillway conduit, undersized and failing auxiliary spillway, undersized embankment crest, woody vegetation on the embankment, and reduced storage due to sedimentation. Figures 3, 4, and 5 show the location and current configuration of the features associated with the deficiencies mentioned above and in subsequent paragraphs. The most pressing issue is the auxiliary spillway. This spillway has extensive damage, and because of its location on the embankment, failure of the spillway would cause the entire dam to fail. Failure of the dam would put approximately 409 people at risk according to the 2020 Genterra analysis. Failure at peak breach flow would flood the area one mile downstream in 14 feet of water moving eight miles per hour. Damage from the release of sediment would increase flood damage. Additional analysis will be needed to determine if the dam has structural and seismic deficiencies. Samples will also need to be collected of the existing dam materials to determine if the various zone materials are compatible. Since the dam was constructed over 60 years ago, it is likely that some stability and soil compatibility issues will be identified.

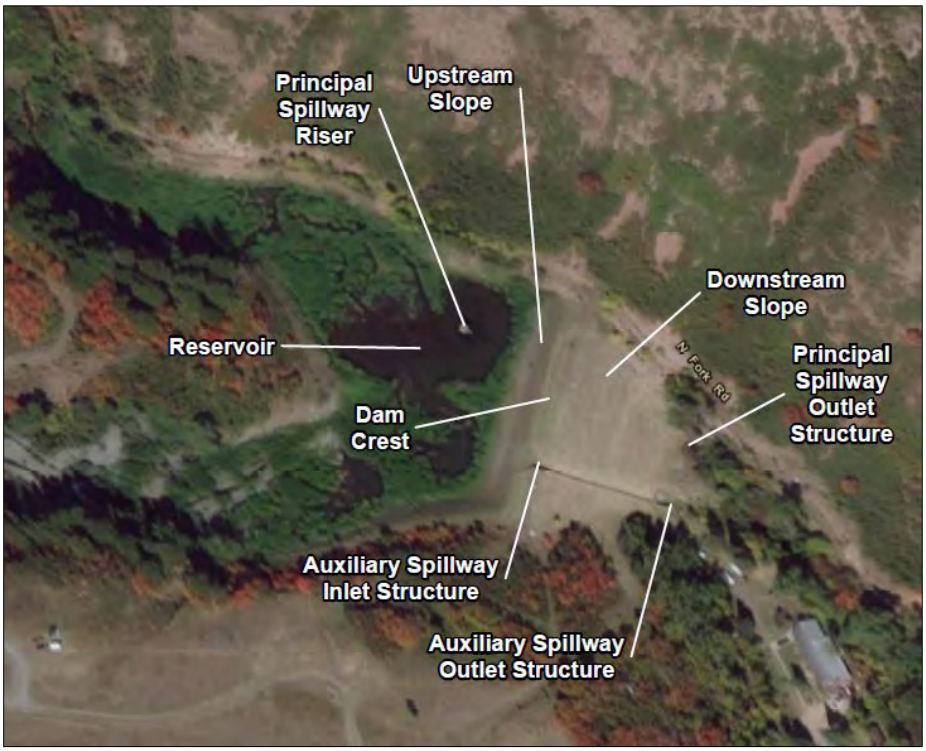

Figure 3: Utaba Retarding Dam Diagram, November 2020

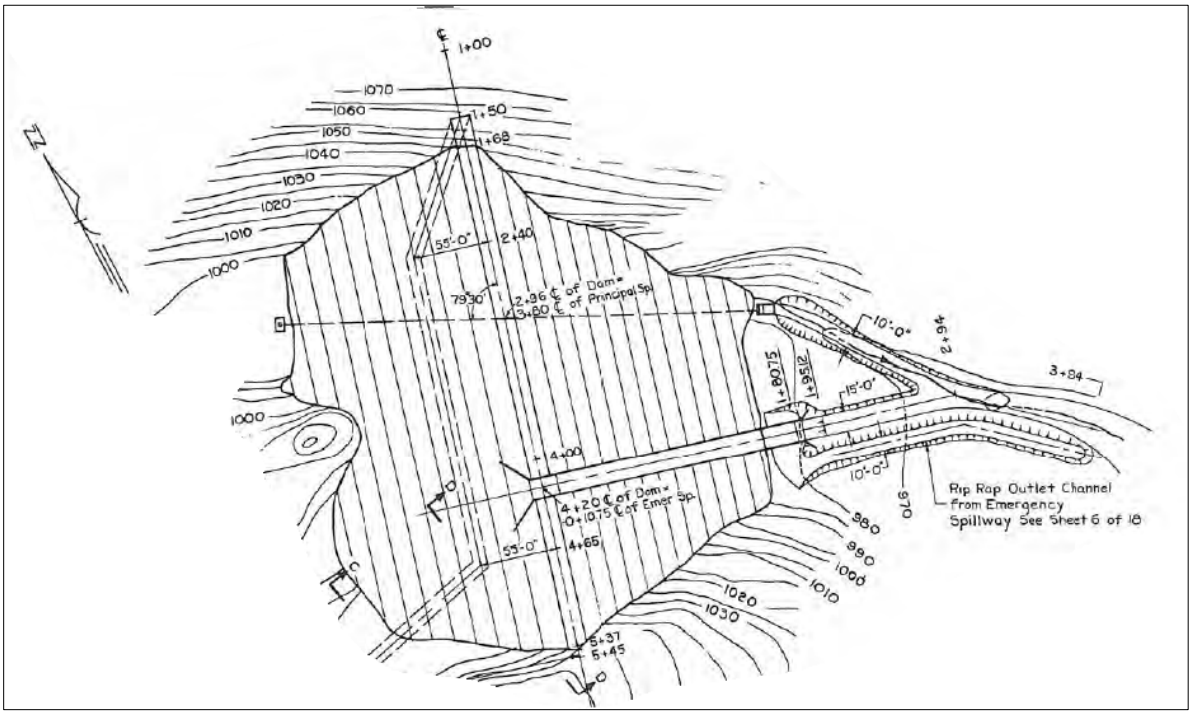

Figure 4: Design Drawing Plan View of Embankment

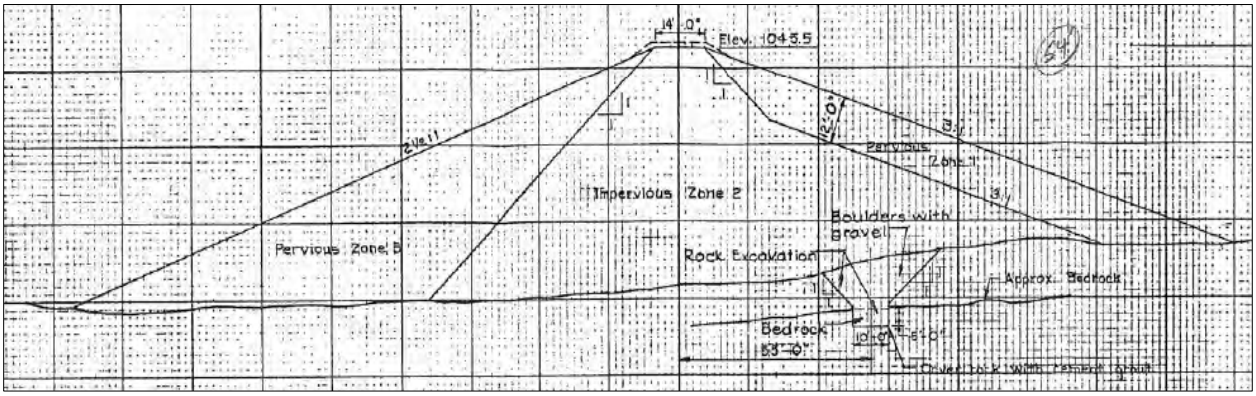

Figure 5: Historic Drawing Cross Section of Embankment

As a retarding dam, Utaba was designed to reduce the peak flow from potential flood events by storing at least a portion of the flood water and releasing the water over a 72-hour period. It is not known whether the dam was designed to store water for long periods of time. Many dams designed and constructed when Utaba was designed assume the dam would not store water for a long enough period to saturate the dam. Design standards are lower for dams that do not store water for long periods of time. Sediment accumulation and beaver activity have resulted in some water being stored year-round. This results in the lower portions of the dam possibly being saturated, and saturated soils have a lower strength in static conditions and make the structure more susceptible to failure due to liquefaction. This condition likely impacts the stability of the dam. Beaver dams can also be found throughout the reservoir basin.

The Utaba dam embankment crest does not meet current standards. The embankment is 71 feet tall, 369 feet long, and 14 feet wide at the crest. The State of Utah requires a minimum embankment crest of the height of the embankment divided by five plus five feet. Written mathematically, that is height / 5 + 5ft. With a height of 71 feet, the minimum embankment crest of the embankment must be at least 19.2 feet. However, the NRCS requires a minimum embankment crest width of the height of the embankment plus 35 feet divided by 5 or (height + 35ft) / 5. The NRCS minimum embankment crest is 21.2 feet. The more conservative standard dictates what is required, thus the minimum crest width is 21.2 feet. A summary of the details of the original design can be found in Table 1.

Table 1: Design Summary Existing Dam (Genterra 2020)

General Data	
State ID	UT00541
National ID	UT00541
Latitude	41.3868°
Longitude	-111.9096°
Owner/Operator	Weber County
Years Designed	1960-1961
Year Constructed	1962
Embankment Type	Zoned Earth Fill
Purposes	Flood Protection, Sediment Storage
Original Hazard Classification	Moderate (Utah), Significant (NRCS)
Current Hazard Classification	High (Utah), Significant (NRCS)
Design Life	50 years
Drainage Area	6144 acres (9.5 sq mi)
Dam Height Along Center Line	71 feet
Maximum Dam Height	71 feet
Embankment Length	369 feet
Embankment Top Width	14 feet
Embankment Upstream Slope	3:1 H/V
Embankment Downstream Slope	2.5:1 H/V
Elevations	
Top of Dam	5719.91 feet (NAVD 88)
Permanent Pool	N/A
Design High Water	5719.16 feet (NAVD 88)
Principal Spillway Crest	5703.41 feet (NAVD 88)

Outlet Pipe Intake Invert	5654.14 feet (NAVD 88)
Outlet Pipe Downstream Invert	5645.91 feet (NAVD 88)
Auxiliary Spillway Crest	5711.41 feet (NAVD 88)
Spillway Dimensions	
Auxiliary Spillway Width	15 feet
Principal Spillway Diameter	2 feet
Areas	
Permanent Pool	0 acres
Maximum Pool	9 acres
Storage	
Permanent Pool	0 acre-feet
Maximum Pool	220 acre-feet

There are many safety concerns with the dam. For example, there is no drainage system in the embankment. No drainage system means water may be able to move soil material in the dam downstream through the embankment itself and cause failure. According to the inspection done by Genterra, the ground water level is high on the downstream side of the dam. Also, the as-built drawings indicate that Utaba was built on highly fractured foundation rock. High groundwater coupled with the foundation rock being highly fractured may mean water is flowing uncontrolled through the foundation of the dam. There are currently no soil, stability, or drainage analyses available, which leaves many safety aspects of the embankment unknown. Geotechnical studies are planned to address these concerns. The findings of these studies will be documented in a separate report.

2.1 Sedimentation

Utaba dam was designed with 90 acre-feet of water storage below the crest of the auxiliary spillway. According to the Genterra report, Utaba has 33 acre-feet of that storage capacity filled with sediment, leaving 57 acre-feet of storage available as of 2020. Since the dam was constructed in 1962, Utaba Reservoir accumulates approximately 0.57 acre-feet of sediment per year. If this rate of sedimentation continues, the reservoir will be filled with sediment in about 100 years. As Utaba stores more sediment, it stores less water. The usefulness of the dam will end when the principal spillway riser is completely covered in sediment, which may happen in the next 15 years if the current sedimentation rate remains consistent. However, sedimentation rates are likely not linear. Flood events can deposit large volumes of sediment and debris while during dry years no sediment may accumulate.

A site investigation took place in July 2024 to gather data on the strength and composition of the accumulated sediment. During the investigation, 10 samples from 10 different areas in the Utaba Reservoir basin were collected. At each sample location, a data sheet was prepared with the sediment strength and composition as well as a site description. Sediment strength was estimated using a penetrometer, which measures how much force is needed to push a thin metal rod through the soil. The sediment in Utaba consisted of cobbles, gravel, sand, silt, woody debris, and small

amounts of clay. Because of the way a penetrometer takes measurements, it is possible that the sediment appeared stronger when the penetrometer hit wood or rocks. This discrepancy has been taken into account when determining sediment strengths. Sediment samples were collected using a hand auger, or a hollow cylinder connected to a shaft so it could driven into the sediment to collect the sample. A map of sample collection locations can be found in Figure 6 and data sheets can be found in the appendix. In Figure 6, the reservoir basin is divided into four areas: A, B, C, and D. The sediment in each area exhibited similar characteristics.

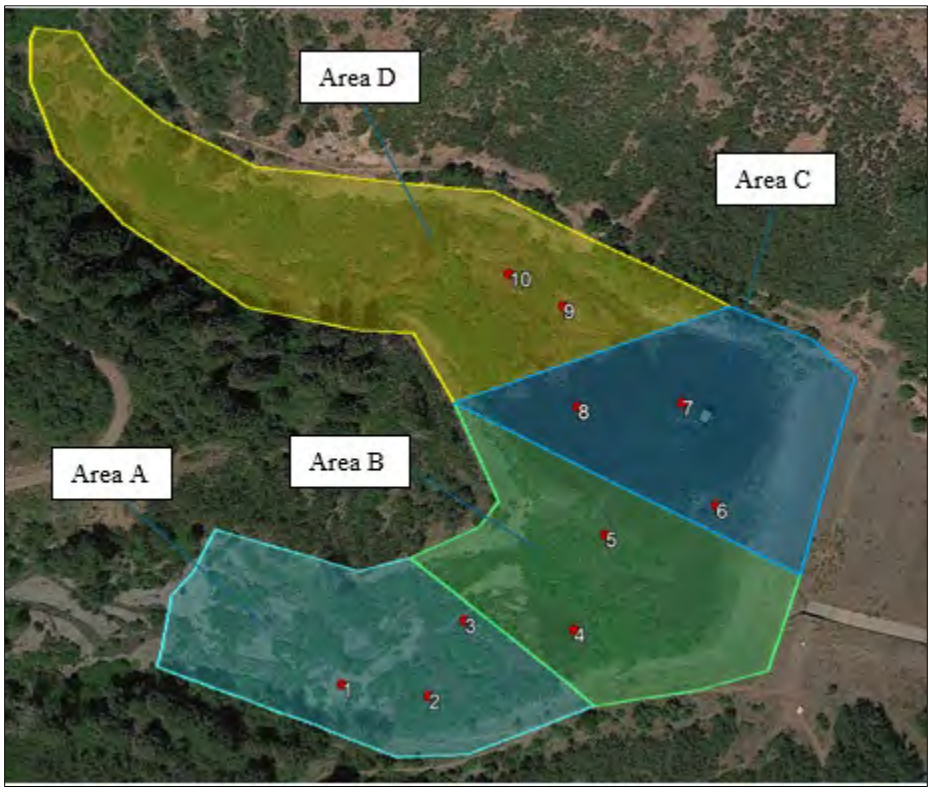

Figure 6: Map of Sediment Sampling Areas

2.1.1 Sediment Site Investigation Summary

Sediment in Area A originates from Cutler Creek and is mostly sand, cobbles, and gravel. Cutler Creek enters from the west and has cobbles on the channel bed. Moving west to east in Area A, the sediments quickly change with increased fine sand and silts. Vegetation density and height increase closer to the center of the reservoir. The content of woody debris in sediment samples increased closer to vegetation. Sediment at Point 1 has a strength of 250 psi at nine inches deep. In Area A, sediment strength appears to get weaker from west to east as seen from the sediment strengths of points 2 and 3, which were 90 psi and 10 psi respectively at nine inches deep. The sediment appears dry, but the water table varies from nine inches deep to right beneath the surface. Walking in this area is easy because the ground is hard and stable. The larger sediment from the west side of Area A may be firm enough to support some equipment and have useful materials needed for the dam rehabilitation. A picture of this area can be seen in Figure 7.



Figure 7: Cutler Creek Entering Utaba

Note gravel and cobbles in the channel and on the bank, evidence of a high-energy environment.

Sediment in Area D originates from the North Fork Ogden River, is mainly comprised of silt, and has tall vegetation throughout. The North Fork Ogden River enters from the north and splits into meandering streams. These streams typically have cobbles, or rocks with diameters between 3 to 10 inches, on the bottom of the channels. The sediment from Area D contains very soft silt with woody debris throughout. Clay particles are typically also mixed throughout the sediment. Recovery of the soil samples ranged between 90% to 100%, meaning that it is very cohesive throughout. The sediment in Area D was typically weak, with a strength of zero psi nine inches deep. Point 9 continues to have no strength deeper than nine inches: however, Point 10 actually increased its strength to 250 psi at 15 inches deep even though the sediment composition throughout Point 10 does not change. This may be because of increased woody vegetation in that particular area at that depth. The sediment is moist throughout. Walking near the North Fork Ogden River isn't recommended because the ground can get very soft and muddy. Removing sediment in Area D would prove difficult because it doesn't appear strong enough to support equipment for mechanical excavation, and there is too much woody debris to try to remove it with a suction dredge. There are also no obvious needs for this kind of soft sediment in the rehabilitation of the Utaba dam, so the removed soft sediment would need to be disposed of offsite. A picture of this area can be seen in Figure 8.



Figure 8: North Fork Ogden River Entering Utaba

Note fine sediments and woody debris on the bank and gravel and cobbles in the current channel.

Water and sediment from Area A flow into Area B. Streams in Area B are dark with suspended sediment as well as sand and gravel in the bed of the channel. Cutler Creek also begins to split and meander in this area. Area B has more vegetation than Area A and is very soft and muddy with water pooling at the surface. Walking in this area is not recommended. The sediment in Area B consists of coarse sand with some gravel in a fine silt matrix. There is a lot of organic material and woody debris on the surface and throughout the sediment samples. Point 4 is an area of coarse sand with gravel, and sediment strength steadily increases at increased depths from 10 psi at three inches deep to 200 psi at 18 inches deep. Point 5 is an area of fine, sandy silt. The sediment here did not have any strength until 15 inches deep with a strength of 90 psi, but sediment strength decreased to 50 psi at 18 inches deep. Although there are some strong sediments like sand and gravel in Area B, removing the sediment via an excavator would be unlikely because of the abundance of soft silt and mud layers. Removing the sediment with a suction dredge is also unlikely because of the vegetation and woody debris.

Water and sediment from Areas B and D flow into Area C. Area C contains a ponded reservoir and the principal spillway riser. The water is dark and typically only a few feet deep, but water gets significantly deeper near the principal spillway intake riser. The sediment sample at Point 7, near the principal spillway riser, is soft silt. However, the sediment sample at Point 8, farther from the riser, is a thin layer of soft silt with a harder layer of sand underneath. Penetrometer tests were not taken at Points 7 and 8 because these points are submerged. However, sediment at Point 7 seemed to have no strength and the sand layer at Point 8 was difficult to push through with a shovel. Sediment from Point 6, on the banks of the reservoir, consisted of silt, clay, and woody debris. Sediment strength typically rose at greater depths with the highest strength recorded at 125

psi. The first couple of feet of sediment in the ponded area of Area C, around Points 7 and 8, may be able to be removed with a suction dredge. The areas around these points have minimal woody debris. However, woody debris is likely to increase as depth increases, and removing sediment via suction would no longer be an option. Removing sediment from the area around Point 6 is unlikely to be feasible because it is very soft sediment with woody debris and vegetation although a dragline or crane with a clamshell bucket may be a feasible alternative. Eliminating the ponded water will be critical to nearly all removal techniques.

During the geotechnical investigation, additional samples will be collected and analyzed to obtain a greater understanding of the sediment characteristics. An excavator will be used to dig test pits allowing data to be collected at a greater depth.

The possible use of the sediment in the reservoir for rehabilitation of the dam will be assessed in more detail when potential rehabilitation options are analyzed. However, some general pros and cons of utilizing the sediment are identified below.

Pros

- Potential source of aggregates very close to the site reducing the need to import material and reduce haul distances.
- Any sediment removed will increase capacity for future sediment accumulation and extend the lifespan of the structure.

Cons

- The sediment includes a large amount of organic material that would need to be removed by screening and possibly washing the material.
- Options for removing the sediment are limited due to the low strength of most of the material and presence of logs, sticks, and other debris.
- Dewatering the material to the point where it is usable is expensive and special permits will likely be needed for the processing of the material and handling the water removed.
- The sediment composition is highly variable thus requiring significant processing to obtain a material that could be used in the rehabilitation.
- Most aggregate in the sediment will be rounded due to its origin. Rounded aggregate is generally not preferred in construction applications. The aggregate material would likely need to be crushed to be usable.

2.2 Principal Spillway

The principal spillway riser is a 50-foot-tall intake structure that connects to the outlet works conduit to allow water to pass through the dam. Because of sedimentation, only ten feet of the structure is currently visible. Although the riser releases most water flowing into the reservoir, some water stays in the reservoir. This results from a combination of lower openings being covered

with sediment and beavers blocking the openings above the sediment. The as-built drawings indicate that the pipe, or conduit, that connects to the principal spillway riser is 24 inches in diameter and made of reinforced concrete. The current condition of this pipe is unknown; it was part of the original construction of Utaba. This 24-inch pipe appears to be the controlling factor on the flow that can be released by the principal spillway. To meet current NRCS standards the pipe must be a minimum of 30-inches. The current maximum discharge capacity of the principal spillway is 105 cfs when the water in the reservoir is at the crest. Increasing the conduit diameter to 30 inches would increase the principal spillway capacity at the crest to 170 cfs.

Seepage appears to be flowing along the outside of the principal spillway conduit. The water seeping around the principal spillway conduit is clear and does not appear to be transporting soil material. However, the seepage can only be differentiated from the discharge from the spillway when the flow in the principal spillway is low. It is possible that soil material is being transported by the seepage when the reservoir is full. It is not known if the source of the seepage originates in the reservoir at the riser, if the water is coming through the foundation/abutment, or both. Either condition is a concern. The principal spillway conduit was installed with anti-seepage collars. At the time of construction, it was standard practice to install anti-seepage collars to spillway conduits. Although good in theory, in practice, anti-seepage collars do not stop seepage because their odd shape makes compacting soil around the conduit difficult. As seepage increases, it may begin washing away the dam itself and cause failure of the entire structure. An investigation is necessary to determine the source of the seepage and develop remediation measures.

Table 2 shows the discharge capacity of the principal spillway that is currently controlled by the 24-inch diameter conduit through the dam. A design drawing of the principal spillway riser can be found in Figure 9. The riser has 1’-4” x 9” openings every 5 feet vertically. At the top of the riser there is a trash rack and cap to prevent debris from entering the spillway. Inside the cap are two six-foot-long walls that act as weirs to control flow into the spillway (see Figure 10). The combination of the openings and the weirs have a greater capacity than the 24-inch conduit other than at the lower water elevations. The flow rate in Table 2 is calculated based on the water elevation in the riser/reservoir. With most of the openings blocked by sediment or debris, the reservoir water level rises quickly to the elevation of the weir in the riser during periods of high flow. Flow over the weir walls quickly exceeds the capacity of 24-inch conduit. Other than at low elevations the water elevation in the riser will match the reservoir water level.

Table 2: Principal Spillway Flows

Water Elevation (NAVD 88)	Flow (cfs)	Notes
5654.14	0	24” Outlet Pipe Invert
5655	15	
5660	30	
5665	41	
5670	50	
5675	58	

Water Elevation (NAVD 88)	Flow (cfs)	Notes
5680	64	
5685	70	
5690	76	
5695	82	
5700	88	
5703.41	90	Principal Spillway Crest
5705	92	
5710	97	
5711.41	97	Auxiliary Spillway Crest
5715	101	
5719.91	105	Top of Dam

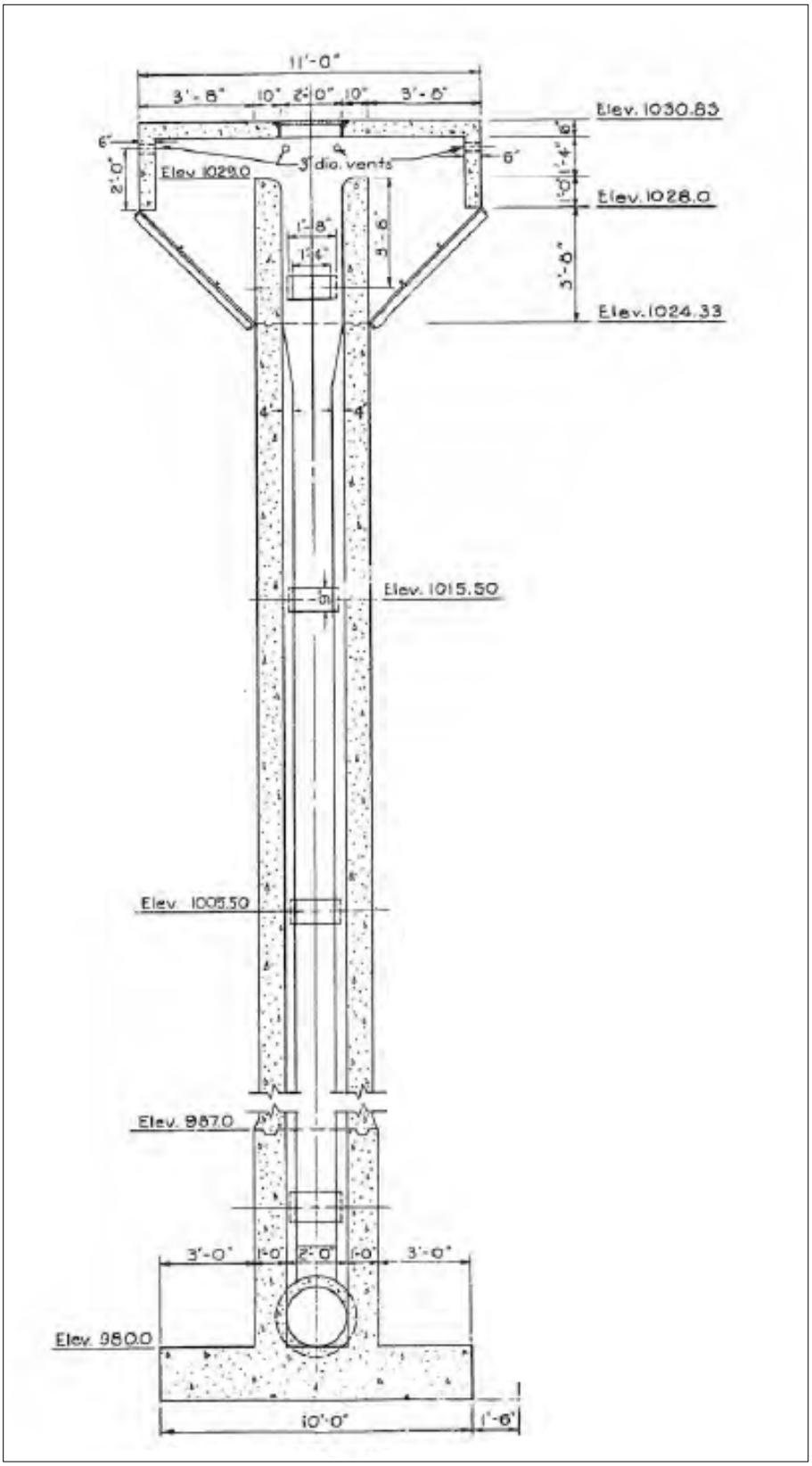

Figure 9: Design Drawing Principal Spillway Riser



Figure 10: Principal Spillway Riser, November 2020

Another problem with the principal spillway is that it is uncontrolled. Although it is convenient to just let the water flow naturally, it means water levels in the reservoir cannot be managed. Due to the uncontrolled nature of the principal spillway and the perennial flow of water in Cutler Creek and North Fork Ogden River, the water flow in the spillway cannot be stopped. This makes a video inspection of the conduit impractical without significant effort to bypass the water or block the openings in the riser. Neither option is feasible without mobilizing significant equipment.

The current principal spillway also does not have venting of the spillway conduit. This results in a surging flow from the spillway that reduces flow capacity and can create alternating vacuum and pressure conditions in the principal spillway which further degrades the spillway.

The concrete of the principal spillway outlet also shows signs of significant erosion (see Figure 11Figure 12). A Utah Dam Safety inspection report from 1993 noted that the concrete of the principal spillway had eroded to the rebar at the normal pool water line at that time. A repair was made at that time, but it occurred over 30 years ago and is now covered with sediment. The visible concrete of the tower shows some evidence of minor degradation. However, it is likely the unseen concrete of the principal spillway below the top of the sediment is significantly degraded and should be evaluated in greater detail before it is considered for use after rehabilitation of the dam.



Figure 11: Principal Spillway Outlet



Figure 12: Closeup of Principal Spillway Outlet Showing Concrete Erosion

2.3 Auxiliary Spillway

The auxiliary spillway is a 15-foot-wide concrete channel located on the embankment. It has a maximum depth of 7 feet 9 inches through the crest and a minimum depth of 3 feet 3 inches on the slope of the dam. The auxiliary is too small by today's standards and is in very poor condition, likely due to the corrosive effect of the acidic soils of the watershed and over 60 years of being exposed to the freeze thaw cycle.

At least some of the significant degradation of the auxiliary spillway concrete can be attributed to the acidic soils and likely acidic water. A custom soils report generated by Web Soil Survey (an online resource provided by the NRCS) indicates that the soils in this watershed are acidic. The pH of the of the soils range from 7.3 to 5.6. About 67.5% of the soils in the watershed are slightly acidic(pH 6.1 to 6.5). Moderately acidic (pH 5.6 to 6) and neutral (pH 6.6 to 7.3) soils make up about 18% and 14.5% of the watershed respectively. Soils along the North Fork Ogden River are neutral, slightly acidic, and moderately acidic. Soils along Cutler Creek are neutral and slightly acidic. The sediments in the reservoir are derived from the acidic soils of the watershed. This acidic soil will attack and degrade the concrete's integrity.

The concrete of the auxiliary spillway is spalling, and large cracks have formed on the spillway wall and along the floor joints. Some concrete joints are offset, indicating failure of the rebar at the joint. A 30-year-old repair of the auxiliary spillway mentioned in the Genterra inspection report is unlikely still protecting the rebar from corrosion. The failing joints have been sealed with a tar-based material, but the repairs are also failing. The purpose of the auxiliary spillway is to allow water to pass over the dam if the reservoir is full during high-flow events. The auxiliary spillway is not intended to be used frequently since it allows debris to pass through the reservoir and flow reduction through the reservoir is very small. However, water currently passes through the auxiliary spillway nearly every year because the principal spillway is too small and there is increased sedimentation in the reservoir. The current maximum capacity of the auxiliary spillway is 1,120 cfs with the water level at the top of the dam. NRCS standards require a capacity over 6,000 cfs. Table 3 shows auxiliary spillway flows at various elevations as well as the total spillway capacity.

Table 3: Auxiliary and Total Spillway Flows

Water Elevation (NAVD 88)	Principal Spillway Flow (cfs)	Auxiliary Spillway Flow (cfs)	Total Discharge (cfs)
5711.41 (a)	97	0	97
5712	98	22.4	120.4
5713	99	99.2	198.2
5714	100	206.3	306.3
5715	101	336.7	437.7
5716	102	486.8	588.8
5717	103	654.2	757.2

5718	104	837.4	941.4
5719	104.5	1035.1	1139.6
5719.91 (b)	105	1226.7	1331.7

(a) Auxiliary Spillway Crest

(b) Top of Dam

Because of extensive damage and high use, the auxiliary spillway is highly likely to fail. Its location on the embankment means that if it were to fail, the entire dam is likely to fail and flood the downstream area. Two failure mechanisms have been identified. The first is a piping failure below the spillway floor. During even small flow through the auxiliary spillway, water could flow through the failed joints eroding soil below the spillway floor. When erosion below the spillway becomes extensive, the concrete of the spillway would fail—allowing water to flow uncontrolled on the earthen dam. This would cause rapid erosion and a breach of the dam. The second failure mechanism would be the overtopping of the dam during a flood event due to the undersized auxiliary spillway or blockage of the spillway with debris or due to beaver activity. As soon as water starts flowing over the dam, it will quickly erode the dam and cause a breach. The undersized and failing auxiliary spillway is the most immediate threat to the safety of the dam. An aerial photo of the auxiliary spillway can be found in Figure 13. Photos of damaged areas of the auxiliary spillway can be found in Figure 14, Figure 15, and Figure 16.



Figure 13: Aerial View of Auxiliary Spillway, June 2024



Figure 14: Repairs Along Auxiliary Spillway Wall, November 2020



Figure 15: Concrete Damage at Floor Joint of Auxiliary Spillway, November 2020



Figure 16: Severe Concrete Deterioration and Attempted Repair of Auxiliary Spillway, November 2020

2.4 Existing Conditions Downstream

Since Utaba Dam was built, there has been significant development downstream. Five campgrounds are located within two miles downstream of Utaba; Camp Utaba is the closest sitting at the toe of the dam. Homes have also been built near the Northfork Ogden River. The closest settlement, Liberty, Utah, has a population of 1,522 according to 2020 census data. The area continues to grow because of its natural beauty and recreational opportunities.

According to the Genterra report, there are several crossings over Northfork Ogden River: a 10-foot by 9-foot concrete box culvert (see Figure 17), a 60-foot by 13-foot bridge opening (see Figure 18), a 22-foot by 7.5-foot and 22-foot by 9-foot double bridge opening (see Figure 19), and a 40-foot by 9.5-foot concrete arch-box culvert (see Figure 20). Some additional culverts have been installed by private parties to access the camps and homes that have been built near the river. These culverts are generally smaller than the ones identified by Genterra. These structures can be prone to vandalism, as seen in the bridge depicted in Figure 18 and 19. However, the vandalism impacts the appearance of the structure more than its function. Although not recommended, the public-owned road crossings would allow safe passage for tubes or very small watercraft during most flow conditions. Private crossings are typically smaller and pose a greater risk to recreationists that may try to float the river. The public and private crossings should have minimal impact on fishing on the river. The public crossings are large enough to not promote sediment accumulation. Private

crossings are generally smaller and may cause ponding that results in sediment accumulation during high flows and increased velocities downstream that could increase channel erosion.



Figure 17: Box Culvert Located at the 5950 N River Crossing, West of North Fork Road



Figure 18: Bridge Located at the 3300 E River Crossing, North of 5100 N



Figure 19: Double Bridge Located at the 4100 N River Crossing, West of River Drive



Figure 20: Arch-box Culvert Located at the Highway 162 River Crossing, West of River Drive

3.0 Conclusion

Utaba Retarding Dam appears stable at the moment, but there are a number of issues with its current function and a variety of deficiencies that will eventually lead to its failure. The known deficiencies are as follows, ranked from most likely to least likely to occur:

1. Potential auxiliary spillway failure. The auxiliary spillway is damaged extensively, and its location on the dam embankment increases the potential for the embankment to breach because of the failure of the auxiliary spillway. This condition results in the greatest risk of dam failure.

2. Insufficient auxiliary spillway capacity. The current spillway capacity is approximately 1226.7 cfs at the crest of the dam. Genterra calculated a required combined spillway capacity of over 12,000 cfs. During a large flood event, the auxiliary spillway not only has a high probability of failure, but the dam may be overtopped due to insufficient spillway capacity.

3. Uncontrolled seepage around the principal spillway conduit, through the foundation, and possibly through the embankment. Seepage has been confirmed around the principal spillway conduit. High groundwater has been noted at the toe of the dam, which may be caused by uncontrolled seepage through the foundation and/or the embankment. Further study is needed to identify the source of the seepage.

4. Undersized principal spillway conduit. The principal spillway conduit diameter currently meets Utah minimum standards, but it must be increased from 24 inches to 30 inches to meet minimum NRCS standards. The undersized principal spillway results in the auxiliary spillway being used nearly every year during spring runoff. If the water rises to the level of the auxiliary spillway the floating debris previously captured in the reservoir is released through the auxiliary spillway. The principal spillway also has no capability to control releases, making regular inspection and maintenance very difficult and costly. The difficulty and cost have resulted in the principal spillway way likely not being inspected since construction.

5. Unknown dam zone compatibility. It is unknown whether the composition of the various zones of the dam are compatible. There is potential for migration of soils between zones or the foundation that would lead to a piping failure of the dam.

6. Seismic and static stability of the dam. There are no stability, seepage, or settlement analyses for the embankment, making much of its current condition unknown. However, given the age of the dam and the advancement of dam safety standards, the dam is unlikely to meet current dam safety stability standards. The stability of the dam and conformance with dam safety standards will be assessed during the planned geotechnical investigation.

7. Inadequate crest width. The embankment crest must be increased from 14 feet to 19.2 feet to meet Utah standards or 21.2 feet to meet NRCS criteria.

8. Unanticipated long-term detention of water in the reservoir. During design, it was assumed the reservoir would hold water for a few days after a flood event and then empty completely. The inadequate size of the principal spillway results in the reservoir filling for weeks during spring runoff. Undersized openings in the riser, sediment accumulation, and beaver activity also results in some water being detained in the reservoir year-round. This condition affects the uncontrolled seepage mentioned above and results in at least a portion of the embankment being saturated, which impacts the stability of the embankment.

9. Decreased sediment and debris storage capacity. With decreased storage capacity due to sediment accumulation, the effectiveness of the reservoir at reducing flood flows is diminished. The ability of the reservoir to store sediment and debris will be eliminated when the sediment reaches the crest of the auxiliary spillway.

The severity of each deficiency is different from its likelihood of occurring. The order of severity of each deficiency from most catastrophic to least catastrophic is: 1, 3, 2, 5, 6, 4, 8, 7, and 9. Only deficiencies 1, 3, 2, 5, and 6 would cause dam failure if they occurred. Finally, the deficiencies from most expensive to address to least expensive are: 1, 2, 4, 7, 5, 3, 6, 9, and 8.

4.0 References

Conservation Engineering Division. (2005). *Earth Dams and Reservoirs: TR-60.* Natural Resources Conservation Service.

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Design Criteria Tech Memo

Technical Memorandum 002

Design Criteria

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1.0 Introduction

The U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS) and Weber County as the project sponsor have initiated a Watershed Plan-Environmental Assessment (Plan-EA) of the Utaba Dam watershed in Weber County with funding from the Watershed Rehabilitation Program, which is focused on rehabilitating aging dams. The project includes:

- Completing an Environmental Assessment for Utaba Retarding Dam, and
- Assessing potential alternatives for rehabilitation of the Utaba Dam.

This Technical Memorandum identifies the design criteria to meet NRCS and other applicable design requirements and standards. The feasibility of addressing flood control and recreation elements was evaluated, and a list of design criteria relating to these elements is presented in this technical memo. Table 1 summarizes the applicable design standards upon which the 30% design for the project is based, and it also identifies the future final design standards. Standards include County standards, NRCS Conservation Practice Standards (CPS), NRCS National standards, and State standards.

Table 1: Design Criteria Utilized for the Project

Design Criteria & Practice Standards
Weber County Road and Bridge Design Standards
NRCS CPS 327: Conservation Cover
NRCS CPS 342: Critical Area Planting
NRCS CPS 373: Dust Control on Unpaved Roads and Surfaces
NRCS CPS 402: Dam
NRCS CPS 472: Access Control
NRCS CPS 560: Access Road
NRCS CPS 570: Stormwater Runoff Control
NRCS CPS 582: Open Channel
NRCS CPS 587: Structure for Water Control
NRCS National Engineering Handbook (NEH)
NRCS National Engineering Manual (NEM)
Utah Pollution Discharge Elimination System General Construction Permit
UDOT Drainage Regulations
Utah Division of Water Rights Dam Safety Rules
Utah Pollutant Discharge Elimination System MS4 Permit

2.0 Design Criteria & Practice Standards

2.1 Weber County Road and Bridge Design Standards

The Weber County Road and Bridge Department requires their roads to meet certain design standards. The access and much of the construction area are on land owned or operated by Weber County. Permanent roads, bridges, or road crossings constructed in connection with rehabilitating the Utaba Dam would need to be designed to meet Weber County standards.

2.2 NRCS CPS 342: Critical Area Planting

NRCS Conservation Practice Standard (CPS) 342 design criteria applies to highly disturbed areas such as construction areas, conservation practice construction sites, eroded banks of natural channels, or other areas degraded by human activities. CPS 342 would be applied in the project in areas where permanent vegetation is needed but cannot be achieved with normal seeding/planting methods.

2.3 NRCS CPS 373: Dust Control on Unpaved Roads and Surfaces

NRCS CPS 373 provides the minimum design criteria for controlling direct particulate matter emissions that result from vehicle and machinery traffic or wind by applying a palliative on the surface of concern. There are unpaved roads and surfaces within the project area, including those that would be created using CPS 560 (Access Road). Construction on and near these unpaved surfaces would require CPS 373.

2.4 NRCS CPS 402: Dam and TR 210-60 Earth Dams and Reservoirs

NRCS CPS 402 gives design criteria for dams constructed with the purpose of reducing flood damage, providing permanent storage for one or more beneficial uses, or creating or improving fish and wildlife habitat. The project proposes to replace the existing dam to provide flood control. CPS 402 and design criteria from the Utah Division of Water Rights Dam Safety Rules will be used. NRCS Technical Release (TR) 210-60 Earth Dams and Reservoirs is the same.

2.5 NRCS CPS 472: Access Control

NRCS CPS 472 provides minimum requirements for implementing temporary or permanent access control measures to an area. The project may require access control measures for access roads created under CPS 560 (Access Road) to project locations like the access road to the top of the embankment.

2.6 NRCS CPS 560: Access Road

NRCS CPS 560 provides the minimum design criteria for constructing access roads for equipment and vehicles. Access roads would need to be designed to allow access to construct and maintain project facilities.

2.7 NRCS CPS 562: Recreation Area Improvement

NRCS CPS 562 provides the minimum design criteria for improving "the attractiveness and usefulness of recreation areas and to protect the soil and plant resources" (NRCS 1977). It does not appear that the rehabilitation of the Utaba Dam will include recreational components. However, if recreational components are incorporated into the rehabilitation of the reservoir, CPS 562 would be followed to create recreation facilities.

2.8 NRCS CPS 566: Recreation Land Grading and Shaping

NRCS CPS 566 provides the minimum design criteria for modifying the land surface to better support recreational use. If recreational facilities are included in the dam rehabilitation, recreational facilities would be graded and shaped following CPS 566.

2.9 NRCS CPS 570: Stormwater Runoff Control

NRCS CPS 570 provides design criteria for controlling erosion, sedimentation, and quantity and quality of stormwater leaving developing or developed sites during and following construction activities. Any area where construction activities occur during the project would consider CPS 570.

2.10 NRCS CPS 582: Open Channel

NRCS CPS 582 provides the minimum design criteria for improvement, construction, and restoration of open channels (NRCS 2015). The project would look at working on open drainage channels. CPS 582 would be used where applicable.

2.11 NRCS CPS 587: Structure for Water Control

NRCS CPS 587 provides the minimum design criteria for water management systems that control the stage, discharge, distribution, delivery, or direction of water flow. The project includes culvert replacement for increased hydraulic capacity for flood control. These water control structures would be designed in accordance with NRCS CPS 587 (NRCS 2014).

2.12 NRCS National Engineering Handbook (NEH)

The National Engineering Handbook (NEH; NRCS 2010) provides design criteria for several engineering applications. Only the design criteria applicable to drainage, flood prevention and protection, and hydrology modeling and design are included in this tech memo.

2.13 NRCS National Engineering Manual (NEM)

The National Engineering Manual (NEM, NRCS 2017) provides design policy for several different engineering applications. Only the design policies applicable to drainage, flood prevention and protection, and hydrology modeling and design are included in this tech memo.

2.14 UDOT Drainage Regulations

Utah Department of Transportation (UDOT) has provided this technical reference as a guide to designing drainage structures and components in areas of UDOT jurisdiction. Design criteria pertaining to this project would be utilized on all UDOT drainage structures along with applicable NRCS and other design standards. Although no UDOT facilities are expected to be impacted by the rehabilitation of Utaba Dam, the UDOT drainage regulations are a good reference.

2.15 Utah Division of Water Rights Dam Safety Rules

The Utah Division of Water Rights Dam Safety program is the agency that ensures that plans for new dams and enlargement, alteration, or repair of existing dams meet the design criteria and standards enumerated in the Utah Office of Administrative Rules as R655-10, R655-11, and R655-12. These rules are established under the authority of Utah Code Title 73, Chapter 5a. Rule R655-10 provides the criteria for how water impounding structures are classified, approved, and reviewed. Rule R655-11 provides the criteria for the design and construction of water impounding structures. Rule R655-12 provides criteria for initial filling, operation, and maintenance of a reservoir. Most of the criteria in these three rules apply to water impoundments of 20 acre-feet or more. The proposed rehabilitation of the existing dam would be designed following all applicable Dam Safety criteria, along with applicable NRCS and other design standards.

2.16 Utah Pollutant Discharge Elimination System General Construction Permit

Construction would occur in the state of Utah. Utah has a Pollutant Discharge Elimination System to develop permits authorizing effluent discharges and provides criteria and standards for stormwater discharges. A Stormwater Pollution Prevention Plan (SWPPP) following the criteria and standards provided by the state would be followed.

3.0 References

2017. Critical Area Planting – Code 342. Natural Resources Conservation Service.

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Hydrology Tech Memo

Technical Memorandum 003
Utaba Dam Hydrology

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1.0 Introduction

To evaluate any alternatives associated with the Utaba Dam Watershed Plan-EA, it is necessary to determine the amount of water generated by the Utaba Dam contributing watershed for the following purposes:

- To determine the flows used to evaluate flooding with and without the debris basin for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence events including the depths of flooding throughout the community.
- To determine the probable maximum flood (PMF) conditions as defined by TR-60 and Utah State Code necessary to:
    - evaluate the requirements for the primary and auxiliary spillways and the freeboard of the debris basin,
    - to size the associated flood and bypass channels (if any), and
    - to perform breach analysis on the debris basins with the associated downstream risks to the community, including the possible loss of life.

To accomplish this, this technical memorandum:

- Defines the characteristics of the Utaba Dam Watershed.
- Defines the guidelines and codes that govern the analyses.
- Discusses the available data used to evaluate the watershed and dam hydrology.
- Defines the resulting methodology used based on the available data.
- Documents the precipitation source types, including the depth-duration curves for each event.
- Document the landcover, geology, soils, and assumptions used to model runoff.
- Documents calibration of modeled runoff.
- Documents the results of each of the required controlling events specified by code and guidelines.

2.0 Characteristics of Utaba Dam Watershed

Utaba Dam sits on the North Fork of the Ogden River and collects water from a small watershed in the Wasatch Mountain Range northwest of Pineview Reservoir and the town of Eden in Weber County, Utah, with an area of approximately 9.5 square miles (USGS StreamStats). Figure 1 shows a map of the basin as delineated using the USGS tool StreamSTATS and verified using GIS and topographic mapping. Basic watershed characteristics are summarized in Table 1.

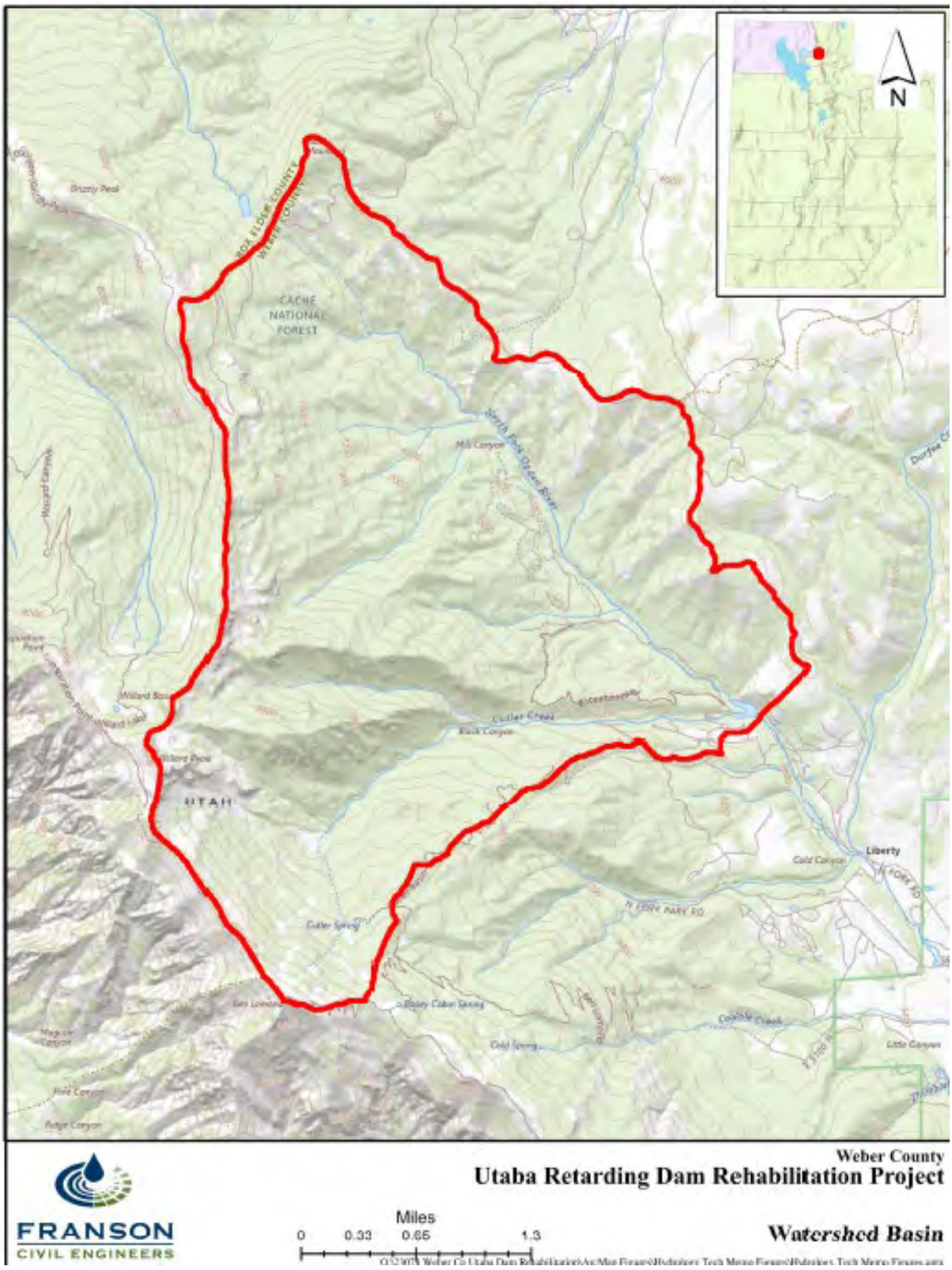

Figure 1: Utaba Dam Watershed Basin

Table 1: Utaba Dam Watershed Characteristics

Location (StreamStats)	Latitude 41° 23' 11.796" N Longitude 111° 54' 33.912" W
Dam Classification	High
Drainage Area	9.5 Square Miles
Maximum Flow Path Length	21,788 Feet
Estimated Time of Concentration (TR-55 method)	125 min (2.08 hrs)
Mean Basin Elevation (StreamStats)	7,300 Feet
Highest Elevation (Ben Lomond Peak)	9,716 Feet
Minimum Elevation (Utaba Reservoir)	5,720 Feet
Percentage of Area Covered by Forests.	19.3%
Percent of Natural Herbaceous Upland Vegetation	33.3%
Percent Area with Slopes greater than 30 Percent	75.3%
Mean Basin Slope	42.9%
Mean Annual Precipitation	55.9

Sources: USGS StreamStats; USGS WaterData; USGS "National Hydrography Dataset"

As is demonstrated by this data, while the elevations in the Utaba Dam Watershed are quite high, the basin is still very dry in the summer months, receiving very little rain. A review of the average precipitation distribution is shown below in Figure 2. However, the total amount of precipitation in the year, 55.9 inches, makes it the wettest gauged watershed in the Wasatch Front area. This provides some unique challenges for using USGS StreamSTATS, which identifies the precipitation amounts as exceeding the maximum elevation calibration range of the equations used while the basin area is smaller than the minimum for which the equation was calibrated.

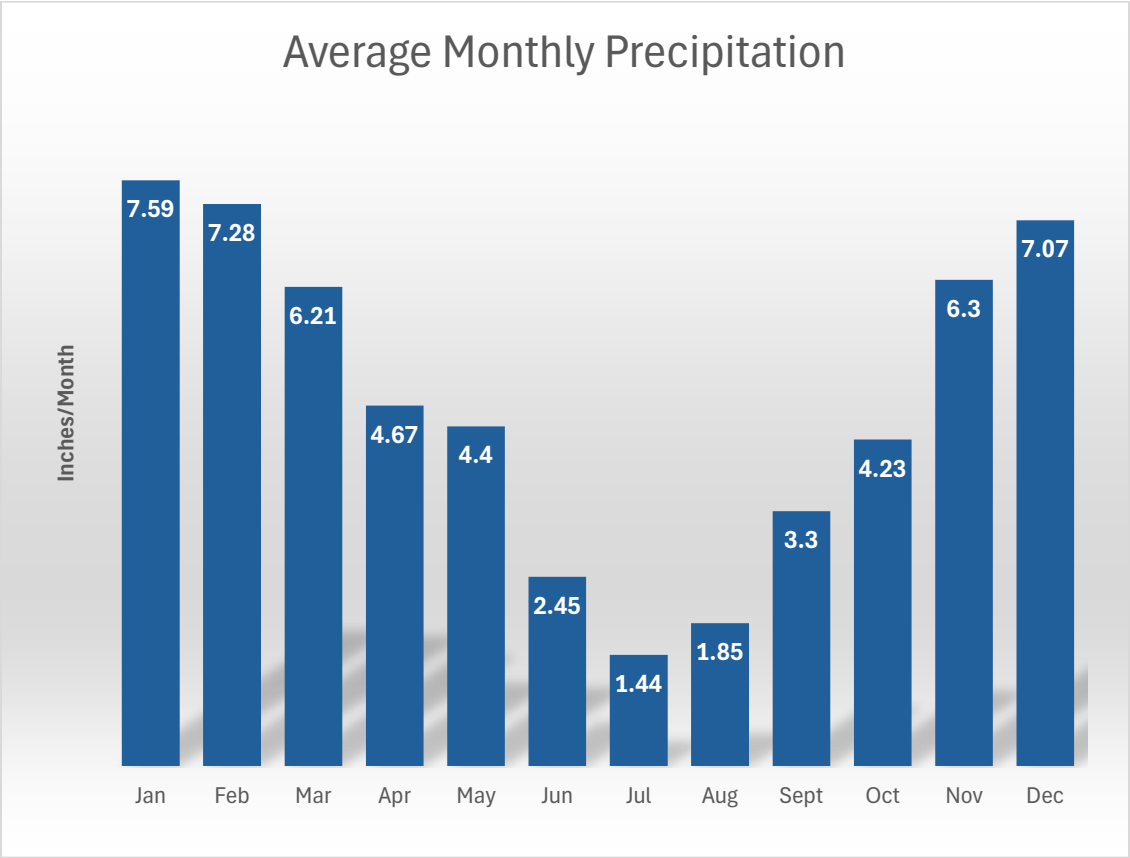

Figure 2: Utaba Dam Watershed Average Precipitation (USGS StreamStats)

The precipitation cycle reflects that snowmelt is the primary water supply for the basin and will result in long periods of snow melt. Additionally, this basin is subject to very intense rainstorm events. Generating average NOAA Atlas 14 summary tables for the basin generates the following depth, duration, frequency information as provided in Table 2. Based on this data, this basin—being as high and as small as it is—is subject to high flows from both snowmelt and rainfall with potential significant flash floods.

Table 2: NOAA Atlas 14 Rainfall Depths versus Duration (inches)

Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	200-Yr	500-Yr
5-min	0.245	0.329	0.404	0.519	0.623	0.746	0.891	1.130
10-min	0.373	0.501	0.615	0.750	0.930	1.136	1.359	1.719
15-min	0.462	0.621	0.762	0.950	1.175	1.450	1.740	2.200
30-min	0.622	0.837	1.026	1.300	1.584	1.898	2.265	2.870
60-min	0.770	1.035	1.300	1.595	1.960	2.430	2.803	3.400

Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	200-Yr	500-Yr
2-hr	1.000	1.280	1.600	1.900	2.385	2.750	3.180	3.850
3-hr	1.175	1.453	1.800	2.200	2.600	3.010	3.530	4.220
6-hr	1.671	1.950	2.310	2.810	3.230	3.720	4.250	5.000
12-hr	2.500	2.870	3.320	3.960	4.480	5.120	5.670	6.530
24-hr	3.869	4.663	5.328	6.250	6.978	7.730	8.504	9.563
72-hr	4.450	5.490	6.680	7.670	9.060	10.200	11.300	12.500

2.1 Geology and Soils

2.1.1 Geology

Geology information was provided by the Utah Geological Survey (UGS). A map of the geology data is shown in Figure 3.

Primary geologic formations in this area include:

- Perry Canyon formations of mudstone primarily in the bottom of the canyon including Perry Canyon mudstone, sandstone overlaying mudstone, and the diamictite member with boulders to pebble size quarzitic and granitoid clasts set in Perry Canyon mudstones.
- Brigham Group including the Geertsen Canyon Quartzite, a medium to thick bedded medium to coarse grained quartzite with scattered zones of small pebbles, which is similar to the Caddy Canyon Quartzite, another medium grained vitreous quartzite. Colors are highly variable for the Caddy Canyon Quartzite.
- Large deposits of quartz and gneiss are also present in this basin, including Vein quartz, Pegmatite, Leucocratic gneiss, and others.

As reflected by the above geology, the formations in this area are based heavily on quartzite, gneiss, and mudstone from eons of glacial prehistoric formation supplemented by erosion. This combined with the high precipitation in this basin has resulted in the low pH.

A review of the UGS data on fault lines along the Wasatch front identifies a fault passing up Northfork Odgen River Canyon, through the ridge line to the northwest, and west to Perry. Additionally numerous well-defined thrust faults are present in the basin, the backside of the Wasatch Mountains. These faults are shown in Figure 3.

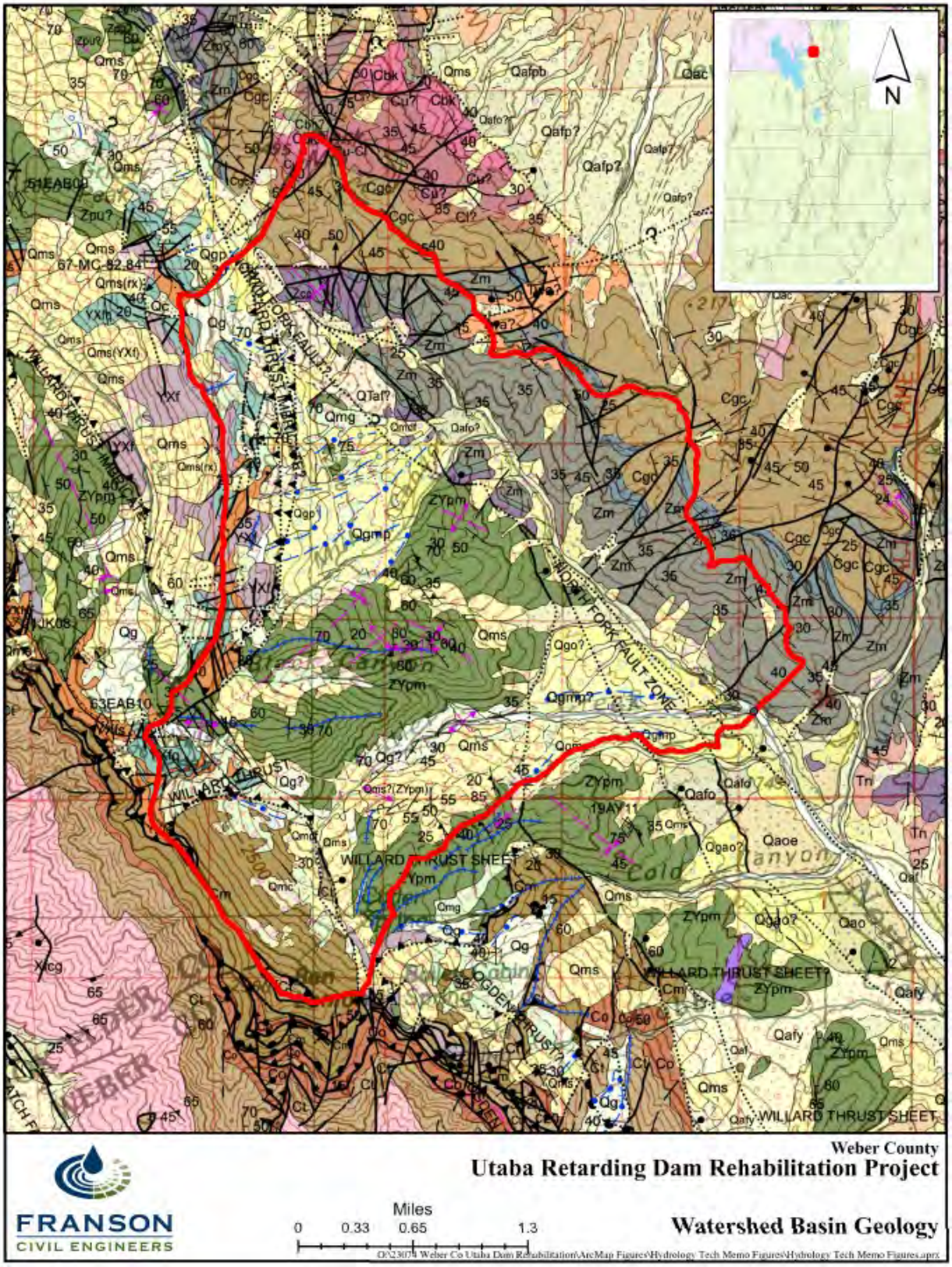

Figure 3: Utaba Basin Geology

2.1.2 Soils

Soils in this area consist of rock outcrops (approximately 36%), stony loams with 30% to 70% steep slopes which are shallow stoney and cobbly loams over weathered rock (approximately 33%), with the remaining approximately 30% being in channel bottoms, canyon bottoms, and alluvial fans.

Soils in this area are not typical for Utah. Due to the high elevation and extreme geological formation conditions, the pH of the soils within this basin are all documented to range between 6.3 and 5.8 at a 1:1 ratio soil to water when mixed with distilled water. This acidic condition, the pH being less than 7.0, is very damaging to the concrete that is not designed with special consideration, particularly if aggregate from the local area is used, as typically was done when Utaba Dam was constructed.

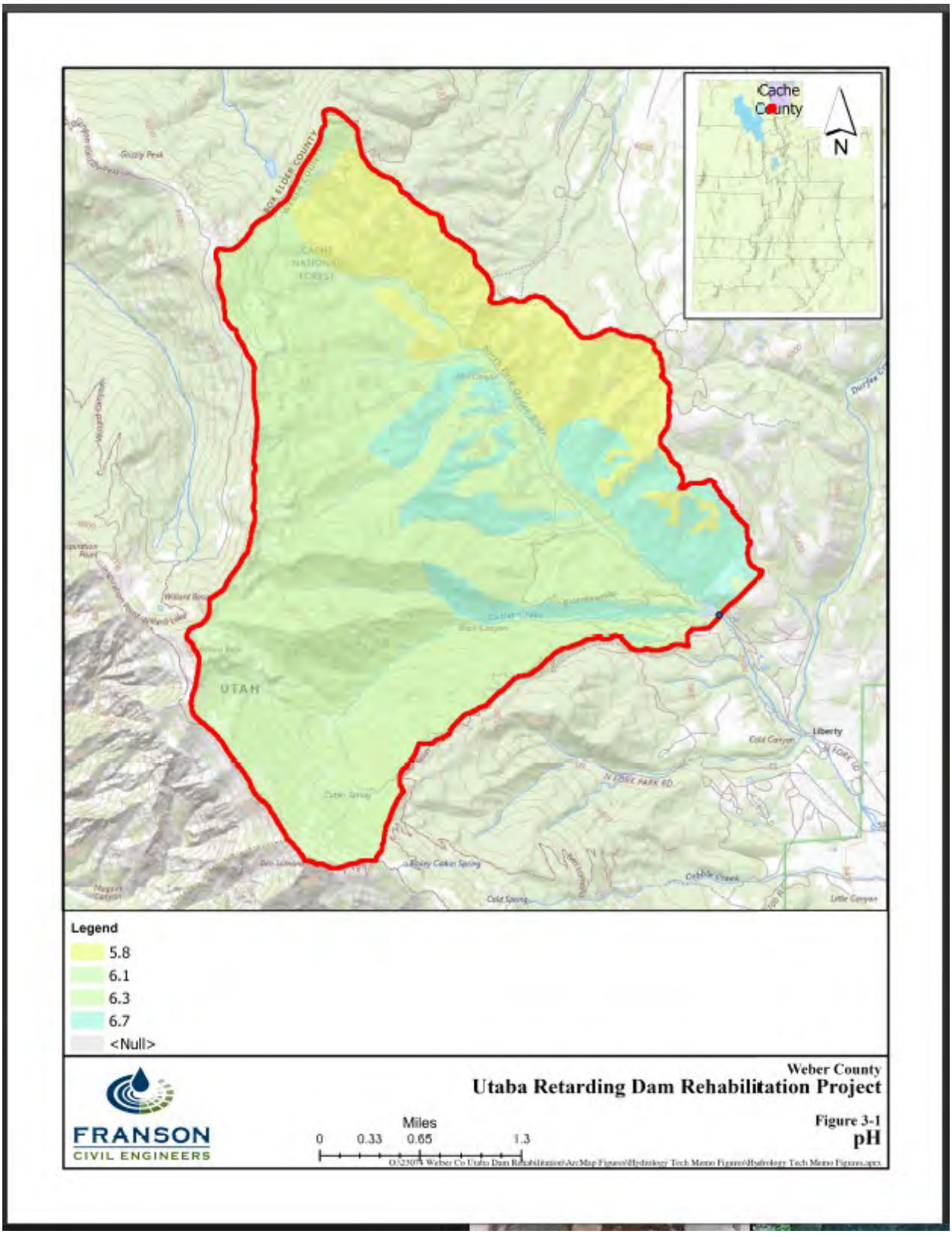

Figure 4: Soil pH Levels in the Project Area

Additionally, Figure 4 shows the hydrologic soil groups reflecting the ability of the soils to infiltrate and absorb water. This information was critical to understanding the conditions affecting flooding in the basin. A-soils tend to have the highest infiltration rates, while D-soils are either near impermeable in high intensity storms or already saturated. This is important to know when assigning curve number values. As the figure shows, Northfork Ogden River has a high percentage of D soils, which coincides with the geologic maps area of exposed granite and gneiss with very shallow fine-grained soils. This provides for a very low permeability approaching zero or impermeable in some areas. This is supported by the apparent rapid runoff experienced from rainstorms in this area from this drainage.

2.1.3 Land Cover

The land cover data used to create the hydrology model came from a study done by the Utah State University, College of Natural Resources, RS/GIS Laboratory from 2018 to 2023. The study categorized the land cover types for the entire Utaba Dam Watershed. The study looked at 125 different land classes based on vegetation type. Only land classes were found within the Utaba Dam Watershed are included in Figure 6. Each of those land classes were correlated to a hydrologic soil cover type, per National Engineering Handbook (NEH) Part 630 Chapter 9.

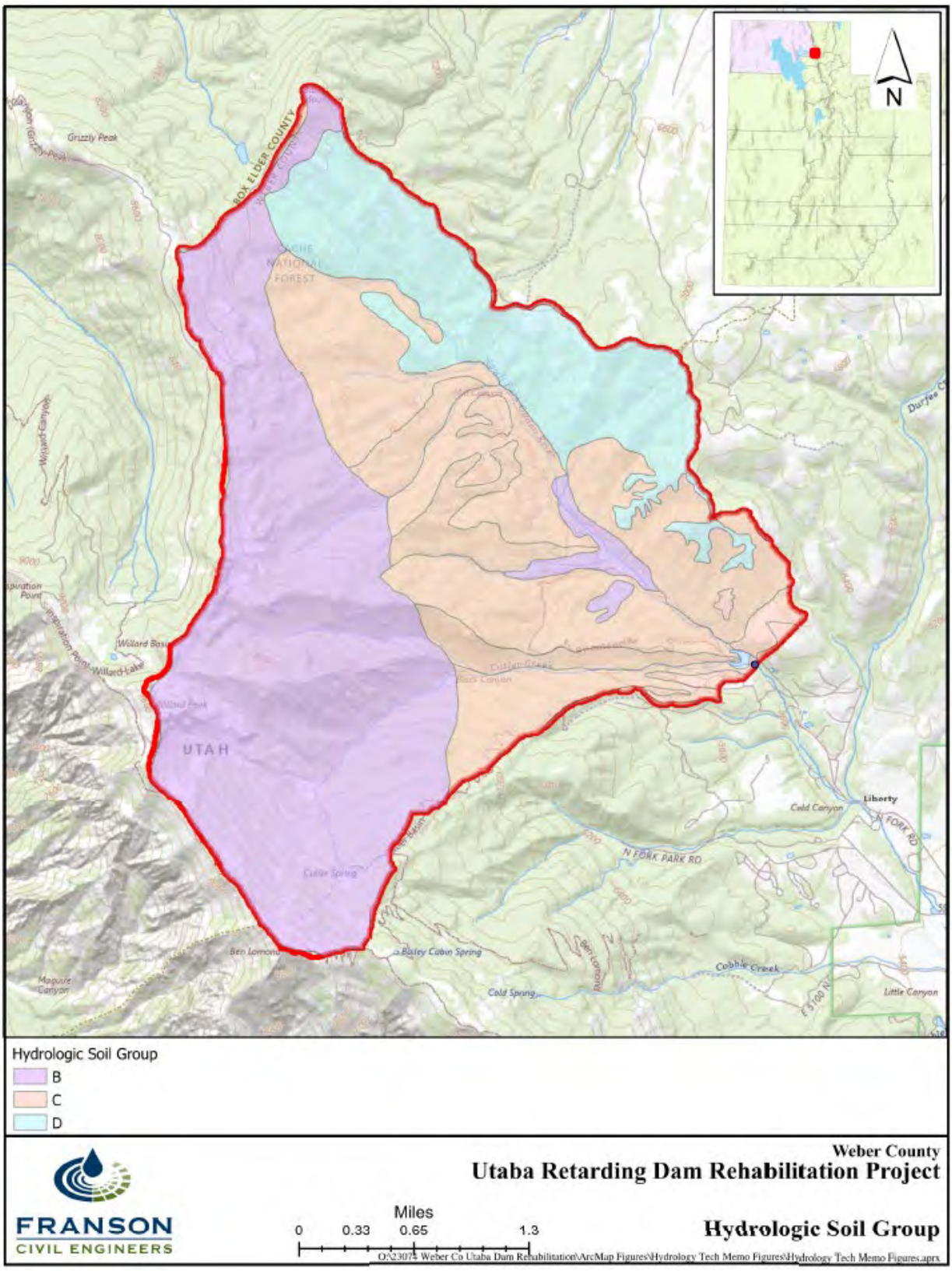

Figure 5: Hydrologic Soil Groups (HSGs)

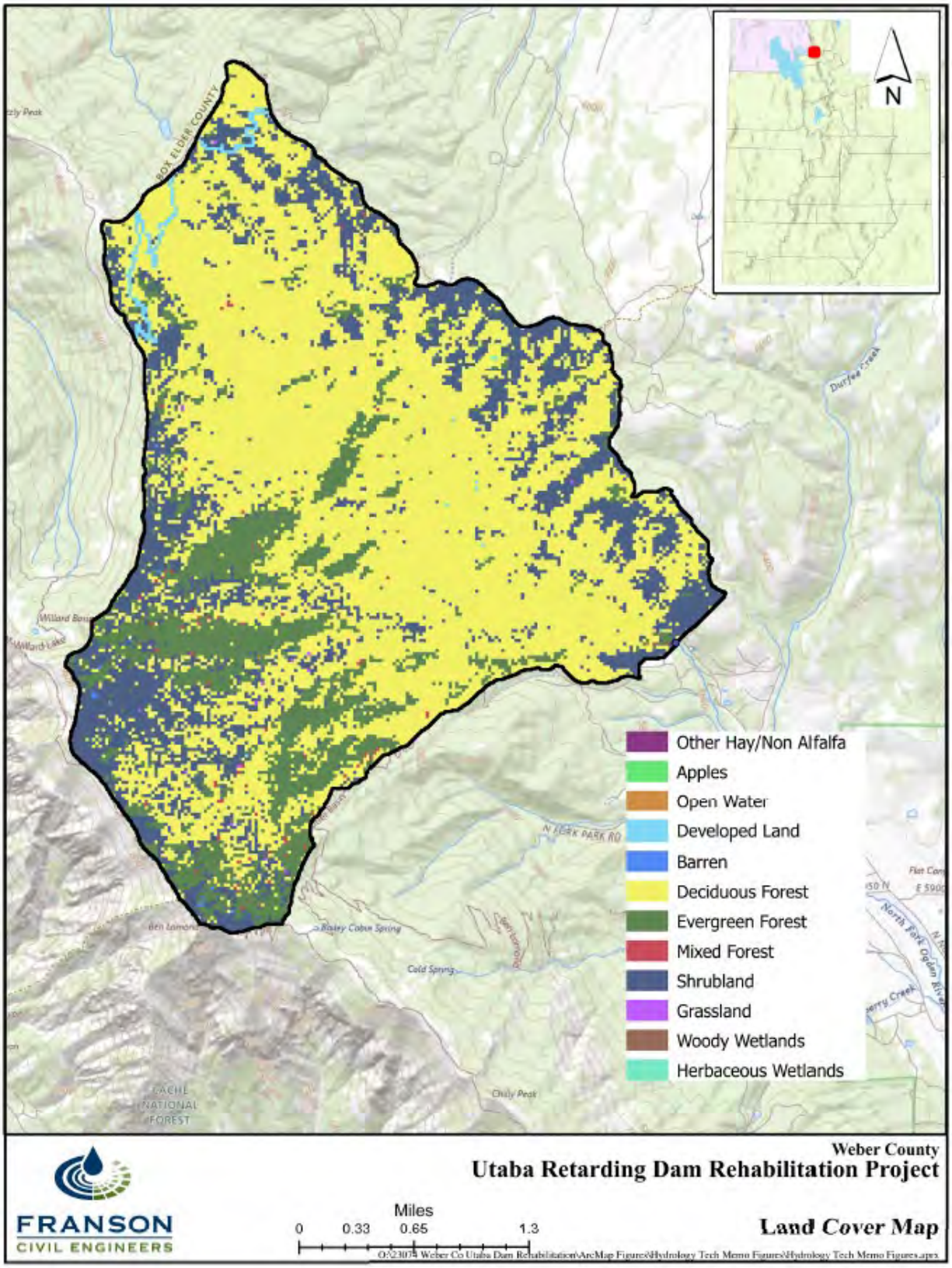

Figure 6: Land Cover Map

2.2 Required Analyses Completed

2.2.1 Governing Codes and Guidelines

The following codes and guidelines dictate the analysis completed as part of this Watershed Plan-EA.

- Title 390 National Watershed Program Manual, June 2024
- Title 390 National Watershed Program Manual, 2014
- TR-210-60 – Earth Dams and Reservoirs
    - NOAA Atlas 14, Hydrometeorological Design Studies Center (https://hdsc.nws.noaa.gov/pfds/)
    - Hydrometeorological Report No. 49 (HMR49) – "Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages", National Oceanic and Atomospheric Administration (NOAA).
- Utah Rule R655. Natural Resources, Water Rights, R655-11. Requirements for the Design, Construction and Abandonment of Dams.
    - 2002 Update for Probable Maximum Precipitation, Utah 72 Hour Estimates to 5,000 sq. mi. – March 2003" (USU), Donald T. Jensen, Utah Climate Center
    - Probable Maximum Precipitation Estimates for Short Duration, Small Area Storms in Utah- October 1995, (USU), Donald T. Jensen, Utah Climate Center
- National Engineering Handbook (NEH) Part 630, Chapters 4, 5, 7, 9, 10, 16, and 21.

2.2.2 Required Inflow Design Flood (IDF) Frequency Analysis

Requirements of PL-566 PR&G, the NEH, and the dam safety rules and regulations of the State of Utah (R655) provide specific conditions which are required to be evaluated as part of the analysis. Each precipitation event and condition are evaluated for different purposes. While flood flow conditions associated with snow melt are evaluated as part of identifying the peak discharges for the flood frequency flows and particularly for sizing the primary outlet structures, rainfall runoff models and rain-on-snow evaluation models become the predominant methods of sizing the primary and auxiliary spillways, freeboard, and primary uncontrolled flood analysis as directed in NEH Part 630 and R655. The following sections define the individual events that govern the discharges used in the evaluations.

2.2.2.1 PR&G Ecosystem Services and Economic Analysis

The PR&G ecosystem services and economic analysis requires the evaluation of impacts of each alternative from the following events based on the NOAA Atlas 14 depths and hyetographs created using the TR-20 methodology:

- 2-Year, 24 Hour

- 5-Year, 24 Hour
- 10-Year, 24 Hour
- 25-Year, 24 Hour
- 50-Year, 24 Hour
- 100-Year, 24 Hour
- 200-Year, 24 Hour
- 500-Year, 24 Hour

These should then be compared to the projected flows from snow-melt and rain-on-snow to determine which is the higher flow rates for the controlling hydrograph.

2.2.2.2 Dam Safety Evaluation Precipitation Events

The evaluation of dams for design, rehabilitation, or removal requires the additional evaluation of the following storms as calculated based on HMR49 as updated with Utah specific calibration by Jensen as referenced above (TR-60, R655, and NEH Part 628). These are summer hyper-saturated monsoon rainfall events which typically occur between late July to late September according to HMR49.

- 6-Hour, 100 Year, Antecedent Runoff Condition (ARC) III Condition (R655, TR-60)
- 24-Hour, 100 Year, ARC III Condition (TR-60)
- 72-Hour, 100 Year, ARC III Condition (R655, TR-60)
- 72 Hour, PMP with Jensen Calibration (R655, TR-60)
- 6 Hour, PMP with Jensen Calibration (R655, TR-60)
- 10 Day, 100 Year (TR-60) with the appropriate adjustments to the infiltration impacts on the curve numbers as required in Table 2-3(b) of TR-210-60 for point 10-day precipitation exceeding 6.0 inches.

Additionally, it is necessary to evaluate snow melt runoff flows and hydrographs since these may exceed rainfall events alone, especially when combined with rain-on-snow conditions (NEH Part 630, Chapter 11).

2.2.2.3 Required Sizing Hydrographs

The required design hydrographs, or inflow design flow (IDF), to be evaluated is the resulting runoff from the above precipitation events, or a combination of those events as specified by code and TR-60. These hydrographs are created according to the following table for high hazard classification dams such as Utaba Dam.

Table 3: Hydrograph Required for Reservoir Design Flows

IDF	Design Precipitation (inches)
Principal spillway (PSH)	[1] P_{100}
Auxiliary spillway (ASH)	P_{100}+0.26([2]PMP-P_{100})
Freeboard hydrograph (FSH)	[2] PMP

1. This is typically the ARC III Conditions for either the 6-hour or 72-hour condition. The IDF is the hydrograph generating the highest peak flow after being routed through the reservoir. So, while the 6-hour may have a higher inflow peak, due to attenuation, the 72-hour may cause a higher peak flow and shall be considered per R655-11-4A.
2. This is the PMP hydrograph that yields the highest peak flow rate when routed through the reservoir. So, while the 6-hour may have a higher peak flow, due to attenuation, the 72-hour may cause a higher peak flow and shall be considered per R655-11-4A.

2.2.2.4 Design Precipitation Events

Table 4 summarizes all the design precipitation events with the associated data source and governing regulations.

Table 4: Precipitation Events Required in all Evaluations

Storm Event	Source	Precipitation Value (inches)
2-Year 24-Hour ARC II	NOAA	3.87
5-Year 24-Hour ARC II	NOAA	4.66
10-Year 24-Hour ARC II	NOAA	5.33
25-Year 24-Hour ARC II	NOAA	6.25
50-Year 24-Hour ARC II	NOAA	6.98
100-Year 24-Hour ARC II	NOAA	7.73
200-Year 24-Hour ARC II	NOAA	8.50
500-Year 24-Hour ARC II	NOAA	9.56
100-Year 6-Hour ARC III	NOAA	3.72
100-Year 24-Hour ARC III	NOAA	7.73
100-Year 72-Hour ARC III	NOAA	11.3
100-Year 10-Day	NOAA	18.19

Storm Event	Source	Precipitation Value (inches)
6-Hour PMP	HMR 49 & Jensen Short Duration	6.62
72-Hour PMP	HMR 49 & Jensen 72 Hour	18.61
Principal Spillway 6-Hour	TR-60-Table 2-2 ARC III	3.72
Principal Spillway 72-Hour	TR-60-Table 2-2 ARC III	7.73
Auxiliary Spillway 6-Hour	TR-60-Table 2.5 ARC III	4.48
Auxiliary Spillway 72-Hour	TR-60-Table 2.5 ARC III	13.2
Freeboard 6-Hour	TR-60-Table 2.5 ARC III	6.62
Freeboard 72-Hour	TR-60-Table 2.5 ARC III	18.61

2.3 Available Hydrologic Data

To better understand the nature of flood events in a watershed, it is important to determine if the extreme events are driven by snowmelt, rain-on-snow, or thunderstorms in the summer. This is accomplished by evaluating stream gauge data (when possible), or by reviewing nearby gauges on similar basins and completing a comparative basin analysis.

2.3.1 Northfork Ogden River and Regional Stream Gauge Records and Historical Data

The Northfork Odgen River does not have an active gauge but does have an abandoned gauge near Eden (10137680) just upstream of Utaba Reservoir with records from September 30, 1963, to September 28, 1974. Due to the extremely short duration of the records, there is insufficient data to perform a statistical analysis on this gauge which is sufficient for peak flow determination for this basin. A review of the Middlefork Ogden River has the same problem. The years of data available are over the same period and again only reflect this drought period, thus basin similarity will not help extend the period of record.

However, nearby Southfork Ogden River near Huntsville, Gauge 10137500 has records recording flow from March 20, 1921, to present. This over 100 years of data provides excellent quality data for statistical analysis but does have some significant differences from the Northfork Ogden River as shown in Table 5: Basin Comparisons.

Table 5: Basin Comparisons

Location (StreamStats)	Northfork Ogden River near Eden	Southfork Ogden River near Huntsville
Drainage Area	5.98 square miles	137 square miles
Maximum Flow Path Length	21,778 feet	70,273 feet
Mean Basin Elevation (StreamStats)	7,110 feet	7,220 feet
Highest Elevation	9,260 feet	9,144 feet
Percentage of Area Covered by Forests	12.7%	26.3%
Percent of Natural Herbaceous Upland Vegetation	8.7%	21.9%
Percent Area with Slopes greater than 30%	73.3%	50.2%
Mean Basin Slope	39.3%	32.1%
Mean Annual Precipitation	53.9 inches	35.5 inches
Reservoirs	None	Causey (7,870 acre-feet)

Based on the review, the two basins are:

- significantly different is size,
- flow paths (time of concentration) significantly vary,
- significant elevation differences
- slopes exceeding 30% and mean basin slope greatly vary,
- different slope aspects, with the Northfork (primarily south aspect ratio with highest ridges on West) and Southfork (primarily west aspect ratio with highest ridges on the southwest),
- a storage reservoir upstream of the gauging station on the Southfork.
- and the differences in forest and herbaceous vegetation are significant.

All of the differences imply a significantly different unit runoff from Northfork Ogden River than Southfork Ogden River.

Flow data reflecting annual peak flows and daily peak flows were downloaded from the Utah Division of Water Rights for both sites. These flow records automatically calculate multiple statistical analyses including log Pearson type III (LP 3), ranked, log normal, Gumbel extreme distribution, and other statistical evaluations without any consideration of the statistical significance of the number of data points or years of data. The applicability of each method is left to the professional reviewing the data. The Southfork data is excellent with over 100 years of record, while the Northfork data, due to the limited sample size, is statistically unreliable. Under this condition, experience prefers the LP 3 method and simple ranked method over the other extreme event methods.

Reviewing Southfork Ogden River data from 1963 to 1974 reflects that these years were during an extended dry period without any runoff events generating peak flows above 5-year return event as shown in Table 6. Due to the proximity and apparent consistency of the data, it is apparent that the Northfork Ogden River similarly experienced dry flow years. However, by correlating these periods' peak flows between the two basins, a relationship was developed to relate the peak flows from each basin using the best available data to compare various results as a basis of "reasonableness." Table 6 provides the expected return frequency for each year's peak flows years of common record from the Southfork Ogden River based on the LP 3 methodology. Table 7 provides a comparison of the flows from the Northfork by ranking, and the comparison of the annual discharge per square mile of each basin. As noted, the ratio between the two basins is inconsistent and varies due to the many variations between the two basins. This reflects the correlation between the basins.

Table 6: Annual Peak Flows of Southfork Ogden River, 1964 to 1974 by Rank

Date	Peak Flow	Return Frequency
5/10/1974	1230	5-Year
5/15/1964	1150	3.5-Year
4/30/1965	1080	2.8-Year
5/16/1971	1070	2.7-Year
5/23/1967	1040	2.5-Year
5/20/1970	951	2.4-Year
5/12/1966	919	2.3-Year
4/23/1969	901	2.1-Year
5/5/1972	822	2-Year
5/13/1973	812	2-Year
5/5/1968	622	< 2-Year

Table 7: Northfork Ogden River Annual Unit Peak Discharge - Annual Peak Flow During Period of Record (1964-1974)

Rank	Southfork Flow (cfs)	Southfork cfs/sqmi	Northfork Flow (cfs)	Northfork cfs/sqmi
1	1230	8.98	156	25.87
2	1150	8.39	131	21.72
3	1080	7.88	126	20.90
4	1070	7.81	108	17.91

Rank	Southfork Flow (cfs)	Southfork cfs/sqmi	Northfork Flow (cfs)	Northfork cfs/sqmi
5	1040	7.59	89	14.76
6	951	6.94	87	14.43
7	919	6.71	84	13.93
8	901	6.58	75	12.44
9	822	6.00	70	11.61
10	812	5.93	69	11.44
11	622	4.54	51	8.46

While any correlation is of limited value at best, it is useful to determine the relationship between snowmelt peaks during the drought period compared to rain on snow events as seen in other basins, particularly the Little Bear River Basin just to the North. Based on this correlation, the following equation can be developed representing the runoff flow rates of Southfork and the reasonable areas of the Utaba basin:

$$Qnf = (.000238Qsf^2 - 0.273397Qsf + 130.878224)$$

R2= 0.956 (95.6%)

Where:

Qnf = Peak flow in the Northfork Ogden River (cfs)

Qsf = Peak flow in the Southfork Ogden River (cfs)

With the Northfork flows, the peak can be upsized by the area calibration factor (C) to adjust for the whole Utaba drainage reflected in the following equation:

$$Q = C(Qnf)$$

Where:

C = Area Calibration factor calculated as

$$Q = Qnf(\frac{Aabove}{Anf})$$

As a result, where:

Qnf = Peak flow leaving the Northfork Ogden River

Autaba = Area of the Utaba Drainage Basin (9.5 square miles)

Anf = Area of the Northfork Drainage Basin (6.03 square miles)

Cnf=1.00

Cutaba = 1.58

A comparison of the above methodology is provided in Figure 7. As the figure shows, the LP 3, regression equation, and USGS StreamSTATS results demonstrate a reasonable correlation with all of the data sources; they also reflect the limitations of predicting extreme events from very small data sets. Since the Utaba basin is too small and too high in elevation for the regression equation's constraints and with the limited data coming from years with flows less than the 5-year expected return period, it is not surprising that the basin similarity deviates from the regression equation and the LP 3 analysis for the extreme event analysis, greater than 5 years. It must also be noted that StreamSTATS regression equations are generating such an "interesting" pattern compared to the LP 3 and basin similarity analysis due to independent regression equations for each return period being created from all of the gauging stations in the region including many stations that are not in the Ogden River basin, rather than reporting data from just one station.

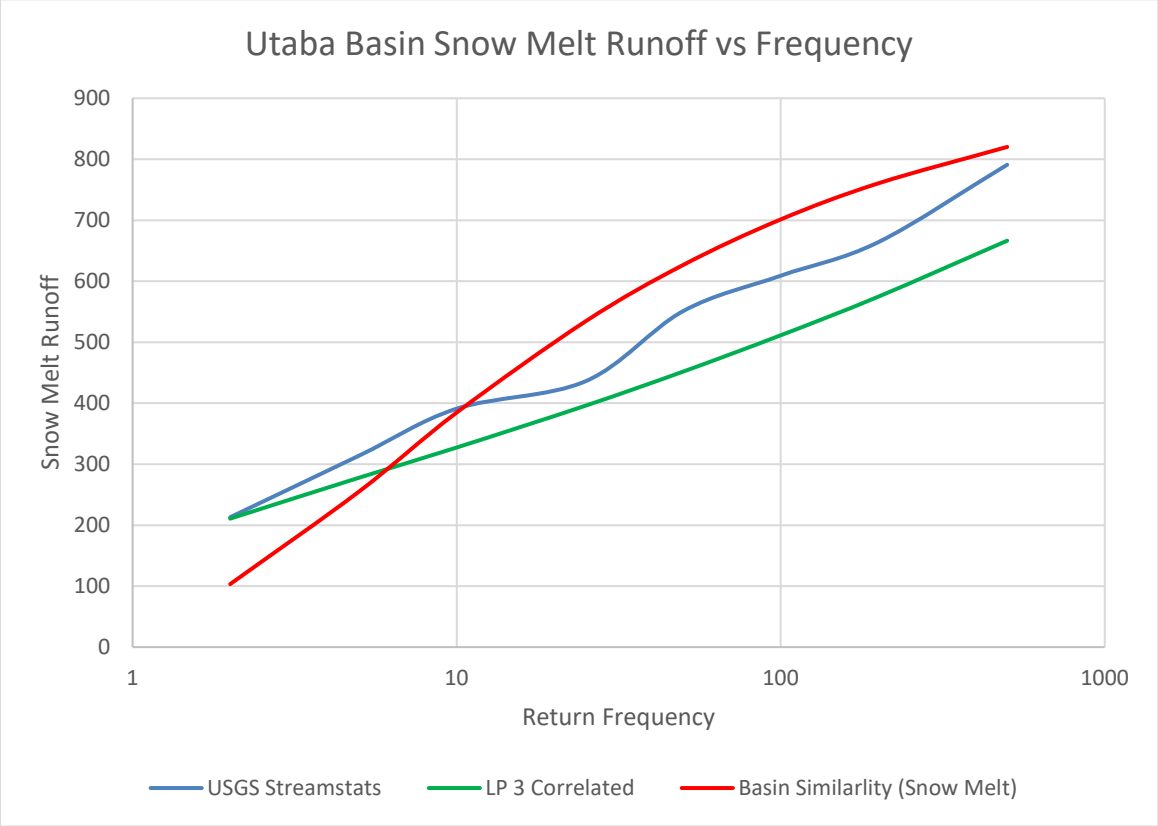

Figure 7: Comparison of Different Methods of Estimating Snow Melt from Utaba Basin

Even with all the deviations, there is enough apparent basin similarity to reflect a reasonable correlation with snow melt events, providing a "reasonable" basis of snowmelt IDF in the absence of other conditions. However, based upon the intensity of the summer rainstorm events, and the

lack of peak runoff events being associated with rain-on-snow events in either of the water sheds, it is necessary to model rainfall runoff storms using the Curve Number (CN) method to determine the controlling runoff events for the PR&G economic analysis and for sizing the primary spillways and auxiliary spillways as well as overtopping events. A review of observations from Weber County and surrounding property managers has confirmed that summer thunderstorms result in rapid flash floods filling the retarding basin. This has been further confirmed by modeling in accordance with NEH Part 630 as required.

2.3.2 Establishment of Base Flow

The first step is to establish the base flow for the basin. The Northfork Ogden River is a perennial stream with a native population of Bonneville Cutthroat living upstream of Utaba Dam and up both primary tributaries, Cutler Creek and Northfork Ogden River. This base flow is included in the basin similarity analysis and USGS regression equation flows based on existing gauging station data. However, it needs to be added to any hydrologic modeling results generated by normal rainfall only analysis. Due to the limitations in gauging data, the base flows were evaluated again using the basin similarity approach and equation with the flow correlation equation. Using the daily low flows during the summer months of July, August, and September, a correlated equation for base flow was similarly attempted. However, the highest R squared obtained was 0.30 which, being significantly less than 0.50, reflects a purely random correlation. A gauging station on the Northfork lower downstream was evaluated near Huntsville for an early period of record of approximately the same period of duration, but the base flows were erratic reflecting either inaccuracy in measurement equipment or water being lost to alluvial infiltration prior to reaching the gauging station. Again, the Middlefork Ogden River Station provided no assistance for similar reasons previously discussed.

Lacking reliable basin similarity for base flows, the existing Northfork daily data for the months of July through September were evaluated, being the most likely to consistently occur at the same time as severe thunderstorms based on Jensen et.al, and the 90th percentile value was selected as the base flow. The correlating statistics for the historical flows from the Northfork Ogden River gauging station are provided in Table 8. This value was then scaled up for the entire Utaba basin as discussed for the similarity procedures previously.

Table 8: Utaba Reservoir Base Flows

	Northfork Odgen	Utaba Reservoir
Number of Readings	33	N/A
Mean Flow (cfs)	5.29	8.34
90th Percentile (cfs)	9.15	14.4

Again, recognizing that the data in Northfork was collected during a drought cycle and the lack of correlation of the low flows from the Northfork Basin to the other basins in the area (including Middlefork and Southfork) combined with the lack of water right diversion records, this was the best information available. Subsequent site visits and observations of the channel combined with the apparent health and condition of the aquatic system seemed to justify these estimates. The Bonneville Cutthroat are very small and sparse in the upstream river, often suffering from temperature issues related to low flows. It should be noted that this correlates very closely to the

estimated base flows and the expected conditions that would result, as well limited vegetation over the water that results from high cleansing flows during rain events and snow melt that prevent vegetation from establishing in the channel. It should also be noted that even a 100% increase in base flow, in this case where the base flow is such a small portion of the flood hydrograph, would not change the flood modeling results for the purposes of this Watershed Plan-EA, change the size of the spillways, size of the headgates, nor alter the management of the reservoir which is only used to capture flows for fire management. As a result, the base flows are not a significantly sensitive design element for this basin. Additionally, it should also be noted that there is not a regulating pool associated with the Utaba retarding basin.

2.4 Curve Number Methodology and Procedures

As directed by the NRCS standard procedures in the NEH Part 630, TR-60 directs the use of the TR-55, or the NRCS Curve Number method, as the infiltration and runoff method and for the calculation of hydrologic discharges. This method is a tool specifically designed around simulations for rainstorm hyetographs developed by the TR-20 methodology using NOAA Atlas 14 rainfall data.

Under this simulation, HEC-RAS version 6.5 has been used to complete a rain-on-grid analysis of the entire basin to:

- Map the flows within the basin and flow paths to the dam.
- Determine the relationship of flows in the basin and the times of concentration to probable multiple peaks for each storm event.
- Allow for the spatial distribution of the storm event.
- Allow for the spatial distribution of the soil conditions and vegetative cover.
- Address the varying hydraulic roughness of the soil surface.
- Incorporate the effects of the varying surface slopes which change rapidly.
- Allow for a more comprehensive calibration of the model for the variety of conditions.

2.4.1 Topographic Data

The topography of the basin was generated from the USGS digital elevation model (DEM) 1/3 ARC (10 meter) resolution available from the Utah Geospatial Resource Center (UGRC). This dataset typically provides a vertical accuracy within 0.62 meters (2.03 feet) in evergreen forests and 0.33 meters (1.08 feet) in deciduous forests and grasslands (see Table 4, Accuracy Assessment of the U.S. Geological Survey National Elevation Dataset, and Comparison with Other Large-Area Elevation Datasets – SRTM and ASTER, Open-File Report 2014—1008, U.S. Department of the Interior, U.S. Geological Survey). This accuracy is more than adequate for the purposes of hydrologic modeling of the basin at this scale and meets the requirements of the NEH.

2.5 Hydrologic Analysis

2.5.1 Basin Delineation of Utaba Dam Watershed

The basin was preliminarily delineated using the USGS tool StreamSTATS to create a GIS shape file. The watershed boundary was then verified in GIS using topographic mapping based on a 10-meter DEM and adjusted where necessary. Due to the small size of the water shed, it was decided not to break the watershed into smaller sub-basins due to the effectiveness of the HEC-RAS rain-on-grid capability with two-dimensional modeling. This basin boundary has been shown previously in Figure 1.

2.5.2 Curve Number and Mannings Roughness Coefficients

Curve numbers (CNs) were developed into a GIS map based upon the guidance provided in the NEH Part 630 Chapter 7 (Hydrologic Soil Groups) and Chapter 9 (Hydrologic Soil-Cover Complexes). The hydrologic soil groups (HSGs) were taken from the NRCS WEBSOILs program, with a GIS layer for the soils. This layer was spot checked for comparison with the geological maps and site conditions recognizing bare rock and unvegetated conditions exist in several locations. It needs to be recognized that this basin will be nearly static under development conditions since it falls entirely within the bounds of the Wasatch National Forest. As such, development and associated hardening is not probable. Additionally, vegetation conditions over the last several years have been steady without any significant change.

Additionally, the land cover, discussed in the basin conditions descriptions, was used to further refine the CNs for the area. Based on site conditions of the project area, Table 9: Calibrated Curve Numbers includes the defined land cover, with the associated HSG and assigned CNs. The CNs were then adjusted as part of calibration until the results converged with observed results under known conditions.

The Manning's roughness coefficient represents the hydraulic roughness of the different soil and vegetated areas of the watershed and channels. The Manning's roughness was developed based on a GIS intersection of the landcover classification and HSG. Additional information considered included the land slope, vegetative density based on a review of aerial photography and imagery, and sight observations. The assigned Manning's roughness coefficients are also included Table 10.

Table 9: Calibrated Curve Numbers

Land Cover	Base CN	10 Day CN	ARC 3 CN
No Data	64	45	81
B Barren	80	65	91
B Deciduous Forest	50	32	70
B Developed Low Intensity	55	36	74
B Developed Med Intensity	55	36	74
B Evergreen Forest	50	32	70
B Grassland Pasture	55	36	74

Land Cover	Base CN	10 Day CN	ARC 3 CN
B Herbaceous Wetlands	64	45	81
B Mixed Forest	50	32	70
B Open Water	99	98	100
B Shrubland	66	47	82
B Woody Wetlands	50	32	70
C Deciduous Forest	48	30	68
C Evergreen Forest	48	30	68
C Grassland Pasture	55	36	74
C Herbaceous Wetlands	58	39	76
C Mixed Forest	48	30	68
C Open Water	99	98	100
C Shrubland	65	46	82
C Woody Wetlands	58	39	76
D Deciduous Forest	53	34	72
D Evergreen Forest	53	34	72
D Grassland Pasture	68	50	84
D Herbaceous Wetlands	79	64	91
D Mixed Forest	53	34	72
D Shrubland	76	60	89

Table 10: Manning's n Hydraulic Roughness

Land Cover	Mannings "n"
Barren	0.027
Developed Low Intensity	0.09
Developed Med Intensity	0.09
Shrubland	0.12
Grassland Pasture	0.038

Land Cover	Mannings "n"
Herbaceous Wetlands	0.067
Woody Wetlands	0.08
Deciduous Forest	0.15
Evergreen Forest	0.12
Mixed Forest	0.14
Open Water	0.038

2.5.3 Development of Hyetographs for Modeling

Rainfall hyetographs were developed using TR-20 methodology by applying the unit hydrograph to each of the applied storm event depths and durations in accordance with NEH Part 630 and Utah R655 for the 2-Year to 500-Year, 24-hour events. The 10-Day, 100-Year, 6-hour, and 72-hour events were developed using the NRCS time transformation spreadsheet developed by William Merkel, NRCS. The respective rainfall hydrographs, following mandated smoothing, are included in the following figures. The tabular forms were imported into HEC-RAS version 6.5 for modeling purposes.

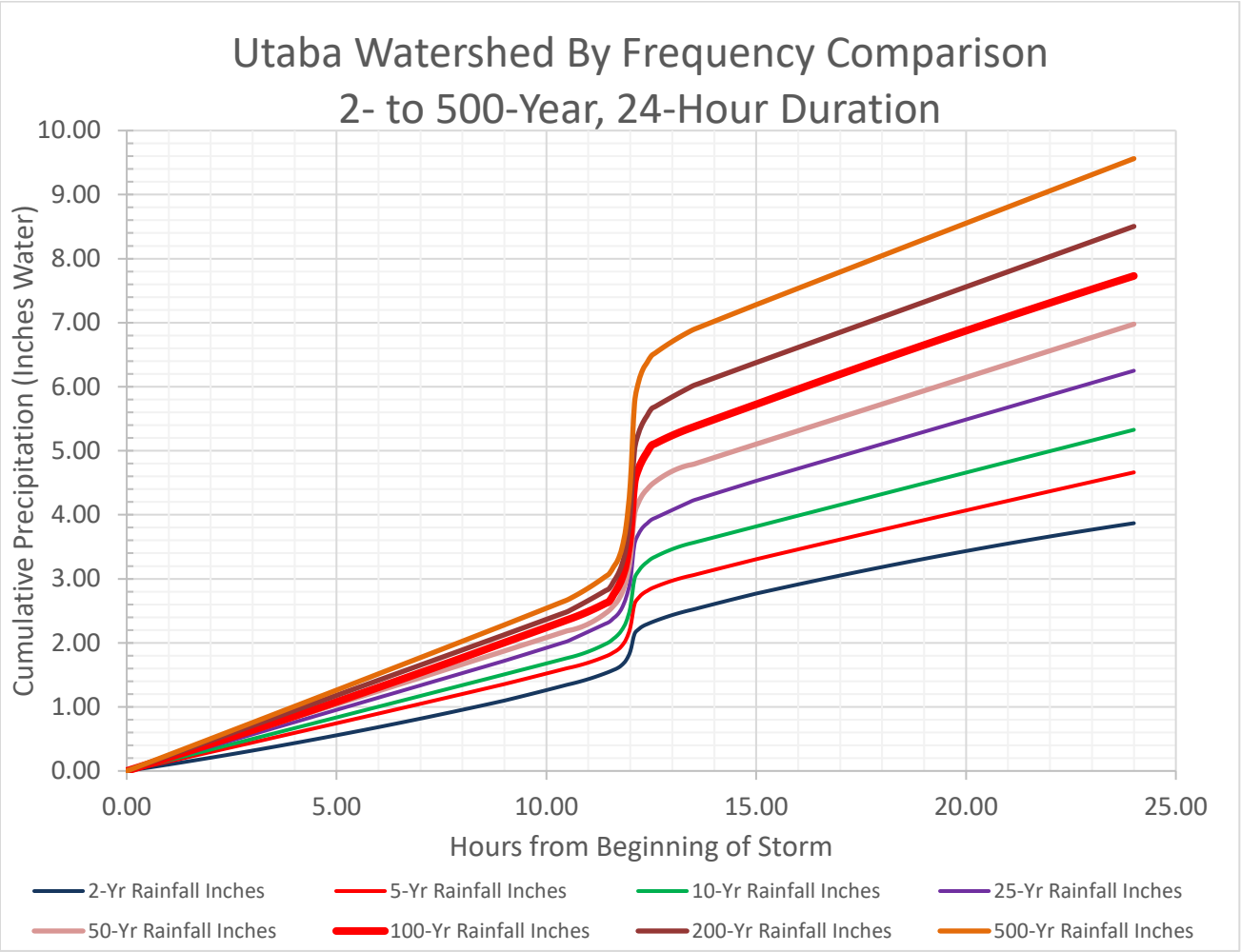

Figure 8: 2-Year to 500-Year, 24-Hour Duration Cumulative Hyetographs

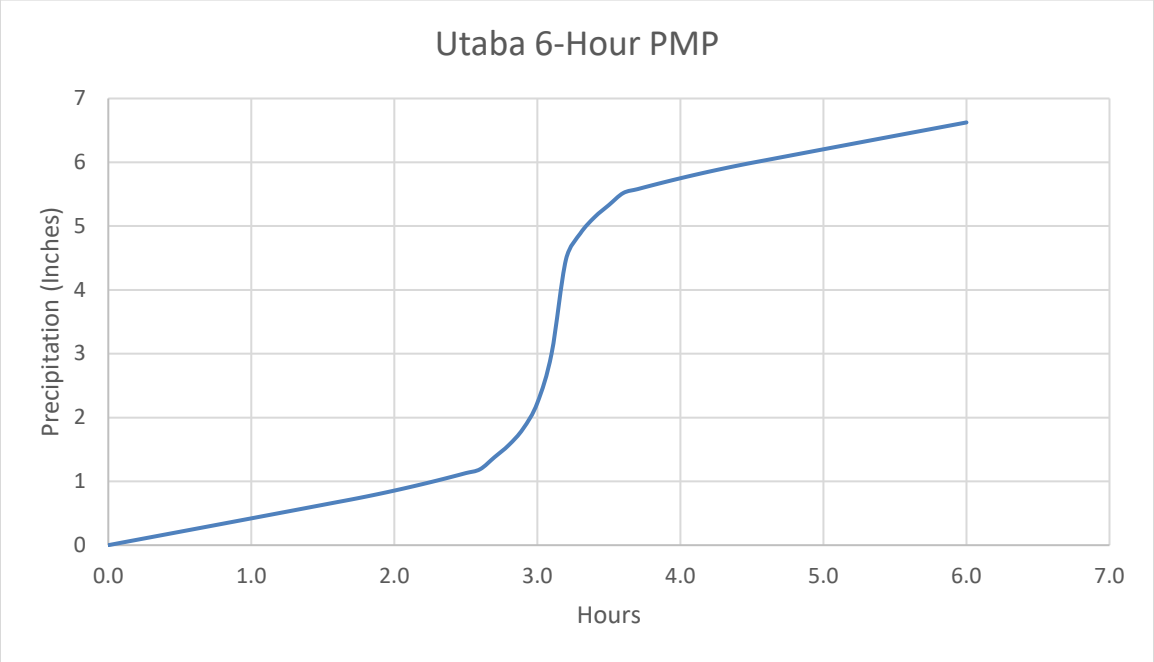

Figure 9: 6-Hour PMP Hyetograph for Utaba Watershed

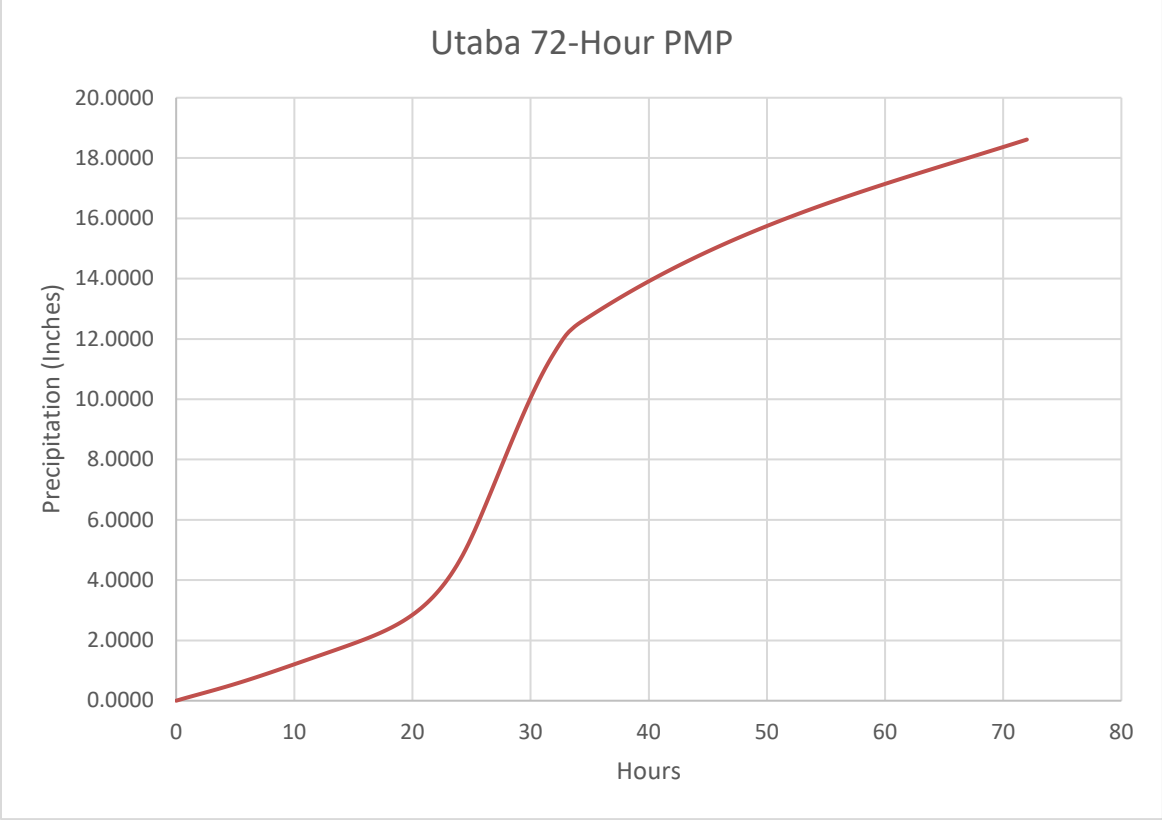

Figure 10: 72-Hour PMP Hyetograph for Utaba Watershed

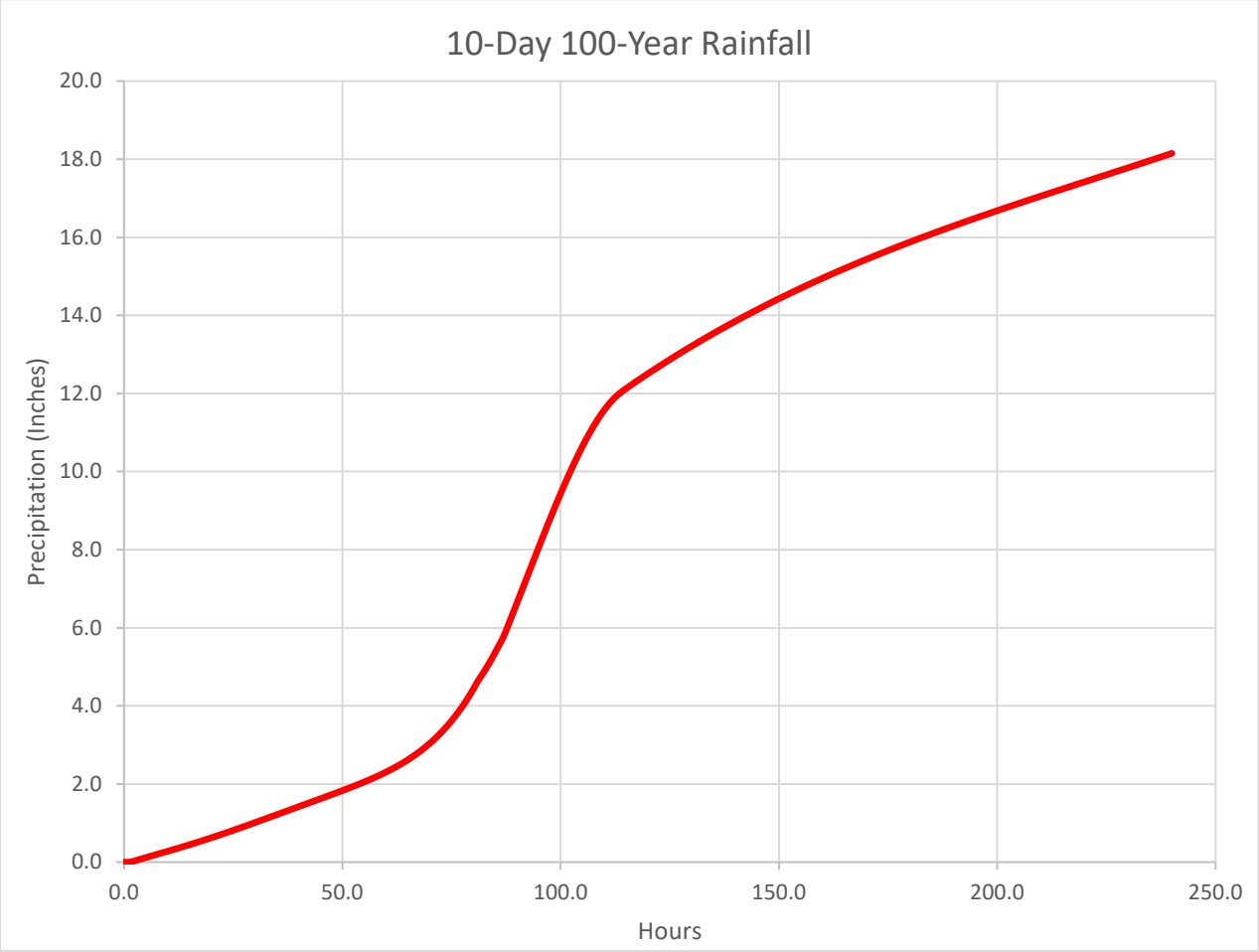

Figure 11: 10-Day 100-Year Hyetograph for Utaba Watershed

2.5.4 Calibrated Rainfall Modeled Flows

Table 11 includes the results of the HEC-RAS models generating the IDF hydrographs using the methodology discussed above. Each IDF was adjusted by the base flow to provide the complete IDF with the peak flows reflected in the table. The controlling IDFs are reflected in the following figures. Additionally, the cumulative runoff volume is provided to reflect the overall potential impact of the storm on the reservoir.

Table 11: Summary of Flood Conditions Evaluated

Storm #	Storm Event & Duration	Source	Model Flows (cfs)	Peak Flows with Base Flow (cfs)	Runoff Volume (Acre-ft)
1	**2-Year 24-Hour**	**NOAA Atlas 14**	**83**	**97**	**111**
2	**5-Year 24-Hour**	**NOAA Atlas 14**	**171**	**185**	**210**
3	**10-Year 24-Hour**	**NOAA Atlas 14**	**259**	**273**	**310**

Storm #	Storm Event & Duration	Source	Model Flows (cfs)	Peak Flows with Base Flow (cfs)	Runoff Volume (Acre-ft)
4	**25-Year 24-Hour**	**NOAA Atlas 14**	**373**	**387**	**473**
5	**50-Year 24-Hour**	**NOAA Atlas 14**	**636**	**651**	**613**
6	**100-Year 24-Hour**	**NOAA Atlas 14**	**1,002**	**1,017**	**783**
7	**200-Year 24-Hour**	**NOAA Atlas 14**	**1,640**	**1,654**	**944**
8	**500-Year 24-Hour**	**NOAA Atlas 14**	**2,930**	**2,944**	**1,193**
9	**100-Year 6-Hour ARC III**	**NOAA Atlas 14**	**1,321**	**1,335**	**484**
10	**100-Year 24-Hour ARC III**	**NOAA Atlas 14**	**4,078**	**4,087**	**1,608**
11	**100-Year 72 Hour ARC III**	**NOAA Atlas 14**	**2,600**	**2,614**	**3,550**
12	**100 Year 10-Day PSH**	**NOAA Atlas 14**	**344**	**358**	**1,605**
13	PMP 6-Hour (ARC II) **PMP 6 HR (ARC III)**	HMR 49 & Jensen	2,964 **9,721**	2,978 **9,736**	803 **1,652**
14	PMP 72-Hour (ARC II) **PMP 72 HR (ARC III)**	HMR 49 & Jensen	3,736 **4,857**	3,750 **4,872**	5,335 **6,800**
15	Local ASH 6-Hour ARC III	TR-60, R655	**3,218**	**3,232**	**861**
16	**General ASH 72-Hour ARC III**	**TR-60, R655**	**3,216**	**3,230**	**4,500**
17	**Local FBH 6-Hour ARC III**	**TR-60, R655**	**9,721**	**9,736**	**1,652**
18	General FBH 72-Hour ARC III	TR-60, R655	4,857	4,872	6,800

Note: Governing IDF for each criteria required is in bold lettering.

2.6 Modeling Results Comparison

The final comparison is the check of reasonableness of the modeling results. This process compares the known flow data, basin similarity comparison, and the observed historical data.

Figure 12 shows a plot of the modeling results reflecting severe summer rainfall only events, the basin similarity data reflecting snow melt runoff, and the USGS StreamSTATS calculated flows, which is based on the regional regression equations.

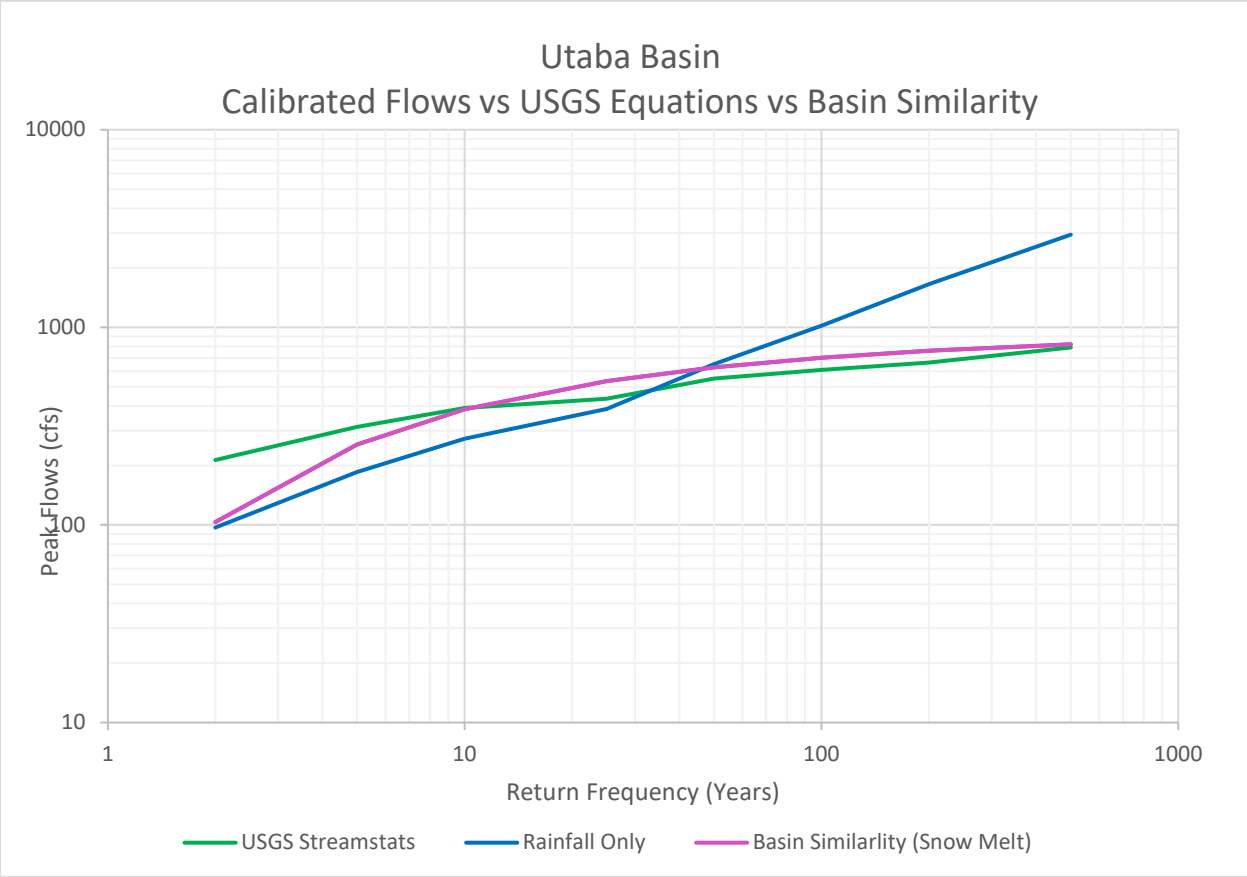

Figure 12: Comparison of Basin Similarity Flows, USGS Equations, and Rainfall Model Results

As is becoming very apparent in Utah from the completion of other Watershed Plan-EA/EIS documents, snow melt is the higher runoff up to about the 30-40-year return frequency. As the return frequencies get larger, i.e., the events larger and less frequent, the severe summer rainstorms begin to become the more severe flood events. Numerous discussions with the Utaba Reservoir owner, the neighboring campground hosts, downstream residents, and the comparison of timing and estimated return frequencies of the events that were gauged has confirmed that the hydrologic modeling results appear to be reasonable for the purposes of the project. Due to the nature of the analysis, rainstorm events are the focus of the analysis, since the snow melt events are predictable and primary outlet structures are able to be opened in advance and regulated to manage snowmelt flows. Additionally, there is significant time for providing notice to downstream residents and occupants.

The resulting inflow hydrographs are used to size the infrastructure and to evaluate each of the scoped alternatives in the Watershed Plan-EA. The following figures reflect each of the hydrographs.

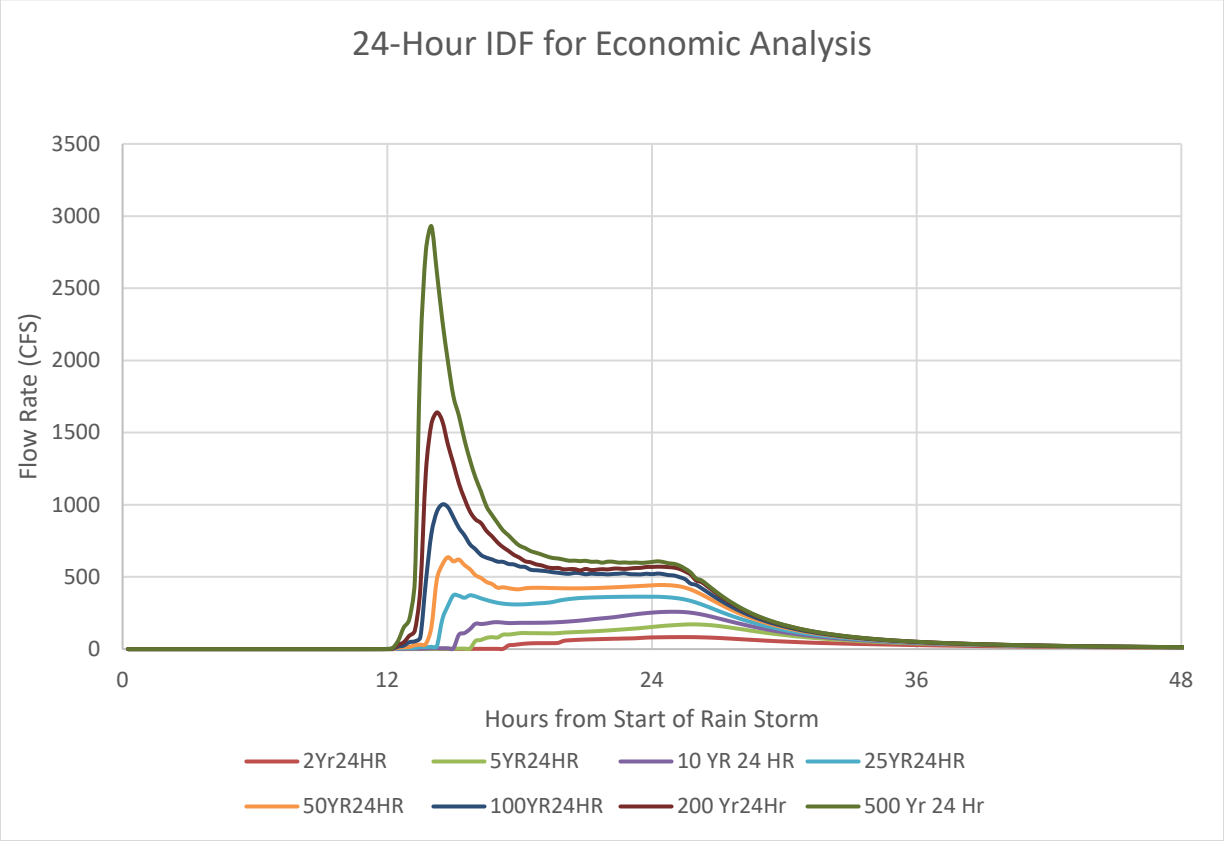

Figure 13: IDF Hydrographs for Economic Analysis

As Figure 13 shows, this basin is subject to extreme flash floods. Once the storm flows begin to arrive, after the initial abstraction and storage have been met, larger events create potentially massive flash floods. These events are then then routed through the dam structure to determine the attenuation on the hydrograph with the conditions of the spillways under each alternative.

Figure 14 provides the 100-Year 24-Hour ARC III hydrograph required by the TR-60. The 100-Year event uses the NOAA Atlas 14 storm hyetograph on saturated soils, and thus reflects the effects of an extreme event following several previous days of rain which, in the case of the Utaba watershed at the higher elevations and with a mountain barrier, is commonly expected where summer rainfalls occur nearly daily.

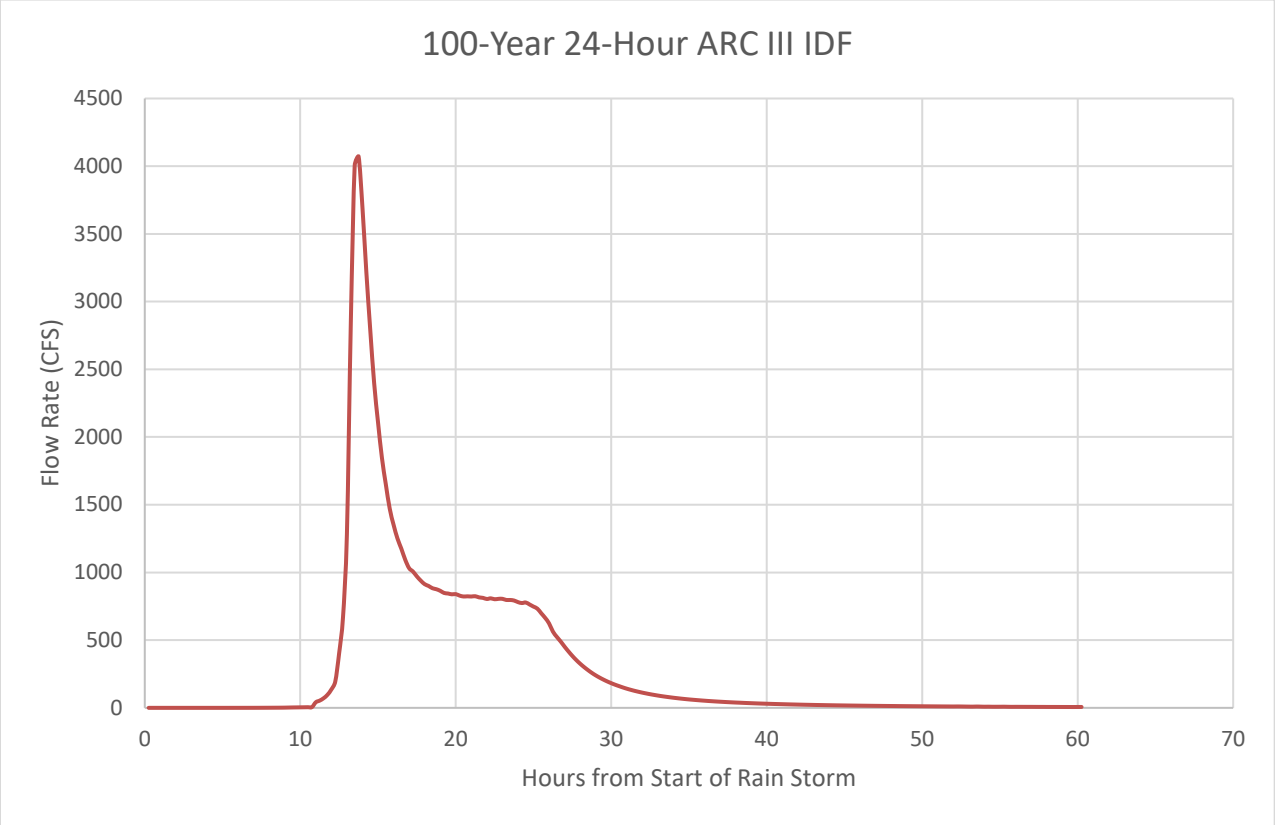

Figure 14: 100-Year 24-Hour ARC III IDF

The 6-hour extreme event hydrographs in Figure 15 represent a localized basin focused storm and are used in the evaluation and design of the primary spillway, auxiliary spillway, and freeboard of the dams and evaluating each of the proposed alternatives. The ARC II conditions, while not carried forward, are included based on the NEH comment that the PMP should be with ARC II conditions or greater. However, in Utah, based on R655 and HMR 49 and associated references, ARC III is the governing condition as shown in the graphical comparison of ARC II PMP and ARC III PMP.

The 72-hour extreme event hydrographs represent a regional extreme event and are used likewise in the evaluation and design of the primary spillway, auxiliary spillway, and freeboard of the dam and evaluation of the proposed alternatives. The same conditions were evaluated. It should also be noted that the 6-hour and 72-hour events are both routed due to the volumetric differences involved in the events which can cause significant differences in flow attenuation and effectiveness of the reservoir in reducing flash flood impacts.

All of the hydrographs were provided from HEC-RAS version 6.5 in tabular format on 15-minute time steps for use in other models for routing purposes.

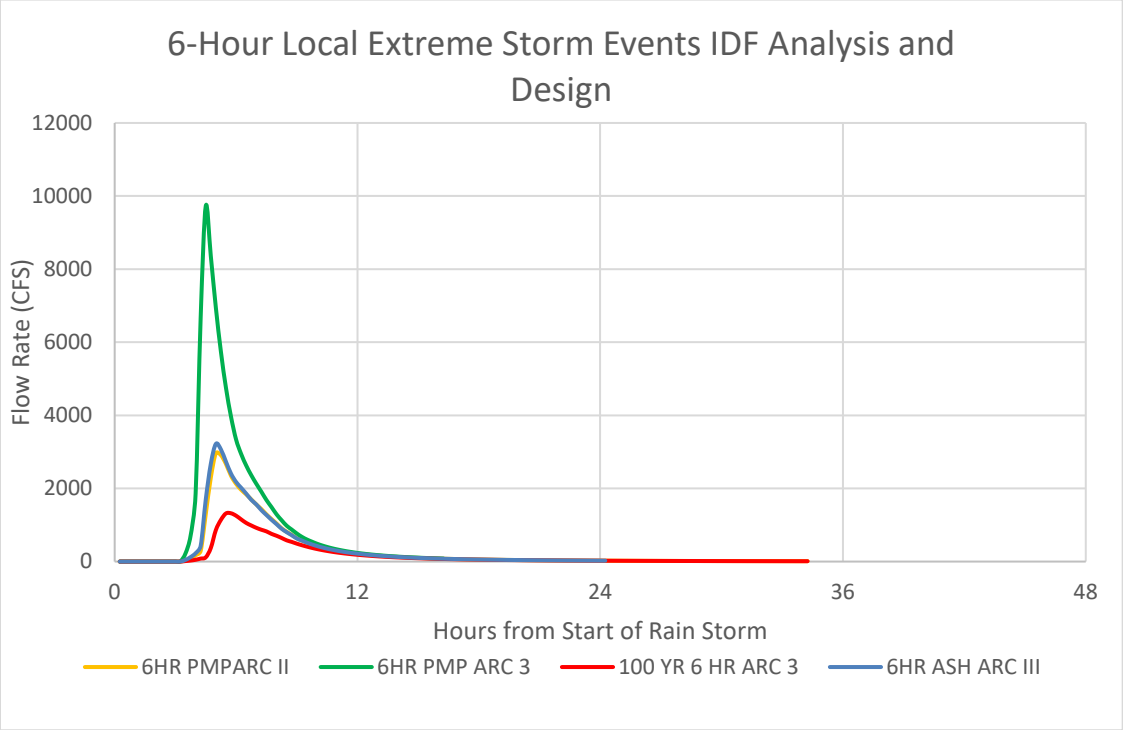

Figure 15: 6-Hour Extreme Event IDFs

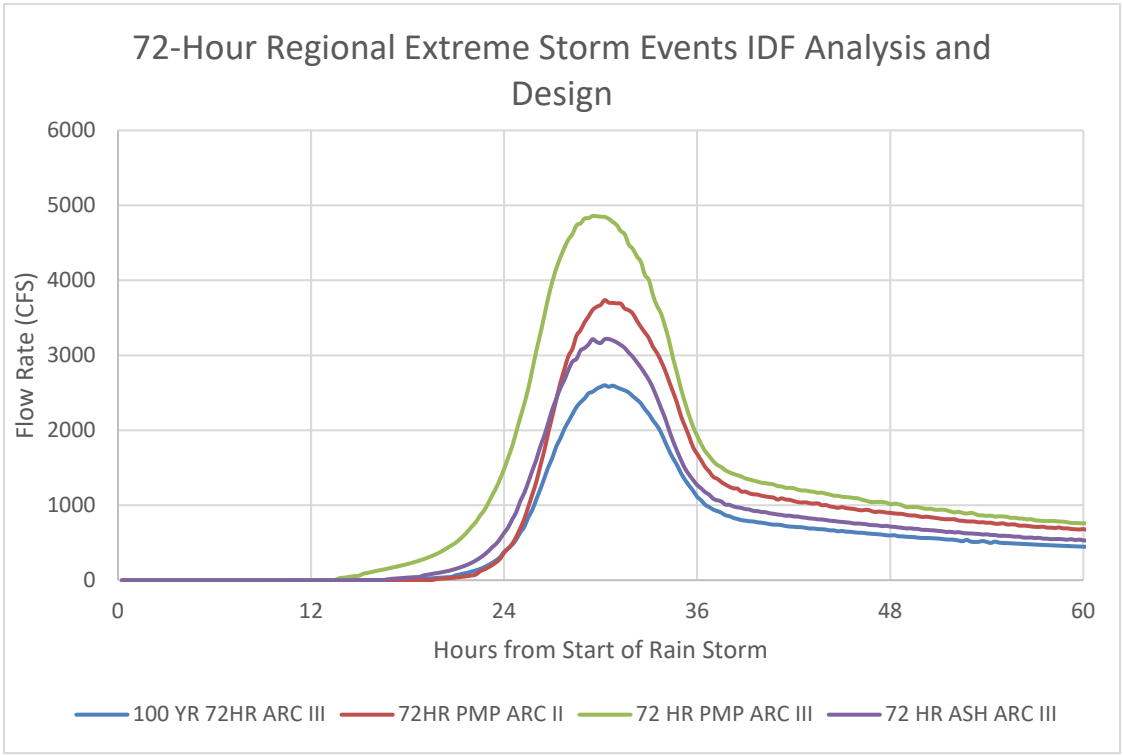

Figure 16: 72-Hour Regional Extreme Storm IDF Hydrographs

At this point, it should be noted that the 6-hour ASH (Auxiliary Spillway Hydrograph) IDF and the 72-hour ASH are almost identical in peak flow rate, while the 72-hour ASH has a much larger volume. Based on this alone, the 72-hour ASH will govern the auxiliary spillway design.

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Hydraulic Modeling & Flood Inundation Tech Memo

Technical Memorandum 004
Hydraulic Modeling and Flood Inundation

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1.0 Introduction

To evaluate dam rehabilitation alternatives associated with Utaba Retarding Dam, it was necessary to evaluate the impacts of water generated by the Utaba watershed basin which drains to Utaba Reservoir.

Models were created for 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence flood events for each of three Final Array alternatives: the No Action – Future Without Federal Investment (FWOFI) Alternative (existing conditions), the Structural Rehabilitation Alternative (Alternative 2), and the Decommissioning Alternative (Alternative 3, Non-Structural). For each flood event and alternative, the depths and duration of flooding at homes, buildings, and roads were determined. The comparison of the flooding impact under existing conditions was compared to the structural and decommissioning alternatives to determine the economic benefits of the project to the community. The following sections explain the methodology and results of the analysis.

Table 1 is a summary of the alternatives that were modeled for the Utaba Watershed Plan EA. The hydrology that was used in these models is discussed in Technical Memorandum 003: Utaba Dam Hydrology.

Table 1: Alternatives Modeled

Alternative	Explanation
No Action – Future Without Federal Investment (FWOFI) Alternative (Existing Conditions)	Runoff from each storm event entered Utaba Reservoir. If the water level overtopped the dam, the dam was then assumed to fail/breach and water would flood the downstream area. If the water level did not overtop the dam but did result in significant flow in the auxiliary spillway, then the auxiliary spillway was assumed to fail due to its extremely poor condition. Failure of the auxiliary spillway was then assumed to cause failure/breach of the dam.
Structural Rehabilitation Alternative (Alternative 2)	The dam is assumed to have been rehabilitated to comply with current dam safety standards and will not fail/breach during any storm event.
Decommissioning Alternative (Alternative 3, Non-Structural)	Runoff from each storm event was modeled to enter the downstream area assuming the dam had been completely removed.

2.0 Methodologies

The flood events were modeled for each alternative in HEC-RAS, software developed by the U.S. Army Corps of Engineers (USACE). The software can model one- and two-dimensional flows, steady flows, unsteady flows, sediment transport, water temperature, and water quality. Two-dimensional unsteady flow modeling was used for this project. The user defines the topography, cell positions, cell sizes, and flow inputs. Each cell represents an area where specific flow calculations are made based on topography and other current conditions. When put together, the

results show how water would act over large regions of land with varying topography throughout. The Navier-Stokes equations and numerical methods are used to calculate the depth and velocity of the water from cell to cell with the user input data.

The model was created using cells of various sizes. Cells just downstream of the dam were 200-foot cells. The cells in the main river channel were 40-foot cells. All other areas were 60-foot cells. Channels and high areas that have a significant impact on the behavior of the flood waters were defined with break lines and some areas were refined to cell sizes of 10 feet. The same mesh was used for modeling each alternative. The timestep was set to be adjusted based on the Courant Number (0.45-1.0).

The surface elevation data used for the model was downloaded from the Utah Geospatial Resource Center (UGRC) website (gis.utah.gov). The surface elevation data used to model the project area was 0.5-meter lidar data.

The National Land Cover Database (NLCD) was used to determine the roughness of the various land cover types found in the project area. In the model, the roughness of the various land cover types is defined using the Manning's coefficients. The assumed Manning's coefficients for each land cover type are shown in Table 2.

Table 2: NLDC Land Cover Manning's n Coefficients

Class\ Value	Classification Description	Manning's Coefficient
0	No Data	0.06
11	Open Water	0.035
12	Perennial Ice/Snow	N/A
21	Developed, Open Space	0.04
22	Developed, Low Intensity	0.08
23	Developed, Medium Intensity	0.1
24	Developed, High Intensity	0.15
31	Barren Land	0.04
41	Deciduous Forest	0.1
42	Evergreen Forest	0.12
43	Mixed Forest	0.08
51	Dwarf Scrub	N/A
52	Shrub/Scrub	0.08
71	Grassland/Herbaceous	0.045
72	Sedge/Herbaceous	N/A

Class\ Value	Classification Description	Manning's Coefficient
73	Lichens	N/A
74	Moss	N/A
81	Hay/Pasture	0.06
82	Cultivated Crops	0.06
90	Woody Wetlands	0.12
95	Emergent Herbaceous Wetlands	0.08

The hydraulic soils groups (HSG) map was downloaded from the USDA-NRCS Web Soil Survey database (websoilsurvey.sc.egov.usda.gov). Curve numbers for the downstream area were determined using the HSG, land cover data, and tables through the National Engineering Handbook Part 630 chapter 9. Curve numbers are numerical values that indicate runoff potential of an area.

The culverts modeled used elevations and sizes from field data when available. Not all the culverts were surveyed and Google Earth imagery was used to estimate an appropriate size and material for culverts not surveyed. Manning's coefficients and entrance/loss coefficients were assigned to culverts as shown in the following tables.

Table 3: Manning's Values for Culverts

Culvert Material	Manning's n
Concrete	0.015

Table 4: Culvert Minor Losses

Description	Coefficient
Exit Loss	1
Entrance Loss: Headwall	0.5

3.0 Floodplain Analysis

3.1 Alternatives

As explained in Technical Memorandum 001: Existing Conditions, numerous current conditions put Utaba Dam at risk of failure. There are two existing condition scenarios possible. One, the debris basin does not fail, and two, the debris basin fails during a flooding. All storm events were modeled in HEC-RAS. The inflow storm hydrographs used for all models, shown in Figure 1

below, were developed using HEC-RAS and are discussed in detail in Technical Memorandum 003: Utaba Dam Hydrology.

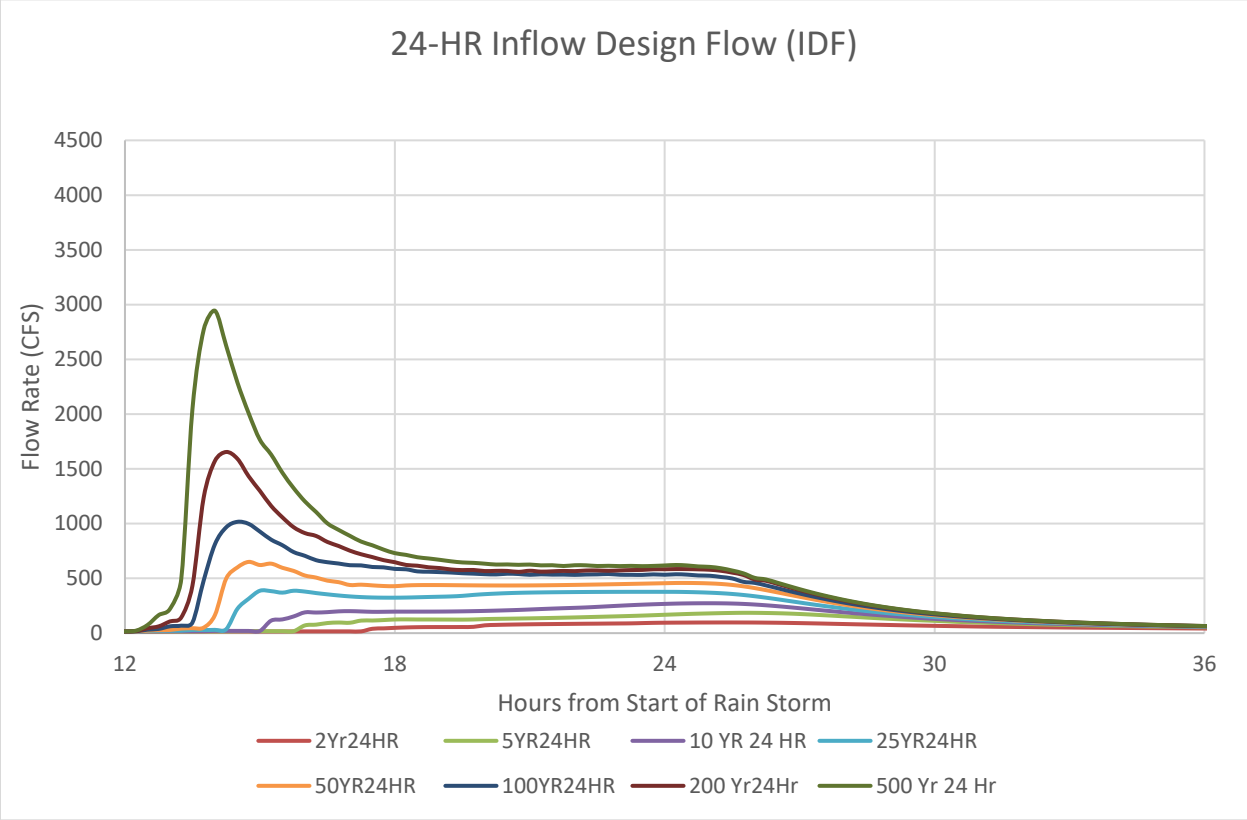


Figure 1: 24-Hr Inflow Design Flows (IDF)

3.1.1 No Action (FWOFI) Alternative Flooding

Taking into account existing conditions, Utaba dam is likely to breach via overtopping because of the decreased storage in the reservoir, insufficient spillway capacity, and the high amounts of runoff in the watershed basin. The modeling for the No Action (FWOFI) Alternative represents the impact to homes, businesses, roads, and agricultural fields that would take place if the flood events happened with the existing conditions. During the modeling, it was assumed that the dam would breach and thus fail during all analyzed storms for the existing reservoir. The modeled breach occurred when the reservoir water elevation reached the auxiliary spillway elevation or, for smaller storm events, at the time that the reservoir water elevation peaked. The breach water surface elevations of each storm event are shown in Table 5 below. This assumption is conservative since, during larger events, the water level will be higher than the crest elevation of the auxiliary spillway. For flood events larger than the 100-year event, the dam would overtop if the auxiliary spillway did not fail.

Table 5: Existing Conditions Breach Water Elevation

24-hr Flood Event	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	200-Year	500-Year
Breach Water Elevation (feet)	5705	5709	5711	5711	5711	5711	5711	5711

The following was assumed in the breach model:

- The breach was assumed to happen at the auxiliary spillway crest (elevation of 5,711 feet) or peak water elevation for smaller storm events
- Mode of failure was breach of the dam at elevations in Table 5 for each storm event
- The trigger for failure was when the elevation of the water in the debris basin reached the auxiliary spillway elevation
- Final bottom width of breach was 50 feet
- Left- and right-side slope of breach was 1
- Breach weir coefficient was 2.6
- Breach formation time was 0.5 hours

The resulting outflow hydrographs for the Existing Conditions are shown in Figure 2. The resulting peak flows are summarized in Table 6. The inflow represents flow coming into Utaba. The outflow represents the combined discharge from the principal spillway, auxiliary spillway, and from a dam breach.

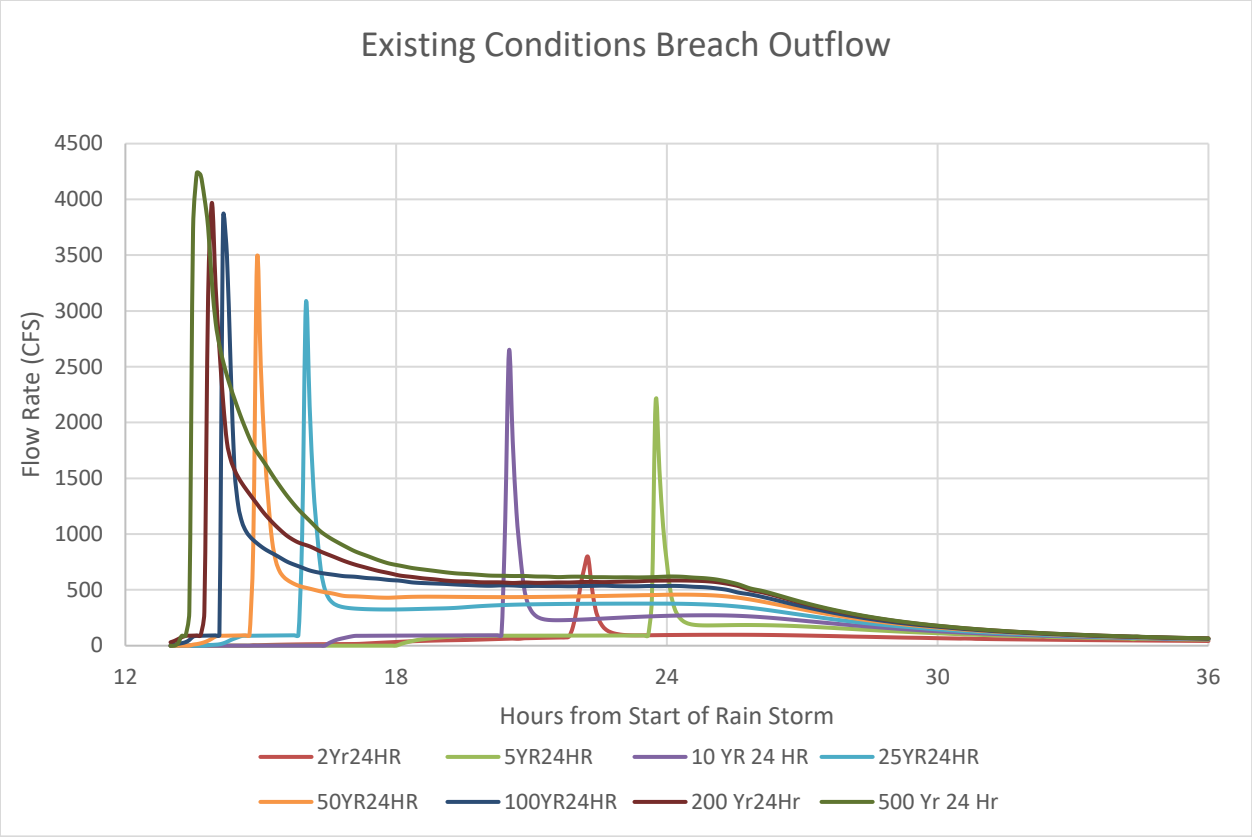


Figure 2: Existing Conditions Breach Outflow

Table 6: No Action Alternative (Existing Conditions) Peak Flows

Flood Events Modeled	Inflow (cfs)	Outflow (cfs)
2-Year	97	796
5-Year	186	2,183
10-Year	273	2,639
25-Year	387	3,061
50-Year	651	3,456
100-Year	1,017	3,836
200-Year	1,654	3,969
500-Year	2,944	4,237

The Existing Alternative model results can be seen in Figure 4 through Figure 14. These results were used to determine the impact to structures and roadways.

3.1.2 Decommissioning Alternative Flooding

The model was adjusted to simulate flooding that would occur if the dam were removed. Results were compared to the No Action Alternative (existing conditions) model to determine how effective Utaba Retarding Dam is at slowing high flow events. The Decommissioning Alternative model results can be seen in Figure 15 through Figure 25. The outflow hydrographs would be the same as the inflow hydrographs shown in Figure 1. The maximum outflows would be the same as the maximum inflows which can be seen in Table 6 or Table 7.

3.1.3 Structural Rehabilitation Alternative

The model was updated to simulate potential flooding that would occur if the existing dam was rehabilitated to comply with current dam safety standards. The Structural Rehabilitation Alternative model results can be seen in Figure 26 through Figure 36. The resulting outflow hydrographs for the Structural Rehabilitation Alternative are shown in Figure 3. The maximum outflows can be seen in Table 7.

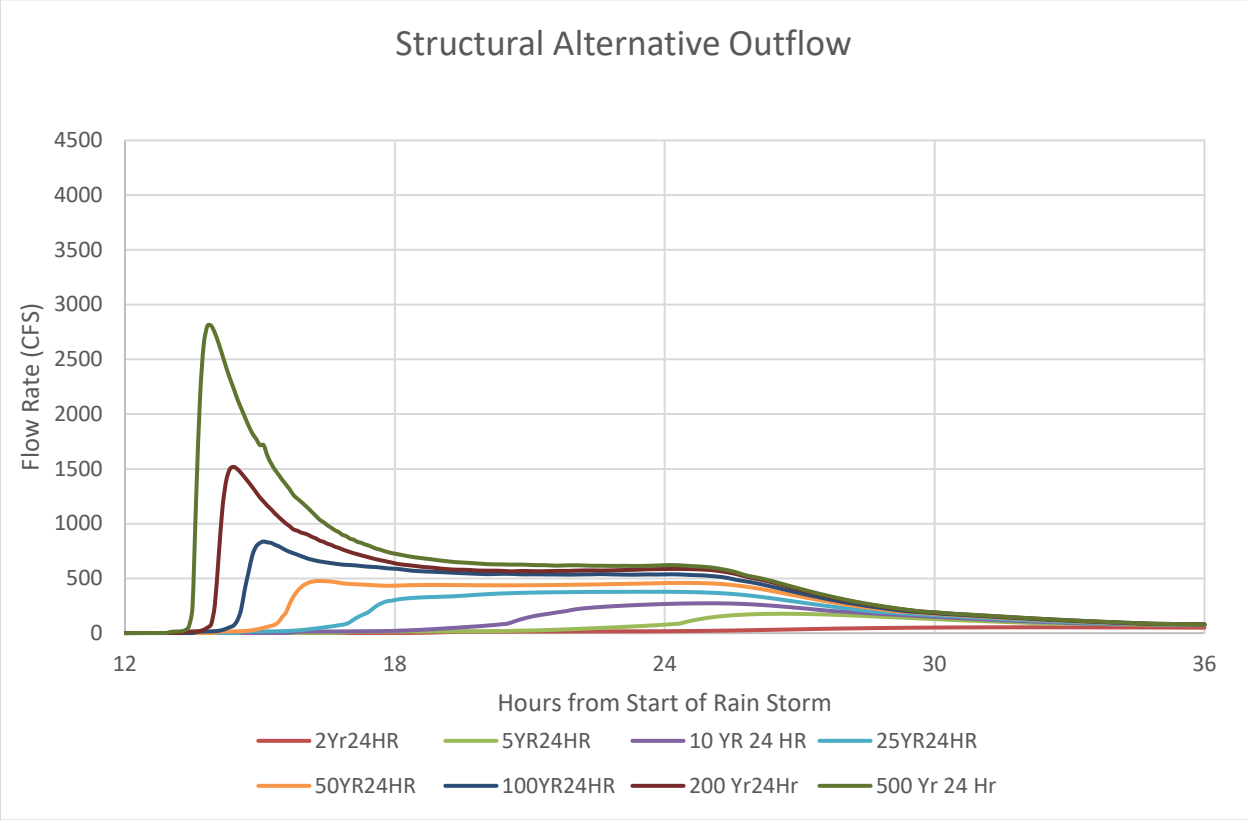


Figure 3: Structural Alternative Outflow

Table 7: Structural Alternative Peak Flows

Flood Events Modeled	Inflow (cfs)	Outflow (cfs)
2-Year	97	54
5-Year	186	177
10-Year	273	272
25-Year	387	378
50-Year	651	476
100-Year	1,017	837
200-Year	1,654	1,518
500-Year	2,944	2,807

4.0 Summary of Results

Hydraulic modeling was performed for the watershed to determine the impact of flooding from a storm event for the 5-, 10-, 25-, 50-, 100-, 200-, and 500-year storms from a potential dam breach. The model was then adjusted to determine the impact of flooding for the Decommissioning Alternative and the Structural Rehabilitation Alternative. By comparing the flooding across all alternatives, the best alternative for flood routing may be determined. The Structural Rehabilitation Alternative resulted in the greatest reduction of downstream flooding when compared to the other two alternatives. The Decommissioning Alternative also reduced downstream flooding when compared to the No Action Alternative.

5.0 References and Attachments

5.1 References

National Engineering Handbook

National Land Cover Database (NLCD)

USDA-NRCS Web Soil Survey Database. https://websoilsurvey.sc.egov.usda.gov.

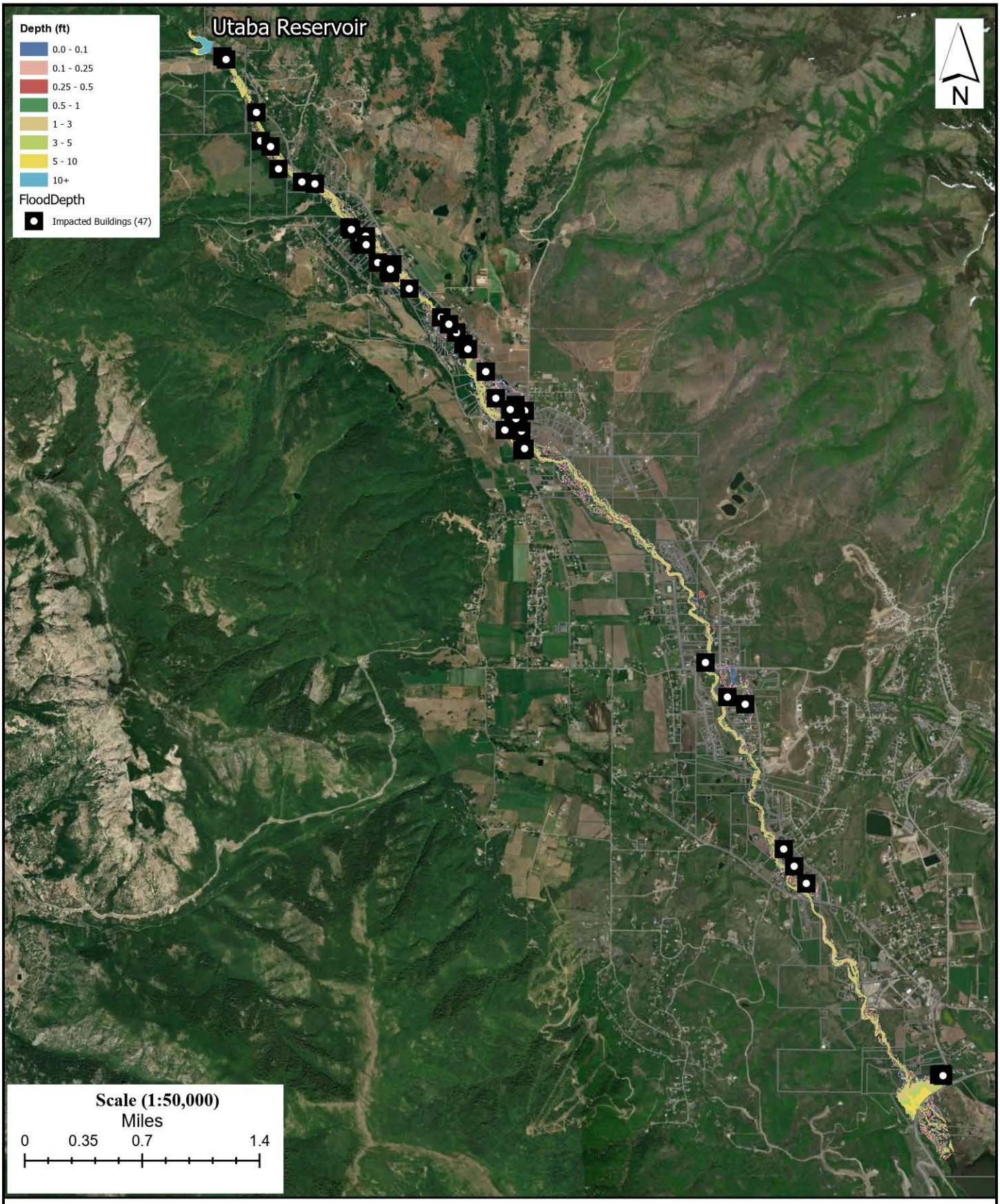
Utah's State Geographic Information Database. https://gis.utah.gov/.

Utah Geological Survey. Interactive Map, Intermediate Scale Maps and 1:24,000 Scale Maps

Utah Geospatial Resource Center (UGRC). https://gis.utah.gov/.

5.2 Existing Conditions Flood Maps

See Figure 4 through Figure 14 below.



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Natural Resources Conservation Service

Weber County

Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Existing (Breached) Flood Inundation Area: 100-Year Storm, Max Impact

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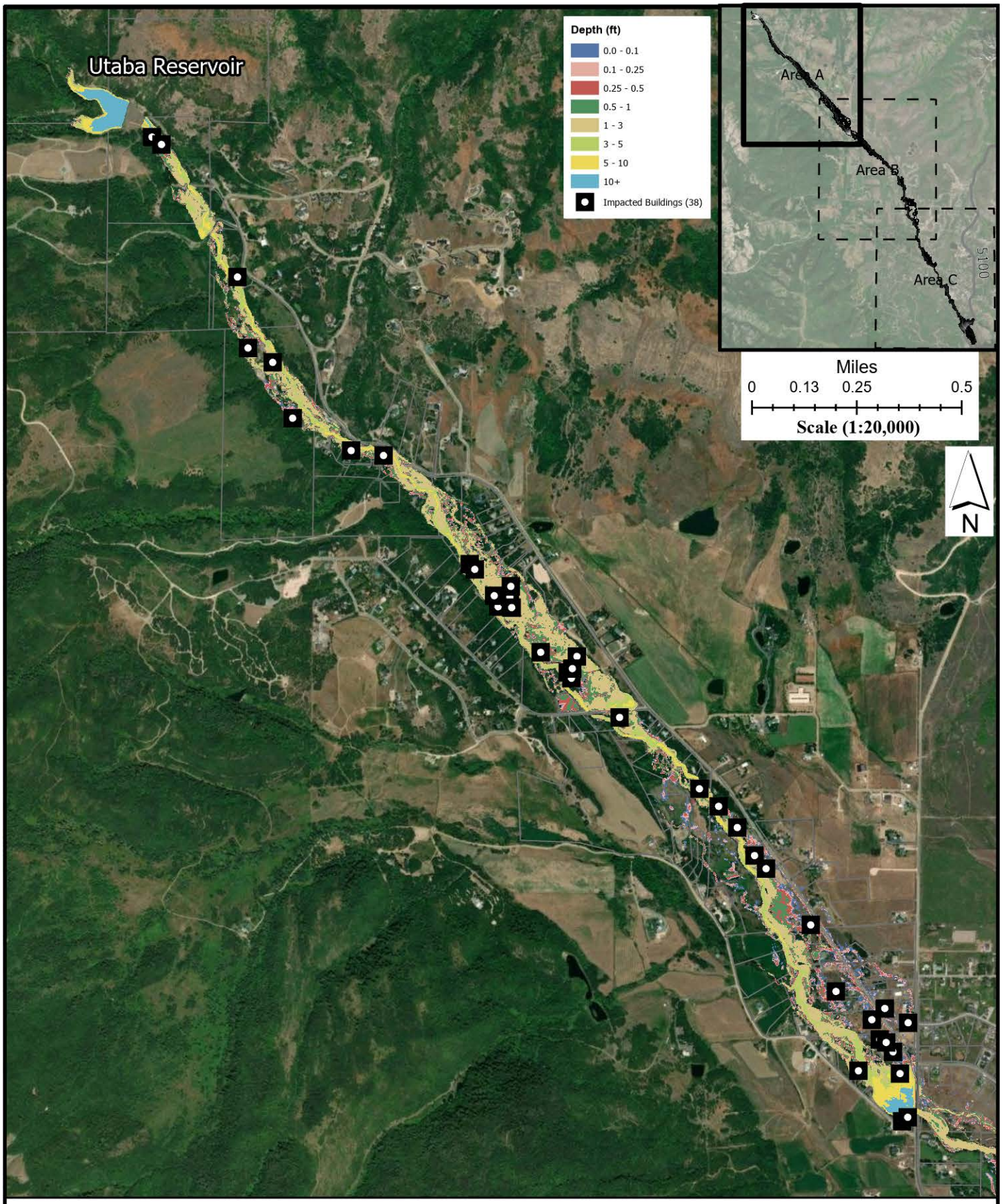

Weber County

Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Existing (Breached) Flood Inundation Area: 100-Year Storm, Max Impact

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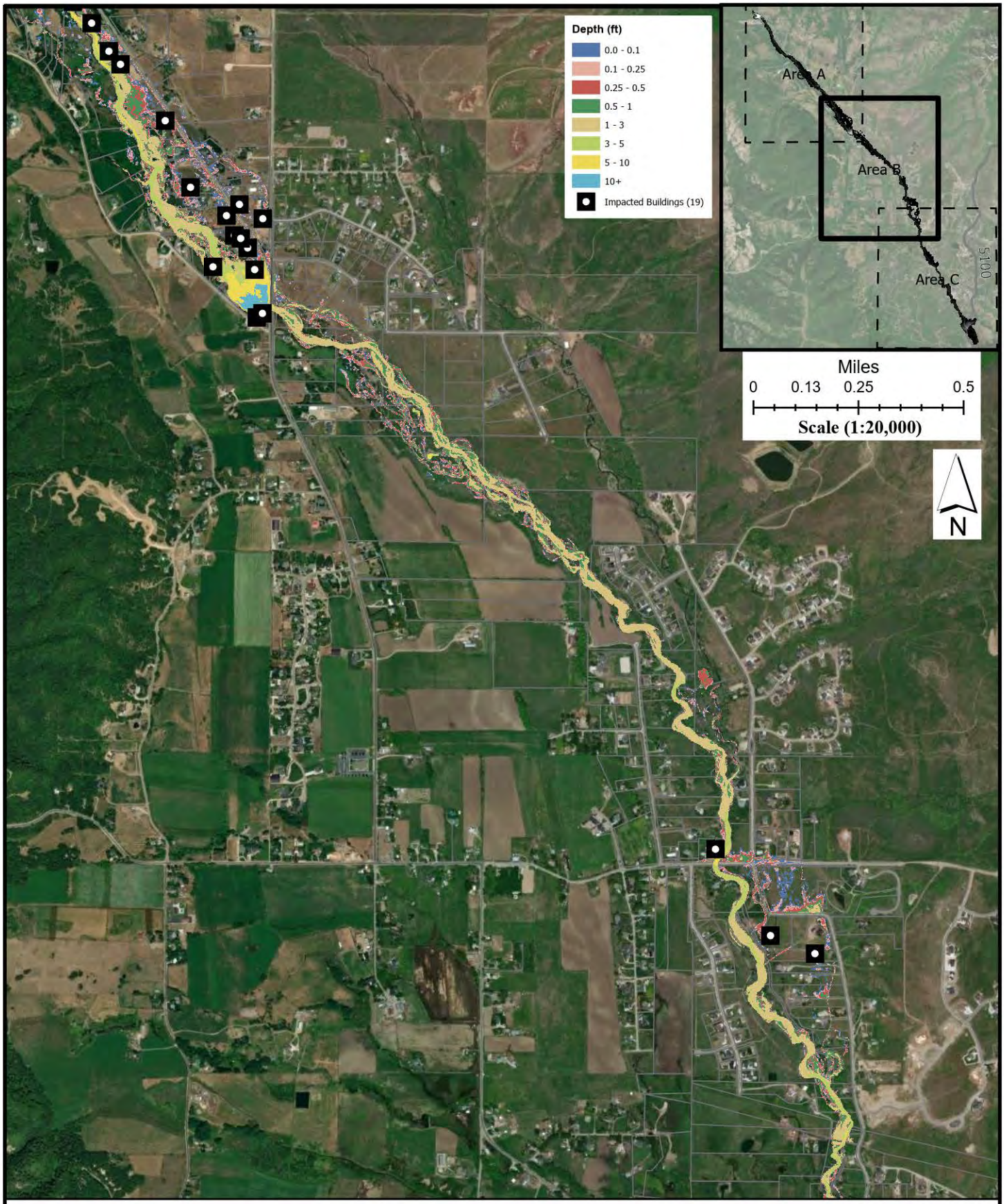

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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Existing (Breached) Flood Inundation Area: 100-Year Storm, Max Impact

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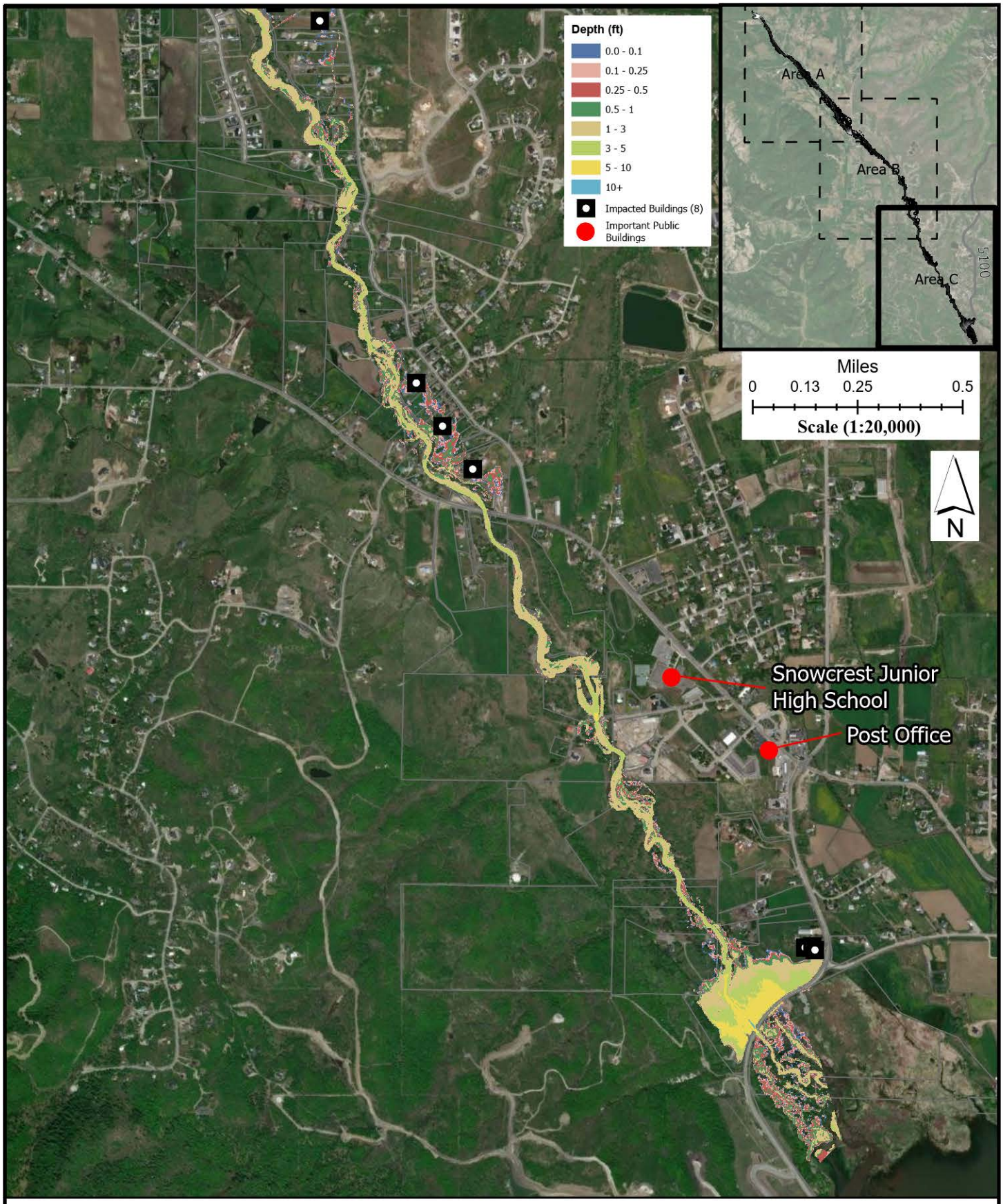

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Existing (Breached) Flood Inundation Area: 100-Year Storm, Max Impact

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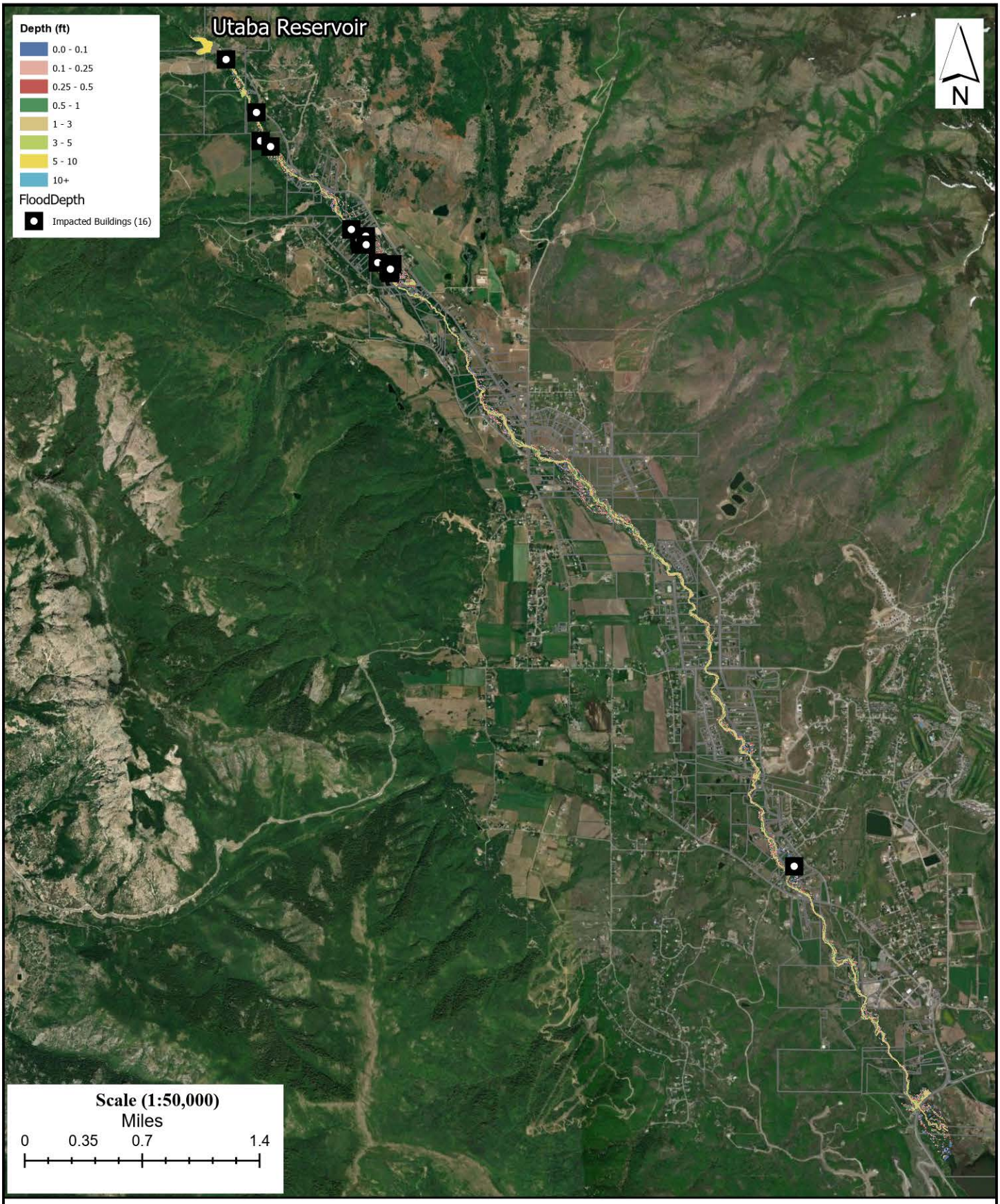

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Existing (Breached) Flood Inundation Area: 2-Year Storm, Max Impact

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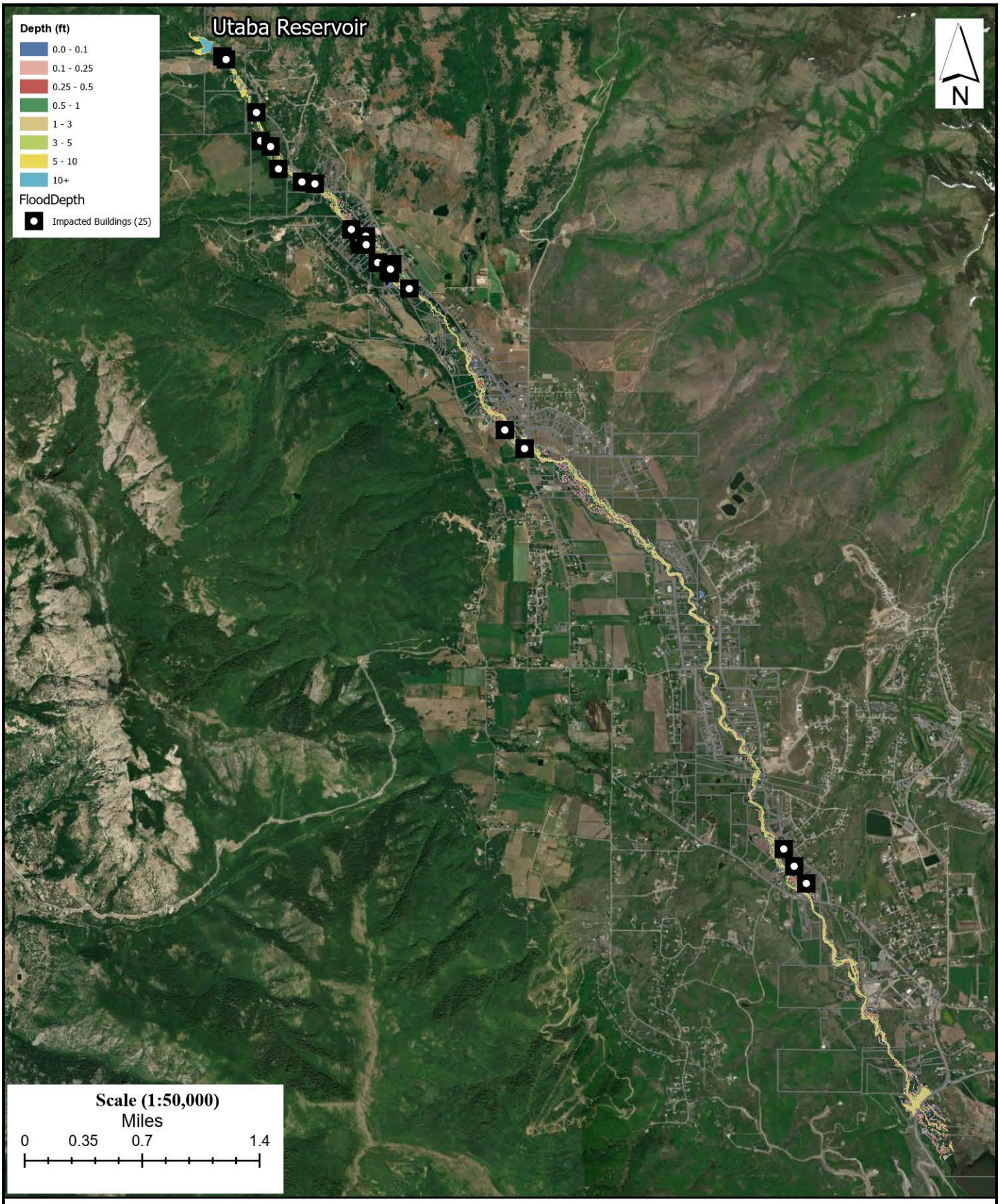

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Natural Resources Conservation Service

Weber County

Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Existing (Breached) Flood Inundation Area: 5-Year Storm, Max Impact

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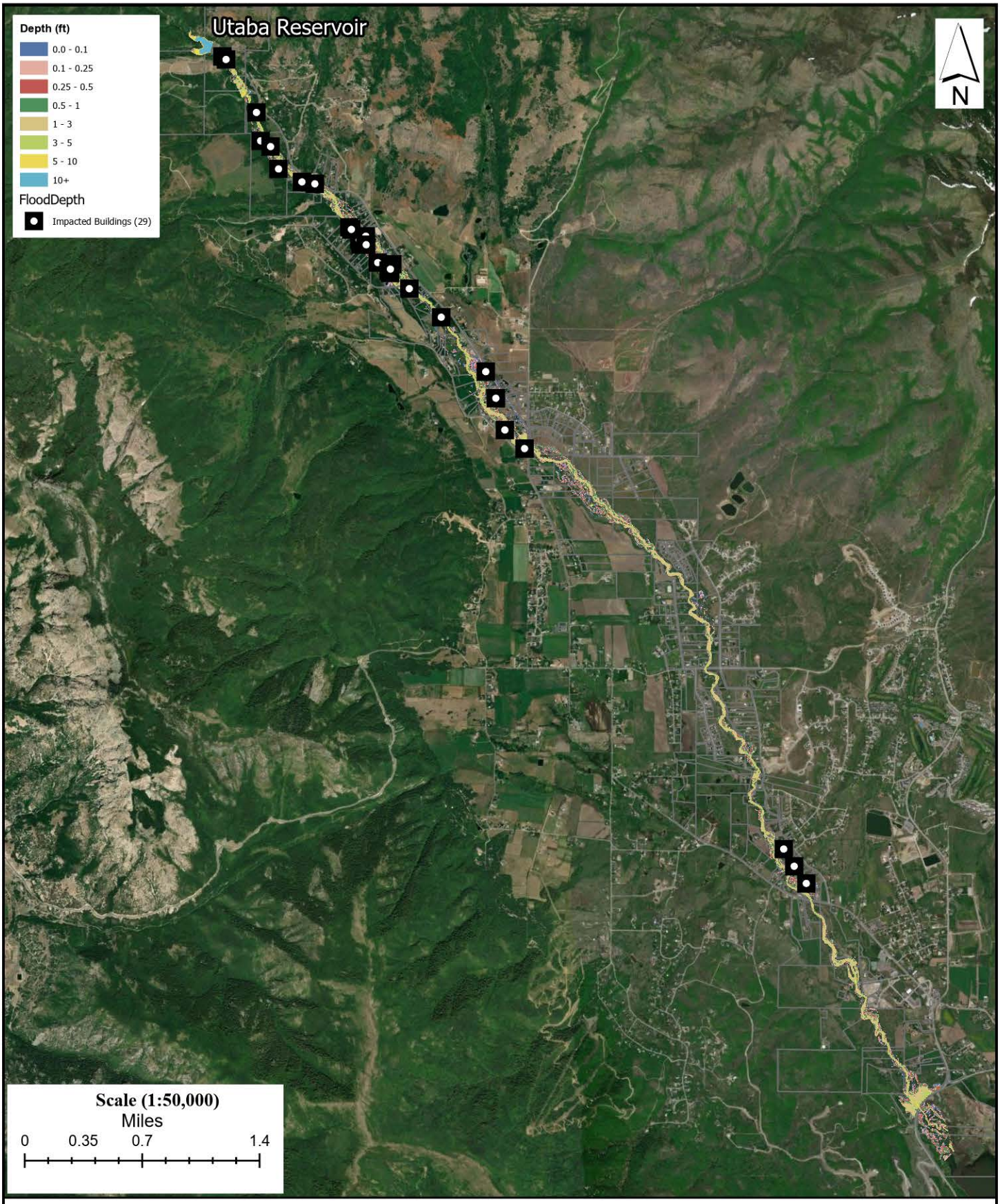

Weber County

Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Existing (Breached) Flood Inundation Area: 10-Year Storm, Max Impact

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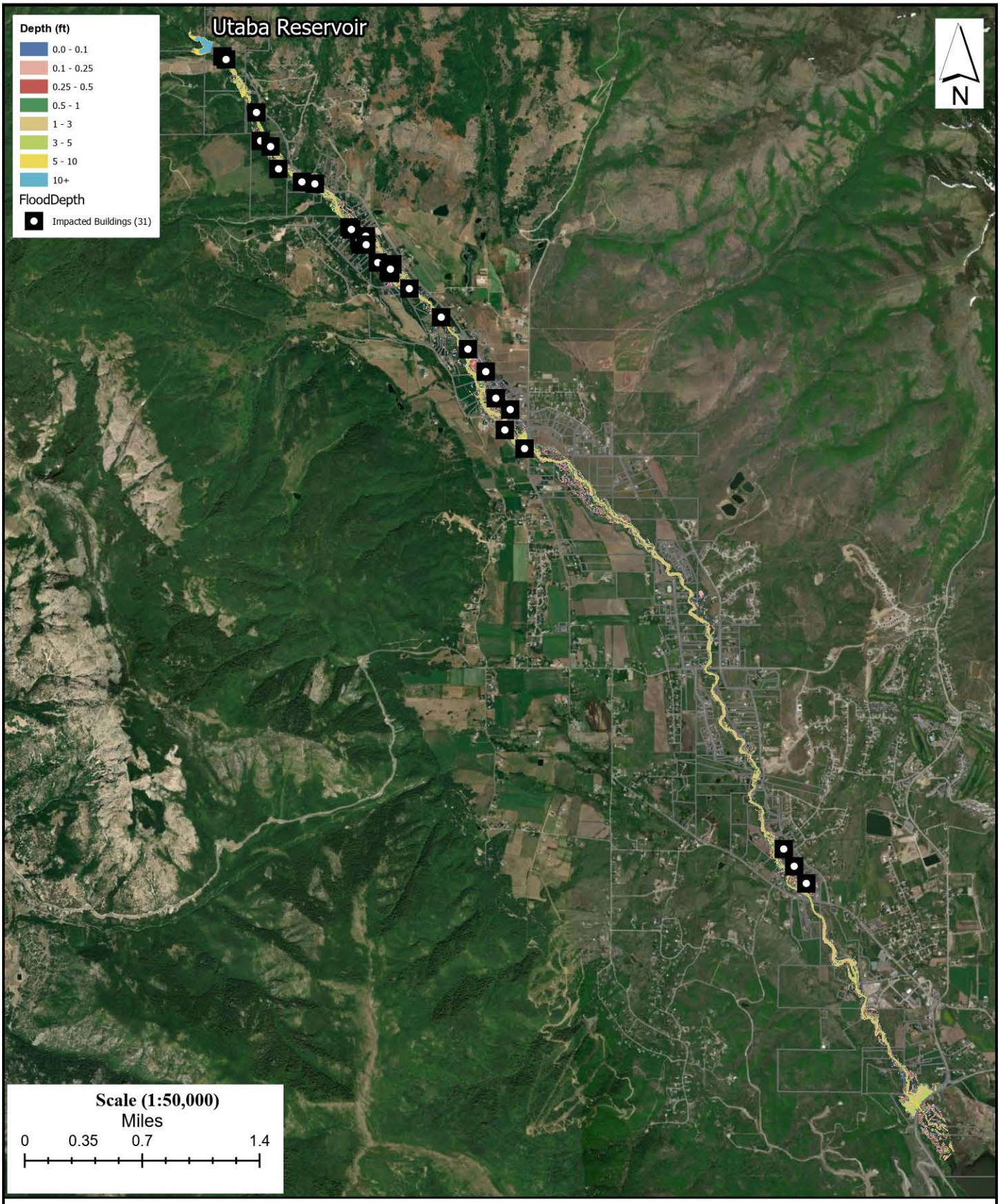

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USDA United States Department of Agriculture
Natural Resources Conservation Service

Weber County

Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Existing (Breached) Flood Inundation Area: 25-Year Storm, Max Impact

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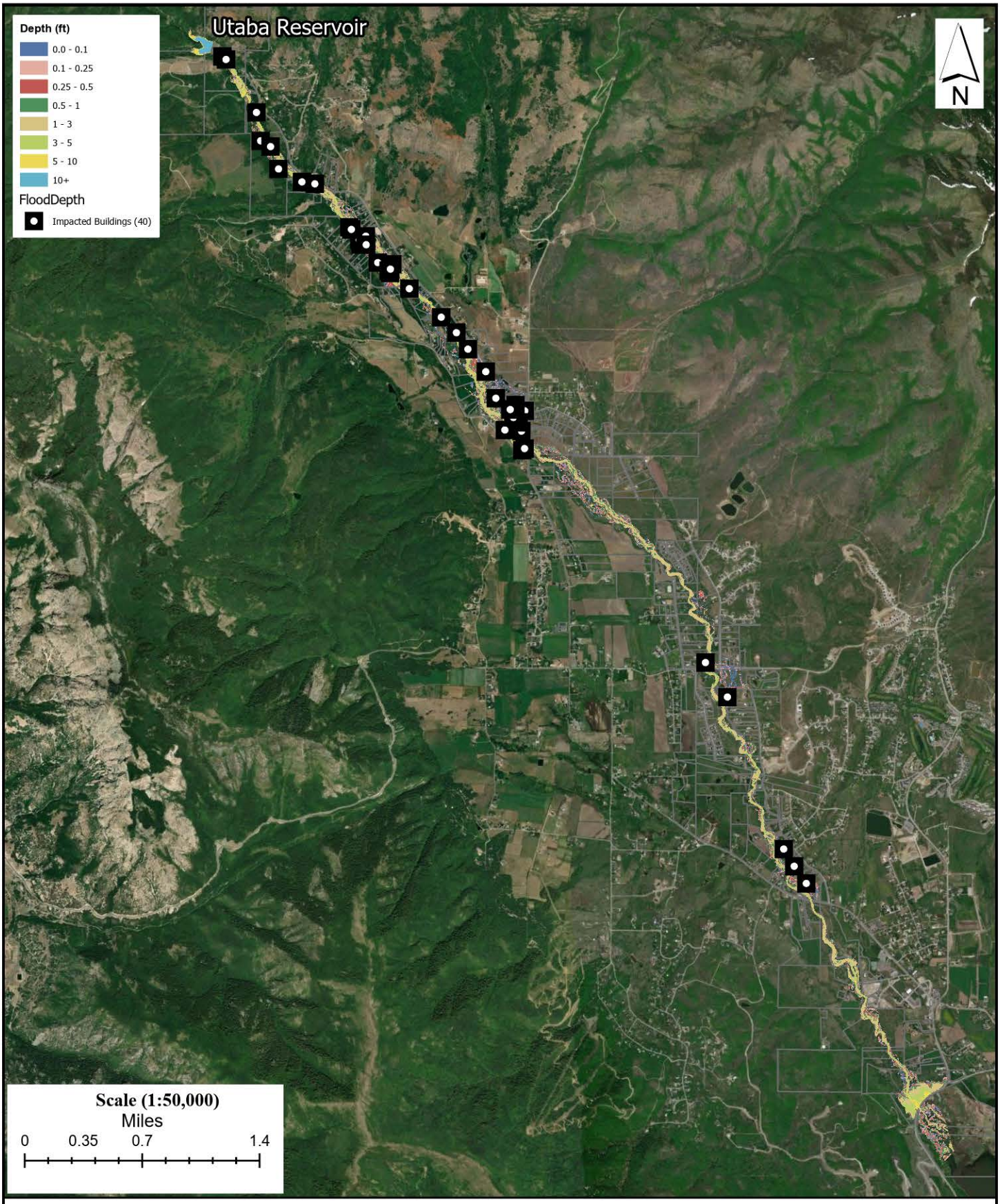

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Existing (Breached) Flood Inundation Area: 50-Year Storm, Max Impact

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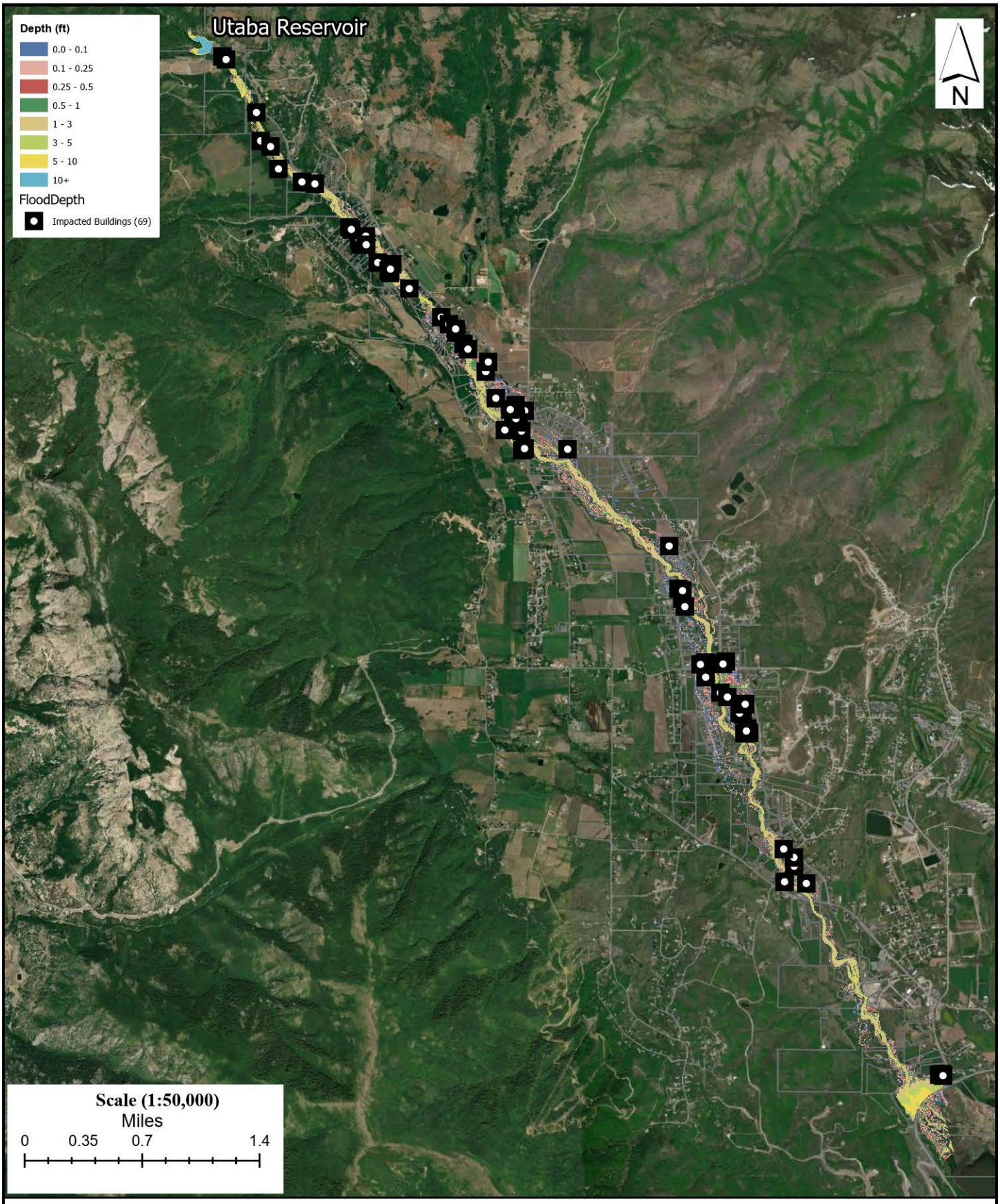

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Existing (Breached) Flood Inundation Area: 200-Year Storm, Max Impact

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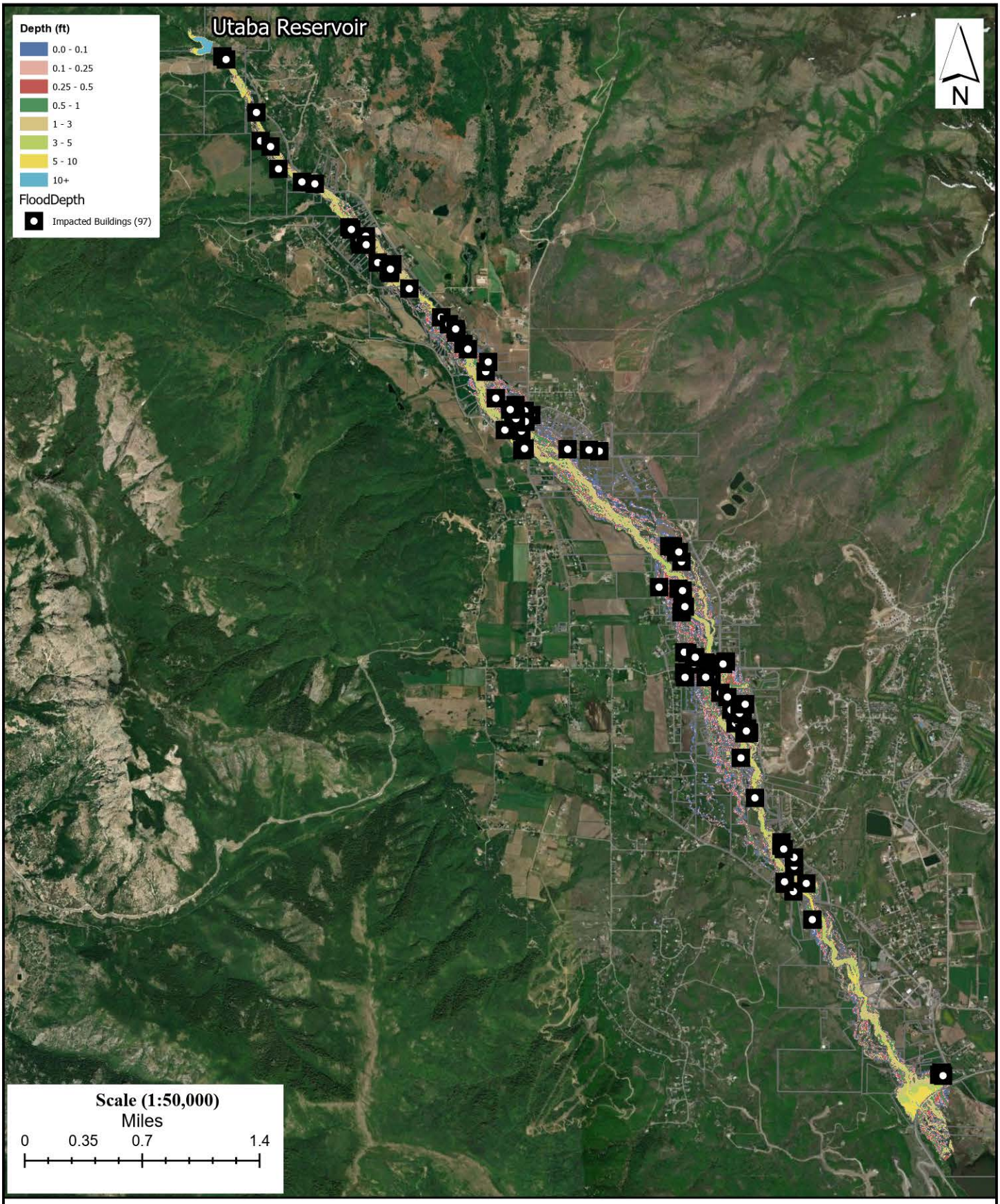

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Existing (Breached) Flood Inundation Area: 500-Year Storm, Max Impact

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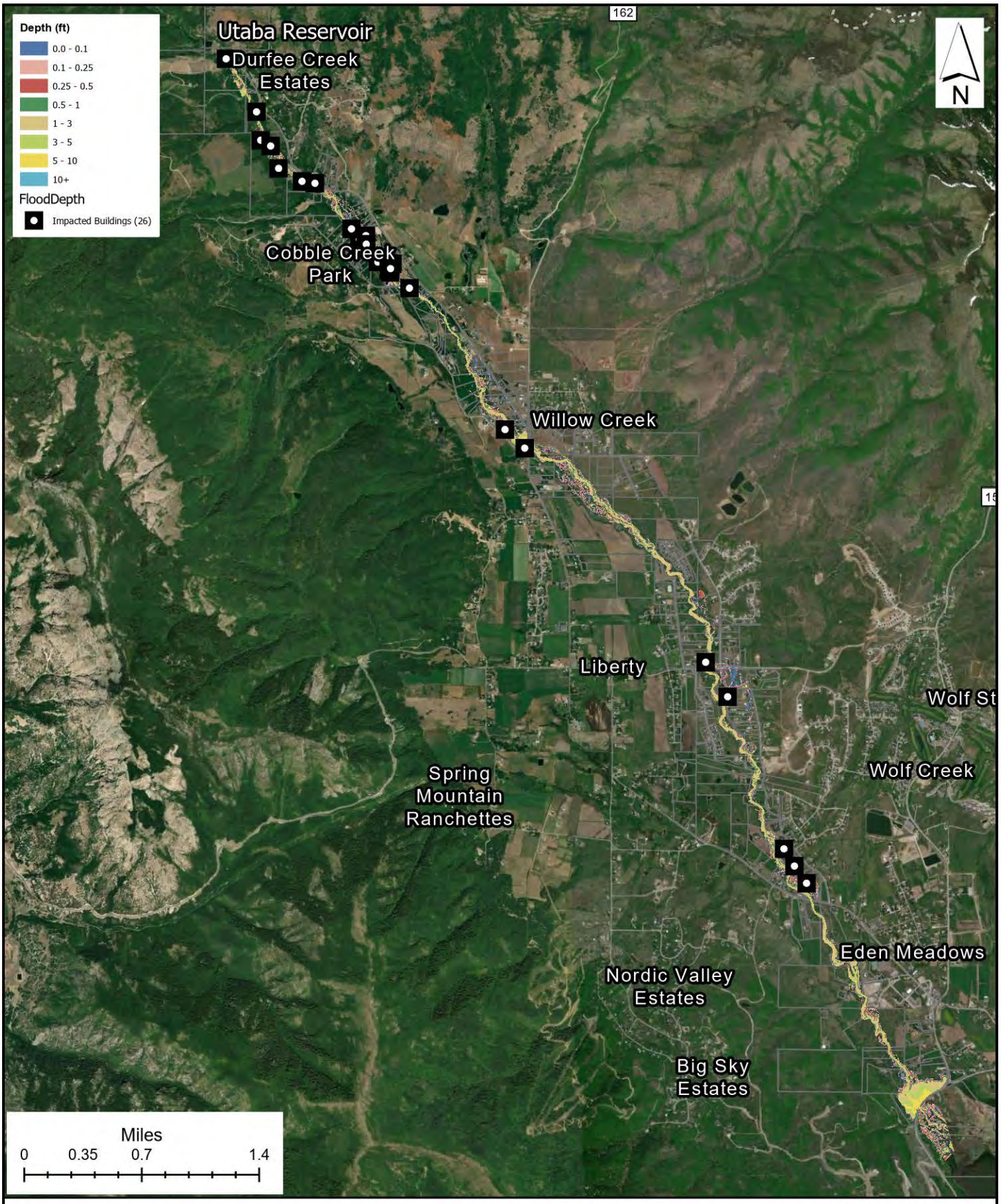
5.3 Decommissioning Alternative Flood Maps

See Figure 15 through Figure 25 below.



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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Decommissioning Flood Inundation Area: 100-Year Storm, Max Impact

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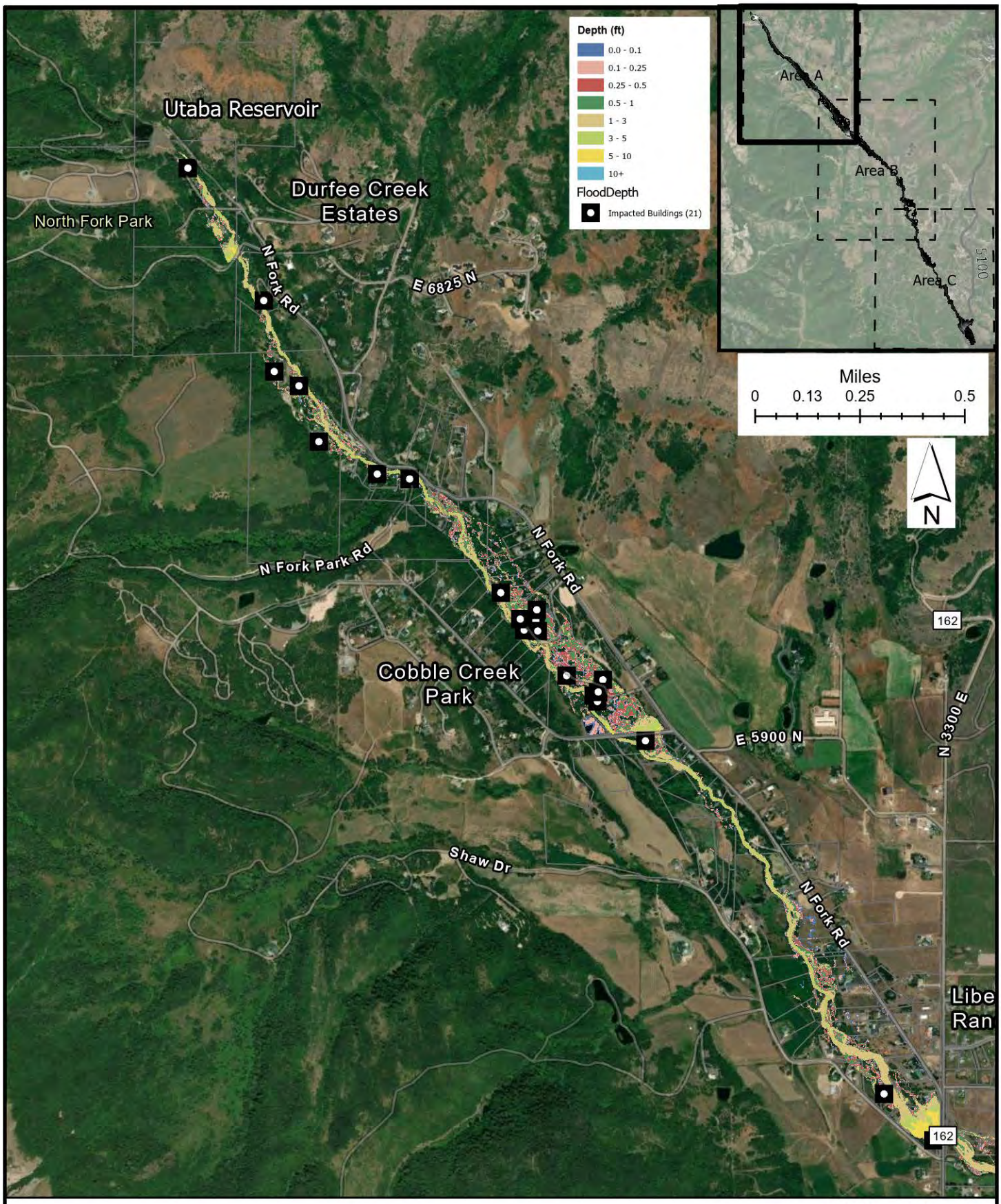

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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Decommissioning Flood Inundation Area: 100-Year Storm, Max Impact

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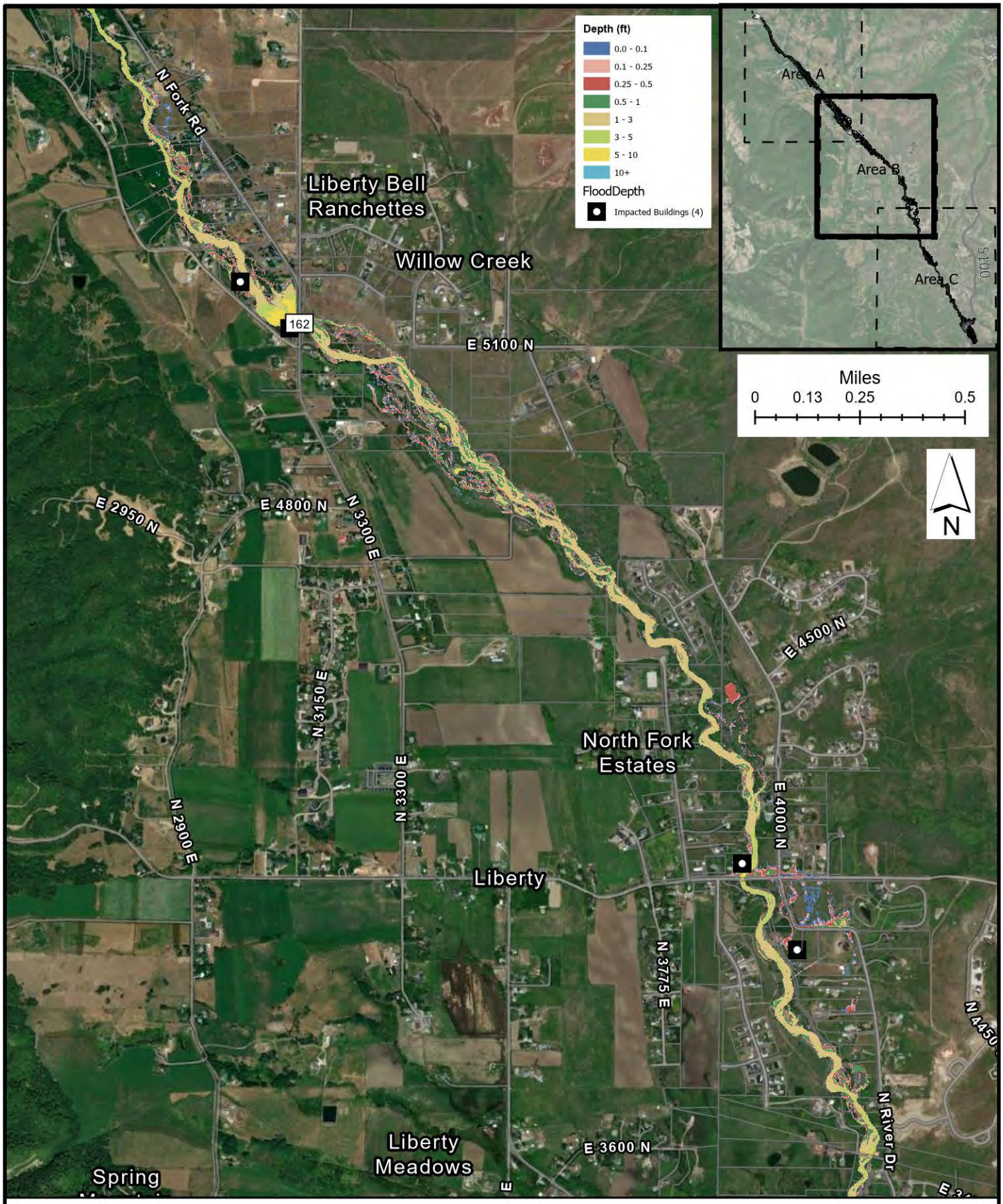

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Decommissioning Flood Inundation Area: 100-Year Storm, Max Impact

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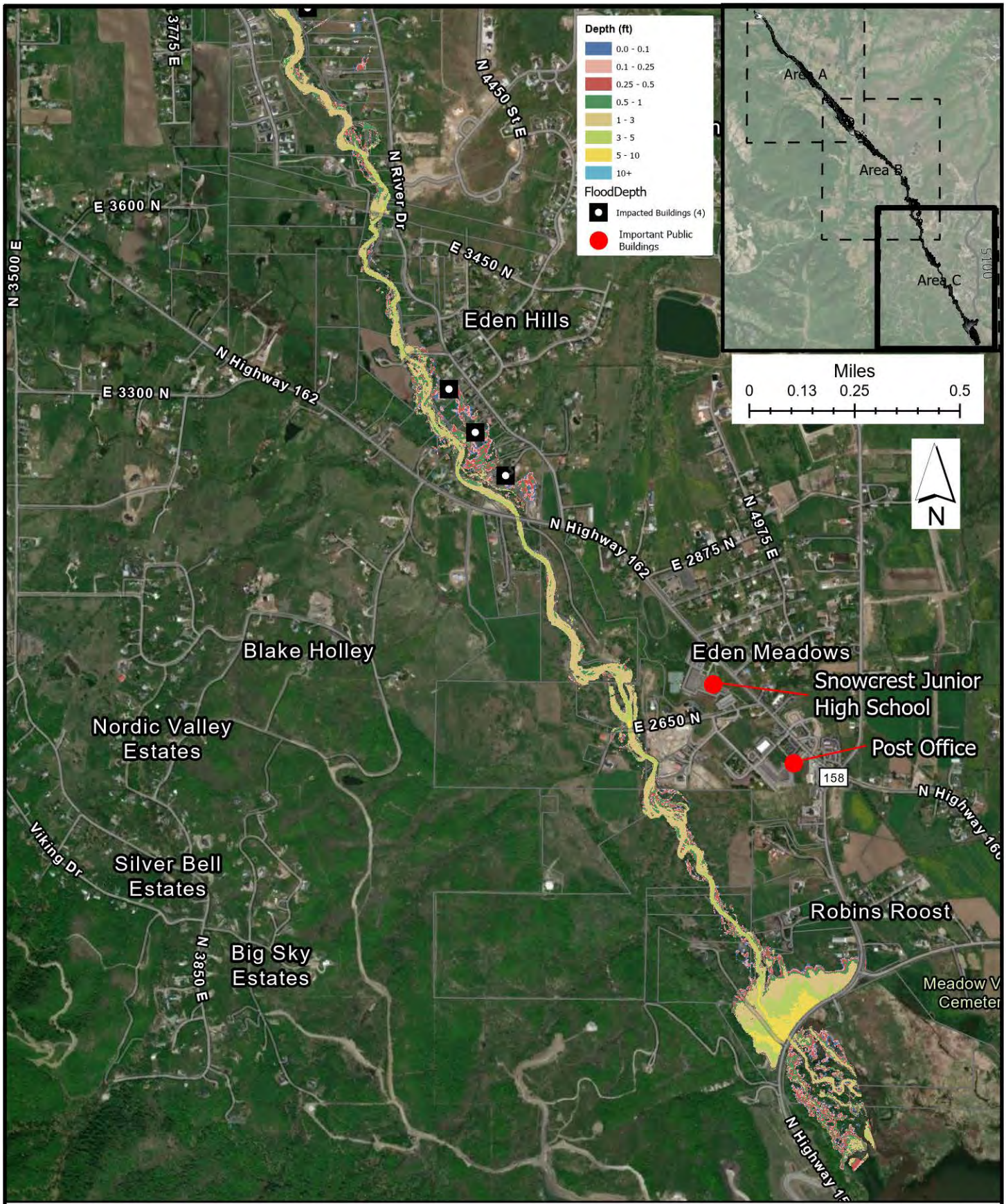

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Decommissioning Flood Inundation Area: 100-Year Storm, Max Impact

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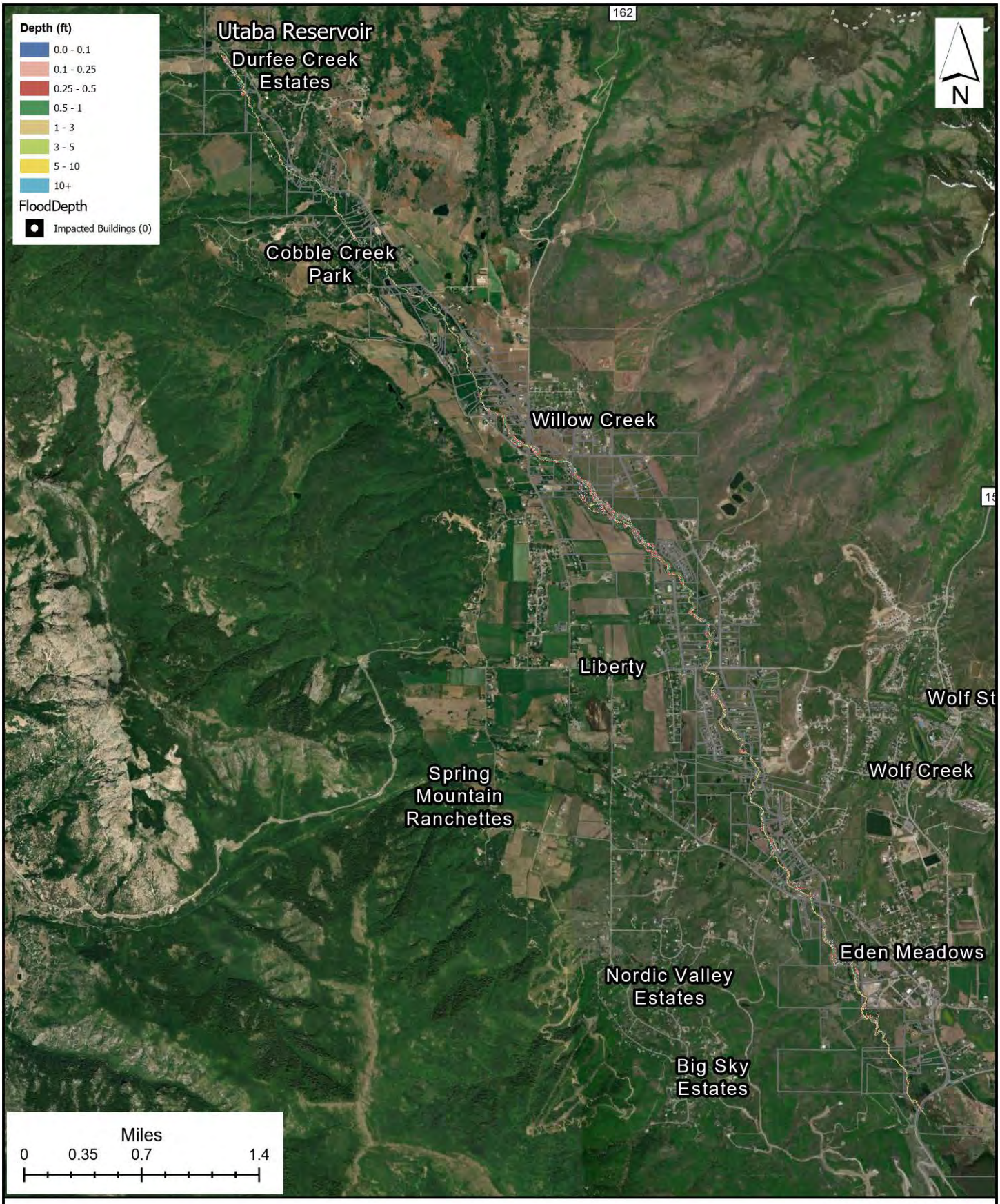

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Decommissioning Flood Inundation Area: 2-Year Storm, Max Impact

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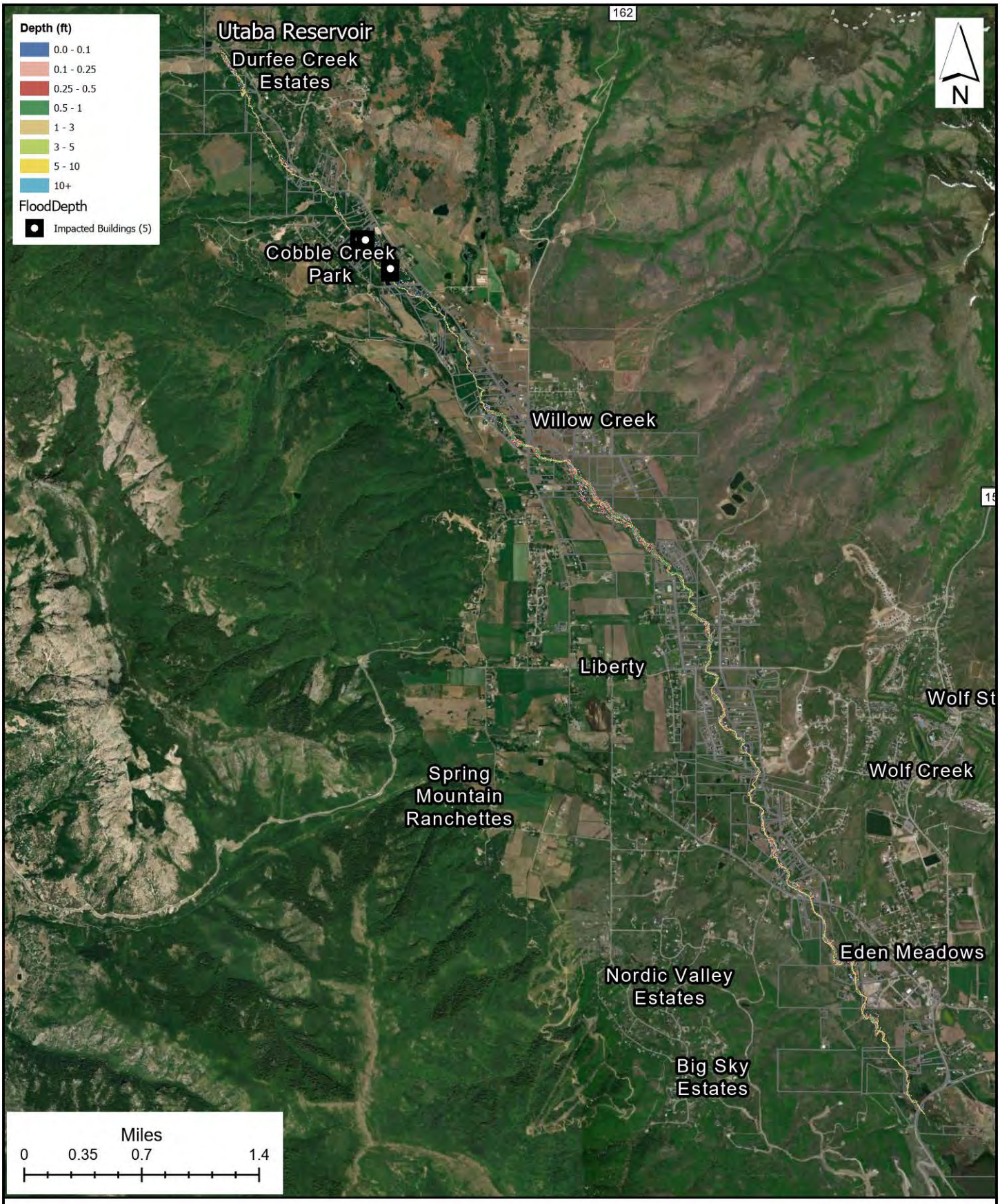

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Decommissioning Flood Inundation Area: 5-Year Storm, Max Impact

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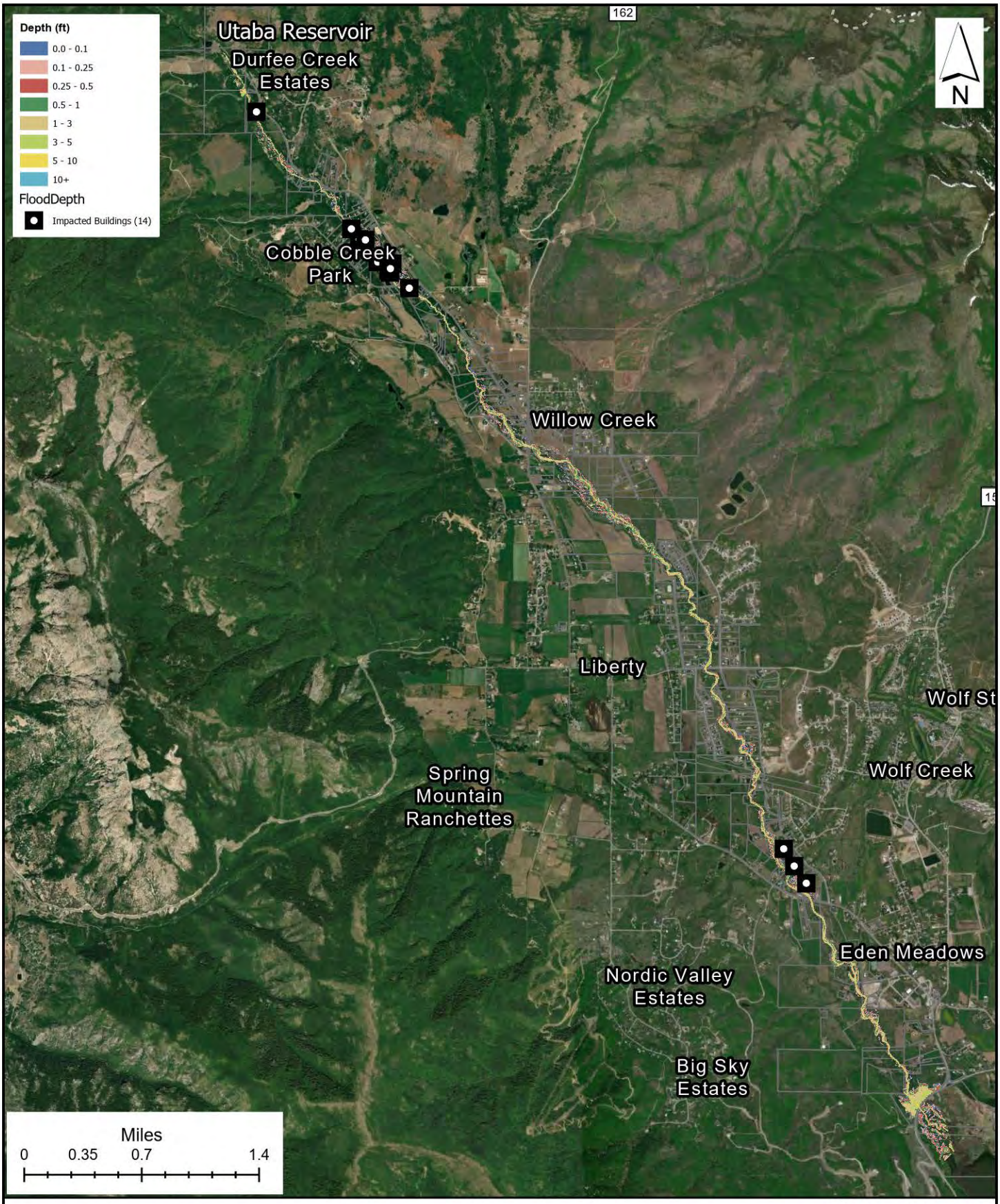

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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Decommissioning Flood Inundation Area: 10-Year Storm, Max Impact

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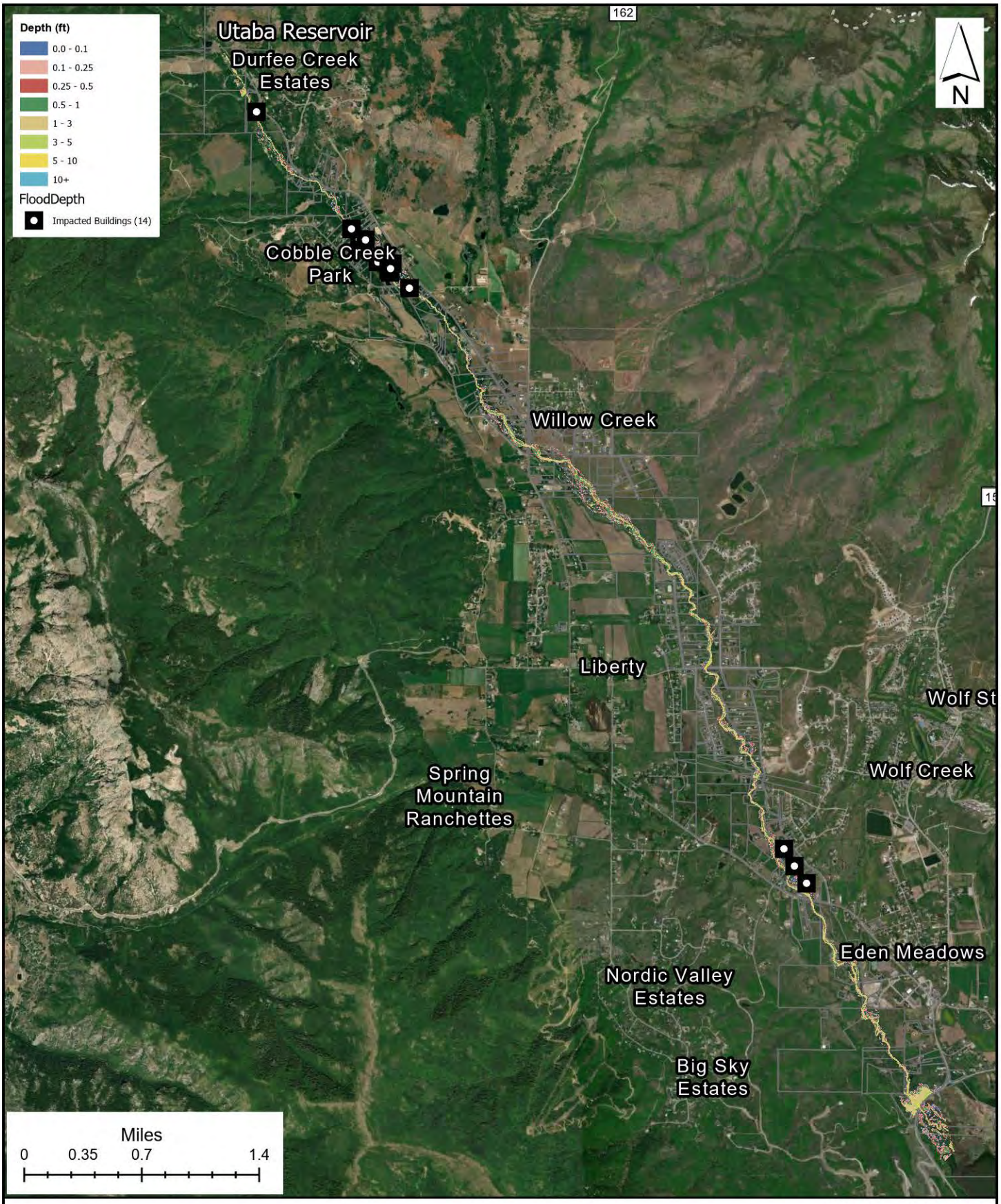

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Decommissioning Flood Inundation Area: 25-Year Storm, Max Impact

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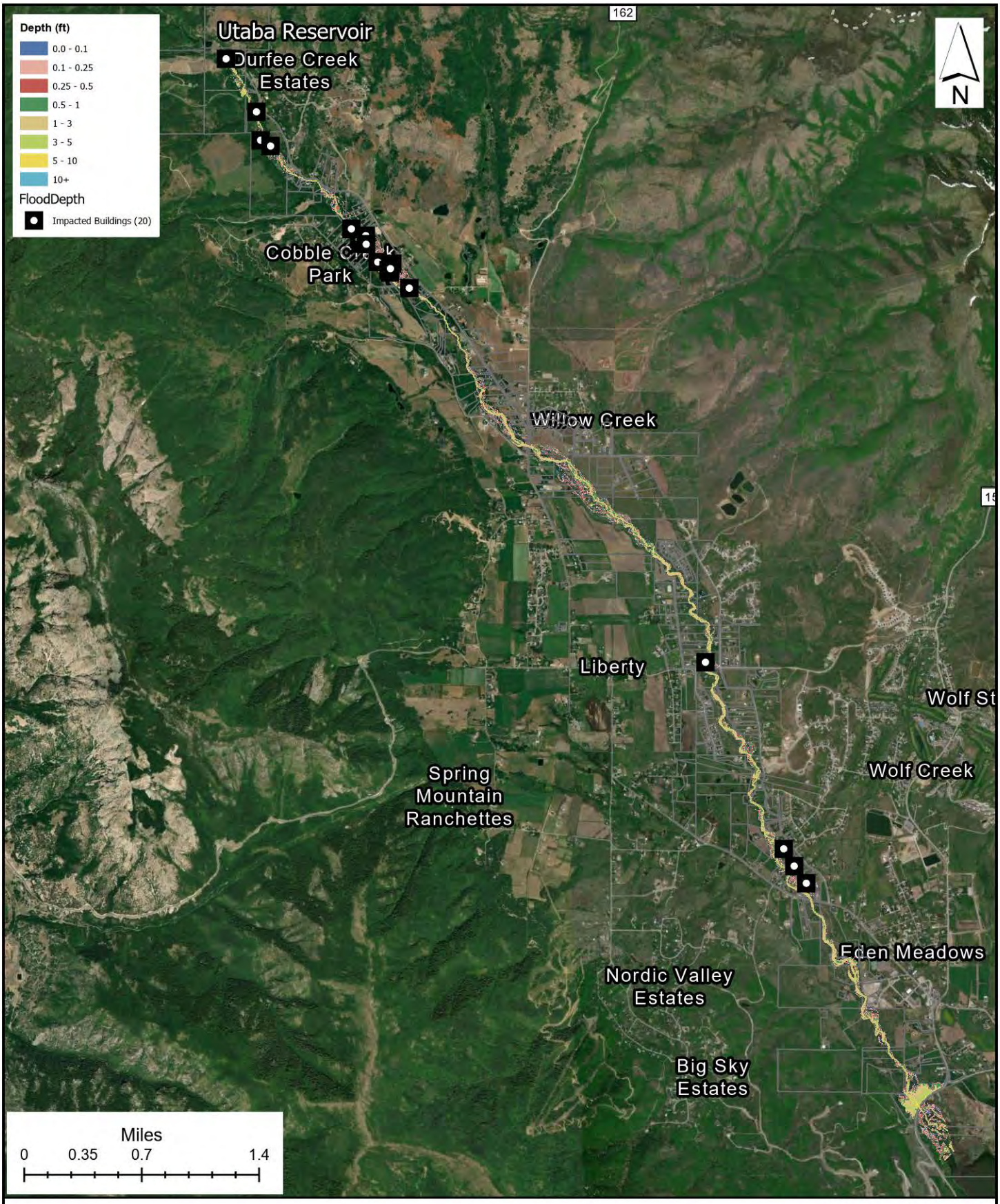

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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Decommissioning Flood Inundation Area: 50-Year Storm, Max Impact

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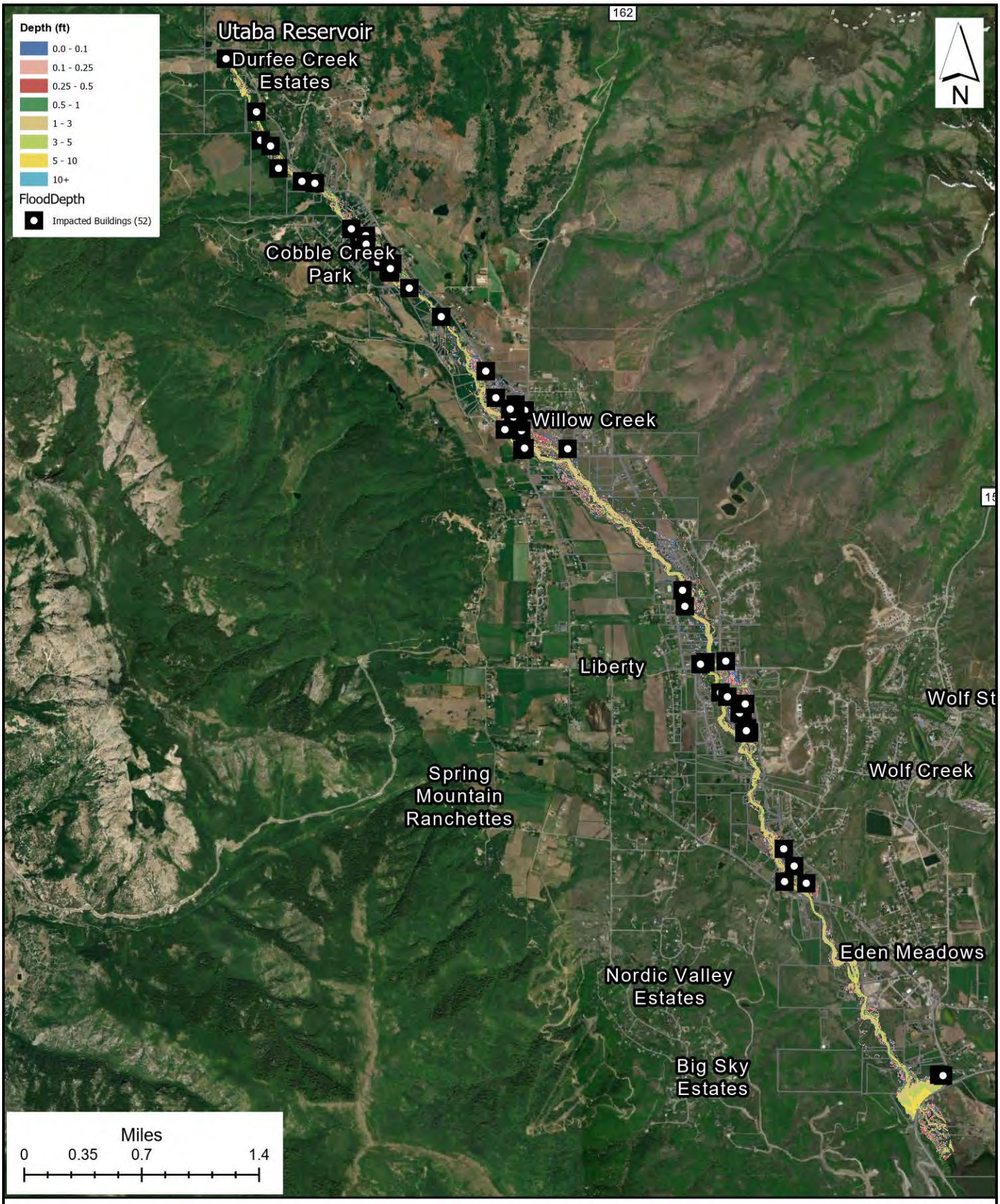

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Decommissioning Flood Inundation Area: 200-Year Storm, Max Impact

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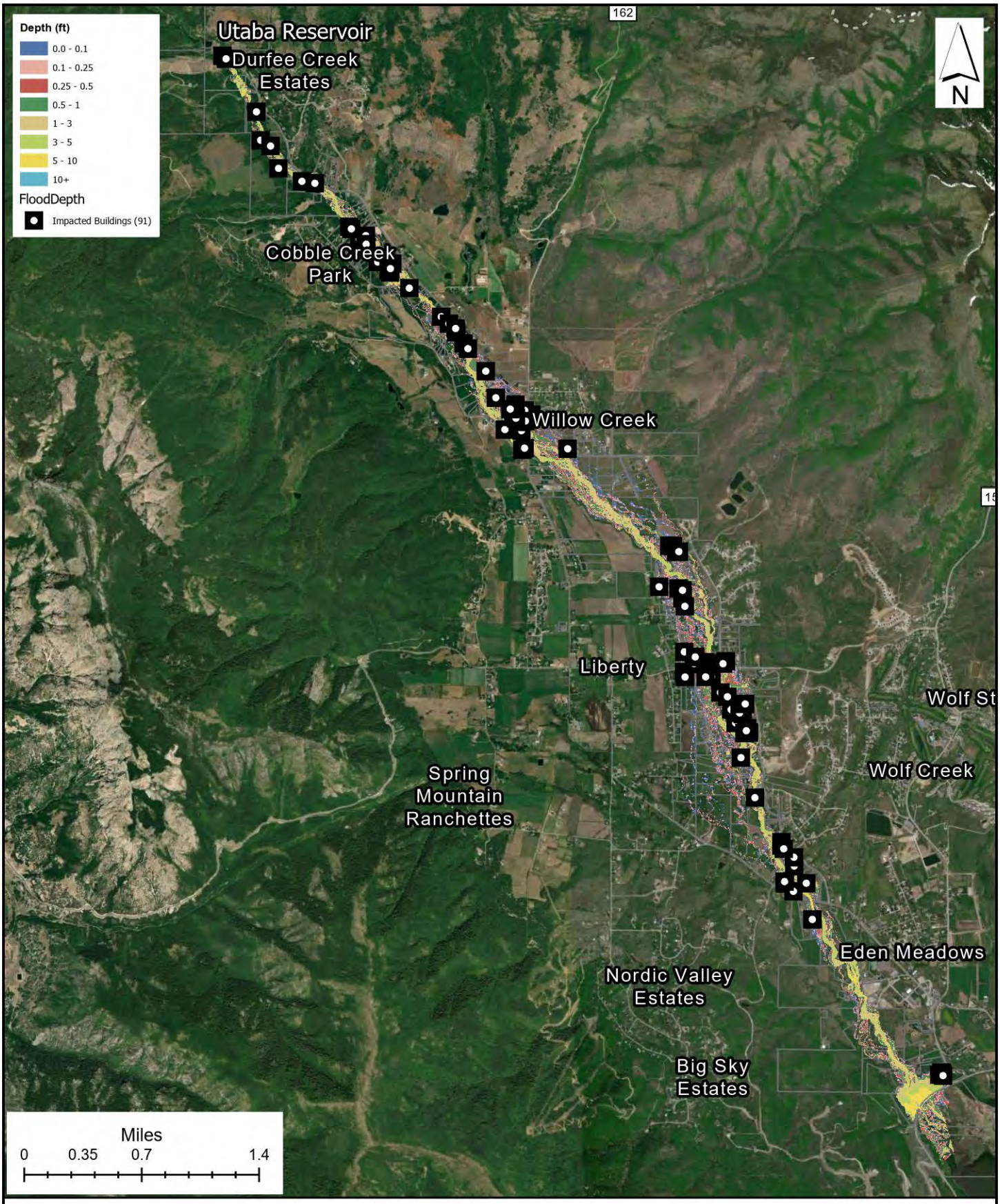

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Decommissioning Flood Inundation Area: 500-Year Storm, Max Impact

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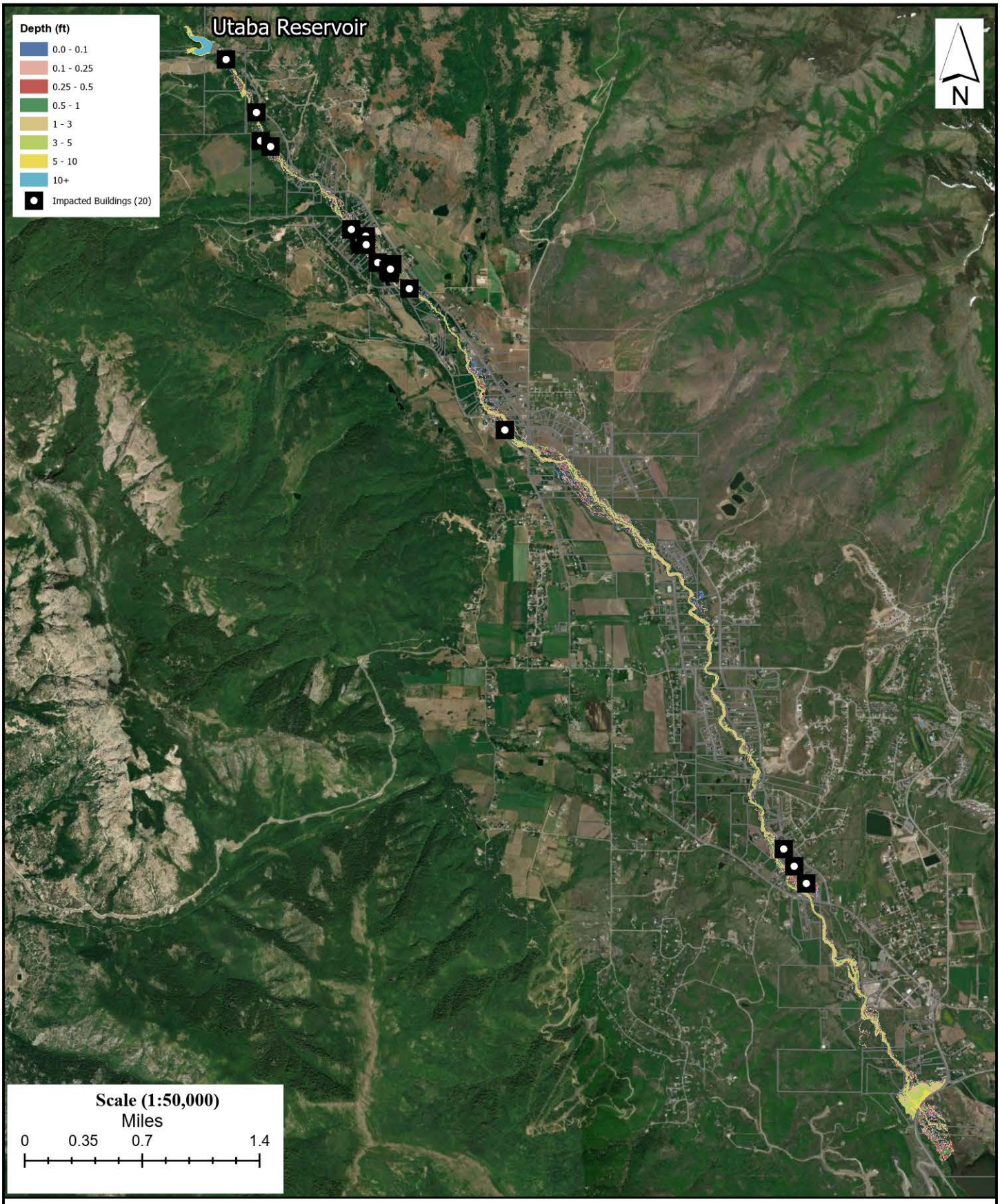
5.4 Structural Rehabilitation Alternative Flood Maps

See Figure 26 through Figure 36 below.



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Structural Alternative Flood Inundation Area: 100-Year Storm, Max Impact

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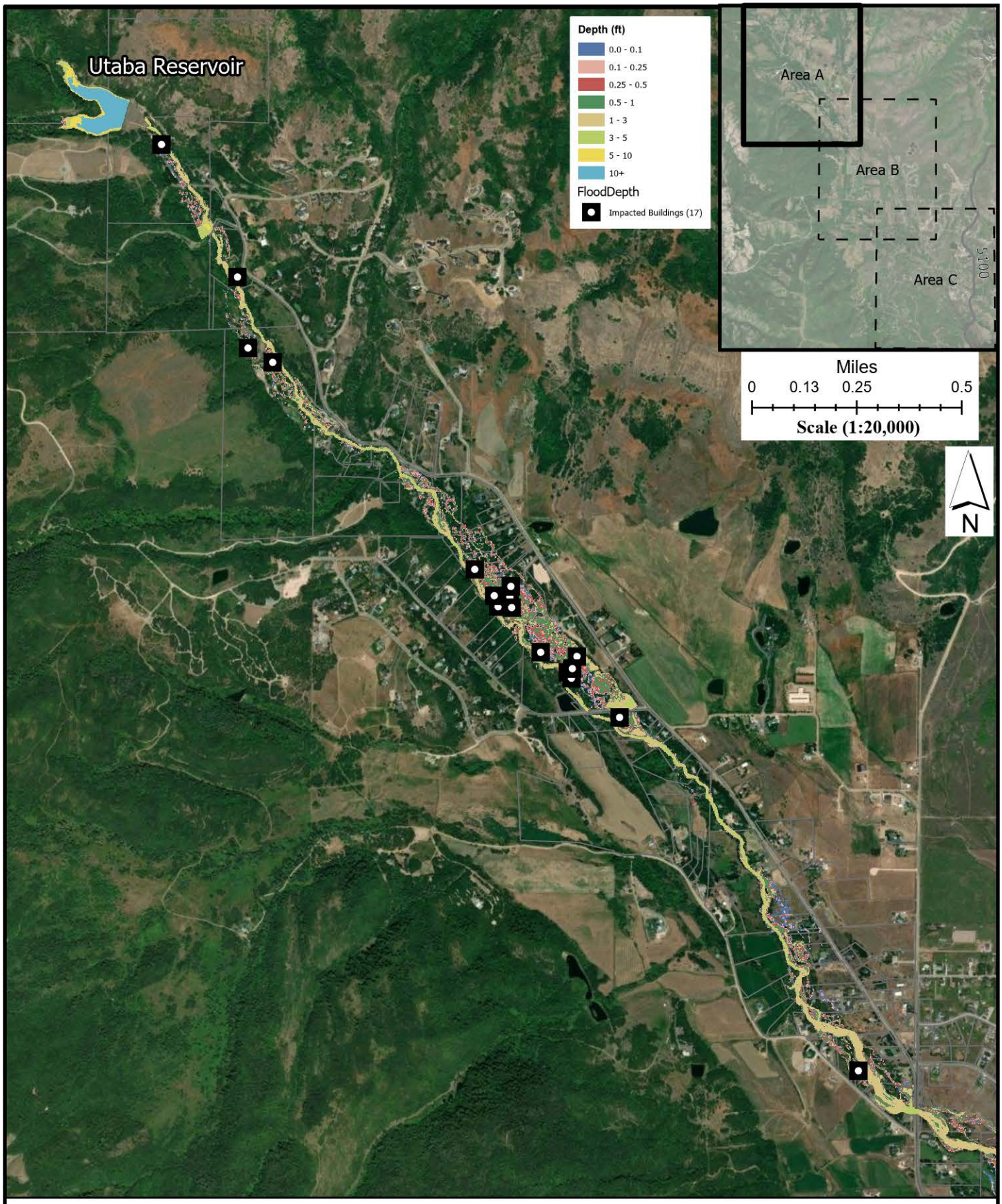

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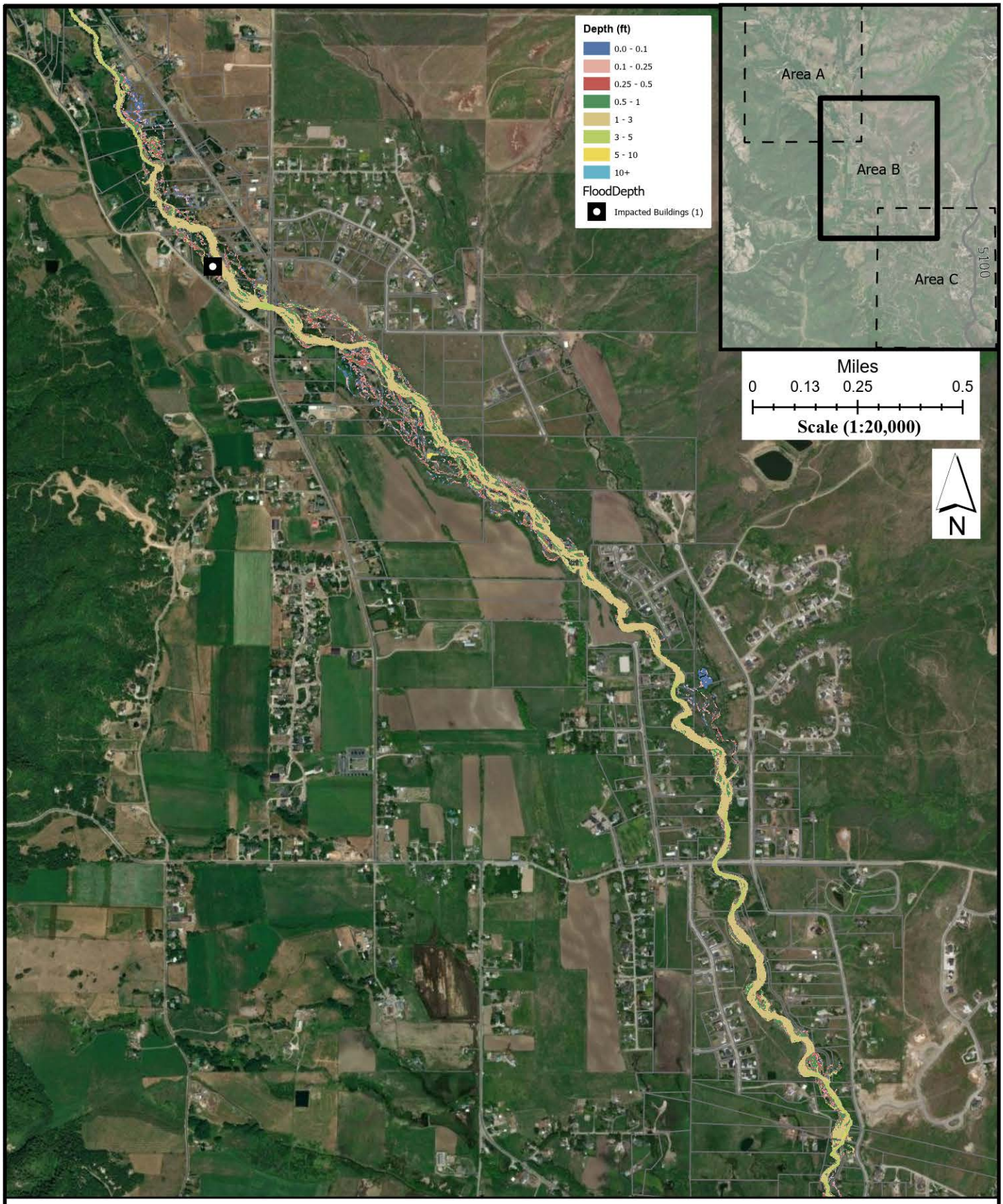

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Structural Alternative Flood Inundation Area: 100-Year Storm, Max Impact

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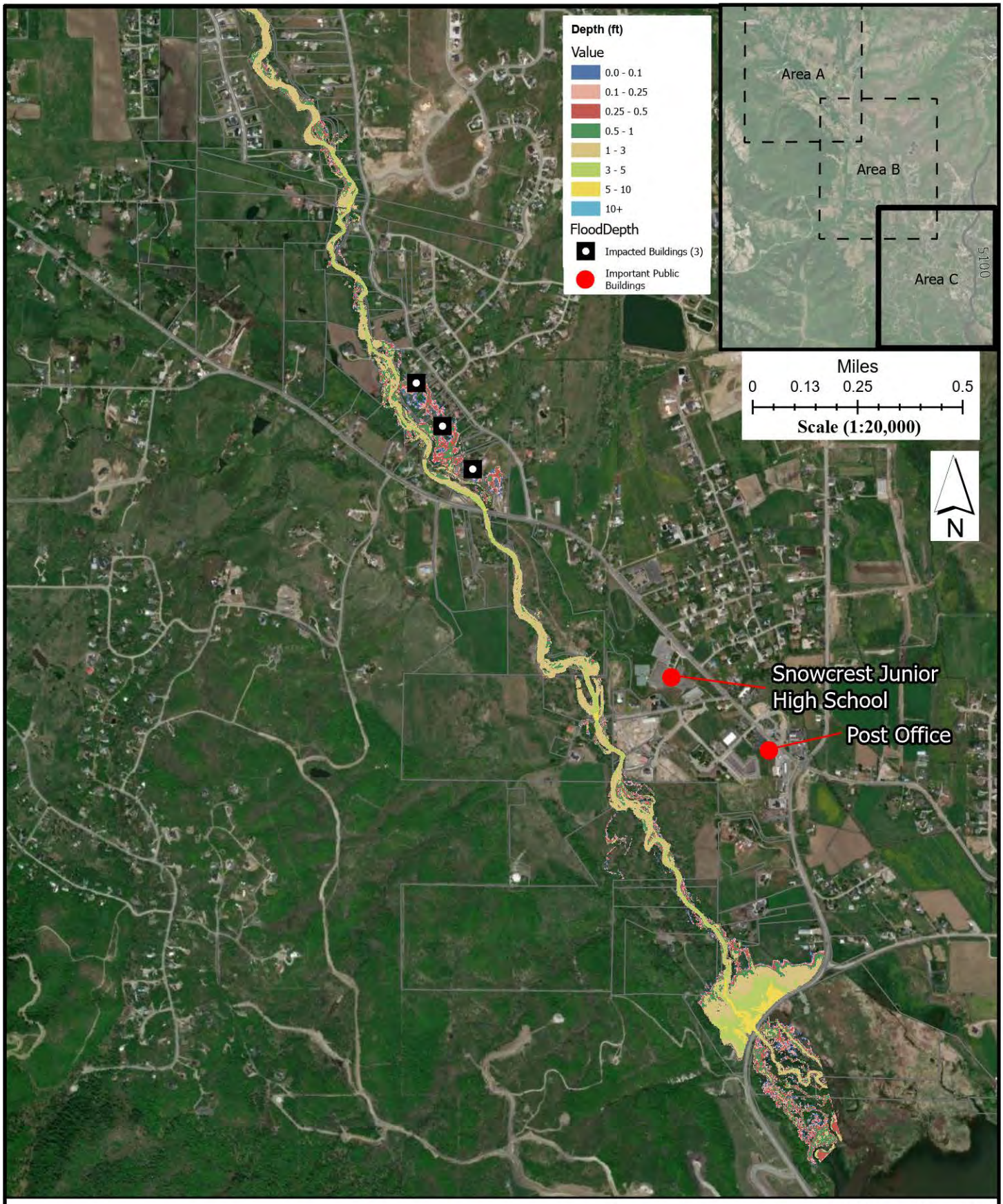

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Structural Alternative Flood Inundation Area: 100-Year Storm, Max Impact

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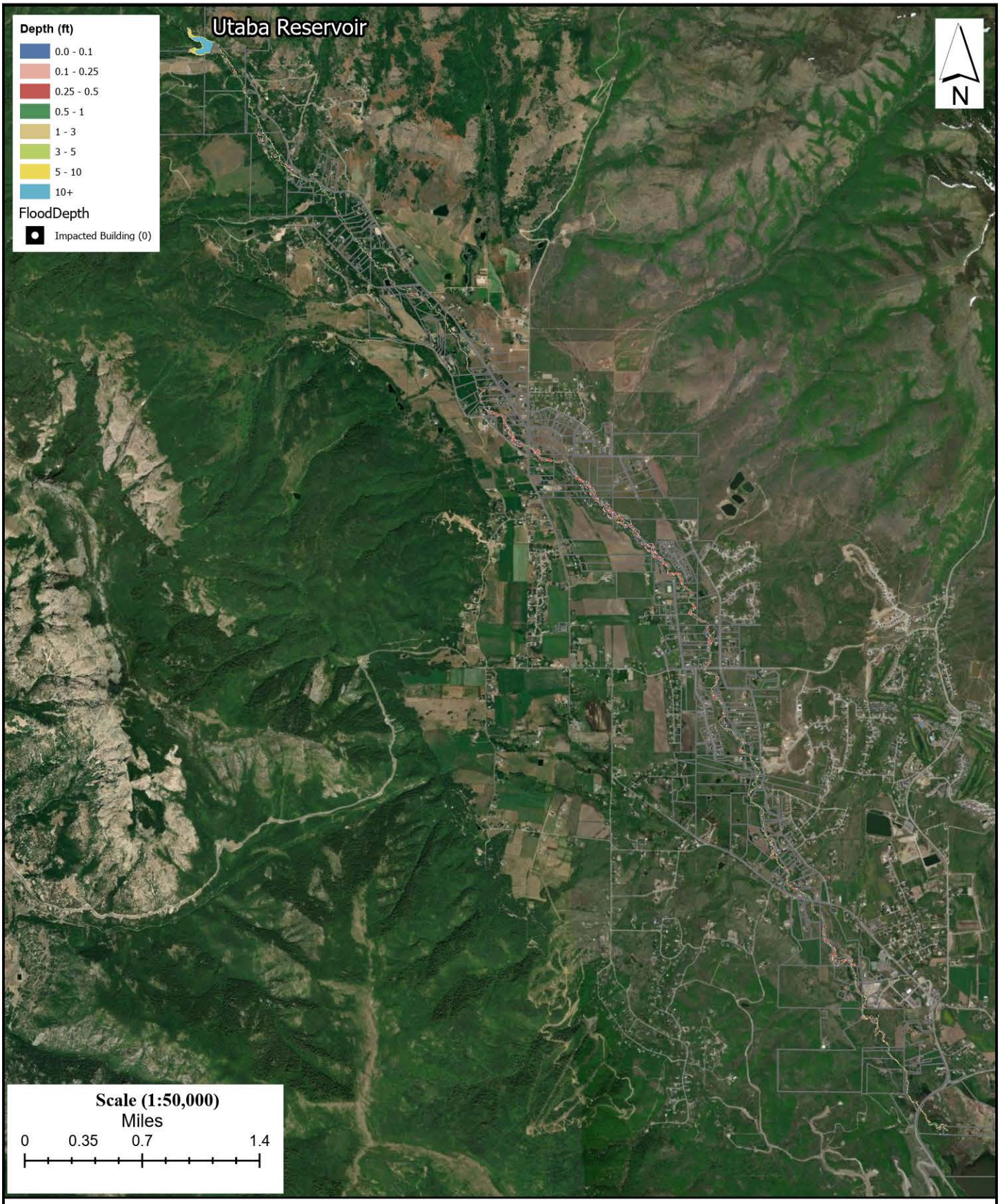

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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Structural Alternative Flood Inundation Area: 2-Year Storm, Max Impact

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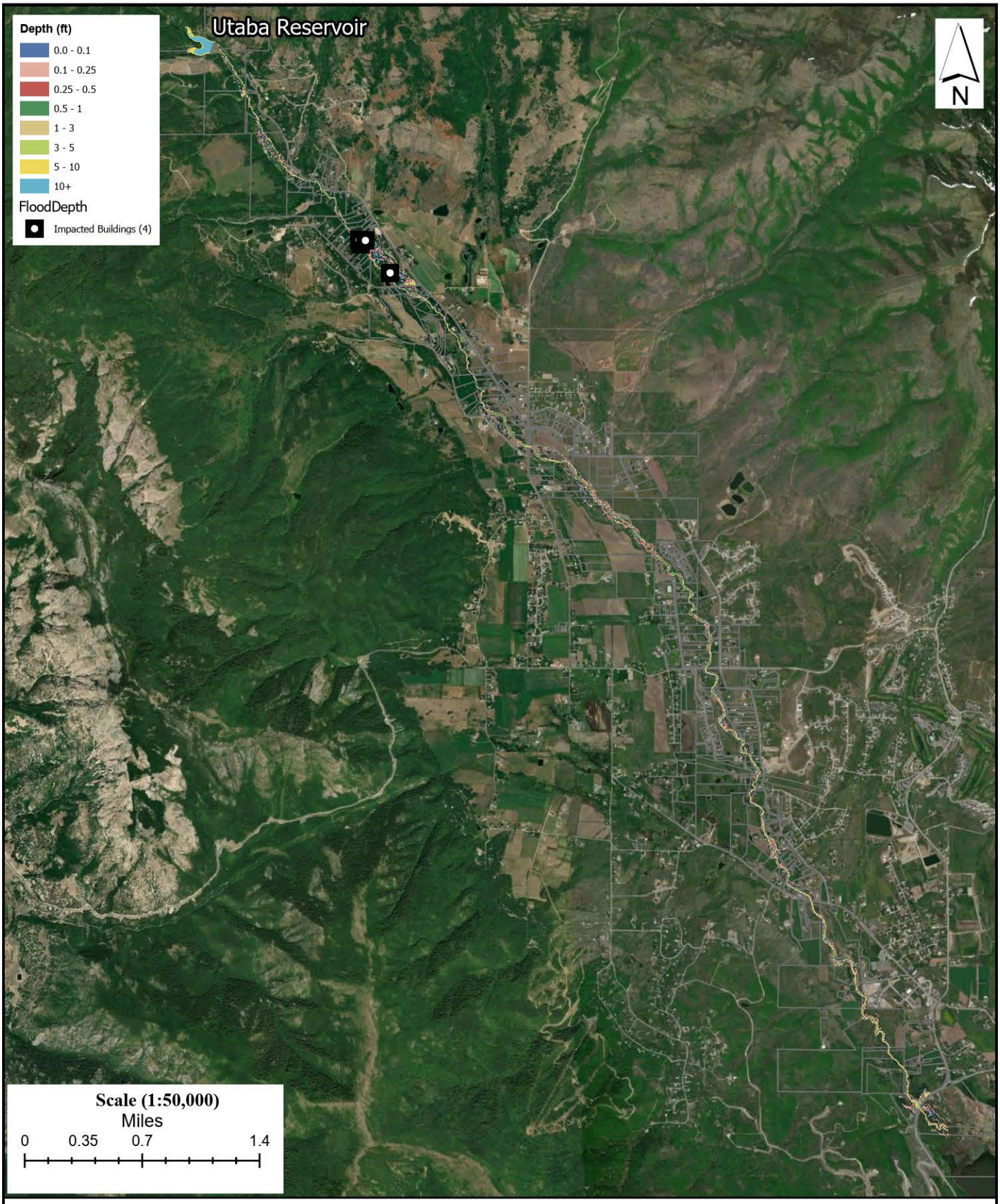

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Utaba Retarding Dam Rehabilitation Plan Environmental Assessment

Structural Alternative Flood Inundation Area: 5-Year Storm, Max Impact

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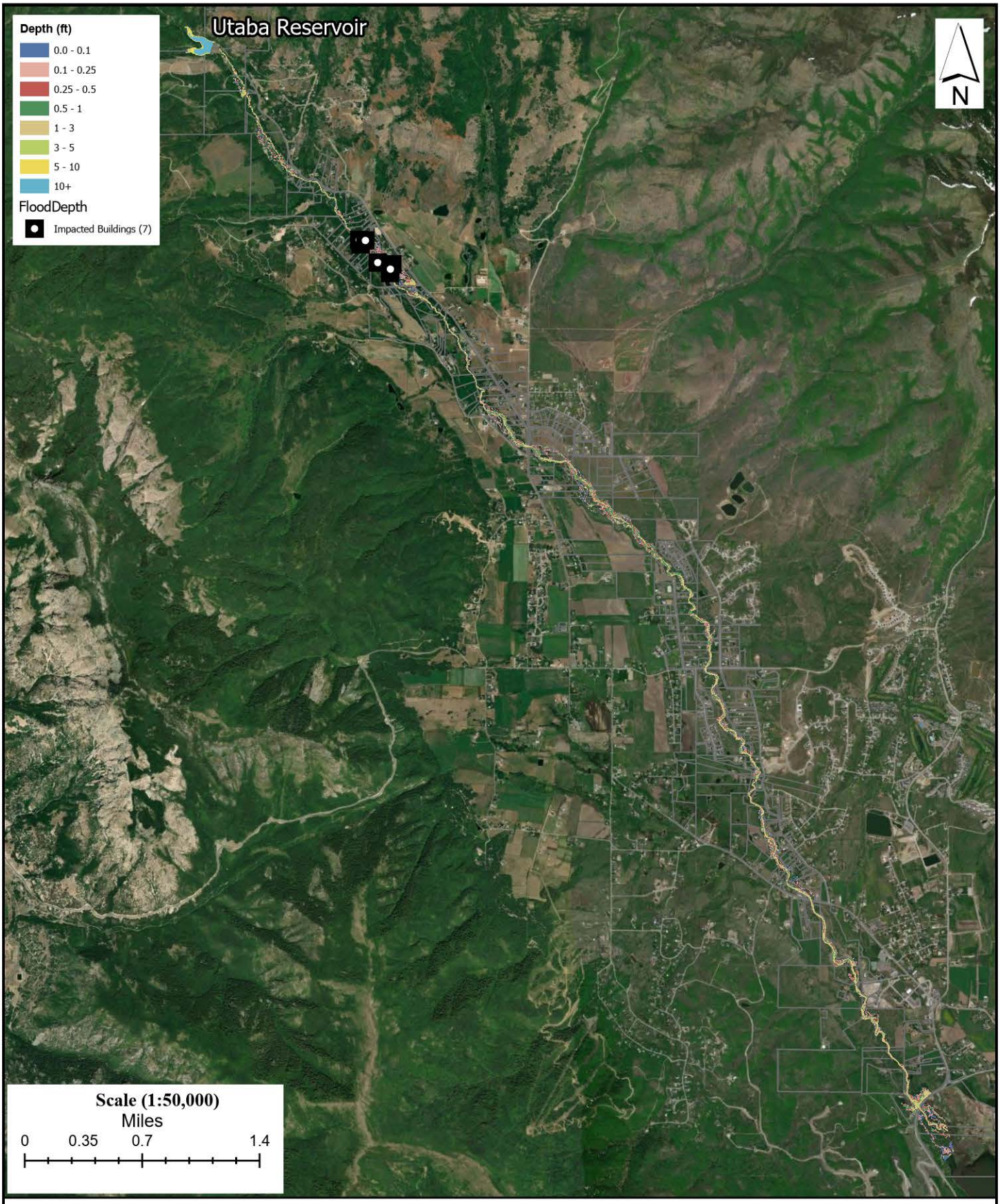

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Structural Alternative Flood Inundation Area: 10-Year Storm, Max Impact

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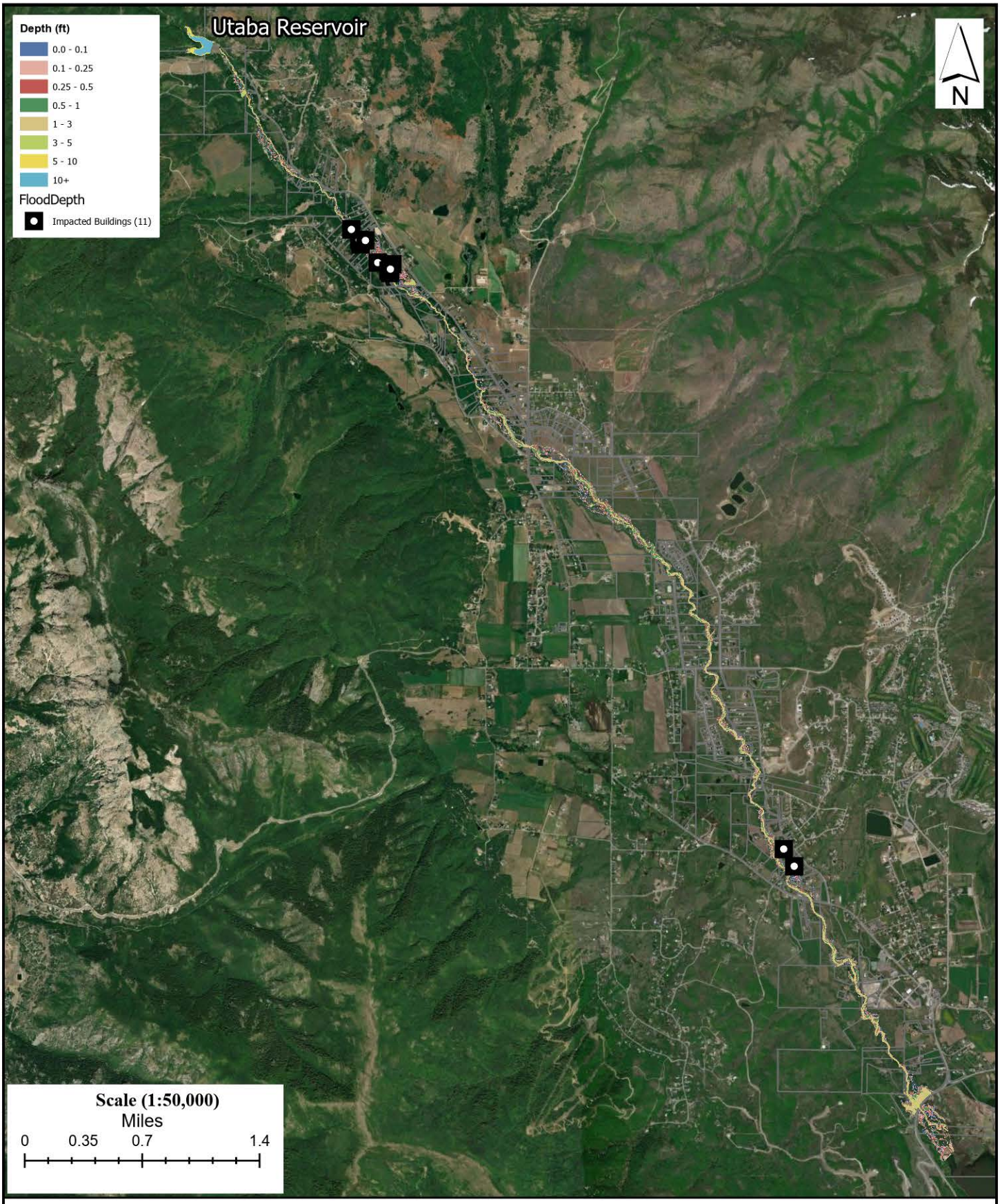

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Structural Alternative Flood Inundation Area: 25-Year Storm, Max Impact

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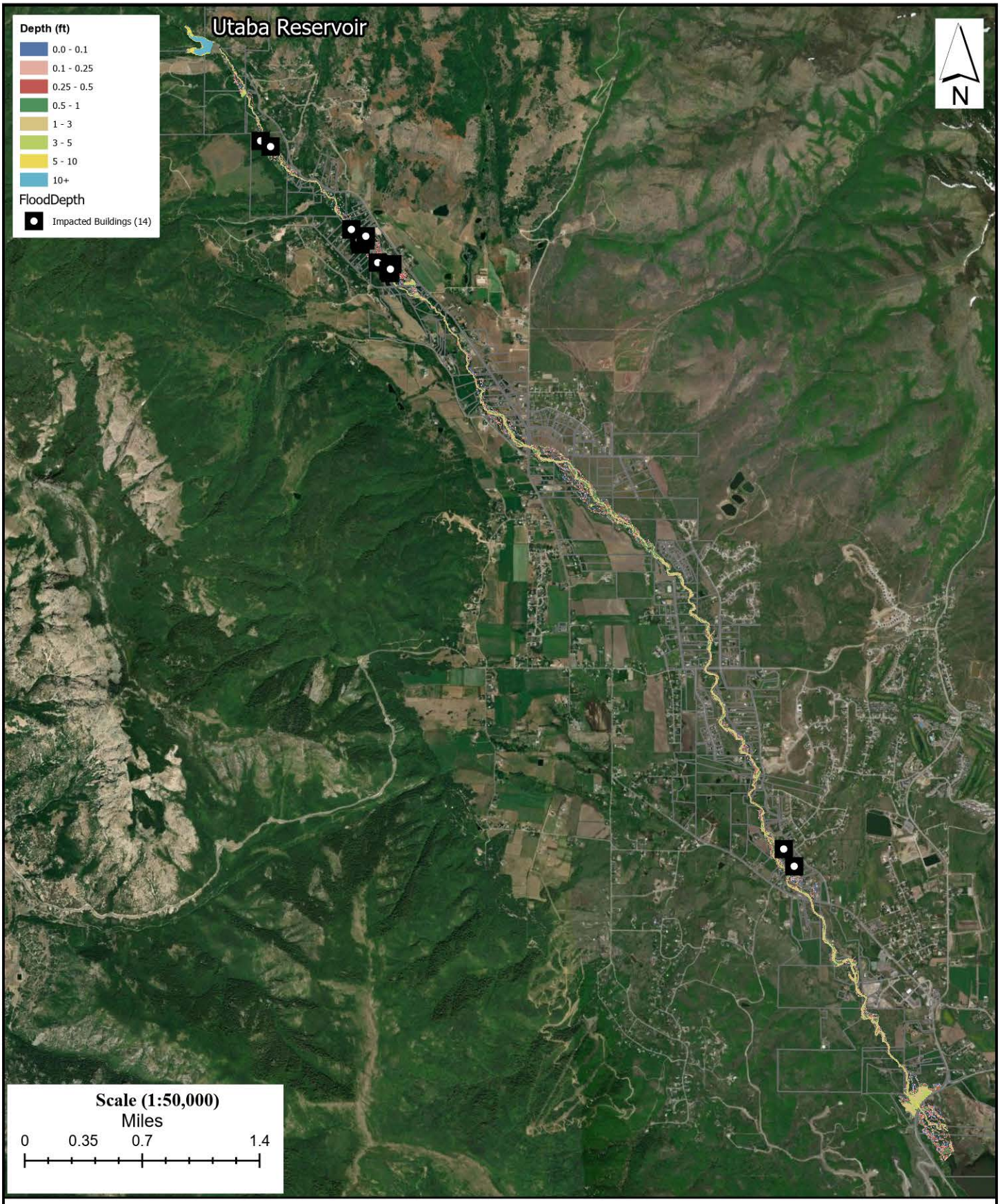

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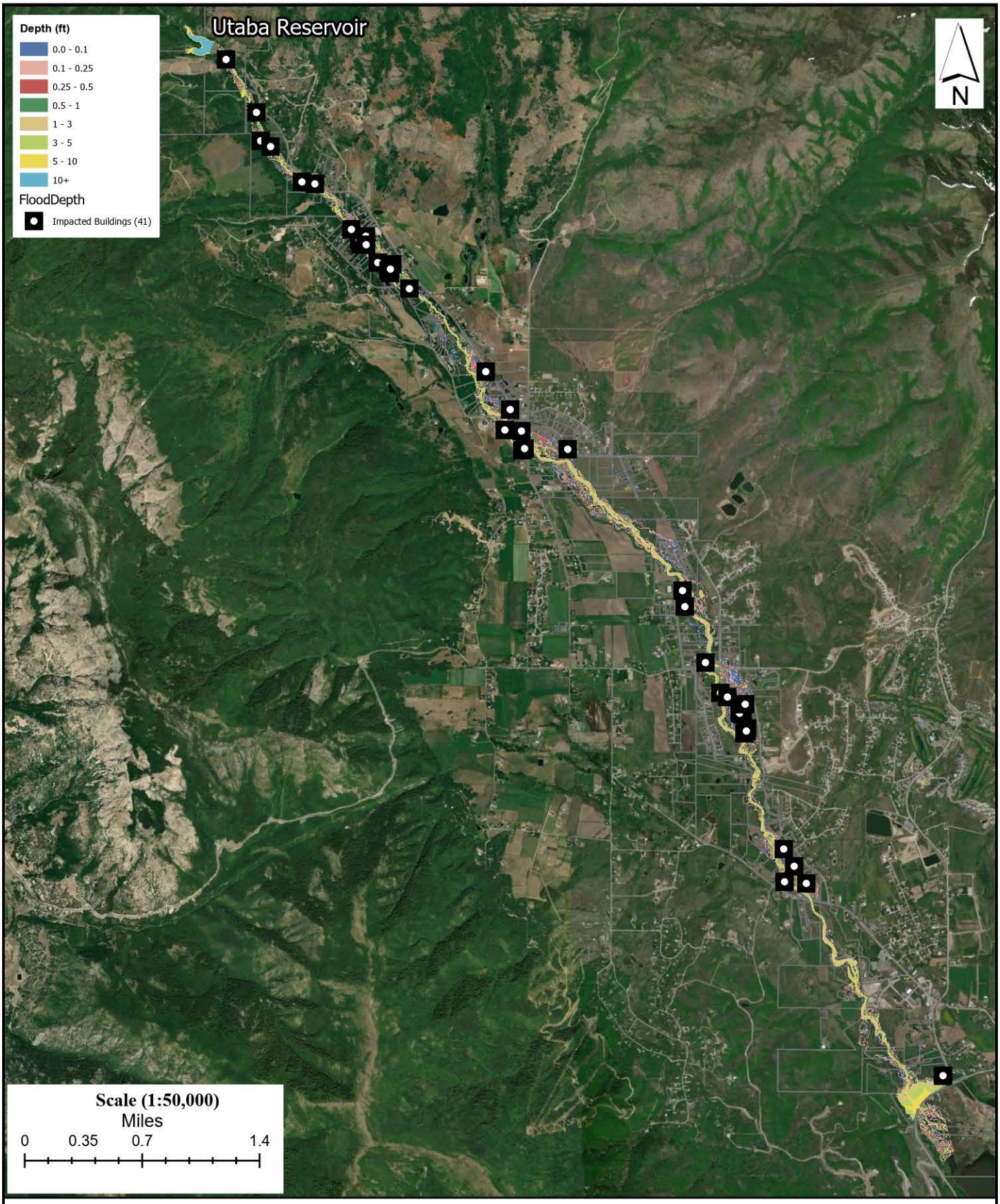

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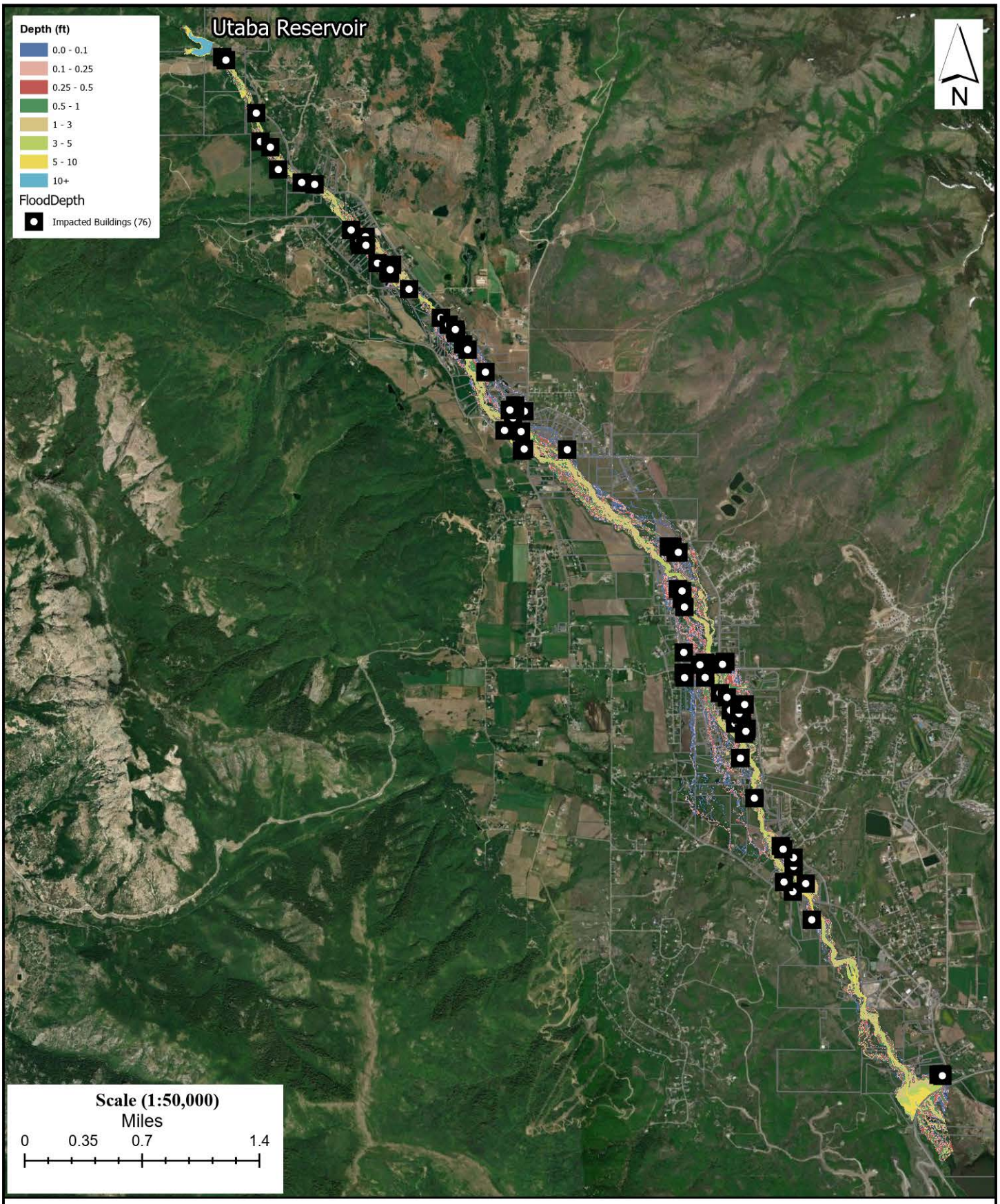

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Structural Alternative Flood Inundation Area: 500-Year Storm, Max Impact

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Dam Rehabilitation Design Tech Memo

Technical Memorandum 007
Dam Rehabilitation Design

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1.0 Introduction

Many potential project actions were identified during the scoping process, which included meetings with the sponsors. As a part of the NEPA process, the actions related to the dam rehabilitation design have been documented here in TM007. The process used to evaluate each option and determine which ones to carry forward to the final proposed alternative is described in the main EA document, Chapter 4, sections 1-3.

2.0 Action Alternatives

The existing debris basin dam has multiple issues that have been documented and require significant repairs and upgrades, full replacement, or removal of the existing dam. The existing dam has a high potential of failure in the following ways:

- **Potential spillway structural failure.** The auxiliary spillway concrete has experienced significant degradation. Of great concern is the open joints that could allow water to erode beneath the spillway. Weber County has made repairs, but the degradation is such that repairing the structure will soon not be an option. The location of the spillway on the dam embankment increases the potential for the embankment to breach because of the failure of the auxiliary spillway. This condition results in the greatest risk of dam failure.
- **Inadequate spillway capacity.** The principal and auxiliary spillways are both undersized and cannot pass the required storm events. The NRCS requires the principal spillway to pass the 100-year, 10-day storm event and the auxiliary spillway to pass the required probable maximum flood event. The principal spillway is also easily blocked by beavers and is difficult to clean and maintain.
- **Foundation and embankment seepage.** Seepage has been observed at the toe of the dam and around the principal spillway conduit. The seepage appears to be coming through the foundation materials. Uncontrolled seepage has the potential to create seepage pathways that will increase in size over time and could eventually lead to the failure of the dam when it is full.
- **Insufficient crest width.** The current crest width does not comply with Utah Dam Safety or NRCS standards.
- **Permanent detention of water.** Flood control dams are designed to lower standards than water storage dams since they only detain water for short periods of time. Utaba Dam is a flood control dam, but the blocking of the openings into the principal spillway by beavers causes water to be permanently detained. Permanent storage of water in the reservoir causes some of the embankment materials to become saturated. Saturated soils have less strength than non-saturated soils. Having permanent water detention also reduces the capacity and effectiveness of the reservoir to reduce flood flows.
- **Decreased sediment and water storage capacity.** With decreased storage capacity due to sediment accumulation, the effectiveness of the reservoir at reducing flood flows is diminished.

The options considered for addressing these issues are described in the following sections.

2.1 Structural Alternative

The issues with the existing dam are significant. Repair and upgrade of the existing dam would require at least:

- Removing or replacing the existing principal and auxiliary spillway.
- Increasing the storage capacity by removing sediment from the debris basin or raising the dam.
- Configuring a new principal spillway to reduce the rate of sediment accumulation by allowing finer grained sediment to stay entrained in the water and continue downstream.
- Configuring a new principal spillway to prevent beavers from blocking the release of water from the reservoir and causing permanent water detention.
- Installing a new filter and drain system to control and measure seepage and prevent soil material from migrating.
- Adding material to the downstream slope to increase the crest width.
- Establishing access routes to the crest and upstream face of the dam to allow easier maintenance of the dam and spillways.
- Raising the dam to provide the freeboard needed to pass the Probable Maximum Flood (PMF).

Rehabilitating and upgrading the existing dam is possible, and it is likely more feasible than replacing the dam. Specific items that need to be addressed are listed below. Items impacting the efficiency and cost of construction are also identified below.

- To provide the necessary spillway capacity and increase the crest width, additional material will need to be added to the downstream side of the dam. Camp Utaba is located near the dam. Raising the dam would require a larger base, and the camp may need to be relocated.
- Replacing the principal spillway could require removing much of the dam and sediment. The removal of the dam and sediment will impact the cost of this alternative. Sediment removal and disposal will be a significant challenge.
- The auxiliary spillway will be relocated to the north abutment, where a historic road is currently located. The road is no longer usable by vehicles, but it is occasionally used as a walking path. The path may need to be relocated, closed, or incorporated in the design.
- Access to the dam is limited by topography and Camp Utaba.
- Materials needed for the filter and drain system likely cannot be generated by onsite materials, requiring them to be imported.
- Cutler Creek and North Fork Ogden River are perennial streams, and water management will be a critical element during construction. Removal of the currently ponded water is necessary and will require beaver control.

In summary, many improvements are necessary to rehabilitate the dam and bring it up to modern safety standards. These repairs must happen in a timely matter to prevent dam failure and endanger the lives and property of those downstream.

2.2 Decommissioning Alternative

As shown in TM004, the failure of the dam during a flood event will cause more damage than if the debris basin did not exist. The removal of the debris basin reduces potential flooding damage when compared to the worst-case existing condition, which is dam failure, As a result, the option to remove the debris basin must be evaluated.

While potential flood damage under worst-case conditions is less without the existing debris basin, there would still be significant flood damage. Without the debris basin removing debris and sediment, culverts are likely to be blocked by debris, thus increasing the flooding potential even at relatively small flood events.

Removing the debris basin reduces the potential flooding from a failed dam, but it does not meet the project purpose and the need to protect the downstream area from flooding. Without a debris basin, all culverts and bridges along the North Fork River would be subject to debris blockages and sediment accumulation. Regardless of what measures are taken downstream, debris and sediment in flood water will increase the potential for flooding and damage. Removing the debris basin is not an acceptable alternative for the sponsors due to the threat posed by the debris and sediment.

2.3 No Action Alternative

Under this option, the debris basin is not removed, and the outlet works will remain unchanged. Due to the almost constant use of the damaged auxiliary spillway, the dam is likely to fail at some point during spring runoff or a flood event. For larger storm events, failure is probable. Sediment will continue to accumulate, making the reservoir less effective at removing debris and sediment and reducing the peak flow of flood events. The No Action Alternative is not recommended.

2.4 Evaluation of Action Alternatives

The purpose of a debris basin is to remove the debris and sediment from flood events that can diminish downstream channel and culvert capacity and/or completely block culverts and channels. In addition to removing sediment, Utaba is a retarding dam and has the additional purpose of reducing the volume of flood events by temporarily storing water in the debris basin. The accumulation of sediment has reduced storage capacity. Properly sized channels and culverts can cause flooding from even small flood events if debris and sediment in the flood waters cause blockages and capacity reductions.

Removing the debris basin and restoring the natural channels is an alternative to rehabilitating the dam. The potential for blockages is much greater without a debris basin. Regardless of the downstream flood control facilities, a means to remove debris is critical to maintaining the ability of the flood control facilities to safely convey flood waters. For this reason, the repair or replacement of the debris basin is likely to be a component of the preferred alternative when it is selected.

3.0 Proposed Structural Alternative

Details about the assumptions and calculations for the proposed debris basin are described in the following sections.

3.1 Data and Assumptions

The primary purpose of the dam is to create a reservoir that will remove debris and sediment from flood waters and temporarily store water to reduce flooding during storm events.

3.1.1 Hazard Classification

The existing Utaba Retarding Dam and debris basin has been classified by NRCS as a significant hazard dam. However, current studies and simulations indicate that Utaba should be considered a high-hazard dam because of the influx of people downstream since it was constructed. Utah Dam Safety identifies Utaba as a high hazard dam. Although the dam has been identified as having a high potential for failure, that is not the reason it has been classified as a high hazard dam. The high hazard classification is a result of its proximity to residential areas like Liberty and Eden and the high potential for significant damage to downstream areas and possible loss of life if the dam failed.

3.2 Design Criteria

Two standards identify the design criteria for the dam. The first is the Utah Dam Safety Standards for the Design, Construction, and Abandonment of Dams Utah Code R655-11. The second is NRCS Technical Release (TR) 210-60 Earth Dams and Reservoirs.

3.2.1 Embankment Design

The purpose of the dam is for flood control. Both the Utah Dam Safety standards and TR 210-60 have different standards for flood control and storage dams. If a dam is designed strictly as a flood control structure, it is assumed that water will be detained in the structure for only a short period of time, which would not allow the embankment or foundation to become saturated. Meetings were held with NRCS and Utah Dam Safety to determine whether the dam should be evaluated as a flood control dam or water storage dam. It was determined that the dam should be evaluated as a flood control dam. This decision assumes that the improvements will allow impoundment of water to occur only during high spring runoff and flood events. Short-term (1-2 weeks or as long as a potential fire is active) water impoundment is also possible in the event of wildfires and the need to use the reservoir as a source of water for firefighting.

Field studies and geotechnical design were conducted by Gerhart Cole Geotechnical Engineers. Field studies included test hole drilling and sampling, seismic refraction surveys, and field permeability testing. Laboratory testing was performed on the samples collected from the drill holes and test pits as well as surface samples. Geologic data was collected during a file search and field reconnaissance. The collected data was used to prepare a preliminary dam design. Three reports were generated as part of the geotechnical design. The reports are the:

- Site Specific Seismic Study Technical Memorandum. This report determined the seismic criteria for the design calculations. The seismic criteria were determined following an unpublished guidance document provided by NRCS.
- Geologic and Geotechnical Data Technical Memorandum. This report summarizes all the data collected during the field work and laboratory analysis.
- Geotechnical Design Technical Memorandum. This report utilizes the data gathered in the previous reports to prepare a rehabilitation design for the dam.

All three reports can be found in Appendix E of the Plan-EA. These reports will be referred to collectively as the Geotechnical Design Report. The results of the analysis and design are briefly summarized in the below sections. The layout of the dam and associated structures can be seen in Figure 1. A section of the dam can be seen in Figure 2. The embankment crest profile is shown in Figure 3.

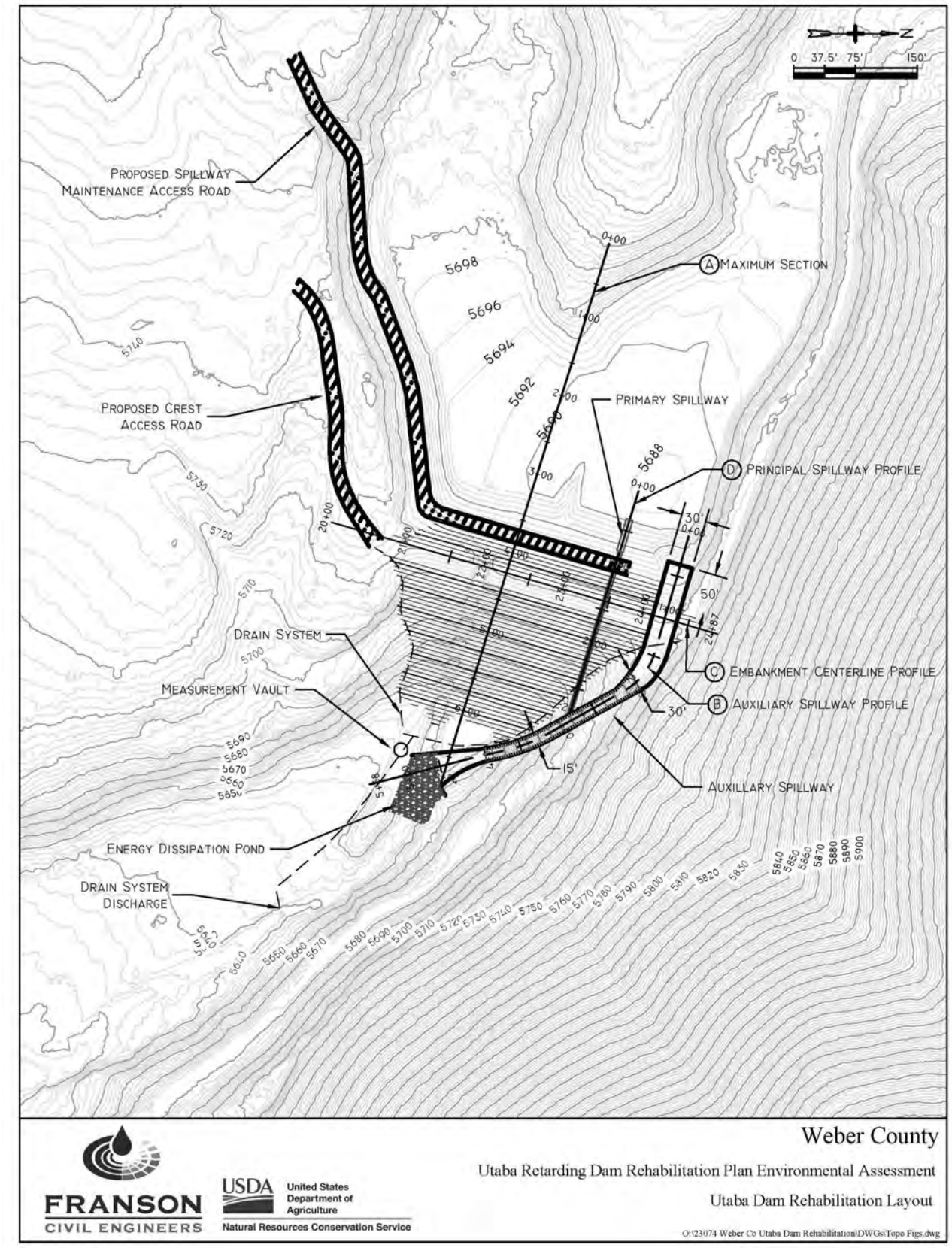

Figure 1: Proposed Embankment and Spillways

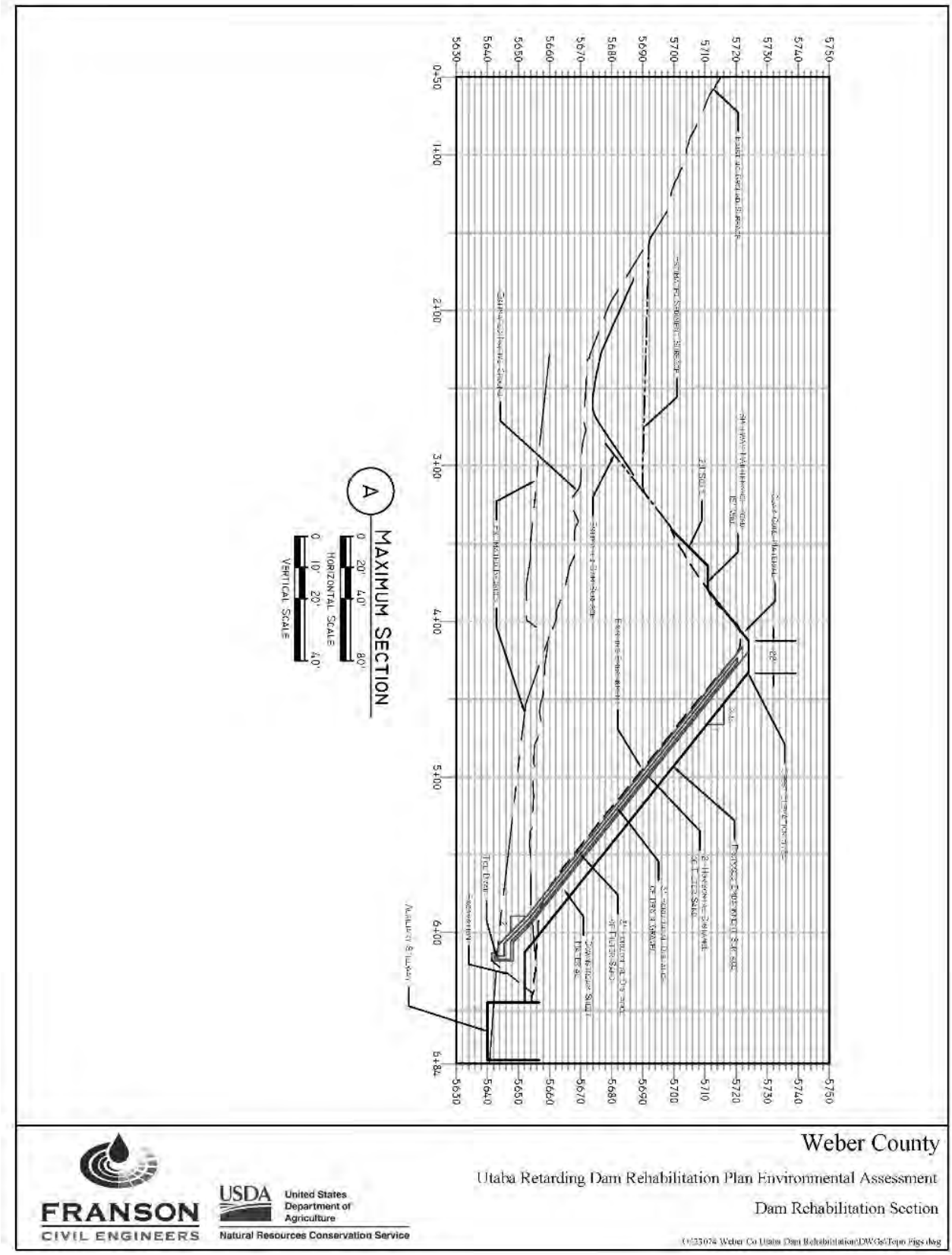

Figure 2: Proposed Debris Basin Embankment Section

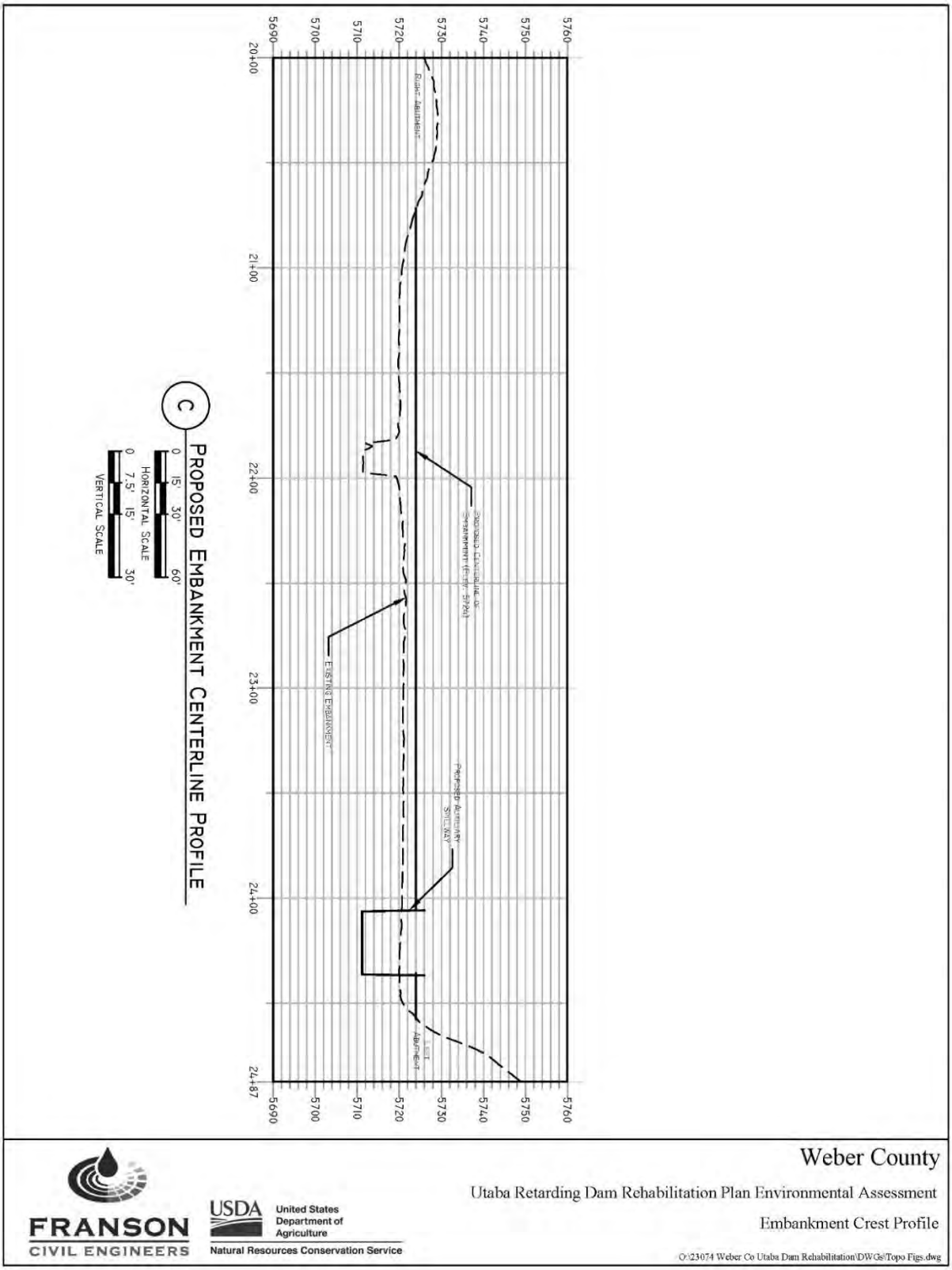

Figure 3: Embankment Crest Profile

Seismic and Geological Analysis

The Geotechnical Design Report includes a detailed discussion of the seismic and geologic site conditions for the project area in general and the dam site. Numerous active faults are identified, but none of them are within 900 feet to the site. However, this does not prevent large faults in the region from causing a seismic event. The Site Specific Seismic Study Technical Memorandum concludes with the identification of the seismic design criteria used for the design efforts.

The site lays in a valley filled with Holocene and Pleistocene sediment associated with stream and lacustrine deposits. The valley fills and deposits to the west side of the canyon are associated with and consist of Holocene-aged unconsolidated stream and fan deposits composed primarily of gravel, sand, and silt. These include both terrace deposits as well as recent channel deposits.

Pleistocene-aged deposits associated with Late Prehistoric High Lake Bonneville lacustrine deposits are present to the east and south of the dam. These five lacustrine deposits are composed of unconsolidated gravel, sand, and silt. Pleistocene glacial moraine deposits are north, west, and south of the site and primarily consist of unsorted gravel, sand, and silt, along with cobbles and boulders. The project area is generally located on late Holocene alluvial deposits.

Crest Width

The Utaba dam embankment crest does not meet current standards. The embankment is 71 feet tall, 369 feet long, and 14 feet wide at the crest. The State of Utah requires a minimum embankment crest of the height of the embankment divided by five plus five feet. Written mathematically, that is height / 5 + 5ft. With a height of 71 feet, the minimum embankment crest of the embankment must be at least 19.2 feet. However, the NRCS requires a minimum embankment crest width of the height of the embankment plus 35 feet divided by 5 or (height + 35ft) / 5. The NRCS minimum embankment crest is 21.2 feet. The more conservative standard dictates what is required; thus, the minimum crest width is 21.2 feet. The minimum crest width for the preliminary design has been identified as 22 feet.

Slope Stability

NRCS and Utah Dam Safety require that all embankment slopes be analyzed for stability. The more conservative factors for the two standards are referenced. Factors of slope safety that require analysis and its associated minimum factor of safety are: long-term full impoundment (1.5), construction no impoundment (1.3), rapid drawdown (1.2), and pseudo-static seismic stability (1.0). The calculated factors of safety for the various stability conditions of the rehabilitated dam can be seen in Table 1.

Table 1: Calculated Factors of Safety

Analysis Scenario	Long Term Full Impoundment	Construction No Impoundment	Rapid Drawdown	Pseudo-Static Seismic	
				MCE/MDE	OBE
Downstream Slope	1.65	1.4	NA	1.63	1.84
Upstream Slope	2.14	1.83	1.31	1.24	1.43

Analysis Scenario	Long Term Full Impoundment	Construction No Impoundment	Rapid Drawdown	Pseudo-Static Seismic	
				MCE/MDE	OBE
Minimum Allowable Factor of Safety	1.5	1.3	1.2	1.0	1.0

External Erosion Control

The NRCS requires that embankment surfaces be protected from erosion, while Utah Dam Safety would require only the downstream side to be protected from erosion. In compliance with NRCS, Utaba will have native vegetation on upstream and downstream slopes. Grass vegetation has been successful at providing erosion protection for the existing embankment. For this reason, it is proposed that the same erosion protection be used for the rehabilitated embankment. This vegetation will include local, visually appealing grasses. No shrubs, trees, or other woody species will be allowed on the dam. Removal of woody vegetation is included in the O&M costs shown in Table 11 below in the Vegetation Control line items.

Internal Erosion Control and Drainage

The Geotechnical Design Report describes the materials available for construction and their properties. An analysis is also made of the compatibility of the various zone materials. The various zones of the existing dam were found to be generated from the same source (North Fork Park). The source material was processed to produce the required characteristics. For example, the core material was generated by removing coarse material from the soil. It was determined that, because the materials used to build the existing dam came from the same source, the various zone materials are compatible. The potential for core materials to migrate into the downstream shell materials is low. The core materials were also tested and found to be non-dispersive, further decreasing the potential for internal erosion.

A two-stage filter blanket and chimney drain are part of the design. The two-stage filter blanket drain will protect the foundation materials from internal erosion. The two-stage filter chimney drain will protect the core from internal erosion in the unlikely event that there is internal erosion. The sand filter material is anticipated to be ASTM C-33 concrete sand. The drain gravel is anticipated to be ASTM C-33 No. 8 stone.

3.2.2 Hydrologic Analysis

The full hydrologic analysis for the project can be found in TM003. The Inflow Design Flood (IDF) was determined to be the 6-hour PMP at 9,736 cfs. In the terminology identified in Utah Code R655-11-4, this flood is the Spillway Evaluation Flood (SEF) rather than the Probable Maximum Flood (PMF), which has a slightly lower peak flow than the SEF. The SEF is the flood event the dam and spillways will be designed to pass. NRCS standards refer to a Probable Maximum Precipitation (PMP) event. The SEF matches or exceeds the PMP.

Incremental Damage Assessment

According to Utah Dam Safety, an IDF less than the SEF may be accepted if the results of an Incremental Damage Assessment show that failure of the dam would cause insignificant incremental damage to property and no additional threat to human life. Although there is potential that an Incremental Damage Assessment would show that the failure of the dam would cause insignificant incremental damage to the property and no additional threat to human life, a decision was made to not perform this assessment at this time and design the dam to pass the full Inflow Design Flood.

3.2.3 Freeboard

There are principal and auxiliary spillways associated with this debris basin to meet the dam safety standards. The principal spillway will have a guard gate that can be closed to provide some control during spring runoff and smaller flood events. The guard gate will also allow water to be impounded in the reservoir if a water source is needed to fight wildfire.

There are freeboard requirements for both the principal spillway and the auxiliary spillways. The more conservative NRCS standard requires the principal spillway to have sufficient freeboard to pass the 100-year, 10-day event without activating the auxiliary spillway. The proposed crest elevation for the principal spillway is 5690.0 feet, 13.41 feet below the existing principal spillway elevation of 5,703.41 feet. The crest elevation of the auxiliary is 5,711.2 feet, the same elevation as the current auxiliary spillway. There are 21.2 feet of freeboard between the principal spillway crest and the auxiliary spillway crest. The proposed crest elevation of the rehabilitated dam is 5724.0. This provides 10.8 feet of available freeboard between the auxiliary spillway crest and the crest of the dam. Utah Dam Safety and NRCS standards require sufficient freeboard above the principal spillway to route the IDF/PMF without overtopping the dam. Utah Dam Safety standards also require sufficient freeboard to control wave action from a fetch controlled 50 mile per hour wind while routing the 100-year, 24-hour precipitation event or a fetch controlled 100 mile per hour wind, whichever is more conservative.

Flood Routing

When routing the 100-year, 10-day flood event with a peak flow of 359 cfs through the debris basin and dam, the maximum water level is 5,711 feet, leaving 0.2 feet between the crest elevation of the auxiliary spillway and the maximum water level. There are 13 feet of freeboard between the water level and the crest of the dam. The configuration of the principal spillway is discussed below.

When routing the IDF/PMF with a peak flow of 9,735 cfs through the debris basin, the maximum water level is 5,723.9 feet, leaving 0.1 feet of freeboard. Table 2 shows a summary of the maximum water levels for each flood event. Table 3 shows a summary of the discharge from the Principal/Pipe Spillway as well as the Auxiliary Spillway with the water level at 1-foot increments.

Table 2: Maximum Water Level

	Elevation (feet)	Freeboard (feet)
Dam Crest	5724.0	n/a
IDF/PMF	5723.9	0.1
100-year 10-day flood	5711.0	13
Auxiliary Spillway	5711.2	n/a

	Elevation (feet)	Freeboard (feet)
Max Emergency Storage For Wildfires	5705.0	19

Table 3: Spillway Discharge Table

	Elevation (feet)	Total Discharge (cfs)	Principal Spillway/ Pipe Discharge (cfs)	Principal Spillway/Pipe Controlling Structure	Auxiliary Spillway Discharge (cfs)	Auxiliary Spillway Controlling Structure
Principal Spillway	5690	0	0	n/a	0	n/a
	5691	10	10	30-inch Orifice	0	n/a
	5692	21	21	30-inch Orifice	0	n/a
	5693	32	32	30-inch Orifice	0	n/a
	5694	40	40	30-inch Orifice	0	n/a
	5695	47	47	30-inch Orifice	0	n/a
	5696	52	52	30-inch Orifice	0	n/a
	5697	58	58	30-inch Orifice	0	n/a
	5698	62	62	30-inch Orifice	0	n/a
	5699	67	67	30-inch Orifice	0	n/a
First Chamber Wall	5700	71	71	30-inch Orifice	0	n/a
	5701	107	107	36-inch Orifice	0	n/a
	5702	112	112	36-inch Orifice	0	n/a
	5703	117	117	36-inch Orifice	0	n/a
	5704	122	122	36-inch Orifice	0	n/a
Second Chamber Wall	5705	127	127	36-inch Orifice	0	n/a
	5706	304	304	60” Conduit	0	n/a
	5707	315	315	60” Conduit	0	n/a
	5708	326	326	60’ Conduit	0	n/a
	5709	337	337	60” Conduit	0	n/a
	5710	347	347	60” Conduit	0	n/a
Auxiliary Spillway Notch Invert (5711.2)	5711	357	357	60’ Conduit	0	n/a
	5712	385	366	60’ Conduit	19	Notch
	5713	440	375	60’ Conduit	65	Notch

	Elevation (feet)	Total Discharge (cfs)	Principal Spillway/ Pipe Discharge (cfs)	Principal Spillway/Pipe Controlling Structure	Auxiliary Spillway Discharge (cfs)	Auxiliary Spillway Controlling Structure
	5714	510	384	60’ Conduit	126	Notch
	5715	593	393	60’ Conduit	200	Notch
	5716	686	402	60’ Conduit	283	Notch
Auxiliary Spillway Weir Crest (5717.2)	5717	787	411	60’ Conduit	376	Notch
	5718	1192	419	60’ Conduit	773	Notch + Auxiliary Weir
	5719	2030	427	60’ Conduit	1603	Notch + Auxiliary Weir
	5720	3147	435	60’ Conduit	2713	Notch + Auxiliary Weir
	5721	4506	442	60’ Conduit	4063	Notch + Auxiliary Weir
	5722	6087	450	60’ Conduit	5636	Notch + Auxiliary Weir
	5723	7880	458	60’ Conduit	7421	Notch + Auxiliary Weir
Dam Crest	5724	9878	466	60’ Conduit	9412	Notch + Auxiliary Weir

Wave Action

Wave height and impact on the dam must be calculated to determine the minimum required freeboard. Several methods have been developed to estimate wave height. We have chosen to use the USDA NRCS method defined in “A Guide for Design and Layout of Vegetated Wave Protection for Earthen Embankments and Shorelines, Technical Release 56.” The calculations are shown in the reference materials section at the end of the document.

According to Utah Admin. Code R655-11-4B-Freeboard Requirements (R655-11-4B), all high and moderate hazard dams must have a normal freeboard above the crest of the principal spillway capable of 1) routing the IDF, 2) containing the maximum wave action generated from an overland wind velocity of 100 mph, 3) containing the combined 100-year, 24-hour precipitation event and 50-mph wind event, and 4) the normal freeboard will be no less than three feet.

The maximum water elevation in the debris basin while routing the IDF/PMF was discussed above. The required freeboard to route the IDF/PMF is 12.7 feet.

The fetch (maximum length wind can act upon the water perpendicular to the dam) and wind velocity will determine the size of waves that could potentially impact the dam. The wave height and slope of the dam determine the height at which the waves run up the face of the dam. The maximum fetch was measured as the longest length perpendicular to the crest and is equal to 800 feet. A wind velocity over land of 100 mph has been used to follow R655-11-4B freeboard requirements. A wind ratio of 1.03 was determined as a function of the effective fetch and then used to calculate an overwater wind velocity equal to 103 mph. The maximum significant wave height of 3.15 feet has been calculated as a function of the effective fetch and overwater wind velocity. Using a wind velocity of 50 mph, the maximum significant wave height is 1.58 feet.

The upper limit of wave impact is defined as the sum of the run-up and set-up caused by the highest wave. The wave run-up has been calculated from the significant wave height, two constants, the embankment slope, and the deep-water wavelength. The wave set-up has been calculated from a relationship between the effective fetch, the significant wave height and the average water depth along the fetch line. This calculation resulted in a 3.15-foot wave run-up, a 0.04-foot wave set-up, and an upper limit of the wave impact of 3.19 feet above the still water elevation for the 100-mph wind event. For the 50-mph wind event, the wave run-up is 1.58 feet and the wave setup is 0.01 feet for an upper limit of wave impact of 1.59 feet.

The principal spillway has a crest elevation of 5,699.8 feet. When not routing a flood event, the water level in the debris basin is determined by the crest elevation of the principal spillway gate—5,690 feet. Since the standard dictates a freeboard while routing the 100-year, 24-hour flood event in addition to the freeboard at the crest of the principal spillway to contain the maximum wave action, the appropriate crest elevation for evaluating the freeboard needed to contain the maximum wave action is 5,699.8 feet. During a 100-mph wind event, the maximum wave action would result in an increase of 3.19 feet or a water elevation of 5,714.15 feet. This is well below the dam crest elevation of 5,724 feet.

The third freeboard criterion from R655-11-4B assumes a 50-mph wind event while routing the 100-year, 24-hour flood event through the debris basin. The maximum water elevation in the debris basin while routing the 100-year, 24-hour flood event is 5,711 feet. During the 50-mph wind event, the maximum wave action would result in an increase of 1.59 feet or a water elevation of 5,712.58 feet. This is below the dam crest elevation of 5,724 feet.

3.2.4 Spillways

The new dam and debris basin was designed to pass the Spillway Evaluation Flood (SEF) without overtopping the dam embankment. The debris basin also has the purpose of removing debris and sediment that could block downstream culverts. The principal and auxiliary spillways were designed to:

- Prevent long-term detention of water, i.e. the reservoir will automatically drain when the inflow into the reservoir drops below the discharge capacity of the principal spillway.
- Utilize the storage capacity in the reservoir to reduce the peak flow from storm events.
- Allow temporary detention of an approximately 15-foot-deep pond of water that helicopters can dip water from when fighting wildfires.
- Pass the IDF/PMF without overtopping the dam.

- Prevent beavers from blocking the principal spillway and causing permanent detention of water.
- Allow easy maintenance of the principal spillway.
- Allow inspection of the principal spillway conduit.
- Move the chute of the auxiliary spillway off the embankment.
- Capture debris in flood water that could block downstream culverts and bridges.
- Capture coarse sediment (cobbles, gravel, and coarse sand) that could plug downstream culverts.
- Allow finer-grained sediment to remain entrained in flood water to reduce the rate of sediment accumulation in the reservoir.

Both Utah Dam Safety and NRCS standards differentiate between a principal spillway and an auxiliary spillway. Utah Dam Safety Standards do not specify a flood event that the principal spillway must pass other than to indicate it must have the capacity to drain the full reservoir in less than 30 days. NRCS design standards indicate the principal spillway for a high hazard dam must be able to pass the 100-year, 10-day precipitation event without utilizing the auxiliary spillway. In this case, the flow that must be passed is 359 cfs. The combination of the spillways must safely pass the IDF/PMF flood event without overtopping the dam. Below is a discussion of each of the spillways.

Principal Spillway

The principal spillway allows the debris basin to fully drain. Since there is not a storage right associated with this reservoir, the principal spillway allows a constant release of water and prevents the reservoir from filling other than during high flow and flood events.

The proposed principal spillway has been designed to release water in stages to maximize the use of the reservoir's storage capacity to reduce the peak flow from flood events. The configuration of the principal spillway can be seen in Figure 4. The first stage of the principal spillway is an eight-foot-wide channel with an invert at an elevation of 5690 feet. This first stage channel has a 10-foot wall with a 30-inch opening. The 30-inch opening is uncontrolled and can pass the base flow of the creeks without causing any detention of water in the reservoir (30 cfs). If inflows exceed the capacity of the 30-inch opening, the water level will rise until it spills over the 10-foot wall into the next stage/chamber. The second stage is a 15-foot wall in the same 8-foot-wide channel and invert elevation. The 15-foot wall has a 36-inch opening with a hydraulically operated guard gate that is typically open. If the inflow exceeds the capacity of the 36-inch opening, the water will rise until it spills over the 15-foot wall into the third stage/chamber. The hydraulic gate can be closed to provide some control during spring runoff or smaller flood events. The gate can also be closed to create a pool for fighting wildfires. The third stage contains an uncontrolled 60-inch opening and conduit to convey the water through the dam embankment to the auxiliary spillway channel on the downstream side of the dam. The 8-foot channel that includes all three stages is covered by a trash rack. The trash rack can pass the SEF even if 94% of the opening has been blocked by debris. During periods of base flow, the hydraulic gate can be closed to allow the principal spillway conduit to be inspected.

It is anticipated that the 60-inch conduit will be a steel pipe encased in concrete to allow better compaction around the principal spillway conduit. Anti-seepage collars on the conduit will not be used. The principal spillway conduit will be about 240 feet long and will tie into the auxiliary spillway chute at an approximate elevation of 5683 feet. The configuration of the principal spillway can be seen in Figure 4.

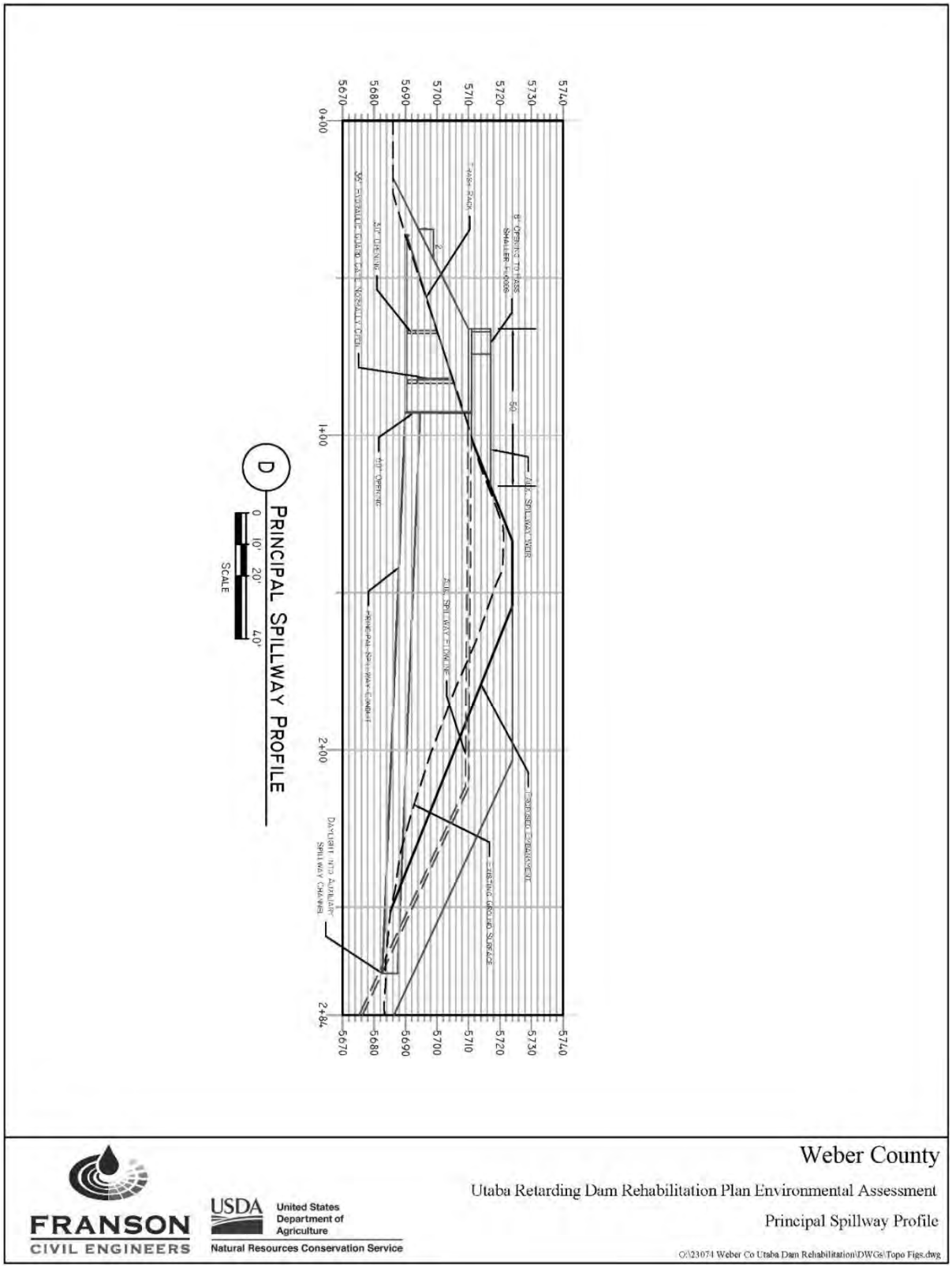

Figure 4: Principal Spillway Configuration

During the evaluation of the ability of the spillways to pass various storm events and for modeling, the guard gate to the principal spillway was assumed to be closed as required by the design standards. The purpose of this was to demonstrate the principal spillway could pass the SEF even if the guard gate was closed for some reason. During the design of the principal spillway, the guard gate was also assumed to be wide open to evaluate the performance of the spillway during normal operating conditions. The primary criteria when designing the principal spillway/low-level outlet is the following NRCS standard: "The principal spillway capacity should empty at least 85 percent of the principal spillway hydrograph (PSH) routed through the retarding pool in 10 days or less. The 10-day drawdown begins when attaining the maximum water surface elevation during the passage of the PSH."

For this situation, our interpretation of this standard is that the principal spillway must be able to drain 85% of the volume in the debris basin through the principal spillway between the elevation of the auxiliary spillway and the principal spillway/pipe outlet. In addition to draining the water resulting from the storm event, the principal spillway must also be able to continue passing a base flow.

The base flow was shown to be 14.4 cfs as can be seen in Technical Memorandum 003: Utaba Dam Hydrology. The storage in the debris basin when the water elevation is at 5711 feet is 71 acre-feet. It was assumed that if the storage dropped to 15% of this storage amount (11 acre-feet) in under 10 days, the NRCS standard referenced above was satisfied.

The 100-year, 10-day storm event was analyzed to verify compliance with this standard. The peak storage (approximately 40.5 acre-feet) occurred from day five to day 10 after the storm started. The debris basin drained to 11 acre-feet approximately 11 days after the storm started or six days after the storage peaked. This is below the 10-day threshold for the NRCS standard. Table 5 shows the area, storage, and outlet capacity from the elevation of the principal spillway/pipe outlet up to the crest of the dam embankment.

Auxiliary Spillway

The purpose of the auxiliary spillway is to prevent the overtopping of the dam embankment during the IDF/PMF event. The auxiliary spillway will be located on the north (left) abutment of the dam embankment, and water will be routed into the existing channel on the downstream side of the embankment. The layout of the auxiliary spillway can be seen on the plan view in Figure 5.

The proposed auxiliary spillway will be constructed of concrete. The entrance to the auxiliary spillway will be a six-foot-tall concrete weir wall with a weir crest elevation of 5,717.2 feet. The 30-foot-wide channel behind the weir wall has a flowline elevation of 5711.2 (approximately the same elevation as the existing auxiliary spillway crest) and a channel width of 30 feet. The horizontal weir wall length is 130 feet long with an eight-foot-wide notch on one side of the weir wall, which allows water to start flowing into the auxiliary spillway at elevation 5711.2. The purpose of the notch is to allow the discharge rate to increase more slowly by more effectively utilizing the reservoir capacity to reduce the peak discharge from a flood event. Without the notch, the reservoir would fill more quickly, and the peak discharge rate would be higher. The concrete walls creating the auxiliary spillway entrance extend up the slope of the dam to the crest to allow additional water to enter the auxiliary spillway as the water rises to the dam crest. All surfaces of the auxiliary spillway will be concrete.

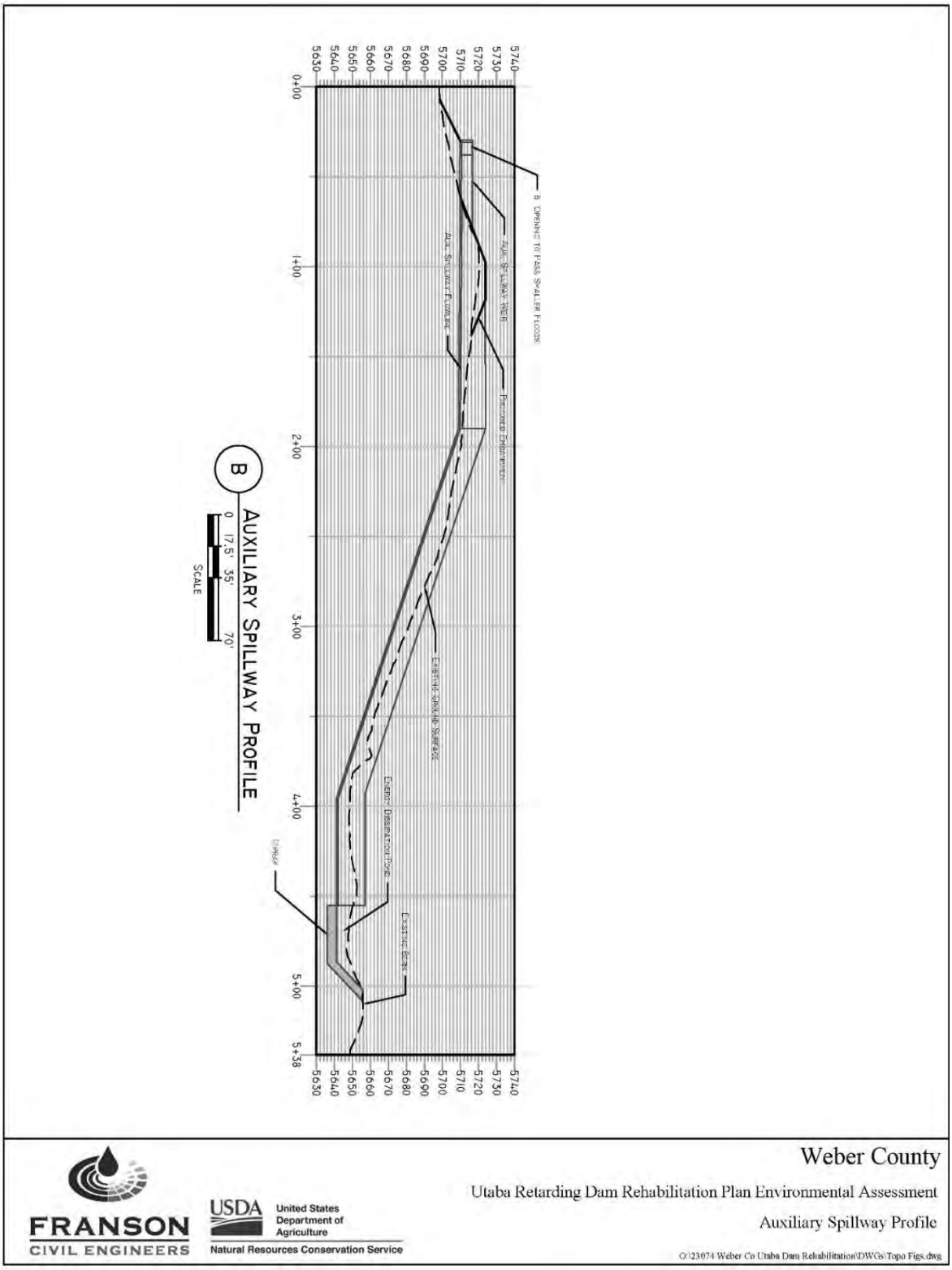

Figure 5: Auxiliary Spillway Profile

The channel behind the weir walls slopes downstream at 1% until it reaches the chute that drops the water beyond the toe of the dam. The chute starts with a width of 30 feet and narrows to 15 feet as the slope increases to approximately 34%. At the toe of the dam, the concrete channel flattens and gets wider to dissipate the energy. The flat, concrete portion of the auxiliary spillway extends 60 feet with 15-foot-tall walls to contain the hydraulic jump associated with the energy dissipation. A permanent five-foot-deep pool of water will be at the end of the auxiliary spillway. The water depth in the pool will be greater during spring runoff and flood events to further dissipate the energy. The pool at the end of the concrete channel will be lined with riprap to control erosion by wave action. The flow velocity will be dropped to at least the velocity in the downstream channel before water is discharged to the natural channel.

The auxiliary spillway has been designed to safely convey the IDF/PMF flow of 9,735 cfs without overtopping the dam or the concrete channel portion of the auxiliary spillway.

Summary of Spillways

The 100-year, 10-day storm event peaks at a flow rate of 359 cfs, and the water elevation in the debris basin rises to just over 5,710 feet. The IDF/PMF flood event peaks at a flow of 9,735 cfs. At this flow rate, all spillways are fully engaged and the water elevation in the debris basin rises to 5,723.9 feet assuming the guard gate to the primary spillway is closed. During the peak flow of the IDF/PMF event, the emergency flood channel will have flow depths that may be above the downstream bank, but the water will be beyond the dam at this point, so the dam is protected. A summary of the spillways can be seen in Table 4.

Table 4: Spillway Design Summary

Spillway	Design	Invert Elevation (ft)	Width (ft)	100-yr, 24-hr Design Flow Rate (cfs)	PMF Design Flow Rate (cfs)
Principal	Conduit	5690.0	60-inch*	359	480
Auxiliary	Armored	5711.2	30	0^	9,255
Total				359	9,735

*This represents the diameter of conduit since width does not apply.

^The 100-yr, 10-day peak flow is fully passed by the principal spillway, so no flow goes over the auxiliary spillway. However, the principal spillway discharges into the chute of the auxiliary spillway so there is flow in the lower portion of the auxiliary spillway.

The storage area table shown in Table 5 describes conditions when the principal spillway/low-level outlet is wide open.

Table 5: Storage Area and Outlet Capacity

Elevation (Feet)	Surface Area (Acres)	Capacity (Acre-Feet)	Outlet Capacity (cfs)	Notes
5724	10.17	174.8	9878	Dam Crest
5723	9.85	164.8	7880	-

Elevation (Feet)	Surface Area (Acres)	Capacity (Acre-Feet)	Outlet Capacity (cfs)	Notes
5722	9.5	155.1	6087	-
5721	9.09	145.8	4506	-
5720	8.65	136.9	3147	-
5719	8.28	128.4	2030	-
5718	8	120.3	1192	-
5717	7.72	112.4	787	Auxiliary Spillway Weir Crest (5717.2)
5716	7.47	104.8	686	-
5715	7.16	97.5	593	-
5714	6.85	90.5	510	-
5713	6.57	83.8	440	-
5712	6.27	77.4	385	-
5711	5.97	71.3	357	Auxiliary Spillway Notch Invert (5711.2)
5710	5.72	65.5	347	-
5709	5.46	59.9	337	-
5708	5.22	54.6	326	-
5707	4.99	49.5	315	-
5706	4.78	44.6	304	-
5705	4.54	39.9	127	Second Principal Chamber Wall
5704	4.29	35.5	122	-
5703	4.08	31.3	117	-
5702	3.86	27.3	112	-
5701	3.6	23.6	107	-
5700	3.27	20.2	71	First Principal Chamber Wall
5699	2.92	17.1	67	-
5698	2.75	14.3	62	-
5697	2.5	11.7	58	-
5696	2.25	9.3	52	-
5695	2.03	7.2	47	-
5694	1.81	5.3	40	-

Elevation (Feet)	Surface Area (Acres)	Capacity (Acre-Feet)	Outlet Capacity (cfs)	Notes
5693	1.55	3.6	32	-
5692	1.29	2.2	21	-
5691	1.06	1	10	-
5690	0.84	0	0	Principal Spillway Intake Structure Invert

4.0 Non-Structural (Decommissioning) Alternative

The non-structural (decommissioning) alternative includes the removal of Utaba Dam and its facilities, removing nearly all accumulated sediment, stream restoration of Cutler Creek and North Fork Ogden River, and wetlands restoration. This section includes methods, standards, and details for each item. The final configuration of the non-structural alternative can be seen in Figure 6.

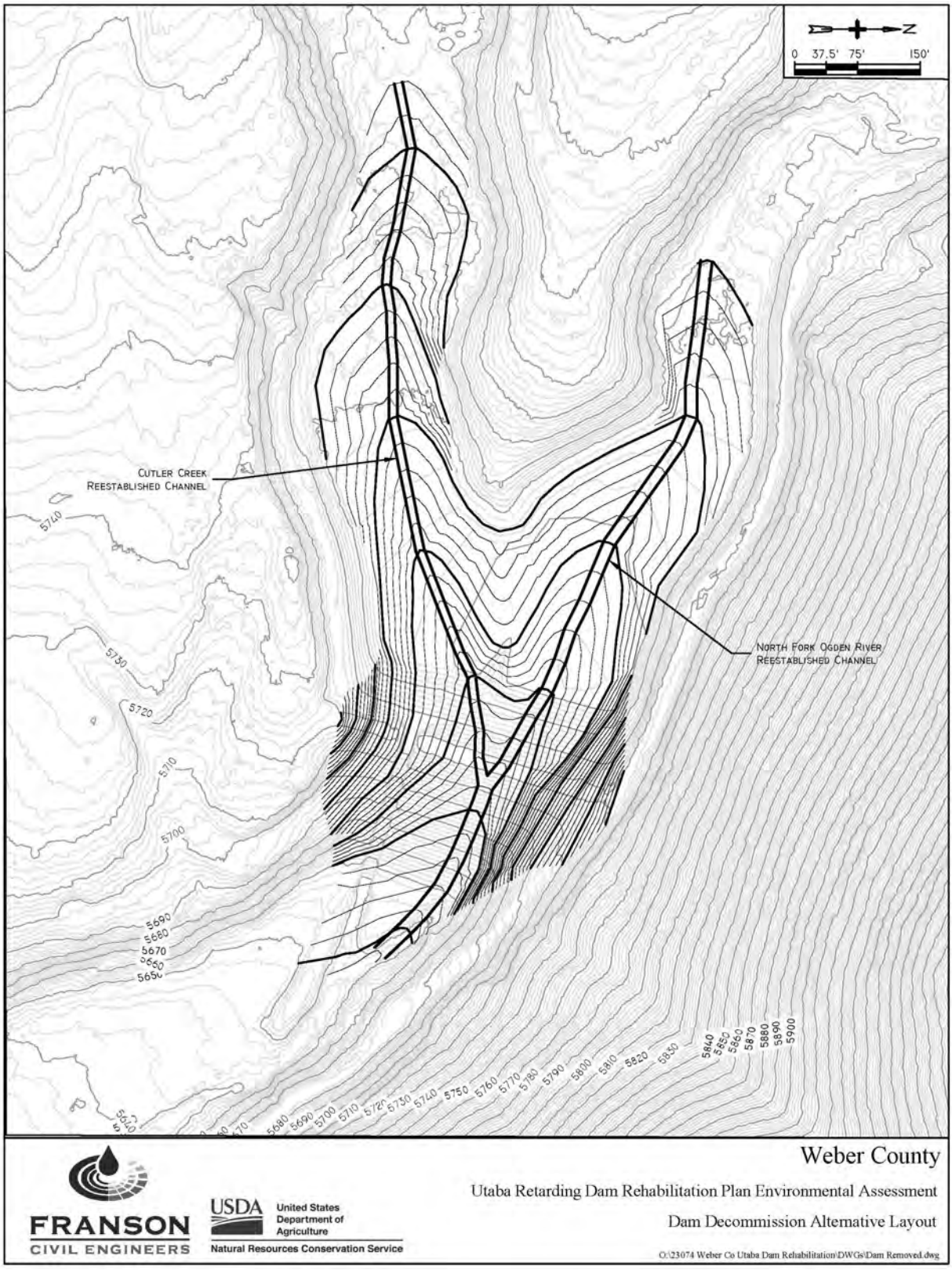

Figure 6: Decommissioning Alternative Layout

4.1 Dam Removal

Utaba Retarding Dam consists of an earth embankment, an auxiliary spillway, and a principal spillway. The embankment consists of approximately 65,055 cubic yards of earth fill. Removing the embankment would require the construction of a temporary access road so construction vehicles can haul the earth off-site. The North Fork Park area was used as the borrow source for building the dam originally, and it is assumed that the material that will be removed will be disposed of in this area.

The principal spillway consists of the intake tower, the spillway conduit, and the outlet. Removal of the Intake tower would occur after the accumulated sediment is removed. The tower would be removed to at least five feet below the finished grade. The concrete of the tower would be hauled to a permitted landfill. The principal spillway conduit will be abandoned in place rather than removed because it is located well below the pre-dam ground level where it will not impact the channel restoration. Abandoning the principal spillway conduit would involve filing the conduit with 35 cubic yards of grout to fill and seal the conduit and any remaining portions of the tower. The concrete of the final 20 feet of the conduit and outlet will need to be removed to restore the channel. The removed concrete will be disposed of in a permitted offsite landfill

The auxiliary spillway consists of a concrete channel on the face of the embankment that discharges into energy dissipating riprap. A temporary access road would be constructed to provide access for the removal of the dam and auxiliary spillway. The concrete from the auxiliary spillway would be disposed of in a permitted offsite landfill. The riprap will be used to reestablish the channels.

4.2 Sediment Removal

There are approximately 39,432 cubic yards of sediment that have accumulated in the reservoir basin that will need to be removed to re-establish the creeks through this area. Methods to remove sediment vary depending on the type of sediment. Considering the sediment in Utaba also varies, more than one method for removing sediment will be used. Inflow from Cutler Creek typically consists of cobbles, gravel, and sand with some fines. These sediments may be removed by mechanical means such as an excavator. Much finer sediment comes from the North Fork Ogden River. This sediment is very soft and cannot support standard excavation equipment. The soft sediment in the reservoir may be suction dredged, but this method poses other challenges. Most suction dredges are mounted on boats, but Utaba's low and uncontrolled water level would make navigating a boat difficult. The high amount of woody debris in the sediment also makes using a dredge difficult. It is likely that some form of mechanical excavation will be used, but extensive stabilization of the sediment will be needed to facilitate mechanical excavation and removal. The cost of removing the finer-grained sediment will be significantly more expensive than standard excavation.

Sediment must also be dewatered before it is hauled offsite. Common dewatering methods that are applicable to the project include the use of geotextile bags, mechanical filter press, vacuum filtration, or creating a basin where the sediment can be spread out over a large area to naturally dewater. Geotextile bags are typically low-cost and easy to implement but are slow and require a large space to implement. It is assumed that the removed sediment can be disposed of in North Fork Park with the material from the dam removal. The drier material from the dam could be mixed with the sediment to make it more manageable. The use of geotextile bags or spreading the soil over a large area are the more likely methods for dewatering.

4.3 Channel Restoration

Once the sediment, the embankment, and the facilities are removed, the remaining project area will be regraded to approximate preexisting conditions. New channels will be created with capacity to pass the 100-year, 24-hour storm event. The 100-year, 24-hour storm event has a peak flow of 1019 cfs. The peak flow for The North Fork Ogden River is 694 cfs and the peak flow of Cutler Creek is 325 cfs. Cutler Creek will converge with the North Fork Ogden River and will continue southeast in the existing channel. Channels were designed using the Mannings equation, the USACE Steep Slope method, and the USBR Stilling Basin method for riprap sizing. More details on the stream flows can be found below in Table 6.

Table 6: Stream Flows

Stream	Base Flow (cfs)	2-yr, 24-hr Peak Flow (cfs)	100-yr, 24-hr Peak Flow (cfs)
Cutler Creek	15	31	325
North Fork Ogden River	15	66	694
Convergence	30	97	1019

These methods provide accurate designs for the size, shape, and required riprap sizes for the restored channel. The channel designs for Cutler Creek, the North Fork Ogden River, and the river after they converge are configured in a three-tiered design. The bottom tier is designed for the base flow, the second tier is designed for the 2-year, 24-hour flow, and the third tier is designed for the 100-year, 24-hour flood. All channel side slopes are 2:1. More details on the stream sizing can be found below in Table 7.

Table 7: Reestablished Channel Sizing

Stream	First Tier Bottom Width (ft)	First Tier Depth (ft)	Second Tier Bottom Width (ft)	Second Tier Depth (ft)	Third Tier Bottom Width (ft)	Third Tier Depth (ft)
Cutler Creek	3	1	10	1	25	1.75
North Fork Ogden River	3	1	14	1	30	2.5
Convergence	3	1	18	1	45	2.4

Since the natural channel in the reservoir basin was likely disturbed during the construction of the dam, a riprap channel will be used to reestablish the Cutler Creek and North Fork Ogden River channels through the reservoir basin. Because the gradation of the remaining soils is not known, it is assumed that a filter layer (sandy/gravelly material) will be needed below the riprap to prevent

erosion. Riprap and filter material will be the same for Cutler Creek and the North Fork Ogden River. Additional riprap and filter material are required after the streams converge. For each stream, the riprap and filter material will be used to create the first and second tiers. The third tier will be vegetated with riparian vegetation similar to the floodplain areas in natural channels. The riprap in the first two tiers has been designed to resist the velocities generated during the 100-year, 24-hour flood. The riparian vegetation in the third tier will slow the flow velocity in the floodplain and provide sufficient erosion protection. Riprap and filter material sizing can be found below in Table 8.

Table 8: Riprap and Filter Sizing

Stream	Riprap Median Size (in)	Riparap Layer Thickness (in)	Filter Median Size (in)	Filter Layer Thickness (in)
Cutler Creek	12	24	1	12
North Fork Ogden River	12	24	1	12
Convergence	15	30	2	12

4.4 Wetland Restoration

Wetlands that are disturbed during the embankment and sediment removal process will need to be reestablished at approximately a 2:1 ratio. The US Army Corps of Engineers (USACE) has regulatory authority over certain wetlands, specifically those considered Waters of the United Stated under Section 404 of the Clean Water Act, commonly called jurisdictional wetlands. When jurisdictional wetlands are disturbed, USACE mandates replacement of the wetlands. Since recreated wetlands are not generally as productive as natural wetlands, USACE mandates a mitigation ratio of 2:1 to 5:1. It is estimated that USACE will mandate a 2:1 replacement ratio for this project. The acreage of wetlands and the replacement ratio will be established during Clean Water Act Section 404 permitting process. The floodplain areas mentioned in the channel restoration section above will be used to reestablish wetlands lost as a result of the decommissioning of the dam. The width of the floodplain area will be widened as needed to provide the required acreage of replacement wetlands. The width of the floodplain in Table 7 is a minimum width based on hydraulic calculations. Wetland mitigation is likely to expand the width of the floodplain. In addition to creating a floodplain, rock structures and channels will be created to distribute water through the wetland reestablishment area to promote the growth of wetland vegetation. Reestablishing the wetlands will be a significant cost for the non-structural alternative.

5.0 Cost Analysis

This chapter includes the assumptions and line items that were used to calculate cost estimates for the proposed debris basin embankment, spillways, and flood routing structures.

5.1 Cost of Structural Alternative

This subsection describes the line items considered to construct the proposed dam. It includes the labor and material that would be necessary to heighten and widen the existing embankment,

demolish the existing principal and auxiliary spillways, add a drainage system, construct a new principal spillway, construct a new auxiliary spillway, and construct an energy dissipating structure. See the Design Criteria section for more design details. Table 9 summarizes all costs associated with installing the Structural Alternative.

Table 9: Structural Alternative Cost Summary

Item	Quantity	Unit	Unit Price	Amount
Construction Surveying and QC	1	LS	$150,000.00	$150,000.00
Water Management	1	LS	$200,000.00	$200,000.00
Clear, Grub, and Strip Work Areas	17.4	AC	$5,000.00	$87,000.00
Sediment Removal (for spillway abandonment and construction)	100	CY	$200.00	$20,000.00
Principal Spillway Tower (approx. top 20 feet) - Reinforced Concrete Demolition and Removal	105	CY	$200.00	$21,000.00
Principal Spillway Tower and Conduit Abandonment Grout Fill	44	CY	$245.00	$11,000.00
Embankment				
Remove Existing Auxiliary Spillway	200	CY	$75.00	$15,000.00
General Fill for Removed Auxiliary Spillway	730	CY	$18.00	$14,000.00
Embankment Excavation	3500	CY	$10.00	$35,000.00
Embankment Clay Core	459.2	CY	$12.00	$6,000.00
Embankment General Fill	10000	CY	$18.00	$180,000.00
Embankment Drain Gravel	2032	CY	$51.70	$106,000.00
Embankment Filter Sand	3388	CY	$68.20	$232,000.00
General Fill maintenance road and aux. spillway weir area	1231	CY	$12.00	$15,000.00
Maintenance Road and Crest - untreated base coarse	860	TON	$30.00	$26,000.00
Toe Drain Pipe				
12" Perforated HDPE Pipe	647	LF	$77.00	$50,000.00
12" Solid Wall HDPE Pipe	275	LF	$77.00	$22,000.00
48" x 8' Manhole	1	EA	$10,000.00	$10,000.00
Principal Spillway/Pipe				
Principal Spillway/Pipe Excavation	8300	CY	$10.00	$83,000.00
Replacement of Clay Core	1160	CY	$12.00	$14,000.00

Replacement of General Fill	7140	CY	$12.00	$86,000.00
Principal Spillway/Pipe Subgrade	60	CY	$12.00	$1,000.00
Furnish and install 60" C200 Plain Steel Pipe with typical welded joints	200	LF	$700.00	$140,000.00
Furnish and install concrete casing for 60" pipe	180	CY	$500.00	$90,000.00
Furnish and install 36" Guard Gate	1	EA	$75,000.00	$75,000.00
Furnish and Install Reinforced Concrete Inlet Structure	80	CY	$1,500.00	$120,000.00
Furnish and Install Trash Rack	1	EA	$30,000.00	$30,000.00
Auxiliary Spillway				
New Auxiliary Spillway and Channel Excavation	6239	CY	$10.00	$63,000.00
Furnish and Install Reinforced Concrete Auxiliary Spillway and Channel	1181	CY	$1,500.00	$1,772,000.00
Replacement of Clay Core	1035	CY	$18.00	$19,000.00
Replacement of General Fill	750	CY	$18.00	$14,000.00
Auxiliary Channel Chute Backfill	2301	CY	$18.00	$42,000.00
Log Boom and Anchors	1	LS	$19,000.00	$19,000.00
Plunge Pool				
Excavation	1600	CY	$10.00	$16,000.00
Riprap	3750	SF	$6.50	$25,000.00
Site Restoration				
Wetland water distribution grading	4	AC	$10,000.00	$40,000.00
Wetland Plantings	4	AC	$13,068.00	$53,000.00
Site Restoration Soil Disposal Area (roads, parking, and buildings)	1	LS	$100,000.00	$100,000.00
			Construction Subtotal:	$4,002,000.00
			20% Contingency	$800,000.00
			Mobilization (5%)	$200,000.00
			Construction Total	$5,002,000.00
			Engineering and Construction Management	$1,001,000.00
			Administration	$51,000.00
			Permits	$50,000.00

Easements	$100,000.00
Installation Total	$6,204,000.00

5.2 Cost of Decommissioning Alternative

This subsection describes line items considered for the decommissioning alternative. It includes the construction costs that would be necessary to remove the existing embankment, remove accumulated sediment, demolish the principal and auxiliary spillways, and restore the stream channels. Table 10 summarizes all costs associated with installing the Decommissioning Alternative.

Table 10: Decommissioning Alternative Cost Summary

Item	Quantity	Unit	Unit Price	Amount
Construction Surveying and QC	1	LS	$25,000.00	$25,000.00
Water Management	1	LS	$100,000.00	$100,000.00
Clear and Grub	21.8	AC	$5,000.00	$109,000.00
Sediment Removal	39400	CY	$45.00	$1,773,000.00
Auxiliary Spillway - Reinforced Concrete Demo and Removal	200	CY	$75.00	$15,000.00
Principal Spillway Tower (70%) - Reinforced Concrete Demo and Removal	294	CY	$100.00	$30,000.00
Outlet Works - Reinforced Concrete Demo and Removal	11	CY	$75.00	$1,000.00
Outlet Works - Excavation	50	CY	$20.00	$1,000.00
Principal Spillway Tower and Conduit Abandonment Grout Fill	35	CY	$245.00	$9,000.00
Remove Existing Embankment	65100	CY	$7.00	$456,000.00
Stream/Channel Restoration Grading	40000	SF	$0.50	$20,000.00
Wetland water distribution grading	8.5	AC	$10,000.00	$85,000.00
Wetland Plantings	8.5	AC	$13,068.00	$112,000.00
Stream/Channel Riprap	40000	SF	$6.50	$260,000.00
Stream/Channel Filter Gravel	1481.481	CY	$51.70	$77,000.00
Site Restoration Soil Disposal Area (roads, parking and buildings)	1	LS	$100,000.00	$100,000.00
			Construction Subtotal:	$3,173,000.00
			20% Contingency	$635,000.00
			Mobilization (5%)	$159,000.00

Construction Total	$3,967,000.00
Engineering and Construction Management	$397,000.00
Administration	$40,000.00
Permits	$100,000.00
Easements	$0.00
Installation Total	$4,504,000.00

5.3 Operation and Maintenance Costs

Weber County has the responsibility to manage and maintain the Utaba Retarding Dam. Maintenance items include the removal of woody vegetation from the embankment, keeping recreational vehicles off the dam embankment, keeping the waterways clear of willows, repairing damage from rodent burrows, and removing beaver dams from the principal intake structure. Existing average costs are based on Weber County's current budget for operation and maintenance.

The proposed dam and subsequent operations will be similarly managed and will therefore have similar but lower costs. The improved access and structure design will reduce the effort needed to operate and maintain the facility. The effort needed to repair the failing auxiliary spillway will also be eliminated. It is expected that annual average costs will be significantly lower for Weber County for the proposed alternative. While the operations and maintenance costs for the Decommissioning Alternative would no longer exist for the Dam Embankment, there were some costs estimated for increased culvert cleaning since the dam would no longer be in place to remove debris and sediment from flood waters. The costs for operation and maintenance for each alternative are summarized in Table 11.

Table 11: Annual Operation and Maintenance Costs

Maintenance Type	Existing (No Action) Alternative	Decommissioning Alternative	Proposed Structural Alternative
Concrete Maintenance	$3,181.00	$0.00	$0.00
Vegetation Control Labor	$5,162.00	$0.00	$5,162.00
Vegetation Control Equipment	$648.00	$0.00	$648.00
Quarterly Principal Spillway Debris Removal	$4,084.00	$0.00	$817.00
Monthly Monitoring	$1,932.00	$0.00	$1,932.00
Culvert Debris Removal	$0.00	$5,000.00	$0.00
Downstream Channel Sediment Removal	$0.00	$5,000.00	$0.00
Total	$15,007.00	$10,000.00	$8,559.00

6.0 Conclusion

Throughout the EA process, many actions were evaluated and checked against standards and desired outcomes of the project. The proposed actions include the following:

- Rehabilitating the existing dam embankment.
- Constructing a principal spillway.
- Constructing an auxiliary spillway.

The proposed actions have been developed to a 30% design and follow the design criteria discussed in Technical Memorandum 002: Design Criteria. The design will be more refined during the final design stage, and more cost-effective approaches may be found. The proposed project actions accomplish the following goals of the project:

- Prevent the overtopping of the dam embankment during the IDF/PMF event.
- Reduce flooding of the downstream area during the 100-year, 24-hour storm event.

7.0 Reference Material

7.1 Reference Documents

USBR. (2022). General Spillway Design Considerations. *Design Standards No. 14: Appurtenant Structures for Dams (Spillways and Outlet Works) Design Standard, DS-14(3)-1*.

Utah Admin. Code R655-11-4B. (2025). *Freeboard Requirements. In Requirements for the Design, Construction and Abandonment of Dams (Rule R655-11).* Current through Utah State Bulletin 2025-06, March 15, 2025.

USDA NRCS. (2014). *A Guide for Design and Layout of Vegetated Wave Protection for Earthen Embankments and Shorelines.* Technical Release No. 56 (210–VI–TR–56, April 2014).

7.2 Wave Action Calculations

NRCS 100 MPH Event

Wave height, Run-up and freeboard calculation from USDA NRCS report

Value to be entered

Effective Fetch (miles)	Suggested speed (mph)	Wind Ratio	Wind velocity over land (mph)	Overwater wind velocity (mph)	Significant wave height
Fe	Vi	Vw/Vl	Vl	Vw	Hs
0.15	100	1.03	100	103	1.30

Effective Fetch (ft)
800

* Runup assumption: the protected slopes are fairly smooth

Simplified Setup equation (ft)	Constant	Constant	Surf parameter	Angle of the embankment slope to the horizontal	Deep water wave length (ft)
S	A	B	δ	θ	L
0.05	1.29	0.25	1.52	19	25.46

Still water elevation under normal (ft)	Wave Runup (ft)	Wave Setup (ft)	Upper limit of wave impact (ft)	Average water depth along the fetch line (ft)
Elev NP	R	S		D
5720	3.15	0.04	3.18	30

Figure 7: Wave Action Calculations (1)

NRCS 50 MPH Event

Wave height, Run-up and freeboard calculation from USDA NRCS report

Value to be entered

Effective Fetch (miles)	Suggested speed (mph)	Wind Ratio	Wind velocity over land (mph)	Overwater wind velocity (mph)	Significant wave height
Fe	Vi	Vw/Vl	Vl	Vw	Hs
0.15	100	1.03	50	51.5	0.62

Effective Fetch (ft)
800

* Runup assumption: the protected slopes are fairly smooth

Simplified Setup equation (ft)	Constant	Constant	Surf parameter	Angle of the embankment slope to the horizontal	Deep water wave length (ft)
S	A	B	δ	θ	L
0.05	1.29	0.25	1.62	19	13.83

Still water elevation under normal (ft)	Wave Runup (ft)	Wave Setup (ft)	Upper limit of wave impact (ft)	Average water depth along the fetch line (ft)
Elev NP	R	S		D
5200	1.58	0.01	1.59	30

Figure 8: Wave Action Calculations (2)

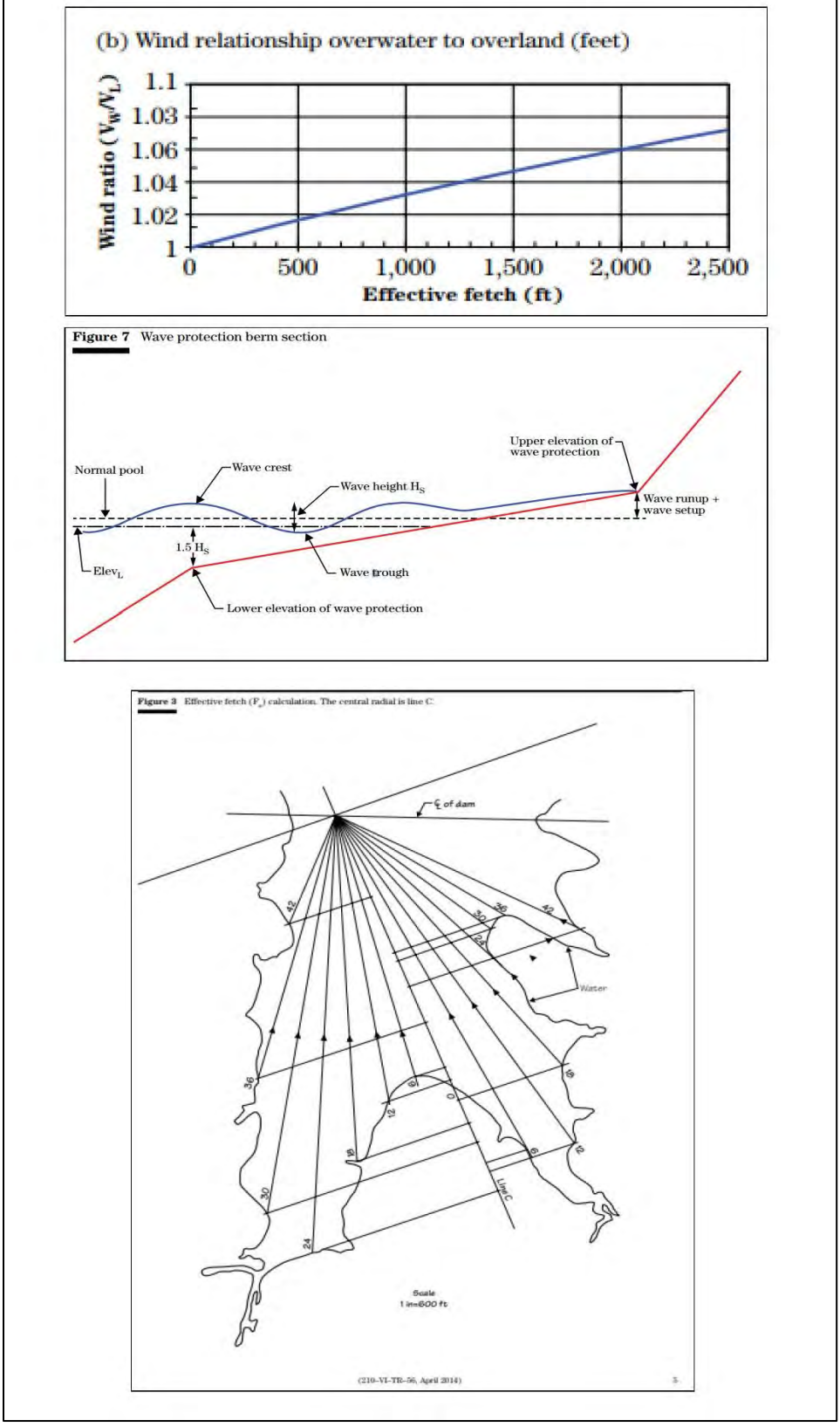

Figure 9: Wave Action Calculations (3)

Economic Investigations & Analysis (I&A) Report

Economic Investigation and Analysis Report

Utaba Watershed Plan

Proposed Flood Prevention Structures

Weber County, Utah

Prepared for:



January 2026

Prepared by:

Hal Gordon, Economist

Economic Investigation and Analysis Report
National Economic Efficiency Analysis

Executive Summary

This National Economic Efficiency (NEE) analysis evaluates the costs and benefits of an Action Alternative that includes one sub-basin that contains dam rehabilitation, channel modifications, piping and earthen channels, compared to the No Action Alternative for the Utaba Watershed Project. All economic benefits and costs are provided in 2025 dollars and have been expressed in average annual values using the fiscal year 2025 federal water resources planning rate of 3.00 percent.

The Preferred Alternative had a single increment. All flood protection improvements work in conjunction with each other, and the omission of any item within the alternative would render the remaining options ineffective. As such, the alternatives for Utaba are inclusive of all items as a single alternative.

Floodwater protection will provide many benefits: agricultural, ecological, operational, public safety, and reducing private and public expenditures. The Utaba Dam rehabilitation upslope of several small communities would reduce flooding to 69 threatened homes and other structures.

The estimated installation cost of the Preferred Alternative was $6,204,000, which includes construction ($5,002,000), engineering ($1,001,000), real property rights/permitting ($150,000), and project administration ($51,000). Average annual installation costs are estimated at $249,100.

It would take approximately 2 years to install the structures and stabilize flood waters. Other direct operation, maintenance, and replacement costs of the project are $8,559 per year. This value combined with the $249,100 of amortized costs leads to the resulting average annual cost of $257,659. Additional potential costs not quantified in the analysis include those associated with changes in aesthetic values due to the flood control structures.

That gives an annual net benefit of $893,358, or in other terms, an annual benefit to cost ratio of 3.47 to 1.00.

Introduction

This NEE Analysis evaluates the costs and benefits of the flood control structures and stream channel stabilization for the project areas over the No Action Alternative for the Utaba Watershed Project. The analysis uses Natural Resources Conservation Service (NRCS) guidelines for evaluating NEE benefits as outlined in the NRCS Natural Resources Economics Handbook and the U.S. Department of Agriculture's (USDA) Guidance for Conducting Analyses Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water Resource Investments (DM 9500-013).

All economic benefits and costs are provided in 2025 dollars and, in accordance with the NRCS Natural Resources Economics Handbook, are presented in average annual values using the fiscal year 2025 federal water resources planning rate of 3.00 percent.

Analysis Components

This section describes the economic analysis, funding sources, interest rates, evaluation units, project implementation timeline, period of analysis, and the project purpose. All values in this analysis are presented in 2025 dollars.

PROJECT PURPOSE

According to the PR&G and the NWPM, "Watershed Structure Rehabilitation" is the project purpose.

The proposed project will reduce flood damages to small rural communities below the Utaba Dam, reduce the amount of sediment downstream and improve public safety to residences, businesses and public works.

FUNDING

Watershed Protection and Flood Prevention Act (PL 83-566) funds would cover about $4,303,301 of the installation cost (or 69 percent of the total project cost). The sponsors and other non-federal funds would contribute $1,900,700, or 31 percent of the total project cost. PL 83-566 funds would cover 65% of construction costs, 100% of engineering and NRCS administration costs, and 0% of real property rights and permitting costs.

EVALUATION UNIT

The proposed project has a single basin evaluation unit on the North Fork Ogden River, Utah. The basin and the specific improvements are described in detail in the Plan EA.

PROJECT IMPLEMENTATION TIMELINE

If PL 83-566 funds are made available, construction would likely be completed over approximately 2 years. The project would be completed in several phases based on the amount of construction that could be completed during the summer. For each phase, the analysis assumes that full benefits would be realized the year after construction is completed.

PERIOD OF ANALYSIS

The analysis period is 52 years since the project would take 2 years to construct, and 50 years is the expected project life of flood protection measures. Construction would start in Year -2, and the analysis period extends from Year 0 to Year 50. A net present value analysis was conducted to compare the costs and benefits of the project alternatives.

ECONOMIC ANALYSIS AND DOCUMENTATION

A customized Excel worksheet using Federal Emergency Management Agency (FEMA) depth-damage curves and locally obtained data was used to evaluate benefits and costs of alternatives. The Excel Workbook "UTABAFloodDamagesBenefits.xml," with associated sheets within the workbook, provides the details for the complete economic analysis. Each project alternative, storm event and flood damage category were included in the worksheet to estimate average annual damages. Alternative cost estimates provided by the project engineers were also included in the worksheet. Economic data and results were linked in the worksheet to create the required PR&G tables for the final project report. While only flood-damage related benefits were quantified, other types of benefits serving the project purposes were still considered qualitatively when evaluating the costs and benefits of project alternatives.

A net present value analysis was conducted to compare the costs of project alternatives. Average annual values were also estimated. All costs of installation, operation and maintenance were based on 2025 prices. The costs associated with designing and implementing all structural measures were assumed to be implemented over a two-year period immediately preceding operation. The NEE alternative with a 52-year period of analysis yielded the highest net benefits using the mandated 3.00% discount rate for all federal water resource projects for FY25 to discount and amortize the anticipated streams of costs and benefits.

ENVIRONMENTAL AND SOCIAL BENEFITS

Environmental and social benefits were not monetized but are further explained for each alternative studied in detail in the environmental consequences Section of the Plan EA.

Environmentally adverse impacts will be minimized during construction. Long-term, there would only be negligible adverse impacts anticipated from any of the evaluated alternatives. The region is semi-arid with sparse trees along the banks of intermittently dry streams.

SOCIAL ENVIRONMENT

The watershed project is located in Weber County and the state of Utah. Two small communities are located near the project area: Liberty and Eden, Utah. They are part of the Ogden–Clearfield, Utah Metropolitan Statistical Area, as well as the Ogden Valley census county division. The project area is northwest of the Ogden Valley of the Wasatch Range, near Utah State Route 158 and 162. Downstream and to the southeast are Pineview Reservoir and the town of Huntsville (Wikipedia.org). Due to small, widely scattered population base in the project area, detailed demographic information was not readily available.

History

British trapper and explorer Peter Skene Ogden was the first European to map and describe the "Ogden Hole" valley which would later include the project area. The area was settled about 1859.

Settlement happened gradually, homes built one at a time rather than in tract housing. Traditionally a farming and ranching community, the area has developed in recent years into a recreational community and commuter town for the Ogden area.

Liberty, Utah Demographics

As of the census of 2010, there were 1,257 people living in the CDP. There were 437 housing units. The racial makeup of the CDP was 96.2% White, 1.0% Asian, 0.7% American Indian and Alaska Native, 0.1% Native Hawaiian and other Pacific Islander, 0.9% from some other race, and 1.2% from two or more races. Hispanic or Latino of any race were 2.5% of the population.

Eden, Utah Demographics

As of the census of 2010, there were 600 people living in the CDP. There were 204 housing units. The racial makeup of the town was 95.8% White, 1.0% Black or African American, 0.2% American Indian and Alaska Native, 0.5% Asian, 0.3% Native Hawaiian and Other Pacific Islander, 1.0% some other race, and 1.2% from two or more races. Hispanic or Latino of any race were 3.2% of the population.

Alternatives Considered During Formulation

This section presents the alternatives considered during project formulation. Additional information is found in the Plan-EA.

During the formulation phase, alternatives were evaluated based on meeting both National Environmental Policy Act (NEPA) and environmental review requirements specific to NRCS federal investments in water resources projects (PR&G). NEPA requires agencies to develop a reasonable range of alternatives and to ensure economic and technical feasibility (7 CFR 650). According to the PR&G DM 9500-013 (USDA-NRCS, 2017a), alternatives should reflect a range of scales and management measures and be evaluated against the Federal Objective and Guiding Principles; against the extent to which they address the problems and opportunities identified in the purpose and need; and against the criteria of completeness, effectiveness, efficiency, and acceptability.

1. Completeness is the extent to which an alternative provides and accounts for all features, investments, and/or other actions necessary to realize the planned effects including any necessary actions by others. It does not necessarily mean that alternative actions need to be large in scope or scale.

2. Effectiveness is the extent to which an alternative alleviates the specified problems and achieves the specified opportunities.

3. Efficiency is the extent to which an alternative alleviates the specified problems and realizes the specified opportunities at the least cost.

4. Acceptability is the viability and appropriateness of an alternative from the perspective of the Nation's general public and consistency with existing federal laws, authorities, and public policies. It does not include local or regional preferences for particular solutions or political expediency.

According to the PR&G and the NWPM, "Watershed Structure Rehabilitation is the purpose analyzed for the Utaba Watershed Plan-EA. Economic Table 7, Comparison of NEE Benefits and Costs, contains a summary of the average annual project costs and benefits. An Excel Workbook, with associated sheets within the workbook, provide the detail for the complete economic analysis. Incremental analysis was conducted considering project measures.

As described in the General Plan EA, the main purpose of the watershed plan is to bring Utaba dam into compliance with current NRCS and Utah State dam safety standards. While only flood-damage related benefits were quantified, other types of benefits serving the project purposes were still considered qualitatively when evaluating the costs and benefits of project alternatives.

According to PR&G, after preliminary consideration, agencies may remove from detailed study those alternatives that do not achieve the Federal Objective and Guiding Principles. In addition, alternatives that may at first appear reasonable but clearly become unreasonable because of cost, logistics, existing technology, social, or environmental reasons may also be eliminated from further analysis. These alternatives were briefly discussed to indicate that they were considered, and the analysis documented the reason(s) why they were eliminated (e.g., they do not achieve the Federal Objective and Guiding Principles).

In addition to PR&G guidance, concepts from P&G may be considered when analyzing Federal investments in water resources and the P&G General Requirements are topics that agencies must

consider when analyzing Federal investments in water resources. The following Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future.

A. Healthy and Resilient Ecosystems. Federal investments in water resources should protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems.

B. Sustainable Economic Development. Federal investments in water resources should encourage sustainable economic development.

C. Floodplains. Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.

D. Public Safety. Threats to people, including both loss of life and injury from natural events, should be assessed in the determination of existing and future conditions and, ultimately, in the decision-making process.

E. Watershed Approach. A watershed approach to analysis and decision-making facilitates evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed

In addition, there is not a hierarchal relationship among the economic, social, or environmental goals regardless of whether they can be monetized. Agency policy allows for the use of social effect goals to make the case for project activities, even if the associated benefit-cost (B/C) ratio is less than 1:1. This is due to the difficulty in monetizing the value of life and quality of life, which is laden with subjective value judgments. Threat to human life and quality factors can therefore be used to outweigh purely economic considerations when appropriate. PR&G allows a wide range of alternatives to illustrate the range of potential tradeoffs among environmental, economic, and social goals.

In general, the NEE alternative was developed in accordance with PR&G by evaluating economic, social, and environmental impacts from flood damage reduction in the rural community. Given the emphasis placed on the construction of flood control structures by the local steering committee to provide flood mitigation, the geographic extents of evaluated alternatives are limited to the area in which one or more of the proposed structural alternatives would have an estimated impact to the 500-year flood depth. The project life was 50-years, the flood protection design was for 100-year flood event and the average annual flood benefits were based on 2-year through the 500-year flood event (because any of the flood events could occur during the 50-year project life). The annual benefits of the project alternatives are based on the estimated reduction in average annual floodwater damages with proposed flood control measures in place compared to future conditions without mitigative action (No Action Alternative).

Alternatives considered included the No Action Alternative, nonstructural alternatives, the locally preferred alternative, and the NEE Alternative. Alternatives were compared against the No Action Alternative which involved projecting existing resources and conditions into the future to establish a benchmark against which alternatives were evaluated. Tradeoffs between alternatives with respect to environmental, economic, and social goals were identified.

Alternatives Considered but Eliminated from Detailed Study

Some of the alternatives considered in the planning process were eliminated from detailed consideration because they either did not meet the proposed purpose or need for federal action, were exorbitantly expensive, or were logistically impractical to implement. The following are summaries of eliminated alternatives that propose to mitigate damages from the 100-year flood.

RELOCATION

This nonstructural alternative would establish a flood easement for the 100-year floodplain and require acquisition of private lands. Approximately 69 homes, and one school are located within the 100-year flood inundation area that would need to be purchased. All structures would need to be demolished, utilities relocated, roads removed, and the land returned to a natural state. Costs were estimated and averaged per structure type and the total cost for purchase of structures alone would be extremely high (almost 30 million dollars). Costs do not include purchase of undeveloped lands, demolition of structures, relocation of roads and utilities, or restoration of land. The extremely high cost far exceeds the flood benefits that could be achieved, resulting in negative economic benefits. Adverse social impacts are also anticipated by removing families from homes. Based on the high costs, negative economic benefit, and adverse social impacts to occupants of structures, this alternative was eliminated from further study.

FLOOD PROOFING

This nonstructural alternative was for small rural communities below the Utaba Dam. One method would involve the installation of earthen berms around roadways to protect buildings in the project area at risk from a 100-year flood event. Flood proofed structures would include 69 residences and no commercial businesses or public properties. This would involve berms on the main roadways in the flood area. This alternative was deemed spatially infeasible because of the large footprint of the berms and widely scattered residences.

FLOODWAY

A channel of sufficient size to contain the anticipated flood flow of the 100-year storm event past homes and out buildings was briefly discussed. This channel would be extremely expensive to install, operate and maintain. Few off-site community members would benefit from this alternative, and it does not address road damages, public safety, and other concerns identified in the project purpose. Therefore, due to the lack of qualitative benefits and the expensive cost, it was not acceptable to the sponsor.

Alternatives Considered for Detailed Study

The following sections describe the alternatives carried forward for a detailed resource impact analysis. These included No Action Alternative which represents the baseline condition, Alternative 3 is Dam Decommissioning, and Alternative 2 is Dam Structural Rehabitation, detention basins, floodway channel modifications, and piping. Along with the No Action alternative, two alternatives were identified and evaluated in detail.

Note that all incremental improvements from both proposed Alternatives for the Utaba dam and structures work in conjunction with each other, and the omission of any item within the alternative would render the remaining options ineffective. As such, the alternative increments for Utaba dam are inclusive of all items as a single alternative. These Alternatives are further described below.

NO ACTION ALTERNATIVE

The Utaba Dam is currently in place, but does not meet current dam safety standards; therefore, the No Action Alternative is the projection of future conditions with the inadequate Utaba Dam. Under the No Action Alternative, the dam would fail and cause flood damage downstream. The No Action is a projection of future conditions and serves as a baseline for the evaluation and comparison of effects of the action alternatives. Existing conditions and trends would continue.

Under the No Action Alternative, there would be no federal technical and/or financial assistance through the PL-566 REHAB Program for implementation on any part in the project area. No federally funded project measures would be implemented. The No Action Alternative would not meet the purpose and need for the project. However, the No Action Alternative is carried forward as the basis of comparison for impact analysis.

ALTERNATIVE 3 – PROPOSED ACTION – DECOMMISSIONING ALTERNATIVE (NONSTRUCTURAL)

This alternative recognizes that the potential failure of the existing dam without rehabilitation could create a greater risk to downstream properties and facilities than the benefits that are currently provided by the existing dam. The measures that would be included under this alternative would require the complete removal of the dam, removal and/or stabilization of accumulated sediment, reestablishment of channels through the reservoir area, and site restoration/revegetation. The disposal of the dam material and accumulated sediment represents a significant challenge associated with this alternative. Ultimately, the disposal of material and sediment would require the disturbance of additional areas which would need to be subsequently restored and revegetated. This alternative would also constitute a nonstructural solution to the problems at the site. At least one nonstructural alternative is required to be included in the Final Array of Alternatives for REHAB projects.

ALTERNATIVE 2 – PROPOSED ACTION – STRUCTURAL REHABILITATION ALTERNATIVE

The Structural Rehabilitation Alternative would upgrade Utaba Retarding Dam to meet Utah State and NRCS Dam Safety Standards while maintaining water detention capacity. The dam would be raised 4 feet to provide additional freeboard for the Probable Maximum Flood (PMF) event. The undersized and degraded principal spillway would be replaced, and the auxiliary spillway would be relocated to the left abutment. A downstream filter and drain system would address seepage issues, and a new principal spillway would prevent blockages from beaver activity while allowing full reservoir drainage. A chimney and blanket filter system would be installed to prevent soil migration. Sediment management measures include removing accumulated sediment and reducing sediment buildup by upgrading the principal spillway. To meet safety standards, modifications could include flattening slopes, adding a stability berm, or replacing weak dam material. A control gate on the principal spillway would allow water release to be restricted, enabling the reservoir to serve as a wildfire suppression resource as well as facilitate inspection of the principal spillway conduit.

The Preferred Alternative

The flood depths for the Present Condition and both Alternatives and were significantly different, with greater damages occurring under the Present Condition with dam failure. The annual net benefits for the Decommission Alternative3 were $629,167/year and the Structural Dam Rehabilitation Alternative 2 had about $635,699 benefits per year. Although the Decommissioning Alternative had a higher BCR, it did not have higher net benefits and would have significant environmental impacts if implemented (most significantly to aquatic resources/wetlands), making the Structural Rehabilitation Alternative the NEE.

Alternative 2 was selected as the locally preferred alternative. As the NEE alternative, Alternative 2 is also the Federally Recommended alternative. For purposes of the rehabilitation program, the NED alternative is defined as the federally assisted alternative with the greatest public benefits, with appropriate consideration of costs. Public benefits (i.e., positive ecosystem services) encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures.

The preferred alternative will allow the Sponsors to comply with applicable dam safety and performance standards, to reduce the potential for loss of life, and continue protection of existing property and infrastructure downstream of the dam. The preferred alternative maximizes public benefits. Average annual monetary benefits are estimated to be $893,358. Average annual cost is estimated at $257,659 resulting in net benefits of $635,699.

The threat of a catastrophic dam failure (breach) will be minimized. Dam rehabilitation will minimize the threat to human life. Agency policy allows for use of other social effects to make the case for rehabilitating any given floodwater detention structure, even if the associated B/C ratio were less than 1:1. Trying to monetize the value of life, or in the case of dams, avoidance of loss of life, is left to subjective value judgments. Threat to human life can therefore be used to supersede purely economic considerations when deemed appropriate. With the preferred alternative, incidental recreation after construction will continue. Environmental adverse impacts will be minimized during construction. Long-term there may be adverse, although negligible, impacts.

Benefit to Cost Ratio: 3.47 to 1.0

Net beneficial effects: $635,699

Period of Analysis: 52 years (includes 2 years for design and construction)

Project Life: 50 years

Funding Schedule: The most likely scenario is for the project to be implemented over two years including the design and construction.

Funding Schedule

Fiscal Year	PL-83-566	Other Funds	Total
2026	$526,000	$75,000	$601,000
2027	$3,777,300	$1,825,700	$5,603,000

*Structure life 50-years, 2-year implementation, price base 2025.

Project Benefits

PROJECT BENEFITS SUMMARY

Benefits are determined as the difference between the without-project and the with-project condition. The planning policy used for this plan/environmental document (P&G and PR&G) state that Federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs. Public benefits (i.e., positive ecosystem services) encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration

of both quantified and unquantified measures. The preferred alternative will allow the Sponsors to comply with applicable dam safety and performance standards, to reduce the potential for loss of life, and to continue protection of existing property and infrastructure downstream of the dam. The preferred alternative maximizes public benefits.

The planning policy used for this plan/environmental document (PR&G) state that Federal investments in water resources as a whole should strive to maximize public benefits. Public benefits (i.e., positive ecosystem services) encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures.

The stream of monetary benefits was described in average annual equivalent terms. The average annual expected benefits were the difference between the No Action Alternative and each project Action Alternative. The expected average annual damages for each alternative, storm event (8 events), and damage category below were estimated with the following equation:

$$\sum_{i=1}^{8} (\underline{PFED_{i-1} + FED_i)/2} * (PPFE_{i-1} - PFE_i)$$

$PFED_{i-1}$ - Previous Flood Event Damages
FED_i - Flood Event Damages
$PPFE_{i-1}$ - Probability of Previous Flood Event
PFE_i - Probability of Flood Event

The damage (and benefit) categories used in this analysis are defined below.

ENVIRONMENTAL AND SOCIAL BENEFITS

Environmental and social benefits were not monetized but are further explained for each alternative studied in detail in the environmental consequences section of the Plan/EA.

Environmentally adverse impacts will be minimized during construction. Long-term, there would only be negligible adverse impacts anticipated from any of the evaluated alternatives.

Socially, the threat of loss of life or property will be minimized with reduced flood depths at buildings and roads with the existing dam and improvements. The annual average daily traffic was difficult to find in the project area because of limited data, but State Route HWY 158 via SR 39 near the project area was about 4,000 to 9,000 vehicles per day (UDOT Website, Eden, UT area, 2020). Incidental recreation after construction will continue and is expected to have minimal benefits from the structural alternatives through enhancement of wildlife and scenic improvement. Significant changes in hunting, fishing, and general outdoor activity in the vicinity of the dams are not expected.

ECOSYSTEM SERVICES

During the scoping process, ecosystem service benefits that currently exist in the watershed were identified. The scoping process identified provisioning, regulating, and cultural services in the watershed. The services identified also included intermediate supporting services, which is why those services were not carried forward in the ecosystem services analysis. The entire ecosystem services analysis is documented in the PR&G Ecosystem Services Scoping and Evaluation Worksheet located in Appendix E to the Plan-EA.

The Provisioning Services in the area result from the water quality of the North Fork of the Ogden River and Pineview Reservoir, which provide drinking and irrigation water. The areas irrigated with Pineview reservoir water produce direct benefits from harvested crops that are used for various purposes. Additionally, a provisioning service is generated by the fish population in Pineview Reservoir which can be a source of sustenance for those who fish in the reservoir.

The Regulating Services in the study area include damages and safety hazards associated with flooding following a breach of Utaba dam. Currently, the hazardous condition of Utaba Dam can allow for a reasonable prediction of future failure, incurring significant damages and potential loss of life or injury to residents downstream. Additionally, fire suppression capability is a regulating service in the area that is critical to buffer against harmful impacts of wildfire during events. However, the resources for fire suppression in the area are somewhat limited and require expansion under current conditions.

Cultural Services are present in the watershed. There are opportunities for walking, hiking, cycling, and other outdoor activities. Camp Utaba, and other various church-sponsored youth camps, are located downstream of Utaba Dam and provide an important cultural service to the youth who attend the during the summertime. The North Fork Park provides an important cultural service and contributes to aesthetic conditions, another service, by serving as an International Dark Sky Park (IDSP). Additionally, there is an inherent existence value to the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) habitat, a Federally Threatened species, located around Utaba Dam.

FLOOD DAMAGES

All estimated values and damages were assessed within a customized Excel template prepared for this analysis. The current average annual floodwater damages with the dam are $1,069,987, the floodwater damages with the dam Decommissioned are $250,220, and damages with the dam Structurally Rehabilitated are $176,630. See Plan Annual Expected Damages table below.

Plan Annual Expected Damages

Category	Existing Conditions	Alt 1. Decommission	Alt 2. Structural
UTABA - Watershed Structure Rehabilitation			
Structure, Contents & Vehicles	$1,003,809	$242,118	$171,960
Roads/Crossings	$46,679	$8,102	$4,670
Sediment	$19,500	$0	$0
Total:	$1,069,987	$250,220	$176,630

As displayed in the Plan Annual Expected Benefits table below, the project benefits are estimated for each alternative by subtracting the expected damages from the no action Existing Condition damages. The difference between the Existing Conditions and Dam Decommissioning flood damages is $819,767 which reflects the average annual benefits that the dam currently provides to downstream structures. If the dam was structurally rehabilitated, the annual benefits of the preferred alternative would be $893,358.

Plan Annual Expected Benefits

Category	Alt 3. Decommission	Alt 2. Structural
UTABA Sub-Basin		
Structure, Contents & Vehicles	$761,691	$831,849
Roads/Crossings	$38,576	$42,009
Sediment	$19,500	$19,500
Total:	$819,767	$893,358

STRUCTURE, CONTENT, & VEHICLE DAMAGES

Local tax appraisal district records were used to obtain the structural values of residences, commercial and public properties, and outbuildings that would be affected by project activities. The structure damages were estimated using the methodology described in the Structural Damages Calculations Template (Tim Goode, NWMC). The value of the structures was calculated by subtracting the depreciated replacement value (DRV) from the Tax Accessor's structure value. The structures in the project area that are affected by flooding are located in scattered rural area. The year structures were built was not readily available. The Depreciated Replacement Values used for all structures was .20. Based on the Life Cycle Chart (Swiftestimator.com, building cost reports online 2/2007) the Depreciated Multiplier ranged from 18% to 30%. The structure value used in the flood damage analysis was estimated as: The County Tax Accessed Value * (1- Depreciated Replacement Value Factor) (see: UTABAFloodDamagesBenefitsData.xls for calculations). This estimated Depreciated Replacement Value is also consistent with the USACE National Structure Inventory documentation: "Structure Valuation - These replacement values for structures are then depreciated in order to obtain depreciated replacement value; each structure is depreciated by 1% per year for the first 20 years, after which it is assumed that routine maintenance would keep structure values at 80% of their replacement values". (https://www.hec.usace.army.mil/confluence/nsi/technicalreferences/latest/technical-documentation).

Total value of structures in the 500-year flood plain was estimated at about $20.5 million. No commercial or public buildings were estimated to be damaged.

Content values were estimated as a percentage (about 75%) of assessed property values (Federal Emergency Management Agency). Estimated floodwater depths where flood damage occurs, for various storms (including the 500-year storm), for each structure were based on the results of the hydrology and hydraulics simulation modeling (Franson Civil Engineers, Logan, Utah). Existing (breached), Decommissioning (without dam), and Structural estimated floodwater depths were all analyzed for structural, content, and vehicle damages. To determine damages, floodwater data was then used with water depth to damage functions (Federal Emergency Management Agency) to estimate structural and content damages based on the point of entry where damages would begin. These depth-to-damage functions were specific for 1) different types of residences (i.e. one or two story homes with or without basements; split-level homes; mobile homes; apartments; etc.); and 2) different type of commercial and public properties. A similar analysis was conducted for vehicles located at residences, public properties, and businesses within the floodplain area. For vehicles, local project managers estimated the typical vehicle replacement dollar value. Using the same source as mentioned above, floodwater damages to vehicles located at affected properties were estimated, a conservative value of $18,000 per vehicle was used. Damages to other vehicles not located at each building but possibly in harm's way during a flood event were not included. Damage start for vehicle was 0.5 feet above ground surface elevation. It was

estimated that each affected residence would have a minimum of two vehicles, public properties three, small commercial properties five and large commercial properties ten vehicles.

The number of structures that could be flooded and their total structural value are displayed below. This value does not include land values, only structure values. There are no critical facilities located within the 500-year floodplain without the dam scenario:

Watershed Project Number and Value of Structures Summary

	Residences	Commercial	Public	Out Building
Number	69	0	0	31
Value	$16,123,100	$0	$0	$4,467,635

Structures Flood Depths Without Project

Event	< 4 in[1]	> 4 in < 1 ft	> 1 ft < 3 ft	> 3 ft	< 4 in[1]	> 4 in < 1 ft	> 1 ft < 3 ft	> 3 ft
	Home	Home	Home	Home	Out Building	Out Building	Out Building	Out Building
2-yr	61	7	1	0	28	2	1	0
5-yr	55	9	4	1	23	4	4	0
10-yr	54	4	9	2	23	3	5	0
25-yr	53	5	9	2	23	3	4	1
50-yr	50	7	10	2	21	3	6	1
100-yr	48	9	9	3	20	4	5	2
200-yr	34	20	12	3	14	9	6	2
500-yr	25	22	19	3	7	10	12	2

[1] Depths below 4 inches would cause negligible damage

ROAD & ROAD CROSSING DAMAGES

For the economic analysis, there are 22 roadways below the dams within the project area. Stream crossings were not expected to have significant damage below the dam. Floods from the 2-year through the 500-year storms were included in the worksheet to estimate average annual damages to roads and crossings. Road and crossing location, flood depth and road surface area impacted by floodwater were identified.

Road areas flooded and flood depths with and without project were estimated by Franson Civil Engineers, Logan, Utah (FCE) using the same modeling results used for the structure flood depths. The road segments that intersected the flooded areas were analyzed to compute the average depth of flooding for each road segment.

No road damages were estimated if the flood depth was less than 0.1 foot. If the flood depth was greater than 0.1 foot and less than 0.5 feet, road flood damages were estimated to be half of the road

replacement cost of the road area flooded for each road segment. If the flood depth was greater than 0.5 feet, road flood damages were estimated to be ¾ of the road replacement cost for the road area flooded for each road segment.

FCE assumed road replacement cost to be $64 per square yard to cover all base aggregate and asphalt paving costs.

The annual average daily traffic was difficult to find in the project because of limited data, but State Route HWY 158 via SR 39 near the project area was about 4,000 to 9,000 vehicles per day (UDOT Website, Eden, UT area, 2020).

SEDIMENT

Flood erosion scour damages from each storm event and project alternative were not estimated assuming the existing dam would continue to prevent damages. However, if a dam breach were to occur some areas may be scoured. A reduction of sediment delivered below the dam was estimated by FCE. FCE assumed that 50% of the 100,000 cubic yards of dam material would need to be cleaned up. The assumed cost for clean-up assumed labor, equipment, and transportation at a rate of $15 per cubic yard. Sediment damage was only expected from the 100-year and greater storm events with the dam removed. There were no sediment damages with the dam kept in place.

RECREATION

Based on evidence found at the site and information from local residences, the dam site and upstream and downstream waterways (on private property and public land) are used for recreational purposes. There is a church owned property directly below the dam that is used for recreational activities and camping. The flood prevention structures are not intended to store water for recreation. Incidental recreational activities such as hunting and hiking/walking are expected to be minimal. Since there is no official or unofficial count of usage, estimated annual visitor-days is not available. Therefore, incidental recreation impacts were not evaluated.

OTHER DAMAGES

No additional "Other Damages" (emergency aid, clean-up, sewer, debris removal, etc.) were provided or estimated by local county officials. There were no crop, pasture, range, livestock or confined animal feeding operation damages identified within the project area significantly affected by storms up to and including the 500-year event.

BENEFICIAL EFFECTS

- About 3,000 direct beneficiaries living in small, widely scattered rural communities near the project area.
- With Dam versus Without Dam protects 69 residences and 31 out buildings. No commercial structures or public properties were identified in the flood plain. There were 22 roadways downstream within the 500-year inundation zone.
- Provides protection for about 4,000 to 9,000 vehicles and their occupants who utilize the roads downstream of Utaba Dam daily (using an average of 2 people per vehicle results in up to about 18,000 motorists).
- Reduces the threat of loss of access and loss of emergency services for downstream properties and property owners.
- Provides downstream flood prevention for the residents in the area, as well as those working, recreating, or traversing within the downstream floodplains, for an additional **50** years.

- Eliminates the liability associated with continuing to operate a dam that does not meet current Utah and NRCS safety and performance standards.
- Retains the existing aquatic and terrestrial habitat in and around the dam.
- Leverages federal resources to install the planned works of improvement.
- Will meet current Utah and NRCS safety and performance standards for a high hazard potential dam.

As reflected in the Plan Annual Expected Damages table above, current average annual floodwater damages without project (No Action W/ Dam) are $1,069,987. Floodwater damages with the Preferred Alternative 2 were estimated to be $176,630.

As reflected in the Plan Annual Expected Benefits table above, the benefits to downstream properties were estimated as the difference between Do Nothing and the Preferred Alternative, or $893,358 with project Alternative 2.

The Probable Maximum Precipitation storm event will be retained, thus reducing the threat of a catastrophic dam failure (breach). Incidental recreation after construction will continue. Environmentally adverse impacts will be minimized during construction. Long-term there would be adverse, although negligible, environmental impacts.

Watershed Project Costs

As indicated in Table 1, the total installation cost of the selected plan is $6,204,000. Of this amount, PL-83-566 funds will bear $4,303,300 and nonfederal funds will bear $1,900,700. PL 83-566 funds would cover 65% of construction costs, 100% of engineering and NRCS administration costs, and 0% of real property rights and permitting costs. Table 2 shows details of the costs and cost-share amounts by category. Total annualized costs are shown in Table 4 along with the estimated costs for operation and maintenance. Table 5 displays the average annual flood damage reduction benefits by flood damage categories, and Table 7 displays a comparison of annual costs and benefits. A 2025 price base was used and amortized at 3.00 percent interest for the 52-year period of analysis (including a design and installation period of two years and an expected useful life of 50 years).

The cost projections for the proposed rehabilitation measures are estimated costs only for planning. The fact that these costs are included in this plan does not infer that they are final costs. Detailed structural designs and construction cost estimates will be prepared prior to contracting for the work to be performed. Final construction costs will be those costs incurred by the contractor performing the work, including the cost of any necessary contract modifications.

Project costs for the flood prevention structures were estimated by Franson Civil Engineers, Logan, Utah, in May 2025. Installation and operation & maintenance costs for each activity are described in the engineers cost estimation Excel worksheet, and copied into the UtabaFloodDamagesBenefits Excel worksheet.

All costs were allocated to the watershed structure rehabilitation purpose according to the procedure in the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, Chapter 6 Costs and Cost Allocation (NRCS 2014b). Work Plan-EA tables were constructed based on the calculated cost allocated to watershed structure rehabilitation. Within this purpose the costs were shared between NRCS and the local and state entities as specified in the NWPM, in this case cost share for watershed structure rehabilitation is 65 percent federal and 35 percent local. Within these

guidelines, engineering is 100 percent federal; and operation, maintenance, and replacement is 100 percent local. See the work plan in the Plan-EA for the results of the cost allocation/cost sharing process.

All costs were amortized at the Fiscal Year 2025 Federal Water Resource Discount of 3.00 percent for 52 years. Average Annual Costs are computed as the sum of the amortized construction cost and the annual operation and maintenance cost. Engineers estimate that each of the structures would last 50 years, the life of the project.

All project costs were estimated by project engineers, including installation and annual operation and maintenance, and converted to Present Values by discounting each cost to the beginning of the period of analysis using the applicable project discount rate. Installation expenditures before the project is installed were brought forward to the end of the period of installation by charging compound interest at the project discount rate from the date the costs are incurred. Finally, the project discount rate was used to convert the present values to average annual equivalent terms.

Replacement costs are necessary if the installed structure's life is less that the project life. Average Annual Replacement Costs are calculated by amortizing the Present Value of the warn-out structure's construction cost, with the current FY discount rate over the project structure's life. If the physical life of the alternative is the same as the project, replacement costs are not included and we assume the Replacement Costs are the same as the Average Annual Costs. In this project the structure's life was equal to the project life and replacement costs were not necessary and not calculated.

All estimated values and damages were assessed within a customized Excel template.

Watershed Project Annual Cost Summary

Works of Improvement	Amortization of Installation Cost[1]	Operation, Maintenance and Replacement Cost	Other Direct Costs	Total
Alt 3. Decommissioning Dam	$180,600	$10,000	$0	$190,600
Alt 2. Structural Dam	$249,100	$8,559	$0	$257,659

1/ Discount rate 3.00% with a 52 year period of analysis. Price base 2025

As reflected in the table below, current average annual benefits for the preferred Alternative 2 are $893,358 and the average annual costs are $257,659. The net annual benefits between with and without project that the project would provide to downstream properties is $635,699. Alternative 2 had a B/C ratio greater than 1.0, at 3.47.

Watershed Project Benefit-Cost Summary

Alternative	Average Annual Benefits	Average Annual Cost	Net Benefits	Benefit/Cost Ratio
Alt 3. Decommissioning Dam	$819,767	$190,600	$629,167	4.30
Alt 2. Structural Dam	$893,358	$257,659	$635,699	3.47

1/ Discount rate 3.00% with a 52 year period of analysis. Price base 2025

Final Tables

The PR&G requires that an economic analysis be completed. All economic tables for the Preferred Alternative are displayed below. The economic table names are defined in Title 390 – National Watershed Program Manual, Subpart B – Economic and Structural Tables. A summary of the economic analysis of the Preferred Alternative (NEE Alternative) and No Action Alternative is provided below. The full NEE Analysis can be found in Appendix D. The Preferred Alternative represents the future with federal funding through PL 83-566. The No Action Alternative represents the future if the project sponsors do not receive federal funding. The final Economic Tables:

Table 6-1. Estimated Installation Cost (Alt 1 & 2)

Table 6-2. Estimated Cost Distribution—Water Resource Project Measures (Alt 1 & 2)

Table 6-3. Cost Allocation and Cost Sharing Summary for Watershed Project Plans (Alt 1 & 2)

Table 6-4. Estimated Average Annual Costs (Alt 1 & 2)

Table 6-5a. Estimated Average Annual Flood Damage Reduction Benefits (Alt 1)

Table 6-5b. Estimated Average Annual Flood Damage Reduction Benefits (Alt 2)

Table 6-6a. Estimated Average Annual Watershed Protection Damage Reduction Benefits (Alt 1)

Table 6-6b. Estimated Average Annual Watershed Protection Damage Reduction Benefits (Alt 2)

Table 6-7. Comparison of Preferred Alternative Benefits and Costs (Alt 1 & 2)

Economic Table 1 (1(NWPM 506.11) and Economic Table 2 (NWPM 506.12) present the proportions of PL 83-566 funding and other funding sources. Table 3 shows the project purpose cost share. The average annual NEE costs are shown in Economic Table 4 (NWPM 506.18). The costs shown are the annual costs for the Preferred Alternative above the No Action Alternative, which is discussed further in the NEE Analysis in Appendix D. Economic Table 5 (NWPM 506.20) presents the average annual watershed protection damage reduction benefits, using the benefits and costs from Table 4 and Table 5. Table 6 displays the flood damage reduction benefits. Table 7 presents a comparison of the NEE Analysis average annual benefits and average annual costs.

Table 6-1

Estimated Installation Cost Utaba Watershed, Utah [2025 Dollars][1]

Works of Improvement	Unit	Number			Estimated Cost (2025 Dollars)[1]						
					Public Law 83-566 Funds			Other Funds			Total
		Federal Land	Non-Federal Land	Total	Federal Land	Non-Federal Land	Total	Federal Land	Non-Federal Land	Total	
Structural Measures											
Flood Management											
Alt 1. Decommissioning Dam	Each	0	1	1	$0	$3,015,550	$3,015,550	$0	$1,488,450	$1,488,450	$4,504,000
Alt 2. Structural Dam	Each	0	1	1	$0	$4,303,300	$4,303,300	$0	$1,900,700	$1,900,700	$6,204,000

[1] Price base: 2025

Table 6-2

Estimated Cost Distribution—Water Resource Project Measures Utaba Dam Rehabilitation Supplemental Watershed, Utah [2025 Dollars][1]

Works of Improvement	Increment	Installation Cost—Public Law 83-566						Installation Cost—Other Funds						Total
		Construction[3]	Engineering[6]	Real Property Rights[4,5]	Relocation Payments	Project Admin.	Total Public Law 566	Construction[3]	Engineering[6]	Real Property Rights[4,5]	Relocation Payments	Project Admin.[2]	Total Other	Installation Costs
Flood Management														
Alt 1. Decommissioning Dam	1	$2,578,550	$397,000			$40,000	$3,015,550	$1,388,450		$100,000			$1,488,450	$4,504,000
Alt 2. Structural Dam	1	$3,251,300	$1,001,000			$51,000	$4,303,300	$1,750,700		$150,000			$1,900,700	$6,204,000

1 Price base: 2025

2 Includes $0 for relocation assistance advisory service.

3 Includes $0 of Public Law 83-566 funds and $0 of other funds for cultural resource protection and mitigation measures.

4 Includes $0 of real property cost for mitigation.

5 Includes $0 of surveys, legal fees, other costs.

6 Engineering services contract cost to be borne: $1,001,000 by Public Law 83-566 funds and $0 by other funds.

Table 6-3

Cost Allocation and Cost Sharing Summary for Watershed Project Plans Utaba Watershed, Utah [2025 Dollars][1]

	Alt 3. Decommissioning Dam				Alt 2. Structural Dam			
	Public Law 83-566		Other Funds		Public Law 83-566		Other Funds	
	Flood Management	Total	Flood Management	Total	Flood Management	Total	Flood Management	Total
Structural Measures								
Construction Costs	$2,578,550	$2,578,550	$1,388,450	$1,388,450	$3,251,300	$3,251,300	$1,750,700	$1,750,700
Engineering Costs	$397,000	$397,000	$0	$0	$1,001,000	$1,001,000	$0	$0
Real Property Landrights	$0	$0	$100,000	$100,000	$0	$0	$150,000	$150,000
Relocation Payments	$0	$0	$0	$0	$0	$0	$0	$0
Project Admin. Costs	$40,000	$40,000	$0	$0	$51,000	$51,000	$0	$0
Total		$3,015,550		$1,488,450		$4,303,300		$1,900,700

[1] Price base: 2025

Table 6-4

Estimated Average Annual Costs, UTABA Watershed, Utah (2024 Dollars)[1]

Works of Improvement	Amortization of Installation Cost	Operation, Maintenance and Replacement Cost[2]	Other Direct Costs	Total
Alt 3. Decommissioning Dam	**$180,600**	**$10,000**	**$0**	**$190,600**
Alt 2. Structural Dam	**$249,100**	**$8,559**	**$0**	**$257,659**

1 Price base: 2025, amortized over 52-years at a discount rate of 3.00 percent.

2 Includes $0 for operation, maintenance, and replacement for recreational development.

3 Costs for technical assistance to install measures in this evaluation unit are included.

Table 6-5a

Estimated Average Annual Flood Damage Reduction Benefits Utaba Watershed, Utah [2025 Dollars][1] – Alternative 3 Decommission Dam

Item	Estimated Average Annual Damage				Damage Reduction Benefit[3,4]	
	Without Project		With Project			
	Agriculture-related[2]	Non-agriculture-related	Agriculture-related[2]	Non-agriculture-related	Agriculture-related[2]	Non-agriculture-related
Flood Management Improvements						
Structure, Contents & Vehicles	$1,003,809		$242,118		$761,691	
Roads/Crossings	$46,679		$8,102		$38,576	
Sediment	$19,500		$0		$19,500	
Total	$1,069,987		$250,220		$819,767	$0

[1] Price base: 2025

[2] Agriculture-related damage includes damage to rural communities.

[3] Includes effects of land-treatment measures.

[4] Costs and benefits for on-farmland treatment have been netted out.

Table 6-5b

Estimated Average Annual Flood Damage Reduction Benefits Utaba Watershed, Utah [2025 Dollars][1] – Alternative 2 Structural Dam

Item	Estimated Average Annual Damage				Damage Reduction Benefit[3,4]	
	Without Project		With Project			
	Agriculture-related[2]	Non-agriculture-related	Agriculture-related[2]	Non-agriculture-related	Agriculture-related[2]	Non-agriculture-related
Flood Management Improvements						
Structure, Contents & Vehicles	$1,003,809		$171,960		$831,849	
Roads/Crossings	$46,679		$4,670		$42,009	
Sediment	$19,500		$0		$19,500	
Total					$893,358	$0

[1] Price base: 2025

[2] Agriculture-related damage includes damage to rural communities.

[3] Includes effects of land-treatment measures.

[4] Costs and benefits for on-farmland treatment have been netted out.

Table 6-6a

Estimated Average Annual Watershed Protection Damage Reduction Benefits Utaba Watershed, Utah [2025 Dollars][1] – Alternative 3 Decommissioning

Item	Damage Reduction Benefit, Average Annual	
	Agriculture-related	Non-agriculture-related
Onsite		
Structure, Contents & Vehicles	$761,691	$0
Roads/Crossings	$38,576	$0
Sediment	$19,500	$0
Subtotal	$819,767	$0
Offsite/Public		
Subtotal	$0	$0
Total	$819,767	$0
[1] Price base: 2025		

Table 6-6b

Estimated Average Annual Watershed Protection Damage Reduction Benefits Utaba Watershed, Utah [2025 Dollars][1] – Alternative 2 Structural Dam

Item	Damage Reduction Benefit, Average Annual	
	Agriculture-related	Non-agriculture-related
Onsite		
Structure, Contents & Vehicles	$831,849	$0
Roads/Crossings	$42,009	$0
Sediment	$19,500	$0
Subtotal	$893,358	$0
Offsite/Public		
Subtotal	$0	$0
Total	$893,358	$0
[1] Price base: 2025		

Table 6-7

Comparison of Preferred Alternative Benefits and Costs Utaba Watershed, Utah [2025 Dollars][1]

Works of Improvement	Agricultural		Average Annual Benefits	Average Annual Costs[3]	Benefit Cost Ratio
	Damage Reduction	Intensification			
	Flood Reduction[2]				
Land Treatment—acres					
Alt 3. Decommissioning Dam	$819,767		$819,767	$190,600	4.30
Alt 2. Structural Dam	$893,358		$893,358	$257,659	3.47

[1] Price base: 2025

[2] From Table 6

[3] From Table 4

PR&G Alternative Formulation & Screening Matrix

TABLE 1: PROBLEMS AND OPPORTUNITIES	
Problem Statement	Utaba Retarding Dam does not meet current State Dam Safety and NRCS High Hazard Dam Safety criteria; specifically, there is noncopmpliance with State and NRCS design criteria for auxiliary spillway capacity.
Opportunity 1	Improve the safety to the general public.
Opportunity 2	Enhance community resilience to flooding risks through the best fit of project measures;
Opportunity 3	Increase the level of breach and flood risk awareness in the community;
Opportunity 4	Create new fire suppression resources in the watershed.
Opportunity 5	Reduction of peak flow resulting from a flood event.
Opportunity 6	Removal of sediment and debris to prevent blockage of bridges and culverts during a flood event.

PROBLEM STATEMENT EXAMPLE (BASED ON PL-566 AUTHORIZED PURPOSE(S))
The North Dam and South Dam do not meet current State Dam Safety and Natural Resources Conservation Service (NRCS) High Hazard Dam Safety criteria; specifically, there is noncompliance with State and NRCS design criteria for auxiliary spillway capacity.
*The statement is followed by additional clarifying information about the problem(s) (history, specific non-compliance problems, etc)

OPPORTUNITY STATEMENT EXAMPLES FROM CALAMITY CREEK EXAMPLE PLAN-EA
Opportunity 1: Enhance community resilience to flooding risks through the best fit of project measures;
Opportunity 2: Increase the level of breach and flood risk awareness in the community;
Opportunity 3: Complement the ongoing State Wildlife Agency efforts to improve trout habitat;
Opportunity 4: Incorporate natural and nature-based features; and
Opportunity 5: Enhance outdoor recreational opportunities.

Federal Objective (Required by PR&G)

The Federal Objective specifies that Federal water resource investments shall reflect national priorities, encourage economic development, and protect the environment by:
1. Seeking to maximize sustainable economic development;
2. Seeking to avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area may be used; and
3. Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

TABLE 2: PROJECT OBJECTIVES

Objective 1	Address dam safety compliance problems with the Utaba Retarding Dam through the year 2077
Objective 2	Adress seismic stability concerns associated with Utaba Dam through the year 2077.
Objective 3	Adress recognized breach and flood hazards for critical infrastructure downstream of Utaba Dam through the year 2077.
Objective 4	Address sedimentation issues in the Utaba Retarding Dam and provide for capacity through the year 2077.
Objectve 5	Address the need to maintain a floodwater retarding structure in the watershed to reduce peak flow of flood events and to prevent the blockage of downstream infrastructure by removing debris through the year 2077.

TABLE 3: CONSTRAINTS AND CONSIDERATIONS

Constraint 1	Avoid impacts to Utaba Dam that would directly adversely impact or degrade potential habitat for the Federally-threatened Western Yellow-billed Cuckoo or Ute Ladies'-tresses.
Constraint 2	Avoid impacts to any cultural and/or historic resources other than Utaba Dam itself.
Constraint 3	Avoid Real Property Acquisition challenges for properties in the project area.
Constraint 4	Avoid adverse impacts to Camp UTABA, a socially and culturally significant property in the project area.
Constraint 5	Maintain existing recreational facilities in the project area where possible.

- Good Objective Example
  - "Reduce flood damages in the City of Maccaville through the year 2065"
    - Identifies problem (flood damages)
    - Identifies Location (City of Maccaville)
    - Provides the time the project will be effective (through 2065)
- Bad Objective Example
  - "Provide a levee to prevent flooding in the City of Maccaville"
    - Gives a specific measure to prevent flooding
    - Is a pre-decisional objective.
    - Does not give the time the project will be effective
  - "Assess the impacts of flooding in the City of Maccaville"
    - The Plan itself will assess the impacts, planning is not the project objective
    - Not specific enough

Definitions:

Objectives:

Project objectives are developed to address the problems and realize opportunities in the watershed.

Constraints:

Constraints represent likely insurmountable physical or administrative restrictions pertinent to the formulation of alternative plans.

Objective Examples from Calamity Creek Example Plan-EA

Objective 1: Address dam safety compliance problems with the North Dam and South Dam of the North Fork Tributary and the South Fork Tributary (respectively) of Calamity Creek through the year 2122;
Objective 2: Address recognized breach and flood hazards for critical infrastructure along the North Fork through the year 2122; and
Objective 3: Increase the quantity and/or quality of Calamity cutthroat trout habitat in South Fork, including stream connectivity through the year 2122

Constraint Examples from Calamity Creek Example Plan-EA

Constraint 1: Avoid impacts to critical infrastructure (WTP). Note that this applies only to measures on North Fork because no such resources exist in the South Fork area.
Constraint 2: Avoid impacts to historic resources (high school). Note that this applies only to measures on North Fork because no such resources exist in the South Fork area.
Constraint 3: Avoid real property acquisition or change of use for Section 6(f) resources (sports fields, playgrounds, and outdoor areas at high school campus). Note that this applies only to measures on North Fork because no such resources exist in the South Fork area.
Constraint 4: Avoid real property acquisition at railway.
Constraint 5: Avoid impacts to emergency access routes.
Constraint 6: Avoid impacts to South Fork that would directly adversely impact or degrade potential habitat for the Federally-endangered Calamity cutthroat trout. Note that this applies only to measures on South Fork.

DEFICIENCY #1: PRINCIPAL SPILLWAY UNDERSIZED AND DEGRADED CONDITION

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

5 considered
1 carried forward

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
REMOVE AND REPLACE PRINCIPAL SPILLWAY		
REMOVE AND REPLACE EXISTING PRINCIPAL SPILLWAY WITH A LARGER PRINCIPAL SPILLWAY THAT COMPLIES WITH ALL APPLICABLE STANDARDS	o Would require removal and replacement of nearly the entire existing dam. o Would require removal or stabilization of a significant portion of the accumulated sediment to allow construction. o Would address the observed seepage around the outside of the principal spillway conduit. o Would address the likely degraded condition of the principal spillway concrete. o An upstream control gate could be installed allowing better control and addressing a desire to detain water in the reservoir for use in fire control. This measure is not being carried forward due it being more expensive than all other potential measures without a justifiable benefit.	N
ABANDON AND REPLACE PRINCIPAL SPILLWAY		
ABANDON AND REPLACE EXISTING PRINCIPAL SPILLWAY AT A HIGHER ELEVATION.	o Less of the existing dam and sediment would need to be removed for this measure, but a significant portion of the dam and sediment would still need to be removed. o This measure may not address the seepage around the outside of the current spillway conduit. o New principal spillway could be designed to meet all standards and needs. o May require the dam to be raised to restore the capacity lost to sedimentation. Carried forward.	Y
REHABILITATE PRINCIPAL SPILLWAY & BUILD NEW PRINCIPAL SPILLWAY		
REHABILITATE EXISTING PRINCIPAL SPILLWAY AND CONSTRUCT NEW PRINCIPAL SPILLWAY AT HIGHER ELEVATION TO ADDRESS CAPACITY ISSUES	o Would still require removal of a significant portion of the dam to install a new spillway. o Depending on rehabilitation methods chosen and location of the new spillway significant sediment removal may still be necessary. o Spillway rehabilitation methods will most likely reduce the capacity of the existing spillway. o Would not allow upstream control of water releases from the existing principal spillway. This measure is not being carried forward because the sponsors want the ability to control water releases to allow the reservoir to be used for fire control. This measure does not provide that control nor does it address the root problem for less cost than the above measure.	N
REHABILITATE PRINCIPAL SPILLWAY & REQUEST NRCS VARIANCE		
REHABILITATE EXISTING PRINCIPAL SPILLWAY AND REQUEST A VARIANCE FROM NRCS FOR THE UNDERSIZED CONDUIT.	o Would require far less excavation than other alternatives. o Would not require handling sediment depending on rehabilitation methods. o Principal spillway would likely have less capacity and the ability of the dam and reservoir to control floods would be diminished. o Obtaining a variance would be difficult because it would require ignoring numerous dam safety standards. This measure is not being carried forward because it does not provide meet Dam Safety Standards which have been established to provide public safety.	N
REPLACE TOWER PORTION OF PRINCIPAL SPILLWAY AND REHABILITATE THE CONDUIT		
REPLACE TOWER PORTION OF PRINCIPAL SPILLWAY WITH A STRUCTURE THAT ALLOWS SOME CONTROL OF THE WATER BEING RELEASED. REHABILITATE THE CONDUIT.	o Would require removal or stabilization of a significant portion of the accumulated sediment to allow construction of a replacement inlet structure. o Would not address the observed seepage around the outside of the principal spillway conduit. o Would address the likely degraded condition of the principal spillway concrete. o An upstream control gate could be installed allowing better control and addressing a desire to detain water in the reservoir for use in fire control. o Principal spillway would still not meet Dam Safety Standards and would require a variance. o Would allow upstream control of water releases from the existing spillway This measure is not being carried forward since it would not meet Dam Safety Standards which have been established to provide public safety	N

DEFICIENCY #2: AUXILIARY SPILLWAY UNDERSIZED/INSUFFICIENT FREEBOARD AND STRUCTURAL FAILURE

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
REPLACE EXISTING AUXILIARY SPILLWAY WITH A NEW AUXILIARY SPILLWAY LEFT ABUTMENT		
COMPLETELY REPLACE THE EXISTING AUXILIARY SPILLWAY WITH A NEW AUXILIARY SPILLWAY ON THE LEFT ABUTMENT THAT HAS THE CAPACITY TO PASS THE LARGEST REQUIRED STORM EVENT	The replacement of the auxiliary spillway would involve moving the spillway to the left abutment to reduce the risk of a dam breach if the new spillway failed. The new spillway would be much larger and likely would require the dam to be raised to provide additional freeboard to pass the largest required storm event and provide the minimum freeboard needed to comply with Dam Safety Standards. Carried Forward for detailed analysis.	**Y**
REHABIILITATE THE CURRENT AUXILLIARY SPILLWAY AND ADD A SECOND AUXILIARY SPILLWAY TO PROVIDE NECESSARY CAPACITY		
ADD ANOTHER SPILLWAY TO OBTAIN THE NECESSARY CAPACITY TO PASS THE LARGEST REQUIRED STORM EVENT AND REHABILITATE THE EXISTING SPILLWAY	The concrete of the current auxiliary spillway is in such poor condition that the concrete would need to be overlaid to obtain the necessary structural strength. This would reduce the capacity of the spillway. A second auxilliary spillway would need to be approximately 100 feet wide to pass the largest required storm event without raising the height of the dam. Utah Dam Safety has indicated they do not want a spillway located on in the middle of the dam due to the increase risk of a dam breach if the spillway was to fail. This measure is not being carried forward due to not meeting regulatory preference which is based on public safety.	**N**
REPLACE EXISTING AUXILIARY SPILLWAY WITH A NEW AUXILIARY SPILLWAY RIGHT ABUTMENT		
COMPLETELY REPLACE THE EXISTING AUXILIARY SPILLWAY WITH A NEW AUXILIARY SPILLWAY ON THE RIGHT ABUTMENT THAT HAS THE CAPACITY TO PASS THE LARGEST REQUIRED STORM EVENT	The replacement of the auxiliary spillway would involve moving the spillway to the right abutment to reduce the risk of a dam breach if the new spillway failed. The new spillway would be much larger and likely would require the dam to be raised to provide additional freeboard to pass the largest required storm event and provide the minimum freeboard needed to comply with Dam Safety Standards. Due to access issues and soil instability on the right side of the dam, this measure was not carried forward.	**N**

3 considered
1 carried forward

DEFICIENCY #3: INADEQUATE CREST WIDTH

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES WITHOUT ADDING FREEBOARD

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
REQUEST VARIANCE TO DAM SAFETY STANDARDS TO ALLOW A NARROWER MINIMUM CREST WIDTH		
REQUEST A VARIANCE FROM NRCS AND UTAH DAM SAFETY STANDARDS TO BE ALLOWED A NARROWER MINIMUM CREST WIDTH WITHOUT ADDING FREEBOARD	The current crest width is about eight feet less than dam safety standards. This is a significant deviation from dam safety standards. A variance would be requested for any crest width less than the minimum of 22 feet. This measure will not be carried forward since it would require a significant variance from dam safety standards which have been established to provide public safety.	**N**
WIDEN CREST BY ADDING MATERIAL DOWNSTREAM TO COMPLY WITH DAM SAFETY STANDARDS		
WIDEN CREST TO COMPLY WITH DAM SAFETY STANDARDS BY ADDING MATERIAL ON THE DOWNSTREAM SLOPE	This measure would involve adding material to the downstream slope to allow the crest to be widened. Additional downstream material would likely be needed to meet stability standards and to add a filter and drain system. The crest would be widened from 14 feet to 22 feet wide. Carried Forward.	**Y**
WIDEN CREST BY ADDING A WALL ON THE DOWNSTREAM SIDE		
PLACE A WALL ON THE DOWNSTREAM SLOPE TO ALLOW THE CREST TO BE WIDENED WITHOUT ADDING MATERIAL TO THE ENTIRE DOWNSTREAM SLOPE	Using a wall to obtian the minimum crest width without adding material on the entire downstream slope would greatly reduce the material and cost to widen the crest. This measure is not carried forward because it ignores the purpose of the standard and would not be in the best interest of public safety.	**N**
REQUEST VARIANCE TO DAM SAFETY STANDARDS TO ALLOW A NARROWER MINIMUM CREST WIDTH WITH ADDITIONAL FREEBOARD		
REQUEST A VARIANCE FROM NRCS AND UTAH DAM SAFETY STANDARDS TO BE ALLOWED A NARROWER MINIMUM CREST WIDTH WITH ADDED FREEBOARD	This would involve increasing the height of the dam significantly to provide freeboard to pass the largest required flood event (PMF). The additional freeboard would only be necessary to pass the PMF leaving significant freeboard when passing even very large flood events. The width of the dam would be greater than 22 feet at the location needed to meet all other freeboard requirements (i.e. meet the intent of the rule). This would reduce material needed and reduce cost. It would also reduce the impact on Camp Utaba by reducing the footprint of the rehabilitated dam. Carried Forward.	**Y**

4 considered
2 carried forward

DEFICIENCY #4: UNCONTROLLED SEEPAGE AROUND PRINCIPAL SPILLWAY OUTLET CONDUIT

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
ADDRESS SEEPAGE WITH DS FILTER AND DRAIN		
ADDRESS SEEPAGE WITH A DOWNSTREAM FILTER AND DRAIN SYSTEM	This measure would install a filter and drain system designed to meet filter criteria for emabankment and native materials. The filter and drain system would safely allow the seepage to be collected and measured while preventing migration of embankment or native soils, thus eliminating the concern resulting from the seepage. Carried Forward.	Y
REPLACE THE EXISTING PRINCIPAL SPILLWAY		
REPLACE THE EXISTING PRINCIPAL SPILLWAY WITH A NEW PRINCIPAL SPILLWAY IN THE SAME LOCATION	This measure would require the complete removal of the current dam and significant amounts of sediment to allow access to the existing conduit. Installing a new larger conduit would address the flow capacity deficiency. The new conduit would be installed using current dam construction standards to minimize seepage. While this would prevent seepage along the conduit it would not address foundation seepage. A filter and drain system would be required independent of the principal spillway conduit seepage. This measure is not being carried forward because it does not eliminate the need for a filter and drain system and would cost far more than only the filter and drain system that addresses the deficiency.	N
USE HIGH PRESSURE GROUT TO SEAL SEEPAGE PATHWAYS		
DRILL AROUND THE PRINCIPAL SPILLWAY CONDUIT AND INJECT HIGH PRESSURE GROUT TO SEAL LEAKAGE PATHWAYS	A common method to address seepage in abutments that cannot be controled using a filter and drain system is the use of high pressure grout to seal the voids or fractures conveying the seepage. The method can have good success in fractured rock, but is less successful in soils or weather bedrock both of which is present in this location. The high pressures necessary to fill voids has the potential to collapse the conduit. High pressure grouting, even when successful, does not stop all seepage so a filter and drain system would still be required. This measure is not being carried forward because it does not eliminate the need for a filter and drain system and would cost far more than only the filter and drain system that addresses the deficiency.	N
ABANDON AND REPLACE EXISTING PRINCIPAL SPILLWAY AT A HIGHER ELEVATION.		
ABANDON EXISTING PRINCIPAL SPILLWAY BY SEALING THE CONDUIT WITH LOW VISCOSITY GROUT AND REPLACE EXISTING PRINCIPAL SPILLWAY AT A HIGHER ELEVATION.	Abandoning the principal spillway conduit would involve filling the conduit with a low viscosity grout from the outlet end of the conduit. The low viscosity grout would flow out of the conduit through any failed joints or openings to fill adjacent void. If there are no failed joints or openings there would be no impact on the seepage. Openings in the conduit could be created before grouting, but filling of any seepage pathways would only occur near the conduit. A filter and drain system would still be requried to control the seepage. Abandoning the principal spillway is likely to occur in this manner, but it will not fully address this deficiency so it is not being carried forward.	N

4 considered
1 carried forward

DEFICIENCY #5: UNCONTROLLED SEEPAGE & HIGH GROUNDWATER AT TOE OF THE DAM

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
ADDRESS SEEPAGE WITH DS FILTER AND DRAIN		
ADDRESS SEEPAGE WITH A DOWNSTREAM CHIMNEY AND BLANKET FILTER AND DRAIN SYSTEM	This measure would install a chimney and blanket filter and drain system designed to meet filter criteria for emabankment and native materials. The filter and drain system would safely allow the seepage to be collected and measured while preventing migration of embankment or native soils. Thus eliminating the concern resulting from the seepage. Carried Forward.	**Y**
USE HIGH PRESSURE GROUT TO SEAL SEEPAGE PATHWAYS		
DRILL INTO THE BEDROCK AT THE TOE OF THE DAM AND INJECT HIGH PRESSURE GROUT TO SEAL LEAKAGE PATHWAYS	A common method to address seepage in abutments that cannot be controled using a filter and drain system is the use of high pressure grout to seal the voids or fractures conveying the seepage. The method can have good success in fractured rock, but is less successful in soils or weather bedrock both of which are present in this location. High pressure grouting even when successful does not stop all seepage so a filter and drain system would still be required. This measure is not being carried forward because it does not eliminate the need for a filter and drain system and would cost far more than only installing a filter and drain system which addresses the deficiency.	**N**
INSTALL A CUTOFF TRENCH UNDER THE CORE OF THE DAM		
INSTALL A CUTOFF TRENCH UNDER THE DAM TO PREVENT OR REDUCE SEEPAGE THROUGH THE FOUNDATION SOILS, WEATHERED AND COMPETENT BEDROCK	A cutoff wall would be installed underneath the impervious core of the dam to effectively reduce foundation seepage rather than forcing the seepage to the surface or into the downstream dam materials. Installing the cutoff trench below the core fo the dam would require removal of a large portion of the dam. A cutoff wall would greatly reduce the foundation seepage but is unlikely to prevent the need for a chimney and blanket filter and drain system. This measure is not being carried forward because it does not fully address the deficiency and would still require a filter and drain system.	**N**

3 considered
1 carried forward

DEFICIENCY #6: CURRENT PERMANENT DETENTION OF WATER VS. ORIGINAL DESIGN CRITERIA ASSUMING SHORT PERIODS OF WATER DETENTION

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
REHABILITATE THE DAM TO MEET DAM SAFETY STANDARDS FOR WATER STORAGE		
MAKE IMPROVEMENTS TO THE DAM DURING REHABILITATION SO IT MEETS STANDARDS FOR THE LONG TERM STORAGE OF WATER	The dam safety standards for water storage dams are more stringent than for strictly flood control dams that do not store water. To allow long term storage improvements, flattening upstream and downstream slopes may be necessary. A storage right would also be required to store water. This measure is not being carried forward because the sponsor does not have a storage right and does not want to delay rehabilitation to obtain a storage right or to pay the additional cost of upgrading the dam for water storage.	N
REHABILITATE THE SPILLWAYS TO PREVENT LONG TERM WATER STORAGE		
REHABILITATE THE SPILLWAYS TO MEET CURRENT DAM SAFETY STANDARDS AND PROVIDE THE MEANS TO COMPLETELY DRAIN THE RESERVOIR AFTER FLOOD EVENTS.	The current principal spillway is easily blocked by beavers, which cause consistent detention of water in the reservoir. The existing principal spillway would be replaced with a spillway that cannot be blocked by beavers and that would allow the reservoir to be fully drained. Fully draining the reservoir after flood events would allow the dam to be rehabilitated to less stringent standards for a flood control dam. Carried Forward.	Y
REPLACE THE DAM WITH A DAM THAT MEETS DAM SAFETY STANDARDS FOR WATER STORAGE		
COMPLETELY REPLACE THE CURRENT DAM WITH A NEW DAM THAT MEETS THE DAM SAFETY STANDARDS FOR A WATER STORAGE DAM	This measure would involve the complete removal of the current dam and removal of much of the sediment in the reservoir basin. This measure is not being carried forward because the sponsor does not have a storage right and does not want to delay rehabilitation to obtain a storage right.	N

3 considered
1 carried forward

DEFICIENCY #7: UNKNOWN DAM ZONE COMPATIBILITY

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
REPLACE THE ENTIRE DAM		
REPLACE THE DAM WITH AN EMBANKMENT WITH MATERIALS THAT ARE COMPATIBLE AND MEET DAM SAFETY STANDARDS	The current dam would be completely removed so it could be replaced with a dam constructed of zones that are compatible and meet filter criteria. This measure is not being carried forward because installation of a filter and drain system would address the deficiency more efficiently and in a more cost-effective manner.	**N**
INSTALL A CHIMNEY AND BLANKET FILTER AND DRAIN SYSTEM		
INSTALL A CHIMNEY AND BLANKET FILTER AND DRAIN SYSTEM THAT PREVENTS THE MIGRATION OF SOIL PARTICLES	Incompatible soils in the dam can result in the migration of soil particles from an upstream zone into downstream soils thus causing voids to be created that can result in the failure of the dam. A properly designed filter and drain system designed to meet filter criteria for emabankment and native materials prevents the migration of soil particles. This prevents voids from propagating until they reach the surface. Carried Forward.	**Y**
REMOVE AND REPLACE THE DOWNSTREAM ZONE		
REMOVE THE ZONE DOWNSTREAM OF THE IMPERVIOUS CORE AND REPLACE IT WITH MATERIALS THAT ARE COMPATIBLE AND MEET FILTER CRITERIA	The downstream zone materials are typically more coarse than the impervious core potentially allowing soils in the core to migrate into the more coarse downstream materials. This can result in voids that will ultimately cause the failure of the dam. The downstream zone materials would be removed and replaced with compatible soils that meet filter criteria. This measure is not being carried forward because installation of a filter and drain system would address the deficiency effectively with far less impact and cost.	**N**

3 considered
1 carried forward

DEFICIENCY #8: DECREASED SEDIMENT AND STORAGE CAPACITY

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
REMOVE ACCUMULATED SEDIMENT		
REMOVE ACCUMULATED SEDIMENT TO RESTORE SOME OR ALL OF THE ORIGINAL STORAGE CAPACITY	The facility was designed with 137 Acre-feet of storage capacity, 90 Acre-feet of which was allocated for sediment accumulation. Approximately 33 Acre-feet of sediment has accumulated in the reservoir. Removal of the sediment would involve removing, dewatering the sediment and hauling it to a disposal site. Removal of sediment would restore storage capacity and improve the effectiveness of the structure at reducing peak flood flows. Sediment removal is difficult and expensive. Carried Forward.	Y
RAISE THE DAM TO RESTORE LOST CAPACITY		
RAISE THE DAM AND SPILLWAY FLOWLINE ELEVATIONS TO INCREASE OR RESTORE RESERVOIR STORAGE CAPACITY	It is a common practice to raise a dam to restore lost capacity rather than remove sediment due to the greater cost and difficulty of removing sediment. The dam would be raised and the spillways also raised to increase storage capacity. The amount of storage capacity that can be restored is limited by the topography. The material needed to raise a dam can increase dramatically depending on the conditions at the abutments. At this site, the amount of material needed to raise the dam increases dramatically beyond a raise of six feet. Additional freeboard would also be necessary to pass the PMF to comply with Dam Safety Standards so the ability to raise the dam to gain additional storage may be limited. Not carried forward as other measures would address this deficiency more effectively.	N
REPLACE PRINCIPAL SPILLWAY TO REDUCE RATE OF SEDIMENT ACCUMULATION		
REPLACE PRINCIPAL SPILLWAY TO REDUCE RATE OF SEDIMENT ACCUMULATION TO MAINTAIN THE CURRENT EFFECTIVENESS OF THE FACILITY TO REDUCE FLOODING.	This measure would not restore lost storage capacity, but it would reduce the rate at which sediment accumulates and prolong the life of the facility. The new principal spillway would be configured to allow most of the flow and entrained sediment to continue through the reservoir without detention, thus reducing the rate of accumulation. Coarse material such as sands, gravels, and cobbles would continue to accumulate in the reservoir but the finer grained sediment would remain entrained in the water and would continue downstream. Carried Forward.	Y

3 considered
3 carried forward

DEFICIENCY #9: SEISMIC AND STATIC STABILITY OF THE DAM NOT MEETING CURRENT DAM SAFETY STANDARDS

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
MAKE IMPROVEMENTS TO DAM TO COMPLY WITH CURRENT DAM SAFETY STANDARDS		
PERFORM IMPROVEMENTS AS NECESSARY TO BRING THE DAM INTO COMPLIANCE WITH DAM SAFETY SEISMIC AND STABILITY STANDARDS	It is currently unknown if the existing dam meets current dam safety seismic and stability standards. A geotechnical investigation and study would identify the specific deficiencies and recommend improvements. It is unlikely improvements beyond what is necessary to address other deficiencies would be necessary to bring the dam into compliance with seismic and stability standards. Improvements to bring an existing dam into compliance may include: flattening upstream and downstream slopes, adding a stability berm at the upstream and/or downstream toe of the dam, removing a portion of the dam and replacing it with better material, and adding a filter and drain system to remove seepage thus improving strength and stability of downstream materials. Carried Forward.	**Y**
COMPLETELY REPLACE THE EXISTING DAM		
COMPLETELY REPLACE THE EXISTING DAM	To ensure compliance with current dam safety standards the existing dam would be completely removed and replaced with a dam that has been designed and constructed to comply with current dam safety standards. It is unlikely any seismic or stability issues could not be addressed with methods far less impactful than completely removing the dam. Complete removal fo the dam would also require removal of a large portion of the accumulated sediment and the associated impacts. This measure is not being carried forward due to the significantly greater impacts and costs in comparison to the targeted improvements.	**N**

2 considered
1 carried forward

DEFICIENCY #10: NONSTRUCTURAL SOLUTIONS TO PROBLEMS AT UTABA RETARDING DAM

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

6 considered
4 carried forward

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
FLOODPROOFING OF DOWNSTREAM STRUCTURES		
ADD BERMS, LEVYS, CHANNEL IMPROVEMENTS, CULVERT AND BRIDGE REPLACEMENT, ETC. TO PREVENT FLOODING OF DOWNSTREAM STRUCTURES.	This measure would involve identifying any structures that would be impacted by the failure (breach) of the dam during a flood event and would install improvements to prevent damage of the structure. These improvements could include berms, walls, levees, channel improvements, raising structures, rebuilding structures at higher elevations, enlarging culverts or bridges, and raising roads. Floodproofing structures immediately downstream of the dam such as Camp Utaba would require a second dam or channel improvements that would eliminate the camp, which would be difficult. Carried Forward.	Y
DECOMMISSIONING OF THE DAM		
REMOVAL OF THE DAM AND RESTORATION OF THE IMPACTED AREA	The potential failure of the dam could create a greater risk to downstream facilities than the benefits provided by the dam. In recognition of this possibility, the decommisioning of the dam is being considered. Decommissioning the dam would involve removal of the dam, removal and/or stabilization of accumulated sediment, reestablishment of channels through the reservoir area, and site restoration. A significant challenge asociated with this measure is where to dispose of the material from the dam and the accumulated sediment. Disposal of the material would require additional areas to be disturbed and restored. Carried Forward.	Y
PROPERTY RELOCATIONS/BUYOUTS OF STRUCTURES IN FLOODPLAIN		
PURCHASE PROPERTY AND STRUCTURES WITHIN THE FLOODPLAIN TO REMOVE THE HAZARD FROM A POTENTIAL DAM FAILURE	This alternative would identify all property and structures that would be impacted by the failure (breach) of the dam during a flood event. The properties and structures impacted would be purchased. Relocating structures to areas outside the floodplain is also a posibility. Carried Forward.	Y
CHANGE PURPOSE OF THE DAM TO WATER STORAGE		
ADD STORAGE TO THE PROPOSES PURPOSES OF THE DAM	Water storage is a valuable commidity so it would be irresponsible to not consider using the dam to store water. The dam is currently classified as a flood control structure. Design standards are different for water storage dams and flood control dams. A storage right must be obtained for a water storage facility that is not required for a flood control structure. This measure is not being carried forward because the sponsor does not hold a storage right and does not want to delay the project the necessary time to obtain a storage right and to change the classification of the dam. The sponsor is also not interested in the additional costs assiciated with changing the classification. Not Carried Forward.	N
USE OF UTABA RESERVOIR FOR RECREATION		
ADD RECREATION TO THE PURPOSE OF THE DAM AND RESERVOIR	Adding recreation to the current flood control purpose of the dam would change design, management, and operation of the facility. Adding recreation to the purpose would require permanent storage of water and improved pubic access. The area would receive significantly increased public usage. This measure is not being carried forward because the sponsor does not hold the necessary storage right, is not interested in the associated liabilty and cost. Additional the owners of the land which the dam and reservoir are located (Camp Utaba and Durfree Creek HOA) both oppose promoting recreational use of the reservoir. Not Carried Forward.	N
ABILITY TO DETAIN WATER FOR WILDFIRE SUPPRESSION		
RECONFIGURE THE PRINCIPAL SPILLWAY TO INCLUDE A GATE THAT CAN BE CLOSED TO CREATE A SMALL POOL THAT COULD BE USED FOR WILDFIRE SUPPRESSION	Wildland firefighters are interested in having a source of water to use to fight potentail fires on the north end of the Ogden Valley. Currently there is no way to prevent discharge of water from the reservoir. Adding the ability to detain water in the reservoir for wildfire suppression would involve adding a control gate to the principal spillway so that release of water from the reservoir could be restricted causing the reservoir to fill. A control gate would be added to the principal spillway to allow inspection of the spillway conduit independent of a desire for a water source for wildland fire suppression. Carried Forward.	Y

TABLE 5: MEASURES CONSIDERED AND SELECTED FOR INCORPORATION INTO ALTERNATIVES

C = Compatible/Combinable, M = Mutually Exclusive or Unecessarily Redundant

Pairwise Compatibility	Abandon & Replace Principal Spillway	Replace Existing Auxiliary Spillway Left Abutment	Widen Crest by Adding Material Downstream	Request Variance for Crest Width & Freeboard	Principal Spillway Seepage DS Filter & Drain System	Toe of Dam Seepage DS Filter & Drain System	Rehabilitate the Spillways to Prevent Long-Term Water Storage	Install Chimney & Blanket Filter & Drain System	Remove Accumulated Sediment	Replace Principal Spillway to Reduce Sedimentation	Improve Dam to Comply with Safety Standards	Floodproofing of Downstream Structures	Decommissioning of the Dam	Property Relocations of Structures in Floodplain	Ability to Detain Water for Wildfire Suppression	Preliminary Evaluation of Combinations	Carried Forward?
Abandon & Replace Principal Spillway	NA	C	C	C	C	C	C	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Replace Existing Auxiliary Spillway Left Abutment	C	NA	C	C	C	C	C	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Widen Crest by Adding Material Downstream	C	C	NA	C	C	C	C	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Request Variance for Crest Width & Freeboard	C	C	C	NA	C	C	C	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Principal Spillway Seepage DS Filter & Drain System	C	C	C	C	NA	C	C	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Toe of Dam Seepage DS Filter & Drain System	C	C	C	C	C	NA	C	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Rehab. the Spillways to Prevent Long-Term Water Storage	C	C	C	C	C	C	NA	C	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Install Chimney & Blanket Filter & Drain System	C	C	C	C	C	C	C	NA	C	C	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Remove Accumulated Sediment	C	C	C	C	C	C	C	C	NA	C	C	M	C	M	C	This measures is compatible/combinable with all other measures with the exception of floodproofing and property relocations. Carried forward for combination into alternative plans.	Y
Replace Principal Spillway to Reduce Sedimentation	C	C	C	C	C	C	C	C	C	NA	C	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Improve Dam to Comply with Safety Standards	C	C	C	C	C	C	C	C	C	C	NA	M	M	M	C	This measure is compatible/combinable with all other measures with the exception of floodproofing, deommissioning, and property relocations. Carried forward for combination into alternative plans.	Y
Floodproofing of Downstream Structures	M	M	M	M	M	M	M	M	M	M	M	NA	M	M	M	This measure is only compatible with itself. All other measures are mutually exclusive or redundant. Carried forward for combination into alternative plan.	Y
Decommissioning of the Dam	M	M	M	M	M	M	M	M	C	M	M	M	NA	M	M	This measure is only compatible with removal of accumulated sediment. All other measures are mutually exclusive or redundant. Carried forward for combination into alternative plan.	Y
Property Relocations of Structures in Floodplain	M	M	M	M	M	M	M	M	M	M	M	M	M	NA	M	This measure is only compatible with itself. All other measures are mutually exclusive or redundant. Carried forward for combination into alternative plan.	Y
Ability to Detain Water for Wildfire Suppression	C	C	C	C	C	C	C	C	C	C	C	M	M	M	NA	This measure is compatible/combinable with all other measures with the exceptions of floodproffing, decommissioining, and property relocations. Carried forward for combination into alternative plan.	Y

TABLE 6: SUMMARY OF INITIAL ALTERNATIVES AND 1ST SCREENING BASED ON OBJECTIVES AND CONSTRAINTS

N = not met, Y = met, NA = not applicable

ID	ALTERNATIVE DESCRIPTION	DAM SAFETY OBJECTIVE	SEISMIC STABILITY OBJECTIVE	FLOOD HAZARDS OBJECTIVE	SEDIMENTATION OBJECTIVE	ESA IMPACTS CONSTRAINT	HISTORIC PROPERTIES CONSTRAINT	REAL PROPERTY RIGHTS CONSTRAINT	CAMP UTABA/HOA CONSTRAINT	RECREATIONAL FACILITIES CONSTRAINT	FUNDING CONSTRAINT	CARRIED FORWARD Y/N?
NO ACTION/FWOFI ALTERNATIVE	**The No Action/FWOFI Alternative** would be the scenario in which no Federal funding is provided and therefore no measures implemented.	N	N	N	N	Y	N	Y	N	Y	Y	Y
STRUCTURAL REHABILITATION ALTERNATIVE	**Structural Rehabilitation Alternative** • Abandon & Replace Principal Spillway • Replace Existing Auxiliary Spillway with a New Auxiliary Spillway Left Abutment • Replace Existing Auxiliary Spillway with a New Auxiliary Spillway Right Abutment • Widen Crest by Adding Material Downstream to Comply with Dam Safety Standards • Request Variance to Dam Safety Standards to Allow a Narrower Minimum Crest Width with Additional Freeboard • Address Seepage with Downstream Filter & Drain System (Principal Spillway) • Address Seepage with Downstream Filter & Drain System (Toe of the Dam) • Rehabilitate the Spillways to Prevent Long-Term Water Storage • Install a Chimney & Blanket Filter & Drain System • Remove Accumulated Sediment • Raise the Dam to Restore Lost Capacity • Replace Principal Spillway to Reduce Rate of Sediment Accumulation • Make Improvements to Dam to Comply with Current Dam Safety Standards Ability to Detain Water for Wildfire Suppression	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
DECOMMISSIONING ALTERNATIVE	**Decommissioning Alternative** Decommissioning of the Dam/Removal of the Dam	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y
FLOODPROOFING ALTERNATIVE	**Floodproofing Alternative** Floodproofing of Downstream Structures	Y	N	Y	N	Y	Y	N	N	N	N	Y
RELOCATIONS/PROPERTY BUYOUTS ALTERNATIVE	**Relocations/Buyouts Alternative** Conduct Property Relocations/Buyouts of Structures in Floodplain	Y	N	Y	N	Y	N	N	N	N	N	N

TABLE 7: SUMMARY OF 2ND SCREENING OF INITIAL ARRAY OF ALTERNATIVES BY ECOSYSTEM SERVICES AND ECONOMICS

N = not met, Y = met, NA = not applicable

ID	ALTERNATIVE NAME	PROVISIONING	REGULATING	CULTURAL	SUPPORTING	BCR	NET BENEFITS	CARRIED FORWARD?
NO ACTION/FWOFI ALTERNATIVE	The No Action Alternative would negatively impact downstream water quality in Pineview Reservoir following a breach of the dam. Additionally, sediment washed downstream would also adversely impact fish populations. The No Action Alternative would cause public safety to be endangered as a breach becomes more likely. This alternative would negatively impact Camp UTABA and other downstream youth camps when a breach eventually occurs. Aesthetic value would be degraded following a breach and existing habitat for the WYBC would be damaged or destroyed in a breach event. Overall, cultural services would be degraded under this alternative. Overall ecosystem services would be degraded under this alternative. However, the No Action/FWOFI is required to be carried forward into the Final Array of Plans under NEPA and the PR&G to act as an analytic baseline. Carried into the FInal Array of Alternatives.	X	X	X	NA	0	$0	Y
STRUCTURAL REHABILITATION ALTERNATIVE	The Structural Rehabilitation Alternative would have no impacts on water quality, irrigation water for agriculture, or downstream fish populations. The measures included under this alternative would reduce the likelihood of a breach significantly and would allow the dam to be utilized as a fire suppression resource during a wildfire event. Camp UTABA and other youth camps downstream would be protected by a structural rehabilitation which would make a breach significantly less likely than the current condition. No change would occur to aesthetic value or any WYBC habitat. There would be temporary negative impacts to North Fork Park, which would be used to relocated removed sediment and dam material, but it would be restored to its former condition following construction. Overall, the ecosystem services in the area would improve under this alternative. The BCR would be above 1.0 and the net benefits would be positive. Carried Forward into the Final Array of Alternative Plans.	X	X	X	NA	3.47	$635,699	Y
DECOMMISSIONING ALTERNATIVE	The Decommissioning Alternative would have no impacts on water quality, irrigation water for agriculture, or downstream fish populations. The measures included under this alternative would eliminate the risks associated with a breach entirely. As the dam would be removed, there would be no change in the ability of the site to be used as a fire suppression resource. There would be negative impacts to the aesthetic value of the area and to North Fork Park that would occur as a result of the Decommissioning Alternative. There would be no change in WYBC habitat or the quality of Camp UTABA or the youth camps. Overall, ecosystem services in the project area would be improved under this alternative although not to the same extent as other alternatives and with some adverse impacts to cultural services. Carried Forward into the Final Array of Alternative Plans, as at least one Nonstructural Alternative is required in the Final Array under the PR&G Planning framework.	X	X	X	NA	4.3	$629,167	Y
FLOODPROOFING ALTERNATIVE	Provisioning and Cultural services would experience significant degradation over time as a result of the implementation of the Floodproofing of structures Alternative plan. Floodproofing would improve the condition of some regulating ecosystem services, however. This alternative would generally degrade the provision of ecosystem services in the project area and, although it would provide some benefits, the decommissioining alternative is a more cost effective, feasible, and beneficial nonstructural alternative to be included in the Final Array of Alternatives. Not Carried forward into the Final Array of Alternative Plans.	X	X	X	NA	NA	NA	N

TABLE 8: FINAL ARRAY OF ALTERNATIVES	
Alternative 1 -- No Action -- Future Without Federal Investment (FWOFI) Alternative	Taking no action would consist of activities carried out if no federal action or funding were provided. This alternative would not address the deficiencies at Utaba Retarding Dam. There would be no improvements made to the current condition of the principal and auxiliary spillways, the inadequate crest width of the dam, or the uncontrolled seepage issues that exist at the outlet conduit of the principal spillway and at the toe of the dam. Furthermore, soil migration would continue to occur, and sediment would continue to accumulate, with no storage capacity being restored. Seismic and static stability of the dam would remain unknown, and the risk of a breach would grow more likely over time. Under this alternative, it is reasonable to assume that a breach would become imminent.
Alternative 2 -- Proposed Action -- Structural Rehabilitation Alternative	The Structural Rehabilitation Alternative would upgrade Utaba Retarding Dam to meet Utah State and NRCS Dam Safety Standards while maintaining water detention capacity. The dam would be raised 4 feet to provide additional freeboard for the Probable Maximum Flood (PMF) event. The undersized and degraded principal spillway would be replaced, and the auxiliary spillway would be relocated to the left abutment. A downstream filter and drain system would address seepage issues, and a new principal spillway would prevent blockages from beaver activity while allowing full reservoir drainage. A chimney and blanket filter system would be installed to prevent soil migration. Sediment management measures include removing accumulated sediment and reducing sediment buildup by upgrading the principal spillway. To meet safety standards, modifications could include flattening slopes, adding a stability berm, or replacing weak dam material. A control gate on the principal spillway would allow water release to be restricted, enabling the reservoir to serve as a wildfire suppression resource.
Alternative 3 -- Proposed Action -- Decommissioning Alternative (Nonstructural)	The PR&G requires that at least one nonstructural alternative be evaluated in full detail for REHAB projects such as this. Three nonstructural alternatives were evaluated in the initial array of alternative plans but only one was included in the final array as it was the only one that was deemed potentially feasible by the sponsors. This alternative recognizes that the potential failure of the dam could create a greater risk to downstream properties and facilities than the benefits that are provided by the dam. The measures that would be included under this alternative would require the complete removal of the dam, removal and/or stabilization of accumulated sediment, reestablishment of channels through the reservoir area, and site restoration/revegetation. The disposal of the dam material and accumulated sediment represents a significant challenge associated with this alternative. Ultimately, the disposal of material and sediment would require the disturbance of additional areas which would need to be subsequently restored and revegetated. Although the Purpose and Need of the project would be met with a single measure (i.e., decommissioning) under this alternative, it would be costly and have substantial impacts as discussed in Chapter 5. However, the option remains to implement this nonstructural alternative and decommission the existing dam.
Environmentally Preferred/LEDPA (from NEPA)	The NEPA process mandates that an environmentally preferred alternative be identified as a part of the planning process. Additionally, if a CWA Section 404 permit (any potential impacts to WOTUS) is required, the principles of the U.S. Army Corps of Engineers (USACE) Least Environmentally Damaging Practicable Alternative (LEDPA) should be followed and complied with during the development of alternative plans. LEDPA principles are best adhered to using the framework of first avoidance, then minimization, then mitigation. Alternative 2 – Structural Rehabilitation Alternative is the environmentally preferable/LEDPA alternative for this Plan-EA because it is the alternative which maximizes environmental benefits. The Structural Rehabilitation would have the least significant and adverse impacts to the environment of the three alternatives in the final array.
Locally Preferred	Under the PR&G, it is required to identify an alternative plan that is locally preferred. This alternative was developed with sponsors and local interests that have oversight or implementation authorities and responsibilities. In the case of this project, the locally preferred alternative is Alternative 2 – Proposed Action – Structural Rehabilitation Alternative because it would be the most cost-effective for the sponsors and received the most positive input and support from project stakeholders during scoping and during the Alternative Selection Meeting held on March 5, 2025.
National Economic Efficiency (NEE) Alternative (Economically Preferred)	Under the PR&G, the NRCS must identify the Federally assisted alternative plan with the greatest net benefits, otherwise known as the National Economic Efficiency (NEE) plan. The alternative selected as the NEE must also comply with the PL 83-566 program and be in accordance with the six Guiding Principles of the PR&G. These principles incorporate selecting the alternative in the final array with the highest BCR. For this Plan-EA, the NEE Alternative is Alternative 2 – Structural Rehabilitation Alternative, which has a BCR of X.X and total net benefits of $XX,XXX - $XX,XXX.

TABLE 9: SUMMARY AND COMPARISON OF ALTERNATIVES -- PLANNING PROCESS

ITEM OR CONCERN	ALTERNATIVE 1 - FWOFI/NO ACTION	ALTERNATIVE 2 - STRUCTURAL REHABILITATION	ALTERNATIVE 3 - DECOMMISSIONING
DEFICIENCIES			
DEFICIENCY #1. Principal Spillway Undersized & Degraded	The No Action Alternative would not improve the principal spillway, which would remain degraded and undersized.	This alternative would address this deficiency by abandoning and replacing the current principal spillway with a new one at a higher elevation. The new spillway would meet all dam safety standards.	The Decommissioning Alternative would address this deficiency by completely removing the entire dam, including the principal spillway. This would constitute a nonstructural solution to this deficiency.
DEFICIENCY #2. Auxiliary Spillway Undersized & Insufficient Freeboard	The auxiliary spillway would not be improved under this alternative.	This alternative would replace the existing auxiliary spillway with a new one on the left abutment of the dam with capacity to pass the PMF.	This alternative would remove the current dam, including the auxiliary spillway, constituting a nonstructural solution to this deficiency.
DEFICIENCY #3. Inadequate Crest Width	The No Action Alternative would not improve the crest width to meet Federal or State Dam Safety Standards.	The Structural Rehab. Alternative would address this deficiency by widening the crest width to comply with dam safety standards by adding material on the downstream slope. A variance may be requested from NRCS and Utah Dam Safety to allow a narrower minimum crest width with added freeboard if all other stability requirements are met during the design process.	The Decommissioning Alternative would address this deficiency by completely removing the dam, which would eliminate the need to update crest width as there would no longer be a dam in place. This would constitute a nonstructural solution to this deficiency.
DEFICIENCY #4. Uncontrolled Seepage Around Principal Spillway Outlet Conduit	This alternative would not address the uncontrolled seepage at the principal spillway outlet conduit. The dam would eventually breach.	This alternative would address the uncontrolled seepage around the principal spillway outlet conduit by installing a downstream filter and drain system that would meet filter criteria for embankment & native materials.	This alternative would address the uncontrolled seepage around the principal spillway outlet conduit by removing the dam, including the principal spillway outlet conduit, altogether. This would constitute a nonstructural solution.
DEFICIENCY #5. Uncontrolled Seepage & High Groundwater at the Toe of the Dam	The No Action Alternative would not address the seepage and high groundwater issues at the toe of the dam. The dam would eventually fail under this plan.	The Structural Rehab. Alternative would address the seepage and high groundwater at the toe of the dam by installing a downstream chimney and blanket filter and drain system to safely allow the collection and measurement of seepage & prevent migration of soils.	The Decommissioning Alternative would address the seepage and high groundwater at the toe of the dam by completely removing the dam and the accumulated sediment. This would constitute a nonstructural solution to this deficiency.
DEFICIENCY #6. Permanent Detention of Water vs. Original Design Criteria	This alternative would not address this deficiency as no action or Federal funding would be provided.	This alternative would rehabilitate the principal and auxiliary spillways to prevent long-term water storage and provide the means to completely drain the reservoir after flood events.	This alternative would eliminate the need to prevent the long-term storage of water or to drain the reservoir after flood events by decommissioning the entire dam, which would constitute a nonstructural solution to this deficiency.
DEFICIENCY #7. Unknown Dam Zone Compatibility	The dam zone compatibility would remain unknown under this alternative, as no funding would be provided.	This alternative would install and chimney & blanket filter & drain system to prevent the migration of soil particles, which can create voids which can propagate and cause failure.	This alternative would make the unknown dam zone compatibility a moot point as the dam would be decommissioned, constituting a nonstructural solution to this deficiency.
DEFICIENCY #8. Decreased Sediment & Storage Capacity	The No Action Alternative would not address sediment accumulation or restore storage capacity for sediment. The dam would eventually fail.	The Structural Rehabilitation Alternative may remove accumulated sediment to restore some or all of the original sediment storage capacity and would replace the principal spillway to reduce the sedimentation rate and to maintain the current efficacy of the facility in order to reduce flooding.	The Decommissioning Alternative would completely remove the existing dam, including the accumulated sediment in the dam. The sediment would need to be moved to another location. The removal of sediment would be costly. This alternative would constitute a nonstructural solution to address this deficiency.
DEFICIENCY #9. Seismic & Static Stability Not Meeting Dam Safety Standards	This alternative would not upgrade Utaba Dam to meet static and/or seismic stability standards. The dam would eventually breach.	This alternative would make improvements to the dam to comply with current dam safety standards as necessary beyond the measures that would be taken to address other deficiencies. This could include flattening slopes, adding a stability berm, or removing a portion of the dam and replacing it with better material.	This alternative would completely remove and decommission the existing dam, eliminating the need to upgrade the facility for seismic and static stability criteria. This would constitute a nonstructural solution to this deficiency.
DEFICIENCY #10. Nonstructural Solutions to Problems at Utaba Dam	Under this alternative, no Federal investment would be made, so no actions, structural or nonstructural would be taken.	This alternative would include a single nonstructural measure to reconfigure the principal spillway of the dam to be able to detain water for short periods of time to allow inspection of the principal spillway conduit and allow the reservoir to serve as a fire suppression resource	The entire process of decommissioning the dam that would be undertaken as a part of this alternative would be representative of a nonstructural solution to problems at Utaba Dam. The entire dam and the accumulated sediment would be removed, and the natural course of the river would be restored to as close as possible to the pre-dam state. Wildland firefighters would not have a

		should wildland firefighters need an additional source of water.	close as possible to the pre-dam state. Wildland firefighters would not have a source of water.
PROJECT OBJECTIVES			
OBJECTIVE #1. Dam Safety	This alternative would not bring the dam into compliance with Dam Safety Criteria. **Objective Not Met**	This alternative would rehabilitate Utaba Dam to bring it into compliance with NRCS and Utah Dam Safety Standards through various structural measures. **Objective Met.**	This alternative would eliminate the need to rehabilitate the dam by decommissioning it. It would meet the objective to bring the facility into compliance. **Objective Met.**
OBJECTIVE #2. Seismic Stability	This alternative would not improve the seismic or static conditions at the facility. **Objective Not Met.**	The Structural Rehab. Alternative would address concerns related to the seismic and static stability of Utaba Dam through various structural measures. **Objective Met.**	The Decommissioning Alternative would address concerns related to the static and seismic stability of the current dam by removing it & the accumulated sediment. **Objective Met.**
OBJECTIVE #3. Breach Hazard	This alternative would not increase the public's awareness of breach/flood risks & the dam would eventually fail. **Objective Not Met.**	This alternative would increase public awareness of recognized breach and flood hazards associated with the dam through the public notification process which would explain why construction would take place and what the reasons are. **Objective Met.**	This alternative would increase public awareness of recognized breach and flood hazards associated with the dam through the public notification process which would explain why the dam was being decommissioned. **Objective Met.**
OBJECTIVE #4. Sediment Issues	This alternative would not address sediment accumulation or storage in Utaba Dam. **Objective Not Met.**	This alternative may remove the accumulated sediment from the dam and rehabilitate the principal spillway to reduce the accumulation rate in the dam. Reducing the accumulation rate would allow the facility to function through its intended lifespan. **Objective Met.**	This alternative would remove the accumulated sediment along with the dam and deposit it elsewhere. The removal of the dam and sediment would eliminate all other sediment concerns. **Objective Met.**
OBJECTIVE #5. Flood Control	This alternative would not provide a floodwater retarding structure to take the peaks off flood flows or prevent the downstream blockage of infrastructure by. **Objective Not Met.**	This alternative would rehabilitate Utaba Dam to provide a floodwater retarding structure to take the peak off flood flows and prevent blockage of infrastructure by debris through the year 2077. **Objective Met.**	This alternative would not provide a floodwater retarding structure to take the peaks off flood flows or prevent the downstream blockage of infrastructure by debris through the year 2077. **Objective Not Met.**
CONSTRAINTS			
CONSTRAINT #1. Special Status Species	The No Action/FWOFI Alternative would not have any impacts on ESA species. **Constraint Met.**	The Structural Rehab. Alternative would avoid impacts on Federally listed species to the maximum extent possible. With no effects on the ULT and indirect temporary effects to the WYBC. **Constraint Met**	The Decommissioning Alternative would not avoid impacts to ESA species/suitable habitat to the maximum extent practicable as removal of the dam could modify ULT habitat and WYBC habitat upstream. **Constraint Not Met.**
CONSTRAINT #2. Cultural/Historic Properties	The FWOFI Alternative would include the eventual failure of the dam, leading to adverse impacts on historic properties located within the Indirect APE and Camp UTABA, a historic district. **Constraint Not Met.**	The Structural Rehabilitation would have no adverse impacts on cultural or historic properties other than the dam itself, which is specified in the constraint description. **Constraint Met.**	The Decommissioning Alternative would have no adverse impacts on cultural or historic properties other than the dam itself, which is specified in the constraint description. **Constraint Met.**
CONSTRAINT #3. Real Property Rights	The No Action Alternative would avoid any challenges to real property acquisition to the maximum extent possible. **Constraint Met.**	The Structural Rehabilitation would minimize real property acquisition challenges to the maximum extent practicable. **Constraint Met.**	The Decommissioning Alternative would minimize real property acquisition challenges to the maximum extent practicable. **Constraint Met.**
CONSTRAINT #4. Camp UTABA Impacts	Camp UTABA would be essentially destroyed when the dam eventually failed. **Constraint Not Met.**	There would be no permanent adverse impacts to Camp UTABA as a result of this alternative's implementation. In fact, the camp would be protected from future damages. **Constraint Met.**	The decommissioning alternative would temporarily disturb Camp UTABA in the process pf dam removal. This means that adverse impacts to the camp and the HOA would not be avoided under this plan. **Constraint Not Met**.
CONSTRAINT #5. Recreational Facilities	The FWOFI would not impact current recreational opportunities in the short term, although the impacts to Camp UTABA (included under constraint 4) would eventually occur. **Constraint Met.**	Under this alternative, there would be no change in the recreational opportunities that currently exist in the study area. The the use of the Camp, North Fork Park, and the other potential opportunities would remain as they are now. **Constraint Met.**	Under this alternative, there would be a removal of the dam, effectively eliminating a potential/existing recreational facility. Furthermore, North Fork Park would likely be used as an area to store accumulated sediment and material from the dam as it was removed but would be restored after implementation. **Constraint Not Met**.
CONSTRAINT #6. Funding	This alternative would not exceed the funding limits of the PL-566 program. **Constraint Met**.	The Structural Rehabilitation Alternative would not exceed the funding limits established by PL-566. **Constraint Met**.	The Decommissioning Alternative would not exceed the funding limits established by PL-566. **Constraint Met**

PR&G EVALUATION CRITERIA			
COMPLETENESS	The No Action/FWOFI Alternative would **not constitute a complete solution** as no problems would be addressed.	The Structural Rehab. Alternative would account for all necessary investments needed to achieve the planned effects and **constitutes a complete alternative/solution.**	The Decommissioning Alternative would account for all necessary investments needed to achieve the planned effects and **constitutes a complete alternative/solution.**
EFFECTIVENESS	This alternative would **not constitute an effective solution** as no problems would be solved and no objectives would be met.	This alternative would address all of the identified problems and meet all of the opportunities. The alternative would stay within all the constraints and meet the objectives. **Constitutes an effective solution.**	Not all objectives and planning constraints would be adhered to under this plan. This alternative would **not constitute an effective solution.**
EFFICIENCY	This alternative would not cost anything to implement and so would **constitute a cost efficient solution.**	This alternative is also the NEE Alternative and has net positive economic benefits with a BCR of 3.47. This alternative **would constitute a cost efficient solution.**	This alternative, although not as cost efficient as the Structural Rehab plan, would still have positive net economic benefits with a BCR of 4.30. **Would constitute an efficient solution.**
ACCEPTABILITY	This alternative would **not be acceptable** or consistent with existing Federal laws as it would not protect the environment and would not address any of the problems in the watershed.	This alternative would comply with all Federal and State regulatory frameworks and is the environmentally preferred alternative (from NEPA) and the locally preferred alternative. The problems in the watershed would be addressed. This option **constitutes an acceptable solution**.	This alternative would comply with all Federal and State regulatory frameworks. The problems in the watershed would be addressed. This option **constitutes an acceptable solution.**

Ecosystem Services Framework Worksheet

PR&G Ecosystem Services Scoping and Evaluation Worksheet

Franson Civil Engineers

PROJECT NAME	Utaba Dam Rehabilitation Supplemental Plan-EA
PROJECT NUMBER	23074
PROJECT MANAGER	Layne Jensen/Chad Brown

Overview of Framework

The PR&G Ecosystem Services Framework is an analysis approach that traces the pathways of natural ecosystem processes to the benefits which they grant to society in monetary and non-monetary terms. NRCS requires that an ecosystem services framework be worked within throughout the preliminary investigation and planning process. Ecosystem services are broken into four service categories which include:

(1) Provisioning Services: tangible goods for human use such as food, clean air, fresh water, energy, fuel, forage, fiber, and minerals.
(2) Regulating Services: maintain natural processes which provide buffers against environmental catastrophe such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood prevention/control; and disease regulation.
(3) Supporting Services: underlying processes maintaining conditions for life such as pollination, seed dispersal, soil formation, and nutrient cycling.
(4) Cultural Services: services related to the cultural or spiritual needs of people such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

Evaluation Approach

Ecosystem services are first evaluated from a qualitative perspective during scoping to identify the types of services present in the watershed, and then specifically to identify those that could interact with (impact or be impacted by) the authorized project purpose(s)/problems.

Regulatory Requirement (Level II PR&G Analysis)

The National Watershed Program Manual (NWPM) requires a level II PR&G analysis for any WSOP or REHAB program that will have a Federal construction cost-share of more than $10 million. This level of PR&G analysis requires the robust development of an ecosystem service framework and resulting ecosystem services flows.

Use of this Worksheet

This worksheet was created as a way to document our incorporation and use of the ecosystem services framework and to provide written evidence of the evaluation approach described above. Fill in all the applicable fields on this worksheet for the project you are working on. If it is not a text form or dropdown list, it should not be changed. Depending on the project, not every form or field will be applicable.

AFFECTED ENVIRONMENT: IDENTIFICATION/SCOPING FOR ECOSYSTEM SERVICES

In the tables below, identify ecosystem services that currently exist in the project area and place them under the appropriate service categories as described in the "Overview of Framework" section of this worksheet. Remember, the initial evaluation of ecosystem services should be conducted from a qualitative perspective. The services identified should be directly related to the PL-566 authorized purpose(s)/Problem(s) for the project. Incidental service benefits will be identified in a later section.

Table 1 Scoped Provisioning Services in the Project Area

PROVISIONING SERVICES
Drinking Water Quality(North Fork Ogden River/Pineview Reservoir)
Food Production/Irrigation Water pulled from Pineview Reservoir
Fish Population Downstream of Utaba Reservoir
NA

Provisioning Services: tangible goods for human use such as food, clean air, fresh water, energy, fuel, forage, fiber, and minerals.

Table 2 Scoped Regulating Services in the Project Area

REGULATING SERVICES
Flood Prevention/Public Safety Generated by Dam
Floodwater Detention in Reservoir for Fire Suppression
NA
NA

Regulating Services: maintain natural processes which provide buffers against environmental catastrophe such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood prevention/control; and disease regulation.

Table 3 Scoped Supporting Services in the Project Area

SUPPORTING SERVICES
Evaluated as an intermediate ecosystem service, therefore it is not carried forward in this ecosystem services analysis.
NA
NA
NA

Supporting Services: underlying processes maintaining conditions for life such as pollination, seed dispersal, soil formation, and nutrient cycling.

Table 4 Scoped Cultural Services in the Project Area

CULTURAL SERVICES
Cultural/Spiritual experiences from Youth Camps
Aesthetic Value of natural stream systems and forest
Recreational experiences at North Fork Park
Existence value of Yellow-billed Cuckoo habitat

Cultural Services: services related to the cultural or spiritual needs of people such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

FORECASTED FUTURE CONDITIONS (NO ACTION/FWOFI/ANALYTIC BASELINE)

In the section below, evaluate the reasonably projected changes in the ecosystem service benefits you identified in the previous section. The main focus of this projections should be on how the change in the provision of the service will alter the benefits they provide to society/human welfare. Again, this section should be qualitative and does not necessarily need to provide any specific quantities of services. This write-up (or some slight variation of it) will be included in the Plan-EA/EIS.

The projected changes in the provision of ecosystem services in the project area if no Federal Investment were made would result in overall reductions in the ecosystem service benefits that the natural systems in the project area provide to society. The following changes in ecosystem service benefits would be expected if existing conditions are to continue:

1. Drinking Water Quality Provisioning Service:
   - Following a breach, the dam would provide the same level of drinking water to Pineview Reservoir
   - Drinking water quality in the river and Pineview Reservoir would be degraded due to the sediment accumulated in the reservoir being washed into the reservoir, making drinking water treatment more difficult.

2. Food Production/Irrigation Water Provisioning Service:
   - Following a breach, the dam would provide the same quantity of irrigation water to Pineview Reservoir.

3. Fish Population Downstream Provisioning Service:
   - Following a breach, the reservoir's accumulated sediment would be flushed downstream and would degrade water quality which would generate die off of fish populations in Pineview Reservoir.

2. Flood Prevention/Safety Regulating Service:
   - Dam would not be rehabilitated and risk of breach would remain high
   - Dam will eventually breach, which has potential risk to life and property

3. Fire Suppression/Floodwater Detention Regulating Service:
   - Following a breach, the dam would not be able to serve as a fire suppression resource
   - Floodwater detention capabilities of the project area would be eliminated

5. Youth Camp Downstream Cultural Service:
   - Camp UTABA and other downstream youth camps would be at risk of destruction if dam were to breach
   - Breach can be reasonably forecasted and would eliminate all youth camps in the breach zone

6. Aesthetic Value Cultural Service:
   - The visual aesthetics of the site would be changed during a dam breach, accumulated sediment in the reservoir that would be left over and the scar from the breach would negatively impact the viewshed

7. North Fork Park Cultural Service:
   - No expected change in service provision

8. Yellow-billed Cuckoo Habitat Cultural Service:
   - The potentially suitable habitat downstream of the dam would be eliminated in a breach

MONETIZING, QUANTIFYING, AND QUALIFYING ECOSYSTEM SERVICES

The decision tree below was provided by the National Watershed Management Center (NWMC) and should be a helpful reference in completing this section of the worksheet.

NWMC Decision Tree for Ecosystem Services

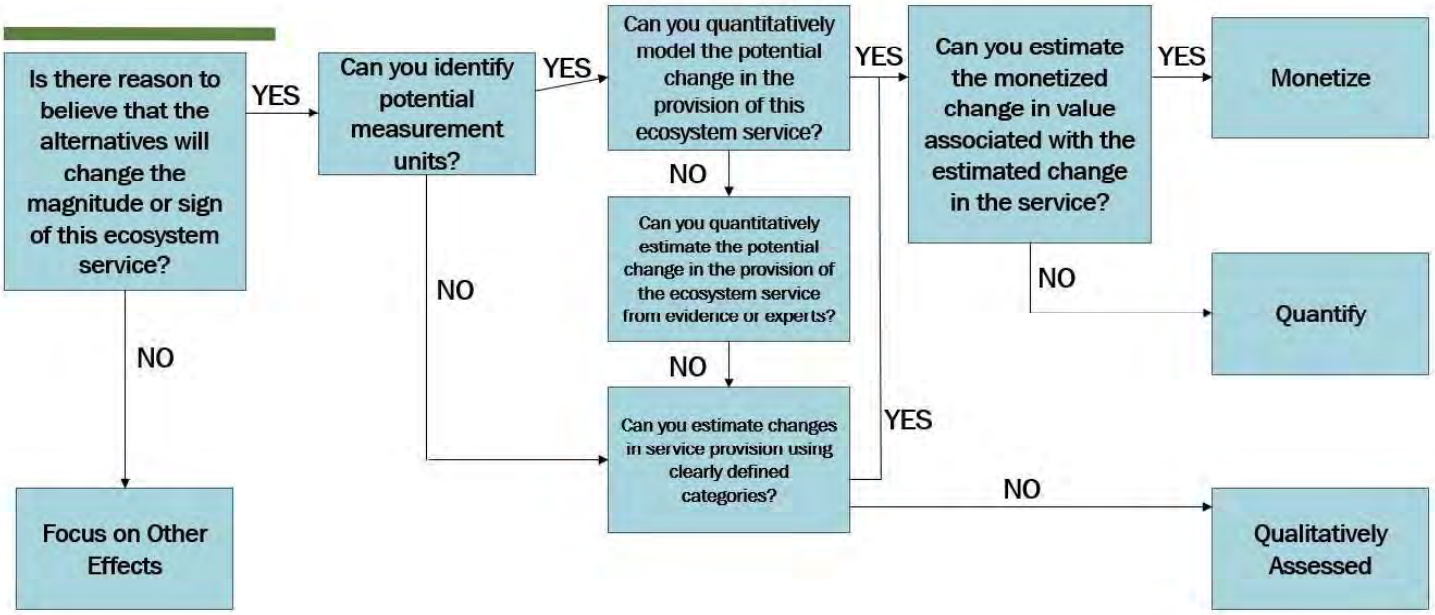

Table 5 Summary of Ecosystem Services & Their Representative Metrics

PROVISIONING SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
Drinking Water Quality	Quantified	Turbidity Measurements Pineview Res.
Irrigation Water	Quantified	Acre-Feet Delivered to Pineview Res.
Fish Population	Qualified/Non-Monetized	Turbidity (Qualitatively Observed)
NA	Not Applicable	NA
REGULATING SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
Flood Prevention	Monetized	Cost of Flood Damages/Breach
Floodwater Detention/Fire Supp.	Qualified/Non-Monetized	Availability of Dam for Fire Suppression
NA	Not Applicable	
NA	Not Applicable	NA
SUPPORTING SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
NA	Not Applicable	NA
NA	Not Applicable	NA
NA	Not Applicable	NA
NA	Not Applicable	NA
CULTURAL SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
Youth Camps	Qualified/Non-Monetized	Availability of Camp UTABA
Aesthetic Value	Quantified	USDA Scenic Beauty Estimation Tool
North Fork Park	Qualified/Non-Monetized	Availability of North Fork Park
Cuckoo Habitat	Quantified	Acres of Potentially Suitable Habitat

Examples of Monetized Representative Metrics: flood damage benefits (dollars), expected tourism (dollars)

Examples of Quantified Representative Metrics: protected/restored acres of farmland, crop yields, acre-feet of saved water, WQ Index, habitat units, wildlife/fish/plant species population changes

Examples of Qualified Representative Metrics: aesthetic improvements, vegetation restoration, new recreational opportunities, improved access to the outdoors

MONETIZED ECOSYSTEM SERVICES BENEFITS SUMMARY FOR ALTERNATIVES

Fill in the table below to summarize the estimated monetized benefits of the ecosystem services you identified (if applicable). This table should be provided to the project economist to be included in the economic analysis. It should also be noted that, if necessary, the non-monetized ecosystem service benefits should be provided to the economist to serve as a tradeoff if the B/C ratio does not meet at least 1. These benefits may be used to raise the B/C ratio given subjective values.

Also note, if there were no monetized benefits identified or if any of the ecosystem service categories were eliminated during scoping, note that in the table by including a line that says, "not monetized for this plan".

Table 6 Monetized Benefits Summary for Ecosystem Services

	No Action	Action Alternative 1	Action Alternative 2
PROVISIONING SERVICES			
Drinking Water Quality	Not monetized for this plan	Not monetized for this plan	Not monetized for this plan
Irrigation Water	Not monetized for this plan	Not monetized in this Plan	Not monetized in this Plan
Fish Population	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
NA	NA	NA	NA
REGULATING SERVICES			
Flood Prevention	$0	$893,358 Damage Reduction benefit	$819,767 Damage Reduction Benefit
Fire Suppression/Floodwater Detention	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
NA	NA	NA	NA
NA	NA	NA	NA
SUPPORTING SERVICES			
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
CULTURAL SERVICES			
Youth Camps	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Aesthetic Value	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
North Fork Park	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Yellow-billed Cuckoo Habitat	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Total Annual Monetized Benefits	$0	$893,358	$819,767
Total Annual Monetized Costs	$1,003,809	$257,659	$190,600
Benefit-Cost Ratio	0.0	3.47	4.30
Annual Monetized Net Benefit	$0	$893,358	$819,767

IDENTIFICATION OF INCIDENTAL ECOSYSTEM SERVICES

If necessary (usually meaning the B/C ratio for alternative(s) are not reaching 1 with the benefits of problem/authorized purpose related ecosystem benefits), incidental ecosystem services may be used to help raise the B/C ratio to 1 subjectively. The identification of incidental ecosystem services can also help support the environmental/NEPA analysis in the Plan-EA/EIS document.

If desired, fill in the tables below for incidental ecosystem services in the project area.

Table 7 Incidental Provisioning Services in the Project Area

PROVISIONING SERVICES
NA
NA
NA
NA

Provisioning Services: tangible goods for human use such as food, clean air, fresh water, energy, fuel, forage, fiber, and minerals.

Table 8 Incidental Regulating Services in the Project Area

REGULATING SERVICES
Water Quality/Filtration via Aquatic Vegetation & Wetlands
NA
NA
NA

Regulating Services: maintain natural processes which provide buffers against environmental catastrophe such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood prevention/control; and disease regulation.

Table 9 Incidental Supporting Services in the Project Area

SUPPORTING SERVICES
NA
NA
NA
NA

Supporting Services: underlying processes maintaining conditions for life such as pollination, seed dispersal, soil formation, and nutrient cycling.

Table 10 Incidental Cultural Services in the Project Area

CULTURAL SERVICES
NA
NA
NA
NA

Cultural Services: services related to the cultural or spiritual needs of people such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

ENVIRONMENTAL CONSEQUENCES: IMPACTS OF ALTERNATIVES ON ECOSYSTEM SERVICES

In the environmental consequences chapter of the Plan-EA/EIS, the impacts of each alternative in the final array on ecosystem services must be evaluated. If the service is monetized or quantified, the dollars or values associated with that service under each alternative should be listed in the descriptions. In the sections below, generate write-ups for the Plan-EA/EIS that evaluate the environmental consequences/impacts to the ecosystem services in the project area.

Ecosystem Services Impact Write-Ups:

PROVISIONING SERVICES

No Action: Utaba Dam would continue to contribute to drinking and irrigation water supply in Pineview Reservoir and provide water to the reservoir annually until dam failure. Following failure, the flow in the river would pass through the area instead of being slowed down, but would deliver approximately the same amount of drinking/irrigation water to Pineview reservoir. However, due to the heavy sediment load that would be flushed into Pineview Reservoir following a breach, the costs of drinking water treatment would be expected to increase. Additionally, the heavy sediment load would generate higher turbidity and degrade the water quality in Pineview which would cause die off of certain fish species.

Action Alternative 1: Utaba Dam would allow water to pass through the reservoir and provide water to the reservoir annually for drinking water supply and irrigation. Drinking water treatment costs would remain at their current costs. Downstream fish populations would also remain in their existing condition.

Action Alternative 2: Utaba Dam would be decommissioned and the flow of the North Fork Ogden River would deliver the same amount of water to the reservoir annually. Sediment would be removed/stabilized meaning the water quality would not be impacted downstream to a great extent. Treatment costs would remain static. Downstream fish populations would also remain in their existing condition.

REGULATING SERVICES

No Action: Utaba Dam would result in $1,003,809 of average annual flood damages attributable to dam failure/breach. The dam would not serve as a fire suppression resource. The dam would maintain its existing floodwater detention capacity of XX acre-feet until failure, at which point there would be no water storage in the area.

Action Alternative 1: Utaba Dam would provide $893,358 of average annual flood damage reduction benefits. The dam would serve as a wildfire suppression resource. The floodwater detention capacity of the dam would be increased under this alternative.

Action Alternative 2: Utaba Dam would result in $819,767 of average annual flood damages attributable to the decommissioning of the dam. Note that the cost is higher as this alternative would be accompanied by buyouts of properties in the breach zone. The dam would not serve as a fire suppression resource. There would be no floodwater detention in the area if the dam were removed.

SUPPORTING SERVICES EVALUATED AS INTERMEDIATE SERVICE IN THIS PLAN, NO ADDITIONAL INFORMATION NECESSARY.

CULTURAL SERVICES

No Action: The nearby Youth Camps would remain available for cultural/spiritual use until the threat of a breach was too great, at which point the camps would be eliminated and would no longer be available. The aesthetic value of the area would be changed following dam failure as the accumulated sediment and the breach scar would be visible. North Fork Park would continue to be used. The potentially suitable Yellow-billed Cuckoo habitat downstream of the dam would likely be destroyed under a dam failure, reducing the acres of potentially suitable habitat.

Action Alternative 1: The nearby Youth Camps would be able to remain available for cultural/spiritual use for the entire life of the rehabilitated dam (52 years). The aesthetic value of the site would remain mostly in tact even though the dam will be enlarged and the spillway moved. North Fork Park would be utilized as a borrow area. Weber County has expressed interest in restoring the park following construction. The suitable habitat for Yellow-billed Cuckoo would not be changed and would remain in current condition.

Action Alternative 2: The nearby Youth Camps would be allowed to remain if desired by owners if the dam were decommissioned. However, the cultural services offered by the camp would not be as great as there would no longer be the reservoir for recreation. The aesthetic value of the site would be changed by the removal of the dam and the removal/stabilization of the accumulated sediment. North Fork Park could remain available for recreational use, however the service would be modified in that the reservoir/aesthetics would have changed. The amount of suitable Yellow-billed Cuckoo habitat would not change and would remain in current condition.

Biological Assessment (BA) of the Preferred Alternative

Biological Assessment

Utaba Dam Rehabilitation Supplemental Watershed Plan-EA

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January 2026

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1 Introduction

This Biological Assessment (BA) has been prepared to document the potential effects of the Utaba Dam Rehabilitation Supplemental Watershed Plan-EA project on Federally listed species afforded protection under Section 7 of the Endangered Species Act (ESA). The Natural Resources Conservation Service (NRCS) is the lead Federal agency for the project, providing technical and financial assistance to the sponsor through the Watershed Rehabilitation Program (Public Law 83-566).

Weber County, Utah, the Sponsoring Local Organization (SLO) for the project, is developing a Plan-EA that seeks to identify a viable alternative solution to address current dam safety issues at Utaba Retarding Dam located upstream of Pineview Reservoir and just downstream of the confluence of the North Fork Ogden River with Cutler Creek.

1.1 Consultation to Date

- **July 2, 2024** – Project Kickoff Meeting
    - Representatives from NRCS, Weber County, Camp Utaba, Durfee Creek HOA, Utah Dam Safety, Franson Civil Engineers, Gerhart Cole Geotechnical, and Cirrus Ecological Solutions were in attendance.
    - Prior to geotechnical field work occurring, a courtesy copy of a short-form BA was sent to the U.S. Fish and Wildlife Service (USFWS) with a no effect determination.
- **August 13, 2024** – BA Planning Discussion
    - NRCS: Derek Hamilton
    - Franson Civil Engineers: Layne Jensen, Landon Richins
    - Cirrus Ecological Solutions: Scott Evans, Adam Clifford
- **August 14, 2024** – Agency Scoping Meeting
    - USFWS Attendees: Dannette Weiss
    - NRCS Attendees: Derek Hamilton, Tara Hoffmann, Shawn Stanley, Anders Fillerup
    - Franson Civil Engineers (FCE): Layne Jensen, Landon Richins

1.2 Consultation Participants

The following individuals consulted to determine the level of consultation necessary and the conservation measures to be committed to for each considered species in this BA (Table 1).

Table 1. List of Consultation Participants and Affiliations.

Name	Title	Affiliation
Derek Hamilton	Biologist	Natural Resources Conservation Service
Shawn Stanley	Project Engineer	Natural Resources Conservation Service
Layne Jensen	Project Manager	Franson Civil Engineers
Landon Richins	Environmental Specialist I	Franson Civil Engineers
Scott Evans	Biological Survey Lead	Cirrus Ecological Solutions
Adam Clifford	Senior Wildlife Biologist	Cirrus Ecological Solutions
John Stewart	Senior Botanist	Cirrus Ecological Solutions

2 Project Description

2.1 Project Area

The project area is located in Weber County, Utah just downstream of the confluence of the North Fork Ogden River and Cutler Creek and upstream of Pineview Reservoir. Figure 1 shows the general vicinity of the project and Figure 2 shows the project area (study area). The project area for the proposed action is limited to the existing dam embankment. Figure 3 shows the areas of disturbance associated with the proposed action.

2.2 Action Area

The Action Area includes the area of disturbance associated with dam rehabilitation, including the associated species buffers (0.5 miles for birds and 300 feet for plants). The Action Area is shown in Figure 2 (1/2 Mile Buffer for Biological Studies). The following acreages are associated with the Action Area:

- Action Area: 61 acres.
- Action Area with 0.5-mile bird buffer: 1,152 acres.
- Action Area with 300-foot plant buffer: 147 acres.

2.3 Project Details

Detailed drawings of the proposed action are located in Attachment A. The proposed action consists of the following components:

2.3.1 Proposed Action – Structural Rehabilitation Alternative

The Structural Rehabilitation Alternative would upgrade Utaba Retarding Dam to meet Utah State and NRCS Dam Safety Standards while maintaining water detention capacity. The dam would be raised 4 feet to provide additional freeboard for the Probable Maximum Flood (PMF) event. The undersized and degraded principal spillway would be replaced, and the auxiliary spillway would be relocated to the left abutment. A downstream filter and drain system would address seepage issues, and a new principal spillway would prevent blockages from beaver activity while allowing full reservoir drainage. A chimney and blanket filter system would be installed to prevent soil migration. Sediment management measures include removing accumulated sediment and reducing sediment buildup by upgrading the principal spillway. To meet safety standards, modifications could include flattening slopes, adding a stability berm, or replacing weak dam material. A control gate on the principal spillway would allow water release to be restricted, enabling the reservoir to serve as a wildfire suppression resource. The following management measures are included in the Structural Rehabilitation Alternative:

2.3.1.1 Principal & Auxiliary Spillways

2.3.1.1.1 Abandon & Replace Principal Spillway

This measure would abandon the existing principal spillway and replace it with a new spillway located at a higher elevation. The new principal spillway would be designed to meet all standards and needs. This measure would require less of the existing dam and accumulated sediment to be removed but would still require a significant portion of the dam and some sediment to be removed. This measure alone may not address the uncontrolled seepage that currently occurs around the outside of the current spillway conduit, which is addressed in another measure using a downstream filter and drain system.

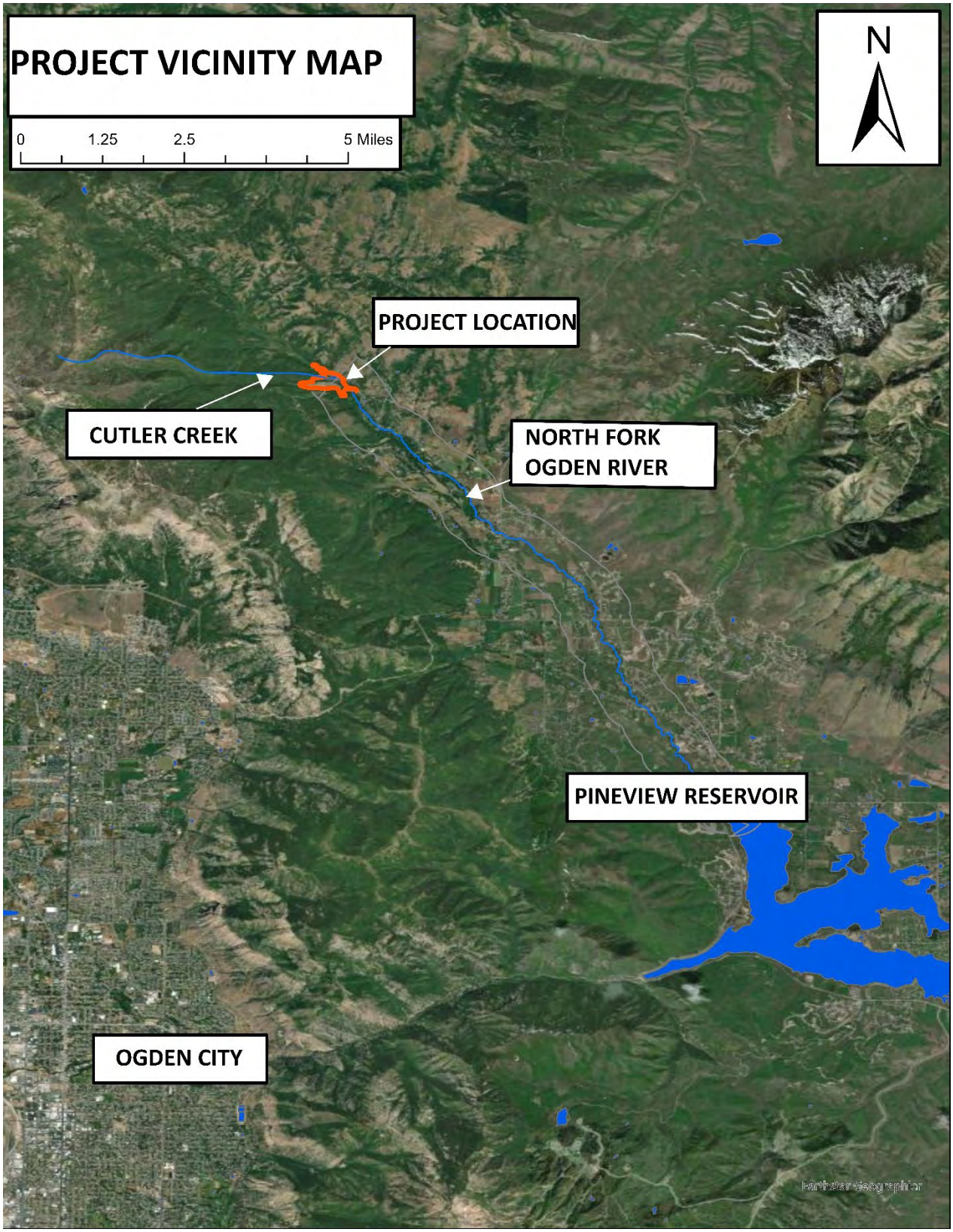

Figure 1. Vicinity map of the Utaba Dam rehabilitation project.

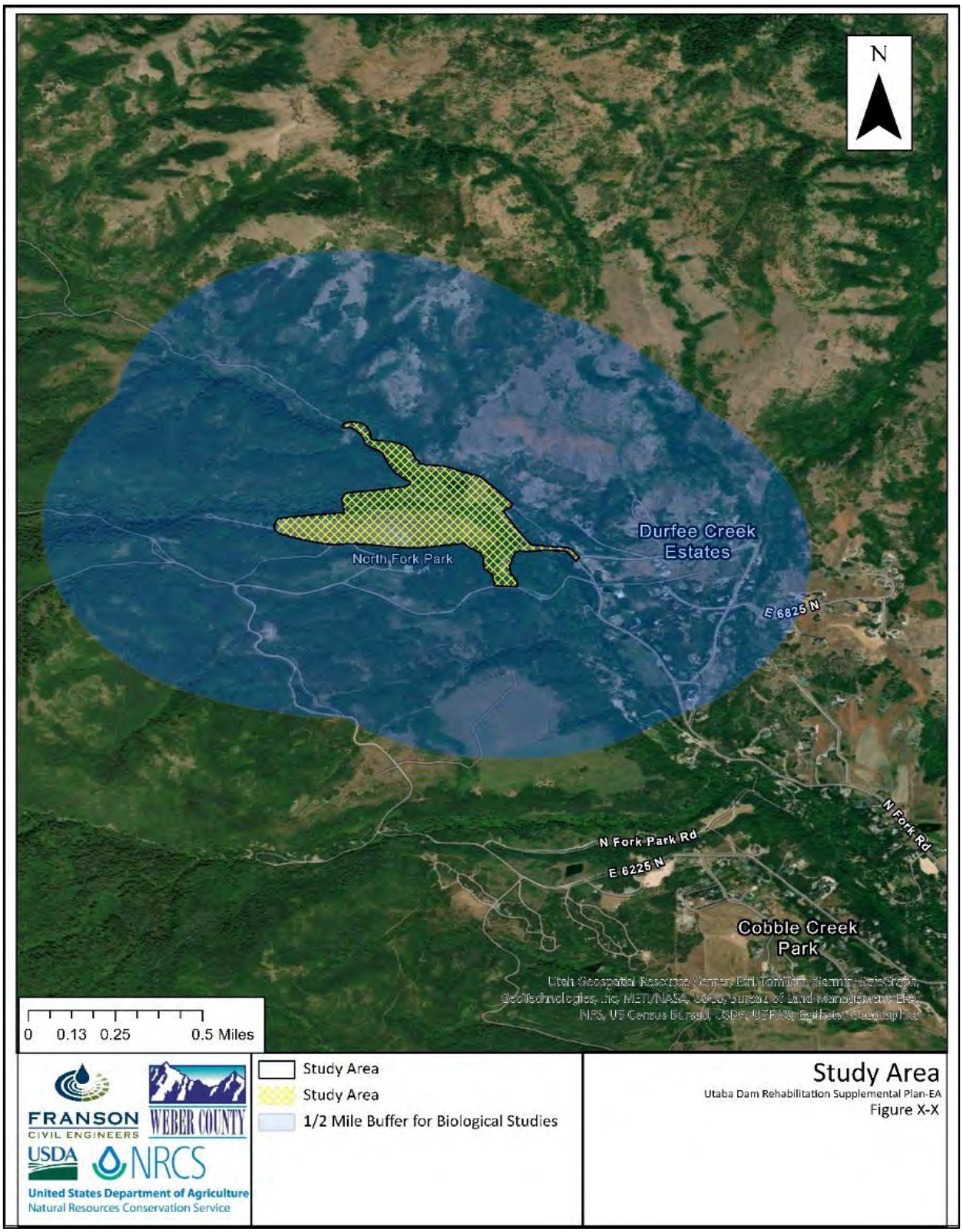

Figure 2. Project Action Area with 0.5-mile Western Yellow-billed Cuckoo survey buffer.

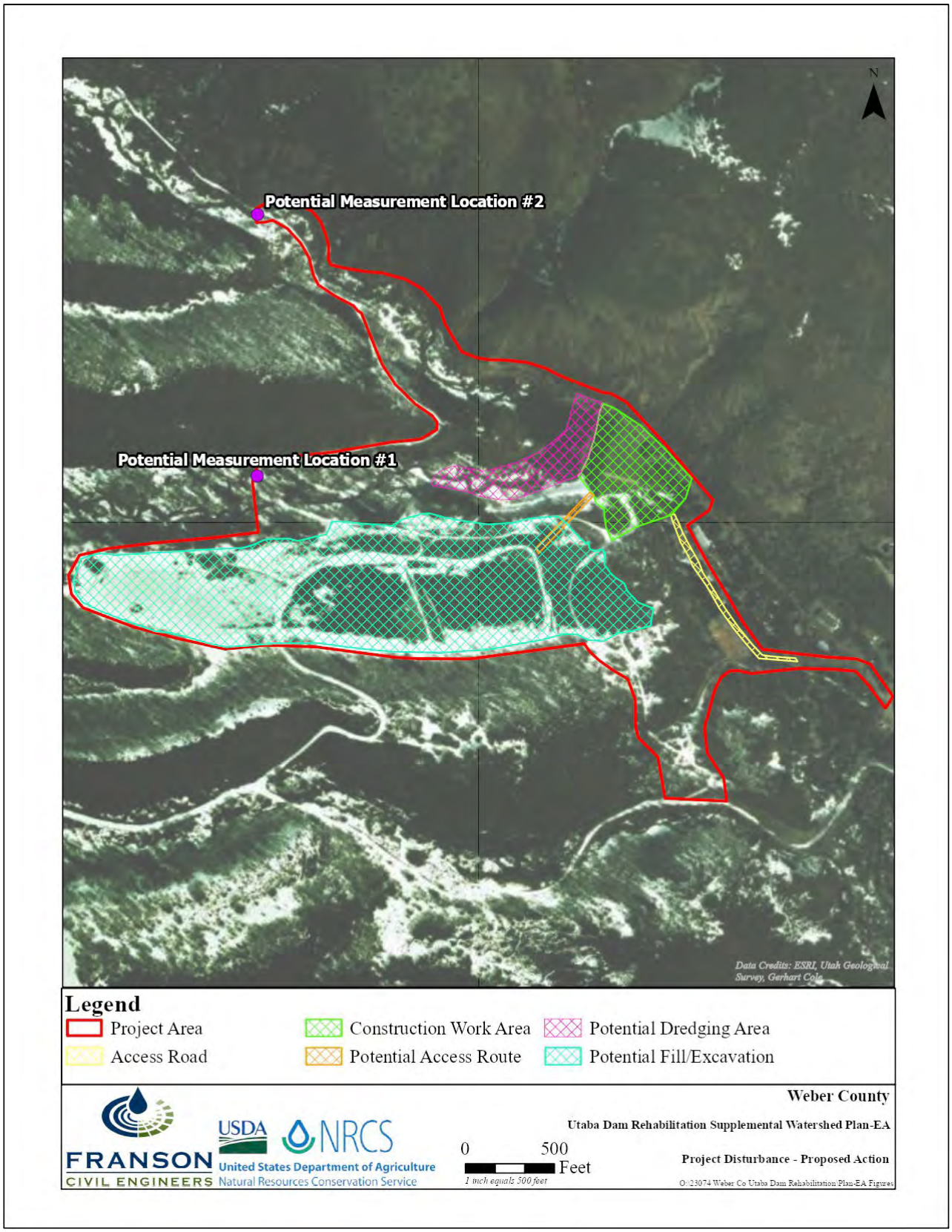

Figure 3. Project disturbance associated with the proposed action.

2.3.1.1.2 Replace Auxiliary Spillway – Left Abutment

In this measure, the entire existing auxiliary spillway would be completely replaced, and a new auxiliary spillway structure would be installed on the left abutment of the dam. The purpose of relocating the auxiliary spillway, besides updating the spillway to meet current dam safety standards, would be to reduce the risk of a structural failure of the dam. Current dam safety standards would require the new auxiliary spillway to provide a significant amount of additional freeboard and to pass the largest required storm event (the PMF).

2.3.1.1.3 Rehabilitate Spillways to Prevent Long-Term Water Storage

Utaba Reservoir is not currently able to completely drain following flood events due to woody debris blockages at the principal spillway. These blockages are a result of regular beaver (*Castor canadensis*) activity near the site. In this measure, the new principal spillway would be designed so that it could not be choked by woody debris generated from beaver activity. Doing this will allow the reservoir to be fully drained after flood events and would require the rehabilitation to be completed with less stringent standards for a flood control dam.

2.3.1.2 Crest Width of the Dam

2.3.1.2.1 Widen Crest by Adding Material Downstream to Comply with Safety Standards

To meet current dam safety standards, the crest width of the dam needs to be widened. This measure would accomplish this by adding material to the downstream (and possibly upstream) slope of the dam, which would allow the crest to be widened to meet safety standards. Stability standards would likely also require additional downstream material to be used and would allow the installation of a filter and drain system. The crest would be widened from 14-feet to 22-feet wide.

2.3.1.2.2 Request Variance to Safety Standards to Allow a Narrower Minimum Crest Width

Under this management measure, a variance would be requested from NRCS and Utah Dam Safety to allow a narrower minimum crest width with additional freeboard. To do this, the height of the dam would be increased significantly to generate freeboard to pass the largest required flood event, or the PMF. This additional freeboard would only be necessary to pass this PMF, with even very large flood events still being able to pass. At the location needed to meet all freeboard requirements, the width of the dam would be greater than 22 feet (i.e., to meet the intent of the rule). However, the variance would allow materials and costs to be reduced and would limit the impact on Camp UTABA by reducing the overall footprint of the rehabilitated dam.

2.3.1.3 Seepage Control

2.3.1.3.1 Address Seepage at Principal Spillway Outlet Conduit with Filter & Drain System

Uncontrolled seepage around the outlet conduit of the principal spillway would be addressed through the installation of a filter and drain system. This system would be designed to meet filter criteria for the embankment and native materials. The system would allow the seepage to be collected and measured while preventing migration of embankment or of native soils. The system would eliminate the risks and concerns associated with the seepage.

2.3.1.3.2 Address Seepage & High Groundwater at Toe of Dam with Filter & Drain System

Uncontrolled seepage and high groundwater conditions at the toe of the dam would be addressed through the installation of a downstream chimney and blanket filter and drain system. The system would be designed to meet filter criteria for the embankment and native materials. The system would allow the seepage to be collected and measured while preventing migration of the embankment or of native soils. The system would eliminate the risks and concerns associated with the seepage itself.

2.3.1.4 Prevention of Soil Migration

2.3.1.4.1 Install Chimney & Blanket Filter & Drain System

Migration of incompatible soil particles from an upstream zone into downstream soils can cause voids to be created. These voids have the potential to result in the failure of the dam. To prevent the migration of soil particles at Utaba Dam, this measure would install a chimney and blanket filter and drain system that would prevent voids from propagating until they reach the surface. The system would be designed to meet filter criteria for the embankment and native materials.

2.3.1.5 Sediment Storage Management

2.3.1.5.1 Rehabilitate Principal Spillway to Reduce Rate of Sediment Accumulation

This measure would address the management of sediment storage in the reservoir without directly restoring lost sediment storage capacity. This measure would reduce the rate at which sediment accumulates and would prolong the life of the facility. The new principal spillway would be configured to allow most of the flow and entrained sediment to continue to pass through the reservoir without detention. This would reduce the sediment accumulation rate in the reservoir. Coarse materials like sands, gravels, and cobbles would continue to settle out and accumulate in the reservoir, but the finer grained sediment would remain entrained in the water and continue downstream before settling out.

2.3.1.5.2 Remove Accumulated Sediment

This measure would remove accumulated sediment in the dam to restore some or all of the original sediment storage capacity. The facility was designed to include 137 acre-feet of total storage capacity with 90 acre-feet of this capacity allocated for sediment accumulation. Currently, about 33 acre-feet of sediment has accumulated in the reservoir (Genterra Consultants 2020). Removal of the sediment would require dewatering of the sediment and hauling it to a designated disposal site. Removal of the sediment would restore storage capacity and would improve the effectiveness of the structure at reducing peak flood flows. Sediment removal is very difficult and expensive.

2.3.1.6 Seismic and Static Stability of the Dam

2.3.1.6.1 Additional Improvements to Comply with Current Dam Safety Standards

There could be additional improvements that would need to be made at the site to ensure the rehabilitated structure complies with all State and Federal dam safety standards. These improvements are included in the Plan-EA but would only be implemented if necessary. It is currently not known if the existing dam meets current dam safety seismic and stability standards. A geotechnical investigation and study would identify the specific deficiencies of this nature and would make recommendations for improvements. It is unlikely that improvements would extend beyond what is already known to be necessary to address other deficiencies. However, additional improvements could include flattening upstream and downstream slopes, constructing a stability berm at the upstream and/or downstream toe of the dam, removing a portion of the dam and replacing it with

better material, and/or adding a filter and drain system to remove seepage for improvement of strength and stability of downstream materials.

2.3.1.7 Fire Suppression Resource

2.3.1.7.1 Install Control Gate to Detain Water for Wildfire Suppression

An additional management measure that would be implemented under this alternative would be to create the ability for the Utaba Reservoir to serve as a fire suppression resource should a wildfire be in the area. This would require the new principal spillway to be reconfigured to include a gate that could be closed to detain water to be used for wildfire suppression. Wildland firefighters in the area have expressed interest in having a source of water to use to fight potential fires on the north end of the Ogden Valley. The current reservoir has no way to prevent discharge of water. To provide the reservoir with this capability, a control gate would be installed at the principal spillway, allowing the release of water to be restricted to fill the reservoir. A control gate would be added to the principal spillway to allow inspection of the spillway conduit independent of a desire for a water source for wildland fire suppression.

2.4 Conservation Measures

The following conservation measures are proposed for the species considered in this BA:

- Conduct a third-year survey for the Ute Ladies'-Tresses (ULT) (*Spiranthes diluvialis*) in 2026 in the Action Area. If any ULT plants are found in the project area, initiate discussions with the USFWS to determine if any additional measures are needed to protect the plants or their habitat.
- Ensure all staging areas are located outside areas identified as suitable ULT habitat.
- If work requiring heavy machinery is located within suitable ULT habitat, geotextile matting would be used as a barrier to reduce soil compaction, when practical.
- All disturbed areas must be reseeded with an appropriate seed mix using non-invasive species.
- All construction equipment must be cleaned prior to accessing the project site.
- Machinery fueling would take place in a confined, designated upland area. All fueling areas are to be contained and appropriate spill prevention and cleanup materials will be present in compliance with the Utah Pollution Discharge Elimination System (UPDES) requirements.
- Fill material will be free of waste, pollutants, and noxious weeds/seeds.
- Only water will be used for dust suppression efforts. If any WYBC individual(s) are found in the project area prior to or during construction, initiate discussions with the USFWS to determine if any additional measures are needed to protect the individual(s) or their habitat.

Project Area

1. Project actions will not take place or have a physical footprint (e.g., construction, temporary access routes, staging grounds) within suitable habitat.

Project Timing and Surveys

1. Since suitable habitat occurs within the action area, and project work will occur during the breeding season, additional protocol level surveys are required the breeding season (June 1 – August 31) prior to the initiation of construction activities. Surveys will be conducted by qualified individual(s) according to the Service-accepted survey protocol. If nesting cuckoos are detected, or breeding behavior is observed during the breeding season (June 1st

through August 31st), and project work is still planned for the following breeding season, reinitiation of Section 7 consultation with Service is required. If there are no detections of yellow-billed cuckoo and breeding during protocol-level surveys the breeding-season prior to construction, the following conservation measures apply:

a. Initiation of construction activities (noise-producing actions) will occur a minimum of two weeks prior to the onset of breeding season.

b. If construction overlaps with the breeding season but cannot begin prior to the breeding season (previous bullet), a permitted, qualified biologist shall conduct pre-construction surveys to verify that cuckoos are not present in suitable habitat within 0.5 miles of project activities. These surveys will take place 3 to 7 days before project activities begin.

    i. Pre-construction surveys will be conducted at the point locations previously surveyed the year prior. Each location will be surveyed once in the 3-7 days before project activities commence. Apart from the number of visits, protocol-level survey procedures will be followed.

2. If there is a pause in noise-generating construction activities for ≥14 days during the breeding season, additional surveys will be conducted as above.

Reporting

1. If one or more yellow-billed cuckoos are detected during pre-construction surveys, UTESFO will be contacted within 24 hours of survey completion for additional guidance.
2. Official survey reports will be submitted to UTESFO within 60 days for inclusion in the project record.

Noise disturbance

1. All equipment will have properly functioning mufflers to minimize engine noise.

Habitat alterations

1. Project activities will be managed to avoid changes to the hydrologic regime that would result in loss or degradation of suitable habitat and/or recruitment of riparian vegetation in suitable habitat (e.g., water extracted, diverted, or produced as a by-product).
2. No new access routes will be created by the project within suitable breeding habitat. New access routes within suitable foraging or migratory habitat will be limited. Disturbance to all habitats will be minimized by staying on designated access routes.
3. No vegetation removal will occur within suitable habitat. If vegetation is removed, it will be replaced with native species using best management practices for successful establishment of plantings in coordination with the Service.
4. All areas of surface disturbance created by the project (e.g., access routes, staging sites, work areas) within riparian areas or adjacent uplands will be rehabilitated through such means as raking out scars, gating access points, and revegetation with native species using best management practices for successful establishment of plantings in coordination with the Service.
5. Revegetation sites will be monitored and maintained to improve planting establishment and survival for two to three growing seasons. If not successful, revegetation sites will be replanted/reseeded in coordination with the Service.

2.5 Existing Habitat Conditions

The Action Area is located within the Wasatch and Uinta Mountains, Alpine Zone ecoregion. The ecoregion is defined by high, glaciated mountains, dissected plateaus, foothills, and intervening valleys. Land uses in the area surrounding the Action Area include residential, agricultural, and recreational.

3 Species Considered

3.1 Species that May Be Present

An official species list was obtained for the Action Area from the Information for Planning and Consultation (IPaC) system on March 12, 2025 (see Attachment B). The species listed as threatened or endangered that "may be present in the area of the proposed action" are listed in Table 2. There is no designated critical habitat for any of the species within or adjacent to the Action Area.

Table 2. Listed Species that May Occur in the Study Area & Rationale for Further Consideration in this Biological Assessment.

Species	Status	Species Consideration in this BA and Likely Occurrence
Canada Lynx (*Lynx canadensis*)	Threatened	Not Considered. Due to the proximity of the study area to human activity within and adjacent to the study area and due to the lack of dense horizontal forest cover with significant snowshoe hare populations, there is no suitable habitat for the Lynx in the Action Area.
North American Wolverine (*Gulo gulo luscus*)	Threatened	Not Considered. Due to the proximity of the study area to human activity within and adjacent to the study area and due to the lack of the landscape structure to support den sites, there is no suitable habitat for the Wolverine in the Action Area.
Western Yellow-billed Cuckoo (*Coccyzus americanus occ.*)	Threatened	**Considered**. Approximately 46 acres of potentially suitable habitat for the WYBC was identified in the Action Area during the 2024 habitat suitability survey. There were no WYBC detections during the 2025 presence/absence surveys.
Monarch Butterfly (*Danaus plexippus*)	Proposed Threatened	Not Considered. Monarchs require milkweed (*Asclepias spp.*), nectar sources, overwintering habitat, and migration habitat (USFWS 2020). There is no suitable habitat for the Monarch Butterfly in the Action Area.

Species	Status	Species Consideration in this BA and Likely Occurrence
Suckley's Cuckoo Bumble Bee (*Bombus suckleyi*)	Proposed Endangered	Not Considered. Suckley's Cuckoo Bumble Bee and its host species require open grassy areas, urban parks and gardens, chaparral and shrub areas, and mountain meadows (Williams et al. 2014). There is no suitable habitat for Suckley's Cuckoo Bumble Bee or its host species in the Action Area.
Ute Ladies'-Tresses (*Spiranthes diluvialis*)	Threatened (Proposed Delisted)	**Considered**. Suitable habitat for the ULT was identified in the Action Area during the field assessment and verified by USFWS during a site visit on May 6, 2025.

3.2 Species Carried Forward

The WYBC and ULT were both identified as potentially occurring in the vicinity of proposed project activities; therefore, these species are being carried forward in this BA for further analysis.

3.3 Species Descriptions and Effect Analyses

3.3.1 Western Yellow-billed Cuckoo

The WYBC is an avian species, classified as a riparian obligate species, that was listed as threatened by the USFWS on October 3, 2014 (USFWS 2014). The WYBC is a migratory bird that spends its winters in Central and South America. The species uses riparian corridors as breeding grounds in North America. The WYBC typically prefers large tracts of multi-layered cottonwood and willow habitat with dense sub-canopies (below 33 feet). In Utah, sightings/populations of the WYBC are rare. This species is dependent on riparian areas with woody vegetation that creates a dense shrubby understory for nesting and a cottonwood overstory for foraging (USFWS 2021).

The WYBC is distinguished by its sizeable and gently curved bill that has a blue-black coloration with yellow on the basal half of the lower mandible, accompanied by a slender, elongated body that imparts a long-tailed appearance. Around the eye, there is a yellow ring of exposed colored skin. These birds are medium-sized measure around 12 inches in length and weigh approximately 60 grams.

Current threats to the WYBC include loss of riparian habitat to agriculture and other land uses, dam construction, stream channelization and stabilization, and livestock grazing (USFWS 2015). The IPaC report for the Action Area did not identify any proposed or designated final critical habitat for the WYBC in the Action Area.

3.3.1.1 Previously Completed Habitat Suitability Survey Methods/Results – WYBC

Due to the amount of streams, rivers, and riparian habitat near the Action Area, habitat suitability surveys for the WYBC were conducted on July 10, 2024, within the Action Area and associated 0.5-mile buffer (Figure 2). A copy of the survey memo (Cirrus 2024) is included below in Attachment C.

According to the USFWS (2017), areas that meet the minimum criteria for suitable habitat should be (1) avoided by 0.5 mile, or (2) surveyed, and/or (3) carried forward for evaluation of potential effects.

The USFWS provides guidelines for the identification of suitable habitat for WYBC in Utah to assist with these surveys (USFWS 2017). The methods are stated as follows:

> Step 1: Identify and delineate all riparian habitats within 0.5 miles of the proposed action, below the elevation of 8,500 feet.
>
> Step 2: Identify suitable cuckoo breeding, nesting habitat, including associated foraging areas.
>
> Riparian patches used by breeding and nesting cuckoos vary in size and shape, ranging from a relatively contiguous stand of mixed native/exotic vegetation to an irregularly shaped mosaic of dense vegetation with open areas. The following parameters characterize suitable breeding and nesting cuckoo habitat:
>
> - Vegetation that is predominantly multi-layered, with riparian canopy trees and at least one layer of understory shrubby vegetation;
>   - Riparian overstory and understory vegetation that supports suitable cuckoo habitat may include: cottonwood (*Populus spp*), willow (*Salix* spp), alder (*Alnus spp*), walnut (*Juglans spp*), boxelder (*Acer spp*), sycamore (*Plantanus spp*), ash (*Fraxinus spp*), mesquite (*Prosopis spp*), tamarisk (*Tamarix spp*), and Russian olive (*Elaeagnus angustifolia*). Suitable understory vegetation does not include grasses or forbs although herbaceous vegetation is often present alongside shrubby understory.
>   - Western yellow-billed cuckoo nest in tamarisk, consequently, the presence of tamarisk should not eliminate a vegetation patch from a suitability determination. However the potential for cuckoo occurrence decreases rapidly as the amount of tamarisk cover increases.
> - Patches of multi-layered vegetation (as described above) that are at least 12 acres (5 ha) or greater in extent and separated from other patches of suitable habitat by at least 300 meters;
> - Somewhere within a patch, the multi-layered riparian vegetation (as described above) should be at least 100 meters wide by 100 meters long. This is to avoid patches that may be long enough to meet the minimum area (12 acres) but are so narrow that they are unsuitable-- 750 m x 75 m (length x width) for example; and
> - Open areas, or gaps of multi-layered vegetation within a patch are less than 300 meters.

The Action Area is within the elevation guideline of less than 8,500 feet; the Utaba Reservoir has an elevation of 5,692 feet. There is multi-layered riparian vegetation surrounding the North Fork of the Ogden River and Cutler Creek. Each habitat corridor (green and yellow polygons in Figure 4) is greater than 12 acres and contains patches that are 100 meters wide by 100 meters long, thus fulfilling the guideline for habitat patch size. The habitat corridors also contain gaps of less than 300 meters which are used as foraging habitat. See Figure 4 for more detail.

In total, four habitat corridors were identified as containing potentially suitable habitat for the WYBC. The two habitat corridors south of the dam (yellow polygons in Figure 4) are in areas of high human development, including several residences, summer camps, and active road corridors.

The survey memo (Attachment C; Cirrus 2024) originally identified these habitat corridors as suitable or potentially suitable habitat for the WYBC. However, after conversations with the USFWS, these habitat corridors were determined to be unsuitable due to the human development and the shy and secretive nature of the WYBC (email communication with Weiss, Dannette, USFWS, December 12, 2024). Therefore, these areas were not surveyed during the 2025 presence/absence surveys.

The two habitat corridors north and west of the dam meet the requirements for suitable habitat for the WYBC. These can be seen in the green polygons in Figure 4 and have a total area of 46 acres. These areas were surveyed for WYBC in 2025. While there have not been any WYBC observations within 0.5 miles of the Project, there have been observations within 10 miles to the south (UDWR 2024).

As stated above, areas that meet the suitable habitat criteria were surveyed for WYBC during the 2025 field season before implementation of the proposed action. While the proposed action would not take place within suitable habitat for the WYBC, suitable habitat occurs within the 0.5-mile buffer surrounding the Action Area (survey area). Additionally, implementation of the proposed action would occur over multiple successive breeding seasons for WYBC (June 1 to August 31). This could result in visual and noise disturbance during the breeding seasons.

Therefore, presence/absence surveys for the WYBC were conducted in summer 2025. Surveys were performed by a permitted wildlife biologist and followed strict USFWS survey protocol (Halterman et al. 2015). A total of 23 survey points were surveyed throughout the suitable habitat. These points were spaced approximately 100 meters apart from one another, as required by the protocol (Halterman et al. 2015). Each survey point was surveyed 4 times throughout the summer, following the Halterman et al. 2015 protocol. No WYBC individuals were identified during the field survey. If any WYBC individuals are identified in the Action Area prior to or during construction, conversations with the USFWS would be initiated to discuss any new or additional conservation measures. The memo describing the 2025 presence/absence survey for the WYBC is included in Attachment D (Cirrus 2025a).

3.3.1.2 Direct and Indirect Effects – WYBC

Project construction would occur during multiple successive nesting seasons for the WYBC and could result in visual and noise disturbance from construction noise and increased human presence. This disturbance could lead to individuals flushing and flying from nest sites, avoiding the area. Disturbance to WYBC could result in increased energy expenditure caused by displacement, which could lead to individuals being in poorer condition during critical times such as the breeding season or migration. This disturbance and subsequent displacement could cause WYBC to be at a higher risk of predation as they leave their known habitat. Displacement could also cause adults to temporarily or permanently leave their chicks, putting them at a greater risk of predation. However, these potential effects are highly unlikely based on the presence/absence surveys suggesting there are no WYBC in the area. Additionally, there are several conservation measures detailed in section 2.4 above that would preclude the potential effects listed above.

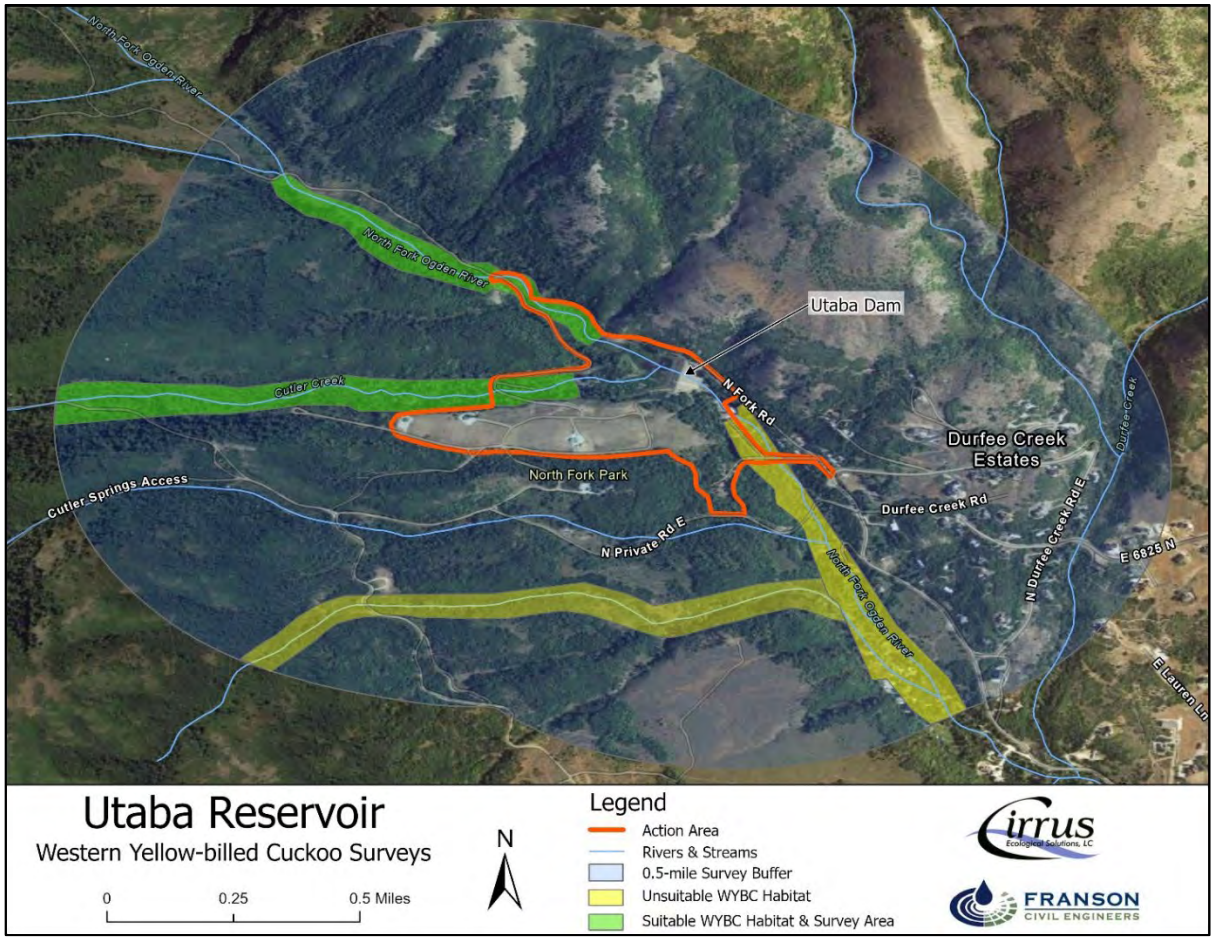

Figure 4. WYBC Suitable Habitat in Action Area.

3.3.2 Ute Ladies'-Tresses

The ULT is a white-flowered, perennial, terrestrial herb that is a member of the family *Orchidaceae* (orchids) that occurs in low to mid-elevation wetlands and riparian zones in the central Rocky Mountains and typically grows to be between 8 and 20 inches tall (USFWS 2025). The species was listed as threatened by the USFWS on January 17, 1992, because of its apparent rarity, small population sizes, and threats of loss or modification to riparian habitats (USFWS 1992).

Suitable ULT habitat is generally characterized by old stream channels, alluvial terraces, sub-irrigated meadows, and other wetland habitats. ULTs have also been documented within irrigated pastures, riparian shrublands, and deciduous forests below 7,000 feet in elevation. The species blooms from late July through August (USFWS 2025).

Current threats to the ULT include loss of riparian and wetland habitat as a result of urbanization, flooding, and dewatering of habitat from dam control and stream channel re-routing for agricultural development (USFWS 2025).

3.3.2.1 Survey Conditions & Findings – ULT

Habitat suitability and presence/absence surveys for the ULT were conducted on August 3, 2024, and July 27, 2025 (Attachment E; Cirrus 2025b), to identify suitable habitat and to determine if the habitat was occupied. Prior to the surveys, a ULT reference population was visited to confirm that flowering was occurring. Based on the reference population, the surveys were conducted during the confirmed ULT blooming window.

Potentially suitable habitat for ULT was identified in the Action Area along the North Fork Ogden River and Cutler Creek. After the first-year survey, the suitable habitat determination was confirmed through consultation with the USFWS (email communication with Reisor, Rita, USFWS, November 9, 2024). In addition, a site visit was held on May 6, 2025, including representatives from USFWS and NRCS. The USFWS recommended that surveys following approved survey protocol be performed during the blooming period in potentially suitable habitat along the stream channels but cleared the rest of the Action Area from needing surveys.

Based on communications with the USFWS, the mapped suitable habitat was expanded in 2025, using a more liberal interpretation of ULT potential habitat, to include the areas shown in Figure 5 (Habitat Areas 1-11). In the process of surveying the suitable habitat polygons shown in Figure 5, the wetland areas shown in Figure 5 were also assessed and surveyed to verify habitat assumptions.

No occurrences of ULT were found in the Action Area during either the 2024 or 2025 surveys.

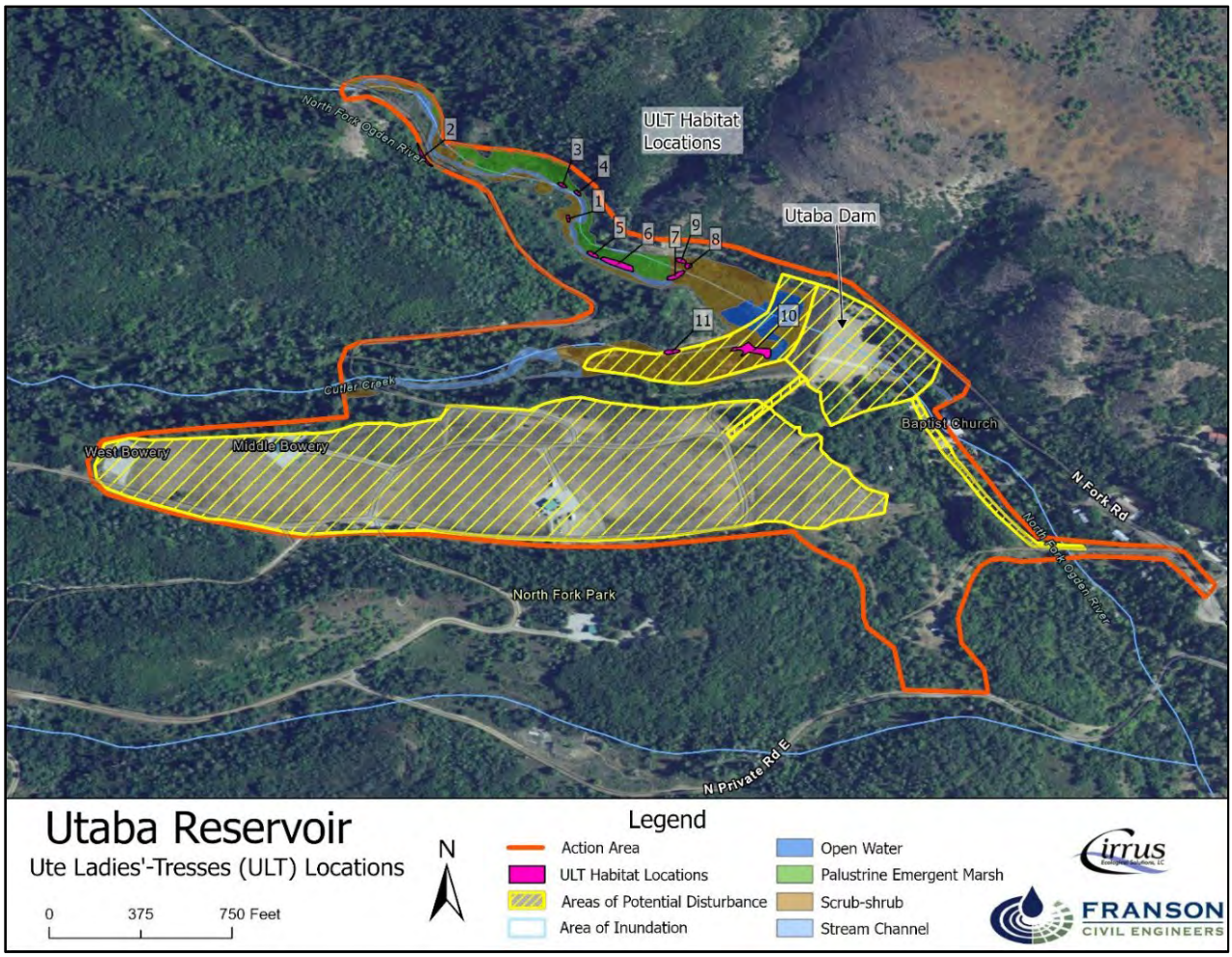

Figure 5. Overview map showing the location of the ULT habitat locations in relation to the areas of potential disturbance in the Utaba Reservoir project area.

3.3.2.2 Direct and Indirect Effects – ULT

Construction activities associated with the project would occur greater than 300 feet away from ULT suitable habitat areas 1 – 9 shown on Figure 5, which is the minimum buffer under USFWS protocol.

ULT suitable habitat areas 10 and 11 would be within areas of potential disturbance. The proposed project would increase the capacity of the Utaba dam spillways so the frequency of inundation, duration of inundation, and height of the water level will decrease after rehabilitation of the dam and spillway. Changes in the management of the dam that affect the frequency, duration, and height of the full elevation would not affect the hydrologic system in the ULT habitat areas because they are above the water level that will be maintained in the reservoir. ULT habitat areas are dependent on groundwater/high water table and/or stream flows, not reservoir water levels. Thus, changes in reservoir water management would not affect suitable ULT habitat and there would be no effect on ULT habitat as a result of changes in the reservoir water level management under the proposed action. Construction activities could physically disturb ULT habitat areas 10 and 11. The potential impacts are in perspective of the apparent unoccupied status of these two habitat areas.

4 Conclusion and Determination of Effects

Table 3 below summarizes and presents the determinations of effects for all of the ESA species in this BA. No actions related to the construction and implementation of the proposed action would have any effect on designated critical habitat for any species.

Table 3. Determination of Effects.

Species	Status	Determination of Effects
Canada Lynx (*Lynx canadensis*)	Threatened	No Effect. No suitable habitat in the Action Area.
North American Wolverine (*Gulo gulo luscus*)	Threatened	No Effect. No suitable habitat in the Action Area.
Western Yellow-billed Cuckoo (*Coccyzus americanus occ.*)	Threatened	May Affect, but is Not Likely to Adversely Affect.
Monarch Butterfly (*Danaus plexippus*)	Proposed Threatened	No Effect. No suitable habitat in the Action Area.
Suckley's Cuckoo Bumble Bee (*Bombus suckleyi*)	Proposed Endangered	No Effect. No suitable habitat in the Action Area.
Ute Ladies'-Tresses (*Spiranthes diluvialis*)	Threatened	May Affect, but is Not Likely to Adversely Affect.

4.1 Determination of Effects – WYBC

Considering all the potential effects disclosed above, we determine that the proposed action **may affect but is not likely to adversely affect the WYBC.** This determination is based on the following:

- The Project would occur over multiple successive WYBC breeding seasons.
- The Project would have no effect on designated critical habitat.
- Results from the 2025 presence/absence surveys suggest that there are no WYBC in the area.
- Conservation measures listed in Section 2.4 would provide additional protection from any potential impacts from the proposed project. Included among these is a conservation measure

stating that initiation of construction activities (noise-producing actions) will occur a minimum of two weeks prior to the onset of breeding season.

4.2 Determination of Effects – ULT

Considering all the potential effects disclosed above, we determine that the proposed action **may affect but is not likely to adversely affect ULT**. This determination is based on the following:

- No occurrence of ULT was found in the Action Area.
- There are areas of suitable habitat for ULT.
- Most of the suitable habitat would not be affected by the proposed action. Project construction/impacts would be greater than 300 feet from the ULT habitat areas on the North Fork Ogden River. However, habitat areas 10 and 11 on Cutler Creek (Figure 5) occur within the area of potential disturbance.
- The hydrologic regime in ULT habitat areas is a groundwater/highwater table system. Changes in the frequency of inundation, duration of inundation, and height of the water level associated with the proposed project changes to the dam would not affect the hydrologic regime in the ULT habitat areas.
- Conservation measures listed in Section 2.4 would provide additional protection from potential impacts from the proposed project.

5 Literature Cited

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Cirrus. 2025a. *Memo: 2025 Western yellow-billed cuckoo survey results at Utaba Reservoir*. Cirrus Ecological Solutions, LC, Logan, Utah. Included as Attachment D.

Cirrus. 2025b. *Memo: Ute ladies'-tresses survey results at Utaba Dam rehabilitation site.* Cirrus Ecological Solutions, LC, Logan, Utah. Included as Attachment E.

Genterra Consultants 2020. *Dam Assessment Report North Fork Ogden River Watershed Utaba Retarding Dam.* Genterra Consultants, Inc. Irvine, California.

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6 Attachments

Attachment A. Detailed Drawings of the Proposed Action
Attachment B. USFWS IPaC Species Report
Attachment C. WYBC Habitat Suitability Survey Memo – Cirrus Ecological Solutions, LC
Attachment D. 2025 WYBC Presence/Absence Survey Memo – Cirrus Ecological Solutions, LC
Attachment E. Habitat Suitability and 2024 and 2025 Survey for the Ute Ladies'-Tresses, Cirrus Ecological Solutions, LC
Attachment F. Utah Natural Heritage Search Report
Attachment G. IPaC Resource List

Attachment A.

Detailed Drawings of the Proposed Action

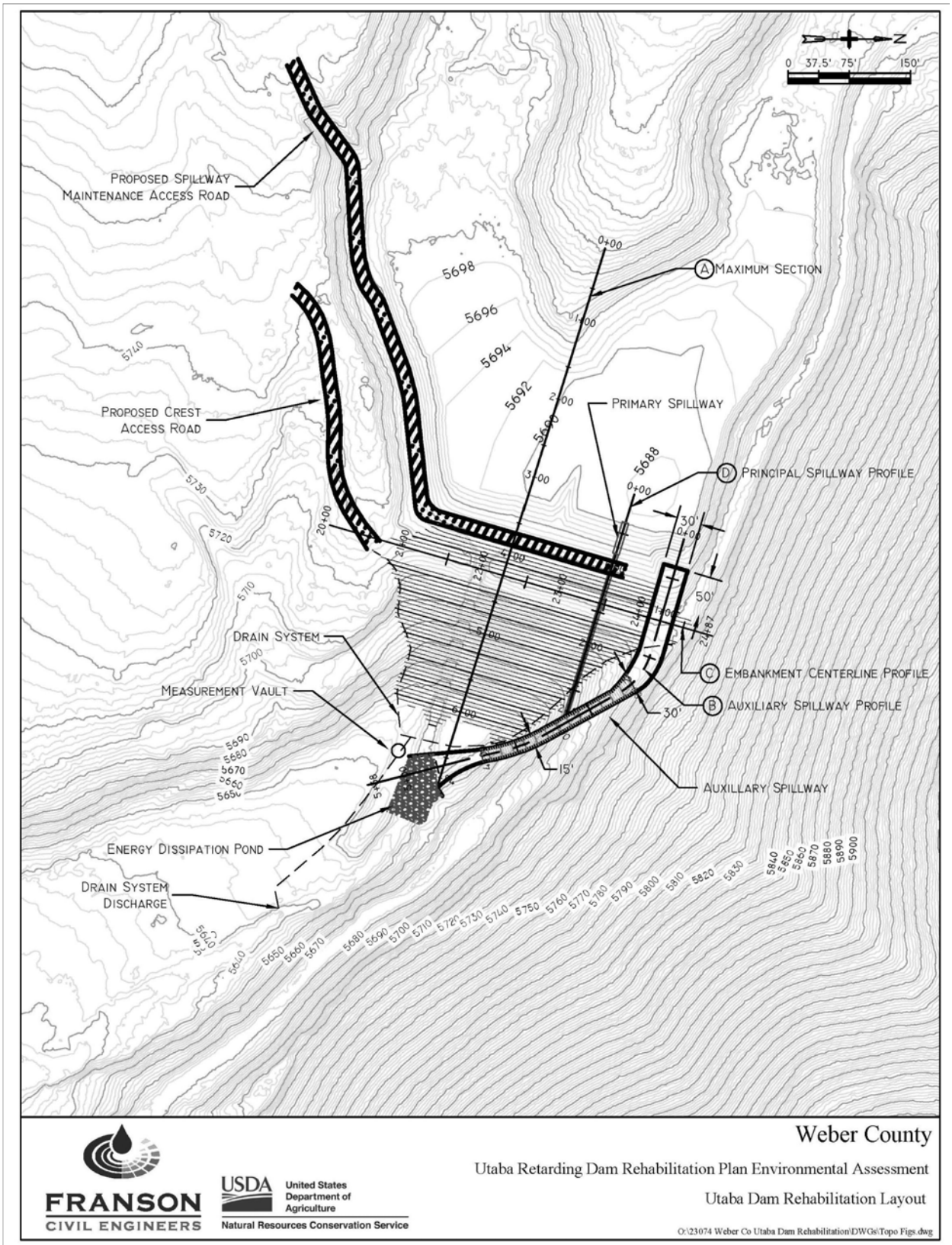

Figure 1: Proposed Embankment and Spillways.

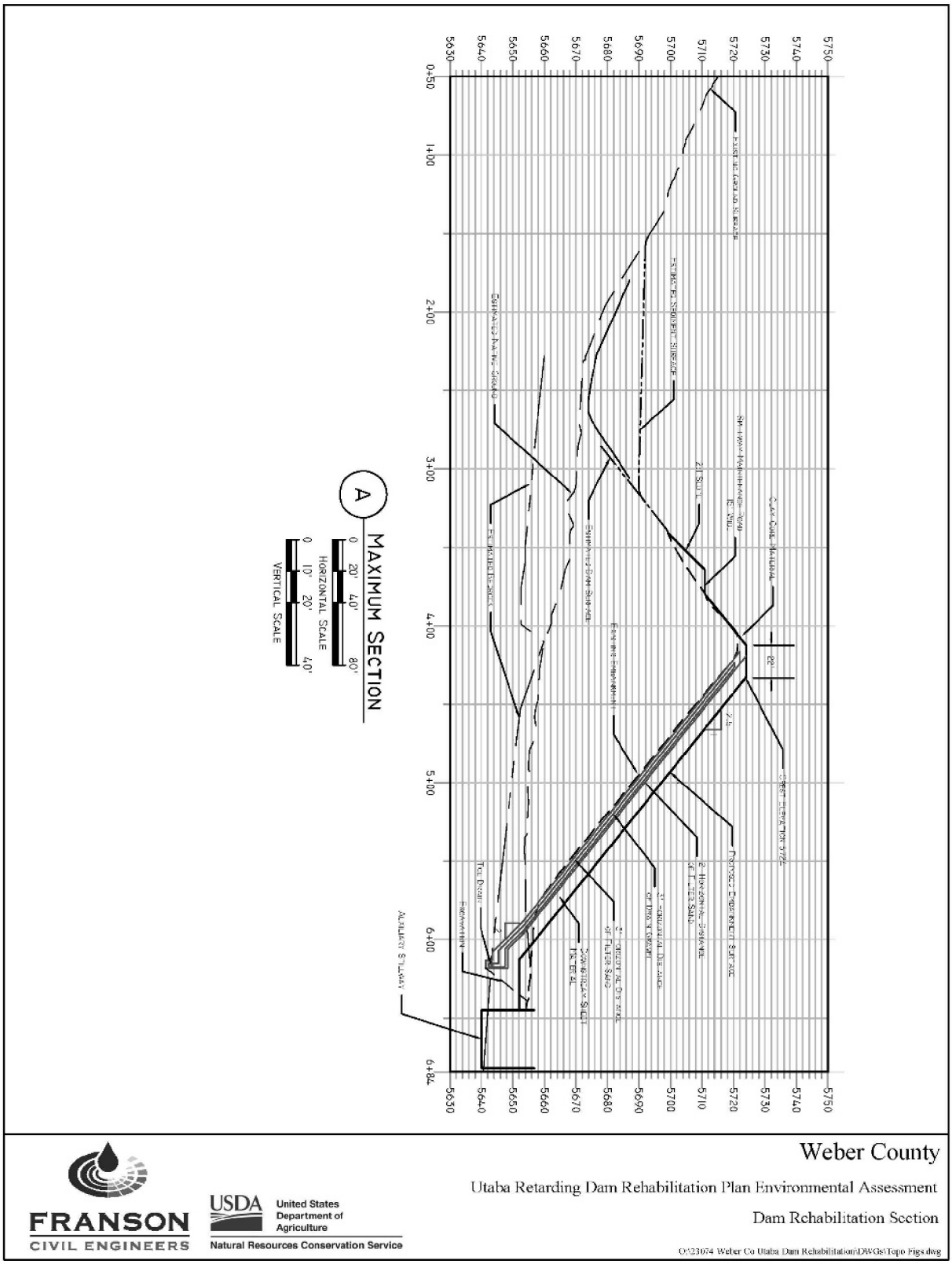

Figure 2: Proposed Debris Basin Embankment Section.

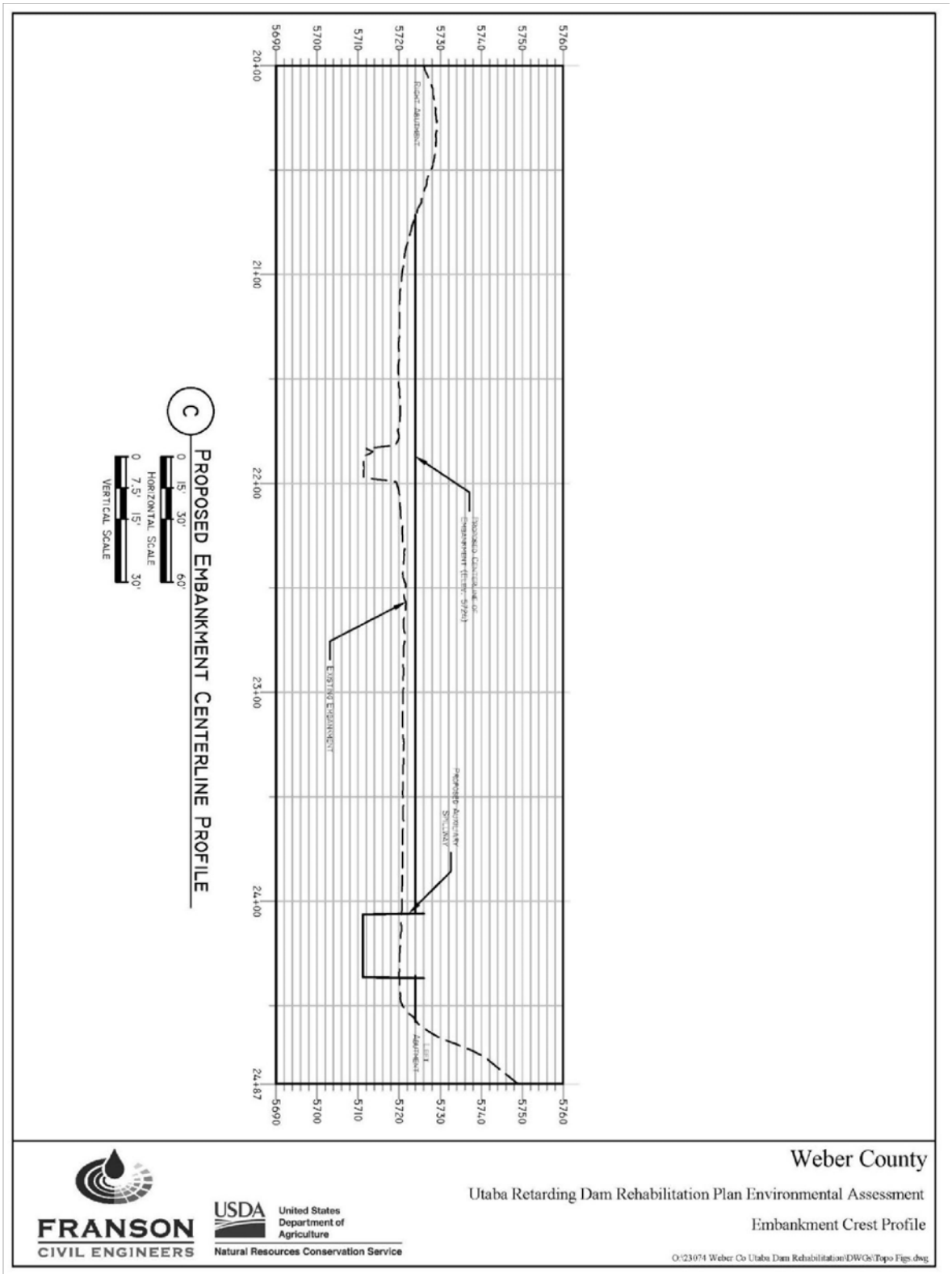

Figure 3: Embankment Crest Profile.

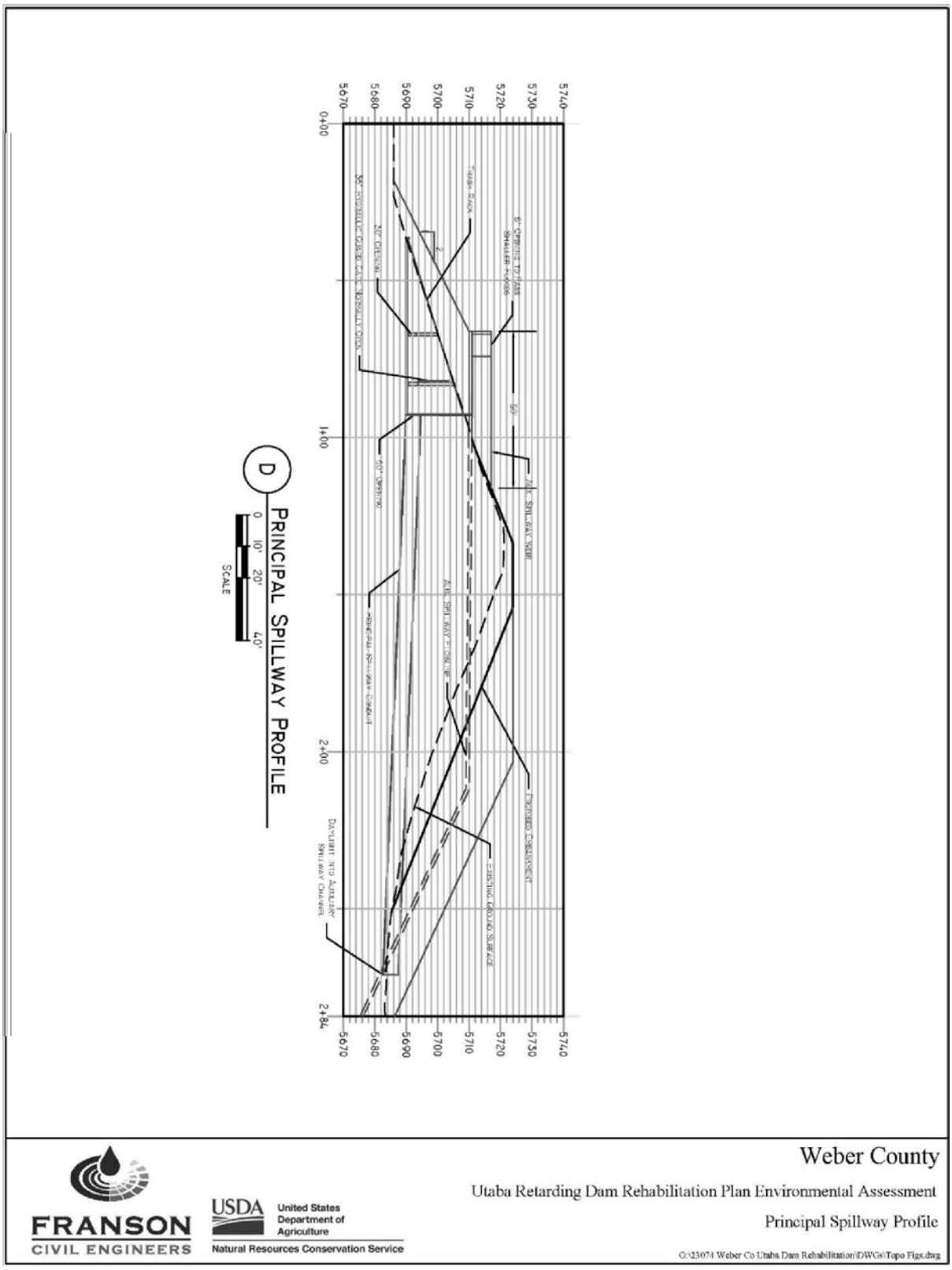

Figure 4: Principal Spillway Configuration.

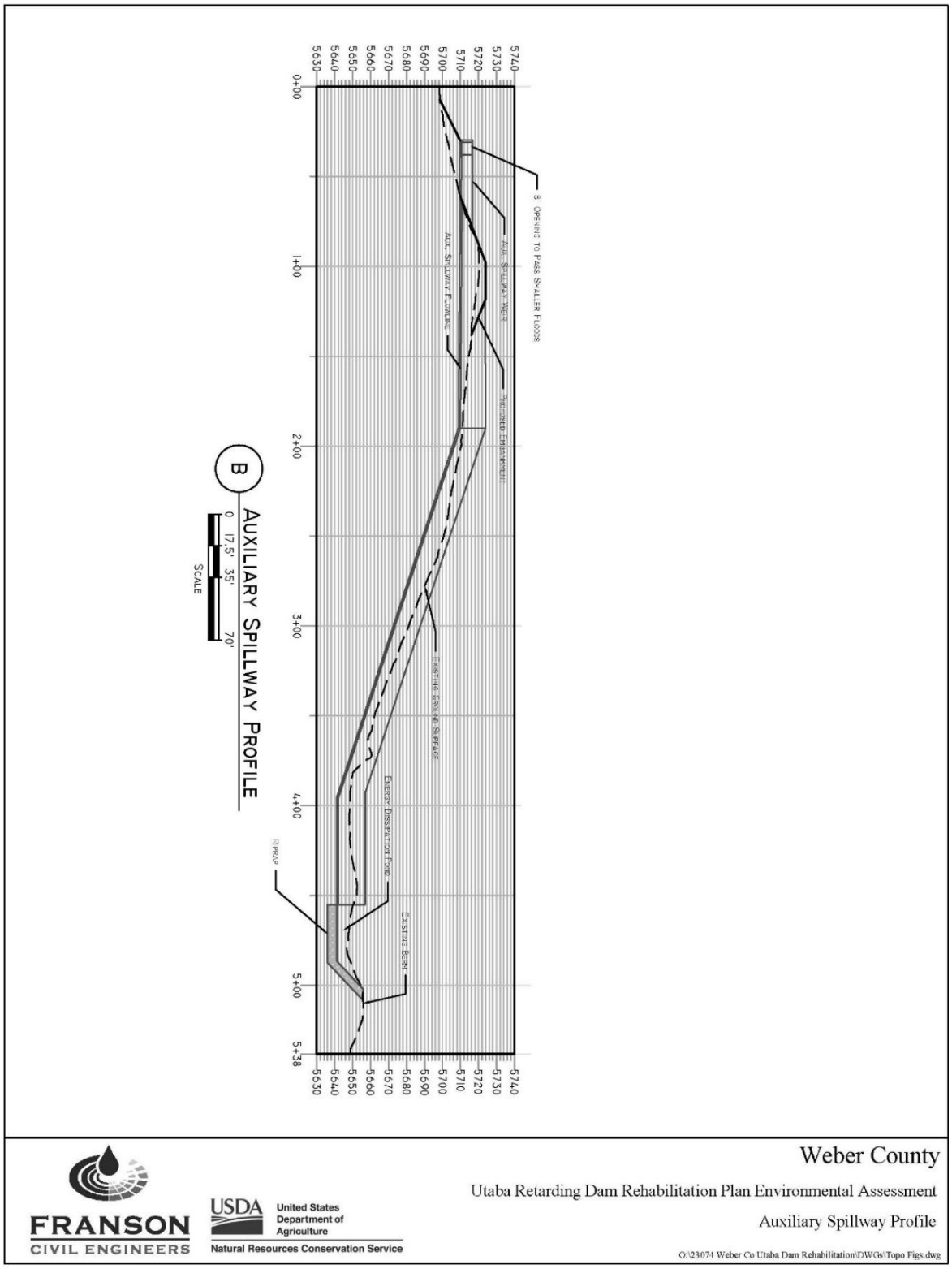

Figure 5: Auxiliary Spillway Profile.

Attachment B.

ECOS IPaC Official Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603

Phone: (801) 975-3330 Fax: (801) 975-3331

In Reply Refer To:
Project Code: 2024-0135067

03/12/2025 17:41:30 UTC

Project Name: Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)

(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see https://www.fws.gov/program/migratory-bird-permit/what- we-do.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office

2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

Project Summary

Project Code: 2024-0135067

Project Name: Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Project Type: Dam - Maintenance/Modification

Project Description: NRCS project to rehabilitate and improve life of Utaba Dam. Polygon generated for proposal to be contractor for environmental document and engineering services.

Utaba Dam is located in Weber County, Utah, latitude 41.387128º, longitude -111.910519º. Utaba Dam was constructed in 1962 under Public Law 566 as a significant hazard potential dam. The evaluated life of Utaba Dam is 50 years.

Utaba is currently classified as a significant hazard potential dam but has been determined by NRCS to be out of compliance with current NRCS and state dam safety criteria, and performance standards. Utah dam safety is in the process of upgrading Utaba Dam to a more representative high hazard class. The hazard class change is due mostly to development downstream and changes in state and NRCS requirements.

The need for the project is to upgrade the dam to meet current NRCS and State dam safety standards to reduce the risk to life and property and extend the service life of the dam and to allow it to continue to provide protection from floods.

Some of the essential changes to make the structure meet requirements is adding material to get a wider top width, replace the primary outlet pipe with a larger pipe, and replace the auxiliary spillway to provide more flow capacity. Sedimentation has also reduced the retention volume of the structure and subsequently its effectiveness as a flood control structure.

Significant deterioration of the concrete in the auxiliary spillway has been observed. Preliminary planning has shown that the sponsor would like to explore adapting the facilities to be able to use it as a water source for aerial wildland fire fighting efforts and create better access for the county to get equipment to the dam and to the outlet works for operation and maintenance.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@41.38632065,-111.9117057853912,14z



Counties: Weber County, Utah

Endangered Species Act Species

There is a total of 6 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 1 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* Population: Wherever Found in Contiguous U.S. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. This species only needs to be considered under the following conditions: ▪ Species may be present based on transient occurrence as it moves through or too suitable habitat. Effects should be considered to species and projects should consult with the Service, however, depending on the project, consultation may not be necessary. Species profile: https://ecos.fws.gov/ecp/species/5123	Threatened

Birds

NAME	STATUS
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus* There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/9743	Proposed Threatened
Suckley's Cuckoo Bumble Bee *Bombus suckleyi* Population: No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10885	Proposed Endangered

Flowering Plants

NAME	STATUS
Ute Ladies'-tresses *Spiranthes diluvialis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2159	Threatened

Critical Habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC User Contact Information

Agency: Franson Civil Engineers
Name: Landon Richins
Address: 1276 South 820 East, Suite 100
City: American Fork
State: Utah
Zip: 84003
Email lrichins@fransoncivil.com
Phone: 801-756-0309

Lead Agency Contact Information

Lead Agency: Natural Resources Conservation
Service Name: Derek Hamilton
Email: derek.hamilton@usda.gov
Phone: 385-321-4987

Attachment C.

Habitat Suitability Assessment for the Western Yellow-billed Cuckoo, Cirrus Ecological Solutions, LC

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 22, 2024

TO: Landon Richins, Environmental Specialist, Franson Engineering; Derek Hamilton, Water Resources Coordinator, NRCS.

CC: Scott Evans, Owner, Cirrus Ecological Solutions; John Stewart, Botanist Cirrus Ecological Solutions; Layne Jensen, Professional Engineer, Franson Engineering.

FROM: Adam Clifford, Wildlife Biologist, Cirrus Ecological Solutions.

RE: Western yellow-billed cuckoo habitat surveys

On July 10, 2024, personnel from Cirrus Ecological Solutions, LC conducted habitat surveys for western yellow-billed cuckoos associated with the preparation of the Plan-EA for the Utaba Dam rehabilitation project.

Western Yellow-billed Cuckoo Habitat Survey

The western yellow-billed cuckoo (WYBCU; *Coccyzus americanus*) was listed as Threatened under the Endangered Species Act in 2014. Because the Utaba Dam rehabilitation project (Project) has several streams, rivers, and riparian habitat in the Project area, habitat surveys were conducted to determine if the area contains suitable habitat for WYBCU. According to the U.S. Fish and Wildlife Service (FWS), areas that meet the minimum criteria for suitable habitat should be (1) avoided by 0.5 mile, or (2) surveyed, and/or (3) carried forward for evaluation of potential effects.

The FWS provides guidelines for the identification of suitable habitat for WYBCU in Utah to assist with these surveys (FWS 2015). The methods are stated as follows:

Step 1: Identify and delineate all riparian habitats within 0.5 mile of the proposed action, below the elevation of 8,500 feet.

Step 2: Identify suitable WYBCU breeding and nesting habitat, including associated foraging areas.

Riparian patches used by breeding and nesting cuckoos vary in size and shape, ranging from a relatively contiguous stand of mixed native/exotic vegetation to an irregularly shaped mosaic of dense vegetation with open areas. The following parameters characterize suitable breeding and nesting cuckoo habitat:

- Vegetation that is predominantly multi-layered, with riparian canopy trees and at least one layer of understory shrubby vegetation;
- Patches of multi-layered vegetation (as described above) that are at least 12 acres (5 ha) or greater in extent and separated from other patches of suitable habitat by at least 300 meters;
- Somewhere within a patch, the multi-layered riparian vegetation (as described above) should be at least 100 meters wide by 100 meters long. This is to avoid patches that may be long enough to meet the minimum area (12 acres) but are so narrow that they are unsuitable-- 750 m x 75 m (length x width) for example; and
- Open areas, or gaps of multi-layered vegetation within a patch are less than 300 meters.

The Project area is within the elevation guideline of less than 8,500 feet; the Utaba Reservoir has an elevation of 5,692 feet. There is multi-layered riparian vegetation surrounding the North Fork of the Ogden River and Cutler Creek. Each habitat corridor (green and yellow polygons in Figure 1) is greater than 12 acres contains patches that are 100 meters wide by 100 meters long, thus fulfilling the guideline for habitat patch size They also contain gaps of less than 300 meters which are used as foraging habitat. See Figure 1 for more detail.

Based on the survey results detailed above and in Figure 1, there are 3 areas meeting the requirements for suitable habitat for the WYBCU. These can be seen in the green polygons in Figure 1 and have a total area of 72 acres. The yellow polygon in Figure 1 has not been surveyed for suitable habitat due to access issues during the surveys on July 10. While there have not been any WYBCU observations within 0.5 miles of the Project, there have been observations within 10 miles to the south (UDWR 2024).

The suitable habitat south of the Utaba Reservoir along the North Fork of the Ogden River contains several private residences. These areas are less likely to provide suitable habitat for WYBCU, due to ongoing disturbance and large gaps in the habitat patches, which could discourage WYBCU from nesting.

As stated above, areas that meet the suitable habitat criteria should be surveyed for WYBCU before Project implementation. While the Project would not directly impact any suitable habitat, the 0.5-mile buffer protects WYBCU from the impacts of noise disturbance during Project implementation (FWS 2015).

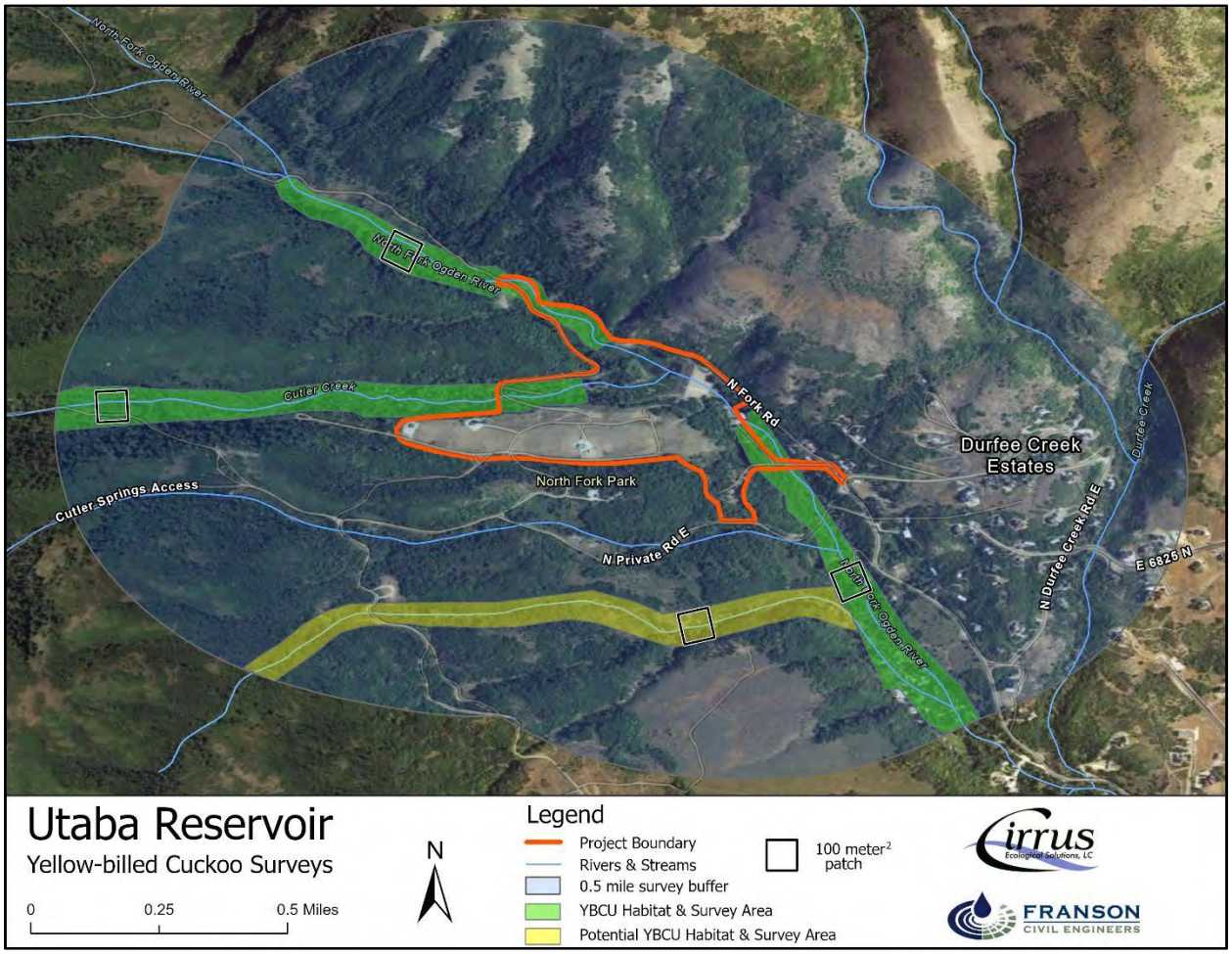

Figure 1. Overview of suitable and potentially suitable WYBCU habitat surrounding the Utaba Reservoir.

References

FWS (U.S. Fish and Wildlife Service). 2015. Guidelines for the identification of suitable habitat for WYBCU in Utah. Available at [https://www.fws.gov/sites/default/files/documents/yellow-billedcuckoo-guidelines-identification-suitable-habitat-utah-2015_0.pdf]. Accessed July 9, 2024.

UDWR (Utah Division of Wildlife Resources). 2024. Utah Natural Heritage Program Online Species Search Report. Available at [https://dwrapps.utah.gov/HeritageDataRequest/Reports?id=15840]. Accessed August 8, 2024.

Attachment D.

2025 WYBC Presence/Absence Survey Memo – Cirrus Ecological Solutions, LC

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 8, 2025

TO: Layne Jensen, P.E., Franson Civil Engineers; Landon Richins, Environmental Specialist, Franson Civil Engineers

CC: Scott Evans, Owner, Cirrus Ecological Solutions

FROM: Adam Clifford, Senior Wildlife Biologist, Cirrus Ecological Solutions

RE: 2025 Western yellow-billed cuckoo survey results at Utaba Reservoir

During the summer of 2025, Adam Clifford, Senior Wildlife Biologist from Cirrus Ecological Solutions, LC, conducted surveys for the western yellow-billed cuckoo (WYBC) associated with the Utaba Dam Rehabilitation Supplemental Watershed Plan-EA project (Project) located in Weber County, Utah.

Presence/absence surveys were conducted following a strict U.S. Fish and Wildlife Service (USFWS) protocol as described in Halterman et al. (2015). This memo describes the survey area, the survey methods, and the results. As described below, no WYBC individuals were detected during the 2025 presence/absence surveys.

Existing Habitat Conditions

The Project Area is located within the Wasatch and Uinta Mountains, Alpine Zone ecoregion. The ecoregion is defined by high, glaciated mountains, dissected plateaus, foothills, and intervening valleys. Land uses in the area surrounding the Project area include residential, agricultural, and recreational.

Due to the number of streams, rivers, and riparian habitat near the Project area, habitat suitability surveys for the WYBC were conducted on July 10, 2024, within the Project area plus a 0.5-mile buffer (survey area; Figure 1). The 0.5-mile buffer is a USFWS requirement for projects that could potentially cause visual and noise disturbance to WYBC during their breeding season.

In total, four habitat corridors were identified as containing potentially suitable habitat for the WYBC. The two habitat corridors south of the dam (yellow polygons in Figure 1) are in areas of high human development, including several residences, summer camps, and active road corridors.

The survey originally identified these habitat corridors as suitable or potentially suitable habitat for the WYBC (Cirrus 2024). However, after conversations with the USFWS, these habitat corridors were determined to be unsuitable due to human development and the shy and secretive nature of the WYBC (email communication with Weiss, Dannette, USFWS, December 12, 2024). Therefore, these areas were not surveyed during the 2025 presence/absence surveys.

The two habitat corridors north and west of the dam meet the requirements for suitable habitat for the WYBC. These can be seen in the green polygons in Figure 1 and have a total area of 46 acres. These areas were surveyed for WYBC in 2025.

Species Description

The WYBC is a riparian obligate avian species listed as threatened by the USFWS on October 3, 2014 (USFWS 2014a). The WYBC is a migratory species that winters in Central and South America and utilizes riparian corridors as breeding grounds in North America. The WYBC exhibits a robust and gently curved bill which showcases a blue-black coloration with yellow on the basal half of the lower mandible, accompanied by a slender, elongated body that imparts a long-tailed appearance. Around the eye, there is a slim yellow ring of exposed colored skin. The plumage appears loose and is characterized by a grayish-brown hue on the upper side and a white shade underneath, featuring reddish primary flight feathers. The tail feathers boast a striking pattern of black and white beneath. These medium-sized birds measure around 12 inches in length and weigh approximately 60 grams (Hughes 1999).

Throughout its range, most breeding and nesting populations of cuckoos utilize riparian habitat patches, each exhibiting diverse size and shape characteristics. These patches can vary from a relatively uniform expanse of mixed native and exotic vegetation to an irregularly shaped mosaic. Specifically, these habitats are defined as multi-layered vegetation patches, extending at least 12 acres and isolated from other suitable habitat patches by a minimum of 300 meters. Within a given patch, the multi-layered riparian vegetation should measure at least 100 meters in width by 100 meters in length, ensuring that the minimum area requirement (12 acres) is met while avoiding unsuitably narrow configurations.

Additionally, open areas or gaps in the multi-layered vegetation within a patch should be less than 300 meters (Halterman et al. 2015). The vegetation within these patches is predominantly multi-storied, encompassing riparian canopy trees and at least one layer of understory shrubby vegetation. Suitable overstory and understory vegetation may include cottonwood (*Populus* spp.) willow (*Salix* spp.), alder (*Alnus* spp.), walnut (*Juglans* spp.), boxelder (*Acer* spp.), sycamore (*Plantanus* spp.), ash (*Fraxinus* spp.), mesquite (*Prosopis* spp.), tamarisk (*Tamarix* spp.), and Russian olive (*Elaeagnus angustifolia*). While herbaceous vegetation is often present alongside shrubby understory, suitable understory vegetation does not include grasses or forbs. Notably, the presence of tamarisk should not automatically exclude a vegetation from suitability determination as WYBC are known to nest in tamarisk; however, the potential for cuckoo occurrence diminishes as the amount of tamarisk cover increases (Halterman et al. 2015, Laymon and Halterman 1989, USFWS 2014b).

The WYBC is an insect specialist that also consumes small vertebrates like tree frogs and lizards. WYBC rely on abundant insect and small vertebrate prey, often found in cottonwood-willow riparian areas throughout the arid Western US. Prey abundance influences WYBC nesting behavior, as larger clutches and multiple nesting attempts have been recorded during years of prey abundance (Laymon et al. 1997). Diet studies reveal a preference for large caterpillars, katydids,

grasshoppers, and tree frogs. Vegetation health and density play a crucial role, with cottonwoods and willow hosting specific insect larvae preferred by the species. The WYBC primarily forages within the tree canopy, making the presence and abundance of prey and specific riparian vegetation during nesting season a crucial factor for the species (USFWS 2014b).

Concerning habitat, perennial rivers, streams, and varying hydrologic conditions are vital for supporting the necessary vegetation, food availability, and habitat suitability for the WYBC. The species shows a preference for humid conditions, with research suggesting that nest sites typically exhibit higher humidity and lower temperatures than the surrounding landscape (Laymon et al. 1997, USFWS 2014b). In addition, subsurface hydrologic conditions, particularly an elevated water table, are crucial for riparian vegetation and cuckoo habitat (USFWS 2014b).

Survey Methods

The surveyor followed a strict USFWS survey protocol as described in Halterman et al. (2015). This protocol requires that surveys be performed four times throughout the breeding season within specific survey periods: one survey June 15-June 30, two surveys July 1-July 31, and one survey August 1-August 15. Due to differences in breeding seasons across the western US, a survey window of ± 3 days is acceptable for the start and end of each survey period. Each survey site is visited a minimum of four times within the breeding season, with a minimum of 12 days and a maximum of 15 days between surveys at a particular site. Surveys are required to occur in the mornings from sunrise until 1100. As required by the protocol, the surveys are to be performed in the Project area with a 0.5-mile buffer. The survey points were spaced approximately 100 meters apart throughout the survey area, which resulted in 23 points (Figure 2). Surveys were not performed when temperatures were above 104 degrees F or when the detectability of cuckoos was reduced by environmental factors (e.g., excessive heat, cold, wind, or noise).

The survey protocol uses a call-back broadcast survey technique, which simulates the presence of a cuckoo in the area, which may elicit a response from a cuckoo (if there is one in the area), thus increasing its detectability. The broadcast consisted of five contact/“kowlp” calls, each spaced one minute apart. For consistency and comparability of the data, only the call provided during the protocol training workshop was used for the surveys. The recording was played at approximately 70db.

Upon arrival at each survey point, the surveyor waited at least one minute to listen for unsolicited cuckoo calls (i.e., cuckoos that may be calling before broadcast of the calls). If no cuckoos were identified during the initial listening period, the surveyor began the first broadcast. The surveyor listened and watched intently for responding cuckoos during and after each of the five broadcast calls. This included watching for movement, as silent birds may move closer to investigate. If no cuckoo was detected at the survey point after five broadcast calls, the surveyor continued on to the next survey point.

Results

Each of the 23 points shown in Figure 2 were surveyed four times over the course of summer 2025 as described above. The surveys took place on June 26-27, July 10-11, July 24-25, and August 7-8. No WYBC were observed during the surveys. While the majority of the points were within suitable habitat for the WYBC, some points were in marginal breeding habitat, including points 17, 20, and 21. These three points had few trees in the 100-meter square radius, however, they were still surveyed because they represented potential dispersal/foraging habitat and were adjacent to suitable breeding habitat.

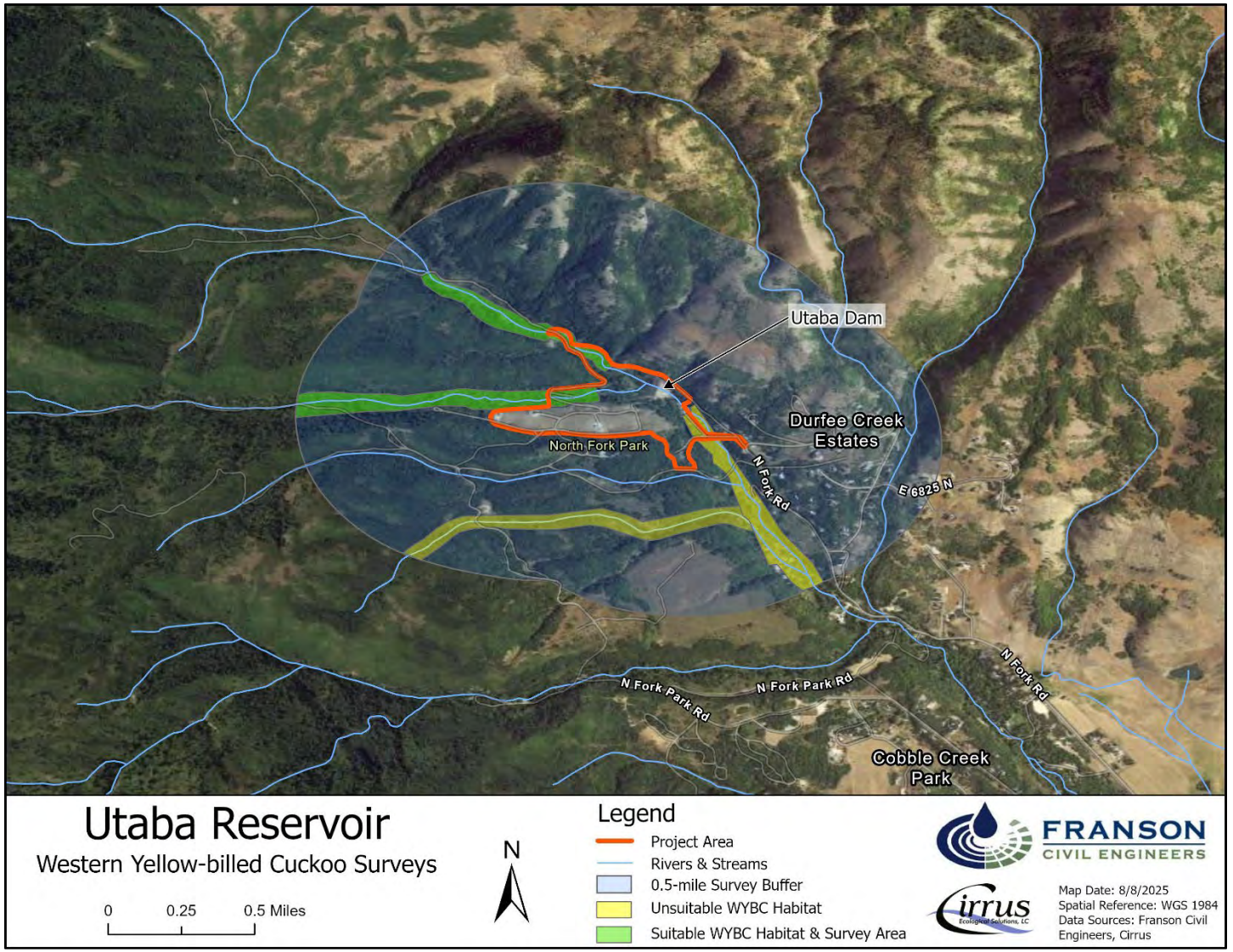

Figure 1. General location of the Utaba Dam Rehabilitation Supplemental Watershed project (Project), showing the results of the western yellow-billed cuckoo habitat assessment surveys in Weber County, Utah.

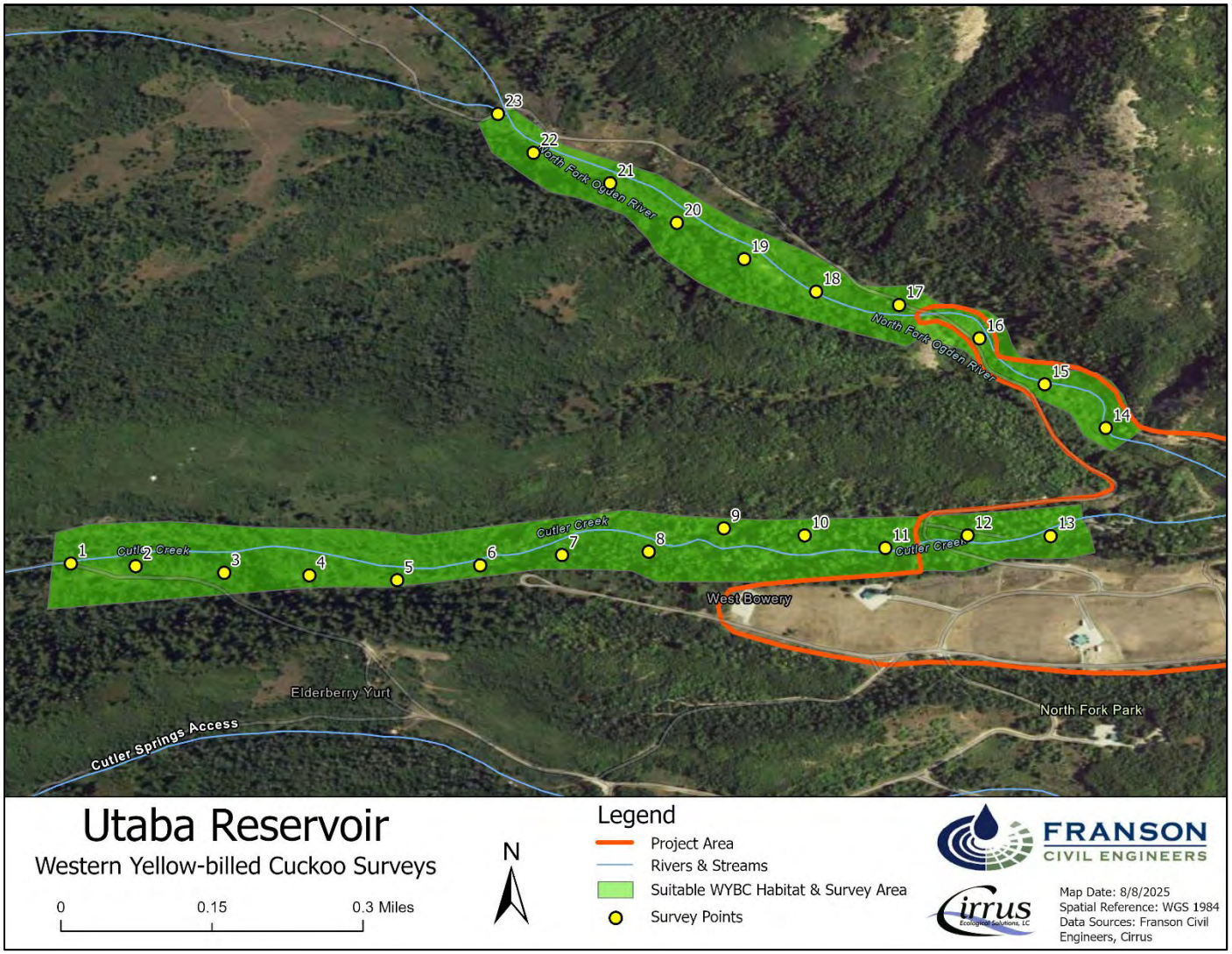

Figure 2. Western yellow-billed cuckoo presence/absence survey point locations for the associated with the Utaba Dam Rehabilitation Supplemental Watershed project (Project) in Weber County, Utah.

References

Cirrus (Cirrus Ecological Solutions, L.C.). 2024. *Memo: Western yellow-billed cuckoo habitat surveys*. Cirrus Ecological Solutions, LC, Logan, Utah. Included as Attachment B in the Utaba Reservoir biological assessment.

Halterman, M.D., M.J. Johnson, J.A. Holmes, and S.A. Laymon. 2015. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: U.S. Fish and Wildlife Techniques and Methods, 45 p.

Hughes, J.M. 1999. Yellow-billed Cuckoo (Coccyzus americanus). In The Birds of North America, No. 148 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA. 28 pp.

Laymon, S.A. and M.D. Halterman. 1989. A proposed habitat management plan for yellow-billed cuckoos in California. In California Riparian Systems Conference (p. 272).

Laymon, S.A, P.L. Williams, and M.D. Halterman. 1997. Breeding status of the yellow-billed cuckoo in the South Fork Kern River Valley, Kern County, California: Summary report 1985-1996. Prepared for the U.S. Department of Agriculture, Forest Service, Sequoia National Forest, Cannell Meadow Ranger District. Challenge Cost-Share Grant 92-5-13.

USFWS (U.S. Fish and Wildlife Service). 2014a. Final rule determining threatened status for the western yellow-billed cuckoo. Federal Register 79: 5999260038.

USFWS. 2014b. Endangered and threatened wildlife and plants; Designation of critical habitat for the western distinct population segment of the yellow-billed cuckoo. Proposed Rule. Federal Register 79: 48551.

Attachment E.

Habitat Suitability and 2024 and 2025 Survey for the Ute Ladies'-Tresses, Cirrus Ecological Solutions, LC

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 22, 2024, Updated September 21, 2025.

TO: Landon Richins, Environmental Specialist, Franson Civil Engineers; Derek Hamilton, Water Resources Coordinator, NRCS.

CC: Scott Evans, Owner, Cirrus Ecological Solutions; Adam Clifford, Wildlife Biologist, Cirrus Ecological Solutions; Layne Jensen, Professional Engineer, Franson Civil Engineers.

FROM: John Stewart, Botanist, Cirrus Ecological Solutions.

RE: Ute ladies'-tresses survey results at Utaba Dam rehabilitation site.

The first-year survey for Ute ladies'-tresses orchid (*Spiranthes diluvialis*) was completed on August 3, 2024, within the project area for the Utaba Dam rehabilitation project. The second-year survey for Ute ladies'-tresses was conducted on July 27, 2025. Prior to the surveys, a known population of Ute ladies'-tresses was visited to confirm that Ute ladies'-tresses was in flower.

During the first-year survey, potentially suitable habitat for Ute ladies'-tresses was identified in the project area. After the first-year survey, the suitable habitat determination was confirmed through consultation with the U.S. Fish and Wildlife Service (USFWS, email communication with Reisor, Rita, November 9, 2024). In addition, a site visit was held on May 6, 2025, with representatives from USFWS and NRCS. A more liberal interpretation of Ute ladies'-tresses potential habitat was requested.

In response to the request, the 2025 survey revisited the habitat that was identified in the year 1 survey and mapped additional potential Ute ladies'-tresses habitat within the project area. The surveys in both 2024 and 2025 comprehensively surveyed wetland within the project area for potential Ute ladies'-tresses habitat, and where such was found, closely spaced transects were used to survey for Ute ladies'-tresses.

Background

Ute ladies'-tresses was federally listed as threatened on January 17, 1992 (57 FR 2048). Critical habitat has not been designated for this species.

Ute ladies'-tresses is a perennial orchid with stems that arise from thickened roots. The bloom consists of 3 to 15 small white- or ivory-colored flowers clustered into a spike arrangement at the top of the stem.

Depending on location, the species may flower as early as early July or as late as early October. Mature plants may remain dormant for one or more growing seasons without producing aboveground shoots or may exhibit vegetative shoots only. Bumblebees are one of the main pollinators for Ute ladies'-tresses and population numbers can affect how many and when flowering occurs.

Habitat Characteristics

Ute ladies'-tresses may be found in moist to wet soils in mesic or wetland habitat associated with springs, lakes, and perennial streams. The elevation range of occupied habitat is 700 to 7,000 feet throughout the species range. Most occurrences are along riparian edges, gravel bars, old oxbows, and moist to wet meadows. Some localities are near freshwater lakes and springs/groundwater discharge zones. Ute ladies'-tresses is adapted to disturbances caused by water movement through flood plains over time. The species occurs primarily in areas where the vegetation is relatively open and not very dense. It often grows on point bars and other recently created riparian habitat. The orchid appears to require permanent subirrigation, with the water table holding steady throughout the growing season and into late summer and early autumn.

Populations appear to fluctuate dramatically from year to year, making it difficult to assess population status and distribution. The genus *Spiranthes* may also undergo a dormant period that may last 7–10 years, with no evidence of above-ground structures. Nothing is known about the dormancy-triggering mechanisms. In order to locate this species, potential habitat should be surveyed multiple years due to potential dormancy.

Ute Ladies'-tresses Orchid Survey/Habitat Assessment

The survey for Ute ladies'-tresses orchid was completed following the protocol developed by the USFWS (1992). Note that this protocol requires 3 years of surveys if suitable habitat is identified because the species may not flower every year. Important elements of the survey protocol included the following:

- Evaluation of the study area to determine where potentially suitable habitat exists using a combination of aerial imagery, existing information, and field reconnaissance.
- Scheduling field surveys corresponding to flowering in other known populations, typically beginning in the later part of July and extending into mid-to-late August, depending on conditions.
- Completing pedestrian surveys providing 100 percent coverage in suitable habitat using closely-spaced transects.
- Recording population information if any occurrences of Ute ladies'-tresses orchid are located.

Survey Results

Ute ladies'-tresses was not found in the Utaba Reservoir survey area during the 2024 or 2025 surveys.

Potentially suitable habitat for Ute ladies'-tresses orchid was identified in the project survey area. Potentially suitable habitat located in 2024 is shown in Figures 1 and 2.

Habitat Area 1, shown on Figure 2, is a small riparian wetland area along the North Fork of the Ogden River (Photo 1). This habitat is characterized by creeping bentgrass (*Agrostis stolonifera*), sedge (*Carex* spp.), and monkey flower (*Mimilis tilingii*).

Habitat Area 2, shown on Figure 2, is a narrow seep along the toe of the mountain where the road cut intercepts groundwater and creates a wetland along the edge of the road (Photo 2). This habitat is characterized by creeping bentgrass, northern green bog orchid (*Platanthera aquilonis*), sedge, and willow (S*alix spp*.)

Habitat Area 3, shown on Figure 2, consists of a series of wetlands along the east side of the project area at the toe of the mountain. Groundwater discharge creates a wetland community. This wetland habitat is characterized by a community of tall (3 to 4 feet tall), dense wetland plants, including lesser panicled sedge (*Carex diandra*), cutleaf water parsnip (*Berula erecta*), and small-fruited bullrush (S*cirpus microcarpus*) (Photos 3 and 4). Hydrology is very wet with areas of standing water during the August survey. The wetland community in these wetlands may be too tall and dense to represent potential habitat for Ute ladies'-tresses. Much of this habitat extends beyond the project area.

As noted, the USFWS reviewed the year 1 survey and concurred that Habitat 3 on Figure 2 was not suitable Ute ladies'-tresses habitat. Therefore, this habitat was not resurveyed in 2025 and is not shown on Figure 3.

Following communications with representatives from the USFWS and NRCS, a more liberal interpretation of Ute ladies'-tresses potential habitat was implemented in 2025 (Figure 3). Nine additional potential habitat areas were identified, mapped, and surveyed during the 2025 survey efforts (Habitat Areas 3 through 11 on Figure 3) in response to the USFWS request. Habitat Areas 3 through 11 on Figure 3, are generally similar to Habitat Area 1, (low-lying herbaceous wetlands along the stream channels, see Photo 1). Surveys completed in 2024 covered the additional habitat areas that were mapped in 2025, and no Ute ladies'-tresses individuals were found.

Discussion/Results

Ute ladies'-tresses was not found in the project area during the year 1 surveys completed in 2024 or year 2 surveys completed in 2025. Potentially suitable wetland habitat was found in the project area. Habitat Areas 1 and 2 on Figures 2 and 3 were determined to represent suitable habitat. Habitat Area 3 on Figure 2 was determined to be unsuitable habitat because the wetland vegetation is tall and dense. Additional Habitat Areas 3 through 11 on Figure 3 were mapped as suitable habitat in 2025. However, they were surveyed in both 2024 and 2025 and no Ute ladies'-tresses were found.

References

U.S. Fish and Wildlife Service (USFWS). 1992. Interim Survey Requirements for Ute Ladies'-tresses Orchid (*Spiranthes diluvialis*). Revised 2017.

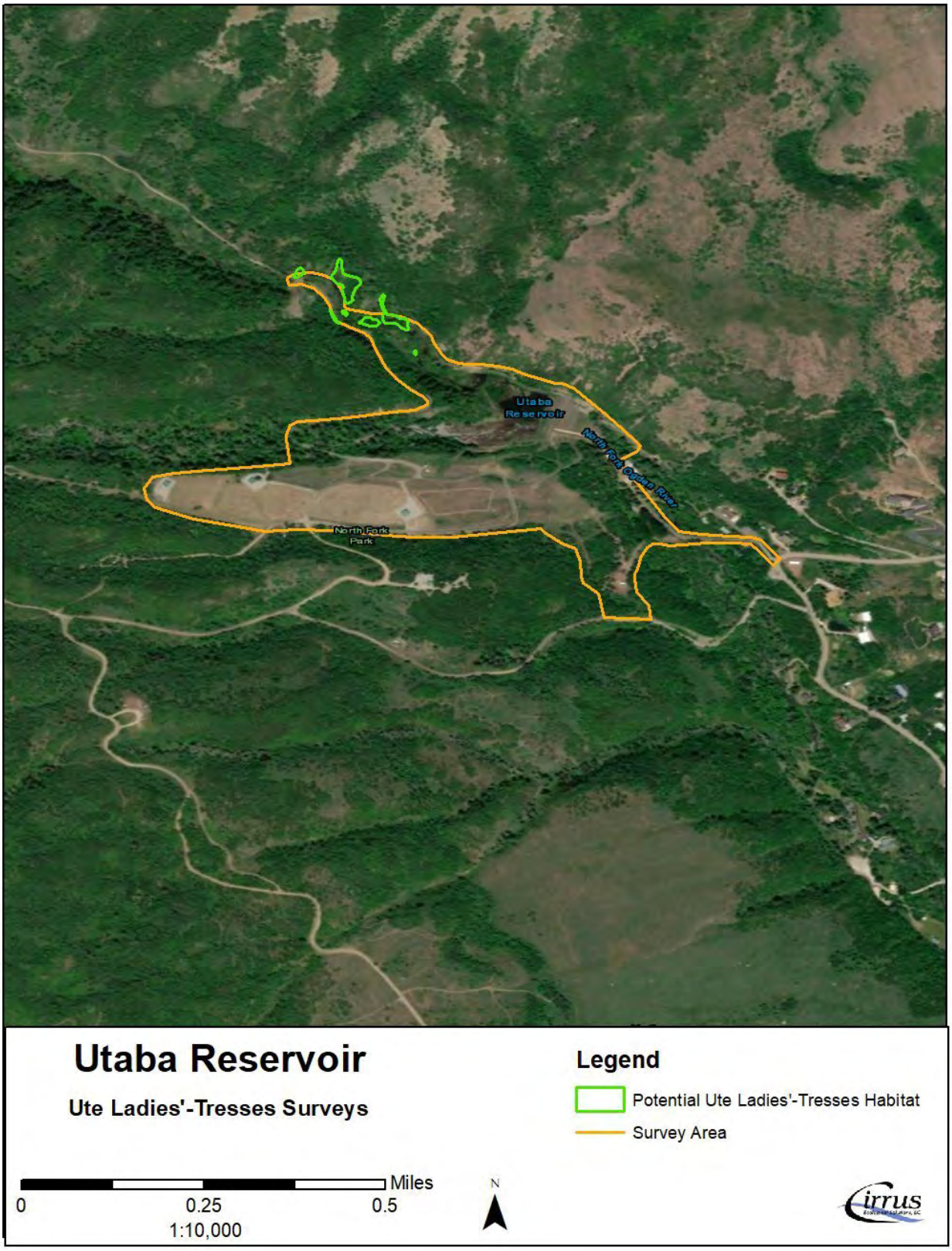

Figure 1. Overview of potentially suitable Ute ladies'-tresses habitat within the Utaba Reservoir project area.

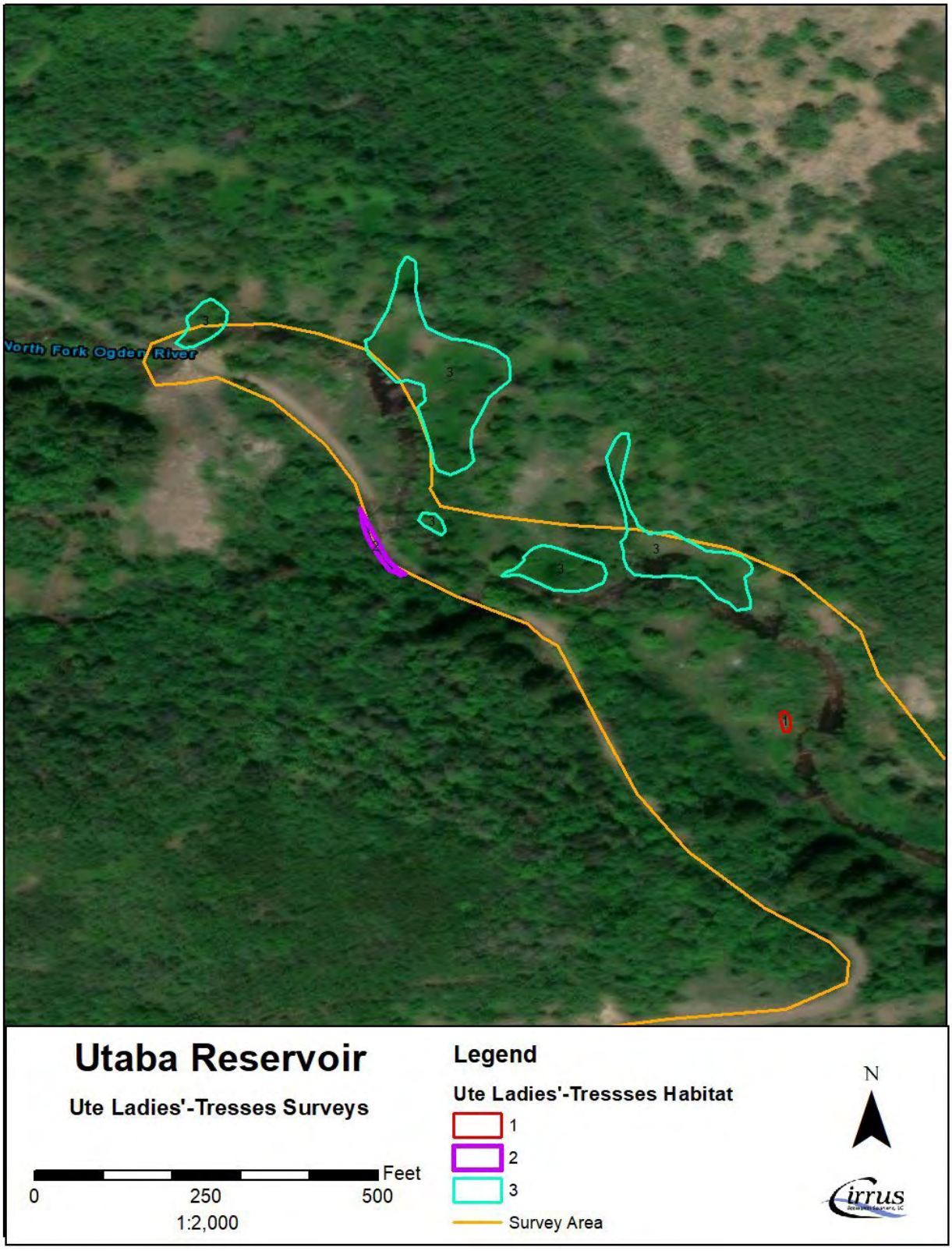

Figure 2. Detail showing potentially suitable Ute ladies'-tresses habitat within the Utaba Reservoir project area.

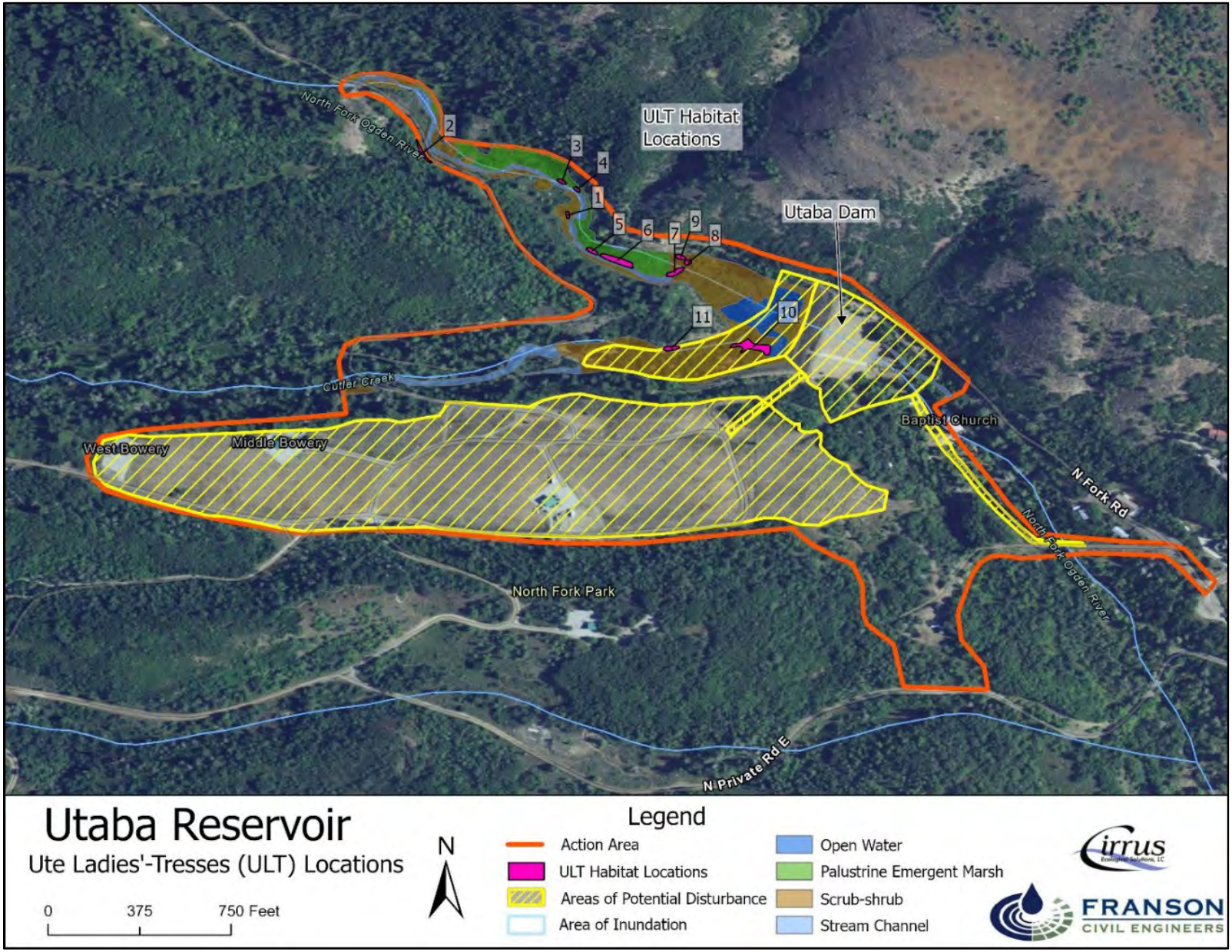

Figure 3. Map showing suitable habitat for Ute ladies'-tresses within the Utaba project area after the 2025 surveys.



Photo 1. Habitat Area 1.



Photo 2. Habitat Area 2.



Photo 3. Habitat Area 3.



Photo 4. Habitat Area 3.

Attachment F.

Utah Natural Heritage Search Report

Utah Division of Wildlife Resources
Utah Natural Heritage Program
1594 W. North Temple
PO Box 146301
Salt Lake City, UT 84116

Report Number: 15895
August 26, 2024

Utah Natural Heritage Program Online Species Search Report

Project Information

Project Name

Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Project Description

NRCS project to rehabilitate and improve life of Utaba Dam. Polygon generated for proposal to be contractor for environmental document and engineering services. Utaba Dam is located in Weber County, Utah, latitude 41.387128?, longitude -111.910519?. Utaba Dam was constructed in 1962 under Public Law 566 as a significant hazard potential dam. The evaluated life of Utaba Dam is 50 years. Utaba is currently classified as a significant hazard potential dam but has been determined by NRCS to be out of compliance with current NRCS and state dam safety criteria, and performance standards. Utah dam safety is in the process of upgrading Utaba Dam to a more representative high hazard class. The hazard class change is due mostly to development downstream and changes in state and NRCS requirements. The need for the project is to upgrade the dam to meet current NRCS and State dam safety standards to reduce the risk to life and property and extend the service life of the dam and to allow it to continue to provide protection from floods. Some of the essential changes to make the structure meet requirements is adding material to get a wider top width, replace the primary outlet pipe with a larger pipe, and replace the auxiliary spillway to provide more flow capacity. Sedimentation has also reduced the retention volume of the structure and subsequently its effectiveness as a flood control structure. Significant deterioration of the concrete in the auxiliary spillway has been observed. Preliminary planning has shown that the sponsor would like to explore adapting the facilities to be able to use it as a water source for aerial wildland fire fighting efforts and create better access for the county to get equipment to the dam and to the outlet works for operation and maintenance.

Location Description

Weber County, Utah. Upstream of Pineview Reservoir at the confluence of the North Fork of the Ogden River with Cutler Creek.



August 26, 2024

Animals within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Bald Eagle	Haliaeetus leucocephalus	SGCN		1983
Bonneville Cutthroat Trout	Oncorhynchus clarkii utah	SGCN		2006

Plants within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Animals within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Bald Eagle	Haliaeetus leucocephalus	SGCN		1983
Bonneville Cutthroat Trout	Oncorhynchus clarkii utah	SGCN		2022
Greater Sage-grouse	Centrocercus urophasianus	SGCN		1999

Plants within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Definitions

State Status

SGCN	Species of greatest conservation need listed in the Utah Wildlife Action Plan

U.S. Endangered Species Act

LE	A taxon that is listed by the U.S. Fish and Wildlife Service as "endangered" with the probability of worldwide extinction
LT	A taxon that is listed by the U.S. Fish and Wildlife Service as "threatened" with becoming endangered
LE;XN	An "endangered" taxon that is considered by the U.S. Fish and Wildlife Service to be "experimental and nonessential" in its designated use areas in Utah
C	A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a "candidate" for listing as endangered or threatened
PT/PE	A taxon "proposed" to be listed as "endangered" or "threatened" by the U.S. Fish and Wildlife Service

Disclaimer

The information provided in this report is based on data existing in the Utah Division of Wildlife Resources' central database at the time of the request. It should not be regarded as a final statement on the occurrence of any species on or near the designated site, nor should it be considered a substitute for on-the-ground biological surveys. Moreover, because the Utah Division of Wildlife Resources' central database is continually updated, any given response is only appropriate for its respective request.

The UDWR provides no warranty, nor accepts any liability, occurring from any incorrect, incomplete, or misleading data, or from any incorrect, incomplete, or misleading use of these data.

The results are a query of species tracked by the Utah Natural Heritage Program, which includes all species listed under the U.S. Endangered Species Act and species on the Utah Wildlife Action Plan. Other significant wildlife values might also be present on the designated site. Please contact UDWR's regional habitat manager if you have any questions.

For additional information about species listed under the Endangered Species Act and their Critical Habitats that may be affected by activities in this area or for information about Section 7 consultation under the Endangered Species Act, please visit https://ecos.fws.gov/ipac/ or contact the U.S. Fish and Wildlife Service Utah Ecological Services Field Office at (801) 975-3330 or utahfieldoffice_esa@fws.gov.

Please contact our office at (801) 538-4759 or habitat@utah.gov if you require further assistance.

Your project is located in the following UDWR region(s): Northern region

Report generated for:
Landon Richins
Franson Civil Engineers
1276 South 820 East, Suite 100
American Fork, UT 84003
(801) 756-0309
lrichins@fransoncivil.com



Attachment G.

ECOS IPaC Resource List

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

NOT FOR CONSULTATION

Location

Weber County, Utah



Local office

Utah Ecological Services Field Office

(801) 975-3330
(801) 975-3331

2369 West Orton Circle, Suite 50

West Valley City, UT 84119-7603

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Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

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2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Canada Lynx Lynx canadensis There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine Gulo gulo luscus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Threatened

Birds

NAME	STATUS
Yellow-billed Cuckoo Coccyzus americanus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3911	Threatened

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Ute Ladies'-tresses Spiranthes diluvialis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2159	Threatened

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Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

There are likely bald eagles present in your project area. For additional information on bald eagles, refer to Bald Eagle Nesting and Sensitivity to Human Activity

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NOT FOR CONSULTATION

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Golden Eagle Aquila chrysaetos This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds Dec 1 to Aug 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12

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(0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

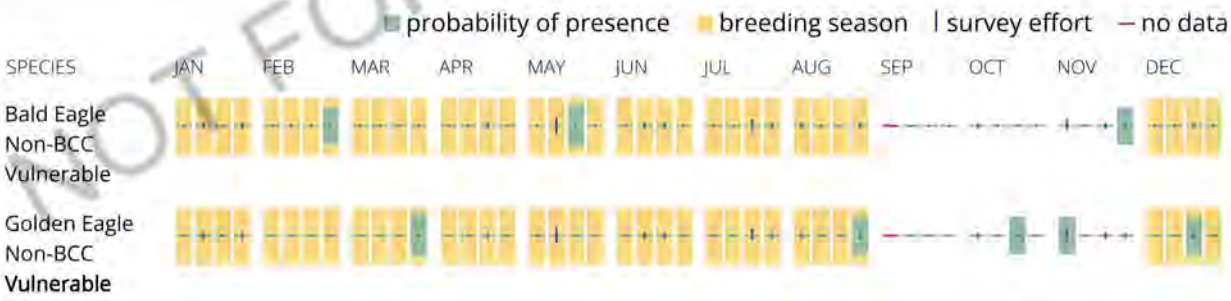
Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

NOT FOR CONSULTATION

What does IPaC use to generate the probability of presence graphs of bald and golden eagles in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur. Please contact your local Fish and Wildlife Service Field Office if you have questions.

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Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-

golden-eagles-may-occur-project-action

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Broad-tailed Hummingbird Selasphorus platycercus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 25 to Aug 21
California Gull Larus californicus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 1 to Jul 31
Cassin's Finch Haemorhous cassinii This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9462	Breeds May 15 to Jul 15
Clark's Nutcracker Nucifraga columbiana This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Jan 15 to Jul 15

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Evening Grosbeak Coccothraustes vespertinus — Breeds May 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Flammulated Owl Psiloscops flammeolus — Breeds May 10 to Aug 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/7728

Golden Eagle Aquila chrysaetos — Breeds Dec 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Lewis's Woodpecker Melanerpes lewis — Breeds Apr 20 to Sep 30
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9408

Long-eared Owl asio otus — Breeds Mar 1 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3631

Olive-sided Flycatcher Contopus cooperi — Breeds May 20 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3914

Virginia's Warbler Leiothlypis virginiae — Breeds May 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9441

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read

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"Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (▪)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (▪)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

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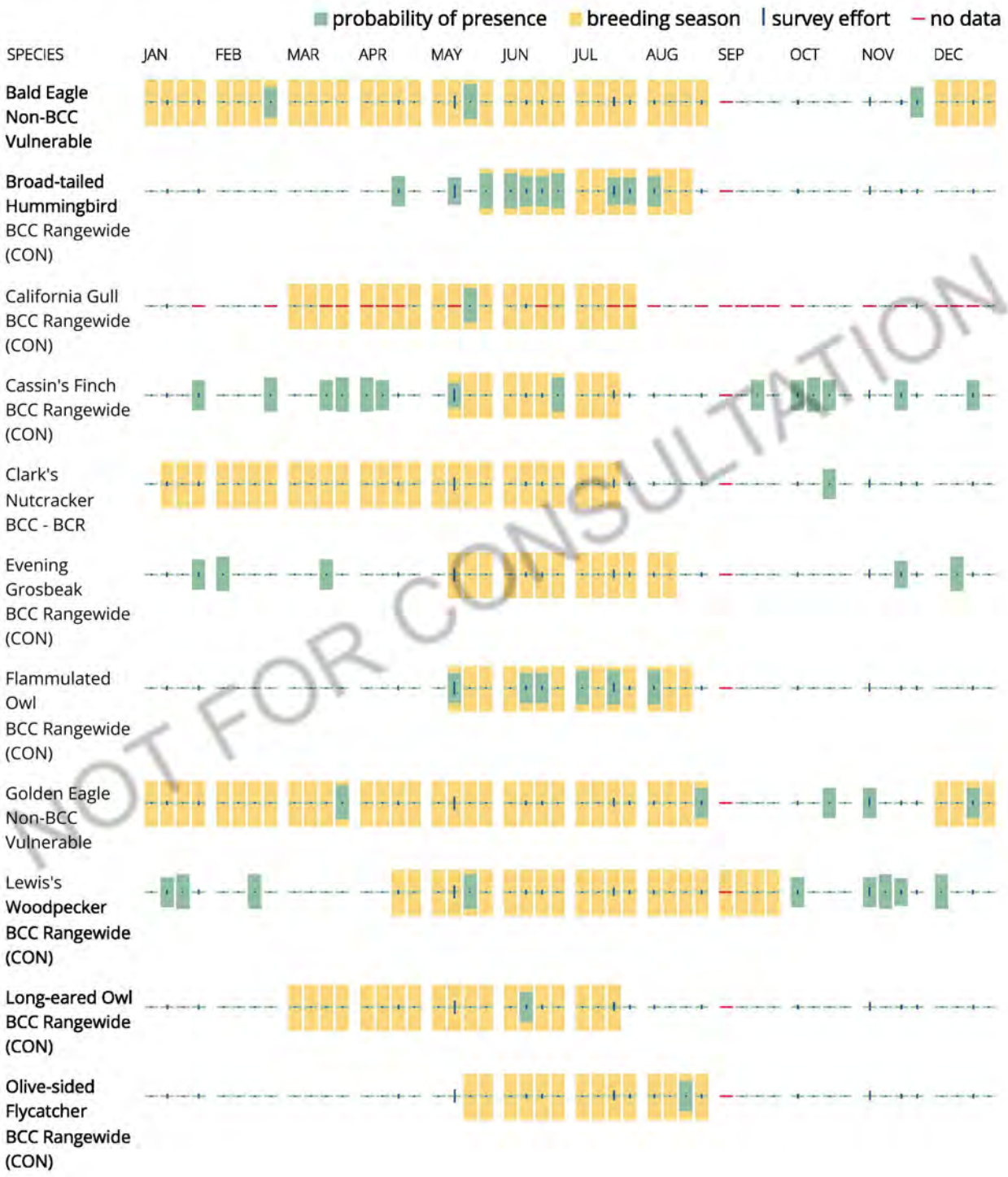
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



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Virginia's Warbler BCC Rangewide (CON)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird

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on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key

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component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

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This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

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Biological Assessment (BA) for Geotechnical Clearance

Biological Assessment

Utaba Dam Rehabilitation Supplemental Watershed Plan-EA–
Project Planning Geotechnical Work

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October 2024

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1 Introduction

This Biological Assessment (BA) has been prepared to document the potential effects of the Utaba Dam planning level geotechnical field work on Federally listed species afforded protection under Section 7 of the Endangered Species Act (ESA). The Natural Resources Conservation Service (NRCS) is the lead Federal agency for the project. It is providing technical and financial assistance to the sponsor through the Watershed Rehabilitation Program (Public Law 83-566).

Weber County, Utah, the Sponsoring Local Organization (SLO) for the project, is developing a Plan-EA that seeks to identify a viable alternative solution to address current dam safety issues at Utaba Retarding Dam located upstream of Pineview Reservoir and just downstream of the confluence of the North Fork Ogden River with Cutler Creek.

1.1 Consultation to Date

- **July 2, 2024** – Project Kickoff Meeting
    - It was determined that ESA Section 7 clearance would need to be received prior to geotechnical field work occurring.
- **August 13, 2024** –BA Planning Discussion
    - NRCS: Derek Hamilton
    - Franson Civil Engineers: Layne Jensen, Landon Richins
    - Cirrus Ecological Solutions: Scott Evans, Adam Clifford
- **August 14, 2024** – Agency Scoping Meeting
    - USFWS Attendees: Dannette Weiss
    - NRCS Attendees: Derek Hamilton, Tara Hoffmann, Shawn Stanley, Anders Fillerup
    - Franson Civil Engineers (FCE): Layne Jensen, Landon Richins

1.2 Consultation Participants

The following individuals consulted to determine the level of consultation necessary and the conservation measures to be committed to for each considered species in this BA.

Table 1: List of Consultation Participants and Affiliations

Name	Title	Affiliation
Derek Hamilton	Biologist	Natural Resources Conservation Service
Shawn Stanley	Project Engineer	Natural Resources Conservation Service
Layne Jensen	Project Manager	Franson Civil Engineers
Landon Richins	Environmental Specialist I	Franson Civil Engineers
Scott Evans	Biological Survey Lead	Cirrus Ecological Solutions
Adam Clifford	Wildlife Biologist	Cirrus Ecological Solutions
John Stewart	Botanist	Cirrus Ecological Solutions

2 Project Description

2.1 Project Area

The Action Area is located in Weber County, Utah just downstream of the confluence of the North Fork Ogden River and Cutler Creek and upstream of Pineview Reservoir. The figure on the following page shows the project area. The project area for the geotechnical work is limited to the existing dam embankment. Access is already established..

2.2 Action Area

The Action Area includes the area of disturbance associated with geotechnical activities, including the associated species buffers (0.5 mile for birds and 300 feet for plants). The Action Area is shown in the figure on the following page.

2.3 Project Details

The proposed action (geotechnical work) consists of the following components:

2.3.1 Planning Level Geotechnical Field Investigation

Geotechnical field studies are currently scheduled to occur in the study area for October 21st, 2024. These field studies will provide critical information about Utaba Dam's underlying geology that must be gathered in order for the NEPA and PL 83-566 planning processes to progress. All planned geotechnical work would occur outside of the identified suitable habitat areas for Federally listed species.

The work would consist of digging test pit and drilling test boreholes on the embankment of the dam and would not conduct any work in the canyons upstream of the dam. Ground disturbance would be very limited. More detailed descriptions of the work to be conducted is described below. A copy of the full geotechnical field study plan is included as Attachment D to this BA.

2.3.2 Test Pits

An excavator would be used to dig 2-foot wide, 10-12 foot long, 8-12 foot deep test pits in the action area to better understand the underlying geology of the site. The test pits excavated on the face of the dam itself would only be 1-foot deep. The pits would be backfilled following data collection, returning all material to the site it was removed from following the study.

2.3.3 Test Boreholes

Two six-inch diameter test boreholes would be drilled with the first being drilled 40-feet deep and the second being drilled 100-feet deep. A 2-inch diameter PVC pipe (piezometer) would be installed inside the hole that would be protected with a metal box casing.

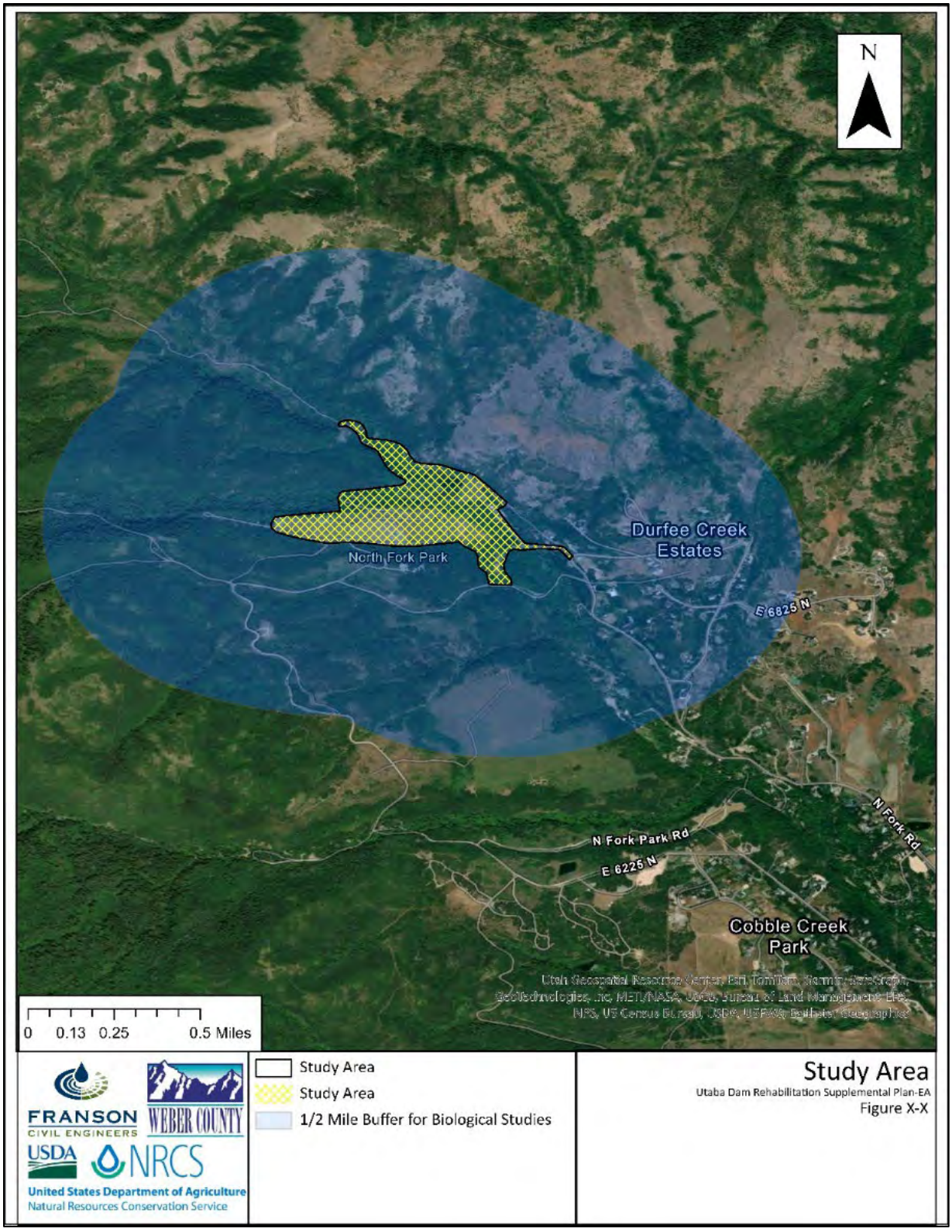

Figure 1 Project Action Area with 0.5 Mile WYBC Survey Buffer

2.3.4 Schedule of Geotechnical Field Study

The onsite geotechnical field work would occur over 2-5 days and would begin with the boreholes and conclude with the pits, although the work may be completed concurrently. The work is scheduled to begin on October 21st, 2024, and be completed by the end of the month.

2.4 Conservation Measures

The following conservation measures are proposed for the species considered in this BA:

- All planned geotechnical work would occur outside of the identified suitable habitat areas for Federally listed species considered in this BA.
- Geotechnical work would occur outside of the breeding and nesting season for the WYBC which runs from mid-May to August 15. Furthermore, the work would occur outside of the window when the species is known to occur in Utah (Utah Division of Wildlife Resources, 2019)
- All necessary surveys for considered species will be conducted in 2025 and a full Biological Assessment for the larger Proposed Action will be prepared. USFWS will be given an opportunity to review the full BA as well. This BA only serves to make determinations based on impacts of the planned geotechnical work.

2.5 Existing Habitat Conditions

The Action Area is located within the Wasatch and Uinta Mountains, Alpine Zone ecoregion. The ecoregion is defined by high, glaciated mountains, dissected plateaus, foothills, and intervening valleys. Land uses in the area surrounding the Action Area include residential, agricultural, and recreational.

3 Species Considered

3.1 Species that May Be Present

An official species list was obtained for the Action Area from the Information for Planning and Consultation (IPaC) system on August 26, 2024 (see Attachment A). The species listed as threatened or endangered that “may be present in the area of the proposed action” are listed in Table 1. There is no designated critical habitat for any of the species within or adjacent to the Action Area.

Table 1: Listed Species that May Occur in the Study Area & Rationale for Further Consideration in this Biological Assessment

Species	Status	Species Consideration in this BA and Likely Occurrence
Canada Lynx (*Lynx canadensis*)	Threatened	Not Considered. Due to the proximity of the study area to human activity within and adjacent to the study area and due to the lack of dense horizontal forest cover with significant snowshoe hare populations, there is no suitable habitat for the Lynx in the Action Area.
North American Wolverine (*Gulo gulo luscus*)	Threatened	Not Considered. Due to the proximity of the study area to human activity within and adjacent to the study area and due to the lack of the landscape structure to support den sites, there is no suitable habitat for the Wolverine in the Action Area.
Western Yellow-billed Cuckoo (*Coccyzus americanus occ.*)	Threatened	**Considered**. Approximately 72 acres of potentially suitable habitat for the WYBC was identified in the Action Area during the field assessment.
Monarch Butterfly (*Danaus plexippus*)	Candidate	Not Considered. Monarchs require milkweed (*Asclepias spp.*), nectar sources, overwintering habitat, and migration habitat (USFWS, 2020). There is no suitable habitat for the Monarch Butterfly in the Action Area.
Ute Ladies'-Tresses (*Spiranthes diluvialis*)	Threatened	**Considered**. Potentially Suitable habitat for the ULT was identified in the Action Area during the field assessment.

3.2 Species Carried Forward

WYBC and ULT were both identified as potentially occurring in the vicinity of proposed project activities; therefore, these species are being carried forward in this BA for further analysis.

3.3 Species Descriptions and Effect Analyses

3.3.1 Western Yellow-billed Cuckoo

The WYBC is an avian species, classified as a riparian obligate species, that was listed as threatened by the USFWS on October 3, 2014 (USFWS, 2014). The WYBC is a migratory bird that spends its winters in Central and South America. The species uses riparian corridors as breeding grounds in North America. The WYBC typically prefers large tracts of multi-layered cottonwood and willow habitat with dense sub-canopies (below 33 feet). In Utah, sightings/populations of the WYBC are rare. This species is dependent on riparian areas with woody vegetation that creates a dense shrubby understory for nesting and a cottonwood overstory for foraging (USFWS, 2021b).



Figure 2 Western Yellow-billed Cuckoo (USFWS)

The WYBC is distinguished by its sizeable and gently curved bill that has a blue-black coloration with yellow on the basal half of the lower mandible, accompanied by a slender, elongated body that imparts a long-tailed appearance. Around the eye, there is a yellow ring of exposed colored skin. These birds are medium-sized measure around 12 inches in length and weigh approximately 60 grams.

Current threats to the WYBC include loss of riparian habitat to agriculture and other land uses, dam construction, stream channelization and stabilization, and livestock grazing (USFWS, 2017). The IPaC report for the Action Area did not identify any proposed or designated final critical habitat for the WYBC in the Action Area.

3.3.2 Survey Conditions & Findings – Western Yellow-Billed Cuckoo

A habitat suitability assessment for the Western Yellow-billed Cuckoo (WYBC) occurred on July 10, 2024 (Attachment B) to determine if any suitable habitat exists within the Action Area. The survey identified three areas that met the requirements for suitable WYBC habitat. These areas are shown in green in the figure on the following page.

The total acreage of suitable WYBC habitat in the Action Area is 72 acres. The yellow polygon in the figure has not been surveyed for suitable habitat due to property access issues. Additionally, it should be noted that there have been recorded observations of WYBC approximately 10 miles south of the study area (UDWR, 2024).

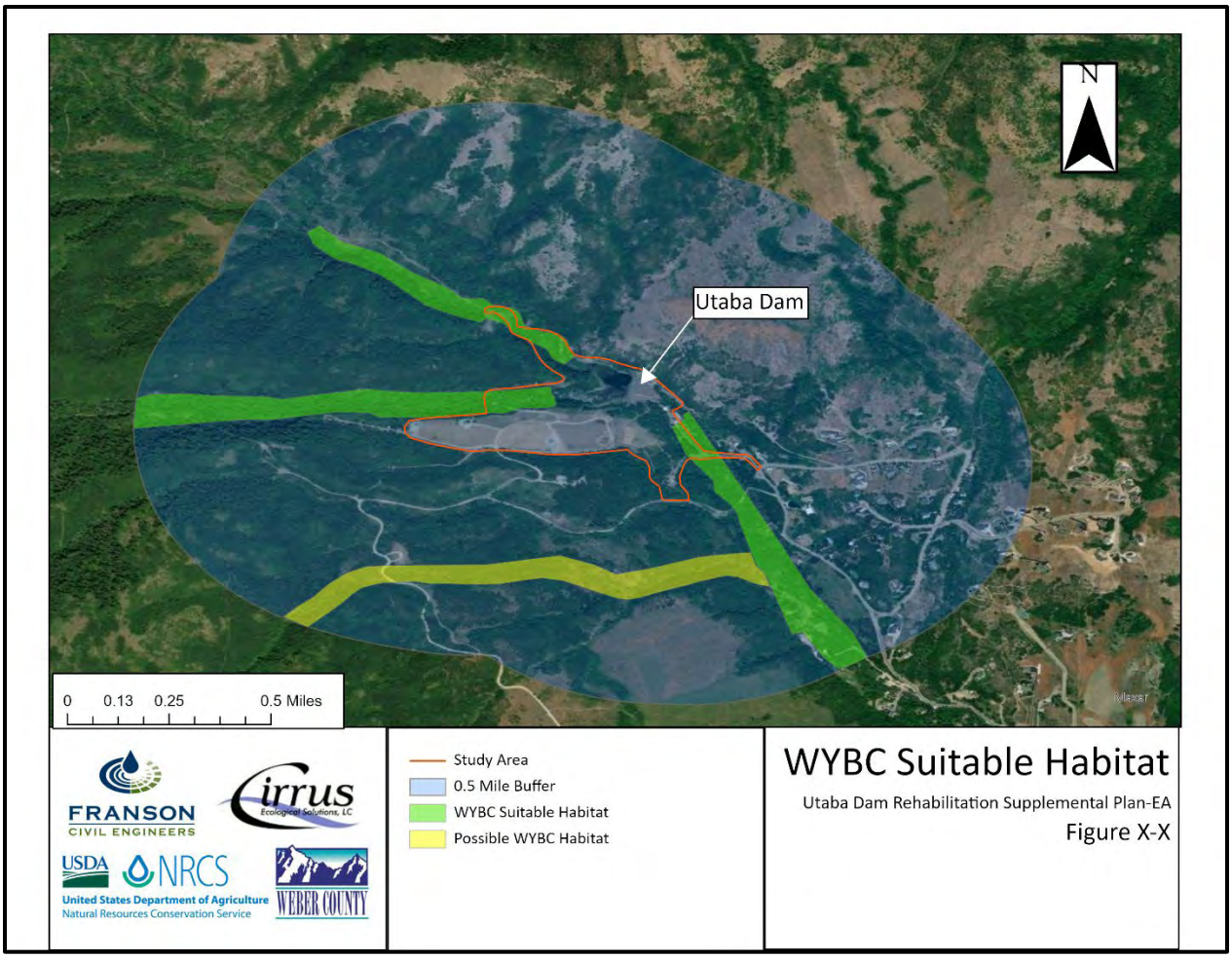

Figure 3 WYBC Suitable Habitat in Action Area

3.3.3 Direct and Indirect Effects – WYBC

The WYBC is a shy bird and is not typically found in areas of high residential development or human activity, such as the Action Area. Because of this, the suitable habitat identified south of the reservoir along the North Fork Ogden River is less significant suitable habitat for WYBC due to ongoing disturbance, adjacent residential development, and large gaps in the habitat patches (Cirrus, 2024). All these factors would likely discourage any WYBCs in the area from nesting in the Action Area. All planned geotechnical work would occur outside of suitable habitat areas for the WYBC. Additionally, the potentially suitable habitat for WYBC downstream of the dam would not be occupied due to the WYBC's shy nature, gaps in the habitat, and the presence of heavy human-use and development. Finally, and perhaps most importantly, all geotechnical work would occur outside of the breeding and nesting season for the WYBC which runs from mid-May to August 15 and would take place during a time period where birds are not known to occur in Utah. As the Utah Division of Wildlife Resources (UDWR) states, "Western Yellow-billed Cuckoos are one of the latest migrants to arrive and breed in Utah. They arrive in extremely late May or early June and breed in late June through July. Cuckoos typically start their southerly migration by late August or early September" (UDWR, 2019).

3.3.4 Ute Ladies'-Tresses



Figure 4: Ute Ladies'-Tresses (USFWS)

The ULT is a white-flowered, perennial, terrestrial herb that is a member of the family *Orchidaceae* (orchids) that occurs in low to mid-elevation wetlands and riparian zones in the central Rocky Mountains and typically grows to be between 8 and 20 inches tall (USFWS, 2021a). The species was listed as threatened by the USFWS on January 17, 1992, because of its rarity, small population sizes, and threats of loss or modification to riparian habitats (USFWS, 1992).

Suitable ULT habitat is generally characterized by old stream channels, alluvial terraces, sub-irrigated meadows, and other wetland habitats. ULTs have also been documented within irrigated pastures, riparian shrublands, and deciduous forests below 7,000 feet in elevation. The species blooms from late July through August (USFWS 2021).

Current threats to the ULT include loss of riparian and wetland habitat as a result of urbanization, flooding, and dewatering of habitat from dam control and stream channel re-routing for agricultural development (USFWS 2021a).

3.3.5 Survey Conditions & Findings – Ute Ladies'-Tresses

A habitat suitability assessment for the ULT was conducted on August 3, 2024 (Attachment C) to determine if any suitable habitat exists in the Action Area and to identify if any ULT individuals existed in the project area. The survey was conducted during the ULT blooming window. The study did not identify any ULT individuals in the Action Area. A copy of the survey memo is included in Appendix C.

3.3.6 Direct and Indirect Effects – ULT

The geotechnical work would occur approximately 1,000 feet away from the nearest area of potentially suitable ULT habitat. The minimum buffer between a proposed action and ULT habitat is 300 feet, thus there would be no effect on the ULT as a result of the proposed action.

4 Conclusion and Determination of Effects

4.1 Determination of Effects – No Effect

Considering all the information presented in the preceding sections of this chapter, it can be reasonably concluded that the magnitude of impacts on the ULT and WYBC resulting from the geotechnical would be negligible (i.e., no effect).

The geotechnical field work would not occur within the breeding/nesting season of the WYBC or occur during a time period when the bird is known to occur in Utah. Additionally, there would be no overlap between the proposed action and any suitable habitat in the Action Area.

Additionally, the geotechnical work would not occur within 300-feet of any potentially suitable habitat for ULTs. There would be no disturbance to any area in which ULTs could potentially occur.

The table below summarizes and presents the determinations of effects for all of the ESA species in this BA. No actions related to the geotechnical work would have any effect on designated critical habitat for any species.

Table 2 Determination of Effects

Species	Status	Determination of Effects
Canada Lynx (*Lynx canadensis*)	Threatened	No Effect. No suitable habitat in the Action Area.
North American Wolverine (*Gulo gulo luscus*)	Threatened	No Effect. No suitable habitat in the Action Area.
Western Yellow-billed Cuckoo (*Coccyzus americanus occ.*)	Threatened	No Effect. Work would not occur within the breeding/nesting season for the WYBC or within a time period they are known to occur in Utah.
Monarch Butterfly (*Danaus plexippus*)	Candidate	No Effect. No suitable habitat in the Action Area.
Ute Ladies'-Tresses (*Spiranthes diluvialis*)	Threatened	No Effect. All work would occur approximately 1,000 feet from the nearest potential ULT habitat (minimum distance is 300 feet).

5 Literature Cited

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Ute Ladies'-Tresses, USFWS/B. Hotze, Public Domain, https://www.fws.gov/banner/ute-ladies-tresses.

6 Attachments

Attachment A. USFWS IPaC Species Report
Attachment B. WYBC Habitat Suitability Assessment Memo – Cirrus Ecological Solutions
Attachment C. ULT Suitability & Presence/Absence Survey Memo – Cirrus Ecological Solutions
Attachment D. Geotechnical Field Studies Plan – Technical Memorandum – Gerhart Cole, Inc.

Attachment A
ECOS IPaC Official Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
Phone: (801) 975-3330 Fax: (801) 975-3331

In Reply Refer To: 08/26/2024 15:13:23 UTC
Project Code: 2024-0135067
Project Name: Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through IPaC by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)

(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see Migratory Bird Permit | What We Do | U.S. Fish & Wildlife Service (fws.gov).

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

PROJECT SUMMARY

Project Code: 2024-0135067

Project Name: Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Project Type: Dam - Maintenance/Modification

Project Description: NRCS project to rehabilitate and improve life of Utaba Dam. Polygon generated for proposal to be contractor for environmental document and engineering services.

Utaba Dam is located in Weber County, Utah, latitude 41.387128º, longitude -111.910519º. Utaba Dam was constructed in 1962 under Public Law 566 as a significant hazard potential dam. The evaluated life of Utaba Dam is 50 years.

Utaba is currently classified as a significant hazard potential dam but has been determined by NRCS to be out of compliance with current NRCS and state dam safety criteria, and performance standards. Utah dam safety is in the process of upgrading Utaba Dam to a more representative high hazard class. The hazard class change is due mostly to development downstream and changes in state and NRCS requirements.

The need for the project is to upgrade the dam to meet current NRCS and State dam safety standards to reduce the risk to life and property and extend the service life of the dam and to allow it to continue to provide protection from floods.

Some of the essential changes to make the structure meet requirements is adding material to get a wider top width, replace the primary outlet pipe with a larger pipe, and replace the auxiliary spillway to provide more flow capacity. Sedimentation has also reduced the retention volume of the structure and subsequently its effectiveness as a flood control structure. Significant deterioration of the concrete in the auxiliary spillway has been observed. Preliminary planning has shown that the sponsor would like to explore adapting the facilities to be able to use it as a water source for aerial wildland fire fighting efforts and create better access for the county to get equipment to the dam and to the outlet works for operation and maintenance.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@41.3862764,-111.91171371499274,14z



Counties: Weber County, Utah

ENDANGERED SPECIES ACT SPECIES

There is a total of 5 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Canada Lynx *Lynx canadensis* Population: Wherever Found in Contiguous U.S. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5123	Threatened

BIRDS

NAME	STATUS
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

FLOWERING PLANTS

NAME	STATUS
Ute Ladies'-tresses *Spiranthes diluvialis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2159	Threatened

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Franson Civil Engineers
Name: Landon Richins
Address: 1276 South 820 East, Suite 100
City: American Fork
State: UT
Zip: 84003
Email lrichins@fransoncivil.com
Phone: 8017560309

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Natural Resources Conservation Service
Name: Derek Hamilton
Email: derek.hamilton@usda.gov
Phone: 3853214987

Attachment B

Cirrus Ecological Solutions Habitat Suitability Assessment for the Western Yellow-billed Cuckoo

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 22, 2024

TO: Landon Richins, Environmental Specialist, Franson Engineering; Derek Hamilton, Water Resources Coordinator, NRCS.

CC: Scott Evans, Owner, Cirrus Ecological Solutions; John Stewart, Botanist Cirrus Ecological Solutions; Layne Jensen, Professional Engineer, Franson Engineering.

FROM: Adam Clifford, Wildlife Biologist, Cirrus Ecological Solutions.

RE: Western yellow-billed cuckoo habitat surveys

On July 10, 2024, personnel from Cirrus Ecological Solutions, LC conducted habitat surveys for western yellow-billed cuckoos associated with the preparation of the Plan-EA for the Utaba Dam rehabilitation project.

Western Yellow-billed Cuckoo Habitat Survey

The western yellow-billed cuckoo (WYBCU; *Coccyzus americanus*) was listed as Threatened under the Endangered Species Act in 2014. Because the Utaba Dam rehabilitation project (Project) has several streams, rivers, and riparian habitat in the Project area, habitat surveys were conducted to determine if the area contains suitable habitat for WYBCU. According to the U.S. Fish and Wildlife Service (FWS), areas that meet the minimum criteria for suitable habitat should be (1) avoided by 0.5 mile, or (2) surveyed, and/or (3) carried forward for evaluation of potential effects.

The FWS provides guidelines for the identification of suitable habitat for WYBCU in Utah to assist with these surveys (FWS 2015). The methods are stated as follows:

> Step 1: Identify and delineate all riparian habitats within 0.5 mile of the proposed action, below the elevation of 8,500 feet.
>
> Step 2: Identify suitable WYBCU breeding and nesting habitat, including associated foraging areas.

Riparian patches used by breeding and nesting cuckoos vary in size and shape, ranging from a relatively contiguous stand of mixed native/exotic vegetation to an irregularly shaped mosaic of dense vegetation with open areas. The following parameters characterize suitable breeding and nesting cuckoo habitat:

- Vegetation that is predominantly multi-layered, with riparian canopy trees and at least one layer of understory shrubby vegetation;
- Patches of multi-layered vegetation (as described above) that are at least 12 acres (5 ha) or greater in extent and separated from other patches of suitable habitat by at least 300 meters;
- Somewhere within a patch, the multi-layered riparian vegetation (as described above) should be at least 100 meters wide by 100 meters long. This is to avoid patches that may be long enough to meet the minimum area (12 acres) but are so narrow that they are unsuitable-- 750 m x 75 m (length x width) for example; and
- Open areas, or gaps of multi-layered vegetation within a patch are less than 300 meters.

The Project area is within the elevation guideline of less than 8,500 feet; the Utaba Reservoir has an elevation of 5,692 feet. There is multi-layered riparian vegetation surrounding the North Fork of the Ogden River and Cutler Creek. Each habitat corridor (green and yellow polygons in Figure 1) is greater than 12 acres contains patches that are 100 meters wide by 100 meters long, thus fulfilling the guideline for habitat patch size They also contain gaps of less than 300 meters which are used as foraging habitat. See Figure 1 for more detail.

Based on the survey results detailed above and in Figure 1, there are 3 areas meeting the requirements for suitable habitat for the WYBCU. These can be seen in the green polygons in Figure 1 and have a total area of 72 acres. The yellow polygon in Figure 1 has not been surveyed for suitable habitat due to access issues during the surveys on July 10. While there have not been any WYBCU observations within 0.5 miles of the Project, there have been observations within 10 miles to the south (UDWR 2024).

The suitable habitat south of the Utaba Reservoir along the North Fork of the Ogden River contains several private residences. These areas are less likely to provide suitable habitat for WYBCU, due to ongoing disturbance and large gaps in the habitat patches, which could discourage WYBCU from nesting.

As stated above, areas that meet the suitable habitat criteria should be surveyed for WYBCU before Project implementation. While the Project would not directly impact any suitable habitat, the 0.5-mile buffer protects WYBCU from the impacts of noise disturbance during Project implementation (FWS 2015).

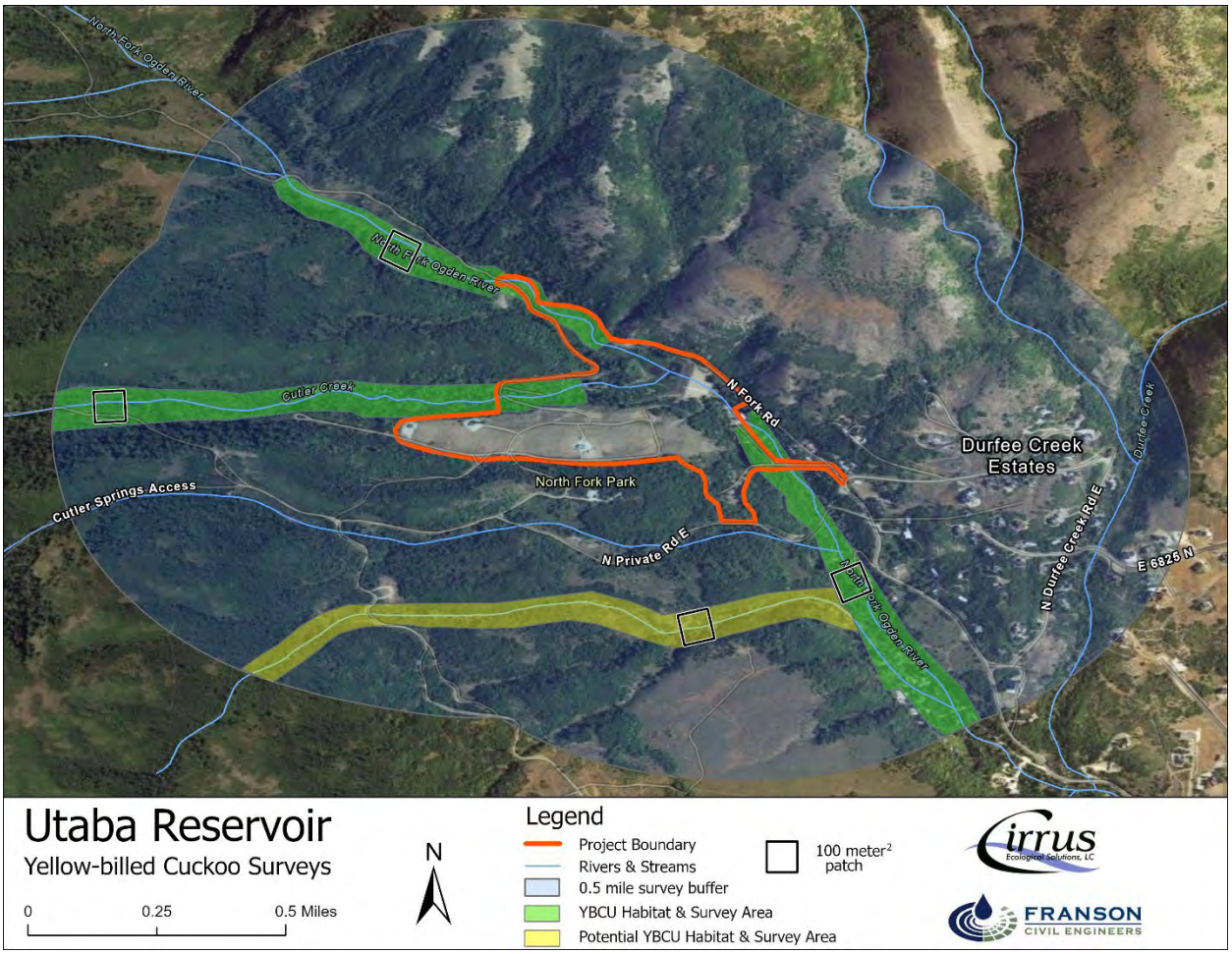


Figure 1. Overview of suitable and potentially suitable WYBCU habitat surrounding the Utaba Reservoir.

References

FWS (U.S. Fish and Wildlife Service). 2015. Guidelines for the identification of suitable habitat for WYBCU in Utah. Available at [https://www.fws.gov/sites/default/files/documents/yellow-billed-cuckoo-guidelines-identification-suitable-habitat-utah-2015_0.pdf]. Accessed July 9, 2024.

UDWR (Utah Division of Wildlife Resources). 2024. Utah Natural Heritage Program Online Species Search Report. Available at [https://dwrapps.utah.gov/HeritageDataRequest/Reports?id=15840]. Accessed August 8, 2024.

Attachment C

Cirrus Ecological Solutions Habitat Suitability and 2024 Presence/Absence Assessment for the Ute-Ladies' Tresses

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 22, 2024

TO: Landon Richins, Environmental Specialist, Franson Engineering; Derek Hamilton, Water Resources Coordinator, NRCS.

CC: Scott Evans, Owner, Cirrus Ecological Solutions; Adam Clifford, Wildlife Biologist, Cirrus Ecological Solutions; Layne Jensen, Professional Engineer, Franson Engineering.

FROM: John Stewart, Botanist, Cirrus Ecological Solutions.

RE: ULT surveys at Utaba Dam rehabilitation site

On August 3, 2024, a survey was conducted for Ute ladies' tresses orchid (*Spiranthes diluvialis*) within the project area for the Utaba Dam rehabilitation project.

Background

Ute ladies'-tresses was federally listed as threatened on January 17, 1992 (57 FR 2048). Critical habitat has not been designated for this species.

Ute ladies'-tresses is a perennial orchid with stems that arise from thickened roots. The bloom consists of 3 to 15 small white- or ivory-colored flowers clustered into a spike arrangement at the top of the stem. Depending on location, the species may flower as early as early July or as late as early October (Sheviak 1984, Jennings 1989, and Coyner 1990 as cited in USDI-BLM 2017). Mature plants may remain dormant for one or more growing seasons without producing aboveground shoots or may exhibit vegetative shoots only. Bumblebees are one of the main pollinators for Ute ladies'-tresses and population numbers can affect how many and when flowering occurs.

Habitat Characteristics

Ute ladies'-tresses may be found in moist to wet soils in mesic or wetland habitat associated with springs, lakes, and perennial streams. The elevation range of occupied habitat is 700 to 7,000 feet throughout the species range. Most occurrences are along riparian edges, gravel bars, old oxbows, and moist to wet meadows. Some localities are near freshwater lakes and springs/groundwater discharge zones. Ute ladies'-tresses is adapted to disturbances caused by water movement through flood plains over time. The species occurs primarily in areas where the vegetation is relatively open and not very dense. It often grows on point

bars and other recently created riparian habitat. The orchid appears to require permanent subirrigation, with the water table holding steady throughout the growing season and into late summer and early autumn (USFWS 1995).

Populations appear to fluctuate dramatically from year to year, making it difficult to assess population status and distribution. The genus *Spiranthes* may also undergo a dormant period that may last 7–10 years, with no evidence of above-ground structures. Nothing is known about the dormancy-triggering mechanisms. In order to locate this species, potential habitat should be surveyed multiple years due to potential dormancy.

Ute Ladies'-tresses Orchid Survey/Habitat Assessment

The survey for Ute ladies'-tresses orchid was completed following the protocol developed by the USFWS (1992). Note that this protocol requires 3 years of surveys if suitable habitat is identified because the species may not flower every year. Important elements of the survey protocol included the following:

- Evaluation of the study area to determine where potentially suitable habitat exists using a combination of aerial imagery, existing information, and field reconnaissance.
- Scheduling field surveys corresponding to flowering in other known populations, typically beginning in the later part of July and extending into mid-to-late August, depending on conditions.
- Completing pedestrian surveys providing 100 percent coverage in suitable habitat using closely-spaced transects.
- Recording population information if any occurrences of Ute ladies'-tresses orchid are located.

Surveys Results

ULT was not found in the Utaba Reservoir survey area.

Potentially suitable habitat for Ute ladies'-tresses orchid was identified in the project survey. This habitat occurs in three habitat areas as shown in Figures 1 and 2.

Habitat 1 is a small riparian wetland area along the North Fork of the Ogden River (Photo 1). This habitat is characterized by creeping bentgrass (*Agrostis stolonifera*), sedge (*Carex* spp.), monkey flower (*Mimilis tilingii*).

Habitat 2 is a narrow seep along the toe of the mountain where the road cut intercepts groundwater and creates a wetland along the edge of the road (Photo 2). This habitat is characterized by creeping bentgrass, northern green bog orchid (*Platanthera aquilonis*), sedge, and willow (*salix spp*.)

Habitat 3 is a series of wetlands along the east side of the project area at the toe of the mountain. Groundwater discharge creates a wetland community. This wetland habitat is characterized by a community of tall (3 to 4 feet tall), dense wetland plants, including lesser panicled sedge (*Carex diandra*), cutleaf water parsnip (*Berula erecta*), and small-fruited bullrush (*scirpus microcarpus*) (Photos 3 and 4). Hydrology is very wet with areas of standing water during the August survey. The wetland community in these wetlands may be too tall and dense to represent potential habitat for Ute ladies'-tresses. Much of this habitat extends beyond the project area.

Discussion

Ute ladies'-tresses was not found in the project area. Potentially suitable wetland habitat was found in the project area. Habitat areas 1 and 2 were evaluated to represent potentially suitable habitat. Habitat areas 3 may be unsuitable habitat because the wetland vegetation is tall and dense. If USFWS concurs that habitat 3 is not suitable, additional surveys in years 2 and 3 may not be required in these areas.

References

U.S. Fish and Wildlife Service (USFWS). 1992. Interim Survey Requirements for Ute Ladies-tresses Orchid (*Spiranthes diluvialis*). Revised 2017.

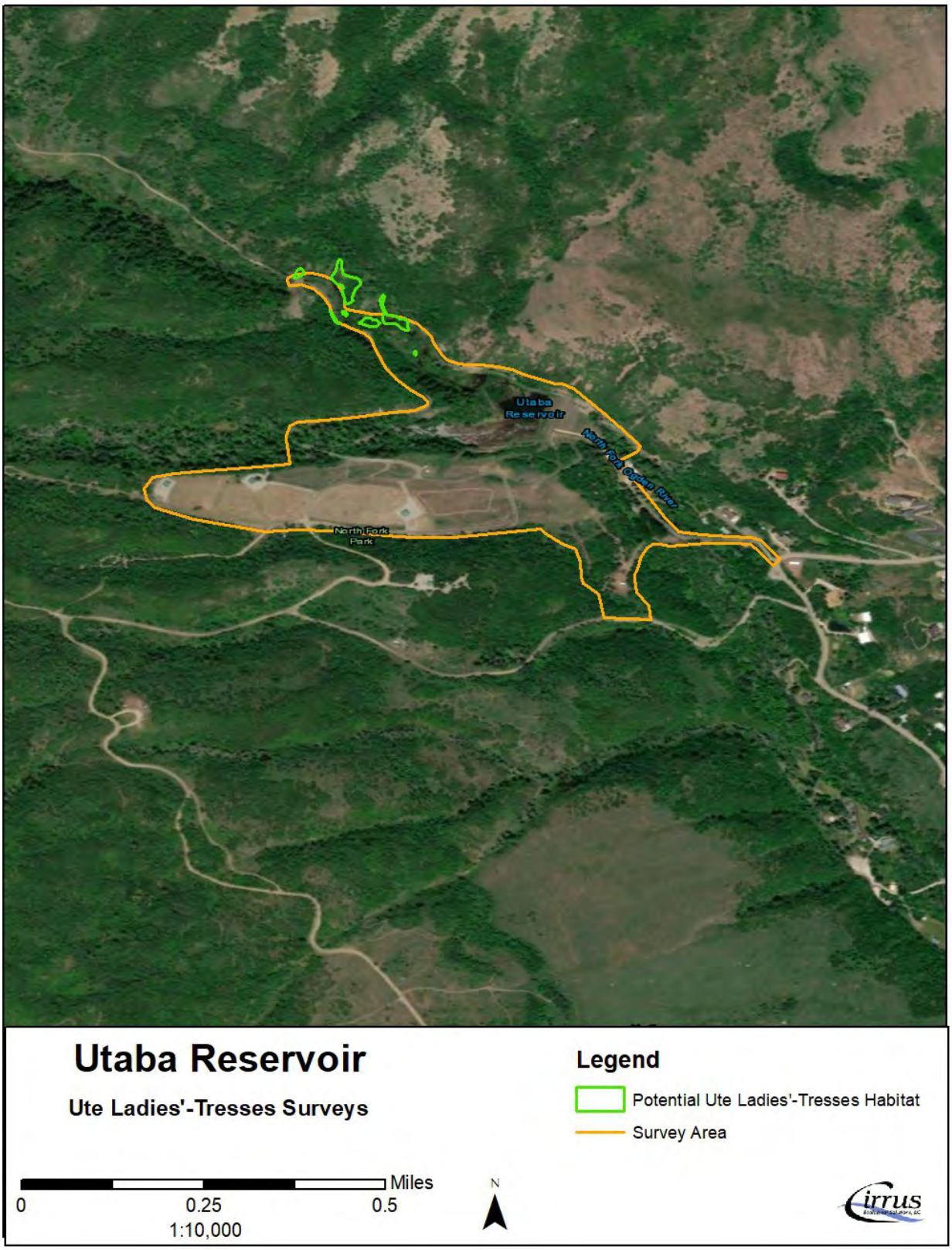


Figure 1. Overview of potentially suitable Ute ladies'-tresses habitat within the Utaba Reservoir project area.

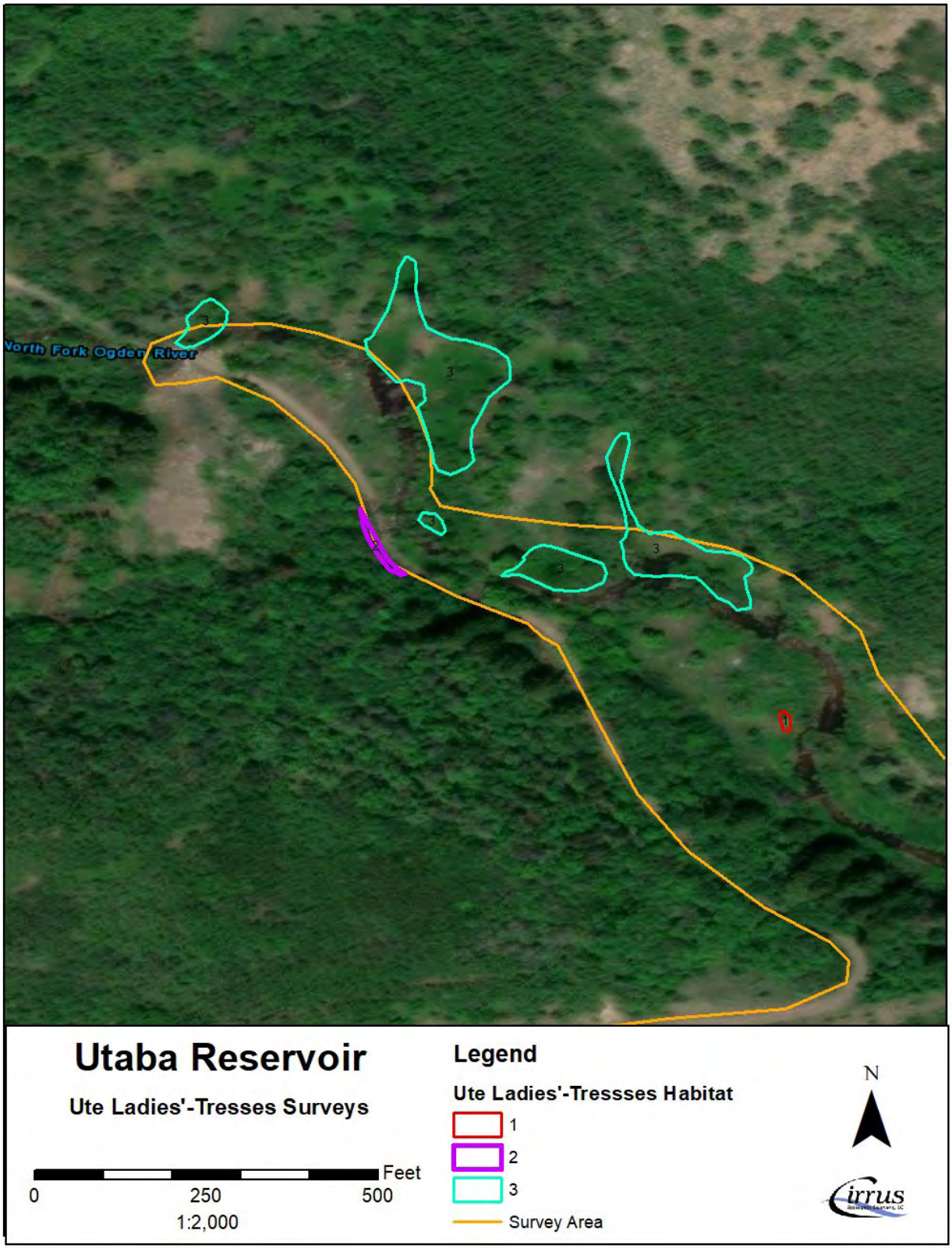


Figure 2. Detail showing potentially suitable Ute ladies'-tresses habitat within the Utaba Reservoir project area.



Photo 1. Area 1 habitat.



Photo 2. Area 2 habitat.



Photo 3. Area 3 habitat.



Photo 4. Area 3 habitat.

Attachment D

Gerhart Cole, Inc. Geotechnical Field Study Plan – Technical Memorandum

GERHART COLE

PO Box 880
Midvale, Utah 84047
801.849.0055
gerhartcole.com

MEMORANDUM

To:	Mr. Layne Jensen, PE & Mr. Chad Brown, PE Franson Civil Engineers 1276 South 820 East, Suite 100 American Fork, Utah 84003
From:	Jed McFarlane, PE
Reviewed by:	Richard Buhler, PE & Jamie Schick (PG)
Date:	September 18, 2024
Job Number:	24-1762
Subject:	Geotechnical Field Studies Plan

PROJECT OVERVIEW

The Utaba Dam, located in Weber County, Utah, was constructed in 1961 with funding from the Soil Conservation Service utilizing P.L. 566 funds (SRS,1959). In November 2020 the Natural Resources Conservation Service (NRCS [formerly the SRS]) issued the "Dam Assessment Report, North Fork Ogden River Waterhshed, Utaba Retarding Dam" prepared by GENTERRA for the NRCS. The geotechnical assessment in this report can be summarised as follows:

- The geotechnical information available was contained in the as built drawings.
- The dam is a zoned embankment comprising of three zones: Zone 1 and Zone 3 are the upstream and downstream pervious zones "shell". Zone 2 is an impervious zone "core".
- Test pit logs show most materials in the borrow areas consisted mainly of gravels with large amounts of cobbles and boulders.
- Soils used for the different zones came from 5 borrow areas although their location(s) were not designated.
- A core trench was excavated throug the overburden to the bedrock.
- No slope stability analyses are provided.
- No seismic analyses are provided. We note, there are two Quaternary age faults located with 1.5 miles of the dam; the closest one being less than 0.5 miles away.
- Filter compatibility between the different zones and foundation materials are unknown.
- There is no toe drain or other seepage control measures in place.
- Bedrock beneath the dam is reported as thinly bedded and highly fractured. Flow through the fractured bedrock could be a cause for the high groundwater observed at the toe of the dam.

This memorandum summarizes Gerhart Cole's (GC) planned Geotechnical Field Studies for the proposed Utaba Dam Rehabilitation. This work is being completed as part of the

Franson Civil Engineers (FCE) design team for Weber County (WC) and the Natural Resources Conservation Service (NRCS). The existing embankment is located at the North end of Ogden Valley, approximately 8 miles northwest of Eden, Utah. Figure 1 Shows the general project location.

The purpose of this field study is to collect subsurface data of potential borrow and existing embankment materials. Depending on the findings from these studies additonal field studies may be required as part of final design efforts.

GEOLOGIC RECONAISSANCE

A geologic reconnaissance was completed on July 8, 2024 to observe and document existing site conditions. Information collected during the reconnaissance was used to develop the preliminary geologic map included as Figure 2a. General geologic descriptions are included in Figure 2b. In general, observed conditions are generally consistent with previously published geologic mapping.

Near surface deposits in the vicinity of the dam include alluvial deposits stream channels and terrace terrace deposits along the right abutment. The left abutment was originally mapped as being underlain by quartzite bedrock however during the site reconnaissance it appears that it is actually underlain by colluvial soils.

PLANNED LOCATIONS AND MINIMUM DEPTHS FOR DRILLED TEST HOLES, TEST PITS AND OTHER EXPLORATION POINTS

Proposed field study locations are plotted relative to the project and aerial photography in Figure 3 and also plotted on Figure 2a. Planned test hole locations and depths were based on the existing embankment location and site access. Test Hole and Test Pit numbering is based on Table 2-2 found in the Chapter 2 of the Part 631 Geology National Engineering Handbook (NRCS, 2012). The reference to the table provides additional information about the purpose of the test hole and test pit. Erosion and sediment control will be implemented around each study location using straw wattles. It is anticipated that all field studies will be completed over a period of 3 to 4 weeks.

Prior to drilling GC will coordinate Blue Stakes and confirm planned field study locations. GC will implement a field safety plan and coordinate these efforts with the drilling and excavation subcontractors.

SUBSURFACE EXPLORATIONS, DRILLING, SAMPLING AND TESTING

Following a review of site conditions this subsurface exploration plan assumes:

1. Property access, environmental / archeological clearances, public involvement, and agreements (if required) will be completed and coordinated through FCE or WC.
2. All test holes are accessible with track mounted drilling and excavation equipment.
3. Drilling methods will consist of hollow stem auger (HSA) and coring methods.
    a. Coring will consist of HQ coring methods in the foundation if bedrock is found and generally be completed at runs of 5 feet unless refusal conditions occur.

b. These methods may be revised or adjusted depending on conditions found at each location.

SAMPLING AND TESTING INTERVALS OR DEPTHS

Drilled Test Holes (TH)

Figure 3 shows the locations of the planned test holes. Note there are two locations shown for 24-TH-401 (a & b). The purpose for this is access may be restricted to the "a" location due to needing to transverse down the downstream face of the dam. If this cannot be safely completed we will drill at the other location which can be accessed from below. The primary purpose of drilling will be to complete in-situ testing (i.e. Standard Penetration Testing [SPT], or oversize sampler if refusal conditions are met with the SPT, and packer testing) and collect split spoon samples and conventional Shelby tubes. Drilling and Sampling methodology will generally consist of the following:

1. Drilling will be completed utilizing hollow stem auger driller techniques through dam embankment material.
    a. Sampling during drilling will be collected at 2.5 or 5 foot intervals from the surface to bedrock or where judged appropriate..
        i. Shelby tubes will be collected in fine grained layers.
        ii. Split spoon samples will be collected in granular layers
    b. Coring of the bedrock below the embankment if found.
        i. Rock cores, if collected, will be transported and stored at our office in Midvale, Utah.
2. Perform packer testing in bedrock if found.
    a. Packer testing will be completed in roughly 10-foot increments in bedrock at pressures selected to remain within the range of elastic deformation of rock materials.

Planned test hole locations are summarized in Table 1.

Test Pits (TP)

The primary purpose of excavating TPs will be to collect bulk (e.g. 5-gallon buckets) samples of materials in the reservoir basin and or in the previous borrow areas.

Two test pits (TP-02 and TP-03) will be excavated on the embankment, one on the upstream and downstream face to collect bulk samples of Zones 1 and 3 respectively. An additional three test pits will be excavated in the reservoir basin to help understand the material within the reservoir basin and also look at the colluvium material (TP-101 to 103) with one test pit (24-TP-201) along one of the proposed alignments for the auxiliary spillway. Then five (5) to nine (9) test pits will be excavated throughout the proposed borrow area shown in Figure 3. Based on the as-builts it appears this was where borrow was sourced during original construction.

The test pits along the dam face (24-TP-02 and 24-TP-03) will be excavated by scrapping the surface to remove any vegetation and potentially excavating to a maximum depth of 1 to 2 feet below the existing ground surface. Samples will be then collected using hand tools

including shovels and hand augers below this point. The goal is to minimize disturbance into the dam but also to collect material to help characterize Zone 1 and 3. These two test pits will then backfilled in 8 to 12-inch lifts and erosion control measures will be placed around these test pits. All other test pits will be placed back in the excavation and compacted with the bucket of the excavator. The remaining test pits will be excavated to the maximum extent of the excavator, typically about 15 feet, or until refusal conditions are met and backfilled with the spoils.

Planned test pit locations are summarized in Table 1 other than the test pits in the borrow area have not been located but will generally be located throughout the proposed borrow area highlighted in Figure 3.

Geophysical Survey

Geophysical survey line (seismic refraction) will be completed along the dam and perpendicular to the dam and abutments. The geophysical survey will provide P-wave and shear wave measurements along with a shear wave profile at toe of the dam to provide site conditions to be used in site specific seismic hazard assessment.

Laboratory Testing

Samples collected in the field will be transported to our geotechnical laboratory. Testing will include but not necessarily be limited to index testing (moisture content, Atterberg limits, grain-size distributions, and hydrometers), compaction (standard Proctor), shear strength/triaxial testing, permeability, pin hole dispersion, soluble salt testing, dispersion, and collapse/expansion. Final laboratory test assignments will be provided after samples are collected and we will provide the proposed plan to NRCS to review before testing commences.

COMPLETION OR CLOSURE OF SUBSURFACE EXPLORATIONS

Completion of test holes will include

1. Test holes will be completed with piezometers to monitor groundwater.
    a. Piezometers will include a screened length at the bottom surrounded by sand filter pack extending a minimum of two feet above the screened section. Casing will extend from the screened section to the surface and will be completed using a bentonite or lean cement grout.
2. Test pits will be backfilled with spoils and tamped into place with the bucket of the excavator.
3. Geophysical surveys are non-destructive.

GROUND CONDITIONS AND MONITORING

The following is our approach to measure groundwater conditions near the proposed structure:

1. Groundwater levels will be observed during drilling of test holes.
2. Install two piezometers; one to 120 feet below the crest of the dam (installed from the crest), and the other to 30 feet below the toe of the dam.

3. Make up to 4 site visits to measure groundwater within the piezometers.

SUMMARY AND CONCLUSION

Minor adjustments in the field may be required at the proposed locations to address potential conflicts with utilities, environmental constraints or for safety of crews. Survey will be provided by FCE.

TABLES

Table 1 Planned Field Study Locations

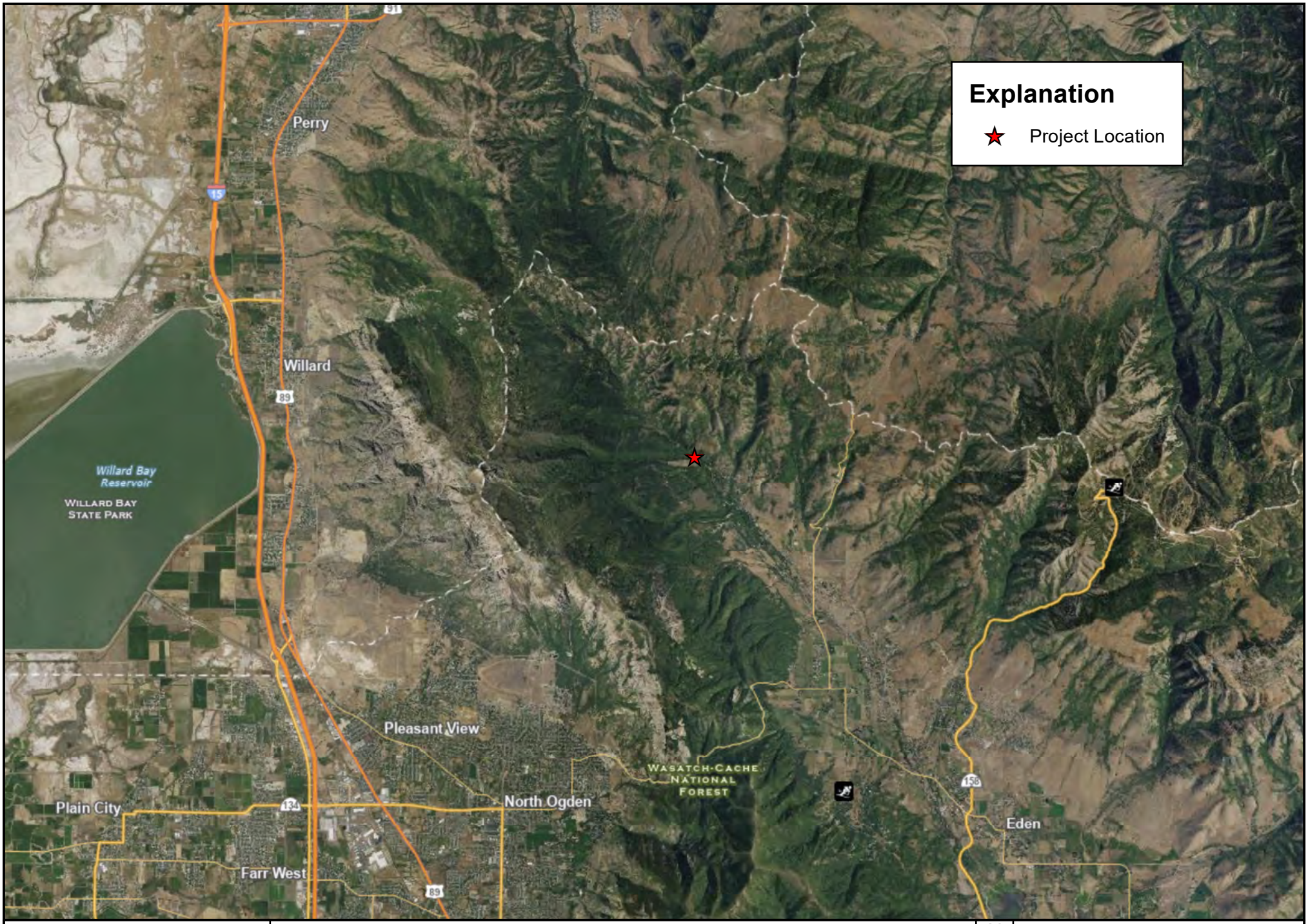
FIGURES

Figure 1 Vicinity Map
Figure 2 Preliminary Geologic Map
Figure 2b Description of Geologic Units
Figure 3 Proposed Field Study Locations

Table 1: Planned Field Study Locations
Utaba Dam

Test Hole ID	Latitude[1]	Longitude[1]	Planned Depth (ft)	Proposed Field Study Method	Comments
24-TH-01	41.38684	-111.90983	120	HSA/Rock Coring	
24-TH-401a	41.38661	-111.90916	30	HSA/Rock Coring	
24-TH-401b	41.38653	-111.91065	30	HSA/Rock Coring	Drill if cannot access 24-TH-401a
24-TP-02	41.38701	-111.90997	1-2	Excavate	
24-TP-03	41.38683	-111.90955	1-2	Excavate	
24-TP-101	41.38736	-111.91009	15	Excavate	
24-TP-102	41.38694	-111.91034	15	Excavate	
24-TP-103	41.38653	-111.91065	15	Excavate	
24-TP-201	41.38600	-111.90994	15	Excavate	

Notes: 1. Approximate locations. Final locations to be determined in the field. WGS 1984 horizontal datum.



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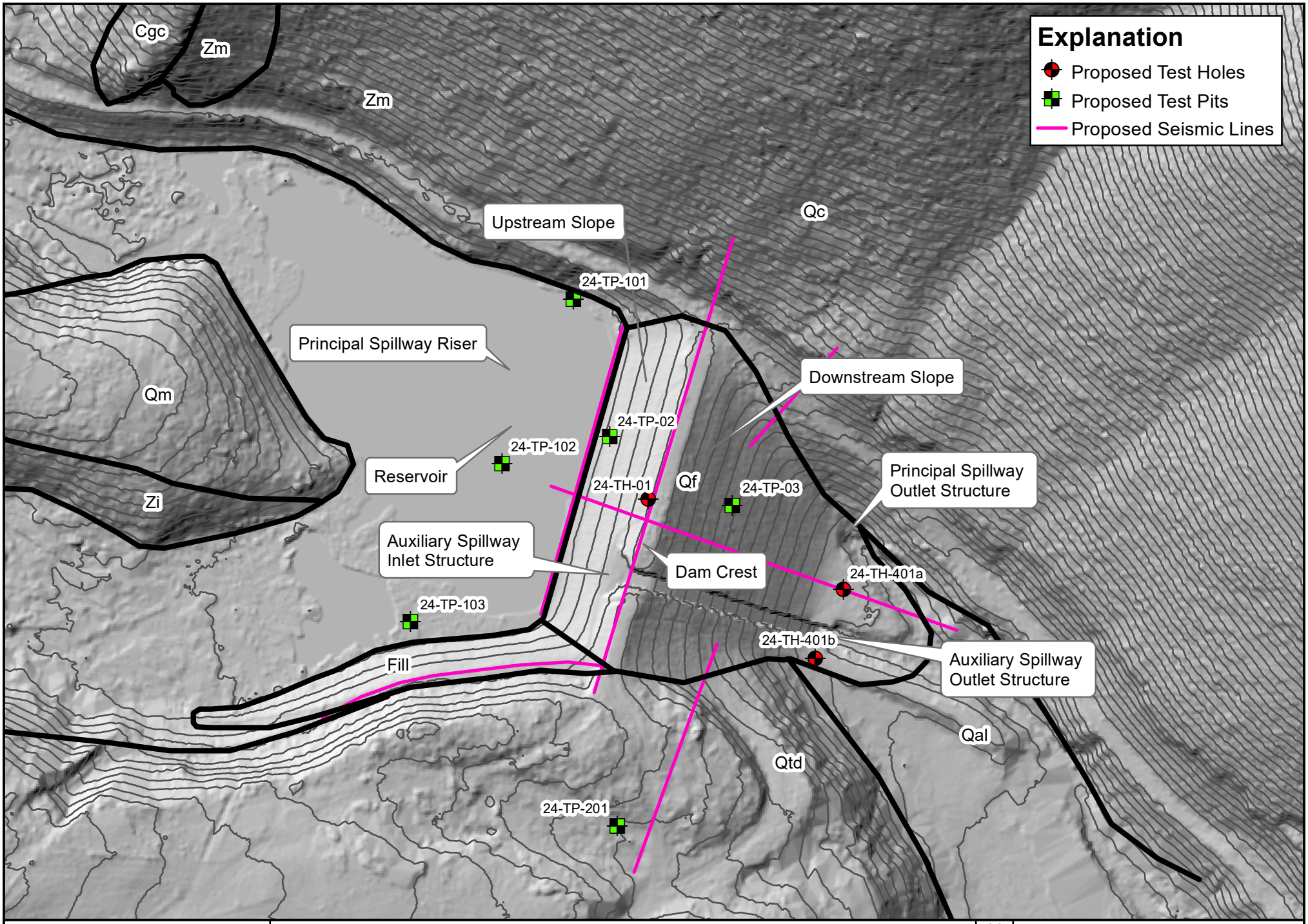
Vicinity Map

Utaba Dam

Figure 1



GERHART COLE

Preliminary Geologic Map

Utaba Dam

N

0 37.5 75 150

Feet

Figure 2a

DESCRIPTION OF GEOLOGIC MAP UNITS

Qal **Alluvial Deposits (Holocene) –** Unconsolidated deposits of gravel, sands, and silts in active stream channels and flood plains; thickness 0-6 m.

Qf **Alluvial Fan Deposits (Holocene) –** Deposits of gravel, sand, and silt along Wasatch front; mostly younger than high standing Lake Bonneville; thickness 0-25 m.

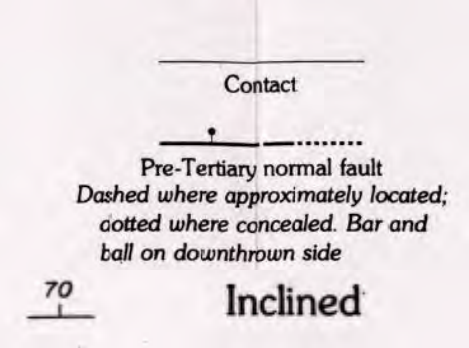
Qtd **Terrace deposits (Pleistocene) –** Gravel, sand, and silt in stream terraces graded to high standing Lake Bonneville. South of Mantua, includes terraces graded below Bonneville level.

Qm **Moraine(?) Deposits (Pleistocene)** – Unsorted deposits composed of sand- and silt- sized debris with abundant, locally derived cobbles and boulders, thickness 0-30 m.

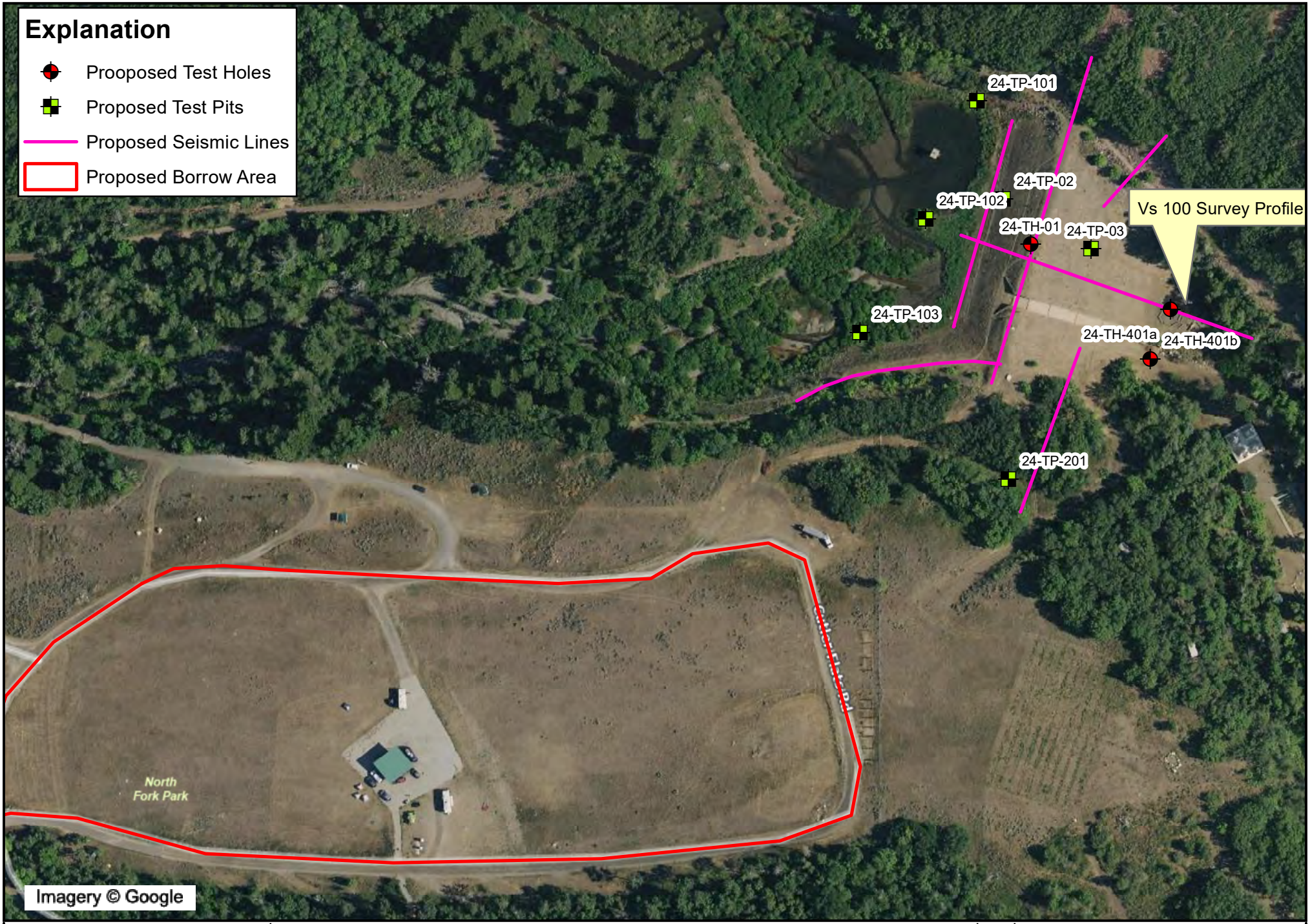
€gc **Geertsen Canyon Quartzite (Lower Cambrian) –** Medium- to thick-bedded, medium- to coarse-grained quartzite with scattered zone of small pebbles; upper part is white, gray, and light green, rarely feldspathic; lower part is streaked grayish purple or pale green and may contain as much as 20 percent salmon-colored potassium feldspar. Scolithus tubes very abundant in uppermost beds. Thickness 1,200 m.

Zm **Mutual Formation (Upper Proterozoic) –** Medium- to thick-bedded, medium- to coarse-grained, locally pebbly, locally feldspathic quartzite in dark shades of purple, grayish red, green, and brown; thickness 675-800 m.

Zi **Inkom Formation (Upper Proterozoic) –** Upper part very fine-grained, dark-green sandstone underlain by laminated dark-green to olive-drab siltstone; lower part contains lenses of silver- to gray-weathering tuff. Thickness 5-60 m.



Note: 1. See Figure xx for Geologic Map (Crittenden, M.D., Jr., 1985)
2. See referenced Geologic Map for additional information on mapping, descriptions shown are the units that are in the vicinity of the project



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Proposed Field Study Locations

Utaba Dam

N

0 55 110 220 Feet

Figure 3

Geotechnical Survey Report Memoranda

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TECHNICAL MEMORANDUM

To:	Mr. Layne Jensen, PE Franson Civil Engineers 1276 South 820 East, Suite 100 American Fork, Utah 84003 Office: (801) 756-0309 ljensen@fransoncivil.com
From:	Richard Buhler, PE
Reviewed by:	Ryan Cole, PhD, PE, BCGE
Date:	June 18, 2025
Job Number:	24-1762
Subject:	UTABA Retarding Dam Geotechnical Design Technical Memorandum

PROJECT DESCRIPTION

This Geological Design Technical Memorandum (TM) presents the results of geotechnical field and laboratory studies and provides preliminary geological reconnaissance for UTABA Retarding Dam (UTABA). We understand the overall project consists of an assessment of the Watershed and completing an Environmental Assessment (EA) for the proposed project. Natural Resources Conservation Service (NRCS) is overseeing the funding of the overall project and Utah Dam Safety (UDS) regulates the construction and performance of UTABA Dam. Weber County is the owner of the dam.

Franson Civil Engineers (FCE) is working with NRCS on the project, while Gerhart Cole's (GC) role is to complete geotechnical studies at UTABA Dam. We understand the dam's primary function is to provide flood control and that there is currently no water storage rights for the reservoir. We understand that limited water can pass through the intake tower and into the principal spillway given that primary lower ports have become plugged with debris and beaver activity. Additionally, we understand the principal spillway may be undersized.

Given the limitations of the intake tower and the undersized principal spillway being undersized, a few feet of water remains stored in the reservoir. Based on discussions with Weber County the auxiliary spillway generally passes water every spring and the reservoir holds water for an extended amount of time during the spring and summer. Given the large retention time of flood waters, both NRCS and UDS have changed the dam classification to high hazard, and desire to rehabilitate the dam to function as a flood control structure that releases water during flood events.

UTABA is located just northwest of Liberty, Utah as illustrated in Figure 1. A site map showing the dam and surrounding area is provided in Figure 2. We understand, pending the results of the EA, UTABA could be raised to provide additional sediment storage and regain

some of its flood control capabilities. The rehabilitated structure will be designed to not retain water other than during flooding events.

This Geotechnical Design Technical Memorandum (TM) presents preliminary recommendations for the rehabilitation of the UTABA Retarding Dam.

PURPOSE, AUTHORIZATION, AND SCOPE OF WORK

This TM presents the results of geotechnical design analysis in support of project design by FCE. This work was completed following the approach discussed in our proposal dated December 19, 2023, and under GC's Cooperative Reciprocal Service Agreement with FCE, dated December 19, 2016. The scope of services provided includes:

- Develop material properties and characteristics needed to perform engineering assessments (e.g., stability, seismic analyses, seepage) of the existing embankment.
- Development of a conceptual dam cross-section, for the preferred rehabilitation section, which meets Utah Dam Safety Administrative Rules (R655-10 and R655-11) and NRCS TR-210-60 with a high hazard classification.
- Develop embankment seepage phreatic surface for stability assessments.
- Perform stability assessments (construction, steady state, seismic, and rapid drawdown) to develop preferred embankment configuration to satisfy Utah Dam Safety and NRCS minimum standards.
- Prepare a draft geotechnical TM to submit to Utah Dam Safety and NRCS for review.

Two other TM's have been completed and provided to the team and should be reviewed along with this TM) which provide background information utilized to develop this document. These documents are provided in Appendix A of this document for reference.

- Geological and Geotechnical Data Technical Memorandum (Gerhart Cole, 2025a).
- Site Specific Seismic Study TM (Gerhart Cole, 2025b).

GENERAL INFORMATION

General information considered in this study, including that from UDS within the Utah Division of Water Rights (UDWR), NRCS, and from Franson (specifically relating to inputs for hazard and consequence assessments/classifications), include:

- Location (latitude, longitude): 41.386815º, -111.909813º
- UDS identifier: UTABA, UT00541
- Function: Flood control [typically empty for future planned use]
- Existing structural height (per UDS): 71 feet
- Existing hydraulic height (per UDS): 54 feet
- Existing storage at spillway and dam crests (per UDS): 91 and 180 acre-feet (not accounting for accumulated sediments)
- Planned future structural height (per Franson): 71 existing +4 raise = 75 feet (crest elevation 5724 ft)
- Planned future hydraulic height (per Franson): 54 existing +4 raise = 58 feet

- Planned future storage at spillway and dam crests (per Franson, accounting for accumulated sediments): 72 and 175 acre-feet
- UDS dam type category: Inspected flood control dams greater than 20 acre-feet
- UDS hazard rating: High
- NRCS hazard class: High
- NRCS structure classification: Group A
- NRCS consequence of seismic failure: Low
- Seismic site characterization:
    - NEHRP 2020 and 2023 USGS site class: B (see Seismic Memo text for discussion of potential range)
    - Site-specific Vs30 value: 973 m/s [3,192 ft/s] (see Seismic Memo text for discussion of potential range)
    - Liquefaction potential: Negligible

Additional information / details regarding the above summary are presented in the following sections of this document. General information regarding the dam embankment as well as the analytical guidance used for this study is based on:

- UDS/UDWR website page for UTABA Dam (UDWR, 2024)
- Utah Code, Title 73 Water and Irrigation, Chapter 5a Dam Safety (State of Utah, 2025)
- Utah Rules, R655-10 Dam Safety Classifications, Approval Procedures and Independent Reviews (UOAR, 2025a)
- Utah Rules, R655-11 Requirements for the Design, Construction, and Abandonment of Dams (UOAR, 2025b)
- NRCS Title 210 National Engineering Manual [NEM], Part 520, Subpart C Dams (NRCS, 2017a)
- NRCS Title 210 National Engineering Manual [NEM], Part 531 Geology (NRCS, 2017b)
- NRCS Technical Release 210-60, Earth Dams and Reservoirs (NRCS, 2019)

BACKGROUND

UTABA Dam was constructed in 1962 and was constructed at the confluence of Cutler Creek and North Fork Ogden River to assist with flood control and sediment storage. It is a zoned earthen embankment having an upstream pervious section (Zone 1), a central relatively impervious core (Zone 2), and a downstream pervious section (Zone 3). The maximum embankment height is 71 feet. The principal outlet includes a 24-inch diameter reinforced concrete pipe that discharges into an energy dissipator. The auxiliary spillway is a reinforced concrete chute founded on the embankment. Record drawings are provided in Appendix D.

Cross-sections from the record drawings show upstream slope at 3H:1V and downstream slopes at 2H:1V. The dam rests on a silty gravel foundation with a cutoff through the silty gravel foundation and excavated into bedrock through the foundation and along the left abutment. The record drawings also show the cutoff trench extending up the right abutment

until it wraps around the upstream side of the abutment with an relatively impervious blanket. The cutoff trench is extended into bedrock below the impervious blanket.

Since the dam was reconstructed in 1986 the main deficiency identified in inspection reports is seepage around the outlet conduit and storing of water longer than the original design (UDWR, 2024). In addition, the Dam Assessment Report (Genterra Consultants, 2020) mentions the following concerns:

- No slope stability analyses are provided.
- Filter compatibility between the different zones and foundation materials are unknown.
- Cutoff collars appear to be the only seepage control measures.
- There is no toe drain or other seepage control measures in place.
- No seepage analyses are available.
- Source and cause of seepage around the outlet conduit is unknown.
- Bedrock beneath the dam is reported as thinly bedded and highly fractured. Flow through the fractured quartzite bedrock could be a cause for the high groundwater observed at the toe of the dam.

ANALYSIS AND DESIGN RECOMMENDATIONS

This section of this document discusses the preliminary stability analyses of the existing dam, and the preferred dam section based on the findings from the geological and geotechnical field studies and site-specific seismic study (Gerhart Cole, 2025a; 2025b). In addition, this section provides recommendations that we believe will satisfy UDS rules (R655-11) and NRCS TR-60 rules (NRCS, 2019) as the project moves towards final design.

Liquefaction Potential

In our assessments of liquefaction potential at the dam, we have considered the geologic setting together with [drilled] test hole data and accompanying SPT blowcounts. We completed liquefaction assessments on test holes 24-TH-01 and 24-TH-401.

To assess liquefaction triggering, we used Youd et al.'s (2001) NCEER method and Idriss and Boulanger's (2012) methods. Seismic demands were based on the results of our site-specific seismic study (GC, 2025b). Design criteria are a peak ground acceleration (As value) of between 0.27 to 0.32 g, with a representative moment magnitude of 6.7 (see Gerhart Cole 2025b). Given the dense foundation conditions in the alluvial soils (SPT blow counts >30), shallow bedrock, and the embankment being constructed out of materials with a PI > greater than 7 (see Idriss and Boulanger 2008), the liquefaction risk is considered negligible.

Conceptual Design

Figure 3 presents the preliminary earthen dam configuration to increase storage and flood control based on FCE evaluation. The portion upstream slope is proposed to be steepened to a 2.5H:1V slope from the auxillary spillway elevation (5711 ft) to the new crest elevation (5724 ft). The proposed configuration has also been developed based on assessments of

existing geometry, field and laboratory data, and the results of stability and seepage analyses.

We understand from FCE hydrology and hydraulic study (FCE, 2025) the following items are recommended to meet UDS and NRCS standards for flood control structures:

- Raise the dam approximately 4 feet to replace the lost storage during flood events due to the sediment infilling of the reservoir basin since it was reconstructed.
- A new principal spillway will be constructed through the dam which will better handle typical flows with a minimum diameter of 30" but it it anticipated to be 60" in diameter, and
- A new auxiliary spillway to be moved and could be located near the left abutment of the dam.
- The existing principal spillway will be abandoned and probably grouted in place.

Borrow Studies

The original construction documents show borrow areas in North Fork Park and the reservoir basin. North Fork Park is owned and operated by Weber County. Four test pits (24-TP-104 through 24-TP-107) were excavated in North Fork Park. Two test pits (24-TP-101 and 24-TP-103) were excavated within the existing reservoir basin and included assessments of material that has infilled the reservoir basin since construction of the dam.

Figure 4 provides the grain size plots for the material collected as part of the borrow studies and compared to the results of grain sizes from samples collected for the field studies at the dam.

In general, it appears the material collected in our borrow study at the North Fork Park have similar grain sizes and helps to conclude that the borrow material was probably sourced from the North Fork Park. For example, the two grain size distributions for Zone 1 and 3 permeable zone collected by test pits (24-TP-02 and 24-TP-03) have a similar shape and fines content as the composite sample from the North Fork Park material (See green and orange lines on Figure 4). The brown lines in Figure 4 show grain size testing from borrow areas with the blue lines being tested in 24-TH-01 through Zone 2. There is more variability between these lines, but they generally have similar shape and range of fines content. There was probably some processing of Zone 2 to eliminate the gravels and cobbles which could account for a higher fines content compared to the borrow sources.

We understand the total dam raise will probably require about 16,000 cubic yards of material. Based on the depth of the test pits (approximately 10 feet) and the area studied there could be about 150,000 cubic yards of material in North Fork Park. There is likely additional material that could be sourced in North Fork Park outside of the area where the test pits were completed. If the project moves to final design, we recommend additional borrow studies to assess material quantities available compared to what is needed for final design. We typically recommend a volume of three to four times the design quantity be identified and available for construction to help account for losses, unsuitability, volumetric changes and some potential inaccuracy of initial quantity estimates.

Spillways

As mentioned above, FCE is looking to increase the capacity of both primary and auxiliary spillways. The principal spillway will be utilized to pass base flows and flooding up to the 100-year 10 day event of 359 cfs and the auxiliary spillway will address larger events up to the Peak Maximum Flood. We understand the prinicpal spillway will be a 60-inch diameter conduit placed through the dam but to limit the excavation it would be placed at an elevation of about 5690 and be controlled by a gate and likely discharge into the auxiliary spillway.

It is preferred by UDS and NRCS to move the auxiliary spillway off the maximum cross section of the dam to limit damage to the embankment if the spillway is compromised during a flooding event. The challenges with this approach are that the right abutment does not appear to have any shallow bedrock. The as-builts estimate bedrock could be 40 feet below the right abutment at this contact. The geophysical P wave profiles (GC, 2025a; Appendix B Line 3-1 and Line 5) also show that the bedrock to be deep on the right abutment.

At the left abutment the as-builts and the geophysical P Wave profiles show shallower bedrock compared to the right abutment. The as-built shows that colluvium material along the left abutment was removed to bedrock and a cutoff was excavated into rock that was about 5.5 feet deep. Due to the geometry of the left abutment and the depth of bedrock it might not be practical to place the spillway on bedrock. This should continue to be studied and may require concrete lining the spillway if it cannot be placed on a bedrock.

We recommend additional field studies at each abutment to understand the bedrock profile and requirements needed to design and protect the spillway. These field studies should include additional test holes on the right and left abutment which might be both vertical and angled holes along the proposed alignment.

Foundation Treatment

The field studies show the foundation of the dam to consist of coarse-grained alluvial soil over a quartzite bedrock material. At the location of the test holes (24-TH-01 and 24-TH-401) the alluvial soils were between 10 to 14 feet thick which correspond with the provided as-builts. The bedrock is described as slightly to intensely fractured quartzite. The packer testing showed the bedrock to vary from semi impervious to quite permeable with permeability ranging from $1x10^{-5}$ to $1x10^{-3}$ cm/sec (See Table 2, GC 2025a)

The as-builts show an impervious cutoff about 5 feet into the bedrock from the left abutment across the dam and up a portion of the right abutment. Then it appears due to the depth of the bedrock on the right abutment an impervious blanket was placed around the right abutment to limit seepage. If the dam is raised this cutoff might need to be extended along the left abutment and the impervious blanket might need to be raised around the right abutment depending on the future field studies along the right abutment.

Shell Materials (Zone 1 and 3)

The shell of the existing dam consists of ‘pervious material’ based on the as-builts. The as-builts do not provide any specifications or description other than being ‘pervious’. Two shallow test pits (24-TP-02 and 24-TP-03) were completed to collect additional information about the material consistency. The grain size testing (Figure 4) shows it to be sandy gravel

with some clay. To minimize disturbance to the dam the test pits were only excavated a few feet into the dam. As such we recommend additional studies (test holes) be completed to assess variability and relative consistency through this zone.

The composite sample from the North Fork Park Borrow, which shows similar grain size characteristics of the shell materials (see Figure 4), was prepared at 95% relative compaction (standard Proctor) and at a moisture content near optimum moisture content and a consolidated undrained (CIU) test was completed. The drained friction angle obtained was about 36 degrees when tested at confining stresses ranging from 30 to 150 psi.

Figure 3, the proposed dam cross section, shows additional shell material will be utilized to raise the dam. This material should be available from the North Fork Park borrow area with minimal processing other than limiting the maximum size to being less than 6 to 8 inches.

Internal Stability (Piping)

The potential for piping or filter incompatibility between Zone 2 and Zone 3 is a potential deficiency pointed in UDS inspection reports and the Dam Assessment report (Genterra Consultants, 2020).

As part of this study, grain size analysis was performed on nine different samples from Zone 2. Of the nine samples, six of the samples had the fines contents ranging from 35 to 54 percent and were classified as either clayey sand (SC) with gravel or lean clay (CL) with some gravel.

One sample was tested from the Zone 3 material collected on the downstream side of the dam and it classified as a silty sandy gravel (GC-GM) and had 49 percent gravel size, 33 percent sand size, and 18 percent passing the No. 200 sieve. Figure 5 shows the gradation tests performed in the Zone 2 and Zone 3 materials with the Zone 2 material re-graded over the #4 sieve.

The piping potential from Zone 2 into Zone 3 was evaluated by comparing the D85 of the regraded Zone 2 with the D15 of the Zone 3 materials. The D85 of the Zone 2 samples tested ranged between about 0.7 and 2.0 mm and the D15 of the Zone III materials tested was less than 0.075 mm (No. 200 sieve). This results in a maximum D15/D85 ratio of 0.11. Filter criteria with regard to particle movement between adjacent zones is considered satisfied for D15/D85 ratios less than 4 or 5. In addition Foster and Fell (2001) state for materials with a fines content between 35 to 85 percent if the D15 of the filter is less than or equal to 0.7 than no erosion (piping) is expected.

Five samples were also collected from the borrow area that is shown on the as-built plans and this material appears to have been used for construction of the dam. The grain size analysis tests we completed in the borrow area show the material to have a fines content between 21 to 40 percent which would also provide adequate filter compatibility.

Based on these observations, the potential for Zone 2 materials to migrate into the Zone 3 appears to be low. It should be noted that a double hydrometer and a dispersive clay pinhole test were performed on zone 2 samples and the material tested classified as non-dispersive

(ND-1). Based on these laboratory tests, the potential of piping is decreased due to the non-dispersive nature of the Zone 2 soils. We do recommend test holes be completed in downstream Zone 3 so additional samples be collected on the Zone 3 and analyzed for filter incompatibility and internal piping potential.

Impermeable Core (Zone 2)

24-TH-01 was completed through Zone 2 of the existing dam and consists of clayey sand to sandy clay. The fines content ranged from 35% to 54% with plasticity indices (PI) ranging from 11 to 22. A permeability (k) value of 3.2 $x10^{-9}$ cm/s was measured based on hydraulic conductivity test of a relatively undisturbed sample at a depth of 45 feet which indicates the material is quite impermeable. Two consolidated undrained (CIU) tests were performed on undisturbed samples (35-37 feet and 45-47 feet) collected in 24-TH-01. These tests showed a drained friction angle of this material of 33 and 27 degrees. Pinhole and double hydrometer testing showed the Zone 2 material to be nondispersive.

In addition, a composite sample from the North Fork Park borrow area was tested by screening the material over the #4 sieve to check its suitability for use as Zone 2 material. The sample was then prepared at 95% relative compaction (standard Proctor) and at a moisture content near that considered optimum and a CIU test was completed. The drained friction angle of this material was 36 degrees when tested at confining stresses ranging from 30 to 150 psi. The pinhole testing also showed the material to be nondispersive. The borrow area soils dispersive characteristics were also assessed based on total salt content relative to the percentage of sodium cations. TDS testing for both a sample collected, and the composite samples was completed. Table 1 provides the results and the published correlations relating TDS to dispersivity (Sherard, et. Al 1976) would suggest the material is nondispersive.

This North Fork Park borrow appears to be suitable for Zone 2, and was probably used for construction of the existing dam as described in the borrow area section. This borrow area will require some processing to remove the larger gravel material. Additional studies are recommended once final quantities are achieved. We also recommend additional test holes be completed within Zone 2 to assess the soil conditions across the dam. In addition, in-situ permeability testing should be performed in these test holes to assist with future seepage analysis.

Sand and Filter Drain Materials

As shown in Figure 3, a two-stage filter (drain gravel and filter sand) should be utilized between the additional Zone 3 material and the existing Zone 3 material. It should also be extend down along the toe of the dam to collect uncontrolled seepage that has been observed around the principal spillway and the foundation.

Sand and gravel filter criteria were developed using NRCS Chapter 26 (NRCS, 2017) procedures. In general terms, filter materials are sized to protect foundation and embankment materials, while drain materials are sized to protect filter material migration and to efficiently transport intercepted seepage to the drainpipe. Filtering analyses were calculated based on the fine limit of the Zone 2 material and show a typical concrete sand (C-33) will work as a filter. This is a conservative approach as the rehabilitation concept

shows filter material placement adjacent to Zone 3. With the internal stability calculations to date showing piping is unlikely to develop and no observations of piping at the dam we feel the filter and drain will perform adequately between the existing dam and new material being placed. In addition, the composite sample from the North Fork Park borrow area was checked and shows that a typical ASTM concrete sand (C-33) will work as the filter material. Then the filter calculation for the drain gravel shows something similar to coarse-grained ASTM C-33 No. 7 stone will work for filtering the filter sand and provide filtration to the filter sand. Both of these materials will likely need to be imported to the site. The filter calculations are provided in Appendix B.

Seepage Analysis

The existing dam has no historic measurements of groundwater levels in the dam so the seepage modeling is relying on a few measurements taken since piezometers were installed for this study. Assessments of seepage were performed on existing geometry to estimate the phreatic surface through the dam and then have been compared to the field measurements from the piezometers installed in the dam to try to calibrate the model. Analyses were performed using Geo-Slope's Seep/W computer programs as integrated into its GeoStudio 2024 software package. The hydraulic conductivity (k) parameters assigned for the embankment zones were developed based on laboratory testing of composite samples, engineering correlations based on the material characteristics, and by adjusting the values to calibrate the phreatic surface to the field groundwater measurements. The hydraulic conductivity used in the models are summarized in Table 2.

The reservoir level was estimated to be about 5695 ft when the groundwater was measured in the temporary piezometers (24-TH-01 and 24-TH-401) and was used as the upstream constant head condition in the model. The downstream face of the existing dam was modeled as a seepage face. The ratio of vertical to horizontal permeability for each material in the model used in the analysis is also listed in Table 2. The results of the existing condition are shown in Appendix B (Page B-7 through B-9) and show the phreatic surface about 58 feet below the crest of the dam and suggest a total seepage on the order of 29 cubic feet per day per foot of dam. This depth of the phreatic surface matches well with the measurements taken to date in piezometer 24-TH-01. An analysis was also completed assuming a full reservoir (EL 5711 ft) condition for the existing dam cross section showing the phreatic surface if steady state seepage is achieved (Appendix B – Page B-10 through B-12) which shows the phreatic surface about 52 below the crest of the dam and suggests a total seepage on the order of 40 cubic feet per day per foot of dam.

With the rehabilitated dam being designed to only hold water if the flooding event is greater than the 25-year event and then for only a few days (Franson, 2025) we do not expect steady state seepage to develop through the dam. But we have modeled the scenario for the rehabilitated dam with a full reservoir and the filter/drain modeled as a seepage face. The analysis is shown in Appendix B (Pages B-13 to B-15) and shows the phreatic surface about 50 below the crest of the dam and suggest a total seepage on the order of 53 cubic feet per day per foot of dam.

Stability Analysis

Stability analyses were completed using the conceptual cross-section shown in Figure 3. Analyses were performed using Geo-Slope's Slope/W computer program as integrated into its GeoStudio 2024 software package. We have used Morgenstern and Price's method of slices to evaluate minimum factors of safety for the upstream and downstream sections of the dam and under the following conditions:

- end of construction,
- steady state long term
- rapid drawdown, and
- seismic loading conditions (pseudo-static).

Material strength discussions for the earth dam and borrow materials are found in the sections above. A summary of the material properties for each zone is presented in Table 3.

End of Construction Stability Analysis

Construction conditions were modeled for both upstream and downstream slopes at end of construction with groundwater at a depth as found during the field studies. Total stress parameters were used for the material properties for zone 1 through 3 and drained strengths were used for foundation soils. Results for the downstream and upstream analyses for end of construction are presented in Appendix B. Computed factors of safety for both the upstream and downstream steady states are tabulated in Table 4 and meet UDS and NRCS minimum requirements.

Steady State Stability Analysis

The conceptual embankment was modeled by assuming a phreatic surface from the auxiliary spillway elevation to the toe of the dam. It should be recognized this is a worst case scenario since the flood waters should only be above the normal pool for a few days which shouldn't allow for steady state seepage conditions to be achieved. Drained (effective stress) parameters were used to model the materials as summarized in Table 3. Results for the downstream and upstream analyses for the steady state seepage case are presented in Appendix B. Computed factors of safety for both the upstream and downstream steady states are tabulated in Table 4 and meet UDS and NRCS minimum requirements.

Upstream Rapid Drawdown Analyses

Similar to the steady state seepage analysis we do not expect the upstream zones to achieve steady state seepage and then drain fast enough to experience a rapid drawdown scenario. This case was still modeled though assuming the reservoir fills to auxiliary spillway elevation (5711 ft) and then draws down rapidly to the normal operating pool elevation (5690 ft). Pore pressures in the embankment were conservatively approximated using the same phreatic surface as used in the steady state analyses. Embankment material strength was modeled using a bilinear strength envelope as recommended in TR-60 (NRCS, 2019). Drained strength parameters were used for the foundation soils. Results

are presented in Appendix B. The computed factor of safety for this condition is summarized in Table 4 and meets UDS and NRCS minimum requirements.

Pseudo-static Analyses

The conceptual embankment was modeled using a pseudo-static coefficient equal to one half the design PGA value (Kh = 0.16 for MCE; and Kh = 0.1 for OBE) event (GC, 2025b). The results are summarized graphically in Appendix B. Computed factors of safety for this condition are summarized in Table 3 and exceed a FS >1.1. We do note that TR-60 (NRCS, 2019) and UDS prescribe different methodologies for seismic slope stability. Per Utah Code Title 73, Chapter 5a (Dam Safety), "No seismic standards shall be established for existing high hazard dams within the flood control use classification." Consequently, relative to the State of Utah, seismic stability is not really applicable for seismic analysis/design and is not required for UTABA Dam.

NRCS TR-60 (2019) states that if the design ground motion exceeds 0.07 g, the potential for loss of shear strength due to liquefaction or cyclic failure under seismic loading should be evaluated. Liquefaction risk seems to be negligible based on the liquefaction assessment; therefore, loss of shear strength should be minimal such that no post seismic stability is required for this dam.

Due the structure being primarily intended for flood control and not having liquefiable soils, post liquefaction analysis and deformation analysis are not a risk to this structure and have not been performed.

CONCLUSION AND RECOMMENDATIONS FOR ADDITIONAL STUDIES

UTABA Dam has a few deficiencies including the reservoir losing flood storage capacity due to infilling of the basing, seepage around the toe, and lack of capacity in the principal spillway. The rehabilitated dam cross section has been developed that shows a 4 ft raise along with the addition of a chimney/toe filter drain to limit the development of piping and seepage around the toe of the dam. The conceptual cross-section has been developed that we believe will mitigate these concerns and meets NRCS and UDS rules and regulations. Project risks associated with slope stability have been considered as part of our seepage and slope stability analyses in developing a conceptual cross-section for the dam. *Project risks that will need to be addressed as part of future phases and additional coordination needed for future studies include:*

- Spillway alignment and mitigation measures around the spillway.
- Seepage measures along the abutment if needed (based on future studies) and additional foundation cutoff for the raised dam along the abutments.
- Availability and location(s) of borrow materials, and studies to understand material quantities and properties.
- Additional field studies at the abutments to understand the depth to bedrock for foundation cutoff requirements and spillway foundation conditions.
- Additional field studies of the existing dam embankment to understand variability of material composition, permeability, and strength characteristics of Zone 2 and Zone 3 materials.

- We recommend Weber County monitor the piezometer levels so that the final design can reassess the seepage modeling.
- More detailed embankment performance analyses and detailing will be required to move the project towards final design. Such analyses include seepage analysis in the main section and on the left and right abutments, outlet works assessments, filter, and drain requirements.

LIMITATIONS

The assessments and recommendations presented in this document are based on limited field studies and laboratory testing, as well as our understanding of the project's design and manner of construction. If the project's design or manner of construction changes, or if conditions are found that are different from those described, we should be notified immediately so that we can make revisions as necessary. We recommend that project plans, specifications, and construction-related submittals be reviewed by Gerhart Cole for compatibility with our recommendations.

This document was prepared solely for the use of the addressee (our Client) for the specified project and may not contain sufficient information for other parties or uses. Also, this document does not constitute a specification and should not be treated or referred to as such in project design drawings or documents.

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Table 2 Seepage Parameters
Table 3 Soil Shear Strength Parameters for Slope Stability Analysis
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Figure 3 Rehabilitation Conceptual Cross-Section
Figure 4 Grain-Size Analysis – Zone Comparisons
Figure 5 Grain-Size Analysis – Filter Compatibility

APPENDICES

Appendix A Gerhart Cole Technical Memorandums
Appendix B Calculations

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Table 1: Total Dissolved Salts and Analytical Results
Utaba Dam (24-1762)

Test Pit Designation	Sample Depth (ft)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Calcium (meq/L)	Magnesium (meq/L)	Potassium (meq/L)	Sodium (meq/L)	TDS[1]	Percent Sodium
Combined Sample	Various	44.7	115.0	156.0	0.0	2.2	9.5	4.0	0.0	15.7	0.0%

Notes: 1) TDS is the sum total of the Calcium, Sodium, Potassium, and Magnesium in meq/L

Table 2: Seepage Parameters for Preliminary Design

Utaba Dam (24-1762)

Material Names	GeoStudio Name	Saturated Vertical Hydraulic Conductivity Selected, ky (cm/sec)	Saturated Hydraulic Conductivity Selected, ky (ft/day)	Vertical / Horizontal Hydraulic Conductivity Ratio, kratio = ky/kx, kv/kh	Saturated Hydraulic Conductivity Used in SEEP/W, kx (ft/day)	Data Source
Shell Material (Zone 1 and 3)	Shell Material	4.0E-04	1.1E+00	0.1	1.1E+01	GCI Evalulation
Core (Zone 2)	Zone 2 Impervious Zone	1.0E-07	2.8E-04	0.1	2.8E-03	GCI Evalulation
Reservoir Sediment	Reservoir Infill	1.0E-08	2.8E-05	0.1	2.8E-04	GCI Evalulation
Alluvium	Foundation - Alluvial Soil	6.0E-03	1.7E+01	1	1.7E+01	Correlations
Bedrock	Foundation - Bedrock	2.0E-03	5.7E+00	1	5.7E+00	GCI Evalulation

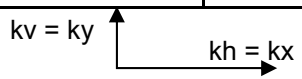

Table 3: Soil Shear Strength Parameters for Slope Stability Analysis
Utaba Dam (24-1762)

Soil Description	Moist Unit Weight (pcf)	Slope Stability Scenario							
		Construction		Long-Term		Pseudo-Static Seismic		Rapid Drawdown (Bilinear Envelope)	
		Phi	c (psf)	Phi '	c ' (psf)	Phi	c (psf)	Phi	c (psf)
Zone 2 - Impervious Zone	130	22	200	30	200	22	200	30 18	100 150
Shell Material - Pervious Zone (Zone 1 and 3)	135	14	750	35	50	14	750	35 14	50 750
Alluvial Soil	135	34	0	34	0	34	0	34	0
Foundation - Bedrock	140	30	2000	30	2000	30	2000	30	2000

Notes:
1. Parameters shown for rapid drawdown scenario represent ICU test ("R-test") shear strength envelope, which are combined in analyses with long-term (drained) parameters to obtain multi-stage

Table 4: Slope Stability Analysis Results
Utaba Dam (24-1762)

Analysis Scenario	Geometry Fig. #	Factor of Safety								
		Long Term (CD) - Full Impoundment		Construction (UU) - No Impoundment		Rapid Drawdown		Pseudo-Static Seismic		
		Critical	Fig. #	Critical	Fig. #	Critical	Fig. #	Critical (MCE/MDE)	Fig. #	Critical (OBE)
Dam Raise - Downstream Slope	3	1.65	B-16	1.40	B-17	--	--	1.63	B-18 B-19	1.84
Dam Raise - Upstream Slope		2.14	B-20	1.83	B-21	1.31	B-22	1.24	B-23 B-24	1.43
Target (Allowable) Factor of Safety		≥ 1.5		≥ 1.3		≥ 1.2		≥ 1.0		



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Vicinity Map

Utaba Dam

N

0 0.4 0.8 1.6

Miles

Figure 1



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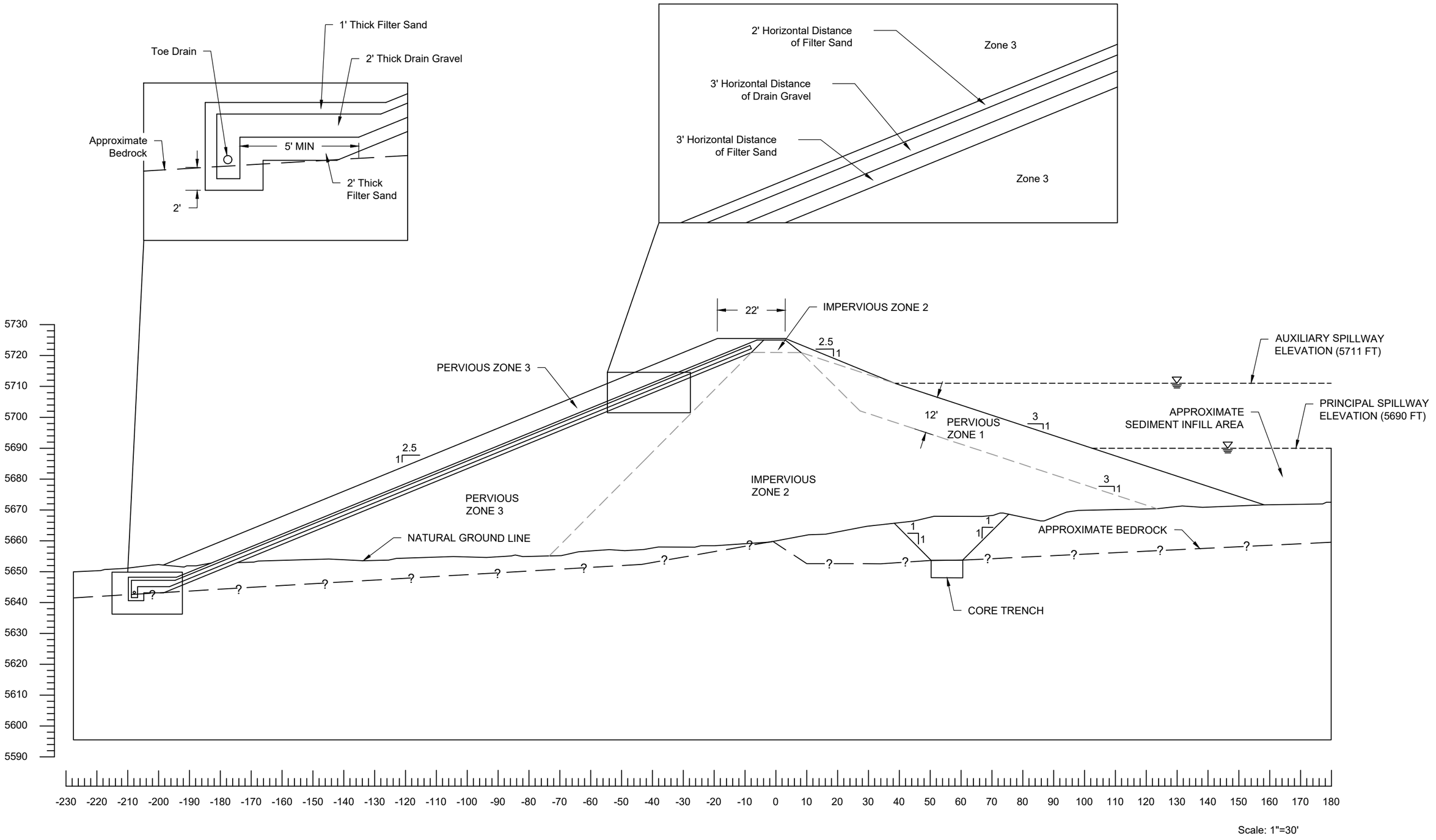
Site Map

Utaba Dam

N

0 45 90 180 Feet

Figure 2



Scale: 1"=30'

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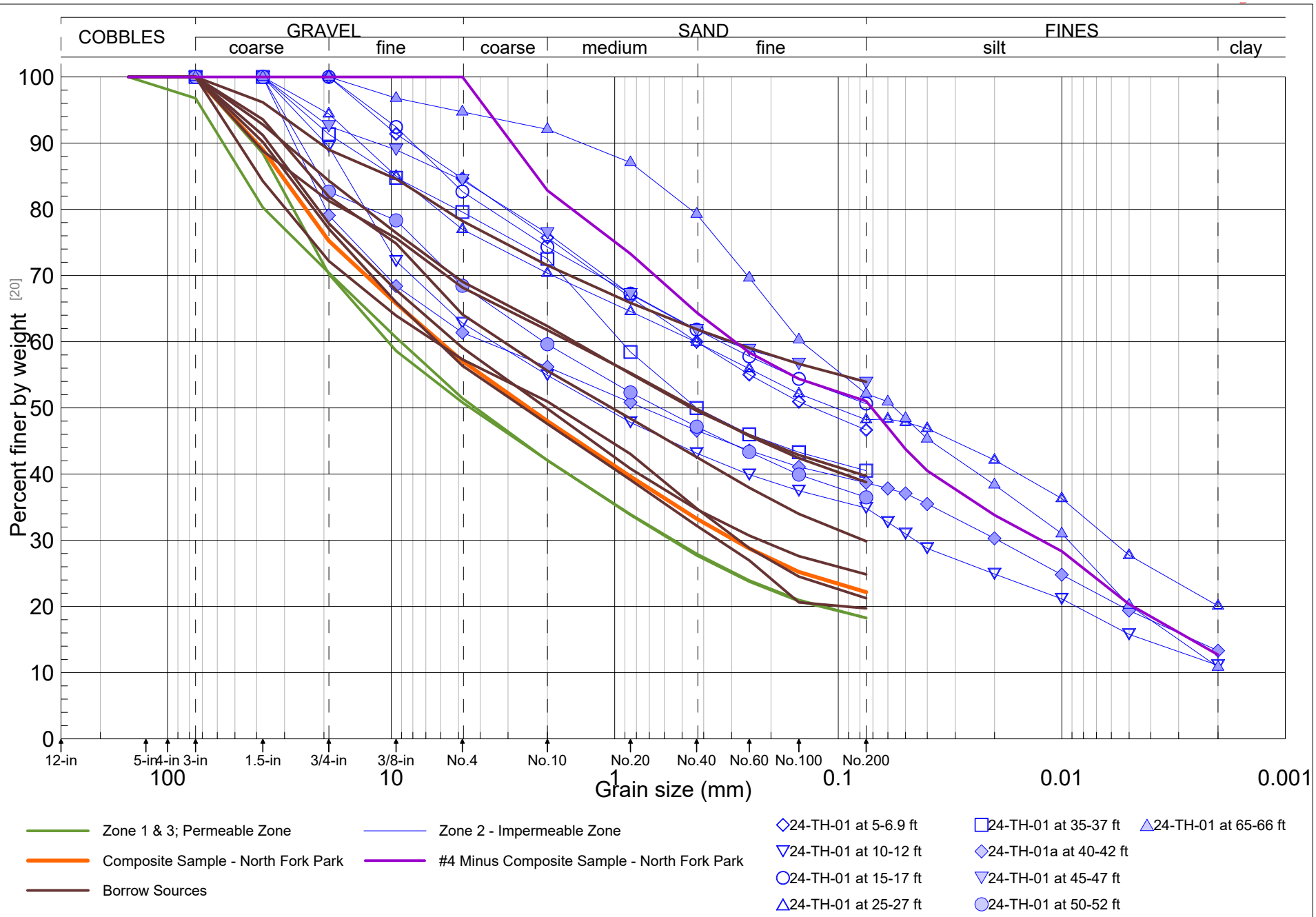
REHABILITATION CONCEPTUAL CROSS-SECTION

UTABA DAM

PROJECT NO. 24-1762

FIGURE 3



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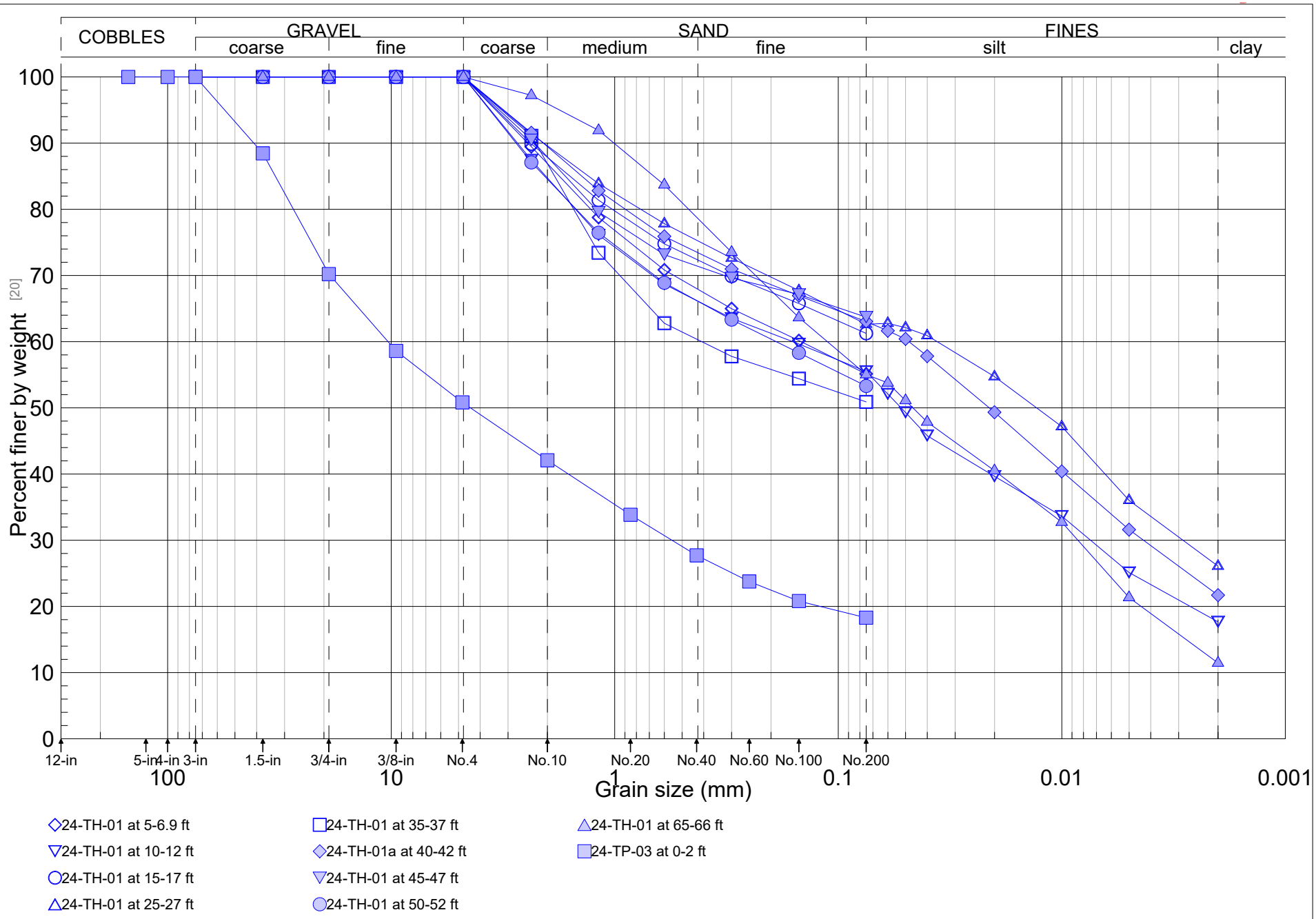
Grain-Size Analysis - Zone Comparisions

Utaba Dam

Figure 4



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Grain-Size Analysis - Filter Compatibility

Utaba Dam

Figure 5

Appendix A

Gerhart Cole Technical Memorandums
UTABA Dam (24-1762)

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Appendix B

Calculations
UTABA Dam (24-1762)

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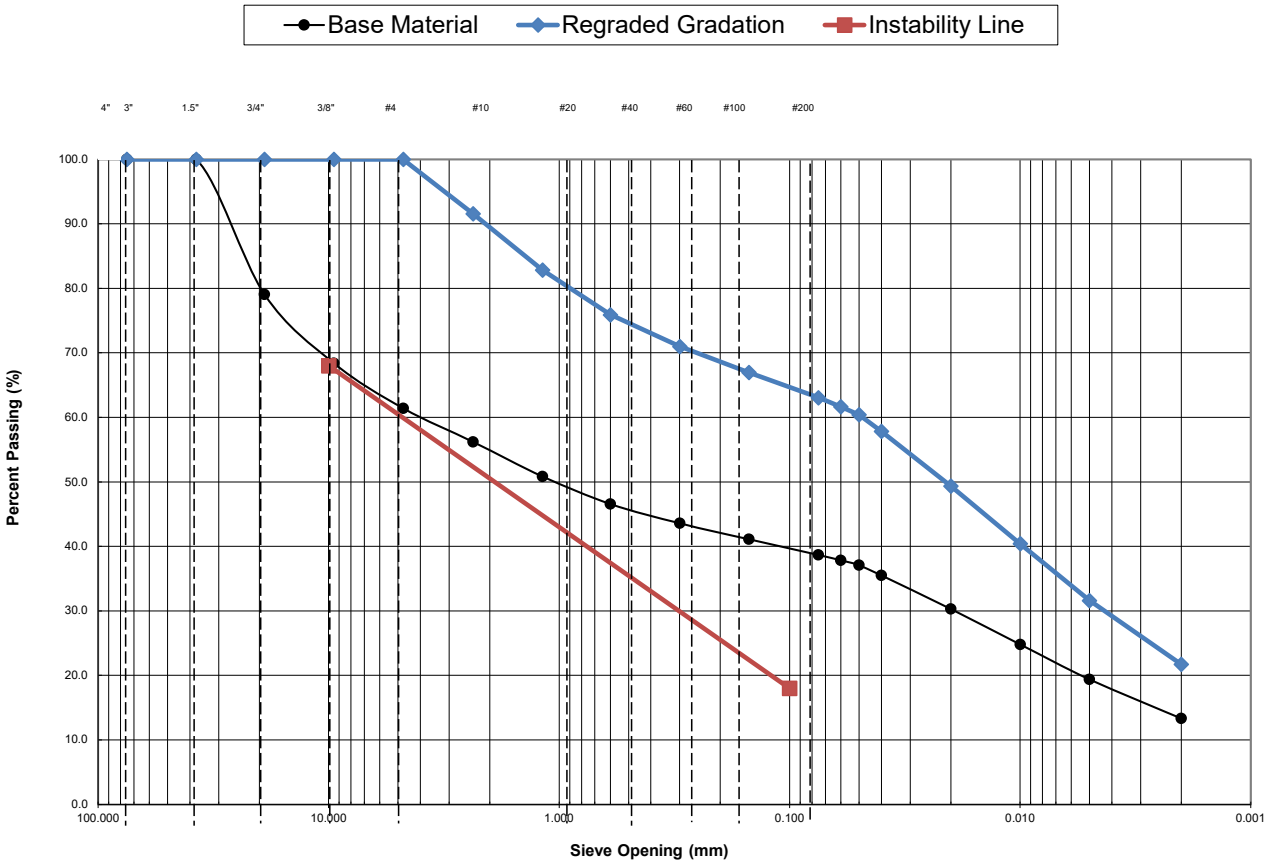
UTABA Dam – Dam Raise - Stability Analysis	B-16

Project Name:	UTABA Dam - Filter Calculations	Computed by:	RRB	Date:	1/14/2025
Project #:	24-1762	Reviewed by	RTC	Date:	3/4/2025



Design Criteria

1. Plot the gradation curve
2. Are base materials unstable (minus 75% to plus #200)? No
   If unstable, at what sieve to they become stable?
3. Adjust gradation curve, if needed
   a. Is plus #4 > 0 percent? Yes
   b. Is base material unstable? No
   c. Is minus #200 < 15% No
   d. Regrade based on the following sieve #4

Correction Factor =	1.63	
look at plot and determine original d_{15} =	0.003	
look at plot and determine adjusted d_{85} =	1.403	
look at plot and determine adjusted d_{98} =	4.024	mm

4. Place soil in a category based on adjusted No. 200 sieve
   Cat. 1 = minus #200 > 85
   Cat. 2 = minus #200 is 40-85
   Cat. 3 - minus #200 is 15-39
   Cat. 4 - minus #200 < 15

Adjusted No. 200 =	63.0
Category =	2

Blue text need to be input or adjusted to calculate filter criteria

Sieve Size	mm	Base Material	Regraded Gradation
3"	75	100.0	100.0
1-1/2"	37.5	100.0	100.0
3/4"	19	79.1	100.0
3/8"	9.5	68.4	100.0
#4	4.75	61.4	100.0
#8	2.36	56.2	91.6
#16	1.18	50.8	82.8
#30	0.6	46.6	75.9
#50	0.3	43.6	71.0
#100	0.15	41.1	67.0
#200	0.075	38.7	63.0
	0.06	37.8	61.7
	0.05	37.1	60.4
	0.04	35.5	57.8
	0.02	30.3	49.3
	0.01	24.8	40.4
	0.005	19.4	31.6
	0.002	13.3	21.7

NRCS Filter Limits		Min Filter Limits	Max Filter Limits
	0.15		0
	0.500		10
Point 1	0.600		15
Point 3	2.150		60
Point 7	20.00		90
Point 6	50.00		100
Point 5	0.075	5	
	0.117	10	
Point 2	0.140	15	
Point 4	0.500	60	
	1.5	100	

Instability Line	
Size	% passing
10	68
0.1	18

5. Determine maximum D_{15} size based on category
(use adjusted d_{85} for calculations)
Are base materials dispersive? No
If d_{98}/d_{85} < 2, treat Cat. 1 materials as dispersive)
d_{98}/d_{85} = 2.9
Cat. 1 - D_{15} max = 9.0 x d_{85} (minimum value is 0.2 mm) n/a
Cat. 1 (disp.) - D_{15} max = 6.5 x d_{85} (minimum value is 0.2 mm) n/a
Cat. 2 - D_{15} max = 0.7* mm 0.7 mm
Cat. 3 - D_{15} max = (40-Adj. No. 200)/25 x (4 x d_{85} - 0.7*) + 0.7* n/a
Cat. 4 - D_{15} max = 4 x d_{85} n/a
* Use 0.5 for dispersive soils
D_{15} max. 0.70 mm
Value Selected 0.6 mm

6. Determine minimum D_{15} size as largest of the following
a. 0.1 mm 0.10 mm
b) (this can be neglected if band is too narrow) 4 x original d_{15} = 0.01 mm
c) D_{15} max / 5 0.14 mm
D_{15} min = 0.14 mm
Value Selected 0.14 mm

7) Check width of filter design band
check D_{15max}/D_{15min}<=5 4.29

8. Determine D_{60} and D_{10} values
a. D_{10}max 0.50
b. D_{10}min 0.12
c. D_{60} min 0.60 mm
Value Selected 0.50 mm
d. D_{60} max 3.00 mm
Value Selected 2.15 mm
Fine Limit $c_u = D_{60}/D_{10}$ 4.3
cu must be between 2 and 6 = OK
Fine Limit $c_u = D_{60}/D_{10}$ 4.3
cu must be between 2 and 6 = OK

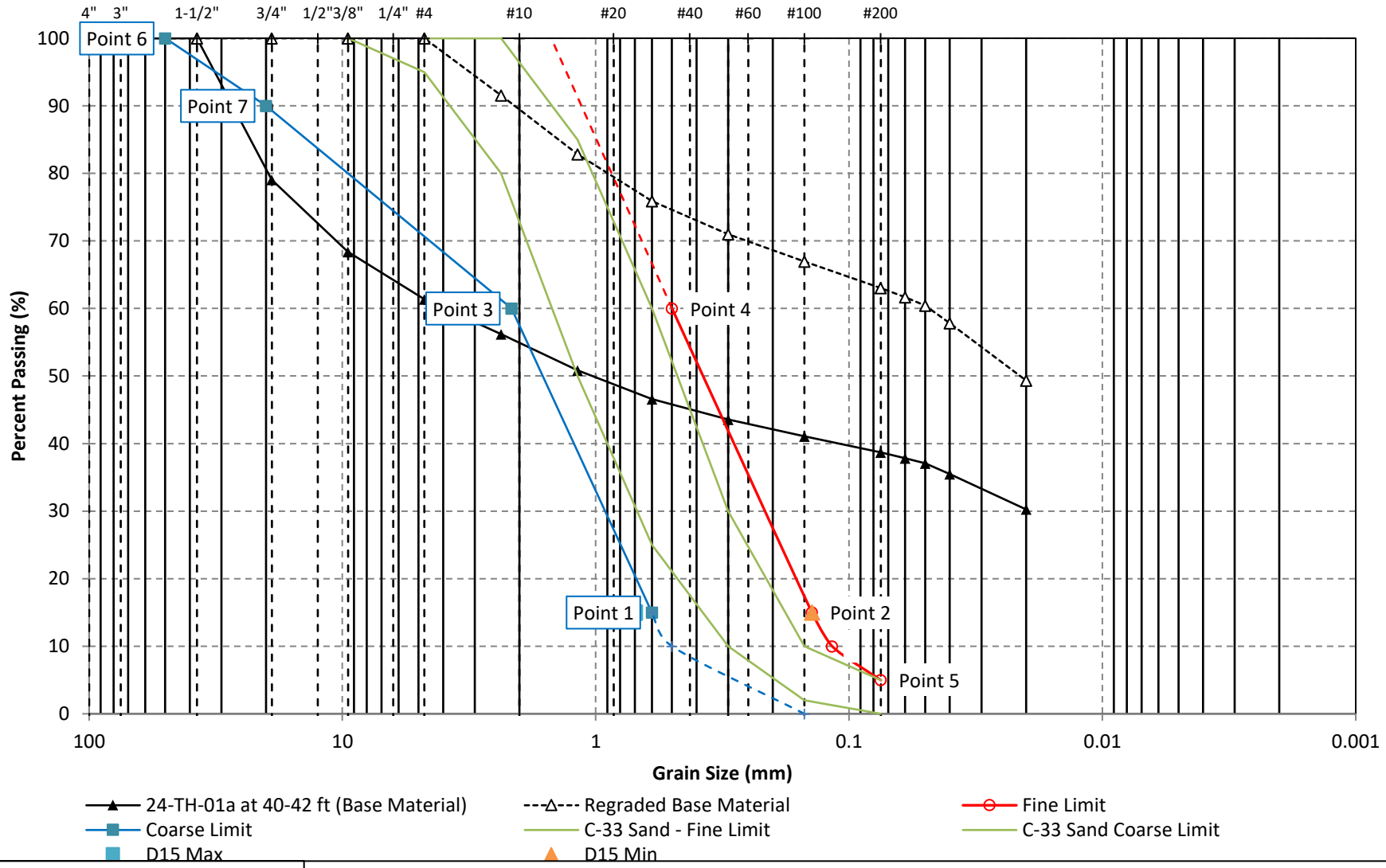
9. Determine maximum D_{100} and minimum D_5
D_{100} max. = 2 inches = 50 mm
D_5 min = No. 200 sieve = 0.075 mm

10. Determine maximum D_{90} from D_{10}min
a. D_{10}min 0.117 mm

If D_{10}min is	then D_{90}max is
< 0.5 mm	20 mm
0.5-1.0 mm	25 mm
1.0-2.0 mm	30 mm
2.0-5.0 mm	40 mm
5.0-10 mm	50 mm
> 10 mm	60 mm

D_{90}max = 20 mm

11. Connect limits and evaluate segregation potential
D_{30} min = 0.21 mm
Set D_{100} max = 50 mm
For D_{30} min ----- S_m = 0.57
Weak



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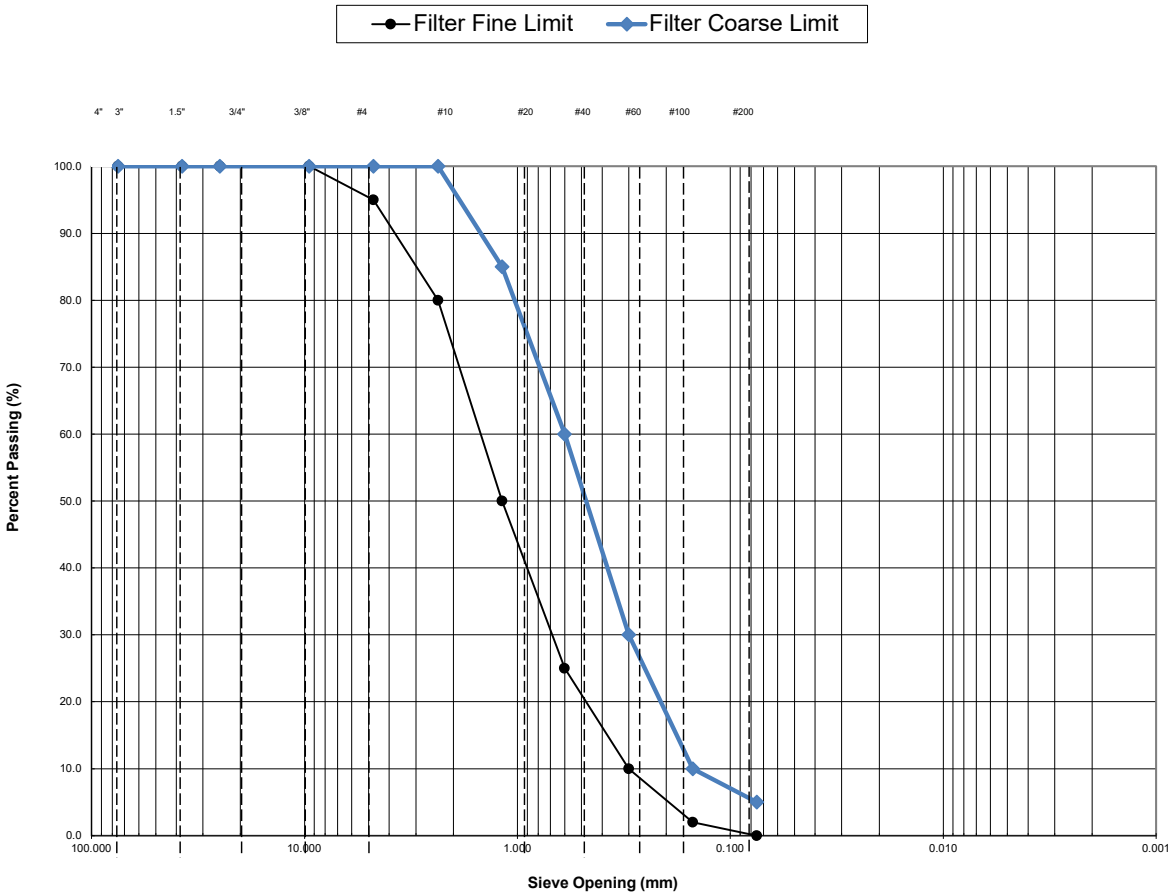
Filter Analysis

UTABA Dam

Project Name:	UTABA Dam - Drain Calculation	Computed by:	RRB	Date:	1/14/2025
Project #:	24-1762	Reviewed by	RTC	Date:	3/4/2025



Design Criteria

1. Plot the gradation curve
2. Are base materials unstable (minus 75% to plus #200)? — No
   If unstable, at what sieve to they become stable?
3. Adjust gradation curve, if needed
   a. Is plus #4 > 0 percent? — Yes
   b. Is base material unstable? — No
   c. Is minus #200 < 15% — Yes
   d. Regrade based on the following sieve — None

Correction Factor =	1.00	
look at plot and determine original d_{15} =	0.378	
look at plot and determine adjusted d_{85} =	2.980	
look at plot and determine original d_{15} =	0.178	
look at plot and determine adjusted d_{98} =	2.152	mm

4. Place soil in a category based on adjusted No. 200 sieve
   Cat. 1 = minus #200 > 85
   Cat. 2 = minus #200 is 40-85
   Cat. 3 - minus #200 is 15-39
   Cat. 4 - minus #200 < 15

Adjusted No. 200 =	0.0
Category =	4

Blue text need to be determined in order to calculate filter criteria

Sieve Size	mm	Filter Fine Limit	Filter Coarse Limit
3"	75	100.0	100.0
1-1/2"	37.5	100.0	100.0
1"	25	100.0	100.0
3/8"	9.5	100.0	100.0
#4	4.75	95.0	100.0
#8	2.36	80.0	100.0
#16	1.18	50.0	85.0
#30	0.6	25.0	60.0
#50	0.3	10.0	30.0
#100	0.15	2.0	10.0
#200	0.075	0.0	5.0

NRCS Filter Limits		Min Coarse Filter Limits	Max Coarse Filter Limits
	6		0
	9.167		10
Point 1	11.000		15
Point 3	24.000		60
Point 7	30.000		90
Point 6	75.000		100
Point 5	0.075	5	
Point 2	2.300	15	
Point 4	5.000	60	
	12.7	100	

5. Determine maximum D_{15} size based on category
(use adjusted d_{85} for calculations)
Are base materials dispersive? No
If d_{98}/d_{85} < 2, treat Cat. 1 materials as dispersive)

d_{98}/d_{85} = 0.7
Cat. 1 - D_{15} max = 9.0 x d_{85} (minimum value is 0.2 mm) n/a
Cat. 1 (disp.) - D_{15} max = 6.5 x d_{85} (minimum value is 0.2 mm) n/a
Cat. 2 - D_{15} max = 0.7* mm n/a
Cat. 3 - D_{15} max = (40-Adj. No. 200)/25 x (4 x d_{85} - 0.7*) + 0.7* n/a
Cat. 4 - D_{15} max = 4 x d_{85} 11.9 mm
* Use 0.5 for dispersive soils

D_{15} max. 11.92 mm
Value Selected 11 mm

6. Determine minimum D_{15} size as largest of the following - use coarse side of fine filter if permeability is required
a. 0.1 mm 0.10 mm
b) (this can be neglected if band is too narrow) 4 x original d_{15} = 0.71 mm
c) D_{15} max / 5 2.38 mm
D_{15} min = 2.38 mm
Value Selected 2.3 mm

7) Check width of filter design band
check d_{max}/d_{min}<=5 4.78

8. Determine D_{60} and D_{10} values

a. D_{10}max 9.17
b. D_{10}min 1.92
11.00 mm
c. D_{60} min 5.00 mm
d. D_{60} max 55.00 mm
Value Selected 24.00 mm
$c_u = D_{60}/D_{10}$ = 2.6
cu must be between 2 and 6 = OK
$c_u = D_{60}/D_{10}$ = 2.6
cu must be between 2 and 6 = OK

9. Determine maximum D_{100} and minimum D_5
D_{100} max. = 3 inches = 75 mm
D_5 min = No. 200 sieve = 0.075 mm

10. Determinemaximum D_{90}
a. D_{10}min 1.917 mm

If D_{10}min is	then D_{90}max is
< 0.5 mm	20 mm
0.5-1.0 mm	25 mm
1.0-2.0 mm	30 mm
2.0-5.0 mm	40 mm
5.0-10 mm	50 mm
> 10 mm	60 mm

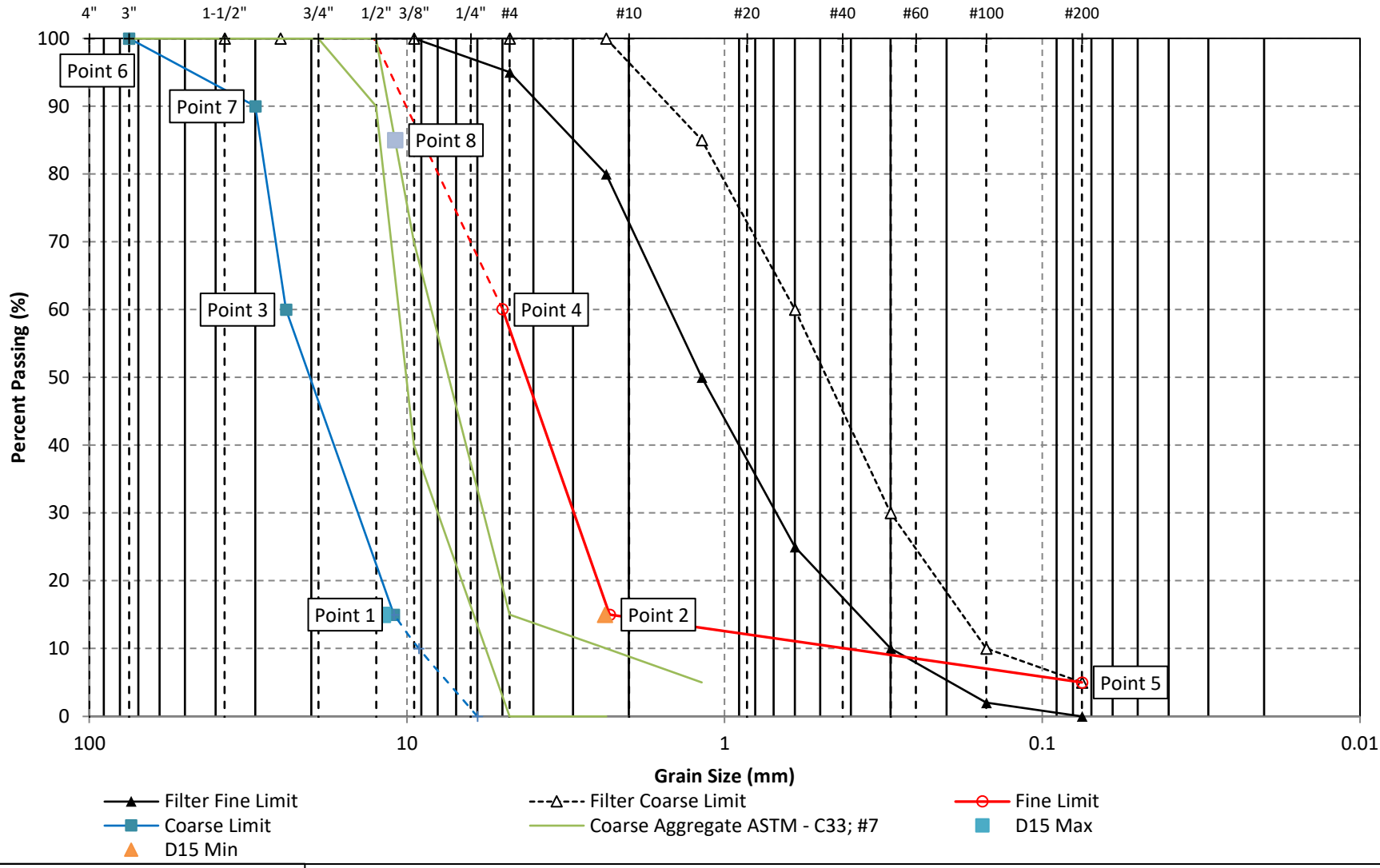
D_{90}max = 30 mm

11. Connect limits and evaluate segregation potential
D_{30} min = 2.98 mm
Set D_{100} max = 75 mm
For D_{30} min ----- S_m = 0.14
Intermediate

12 Max Peforation Size (D_{85})
(NRCS Criteria) 10.90 mm
(USBR - Criteria) 5.45 mm

GERHART COLE

3/21/2025



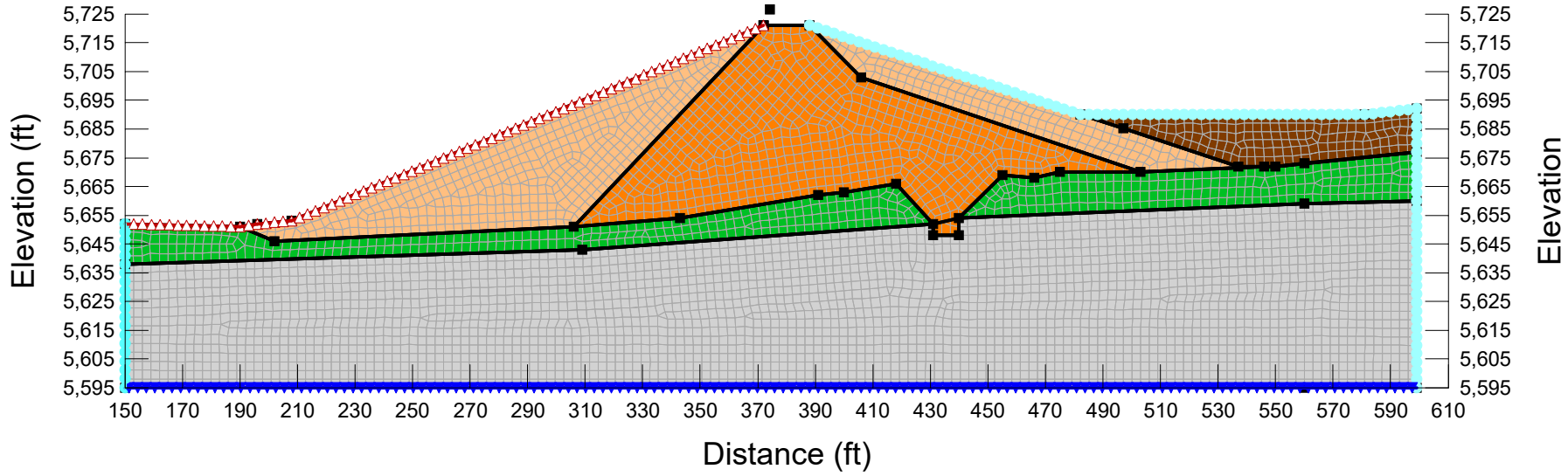
GERHART COLE

Filter Analysis - Drain Gravel

UTABA Dam

Color	Name	Hydraulic Material Model	Sat Kx (ft/d)	Ky'/Kx' Ratio
	Foundation - Alluvial Soil	Saturated Only	17	1
	Foundation - Bedrock	Saturated Only	5.7	1
	Reservoir InFill	Saturated Only	0.00028	0.1
	Shell Material	Saturated Only	11	0.1
	Zone 2 - Impervious Zone	Saturated Only	0.0028	0.1

Color	Name	Category	Kind	Parameters
	Bottom of Model	Hydraulic	Water Flux	0 ft/d
	Downstream Toe	Hydraulic	Water Total Head	5,648 ft
	Normal Flow 5695 ft	Hydraulic	Water Total Head	5,695 ft
	Seepage Face	Hydraulic	Water Rate	0 ft³/d



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GERHART COLE

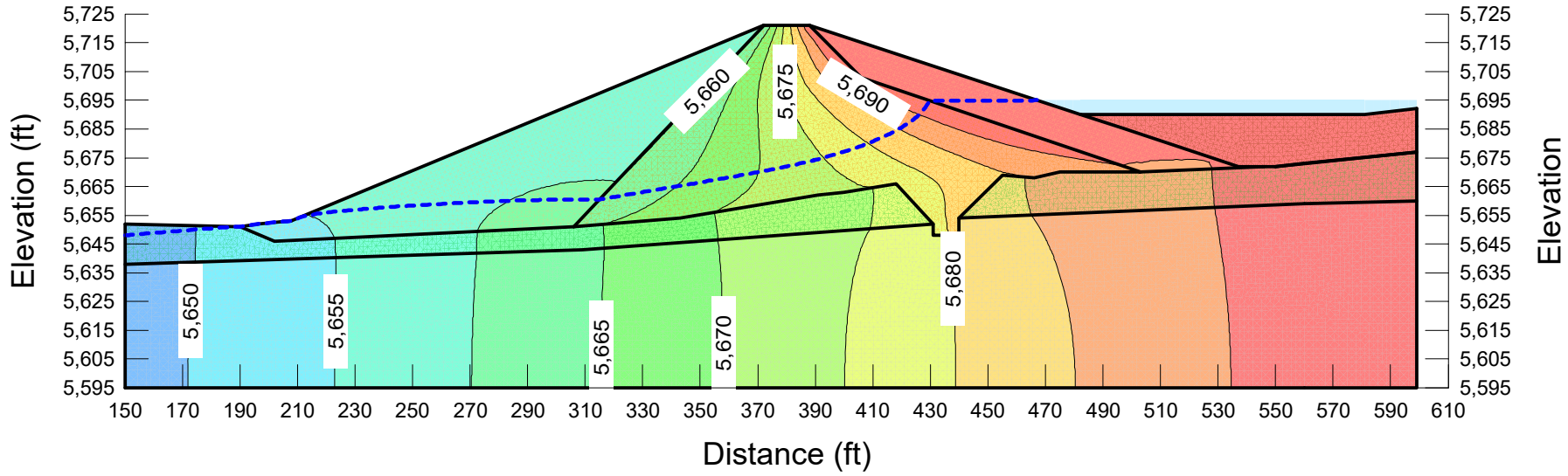
Existing Dam - Steady-State Seepage - Boundary Conditions

24-1762

UTABA Dam

Color	Name	Hydraulic Material Model	Sat Kx (ft/d)	Ky'/Kx' Ratio
	Foundation - Alluvial Soil	Saturated Only	17	1
	Foundation - Bedrock	Saturated Only	5.7	1
	Reservoir InFill	Saturated Only	0.00028	0.1
	Shell Material	Saturated Only	11	0.1
	Zone 2 - Impervious Zone	Saturated Only	0.0028	0.1

Color	Name	Category	Kind	Parameters
	Bottom of Model	Hydraulic	Water Flux	0 ft/d
	Downstream Toe	Hydraulic	Water Total Head	5,648 ft
	Normal Flow 5695 ft	Hydraulic	Water Total Head	5,695 ft
	Seepage Face	Hydraulic	Water Rate	0 ft³/d



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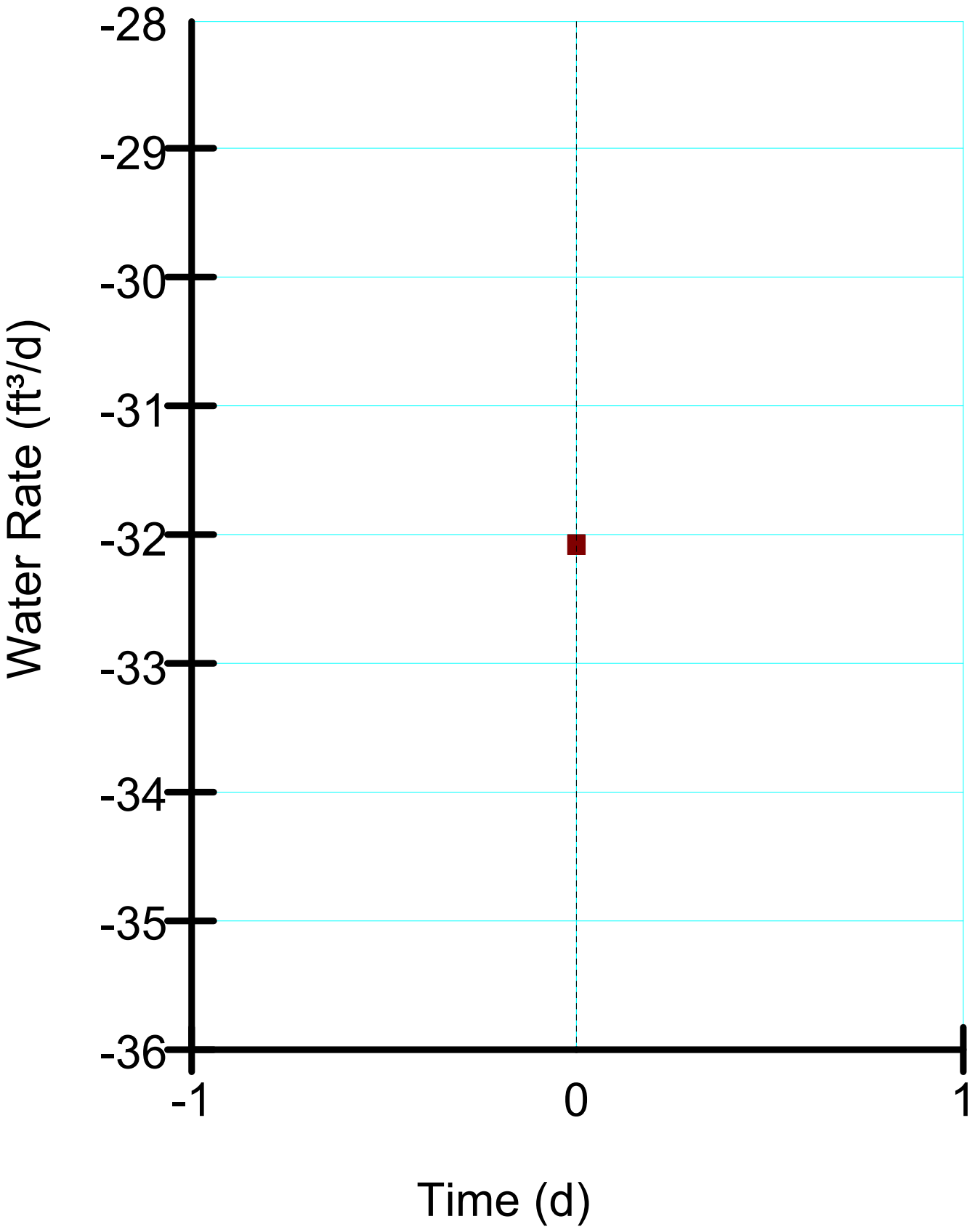
GERHART COLE

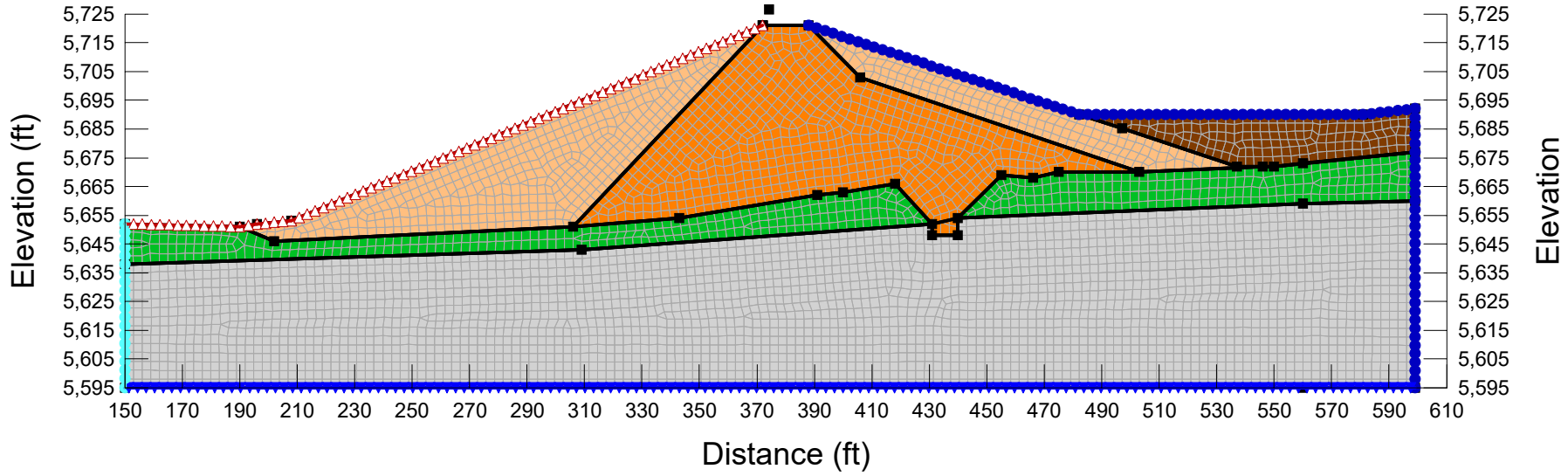
Existing Dam - Steady-State Seepage - Total Head	24-1762
UTABA Dam	

Flow through Dam/Alluvial Foundation



Color	Name	Hydraulic Material Model	Sat Kx (ft/d)	Ky'/Kx' Ratio
	Foundation - Alluvial Soil	Saturated Only	17	1
	Foundation - Bedrock	Saturated Only	5.7	1
	Reservoir InFill	Saturated Only	0.00028	0.1
	Shell Material	Saturated Only	11	0.1
	Zone 2 - Impervious Zone	Saturated Only	0.0028	0.1

Color	Name	Category	Kind	Parameters
	Bottom of Model	Hydraulic	Water Flux	0 ft/d
	Downstream Toe	Hydraulic	Water Total Head	5,648 ft
	Full Reservoir 5711	Hydraulic	Water Total Head	5,711 ft
	Seepage Face	Hydraulic	Water Rate	0 ft³/d



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GERHART COLE

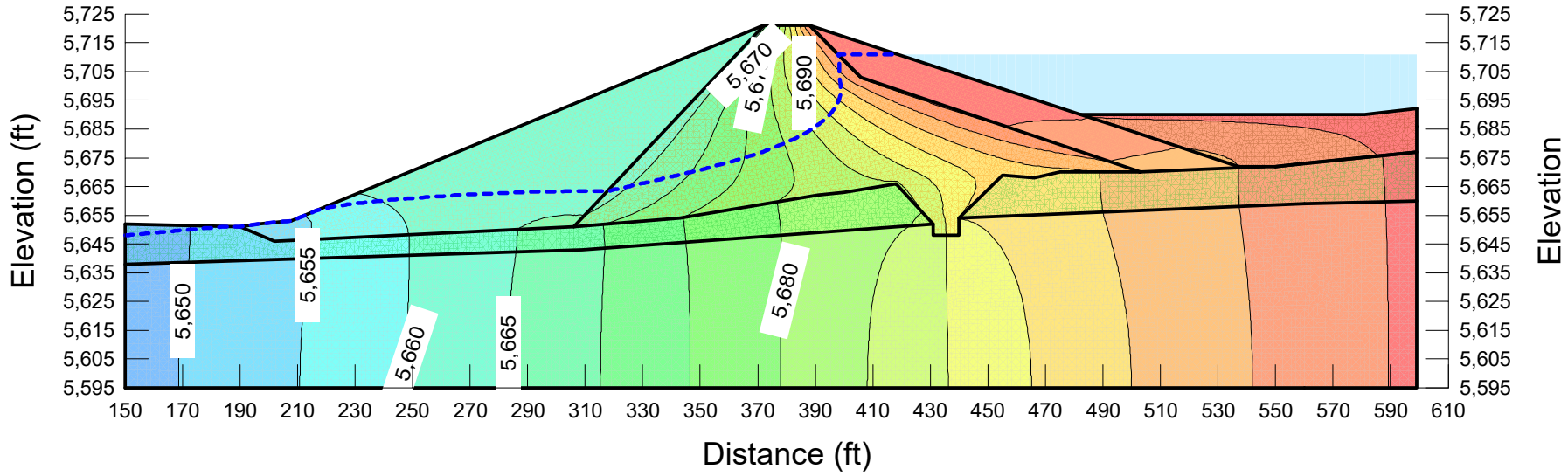
Existing Dam - Steady-State Seepage (Full Reservoir) - Boundary Conditions

24-1762

UTABA Dam

Color	Name	Hydraulic Material Model	Sat Kx (ft/d)	Ky'/Kx' Ratio
	Foundation - Alluvial Soil	Saturated Only	17	1
	Foundation - Bedrock	Saturated Only	5.7	1
	Reservoir InFill	Saturated Only	0.00028	0.1
	Shell Material	Saturated Only	11	0.1
	Zone 2 - Impervious Zone	Saturated Only	0.0028	0.1

Color	Name	Category	Kind	Parameters
	Bottom of Model	Hydraulic	Water Flux	0 ft/d
	Downstream Toe	Hydraulic	Water Total Head	5,648 ft
	Full Reservoir 5711	Hydraulic	Water Total Head	5,711 ft
	Seepage Face	Hydraulic	Water Rate	0 ft³/d



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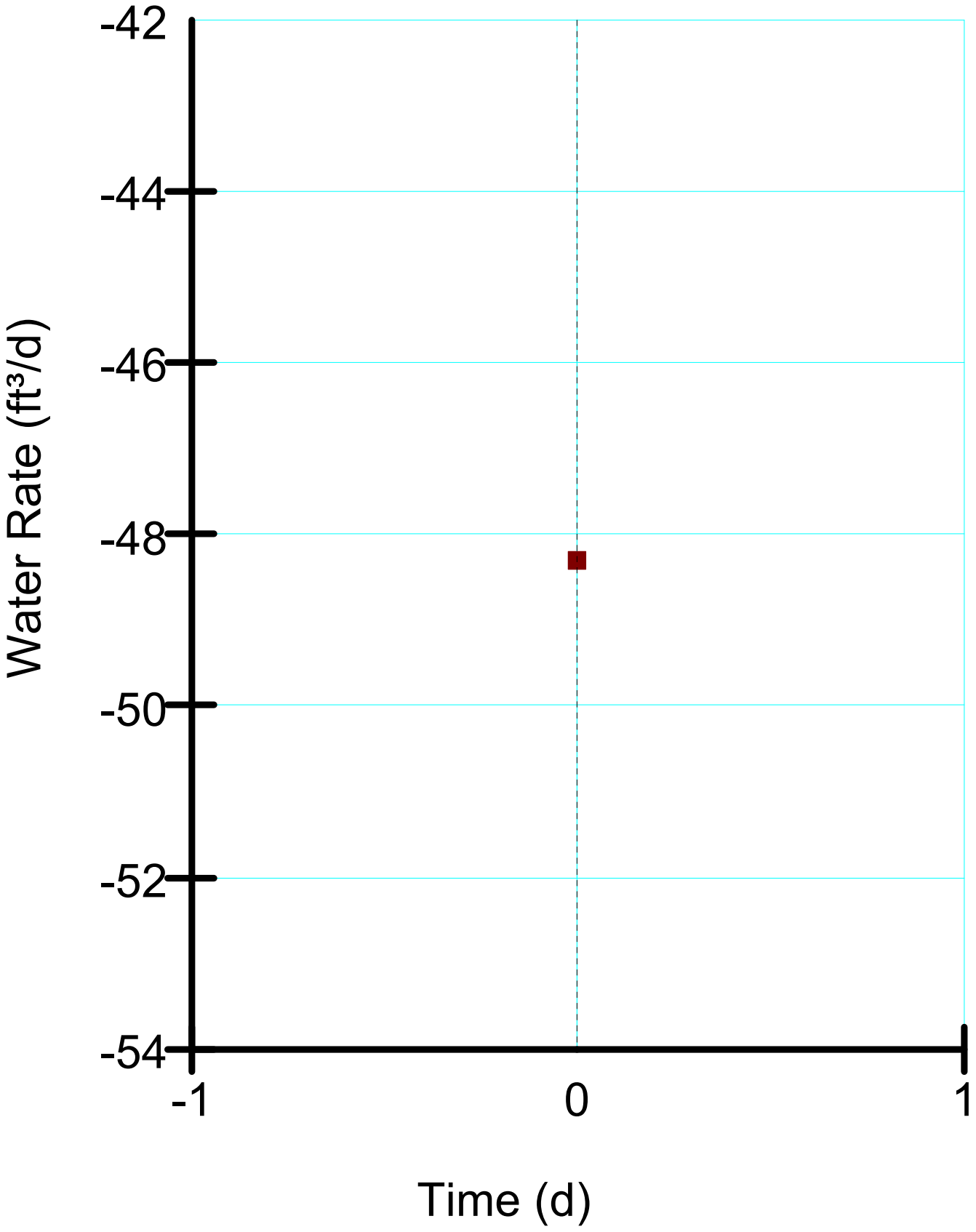
GERHART COLE

Existing Dam - Steady-State Seepage (Full Reservoir) - Total Head

24-1762

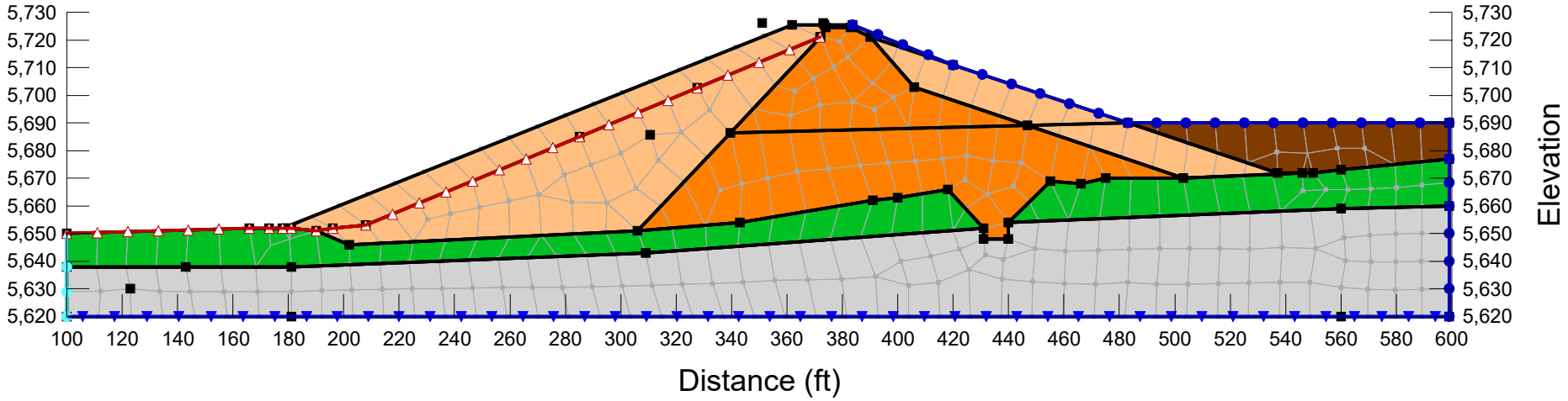
UTABA Dam

Flow through Dam/Alluvial Foundation



Color	Name	Hydraulic Material Model	Sat Kx (ft/d)	Ky'/Kx' Ratio
	Foundation - Alluvial Soil	Saturated Only	17	1
	Foundation - Bedrock	Saturated Only	5.7	1
	Reservoir InFill	Saturated Only	0.00028	0.1
	Shell Material	Saturated Only	11	0.1
	Zone 2 - Impervious Zone	Saturated Only	0.0028	0.1

Color	Name	Category	Kind	Parameters
	Bottom of Model	Hydraulic	Water Flux	0 ft/d
	Downstream Toe	Hydraulic	Water Total Head	5,648 ft
	Full Reservoir 5711	Hydraulic	Water Total Head	5,711 ft
	Seepage Face	Hydraulic	Water Rate	0 ft³/d
	Zero Pressure	Hydraulic	Water Total Head	0 ft



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GERHART COLE

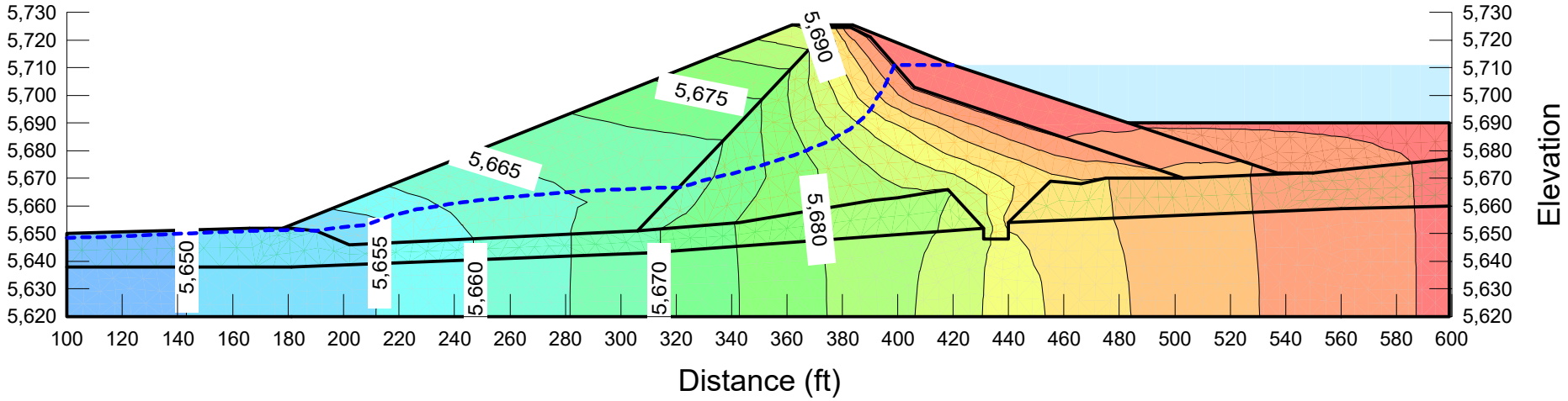
Dam Raise - Alt 1; Steady-State Seepage (Full Reservoir) - Boundary Conditions

24-1762

UTABA Dam

Color	Name	Hydraulic Material Model	Sat Kx (ft/d)	Ky'/Kx' Ratio
	Foundation - Alluvial Soil	Saturated Only	17	1
	Foundation - Bedrock	Saturated Only	5.7	1
	Reservoir InFill	Saturated Only	0.00028	0.1
	Shell Material	Saturated Only	11	0.1
	Zone 2 - Impervious Zone	Saturated Only	0.0028	0.1

Color	Name	Category	Kind	Parameters
	Bottom of Model	Hydraulic	Water Flux	0 ft/d
	Downstream Toe	Hydraulic	Water Total Head	5,648 ft
	Full Reservoir 5711	Hydraulic	Water Total Head	5,711 ft
	Seepage Face	Hydraulic	Water Rate	0 ft³/d
	Zero Pressure	Hydraulic	Water Total Head	0 ft



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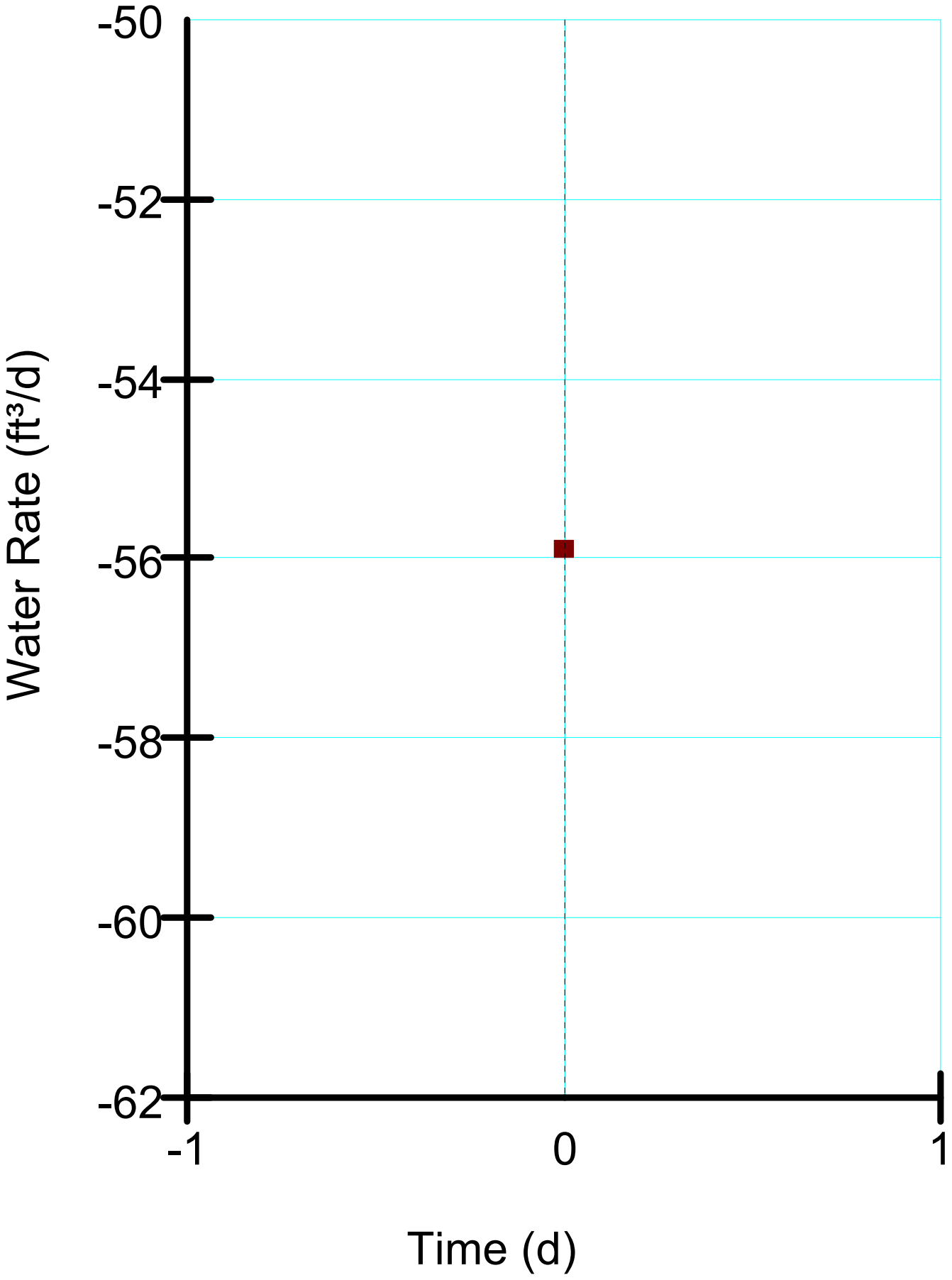
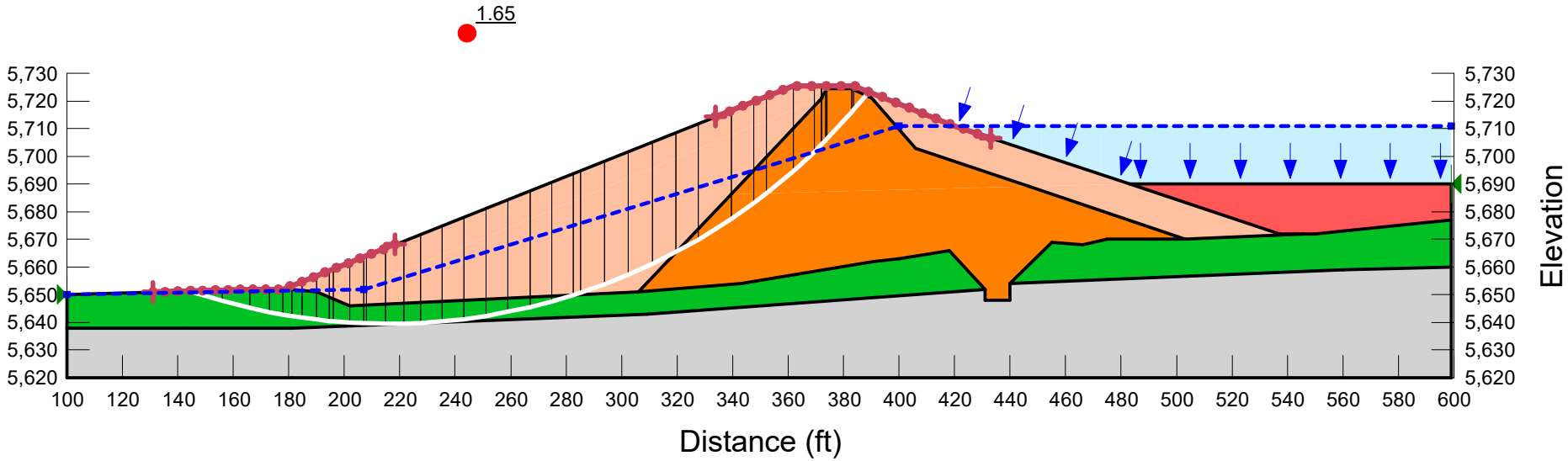
GERHART COLE

Dam Raise - Alt 1; Steady-State Seepage (Full Reservoir) - Total Head	24-1762
UTABA Dam	

Flow into Drain



Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone	135	50	35
	Zone 2 - Impervious Zone	130	200	30



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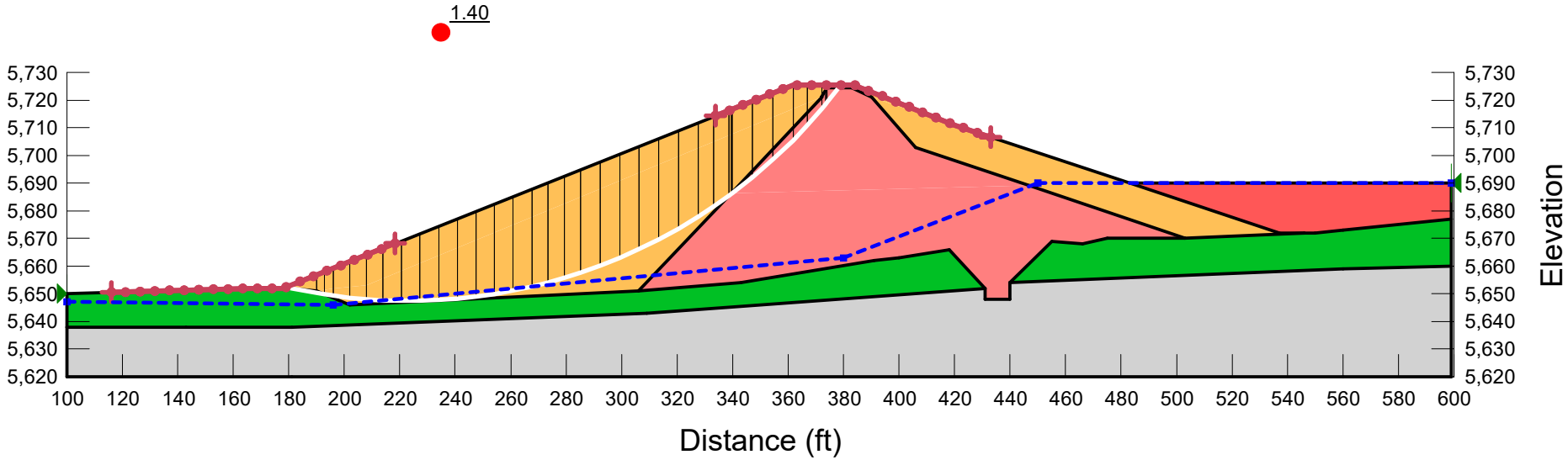
GERHART COLE

Dam Raise - Alt-1; Downstream - Long Term Static

24-1762

UTABA Dam

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone (Total Stress)	135	750	14
	Zone 2 - Impervious Zone (Total Stress)	130	200	22



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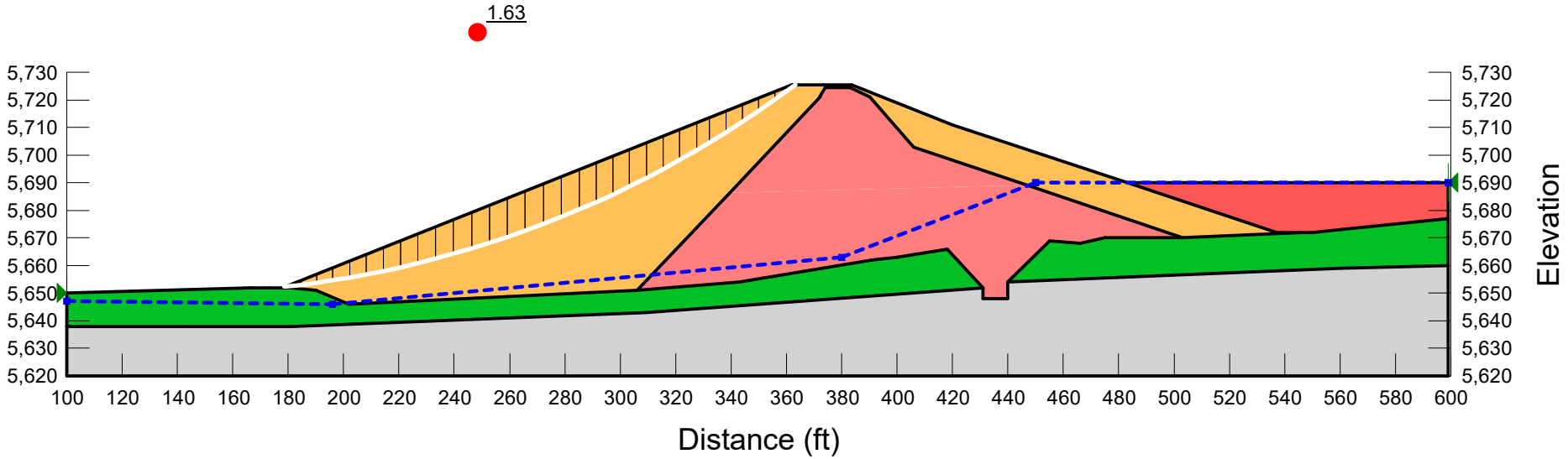
GERHART COLE

Dam Raise - Alt-1; Downstream - End of Construction	24-1762
UTABA Dam	

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone (Total Stress)	135	750	14
	Zone 2 - Impervious Zone (Total Stress)	130	200	22

Horz Seismic Coef.: 0.16



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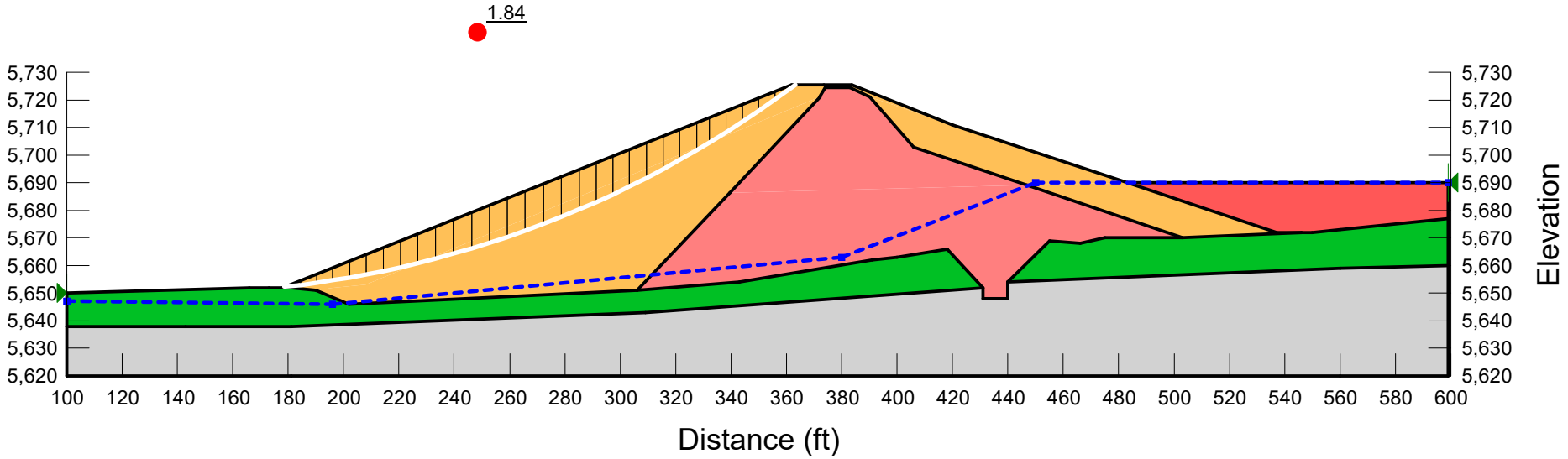
GERHART COLE

Dam Raise - Alt-1; Downstream - Pseudo Static (MCE/MDE)	24-1762
UTABA Dam	

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone (Total Stress)	135	750	14
	Zone 2 - Impervious Zone (Total Stress)	130	200	22

Horz Seismic Coef.: 0.1



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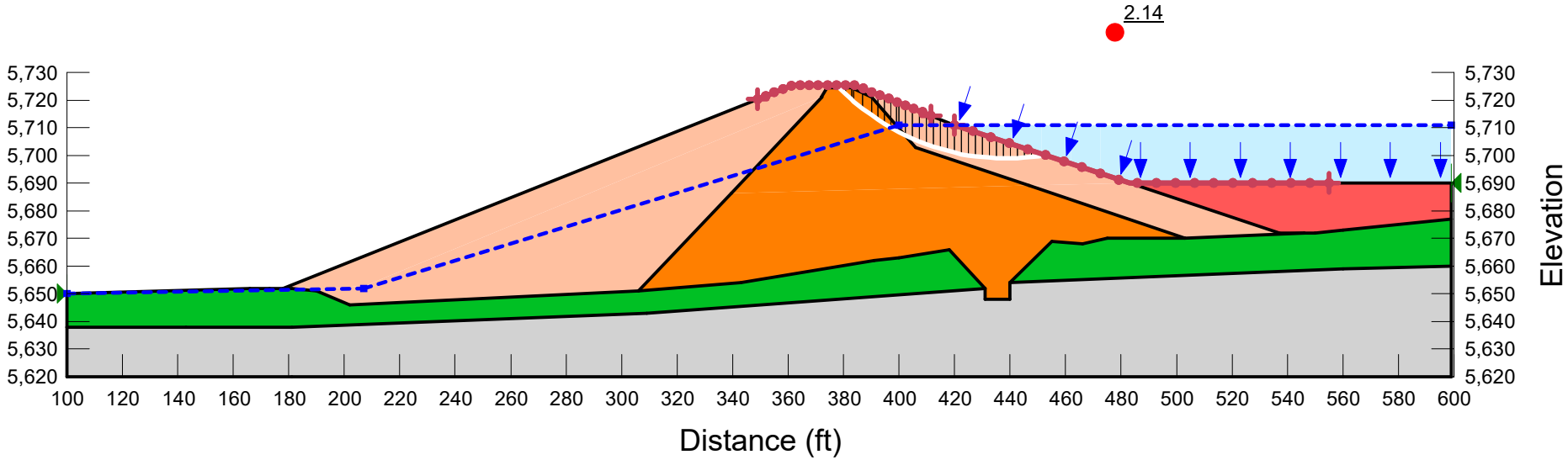
GERHART COLE	Dam Raise - Alt-1; Downstream - Pseudo Static (OBE)	24-1762
	UTABA Dam	

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone	135	50	35
	Zone 2 - Impervious Zone	130	200	30



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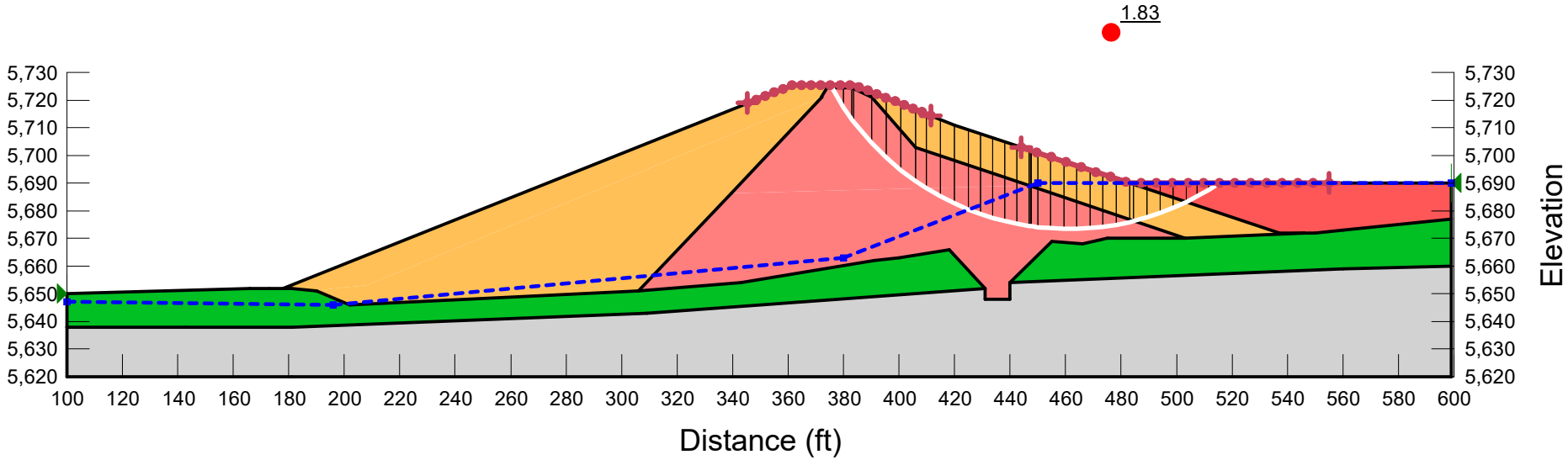
GERHART COLE

Dam Raise - Alt-1; Upstream - Long Term Static	24-1762
UTABA Dam	

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone (Total Stress)	135	750	14
	Zone 2 - Impervious Zone (Total Stress)	130	200	22



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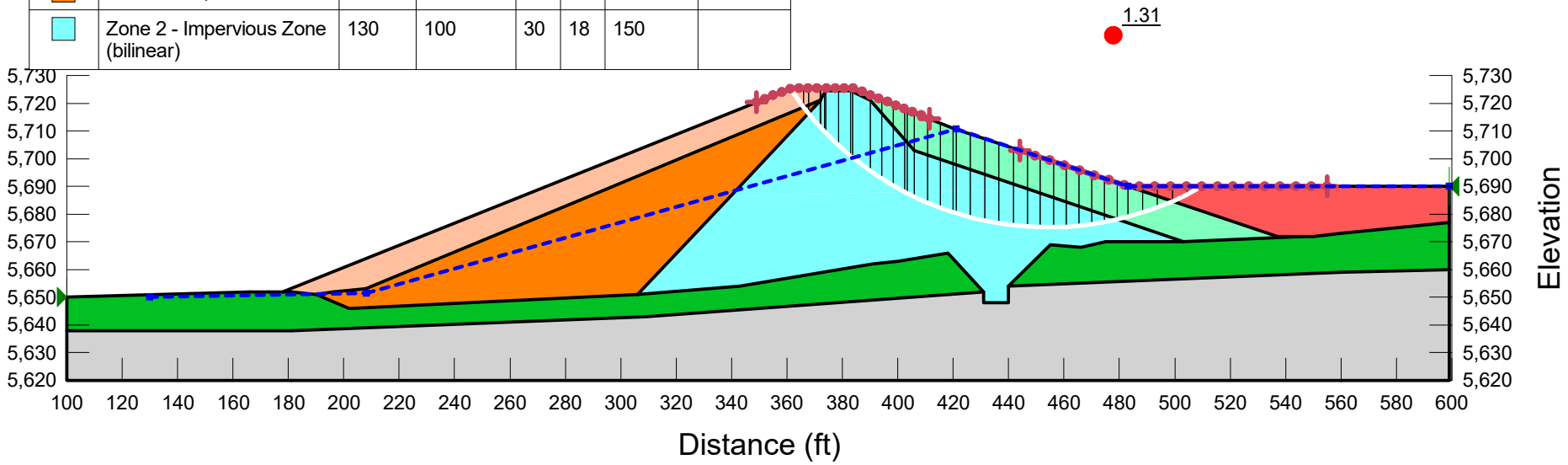
GERHART COLE

Dam Raise - Alt-1; Upstream - End of Construction

24-1762

UTABA Dam

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Phi 1 (°)	Phi 2 (°)	Normal Effective Stress (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0				34
	Foundation - Bedrock	140	2,000				30
	Reservoir Sediement	105	0				26
	Shell Material - Pervious Zone	135	50	0	0	0	
	Shell Material - Pervious Zone (bilinear)	135	750	14	35	50	
	Zone 2 - Impervious Zone	130	200				30
	Zone 2 - Impervious Zone (bilinear)	130	100	30	18	150	



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GERHART COLE

Dam Raise - Alt-1; Upstream - Rapid Drawdown - Total Head

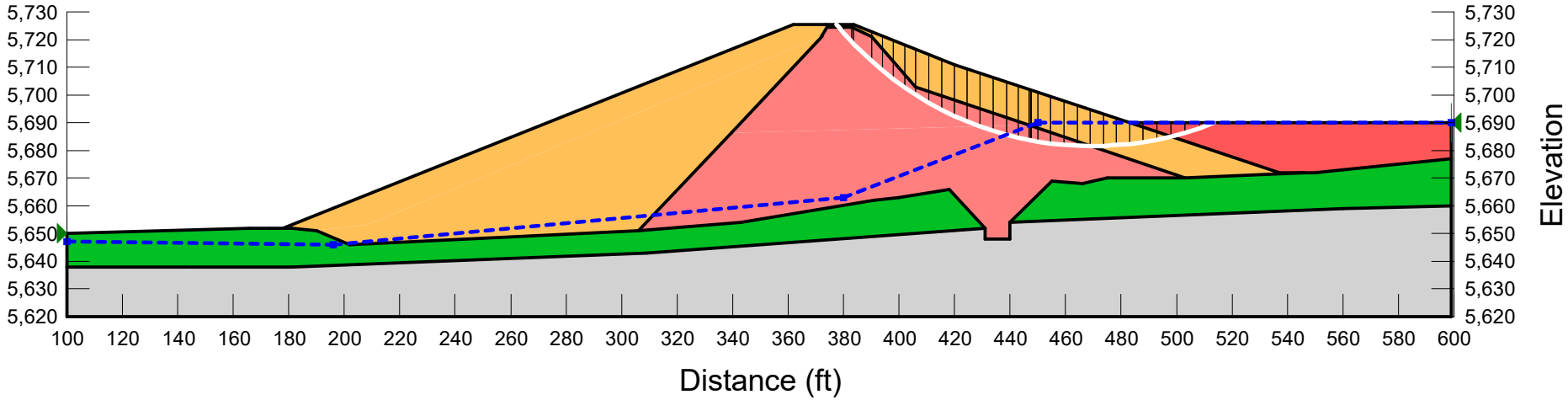
24-1762

UTABA Dam

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone (Total Stress)	135	750	14
	Zone 2 - Impervious Zone (Total Stress)	130	200	22

1.24

Horz Seismic Coef.: 0.16



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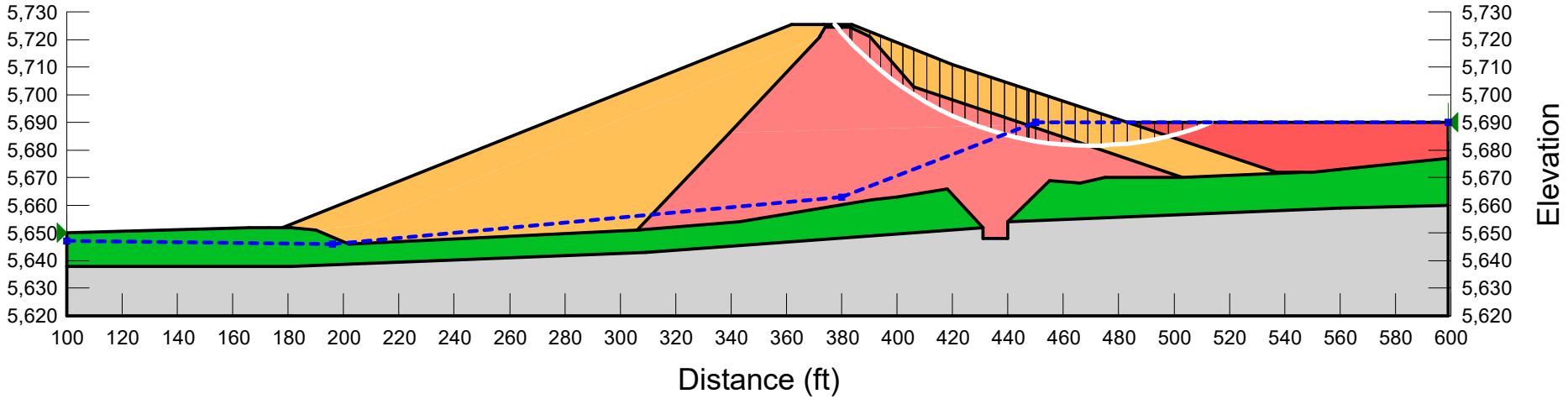
GERHART COLE	Dam Raise - Alt-1; Upstream - Pseudo Static (MCE/MDE)	24-1762
	UTABA Dam	

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Foundation - Alluvial Soil	135	0	34
	Foundation - Bedrock	140	2,000	30
	Reservoir Sediement	105	0	26
	Shell Material - Pervious Zone (Total Stress)	135	750	14
	Zone 2 - Impervious Zone (Total Stress)	130	200	22

1.43

Horz Seismic Coef.: 0.1



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GERHART COLE	Dam Raise - Alt-1; Upstream - Pseudo Static (OBE)	24-1762
	UTABA Dam	

GERHART COLE

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TECHNICAL MEMORANDUM

To:	Mr. Layne Jensen, PE and Mr. Chad Brown, PE Franson Civil Engineers 1276 South 820 East, Suite 100 American Fork, UT 84003
From:	Travis M. Gerber, PhD, PE
Reviewed by:	Richard R. Buhler, PE and Ryan Cole, PhD, PE, BCGE
Date:	June 9, 2025
Job Number:	24-1762
Subject:	Site-Specific Seismic Study UTABA Dam, near Liberty, Weber County, Utah **[REVISION #2]**

INTRODUCTION AND BACKGROUND

This document (technical memorandum, TM) presents Gerhart Cole's (GC) site-specific seismic study prepared for UTABA Dam and Reservoir. This study was performed as part of our proposal (scope of work) to Franson Civil Engineers, dated December 19, 2023.

This document is intended to be an appendix in the geotechnical design report (GDR) for UTABA Dam and Reservoir. Supplemental, more detailed information regarding items such as embankment geometry, site geology, subsurface soil conditions, and liquefaction triggering analyses may be found in the GDR.

General Information

UTABA Dam and Reservoir are existing facilities located at the confluence of North Fork Ogden River (to the northwest) and Cutler Creek (to the west) near Liberty, Weber County, Utah. General information considered in this study, including that from Utah Dam Safety within the Utah Division of Water Rights (USD within UDWR), National Resources Conservation Service (NRCS), and from Franson Civil Engineers (Client; specifically relating to inputs for hazard and consequence assessments/classifications), include:

- Location (latitude, longitude): 41.386815º, -111.909813º
- UDS identifier: UTABA, UT00541
- Function: Flood control [typically empty for future planned use]
- Existing structural height (per USD): 71 feet
- Existing hydraulic height (per USD): 54 feet
- Existing storage at spillway and dam crests (per UDS): 91 and 180 acre-feet (not accounting for accumulated sediments)
- Planned future structural height (per Franson): 71 existing +4 raise = 75 feet (crest elevation 5724 ft)
- Planned future hydraulic height (per Franson): 54 existing +54 raise = 58 feet

- Planned future storage at spillway and dam crests (per Franson, accounting for accumulated sediments): 72 and 175 acre-feet
- UDS dam type category: Inspected flood control dams greater than 20 acre-feet
- UDS hazard rating: High
- NRCS hazard class: High
- NRCS structure classification: Group A
- NRCS consequence of seismic failure: Low
- Seismic site characterization:
    - NEHRP 2020 and 2023 USGS site class: B (see text for discussion of potential range)
    - Site-specific Vs30 values: 973 m/s [3,192 ft/s] (see text for discussion of potential range)
    - Liquefaction potential: Negligible

Additional information / details regarding the above summary are presented in the following sections of this document. General information regarding the dam embankment as well as the analytical guidance used for this seismic study is based on:

- UDS/UDWR website page for UTABA Dam (UDS, 2025a)
- Utah Code, Title 73 Water and Irrigation, Chapter 5a Dam Safety (State of Utah, 2025)
- Utah Rules, R655-10 Dam Safety Classifications, Approval Procedures and Independent Reviews (UOAR, 2025a)
- Utah Rules, R655-11 Requirements for the Design, Construction, and Abandonment of Dams (UOAR, 2025b)
- NRCS Title 210 National Engineering Manual [NEM], Part 520, Subpart C Dams (NRCS, 2017a)
- NRCS Title 210 National Engineering Manual [NEM], Part 531 Geology (NRCS, 2017b)
- NRCS Technical Release 210-60, Earth Dams and Reservoirs (NRCS, 2019)
- NRCS Guidance for Seismic Hazard Data Collection and Evaluation for the Planning and Design of NRCS Structures (prepared by A.Vargo; NRCS, 2025)

HAZARD RATING FOR ANALYSIS / DESIGN

Per the State of Utah (Utah Dam Safety, UDS) the hazard rating for UTABA embankment dam is “high” dam. However, as the dam is for flood control, per Utah Code Title 73, Chapter 5a (Dam Safety), “No seismic standards shall be established for existing high hazard dams within the flood control use classification.” Consequently, relative to the State of Utah, the seismic hazard rating is not really applicable as seismic analysis/design for UTABA Dam is not required.

Per NRSC (2017a and 2025a), we understand that UTABA Dam is classified as having “High Hazard Potential”, which is typified as a condition where “a failure may cause loss of life or serious damage to homes, industrial or commercial buildings, important public utilities, main highways, or railroads]”. This High Hazard rating appears to be justified in

consideration of "'the worst-case probable scenario of failure or misoperation of the dam,' meaning assignment of hazard potential classification 'based on failure consequences that will result in the assignment of the highest hazard potential classification of all probable failure and misoperation scenarios.'" as directed in NRCS (2019), if one assumes that failure of the outlet/spillway during a flood event caused unintentional impoundment of water and then a breach occurred. Related to this classification, per the guidance of NRCS (2017b), this hazard is paired with a Structure Classification (for Engineering Geological Investigations) of Group A.

Franson found that with a breach under the water level in the reservoir for 90% of the year, "the peak flow under these conditions was less than 250 cfs (less than a 10-year event)" and "this flow stayed within the banks of the creek" (see Franson, 2025). NRCS (2019) looks at the "consequence of seismic failure" which is the hazard of the dam at normal pool and not at flood potential. The UTABA dam normal pool is dry; therefore, the consequence of seismic failure is low. Consequently, per TR-60 (Figure 4-1), the seismic analysis and design for UTABA Dam is to be performed with a maximum design earthquake (MDE) loading having a return period of 1,000 years (which approximately correlates to a 5% probability of exceedance in 50 years (~5PE50).

We note that while UDS rules typically require consideration of both probabilistic- and deterministic-based ground motions, NRCS' seismic criteria only considers probabilistic-based ground motions.

Per NRCS' TR 210-60, Figure 4-2, the operating basis earthquake (OBE) for high hazard potential dams (and independent of consequence) is defined as ground motions having a return period of 500 years (which approximately correlates to a 5% probability of exceedance in 50 years (~10PE50).

SITE SOIL CONDITIONS / SEISMIC SITE CLASSIFICATION

Subsurface seismic wave velocities were assessed at the embankment dam by GC. Both multichannel analysis of surface waves (MASW) and microtremor array measurements (MAM) techniques were used to develop a shear wave velocity profile along the dam. The weighted average shear wave velocity for the first 30 meters of subsurface (i.e., Vs30 value, calculated as a weighted harmonic mean [see Appendix A for illustrative calculations]) is approximately 594 m/s (1,950 ft/s). (See separate GC technical memorandum regarding geophysical survey conducted at the site for additional information; the shear wave velocity profile itself is presented in Figure 3.) This Vs30 value falls within site class C per the "newer" seismic site classifications of NEHRP 2020 and upon which the USGS' 2018 and 2023 NSHMPs [in which site effects are explicitly included in the site spectra without the need of site factors/coefficients] are based (see FEMA, 2015 and 2020). This value also falls within site class C per NEHRP's 2015 (and earlier) site classification framework.

Seismic refraction lines were placed at several locations along the dam and on surrounding ground (again see GC geophysical survey technical memorandum for map and test details). The longest line (Line 1; providing the greatest depth of information from the refraction lines due to its longest length) was located in the vicinity of the right abutment. The approximate depth of reliable resolution was about 85 feet. The refraction lines were initially intended to

provide information regarding depth to bedrock and rippability. However, this data can also be used to help assess the variability of site conditions and its effect of seismic ground response at the site.

Shear wave velocity data was extracted from two profiles along Line 1 (one at position 110 feet and the other at position 220 feet, as measured from the southeast end of the line) where the two positions / locations appear to present the least and most stiff conditions along the line. The resulting profiles are presented in Figure 3. In comparing shear wave velocities in the abutment area to those in the central portion of the dam, the velocities above a depth of about 50 feet are higher at the abutment, as expected. The refraction data agrees relatively well with the shear wave velocities obtained from the surface wave line at depth, being on the order of 3,000 ft/s.

For the purposes of assessing site subsurface variability on seismic ground response, we calculated Vs30 values based on the refraction line data. In as this data truncated at depths of about 85 feet, we extrapolated the data another approximately 15 feet using two different approaches: 1) the method of Boore (2004) developed for such purposes, and 2) assuming the shear wave velocity of the interval was 3,192 ft/s [973 m/s], consistent with the data obtained from MASW and MAM at depths below the dam (see Figure 3). The two approaches did not produce appreciably different results (which is not surprising, given the manner in which Vs30 is calculated, with the lower velocities having greater influence on the result). For position 110 feet, the resulting Vs30 value was 2,256 to 2,259 ft/s [688 to 689 m/s]. For position 220 feet, the resulting Vs30 value was 2,620 to 2,667 ft/s [799 to 813 m/s]. These values are summarized in Table 2. Supporting calculations for the determination of these Vs30 values are presented in Appendix A. These abutment-based Vs30 values are within site class BC under the “newer” seismic site classifications of NEHRP 2020. In the previous NEHRP site class framework, the Vs30 from position 110 feet would be considered within site class C whereas the Vs30 from position 220 feet would be considered within site class B.

In our evaluation of seismic site class, we also considered site conditions corresponding to those existing at the base of the dam without the embankment in place, as inferred from the shear wave velocities as obtained by MASW and MAM. As seen in Figure 3, this results in a uniform shear wave velocity profile of approximately 3,192 ft/s [973 m/s] and a calculated Vs30 value of the same 3192 ft/s [973 m/s]. This Vs30 is within the site classes B as defined by either NEHRP (2020) or its predecessors.

While the Vs30 value based on geophysical measurements made on the embankment is the less representative Vs30 value for ground motions at the site affecting the dam, it is also the lowest of those obtained. As subsequently shown for the 1,000-year hazard level used in assessing the performance of the dam, a Vs30 value of 594 m/s (1,950 ft/s) produces a site-adjusted peak ground acceleration of 0.32 g (see Figure 4). This PGA value is somewhat conservative when compared to PGA values obtained using the higher Vs30 values which are representative of conditions elsewhere at the site (this matter is discussed more in a later section of this document, but can be seen as part of the data presented in Table 2). Recognizing that site conditions are expected to vary spatially, and that these few

locations where shear wave velocities were measured may not represent the full range of conditions present (even below the dam), we believe some consideration should be given to the more conservative value Vs30 for analysis and design when accounting for potential site variability effects (conservative not because it is the smallest Vs30 value, but because it results in higher spectral accelerations from the hazard analysis [and this is true for all response periods of interest, and not just PGA, as again shown later]).

Based on the discussions above, and barring any potential for liquefaction or other atypical/extreme soil conditions (such as liquefaction, which has been assessed as being negligible), a Vs30 value of 973 m/s (3192 ft/s) may be used for analysis and design of this embankment dam. However, a Vs30 of 594 m/s (1950 ft/s) may be considered when bracketing potential site variability effects. Ground motions and spectral accelerations corresponding to these shear wave-based site characterizations are presented hereafter.

REGIONAL AND LOCAL SEISMICITY

General

As stated previously, UTABA Dam and Reservoir are existing facilities located at the confluence of North Fork Ogden River (to the northwest) and Cutler Creek (to the west) near Liberty, Weber County, Utah. Geologically, the site lies in the Wasatch Range Section of the Middle Rocky Mountains physiographic Province (Stokes, 1986). In general, this mountainous section consists of Paleozoic rocks that “have been moved eastward to their present position along great thrust faults” (Stokes, 1986). The western bound of the province is provided by the Wasatch Front and much lower, alluvium filled, semi-arid valleys.

The site is seismically active, with multiple faults of varying ages in the general vicinity. The site is at the periphery of the north-south trending zone known as the Intermountain Seismic Belt (ISB) which extends from northwestern Montana to at least southwestern Utah (Smith and Arabasz, 1991). The ground shaking hazard is illustrated in part by a 1914 magnitude 5-1/2 event and an 1894 magnitude 5 event, both in the Ogden area (both did not produce ground rupture). During the 1914 earthquake, “shaken buildings sustained cracks and plaster damage to walls as well as downed chimneys. Various parts of the city reported cracked windowpanes. In Farmington, Utah and Bountiful, Utah those in two-story buildings were frightened as dishes rattled and furniture moved.” Fortunately, “no significant damage and no injuries were reported for this earthquake.” (UUSS, 2024a). Another very notable historic earthquake in the area was the 1934 Hansel Valley earthquake (magnitude 6.6). Accounts of this earthquake describe damage ranging from “a three-story brick building on the campus of the Utah State Agricultural College in Logan being ‘split from top to bottom’” to several fissures or cracks in the ground surface near the epicenter (UUSS, 2024a). The fissures were reportedly about eight miles in length, with a maximum reported fissure width of 14 inches, and a maximum downdrop on one side of the fissure relative to the other side measuring 19 inches (UUSS, 2024a).

A map of historic seismicity within 100 km (62 miles) of the site is presented in Figure 1. The site is located in the center of the Figure. The data shown, sourced from the University of Utah Earthquake Information Center, represents a compilation of Utah earthquakes from 1850 through 2016 (see Bowman and Arabasz, 2017; UUSS, 2024a; UUSS, 2024b), with

post-June 1962 magnitudes uniformly expressed in terms of uniform moment magnitude (whereas magnitudes of other events and catalogs may be expressed in terms of different magnitude types such as Richter (long), surface wave, or body wave). Post-2016 data (2017 through third quarter of 2023) derives from the University of Utah Seismograph Stations' (UUSS) current digital earthquake catalog (UUSS 2024c). Larger magnitude (M) events shown in Figure 1, within 100 km of the site, are tabulated in Table 1, the largest of which is the 1934 magnitude 6.6 Hansel Valley Earthquake.

Quaternary faults mapped in the vicinity (100 km radius) of site are presented in Figure 2a (data from USGS, 2024a). It should be noted that only one instance of historic fault rupture has occurred within the extents shown in Figure 2a, which is that associated with the previously referenced 1934 magnitude 6.6 Hansel Valley Earthquake. Other key faults in the subject area are discussed in the next section of this document.

As shown in Figure 2b (which presents fault mapping viewed in close proximity to the dam), no mapped Quaternary faults are located within the reservoir and embankment dam footprint.

A review of USGS' 2023 National Seismic Hazard Maps (NSHM) and their seismic source information (USGS, 2024c) indicates that for the long-term recurrence intervals of design interest for this embankment dam (being 1,000 years), the probabilistic ground shaking hazard at the site for short periods is dominated by discrete faults (more particularly the Weber and Brigham City segments of the Wasatch Fault Zone). Gridded seismicity (also referred to as background seismicity, or a random earthquake), constitutes about 15 to 20% of the low-period ground shaking hazard (USGS, 2024c).

Key Faults Characterization

General

In this section, we describe active faults which are near the site and also those which may be further away but can have large enough ruptures (magnitudes) to materially contribute to the seismic ground motion hazard. In doing this, we have generally limited our more detailed discussion of faults to those which are at least as near to the site as the Wasatch Fault Zone (WFZ); further beyond the WFZ, active faults have smaller slip rates and characteristic magnitudes, so they only contribute small portions to the overall probabilistic-based ground shaking hazard. Large events on the Wasatch Fault Zone overshadow the effect of other faults further away. A subsequent section of this document provides additional information regarding our probabilistic seismic hazard analyses (PSHA). In the case of this dam, we have not performed any deterministic seismic hazard analyses (DHSA) in as UDS requirements which would otherwise require such are not applicable.

In our following characterization of faults, we generally ascribe fault parameters/ properties as to be consistent with those used in notable studies, which we cite. In some instances (such as some of the lesser known/documented faults which were added to the USGS' 2023 national seismic hazard maps [NSHM]), certain properties (such as characteristic magnitude) are derived from other parameters (such as slip rates and fault lengths) and are not explicitly/readily identifiable in literature/technical documentation. In such cases, we

calculate earthquake magnitude (specifically, Mw, moment magnitude), using the methodology used by the Working Group on Utah Earthquake Probabilities (WGUEP) in its study published by the UGS as Miscellaneous Publication 16-3 (see Table 3.6-2 of WGUEP, 2016). This locally employed methodology considers linear surface rupture length and/or average fault displacement (physically measurable properties) using weighted regressions to calculate full-rupture moments.

References made herein to UGS' fault database (which has been migrated from the UGS' webserver) are cited as Utah Public Lands Policy Coordinating Office [UPLPCO] (2024). Subsequent references made to USGS' fault database (including fault numbers) reflect USGS, 2024a and 2024b. References made to USGS' 2023 seismic hazard model as whole reflect USGS, 2024e and 2024f. For reference, archival descriptions from USGS' Quaternary Fault and Fold Database (USGS, 2024b) of the key faults in the area are presented (according to fault ID number) in Appendix C.

It should be kept in mind that the descriptions of active faults provided in this section are generally framed relative to defining the input parameters for a DSHA, but they also provide a general characterization of each fault. For other fault details such as partial fault rupture modelling and fault recurrence relationships (i.e., magnitude frequency distributions) as employed in the PSHAs performed for this study, the reader is referred to the USGS' documentation of its 2023 National Seismic Hazard Model (NSHM), including Petersen et al. (2023a and 2023b). Our PSHAs and resulting MDE and OBE ground motions are discussed later in this document.

Unless indicated otherwise, we treat all faults as being normal and penetrating to a seismogenic depth of 15 km, consistent with the general characterization of Basin and Range Faults.

Ogden Valley North Fork Fault

The Ogden Valley North Fork ["OVNF"] Fault (identified in UGS/USGS fault databases as fault #2376 [and also #2764]) is located approximately 900 feet west of the reservoir or 1,400 feet from the embankment dam). Per the information in these databases, the fault is approximately 26 km long, extending both north and south relative to the site. The fault appears to dip northeast toward the site (and in USGS' hazard model is assumed to dip at 50 degrees). The southern portion of the fault in Ogden Valley is considered to be of middle to late Quaternary age, whereas the middle and northern portions are of undifferentiated Quaternary age. The fault is considered to have a slip rate of less than 0.2 mm/yr (in comparison, the Wasatch Fault Zone has a slip rate on the order of at least 10 times this amount). The best estimate of the moment magnitude for a full rupture of the fault is 6.83 (reflective of WGUEP magnitude estimation methodology for unsegmented behavior with limited displacement data). This fault was removed from consideration in WGUEP's (2016) earthquake forecast for northern Utah. However, this fault was added to the USGS' 2023 NSHMP (not having been included in earlier versions).

Ogden Valley Southwestern Margin and Ogden Valley Northeastern Margin Faults

The Ogden Valley Southwestern Margin ["OVSWM"] Fault (#2375) and the Ogden Valley Northeastern Margin ["OVNEM"] Fault (#2379) flank both Ogden Valley and the Ogden Valley North Fork Fault. Both faults are "poorly understood" Quaternary faults (Hecker, 1993; USGS, 2024a). Some parties have inferred late period movement along these faults, while Sullivan et al. (1988) report an absence of such. If active, these faults would present smaller deterministic-based ground shaking hazards than the Ogden Valley North Fork Fault due to their locations generally south of site and their appreciably shorter lengths (lengths on the order of 13 to 17 km [northeast and southwest, respectively). As with many poorly understood faults in Utah's Basin and Range areas, the slip rates of these two faults are categorized as being less than 0.2 mm/yr. We note that these known faults were both explicitly excluded from WGUEP's (2016) earthquake forecast for northern Utah, and also were not included in the USGS' 2023 NSHMP.

Broadmouth Canyon Fault

The Broadmouth Canyon ["BC"] Fault (#2377) is of late Quaternary age with a slip rate of less than 0.2mm/yr. The nearest trace is located about 2.9 miles (4.7 km) southeast of the site. The length of this northwest dipping fault is only 3 km, making it by itself a non-consequential seismic source. This fault is sometimes modeled together with the James Peak Fault as extensions of the East Cache Fault Zone, Southern Segment (as with WGUEP's 2016 earthquake forecast for northern Utah and in USGS' 2023 NSHM).

James Peak Fault

The James Peak ["JP"] Fault (#2378) of is of late Quaternary age with a slip rate of less than 0.2mm/yr. The nearest trace is located about 3.8 miles (6.1 km) east of the site. The length of this northwest dipping fault is only 6 km. This fault is sometimes modeled together with the Broadmouth Canyon Fault as extensions of the East Cache Fault Zone, Southern Segment (as with WGUEP's 2016 earthquake forecast for northern Utah and in USGS' 2023 NSHM).

East Cach Fault Zone

The East Cache Fault Zone ["ECFZ"] (#2352) is a late Quaternary fault zone generally understood to consist of three segments (northern, central, and southern) with a total linear surface length of approximately 79 km, making it a notable potential source of seismic ground shaking. Typically, however, the segments are assumed to rupture independently. The overall fault dip of the segments is assumed to be 50 degrees down to the west. WGUEP (2016) identifies the preferred slip rates of the different ECFZ segments as 0.1, 0.2, and 0.03 mm/yr, from north to south, respectively.

Excluding potential coupling with the Broadmouth Canyon and James Peak Faults (discussed hereafter), the south end of the East Cache Fault Zone is approximately 7.9 miles (12.7 km) east-northeast of the site. When linked with the Broadmouth Canyon and James Peak Faults as described hereafter, the Southern Segment length becomes 29 km, and the total overall length is 86 km. A rupture of the Southern Segment with the James Peak and Broadmouth Canyon linkages corresponds to a moment magnitude of 6.95.

The linked definition of the fault has been used in both WGUEP's 2016 earthquake forecast for northern Utah and USGS' 2023 NSHMP fault source model. Per WGUEP (2016), the characteristic magnitude of the linked fault system is 7.15, assuming unsegmented rupture of up to 43.5 km somewhere along the entire fault zone (a reasonable rupture scenario as compared to a three-segment, 79 km full length rupture).

Mantua Area Faults

The Mantua Area ["MA"] Faults (#2373) are "poorly understood," perhaps middle to late Quaternary, faults in the southern Wellsville Mountains (Hecker, 1993; USGS, 2024a). The nearest splay of the fault group is about 2.8 miles (4.5 km) north of the site. The faults are categorized as having a slip rate of less than 0.2 mm/yr. The total combined length of the spatially distributed splays is 21 km. We note that these faults were purposefully removed from consideration in WGUEP's 2016 earthquake forecast for northern Utah. Also, these faults are not part of USGS' 2014 nor 2023 NSHMP fault source models. We similarly do not consider these faults as material contributors to the seismic ground shaking hazard for this project.

Wasatch Fault Zone – Weber and Brigham City Segments

The nearest mapped segment of the Wasatch Fault Zone ["WFZ"] is approximately the north end of the Weber Segment (where it begins to transition into the Brigham City Segment), located at a distance of about 3.6 miles (5.8 km) to the southwest of the site. The Weber Segment (#2351e) is characterized as a west-dipping, 56 km long, normal fault capable of producing a 7.28 characteristic magnitude event. The vertical slip rate for the Weber Segment is between 0.9 and 2.4 mm/year, with a best estimate of 1.5 mm/year, and has an estimated mean event recurrence of about 1,300 years (WGUEP, 2016).

The Brigham City Segment (#2351d) which is essentially west and northwest of the site, north of the Weber Segment) is a normal, 35 km long, west-dipping fault capable of producing a characteristic magnitude 7.06 event. The vertical slip rate for the Brigham City Segment is between 0.8 and 2.0 mm/year, with a best estimate of 1.3 mm/year, and has an estimated mean event recurrence of about 1,100 years (WGUEP, 2016).

Both faults are typically modeled with a preferential dip of 50 degrees and seismogenic depth of 15 km. Uncertainty in the dip is reflected in USGS' 2023 NSHM probabilistic analyses using plus-or-minus 15 degrees for the dip, with weights of 0.6 for the preferred central value and 0.2 for the two others.

MAXIMUM DESIGN EARTHQUAKE (MDE) GROUND MOTIONS

General

Unless indicated otherwise, all response spectra presented in this document are for the horizontal direction (geometric mean basis) and a damping ratio of 5%.

As discussed previously, the hazard level defining this event for this project is a return interval of 1000 years, which approximately corresponds to 5PE50.

Seismic hazard curves for select periods were obtained using USGS' Seismic Hazard Toolbox [see USGS, 2024d] with data from the 2023 edition/version of the USGS' NSHMP. The NSHMP includes the seismic sources (background earthquakes [gridded seismicity] and discrete faults) which are expected to affect the site within the exposure periods considered in this study. For details regarding the USGS' hazard model and its results, the reader is referred to USGS' multiple NSHMP publications, including Petersen et al. (2023a and 2023b). Response spectra were obtained from these curves. Appendix B1 presents screenshots of select USGS website pages which inform the hazard curves, response spectra, and deaggregations for the MDE as presented in this document.

Hazard Curves

The hazard curves, representing geometric mean ground motions for the site-specific Vs30 of 594 m/s from the embankment section, are presented in Figure 5. Similar curves for assumed soft bedrock (site class BC; characterized using Vs30 of 760 m/s), and also for Vs30 of 973 m/s as inferred the shear wave velocity profile without the dam section in place, are also provided in the same Figure 5. These curves illustrate the amplification / deamplification effects of local site conditions relative to traditionally referenced baseline "bedrock" site conditions. As can be seen in the figure, for the stiffer (higher Vs30) site conditions, spectra accelerations are smaller (i.e., plot left) for the same annual frequency of exceedance. This trend occurs for the range of response periods shown.

Response Spectra

Relating to the previous discussion regarding Vs30 and site class, we performed a parametric analysis in which we evaluated PGA for a 1,000-year return period (~5PE50) at the site as a function of Vs30 value and site class. The results of this analysis are presented in Table 2 and Figure 4. It can be seen in the figure that PGA decreases with increasing Vs30. For a Vs30 of 594 m/s [1,974ft/s], the PGA is 032 g. For the range of Vs30 values obtained on the right abutment, PGA ranges slightly smaller, from 0.29 to 0.31 g. For the highest Vs30 value (973 m/s [3,192 ft/s]) obtained for site (being for the bedrock below the dam), the PGA is 0.27 g. (All data sourced from ["USGS Earthquake Hazard Toolbox"; USGS, 2024d]).

Using hazard curves such as those just discussed and those available for other periods, geometric mean acceleration response spectra representing a 1,000-year return period (~5PE50) hazard level with Vs30 = 594 m/s and Vs30 = 973 m/s were developed. These spectra are presented in Figures 6a and 6b. Also presented is another 1,000-year return period response spectrum representing BC "bedrock" conditions, historically used as the basis for hazard mapping in the US and typified by Vs30 = 760 m/s. (The reader is referred to Appendix B1 which documents the source of the data constituting these site response spectra ["USGS Earthquake Hazard Toolbox"; USGS, 2024d]). It can be seen in these spectra that relative to generic bedrock (i.e., BC conditions), conditions reflected in a Vs30 value of 594 m/s amplify the spectral response. Conditions corresponding to a Vs30 value of 973 m/s deamplify the spectral response relative to nominal bedrock conditions.

For the purposes of this project, the response spectrum for Vs30 = 973 m/s as obtained for the subsurface conditions beneath the embankment dam toward the bottom of the

measured shear wave velocity profile may be used as the MDE in analysis and design. This MDE spectrum is presented in Figure 9. Given the potential for variable foundation conditions in the subsurface at the site and anticipating that the spectrum for Vs30 = 594 m/s is a lower bound value for those conditions (since the Vs30 = 594 m/s value includes compacted embankment material which should be less competent than the abutments [and indeed this is shown in Figure 3]), consideration may be given to using the Vs30 = 594 m/s spectrum to approximately bracket potential effects of site variability. This spectrum is presented with the MDE in Figure 9 as a dashed line. The PGA of the MDE spectrum is 0.27 g, and the associated single-sided variability in the PGA as inferred from the Vs30 = 594 m/s spectrum is 0.05 g (0.27+0.05=0.32).

It should be recognized that while spectra up to 3 seconds are presented in the figure (with differences between the two spectra only becoming pronounced at periods greater than about 0.15 seconds), it is really only PGA which will be used in assessing this dam. If seismic performance analyses are performed, they will be pseudo-static and/or post-earthquake limit-equilibrium based analyses which only need PGA, and more complex deformation analyses which rely on other parts of the response spectrum are not expected to be performed.

Deaggregation

Deaggregation (also referred to as disaggregation) of the 2023 USGS NSHM ground motions for the 1,000-year (~5PE50) hazard level at response periods of 0 [corresponding to PGA], 0.2, and 1.0 seconds are presented in Figures 7a through 7c for Vs30 = 594 m/s site conditions (see supporting documents in Appendix B1). As can be seen, the ground shaking hazard at the site for short periods is dominated by nearby, large magnitude earthquakes. In breaking down the data, events on discrete faults dominate the hazard (more particularly the Weber and Brigham City segments of the Wasatch Fault Zone, constituting about 70% of the total hazard). Gridded seismicity (also referred to as background seismicity, or a random earthquake), constitutes about 16% of the hazard. At longer periods (say 1.0 seconds), the results generally are similar, with a somewhat lower contribution from gridded seismicity.

Based on a deaggregation of the hazard for PGA (see USGS, 2024c), the mean magnitude-distance pair is 6.91 and 7.01 km whereas the modal pair is 6.70 and 7.3 km (with a 23% relative contribution to the hazard, as binned and calculated by USGS). At longer periods (say 1.0 seconds), discrete faults continue to dominate the ground shaking hazard. At this period, the mean magnitude-distance pair is 6.88 and 11.4 km, and the modal pair is 6.71 and 8.1 km (with a 27% relative contribution to the hazard, as binned and calculated by USGS). Based on the deaggregation of the hazard and the spatial distribution of contributing magnitude-distance pairs together with epsilon values, a moment magnitude (Mw) compatible with the PGA and suitable for MDE analysis and design is 6.71.

Deaggregation of the 2023 USGS NSHM ground motions for the 1,000-year (~5PE50) hazard level at response periods of 0 [corresponding to PGA], 0.2, and 1.0 seconds for Vs30 = 973 m/s site conditions are presented in Figures 8a through 8c (see supporting documentation in Appendix B1). The results are similar to those obtained with Vs30 =

594 m/s site conditions. At shorter periods, gridded seismicity (also referred to as background seismicity, or a random earthquake), constitutes about 16% of the hazard (the same for both Vs30 values). For PGA, the mean magnitude-distance pair is slightly smaller at 6.77 and 10.5 km, whereas the modal pair is a similar 6.71 and 8.0 km (with a 27% relative contribution to the hazard, as binned and calculated by USGS). These results lead to the recommendation for a moment magnitude (Mw) compatible with the PGA and suitable for MDE analysis and design of 6.71.

OPERATING BASIS EARTHQUAKE (OBE) GROUND MOTIONS

General

Unless indicated otherwise, all response spectra presented in this document are for the horizontal direction (geometric mean basis) and a damping ratio of 5%.

The operating basis earthquake (OBE) is considered to be a seismic event during which there should be no adverse effect on the dam. As discussed previously, the hazard level defining this event for this project is a return interval of 500 years, which approximately corresponds to 10PE50. As stated previously, the probabilistic seismic hazard data presented in this report was obtained from the 2023 edition/version of the USGS' NSHMP. Appendix B2 presents screenshots of select USGS website pages which inform the hazard curves, response spectra, and PGA deaggregation for the OBE presented in this document.

Response Spectra and Deaggregation

Using the hazard curves obtained from the USGS Seismic Hazard Toolbox [see USGS, 2024d] (as discussed previously and shown in Figure 5), we obtained the acceleration response spectra representing a return period of 500 years and local site-specific soil/rock conditions (Vs30) of 594 and 973 m/s. These spectra are presented in Figure 10. The peak ground acceleration (PGA) is approximately 0.17 g for Vs30 = 973 m/s and approximately 0.20 g for Vs30 = 594 m/s. As can be seen in the figure, the lormer spectrum is smaller than the latterfor all of the response periods considered. As was the case with the MDE (see preceding section), the spectrum for Vs30 = 973 m/s may be used as the OBE for performance evaluations, and consideration may be given to using the spectrum for Vs30 = 594 m/s to approximately account for potential site variability effects. The OBE spectrum with the one-sided variability estimate is shown in Figure 13.

A deaggregation of the hazard represented by the Vs30 = 594 m/s response spectrum at a period of zero (i.e., PGA) is presented in Figure 11 (see Appendix B2 for supporting documentation). The deaggregation data indicates that OBE ground motion is dominated by discrete faults (notably the Weber and Brigham City Segments of the WFZ), but with about 20 to 25% of the hazard coming from gridded/background seismicity. The calculated mean magnitude-distance pair is 6.67 and 8.3 km, and the modal pair is 6.71 and 8.3 km (the latter contributing about 24% to the hazard, as calculated by USGS). Based on the deaggregation of the hazard (and the spatial distribution of contributing magnitude-distance pairs and epsilon values), the moment magnitude (Mw) compatible with PGA and suitable for OBE analysis is 6.67.

The deaggregation of the hazard represented by the Vs30 = 973 m/s spectrum at a period of zero (i.e., PGA) presented in Figure 12 is very similar to that of the deaggegation of the Vs30 = 594 m/s spectrum. The mean and modal magnitudes for Vs30 = 973 m/s site conditions are very similar values of 6.68 and 6.71, respectively. The similarities in the two deaggregations indicate that Vs30 does not materially affect selection of moment magnitude at the 500-year return interval. Supporting information for these deaggregations is presented in Appendix B2.

SUMMARY OF MDE AND OBE GROUND MOTIONS

The recommended MDE response spectrum is presented in Figure 9. The PGA of the MDE spectrum is 0.27 g. The MDE PGA-compatible moment magnitude (Mw) is 6.71. If considering potential variability of site conditions, a PGA of 0.32 g may be used.

The recommended OBE response spectrum is presented in Figure 13. The PGA of the OBE spectrum is 0.17 g, while the OBE PGA-compatible moment magnitude (Mw) is 6.68. If considering potential variability of site conditions, a PGA of 0.20 g may be used.

LIMITATIONS

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TABLES

Table 1 Summary of Earthquakes (M>=4.5) within 100 km
Table 2 Calculated Vs30 Values and Corresponding 1000-year Peak Ground Accelerations

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Figure 1 Historic Earthquakes Map
Figure 2a Quaternary Fault Proximity Map
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Figure 5 Acceleration Hazard Curves
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Figure 6b PSHA-Based Response Spectra, 1000-Return Period (log scale)
Figure 7a Deaggregation (Magnitude and Distance Pairs); 1000-year [~5PE50]; Spectral Period = PGA; Vs30=594 m/s

Figure 7b	Deaggregation (Magnitude and Distance Pairs); 1000-year [~5PE50]; Spectral Period = 0.2s; Vs30=594 m/s
Figure 7c	Deaggregation (Magnitude and Distance Pairs); 1000-year [~5PE50]; Spectral Period = 1.0s; Vs30=594 m/s
Figure 8a	Deaggregation (Magnitude and Distance Pairs); 1000-year [~5PE50]; Spectral Period = PGA; Vs30=973 m/s
Figure 8b	Deaggregation (Magnitude and Distance Pairs); 1000-year [~5PE50]; Spectral Period = 0.2s; Vs30=973 m/s
Figure 8c	Deaggregation (Magnitude and Distance Pairs); 1000-year [~5PE50]; Spectral Period = 1.0s; Vs30=973 m/s
Figure 9	MDE Response Spectrum
Figure 10	PSHA-Based Response Spectrum, 500-Return Period
Figure 11	Deaggregation (Magnitude and Distance Pairs); 500-year [~10PE50]; Spectral Period = PGA; Vs30=594 m/s
Figure 12	Deaggregation (Magnitude and Distance Pairs); 500-year [~10PE50]; Spectral Period = PGA; Vs30=973 m/s
Figure 13	OBE Response Spectrum

APPENDICES

Appendix A	Supporting Calculations for Vs30
Appendix B1	Supporting Documentation for 1,000-Year (MDE) Ground Motions: Screenshots of USGS Website Pages – Hazard Curves, Response Spectra, and Deaggregations
Appendix B2	Supporting Documentation for 500-Year (OBE) Ground Motions: Screenshots of USGS Website Pages – Hazard Curves, Response Spectra, and Deaggregations
Appendix C	Archival Descriptions of Faults from USGS' Quaternary Fault and Fold Database (USGS, 2024b)

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Table 1 Summary of Earthquakes (M>=4.5) Within 100km
UTABA Dam (24-1762)

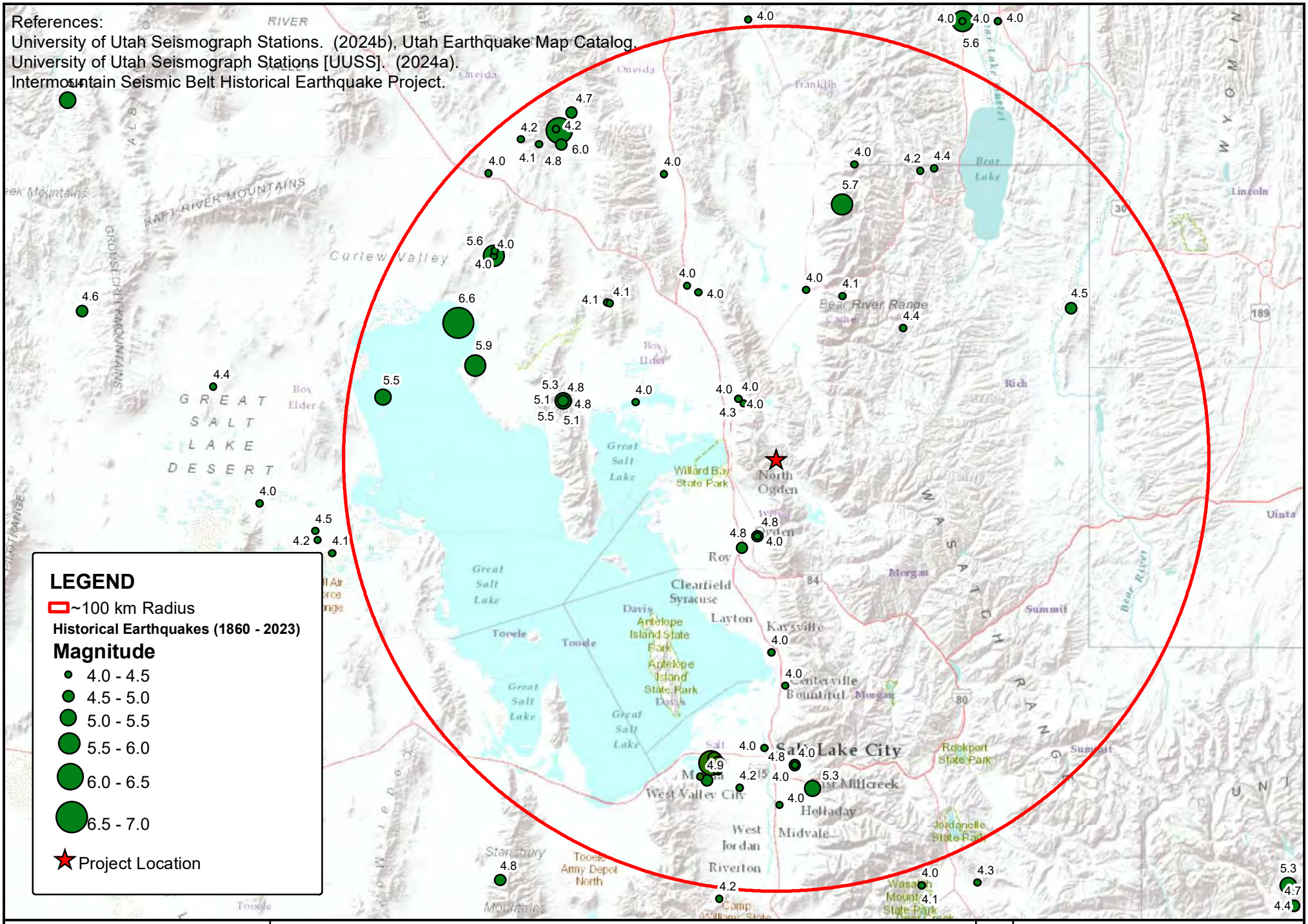
Date	Latitude / Longitude	Moment Magnitude (M)	Distance to Site (km/mi)	Event Designation
7/18/1894	41.224 / -111.959	4.8	18.6 / 11.6	5.0 (M_L) Ogden, UT
10/6/1909	41.8 / -112.7	5.6	80.2 / 49.9	~6 (M_L) Hansel Valley, UT
5/22/1910	40.7 / -111.8	5.3	77 / 47.8	5-1/2 (M_L) Salt Lake City, UT
5/13/1914	41.2 / -112	4.8	22.1 / 13.8	~5-1/2 (M_L) Ogden, UT
3/12/1934	41.658 / -112.795	6.6	79.7 / 49.5	
3/12/1934	41.5 / -112.5	4.8	50.8 / 31.6	
3/12/1934	41.5 / -112.5	5.1	50.8 / 31.6	
3/12/1934	41.571 / -112.745	5.9	72.6 / 45.1	Hansel Valley Earthquake and related aftershocks
3/15/1934	41.5 / -112.5	5.1	50.8 / 31.6	
3/15/1934	41.5 / -112.5	4.8	50.8 / 31.6	
4/7/1934	41.5 / -112.5	5.5	50.8 / 31.6	
4/14/1934	41.5 / -112.5	5.3	50.8 / 31.6	
5/6/1934	41.5 / -113	5.5	91.8 / 57	
3/7/1949	40.749 / -111.849	4.8	71.2 / 44.2	5.0 (M_L) Salt Lake City, UT
8/30/1962	41.917 / -111.733	5.7	60.8 / 37.8	Cache Valley, UT
9/5/1962	40.7153 / -112.0888	4.9	76.2 / 47.4	5.2 (M_L) Magna, UT
3/28/1975	42.0628 / -112.5247	6.0	90.9 / 56.5	Pocatello Valley Earthquake and related aftershock
3/29/1975	42.0333 / -112.5182	4.8	87.9 / 54.6	
11/30/1978	42.1013 / -112.4913	4.7	93 / 57.8	- - -
4/15/2010	41.7033 / -111.0942	4.5	76.5 / 47.6	- - -
3/18/2020	40.751 / -112.0783	5.7	72.1 / 44.8	Magna Earthquake and related aftershocks
3/18/2020	40.7605 / -112.0693	4.6	71 / 44.1	
3/18/2020	40.751 / -112.059	4.6	71.8 / 44.7	

Note: 1. Data from University of Utah Earthquake Information Center, Utah Earthquakes Databases, from 1850 through 2016, and 2017 through 3Q 2023 (Bowman and Arabasz, 2017; UUSS, 2024a; UUSS, 2024b; UUSS, 2024c)

Table 2 Calculated Vs30 Values and Corresponding 1000-year Peak Ground Accelerations
UTABA Dam (24-1762)

Vs Data Source	Calculated Vs30 Value (ft/s) [not Vs100]	Calculated Vs30 Value (m/s)	1000-year Site-Corrected PGA, g (from 2023 USGS NHSM)
Surface Wave Array, Crest of Dam	1947	594	0.32
Surface Wave Array at Crest of Dam, Remove Embankment Section w/ No Other Adjustments	3192	973	0.27
Refraction Line 1 @ Position 110 ft (extrapolate bottom 15 feet using Boore, 2004)	2259	689	0.31
Refraction Line 1 @ Position 110 ft (extrapolate bottom 15 feet using 3192 ft/s from Surface Wave Array)	2256	688	0.31
Refraction Line 1 @ Position 220 ft (extrapolate bottom 15 feet using Boore, 2004)	2667	813	0.29
Refraction Line 1 @ Position 110 ft (extrapolate bottom 15 feet using 3192 ft/s from Surface Wave Array)	2620	799	0.29
Comparison - Site Class C	1739	530	0.33
Comparison - Site Class C / BC Boundary	2100	640	0.31
Comparison - Site Class BC	2493	760	0.30
Comparison - Site Class BC / B Boundary	3000	914	0.27

Note: Data sourced from USGS Earthquake Hazard Toolbox - NSHM Conterminous U.S. 2023 [USGS, 2024d]



GERHART COLE

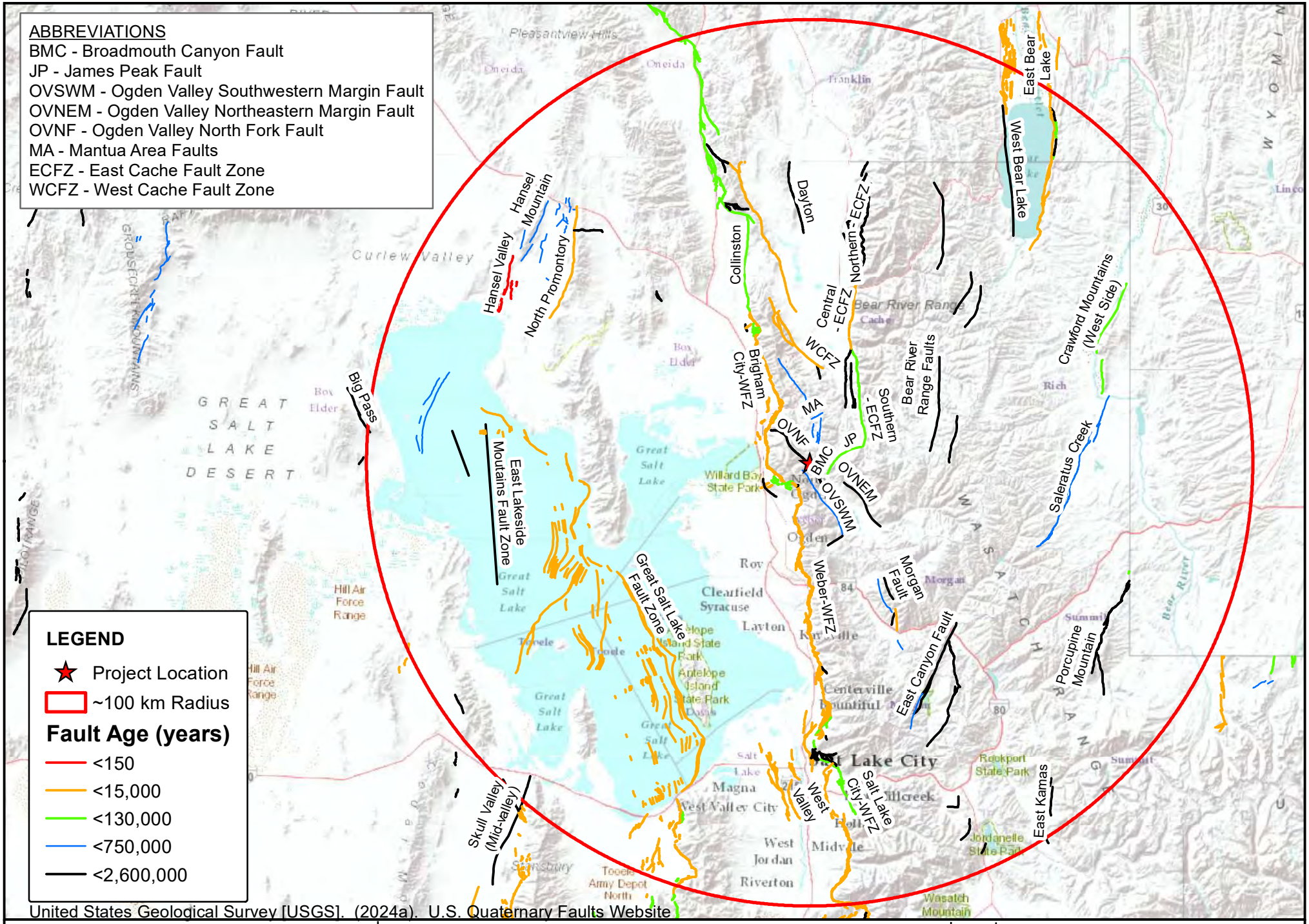
Historic Earthquakes Map

UTABA Dam

N

0 5 10 20 Miles

Figure 1



United States Geological Survey [USGS]. (2024a). U.S. Quaternary Faults Website

GERHART COLE

Quaternary Fault Proximity Map

UTABA Dam

Figure 2a



GERHART COLE

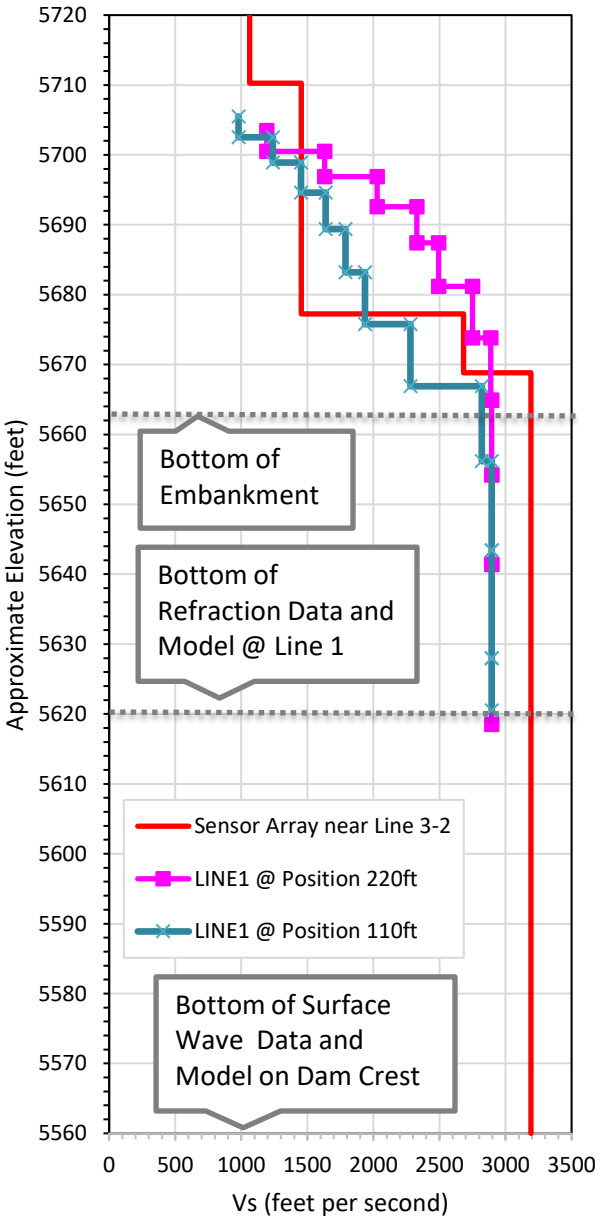
Quaternary Fault Map - Close Proximity View

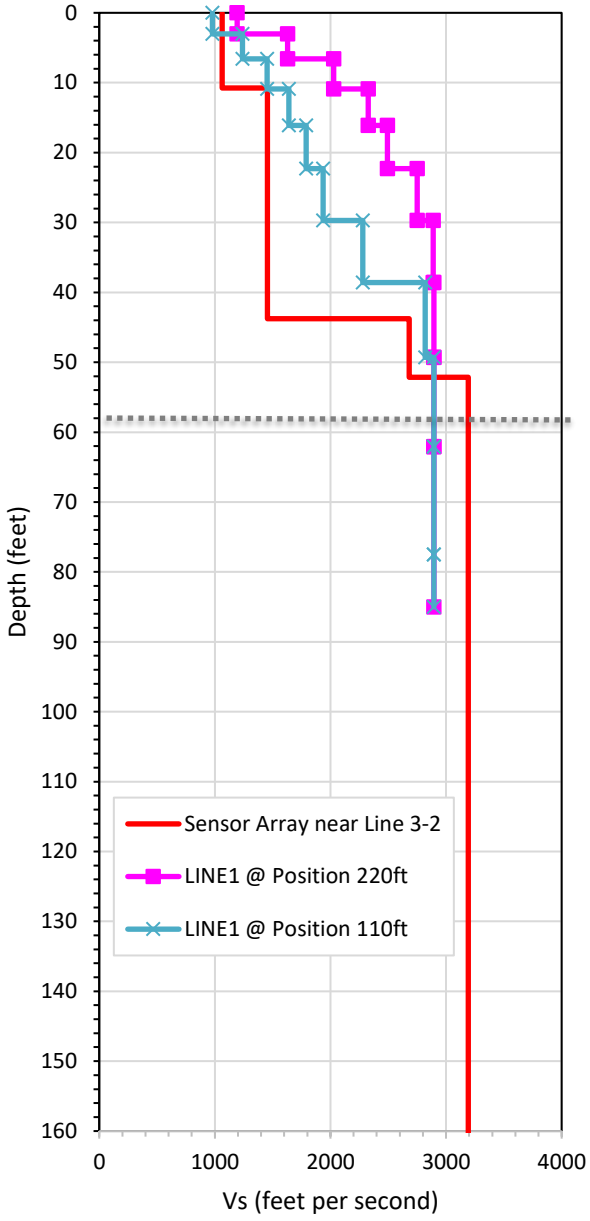
UTABA Dam

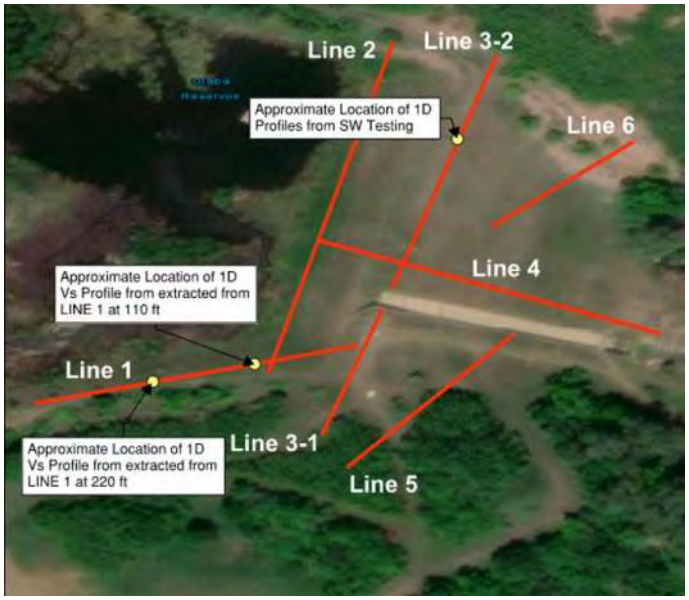
N

0 137.5 275 550 Feet

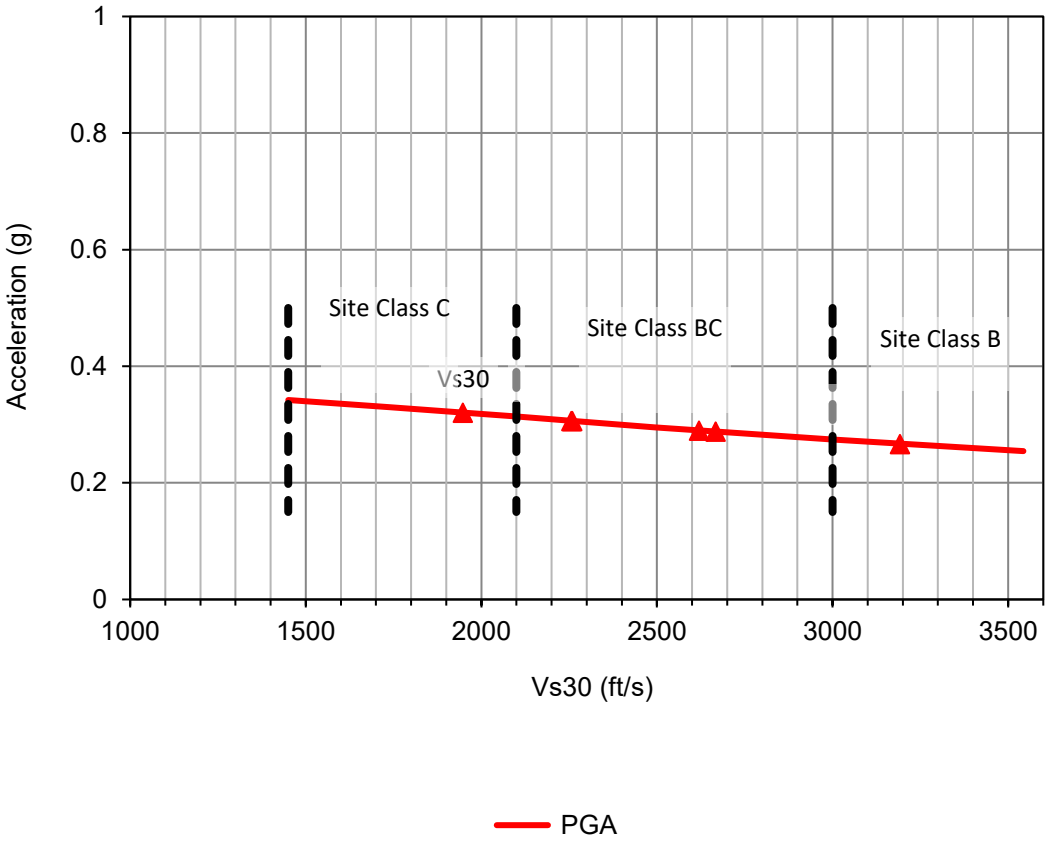
Figure 2b





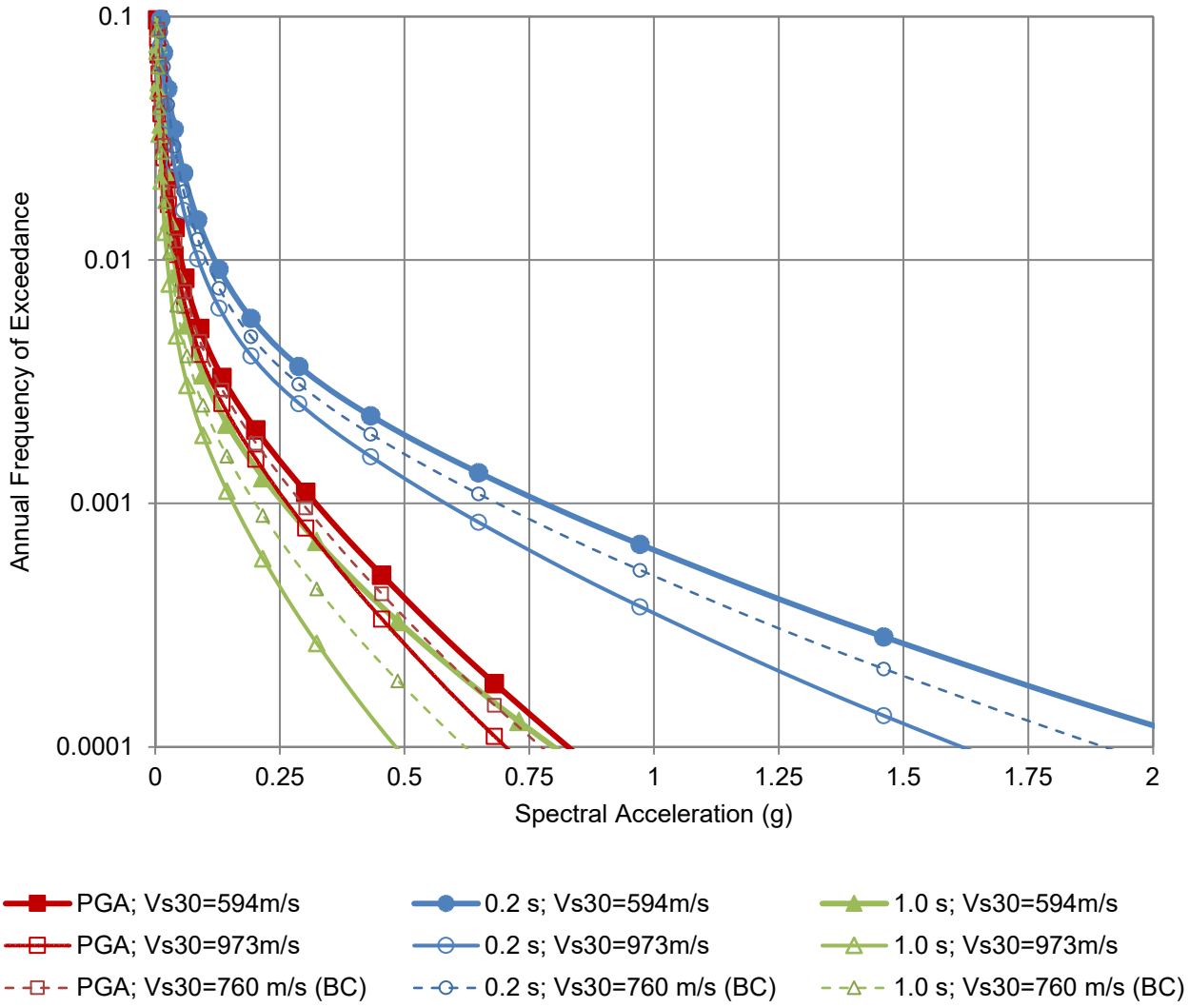


GERHART COLE	Shear Wave Velocity Profiles UTABA Dam	Figure 3



Data sourced from: USGS Earthquake Hazard Toolbox - NSHM Conterminous U.S. 2023 [USGS, 2024d]

GERHART COLE	PGA versus Vs30 (with Site Class Boundaries) 1000-year Return Period (~5PE50)	
	UTABA Dam	Figure 4



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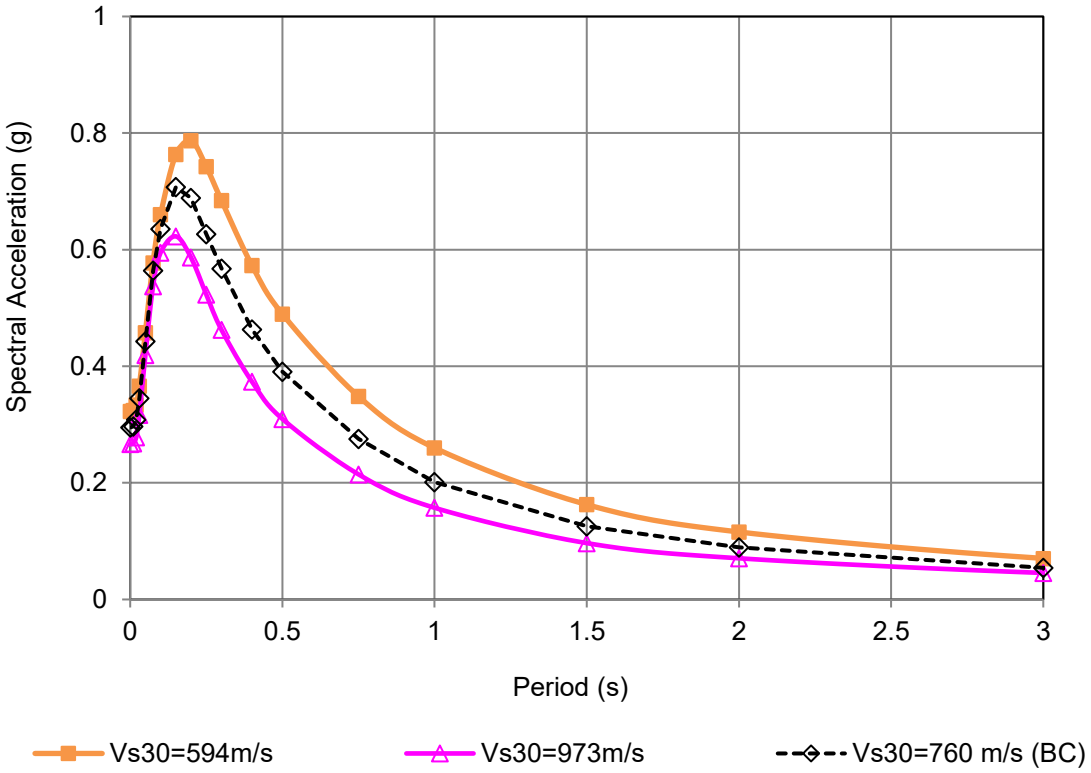
GERHART COLE	Acceleration Hazard Curves	
	UTABA Dam	Figure 5



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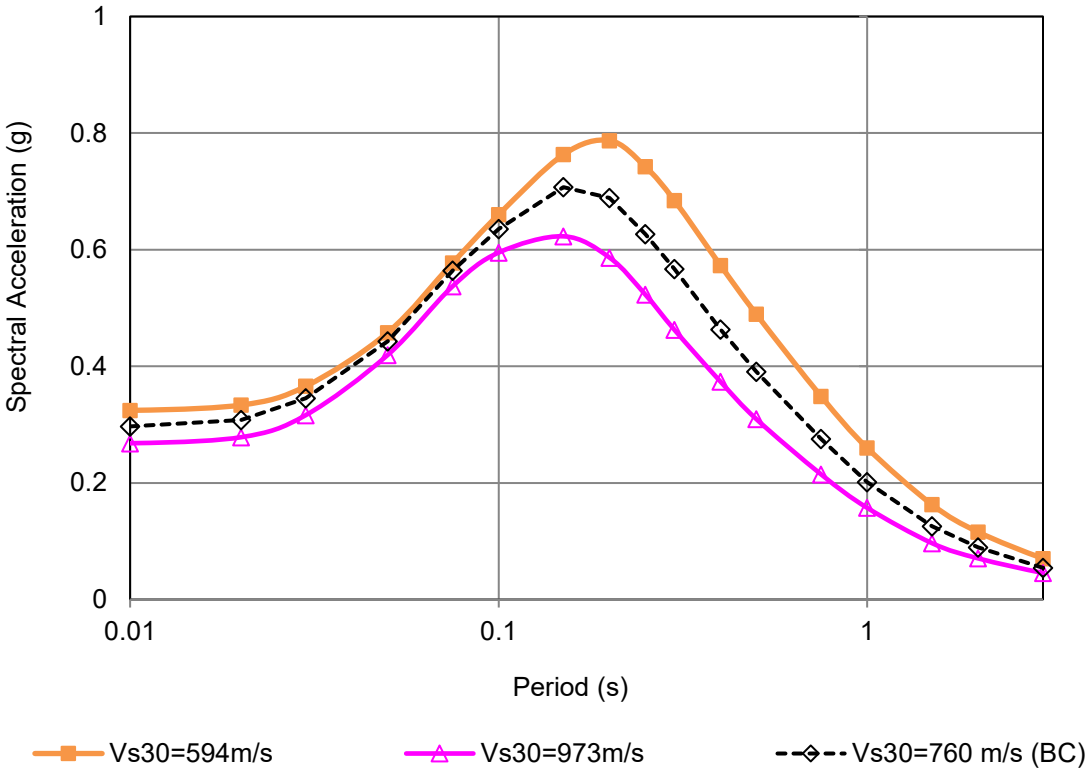
GERHART COLE	PSHA-based Response Spectra 1000-year Return Period (~5PE50)	
	UTABA Dam	Figure 6a



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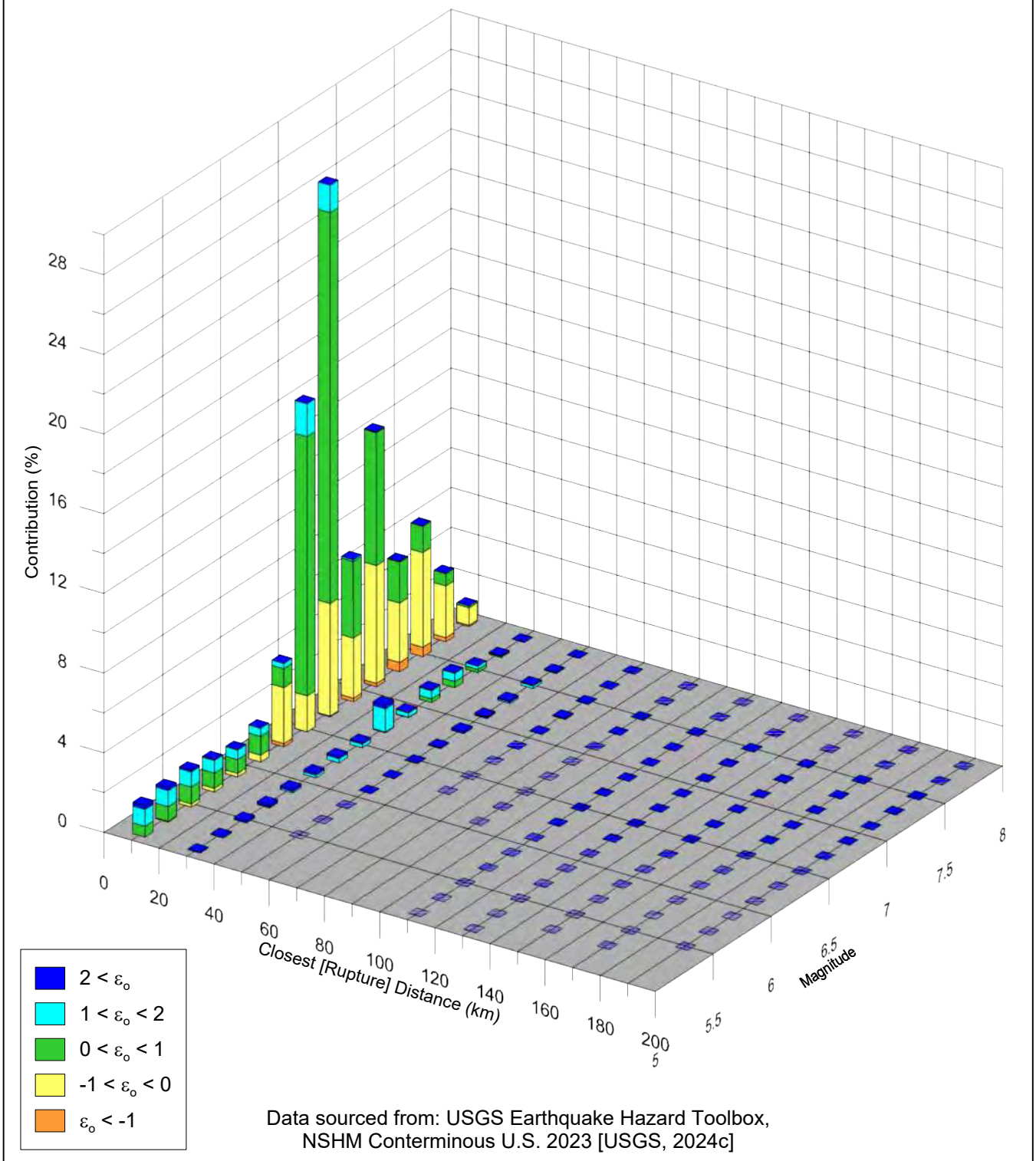
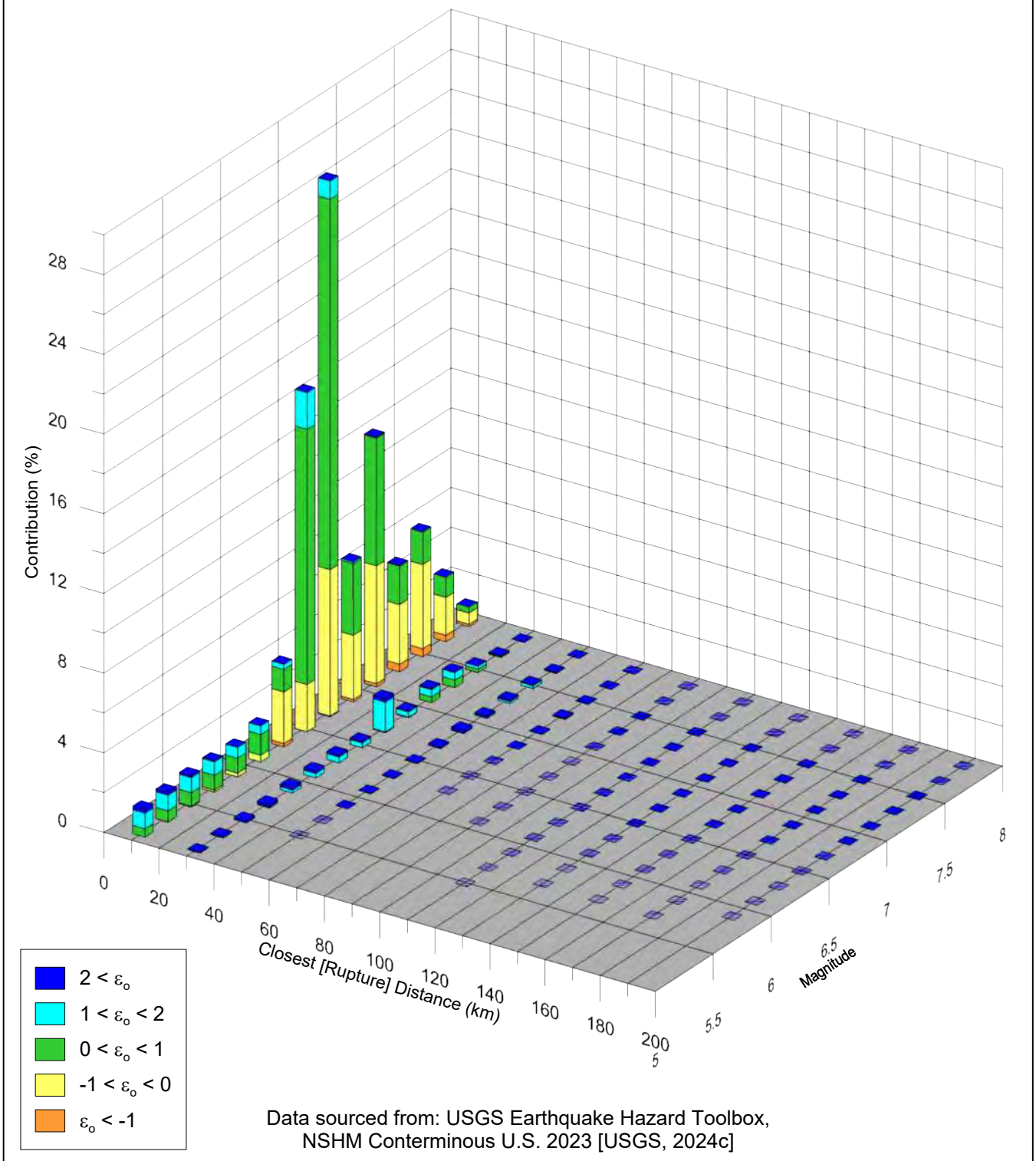
GERHART COLE	PSHA-based Response Spectra 1000-year Return Period (~5PE50)	
	UTABA Dam	Figure 6b



Data sourced from: USGS Earthquake Hazard Toolbox,
NSHM Conterminous U.S. 2023 [USGS, 2024c]

GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 1000-year [~5PE50]; Spectral Period = PGA; Vs30 = 594 m/s	
	UTABA Dam	Figure 7a



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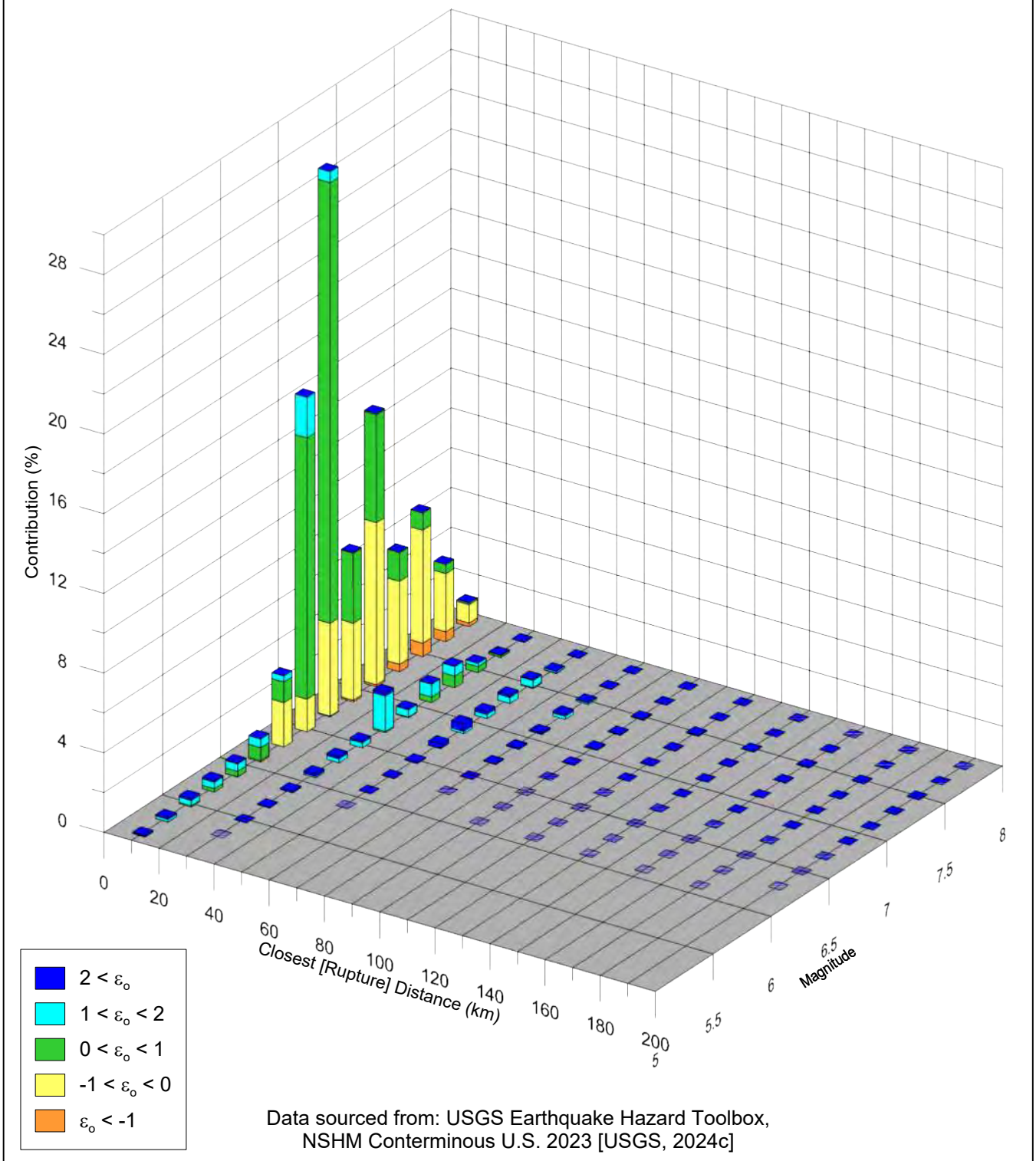
GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 1000-year [~5PE50]; Spectral Period = 0.2 s; Vs30 = 594 m/s	
	UTABA Dam	Figure 7b



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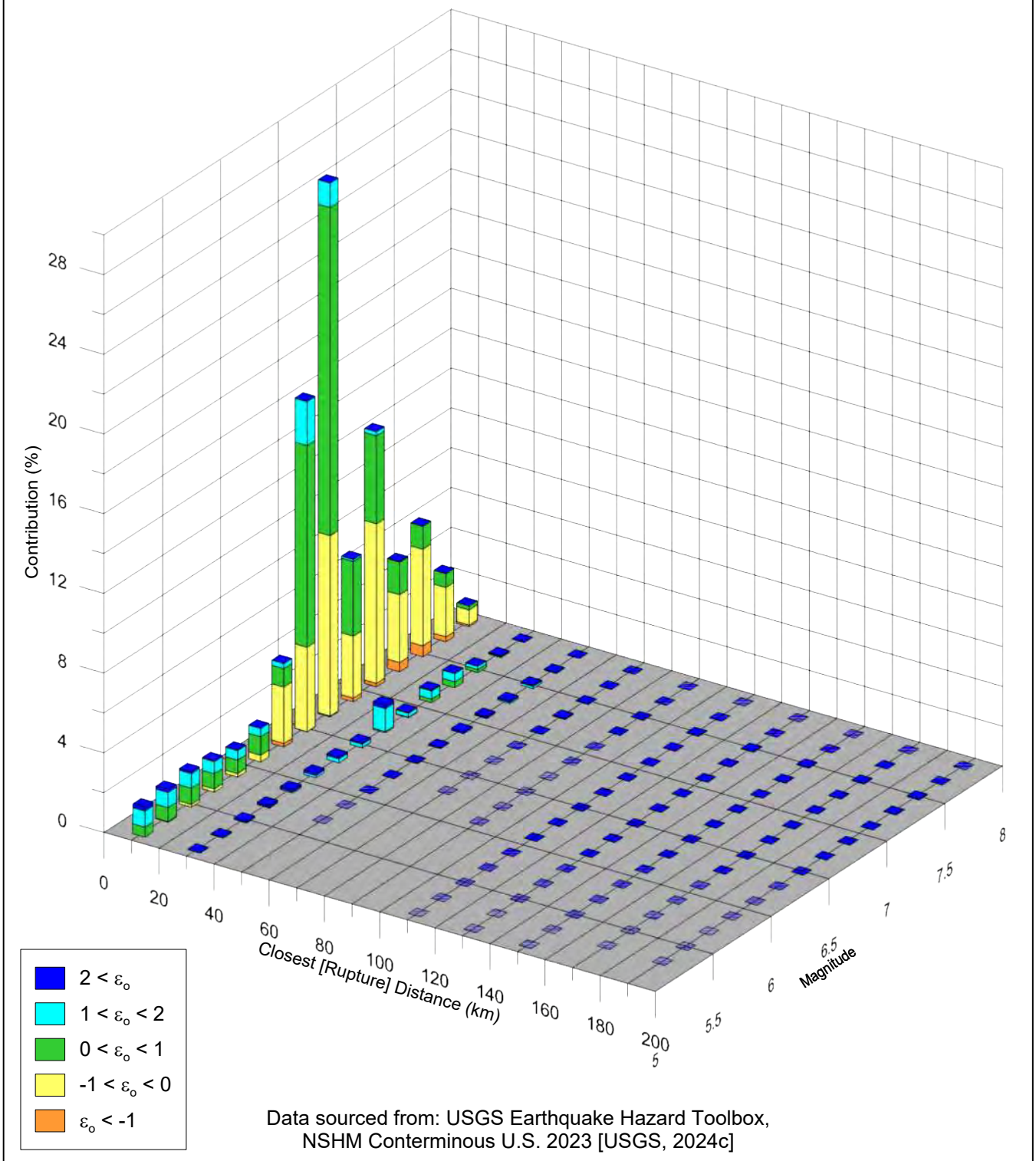
GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 1000-year [~5PE50]; Spectral Period = 1 s; Vs30 = 594 m/s	
	UTABA Dam	Figure 7c



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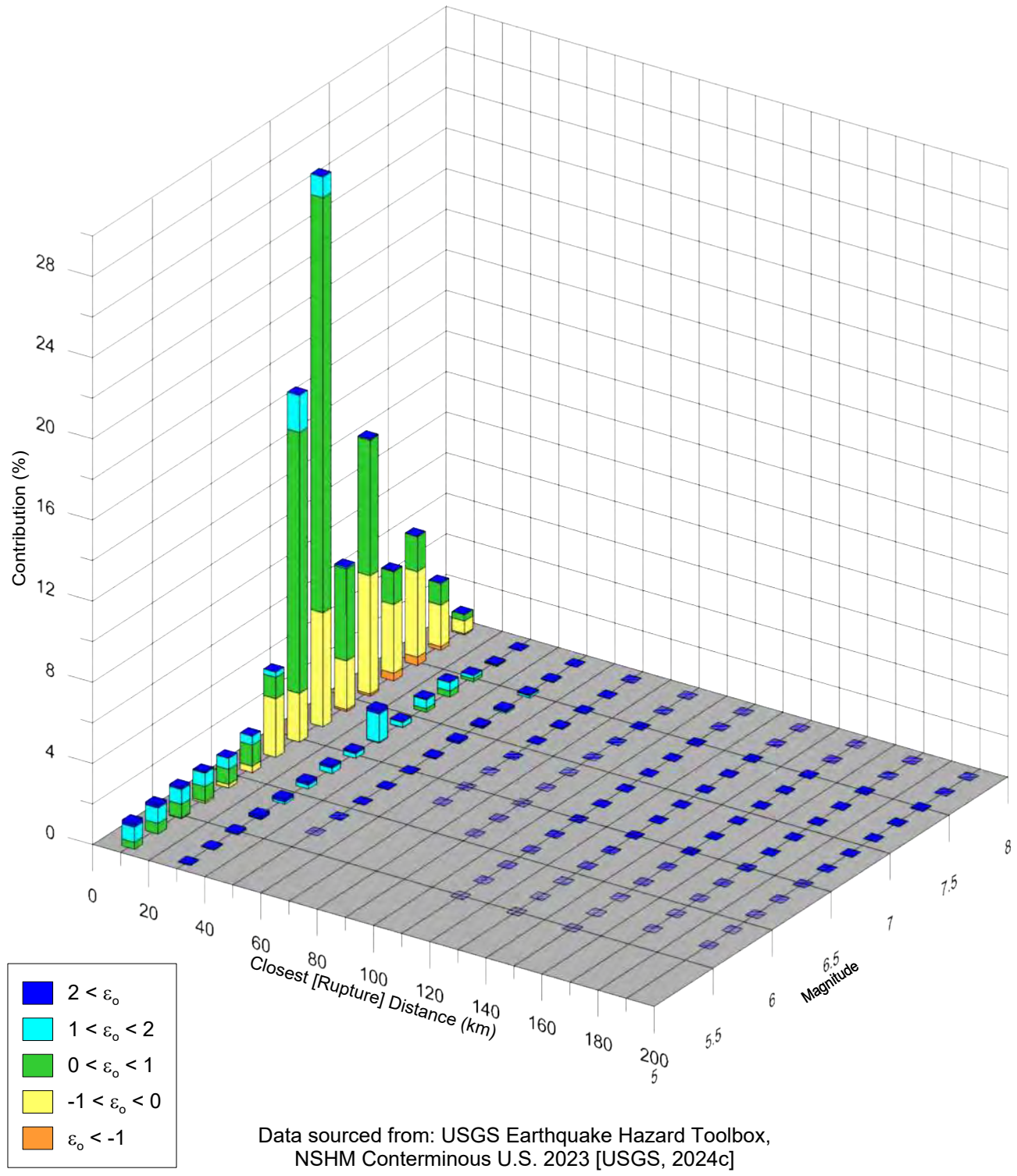
NSHM Conterminous U.S. 2023 [USGS, 2024c]

GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 1000-year [~5PE50]; Spectral Period = PGA; Vs30 = 973 m/s	
	UTABA Dam	Figure 8a



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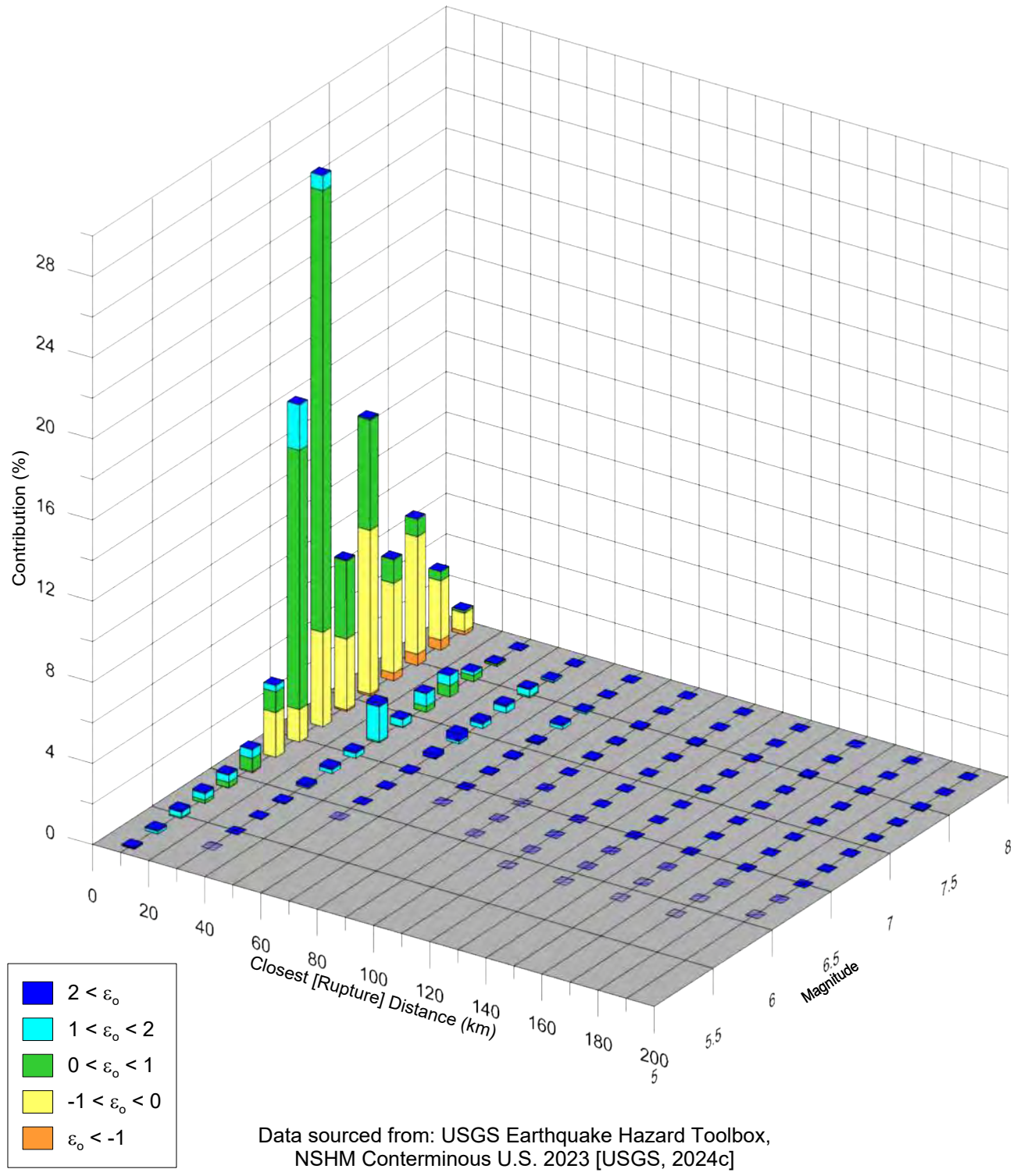
NSHM Conterminous U.S. 2023 [USGS, 2024c]

GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 1000-year [~5PE50]; Spectral Period = 0.2 s; Vs30 = 973 m/s	
	UTABA Dam	Figure 8b



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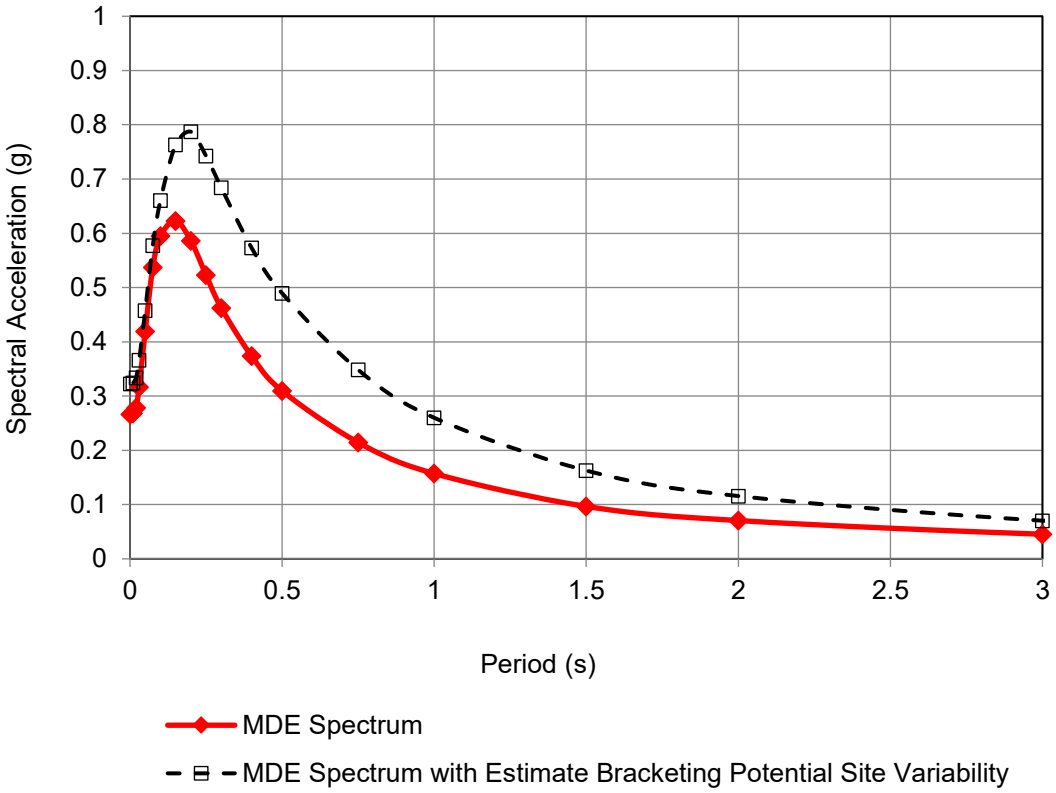
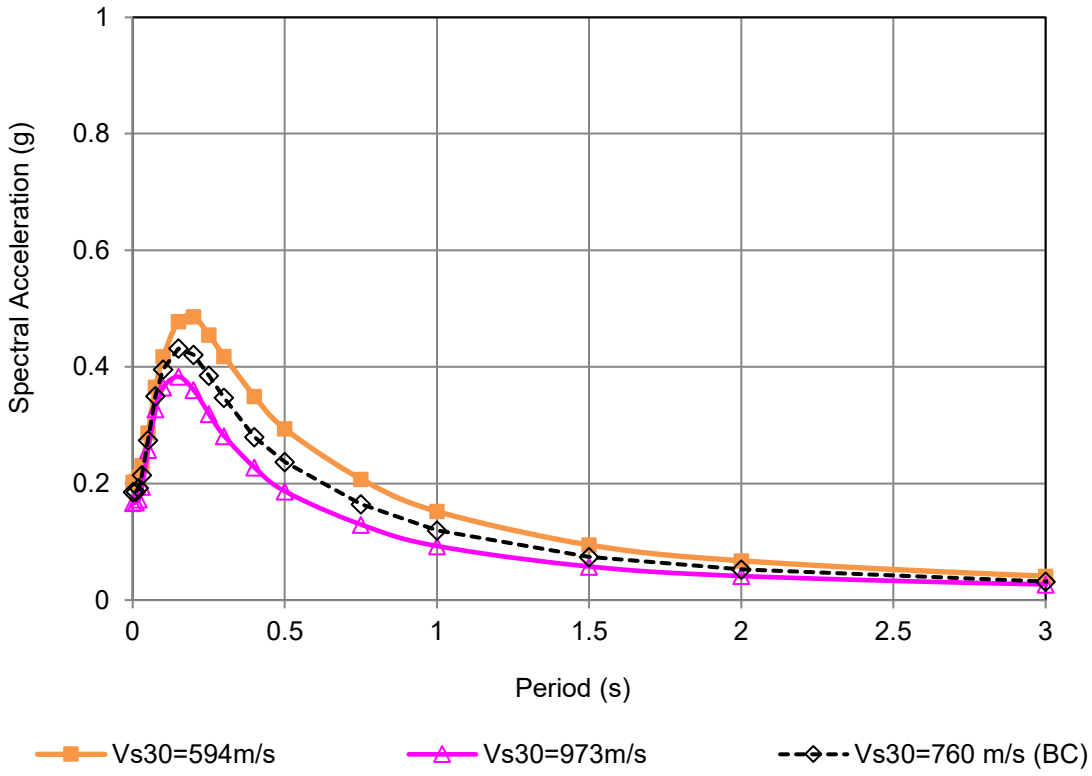
GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 1000-year [~5PE50]; Spectral Period = 1 s; Vs30 = 973 m/s	
	UTABA Dam	Figure 8c



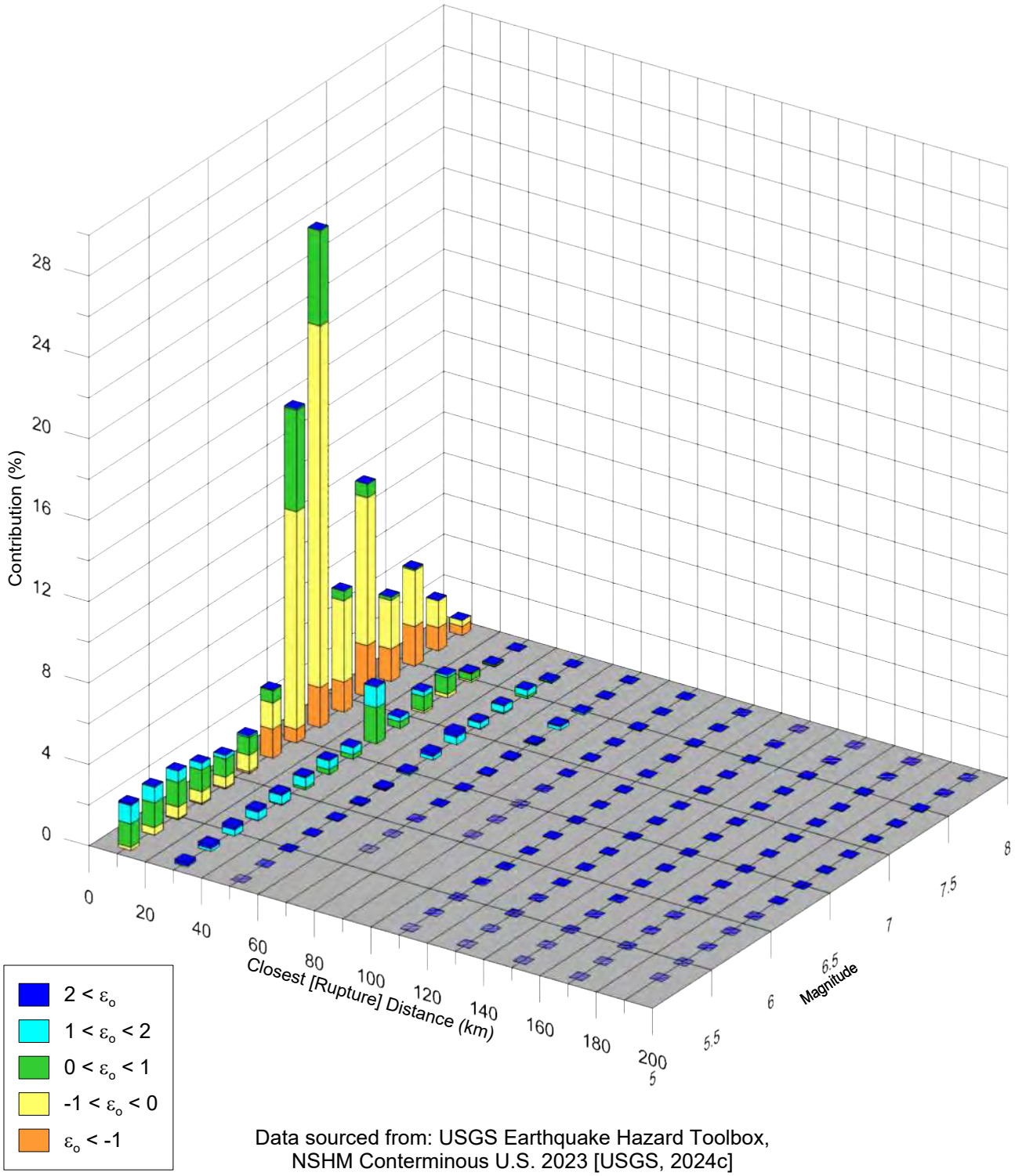
Refer to Figure 6 and text of document for discussion of spectra shown and data sourcing

GERHART COLE	MDE Response Spectrum	
	UTABA Dam	Figure 9



Data sourced from: USGS Earthquake Hazard Toolbox - NSHM Conterminous U.S. 2023 [USGS, 2024d]

GERHART COLE	PSHA-based Response Spectra 500-year Return Period (~10PE50)	
	UTABA Dam	Figure 10



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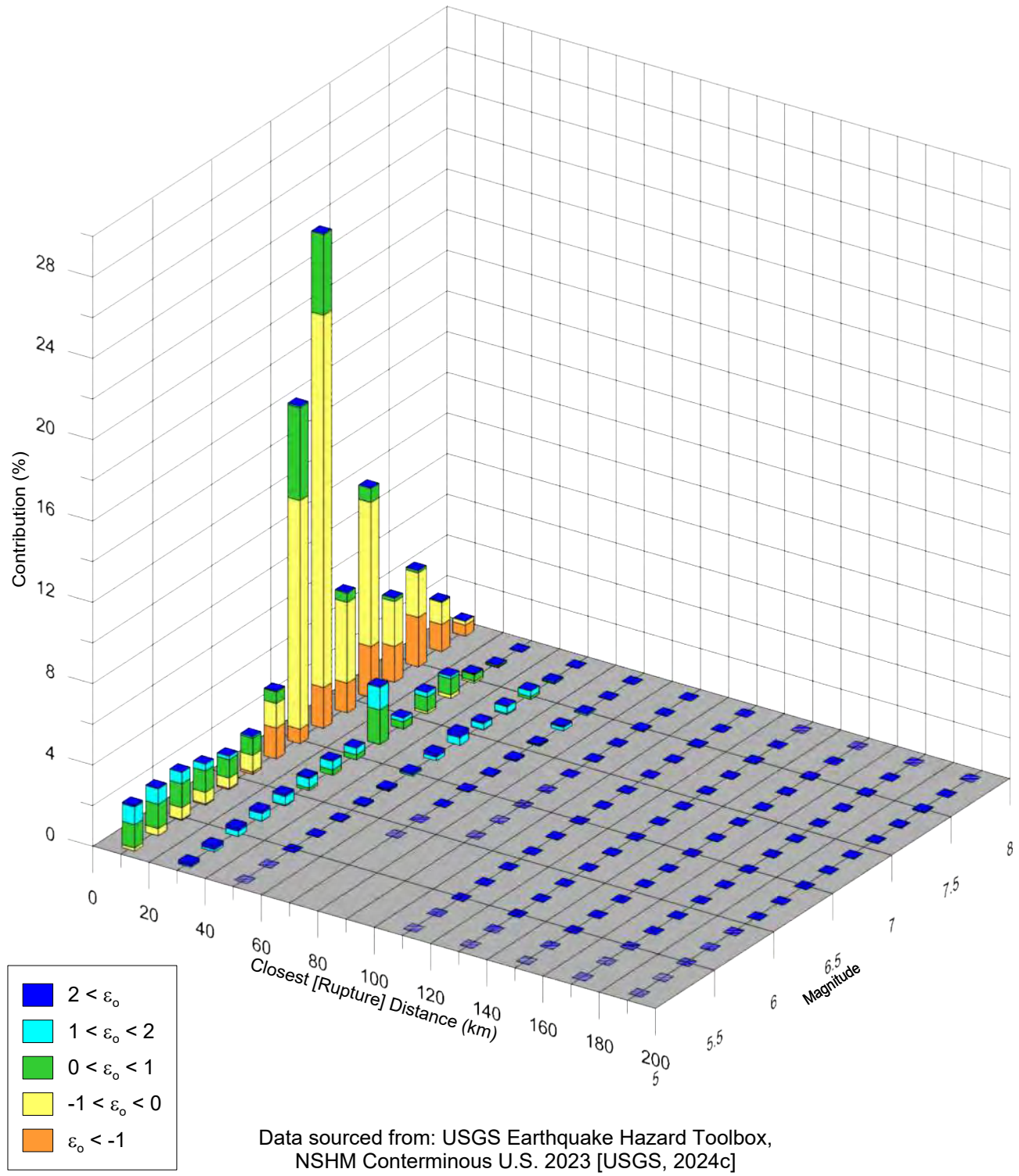
GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 500-year [~10PE50]; Spectral Period = PGA; Vs30 = 594 m/s	
	UTABA Dam	Figure 11



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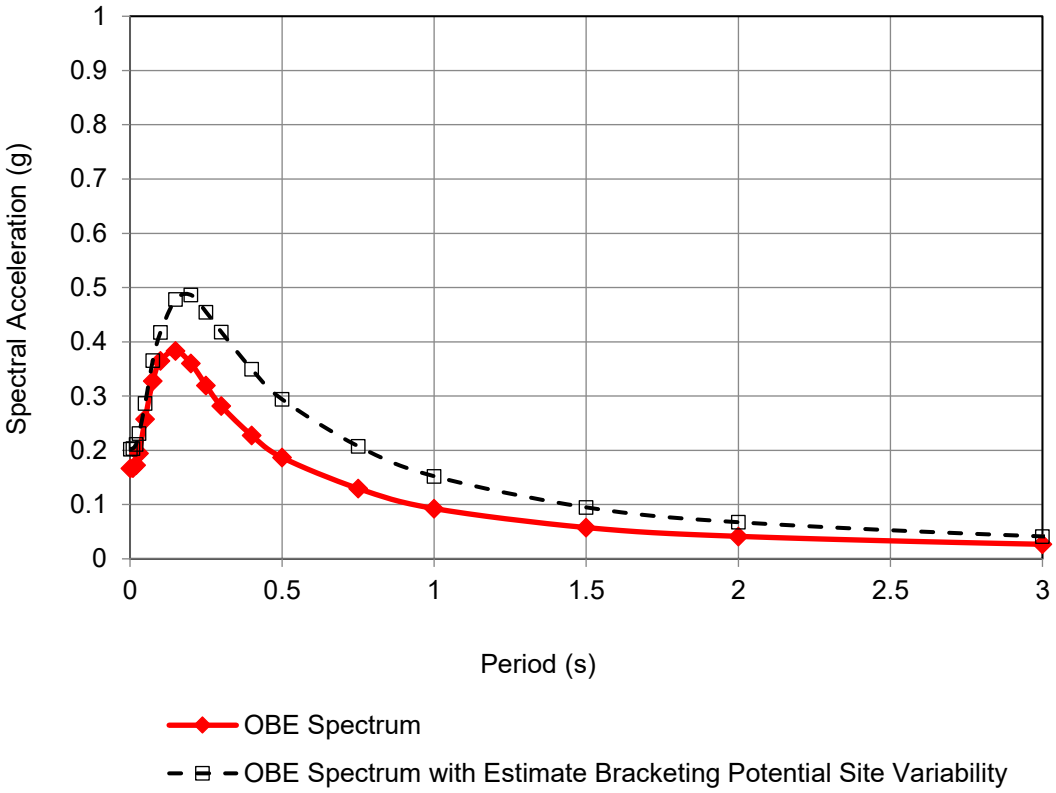
GERHART COLE	Deaggregation (Magnitude and Distance Pairs) 500-year [~10PE50]; Spectral Period = PGA; Vs30 = 973 m/s	
	UTABA Dam	Figure 12



Refer to Figure 10 and text of document for discussion of spectra shown and data sourcing

GERHART COLE	OBE Response Spectrum	
	UTABA Dam	Figure 13

APPENDIX A

Supporting Calculations for Vs30

For Surface Wave Line on Embankment

(Illustrative hand calculation and spreadsheet calculations; also refer to Figure 3)

GERHART COLE

Job UTABA Dam | Project No. | Page ___ of ___

Description V_{s30} hand calc using data at dam crest | Computed by TMG | Date 5/14/2025

Checked by RB | Date 5/16/2025

V_{s30} calc. [example calc to validate spreadsheet] [see spreadsheet]

$$\bar{V}_s = V_{s30} = \frac{\sum d_i}{\sum \frac{d_i}{V_{s_i}}} = \text{weighted harmonic mean.}$$

Layer	thickness d (ft)	V_s (ft/s)	d/V_s $\frac{ft}{ft/s}$
1	11	1064	0.010338
2	33	1455	0.022680
3	8	2682	0.002983
4	48	3192	0.015038
Σ =	100 ✓		0.051039

$$V_{s100} = \frac{100}{0.051039} = 1959.3 \text{ ft/s}$$

however 30m = 98.425 ft

∴ change layer 4 to only 46.4 ft thick (don't go to 100 ft)

4	46.4		0.014544
Σ	98.4		0.050546

$$V_{s30} = \frac{98.4}{0.050546} = 1947 \text{ ft/s}$$

$$\approx 594 \text{ m/s}$$

Shear Wave Velocity Parameter Calculation (version 2022042701.B)

UTABA - Surface Wave Array at Crest of Dam, near Refraction Line 3-2 ("Vs30")

	(Y/N)	Value	
Extrapolate to top?	n	#N/A	(ft/s)

				49.0728			
Interval	Top Depth (ft)	Bottom Depth (ft)	Top Depth (m)	Bottom Depth (m)	Interval Vs (ft/s)	Interval Vs (m/s)	
1	0	11	0	3.3528	1064	324.3072	(use =na() as needed)
2	11	44	3.3528	13.4112	1455	443.484	(leave blank if no data)
3	44	52	13.4112	15.8496	2682	817.4736	
4	52	161	15.8496	49.0728	3192	972.9216	
5	161		49.0728				
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
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22							
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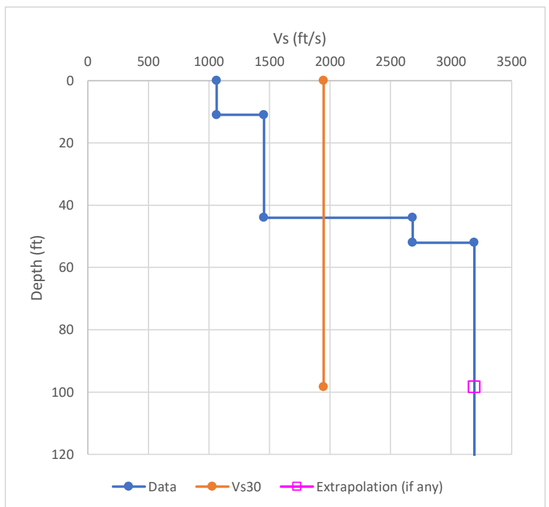
24							
25							
26							
27							
28							
29							
30							
31							
32							
33	98.4252	98.4252	30		3192	972.9216	Interpolated
34	100	100	30.48		3192	972.9216	Interpolated
35	39.37008	39.37008	12		1455	443.484	Interpolated



Vs_avg100

m/s 597.1880147

ft/s 1959.278326

actual

Vs_avg30

m/s **593.520625**

ft/s 1947.246207

actual

Vs_100 calcs (imperial units)

100 = Sum

8 Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (ft)	Cumulative d	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
				0	0		0	
1	0	11	1064	11	11	0.01033835	0.01033835	1064
2	11	39.37008	1455	28.37008	39.37008	0.01949834	0.02983668	1319.519347
3	39.37008	44	1455	4.62992	44	0.00318208	0.03301876	1332.575855
4	44	52	2682	8	52	0.00298285	0.03600161	1444.379975
5	52	98.4252	3192	46.4252	98.4252	0.01454424	0.05054584	1947.246207
6	98.4252	100	3192	1.5748	100	0.00049336	0.0510392	1959.278326
7	100	161	3192	0	100	0	0.0510392	1959.278326
8	161	161	3192	0	100	0	0.0510392	1959.278326
9	161	161	3192	0	100	0	0.0510392	1959.278326
10	161	161	3192	0	100	0	0.0510392	1959.278326
11	161	161	3192	0	100	0	0.0510392	1959.278326
12	161	161	3192	0	100	0	0.0510392	1959.278326
13	161	161	3192	0	100	0	0.0510392	1959.278326
14	161	161	3192	0	100	0	0.0510392	1959.278326
15	161	161	3192	0	100	0	0.0510392	1959.278326
16	161	161	3192	0	100	0	0.0510392	1959.278326
17	161	161	3192	0	100	0	0.0510392	1959.278326
18	161	161	3192	0	100	0	0.0510392	1959.278326
19	161	161	3192	0	100	0	0.0510392	1959.278326
20	161	161	3192	0	100	0	0.0510392	1959.278326
21	161	161	3192	0	100	0	0.0510392	1959.278326
22	161	161	3192	0	100	0	0.0510392	1959.278326
23	161	161	3192	0	100	0	0.0510392	1959.278326
24	161	161	3192	0	100	0	0.0510392	1959.278326
25	161	161	3192	0	100	0	0.0510392	1959.278326
26	161	161	3192	0	100	0	0.0510392	1959.278326
27	161	161	3192	0	100	0	0.0510392	1959.278326
28	161	161	3192	0	100	0	0.0510392	1959.278326
29	161	161	3192	0	100	0	0.0510392	1959.278326
30	161	161	3192	0	100	0	0.0510392	1959.278326
31	161	161	3192	0	100	0	0.0510392	1959.278326
32	161	161	3192	0	100	0	0.0510392	1959.278326
33	161	161	3192	0	100	0	0.0510392	1959.278326
34	161	161	3192	0	100	0	0.0510392	1959.278326
35	161	0	#N/A					

Vs_30 calcs (metric units)

30 = Sum

Interval d (m)	Cumulative d (m)	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
0	0		0	
3.35279989	3.35279989	0.01033835	0.01033835	324.3071896
8.64720011	12	0.01949834	0.02983668	402.1894842
1.41119957	13.4111996	0.00318208	0.03301876	406.1691077
2.43839992	15.8495995	0.00298285	0.03600161	440.2470022
14.1504005	30	0.01454424	0.05054584	593.520625
0	30	0	0.05054584	593.520625
0	30	0	0.05054584	593.520625
0	30	0

For Surface Wave Line on Embankment, with Embankment Removed

(Spreadsheet calculations; also refer to Figure 3)

Shear Wave Velocity Parameter Calculation (version 2022042701.B)

UTABA - Surface Wave Array at Crest of Dam, near Refraction Line 3-2 ("Vs30"); Remove Embankment Section

	(Y/N)	Value	
Extrapolate to top?	n	#N/A	(ft/s)

Vs_avg100

m/s 972.9215689

ft/s 3192

actual

Vs_avg30

m/s **972.9215689**

ft/s 3192

actual

Vs_100 calcs (imperial units)

Vs_30 calcs (metric units)

Interval	Top Depth (ft)	Bottom Depth (ft)	Top Depth (m)	Bottom Depth (m)	Interval Vs (ft/s)	Interval Vs (m/s)	
				31.0896			
1	0	0.01	0	0.003048	3192	972.9216	(use =na() as needed)
2	0.01	102	0.003048	31.0896	3192	972.9216	(leave blank if no data)
3	102		31.0896				
4							
5							
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10							
11							
12							
13							
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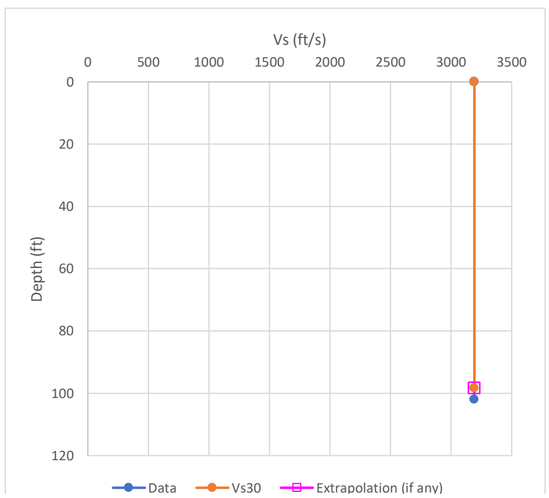
29							
30							
31							
32							
33	98.4252	98.4252	30		3192	972.9216	Interpolated
34	100	100	30.48		3192	972.9216	Interpolated
35	39.37008	39.37008	12		3192	972.9216	Interpolated

6 Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (ft)	Cumulative d	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)	Interval d (m)	Cumulative d (m)	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
				100 = Sum					30 = Sum				
				0	0		0		0	0		0	
1	0	0.01	3192	0.01	0.01	3.1328E-06	3.1328E-06	3192	0.003048	0.003048	3.1328E-06	3.1328E-06	972.9215689
2	0.01	39.37008	3192	39.36008	39.37008	0.01233085	0.01233398	3192	11.996952	12	0.01233085	0.01233398	972.9215689
3	39.37008	98.4252	3192	59.05512	98.4252	0.01850098	0.03083496	3192	18	30	0.01850098	0.03083496	972.9215689
4	98.4252	100	3192	1.5748	100	0.00049336	0.03132832	3192	0	30	0	0.03083496	972.9215689
5	100	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
6	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
7	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
8	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
9	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
10	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
11	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
12	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
13	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
14	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
15	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
16	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
17	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
18	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
19	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
20	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
21	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
22	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
23	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
24	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
25	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
26	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
27	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
28	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
29	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
30	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
31	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
32	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
33	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
34	102	102	3192	0	100	0	0.03132832	3192	0	30	0	0.03083496	972.9215689
35	102	0	#N/A										

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$ $\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$



$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

Vs_100 = $\frac{100}{0.03132832}$ = 3192 ft/s = 973 m/s

Vs_30 = $\frac{30}{0.03083496}$ = 973 m/s = 3192 ft/s

For Refraction Line 1 on Right Abutment, Position 110 feet

(Spreadsheet calculations; also refer to Figure 3)

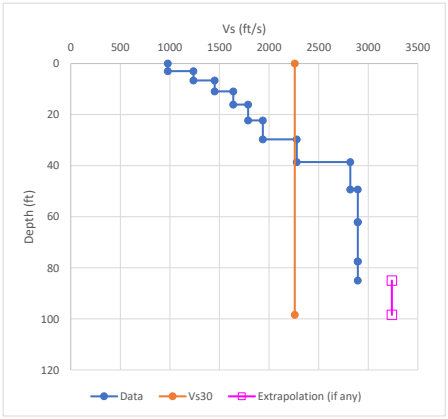
Shear Wave Velocity Parameter Calculation (version 2022042701.B)

UTABA - Refraction Line #1 at 110 ft from end; extrapolate 15 feet using Boore (2004)

	(Y/N)	Value	
Extrapolate to top?	n	#N/A	(ft/s)

23.622

Interval	Top Depth (ft)	Bottom Depth (ft)	Top Depth (m)	Bottom Depth (m)	Interval Vs (ft/s)	Interval Vs (m/s)	
1	0	3	0	0.9144	979	298.3992	(use =na() as needed)
2	3	6.6	0.9144	2.01168	1238	377.3424	(leave blank if no data)
3	6.6	10.9	2.01168	3.32232	1451	442.2648	
4	10.9	16.1	3.32232	4.90728	1639	499.5672	
5	16.1	22.3	4.90728	6.79704	1789	545.2872	
6	22.3	29.7	6.79704	9.05256	1937	590.3976	
7	29.7	38.6	9.05256	11.76528	2279	694.6392	
8	38.6	49.3	11.76528	15.02664	2820	859.536	
9	49.3	62.1	15.02664	18.92808	2895	882.396	
10	62.1	77.5	18.92808	23.622	2895	882.396	
11	77.5	85	23.622		2895		
12	85						
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33	98.4252	98.4252	30		3238.417	987.0694	Extrapolated
34	100	100	30.48		3238.417	987.0694	Extrapolated
35	39.37008	39.37008	12		2820	859.536	Interpolated



Vs_avg100

m/s	691.8244497
ft/s	2269.765327
	extrapolated

Vs_avg30

m/s	**688.5292911**
ft/s	2258.954439
	extrapolated

Vs_100 calcs (imperial units)

100 = Sum

15 Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (ft)	Cumulative d	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
1	0	3	979	3	3	0.0030644	0.0030644	979
2	3	6.6	1238	3.6	6.6	0.0029079	0.0059723	1105.107924
3	6.6	10.9	1451	4.3	10.9	0.0029635	0.0089357	1219.820516
4	10.9	16.1	1639	5.2	16.1	0.0031727	0.0121084	1329.654666
5	16.1	22.3	1789	6.2	22.3	0.0034656	0.015574	1431.870845
6	22.3	29.7	1937	7.4	29.7	0.0038203	0.0193944	1531.372163
7	29.7	38.6	2279	8.9	38.6	0.0039052	0.0232996	1656.681322
8	38.6	39.3701	2820	0.77008	39.37008	0.0002731	0.0235727	1670.157808
9	39.3701	49.3	2820	9.92992	49.3	0.0035212	0.0270939	1819.596499
10	49.3	62.1	2895	12.8	62.1	0.0044214	0.0315153	1970.469288
11	62.1	77.5	2895	15.4	77.5	0.0053195	0.0368349	2103.985675
12	77.5	85	2895	7.5	85	0.0025907	0.0394255	2155.963674
13	85	98.4252	3238.42	13.4252	98.4252	0.0041456	0.0435711	2258.954439
14	98.4252	100	3238.42	1.5748	100	0.0004863	0.0440574	2269.765327
15	100	100	3238.42	0	100	0	0.0440574	2269.765327
16	100	100	3238.42	0	100	0	0.0440574	2269.765327
17	100	100	3238.42	0	100	0	0.0440574	2269.765327
18	100	100	3238.42	0	100	0	0.0440574	2269.765327
19	100	100	3238.42	0	100	0	0.0440574	2269.765327
20	100	100	3238.42	0	100	0	0.0440574	2269.765327
21	100	100	3238.42	0	100	0	0.0440574	2269.765327
22	100	100	3238.42	0	100	0	0.0440574	2269.765327
23	100	100	3238.42	0	100	0	0.0440574	2269.765327
24	100	100	3238.42	0	100	0	0.0440574	2269.765327
25	100	100	3238.42	0	100	0	0.0440574	2269.765327
26	100	100	3238.42	0	100	0	0.0440574	2269.765327
27	100	100	3238.42	0	100	0	0.0440574	2269.765327
28	100	100	3238.42	0	100	0	0.0440574	2269.765327
29	100	100	3238.42	0	100	0	0.0440574	2269.765327
30	100	100	3238.42	0	100	0	0.0440574	2269.765327
31	100	100	3238.42	0	100	0	0.0440574	2269.765327
32	100	100	3238.42	0	100	0	0.0440574	2269.765327
33	100	100	3238.42	0	100	0	0.0440574	2269.765327
34	100	100	3238.42	0	100	0	0.0440574	2269.765327
35	100	0	#N/A					

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$

$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

Vs_100 = $\frac{100}{0.0440574}$ = 2270 ft/s

= 692 m/s

Vs_30 calcs (metric units)

30 = Sum

Interval	Top Depth (m)	Bottom Depth (m)	Interval Vs (m/s)	Interval d (m)	Cumulative d (m)	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
1	0	0.9144	298.3992	0.9144	0.9144	0.0030644	0.0030644	298.3991905
2	0.9144	2.0116799	377.3424	1.09728	2.0116799	0.0029079	0.0059723	336.8368846
3	2.0116799	3.3223199	442.2648	1.31064	3.3223199	0.0029635	0.0089357	371.8012813
4	3.3223199	4.9072798	499.5672	1.5849599	4.9072798	0.0031727	0.0121084	405.2787293
5	4.9072798	6.7970398	545.2872	1.8897599	6.7970398	0.0034656	0.015574	436.4342196
6	6.7970398	9.0525597	590.3976	2.2555199	9.0525597	0.0038203	0.0193944	466.7622204
7	9.0525597	11.76528	694.6392	2.7127199	11.76528	0.0039052	0.0232996	504.9564509
8	11.76528	12	859.536	0.2347204	12	0.0002731	0.0235727	509.0640835
9	12	15.02664	882.396	3.0266395	15.02664	0.0035212	0.0270939	554.6129951
10	15.02664	18.928079	882.396	3.9014399	18.928079	0.0044214	0.0315153	600.5990196
11	18.928079	23.621999	882.396	4.6939198	23.621999	0.0053195	0.0368349	641.2948131
12	23.621999	25.907999	882.396	2.2859999	25.907999	0.0025907	0.0394255	657.1377067
13	25.907999	30	987.0694	4.0920008	30	0.0041456	0.0435711	688.5292911
14	30	30	987.0694	0	30	0	0.0435711	688.5292911
15	30	30	987.0694	0	30	0	0.0435711	688.5292911
16	30	30	987.0694	0	30	0	0.0435711	688.5292911
17	30	30	987.0694	0	30	0	0.0435711	688.5292911
18	30	30	987.0694	0	30	0	0.0435711	688.5292911
19	30	30	987.0694	0	30	0	0.0435711	688.5292911
20	30	30	987.0694	0	30	0	0.0435711	688.5292911
21	30	30	987.0694	0	30	0	0.0435711	688.5292911
22	30	30	987.0694	0	30	0	0.0435711	688.5292911
23	30	30	987.0694	0	30	0	0.0435711	688.5292911
24	30	30	987.0694	0	30	0	0.0435711	688.5292911
25	30	30	987.0694	0	30	0	0.0435711	688.5292911
26	30	30	987.0694	0	30	0	0.0435711	688.5292911
27	30	30	987.0694	0	30	0	0.0435711	688.5292911
28	30	30	987.0694	0	30	0	0.0435711	688.5292911
29	30	30	987.0694	0	30	0	0.0435711	688.5292911
30	30	30	987.0694	0	30	0	0.0435711	688.5292911
31	30	30	987.0694	0	30	0	0.0435711	688.5292911
32	30	30	987.0694	0	30	0	0.0435711	688.5292911
33	30	30	987.0694	0	30	0	0.0435711	688.5292911
34	30	30	987.0694	0	30	0	0.0435711	688.5292911

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$

Vs_30 = $\frac{30}{0.0435711}$ = 689 m/s

= 2259 ft/s

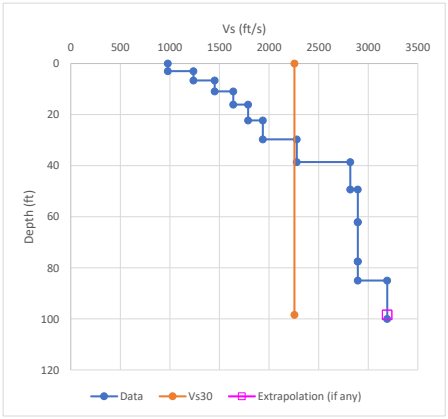
Shear Wave Velocity Parameter Calculation (version 2022042701.B)

UTABA - Refraction Line #1 at 110 ft from end; extrapolate 15 feet using 3192 ft/s from other array

	(Y/N)	Value	
Extrapolate to top?	n	#N/A	(ft/s)

30.48

Interval	Top Depth (ft)	Bottom Depth (ft)	Top Depth (m)	Bottom Depth (m)	Interval Vs (ft/s)	Interval Vs (m/s)	
1	0	3	0	0.9144	979	298.3992	(use =na() as needed)
2	3	6.6	0.9144	2.01168	1238	377.3424	(leave blank if no data)
3	6.6	10.9	2.01168	3.32232	1451	442.2648	
4	10.9	16.1	3.32232	4.90728	1639	499.5672	
5	16.1	22.3	4.90728	6.79704	1789	545.2872	
6	22.3	29.7	6.79704	9.05256	1937	590.3976	
7	29.7	38.6	9.05256	11.76528	2279	694.6392	
8	38.6	49.3	11.76528	15.02664	2820	859.536	
9	49.3	62.1	15.02664	18.92808	2895	882.396	
10	62.1	77.5	18.92808	23.622	2895	882.396	
11	77.5	85	23.622	25.908	2895	882.396	
12	85	100	25.908	30.48	3192	972.9216	
13	100		30.48				
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33	98.4252	98.4252	30		3192	972.9216	Interpolated
34	100	100	30.48		3192	972.9216	Interpolated
35	39.37008	39.37008	12		2820	859.536	Interpolated



Vs_avg100

m/s	690.7684001
ft/s	2266.300598
	actual

Vs_100 calcs (imperial units)

100 = Sum

16 Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (ft)	Cumulative d	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
1	0	3	979	3	3	0.0030644	0.0030644	979
2	3	6.6	1238	3.6	6.6	0.0029079	0.0059723	1105.107924
3	6.6	10.9	1451	4.3	10.9	0.0029635	0.0089357	1219.820516
4	10.9	16.1	1639	5.2	16.1	0.0031727	0.0121084	1329.654666
5	16.1	22.3	1789	6.2	22.3	0.0034656	0.015574	1431.870845
6	22.3	29.7	1937	7.4	29.7	0.0038203	0.0193944	1531.372163
7	29.7	38.6	2279	8.9	38.6	0.0039052	0.0232996	1656.681322
8	38.6	39.3701	2820	0.77008	39.37008	0.0002731	0.0235727	1670.157808
9	39.3701	49.3	2820	9.92992	49.3	0.0035212	0.0270939	1819.596499
10	49.3	62.1	2895	12.8	62.1	0.0044214	0.0315153	1970.469288
11	62.1	77.5	2895	15.4	77.5	0.0053195	0.0368349	2103.985675
12	77.5	85	2895	7.5	85	0.0025907	0.0394255	2155.963674
13	85	98.4252	3192	13.4252	98.4252	0.0042059	0.0436314	2255.833333
14	98.4252	100	3192	1.5748	100	0.0004934	0.0441248	2266.300598
15	100	100	3192	0	100	0	0.0441248	2266.300598
16	100	100	3192	0	100	0	0.0441248	2266.300598
17	100	100	3192	0	100	0	0.0441248	2266.300598
18	100	100	3192	0	100	0	0.0441248	2266.300598
19	100	100	3192	0	100	0	0.0441248	2266.300598
20	100	100	3192	0	100	0	0.0441248	2266.300598
21	100	100	3192	0	100	0	0.0441248	2266.300598
22	100	100	3192	0	100	0	0.0441248	2266.300598
23	100	100	3192	0	100	0	0.0441248	2266.300598
24	100	100	3192	0	100	0	0.0441248	2266.300598
25	100	100	3192	0	100	0	0.0441248	2266.300598
26	100	100	3192	0	100	0	0.0441248	2266.300598
27	100	100	3192	0	100	0	0.0441248	2266.300598
28	100	100	3192	0	100	0	0.0441248	2266.300598
29	100	100	3192	0	100	0	0.0441248	2266.300598
30	100	100	3192	0	100	0	0.0441248	2266.300598
31	100	100	3192	0	100	0	0.0441248	2266.300598
32	100	100	3192	0	100	0	0.0441248	2266.300598
33	100	100	3192	0	100	0	0.0441248	2266.300598
34	100	100	3192	0	100	0	0.0441248	2266.300598
35	100	0	#N/A					

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$

$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

$Vs_100 = \frac{100}{0.0441248}$ = 2266 ft/s

= 691 m/s

Vs_avg30

m/s	**687.5779779**
ft/s	2255.833333
	actual

Vs_30 calcs (metric units)

30 = Sum

Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (m)	Cumulative d (m)	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
1	0	3	979	0.9144	0.9144	0.0030644	0.0030644	298.3991905
2	3	6.6	1238	1.09728	2.0116799	0.0029079	0.0059723	336.8368846
3	6.6	10.9	1451	1.31064	3.3223199	0.0029635	0.0089357	371.8012813
4	10.9	16.1	1639	1.5849599	4.9072798	0.0031727	0.0121084	405.2787293
5	16.1	22.3	1789	1.8897599	6.7970398	0.0034656	0.015574	436.4342196
6	22.3	29.7	1937	2.2555199	9.0525597	0.0038203	0.0193944	466.7622204
7	29.7	38.6	2279	2.7127199	11.76528	0.0039052	0.0232996	504.9564509
8	38.6	39.3701	2820	0.2347204	12	0.0002731	0.0235727	509.0640835
9	39.3701	49.3	2820	3.0266395	15.02664	0.0035212	0.0270939	554.6129951
10	49.3	62.1	2895	3.9014399	18.928079	0.0044214	0.0315153	600.5990196
11	62.1	77.5	2895	4.6939198	23.621999	0.0053195	0.0368349	641.2948131
12	77.5	85	2895	2.2859999	25.907999	0.0025907	0.0394255	657.1377067
13	85	98.4252	3192	4.0920008	30	0.0042059	0.0436314	687.5779779
14	98.4252	100	3192	0	30	0	0.0436314	687.5779779
15	100	100	3192	0	30	0	0.0436314	687.5779779
16	100	100	3192	0	30	0	0.0436314	687.5779779
17	100	100	3192	0	30	0	0.0436314	687.5779779
18	100	100	3192	0	30	0	0.0436314	687.5779779
19	100	100	3192	0	30	0	0.0436314	687.5779779
20	100	100	3192	0	30	0	0.0436314	687.5779779
21	100	100	3192	0	30	0	0.0436314	687.5779779
22	100	100	3192	0	30	0	0.0436314	687.5779779
23	100	100	3192	0	30	0	0.0436314	687.5779779
24	100	100	3192	0	30	0	0.0436314	687.5779779
25	100	100	3192	0	30	0	0.0436314	687.5779779
26	100	100	3192	0	30	0	0.0436314	687.5779779
27	100	100	3192	0	30	0	0.0436314	687.5779779
28	100	100	3192	0	30	0	0.0436314	687.5779779
29	100	100	3192	0	30	0	0.0436314	687.5779779
30	100	100	3192	0	30	0	0.0436314	687.5779779
31	100	100	3192	0	30	0	0.0436314	687.5779779
32	100	100	3192	0	30	0	0.0436314	687.5779779
33	100	100	3192	0	30	0	0.0436314	687.5779779
34	100	100	3192	0	30	0	0.0436314	687.5779779

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$

$Vs_30 = \frac{30}{0.0436314}$ = 688 m/s

= 2256 ft/s

For Refraction Line 1 on Right Abutment, Position 220 feet

(Spreadsheet calculations; also refer to Figure 3)

Shear Wave Velocity Parameter Calculation (version 2022042701.B)

UTABA - Refraction Line #1 at 220 ft from end; extrapolate 15 feet using Boore (2004)

	(Y/N)	Value	
Extrapolate to top?	n	#N/A	(ft/s)

25.908

Interval	Top Depth (ft)	Bottom Depth (ft)	Top Depth (m)	Bottom Depth (m)	Interval Vs (ft/s)	Interval Vs (m/s)	
1	0	3	0	0.9144	1193	363.6264	(use =na() as needed)
2	3	6.6	0.9144	2.01168	1630	496.824	(leave blank if no data)
3	6.6	10.9	2.01168	3.32232	2028	618.1344	
4	10.9	16.1	3.32232	4.90728	2328	709.5744	
5	16.1	22.3	4.90728	6.79704	2494	760.1712	
6	22.3	29.7	6.79704	9.05256	2749	837.8952	
7	29.7	38.6	9.05256	11.76528	2888	880.2624	
8	38.6	49.3	11.76528	15.02664	2895	882.396	
9	49.3	62.1	15.02664	18.92808	2895	882.396	
10	62.1	85	18.92808	25.908	2895	882.396	
11	85		25.908				
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
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24							
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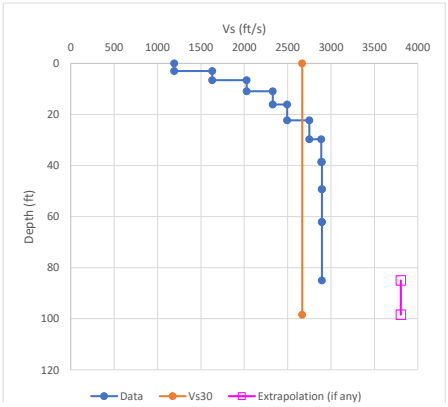
26							
27							
28							
29							
30							
31							
32							
33	98.4252	98.4252	30		3804.313	1159.555	Extrapolated
34	100	100	30.48		3804.313	1159.555	Extrapolated
35	39.37008	39.37008	12		2895	882.396	Interpolated



Vs_avg100

m/s	816.9971773
ft/s	2680.437019
	extrapolated

Vs_100 calcs (imperial units)

100 = Sum

14 Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (ft)	Cumulative d	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
1	0	3	1193	3	3	0.0025147	0.0025147	1193
2	3	6.6	1630	3.6	6.6	0.0022086	0.0047233	1397.340606
3	6.6	10.9	2028	4.3	10.9	0.0021203	0.0068436	1592.735154
4	10.9	16.1	2328	5.2	16.1	0.0022337	0.0090773	1773.66485
5	16.1	22.3	2494	6.2	22.3	0.002486	0.0115632	1928.529103
6	22.3	29.7	2749	7.4	29.7	0.0026919	0.0142551	2083.464179
7	29.7	38.6	2888	8.9	38.6	0.0030817	0.0173368	2226.474937
8	38.6	39.3701	2895	0.77008	39.37008	0.000266	0.0176028	2236.577291
9	39.3701	49.3	2895	9.92992	49.3	0.00343	0.0210328	2343.952461
10	49.3	62.1	2895	12.8	62.1	0.0044214	0.0254543	2439.66964
11	62.1	85	2895	22.9	85	0.0079102	0.0333645	2547.621337
12	85	98.4252	3804.31	13.4252	98.4252	0.0035289	0.0368934	2667.826909
13	98.4252	100	3804.31	1.5748	100	0.000414	0.0373073	2680.437019
14	100	100	3804.31	0	100	0	0.0373073	2680.437019
15	100	100	3804.31	0	100	0	0.0373073	2680.437019
16	100	100	3804.31	0	100	0	0.0373073	2680.437019
17	100	100	3804.31	0	100	0	0.0373073	2680.437019
18	100	100	3804.31	0	100	0	0.0373073	2680.437019
19	100	100	3804.31	0	100	0	0.0373073	2680.437019
20	100	100	3804.31	0	100	0	0.0373073	2680.437019
21	100	100	3804.31	0	100	0	0.0373073	2680.437019
22	100	100	3804.31	0	100	0	0.0373073	2680.437019
23	100	100	3804.31	0	100	0	0.0373073	2680.437019
24	100	100	3804.31	0	100	0	0.0373073	2680.437019
25	100	100	3804.31	0	100	0	0.0373073	2680.437019
26	100	100	3804.31	0	100	0	0.0373073	2680.437019
27	100	100	3804.31	0	100	0	0.0373073	2680.437019
28	100	100	3804.31	0	100	0	0.0373073	2680.437019
29	100	100	3804.31	0	100	0	0.0373073	2680.437019
30	100	100	3804.31	0	100	0	0.0373073	2680.437019
31	100	100	3804.31	0	100	0	0.0373073	2680.437019
32	100	100	3804.31	0	100	0	0.0373073	2680.437019
33	100	100	3804.31	0	100	0	0.0373073	2680.437019
34	100	100	3804.31	0	100	0	0.0373073	2680.437019
35	100	0	#N/A					

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$

$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

$Vs_100 = \frac{100}{0.0373073}$ = 2680 ft/s

= 817 m/s

Vs_avg30

m/s	813.1536157
ft/s	2667.826909
	extrapolated

Vs_30 calcs (metric units)

30 = Sum

Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (m)	Cumulative d (m)	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
1	0	3	1193	0.9144	0.9144	0.0025147	0.0025147	363.6263884
2	3	6.6	1630	1.09728	2.0116799	0.0022086	0.0047233	425.9094031
3	6.6	10.9	2028	1.31064	3.3223199	0.0021203	0.0068436	485.4656595
4	10.9	16.1	2328	1.5849599	4.9072798	0.0022337	0.0090773	540.613029
5	16.1	22.3	2494	1.8897599	6.7970398	0.002486	0.0115632	587.8156518
6	22.3	29.7	2749	2.2555199	9.0525597	0.0026919	0.0142551	635.0398614
7	29.7	38.6	2888	2.7127199	11.76528	0.0030817	0.0173368	678.6295391
8	38.6	39.3701	2895	0.2347204	12	0.000266	0.0176028	681.7087365
9	39.3701	49.3	2895	3.0266395	15.02664	0.00343	0.0210328	714.4366872
10	49.3	62.1	2895	3.9014399	18.928079	0.0044214	0.0254543	743.6112824
11	62.1	85	2895	6.9799198	25.907999	0.0079102	0.0333645	776.5149587
12	85	98.4252	3804.31	4.0920008	30	0.0035289	0.0368934	813.1536157
13	98.4252	100	3804.31	0	30	0	0.0368934	813.1536157
14	100	100	3804.31	0	30	0	0.0368934	813.1536157
15	100	100	3804.31	0	30	0	0.0368934	813.1536157
16	100	100	3804.31	0	30	0	0.0368934	813.1536157
17	100	100	3804.31	0	30	0	0.0368934	813.1536157
18	100	100	3804.31	0	30	0	0.0368934	813.1536157
19	100	100	3804.31	0	30	0	0.0368934	813.1536157
20	100	100	3804.31	0	30	0	0.0368934	813.1536157
21	100	100	3804.31	0	30	0	0.0368934	813.1536157
22	100	100	3804.31	0	30	0	0.0368934	813.1536157
23	100	100	3804.31	0	30	0	0.0368934	813.1536157
24	100	100	3804.31	0	30	0	0.0368934	813.1536157
25	100	100	3804.31	0	30	0	0.0368934	813.1536157
26	100	100	3804.31	0	30	0	0.0368934	813.1536157
27	100	100	3804.31	0	30	0	0.0368934	813.1536157
28	100	100	3804.31	0	30	0	0.0368934	813.1536157
29	100	100	3804.31	0	30	0	0.0368934	813.1536157
30	100	100	3804.31	0	30	0	0.0368934	813.1536157
31	100	100	3804.31	0	30	0	0.0368934	813.1536157
32	100	100	3804.31	0	30	0	0.0368934	813.1536157
33	100	100	3804.31	0	30	0	0.0368934	813.1536157
34	100	100	3804.31	0	30	0	0.0368934	813.1536157
35	100	0	#N/A					

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$

$Vs_30 = \frac{30}{0.0368934}$ = 813 m/s

= 2668 ft/s

Shear Wave Velocity Parameter Calculation (version 2022042701.B)

UTABA - Refraction Line #1 at 110 ft from end; extrapolate 15 feet using 3192 ft/s from other array

	(Y/N)	Value	
Extrapolate to top?	n	#N/A	(ft/s)

	Vs_avg100	Vs_avg30
m/s	800.7628193	798.5021011
ft/s	2627.174688	2619.757634
	actual	actual

Interval	Top Depth (ft)	Bottom Depth (ft)	Top Depth (m)	30.48 Bottom Depth (m)	Interval Vs (ft/s)	Interval Vs (m/s)	
1	0	3	0	0.9144	1193	363.6264	(use =na() as needed)
2	3	6.6	0.9144	2.01168	1630	496.824	(leave blank if no data)
3	6.6	10.9	2.01168	3.32232	2028	618.1344	
4	10.9	16.1	3.32232	4.90728	2328	709.5744	
5	16.1	22.3	4.90728	6.79704	2494	760.1712	
6	22.3	29.7	6.79704	9.05256	2749	837.8952	
7	29.7	38.6	9.05256	11.76528	2888	880.2624	
8	38.6	49.3	11.76528	15.02664	2895	882.396	
9	49.3	62.1	15.02664	18.92808	2895	882.396	
10	62.1	85	18.92808	25.908	2895	882.396	
11	85	100	25.908	30.48	3192	972.9216	
12	100		30.48				
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33	98.4252	98.4252	30		3192	972.9216	Interpolated
34	100	100	30.48		3192	972.9216	Interpolated
35	39.37008	39.37008	12		2895	882.396	Interpolated

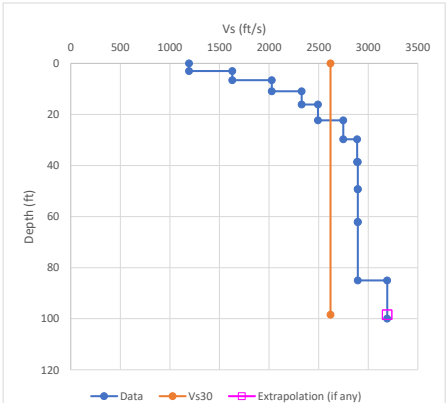
Vs_100 calcs (imperial units)

15 Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (ft)	Cumulative d	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
				100	= Sum			
1	0	3	1193	3	3	0.0025147	0.0025147	1193
2	3	6.6	1630	3.6	6.6	0.0022086	0.0047233	1397.340606
3	6.6	10.9	2028	4.3	10.9	0.0021203	0.0068436	1592.735154
4	10.9	16.1	2328	5.2	16.1	0.0022337	0.0090773	1773.66485
5	16.1	22.3	2494	6.2	22.3	0.002486	0.0115632	1928.529103
6	22.3	29.7	2749	7.4	29.7	0.0026919	0.0142551	2083.464179
7	29.7	38.6	2888	8.9	38.6	0.0030817	0.0173368	2226.474937
8	38.6	39.3701	2895	0.77008	39.37008	0.000266	0.0176028	2236.577291
9	39.3701	49.3	2895	9.92992	49.3	0.00343	0.0210328	2343.952461
10	49.3	62.1	2895	12.8	62.1	0.0044214	0.0254543	2439.66964
11	62.1	85	2895	22.9	85	0.0079102	0.0333645	2547.621337
12	85	98.4252	3192	13.4252	98.4252	0.0042059	0.0375703	2619.757634
13	98.4252	100	3192	1.5748	100	0.0004934	0.0380637	2627.174688
14	100	100	3192	0	100	0	0.0380637	2627.174688
15	100	100	3192	0	100	0	0.0380637	2627.174688
16	100	100	3192	0	100	0	0.0380637	2627.174688
17	100	100	3192	0	100	0	0.0380637	2627.174688
18	100	100	3192	0	100	0	0.0380637	2627.174688
19	100	100	3192	0	100	0	0.0380637	2627.174688
20	100	100	3192	0	100	0	0.0380637	2627.174688
21	100	100	3192	0	100	0	0.0380637	2627.174688
22	100	100	3192	0	100	0	0.0380637	2627.174688
23	100	100	3192	0	100	0	0.0380637	2627.174688
24	100	100	3192	0	100	0	0.0380637	2627.174688
25	100	100	3192	0	100	0	0.0380637	2627.174688
26	100	100	3192	0	100	0	0.0380637	2627.174688
27	100	100	3192	0	100	0	0.0380637	2627.174688
28	100	100	3192	0	100	0	0.0380637	2627.174688
29	100	100	3192	0	100	0	0.0380637	2627.174688
30	100	100	3192	0	100	0	0.0380637	2627.174688
31	100	100	3192	0	100	0	0.0380637	2627.174688
32	100	100	3192	0	100	0	0.0380637	2627.174688
33	100	100	3192	0	100	0	0.0380637	2627.174688
34	100	100	3192	0	100	0	0.0380637	2627.174688
35	100	0	#N/A					

Vs_30 calcs (metric units)

Interval	Top Depth (ft)	Bottom Depth (ft)	Interval Vs (ft/s)	Interval d (m)	Cumulative d (m)	Interval d/v	Top-Down Cumulative d/v	Top-Down Cumulative Vs (d)
				30	= Sum			
1	0	3	1193	0.9144	0.9144	0.0025147	0.0025147	363.6263884
2	3	6.6	1630	1.09728	2.0116799	0.0022086	0.0047233	425.9094031
3	6.6	10.9	2028	1.31064	3.3223199	0.0021203	0.0068436	485.4656595
4	10.9	16.1	2328	1.5849599	4.9072798	0.0022337	0.0090773	540.613029
5	16.1	22.3	2494	1.8897599	6.7970398	0.002486	0.0115632	587.8156518
6	22.3	29.7	2749	2.2555199	9.0525597	0.0026919	0.0142551	635.0398614
7	29.7	38.6	2888	2.7127199	11.76528	0.0030817	0.0173368	678.6295391
8	38.6	39.3701	2895	0.2347204	12	0.000266	0.0176028	681.7087365
9	39.3701	49.3	2895	3.0266395	15.02664	0.00343	0.0210328	714.4366872
10	49.3	62.1	2895	3.9014399	18.928079	0.0044214	0.0254543	743.6112824
11	62.1	85	2895	6.9799198	25.907999	0.0079102	0.0333645	776.5149587
12	85	98.4252	3192	4.0920008	30	0.0042059	0.0375703	798.5021011
13	98.4252	100	3192	0	30	0	0.0375703	798.5021011
14	100	100	3192	0	30	0	0.0375703	798.5021011
15	100	100	3192	0	30	0	0.0375703	798.5021011
16	100	100	3192	0	30	0	0.0375703	798.5021011
17	100	100	3192	0	30	0	0.0375703	798.5021011
18	100	100	3192	0	30	0	0.0375703	798.5021011
19	100	100	3192	0	30	0	0.0375703	798.5021011
20	100	100	3192	0	30	0	0.0375703	798.5021011
21	100	100	3192	0	30	0	0.0375703	798.5021011
22	100	100	3192	0	30	0	0.0375703	798.5021011
23	100	100	3192	0	30	0	0.0375703	798.5021011
24	100	100	3192	0	30	0	0.0375703	798.5021011
25	100	100	3192	0	30	0	0.0375703	798.5021011
26	100	100	3192	0	30	0	0.0375703	798.5021011
27	100	100	3192	0	30	0	0.0375703	798.5021011
28	100	100	3192	0	30	0	0.0375703	798.5021011
29	100	100	3192	0	30	0	0.0375703	798.5021011
30	100	100	3192	0	30	0	0.0375703	798.5021011
31	100	100	3192	0	30	0	0.0375703	798.5021011
32	100	100	3192	0	30	0	0.0375703	798.5021011
33	100	100	3192	0	30	0	0.0375703	798.5021011
34	100	100	3192	0	30	0	0.0375703	798.5021011
35	100	0	#N/A					

$\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$ $\sum_{i=1}^{n} d_i$ $\sum_{i=1}^{n} \frac{d_i}{v_{si}}$



$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

$$Vs_100 = \frac{100}{0.0380637} = 2627 \text{ ft/s} = 801 \text{ m/s}$$

$$Vs_30 = \frac{30}{0.0375703} = 799 \text{ m/s} = 2620 \text{ ft/s}$$

APPENDIX B1

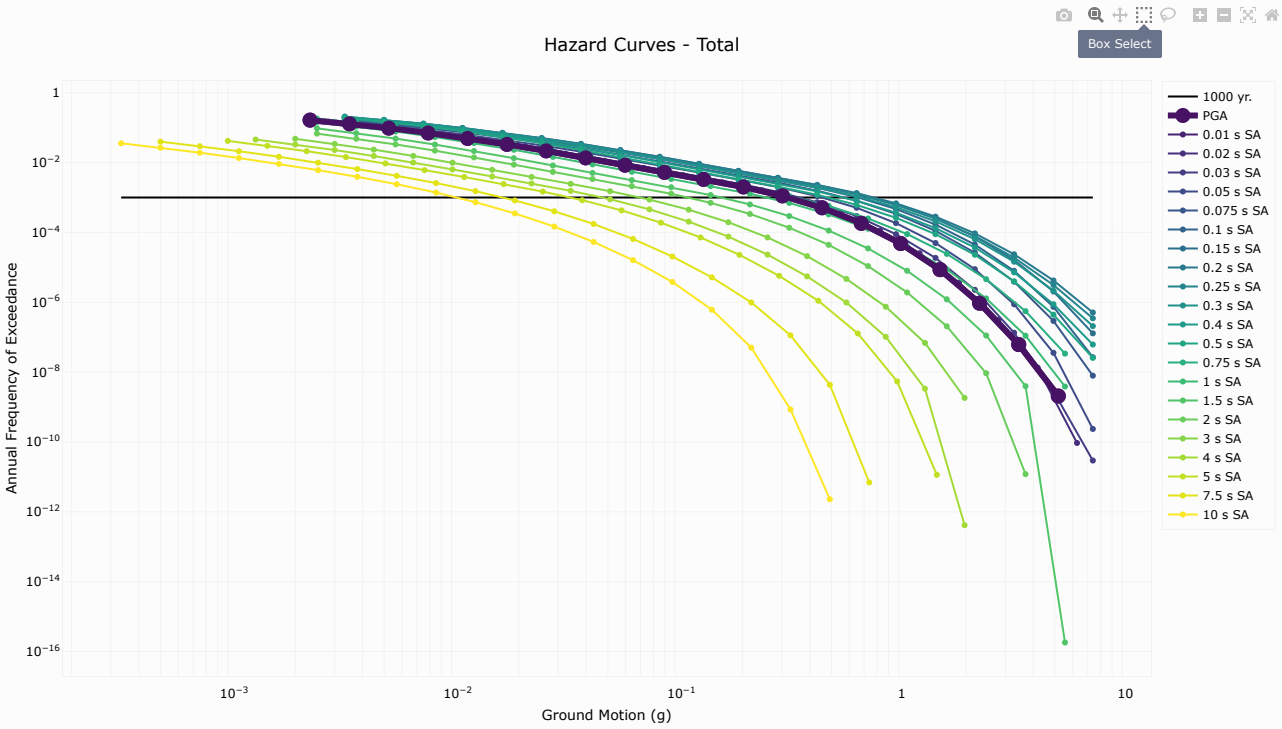
Supporting Documentation for 1,000-Year (MDE) Ground Motions:
Screenshots of USGS Website Pages – Hazard Curves, Response Spectra, and Deaggregations

For Vs30 = 594 m/s

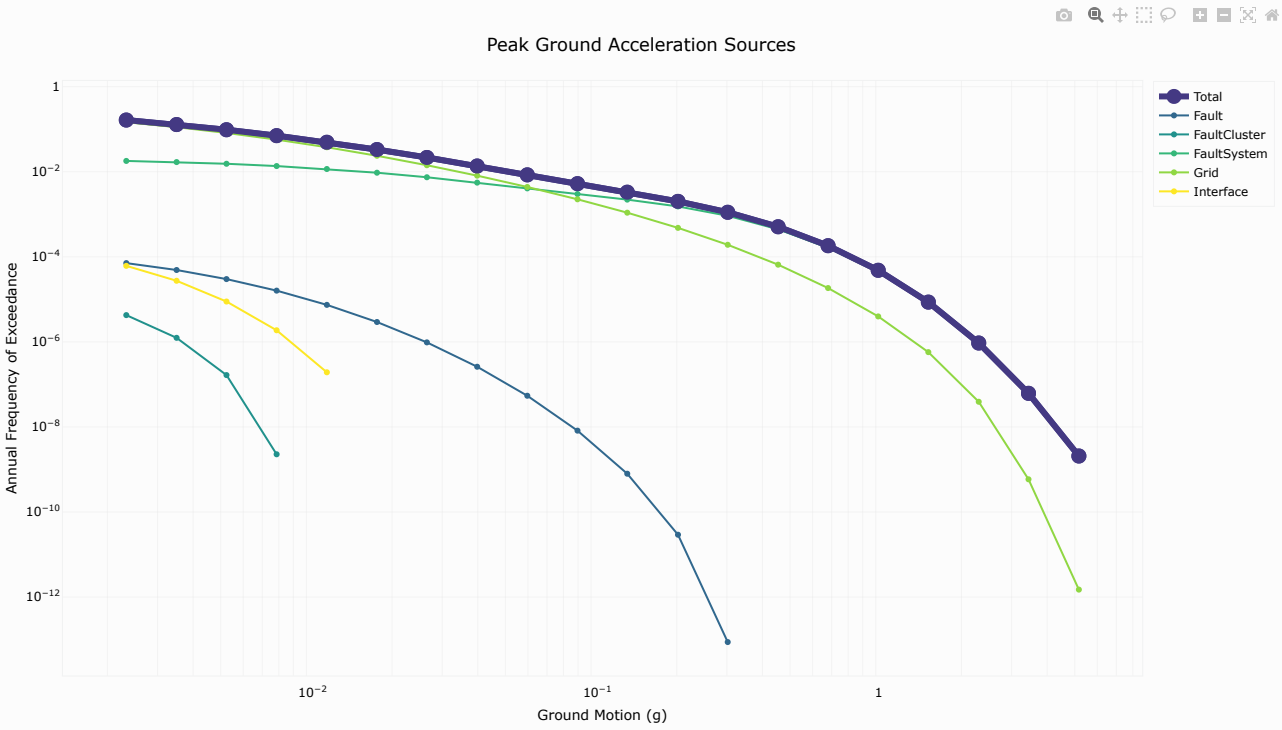
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

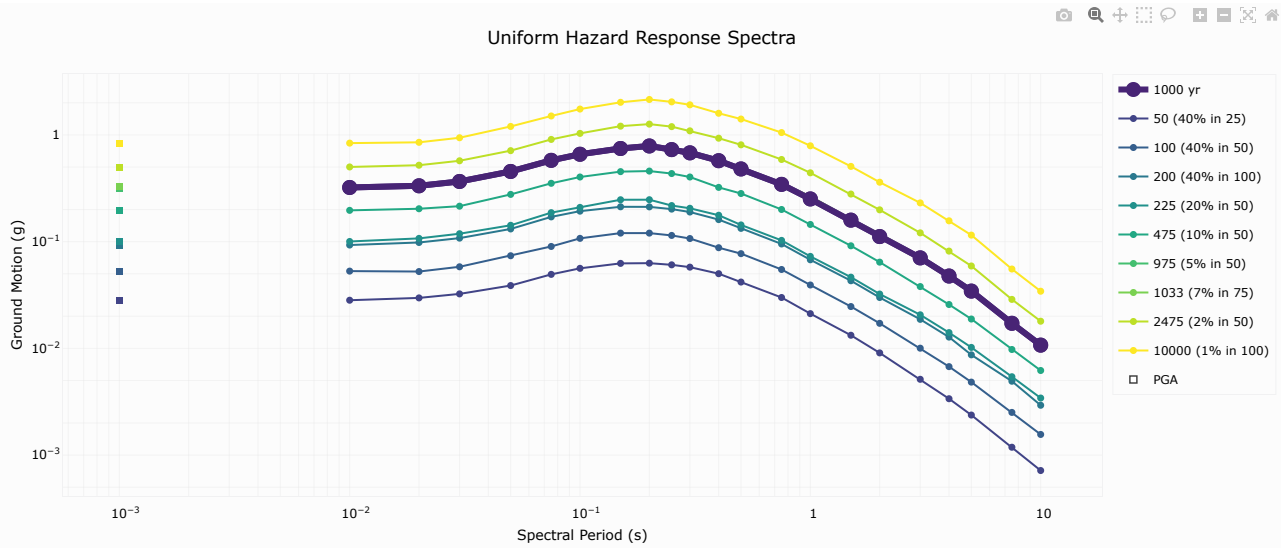
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 594 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 16, 2025, 01:18 PM

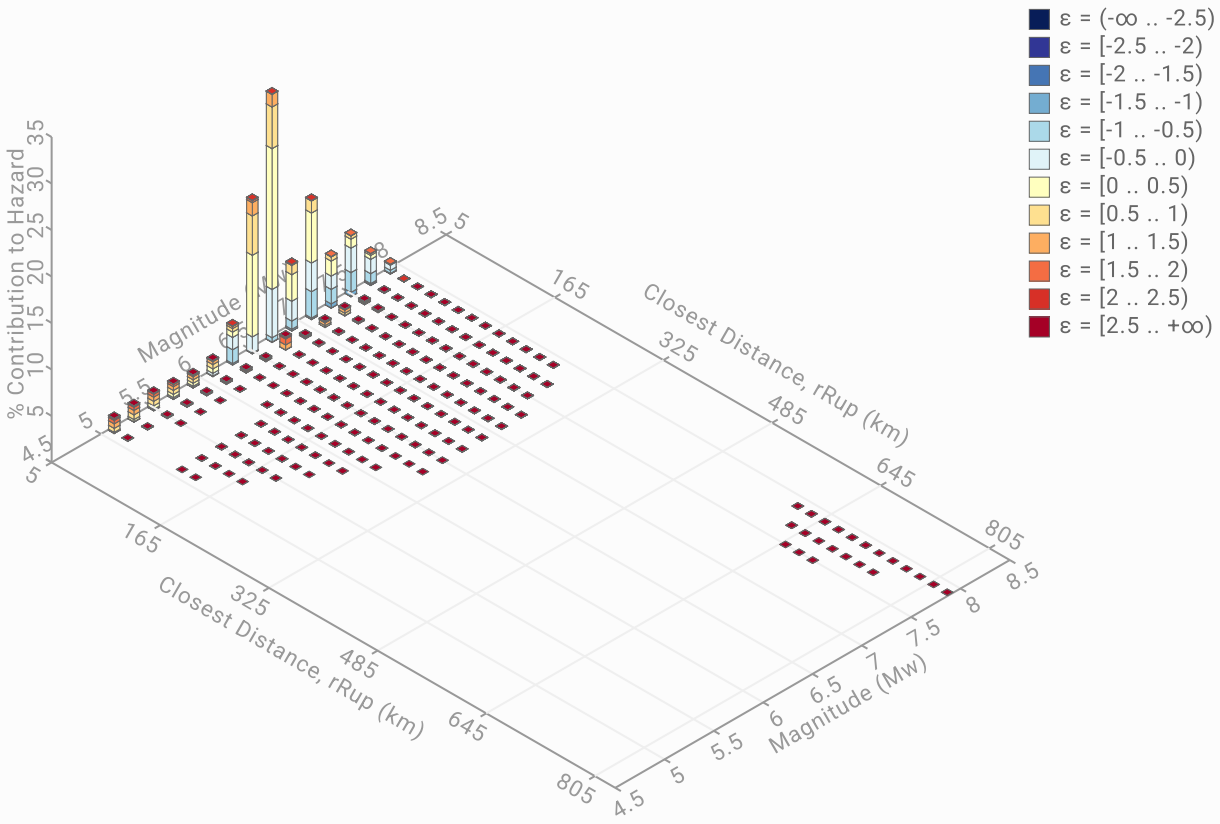
Response Spectra Data

Export Response Spectra as CSV

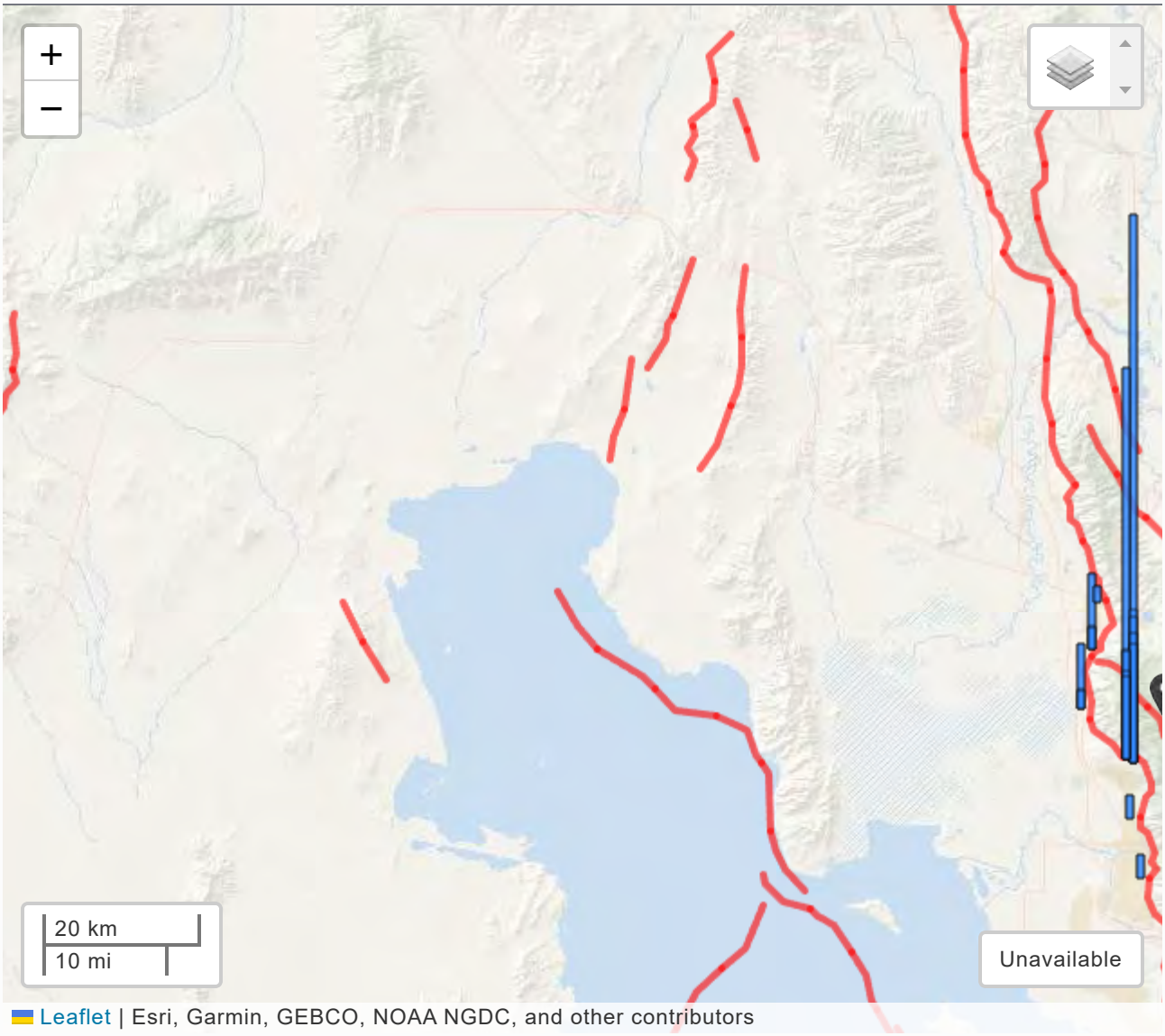
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.320321	29.289401	0.321741	0.333644	0.366214	0.454537	0.57774	0.658823	0.746073	0.787654	0.728364	0.679167	0.573376	0.47979	0.344061	0.251218	0.15901	0.111607	0.070432
50 (40% in 25)	0.028136	2.307529	0.028255	0.029702	0.032388	0.038782	0.049348	0.056221	0.062556	0.062857	0.060643	0.057679	0.050093	0.041826	0.029966	0.021157	0.013271	0.009069	0.005132
100 (40% in 50)	0.052698	4.092958	0.052955	0.052461	0.058128	0.073784	0.090141	0.107354	0.120226	0.120211	0.114357	0.106953	0.087743	0.077176	0.054838	0.039244	0.024657	0.017166	0.010043
200 (40% in 100)	0.092581	7.526951	0.092962	0.098199	0.107896	0.131498	0.17058	0.19308	0.212058	0.211765	0.201772	0.189468	0.160903	0.133168	0.0951	0.067618	0.04302	0.029961	0.018709
225 (20% in 50)	0.099964	8.296899	0.100342	0.107268	0.118628	0.14227	0.186894	0.209363	0.246899	0.247101	0.217807	0.205355	0.176765	0.143388	0.102742	0.072735	0.046457	0.032285	0.020629
475 (10% in 50)	0.195555	15.638149	0.196413	0.203322	0.214928	0.277053	0.35203	0.403234	0.452979	0.458425	0.434515	0.403273	0.322355	0.28244	0.200111	0.144871	0.091474	0.064245	0.037944
975 (5% in 50)	0.316025	28.825653	0.317432	0.328943	0.36092	0.448409	0.569511	0.649894	0.736309	0.755084	0.718395	0.669518	0.564526	0.473016	0.338982	0.247613	0.156656	0.11	0.06926
1033 (7% in 75)	0.32583	29.884106	0.327266	0.339673	0.373003	0.462397	0.588294	0.670272	0.758594	0.803177	0.741148	0.691541	0.584724	0.488478	0.350574	0.265954	0.162028	0.118438	0.071934
2475 (2% in 50)	0.498567	47.892505	0.50089	0.520044	0.572308	0.71223	0.907129	1.033154	1.20788	1.262338	1.195722	1.091766	0.931533	0.807595	0.588533	0.441557	0.279256	0.198563	0.120874
10000 (1% in 100)	0.833515	83.32768	0.83781	0.852398	0.940473	1.200691	1.50469	1.746878	2.021022	2.148139	2.040542	1.913622	1.595313	1.408328	1.051929	0.790925	0.507118	0.360423	0.230706

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 594 m/s

Intensity Measure Type: PGA

Return Period: 1000 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 1000 yrs

Exceedance rate : 0.001 yr^{-1}

PGA ground motion : 3.194e-1 g

Recovered targets

Return period : 987.25238 yrs

Exceedance rate : 1.013e-3 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.78 %

Mean (over all sources)

m : 6.76

r : 9.96 km

ε_0 : 0.27 σ

Mode (largest m-r bin)

m : 6.71

r : 7.98 km

ε_0 : 0.25 σ

Contribution : 26.69 %

Mode (largest m-r-ε_0 bin)

m : 6.7

r : 7.38 km

ε_0 : 0.23 σ

Contribution : 15.15 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							83.51
Wasatch (Weber) (0)		7.01	7.00	0.03	111.960°W	41.338°N	217.76	33.74
Wasatch (Brigham City) (4)		7.19	6.79	0.13	111.969°W	41.342°N	224.89	24.06
Wasatch (Brigham City) (2)		13.08	6.72	0.85	112.023°W	41.467°N	313.57	4.66
Broadmouth Canyon - James Peak (1)		3.78	6.77	-0.60	111.870°W	41.374°N	113.19	4.58
Ogden Valley North Fork (1)		1.66	7.15	-0.65	111.902°W	41.384°N	116.15	4.34
Wasatch (Brigham City) (3)		10.91	6.71	0.64	112.038°W	41.400°N	277.94	3.95
East Cache (8)		10.12	7.19	-0.33	111.781°W	41.422°N	69.67	2.56
Wasatch (Weber) (1)		13.40	7.03	0.67	111.964°W	41.274°N	199.78	1.4
Wasatch (Weber) (2)		20.56	6.89	1.30	111.948°W	41.205°N	189.04	1.39
Wasatch (Brigham City) (1)		17.25	6.60	1.30	112.014°W	41.520°N	329.84	1.01
WUS Branch Average (opt)	Grid							15.95

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.1.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.5.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.5.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

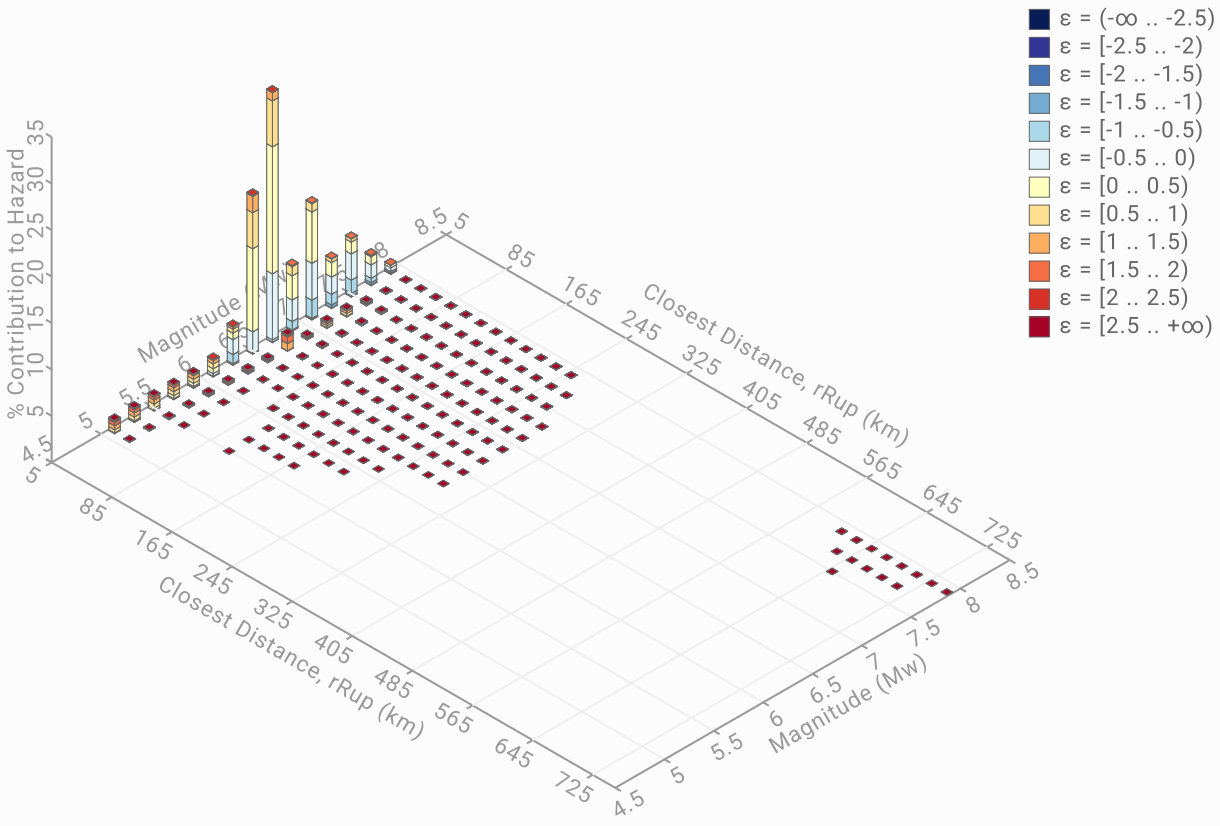
Repository : nshmp-utils-java
Version: 0.4.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-utils-java

Repository : nshm-conus
Version: 6.1.0
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

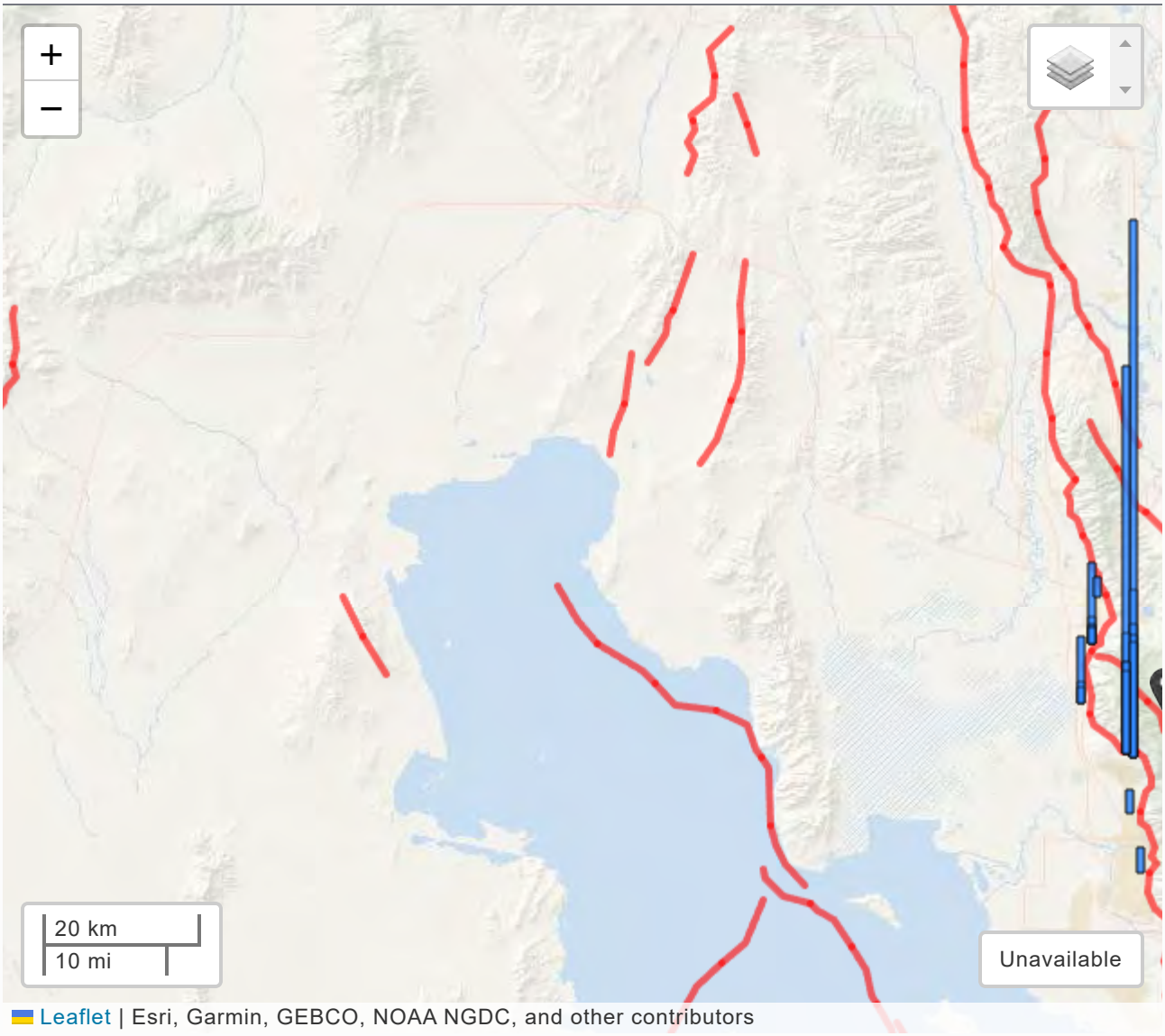
February 06, 2025, 09:25 AM

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 594 m/s

Intensity Measure Type: 0.2 s

Return Period: 1000 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 1000 yrs

Exceedance rate : 0.001 yr^{-1}

0.2 s SA ground motion : 7.717e-1 g

Recovered targets

Return period : 979.47923 yrs

Exceedance rate : 1.021e-3 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.63 %

Mean (over all sources)

m : 6.76

r : 10.07 km

ε_0 : 0.3 σ

Mode (largest m-r bin)

m : 6.71

r : 8.06 km

ε_0 : 0.25 σ

Contribution : 26.91 %

Mode (largest m-r-ε_0 bin)

m : 6.68

r : 7.35 km

ε_0 : 0.26 σ

Contribution : 13.66 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							83.64
Wasatch (Weber) (0)		7.01	7.00	0.04	111.960°W	41.338°N	217.76	33.11
Wasatch (Brigham City) (4)		7.19	6.78	0.13	111.969°W	41.342°N	224.89	23.91
Wasatch (Brigham City) (2)		13.08	6.72	0.79	112.023°W	41.467°N	313.57	5.04
Broadmouth Canyon - James Peak (1)		3.78	6.76	-0.54	111.870°W	41.374°N	113.19	4.38
Wasatch (Brigham City) (3)		10.91	6.71	0.60	112.038°W	41.400°N	277.94	4.15
Ogden Valley North Fork (1)		1.66	7.15	-0.58	111.902°W	41.384°N	116.15	4.11
East Cache (8)		10.12	7.19	-0.31	111.781°W	41.422°N	69.67	2.49
Wasatch (Weber) (2)		20.56	6.87	1.24	111.948°W	41.205°N	189.04	1.59
Wasatch (Weber) (1)		13.40	7.01	0.64	111.964°W	41.274°N	199.78	1.46
Wasatch (Brigham City) (1)		17.25	6.60	1.22	112.014°W	41.520°N	329.84	1.19
WUS Branch Average (opt)	Grid							15.98

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.1.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.5.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.5.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

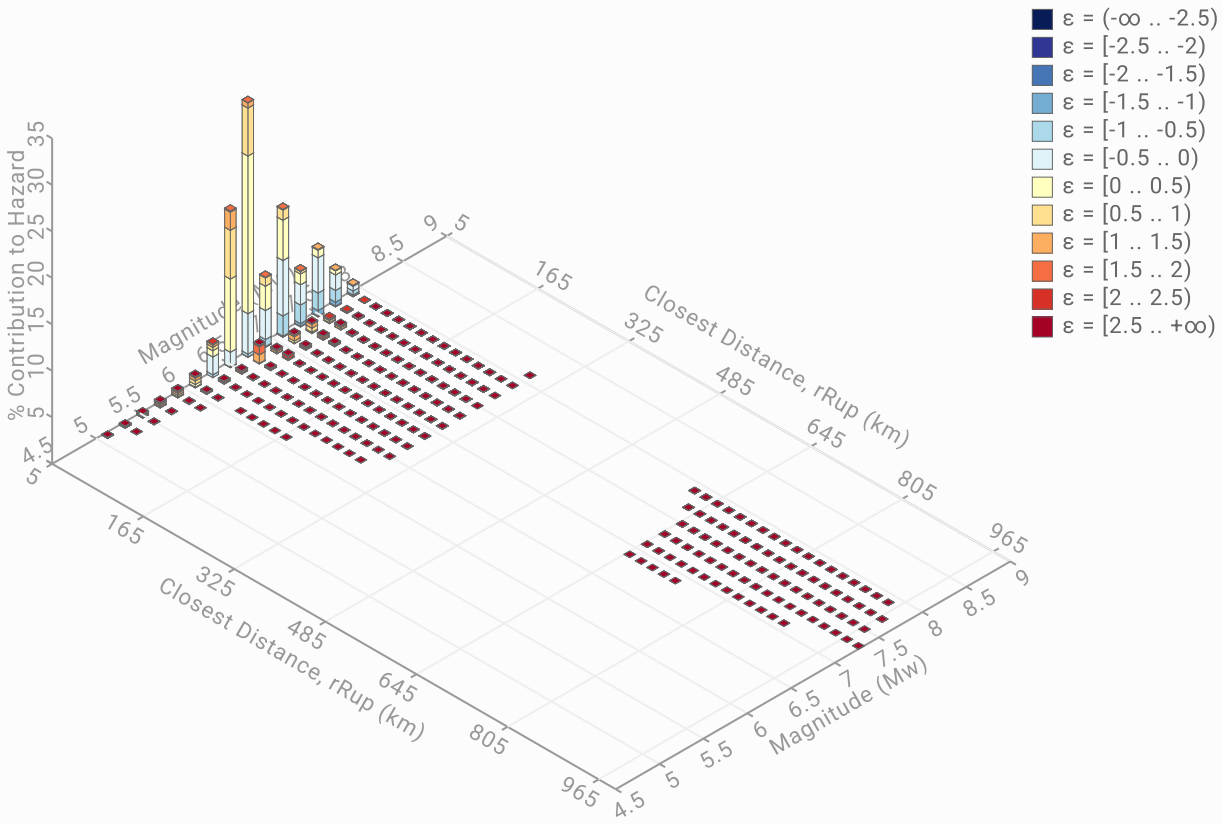
Repository : nshmp-utils-java
Version: 0.4.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-utils-java

Repository : nshm-conus
Version: 6.1.0
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

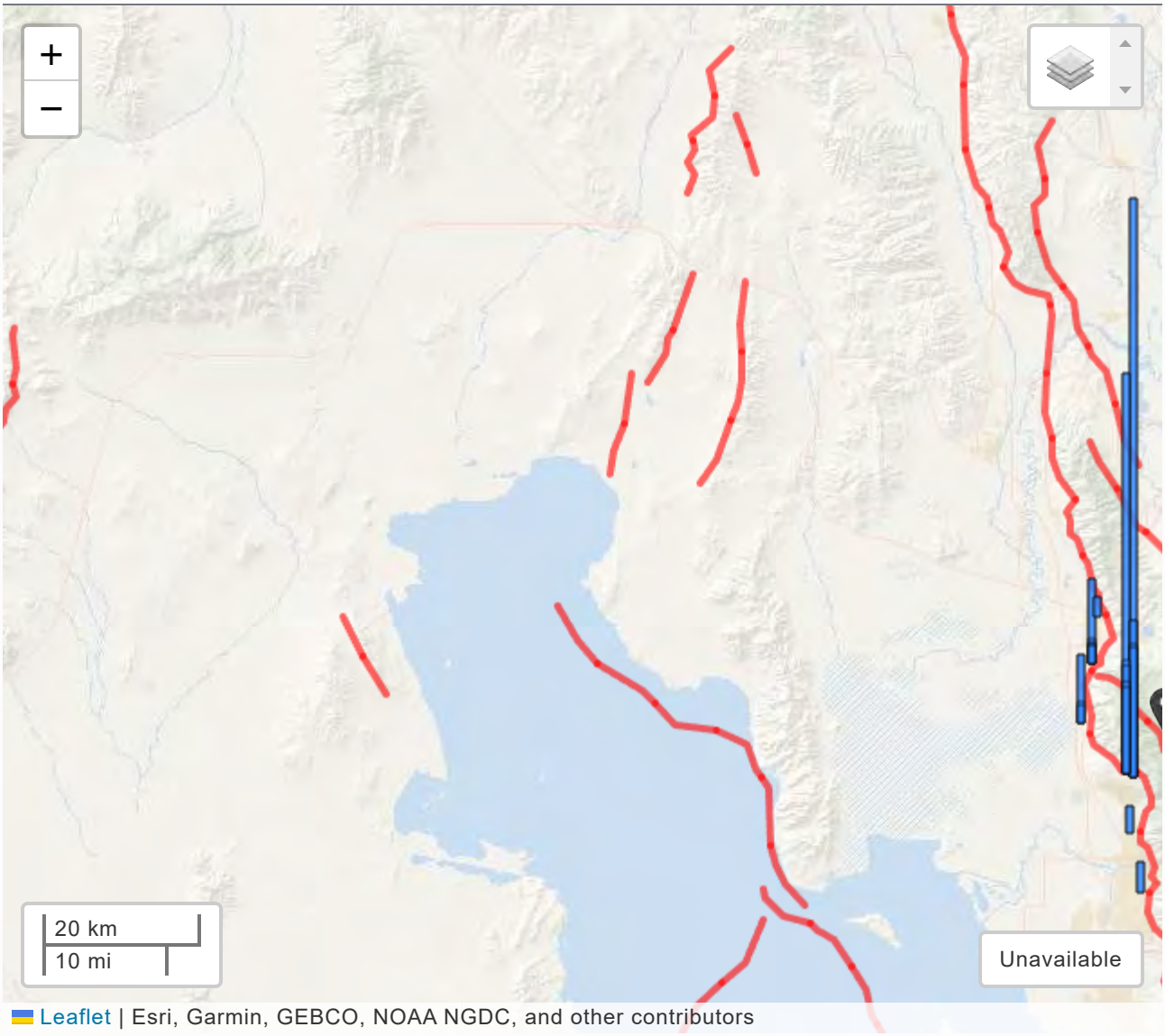
February 06, 2025, 09:25 AM

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 594 m/s

Intensity Measure Type: 1.0 s

Return Period: 1000 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 1000 yrs

Exceedance rate : 0.001 yr^{-1}

1.0 s SA ground motion : 2.549e-1 g

Recovered targets

Return period : 984.84167 yrs

Exceedance rate : 1.015e-3 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.84 %

Mean (over all sources)

m : 6.88

r : 11.38 km

ε_0 : 0.25 σ

Mode (largest m-r bin)

m : 6.71

r : 8.08 km

ε_0 : 0.26 σ

Contribution : 27.37 %

Mode (largest m-r-ε_0 bin)

m : 6.7

r : 7.39 km

ε_0 : 0.23 σ

Contribution : 16.96 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							90
Wasatch (Weber) (0)		7.01	7.02	-0.03	111.960°W	41.338°N	217.76	35.63
Wasatch (Brigham City) (4)		7.19	6.79	0.12	111.969°W	41.342°N	224.89	24.7
Wasatch (Brigham City) (2)		13.08	6.72	0.79	112.023°W	41.467°N	313.57	5.24
Ogden Valley North Fork (1)		1.66	7.17	-0.70	111.902°W	41.384°N	116.15	4.45
Broadmouth Canyon - James Peak (1)		3.78	6.81	-0.48	111.870°W	41.374°N	113.19	4.25
Wasatch (Brigham City) (3)		10.91	6.71	0.60	112.038°W	41.400°N	277.94	4.24
East Cache (8)		10.12	7.21	-0.30	111.781°W	41.422°N	69.67	2.56
Wasatch (Weber) (2)		20.56	6.89	1.17	111.948°W	41.205°N	189.04	1.87
Wasatch (Weber) (1)		13.40	7.04	0.57	111.964°W	41.274°N	199.78	1.64
Wasatch (Brigham City) (1)		17.25	6.60	1.22	112.014°W	41.520°N	329.84	1.23
WUS Branch Average (opt)	Grid							9.52

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.1.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.5.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.5.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshmp-utils-java
Version: 0.4.0
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-utils-java

Repository : nshm-conus
Version: 6.1.0
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

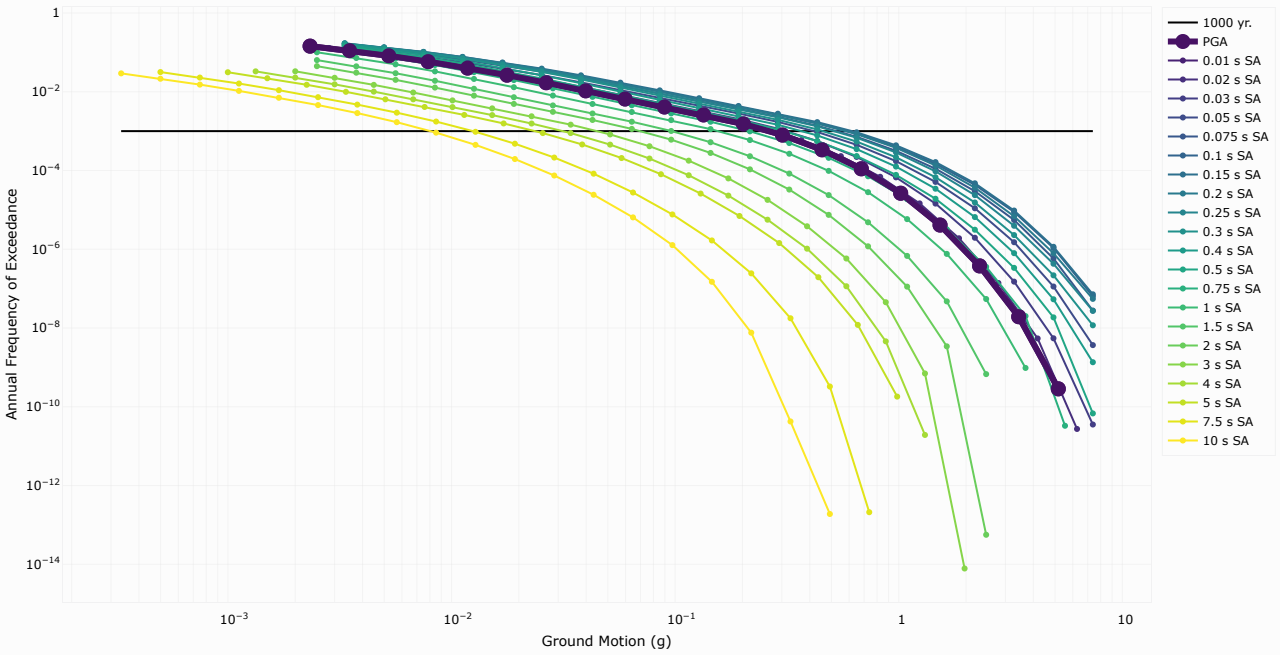
February 06, 2025, 09:25 AM

For Vs30 = 973 m/s

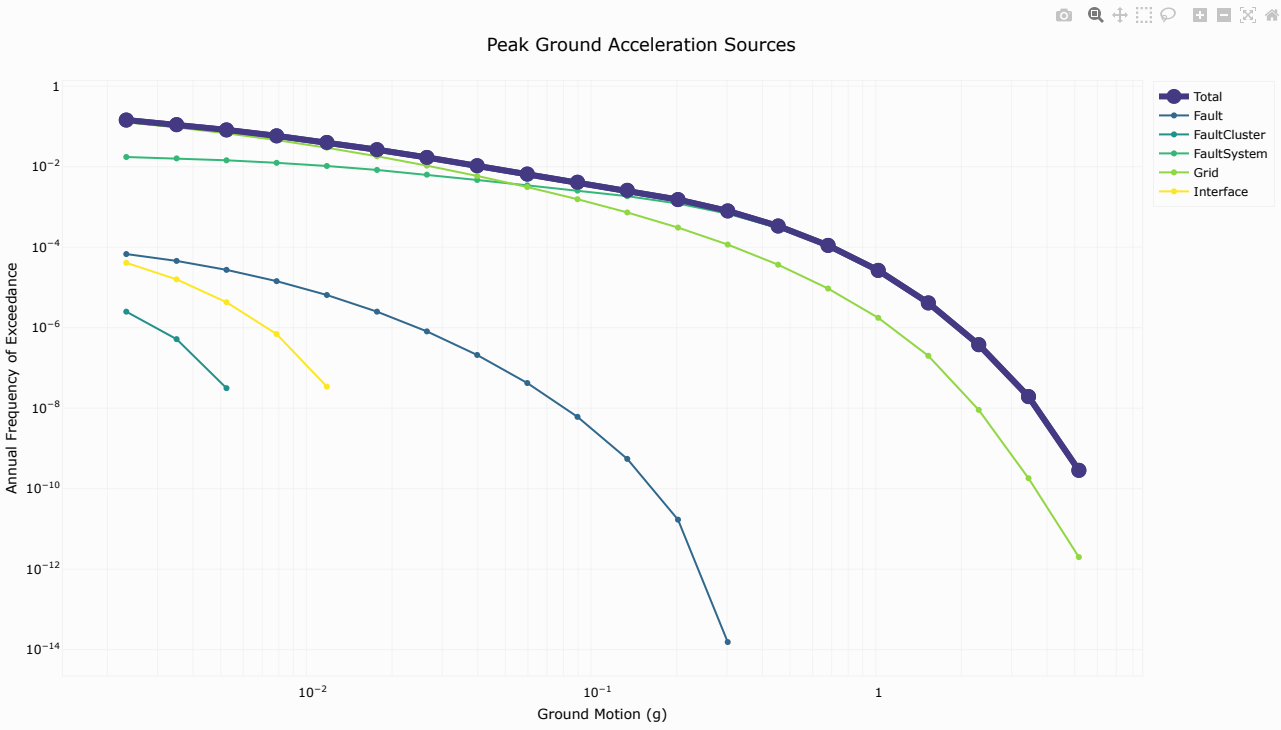
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

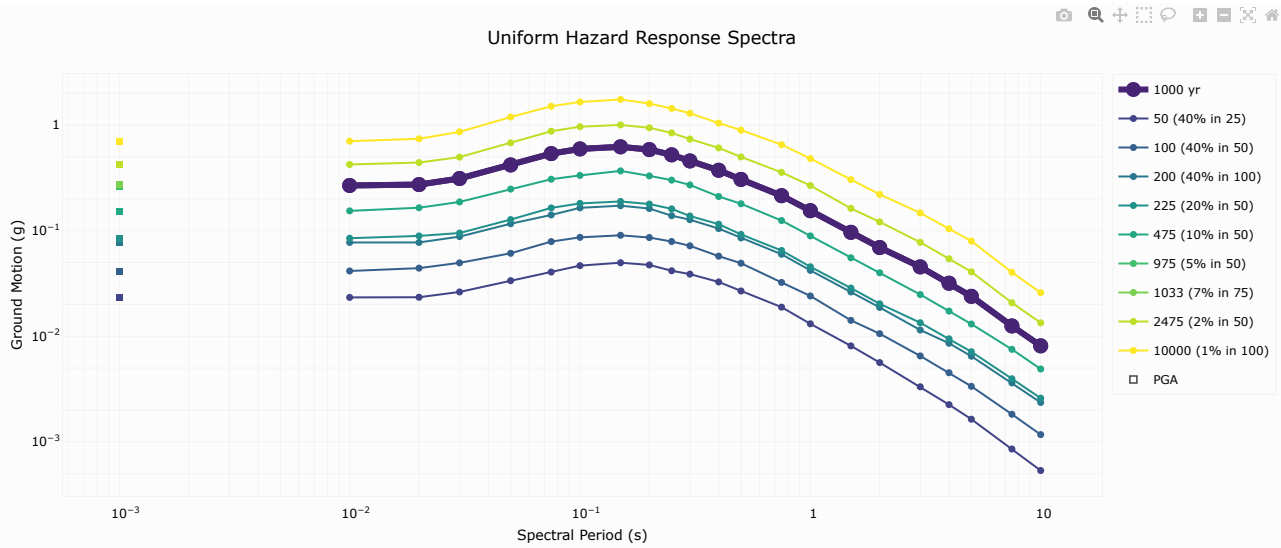
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 973 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 16, 2025, 01:21 PM

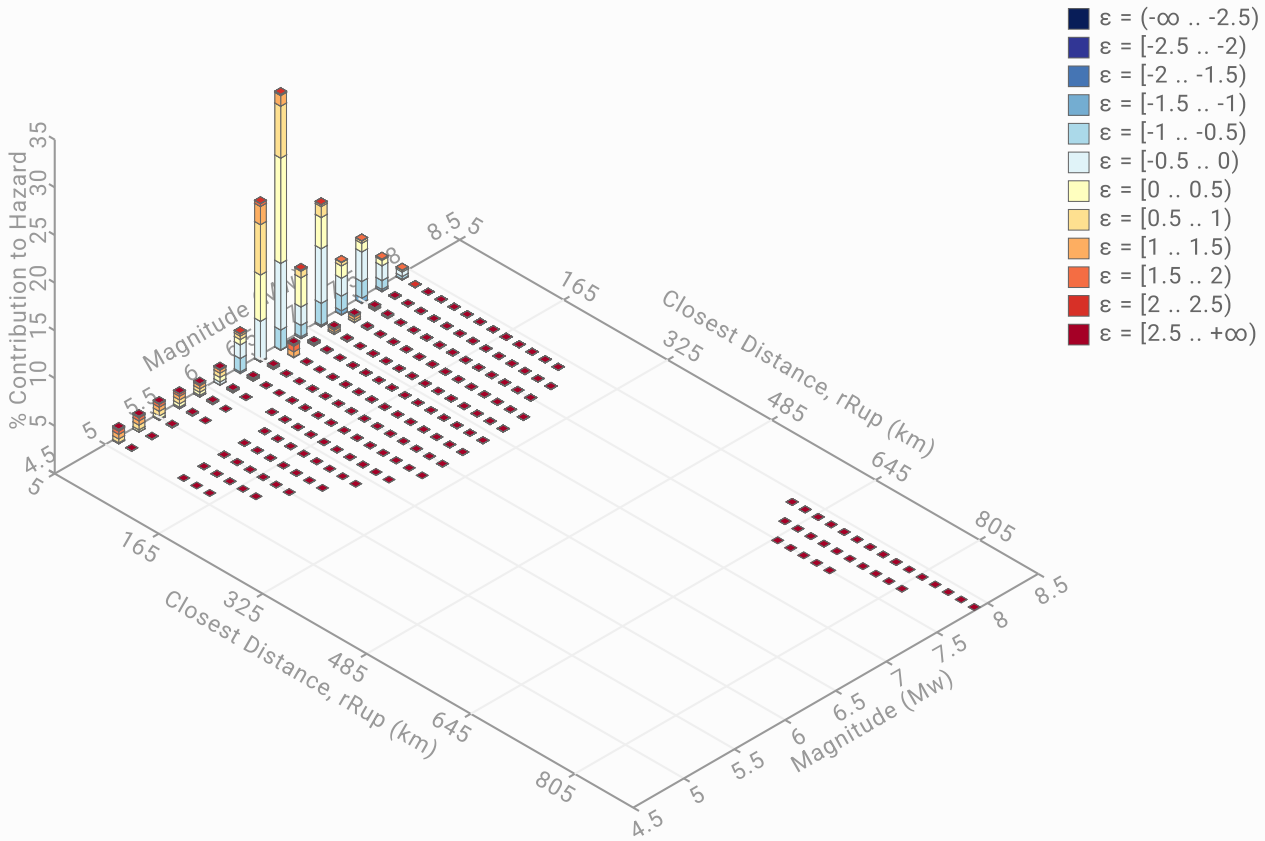
Response Spectra Data

Export Response Spectra as CSV

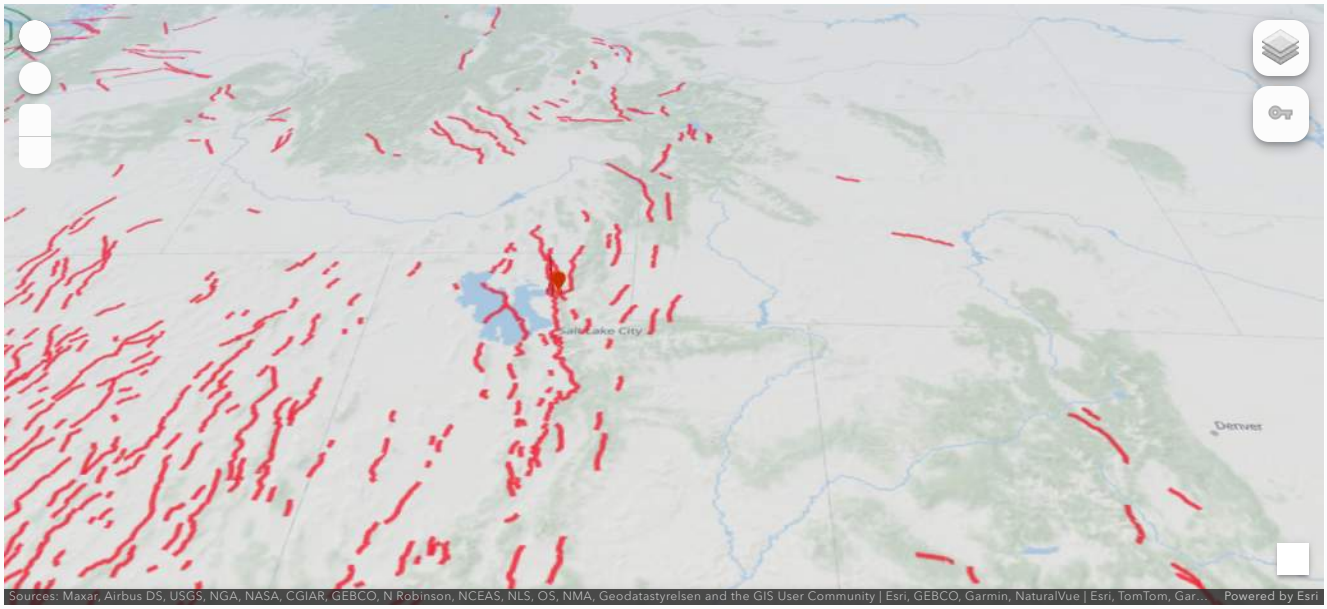
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.266682	20.490753	0.268028	0.273461	0.312052	0.419468	0.537241	0.595097	0.622962	0.586411	0.523112	0.457855	0.373663	0.305943	0.214604	0.154724	0.096509	0.069264	0.045427
50 (40% in 25)	0.023221	1.62017	0.02334	0.023425	0.026293	0.033631	0.040578	0.046658	0.049742	0.047395	0.041725	0.038784	0.032695	0.026859	0.01887	0.013122	0.008108	0.005634	0.003324
100 (40% in 50)	0.041339	2.852787	0.041524	0.044183	0.049611	0.061093	0.078859	0.086491	0.090439	0.086125	0.078975	0.07192	0.057387	0.049207	0.032341	0.024095	0.014154	0.010578	0.006513
200 (40% in 100)	0.076934	5.2948	0.077338	0.077394	0.087903	0.116441	0.140949	0.164616	0.1725	0.162097	0.138618	0.127159	0.104699	0.085391	0.059804	0.042076	0.026308	0.018758	0.011462
225 (20% in 50)	0.08446	5.803425	0.084859	0.089222	0.095034	0.127461	0.164441	0.181375	0.189155	0.178731	0.160978	0.137732	0.115282	0.092218	0.064924	0.045509	0.028617	0.020318	0.013438
475 (10% in 50)	0.153503	11.619521	0.154085	0.164958	0.187195	0.24789	0.307323	0.333879	0.368541	0.330571	0.301362	0.271275	0.210864	0.179997	0.124683	0.089282	0.055385	0.039937	0.024834
975 (5% in 50)	0.262784	20.172657	0.264114	0.26979	0.307761	0.413291	0.528768	0.586118	0.613797	0.577594	0.501667	0.45135	0.367824	0.301532	0.21134	0.152419	0.095014	0.068233	0.044669
1033 (7% in 75)	0.271682	20.898674	0.273047	0.278169	0.317556	0.427388	0.548107	0.606612	0.634716	0.597719	0.533649	0.466195	0.38115	0.3116	0.21879	0.15768	0.098427	0.070585	0.046398
2475 (2% in 50)	0.421332	33.471973	0.423615	0.442222	0.497592	0.678767	0.874869	0.965691	1.004042	0.943489	0.844137	0.737357	0.608437	0.499941	0.356725	0.267762	0.162702	0.121178	0.077611
10000 (1% in 100)	0.700467	58.491512	0.704544	0.742189	0.863257	1.192198	1.508705	1.65643	1.749511	1.600166	1.438899	1.295333	1.044615	0.896803	0.653022	0.482548	0.304796	0.221064	0.147156

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 973 m/s

Intensity Measure Type: PGA

Return Period: 1000 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 1000 yrs

Exceedance rate : 0.001 yr^{-1}

PGA ground motion : 2.620e-1 g

Recovered targets

Return period : 980.55491 yrs

Exceedance rate : 1.020e-3 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 1.08 %

Mean (over all sources)

m : 6.77

r : 10.49 km

ε_0 : 0.24 σ

Mode (largest m-r bin)

m : 6.71

r : 7.99 km

ε_0 : 0.21 σ

Contribution : 26.8 %

Mode (largest m-r-ε_0 bin)

m : 6.71

r : 7.55 km

ε_0 : 0.25 σ

Contribution : 11.03 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							83.69
Wasatch (Weber) (0)		7.01	7.00	0.00	111.960°W	41.338°N	217.76	33.81
Wasatch (Brigham City) (4)		7.19	6.79	0.09	111.969°W	41.342°N	224.89	24.13
Wasatch (Brigham City) (2)		13.08	6.72	0.81	112.023°W	41.467°N	313.57	4.7
Broadmouth Canyon - James Peak (1)		3.78	6.77	-0.63	111.870°W	41.374°N	113.19	4.56
Ogden Valley North Fork (1)		1.66	7.15	-0.67	111.902°W	41.384°N	116.15	4.34
Wasatch (Brigham City) (3)		10.91	6.71	0.59	112.038°W	41.400°N	277.94	3.99
East Cache (8)		10.12	7.19	-0.35	111.781°W	41.422°N	69.67	2.56
Wasatch (Weber) (1)		13.40	7.02	0.65	111.964°W	41.274°N	199.78	1.4
Wasatch (Weber) (2)		20.56	6.89	1.28	111.948°W	41.205°N	189.04	1.38
Wasatch (Brigham City) (1)		17.25	6.60	1.25	112.014°W	41.520°N	329.84	1.03
WUS Branch Average (opt)	Grid							15.42

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

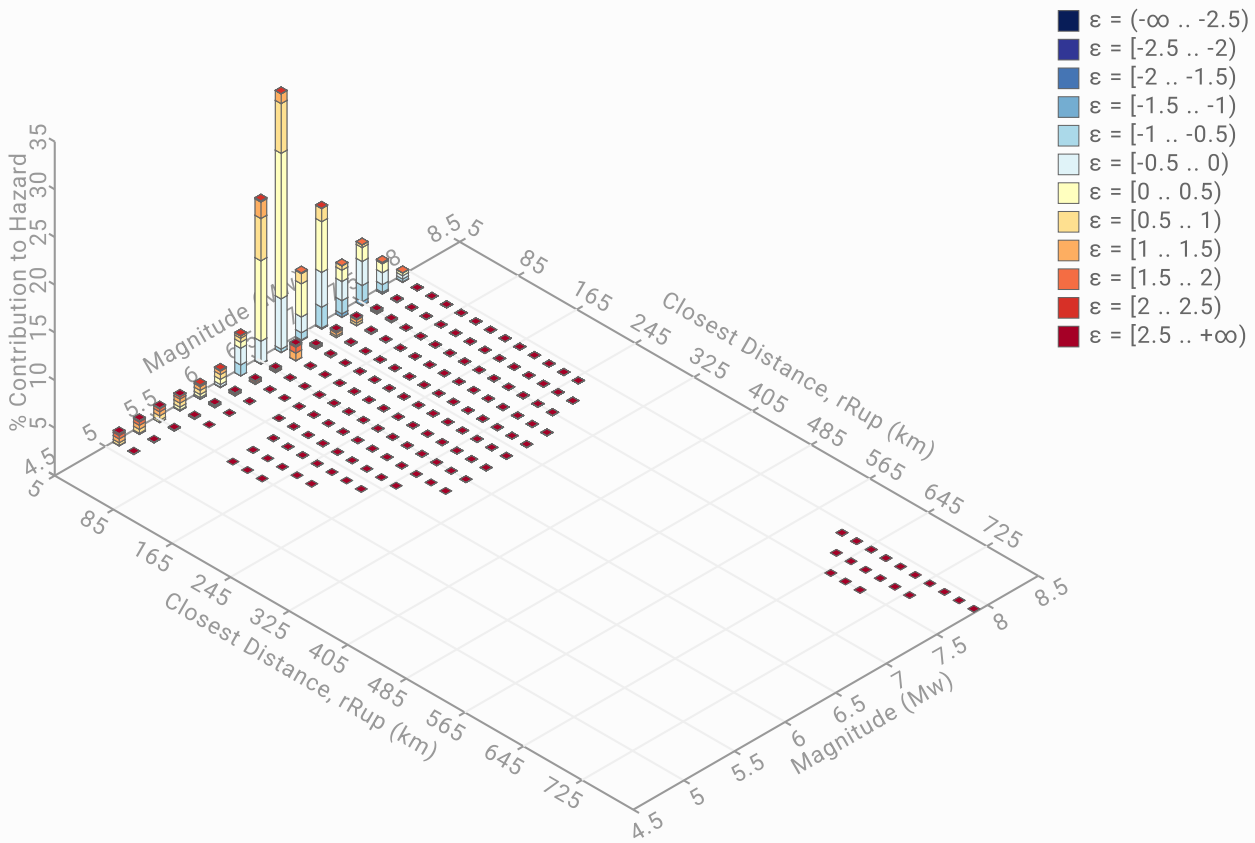
Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 27, 2025, 05:09 PM

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 973 m/s

Intensity Measure Type: 0.2 s

Return Period: 1000 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 1000 yrs

Exceedance rate : 0.001 yr^{-1}

0.2 s SA ground motion : 5.773e-1 g

Recovered targets

Return period : 984.21823 yrs

Exceedance rate : 1.016e-3 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.75 %

Mean (over all sources)

m : 6.77

r : 10.13 km

ε_0 : 0.29 σ

Mode (largest m-r bin)

m : 6.71

r : 8.04 km

ε_0 : 0.26 σ

Contribution : 27.11 %

Mode (largest m-r-ε_0 bin)

m : 6.7

r : 7.37 km

ε_0 : 0.23 σ

Contribution : 15.25 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							84.08
Wasatch (Weber) (0)		7.01	7.00	0.05	111.960°W	41.338°N	217.76	33.51
Wasatch (Brigham City) (4)		7.19	6.78	0.14	111.969°W	41.342°N	224.89	24.16
Wasatch (Brigham City) (2)		13.08	6.72	0.81	112.023°W	41.467°N	313.57	4.99
Broadmouth Canyon - James Peak (1)		3.78	6.77	-0.54	111.870°W	41.374°N	113.19	4.48
Ogden Valley North Fork (1)		1.66	7.15	-0.58	111.902°W	41.384°N	116.15	4.2
Wasatch (Brigham City) (3)		10.91	6.71	0.61	112.038°W	41.400°N	277.94	4.15
East Cache (8)		10.12	7.19	-0.29	111.781°W	41.422°N	69.67	2.53
Wasatch (Weber) (2)		20.56	6.87	1.29	111.948°W	41.205°N	189.04	1.52
Wasatch (Weber) (1)		13.40	7.01	0.67	111.964°W	41.274°N	199.78	1.44
Wasatch (Brigham City) (1)		17.25	6.60	1.25	112.014°W	41.520°N	329.84	1.16
WUS Branch Average (opt)	Grid							15.39

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

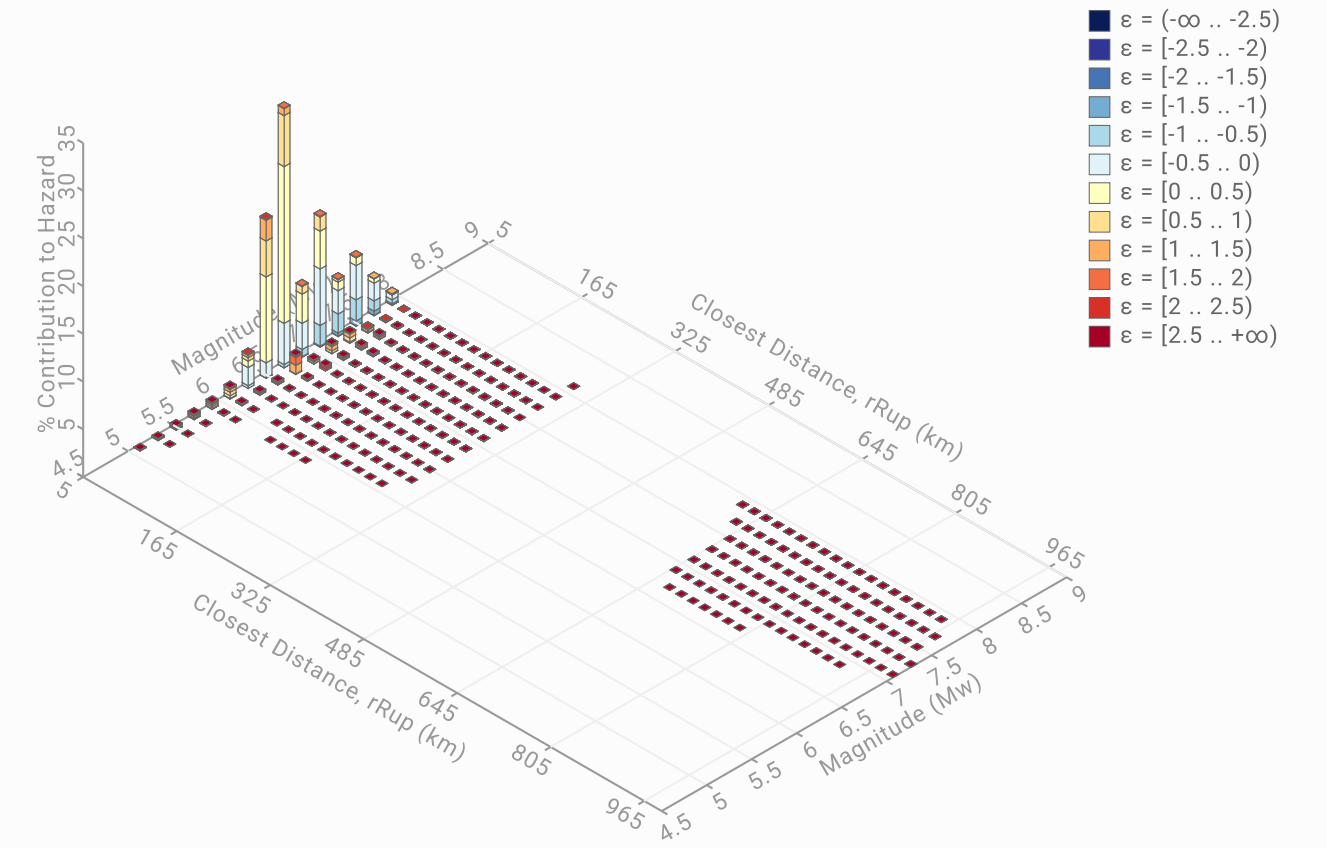
Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

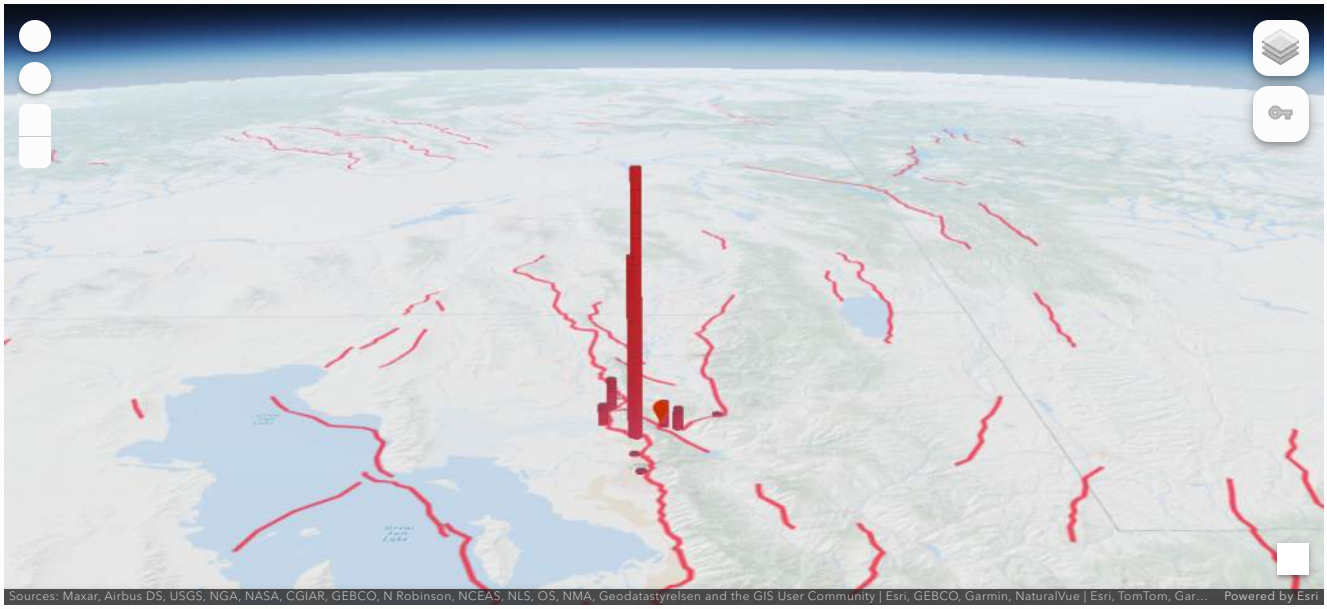
May 27, 2025, 05:09 PM

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 973 m/s

Intensity Measure Type: 1.0 s

Return Period: 1000 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 1000 yrs

Exceedance rate : 0.001 yr^{-1}

1.0 s SA ground motion : 1.552e-1 g

Recovered targets

Return period : 989.95453 yrs

Exceedance rate : 1.010e-3 yr^{-1}

Totals

Binned : 100 %

Residual : 0 %

Trace : 1.31 %

Mean (over all sources)

m : 6.89

r : 12.68 km

ε_0 : 0.27 σ

Mode (largest m-r bin)

m : 6.71

r : 8.07 km

ε_0 : 0.28 σ

Contribution : 27.17 %

Mode (largest m-r-ε_0 bin)

m : 6.7

r : 7.3 km

ε_0 : 0.23 σ

Contribution : 16.43 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							89.51
Wasatch (Weber) (0)		7.01	7.03	-0.02	111.960°W	41.338°N	217.76	35.48
Wasatch (Brigham City) (4)		7.19	6.79	0.13	111.969°W	41.342°N	224.89	24.56
Wasatch (Brigham City) (2)		13.08	6.73	0.80	112.023°W	41.467°N	313.57	5.16
Ogden Valley North Fork (1)		1.66	7.17	-0.69	111.902°W	41.384°N	116.15	4.46
Broadmouth Canyon - James Peak (1)		3.78	6.81	-0.47	111.870°W	41.374°N	113.19	4.24
Wasatch (Brigham City) (3)		10.91	6.71	0.61	112.038°W	41.400°N	277.94	4.19
East Cache (8)		10.12	7.21	-0.29	111.781°W	41.422°N	69.67	2.55
Wasatch (Weber) (2)		20.56	6.89	1.18	111.948°W	41.205°N	189.04	1.84
Wasatch (Weber) (1)		13.40	7.04	0.58	111.964°W	41.274°N	199.78	1.62
Wasatch (Brigham City) (1)		17.25	6.60	1.23	112.014°W	41.520°N	329.84	1.21
WUS Branch Average (opt)	Grid							9.36
CEUS Branch Average (opt)	Grid							1.12

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

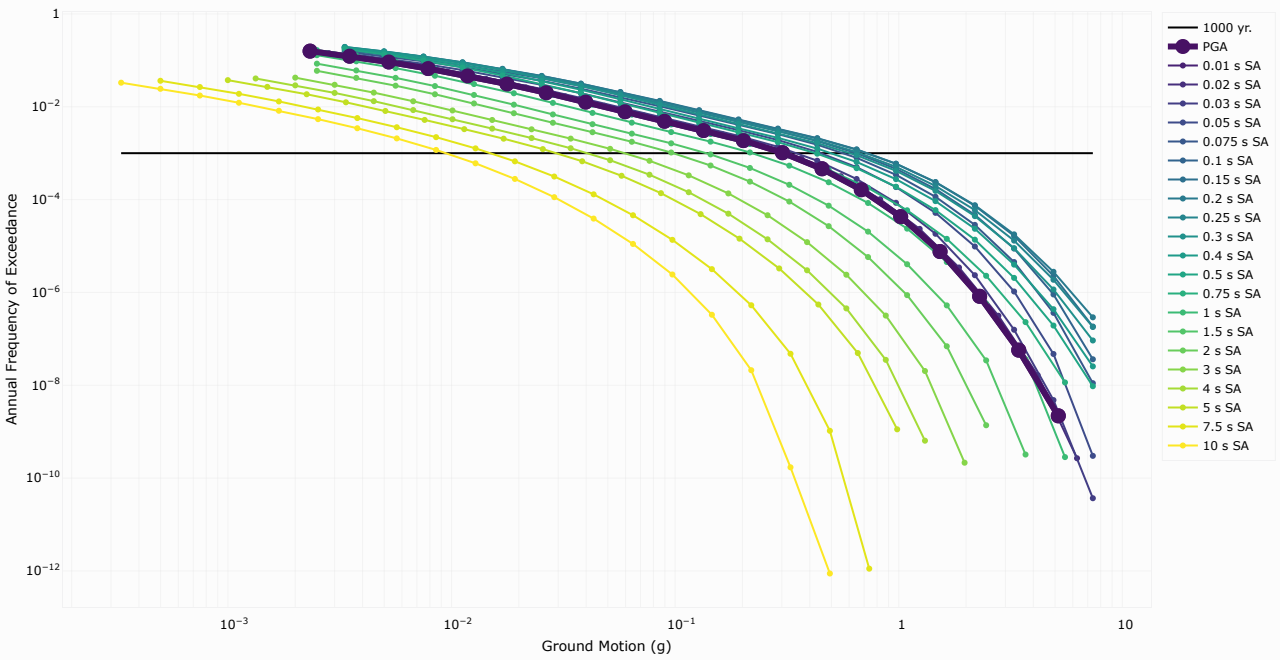
May 27, 2025, 05:09 PM

For Vs30 = 689 m/s

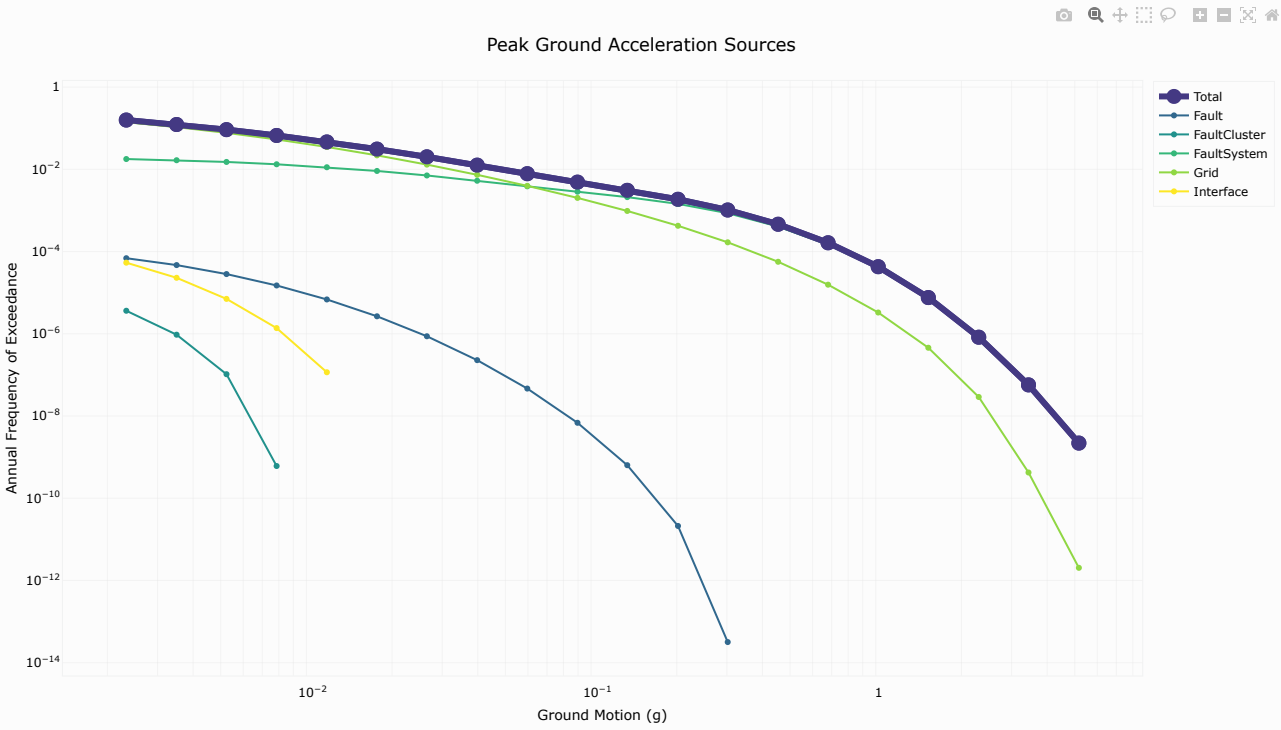
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Hazard

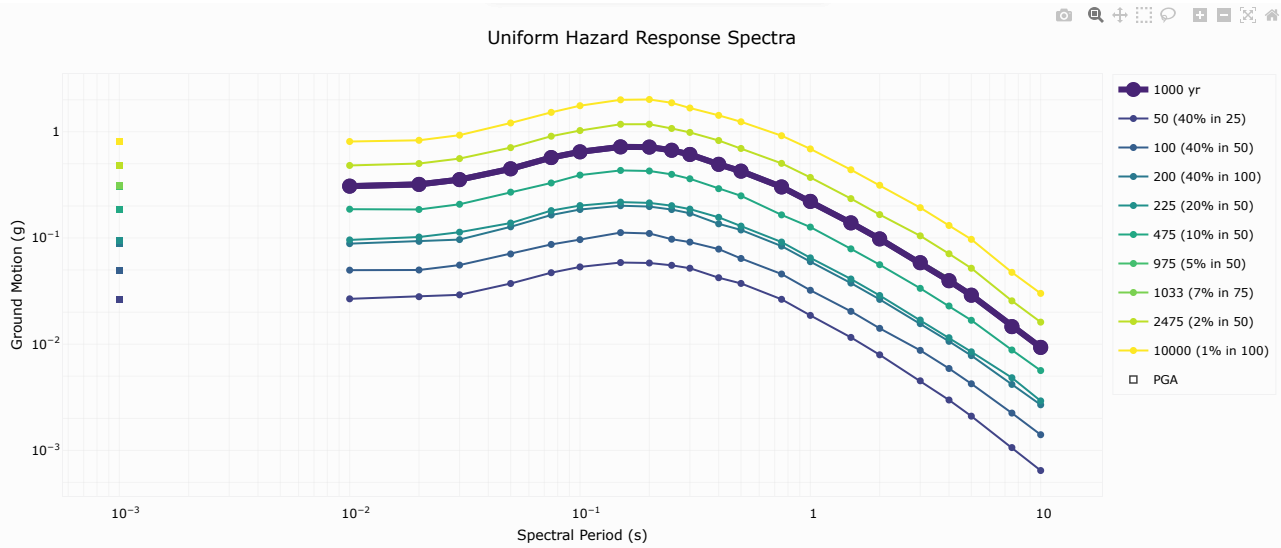


Sources



Spectra

Click on legend entry to highlight



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 689 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Response Spectra Data

Export Response Spectra as CSV

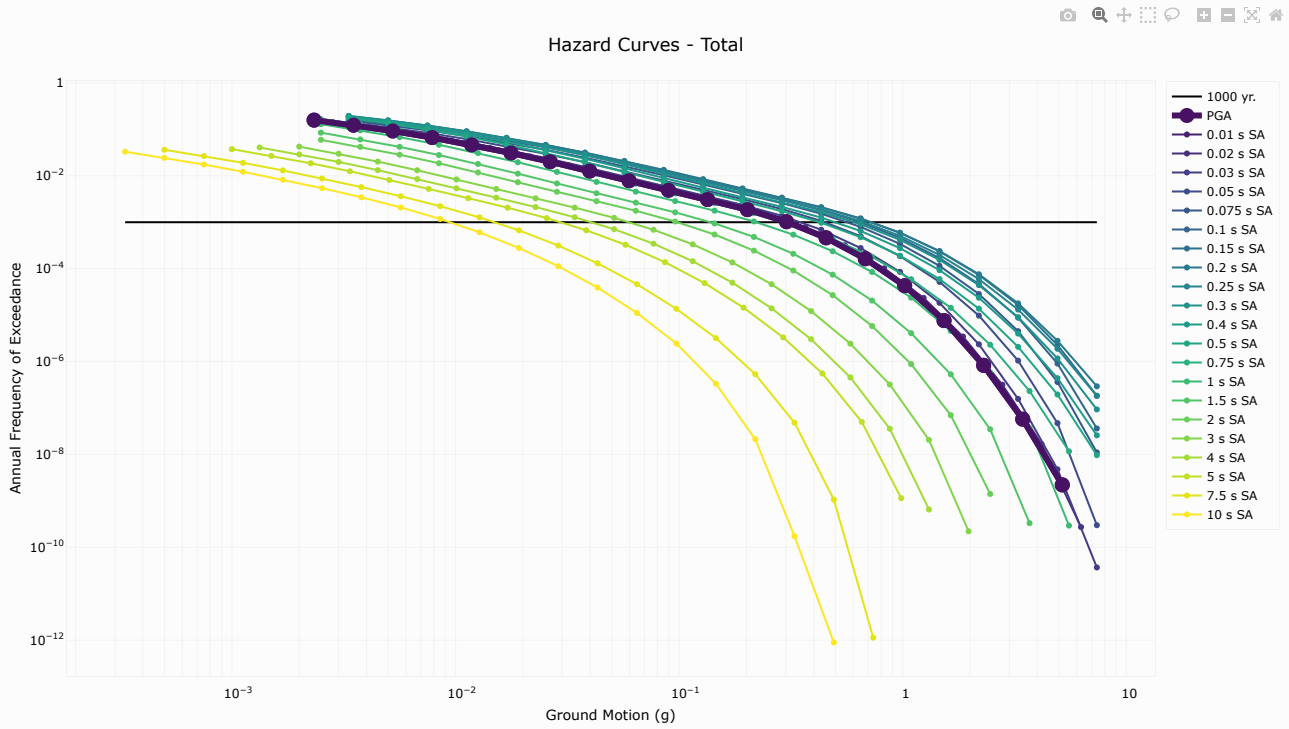
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.306114	26.426936	0.307509	0.319473	0.354193	0.447676	0.571486	0.646907	0.720146	0.717237	0.669305	0.611332	0.493608	0.425607	0.302169	0.220979	0.138666	0.097997	0.058503
50 (40% in 25)	0.026619	1.994973	0.026737	0.028	0.029153	0.037268	0.047105	0.053402	0.058716	0.058148	0.055299	0.051913	0.042253	0.037326	0.026456	0.018666	0.011587	0.007946	0.004523
100 (40% in 50)	0.049521	3.733236	0.04978	0.049947	0.055569	0.070723	0.086932	0.09652	0.112338	0.110283	0.097347	0.091448	0.07855	0.064133	0.045779	0.032192	0.020386	0.014105	0.00875
200 (40% in 100)	0.088044	6.473786	0.088427	0.092926	0.096562	0.12737	0.164449	0.185346	0.201137	0.197508	0.185155	0.170881	0.135913	0.11894	0.083826	0.059805	0.037619	0.026405	0.015614
225 (20% in 50)	0.095489	7.507795	0.095868	0.102078	0.113363	0.138238	0.180963	0.201819	0.217559	0.213874	0.201375	0.186958	0.156387	0.129286	0.091566	0.064987	0.041095	0.028745	0.016887
475 (10% in 50)	0.185734	14.452518	0.186585	0.185412	0.207609	0.27	0.329518	0.390705	0.432278	0.427226	0.396995	0.36077	0.291096	0.24922	0.164963	0.12663	0.078995	0.056004	0.033562
975 (5% in 50)	0.301895	25.994684	0.303276	0.314836	0.348913	0.44148	0.563099	0.637853	0.710358	0.707329	0.65974	0.60224	0.486755	0.419236	0.297401	0.217577	0.136454	0.096478	0.057648
1033 (7% in 75)	0.311526	26.98125	0.312937	0.325418	0.360964	0.455622	0.582241	0.658517	0.732697	0.729943	0.68157	0.622991	0.502396	0.433777	0.308284	0.225342	0.141503	0.099946	0.0596
2475 (2% in 50)	0.479359	43.345006	0.48166	0.501995	0.558923	0.708645	0.907706	1.026255	1.176133	1.177007	1.073506	0.985332	0.826685	0.696241	0.503911	0.371283	0.234649	0.165977	0.104756
10000 (1% in 100)	0.804717	73.91839	0.809121	0.830606	0.928495	1.209266	1.522314	1.758181	1.998064	2.012566	1.872464	1.672552	1.426358	1.240851	0.917769	0.689346	0.438799	0.313454	0.192809

For Vs30 = 688 m/s

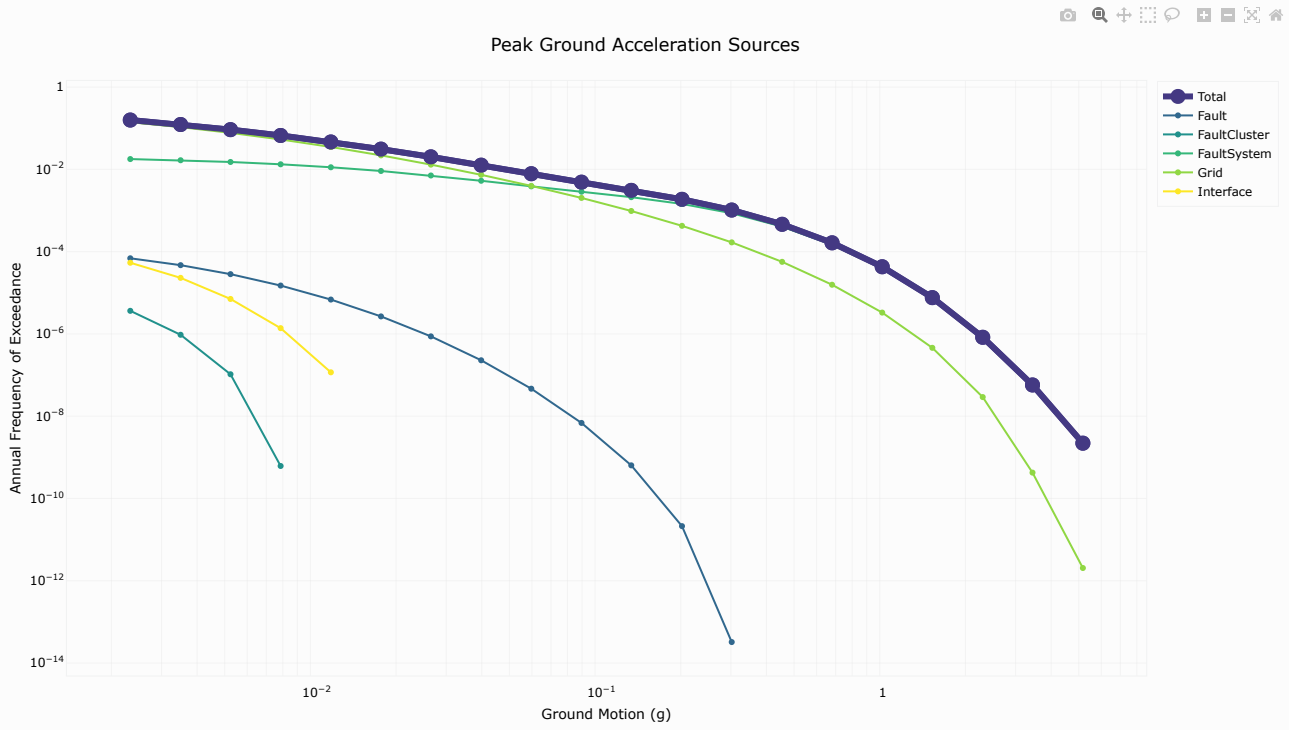
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

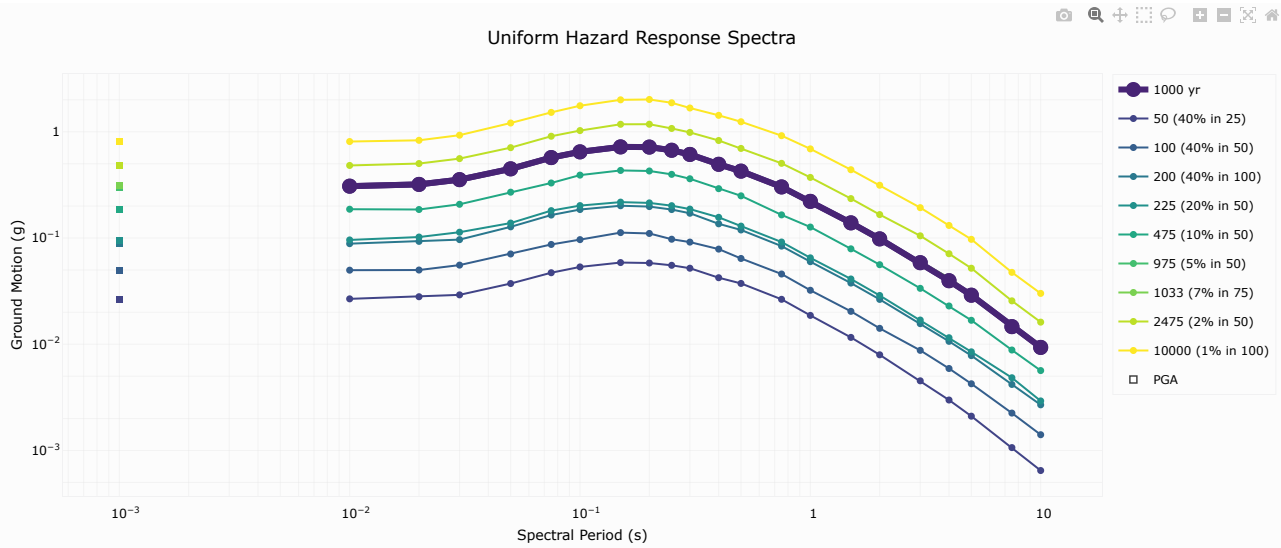
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 688 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Response Spectra Data

Export Response Spectra as CSV

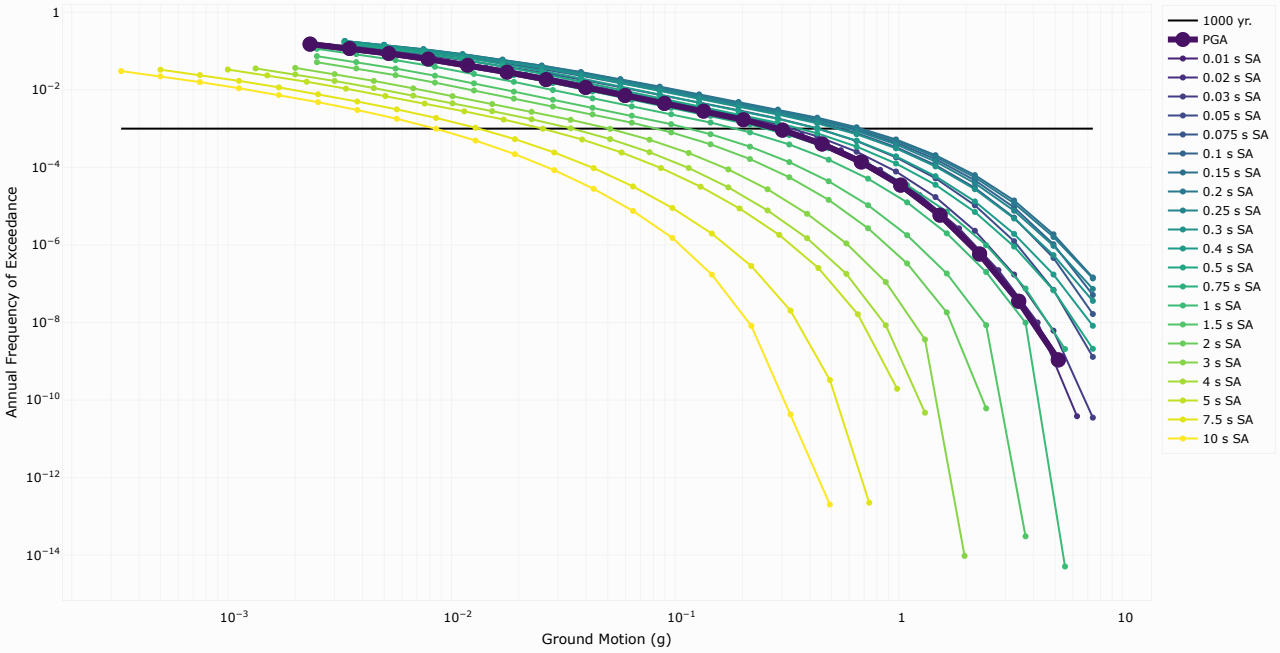
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.306271	26.454197	0.307666	0.319637	0.35432	0.447759	0.571573	0.647052	0.720428	0.717722	0.669934	0.611989	0.494131	0.426129	0.30257	0.22127	0.13886	0.098127	0.058574
50 (40% in 25)	0.026634	1.996641	0.026752	0.028017	0.029165	0.037283	0.047128	0.05343	0.058753	0.058194	0.055351	0.051969	0.042295	0.037369	0.026489	0.01869	0.011603	0.007957	0.004528
100 (40% in 50)	0.049552	3.736732	0.049811	0.049972	0.055594	0.070754	0.086965	0.096561	0.112416	0.11038	0.097425	0.091532	0.07864	0.064198	0.04583	0.032228	0.02041	0.014121	0.008763
200 (40% in 100)	0.08809	6.478827	0.088473	0.09298	0.096597	0.127412	0.164512	0.185425	0.201247	0.197649	0.185322	0.171064	0.136044	0.11908	0.083937	0.059881	0.037672	0.02644	0.015632
225 (20% in 50)	0.095535	7.515625	0.095914	0.102132	0.113416	0.13828	0.181025	0.201896	0.217667	0.214013	0.20154	0.187139	0.156588	0.129425	0.091676	0.065063	0.041148	0.02878	0.016906
475 (10% in 50)	0.185838	14.464384	0.186689	0.185494	0.207685	0.270077	0.329592	0.390842	0.432493	0.42754	0.397384	0.361185	0.291406	0.249544	0.16513	0.126808	0.079115	0.056084	0.033605
975 (5% in 50)	0.30205	26.021636	0.303432	0.314999	0.34904	0.441564	0.563187	0.638	0.71064	0.707812	0.660364	0.602891	0.487274	0.419754	0.297798	0.217866	0.136647	0.096607	0.057719
1033 (7% in 75)	0.311684	27.008906	0.313095	0.325584	0.361092	0.455705	0.582326	0.658662	0.73298	0.730432	0.682206	0.623656	0.502923	0.434304	0.308689	0.225636	0.141699	0.100077	0.059671
2475 (2% in 50)	0.479585	43.388245	0.481885	0.502226	0.559071	0.708708	0.907745	1.026375	1.176512	1.177864	1.074499	0.986359	0.82769	0.697075	0.504556	0.371762	0.234967	0.166193	0.104907
10000 (1% in 100)	0.805101	73.987997	0.809503	0.830937	0.928638	1.209228	1.522213	1.758172	1.998414	2.013918	1.87434	1.674201	1.427985	1.242457	0.919045	0.690302	0.43944	0.313893	0.193063

For Vs30 = 813 m/s

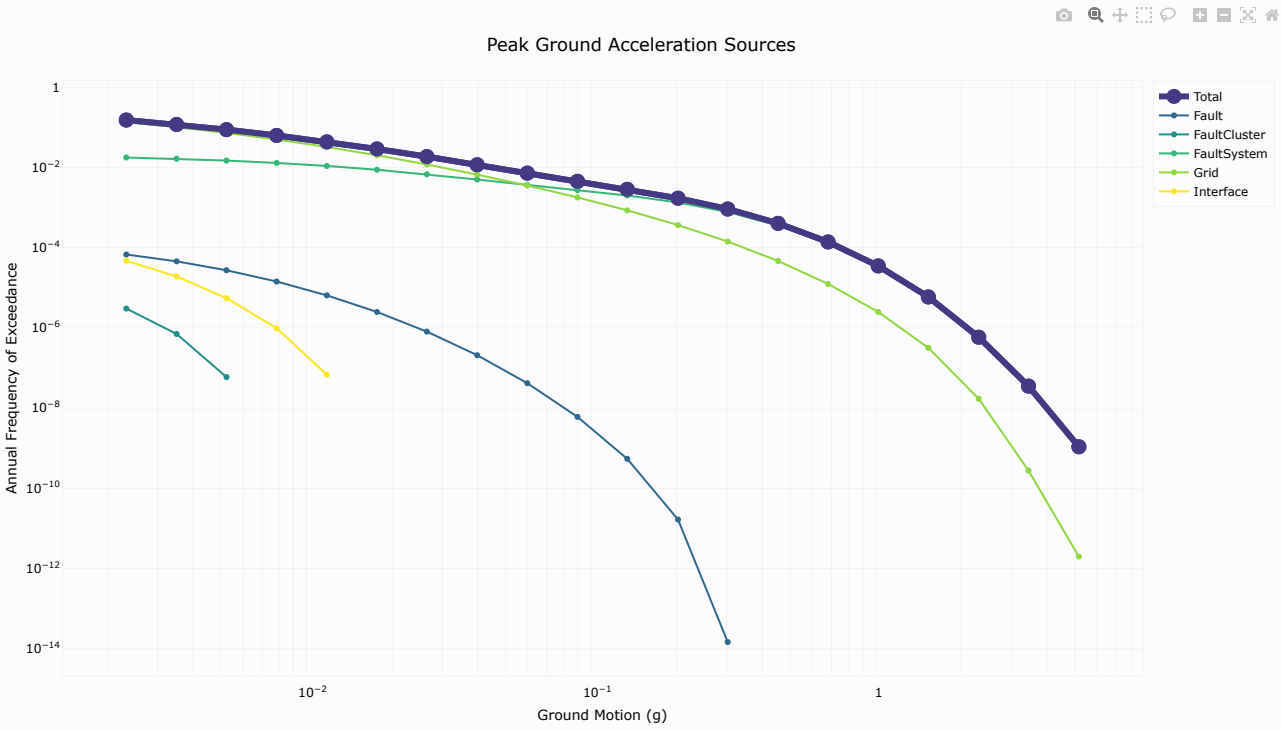
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

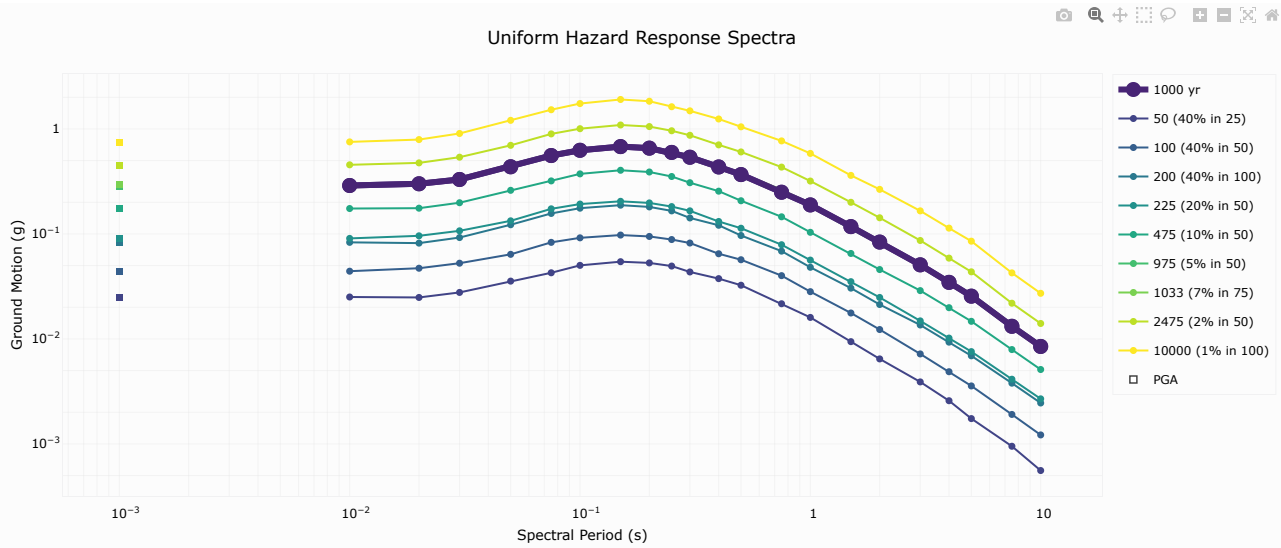
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 813 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Response Spectra Data

Export Response Spectra as CSV

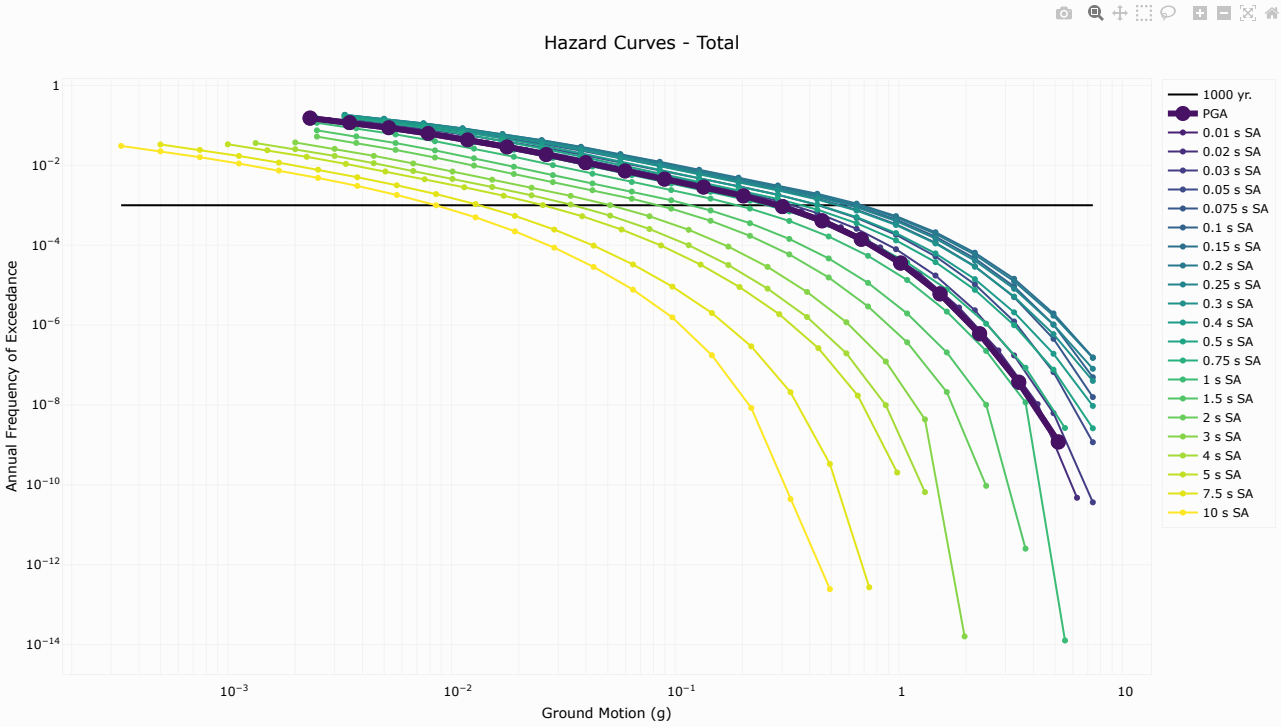
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.287825	23.042843	0.289194	0.300423	0.3301	0.436111	0.557925	0.626228	0.678964	0.656187	0.59763	0.537554	0.434415	0.367559	0.24959	0.188903	0.117395	0.083656	0.05077
50 (40% in 25)	0.024957	1.810133	0.025074	0.024828	0.02772	0.035533	0.042657	0.05019	0.05441	0.052953	0.049438	0.04343	0.037529	0.032468	0.021632	0.016023	0.009421	0.00645	0.003895
100 (40% in 50)	0.043982	3.341684	0.044164	0.047139	0.052629	0.063916	0.083136	0.091789	0.097557	0.094628	0.088435	0.081918	0.064737	0.056798	0.040068	0.028196	0.017658	0.01229	0.007197
200 (40% in 100)	0.082763	5.904783	0.083153	0.081758	0.092377	0.122325	0.15674	0.175854	0.187914	0.180864	0.165802	0.141998	0.120919	0.096606	0.068584	0.048105	0.030466	0.021266	0.013576
225 (20% in 50)	0.090259	6.403721	0.090645	0.095948	0.107038	0.13328	0.173424	0.192496	0.204482	0.197377	0.182197	0.165953	0.131372	0.113319	0.078952	0.056344	0.035111	0.024828	0.014853
475 (10% in 50)	0.173708	13.087534	0.174552	0.175879	0.198255	0.260279	0.319883	0.373219	0.403986	0.388912	0.352409	0.30751	0.255444	0.207087	0.145599	0.103613	0.065174	0.045801	0.028857
975 (5% in 50)	0.28374	22.698958	0.285095	0.295925	0.325679	0.429894	0.549456	0.617141	0.669363	0.646738	0.588698	0.529138	0.428026	0.361689	0.246074	0.185761	0.111259	0.082248	0.049965
1033 (7% in 75)	0.293063	23.483836	0.29445	0.30619	0.33577	0.444083	0.568786	0.63788	0.691276	0.668304	0.609084	0.548346	0.442609	0.375086	0.263572	0.192931	0.120008	0.085463	0.051801
2475 (2% in 50)	0.453007	38.595187	0.455302	0.475083	0.538251	0.697871	0.897025	1.005233	1.090217	1.053322	0.960891	0.869987	0.705144	0.603987	0.433055	0.318946	0.20014	0.142504	0.086617
10000 (1% in 100)	0.748689	66.228122	0.752674	0.792106	0.905187	1.207534	1.523894	1.744774	1.908254	1.835651	1.627515	1.486888	1.244244	1.047603	0.769232	0.584768	0.361104	0.265753	0.165885

For Vs30 = 799 m/s

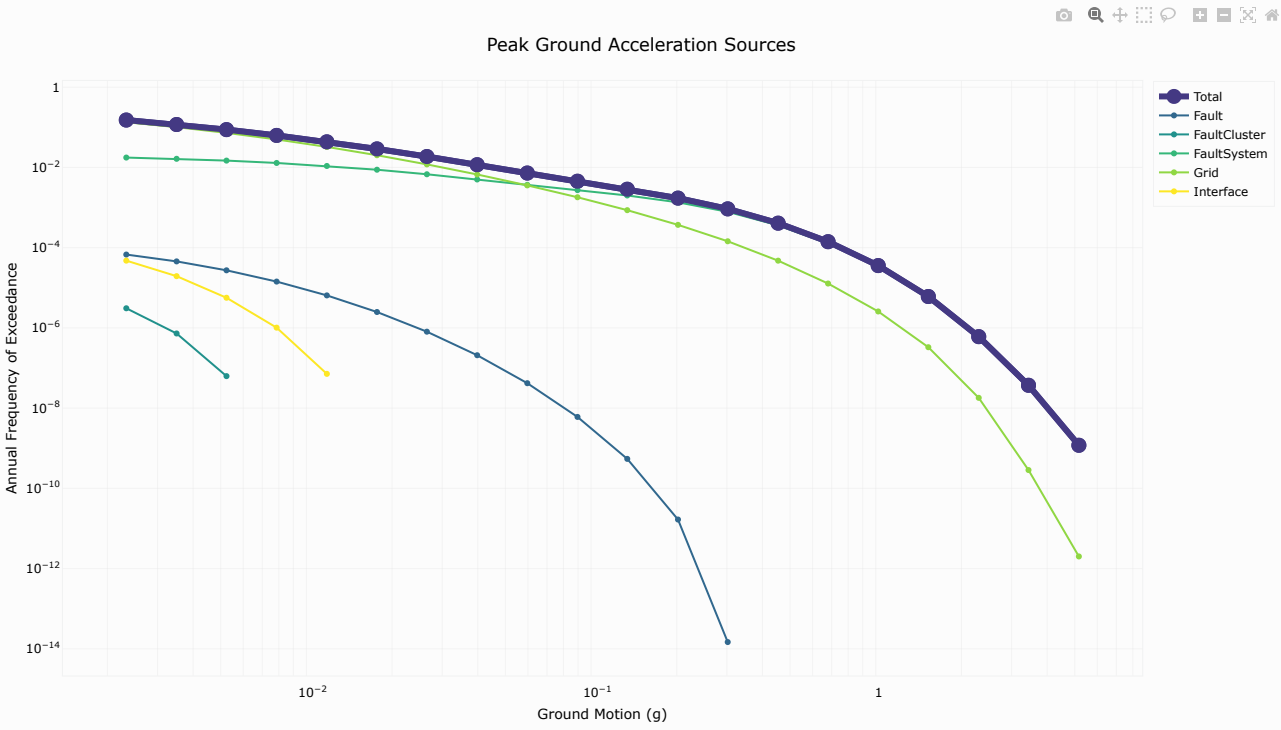
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

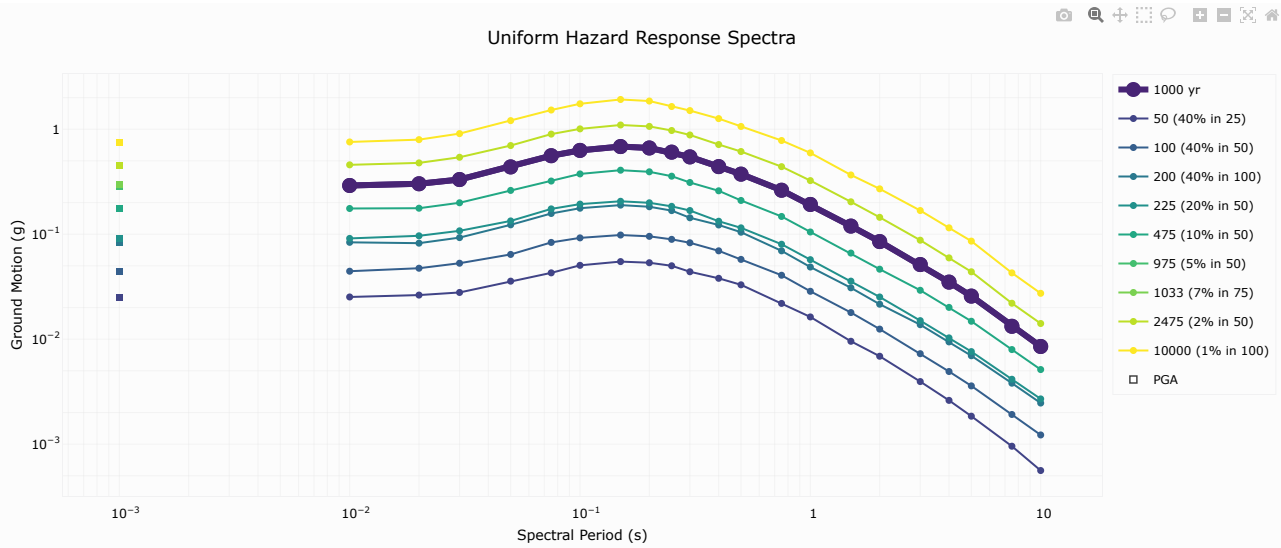
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 799 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 16, 2025, 01:25 PM

Response Spectra Data

Export Response Spectra as CSV

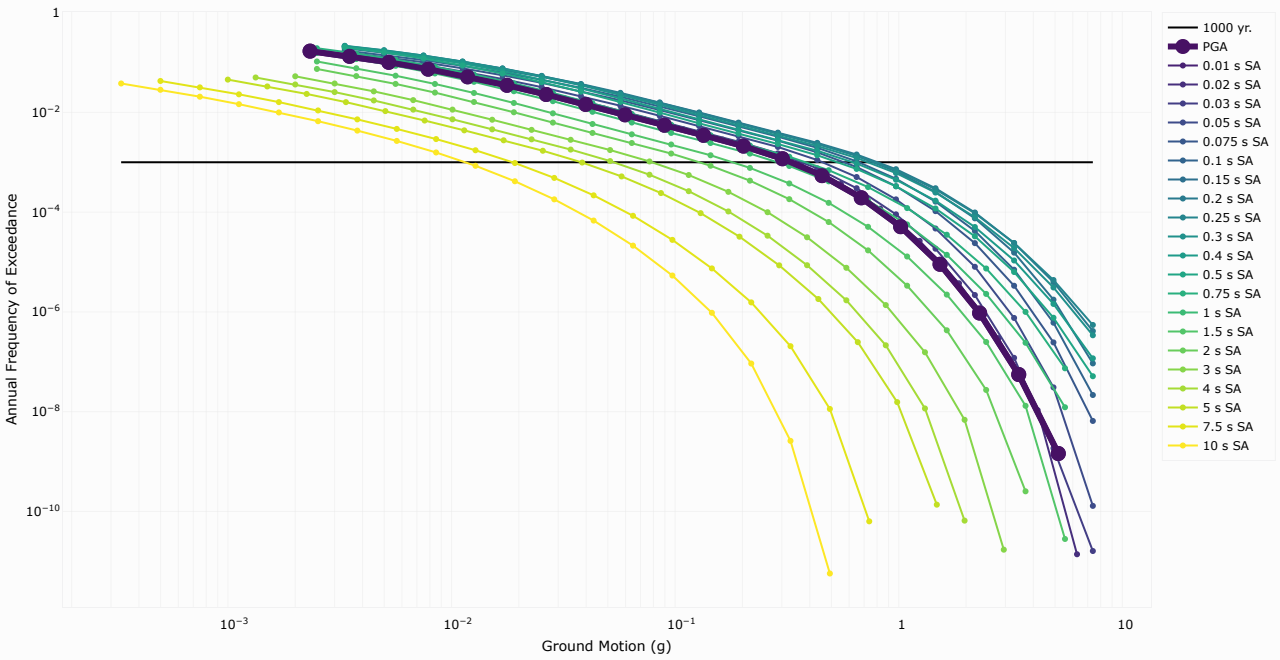
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.289777	23.297854	0.291148	0.302448	0.3318	0.437521	0.559696	0.628791	0.684004	0.66312	0.605138	0.54519	0.440568	0.373499	0.262437	0.192145	0.119537	0.08511	0.0514
50 (40% in 25)	0.025126	1.828915	0.025243	0.026318	0.02787	0.035717	0.042858	0.050531	0.054865	0.053498	0.050048	0.043899	0.038018	0.032972	0.021914	0.01629	0.009553	0.006881	0.003948
100 (40% in 50)	0.044238	3.38191	0.04442	0.047425	0.05294	0.064187	0.083546	0.092296	0.098246	0.09546	0.089366	0.082913	0.069463	0.05756	0.040661	0.028601	0.017936	0.012476	0.007277
200 (40% in 100)	0.083317	5.963694	0.083707	0.082175	0.09283	0.122878	0.157597	0.176901	0.18937	0.182669	0.167864	0.143457	0.122505	0.10453	0.069455	0.048695	0.030876	0.02154	0.013743
225 (20% in 50)	0.09081	6.461813	0.091195	0.096587	0.10773	0.133826	0.174267	0.193528	0.205927	0.19917	0.184242	0.168189	0.132945	0.115012	0.080286	0.05724	0.035735	0.025238	0.015019
475 (10% in 50)	0.174985	13.230644	0.17583	0.176896	0.199328	0.261396	0.321024	0.375249	0.407269	0.393172	0.357102	0.311032	0.259199	0.209721	0.147657	0.104995	0.066133	0.046429	0.029236
975 (5% in 50)	0.285678	22.951564	0.287035	0.297935	0.327368	0.431304	0.551231	0.619703	0.674371	0.653611	0.596136	0.536701	0.434127	0.367575	0.249539	0.188975	0.117481	0.083689	0.05059
1033 (7% in 75)	0.295035	23.741933	0.296424	0.308235	0.337483	0.445494	0.570552	0.640446	0.696358	0.675314	0.616681	0.556075	0.448829	0.381095	0.268119	0.19621	0.122174	0.086932	0.052437
2475 (2% in 50)	0.455825	39.076501	0.45812	0.477961	0.540956	0.699335	0.898736	1.008127	1.097705	1.064282	0.972658	0.881932	0.715006	0.613394	0.440237	0.324211	0.203603	0.144864	0.087684
10000 (1% in 100)	0.752768	67.011792	0.756737	0.796202	0.908689	1.208279	1.524663	1.747522	1.92139	1.856446	1.646428	1.506166	1.26303	1.062958	0.781115	0.595318	0.366899	0.270551	0.168123

For Vs30 = 530 m/s (Site Class C)

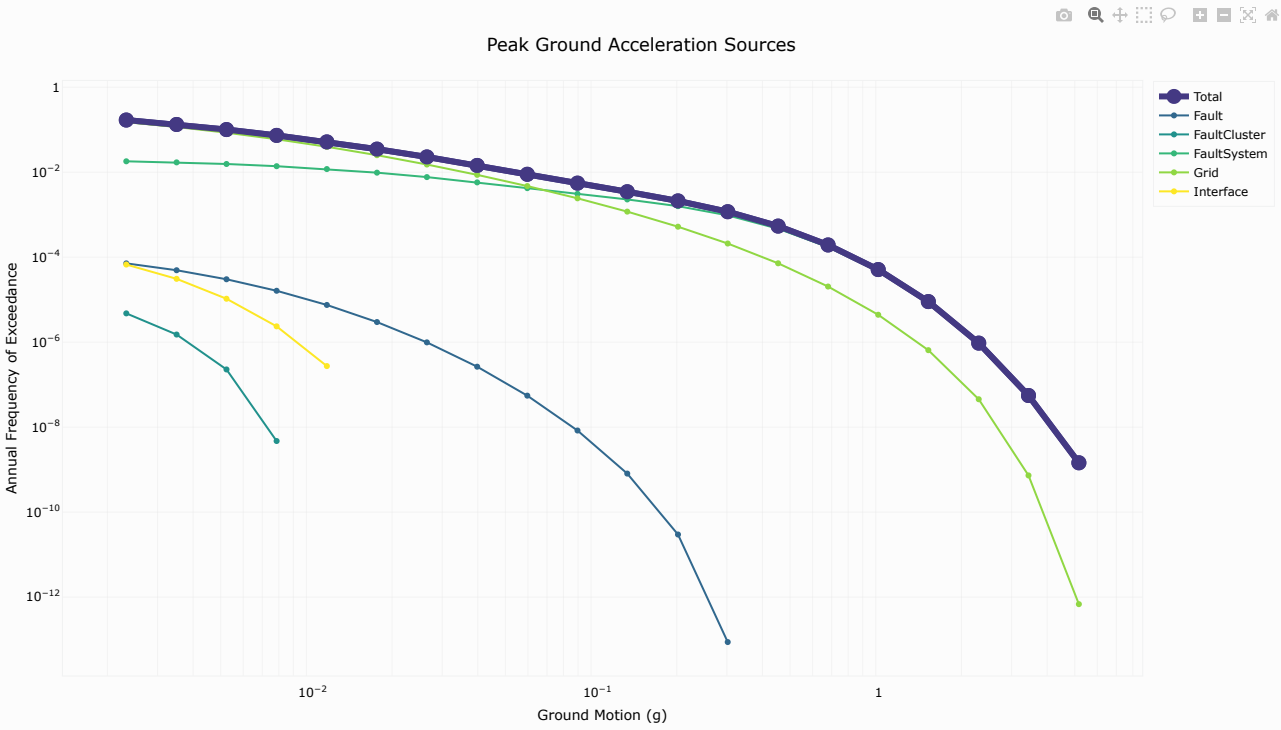
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

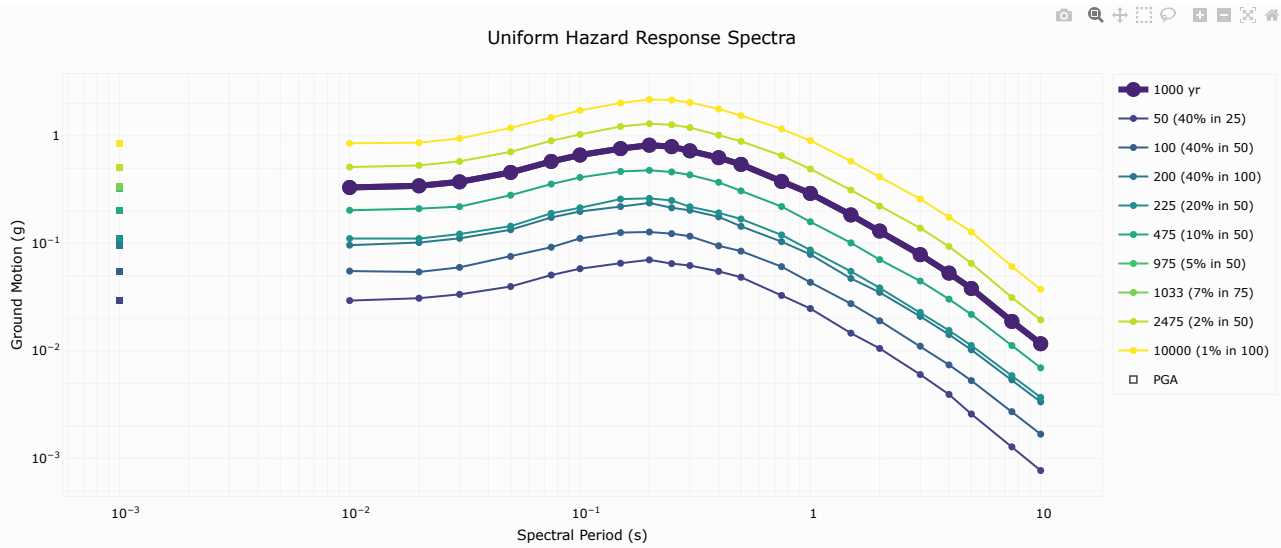
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Site Class: C (Vs30 530)

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.10
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Response Spectra Data

Export Response Spectra as CSV

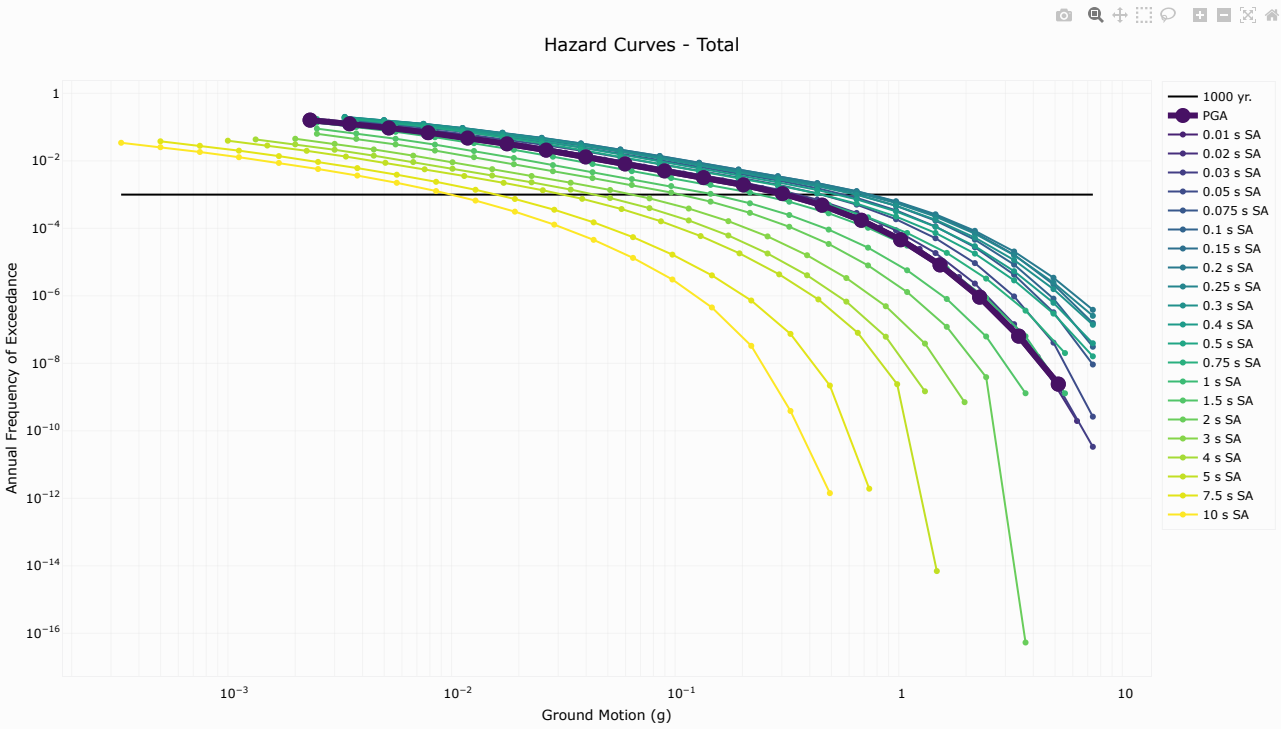
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.329713	31.565409	0.331152	0.342989	0.373433	0.456739	0.577982	0.663163	0.761242	0.818973	0.79329	0.725752	0.62683	0.542789	0.377044	0.291512	0.18391	0.130275	0.078615
50 (40% in 25)	0.02927	2.491493	0.029389	0.030928	0.033576	0.039719	0.050756	0.05817	0.065408	0.070303	0.064895	0.062269	0.054954	0.048456	0.032798	0.024793	0.014635	0.010547	0.006032
100 (40% in 50)	0.055036	4.371234	0.055293	0.054265	0.059864	0.075644	0.092129	0.111259	0.125988	0.127676	0.123203	0.116613	0.095023	0.084758	0.060799	0.043444	0.027529	0.01907	0.01108
200 (40% in 100)	0.095867	8.126197	0.096246	0.10189	0.111456	0.133941	0.17419	0.198176	0.219895	0.237777	0.21433	0.203322	0.17661	0.144154	0.10381	0.079012	0.047232	0.035031	0.020949
225 (20% in 50)	0.11041	8.884183	0.110983	0.110894	0.122116	0.144648	0.190355	0.214313	0.25824	0.262248	0.250745	0.219034	0.192275	0.168711	0.119825	0.086865	0.054938	0.038561	0.022862
475 (10% in 50)	0.202364	17.896851	0.203227	0.210553	0.219627	0.280678	0.356028	0.410332	0.46668	0.478184	0.461613	0.433644	0.369875	0.307796	0.220221	0.15885	0.10118	0.070637	0.044675
975 (5% in 50)	0.325385	31.078079	0.326812	0.338259	0.36815	0.45069	0.569923	0.654389	0.751566	0.80686	0.759708	0.715834	0.617544	0.534122	0.371765	0.286725	0.18078	0.128114	0.077384
1033 (7% in 75)	0.335263	32.190353	0.336717	0.349054	0.380207	0.464496	0.588317	0.674414	0.795965	0.834506	0.808836	0.73847	0.638738	0.553903	0.398796	0.29765	0.187923	0.133046	0.080193
2475 (2% in 50)	0.510443	51.5399	0.512789	0.531223	0.579384	0.710077	0.899381	1.030091	1.221426	1.297402	1.269188	1.193567	1.01457	0.889766	0.654305	0.491792	0.313143	0.221974	0.138697
10000 (1% in 100)	0.84897	90.058948	0.853244	0.864529	0.944844	1.186108	1.479894	1.722481	2.019178	2.179035	2.156233	2.040626	1.778061	1.540804	1.159905	0.903686	0.580272	0.416001	0.258698

For Vs30 = 640 m/s (C to BC Boundary)

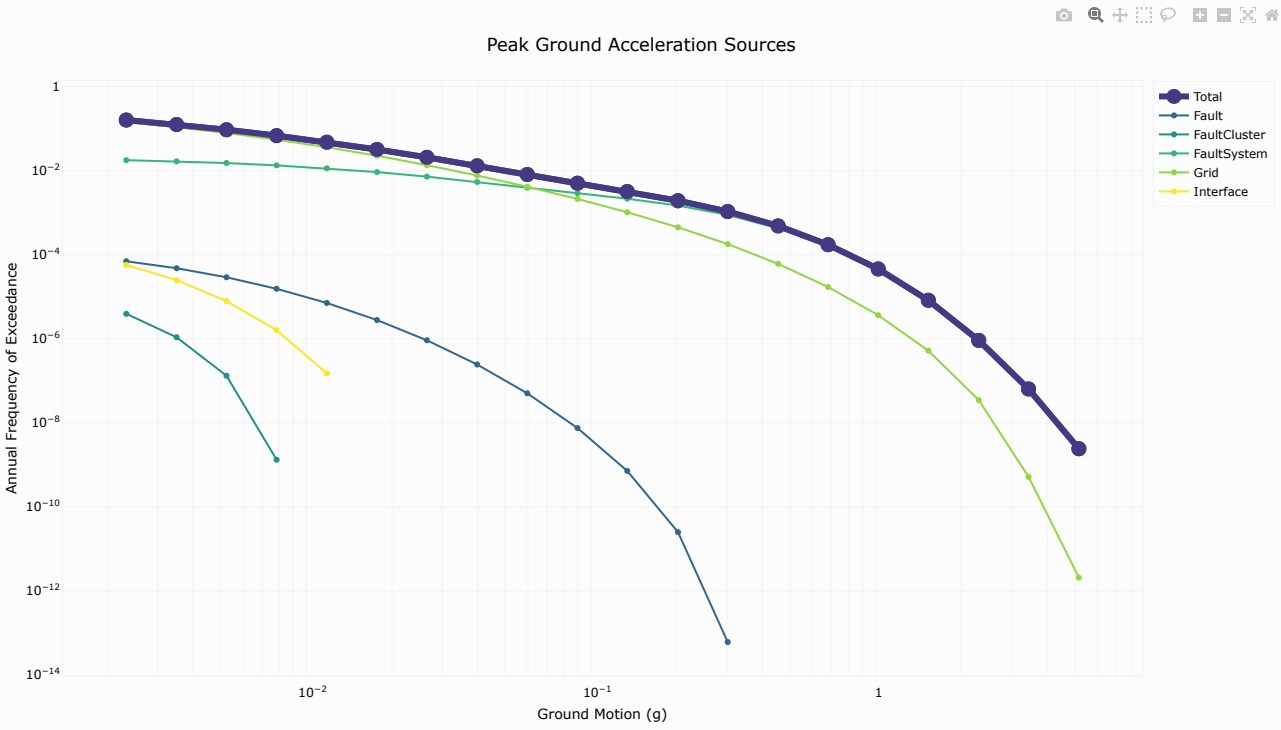
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Hazard

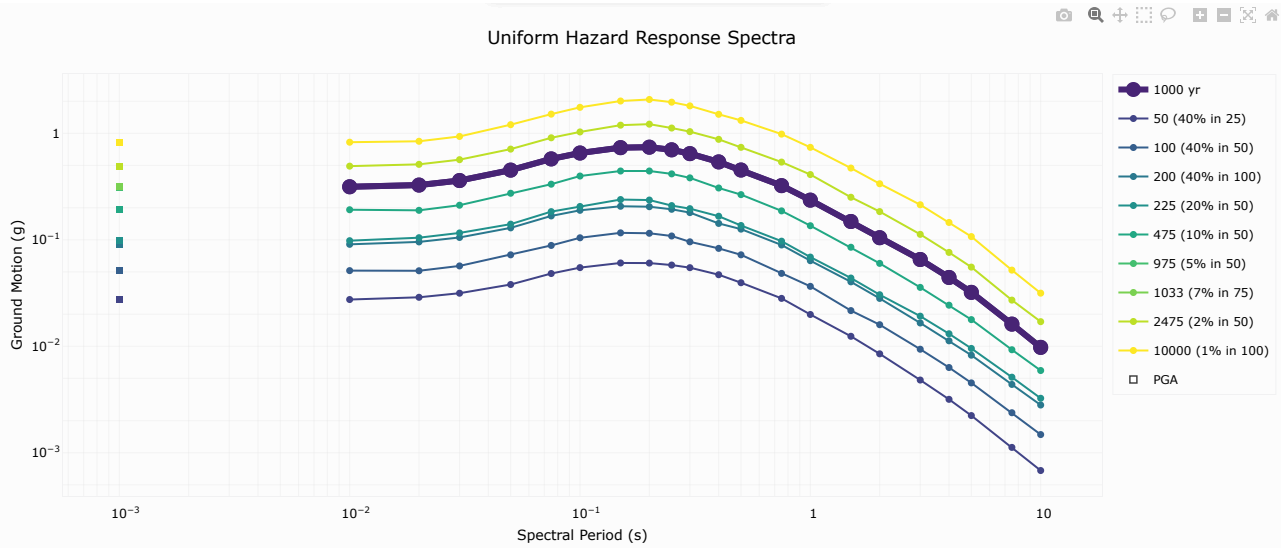


Sources



Spectra

Click on legend entry to highlight



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 640 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Response Spectra Data

Export Response Spectra as CSV

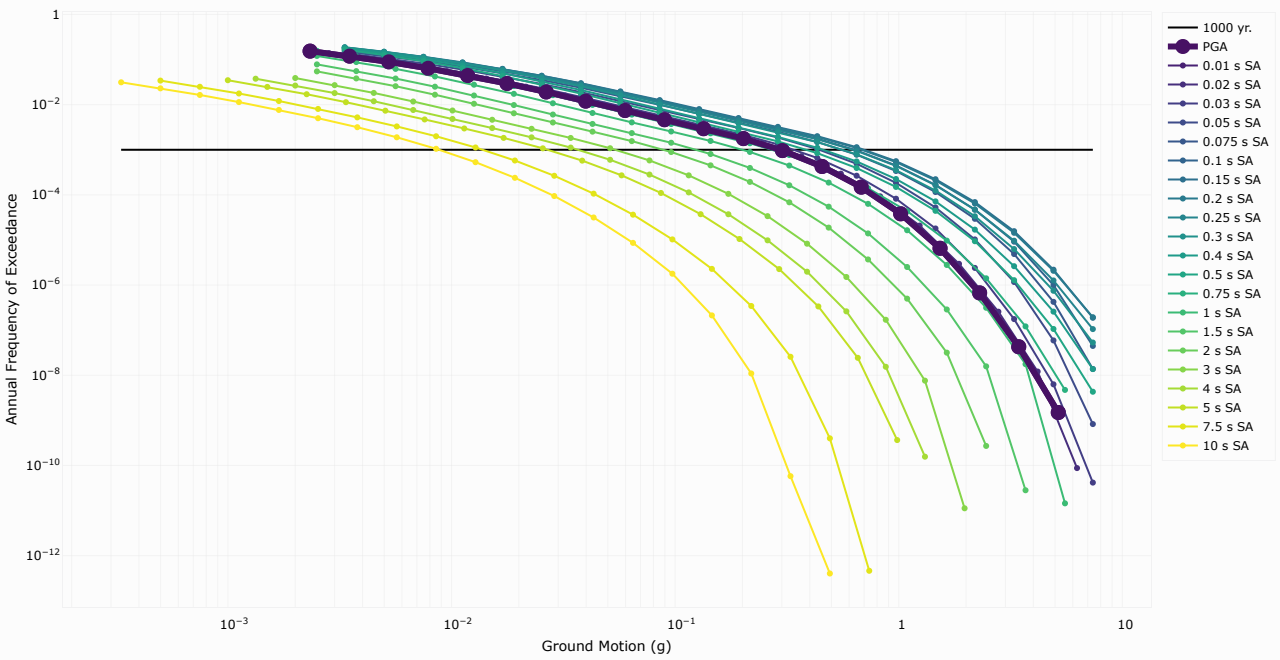
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.313606	27.831841	0.315013	0.326805	0.360448	0.45153	0.575298	0.653607	0.733817	0.741548	0.7002	0.64491	0.539161	0.452373	0.322788	0.235897	0.148658	0.104693	0.065344
50 (40% in 25)	0.027376	2.08027	0.027494	0.028851	0.031519	0.038033	0.04824	0.054816	0.060627	0.060478	0.057946	0.054757	0.047017	0.039542	0.028183	0.019888	0.012412	0.008495	0.00482
100 (40% in 50)	0.051116	3.911471	0.051374	0.051206	0.056856	0.072279	0.088562	0.104503	0.116288	0.115223	0.108642	0.09575	0.0831	0.072312	0.048381	0.036563	0.021642	0.015952	0.009384
200 (40% in 100)	0.09034	6.730048	0.090722	0.095591	0.10525	0.129485	0.167606	0.189288	0.206639	0.204635	0.19354	0.180157	0.142547	0.126028	0.089441	0.063686	0.040302	0.028166	0.016559
225 (20% in 50)	0.097756	7.903036	0.098134	0.104703	0.116033	0.140306	0.184024	0.205669	0.238944	0.236353	0.209673	0.19614	0.166567	0.136309	0.097131	0.068834	0.043757	0.030498	0.019182
475 (10% in 50)	0.190801	15.049377	0.191656	0.189257	0.211362	0.273726	0.333032	0.397305	0.442916	0.442968	0.416289	0.381881	0.306763	0.26573	0.186995	0.135689	0.085165	0.060086	0.035739
975 (5% in 50)	0.30934	27.383902	0.310734	0.322131	0.355157	0.445362	0.56698	0.644605	0.724028	0.731501	0.690398	0.635534	0.530614	0.445794	0.31786	0.232389	0.146373	0.103128	0.064212
1033 (7% in 75)	0.319076	28.406272	0.3205	0.332799	0.367233	0.45944	0.585965	0.665152	0.746369	0.754431	0.712768	0.656935	0.550121	0.46081	0.329108	0.240396	0.151589	0.106701	0.066795
2475 (2% in 50)	0.4898	45.573996	0.49211	0.511526	0.566051	0.711185	0.908613	1.031091	1.193735	1.220072	1.121785	1.037918	0.878292	0.739196	0.537235	0.410264	0.251094	0.184166	0.112578
10000 (1% in 100)	0.821413	77.502729	0.825741	0.842515	0.935173	1.206245	1.515439	1.755268	2.012809	2.080685	1.962701	1.812123	1.50971	1.323329	0.983556	0.738881	0.472049	0.33626	0.213525

For Vs30 = 760 m/s (Site Class BC)

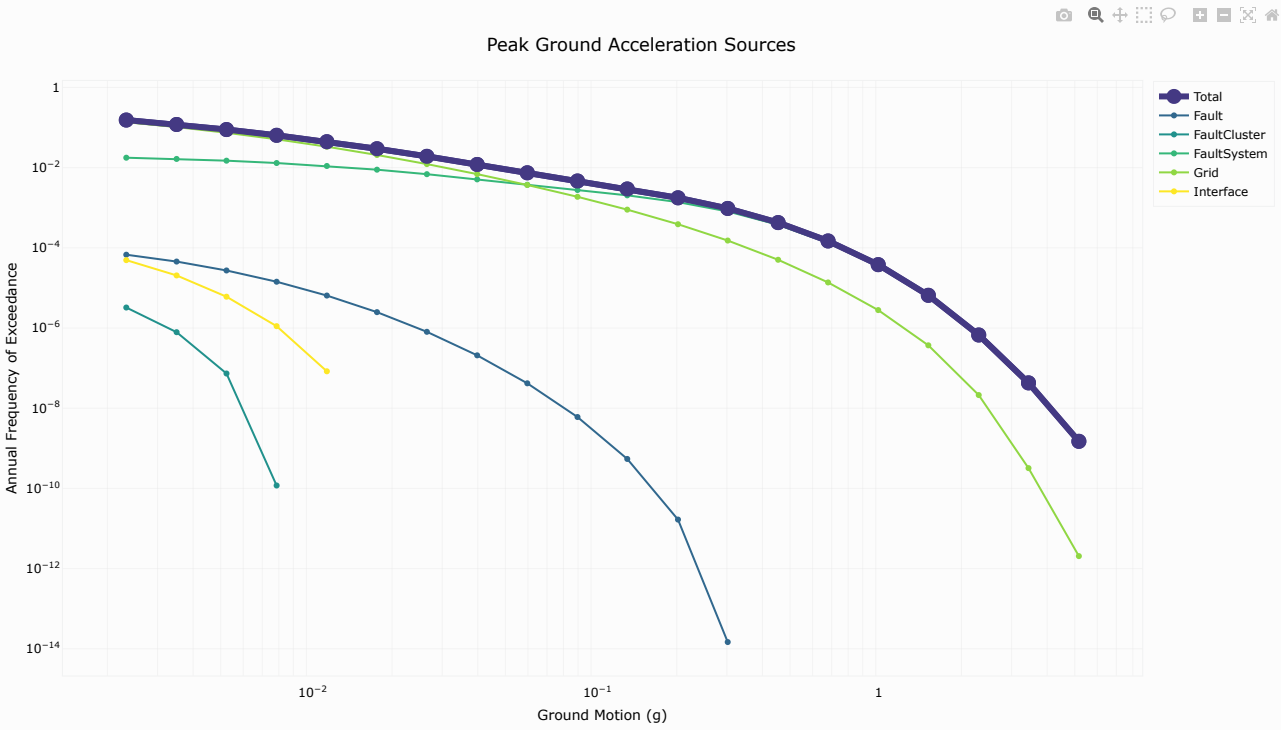
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Hazard

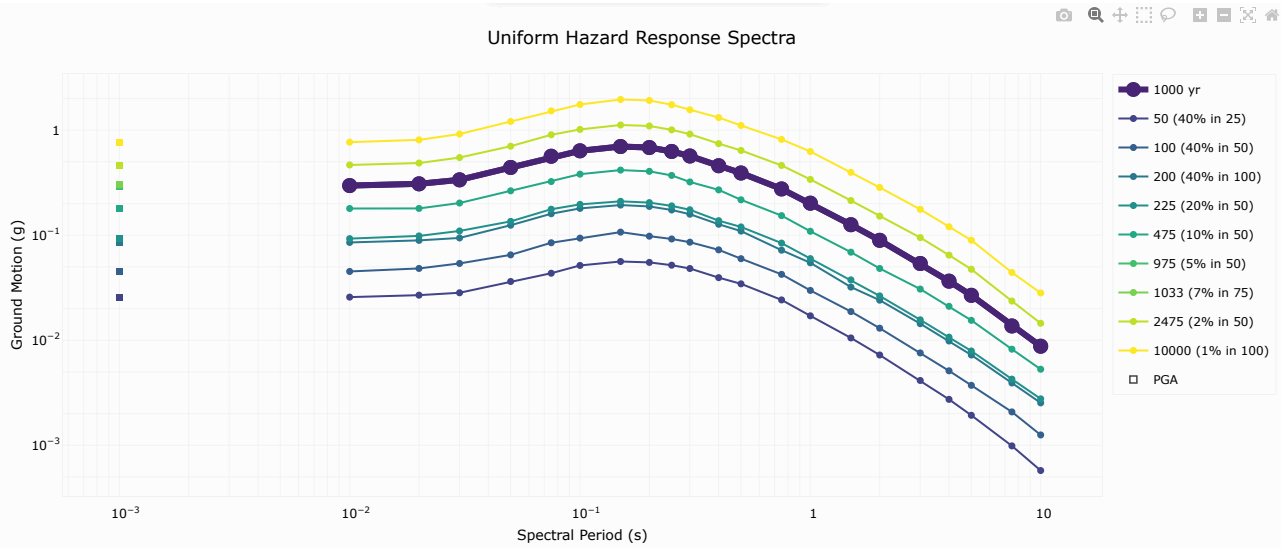


Sources



Spectra

Click on legend entry to highlight



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Site Class: BC (Vs30 760)

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Click on legend entry to highlight

Response Spectra Data

Export Response Spectra as CSV

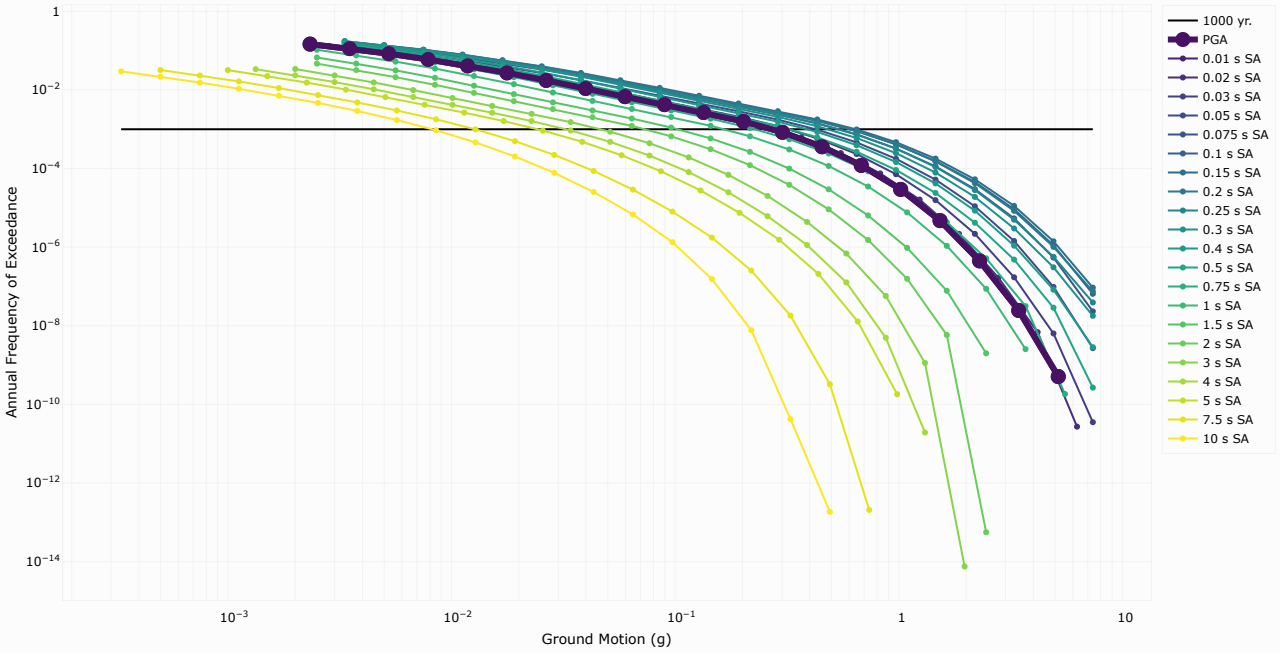
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
1000 yr	0.295418	24.03874	0.296796	0.308299	0.336536	0.441469	0.56458	0.635938	0.698473	0.68324	0.627032	0.567529	0.458509	0.390905	0.275626	0.201704	0.125857	0.089379	0.053764
50 (40% in 25)	0.025616	1.883447	0.025734	0.026865	0.028307	0.036248	0.043439	0.051513	0.056179	0.055076	0.051816	0.048185	0.039437	0.034431	0.024204	0.01708	0.010516	0.007236	0.004139
100 (40% in 50)	0.044981	3.498197	0.045163	0.048252	0.053848	0.064969	0.084724	0.093756	0.107	0.097871	0.092062	0.085793	0.072536	0.059767	0.042378	0.029797	0.018755	0.013019	0.007574
200 (40% in 100)	0.084914	6.133492	0.0853	0.089238	0.094142	0.124462	0.160045	0.179894	0.193553	0.187861	0.173794	0.158418	0.127068	0.109438	0.07197	0.054627	0.032077	0.024068	0.014373
225 (20% in 50)	0.092394	6.629391	0.092776	0.098427	0.109726	0.135387	0.176672	0.196478	0.210078	0.204327	0.190123	0.174615	0.137469	0.119876	0.084121	0.059861	0.037552	0.026424	0.015647
475 (10% in 50)	0.178671	13.642622	0.179516	0.179818	0.202372	0.264565	0.32424	0.380997	0.416695	0.405481	0.370736	0.321139	0.270065	0.217271	0.153572	0.109001	0.068914	0.048238	0.030688
975 (5% in 50)	0.291275	23.685657	0.292639	0.303742	0.332079	0.435252	0.55613	0.626848	0.688749	0.67356	0.617831	0.55883	0.451921	0.384826	0.271079	0.198453	0.123747	0.087924	0.052939
1033 (7% in 75)	0.300731	25.153696	0.302126	0.314143	0.351984	0.449441	0.575416	0.647594	0.710942	0.695653	0.638832	0.578684	0.466958	0.3987	0.281457	0.205873	0.128563	0.091245	0.054822
2475 (2% in 50)	0.463971	40.487414	0.466266	0.486268	0.548312	0.703343	0.90327	1.016004	1.119205	1.096152	1.007012	0.916864	0.743892	0.641002	0.461328	0.33973	0.213817	0.151813	0.094909
10000 (1% in 100)	0.76459	69.304799	0.768511	0.808063	0.917875	1.210109	1.526281	1.754513	1.959282	1.916832	1.746482	1.56242	1.317932	1.107954	0.815997	0.626364	0.396686	0.284664	0.17622

For Vs30 = 914 m/s (BC to B Boundary)

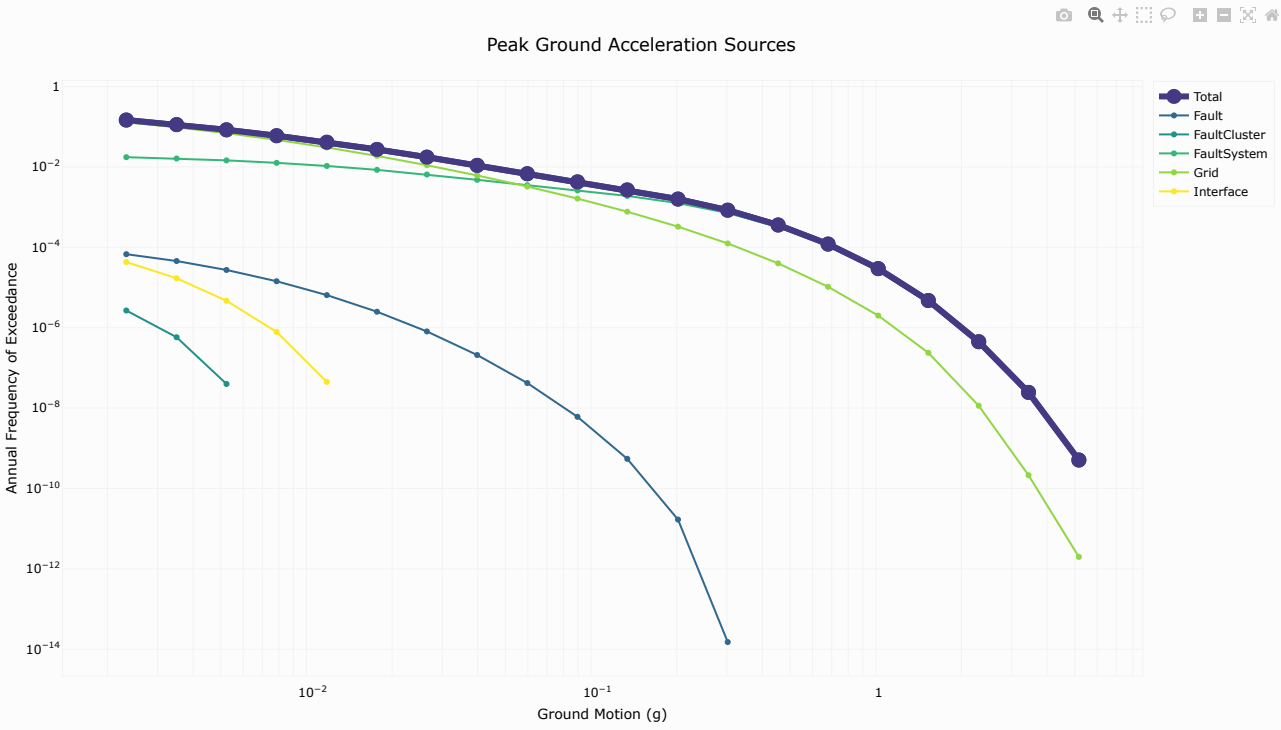
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

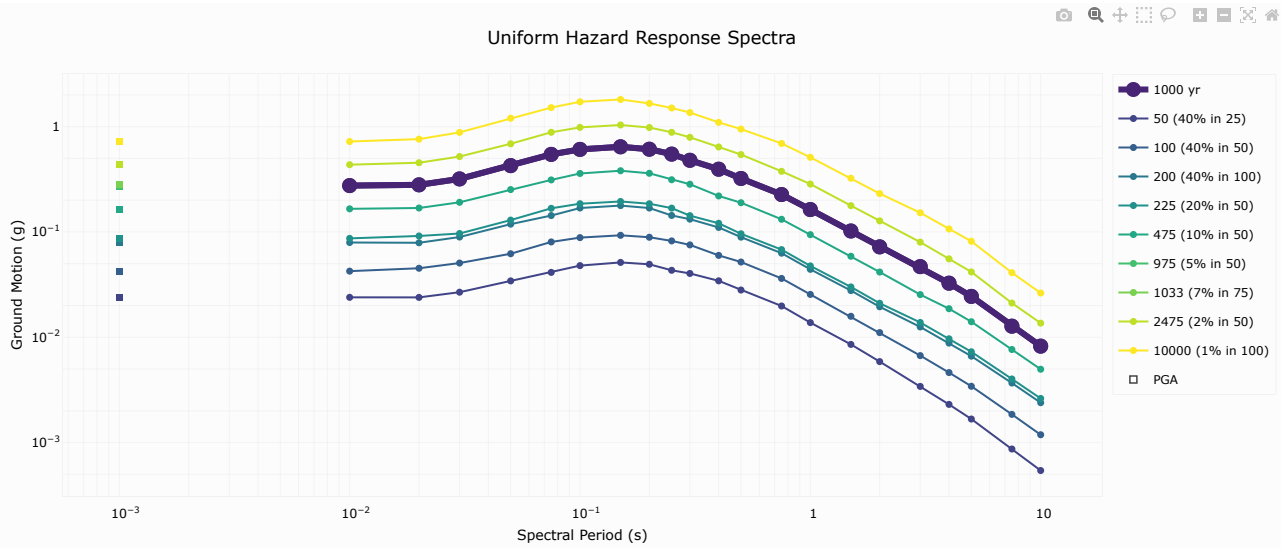
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 914 m/s

Return Period: 1000 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.9
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

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Response Spectra Data

Export Response Spectra as CSV

IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	S
1000 yr	0.274176	21.359739	0.27553	0.280068	0.318741	0.426139	0.545076	0.607802	0.643352	0.61027	0.548358	0.479029	0.3942	0.321843	0.226555	0.163143	0.102098	0
50 (40% in 25)	0.023822	1.685443	0.02394	0.02391	0.026789	0.034297	0.041302	0.047895	0.051362	0.049314	0.043238	0.040359	0.034345	0.028081	0.019815	0.013783	0.008556	0
100 (40% in 50)	0.042255	2.952222	0.042439	0.04521	0.050667	0.062087	0.080359	0.088363	0.092919	0.089064	0.082214	0.075341	0.059901	0.051822	0.036198	0.025507	0.015822	0
200 (40% in 100)	0.078978	5.507493	0.079378	0.07892	0.089485	0.118558	0.143087	0.168682	0.177951	0.16865	0.143404	0.132275	0.110332	0.089275	0.062852	0.044162	0.027749	0
225 (20% in 50)	0.086496	6.012524	0.086891	0.091581	0.096613	0.129562	0.167636	0.185415	0.194583	0.185245	0.16834	0.142819	0.120872	0.096079				
475 (10% in 50)	0.164944	12.126504	0.165784	0.168824	0.191187	0.252562	0.311896	0.359069	0.381214	0.360491	0.313107	0.283809	0.219697	0.18941				
975 (5% in 50)	0.270207	21.032539	0.271546	0.276342	0.314396	0.419933	0.536593	0.598749	0.634011	0.601232	0.539894	0.472347	0.388169	0.31731				
1033 (7% in 75)	0.279265	21.779336	0.280637	0.284846	0.324314	0.434098	0.555955	0.619411	0.65533	0.621862	0.559213	0.487598	0.401934	0.327657			.073526	0.047846
2475 (2% in 50)	0.432755	34.887564	0.435045	0.454159	0.519975	0.687139	0.883811	0.98341	1.036127	0.980964	0.883737	0.791977	0.64102	0.542983			.127323	0.08002
10000 (1% in 100)	0.718276	61.110069	0.722336	0.760859	0.881486	1.201159	1.516128	1.721287	1.810564	1.660768	1.503095	1.360419	1.097631	0.947707			.231438	0.15213

APPENDIX B2

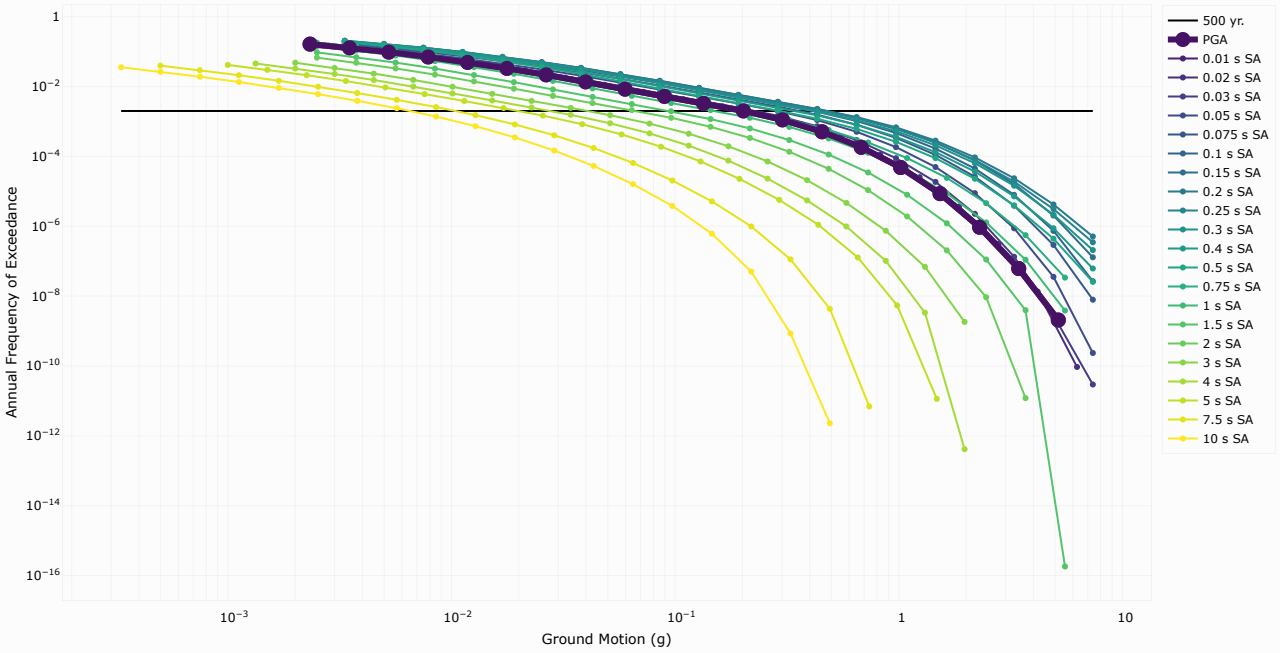
Supporting Documentation for 500-Year (ODE) Ground Motions:
Screenshots of USGS Website Pages – Hazard Curves, Response Spectra, and Deaggregations

For Vs30 = 594 m/s

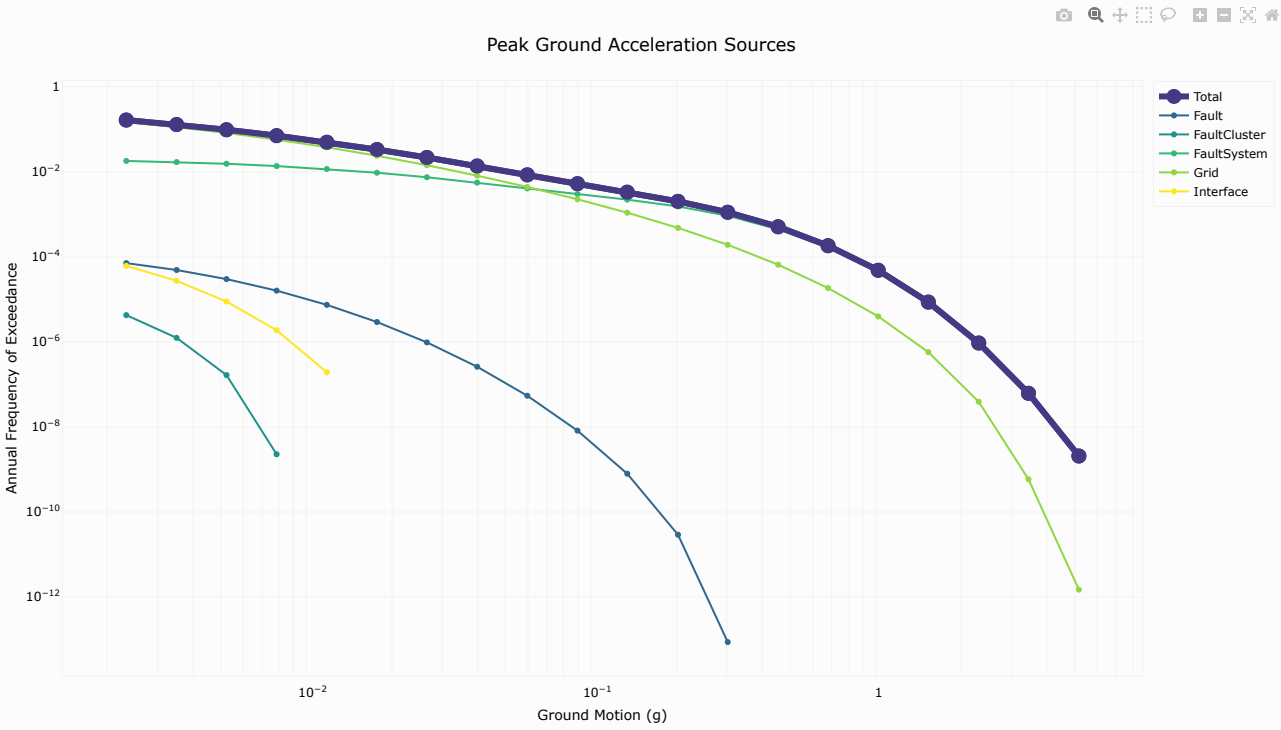
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

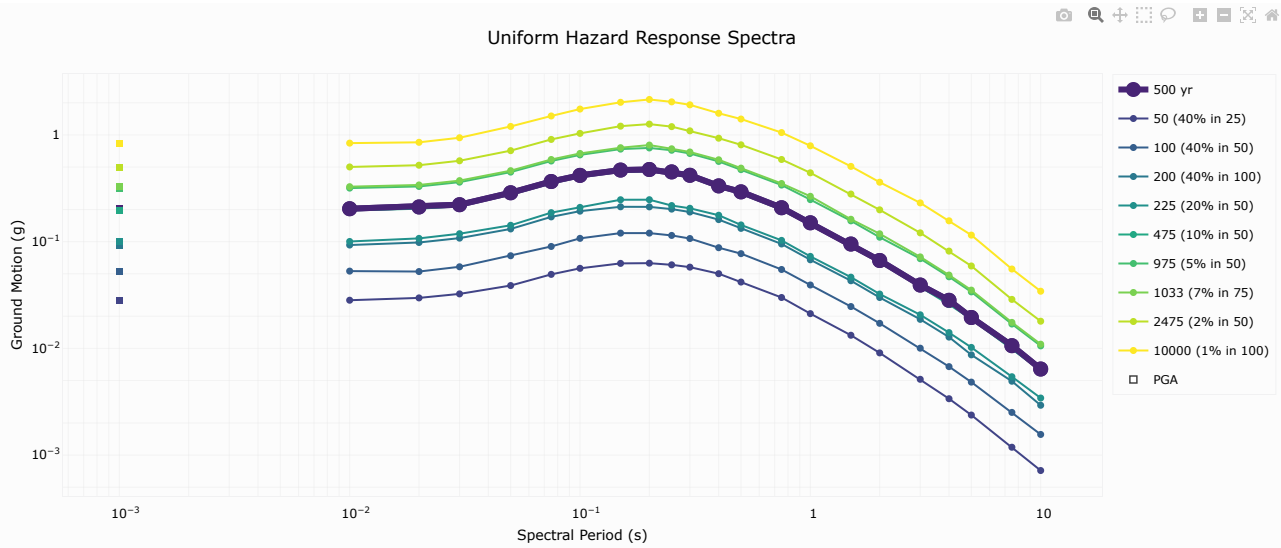
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 594 m/s

Return Period: 500 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.10
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 30, 2025, 03:58 PM

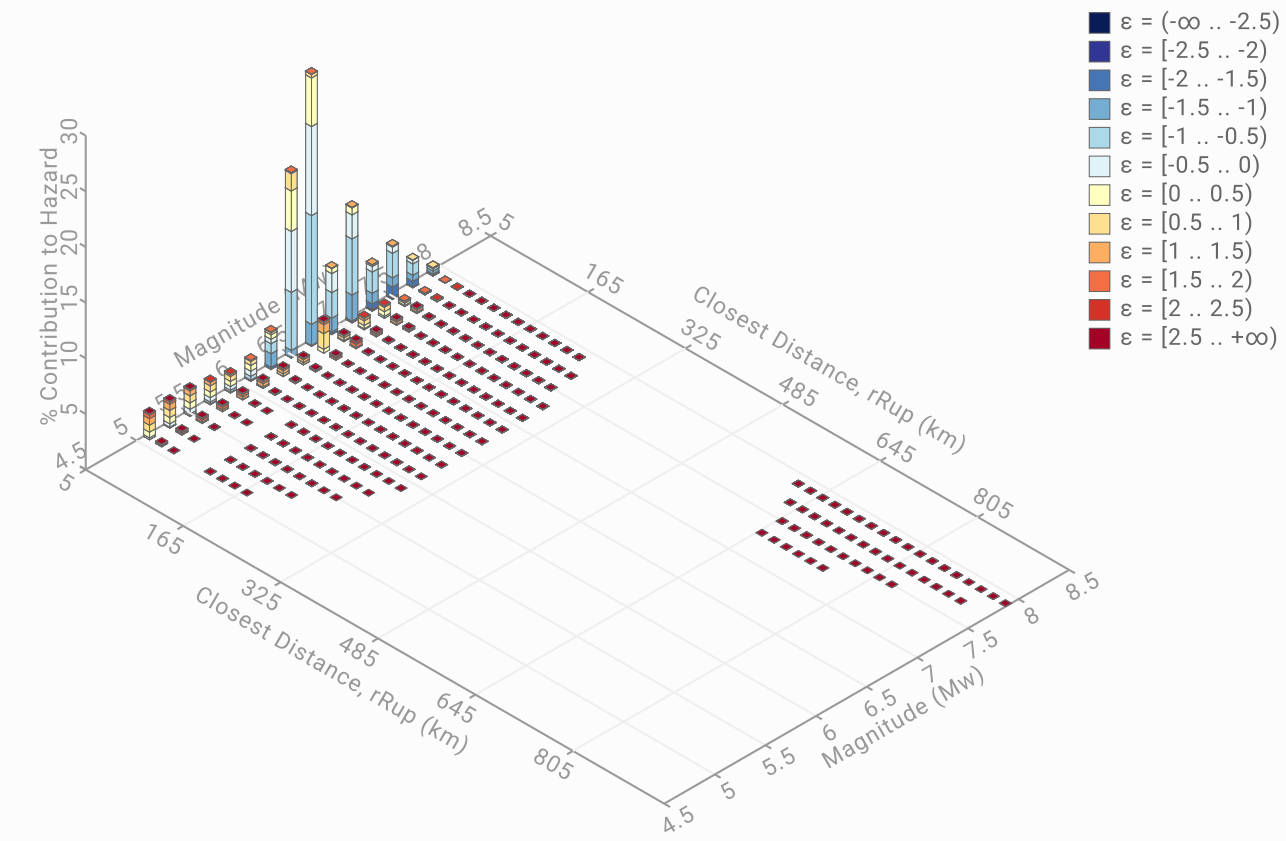
Response Spectra Data

Export Response Spectra as CSV

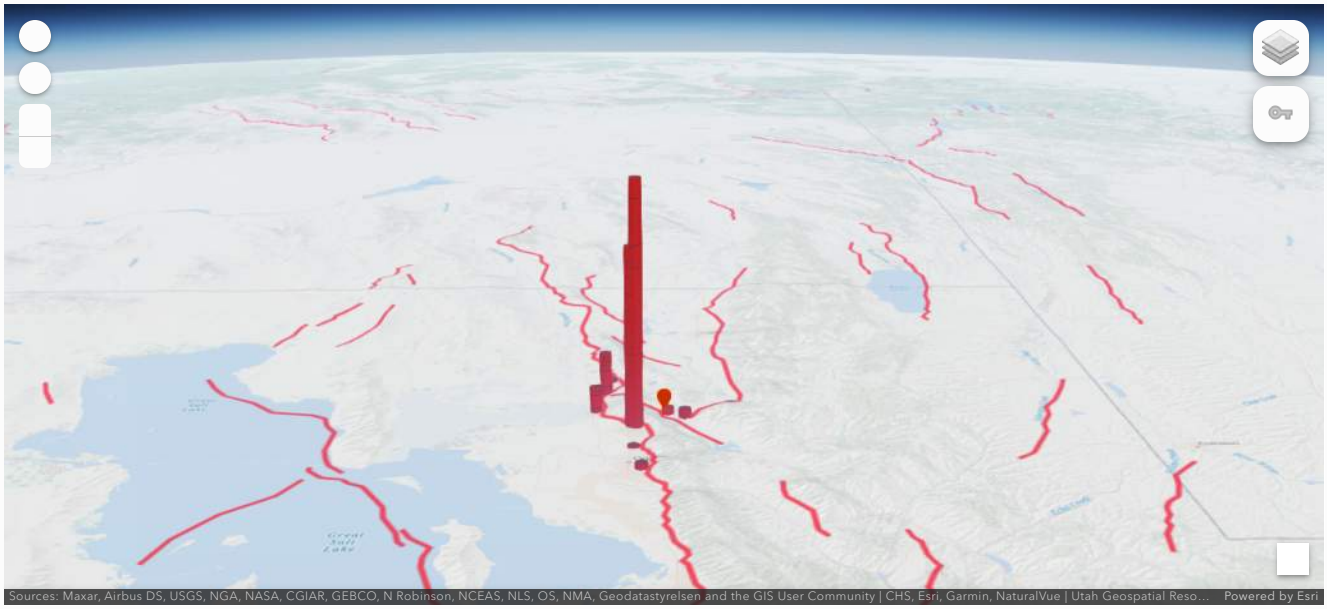
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
500 yr	0.202571	17.296358	0.203436	0.211327	0.221848	0.286996	0.365884	0.417807	0.468361	0.474227	0.450192	0.418635	0.3329	0.292748	0.207794	0.15015	0.094958	0.06659	0.039209
50 (40% in 25)	0.028136	2.307529	0.028255	0.029702	0.032388	0.038782	0.049348	0.056221	0.062556	0.062857	0.060643	0.057679	0.050093	0.041826	0.029966	0.021157	0.013271	0.009069	0.005132
100 (40% in 50)	0.052698	4.092958	0.052955	0.052461	0.058128	0.073784	0.090141	0.107354	0.120226	0.120211	0.114357	0.106953	0.087743	0.077176	0.054838	0.039244	0.024657	0.017166	0.010043
200 (40% in 100)	0.092581	7.526951	0.092962	0.098199	0.107896	0.131498	0.17058	0.19308	0.212058	0.211765	0.201772	0.189468	0.160903	0.133168	0.0951	0.067618	0.04302	0.029961	0.018709
225 (20% in 50)	0.099964	8.296899	0.100342	0.107268	0.118628	0.14227	0.186894	0.209363	0.246899	0.247101	0.217807	0.205355	0.176765	0.143388	0.102742	0.072735	0.046457	0.032285	0.020629
475 (10% in 50)	0.195555	15.638149	0.196413	0.203322	0.214928	0.277053	0.35203	0.403234	0.452979	0.458425	0.434515	0.403273	0.322355	0.28244	0.200111	0.144871	0.091474	0.064245	0.037944
975 (5% in 50)	0.316025	28.825653	0.317432	0.328943	0.36092	0.448409	0.569511	0.649894	0.736309	0.755084	0.718395	0.669518	0.564526	0.473016	0.338982	0.247613	0.156656	0.11	0.06926
1033 (7% in 75)	0.32583	29.884106	0.327266	0.339673	0.373003	0.462397	0.588294	0.670272	0.758594	0.803177	0.741148	0.691541	0.584724	0.488478	0.350574	0.265954	0.162028	0.118438	0.071934
2475 (2% in 50)	0.498567	47.892505	0.50089	0.520044	0.572308	0.71223	0.907129	1.033154	1.20788	1.262338	1.195722	1.091766	0.931533	0.807595	0.588533	0.441557	0.279256	0.198563	0.120874
10000 (1% in 100)	0.833515	83.32768	0.83781	0.852398	0.940473	1.200691	1.50469	1.746878	2.021022	2.148139	2.040542	1.913622	1.595313	1.408328	1.051929	0.790925	0.507118	0.360423	0.230706

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 594 m/s

Intensity Measure Type: PGA

Return Period: 500 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 500 yrs

Exceedance rate : 0.002 yr⁻¹

PGA ground motion : 2.026e-1 g

Recovered targets

Return period : 499.76995 yrs

Exceedance rate : 2.001e-3 yr⁻¹

Totals

Binned : 100 %

Residual : 0 %

Trace : 1.3 %

Mean (over all sources)

m : 6.67

r : 13.56 km

ε_0 : -0.17 σ

Mode (largest m-r bin)

m : 6.71

r : 8.33 km

ε_0 : -0.44 σ

Contribution : 24.41 %

Mode (largest m-r-ε_0 bin)

m : 6.7

r : 7.14 km

ε_0 : -0.7 σ

Contribution : 9.76 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							76.2
Wasatch (Weber) (0)		7.01	6.98	-0.69	111.960°W	41.338°N	217.76	27.76
Wasatch (Brigham City) (4)		7.19	6.78	-0.59	111.969°W	41.342°N	224.89	20.61
Wasatch (Brigham City) (2)		13.08	6.72	0.12	112.023°W	41.467°N	313.57	5.69
Wasatch (Brigham City) (3)		10.91	6.70	-0.09	112.038°W	41.400°N	277.94	4.31
Broadmouth Canyon - James Peak (1)		3.78	6.74	-1.33	111.870°W	41.374°N	113.19	3
Ogden Valley North Fork (1)		1.66	7.15	-1.39	111.902°W	41.384°N	116.15	2.8
Wasatch (Weber) (2)		20.56	6.85	0.64	111.948°W	41.205°N	189.04	2.26
East Cache (8)		10.12	7.17	-1.03	111.781°W	41.422°N	69.67	1.85
Wasatch (Brigham City) (1)		17.25	6.60	0.58	112.014°W	41.520°N	329.84	1.62
Wasatch (Weber) (1)		13.40	6.99	-0.02	111.964°W	41.274°N	199.78	1.58
WUS Branch Average (opt)	Grid							22.82

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.10
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

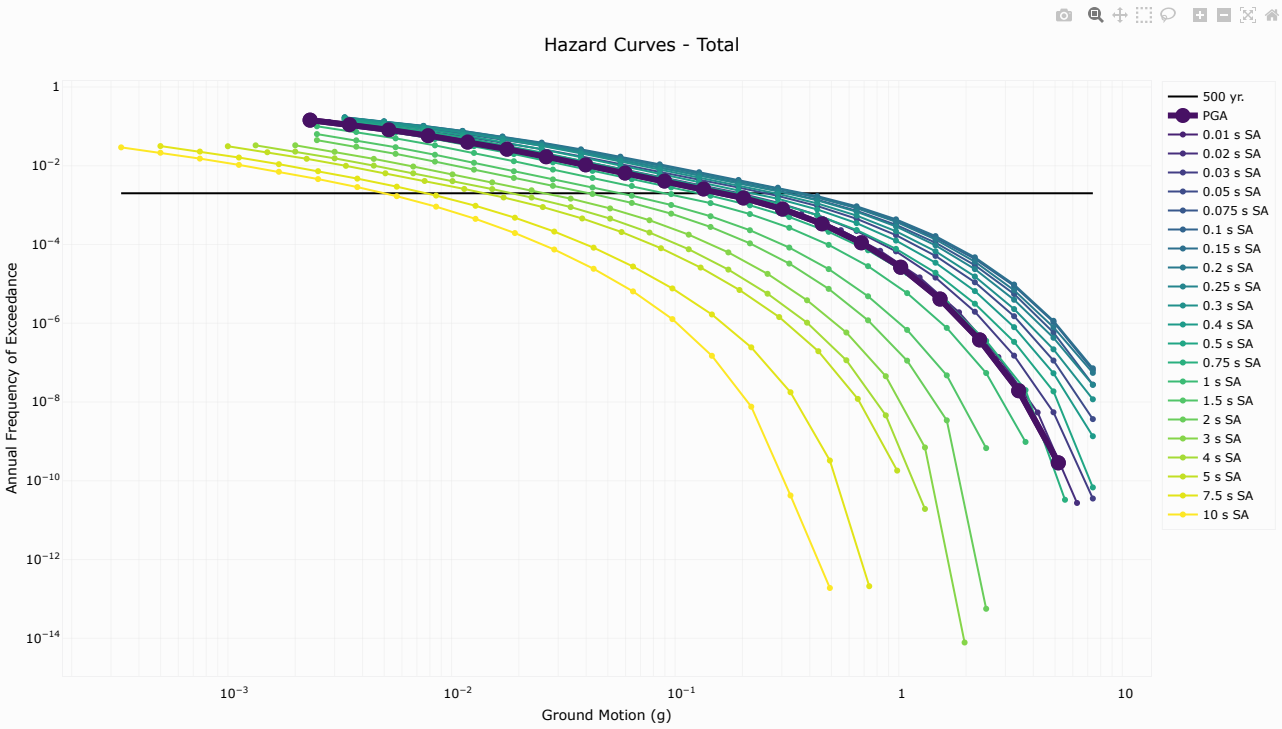
May 29, 2025, 05:21 PM

For Vs30 = 973 m/s

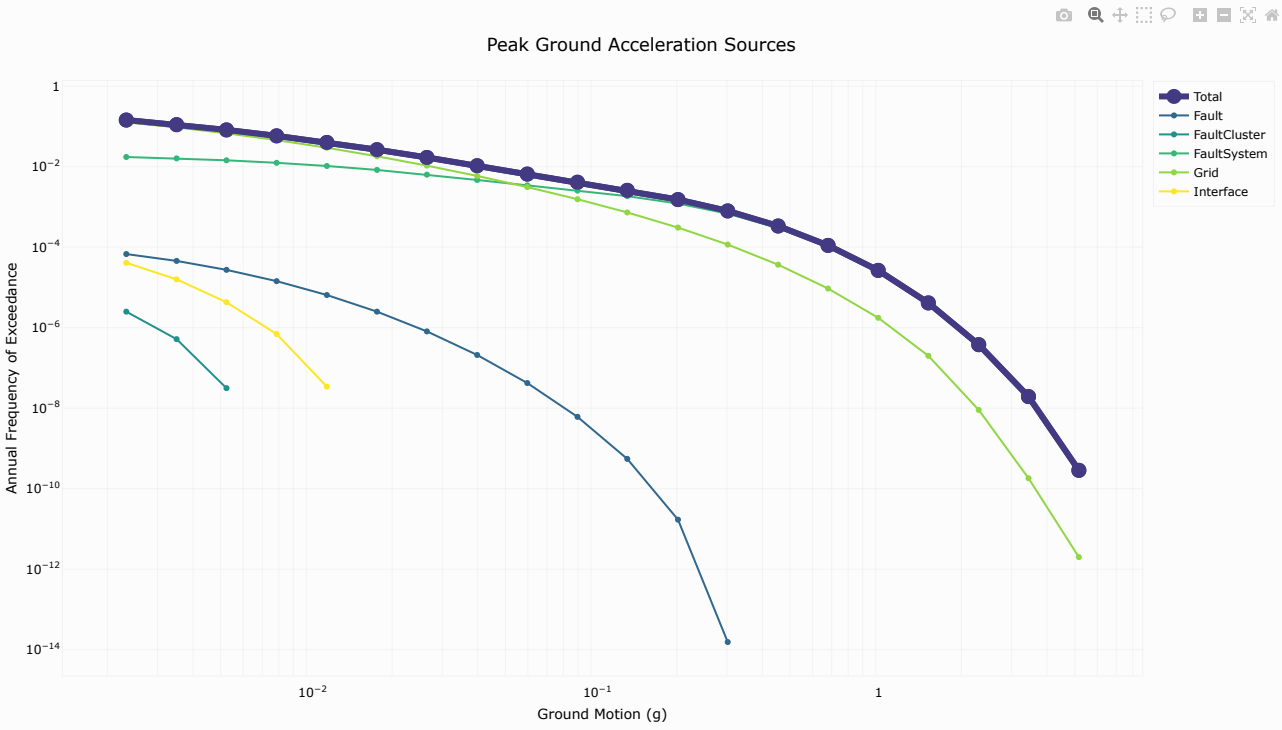
Design Code Warning

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

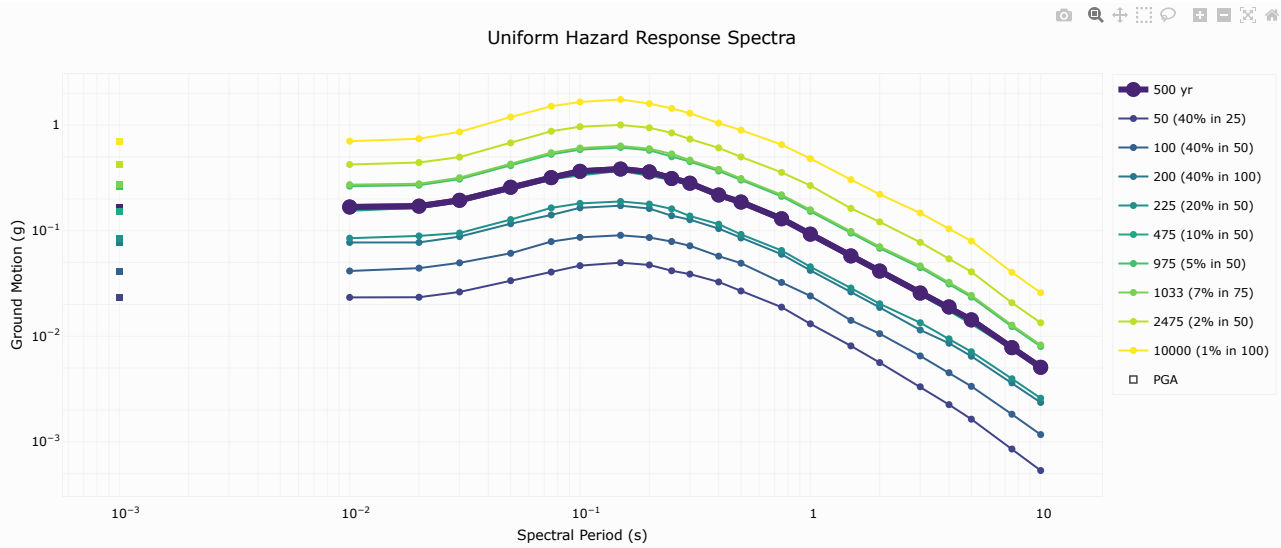
Hazard



Sources



Spectra



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 973 m/s

Return Period: 500 yr

Source Type: Total

Truncate: Off

Max Direction: Off

Application Metadata

Application: Hazard Curves (dynamic)
URL: https://earthquake.usgs.gov/nshmp/hazard/dynamic

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.10
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 30, 2025, 04:08 PM

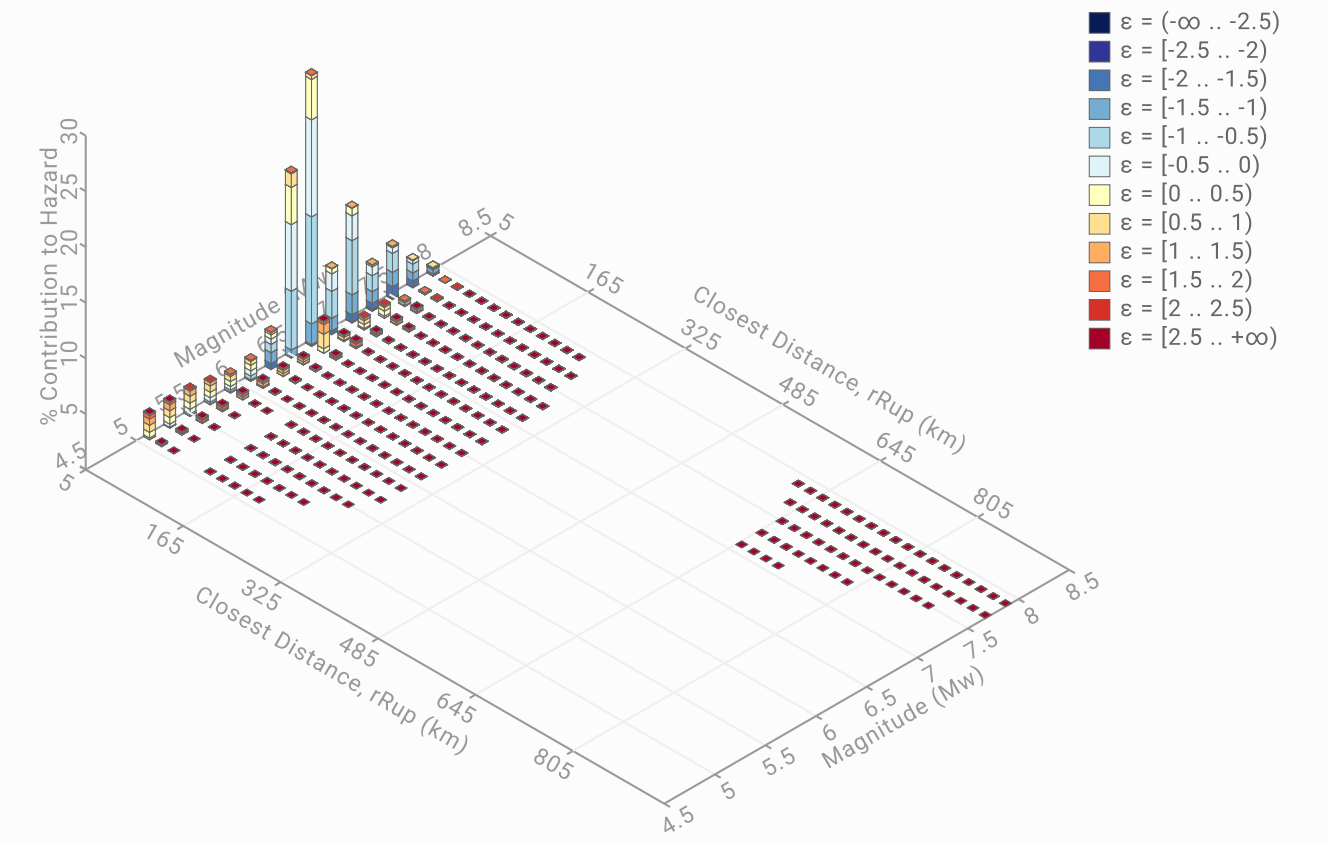
Response Spectra Data

Export Response Spectra as CSV

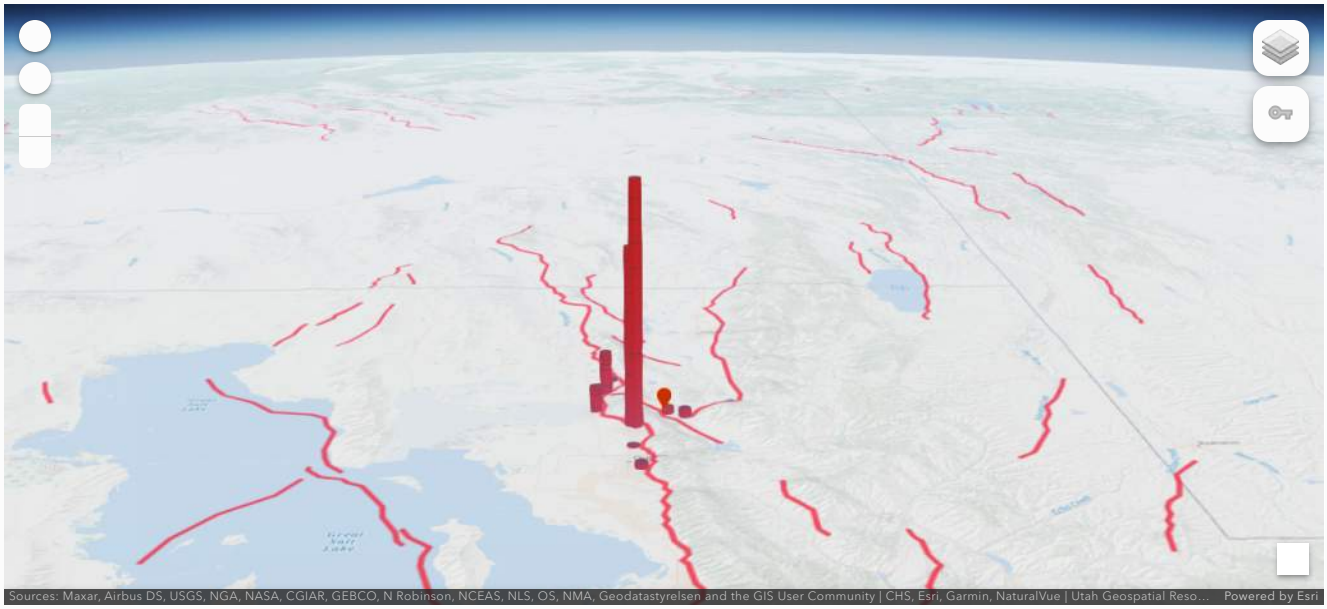
IMT	PGA	PGV	SA0P01	SA0P02	SA0P03	SA0P05	SA0P075	SA0P1	SA0P15	SA0P2	SA0P25	SA0P3	SA0P4	SA0P5	SA0P75	SA1P0	SA1P5	SA2P0	SA3P0
500 yr	0.166821	12.13783	0.16767	0.170767	0.194003	0.257899	0.317999	0.365091	0.383544	0.360315	0.312021	0.281578	0.217882	0.186799	0.129717	0.092751	0.057664	0.041479	0.025676
50 (40% in 25)	0.023221	1.62017	0.02334	0.023425	0.026293	0.033631	0.040578	0.046658	0.049742	0.047395	0.041725	0.038784	0.032695	0.026859	0.01887	0.013122	0.008108	0.005634	0.003324
100 (40% in 50)	0.041339	2.852787	0.041524	0.044183	0.049611	0.061093	0.078859	0.086491	0.090439	0.086125	0.078975	0.07192	0.057387	0.049207	0.032341	0.024095	0.014154	0.010578	0.006513
200 (40% in 100)	0.076934	5.2948	0.077338	0.077394	0.087903	0.116441	0.140949	0.164616	0.1725	0.162097	0.138618	0.127159	0.104699	0.085391	0.059804	0.042076	0.026308	0.018758	0.011462
225 (20% in 50)	0.08446	5.803425	0.084859	0.089222	0.095034	0.127461	0.164441	0.181375	0.189155	0.178731	0.160978	0.137732	0.115282	0.092218	0.064924	0.045509	0.028617	0.020318	0.013438
475 (10% in 50)	0.153503	11.619521	0.154085	0.164958	0.187195	0.24789	0.307323	0.333879	0.368541	0.330571	0.301362	0.271275	0.210864	0.179997	0.124683	0.089282	0.055385	0.039937	0.024834
975 (5% in 50)	0.262784	20.172657	0.264114	0.26979	0.307761	0.413291	0.528768	0.586118	0.613797	0.577594	0.501667	0.45135	0.367824	0.301532	0.21134	0.152419	0.095014	0.068233	0.044669
1033 (7% in 75)	0.271682	20.898674	0.273047	0.278169	0.317556	0.427388	0.548107	0.606612	0.634716	0.597719	0.533649	0.466195	0.38115	0.3116	0.21879	0.15768	0.098427	0.070585	0.046398
2475 (2% in 50)	0.421332	33.471973	0.423615	0.442222	0.497592	0.678767	0.874869	0.965691	1.004042	0.943489	0.844137	0.737357	0.608437	0.499941	0.356725	0.267762	0.162702	0.121178	0.077611
10000 (1% in 100)	0.700467	58.491512	0.704544	0.742189	0.863257	1.192198	1.508705	1.65643	1.749511	1.600166	1.438899	1.295333	1.044615	0.896803	0.653022	0.482548	0.304796	0.221064	0.147156

Disaggregation Report

Disaggregation



Geographical Disaggregation



Parameter Summary

Model: NSHM Conterminous U.S. 2023

Latitude: 41.386815 °

Longitude: -111.909813 °

Vs30: 973 m/s

Intensity Measure Type: PGA

Return Period: 500 yr

Component: Total

Disaggregation Summary: Total

Disaggregation targets

Return period : 500 yrs

Exceedance rate : 0.002 yr⁻¹

PGA ground motion : 1.634e-1 g

Recovered targets

Return period : 494.10622 yrs

Exceedance rate : 2.024e-3 yr⁻¹

Totals

Binned : 100 %

Residual : 0 %

Trace : 1.72 %

Mean (over all sources)

m : 6.68

r : 14.51 km

ε_0 : -0.19 σ

Mode (largest m-r bin)

m : 6.71

r : 8.34 km

ε_0 : -0.48 σ

Contribution : 24.31 %

Mode (largest m-r-ε_0 bin)

m : 6.7

r : 7.27 km

ε_0 : -0.77 σ

Contribution : 9.61 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]

Disaggregation Contributions: Total

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUS Branch Average	FaultSystem							75.95
Wasatch (Weber) (0)		7.01	6.98	-0.72	111.960°W	41.338°N	217.76	27.6
Wasatch (Brigham City) (4)		7.19	6.78	-0.63	111.969°W	41.342°N	224.89	20.49
Wasatch (Brigham City) (2)		13.08	6.72	0.08	112.023°W	41.467°N	313.57	5.72
Wasatch (Brigham City) (3)		10.91	6.70	-0.13	112.038°W	41.400°N	277.94	4.31
Broadmouth Canyon - James Peak (1)		3.78	6.74	-1.36	111.870°W	41.374°N	113.19	2.97
Ogden Valley North Fork (1)		1.66	7.15	-1.41	111.902°W	41.384°N	116.15	2.77
Wasatch (Weber) (2)		20.56	6.85	0.60	111.948°W	41.205°N	189.04	2.28
East Cache (8)		10.12	7.17	-1.06	111.781°W	41.422°N	69.67	1.84
Wasatch (Brigham City) (1)		17.25	6.60	0.54	112.014°W	41.520°N	329.84	1.64
Wasatch (Weber) (1)		13.40	6.99	-0.05	111.964°W	41.274°N	199.78	1.58
WUS Branch Average (opt)	Grid							22.52
CEUS Branch Average (opt)	Grid							1.53

Application Metadata

Application: Disaggregation
URL: https://earthquake.usgs.gov/nshmp/hazard/disagg

Repository: nshmp-apps
Version: 19.9.5
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

Repository : nshmp-haz
Version: 2.6.10
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-haz

Repository : nshmp-lib
Version: 1.7.6
URL: https://code.usgs.gov/ghsc/nshmp/nshmp-lib

Repository : nshm-conus
Version: 6.1.1
URL: https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git

May 29, 2025, 05:21 PM

APPENDIX C

Archival Descriptions of Faults
from USGS' Quaternary Fault and Fold Database (USGS, 2024b)

(Arranged According to Fault ID)

Jump to Navigation

Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Wasatch fault zone, Brigham City section (Class A) No. 2351d

Last Review Date: 2004-04-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., DuRoss, C.B., Hylland, M.D., McDonald, G.N., and Hecker, S., compilers, 2004, Fault number 2351d, Wasatch fault zone, Brigham City section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 03:00 PM.**

Synopsis	**General:** The Wasatch fault zone is one of the longest and most tectonically active normal faults in North America. The fault zone shows abundant evidence of recurrent Holocene surface faulting and has been the subject of detailed studies for over three decades. Half of the estimated 50 to 120 post-Bonneville surface-faulting earthquakes in the Wasatch Front region have been on the Wasatch fault zone. Earthquake-timing, recurrence-interval, and displacement-rate estimates for the Brigham City, Weber, Salt Lake City, Provo, Nephi, and Levan sections of the Wasatch fault

	zone reflect the consensus values of the Utah Quaternary Fault Parameters Working Group (Lund, 2005 #6733). Lund (2005 #6733) did not evaluate the Clarkston Mountain, Collinston, and Fayette sections due to a lack of fault-trench data. The preferred values reported in Lund (2005 #6733) approximate mean values based on available paleoseismic-trenching data, and the minimum and maximum values approximate two-sigma (5th and 95th percentile) confidence limits. The confidence limits incorporate both epistemic (data limitation) and aleatory (process variability) uncertainty (Lund, 2005 #6733). **Sections:** This fault has 10 sections. The nearly 350-km-long Wasatch fault zone has traditionally been divided into seismogenic segments that are thought to rupture at least somewhat independently. The established model is used to define the sections described in this report. The southern eight sections are entirely in Utah. To the north, the Clarkston Mountain section straddles the state line between Idaho and Utah and the northernmost (Malad City) section is entirely in Idaho. The chronology of surface-faulting earthquakes on the Wasatch fault is one of the best dated chronologies in the world and includes 16 earthquakes since 5.6 ka, with an average repeat time of 350 yr. Four of the central five sections [2351e-h] ruptured in the last hundreds to about a thousand years ago, whereas the next section to the north, Brigham City [2351d], has not ruptured in the past 2,125 yr. Vertical displacement rates of 1–2 mm/yr are typical for the central sections during Holocene time. In contrast, middle and late Quaternary (<150–250 ka) rates on these sections are about an order of magnitude lower. This substantial change in the displacement rate may indicate a causal relation between increased Holocene rates of deformation and isostatic rebound/crustal relaxation following deep lake cycles such as Bonneville.
Name comments	**General:** **Section:** All section names follow those proposed by Machette and others (1991 #189; 1992 #607). Refers to fault number 6-6 of Hecker (1993 #642).
County(s) and State(s)	BOX ELDER COUNTY, UTAH WEBER COUNTY, UTAH
Physiographic province(s)	BASIN AND RANGE

Reliability of location	Good Compiled at 1:50,000 scale. *Comments:* Fault trace from 1:50,000 scale mapping of Personius (1990 #1232).
Geologic setting	Generally north-trending, range-bounding normal fault along the western side of the Malad Range (Clarkston Mountain), Wellsville Mountains, Wasatch Range, and San Pitch Mountains. The Wasatch fault zone marks the eastern boundary of the Basin and Range in northern Utah. Alluvial-fan deposits and lacustrine deposits of Pleistocene Lake Bonneville dominate the surficial geology along the fault zone.
Length (km)	This section is 37 km of a total fault length of 357 km.
Average strike	N9°W (for section) versus N10°W (for whole fault)
Sense of movement	Normal
Dip	65–80° W. *Comments:* Reported as 65-80° W. at Bowden Canyon trench (site 2351-7) in fluvial and debris-flow deposits; 70–80° W. at Pleasant View trench (site 2351-20) in lacustrine deposits (Personius, 1991 #2986).
Paleoseismology studies	A trench excavated in 1986 across a fault scarp on the Bowden Canyon alluvial fan at the Brigham City site (site 2351-7), east of Brigham City, exposed evidence for three surface-faulting earthquakes (Personius, 1991 #2986). The oldest of these events could not be directly dated. Radiocarbon age estimates on bulk-soil samples from paleosols and the base of the modern soil provide limiting ages for the penultimate and most recent events on the fault. Timing of the penultimate event may correlate with the timing of the most recent surface-faulting earthquake documented in the Pole Patch trench (site 2351-9) across a fault scarp on the Pleasant View salient, about 20 km south of the Brigham City trench (Personius, 1991 #2986). This scarp is associated with a short, off-trend fault in the area of the boundary between the Brigham City and Weber sections of the Wasatch fault. The trench exposed evidence for three surface-faulting earthquakes. Although a bulk-soil sample yielded a radiocarbon age estimate that closely approximates the age of the most recent

	event, other radiocarbon ages only poorly constrain the timing of the older events. In 1992 and 1993, 14 additional trenches were excavated across scarps of the Brigham City section to lengthen the paleoseismic record for this fault (McCalpin and Forman, 1994 #4626, 2002 #5177). These trenches were on the Provo-level delta at the mouth of Box Elder Canyon (site 2351-27). In total, the trenches exposed evidence for seven, or possibly eight, surface-faulting events. Earthquake timing is constrained by limiting ages obtained from radiocarbon and thermoluminescence dating of bulk soil samples. The most recent event here (event Z) is younger than the most recent event at the Brigham City trench; the timing of that earthquake correlates well with event Y here. Evidence was not observed for an earthquake correlative with the penultimate event at the Brigham City trench. A relatively wide range in limiting ages for event V suggests either a poorly constrained single event, or two separate events. McCalpin and Nishenko (1996 #4627) and McCalpin and Foreman (2002 #5177) prefer the two-event interpretation, resulting in a total of seven paleoearthquakes on the Brigham City section since 14–17 ka.
Geomorphic expression	West-facing scarps along the western base of the Wellsville Mountains and Wasatch Range. Scarps on the valley floor between Willard and Brigham City may be associated with incipient lateral spreads, but have orientations and relief consistent with a faulting origin. In the southern part of the section,15- to 20-m-high scarps on a Provo-level delta suggest as many as 6–10 surface-faulting events occurred since about 16 ka (assuming an average displacement per event of >2 m). However, only a few short, discontinuous scarps are on upper Holocene deposits near the southern section boundary, which is in contrast to the abundance of Holocene scarps on the Weber section to the south. Displacement per event is from 1.0 to 2.5 m. To the north, the boundary between the Brigham City and Collinston sections is defined by a change in fault trend and differences in the amount and timing of displacement of post-Lake Bonneville deposits.
Age of faulted surficial deposits	Holocene alluvial fan, debris-flow and stream deposits; late Pleistocene glacial, lacustrine, and alluvial fan deposits, and middle (?) Pleistocene alluvial fan deposits.
Historic	

earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The Brigham City section is the northernmost section of the Wasatch fault zone that exhibits clear evidence of recurrent Holocene faulting along its entire length (Personius, 1988 #2996; Machette and others, 1992 #607). Lund (2005 #6733) determined the following paleoearthquake chronology, based on the interpretation of seven paleoearthquakes in the past 17 ky (McCalpin and Nishenko, 1996 #4627; McCalpin and Foreman, 2002 #5177), and incorporating both laboratory and geologic uncertainty: Z 2100±800 cal yr B.P. Y 3450±300 cal yr B.P. X 4650±500 cal yr B.P. W 5950±250 cal yr B.P. V 7500±1000 cal yr B.P. U 8500±1500 cal yr B.P. T >14,800±1200, <17,000 cal yr B.P.
Recurrence interval	1300 yr (preferred); minimum 500, maximum 2800 yr (<8.5 ka) *Comments:* Consensus recurrence-interval range reported in Lund (2005 #6733), based on the five interevent times between the six most recent paleoearthquakes (U–Z). The overall temporal pattern since 14.8 ka is one earthquake every 1–2 k.y. since 8.5 ka, with a long seismic gap between 8.5 and 14.8 ka. McCalpin and Forman (1994 #4626, 2002 #5177) indicate the approximately 6.3 k.y. long seismic gap may have been influenced by changes in the crustal stress regime associated with Lake Bonneville dessication, possibly causing crustal rebound to suppress extensional movements. The elapsed time since the last earthquake (2,100±800 yr) exceeds the preferred recurrence interval (1,300 yr), suggesting that the section is due for a surface faulting earthquake, unless strain accumulation rates have declined during the late Holocene. McCalpin and Nishenko (1996 #4627) suggest that the Brigham City section has a time-dependent earthquake probability that approaches or exceeds regional and fault-specific probabilities.
Slip-rate category	Between 1.0 and 5.0 mm/yr *Comments:* Lund (2005 #6733) indicates a Holocene paleoseismic slip rate of 1.4 mm/yr (preferred), and a consensus minimum-maximum range of 0.6–4.5 mm/yr, based on per-event vertical displacements from trenching ranging from 1–2.5 m (Personius, 1991 #2986) and the three recurrence intervals between events V, W, X, and Y. Long-term geologic slip rates

	based on vertically offset Provo-age deposits increase southward from 0.2 mm/yr near the northern section boundary to 1.4 mm/yr near Willard, Utah. Vertical displacement of deltaic deposits of the Bonneville phase of the Bonneville lake cycle at Willard Canyon indicate a long-term geologic slip rate of 1.5–1.6 mm/yr (Personius, 1990 #1232).
Date and Compiler(s)	2004 Bill D. Black, Utah Geological Survey Christopher B. DuRoss, Utah Geological Survey Michael D. Hylland, Utah Geological Survey Greg N. McDonald, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#8535 DuRoss, C.B., 2008, Holocene vertical displacement on the central segments of the Wasatch fault zone, Utah: Bulletin of the Seismological Society of America, v. 98, p. 2918–2933. #7190 DuRoss, C.B., Personius, S.F., Crone, A.J., McDonald, G.N., and Briggs, R.W., 2012, Late Holocene earthquake history of the Brigham City segment of the Wasatch fault zone at the Hansen Canyon, Kotter Canyon, and Pearsons Canyon trench sites, Box Elder County, Utah: Utah Geological Survey Special Study 142, 27 p., http://ugspub.nr.utah.gov/publications/special_studies/ss-142/ss-142.pdf. #7191 DuRoss, C.B., Personius, S.F., Crone, A.J., McDonald,G.N., and Lidke, D.J., 2009, Paleoseismic investigation of the northern Weber segment of the Wasatch fault zone at the Rice Creek trench site, North Ogden, Utah: Utah Geological Survey Special Study 130, 37 p., http://ugspub.nr.utah.gov/publications/special_studies/ss-130.pdf. #642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #6733 Lund, W.R., 2005, Consensus preferred recurrence interval and vertical slip rate estimates—Review of Utah paleoseismic-trenching data by the Utah Quaternary Fault Parameters Working Group: Utah Geological Survey Bulletin 134, compact disk. #607 Machette, M.N., Personius, S.F., and Nelson, A.R., 1992, Paleoseismology of the Wasatch fault zone—A summary of

recent investigations, interpretations, and conclusions, *in* Gori, P.L., and Hays, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch front, Utah: U.S. Geological Survey Professional Paper 1500, p. A1-A71.

#189 Machette, M.N., Personius, S.F., Nelson, A.R., Schwartz, D.P., and Lund, W.R., 1991, The Wasatch fault zone, Utah—Segmentation and history of Holocene earthquakes, *in* Hancock, P.L., Yeats, R.S., and Sanderson, D.J., eds., Characteristics of active faults: Journal of Structural Geology, v. 13, p. 137-150.

#4626 McCalpin, J.P., and Forman, S.L., 1994, Assessing the paleoseismic activity of the Brigham City segment, Wasatch fault zone, Utah—Site of the next major earthquake on the Wasatch Front?: Technical report to U.S. Geological Survey, National Earthquake Hazards Reduction Program Final Technical Report, under Contract 1434-92-G-2205, 19 p.

#5177 McCalpin, J.P., and Forman, S.L., 2002, Paleoseismology of Utah, volume 11—Post-Provo paleoearthquake chronology of the Brigham City segment, Wasatch fault zone, Utah: Utah Geological Survey Miscellaneous Publication 02-9, 46 p., http://ugspub.nr.utah.gov/publications/misc_pubs/mp-02-9.pdf.

#4627 McCalpin, J.P., and Nishenko, S.P., 1996, Holocene probability, temporal clustering, and probabilities of future large (M>7) earthquakes on the Wasatch fault zone, Utah: Journal of Geophysical Research, v. 101, no. B3, p. 6233-6253.

#2996 Personius, S.F., 1988, A brief summary of the surficial geology along the Brigham City segment of the Wasatch fault zone, Utah, *in* Machette, M.N., ed., In the footsteps of G. K. Gilbert—Lake Bonneville and neotectonics of the eastern Basin and Range province—Guidebook for field trip twelve: Utah Geological and Mineral Survey Miscellaneous Publication 88-1, p. 27-32.

#1232 Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Colliston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1979, 1 sheet, scale 1:24,000.

#2986 Personius, S.F., 1991, Paleoseismology of Utah, volume 2

	—Paleoseismic analysis of the Wasatch fault zone at the Brigham City trench site, Brigham City, Utah and Pole Patch trench site, Pleasant View, Utah: Utah Geological and Mineral Survey Special Studies 76, 39 p., http://ugspub.nr.utah.gov/publications/special_studies/SS-76.pdf.

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Wasatch fault zone, Weber section (Class A) No. 2351e

Last Review Date: 2004-04-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., DuRoss, C.B., Hylland, M.D., McDonald, G.N., and Hecker, S., compilers, 2004, Fault number 2351e, Wasatch fault zone, Weber section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 03:00 PM.**

Synopsis	**General:** The Wasatch fault zone is one of the longest and most tectonically active normal faults in North America. The fault zone shows abundant evidence of recurrent Holocene surface faulting and has been the subject of detailed studies for over three decades. Half of the estimated 50 to 120 post-Bonneville surface-faulting earthquakes in the Wasatch Front region have been on the Wasatch fault zone. Earthquake-timing, recurrence-interval, and displacement-rate estimates for the Brigham City, Weber, Salt Lake City, Provo, Nephi, and Levan sections of the Wasatch fault

	zone reflect the consensus values of the Utah Quaternary Fault Parameters Working Group (Lund, 2005 #6733). Lund (2005 #6733) did not evaluate the Clarkston Mountain, Collinston, and Fayette sections due to a lack of fault-trench data. The preferred values reported in Lund (2005 #6733) approximate mean values based on available paleoseismic-trenching data, and the minimum and maximum values approximate two-sigma (5th and 95th percentile) confidence limits. The confidence limits incorporate both epistemic (data limitation) and aleatory (process variability) uncertainty (Lund, 2005 #6733). **Sections:** This fault has 10 sections. The nearly 350-km-long Wasatch fault zone has traditionally been divided into seismogenic segments that are thought to rupture at least somewhat independently. The established model is used to define the sections described in this report. The southern eight sections are entirely in Utah. To the north, the Clarkston Mountain section straddles the state line between Idaho and Utah and the northernmost (Malad City) section is entirely in Idaho. The chronology of surface-faulting earthquakes on the Wasatch fault is one of the best dated chronologies in the world and includes 16 earthquakes since 5.6 ka, with an average repeat time of 350 yr. Four of the central five sections [2351e-h] ruptured in the last hundreds to about a thousand years ago, whereas the next section to the north, Brigham City [2351d], has not ruptured in the past 2,125 yr. Vertical displacement rates of 1–2 mm/yr are typical for the central sections during Holocene time. In contrast, middle and late Quaternary (<150–250 ka) rates on these sections are about an order of magnitude lower. This substantial change in the displacement rate may indicate a causal relation between increased Holocene rates of deformation and isostatic rebound/crustal relaxation following deep lake cycles such as Bonneville.
Name comments	**General:** **Section:** All section names follow those proposed by Machette and others (1991 #189; 1992 #607).
County(s) and State(s)	DAVIS COUNTY, UTAH WEBER COUNTY, UTAH
Physiographic province(s)	BASIN AND RANGE
Reliability of	Good

location	Compiled at 1:50,000 scale. *Comments:* From 1:50,000 scale mapping of Nelson and Personius (1993 #620).
Geologic setting	Generally north-trending, range-bounding normal fault along the western side of the Malad Range (Clarkston Mountain), Wellsville Mountains, Wasatch Range, and San Pitch Mountains. The Wasatch fault zone marks the eastern boundary of the Basin and Range in northern Utah. Alluvial-fan deposits and lacustrine deposits of Pleistocene Lake Bonneville dominate the surficial geology along the fault zone.
Length (km)	This section is 56 km of a total fault length of 357 km.
Average strike	N6°W (for section) versus N10°W (for whole fault)
Sense of movement	Normal
Dip	68–78° W. *Comments:* 68–78° W. measured in Kaysville trench A (Swan and others, 1980 #88) and 68–70° W. measured in re-opened Kaysville trench A (McCalpin and Forman, 1994 #4626) in lacustrine deposits juxtaposed against slope colluvium.
Paleoseismology studies	One of the earliest detailed paleoseismic investigations of the Wasatch fault (1978) was conducted on the Weber section between Bair (or Baer; variant spelling) and Shepard Creeks, about 3 km east-southeast of Kaysville. This study was particularly important from the standpoint of developing two fundamental concepts of modern paleoseismology: colluvial-wedge stratigraphy (Swan and others, 1980 #88), and characteristic earthquakes (Schwartz and Coppersmith, 1984 #347). The Kaysville site (site 2351-1) included five test pits and seven trenches, which exposed evidence for at least three surface-faulting earthquakes since about 12 ka (Swan and others, 1980 #88; Swan, Schwartz, and others, 1981 #347). A single radiocarbon age estimate on detrital charcoal indicated that two earthquakes had occurred since 1,580±150 yr B.P. The Kaysville site was reoccupied in 1988 (site 2351-18) to refine the paleoearthquake chronology; a trench was excavated parallel to and slightly deeper than the 1978 trench A. Detailed stratigraphic analysis and geometrical reconstructions based on data from both

	the 1978 and 1988 trenches indicate five or six surface-faulting earthquakes since 13 ka (McCalpin and others, 1994 #3167). Radiocarbon and thermoluminescence age estimates on bulk-soil samples from paleosols constrain the timing of the three youngest faulting events. The earlier two or three events could not be directly dated because stratigraphic evidence for these postulated events was not exposed. At Garner Canyon (site 2351-10), 2 km south of Coldwater Canyon near North Ogden, an artificial exposure across the fault revealed stratigraphic evidence for four surface-faulting earthquakes (Nelson and others, 1987 #5001; Machette and others, 1992 #607; Nelson and Personius, 1993 #620). Radiocarbon age estimates on bulk-soil samples from paleosols developed on colluvial wedges constrain the timing of the two youngest paleoearthquakes. In 1986, five trenches were excavated across multiple scarps of the Weber section at the East Ogden site (site 2351-11), about 1.5 km north-northwest of the mouth of Ogden Canyon. The trenches exposed evidence for three, and possibly four, surface-faulting earthquakes since middle Holocene time (Nelson, 1988 #4628; Machette and others, 1992 #607). Radiocarbon age estimates on bulk-soil samples from paleosols developed on colluvial wedges provided poor constraint on paleoearthquake timing (Nelson, 1988 #4628), but thermoluminescence age estimates on fault-related colluvial sediments reduced some of the uncertainty (Forman and others, 1991 #542). One of the trenches (EO-3) showed stratigraphic evidence for a small-displacement event within the past 500-600 years, but obscure stratigraphic relations and problems with radiocarbon age estimates make interpretation of this event tenuous (Nelson, 1988 #4628). Although Nelson and Personius (1993 #620) characterize this event as "probable," it has not been observed in any other trenches on the Weber section.
Geomorphic expression	West-facing scarps along the western base of the Wasatch Range. The Weber section is the longest Wasatch fault zone section. The southern boundary of the section is at the prominent Salt Lake salient, but fault scarps in this area are easily confused with nontectonic features and scarp distribution is less certain (Machette and others, 1992 #607). The northern section boundary is at the Pleasant View salient. Scarp heights in the northern part of the Weber section suggest a higher rate of late Holocene faulting than on the Brigham City section to the north (Machette

	and others, 1992 #607). Net displacement measured at three sites (Garner Canyon, East Ogden, and Kaysville), which are about 20 km apart, is from 1.0 to 3.5 m per event. Individual faulting events may not have ruptured the entire section, although the general timing of events at the three sites appears similar.
Age of faulted surficial deposits	Holocene alluvial fan, debris-flow and stream deposits; late Pleistocene glacial, lacustrine, and alluvial fan deposits, and middle (?) Pleistocene alluvial-fan deposits.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Lund (2005 #6733) reports the following earthquake chronology, which includes the four-earthquake model of McCalpin and Nishenko (1996 #6770) (events W, X, Y, and Zb), and honors the Kaysville and East Ogden trench site results, which indicate a most recent (partial rupture ?) event (Za) at ~0.5 ka (Machette and others, 1992 #4529; Nelson and Personius, 1993 #620; McCalpin and others, 1994 #3167). Uncertainties in the event ages incorporate both geologic and laboratory error. Za 500±300 cal yr B.P. (partial section rupture ?) Zb 950±450 cal yr B.P. Y 3000±700 cal yr B.P. X 4500±700 cal yr B.P. W 6100±700 cal yr B.P
Recurrence interval	1400 yr (preferred); minimum 500, maximum 2400 yr (<6.1 ka) *Comments:* Consensus recurrence-interval range reported in Lund (2005 #6733), based on the four interevent times between the five youngest paleoearthquakes on the Weber section (W-Za). The minimum and maximum values reflect the possibility of an interevent time as short as 500 years; however, if a partial rupture has occurred, then the short recurrence interval may only apply to an undefined part of the section (Lund, 2005 #6733).
Slip-rate category	Between 1.0 and 5.0 mm/yr *Comments:* Lund (2005 #6733) indicates a Holocene paleoseismic slip rate of 1.2 mm/yr (preferred) and a consensus minimum-maximum range of 0.6–4.3 mm/yr, based on the displacement measurements of McCalpin and others (1994 #3167) and Nelson and Personius (1993 #620), and the four recurrence intervals between events W and Za. The long-term

	geologic slip rate is as high as 2.0 mm/yr based on offset Bonneville-phase deposits (~18 ka), and up to 1.3 mm/yr based on displaced Provo-phase deposits (<16.2 ka). Field and aerial photo-derived scarp profiles by Nelson and Personius (1993 #620) indicate that latest Pleistocene and Holocene slip is greatest along the central and northern part of the section, decreasing toward the ends.
Date and Compiler(s)	2004 Bill D. Black, Utah Geological Survey Christopher B. DuRoss, Utah Geological Survey Michael D. Hylland, Utah Geological Survey Greg N. McDonald, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#8535 DuRoss, C.B., 2008, Holocene vertical displacement on the central segments of the Wasatch fault zone, Utah: Bulletin of the Seismological Society of America, v. 98, p. 2918–2933. #7191 DuRoss, C.B., Personius, S.F., Crone, A.J., McDonald,G.N., and Lidke, D.J., 2009, Paleoseismic investigation of the northern Weber segment of the Wasatch fault zone at the Rice Creek trench site, North Ogden, Utah: Utah Geological Survey Special Study 130, 37 p., http://ugspub.nr.utah.gov/publications/special_studies/ss-130.pdf. #7192 DuRoss, C.B., Personius, S.F., Crone, A.J., Olig, S.S., and Lund, W.R., 2011, Integration of paleoseismic data from multiple sites to develop an objective earthquake chronology—Application to the Weber segment of the Wasatch fault zone, Utah: Bulletin of the Seismological Society of America, v. 101, p. 2765–2781. #542 Forman, S.L., Nelson, A.R., and McCalpin, J.P., 1991, Thermoluminescence dating of fault-scarp-derived colluvium—Deciphering the timing of paleoearthquakes on the Weber segment of the Wasatch fault zone, north central Utah: Journal of Geophysical Research, v. 96, no. B1, p. 595-605. #642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #6733 Lund, W.R., 2005, Consensus preferred recurrence interval and vertical slip rate estimates—Review of Utah paleoseismic-trenching data by the Utah Quaternary Fault Parameters Working

Group: Utah Geological Survey Bulletin 134, compact disk.

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#607 Machette, M.N., Personius, S.F., and Nelson, A.R., 1992, Paleoseismology of the Wasatch fault zone—A summary of recent investigations, interpretations, and conclusions, *in* Gori, P.L., and Hays, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch front, Utah: U.S. Geological Survey Professional Paper 1500, p. A1-A71.

#189 Machette, M.N., Personius, S.F., Nelson, A.R., Schwartz, D.P., and Lund, W.R., 1991, The Wasatch fault zone, Utah—Segmentation and history of Holocene earthquakes, *in* Hancock, P.L., Yeats, R.S., and Sanderson, D.J., eds., Characteristics of active faults: Journal of Structural Geology, v. 13, p. 137-150.

#4626 McCalpin, J.P., and Forman, S.L., 1994, Assessing the paleoseismic activity of the Brigham City segment, Wasatch fault zone, Utah—Site of the next major earthquake on the Wasatch Front?: Technical report to U.S. Geological Survey, National Earthquake Hazards Reduction Program Final Technical Report, under Contract 1434-92-G-2205, 19 p.

#4627 McCalpin, J.P., and Nishenko, S.P., 1996, Holocene probability, temporal clustering, and probabilities of future large (M>7) earthquakes on the Wasatch fault zone, Utah: Journal of Geophysical Research, v. 101, no. B3, p. 6233-6253.

#3167 McCalpin, J.P., Forman, S.L., and Lowe, M., 1994, Reevaluation of Holocene faulting at the Kaysville site, Weber segment of the Wasatch fault zone, Utah: Tectonics, v. 13, no. 1, p. 1-16.

#4628 Nelson, A.R., 1988, The northern part of the Weber segment of the Wasatch fault zone near Ogden, Utah, *in* Machette, M.N., ed., In the footsteps of G.K. Gilbert—Lake Bonneville and neotectonics of the eastern Basin and Range Province, Guidebook for Field Trip Twelve: Utah Geological and Mineral Survey Miscellaneous Publication 88-1, p. 33-37.

#620 Nelson, A.R., and Personius, S.F., 1993, Surficial geologic map of the Weber segment, Wasatch fault zone, Weber and Davis Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-2199, 22 p. pamphlet, 1 sheet, scale 1:50,000.

#5001 Nelson, A.R., Klauk, R.H., Lowe, M., and Garr, J.D., 1987, Holocene history of displacement on the Weber segment of the Wasatch fault zone at Ogden, northern Utah: Geological Society of America Abstracts with Programs, v. 19, no. 5, p. 322.

#7014 Nelson, A.R., Lowe, M., Personius, S., Bradley, L., Forman, S.L., Klauk, R., and Garr, J., 2006, Holocene earthquake history of the northern Weber segment of the Wasatch fault zone, Utah: Utah Geological Survey Miscellaneous Publications 05-8, 45 p., http://ugspub.nr.utah.gov/publications/misc_pubs/MP-05-8.pdf.

#347 Schwartz, D.P., and Coppersmith, K.J., 1984, Fault behavior and characteristic earthquakes—Examples from the Wasatch and San Andreas fault zones: Journal of Geophysical Research, v. 89, no. B7, p. 5681–5698.

#88 Swan, F.H., III, Schwartz, D.P., and Cluff, L.S., 1980, Recurrence of moderate to large magnitude earthquakes produced by surface faulting on the Wasatch fault zone, Utah: Bulletin of the Seismological Society of America, v. 70, p. 1431-1462.

#4640 Swan, F.H.I., Schwartz, D.P., Hanson, K.L., Kneupfer, P.L., and Cluff, L.S., 1981, Study of earthquake recurrence intervals on the Wasatch fault at the Kaysville site, Utah: U.S. Geological Survey Open-File Report 81-228, 30 p.

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

East Cache fault zone, northern section (Class A) No. 2352a

Last Review Date: 2004-06-01

Compiled in cooperation with the Idaho Geological Survey and the Utah Geological Survey

citation for this record: **Black, B.D., Hylland, M.D., Haller, K.M., and Hecker, S., compilers, 2004, Fault number 2352a, East Cache fault zone, northern section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:57 PM.**

Synopsis	**General:** Normal fault zone that separates Cache Valley from the Bear River Range to the east. The fault zone is at the boundary between the Basin and Range and the Middle Rocky Mountains physiographic provinces. The East Cache fault zone is one of several north-trending, northeast stepping, late Quaternary, normal faults that lie between the Wasatch fault zone in Utah and the Teton fault in Wyoming.

	Sections: This fault has 3 sections. Informally named sections defined here follow McCalpin (1987 #4999; 1994 #4414). McCalpin (1994 #4414) describes physiographic sections because the faulting history cannot be constrained well enough to define seismogenic segments. The sections are differentiated based on fault zone complexity, tectonic geomorphology, and expression of surface fault scarps . Bailey (1927 #5186) alludes to the same sectioning of the fault based on gross differences in the range-front morphology. The central section of the fault is the most active in the latest Quaternary; the northern and southern sections are less active and show evidence of only middle to late Pleistocene activity. The morphology of faceted spurs along the range front suggests that the boundary between the northern and central sections has shifted southward several kilometers during the middle to late Quaternary, probably along with development of a younger, western fault strand in the northern section (McCalpin, 1994 #4414; 1989 #4999). Similarities in the structure of faceted spurs and the absence of a gravity-defined boundary between the central and southern sections suggest that they may have behaved as a single 44-km-long seismogenic section during much of the late Cenozoic. However, the last two events on the East Cache fault zone were limited to the 20-km-long central section, leading McCalpin (1994 #4414; 1989 #4999) to suggest that paleoearthquake magnitudes were in the range of 6.6 to 7.1. The south end of the southern section abuts the northeast-trending James Peak fault [2378].
Name comments	**General:** Early workers in the area referred to this fault as the Bear River Range fault (Bailey, 1927 #5187; 1927 #5186) and Bear River fault (Peterson, 1936 #5184). More recent studies use the name East Cache fault or East Cache fault zone. Fault extends from east of Preston, Idaho, southward to its intersection with the James Peak fault [2378] southeast of Avon, Utah. **Section:** informal section names and are as defined by McCalpin (1994 #4414); this section extends from east of Preston, Idaho, southward to Green Canyon (McCalpin, 1987 #4999; 1994 #4414). McCalpin (1987 #4999) also identified this as segment A; however, even in this paper he does not suggest that these are necessarily seismogenic segments. **Fault ID:** Refers to fault number 11-3 (East Cache fault zone, southern segment) of Hecker (1993 #642).

County(s) and State(s)	FRANKLIN COUNTY, IDAHO CACHE COUNTY, UTAH
Physiographic province(s)	BASIN AND RANGE MIDDLE ROCKY MOUNTAINS
Reliability of location	Poor Compiled at 1:250,000 scale. *Comments:* Location of faults from 1:50,000 scale mapping of McCalpin (1989 #760). Poor designation is because the fault is poorly expressed; therefore, it is approximately located in original mapping.
Geologic setting	Generally north-trending range-front normal fault along the western base of the Bear River Range in eastern Cache Valley. The East Cache fault zone and opposing West Cache fault zone [2521] bound an intermontane graben forming Cache Valley (McCalpin, 1987 #4999). Faulting here probably had begun by at least late Eocene to early Oligocene (Brummer and Evans, 1989 #5185; Brummer and McCalpin, 1995 #4394). Oaks and others (1999 #5157) indicate that the vertical throw across the southern part of the East Cache fault zone is 7,750 m. Evans (1991 #4425) estimates net slip ranges from 2.7 km near the Idaho border to 8.1 km in southern Cache Valley; he indicates that in central Cache Valley, net slip is about 4.5–6.4 km. Brummer (1989 #5185) indicates that total net vertical offset is on the order of 2.7–3.0 km. Earlier estimates by Zoback (1983 #213) indicate that total late Cenozoic slip is 3.4–4.5 km. Faulting has resulted in a pronounced escarpment rising 1000 m above Cache Valley.
Length (km)	This section is 41 km of a total fault length of 79 km.
Average strike	N2°E (for section) versus N1°W (for whole fault)
Sense of movement	Normal
Dip	40–60°W *Comments:* Seismic reflection data indicate the fault dips 70° at the north end of the fault zone (Evans, 1991 #4425). Additional interpretations of seismic reflection data indicate the fault dips at 60? near the surface, flattening at depth to 45–55° between 3.5 and 4.0 km (Smith and Bruhn, 1984 #4561), and probably cuts the Sevier-age Paris thrust (Evans and Oaks, 1990 #4411).

Paleoseismology studies	
Geomorphic expression	The section consists of subparallel, normal faults that are a few kilometers apart. The range front is less youthful appearing than along the central section [2352b], with only three or four recognizable facets sets (McCalpin, 1987 #4999; 1994 #4414). There are no fault scarps on latest Quaternary surfaces (McCalpin, 1994 #4414), and McCalpin (1987 #4999; 1994 #4414) reports only one fault scarp (20 m high) preserved on a pre-Bonneville pediment surface located on the western strand at the extreme southern end of the section. At this location, McCalpin (1994 #4414) states that the "fault is marked by a broad, subdued ramp" probably suggesting that the scarp is quite old. The western strand of the fault defines a low relief range front on Tertiary sedimentary rocks, and the eastern strand is along a higher relief straighter range front on Paleozoic rocks.
Age of faulted surficial deposits	The western strand is shown as concealed along most its entire length (McCalpin, 1989 #760); at the south end of the segment this strand is shown to offset pre-Bonneville alluvium. The easternmost strand is generally within bedrock, except near the south end of the segment where it follows the bedrock-alluvium contact.
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* Time of most recent movement is not well constrained. McCalpin (1987 #4999; 1994 #4414) states that there is no evidence of latest Quaternary movement (less than 15-17 ka); even though Mason (1992 #463) uses data from McCalpin and Forman (1991 #299) to suggest that the most recent event occurred at or before 13.4 ka. The best estimate of the time of the last event is from McCalpin (p. 27 1987 #4999) of "at least early Pleistocene". Thus, the age assignment used here. McCalpin (1987 #4999; 1994 #4414) documents evidence of latest Quaternary surface deformation at the High Creek gravel pit and another site about 1 km to the south, which is located near this section of the fault. There was clear evidence of faults extending from the bottom of the exposure through sediments from the Provo lake level, which would point to faulting occurring between 12.8 and 13.4 ka. However, he believes that this surface

	deformation is likely lateral spreading features due to shaking from the penultimate event on the central section. These failure planes are not primary surface faulting features along the northern part of the fault. Fault is shown as a lesser Tertiary structure by Breckenridge and others (2003 #5878).
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* McCalpin (1987 #4999; 1994 #4414) reports a slip rate of 0.05–0.1 mm/yr based on the 20-m-high scarp on the pre-Bonneville surface. In addition, he reports a long term (Quaternary) slip rate of 0.25–0.5 mm/yr based on 500 m of offset of early Quaternary (1–2 Ma) pediments. He also notes that obviously the higher rate has not been maintained into the late Quaternary. Evans (1991 #4425) reports that the northern part of the fault is characterized by an average slip rate of 0.15 mm/yr for the past 10 m.y. However, on Table 3 he indicates that the post 17–10 Ma slip rate is 0.27–0.45 (respectively) mm/yr based on 4.5 km of net slip, or 0.16–0.36 (respectively) mm/yr based on 3.6 km of net slip. The lowest slip-rate category is indicated here because field relations suggest that late Quaternary rates do not exceed 0.2 mm/yr.
Date and Compiler(s)	2004 Bill D. Black, Utah Geological Survey Michael D. Hylland, Utah Geological Survey Kathleen M. Haller, U.S. Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#5186 Bailey, R.W., 1927, The Bear River Range fault, Utah: American Journal of Science, v. XIII, p. 496-502. #5187 Bailey, R.W., 1927, A contribution to the geology of the Bear River Range, Utah: Chicago, Illinois, University of Chicago, unpublished M.S. thesis, 63 p. #5878 Breckenridge, R.M., Lewis, R.S., Adema, G.W., and Weisz, D.W., 2003, Miocene and younger faults in Idaho: Idaho Geological Survey Map 8, 1 sheet, scale 1:1,000,000. #4394 Brummer, J., and McCalpin, J., 1995, Geologic map of the Richmond quadrangle, Cache County, Utah, and Franklin County, Idaho: Utah Geological Survey Miscellaneous Publication 95-3,

22 p. pamphlet, 2 sheets, scale 1:24,000.

#5185 Brummer, J.E., and Evans, J.P., 1989, Evidence for the onset of extensional tectonics, western Bear River Range, Utah: Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 60.

#4425 Evans, J.P., 1991, Structural setting of seismicity in northern Utah: Utah Geological Survey Contract Report 91-15, 37 p.

#4411 Evans, J.P., and Oaks, R.Q., Jr., 1990, Geometry of Tertiary extension in the northeastern Basin-and-Range Province superimposed on the Sevier fold and thrust belt, Utah, Idaho, and Wyoming: Geological Society of America Abstracts with Programs, v. 22, no. 6, p. 10.

#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000.

#463 Mason, D.B., 1992, Earthquake magnitude potential of active faults in the Intermountain seismic belt from surface parameter scaling: Salt Lake City, University of Utah, unpublished M.S. thesis, 110 p.

#760 McCalpin, J., 1989, Surficial geologic map of the East Cache fault zone, Cache County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-2107, 1 sheet, scale 1:50,000.

#299 McCalpin, J., and Forman, S.L., 1991, Late Quaternary faulting and thermoluminescence dating of the East Cache fault zone, north-central Utah: Bulletin of the Seismological Society of America, v. 81, p. 139-161.

#4999 McCalpin, J.P., 1987, Late Quaternary tectonics and earthquake hazard in Cache Valley, Utah: Technical report to U.S. Geological Survey, Reston, Virginia, under Contract 14-08-0001-G1091, July 1987, 187 p., 2 pls.

#4414 McCalpin, J.P., 1994, Neotectonic deformation along the East Cache fault zone, Cache County, Utah: Utah Geological Survey Special Study 83, 37 p.,

http://ugspub.nr.utah.gov/publications/special_studies/ss-83.pdf.

#5157 Oaks, R.Q., Jr., Smith, K.A., Janecke, S.U., Perkins, M.E., and Nash, W.P., 1999, Stratigraphy and tectonics of Tertiary strata of southern Cache Valley, north-central Utah, *in* Spangler, L.E., and Allen, C.J., eds., Geology of northern Utah and vicinity: Utah Geological Association Publication 27, p. 71-110.

#5184 Peterson, V.E., 1936, The geology of a part of the Bear River Range and some relationships that it bears with the rest of the range: Logan, Utah State Agricultural College, unpublished M.S. thesis, 71 p.

#4561 Smith, R.B., and Bruhn, R.L., 1984, Intraplate extensional tectonics of the western U.S. Cordillera-Inferences on structural style from seismic-reflection data, regional tectonics and thermal-mechanical models of brittle-ductile deformation: Journal of Geophysical Research, v. 89, no. B7, p. 5733-5762.

#320 Witkind, I.J., 1975, Preliminary map showing known and suspected active faults in Idaho: U.S. Geological Survey Open-File Report 75-278, 71 p. pamphlet, 1 sheet, scale 1:500,000.

#213 Zoback, M.L., 1983, Structure and Cenozoic tectonism along the Wasatch fault zone, Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., eds., Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 3-27.

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Quaternary Fault and Fold Database of the United States

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East Cache fault zone, central section (Class A) No. 2352b

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., Hylland, M.D., Haller, K.M., and Hecker, S., compilers, 1999, Fault number 2352b, East Cache fault zone, central section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:57 PM.**

Synopsis	**General:** Normal fault zone that separates Cache Valley from the Bear River Range to the east. The fault zone is at the boundary between the Basin and Range and the Middle Rocky Mountains physiographic provinces. The East Cache fault zone is one of several north-trending, northeast stepping, late Quaternary, normal faults that lie between the Wasatch fault zone in Utah and the Teton fault in Wyoming. **Sections:** This fault has 3 sections. Informally named sections

	defined here follow McCalpin (1987 #4999; 1994 #4414). McCalpin (1994 #4414) describes physiographic sections because the faulting history cannot be constrained well enough to define seismogenic segments. The sections are differentiated based on fault zone complexity, tectonic geomorphology, and expression of surface fault scarps . Bailey (1927 #5186) alludes to the same sectioning of the fault based on gross differences in the range-front morphology. The central section of the fault is the most active in the latest Quaternary; the northern and southern sections are less active and show evidence of only middle to late Pleistocene activity. The morphology of faceted spurs along the range front suggests that the boundary between the northern and central sections has shifted southward several kilometers during the middle to late Quaternary, probably along with development of a younger, western fault strand in the northern section (McCalpin, 1994 #4414; 1989 #4999). Similarities in the structure of faceted spurs and the absence of a gravity-defined boundary between the central and southern sections suggest that they may have behaved as a single 44-km-long seismogenic section during much of the late Cenozoic. However, the last two events on the East Cache fault zone were limited to the 20-km-long central section, leading McCalpin (1994 #4414; 1989 #4999) to suggest that paleoearthquake magnitudes were in the range of 6.6 to 7.1. The south end of the southern section abuts the northeast-trending James Peak fault [2378].
Name comments	**General:** Early workers in the area referred to this fault as the Bear River Range fault (Bailey, 1927 #5187; 1927 #5186) and Bear River fault (Peterson, 1936 #5184). More recent studies use the name East Cache fault or East Cache fault zone. Fault extends from east of Preston, Idaho, southward to its intersection with the James Peak fault [2378] southeast of Avon, Utah. **Section:** Informal section names and are as defined by McCalpin (1994 #4414); this section extends from Green Canyon southward to Blacksmith Fork Canyon (McCalpin, 1987 #4999; 1994 #4414). McCalpin (1987 #4999) also identified this as segment B; however, even in this paper he does not suggest that these are necessarily seismogenic segments. **Fault ID:** Refers to fault number 11-3 (East Cache fault zone, southern segment) of Hecker (1993 #642).
County(s) and State(s)	CACHE COUNTY, UTAH

Physiographic province(s)	MIDDLE ROCKY MOUNTAINS BASIN AND RANGE
Reliability of location	Good Compiled at 1:50,000 scale. *Comments:* Fault traces from 1:50,000 scale mapping of McCalpin (1989 #760).
Geologic setting	Generally north-trending range-front normal fault along the western base of the Bear River Range in eastern Cache Valley. The East Cache fault zone and opposing West Cache fault zone [2521] bound an intermontane graben forming Cache Valley (McCalpin, 1987 #4999). Faulting here probably had begun by at least late Eocene to early Oligocene (Brummer and Evans, 1989 #5185; Brummer and McCalpin, 1995 #4394). Oaks and others (1999 #5157) indicate that the vertical throw across the southern part of the East Cache fault zone is 7,750 m. Evans (1991 #4425) estimates net slip ranges from 2.7 km near the Idaho border to 8.1 km in southern Cache Valley; he indicates that in central Cache Valley, net slip is about 4.5–6.4 km. Brummer (1989 #5185) indicates that total net vertical offset is on the order of 2.7–3.0 km. Earlier estimates by Zoback (1983 #213) indicate that total late Cenozoic slip is 3.4–4.5 km. Faulting has resulted in a pronounced escarpment rising 1000 m above Cache Valley.
Length (km)	This section is 17 km of a total fault length of 79 km.
Average strike	N°7E (for section) versus N1°W (for whole fault)
Sense of movement	Normal
Dip	45°W to near vertical *Comments:* Seismic reflection data indicate the fault dips at 60° near the surface, flattening at depth to 45–55° between 3.5 and 4.0 km (Smith and Bruhn, 1984 #4561), and probably cuts the Sevier-age Paris thrust (Evans and Oaks, 1990 #4411). Near surface dips from the Bonneville trench (site 2352b-2) south of Logan are 65–75° near the trench floor, steepening to near vertical at the surface reported by (McCalpin, 1989 #760).
Paleoseismology studies	Two trenches were excavated across the central section of the East Cache fault zone.

	Site 2352-1. The first trench excavated by McCalpin and variously referred to as the "Bonneville trench" (McCalpin, 1994 #4414), the "East Cache trench" (McCalpin, 1987 #4999), the 1985 "Logan trench" (McCalpin and Forman, 1991 #299). The trench was located 0.9 km south of Logan Canyon in Lake Bonneville deposits that were offset 2.4 m across a broad deformation zone. The trench revealed evidence for two surface-faulting earthquakes (McCalpin, 1987 #4999; 1989 #760; McCalpin and Forman, 1991 #299; McCalpin, 1994 #4414). Within the main fault zone, quantitative pedogenic soil analysis, thermoluminescence age estimates on shallow lacustrine sand and silty colluvial deposits, and an AMS radiocarbon age on gastropod shells within a beach-sand deposit provide limiting ages for the penultimate event and poorly constrain the timing of the most recent event. Calculated displacements for penultimate event at the trench site is 179 cm and 76 cm in the most recent event (McCalpin, 1994 #4414). Site 2352-2. To better constrain the age of the most recent faulting event, the "Provo trench" was excavated about 1 kilometer north of the Bonneville trench, at the Logan Country Club golf course (McCalpin, 1989 #760; 1994 #4414). This trench exposed stratigraphic evidence for the most recent surface-faulting event, and radiocarbon age estimates were obtained from bulk-soil samples of crack-fill material, debris-facies colluvium, and a paleosol beneath the colluvium that better constrain the age of the youngest event. Single-event displacement at this trench site is 1.15 m (McCalpin, 1994 #4414).
Geomorphic expression	Early work by Peterson (1936 #5184) documented scarps on Bonneville and probable Provo-age deposits. Two post-Bonneville highstand surface-faulting earthquakes on the central section created composite fault scarps with 0.36–4.17 m of surface offset over a distance of at least 8 km along the northern half of the section (McCalpin, 1987 #4999; 1994 #4414). Unlike the northern and southern sections, the fault is expressed as a single trace along this section. The range front is abrupt with well-developed triangular facets (Bailey, 1927 #5186; Bailey, 1927 #5187; McCalpin, 1987 #4999; McCalpin, 1994 #4414) on the Paleozoic bedrock of the mountain range. Isolated, higher scarps (up to 10 m) are preserved along the trace of the fault (McCalpin, 1987 #4999; 1994 #4414) The fault is buried by landslide deposits along the southern half of the section (McCalpin, 1987 #4999; 1994 #4414).

Age of faulted surficial deposits	Fault scarps are mapped predominately on Lake Bonneville (upper Pleistocene) deposits; however, at a few locations, younger alluvium colluvium and lake deposits are faulted (McCalpin, 1989 #760). McCalpin (1987 #4999; 1994 #4414) indicates there are isolated scarps on pre-Bonnevile deposits.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Three radiocarbon ages from the Provo trench constrain the timing of the most recent event to between 4.0 and 4.2 ka (McCalpin, 1994 #4414). Thermoluminescence ages from the Bonneville trench supports timing for the event, which places it between 2.5 and 8.7 ka (McCalpin and Forman, 1991 #299). McCalpin and Forman (1991 #299) inferred that the most recent event occurred about 4 ka based on the thermoluminescence ages and the time he estimated for soil formation on the penultimate wedge. Using data from McCalpin and Forman (1991 #299), Mason (1992 #463) suggests the most recent event occurred 5±2 thousand years ago.
Recurrence interval	9.0–11.5 k.y. (<15.5 ka) *Comments:* Recurrence interval is from McCalpin (1994 #4414) based on permissable constraining age estimates of the two most recent events. The preferred timing of the most recent event is 4 ka, and the preferred timing of the penultimate event is 13–15.5 ka. Using data from McCalpin and Forman (1991 #299), Mason (1992 #463) suggests an average recurrence time of 8±2.5 k.y.
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* McCalpin (1994 #4414) calculates a post Bonneville vertical displacement rate of 0.28 mm/yr based on 4.2 m of offset of Bonneville age deposits, which is used here to select the slip-rate category. However, he also reports that vertical displacement rates of 0.02–0.13 may be characteristic for scarps on the pre-Bonneville surfaces. Longer-term slip (?) rates are provided by Evans (1991 #4425). He indicates in the text that post-17-Ma slip (?) rates are 0.32–0.54 mm/yr, but reports values of 0.29–0.54 mm/yr in Table 3.
Date and	1999

Compiler(s)	Bill D. Black, Utah Geological Survey Michael D. Hylland, Utah Geological Survey Kathleen M. Haller, U.S. Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#5186 Bailey, R.W., 1927, The Bear River Range fault, Utah: American Journal of Science, v. XIII, p. 496-502. #5187 Bailey, R.W., 1927, A contribution to the geology of the Bear River Range, Utah: Chicago, Illinois, University of Chicago, unpublished M.S. thesis, 63 p. #4394 Brummer, J., and McCalpin, J., 1995, Geologic map of the Richmond quadrangle, Cache County, Utah, and Franklin County, Idaho: Utah Geological Survey Miscellaneous Publication 95-3, 22 p. pamphlet, 2 sheets, scale 1:24,000. #5185 Brummer, J.E., and Evans, J.P., 1989, Evidence for the onset of extensional tectonics, western Bear River Range, Utah: Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 60. #4425 Evans, J.P., 1991, Structural setting of seismicity in northern Utah: Utah Geological Survey Contract Report 91-15, 37 p. #4411 Evans, J.P., and Oaks, R.Q., Jr., 1990, Geometry of Tertiary extension in the northeastern Basin-and-Range Province superimposed on the Sevier fold and thrust belt, Utah, Idaho, and Wyoming: Geological Society of America Abstracts with Programs, v. 22, no. 6, p. 10. #642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #463 Mason, D.B., 1992, Earthquake magnitude potential of active faults in the Intermountain seismic belt from surface parameter scaling: Salt Lake City, University of Utah, unpublished M.S. thesis, 110 p. #760 McCalpin, J., 1989, Surficial geologic map of the East Cache fault zone, Cache County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-2107, 1 sheet, scale 1:50,000.

#299 McCalpin, J., and Forman, S.L., 1991, Late Quaternary faulting and thermoluminescence dating of the East Cache fault zone, north-central Utah: Bulletin of the Seismological Society of America, v. 81, p. 139-161.

#4999 McCalpin, J.P., 1987, Late Quaternary tectonics and earthquake hazard in Cache Valley, Utah: Technical report to U.S. Geological Survey, Reston, Virginia, under Contract 14-08-0001-G1091, July 1987, 187 p., 2 pls.

#4414 McCalpin, J.P., 1994, Neotectonic deformation along the East Cache fault zone, Cache County, Utah: Utah Geological Survey Special Study 83, 37 p., http://ugspub.nr.utah.gov/publications/special_studies/ss-83.pdf.

#5157 Oaks, R.Q., Jr., Smith, K.A., Janecke, S.U., Perkins, M.E., and Nash, W.P., 1999, Stratigraphy and tectonics of Tertiary strata of southern Cache Valley, north-central Utah, *in* Spangler, L.E., and Allen, C.J., eds., Geology of northern Utah and vicinity: Utah Geological Association Publication 27, p. 71-110.

#5184 Peterson, V.E., 1936, The geology of a part of the Bear River Range and some relationships that it bears with the rest of the range: Logan, Utah State Agricultural College, unpublished M.S. thesis, 71 p.

#4561 Smith, R.B., and Bruhn, R.L., 1984, Intraplate extensional tectonics of the western U.S. Cordillera-Inferences on structural style from seismic-reflection data, regional tectonics and thermal-mechanical models of brittle-ductile deformation: Journal of Geophysical Research, v. 89, no. B7, p. 5733-5762.

#213 Zoback, M.L., 1983, Structure and Cenozoic tectonism along the Wasatch fault zone, Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., eds., Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 3-27.

Questions or comments?

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Quaternary Fault and Fold Database of the United States

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East Cache fault zone, southern section (Class A) No. 2352c

Last Review Date: 2016-02-11

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., Hylland, M.D., Haller, K.M., and Hecker, S., compilers, 2016, Fault number 2352c, East Cache fault zone, southern section, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:57 PM.**

Synopsis	**General:** Normal fault zone that separates Cache Valley from the Bear River Range to the east. The fault zone is at the boundary between the Basin and Range and the Middle Rocky Mountains physiographic provinces. The East Cache fault zone is one of several north-trending, northeast stepping, late Quaternary, normal faults that lie between the Wasatch fault zone in Utah and the Teton fault in Wyoming. **Sections:** This fault has 3 sections. Informally named sections

	defined here follow McCalpin (1987 #4999; 1994 #4414). McCalpin (1994 #4414) describes physiographic sections because the faulting history cannot be constrained well enough to define seismogenic segments. The sections are differentiated based on fault zone complexity, tectonic geomorphology, and expression of surface fault scarps . Bailey (1927 #5186) alludes to the same sectioning of the fault based on gross differences in the range-front morphology. The central section of the fault is the most active in the latest Quaternary; the northern and southern sections are less active and show evidence of only middle to late Pleistocene activity. The morphology of faceted spurs along the range front suggests that the boundary between the northern and central sections has shifted southward several kilometers during the middle to late Quaternary, probably along with development of a younger, western fault strand in the northern section (McCalpin, 1994 #4414; 1989 #4999). Similarities in the structure of faceted spurs and the absence of a gravity-defined boundary between the central and southern sections suggest that they may have behaved as a single 44-km-long seismogenic section during much of the late Cenozoic. However, the last two events on the East Cache fault zone were limited to the 20-km-long central section, leading McCalpin (1994 #4414; 1989 #4999) to suggest that paleoearthquake magnitudes were in the range of 6.6 to 7.1. The south end of the southern section abuts the northeast-trending James Peak fault [2378].
Name comments	**General:** Early workers in the area referred to this fault as the Bear River Range fault (Bailey, 1927 #5187; 1927 #5186) and Bear River fault (Peterson, 1936 #5184). More recent studies use the name East Cache fault or East Cache fault zone. Fault extends from east of Preston, Idaho, southward to its intersection with the James Peak fault [2378] southeast of Avon, Utah. **Section:** Informal section names and are as defined by McCalpin (1994 #4414); this section extends from Blacksmith Fork Canyon southward to the James Peak fault (McCalpin, 1987 #4999; 1994 #4414). McCalpin (1987 #4999) also identified this as segment C; however, even in this paper he does not suggest that these are necessarily seismogenic segments. Oaks and others (1999 #5157) identify the western strand as the "Paradise fault" and the central strand as the "McKenzie Flat fault". **Fault ID:** Refers to fault number 11-3 (East Cache fault zone, southern segment) of Hecker (1993 #642).
County(s) and	

County(s) and State(s)	CACHE COUNTY, UTAH
Physiographic province(s)	MIDDLE ROCKY MOUNTAINS
Reliability of location	Poor Compiled at 1:50,000 scale. *Comments:* Location of faults from 1:50,000-scale mapping of McCalpin (1989 #760). Poor designation is because the fault is poorly expressed; therefore, it is approximately located in original mapping.
Geologic setting	Generally north-trending range-front normal fault along the western base of the Bear River Range in eastern Cache Valley. The East Cache fault zone and opposing West Cache fault zone [2521] bound an intermontane graben forming Cache Valley (McCalpin, 1987 #4999). Faulting here probably had begun by at least late Eocene to early Oligocene (Brummer and Evans, 1989 #5185; Brummer and McCalpin, 1995 #4394). Oaks and others (1999 #5157) indicate that the vertical throw across the southern part of the East Cache fault zone is 7,750 m. Evans (1991 #4425) estimates net slip ranges from 2.7 km near the Idaho border to 8.1 km in southern Cache Valley; he indicates that in central Cache Valley, net slip is about 4.5–6.4 km. Brummer (1989 #5185) indicates that total net vertical offset is on the order of 2.7–3.0 km. Earlier estimates by Zoback (1983 #213) indicate that total late Cenozoic slip is 3.4–4.5 km. Faulting has resulted in a pronounced escarpment rising 1000 m above Cache Valley.
Length (km)	This section is 22 km of a total fault length of 79 km.
Average strike	N4°W (for section) versus N1°W (for whole fault)
Sense of movement	Normal
Dip	45–60°W *Comments:* All of the strands dip to the west following the mapping of McCalpin (1989 #760). However Oaks and others (1999 #5157) indicate that the central strand is down to the east. Seismic reflection data indicate the fault dips 65–70° near the ground surface and shallows to 50° at depth (Evans, 1991 #4425). Additional interpretations of seismic reflection data indicate the fault dips at 60° near the surface, flattening at depth to 45–55°

	between 3.5 and 4.0 km (Smith and Bruhn, 1984 #4561), and probably cuts the Sevier-age Paris thrust (Evans and Oaks, 1990 #4411). Evans and McCalpin (2012 #7323) report that the fault exposed in the eastern trench dips 45° W. and flattens to 40° near the bottom of the approximately 4-m-deep exposure.
Paleoseismology studies	Site 2352-3. Evans and McCalpin (2012 #7323) reports the findings of four trenches excavated across the principle faults of the southern East Cache fault near Paradise, Utah. Only the eastern trench shows evidence of faulting and the location is reported here. The trench exposed a normal fault separating Paleozoic dolostone and a more than 3 m of Quaternary section that did not contain colluvial-wedge deposits; the upper part of the loess deposit yielded optically stimulated luminescence (OSL) ages of 58.8±4.5 ka and 62.5±5.0 ka in proper stratigraphic order. Evans and McCalpin (2012 #7323) speculate, “Even though no young faulting was exposed in this trench, it is possible that faulting…is younger than 59–63 ka on the main fault”.
Geomorphic expression	McCalpin (1994 #4414) describes the fault as having three subparallel traces, similar to the northern section. However, along this part of the fault, the rangefront strand appears to be the most active as expressed in the low saddles that cross the heads of pre-Bonneville fans. High rates of Cenozoic displacement is recognized (Evans and Oaks, 1996 #7324; Oaks and others, 2005 #7325) along this part of the fault. The expression of faulting along the central and western strands is subtler and can be characterized as an alignment of low hills and stream channels. Evans and McCalpin (2012 #7323) conclude the western strand does not demonstrate recent surface rupture and is a bedrock fault juxtaposing different stratigraphic horizons of Salt Lake Group or does not exist at all. No evidence of faulting was exposed in two trenches of the central strand and the scarp may be erosional not tectonic (Evans and McCalpin (2012 #7323). McCalpin (1992 #4423) documents the presence of a fault scarp near Paradise Dry Canyon that has a height of 15.8 m and a surface offset of 10 m. There are no fault scarps on latest Quaternary or younger deposits along this section. McCalpin (1992 #4423) does indicate however that observed displacement in young deposits are probably due to near surface deformation.
Age of faulted surficial	Most of the fault traces are poorly expressed along this section. Mapping by McCalpin (1989 #760) shows that the westernmost

deposits	strand is generally buried, with a couple of scarps on Tertiary sedimentary rocks. The central strand has expression on Tertiary sediments and in middle Pleistocene alluvium. The eastern trace of the fault generally follows the bedrock-alluvium contact with discontinuous scarps on middle Pleistocene alluvium.
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* McCalpin (1992 #4423) suggests that faulting occurred between 26 and 46 ka. However, and earlier report states the most recent event occurred between 25 and 44 ka based on constraining thermoluminescence ages (McCalpin, 1987 #4999). Using data from McCalpin and Forman (1991 #299), Mason (1992 #463) suggests the most recent event occurred 36±18 thousand years ago. In a more recent study, Evans and McCalpin (2012 #7323) interpret the absence of scarp-derived colluvium in a trench across the western trace to indicate that the latest movement on this fault plane is older than the Bonneville lake cycle and younger than 59–63 ka
Recurrence interval	15–30 k.y. (<150 ka–1 Ma) *Comments:* McCalpin (1987 #4999; 1992 #4423) suggests a preferred recurrence interval for this section of 15–30 k.y. for the past 150 k.y. to 1 m.y. He bases this calculation on assuming that the 10 m of surface offset is the product of 0.5–1.5 m/event displacements. This yields 7–20 events since the deposition of the middle Pleistocene fan alluvium, which he assigns an age of 150 k.y.–1 m.y. The resulting recurrence interval is 7.5–143 k.y. Using data from McCalpin and Forman (1991 #299), Mason (1992 #463) suggests an average recurrence time of at least 35±17 k.y. Evans and McCalpin (2012 #7323) suggest that their conclusion of one surface rupture younger than 59–63 ka but older than the Bonneville lake cycle, the elapsed time since the most recent large earthquake is at least 26 k.y.
Slip-rate category	Less than 0.2 mm/yr *Comments:* McCalpin (1987 #4999) indicates that the middle to late Quaternary vertical displacement rate is 0.07 mm/yr based on 10 m of offset of a pre-Bonneville surface. Evans and McCalpin (2012 #7323) concur that the rate of mid-late Quaternary

	deformation is slow; they incorrectly identify their vertical-displacement rate of 0.01 to 0.03 mm/yr as representing a closed-interval rate whereas it is based on displacement in the most recent event and the elapse time since. Longer-term slip (?)(rates are provided by Evans (1991 #4425). He indicates that post-17-Ma slip (?) rates are considerably higher (0.47–0.8 mm/yr), and post Miocene (23 Ma) vertical displacement rate is about 0.35 mm/yr (Evans and McCalpin, 2012 #7323) presumably based on (Evans and Oaks, 1996 #7324; Oaks and others., 2005 #7325).
Date and Compiler(s)	2016 Bill D. Black, Utah Geological Survey Michael D. Hylland, Utah Geological Survey Kathleen M. Haller, U.S. Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#5186 Bailey, R.W., 1927, The Bear River Range fault, Utah: American Journal of Science, v. XIII, p. 496-502. #5187 Bailey, R.W., 1927, A contribution to the geology of the Bear River Range, Utah: Chicago, Illinois, University of Chicago, unpublished M.S. thesis, 63 p. #4394 Brummer, J., and McCalpin, J., 1995, Geologic map of the Richmond quadrangle, Cache County, Utah, and Franklin County, Idaho: Utah Geological Survey Miscellaneous Publication 95-3, 22 p. pamphlet, 2 sheets, scale 1:24,000. #5185 Brummer, J.E., and Evans, J.P., 1989, Evidence for the onset of extensional tectonics, western Bear River Range, Utah: Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 60. #4425 Evans, J.P., 1991, Structural setting of seismicity in northern Utah: Utah Geological Survey Contract Report 91-15, 37 p. #7323 Evans, J.P., and McCalpin, J.P., 2012, Determination of paleoearthquake timing and magnitudes on the southern segment of the East Cache fault, Utah: Final technical report to U.S. Geological Survey, Reston, Virginia, under Contract 07HQGR0079, May 2012, 54 p. #4411 Evans, J.P., and Oaks, R.Q., Jr., 1990, Geometry of Tertiary extension in the northeastern Basin-and-Range Province

superimposed on the Sevier fold and thrust belt, Utah, Idaho, and Wyoming: Geological Society of America Abstracts with Programs, v. 22, no. 6, p. 10.

#7324 Evans, J.P., and Oaks, R.Q., Jr., 1996, Three-dimensional variations in extensional fault shape and basin form—The Cache Valley basin, eastern Basin and Range province, United States: Geological Society of America Bulletin, v. 108, no. 12, p. 1580–1593.

#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000.

#463 Mason, D.B., 1992, Earthquake magnitude potential of active faults in the Intermountain seismic belt from surface parameter scaling: Salt Lake City, University of Utah, unpublished M.S. thesis, 110 p.

#760 McCalpin, J., 1989, Surficial geologic map of the East Cache fault zone, Cache County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-2107, 1 sheet, scale 1:50,000.

#299 McCalpin, J., and Forman, S.L., 1991, Late Quaternary faulting and thermoluminescence dating of the East Cache fault zone, north-central Utah: Bulletin of the Seismological Society of America, v. 81, p. 139-161.

#4999 McCalpin, J.P., 1987, Late Quaternary tectonics and earthquake hazard in Cache Valley, Utah: Technical report to U.S. Geological Survey, Reston, Virginia, under Contract 14-08-0001-G1091, July 1987, 187 p., 2 pls.

#4423 McCalpin, J.P., 1992, Paleoseismicity of the northeastern Basin and Range margin, western U.S.A., and its implications for earthquake potential [abs.], *in* Geologic reason —A basis for decisions affecting society: American Institute of Professional Geologists, Symposium and Annual Meeting, Lake Tahoe, Nevada, September 27-30, 1992, Program with Abstracts, p. 20.

#4414 McCalpin, J.P., 1994, Neotectonic deformation along the East Cache fault zone, Cache County, Utah: Utah Geological Survey Special Study 83, 37 p.,

http://ugspub.nr.utah.gov/publications/special_studies/ss-83.pdf.

#7325 Oaks, R.Q., Janecke, S.U., Langenheim, V.E. and Kruger, J.M., 2005, Insights into geometry and evolution of extensional basins along the Wasatch fault and East and West Cache fault zones, Utah and Idaho, USA: Geological Society of America Abstracts with Programs, vol. 37, no. 7, p. 497, (http://gsa.confex.com/gsa/2005AM/finalprogram/abstract 90595.htm)

#5157 Oaks, R.Q., Jr., Smith, K.A., Janecke, S.U., Perkins, M.E., and Nash, W.P., 1999, Stratigraphy and tectonics of Tertiary strata of southern Cache Valley, north-central Utah, *in* Spangler, L.E., and Allen, C.J., eds., Geology of northern Utah and vicinity: Utah Geological Association Publication 27, p. 71-110.

#5184 Peterson, V.E., 1936, The geology of a part of the Bear River Range and some relationships that it bears with the rest of the range: Logan, Utah State Agricultural College, unpublished M.S. thesis, 71 p.

#4561 Smith, R.B., and Bruhn, R.L., 1984, Intraplate extensional tectonics of the western U.S. Cordillera-Inferences on structural style from seismic-reflection data, regional tectonics and thermal-mechanical models of brittle-ductile deformation: Journal of Geophysical Research, v. 89, no. B7, p. 5733-5762.

#213 Zoback, M.L., 1983, Structure and Cenozoic tectonism along the Wasatch fault zone, Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., eds., Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 3-27.

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Mantua area faults (Class A) No. 2373

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., and Hecker, S., compilers, 1999, Fault number 2373, Mantua area faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:58 PM.**

Synopsis	Poorly understood Quaternary(?) faults in the southern Wellsville Mountains.
Name comments	**Fault ID:** Refers to fault number 11-10of Hecker (1993 #642).
County(s) and State(s)	BOX ELDER COUNTY, UTAH CACHE COUNTY, UTAH
Physiographic province(s)	BASIN AND RANGE MIDDLE ROCKY MOUNTAINS
Reliability of	Good

location	Compiled at 1:50,000 scale. *Comments:* Mapped or discussed by Gilbert (1928 #2954), Crittenden and Sorensen (1985 #4506), Sullivan and others (1988 #4508), Personius (1990 #1232), Dover (1995 #4507), and Solomon (1999 #4395). Fault traces from 1:50,000-scale mapping of Solomon (1999 #4395).
Geologic setting	Generally northwest-trending normal faults in small intermontane basins in the southern Wellsville Mountains. Gilbert (1928 #2954) and Dover (1995 #4507) suggest that the faults are longitudinal faults aligned along the axis of the Dry Lake trough, forming a graben occupied by Mantua Valley. Solomon (1999 #4395) indicates the faults may be related to the West Cache fault zone [2521].
Length (km)	21 km.
Average strike	N10°W
Sense of movement	Normal
Dip Direction	W
Paleoseismology studies	
Geomorphic expression	The presence of faults is mostly inferred from range-front linearity, faceted spurs, disrupted drainage, valley asymmetry, and the thick wedge of alluvial-fan deposits, the latter of which indicates significant uplift along the faults during the Quaternary, probably continuing into the late Pleistocene. Personius (1990 #1232) mapped Quaternary displacement in Holocene to middle Pleistocene alluvium and colluvium along the western boundary fault near the head of Wellsville Canyon, but Solomon (1999 #4395) found no evidence of displacement in post-Bonneville alluvial fans at the mouths of several canyons along the range front and thus doubts Holocene activity. Karst features are present locally in the area, but karst processes are probably of secondary importance in basin development.
Age of faulted surficial deposits	Middle and late Quaternary (?).

Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Based on range-front morphology and basin closure.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Poor geomorphic expression and lack of post-Bonneville displacement indicates a low slip rate.
Date and Compiler(s)	1999 Bill D. Black, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#4506 Crittenden, M.D., Jr., and Sorensen, M.L., 1985, Geologic map of the Mantua quadrangle and part of the Willard quadrangle, Box Elder, Weber, and Cache Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1605, scale 1:24,000. #4507 Dover, J.H., 1995, Geologic map of the Logan 30' x 60' quadrangle, Cache and Rich Counties, Utah, and Uinta County, Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I-2210, scale 1:100,000. #2954 Gilbert, G.K., 1928, Studies of Basin-Range structure: U.S. Geological Survey Professional Paper 153. #642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #1232 Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Colliston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1979, 1 sheet, scale 1:24,000. #4395 Solomon, B.J., 1999, Surficial geologic map of the West Cache fault zone and nearby faults, Box Elder and Cache Counties, Utah: Utah Geological Survey Map 172, 20 p. pamphlet, 2 sheets, scale 1:50,000.

	#4508 Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1988, Central Utah regional seismotectonic study for USBR dams in the Wasatch Mountains: Bureau of Reclamation Seismotectonic Report 88-5, 269 p.

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Quaternary Fault and Fold Database of the United States

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Ogden Valley southwestern margin faults (Class A) No. 2375

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., Hylland, M.D., and Hecker, S., compilers, 1999, Fault number 2375, Ogden Valley southwestern margin faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:58 PM.**

Synopsis	Poorly understood late Quaternary(?) faults along the southwestern margin of Ogden Valley. This generally northwest-trending range-front normal fault bounds the western side of Ogden Valley, which is one of several aligned discontinuous back valleys in the Wasatch hinterlands several kilometers east of the western base of the Wasatch Range.
Name comments	**Fault ID:** Refers to fault number 11-16 of Hecker (1993 #642).
County(s) and	

County(s) and State(s)	WEBER COUNTY, UTAH
Physiographic province(s)	MIDDLE ROCKY MOUNTAINS BASIN AND RANGE
Reliability of location	Good Compiled at 1:125,000 scale. *Comments:* Mapped or discussed by Lofgren (1955 #4509), Sorenson and Crittenden (1979 #4510), Sullivan and others (1988 #4508), and J.C. Coogan and J.K. King (unpublished UGS 1:100,000-scale mapping for the Ogden 30' x 60' quadrangle). Fault traces from Sullivan and others (1988 #4508).
Geologic setting	Generally northwest-trending range-front normal fault bounding the western side of Ogden Valley. Ogden Valley is in a line of discontinuous back valleys in the Wasatch hinterlands several kilometers east of the western base of the Wasatch Range.
Length (km)	17 km.
Average strike	N16°W
Sense of movement	Normal
Dip Direction	NE
Paleoseismology studies	
Geomorphic expression	Range-front escarpment. Sorenson and Crittenden (1979 #4510) mapped faults in late Quaternary alluvial-fan and colluvial deposits, but Sullivan and others (1988 #4508) found no scarps in these deposits. Lofgren (1955 #4509) inferred "recent displacement" based on springs and the steepness (28-33 degrees) of the escarpment. For the purpose of seismic-hazard assessment, values for slip rate, recurrence interval, and single-event displacement are inferred by Sullivan and others (1988 #4508) to be similar to those calculated for the Morgan fault (2353), based on similarities in late Quaternary fault length and escarpment morphology. A short southwest-striking section of the fault south of the Ogden River is associated with a faceted escarpment and may have had Quaternary movement; however, J.C. Coogan and J.K. King (unpublished UGS mapping for the Ogden 30' x 60' quadrangle) did not map a fault in this area.

Age of faulted surficial deposits	Quaternary(?)
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Based on range-front and alluvial-fan morphology.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Sullivan and others (1988, #4508) believe slip rates are similar to the Morgan fault [2353], which are <0.2 mm/yr.
Date and Compiler(s)	1999 Bill D. Black, Utah Geological Survey Michael D. Hylland, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #4509 Lofgren, B.E., 1955, Resume of the Tertiary and Quaternary stratigraphy of Ogden Valley, Utah, *in* Eardley, A.J., ed., Tertiary and Quaternary geology of the eastern Bonneville basin: Utah Geological Society, Guidebook to the Geology of Utah Number 10, p. 70-84. #4510 Sorensen, M.L., and Crittenden, M.D., Jr., 1979, Geologic map of the Huntsville quadrangle, Weber and Cache Counties, Utah: U.S. Geological Survey Geologic quadrangle Map GQ-1503, scale 1:24,000. #4508 Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1988, Central Utah regional seismotectonic study for USBR dams in the Wasatch Mountains: Bureau of Reclamation Seismotectonic Report 88-5, 269 p.

Questions or comments?

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Ogden Valley North Fork fault (Class A) No. 2376

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., and Hecker, S., compilers, 1999, Fault number 2376, Ogden Valley North Fork fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:58 PM.**

Synopsis	Poorly understood late Quaternary(?) fault along the west side of the North Fork of Ogden Valley.
Name comments	**Fault ID:** Refers to fault number 11-14 of Hecker (1993 #642).
County(s) and State(s)	BOX ELDER COUNTY, UTAH WEBER COUNTY, UTAH
Physiographic province(s)	MIDDLE ROCKY MOUNTAINS BASIN AND RANGE

Reliability of location	Poor Compiled at 1:125,000 scale. *Comments:* Fault traces from Sullivan and others (1988 #4508) and 1:50,000-scale mapping of Personius (1990 #1232).
Geologic setting	Northwest-trending range-front normal fault bounding the west side of the North Fork of Ogden Valley. Ogden Valley is one of several "back valleys of the Wasatch", a line of discontinuous valleys in the Wasatch Hinterlands east of the Wasatch Range.
Length (km)	26 km.
Average strike	N42°W
Sense of movement	Normal
Dip Direction	NE
Paleoseismology studies	
Geomorphic expression	Range-front normal fault. A faceted bedrock escarpment having eroded, 22? slopes may have been produced by Quaternary faulting north of a portion of the North Fork fault shown as questionable on Hecker (1993 #642). Personius (1990 #1232) mapped the fault in this area as cutting Quaternary deposits a kilometer west of the escarpment. For the purposes of seismic hazard assessment, Sullivan and others (1988 #4508) inferred values for slip rate, recurrence interval, and single-event displacement to be similar to those for the Morgan fault [2353], based on similarities in late Quaternary fault length and escarpment morphology.
Age of faulted surficial deposits	Quaternary
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Based on range-front morphology.
Recurrence	

interval	*Comments:* For the purposes of seismic hazard assessment, Sullivan and others (1988 #4508) inferred values for slip rate, recurrence interval, and single-event displacement to be similar to those for the Morgan fault (2353), based on similarities in late Quaternary fault length and escarpment morphology.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Sullivan and others (1988 #4508) believe slip rates are similar to the Morgan fault [2353] (<0.2 mm/yr), based on similarities in late Quaternary fault length and escarpment morphology.
Date and Compiler(s)	1999 Bill D. Black, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #1232 Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Colliston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1979, 1 sheet, scale 1:24,000. #4508 Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1988, Central Utah regional seismotectonic study for USBR dams in the Wasatch Mountains: Bureau of Reclamation Seismotectonic Report 88-5, 269 p.

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Broadmouth Canyon faults (Class A) No. 2377

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., and Hecker, S., compilers, 1999, Fault number 2377, Broadmouth Canyon faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:58 PM.**

Synopsis	Poorly understood Quaternary(?) faults that intersect the southern end of the James Peak fault [2378].
Name comments	**Fault ID:** Refers to fault number 11-13 of Hecker (1993 #642).
County(s) and State(s)	CACHE COUNTY, UTAH WEBER COUNTY, UTAH
Physiographic province(s)	MIDDLE ROCKY MOUNTAINS
Reliability of	Good

location	Compiled at 1:125,000 scale. *Comments:* Mapped or discussed by Sullivan and others (1988 #4508) and Nelson and Sullivan (1992 #617). Fault traces from Sullivan and others (Sullivan and others, 1988 #4508).
Geologic setting	Northeast-trending range-front normal faults at the southern end of Cache Valley. Cache Valley is a north-trending intermontane graben (bounded by high-angle normal faults on the east and west) between the Bear River and Wasatch Ranges.
Length (km)	3 km.
Average strike	N30°E
Sense of movement	Normal
Dip Direction	NW
Paleoseismology studies	
Geomorphic expression	Most faults do not extend into sediment of the Tertiary Salt Lake Formation, but in two areas, faint fault lineaments are visible in these deposits. The morphology of the scarps on Paleozoic bedrock suggests no recurrent late Quaternary displacement. The faults intersect and have been displaced by the James Peak section of the East Cache fault zone [2352d]); however, Nelson and Sullivan (1992 #617) speculated that the faults may be the southernmost part of the East Cache fault zone.
Age of faulted surficial deposits	Tertiary
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Although Sullivan and others (1988 #4508) only suspected Quaternary movement, Nelson and Sullivan (Nelson and Sullivan, 1992 #617) show a scarp of probable late Quaternary age at the southwest end of the fault zone.
Recurrence	

interval	
Slip-rate category	Less than 0.2 mm/yr
Date and Compiler(s)	1999 Bill D. Black, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #617 Nelson, A.R., and Sullivan, J.T., 1992, Late Quaternary history of the James Peak fault, southernmost Cache Valley, north-central Utah, *in* Gori, P.L., and Hays, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch front, Utah: U.S. Geological Survey Professional Paper 1500, p. J1-J13. #4508 Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1988, Central Utah regional seismotectonic study for USBR dams in the Wasatch Mountains: Bureau of Reclamation Seismotectonic Report 88-5, 269 p.

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

James Peak fault (Class A) No. 2378

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., McDonald, G.N., and Hecker, S., compilers, 1999, Fault number 2378, James Peak fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:58 PM.**

Synopsis	Late Pleistocene normal fault at the south end of the southern section of the East Cache fault zone [2352c]. Surface faulting on the James Peak fault and southern ECFZ section may have extended onto each other.
Name comments	**Fault ID:** Refers to fault number 11-12 of Hecker (1993 #642).
County(s) and State(s)	CACHE COUNTY, UTAH
Physiographic province(s)	MIDDLE ROCKY MOUNTAINS

Reliability of location	Good Compiled at 1:125,000 scale. *Comments:* Mapped or discussed by Sullivan and others (1988 #4508) and Nelson and Sullivan (1992 #617). Fault traces from Sullivan and others (1988 #4508).
Geologic setting	Northeast-trending range-front normal fault along the northern flank of James Peak at the south end of Cache Valley. Cache Valley is a north-trending intermontane graben (bounded by high-angle normal faults on the east and west) between the Bear River and Wasatch Ranges.
Length (km)	6 km.
Average strike	N°63E
Sense of movement	Normal
Dip Direction	N; NW
Paleoseismology studies	Site 2378-1. Sullivan and others (1988 #4508) excavated a trench about 2.5 km north-northwest of James Peak across a 7-m-high scarp on a glacial outwash fan. Stratigraphic relations and soil development provide ambiguous evidence for two surface-faulting events since about 110 ka.
Geomorphic expression	Faults are present in Bull Lake outwash deposits (~140 ka). The data are ambiguous, but lithofacies analysis of fault colluvium and the cumulative displacement (4.2 m) suggests two events rather than a single, large event. Assuming two events, displacement per event is 1.8 to 2.4 m. The short fault length (7 km) suggests that surface faulting may have extended northward, rupturing the southern ECFZ section. Faceted spurs at the base of James Peak suggest recurrent Quaternary displacements, though the spurs are smaller, less continuous, and less steep than those along the ECFZ and Wasatch fault zone.
Age of faulted surficial deposits	Bull Lake outwash deposits (~140 ka) are offset (Sullivan and others, 1988 #4508).
Historic earthquake	

Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Analyses of soil development in deposits which pre- and post-date faulting bracket the timing of movement between 30 ka and 110 ka (Sullivan and others, 1988 #4508). If faulting on the southern East Cache fault [2352c] extends onto the James Peak fault, then a time of 26-46 ka for most recent faulting applies as well to the James Peak fault.
Recurrence interval	>50 k.y. (?) *Comments:* The lack of a soil between the two colluvial wedges suggests that time between events was short and, therefore, that recurrence intervals may be nonuniform. The two colluvial wedges could also represent separate events on the ECFZ [2352c] and James Peak fault [2378] that propagated onto the adjacent fault.
Slip-rate category	Less than 0.2 mm/yr *Comments:* 0.03 mm/yr for the past 140 k.y. (Sullivan and others, 1988 #4508).
Date and Compiler(s)	1999 Bill D. Black, Utah Geological Survey Greg N. McDonald, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #617 Nelson, A.R., and Sullivan, J.T., 1992, Late Quaternary history of the James Peak fault, southernmost Cache Valley, north-central Utah, *in* Gori, P.L., and Hays, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch front, Utah: U.S. Geological Survey Professional Paper 1500, p. J1-J13. #4508 Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1988, Central Utah regional seismotectonic study for USBR dams in the Wasatch Mountains: Bureau of Reclamation Seismotectonic Report 88-5, 269 p.

Questions or comments?

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Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Ogden Valley northeastern margin fault (Class A) No. 2379

Last Review Date: 1999-10-01

Compiled in cooperation with the Utah Geological Survey

citation for this record: **Black, B.D., and Hecker, S., compilers, 1999, Fault number 2379, Ogden Valley northeastern margin fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 02:58 PM.**

Synopsis	Poorly understood Quaternary(?) fault along the northeastern margin of Ogden Valley.
Name comments	**Fault ID:** Refers to fault number 11-15 of Hecker (1993 #642).
County(s) and State(s)	WEBER COUNTY, UTAH
Physiographic province(s)	MIDDLE ROCKY MOUNTAINS

Reliability of location	Poor Compiled at 1:125,000 scale. *Comments:* Mapped or discussed by Sorenson and Crittenden (1979 #4510) and Sullivan and others (1988 #4508). Fault traces from mapping of Sullivan and others (1988 #4508).
Geologic setting	Northwest-trending range-front normal fault along the eastern side of Ogden Valley. Ogden Valley is one of several "back valleys of the Wasatch," a line of discontinuous valleys in the Wasatch Hinterlands east of the Wasatch Range.
Length (km)	13 km.
Average strike	N40°W
Sense of movement	Normal
Dip Direction	SW
Paleoseismology studies	
Geomorphic expression	Range-front normal fault. The morphology of the range front suggested an absence of late Quaternary faulting to Sullivan and others (1988 #4508). Sorenson and Crittenden (1979 #4510) mapped fault scarps on Holocene colluvium that Sullivan and others (1988 #4508) interpret as shallow landslide scarps.
Age of faulted surficial deposits	Quaternary (?).
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* Based on range-front morphology
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* The absence of late Quaternary faulting indicates a

	low slip rate.
Date and Compiler(s)	1999 Bill D. Black, Utah Geological Survey Suzanne Hecker, U.S. Geological Survey
References	#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000. #4510 Sorensen, M.L., and Crittenden, M.D., Jr., 1979, Geologic map of the Huntsville quadrangle, Weber and Cache Counties, Utah: U.S. Geological Survey Geologic quadrangle Map GQ-1503, scale 1:24,000. #4508 Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1988, Central Utah regional seismotectonic study for USBR dams in the Wasatch Mountains: Bureau of Reclamation Seismotectonic Report 88-5, 269 p.

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TECHNICAL MEMORANDUM

To:	Mr. Layne Jensen, PE Franson Civil Engineers 1276 South 820 East, Suite 100 American Fork, Utah 84003 Office: (801) 756-0309 ljensen@fransoncivil.com
From:	Mike Starkie, PG; and Richard Buhler, PE
Reviewed by:	Jamie Schick PG, and Ryan Cole, PhD, PE, BCGE
Date:	June 18, 2025
Job Number:	24-1762
Subject:	UTABA Retarding Dam Geological and Geotechnical Data TM

PROJECT DESCRIPTION

This Geological and Geotechnical Data Technical Memorandum presents the results of geotechnical field and laboratory studies and provides preliminary geological reconnaissance for UTABA Retarding Dam (UTABA). We understand the overall project consists of an assessment of the Watershed and completing an Environmental Assessment (EA) for the proposed project. Natural Resources Conservation Service (NRCS) is overseeing the funding of the overall project and Utah Dam Safety (UDS) regulates the construction and performance of UTABA Dam. Weber County is the owner of the dam.

Franson Civil Engineers (FCE) is working with NRCS on the project, while Gerhart Cole's (GC) role is to complete geotechnical studies at UTABA Dam. We understand the dam's primary function is to provide flood control and that there is currently no water storage rights for the reservoir. We understand that limited water can pass through the intake tower and into the principal spillway given that primary lower ports have become plugged with debris and beaver activity. Additionally, we understand the principal spillway may be undersized.

Given the limitations of the intake tower and the undersized principal spillway being undersized, a few feet of water remains stored in the reservoir. Based on discussions with Weber County the auxiliary spillway generally passes water every spring and the reservoir holds water for an extended amount of time during the spring and summer. Given the large retention time of flood waters, both NRCS and UDS has changed the dam classification to high hazard, and desire to rehabilitate the dam to function as a flood control structure that releases water during flood events.

UTABA is located just northwest of Liberty, Utah as illustrated in Figure 1. A site map showing the dam and surrounding area is provided in Figure 2. We understand, pending the results of the EA, UTABA could be raised to provide additional sediment storage and regain some of its flood control capabilities, but those details will be discussed more in the

geotechnical design memorandum. The rehabilitated structure will be designed to not retain water other than during flooding events. This Technical Memorandum (TM) is focused on the geological conditions at the site and the geotechnical and geological data collected for the project.

PURPOSE, AUTHORIZATION, AND SCOPE OF WORK

This report presents the results of geotechnical and geologic studies performed by GC in support of project design by FCE. This work was completed following the approach discussed in our proposal dated December 19, 2023, and under GC's Cooperative Reciprocal Service Agreement with FCE, dated December 19, 2016. The scope of services includes:

- Geologic / geotechnical assessment and background review.
- Field study program consisting of a site reconnaissance and advancement of two test holes using auger drilling and HQ coring techniques, test pit excavations, and geophysical surveys.
- Laboratory testing of select samples.
- Development of a conceptual dam cross-section, for a single dam alignment, which meets Utah Dam Safety Administrative Rules (R655-10 and R655-11) and NRCS TR-210-60 with a high hazard classification. This will be provided in the Geotechnical Design Report.
- Development of geologic, seismic, and geotechnical memorandums.

This document will cover the first three bullet items in the list above, and the seismic and geotechnical design memorandums will provide scope for the other two bullets.

GENERAL INFORMATION

General information considered in this study, including that from UDS within the Utah Division of Water Rights (UDWR), NRCS, and from Franson (specifically relating to inputs for hazard and consequence assessments/classifications), include:

- Location (latitude, longitude): 41.386815º, -111.909813º
- UDS identifier: UTABA, UT00541
- Function: Flood control [typically empty for future planned use]
- Existing structural height (per USD): 71 feet
- Existing hydraulic height (per USD): 54 feet
- Existing storage at spillway and dam crests (per UDS): 91 and 180 acre-feet (not accounting for accumulated sediments)
- Planned future structural height (per Franson): 71 existing +4 raise = 75 feet (crest elevation 5724ft)
- Planned future hydraulic height (per Franson): 54 existing +4 raise = 59 feet
- Planned future storage at spillway and dam crests (per Franson, accounting for accumulated sediments): 75 and 190 acre-feet
- UDS dam type category: Inspected flood control dams greater than 20 acre-feet
- UDS hazard rating: High
- NRCS hazard class: High

- NRCS structure classification: Group A
- NRCS consequence of seismic failure: Low
- Seismic site characterization:
    - NEHRP 2020 and 2023 USGS site class: B (see text for discussion of potential range)
    - Site-specific Vs30 value: 973 m/s [3,192 ft/s] (see text for discussion of potential range)
    - Liquefaction potential: Negligible

Additional information / details regarding the above summary are presented in the following sections of this document. General information regarding the dam embankment as well as the analytical guidance used for this seismic study is based on:

- UDS/UDWR website page for UTABA Dam (UDS, 2024)
- Utah Code, Title 73 Water and Irrigation, Chapter 5a Dam Safety (State of Utah, 2025)
- Utah Rules, R655-10 Dam Safety Classifications, Approval Procedures and Independent Reviews (UOAR, 2025a)
- Utah Rules, R655-11 Requirements for the Design, Construction, and Abandonment of Dams (UOAR, 2025b)
- NRCS Title 210 National Engineering Manual [NEM], Part 520, Subpart C Dams (NRCS, 2017a)
- NRCS Title 210 National Engineering Manual [NEM], Part 531 Geology (NRCS, 2017b)
- NRCS Technical Release 210-60, Earth Dams and Reservoirs (NRCS, 2019)

BACKGROUND

UTABA Dam was constructed in 1962 and was constructed at the confluence of Cutler Creek and North Fork Ogden River to assist with flood control and sediment storage. It is a zoned earthen embankment having an upstream pervious section (Zone 1), a central relatively impervious core (Zone 2), and a downstream pervious section (Zone 3). The maximum embankment height is 71 feet. The principal outlet includes a 24-inch diameter reinforced concrete pipe that discharges into an energy dissipator. The auxiliary spillway is a reinforced concrete chute founded on the embankment. Record drawings are provided in Appendix A.

Cross-sections from the record drawings show upstream slope at 3H:1V and downstream slopes at 2H:1V. The dam rests on a silty gravel foundation with a cutoff through the silty gravel foundation and excavated into bedrock through the foundation and along the left abutment. The record drawings also show the cutoff trench extending up the right abutment until it wraps around the upstream side of the abutment with an relatively impervious blanket. The cutoff trench is extended into bedrock below the impervious blanket.

Since the dam was reconstructed in 1986 the main deficiency identified in inspection reports is seepage around the outlet conduit and storing of water longer than the original design

(UDWR, 2024). In addition, the Dam Assessment Report (Genterra Consultants, 2020) mentions the following concerns:

- No slope stability analyses are provided.
- Filter compatibility between the different zones and foundation materials are unknown.
- Cutoff collars appear to be the only seepage control measures.
- There is no toe drain or other seepage control measures in place.
- No seepage analses are available.
- Source and cause of seepage around the outlet conduit is unknown.
- Bedrock beneath the dam is reported as thinly bedded and highly fractured. Flow through the fractured quartzite bedrock could be a cause for the high groundwater observed at the toe of the dam.

REGIONAL GEOLOGIC SETTING

Utaba Reservoir is located within the Wasatch Mountain Range, which is a western arm of the Middle Rocky Mountain Physiographic Province characterized by rocky, mountainous terrain with stream valleys (Hecker, 1993). Specifically, Utaba embankment is situated in the Ogden Valley, a back valley of the Wasatch Hinterlands (Hecker, 1993). To the west lies the Basin and Range Physiographic Province with north-south trending mountains (ranges) separated by semi-arid alluvial/pluvial sediment filled valleys (basins). The separation of these two distinct regions is known as a transitional zone. These two different zones are separated by the Weber Segment of the Wasatch Fault Zone (WFZ), which is located approximately 5 miles west of the site.

The site is underlain by a thick series of Precambrian (4.6 billion to 540 million years ago) to Cambrian aged (540 to 487 million years ago) sedimentary rocks that were deposited in and near shallow oceans. These deposits were brought to the ground surface through a complex series of thrust faulting associate with crustal thickening during the Sevier and Laramide orogenies and later normal faulting associated with crustal extension. Subsequent erosion has exposed the current bedrock units at the site.

During the Pleistocene, multiple periods of glaciation have left the surrounding mountain ranges and valley with a complex assemblage of glacial deposits. These include morainal and till deposits as well as alluvial deposits related to glacial outwash.

SURFICIAL SITE GEOLOGY

The geology of the area has been mapped at a scale of 1:62,500 by Coogen and King (2016) and by Crittenden and Sorensen (1985) at a 1:24:000 scale. Figure 3 provides the geologic map based on Coogen and King (2016).

The site lays in a valley filled with Holocene and Pleistocene sediment associated with stream and lacustrine deposits. The valley fills and deposits to the west side of the canyon are associated with Holocene-aged unconsolidated stream and fan deposits composed primarily of gravel, sand, and silt. These include both terrace deposits as well as recent channel deposits.

Pleistocene-aged deposits associated with Late Prehistoric High Lake Bonneville lacustrine deposits (Currey et al., 1984) are present south and southeast of the dam. These lacustrine deposits are composed of unconsolidated gravel, sand, and silt. Pleistocene glacial moraine deposits are north to west and south of the site and primarily consist of unsorted gravel, sand, and silt, along with cobbles and boulders.

Several different land mass wasting deposits are mapped within the project vicinity. This includes earth flow/debris flow deposits to the west as well as colluvial deposits associated with the steep slopes to the east of the dam. None of these deposits are anticipated to adversely impact the project area.

Bedrock in the project vicinity includes several sedimentary rock types. Coogen and King (2016) mapped all bedrock on the east side of the reservoir as the Mutual Formation. The Mutual Formation is medium to thick-bedded, medium to coarse grained feldspathic quartzite. However, previous mapping in the project area by Crittenden and Sorensen (1985) indicated that bedrock on the east side also included the Geertsen Canyon quartz, which can appear very similar in outcrop. Both maps indicate that bedrock exposed in the fork between the two tributaries is associated with the Inkom Formation. This unit is composed of very fine-grained sandstone to siltstone. The geologic map presented in Figure 3 is based on the more recent mapping by Coogen and King (2016).

FIELD STUDIES

Geotechnical and Geologic field studies were completed around the existing embankment between July 8 and November 2, 2024. These studies included geologic mapping, seven seismic refraction lines, drilling two test holes, and excavating test pits. The purpose of the seismic refraction lines completed around the dam were to assist with bedrock profiling and might provide insight of the groundwater levels around the dam if saturated conditions exist. The two test holes were completed to study the composition and dam materials, and piezometric surface through the dam. Two shallow test pits (24-TP-02 and 24-TP-03) were completed along the slopes of the dam to study soil conditions in the shell material (Zone 1 and Zone 3). Four test pits (24-TP-101a/b to 24-TP-103) were completed to study the soil conditions in the reservoir basin. Four test pits (24-TP-104 to 24-TP-107) were completed in the original borrow source to assess material characteristics. Test pit (24-TP-201) was completed along in the right abutment to collect soil samples for a potential alignment of the auxiliary spillway.

A site map showing test hole (TH), test pits (TP), and seismic refraction line locations are plotted on Figure 2. Test Hole data is summarized along with other information in Table 1. All aspects of field studies were overseen by a field geologist, professional engineer, and professional geologist.

GEOLOGIC RECONNAISSANCE

A geologic reconnaissance was completed on July 8, 2024 to observe and document existing site conditions. Information collected during the reconnaissance was used to develop the geologic map included as Figure 3. General geologic descriptions are included

in Figure 4. In general, observed conditions are generally consistent with previously published geologic mapping except as noted above.

Test Hole Drilling and Sampling

All test holes were drilled using auger and HQ coring methods with casing and a track-mounted CME 850 drill rig equipped with an auto-hammer operated by ConeTec, Inc. under subcontract to GC.

Auger drilling tooling used included an 8.25-inch outside diameter and 4.25 inch inside diameter. Temporary piezometers were installed in test holes 21-TH-01 and 21-TH-401 to measure groundwater levels. Additional information on test hole depths is listed on the test hole logs in Appendix B and summarized in Table 1. The sampling within the test holes included Standard Penetration Tests, Shelby Tube sampling and HQ wire line coring.

Standard Penetration Test (SPT) – Split spoon samples were collected within the dam and foundation by driving a 1⅜-inch ID (inside diameter) by 2-inch OD (outside diameter) "split spoon" sampler with an automatic-trip hammer, consisting of a 140-pound weight falling a distance of 30 inches. The SPT results are in the logs (Appendix B). The auto-hammer was reported by ConeTec as having an average hammer energy transfer of 76.9%. In addition to providing a sample, the SPT provides a relative consistency or relative density measurement of the soil in-situ.

Shelby Tube – Shelby tube samples were collected in dam materials (Zone II) by pushing, with constant hydraulic pressure, a 3-inch tube past the bottom of the advancing drill stem into the fine-grained soils. Before extracting the samples, the samples were allowed to wait for at least 10 minutes. This provided relatively undisturbed samples for performing strength and consolidation testing. It is noted that a number of the Shelby tube samples were damaged due to gravel material in the dam.

HQ cores were collected in the field, packaged, and returned to GC's laboratory for testing. Graphical logs of the test holes and photos of rock cores are included Appendix B. Lines designating boundaries between different materials shown on the logs should be considered approximate; transitions between subsurface materials may be gradual or occur between recovered core segments.

Seismic Refraction Survey

Seven seismic refraction surveys were completed within the project area by GC. Objectives of the surveys included: a) obtaining a series of seismic P-wave (V_p) refraction and surface shear wave velocity (V_s) profiles; b) providing average shear wave velocity profile of near surface V_{S30} to assess NEHRP seismic class; c) providing information for liquefaction susceptibility evaluations; and d) obtaining seismic P-wave velocity measurements as they may relate to bedrock durability and excavatibility. Wave velocities were measured using Multichannel Analysis of Surface Waves (MASW) instruments. The approximate locations of these seismic refraction surveys are plotted in Figure 2; geophysical survey results are provided in Appendix C.

Discussion about the average shear wave velocity Vs and the variability at the site is discussed in Site Specific Seismic Study completed for this site (GC, 2025). The average shear wave velocity V_s for the upper 100 feet was calculated at 973 (m/s) (3192 fps). The average V_{S30} value was utilized in the Seismic Hazard Evaluation for the dam embankment in Seismic Report. V_s and V_p profiles were also utilized in assessing the thickness of alluvial soils and potential depth to bedrock. Additional information on soil and bedrock depths and thicknesses are discussed in the Subsurface Conditions Section.

The seismic refraction surveys in Appendix C show Vp and Vs profiles. Relative to our interpretation it is noted the Vp profiles suggest a contour value of 4,800 fps could indicate potential water level profiles for Lines 1, 2, 3, 4, and 5. The seismic p-wave data has been differentiated in two general velocity zones. The first zone is considered softer soils and embankment soils, with a V_p of less than 2,000 to 3,000 feet per second (fps) (609 to 914 meters per second (m/s). The second zone suggests rock with velocities greater than 7,000 to 10,000 fps (2133 to 3048 (m/s)). All the seismic refraction survey lines indicated the presence of the two V_p velocity zones (soil and bedrock) except for Line 6 which does not seem to indicate the presence of shallow bedrock. The deeper layer in Line 6 may represent the talus layer reported in the as-built drawings. It is noted that the seismic refraction surveys match fairly well with the findings from the test holes (24-TH-01 and 24-TH-401) with where bedrock was found drilling and what is shown on the as-built construction plans for depth of bedrock.

Packer Testing

Water pressure or packer testing was completed in test holes 24-TH-01 and 24-TH-401, to measure the in-situ hydraulic conductivity of the bedrock. No packer testing was completed within the embankment. Packer testing was completed during drilling utilizing a single packer placed at 5 to 10 -foot depth intervals. Following rock core removal after drilling a run, the HQ core barrel was lifted above the test zone and the packer testing equipment was installed down the hole in the exposed rock utilizing the wireline equipment. For each test, the packer was inflated under sufficient air pressure to seal off the rock around the packer and allow testing at target water pressures. The inlet hose to the packer system was equipped with a pressure gauge to continuously monitor changes in fluid head pressure applied at the surface during testing. In addition, a pressure transducer was installed in the zone of test to record pressures during testing. The transducer in the zone of testing was used to calculate actual pressures for permeability calculations. Water losses into the formation, below the packer, were measured using an in-line flow meter installed at the surface.

Water pressures were applied in stages of loading and unloading (i.e., applying head and removing head). Each stage of testing was conducted for a total of about 5 minutes, or until relatively steady flow (or no flow) conditions were measured. Typically, the stages ran for each packer test interval were ratios of 0.25, 0.5, 1, 0.5, and 0.25 of the maximum pressure. Maximum pressure was calculated assuming 1 psi of pressure per foot of bedrock above the test interval. Flow and gage pressure measurements were recorded at one-minute intervals during testing. Water pressure packer testing results are summarized in Appendix B.

Packer Testing Data Interpretation

Lugeon (Lu) values and Hydraulic conductivities (expressed in various units) were computed based on measured pressures at depth, water loss over one-minute intervals, and the exposed perimeter of the test hole. Results of each test were graphed and interpreted using guidance provided by Houlsby (1990), Quiñones-Rozo (2010), and Weaver and Bruce (2007). Based on relative trends. The measured results were categorized, classified, and summarized in Table 2. Individual packer test results are included in Appendix B.

Testing results and selection of Lugeon values over testing depth intervals can be classified by typical behaviors observed as follows (Weaver and Bruce, 2007):

- Laminar Flow: Lugeon values were relatively constant at each pressure step, which usually indicates smooth flow in fine fractures.
- Turbulent Flow: Lugeon values decrease with increasing pressure and increase with decreasing pressure, typically indicative of fast flow in wide fractures.
- Dilation: Lugeon values step up significantly at the highest pressure stage and step back at lower pressure stages, typically indicative of local dilation of fractures due to compression of adjacent softer material or closure of adjacent parallel cracks/fractures.
- Wash-out: increasing Lugeon values during the course of the test, even after the pressure is reduced, indicating either flushing out of joint infilling or displacement.
- Void Filling: decreasing Lugeon values throughout the test indicate that voids are being filled; possibly by loose infillings being washed into the fractures.
- Hydrofracture: Initiation of flow as peak pressure is approached, but no flow at low and moderate pressures. Significant increases at peak pressure can indicate hydraulic fracturing of the rock.

Additional discussion of bedrock permeability is presented in subsurface discussion.

Temporary Piezometer and Groundwater Data

Temporary standpipe piezometers were installed in each of the test holes at a depth of 62 and 32 feet. Piezometers were constructed with the bottom 10 feet of each temporary piezometer being screened. The non-perforated riser pipe of each piezometer was sealed with cement bentonite grout to exclude surface water intrusion. Flush mount covers were used to seal out runoff and prevent tampering. GC returned to the project area after the field studies were completed on November 12th, 20th, and December 16th to measure groundwater levels. In addition, a level troll was installed in each piezometer to take measurements every day through the winter and spring of 2024/2025. Temporary piezometer construction details are summarized in Appendix B. A summary of groundwater observations can be found in Table 3 and is discussed in the Subsurface Conditions section of this TM.

Temporary piezometers were left in place for use by the project team and should be continued to be monitored by Weber County to assist with monitoring of the reservoir in the future. The piezometers will need to be properly abandoned during construction if they

cannot be protected. We recommend they are replaced if they are damaged or abandoned. The design team should include provisions for such within the project plans and specifications and/or include recommendations for new piezometers to be installed with the rehabilitated dam.

Laboratory Testing

Laboratory testing was performed on select soil specimens obtained during the field study to further classify them and evaluate their engineering properties. Laboratory testing consisted of index testing (particle-size distributions and natural moisture contents), moisture-density (i.e., Proctor) and triaxial testing of soils. Rock testing includes point load and unconfined compressive strength testing. Laboratory test results are summarized in Table 4 and 5 with additional data in Appendix D.

Two composite samples were created from materials from 24-TP-104 to 24-TP-107. The first composite sample was by combining all the materials from the samples collected in 24-TP-104 to 24-TP-107. The second sample was created by taking a portion of the first composite sample and then removing all material greater than #4 sieve. The composite samples were also tested to evaluate its laboratory moisture-density relationships (i.e., "Proctor" compaction), strength characteristics, as well as dispersivity via pinhole and total dissolved salts assessments.

Groundwater

Groundwater was observed at the time of drilling in 24-TH-01, 24-TH-401, and 24-TP-101a and 24-TP-102a. Subsequent measurements were taken and are summarized in Table 3. Water was also observed in the reservoir basin and coming out of the principal spillway at the time of our field work. Potential fluctuations in groundwater levels should also be anticipated as part of reservoir elevation, potential seasonal variations, localized zones of increased moisture, and with precipitation / runoff events.

SUBSURFACE CONDITIONS

Figure 7 provides a cross-section across the dam alignment and shows test hole 24-TH-01, an approximate bedrock surface based on the as 1961 built drawings. Also presented are the Lugeon values from the packer testing, RQD values from the coring, and refraction survey (Vp) 7000 fps contours. Figure 8 provides an approximate subsurface condition perpendicular to the dam at 24-TH-01 and 24-TH-401. Based on the subsurface studies, the stratigraphy within the dam at the locations appears to generally align with the 1961 as-builts. The seismic refraction survey aligns with the bedrock surface generally on Figure 7 and 8, except near the 24-TH-401.

Test Holes

The test hole (24-TH-01) drilled at the crest of the dam indicates approximately 5 feet of sandy gravel, underlain by clayey sand to sandy clay to approximately 61 feet. At about 61 feet soils transition, for approximately 10 feet, to sandy gravel with occasional silty sand mixes interpreted as alluvial deposits. From around 71 feet to the bottom of the test hole is quartzite bedrock interpreted to be the Mutual Formation (Zm), which outcrops nearby (see Figure 3). Groundwater levels measured in the piezometer in 24-TH-01 indicate the

groundwater level to between 58 to 60 feet below the ground surface near the sandy gravel foundation level. On the downstream toe of the dam test hole 24-TH-401 encountered alluvial deposited sandy gravel with cobbles and boulders in the upper 14 feet. Underlying the alluvium to the bottom of the test hole (33 feet bgs) is the Mutual Formation (Zm) quartzite bedrock. Groundwater levels measured in the piezometer in 24-TH-401 indicate the groundwater level to be about 4 feet below the ground surface test hole logs and descriptions can be found in Appendix A.

Test Pits (Dam)
Test pits were excavated in three general areas of the dam site, within the immediate dam reservoir basin, on the dam faces, and around the borrow area.

Test pits 24-TP-101a, 24-TP-101b, 24-TP-102a, 24-TP-102b, and 24-TP-103 were all excavated within the reservoir basin or on its outskirts. Soils found in 24-TP-101a were identified as variable colluvium soils deposits with cobbles and boulders up to 2 feet in size with gravel sand and silt. Within 24-TP-102a, the top 3 feet of material is silt with organic mixes, deposited from reservoir catchment from the surface which seems to be part of the infilling of the reservoir. Then coarse-grained alluvial soils were found with cobbles and boulders up to 4 feet in size from approximately 3 feet to 9 feet. Test pits 24-TP-101b and 24-TP-102b were both advanced within the water of the reservoir. Both test pits had elastic silt to 5 to 6 feet underlain by cobble and boulder dominated alluvium. 24-TP-103 is approximately 6 feet of clayey gravel before transitioning to a lean clay to approximately 13 feet.

On the faces of the dam, shallow test pits, 24-TP-02 (upstream) and 24-TP-03 (downstream) were excavated. These test pits in the dam embankment were excavated only a few feet into the shell to collect samples and limit disturbance to the dam. Both test pits found sandy gravel with cobbles suggesting relative consistency with the as-built plans.

Test Pits (Borrow Area)
Test pits excavated in the borrow area include 24-TP-104, 24-TP-105, 24-TP-106, 24-TP-107 and 24-TP-201. Test pits 24-TP-104 and 24-TP-107 are generally in borrow areas 2 and 1, shown in the as-builts, respectively. Soils observed within the test pits are similar to those described in the as-builts, clayey gravel with cobbles and boulders. Test pits 24-TP-105 and 24-TP-106 were both excavated outside of previous study areas. Both test pits showed similar lithology as 24-TP-104 and 24-TP-107.

Excavated in a transitional area between the dam and borrow area one test pit was excavated. 24-TP-201 consisted of silty sand to approximately 2.5 feet and transitioning to a clayey gravel with cobbles and boulders.

GEOLOGIC HAZARDS

We have considered the following geologic/geotechnical hazards considerations relative to the project area:

- Surface fault rupture / ground shaking
- Liquefaction

- Flooding & Debris Flow
- Landslides
- Karst Foundation
- Dispersive and collapsible soils

Surface Fault Rupture / Ground Shaking / Liquefaction

Seismic activity is considered a significant hazard at UTABA Dam and the seismic hazard is addressed in the Site Specific Seismic Hazard TM. Liquefaction triggering analysis results are presented in the Geotechnical Design Report. In summary liquefaction is considered negligible due to very stiff clayey soils found in the dam, dense foundation soils (i.e high SPT blow counts), and shallow bedrock.

Flooding & Debris Flows

Utaba Dam is located at the confluence of the Ogden River and Cutler Creek. It was originally designed to help manage flooding potential, with 37-acre feet flood storage and 90 -acre feet sediment storage when constructed (Bridges, 1977). Over time this has been reduced, making it less effective to manage large volumes of water. Seasonal fluctuations in precipitation, and spring run-off could present flash-flooding along upstream tributaries. Also, as a result, there could be an increased risk of debris flows hazards during these events if the reservoir capacity and dam is not maintained or kept up to current standards.

On May 11, 2023, a mudslide caused by water flowing down the mountainside led to homes being evacuated in Eden, Utah, approximately 7.6 miles southeast (Winn, 2023). The underlying cause was excessive water from recent storms and rapid snowmelt. Wildfires are also a potential hazard in the area which could change the occurrence of flooding and increase the debris and landslide hazard in the drainage area.

Landslides

Utaba Reservoir is surrounded by relatively steep terrain. These slopes contain talus material, alluvium deposits, and unconsolidated sediment. These types of deposits are prone to instability, especially during seismic events and when saturated during extreme precipitation or winter runoff. The geologic mapping indicates a few landslide units (Qms) in the vicinity, but they are located about 0.5 miles northeast of the dam and no landslide units have been mapped at the dam site (Coogan & King 2016, Crittenden & Sorensen 1985).

We do note that landslide mapping for the whole state of Utah was completed by Elliott and Hardy (2010). Their map shows the right and left abutment being mapped as potential landslide deposits; however, this mapping was completed at a very large scale. Based on recent geologic mapping, review of the hill shade imagery based on LiDAR mapping (Figure 5 and Figure 6), and the geologic reconnaissance, GC does not feel there is a high landslide risk for the dam site.

Karst Foundation

Karst foundations can have the potential of subsidence, seepage, and leakage in the dam foundation and reservoir floor (NRCS, 2019). This is due to the potential for soluble bedrock

to dissolve as groundwater or seeps through the foundation creating karst landscapes (i.e sinkholes and caves). Typically, Karst risk is more critical for dams with permanent water storage. Common bedrock types indicating this risk are limestone and or gypsum. Quartzite bedrock mapped at Utaba Dam site and found during drilling is not considered soluble; therefore, karst foundation risk is considered low.

Collapsible and Dispersive Soils

Collapsible soils are typically characterized by a cellular, "honeycomb" structure, low unit weight, low degree of saturation, and high dry strength (Williams and Rollins, 1991). Soils fitting these descriptions may be collapsible when introduced to moisture, causing their interstitial minerals or clay bonds to weaken or dissolve, and the soil to collapse which can cause both overall settlement and differential settlement. Alluvial fan deposits are generally more prone than other soils to contain collapsible soils but typically more in arid and semi-arid environments. UTABA Dam is situated in a mountain valley EcoRegion of Utah which is not considered an arid or semiarid environment (Wood et. al) and considered more a humid environment with more than 20 inches of precipitation a year (Gillies and Ramsey). Honeycomb structure or voids were not observed during the samples collected during field studies and have not been reported in any of the field inspections reviewed; therefore, we consider this hazard to being low.

Soil containing dispersive clays are extremely erosive and dams using dispersive clays are vulnerable to internal erosion failures (NRCS, 2019). Several dispersive tests were performed on samples collected in the dam and at the potential borrow site and the tests showed the soil to be nondispersive, as such we consider this hazard to being low.

LIMITATIONS

The assessments and recommendations presented in this document are based on limited field studies and laboratory testing, as well as our understanding of the project's design and manner of construction. If the project's design or manner of construction changes, or if conditions are found that are different from those described, we should be notified immediately so that we can make revisions as necessary. We recommend that project plans, specifications, and construction-related submittals be reviewed by Gerhart Cole for compatibility with our recommendations.

This document was prepared solely for the use of the addressee (our Client) for the specified project and may not contain sufficient information for other parties or uses. Also, this document does not constitute a specification and should not be treated or referred to as such in project design drawings or documents.

We represent that our services are performed within the limitations prescribed by our Client, in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation expressed or implied, and no warranty or guarantee is included or intended. We do not assume responsibility for the accuracy of information provided by others.

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Figure 8 Estimated Subsurface Profile – Across Dam Alignment (North to South)

APPENDICES

Appendix A Background Information
Appendix B Test Hole and Test Pit Logs
Appendix C Geophysical Survey
Appendix D Laboratory Test Results

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Table 1: Field Studies Test Hole Summary
UTABA Dam (24-1762)

Study Point Identification[a]	Date Started	Latitude[b]	Longitude[b]	Ground Surface Elev. (ft)[c]	Total depth (ft)	Drilling Method/Excavation Equipment	Subcontractor
24-TH-01	10/24/2024	41.38682	-111.90982	5721	101.0	Hollow Stem Auger and HQ Coring	ConeTec
24-TH-401	10/21/2024	41.38643	-111.90929	5658	33.0	Hollow Stem Auger and HQ Coring	ConeTec
24-TP-02	10/21/2024	41.38701	-111.90997	5701	2.0	John Deere 210G	Weber County
24-TP-03	10/21/2024	41.38682	-111.90971	5699	2.0	John Deere 210G	Weber County
24-TP-101a	10/21/2024	41.38731	-111.90995	5698	9.0	John Deere 210G	Weber County
24-TP-101b	10/21/2024	41.38721	-111.91014	5698	5.0	John Deere 210G	Weber County
24-TP-102a	10/21/2024	41.38694	-111.91034	5698	9.0	John Deere 210G	Weber County
24-TP-102b	10/21/2024	41.38699	-111.91032	5698	7.5	John Deere 210G	Weber County
24-TP-103	10/21/2024	41.38651	-111.91048	5698	14.0	John Deere 210G	Weber County
24-TP-104	10/21/2024	41.38537	-111.91222	5764	10.0	John Deere 210G	Weber County
24-TP-105	10/21/2024	41.38525	-111.91420	5796	10.0	John Deere 210G	Weber County
24-TP-106	10/21/2024	41.38475	-111.91331	5777	10.0	John Deere 210G	Weber County
24-TP-107	10/21/2024	41.38493	-111.91116	5744	10.0	John Deere 210G	Weber County
24-TP-201	10/21/2024	41.38600	-111.90994	5715	10.0	John Deere 210G	Weber County

Notes:

a) TH=Test Hole (drilled); TP=Test Pit (excavation)

b) Latitude/Longitude measurements were obtained with a recreational grade handheld GPS device. The coordinates are based on the WGS84 Datum and have an accuracy of ±30 feet.

c) Elevations are estimated from ground surface profile provided by FCE or by pubically available LiDAR Data.

Table 2: Test Hole Packer Testing Summary and Lugeon Interpretation
Utaba Dam (24-1762)

Test Hole	Depth Range (ft)	Representative Flow Rate (gal/min)	Representative Lugeon Value	Classification	Lugeon Interpretation	Condition of Rock Mass Discontinuities	Hydraulic Conductivity Range (cm/sec)	Representative Hydraulic Conductivity (cm/sec)	Representative Hydraulic Conductivity (ft/year)
24-TH-01	75-81	12.2	167	High	Laminar	Many Open	6E-04 to 1E-03	2.2E-03	2.3E+03
24-TH-01	81-91	18.0	96	High	Dilation	Many Open	6E-04 to 1E-03	1.2E-03	1.24E+03
24-TH-01	91-101	18.3	78.0	High	Dilation	Many Open	6E-04 to 1E-03	1.0E-03	1.03E+03
24-TH-401	18-28	<1	<1	Low	Laminar	Tight	1E-05 to 6E-05	1.2E-05	1.24E+01
24-TH-401	28-33	2.6	52	High	Dilation	Many Open	6E-04 to 1E-03	6.8E-04	7.01E+02

Notes: a Testing procedures, reported values, interpretation, and classifications after BOR (2001), Weaver and Bruce (2007), and Quiñones-Rozo (2010)

Table 3: Groundwater Measurements
UTABA Dam (24-1762)

Study Point Identification	Elev. (ft)[a]	10/21/2024[b]	10/23/2024	10/24/2024[b]	11/12/2024	11/20/2024	12/16/2024
24-TH-01	5721		--	57.5	38.4	57.9	59.8
24-TH-401	5658	7.8	4.2	--	3.8	4.2	3.8

a) Elevations are estimated from ground surface profile provided by FCE or by pubically available LiDAR Data.

b) Measurements were taken during drilling.

Table 4: Laboratory Test Results Summary
Utaba Dam (24-1762)

GERHART COLE

Test Hole	Depth (ft)	Moisture content (%)	Dry unit weight (pcf)	Moist / Sat. unit weight (pcf)	Atterberg Limits			Grain-Size					Grain-Size Analysis (Percent Finer)												Corrosion			Other Tests
					LL (%)	PL (%)	PI (%)	GRAVEL (No.4 - 3")	SAND (No.200-No.4)	FINES (<No.200)	silt (0.005-0.075 mm)	clay (<0.005 mm)	6-in (150 mm)	3-in (75 mm)	1.5-in (37.5 mm)	3/4-in (19 mm)	3/8-in (9.5 mm)	No.4 (4.75 mm)	No.10 (2 mm)	No.20 (0.85 mm)	No.40 (0.425 mm)	No.60 (0.25 mm)	No.100 (0.15 mm)	No.200 (0.075 mm)	pH	Soluble chloride (ppm)	Soluble sulfate (ppm)	
24-TP-02	0.5-2 ft	5.5						45	34	18			100	97	80	70	61	51	42	34	28	24	21	18				
24-TP-03	0-2 ft	5.6						49	33	18			100	100	88	70	59	51	42	34	28	24	21	18	7.2	36	ND	
24-TP-101b	0-2 ft	128.9			72	58	14	0	6	94			100	100	100	100	100	100	99	99	98	97	97	94	6.7	78	ND	Organic Content
24-TP-102a	1-2 ft	54.8			44	30	14	0	7	93			100	100	100	100	100	100	100	99	98	97	96	93	6.6	54	59	
24-TP-102a	8-9 ft	33.0						40	20	40			100	100	86	71	66	60	55	50	47	44	42	40				
24-TP-103	2-4 ft	8.6						32	29	39			100	100	89	81	76	68	62	55	50	46	42	39				
24-TP-103	10-12 ft	13.9						22	24	54			100	100	96	89	85	78	72	66	62	59	57	54				
24-TP-104	2-4 ft	5.7						43	36	21			100	100	84	72	64	57	51	43	35	29	25	21				
24-TP-105	1-4 ft	7.3						36	34	30			100	100	94	82	75	64	56	48	43	38	34	30				
24-TP-106	4-6 ft	6.8						41	34	25			100	100	91	78	68	59	50	41	35	31	28	25				
24-TP-107	1-4 ft	7.0						31	29	40			100	100	93	84	76	69	62	55	50	46	43	40				
24-TP-201	6-10 ft	4.7						44	36	20			100	100	90	77	66	56	48	39	32	27	21	20				
#4 Minus - Composite Sample		3.8			26	17	9	0	49	51			100	100	100	100	100	100	83	73	64	58	54	51				Combined Samples from TP-103 to TP-107; CIU, Proctor
Composite Sample		7.0			26	18	8	43	35	22			--	100	89	75	66	57	48	40	33	29	25	22	6.0	32	ND	Combined Samples from TP-103 to TP-107; Pinhole, CIU, Perm, Proctor, and Metals

Table 4: Laboratory Test Results Summary
Utaba Dam (24-1762)

GERHART COLE

Test Hole	Depth (ft)	Moisture content (%)	Dry unit weight (pcf)	Moist / Sat. unit weight (pcf)	Atterberg Limits			Grain-Size					Grain-Size Analysis (Percent Finer)												Corrosion			Other Tests
					LL (%)	PL (%)	PI (%)	GRAVEL (No.4 - 3")	SAND (No.200-No.4)	FINES (<No.200)	silt (0.005-0.075 mm)	clay (<0.005 mm)	6-in (150 mm)	3-in (75 mm)	1.5-in (37.5 mm)	3/4-in (19 mm)	3/8-in (9.5 mm)	No.4 (4.75 mm)	No.10 (2 mm)	No.20 (0.85 mm)	No.40 (0.425 mm)	No.60 (0.25 mm)	No.100 (0.15 mm)	No.200 (0.075 mm)	pH	Soluble chloride (ppm)	Soluble sulfate (ppm)	
24-TH-01	5-6.9 ft	5.6			28	17	11	15	38	47			--	100	100	100	91	85	76	67	60	55	51	47				
24-TH-01	10-12 ft	6.0						37	28	35	19	16	--	100	100	89	72	63	55	48	43	40	37	35				
24-TH-01	15-17 ft	13.2			30	16	14	17	32	51			--	100	100	100	92	83	74	67	62	58	54	51				
24-TH-01	20-21.7 ft																											Double Hydrometer
24-TH-01	25-27 ft							17	32	51	20	28	--	100	100	100	92	83	74	67	62	58	54	51				
24-TH-01	35-37 ft	8.1	121.7	131.6	32	16	16	20	39	41			--	100	100	91	85	80	73	58	50	46	43	41				CU
24-TH-01a	40-42 ft	13.5						39	22	39	20	19	--	100	100	79	68	61	56	51	47	44	41	39				
24-TH-01	40-42 ft	10.2																										
24-TH-01	45-47 ft	8.2	128.6	139.2	38	16	22	16	30	54			--	100	100	93	89	84	76	67	62	59	57	54				CU
24-TH-01	50-52 ft	13.6						32	32	36			--	100	100	83	78	68	60	52	47	43	40	36				
24-TH-01	55-57 ft	10.3			28	17	11																					
24-TH-01	60-61 ft	26.9	95.0	120.6																								Pinhole
24-TH-01	65-66 ft	25.6						5	43	52	32	20	--	100	100	100	97	95	92	87	79	70	60	52				
24-TH-01	66-66.9 ft	10.6						43	35	22	12	9	--	100	100	85	70	57	46	39	33	28	24	22				
24-TH-01	70-71.4 ft	9.5																										
24-TH-401	5-7 ft	6.5						49	29	22	10	12	--	100	100	76	61	51	43	37	32	29	25	22				
24-TH-401	10-11.7 ft							55	32	13	7	6	--	100	100	80	59	45	33	27	22	19	15	13				

Table 5: Laboratory Test Results Summary - Rock Strength

UTABA Dam (24-1762)

GERHART COLE

Test Hole	Depth (ft)	Point Load Test[1]		Unconfined Compressive Strength of Rock[2]		Other Information
		Uniaxial compressive strength, (psi):[1]	Break Type	Corrected Uniaxial Compressive Strength (psi)	Description of Break	
24-TH-01	73.5	10,282	Perpendicular			
24-TH-01	75.75	12,986	Perpendicular			
24-TH-01	77			5315	Verical cracking and fragmenting with conical ends	
24-TH-01	78.5	12,986	Perpendicular			
24-TH-01	80.5	19,766	Perpendicular			
24-TH-01	90			11,880	Verical cracking and fragmenting with conical ends	
24-TH-01	90.3	13,875	Perpendicular			
24-TH-01	95	10,989	Perpendicular			
24-TH-401	12.75	21,559	Perpendicular			
24-TH-401	16.3	5,281	Perpendicular			
24-TH-401	19.25	2,662	Perpendicular			
24-TH-401	22.6	3,250	Perpendicular			
24-TH-401	24			6582	Diagonal fracture	
24-TH-401	25	4,146	Perpendicular			
24-TH-401	29.5	10,506	Perpendicular			
24-TH-401	30	3,390	Perpendicular	3918	Diagonal fracture	
24-TH-401	31.6	17,251	Perpendicular			

1) Values derived from point load testing. Point load testing performed in general accordance to ASTM D5731.

2) UC testing performed in general accordance to ASTM D7012 method C.



GERHART COLE

Vicinity Map

Utaba Dam

N

0 0.4 0.8 1.6
Miles

Figure 1



GERHART COLE

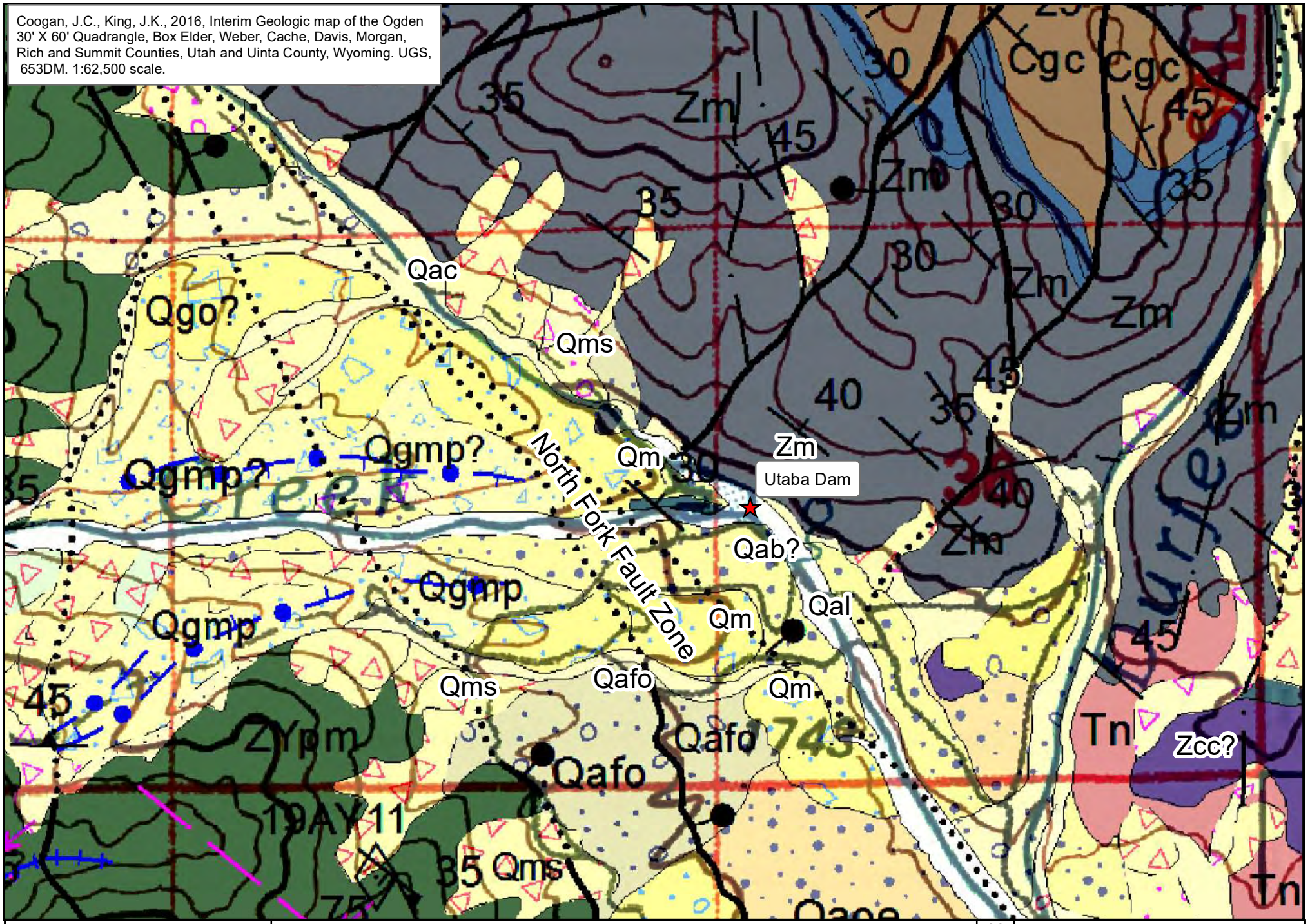
Site Map

Utaba Dam

N

0 45 90 180 Feet

Figure 2



GERHART COLE

Geologic Map

Utaba Dam

N

0 400 800 1,600 Feet

Figure 3

DESCRIPTION OF GEOLOGIC MAP UNITS

Qal **Alluvial Deposits (Holocene) –** Unconsolidated deposits of gravel, sands, and silts in active stream channels and flood plains; thickness 0-6 m.

Qf **Colluvium Deposits (Holocene) –** Unconsolidated deposits of gravel, sands, and rock fragments

Qfo **Alluvial Fan Deposits (Holocene) –** Deposits of gravel, sand, and silt along Wasatch front; mostly younger than high standing Lake Bonneville; thickness 0-25 m.

Qab?/ Qtd **Terrace deposits (Pleistocene) –** Gravel, sand, and silt in stream terraces graded to high standing Lake Bonneville. South of Matua, includes terraces graded below Bonneville level.

Qm **Moraine(?) Deposits** (Pleistocene) – South of Matnua, unsorted deposits composed mainly of deeply weathered silts with abundant quartzite boulders; thickness 0-10 m.

Qms **Landslide Deposits** (Holocene and Pleistocene) – Poorly sorted clay- to coulber sized materia; includes slides, slimps and locally flows and floods.

Tn **Norwood Tuff** (Lower Oligocene and Upper Eocene) – Pale-gray to greenish white, thin-bedded tuff, tuffaceous silt, and sandy tuff. Tuffs are extensively altered to zeolites or bentonite. Commonly covered with black deeply cracked soil in areas of poor exposure.

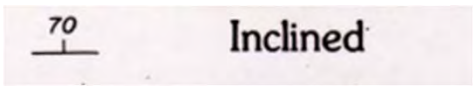
Cgc **Geertsen Canyon Quartzite (Lower Cambrian) –** Medium- to thick-bedded, medium- to coarse-grained quartzite with scattered zone of small pebbles; upper part is white, gray, and light green, rarely feldspathic; lower part is streaked grayish purple or pale green and may contain as much as 20 percent salmon-colored potassium feldspar. Scolithus tubes very abundant in uppermost beds. Thickness 1,200 m.

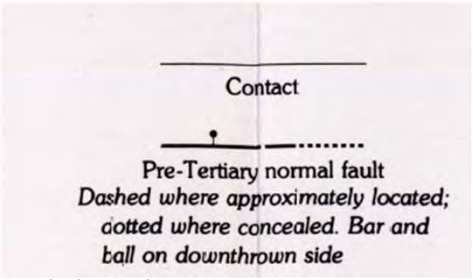
Zcc? **Caddy Canyon Quartzite (Neoproterozoic) –** Mostly vitreous, almost white, cliff-forming quartzite, but colors vary and are tan, light-gray, pinkish-gray, greenish-gray, and purplish-gray hues that are typically lighter shades than the Geertsen Canyon Quartzite.

Zm **Mutual Formation (Upper Proterozoic) –** Medium- to thick-bedded, medium- to coarse-grained, locally pebbly, locally feldspathic quartzite ib dark shades of purple, grayish red, green, and brown; thickness 675-800 m.

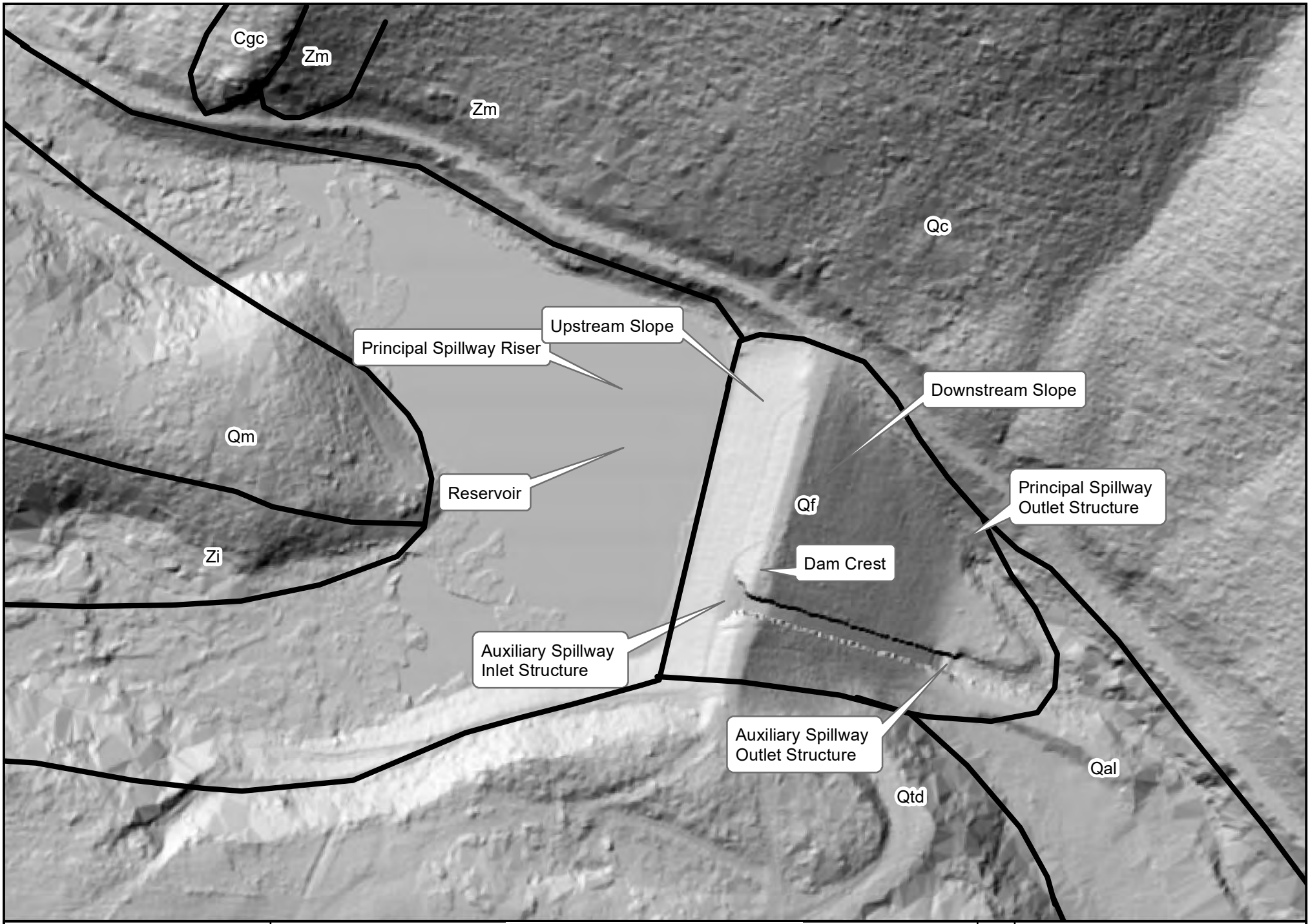
Zi **Inkom Formation (Upper Proterozoic) –** Upper part very fine-grained, dark-green sandstone underlain by laminated dark-green to olive-drab siltstone; lower part contains lenses of silver- to gray-weathering tuff. Thickness 5-60 m.

ZYpm **"Mudstone" member of formation of Perry Canyon (Neoproterozoic and possibly Mesoproterozoic)–** Gray and green-weathering, black, non-foliated argillite and sandy argillite, and slate that grades black chloritoid and pyrite-bearing schistm.





Note: 1. See Figure 3 for Geologic Map (Coogann, and King J.C., 2016)
2. See referenced Geologic Map for additional information on mapping; descriptions shown are the units that are in the vicinity of the project



GERHART COLE

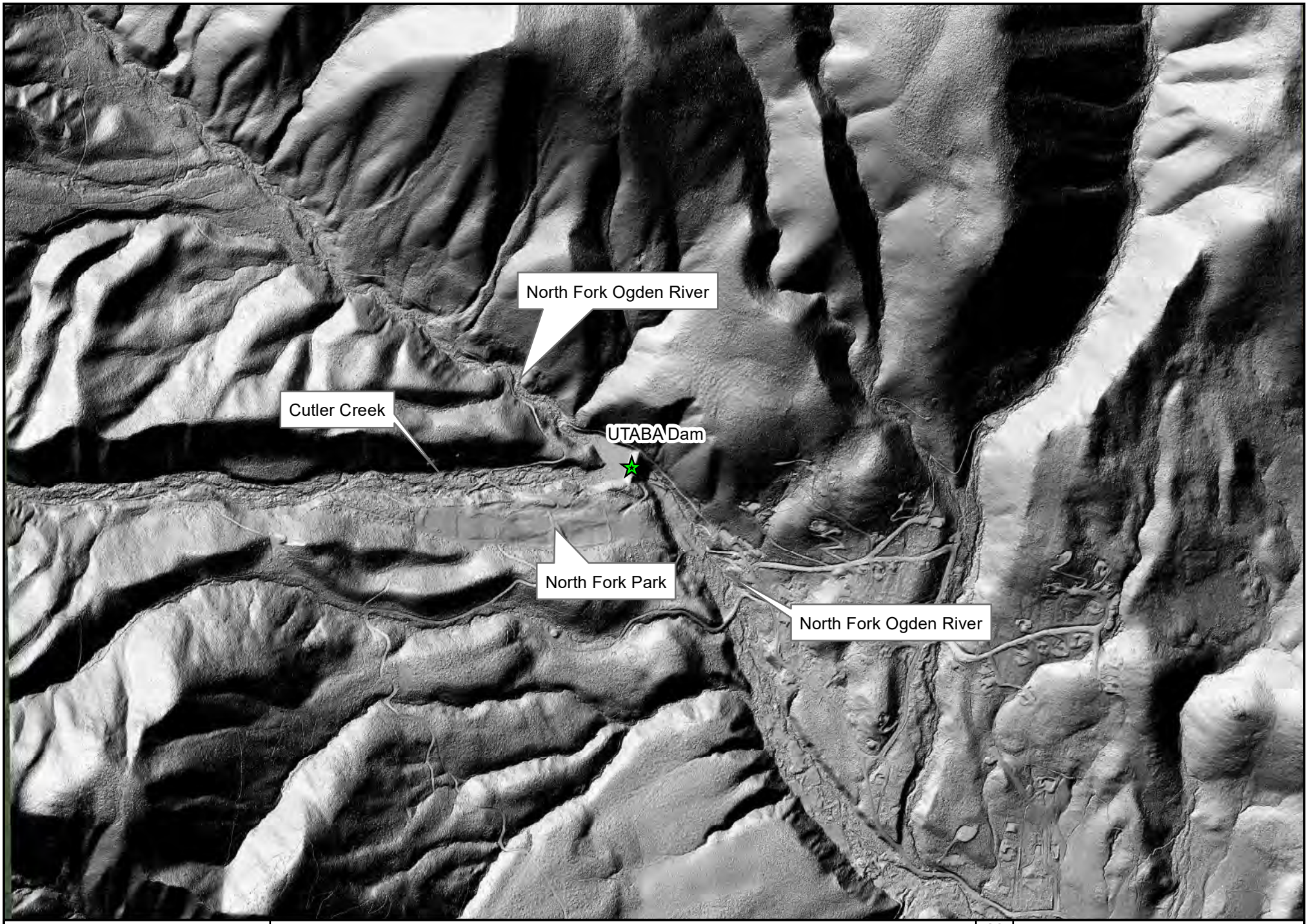
Preliminary Geologic Map

Utaba Dam

N

0 37.5 75 150
Feet

Figure 5



GERHART COLE

Hillshade Map

Utaba Dam

N

0 0.125 0.25 0.5 Miles

Figure 6

Stationing

West

East

20+00 20+50 21+00 21+50 22+00 22+50 23+00 23+50 24+00 24+50 25+00

Elevation (ft)

5750 5745 5740 5735 5730 5725 5720 5715 5710 5705 5700 5695 5690 5685 5680 5675 5670 5665 5660 5655 5650 5645 5640 5635 5630 5625 5620

Right Abutment

Exsting Spillway

Exsting Embankment

Left Abutment

24-TH-01

78 GM (II)

82

32

26

43 SC/CL (II)

22

15

84 SC (II)

51

SC (II)

GP

SM

85

GP

R

40 R 167

75

55 96

Bedrock

52

8 78

0

Extrapolated from Record Drawings As Built

Test Hole ID

N Values | GM - USCS Classification

RQD % | Lugeons

Legend

- Ground Surface - Utaba Centerline Profile
- Extrapolated From Drawings As Built-Bed Rock
- GW 24-TH-01
- Seismic Line #3-2 Vp 4800 fps
- Seismic Line #3-2 Vp 7000 fps

Notes:

All blow counts are uncorrected / field values

The locations of all features shown are based on limited data and are approximate.

This drawing is for information purposes. It is intended to assist in showing features discussed in the attached document.

GERHART COLE

Estimated Subsurface Profile - Across Dam Alignment (West to East)

Utaba Dam

Figure 7

North

Stationing

South

2+0 2+50 3+00 3+50 4+00 4+50 5+00 5+50 6+00

Elevation (ft)

5750 5745 5740 5735 5730 5725 5720 5715 5710 5705 5700 5695 5690 5685 5680 5675 5670 5665 5660 5655 5650 5645 5640 5635 5630 5625 5620

Test Hole ID

N Values | GM - USCS Classification

RQD % | Lugeons

24-TH-01

78 GM (II)

82

32

26

43 SC/CL (II)

22

15

84 SC (II)

51 SC (II)

85 GP/SM - Alluvium

R

40 R 167

75

55 96 Quartzite

52

8 78

0

24-TH-401

Alluvial

101

29

40 GM - Alluvium

72

R

22

0 <1 Quartizite

22

23 52

Estimated Sediment Surface

Existing Embankment

Estimated Original Surface

Extrapolated from Record Drawings As Built

Legend

- Ground Surface - Utaba Profile
- GW
- Ground Surface - Estimated Sediment
- Seismic Line #4 Vp 7000 fps
- Extrapolated from Record Drawings As Built

Notes:

All blow counts are uncorrected / field values

The locations of all features shown are based on limited data and are approximate.

This drawing is for information purposes. It is intended to assist in showing features discussed in the attached document.

GERHART COLE

Estimated Subsurface Profile - Max Section (North to South)

Utaba Dam | Figure 8

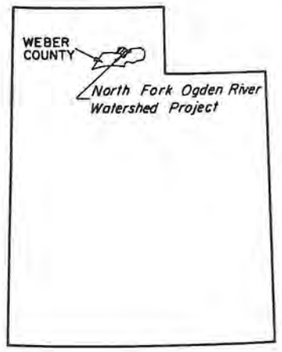
Appendix A

Background Information
UTABA Dam (24-1762)

Table of Contents

Description Page No.

Plans for the Construction of UTABA Retarding Dam – As Built, March 8, 1961 ..... A-1



NORTH FORK OGDEN RIVER WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

WEBER COUNTY, UTAH

PLANS FOR THE CONSTRUCTION OF

UTABA RETARDING DAM

INDEX OF DRAWINGS

DRWG. NO.	SHT. NO.	TITLE
7-E-20355	1	INDEX OF DRAWINGS
	2	LOCATION MAP
	3	PLAN OF DAM & RESERVOIR
	4	PLAN OF DAM
	5	PROFILE & CROSS SECTION
	6	CROSS SECTIONS
	7	PRINCIPAL SPILLWAY DETAILS
	8	PRINCIPAL SPILLWAY DETAILS
	9	PRINCIPAL SPILLWAY DETAILS
	10	PRINCIPAL SPILLWAY OUTLET DETAILS
	11	EMERGENCY SPILLWAY DETAILS
	12	EMERGENCY SPILLWAY DETAILS
	13	EMERGENCY SPILLWAY DETAILS
	14	EMERGENCY SPILLWAY DETAILS
	15	LOG OF TEST PITS
	16	STEEL SCHEDULE
	17	STEEL SCHEDULE
	18	STEEL SCHEDULE

DESIGN DATA

1. Class B Concrete
   - f'_c = 3000 psi.
   - f_c = 1350 psi.
   - f_s = 20,000 psi.
   - n = 10

GENERAL NOTES

1. Elevations are shown in feet (Assumed datum)
2. All stationing refers to centerline of construction and is the measured horizontal distance.
3. Steel and concrete quantities are for information only. Contractor will take responsibility for same and make to correspond with drawings.

STRUCTURAL NOTES

1. All exposed concrete edges shall be chamfered 1 inch or rounded.
2. Unless otherwise shown, transverse joints shall be placed at right angles (or radial) to the spillway centerline and joints in walls and slabs shall be in the same transverse plane.
3. Indicated reinforcing bar spacing is center to center of bars, bar cover is clear distance between surface of bar and face of concrete, and shall be 2" for formed and top surfaces and 3" for surfaces poured against earth, unless otherwise shown.
4. In sections having a single mat of reinforcing, the steel shall be positioned in the center of the section unless otherwise shown.
5. All bar splices not shown on the drawings shall be staggered with bars lapped a min. of 24 dia.
6. Transverse reinforcement shall be placed at right angles to the spillway centerline with spacing measured along spillway centerline, except as otherwise shown.

AS BUILT

OGDEN VALLEY S. C. D.
ACCEPTED
DATE 3-8-61 R. F. Holmes Chairman Title

COUNTY OF WEBER
ACCEPTED
DATE 3/8/61 Chairman Title

INDEX OF DRAWINGS
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R. L. H. ; J. C. S. Date 1-61
Drawn M. H. K. ; R. W. M. 1-61
Traced
Checked W. P. O. ; C. E. B. 2-61
Approved by Head, E. B. W. Unit
Title George E. Lawrence
Title State Conservation Engineer
Sheet No. 1 of 18
Drawing No. 7-E-20355

M 3258-1

R. 1 W. S.L. B.M.

R. 1 E S.L. B.M.

T. 8 N.

T 7 N.

CACHE NATIONAL FOREST

BOX ELDER CO.

WEBER CO.

CACHE COUNTY

WEBER

OGDEN

OGDEN VALLEY

Elev. 9,764 Willard Pk.

Chilly Pk

James Pk. Elev. 9422

To Paradise

To North Ogden

To Huntsville

To Ogden

Proposed Utaba Retarding Dam

Thimbleberry Diversion

Existing Diversion Eden Irrig. Co.

Barrett Ditch Co. Pipe Line

Liberty

Eden

PINEVIEW RESERVOIR
Spillway Elev. 4,872

Black Cr.
Cutler Cr.
Cold Cr.
Cobble Cr.
Little Thimbleberry Cr.
Chicken Cr.
Dry Cr.
Bridge Cr.
Union Cr.
Pine Cr.
Pole Cr.
Grover Cr.
Coal Hollow
Mill Fork
Durfee Cr.
Sheep Cr.
Fiat Cr.
Ogden River
Utah Cache Valley Canal
Broadmouth Cr.
Wolf Cr.
South Fork
Liberty Spring
Holmes-Perrin Ditch
Irrig. Ditch
West Ditch
Heintz Cr.
Haroldsen Ditch
Utah 102

N

SCALE IN MILES
1 0 1 2

LOCATION MAP
NORTH FORK OGDEN RIVER W.P.P
WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed		Approved by: Title Head, E & W P Unit
Drawn M.H.K.	1-61	Title State Conservation Engineer
Traced		Sheet No. 2 of 13 — Drawing No. 7-E-20355
Checked W.P.O. & C.E.B.	2-61	

M 3258-2

NOTE:

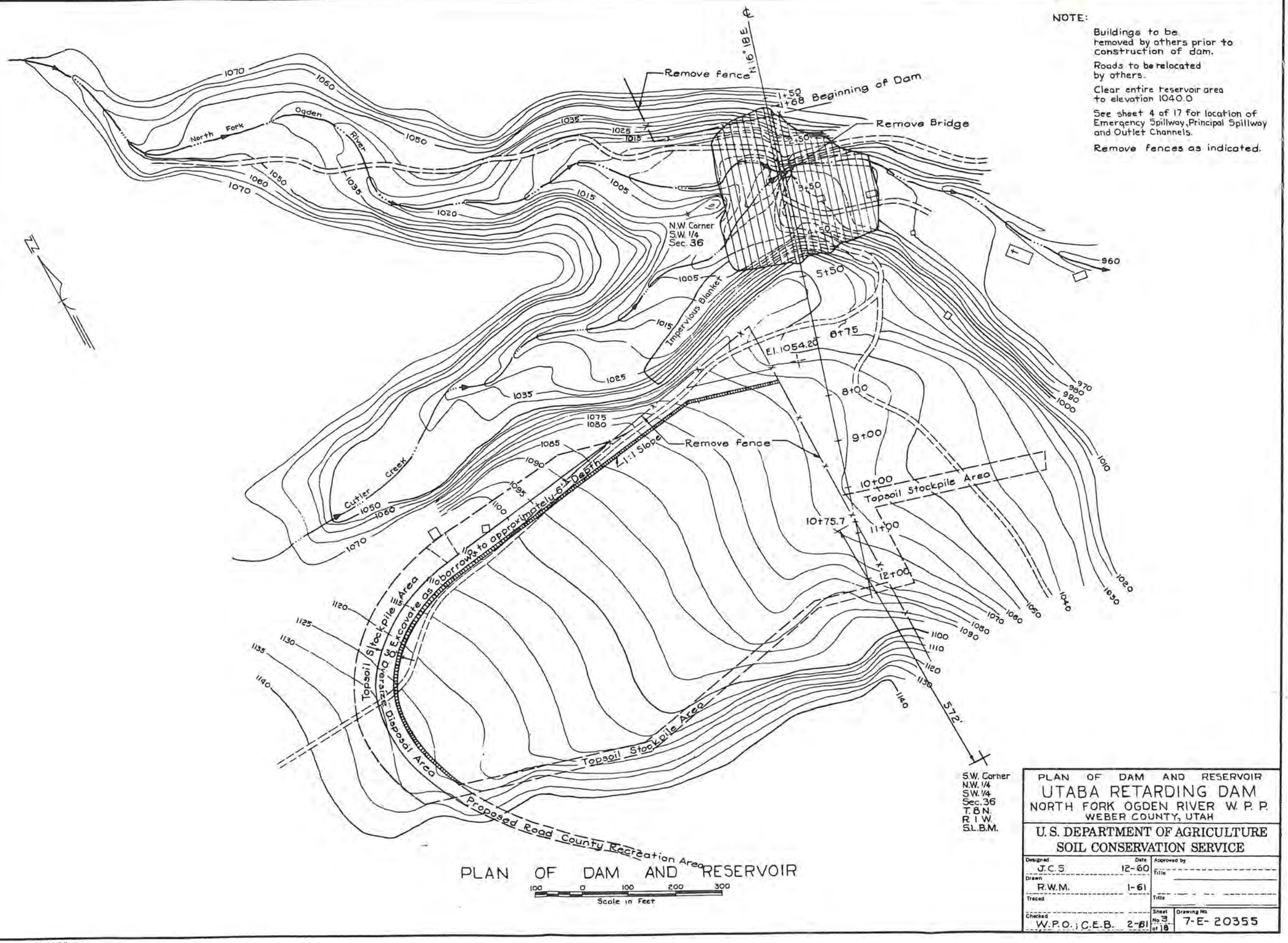
Buildings to be removed by others prior to construction of dam.

Roads to be relocated by others.

Clear entire reservoir area to elevation 1040.0

See sheet 4 of 17 for location of Emergency Spillway, Principal Spillway and Outlet Channels.

Remove fences as indicated.



PLAN OF DAM AND RESERVOIR

100 0 100 200 300

Scale in Feet

PLAN OF DAM AND RESERVOIR

UTABA RETARDING DAM

NORTH FORK OGDEN RIVER W. P. P.

WEBER COUNTY, UTAH

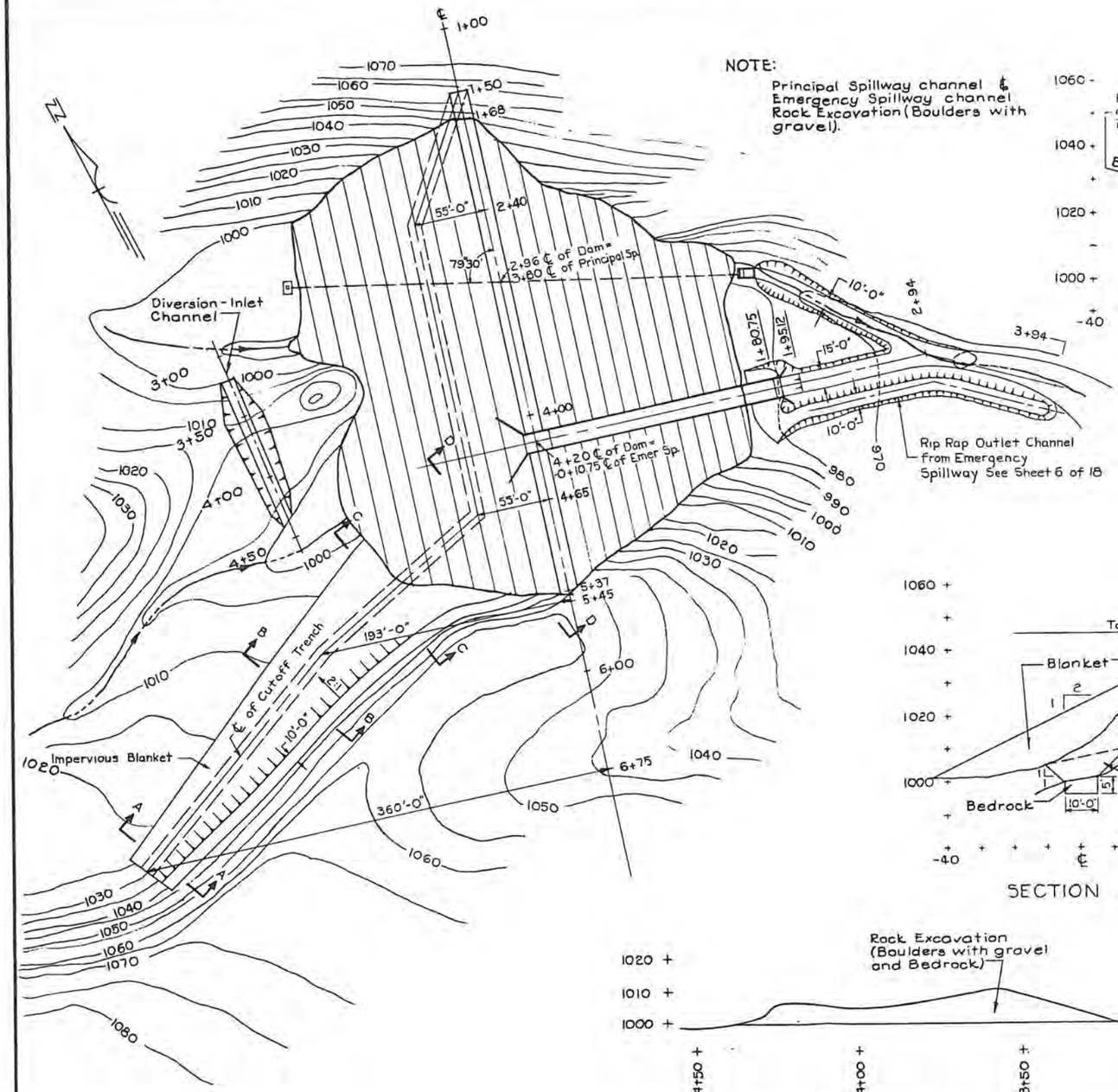
U. S. DEPARTMENT OF AGRICULTURE

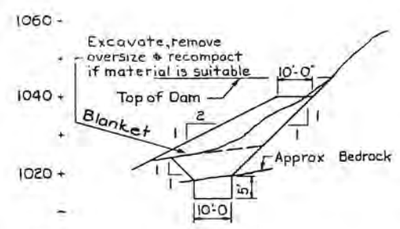
SOIL CONSERVATION SERVICE

Designed J.C.S	Date 12-60	Approved by	Title
Drawn R.W.M.	1-61		
Traced			Title
Checked W.P.O.; C.E.B.	2-61	Sheet No. 3 of 18	Drawing No. 7-E-20355

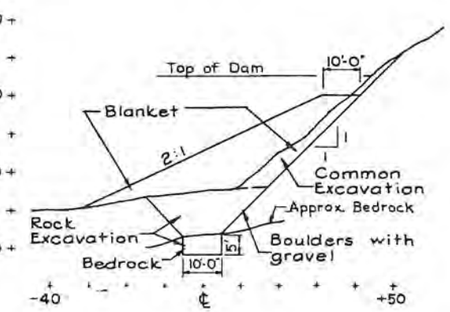
M 3258-3

NOTE:
Principal Spillway channel ℄ Emergency Spillway channel Rock Excavation (Boulders with gravel).



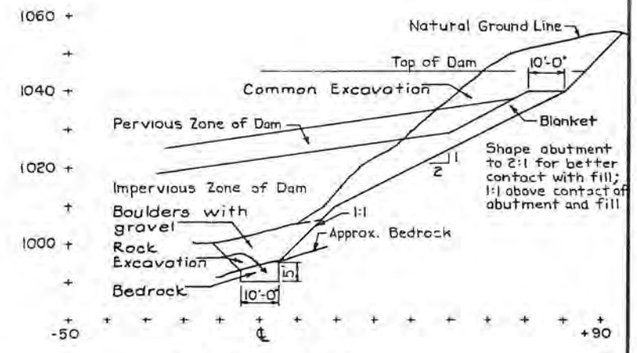


SECTION A-A



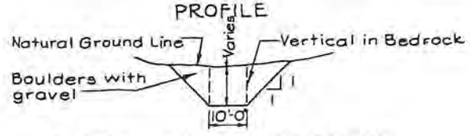
SECTION B-B

SECTION C-C



SECTION D-D

PROFILE



TYPICAL CROSS SECTION
DIVERSION-INLET CHANNEL

NOTE:
Broom grout into face of exposed rock in cutoff trench

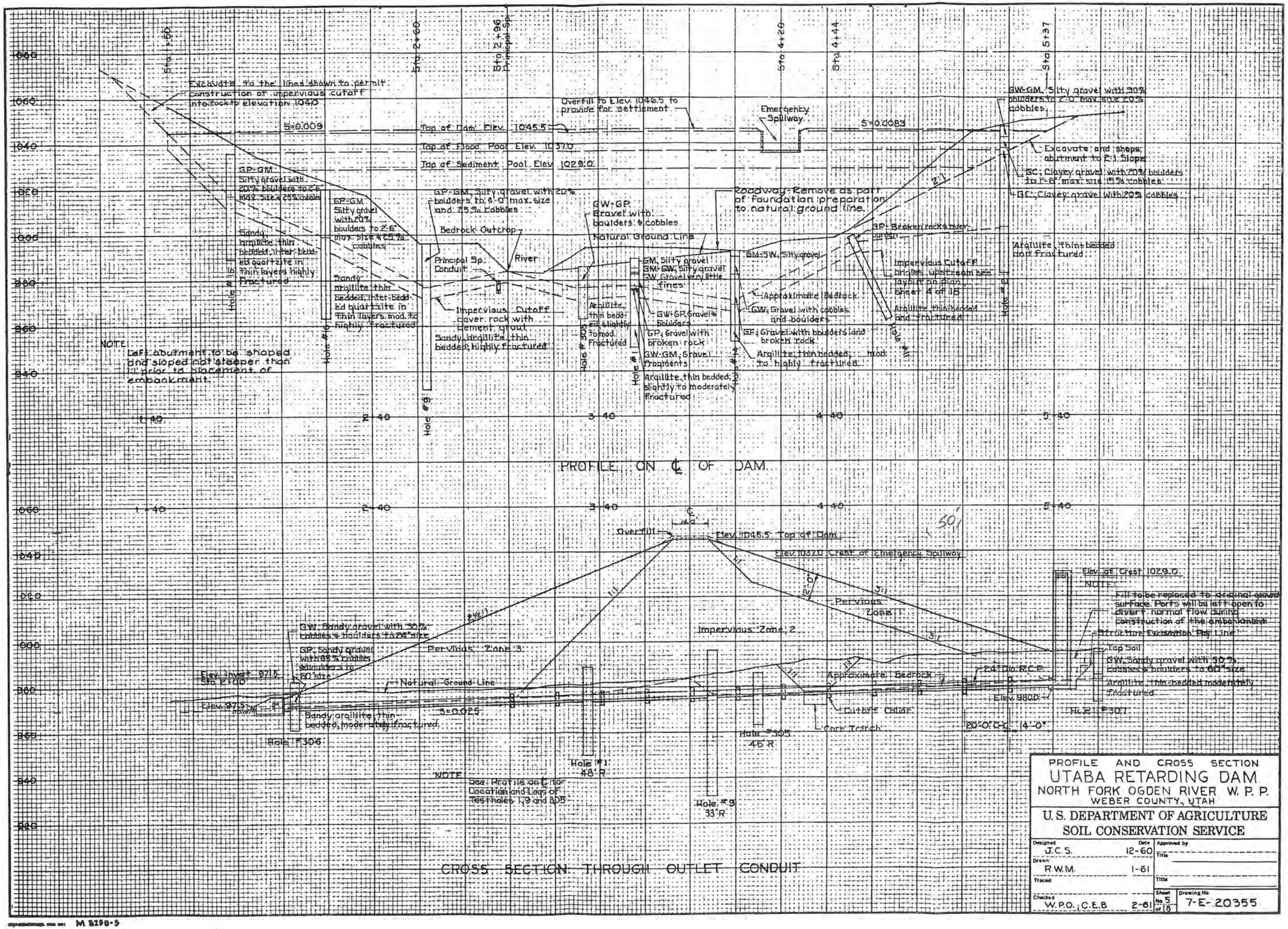


PLAN OF DAM

PLAN OF DAM
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
J.C.S.	12-60	Title
Drawn		
R.W.M.	1-61	Title
Traced		
Checked W.P.O.; C.E.B.	2-61	Sheet No. 4 of 18
		Drawing No. 7-E-20355

M 3258-4


Sta 1+60
Sta 2+60
Sta 2+96
Principal Sp.
Sta 4+20
Sta 4+44
Sta 5+37
Excavate to the lines shown to permit construction of impervious cutoff into rock to elevation 1040
S=0.009
Top of Dam Elev. 1045.5
Top of Flood Pool Elev. 1037.0
Top of Sediment Pool Elev. 1029.0
Overfill to Elev. 1046.5 to provide for settlement
Emergency Spillway
S=0.0083
GW-GM, Silty gravel with 30% boulders to 2'-0" max. size 20% cobbles
Excavate and shape abutment to 2:1 Slope
GC, Clayey gravel with 20% boulders to 1'-6" max. size 15% cobbles
GC, Clayey gravel with 20% cobbles
GP-GM Silty gravel with 20% boulders to 2'-6" max. size & 25% cobbles
Sandy argillite thin bedded, inter-bedded quartzite in thin layers highly fractured
GP-GM Silty gravel with 20% boulders to 2'-6" max. size & 25 % cobbles
GP-GM, Silty gravel with 20% boulders to 6'-0" max. size and 75% cobbles
Bedrock Outcrop
Principal Sp. Conduit
River
Sandy argillite thin bedded, inter-bedded quartzite in thin layers, mod. to highly fractured
Impervious Cutoff cover rock with cement grout
Sandy, Argillite thin bedded, highly fractured
GW-GP Gravel with boulders & cobbles
Natural Ground Line
Roadway-Remove as part of foundation preparation to natural ground line.
GP-Broken rock & river gravel
Argillite, thin-bedded and fractured
GM-SW, Silty gravel
Impervious Cutoff bridges upstream see layout on plan Sheet 4 of 18
Argillite, thin-bedded and fractured
SM, Silty gravel
GM-SW, Silty gravel
SW, Gravel w/ little fines
Argillite, thin bedded slightly to mod. Fractured
GW-GP Gravels Boulders
GP, Gravel with broken rock
GW-GM, Gravel fragments
Argillite, thin bedded, slightly to moderately fractured
Approximate Bedrock
GW, Gravel with cobbles and boulders
GP, Gravel with boulders and broken rock
Argillite, thin bedded, mod. to highly fractured
Hole #305
Hole #1
Hole #9
Hole #307
NOTE
Left abutment to be shaped and sloped not steeper than 1:1 prior to placement of embankment.
1+40
2+40
3+40
4+40
5+40
PROFILE ON ℄ OF DAM
Overfill
Elev. 1046.5 Top of Dam
Elev. 1037.0 Crest of Emergency Spillway
Elev. at Crest 1029.0
NOTE
Fill to be replaced to original ground surface. Ports will be left open to divert normal flow during construction of the embankment
Structure Excavation Pay Line
Top Soil
GW, Sandy gravel with 50% cobbles & boulders to 60" size
Argillite, thin-bedded moderately fractured
Pervious Zone 1
Impervious Zone 2
Pervious Zone 3
GW, Sandy gravel with 30% cobbles & boulders to 24" size
GP, Sandy gravel with 65% cobbles & boulders to 60" size
Sandy argillite, thin bedded, moderately fractured
Natural Ground Line
Elev. Invert 971.5 Sta. 2+00
Elev. 973.5
Approximate Bedrock
24" Dia. R.C.P.
Elev. 980.0
Cutoff Collar
Core Trench
20'-0" C to C
4'-0"
Hole #306
Hole #1 48' R
Hole #305 46' R
Hole #9 33' R
NOTE
See Profile on ℄ for Location and Logs of Test Holes 1, 9 and 305
CROSS SECTION THROUGH OUTLET CONDUIT
PROFILE AND CROSS SECTION
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed J.C.S. Date 12-60
Drawn R.W.M. 1-61
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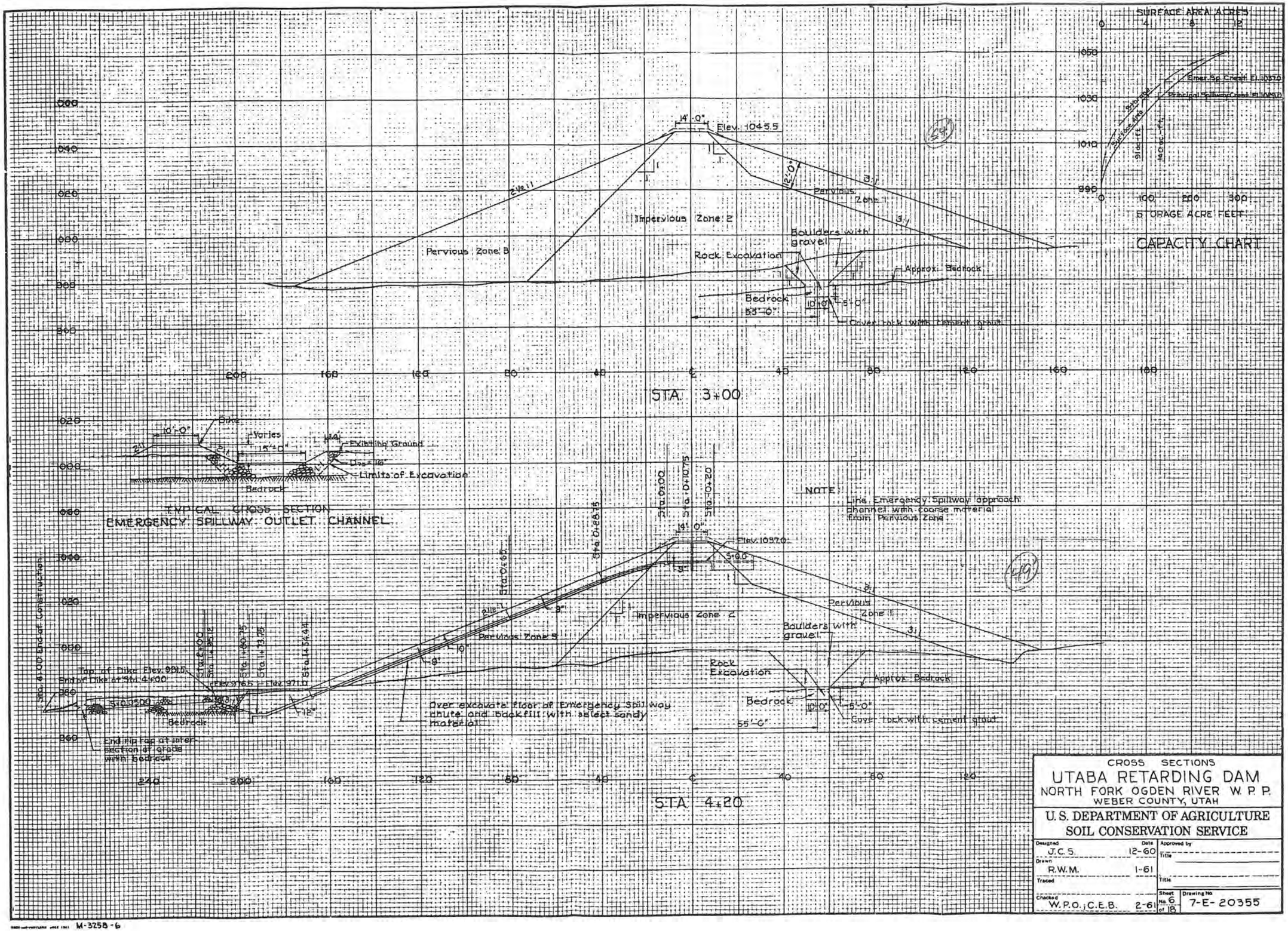
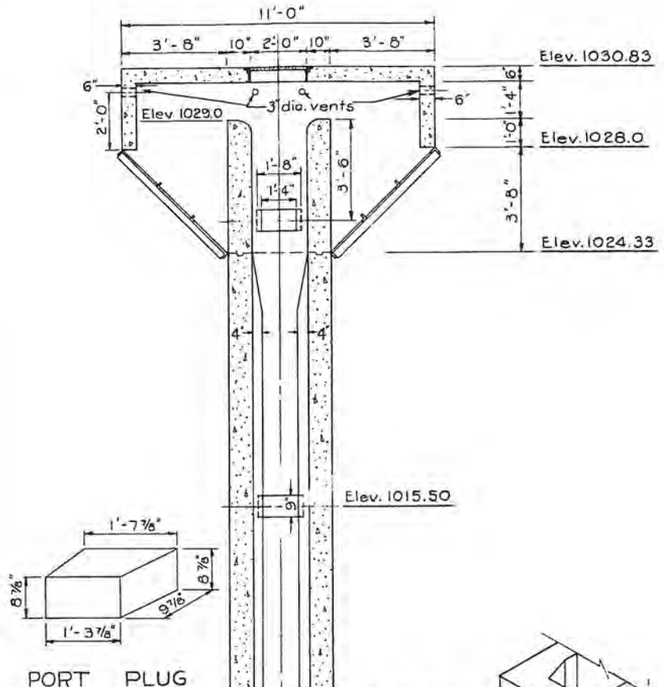
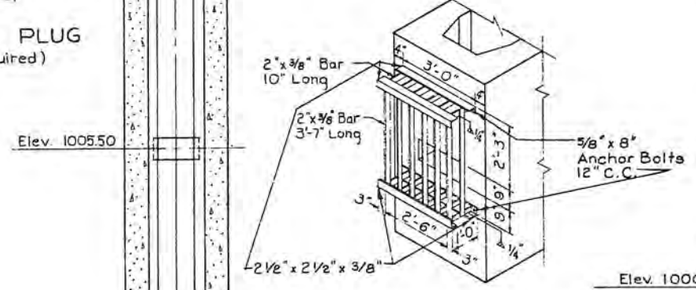
Checked W.P.O., C.E.B. 2-61
Approved by
Title
Sheet No. 5 of 18
Drawing No. 7-E-20355
M 8298-5


Elev. 1045.5
14'-0"
2½:1
Impervious Zone 2
Pervious Zone B
Boulders with gravel
Rock Excavation
Approx. Bedrock
Bedrock
55'-0"
10'-0"
5'-0"
Cover rock with cement grout
STA. 3+00
SURFACE AREA ACRES
0
4
8
12
1050
1030
1010
990
Emer. Sp. Crest El. 1037.0
Principal Spillway Crest El. 1009.0
91 ac.-ft.
140 ac.-ft.
0
100
200
300
STORAGE ACRE FEET
CAPACITY CHART
Dike
10'-0"
Varies
Existing Ground
Dig 18"
Limits of Excavation
Bedrock
TYPICAL CROSS SECTION
EMERGENCY SPILLWAY OUTLET CHANNEL
NOTE:
Line Emergency Spillway approach channel with coarse material from Pervious Zone.
Elev. 1037.0
5'-0"
Impervious Zone 2
Pervious Zone 5
Pervious Zone 3
Boulders with gravel
Rock Excavation
Approx. Bedrock
Bedrock
55'-0"
10'-0"
5'-0"
Cover rock with cement grout
Top of Dike Elev. 991.5
End of Dike at Sta. 4+00
Elev. 976.5
Elev. 971.0
Sta. 0+00
Sta. 1+60.75
Sta. 1+73.75
Sta. 4+54.44
Sta. 0+65
Sta. 0+28.75
Sta. 0+00
Sta. 0+10.75
Sta. 0+20
End of Construction
End rip rap at intersection of grade with bedrock
Over excavate floor of Emergency Spillway chute and backfill with select sandy material
STA. 4+20
CROSS SECTIONS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed J. C. S. Date 12-60
Drawn R. W. M. 1-61
Traced
Checked W. P. O. ; C. E. B. 2-61
Approved by
Title
Title
Sheet No. 6 of 18
Drawing No. 7-E-20355
M-3258-6

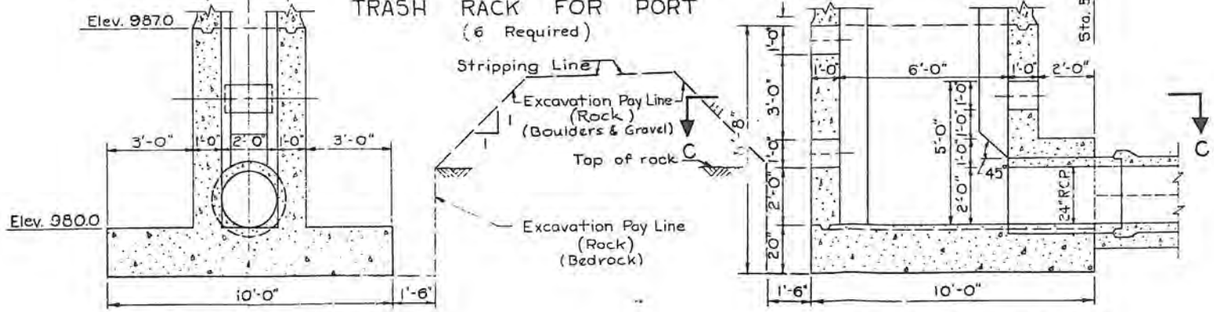
NOTE: Structural backfill is to be replaced to the original ground surface. The three lower ports will be left open to divert normal flows during construction of the embankment After construction of the embankment these three ports will be plugged and backfill placed to the original ground surface. The six 9" x 1'-8" port plugs will be installed later as the sediment pool becomes filled.



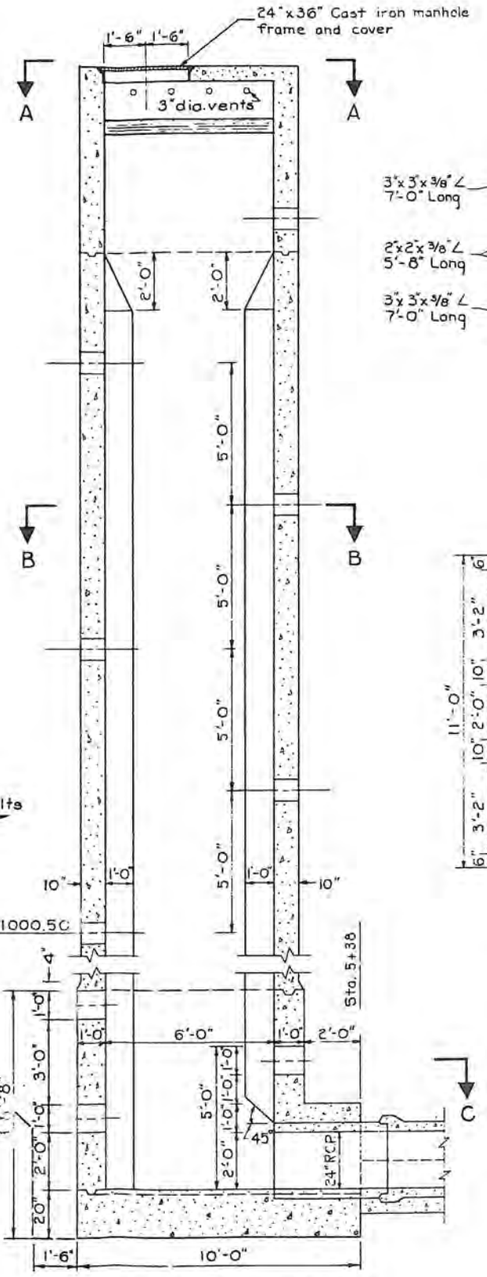
PORT PLUG
(6 Required)



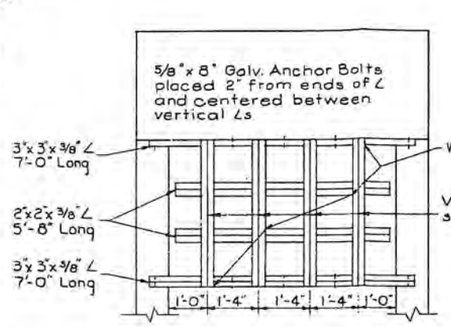
TRASH RACK FOR PORT
(6 Required)

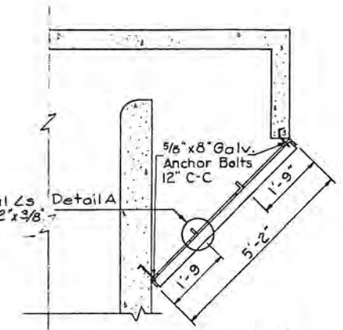


TRANSVERSE SECTION



LONGITUDINAL SECTION



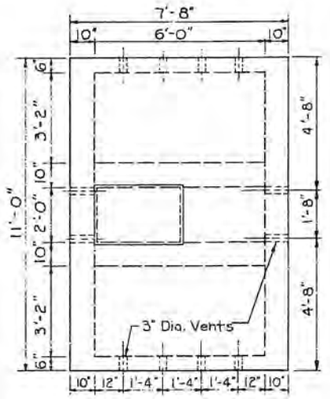


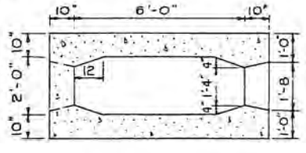


DETAIL A
No Scale

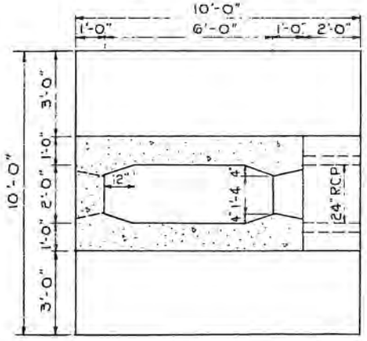
TRASH RACK DETAILS

1 0 1 2 3 4 5
Scale in Feet



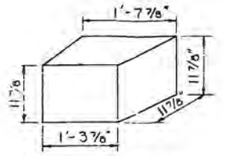


SECTION B-B



SECTION C-C

SECTION A-A



PORT PLUG
(3 Required)

QUANTITIES

Concrete	41.8 C.Y.
Reinforcing Steel	5497 lb.

PRINCIPAL SPILLWAY DETAILS

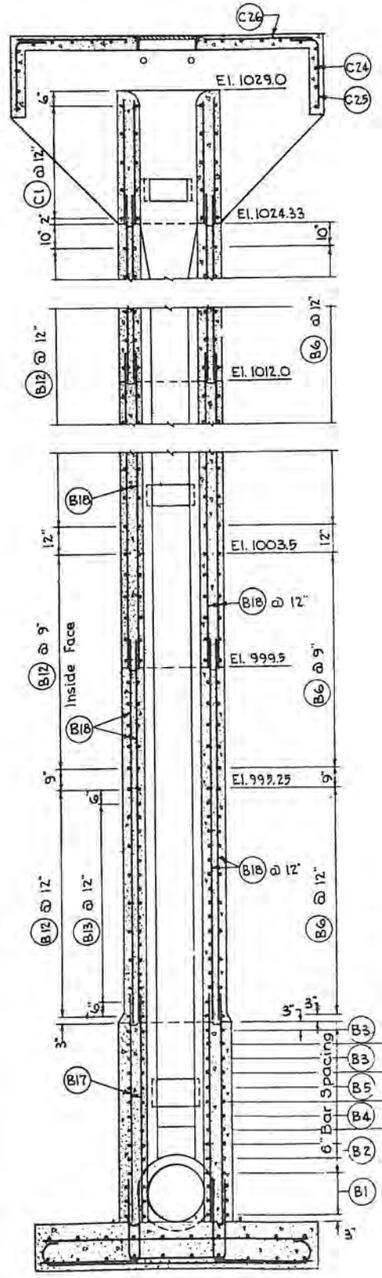
1 0 1 2 3 4 5
Scale in Feet

PRINCIPAL SPILLWAY DETAILS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

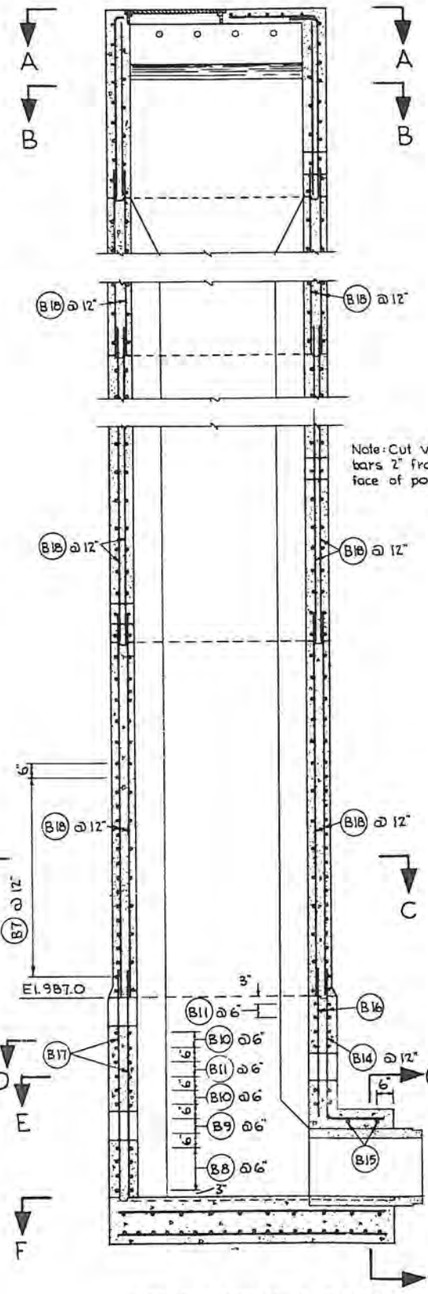
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R. L. H.	Date 12-60	Approved by Title	
Drawn R. W. M.	1-61		
Traced		Title	
Checked W. P. O. ; C. E. B.	2-61	Sheet No. 7 of 18	Drawing No. 7-E-20355

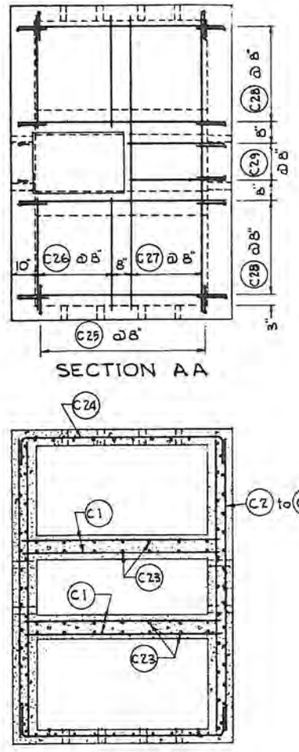
M 3258-7



TRANSVERSE SECTION

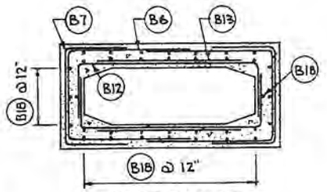


LONGITUDINAL SECTION

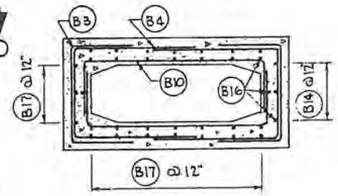


SECTION AA

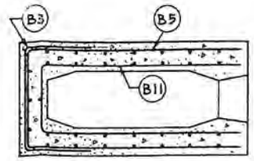
SECTION BB



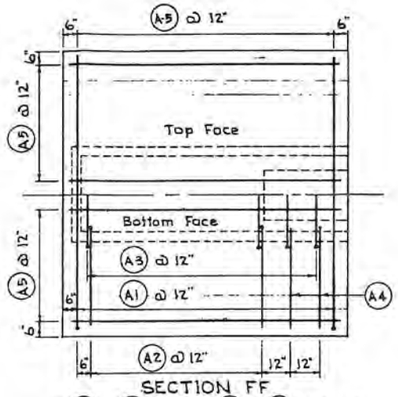
SECTION CC



SECTION DD



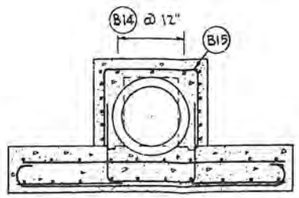
SECTION EE



SECTION FF



ELEVATION



SECTION GG

PRINCIPAL SPILLWAY DETAILS

UTABA RETARDING DAM

NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

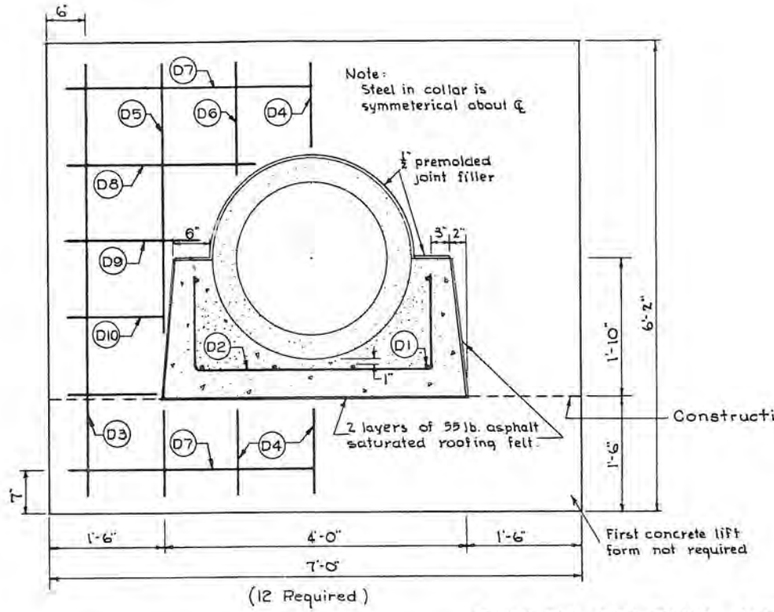
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

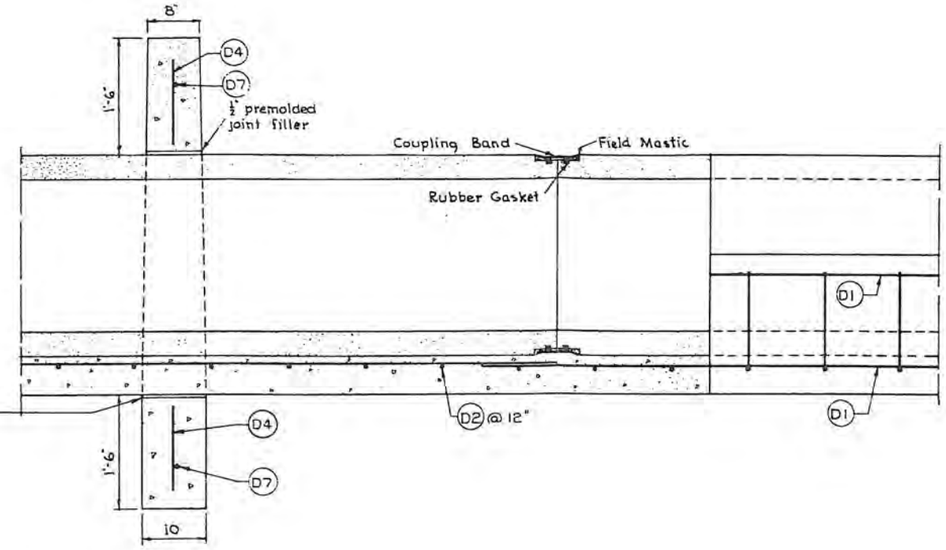
Designed	Date	Approved by
R. L. H.	12-60	Title
Drawn		
M. H. K.	1-61	Title
Traced		
Checked		Sheet No. 5 of 18
		Drawing No. 7-E-20355

PRINCIPAL SPILLWAY DETAILS

1 0 1 2 3 4 5
Scale in Feet

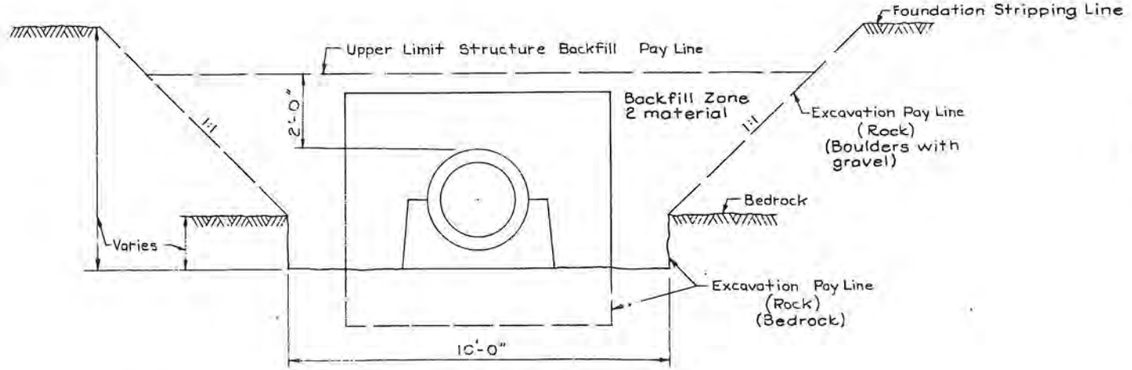
M-3258-B





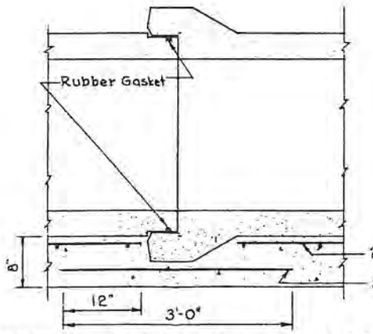
OUTLET CONDUIT AND CUTOFF COLLAR

Scale in Feet



EXCAVATION AND BACKFILL PAY LINES STA. 2+00 TO STA. 5+38

Scale in Feet



Note:
For this alternate, replace the two inside (D1) bars with longitudinal steel as shown.

ALTERNATE CONDUIT JOINT DETAIL

QUANTITIES

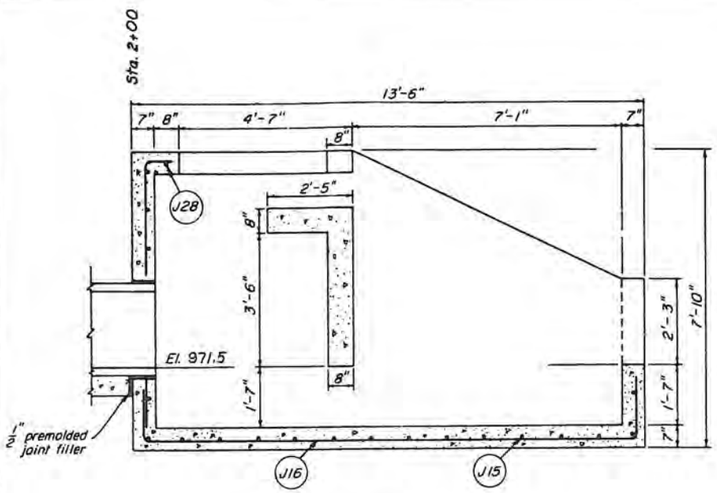
Concrete	64.3 C.Y
Reinforcing Steel	3075 lb.

PRINCIPAL SPILLWAY DETAILS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

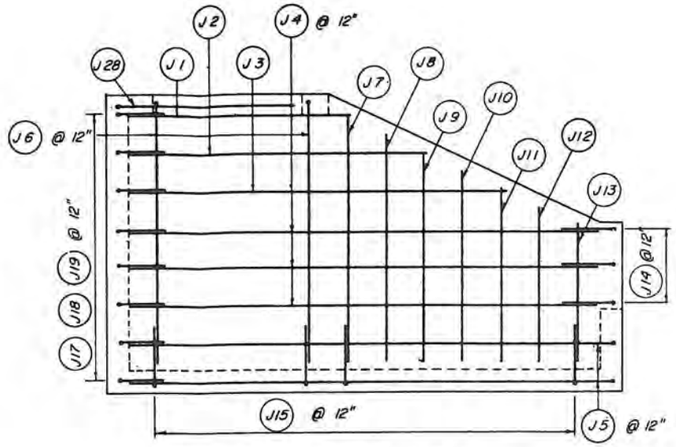
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R. L. H., J. C. S.	Date 1-61	Approved by	
Drawn M. H. K.	1-61	Title	
Traced		Title	
Checked W. P. O.; C. E. B.	2-61	Sheet No 9 of 18	Drawing No. 7-E-20355

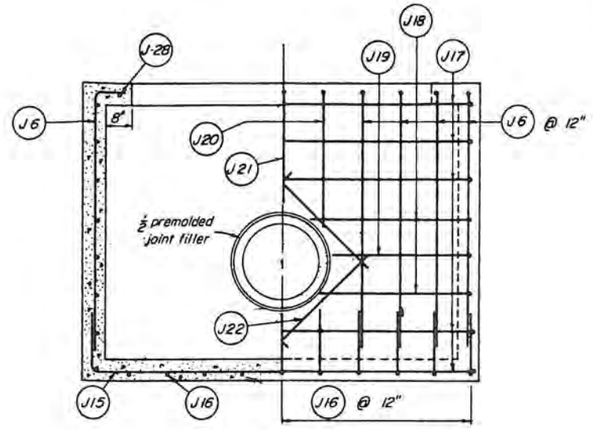
M-3258-9



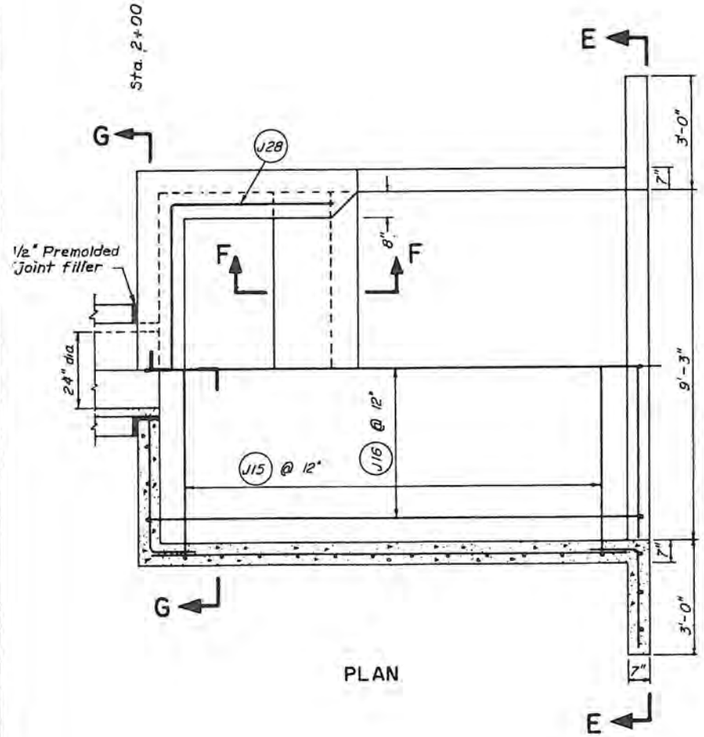
SECTIONAL ELEVATION



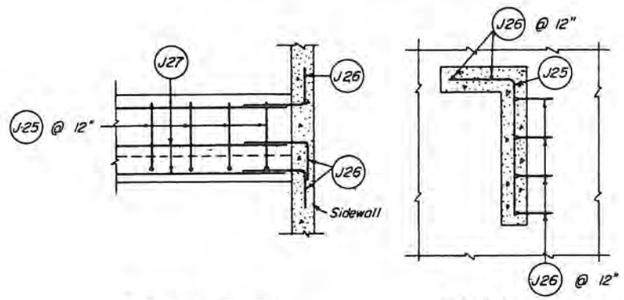
SIDEWALL ELEVATION



SECTION G G

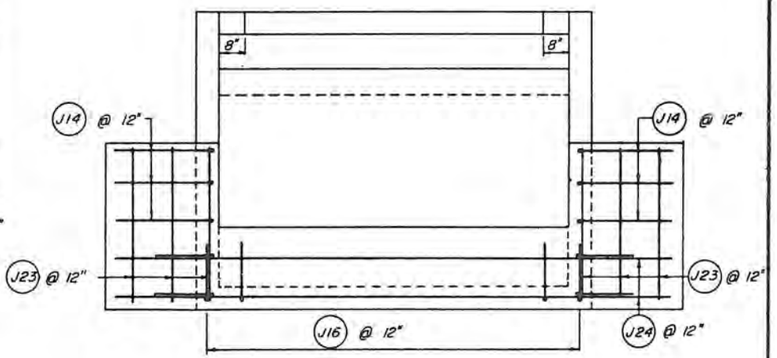


PLAN

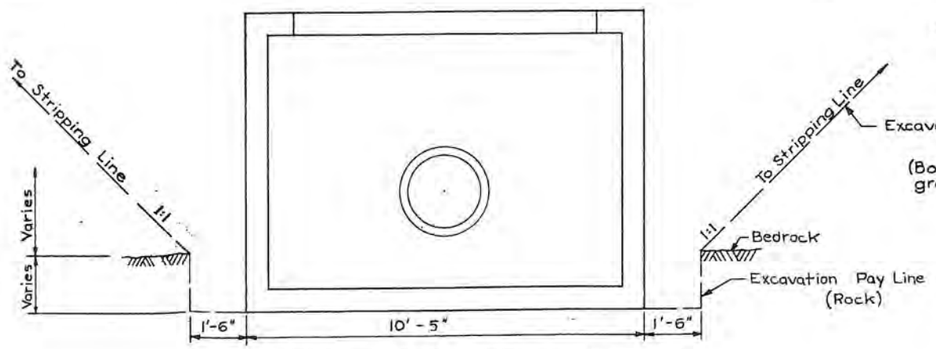


PARTIAL PLAN SECTION F F

BAFFLE WALL



SECTION E E



EXCAVATION PAY LINE

PRINCIPAL SPILLWAY OUTLET

1 0 1 2 3 4 5
Scale in Feet

QUANTITIES

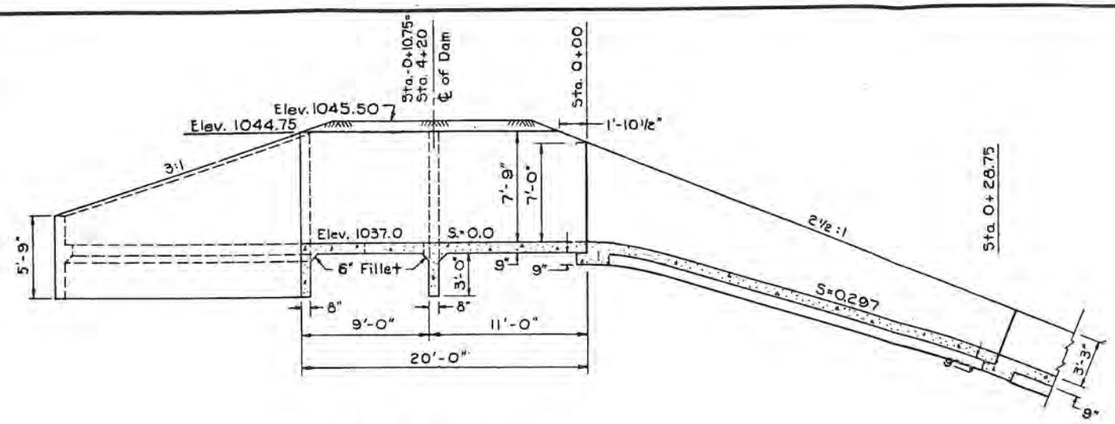
Concrete	10.4 C.Y.
Reinforcing Steel	844 lb.

PRINCIPAL SPILLWAY OUTLET DETAILS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed H.L.C., B.B.O.	Date 1-61	Approved for	
Drawn M.M.E.	1-61	Title	
Traced		Title Sheet No. 10 of 10	Drawing No. 7-E-20355
Checked W.P.O.; C.E.B.	2-61		

M 3258-10



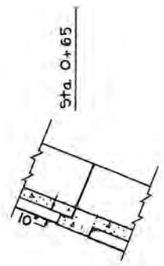
NOTE:
See joint details on sheets 12, 13, 14.

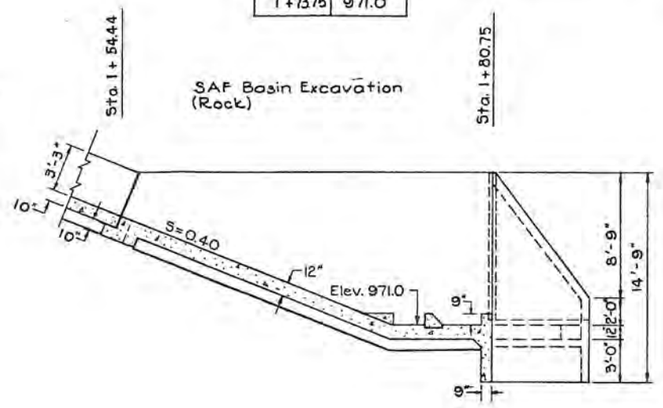
VERTICAL CURVE DATA

STA.	ELEV.
0+00	1037.0
0+02	1036.89
0+04	1036.56
0+05.33	1036.22
0+23.57	1030.80
0+28.75	1029.0
0+65	1014.5
1+54.44	978.72
1+73.75	971.0

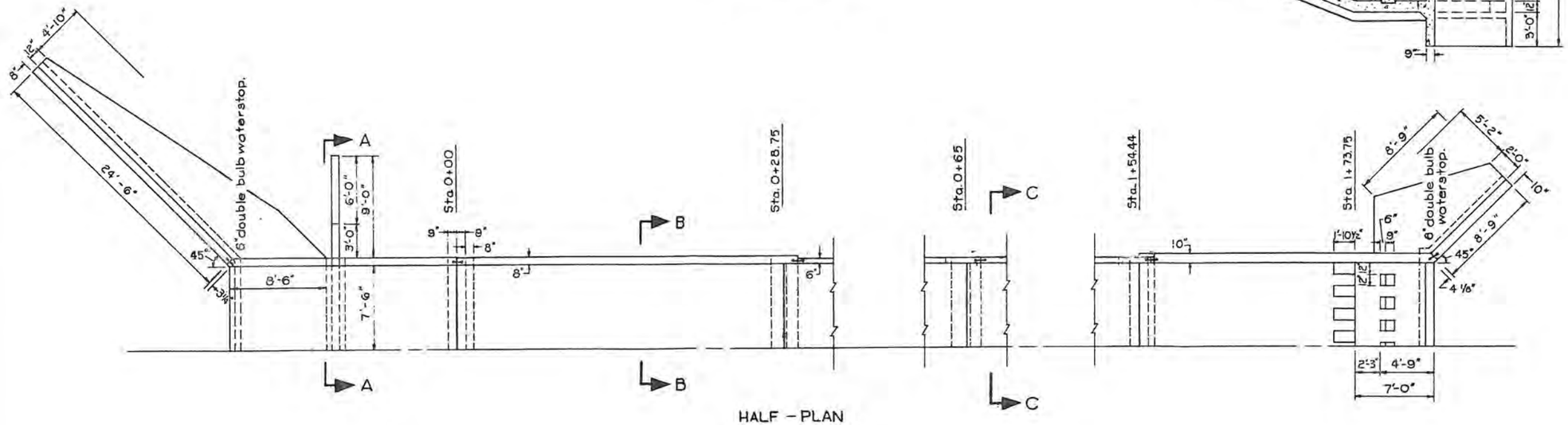
QUANTITIES

INLET	
Concrete	39.6 C.Y.
Reinforcing Steel	4371 lb.
CHUTE	
Concrete	105.7 C.Y.
Reinforcing Steel	7368 lb.
SAF BASIN	
Concrete	43.2 C.Y.
Reinforcing Steel	6341 lb.



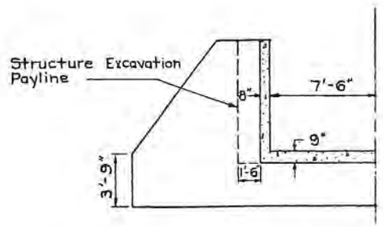


PROFILE ON ℄

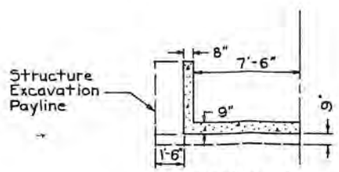


HALF – PLAN

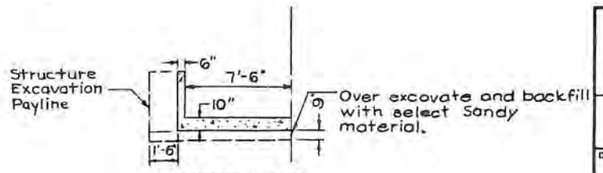
0 1 5 10
Scale in Feet



SECTION A-A



SECTION B-B



SECTION C-C

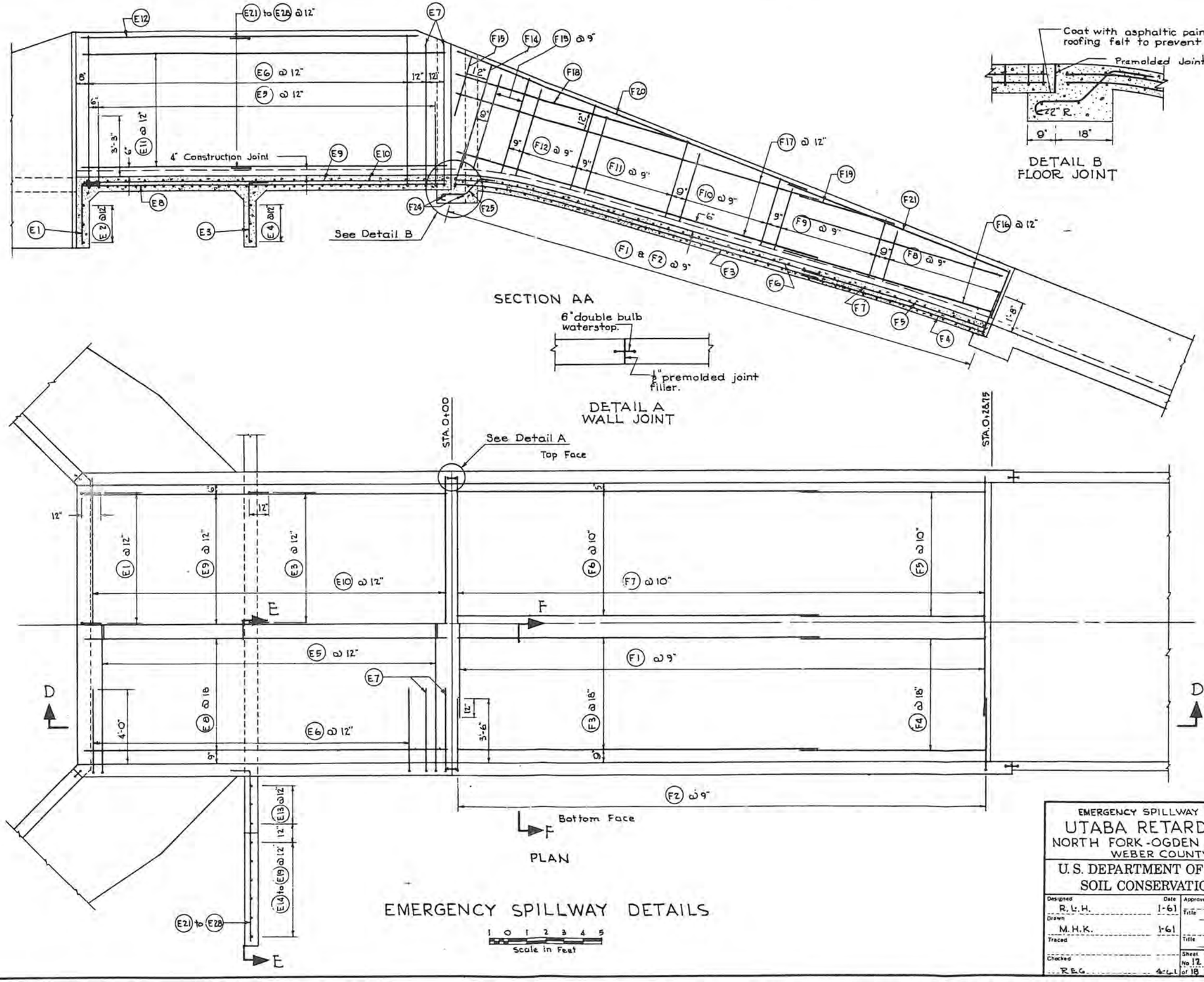
EMERGENCY SPILLWAY DETAILS

EMERGENCY SPILLWAY DETAILS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R. L. H.	Date 12-60	Approved by	
Drawn R. W. M.	1-61	Title	
Traced		Title	
Checked W.P.O.; C.E.B.	2-61	Sheet No. 11 of 18	Drawing No. 7-E-20355

M-3258-11



EMERGENCY SPILLWAY DETAILS

UTABA RETARDING DAM

NORTH FORK-OGDEN RIVER W.P.P.

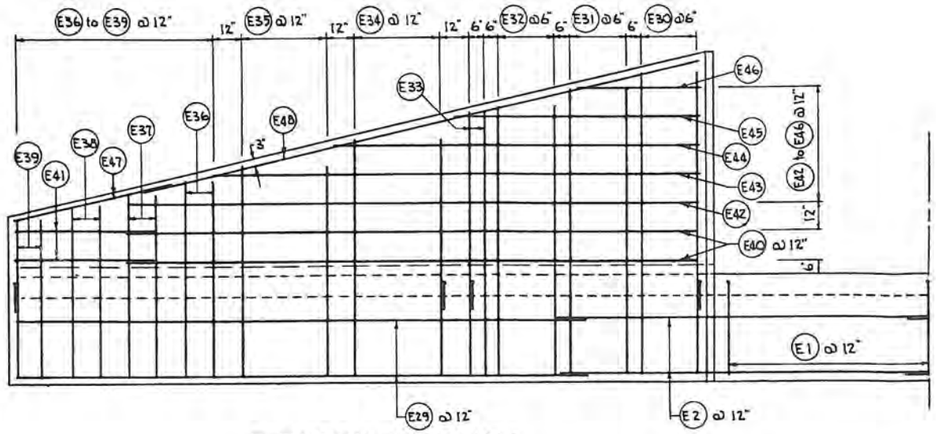
WEBER COUNTY, UTAH

U.S. DEPARTMENT OF AGRICULTURE

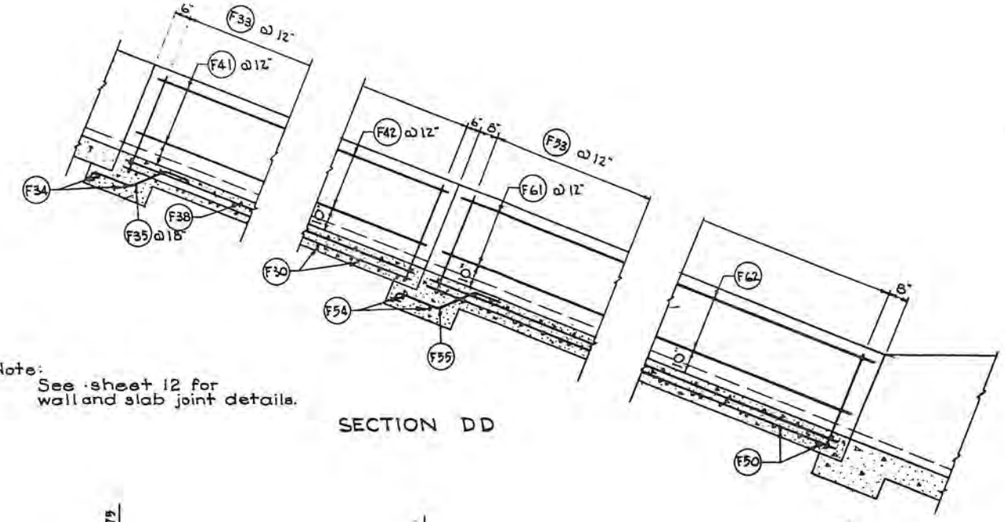
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
R.L.H.	1-61	Title
Drawn M.H.K.	1-61	
Traced		Title
Checked R.E.G.	4-61	Sheet No. 12 of 18
		Drawing No. 7-E-20355

M 3258-12

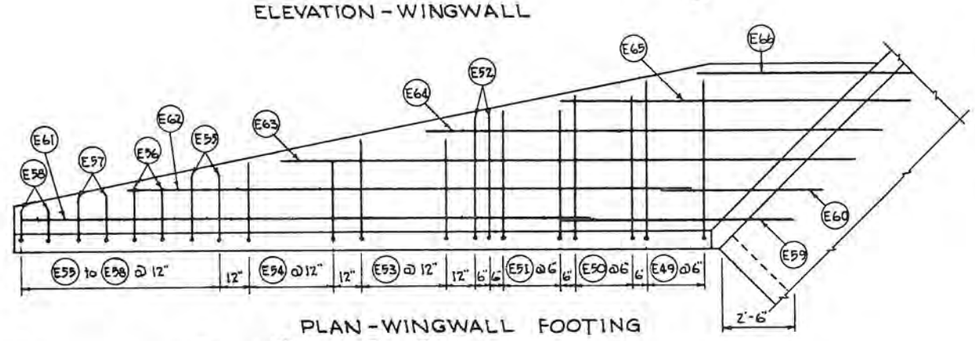


ELEVATION - WINGWALL

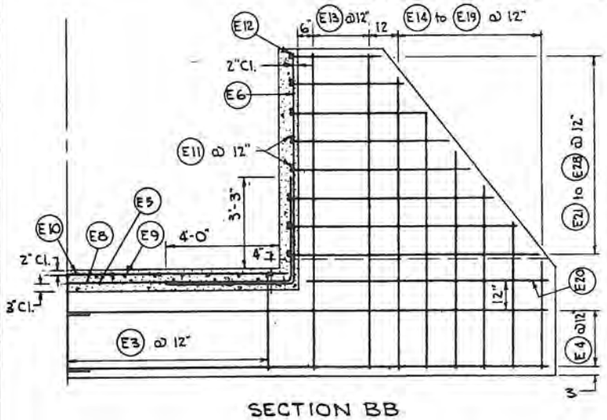


Note:
See sheet 12 for wall and slab joint details.

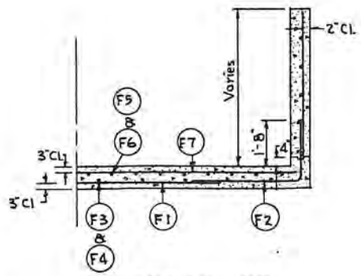
SECTION DD



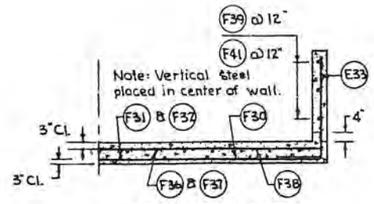
PLAN - WINGWALL FOOTING



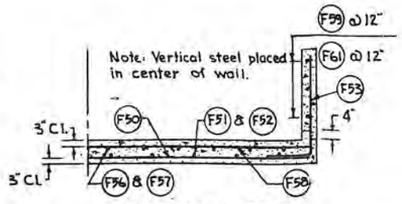
SECTION BB



SECTION CC



SECTION EE



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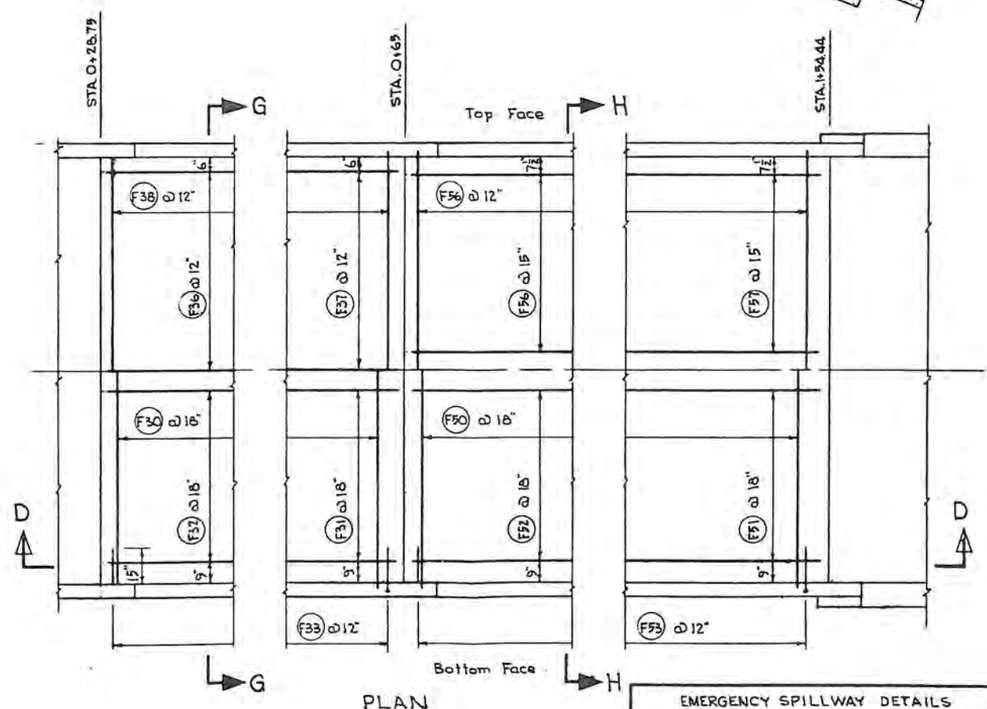


PLAN

1 0 1 2 3 4 5
Scale in Feet

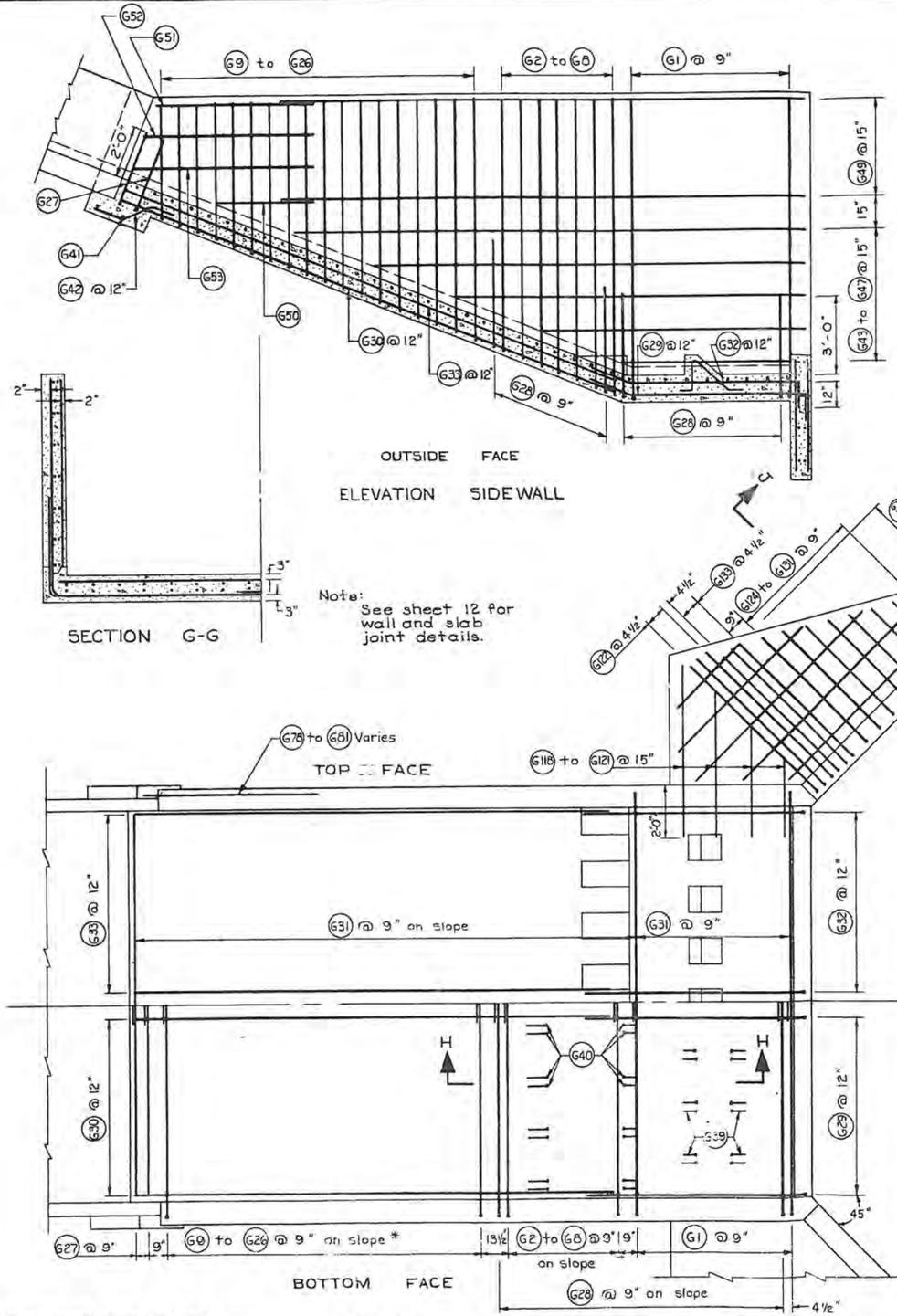
EMERGENCY SPILLWAY DETAILS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
R. L. H.	1-61	Title
Drawn M. H. K.	1-61	
Traced		Title
Checked R. E. G.	4-60	Sheet No 13 of 18

Drawing No. 7-E-20355

M-3258-13



EMERGENCY SPILLWAY DETAILS

UTABA RETARDING DAM

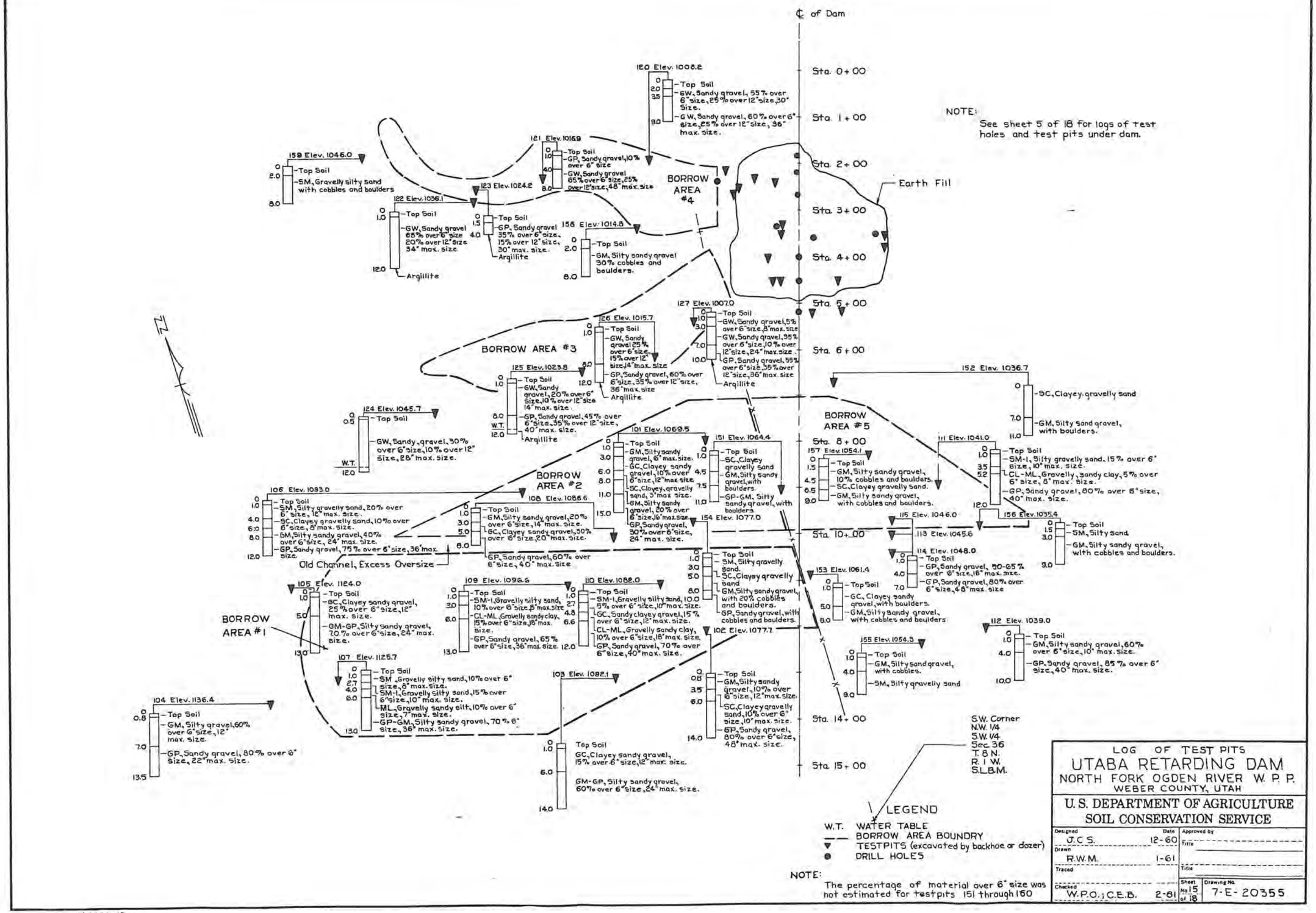
NORTH FORK OGDEN RIVER W. P. P.

WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R.L.H.	Date 12-60	Approved by	
Drawn R.W.M.	1-61	Title	
Traced		Title	
Checked R.E.G.	4-61	Sheet No 14 of 18	Drawing No 7-E-20355

M 3258-14



LOG OF TEST PITS

UTABA RETARDING DAM

NORTH FORK OGDEN RIVER W. P. P.

WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Designed	Date	Approved by
J.C.S.	12-60	Title
Drawn		
R.W.M.	1-61	
Traced		Title
Checked		Sheet No. 15 of 18
W.P.O.; C.E.B.	2-61	Drawing No. 7-E-20355

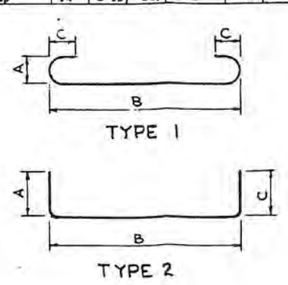
M-3298-15

PRINCIPAL SPILLWAY

Location	Size	Mark	Type	Length	Quan.	A	B	C	Total Length
Footing	#6	A-1	1	11'-7-3/8"	10	0'-11⅜"	9'-8"	1'-0"	116'-1¾"
"	#6	A-2	2	6'-6-1/4"	14	2'-11"	3'-7⅛"		91'-3½"
"	#6	A-3	2	9'-4-1/2"	9	2'-11"	3'-6½"	2'-11"	84'-4½"
"	#6	A-4	St.	4'-3/4"	4				16'-3"
"	#5	A-5	St.	9'-8"	30				290'-0"
Drop Inlet	#6	B-1	2	23'-0"	4	9'-8"	3'-8"	9'-8"	92'-0"
" "	#6	B-2	St.	9'-8"	4				38'-8"
" "	#6	B-3	2	8'-4"	6	2'-4"	3'-8"	2'-4"	50'-0"
" "	#6	B-4	2	12'-10"	4	4'-7"	3'-8"	4'-7"	51'-4"
" "	#6	B-5	2	19'-0"	2	7'-8"	3'-8"	7'-8"	38'-0"
" "	#5	B-6	2	12'-2"	80	4'-5"	3'-4"	4'-5"	973'-4"
" "	#5	B-7	2	7'-8"	16	2'-2"	3'-4"	2'-2"	122'-8"
" "	#6	B-8	2	14'-5-1/2"	4	6'-0"	2'-5½"	6'-0"	57'-10"
" "	#6	B-9	St.	6'-8"	4				26'-8"
" "	#6	B-10	2	10'-5"	8	1'-11¾"	6'-5½"	1'-11¾"	83'-4"
" "	#6	B-11	2	16'-5-1/2"	4	7'-0"	2'-5½"	7'-0"	65'-10"
" "	#5	B-12	2	10'-1-1/2"	80	1'-10½"	6'-5⅛"	1'-10½"	810'-0"
" "	#5	B-13	St.	5'-0"	16				80'-0"
" "	#4	B-14	2	8'-11"	3	3'-7"	5'-4"		26'-9"
" "	#4	B-15	2	8'-10-1/2"	2	2'-8"	3'-6½"	2'-8"	17'-9"
" "	#4	B-16	St.	5'-4"	3				16'-0"
" "	#4	B-17	St.	8'-0"	30				240'-0"
" "	#4	B-18	St.	13'-6"	108				1458'-0"
Anti-vortex device	#4	C-1	St.	6'-10"	20				136'-8"
" "	#4	C-2	St.	10'-6"	12				126'-0"
" "	#4	C-3	St.	9'-9"	4				39'-0"
" "	#4	C-4	St.	8'-6"	2				17'-0"
" "	#4	C-5	St.	7'-0"	2				14'-0"
" "	#4	C-6	St.	2'-0"	8				16'-0"
" "	#4	C-7	St.	4'-6"	2				9'-0"
" "	#4	C-8	St.	7'-6"	2				15'-0"
" "	#4	C-9	St.	3'-8"	2				7'-4"
" "	#4	C-10	St.	2'-8"	4				10'-8"
" "	#4	C-11	St.	3'-10"	4				15'-4"
" "	#4	C-12	St.	4'-9"	4				51'-0"
" "	#4	C-13	St.	5'-8"	4				22'-8"
" "	#4	C-14	St.	6'-0"	4				24'-0"
" "	#6	C-15	St.	4'-4"	2				8'-8"
" "	#4	C-16	2	5'-7"	6	1'-0"	4'-7"		33'-6"
" "	#4	C-17	2	7'-9"	4	1'-0"	6'-9"		31'-0"
" "	#4	C-18	2	6'-10"	4	1'-0"	5'-10"		27'-4"
" "	#4	C-19	2	6'-2"	4	1'-0"	5'-2"		24'-8"
" "	#4	C-20	2	5'-7"	4	1'-0"	4'-7"		22'-4"
" "	#4	C-21	2	4'-10"	4	1'-0"	3'-10"		19'-4"
" "	#4	C-22	2	4'-3"	4	1'-0"	3'-3"		17'-0"
" "	#4	C-23	St.	4'-4"	28				121'-4"
" "	#4	C-24	2	9'-3"	8	1'-0"	7'-3"	1'-0"	74'-0"
" "	#4	C-25	2	3'-5-3/4"	20	1'-0"	2'-5-3/4"		69'-7"
" "	#4	C-26	St.	4'-0"	10				40'-0"
" "	#4	C-27	St.	10'-6"	5				52'-6"
" "	#4	C-28	St.	7'-3"	12				87'-0"
" "	#4	C-29	St.	3'-4"	3				10'-0"
Cradle	#4	D-1	St.	20'-0"	102				2040'-0"
"	#4	D-2	2	5'-8"	325	1'-3"	3'-2"	1'-3"	1841'-8"
"	#4	D-24	St.	16'-0"	6				96'-0"
Collars	#4	D-3	St.	5'-8"	24				136'-0"
"	#4	D-4	St.	1'-2"	72				84'-0"
"	#4	D-5	St.	3'-6"	24				86'-0"
Collars	#4	D-6	St.	1'-8"	24				34'-0"
"	#4	D-7	St.	6'-6"	24				156'-0"
"	#4	D-8	St.	2'-6"	24				60'-0"
"	#4	D-9	St.	1'-9"	24				42'-0"
"	#4	D-10	St.	1'-3"	24				30'-0"
Outlet Structure	#4	J-1	St.	5'-9"	2				11'-6"
" "	#4	J-2	St.	7'-9"	2				15'-6"
" "	#4	J-3	St.	10'-0"	2				20'-0"
" "	#4	J-4	St.	12'-3"	6				73'-6"
" "	#4	J-5	2	14'-3"	4	1'-6"	12'-9"		57'-0"
" "	#4	J-6	2	7'-6"	18	0'-9"	6'-9"		135'-0"
" "	#4	J-7	St.	6'-6"	2				13'-0"
" "	#4	J-8	St.	6'-0"	2				12'-0"
" "	#4	J-9	St.	5'-6"	2				11'-0"
" "	#4	J-10	St.	5'-0"	2				10'-0"
" "	#4	J-11	St.	4'-6"	2				9'-0"
" "	#4	J-12	St.	4'-0"	2				8'-0"
" "	#4	J-13	St.	3'-6"	2				7'-0"
" "	#4	J-14	2	4'-0"	6	1'-6"	2'-6"		24'-0"
" "	#4	J-15	2	12'-11"	12	1'-6"	9'-11"	1'-6"	155'-0"
" "	#4	J-16	2	16'-0"	11	1'-6"	13'-0"	1'-6"	176'-0"
" "	#4	J-17	2	12'-11"	5	1'-6"	9'-11"	1'-6"	64'-7"
" "	#4	J-18	2	5'-6"	4	1'-6"	4'-0"		22'-0"
" "	#4	J-19	2	5'-0"	2	1'-6"	3'-6"		10'-0"
" "	#4	J-20	2	4'-3"	2	0'-9"	3'-6"		8'-6"
" "	#4	J-21	2	3'-9"	1	0'-9"	3'-0"		3'-9"
" "	#4	J-22	St.	3'-6"	4				14'-0"
" "	#4	J-23	St.	4'-0"	6				24'-0"
" "	#4	J-24	St.	14'-9"	2				29'-6"
" "	#6	J-25	2	5'-3"	9	1'-9"	3'-6"		47'-3"
" "	#6	J-26	2	3'-0"	12	1'-0"	2'-0"		36'-0"
" "	#6	J-27	St.	9'-0"	6				54'-0"
" "	#4	J-28	2	9'-0"	2	4'-3"	4'-9"		18'-0"

EMERGENCY SPILLWAY

Location	Size	Mark	Type	Length	Quan.	A	B	C	Total Length
INLET SECTION Toewall	#4	E-1	2	4'-4"	15	12"	3'-4"		65'-0"
Toewall & Wingwall	#4	E-2	S-1	13'-6"	6	5'-6"	8'-0"		61'-0"
Anti-seep	#4	E-3	2	4'-4"	15	12"	3'-4"		65'-0"
"	#4	E-4	St.	17'-6"	6				105'-0"
Apron	#6	E-5	2	12'-4"	38	3'-9"	8'-7"		486'-8"
"	#6	E-6	2	12'-4"	36	4'-4"	8'-0"		444'-0"
"	#6	E-7	2	11'-10"	4	4'-4"	7'-6"		47'-4"
"	#4	E-8	St.	19'-6"	10				195'-0"
"	#4	E-9	St.	19'-6"	15				292'-6"
"	#5	E-10	St.	15'-8"	20				313'-4"
Sidewall	#4	E-11	St.	19'-6"	14				273'-0"
"	#4	E-12	St.	18'-0"	2				36'-0"
Anti-seep	#4	E-13	St.	12'-2"	6				73'-0"
Anti-seep	#4	E-14	St.	11'-4"	2				22'-8"
"	#4	E-15	St.	9'-0"	2				18'-0"
"	#4	E-16	St.	7'-8"	2				15'-4"
"	#4	E-17	St.	6'-6"	2				13'-0"
"	#4	E-18	St.	5'-2"	2				10'-4"
"	#4	E-19	St.	3'-8"	2				7'-4"
"	#4	E-20	St.	8'-6"	2				17'-0"
"	#4	E-21	2	9'-10"	2	12"	8'-10"		19'-8"
"	#4	E-22	2	9'-0"	2	12"	8'-0"		18'-0"
"	#4	E-23	2	8'-2"	2	12"	7'-2"		16'-4"
"	#4	E-24	2	7'-4"	2	12"	6'-4"		14'-8"
"	#4	E-25	2	6'-6"	2	12"	5'-6"		13'-0"
"	#4	E-26	2	5'-10"	2	12"	4'-10"		11'-8"
"	#4	E-27	2	5'-0"	2	12"	4'-0"		10'-0"
"	#4	E-28	2	4'-2"	2	12"	3'-2"		8'-4"
Wingwall	#4	E-29	St.	20'-0"	6				120'-0"
"	#6	E-30	St.	10'-6"	10				105'-0"
"	#6	E-31	St.	9'-6"	10				95'-0"
"	#6	E-32	St.	9'-4"	10				93'-4"
"	#6	E-33	St.	9'-2"	4				36'-8"
"	#5	E-34	St.	8'-2"	8				65'-4"
"	#5	E-35	St.	7'-2"	8				57'-4"
"	#5	E-36	St.	6'-10"	4				27'-4"
"	#5	E-37	St.	6'-5"	4				25'-8"
"	#5	E-38	St.	6'-0"	4				24'-0"
"	#5	E-39	St.	5'-7"	4				22'-4"
"	#4	E-40	St.	20'-0"	4				80'-0"
"	#4	E-41	St.	4'-10"	4				19'-4"
"	#4	E-42	St.	20'-0"	2				40'-0"
"	#4	E-43	St.	17'-0"	2				34'-0"
"	#4	E-44	St.	12'-9"	2				25'-6"
"	#4	E-45	St.	8'-6"	2				17'-0"
"	#4	E-46	St.	4'-4"	2				8'-8"
"	#4	E-47	St.	5'-8"	2				11'-4"
"	#4	E-48	St.	20'-0"	2				40'-0"
Wingwall Ftg.	#6	E-49	2	6'-4"	10	12"	5'-4"		63'-4"
" "	#6	E-50	2	5'-11"	10	12"	4'-11"		59'-2"
" "	#6	E-51	2	5'-5"	10	12"	4'-5"		54'-2"
" "	#6	E-52	2	5'-2"	4	12"	4'-2"		20'-8"
" "	#5	E-53	2	4'-5"	8	12"	3'-5"		35'-4"
" "	#5	E-54	2	4'-0"	8	12"	3'-0"		32'-0"
" "	#5	E-55	2	3'-2"	4	12"	2'-2"		12'-8"
" "	#5	E-56	2	2'-9"	4	12"	1'-9"		11'-0"
" "	#5	E-57	2	2'-6"	4	12"	1'-6"		10'-0"
" "	#5	E-58	2	2'-0"	4	12"	1'-0"		8'-0"
" "	#4	E-59	St.	8'-3"	2				16'-6"
" "	#4	E-60	St.	5'-6"	2				11'-0"



STEEL SCHEDULE

UTABA RETARDING DAM

NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

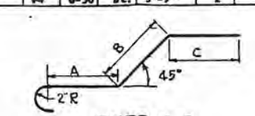
Designed R.L.H.	Date 1-61	Approved by	
Drawn M.H.K.	1-61	Title	
Traced		Title	
Checked E.B.I.	1-61	Sheet No 16 of 18	Drawing No: T-E-20355

M 3258-16

Location	Size	Mark	Type	Length	Quan.	A	B	C				Total Length
Wingwall ftg.	#4	E-61	St.	20'-0"	2							40'-0"
" "	#4	E-62	St.	19'-8"	2							39'-4"
" "	#4	E-63	St.	20'-0"	2							40'-0"
" "	#4	E-64	St.	16'-0"	2							32'-0"
" "	#4	E-65	St.	12'-3"	2							24'-6"
" "	#4	E-66	St.	8'-6"	2							17'-0"
STA.0+00 to0+28.75 Apron	#4	F-1	St.	10'-0"	29							290'-0"
"	#5	F-2	2	6'-2"	58	2'-2"	4'-0"					357'-8"
"	#4	F-3	St.	20'-0"	10							200'-0"
"	#4	F-4	St.	9'-3"	10							92'-6"
"	#4	F-5	St.	9'-3"	18							166'-6"
"	#4	F-6	St.	20'-0"	18							360'-0"
"	#4	F-7	St.	15'-6"	35							542'-6"
Sidewall	#4	F-8	St.	2'-9"	18							49'-6"
"	#4	F-9	St.	3'-2"	16							50'-8"
"	#4	F-10	St.	3'-9"	14							52'-6"
"	#4	F-11	St.	4'-3"	14							59'-6"
"	#4	F-12	St.	4'-8"	10							46'-8"
"	#4	F-13	St.	5'-3"	8							42'-0"
"	#4	F-14	St.	5'-9"	2							11'-6"
"	#4	F-15	St.	3'-3"	2							6'-6"
"	#5	F-16	St.	11'-3"	6							67'-6"
"	#5	F-17	St.	20'-0"	8							160'-0"
"	#5	F-18	St.	13'-0"	2							26'-0"
"	#5	F-19	St.	5'-3"	2							10'-6"
"	#4	F-20	St.	20'-0"	2							40'-0"
"	#4	F-21	St.	12'-9"	2							25'-6"
"												
"												
"	#4	F-24	St.	10'-0"	2							20'-0"
"	#4	F-28	S-2	3'-0"	10	12"	12"	12"	(Plus 7" for hook)			30'-10"
STA.0+28.75 to 0+69 Apron	#4	F-30	St.	15'-6"	24							372'-0"
"	#4	F-31	St.	16'-9"	10							167'-6"
"	#4	F-32	St.	20'-0"	10							200'-0"
"	#4	F-33	2	5'-1"	72	1'-6"	3'-3"					366'-0"
"	#4	F-34	St.	16'-6"	2							33'-0"
"	#4	F-35	S-2	3'-9"	10	12"	1'-2"	12"	(Plus 7" for hook)			37'-8"
"	#4	F-36	St.	20'-0"	15							300'-0"
"	#4	F-37	St.	16'-9"	13							101'-3"
"	#4	F-38	St.	15'-6"	36							558'-0"
"												
"												
Sidewall	#4	F-41	St.	20'-0"	6							120'-0"
"	#4	F-42	St.	16'-9"	6							100'-6"
STA.0+69 to 1+54.44 Apron	#4	F-50	St.	15'-6"	60							930'-0"
"	#4	F-51	St.	13'-10"	10							138'-4"
"	#4	F-52	St.	20'-0"	40							808'-8"
"	#4	F-53	2	5'-1"	180	1'-6"	3'-7"					915'-0"
"	#4	F-54	St.	16'-6"	2							33'-0"
"	#4	F-55	S-2	3'-[illegible]	16	12"	1'-3"	12"	(Plus 7" for hook)			38'-4"
"	#5	F-56	St.	20'-0"	48							960'-0"
"	#5	F-57	St.	13'-10"	12							166'-8"
"	#5	F-58	St.	15'-6"	90							139'-6"
"												
"												
Sidewall	#4	F-61	St.	20'	24							480'-0"
"	#4	F-62	St.	13'-10"	6							83'-0"
S.A.F BASIN Apron & Sidewall	#6	G-1	2	20'-3"	18	11'-6"	8'-11"					367'-6"
" "	#6	G-2	2	20'-3"	2	11'-4"	8'-11"					49'-6"

Location	Size	Mark	Type	Length	Quan.	A	B	C				Total Length
Apron & Sidewall	#6	G-3	2	19'-11"	2	11'-0"	8'-11"					39'-10"
" "	#6	G-4	2	19'-7"	2	10'-8"	8'-11"					39'-2"
" "	#6	G-5	2	19'-3"	2	10'-4"	8'-11"					38'-6"
" "	#6	G-6	2	19'-1"	2	10'-2"	8'-11"					38'-2"
" "	#6	G-7	2	18'-9"	2	9'-10"	8'-11"					37'-6"
" "	#6	G-8	2	18'-5"	2	9'-6"	8'-11"					36'-10"
" "	#6	G-9	2	18'-1"	2	9'-2"	8'-11"					36'-2"
" "	#6	G-10	2	17'-9"	2	8'-10"	8'-11"					35'-6"
" "	#6	G-11	2	17'-5"	2	8'-6"	8'-11"					34'-10"
" "	#6	G-12	2	17'-3"	2	8'-4"	8'-11"					34'-6"
" "	#6	G-13	2	16'-11"	2	8'-0"	8'-11"					33'-10"
" "	#6	G-14	2	16'-7"	2	7'-8"	8'-11"					33'-2"
" "	#6	G-15	2	16'-5"	2	7'-6"	8'-11"					32'-10"
" "	#6	G-16	2	16'-1"	2	7'-2"	8'-11"					32'-2"
" "	#6	G-17	2	15'-9"	2	6'-10"	8'-11"					31'-6"
" "	#6	G-18	2	15'-6"	2	6'-7"	8'-11"					31'-0"
" "	#6	G-19	2	15'-3"	2	6'-4"	8'-11"					30'-6"
" "	#6	G-20	2	14'-11"	2	6'-0"	8'-11"					29'-10"
" "	#6	G-21	2	14'-7"	2	5'-8"	8'-11"					29'-2"
" "	#6	G-22	2	14'-4"	2	5'-5"	8'-11"					28'-8"
" "	#6	G-23	2	14'-1"	2	5'-2"	8'-11"					28'-2"
" "	#6	G-24	2	13'-9"	2	4'-10"	8'-11"					27'-6"
" "	#6	G-25	2	13'-5"	2	4'-6"	8'-11"					26'-10"
" "	#6	G-26	2	13'-3"	2	4'-4"	8'-11"					26'-6"
" "	#6	G-27	2	11'-8"	4	2'-9"	8'-11"					46'-8"
" "	#6	G-28	2	12'-8"	32	3'-9"	8'-11"					405'-4"
Apron	#4	G-29	S-3	7'-8"	16	2'-0"	4'-8"	12"				122'-8"
"	#4	G-30	St.	20'-0"	16							320'-0"
"	#5	G-31	St.	16'-0"	37							592'-0"
"	#5	G-32	S-3	8'-4"	16	2'-3"	5'-1"	12"				133'-4"
"	#4	G-33	St.	20'-0"	16							320'-0"
Toewall	#5	G-34	S-4	19'-0"	3	1'-9"	15'-6"	1'-9"				57'-0"
"	#4	G-35	S-4	19'-0"	3	1'-6"	16'-0"	1'-6"				57'-0"
"	#4	G-36	St.	4'-5"	16							70'-8"
"	#5	G-37	St.	4'-5"	16							70'-8"
"	#4	G-38	St.	14'-6"	2							29'-0"
Floor blocks	#4	G-39	S-5	3'-9"	14	*See Detail A = 6" B = 12" C = 12" D = 8"						44'-0"
Chute blocks	#4	G-40	S-6	2'-8"	16	*See Detail A = 6" B = 2'-8" C = 12" D = 6"						
Offset	#6	G-41	St.	15'-0"	2							30'-0"
"	#4	G-42	S-2	3'-6"	16	1'-3"	1'-3"	12"				56'-0"
Sidewall	#4	G-43	St.	7'-0"	2							14'-0"
"	#4	G-44	St.	10'-2"	2							20'-4"
"	#4	G-45	St.	13'-4"	2							26'-8"
"	#4	G-46	St.	16'-6"	2							33'-0"
"	#4	G-47	St.	19'-6"	2							39'-0"
"	#4	G-49	St.	20'-0"	8							160'-0"
"	#4	G-50	St.	3'-9"	2							7'-6"

Location	Size	Mark	Type	Length	Quan.	A	B	C				Total Length
Sidewall	#4	G-51	St.	7'-0"	2							14'-0"
"	#4	G-52	St.	6'-6"	2							13'-0"
"	#4	G-53	St.	6'-3"	2							12'-6"
"	#5	G-54	St.	10'-3"	12							123'-0"
"	#5	G-55	St.	9'-9"	2							19'-6"
"	#5	G-56	St.	9'-4"	2							18'-8"
"	#5	G-57	St.	8'-10"	2							17'-8"
"	#5	G-58	St.	8'-5"	2							16'-10"
"	#5	G-59	St.	8'-0"	2							16'-0"
"	#5	G-60	St.	7'-6"	2							15'-0"
"	#5	G-61	St.	7'-0"	2							14'-0"
"	#5	G-62	St.	6'-7"	2							13'-2"
"	#5	G-63	St.	6'-2"	2							12'-4"
"	#5	G-64	St.	5'-8"	2							11'-4"
"	#5	G-65	St.	5'-3"	2							10'-6"
"	#5	G-66	St.	4'-9"	2							9'-6"
"	#5	G-67	St.	4'-3"	2							8'-6"
"	#5	G-68	St.	3'-9"	2							7'-6"
"	#5	G-69	St.	3'-3"	2							6'-6"
"	#5	G-70	St.	1'-6"	2							3'-0"
"	#5	G-71	St.	7'-0"	2							14'-0"
"	#5	G-72	St.	10'-3"	2							20'-6"
"	#5	G-73	St.	13'-6"	2							27'-0"
"	#5	G-74	St.	16'-8"	2							33'-4"
"	#5	G-75	St.	19'-9"	2							39'-6"
"	#5	G-77	St.	20'-0"	8							160'-0"
"	#5	G-78	St.	4'-0"	2							8'-0"
"	#5	G-79	St.	7'-6"	2							15'-0"
"	#5	G-80	St.	7'-3"	2							14'-6"
"	#5	G-81	St.	6'-8"	2							13'-4"
"												
Wingwall	#6	G-83	St.	6'-0"	2							12'-0"
"	#6	G-84	St.	6'-9"	2							13'-6"
"	#6	G-85	St.	7'-6"	2							15'-0"
"	#6	G-86	St.	8'-3"	2							16'-6"
"	#6	G-87	St.	9'-0"	2							18'-0"
"	#6	G-88	St.	9'-9"	2							19'-6"
"	#6	G-89	St.	10'-6"	2							21'-0"
"	#6	G-90	St.	11'-3"	2							22'-6"
"	#6	G-91	St.	12'-0"	2							23'-0"
"	#6	G-92	St.	13'-3"	2							26'-6"
"	#6	G-93	St.	14'-0"	2							28'-0"
"	#6	G-94	St.	6'-8"	6							40'-0"
"	#4	G-95	St.	8'-6"	6							51'-0"
"	#4	G-96	St.	8'-4"	4							33'-4"
"	#4	G-97	St.	7'-2"	2							14'-4"
"	#4	G-98	St.	5'-10"	2							11'-8"



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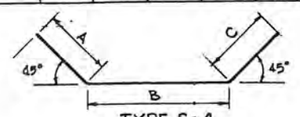

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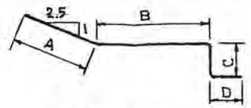

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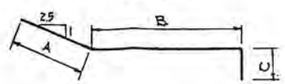

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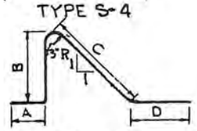


TYPE S-5

STEEL SCHEDULE

UTABA RETARDING DAM

NORTH FORK OGDEN RIVER W.R.P.

WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R.L.H.	Date 1-61	Approved by	
Drawn M.H.K.	1-61	Title	
Traced		Title	
Checked E.B.L.	1-61	Sheet No. 17 of 18	Drawing No. 7-E-20355

M 3258-17

Location	Size	Mark	Type	Length	Quan.	A	B	C				Total Length
Wingwall	#4	G-99	St.	4'-6"	2							9'-0"
"	#4	G-100	St.	3'-4"	2							6'-8"
"	#4	G-101	St.	2'-0"	2							4'-0"
"	#4	G-102	St.	0'-10"	2							1'-8"
"	#5	G-103	St.	8'-6"	6							51'-0"
"	#5	G-104	St.	8'-3"	4							33'-0"
"	#5	G-105	St.	6'-10"	2							13'-8"
"	#5	G-106	St.	5'-9"	2							11'-6"
"	#5	G-107	St.	4'-6"	2							9'-0"
"	#5	G-108	St.	3'-2"	2							6'-4"
"	#5	G-109	St.	2'-0"	2							4'-0"
"	#5	G-110	St.	0'-10"	2							1'-8"
"	#5	G-111	St.	6'-3"	2							12'-6"
"	#5	G-112	St.	7'-6"	2							15'-0"
"	#5	G-113	St.	8'-9"	2							17'-6"
"	#5	G-114	St.	10'-0"	2							20'-0"
"	#5	G-115	St.	11'-3"	2							22'-6"
"	#5	G-116	St.	12'-6"	2							25'-0"
"	#5	G-117	St.	13'-9"	2							27'-6"
Wingwall Footing	#4	G-118	St.	3'-0"	2							6'-0"
" "	#4	G-119	St.	4'-4"	2							8'-6"
" "	#4	G-120	St.	5'-6"	2							11'-0"
" "	#4	G-121	St.	6'-9"	2							13'-6"
" "	#6	G-122	2	7'-9"	6	12"	6'-9"					46'-6"
" "	#6	G-123	2	7'-3"	6	12"	6'-3"					43'-6"
" "	#6	G-124	2	6'-9"	2	12"	5'-9"					13'-6"
" "	#6	G-125	2	6'-3"	2	12"	5'-3"					12'-6"
" "	#6	G-126	2	5'-9"	2	12"	4'-9"					11'-6"
" "	#6	G-127	2	5'-3"	2	12"	4'-3"					10'-6"
" "	#6	G-128	2	4'-10"	2	12"	3'-10"					9'-8"
" "	#6	G-129	2	4'-6"	2	12"	3'-6"					9'-0"
" "	#6	G-130	2	4'-0"	2	12"	3'-0"					8'-0"
" "	#6	G-131	2	3'-8"	2	12"	2'-8"					7'-4"
" "	#4	G-132	St.	8'-9"	4							35'-0"
" "	#4	G-133	St.	10'-0"	2							20'-0"
" "	#4	G-134	St.	10'-3"	2							20'-6"
" "	#4	G-135	St.	6'-9"	2							13'-6"
" "	#4	G-136	St.	3'-6"	2							7'-0"
Wingwall	#4	G-137	St.	12'-0"	4							48'-0"

STEEL SCHEDULE

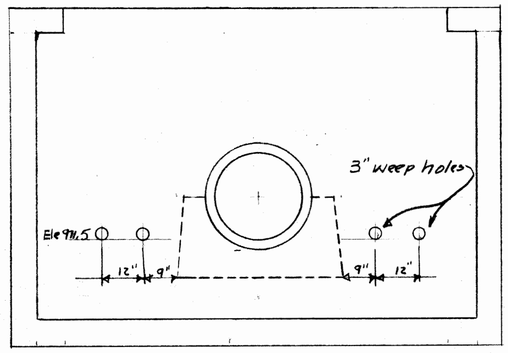
UTABA RETARDING DAM

NORTH FORK OGDEN RIVER W. P. P.
WEBER COUNTY, UTAH

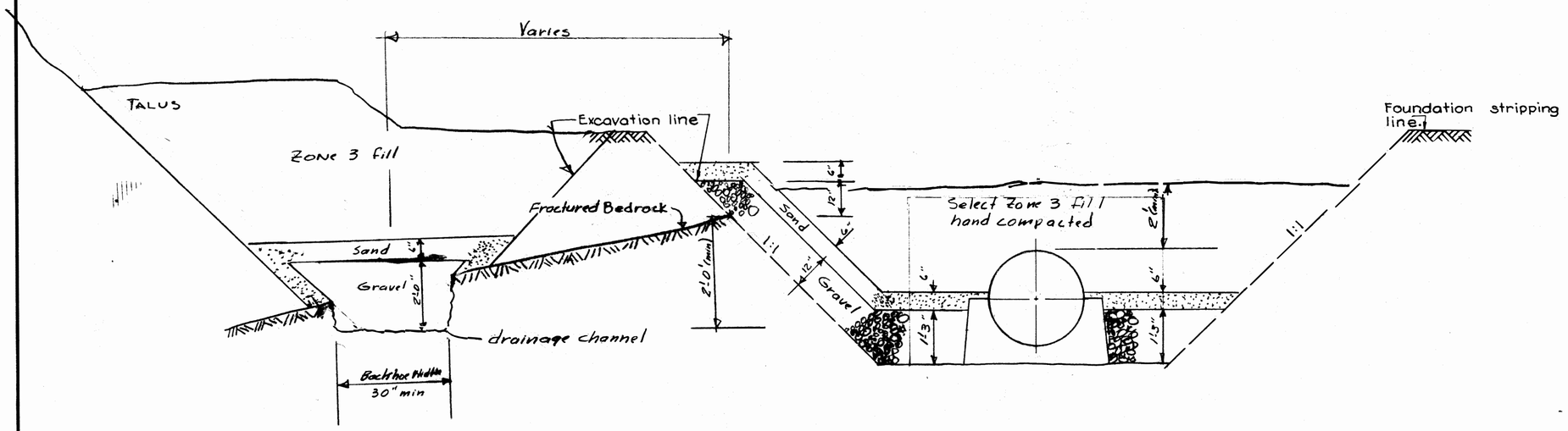
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed R.L.H	Date 1-61	Approved by	
Drawn M.H.K.	1-61	Title	
Traced		Title	
Checked E.B.L.	1-61	Sheet No. 18 of 18	Drawing No. 7-E-20355

USDA SCS PORTLAND, OREG. 1955 M 3258-18



Weep Holes in Principal Spillway Outlet



BACKFILL OF PRINCIPAL SPILLWAY CONDUIT

0 1 2 3 4 5
Scale in Feet

PRINCIPAL SPILLWAY DETAILS
UTABA RETARDING DAM
NORTH FORK OGDEN RIVER W.P.P.
WEBER COUNTY, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by	
Drawn		Title	
Traced R.V.T	9-61	Title	
Checked		Sheet No.	Drawing No. 7-E-20355

U. S. GOVERNMENT PRINTING OFFICE : 1956 O - 372186

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Form SCS-313 (November 1955)

Appendix B

Field Studies Data
UTABA Dam (24-1762)

Table of Contents

Description	Page No.
Legend to Soil Description	B-1
Legend to Rock Description	B-2
Test Hole and Piezometer Logs and Rock Cork Core Photographic Summaries	B-4
Packer Test Data	B-18
Test Pit Logs and Photographic Summaries	B-28

Unified Soil Classification System (USCS)

Material Types	Major Soil Divisions		Group Symbol and Legend		Typical Names
COARSE-GRAINED SOILS >50% retained on No. 200 sieve	GRAVELS >50% of coarse fraction retained on No. 4 Sieve	Clean GRAVELS (little or no fines)		GW	Well-Graded GRAVEL, GRAVEL-sand mixtures, few fines
				GP	Poorly-Graded GRAVEL, GRAVEL-sand mixtures, few fines
		GRAVELS with fines (appreciable amount of fines)		GM	Silty GRAVEL, GRAVEL-sand silt mixtures
				GC	Clayey GRAVEL, GRAVEL-sand clay mixtures
	SANDS >50% of coarse fraction passing the No. 4 sieve	Clean SANDS (little or no fines)		SW	Well-Graded SAND, SAND-gravel mixtures, few fines
				SP	Poorly-Graded SAND, SAND-gravel mixtures, few fines
		SANDS with fines (appreciable amount of fines)		SM	Silty SAND, SAND-silt mixtures
				SC	Clayey SAND, SAND-clay mixtures
FINE-GRAINED SOILS >50% Passing No. 200 Sieve	SILTS and CLAYS liquid limit < 50	Inorganic 1) CF > 30%: + Sandy/Gravelly 2) CF = 15-30% + with sand/gravel		CL	Lean CLAY, Gravelly/Sandy CLAY, low to med. plasticity
				ML	SILT, Gravelly/Sandy SILT, no to slight plasticity
		Organic		OL	Organic CLAY or SILT
	SILTS and CLAYS liquid limit > 50	Inorganic 1) CF > 30%: + Sandy/Gravelly 2) CF = 15-30% + with sand/gravel		CH	Fat CLAY, Gravelly/Sandy Fat CLAY, high plasticity
				MH	Elastic SILT, Gravelly/Sandy Elastic SILT, low to high plasticity
		Organic		OH	Organic CLAY or SILT
Highly organic soils		Primarily Organic Matter; Organic Odor		PT	PEAT
Boulders / Cobbles		> 50% (by volume) particles > 3"		COBBLES BOULDERS	Boulders (>12"); Cobbles (>3" and <12")

Other Material Symbols

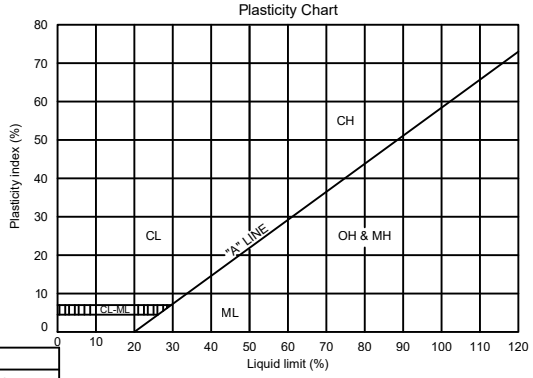
Bedrock
Asphalt
Concrete
Topsoil
Fill

Sample Types

Auger Cuttings
Continuous sampler
Grab Sample
No Recovery
Shelby Tube
Standard Penetration Test (SPT)
California Sampler
Rock Core
Modified California Sampler
Other (see remarks)
Piston Sampler (Shelby Tube)
Vane Shear

Apparent water level
Measured water level

Plasticity Chart



Descriptors for Coarse Grained Soils

Apparent Density	Dr (%)	SPT	MC	CAL
Very Loose	0-15	<4	<6	<8
Loose	15-35	4-10	6-15	8-20
Med. Dense	35-65	10-30	15-42	20-56
Dense	65-85	30-50	42-72	56-96
Very Dense	85-100	>50	>72	>96

Descriptors for Fine Grained Soils

Consistency	Su (psf)	SPT	MC	CAL
Very Soft	< 250	<2	<2	<2
Soft	250-500	2-4	2-4	2-5
Med. Stiff	500-1000	4-8	4-10	5-11
Stiff	1000-2000	8-15	10-19	11-22
Very Stiff	2000-4000	15-30	19-37	22-45
Hard	>4000	>30	>37	>45

SPT - Standard split spoon (SPT): 2" OD, 1.375" ID
MC - Modified California: 2.5" OD, 1.875" ID
CAL - California: 3" OD, 2.375" ID
R - Practical Refusal For Sampling Method

Stratification

Description	Criteria
Seam	1/16" to 1/2"
Layer	1/2" to 12"
Occasional	<= 1 per ft. thickness
Frequent	> 1 per ft. thickness

Modifiers

Description	Est. (%)
Trace	<5
Some	5-12
With	12-30
-ly	>30

Descriptors for Moisture

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

Descriptors for Particle Size

Description	Criteria
Boulder	>12" : larger than a basketball
Cobble	3-12" : larger than an orange
Coarse Gravel	3/4-3" : larger than a grape
Fine Gravel	No.4-3/4" : larger than a pea
Coarse Sand	No.10-4 : larger than a rock salt grain
Medium Sand	No.40-10 : larger than a table salt grain
Fine Sand	No.200-40 : smaller than table salt grain

Descriptors for Particle Angularity

Description	Criteria
Angular	Sharp edges, rel. plane sides, unpolished surface
Subangular	Similar to angular, but with rounded edges
Subrounded	Nearly plane sides, well-rounded corners & edges
Rounded	Smoothly curved sides and no edges

Abbreviations for Laboratory Testing

Description	Criteria
Su	Peak Undrained Shear Stress
UU	Unconsolidated Undrained Triaxial
CON	One-dimensional Consolidation
AL	Atterberg Limits (LL=Liquid Limit & PI=Plasticity Index)
SV / GSD	Sieve / Grain-Size Distribution Testing
CORR	Corrosion - Resistivity

Abbreviated Soil Classification Symbols (after ASTM D2488 X.5)

Prefix	Suffix
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

Abbreviated system for supplementary presentations when complete description is referenced. Examples:

Group Symbol and Full Name	Abbreviated
Sandy Lean CLAY	s(CL)
Poorly Graded SAND with silt and gravel	(SP-SM)g
Poorly Graded Gravel with sand, cobbles, and boulders	(GP)scb
Gravelly SILT with sand and cobbles	g(ML)sc

General Notes:

1) Stratigraphic lines on the logs represent approximate boundaries.
2) No warranty is provided as to the continuity of soil conditions beyond or between points explored and sample locations.
3) Logs represent soil conditions observed at the point of exploration on the date indicated.
4) Visual methods were used to classify the materials in general accordance with Unified Soil Classification System; actual designations based on laboratory methods may vary.
5) Soil descriptions were developed based on visual/manual classification methods and drilling or sampling behavior. Where judged appropriate, soil descriptions, classifications, and consistency/apparent density have been refined based on laboratory testing or correlations with other field tests/observations.

KEY TO SOIL AND ROCK CORE LOG

Depth, feet	ROCK CORE						Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES		FIELD NOTES
	Run No.	Recovery, %	RQD, %	Fractures Density	Weathering	Hardness								Type Number	Sampling Resistance	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

COLUMN DESCRIPTIONS

1 DEPTH: Distance (in feet) below the collar of the borehole.

2 RUN NO.: Number of the individual coring interval.

3 RECOVERY: Rock Coring: Amount (in percent) of core recovered from the coring interval; calculated as length of core recovered divided by length of run.

4 RQD: (Rock Quality Designation) Amount (in percent) of intact core (pieces of sound core greater than 4 inches in length) in each coring interval; calculated as the sum of lengths of intact core divided by length of core run. RQD of moderately weathered / altered rock does not meet soundness requirements, but provides some indication of rock quality with respect to the degree of fracturing.

5 FRACTURES DENSITY: (Fracture Frequency) The density of naturally occurring fractures in each foot of core; does not include mechanical breaks (induced by drilling) or healed fractures. See Sheet 2 for explaination and additional information. "NA" indicates not applicable due to lack of core recovery.

6 WEATHERING: The process of chemical or mechanical degradation of rock. See Sheet 2 for additional information.

7 HARDNESS: See Sheet 2 for explanation and additional information.

8 LITHOLOGY: A graphic log of material encountered using symbols to represent differing soil and types; graphic symbols are explained below.

9 DESCRIPTION: Rock: Lithologic description in this order: rock type, grain size, texture, color, strength, and other features; descriptive terms are defined on the attached sheets and tables.
Soil or weathered rock: See sheet 2 and Legend to Soil Descriptions for explanation and additional information.

10 DISCONTINUITY DRAWING: Sketch of the naturally occurring fractures and mechanical breaks, showing the angle of the fractures relative to the cross-sectional axis of the core. Intensely fractured material are not included in fractured drawings (see core photos, if available). "NR" indicates no recovery.

11 DISCONTINUITY TYPE: See Sheet 2 for explanation and additional Information

12 DISCONTINUITY DESCRIPTION: Orientation, Surface Shape, Roughness, Aperture, Filling Thickness, Filling Type, See Sheet 2 for explanation and additional Information

13 POINT LOAD TEST RESULTS: The testing results from point load tests.

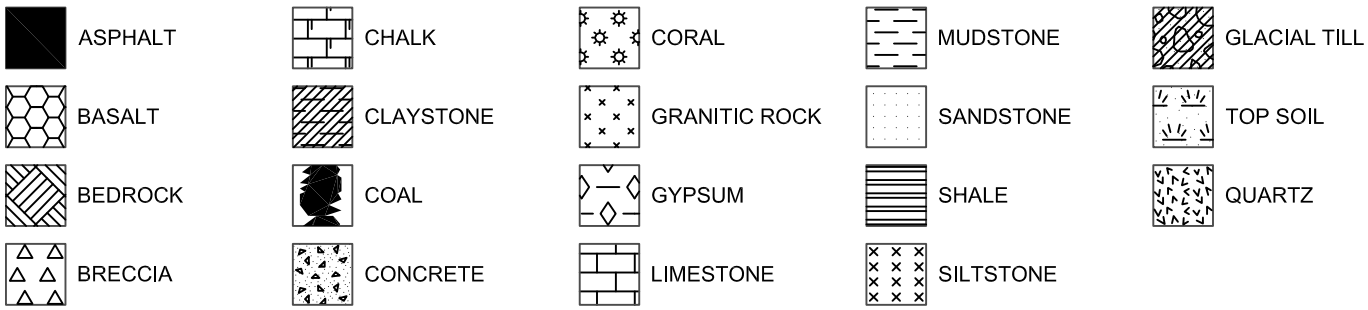
14 PACKER TEST INTERVALS: Testing permeability and water sampling in different regions of test hole by isolation of depths using inflatable packers or bladders.

15 SAMPLE TYPE / NUMBER: Type of soil sample collected at depth interval shown; sampler symbols are explained below. Sample identification number.

16 SAMPLING RESISTANCE.: Number of blows to advance driven sampler each 6-inch drive interval, or distance noted, using a 140-lb hammer with a 30-inch drop (unless otherwise noted).

17 FIELD NOTES: Comments an observation regarding drilling or sampling made by driller or field personnel.

TYPICAL MATERIAL GRAPHIC SYMBOLS FOR ROCK



KEY TO SOIL AND ROCK CORE LOG

ROCK WEATHERING / ALTERATION

Weathering descriptors (Extracted from USBR, 2001)

Descriptors		Diagnostic features					
		Chemical weathering - Discoloration and/or oxidation		Mechanical weathering Grain boundary conditions (disaggregation) primarily for granitics and some coarse grained sediments	Texture and solutioning		
Alpha numeric descriptor	Descriptive term	Body of rock	Fracture surfaces[2]		Texture	Solutioning	General characteristics (strength, excavation, etc.)[3]
W1	Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shale.
W2	Slightly Weathered to Fresh[1]						
W3	Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from fractures; some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved.	Minor leaching of some soluble minerals may be noted.	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classifies as rock excavation.
W4	Moderately to Slightly Weathered[1]						
W5	Moderately Weathered	Discoloration or oxidation extends from fractures, usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved.	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstone or shales.
W6	Intensely to Moderately Weathered[1]						
W7	Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation, see grain boundary conditions	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated.	Texture alerted by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.
W8	Very Intensely Weathered						
W9	Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspar and FE-Mg minerals		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Note: This chart and its horizontal categories are more readily applied to rocks with feldspars and mafic minerals. Weathering in various sedimentary rocks, particularly limestones and poorly indurated sediments, will not always fit the categories established. This chart and weathering categories may have to be modified for particular site conditions or alteration such as hydrothermal effects; however, the basic framework and similar descriptors are to be used.
1) Combination descriptors are permissible where equal distribution of both weathering characteristics are present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, dual descriptors should not be used where significant, identifiable zones can be delineated. When given as a range, only two adjacent terms may be combined (i.e., decomposed to lightly weathered or moderately weathered to fresh are not acceptable).
2) Does not include directional weathering along shears or faults and their associated features. For example, a shear zone that carried weathering to great depths into a fresh rock mass would not require the rock mass to be classified as weathered. 3) These are generalization and should not be used as diagnostic features for weathering or excavation classification. These characteristics vary to a large extent based on naturally weak materials or cementation and type of excavation.

ROCK HARDNESS

Rock Hardness/strength descriptors (Extracted from USBR, 2001)

Alpha numeric descriptor	Descriptor	Criteria
H1	Extremely hard	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
H2	Very hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
H4	Moderately hard	Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow
H5	Moderately soft	Can be grooved 1/16 inch (2 mm) deep by knife or sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
H7	Very soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.
Any bedrock unit softer than H7, is to be described using USBR 5000 consistency descriptors		

Note: Although "sharp pick" is included in these definitions, descriptions of ability to be scratched, grooved, or gouged by a knife is the preferred criteria.

11 Discontinuity Type:

Fa - Fault
Jo - Joint
Sh - Shear
Fo - Foliation
V - Vein
Be - Bedding
Me - Mechanical break

12 DISCONTINUITY DESCRIPTIONS

a Orientation, Angle measured from perpendicular to core axis

b Surface Shape of Joint:

Pl - Planer
Wa - Wavy
St - Stepped
Ir - Irregular

c Roughness of Surface:

Fracture roughness descriptors (Extracted from USBR, 2001)

Alpha numeric descriptor	Descriptor	Criteria
R1	Stepped	Near-normal steps and ridges occur on the fracture surface.
R2	Rough	Large angular asperities can be seen.
R3	Moderately rough	Asperities are clearly visible and fracture surface feels abrasive.
R4	Slightly rough	Small asperities on the fracture surface are visible and can be felt
R5	Smooth	No asperities, smooth to the touch
R6	Polished	Extremely smooth and shiny.

d Aperture:

Fracture openness descriptors (Extracted from USBR, 2001)

Alpha numeric descriptor	Descriptor	Criteria
O0	Tight	No visible separation
O1	Slightly open	Less than 0.003 ft [1/32 inch (in)] (<1 mm)
O2	Moderately open	0.003 to 0.01 ft [1/32 in to 1/8 in] (1 to 3 mm)
O3	Open	0.01 to 0.03 ft [1/8 to 3/8 in] (3 to 10 mm)
O4	Moderately wide	0.03 ft [3/8 in to 0.1 ft (10 to 30 mm)
O5	Wide	Greater than 0.1 ft (>30 mm) (record actual openness)

e Filling Thickness:

Fracture filing thickness (Extracted from USBR, 2001)

Alpha numeric descriptor	Descriptor	Criteria
T0	Clean	No film coating
T1	Very thin	Less than 0.003 ft [1/32 in] (<1 mm)
T2	Moderately thin	0.003 to 0.01 ft [1/32 to 1/8 in] (1 to 3
T3	Thin	0.01 to 0.03 ft [1/8 to 3/8 in] (3 to 10
T4	Moderately thick	0.03 ft [3/8 in] to 0.1 ft (10 to 30 mm)
T5	Thick	Greater than 0.1 ft (>30 mm) (record actual thickness)

f Filling Type:

Cl - Clay
Ca - Calcite
Fe - Iron Oxide
Gy - Gypsum

U.S. Bureau of Reclamation, 2001, Engineering Geology Field Manual, Second Edition, Volume 1: Technical Service Center, Bureau of Reclamation, U.S. Department of the Interior.

Project: UTABA Retarding Dam

Project Location: Weber County, UT

Project Number: 24-1762

LOG OF TEST HOLE 24-TH-01

Sheet 1 of 4

Date(s) Drilled	Oct 24 2024 to Oct 28 2024	Logged By	J. McFarlane/M. McNeil	Checked By	R. Buhler
Drilling Method	HSA / HQ Coring	Drill Bit Size/Type	4 1/4" Bullet Bit / H4 Coring Shoe	Total Depth Drilled (feet)	101.0
Drill Rig Type	CME 850	Drilling Contractor	ConeTec (Ryan, Tony)	Hammer Weight/ Drop (lbs/in.)	Automatic (SPT)
Apparent Groundwater Depth (feet)	57.5	Latitude / Longitude	41.38682 , -111.90982	Ground Surface Elevation (feet)	5721 (Approx.)
Test Hole Backfill	Grout	Comments	60 feet left of spillway on CL of dam. Piezometer located 10 feet left of test hole.	Elevation Datum	NAVD88

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Recovery, %	RQD, %	Fracture Density	Weathering	Hardness	Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES: Type	Number	Sampling Resistance	FIELD NOTES
									GRAVEL, sandy, with silt - very dense, dry, gray to light brown, EMBANKMENT MATERIAL, (GM)							SPT-01	9-29-49-50/5" 78	
5716	5								SAND, clayey to CLAY, sandy, with gravel - medium dense to dense, stiff to hard, dry to moist, gray to dark gray, EMBANKMENT MATERIAL, Zone 2, (SC/CL)							SPT-02	23-42-40-50/5" 82	Softer drilling
5711	10								- transitions to moist							SPT-03	9-16-16-36 32	Gravel stuck in shoe Bulk sample from 10 to 15 feet
5706	15															SPT-05	5-9-17-17 26	
5701	20															ST-06		
5696	25								- transitions to light brown to gray, with gravel							SPT-07	11-20-23-20 43	Bulk sample from 25 to 30 feet
	30																	

GERHART COLE

Project: UTABA Retarding Dam

Project Location: Weber County, UT

Project Number: 24-1762

LOG OF TEST HOLE 24-TH-01

Sheet 2 of 4

Date(s) Drilled	Oct 24 2024 to Oct 28 2024	Logged By	J. McFarlane/M. McNeil	Checked By	R. Buhler
Drilling Method	HSA / HQ Coring	Drill Bit Size/Type	4 1/4" Bullet Bit / H4 Coring Shoe	Total Depth Drilled (feet)	101.0
Drill Rig Type	CME 850	Drilling Contractor	ConeTec (Ryan, Tony)	Hammer Weight/ Drop (lbs/in.)	Automatic (SPT)
Apparent Groundwater Depth (feet)	57.5	Latitude / Longitude	41.38682 , -111.90982	Ground Surface Elevation (feet)	5721 (Approx.)
Test Hole Backfill	Grout	Comments	60 feet left of spillway on CL of dam. Piezometer located 10 feet left of test hole.	Elevation Datum	NAVD88

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Recovery, %	RQD, %	Fracture Density	Weathering	Hardness	Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES: Type	Number	Sampling Resistance	FIELD NOTES
									SAND, clayey to CLAY, sandy, with gravel - medium dense to dense, stiff to hard, dry to moist, gray to dark gray, EMBANKMENT MATERIAL, Zone 2, (SC/CL)							SPT-08	4-10-12-21 22	
5686	35															ST-09		
5681	40															SPT-10	5-6-9-18 15	
5676	45															ST-11		Added water to aid in cutting removal
5671	50															SPT-12	18-47-37-35 84	
5666	55															SPT-13	14-15-36-29 51	
	60																	

GERHART COLE

Project: UTABA Retarding Dam

Project Location: Weber County, UT

Project Number: 24-1762

LOG OF TEST HOLE 24-TH-01

Sheet 3 of 4

Date(s) Drilled	Oct 24 2024 to Oct 28 2024	Logged By	J. McFarlane/M. McNeil	Checked By	R. Buhler
Drilling Method	HSA / HQ Coring	Drill Bit Size/Type	4 1/4" Bullet Bit / H4 Coring Shoe	Total Depth Drilled (feet)	101.0
Drill Rig Type	CME 850	Drilling Contractor	ConeTec (Ryan, Tony)	Hammer Weight/ Drop (lbs/in.)	Automatic (SPT)
Apparent Groundwater Depth (feet)	57.5	Latitude / Longitude	41.38682 , -111.90982	Ground Surface Elevation (feet)	5721 (Approx.)
Test Hole Backfill	Grout	Comments	60 feet left of spillway on CL of dam. Piezometer located 10 feet left of test hole.	Elevation Datum	NAVD88

Elevation, feet	Depth, feet	ROCK CORE Run No.	Recovery, %	RQD, %	Fracture Density	Weathering	Hardness	Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES Type	Number	Sampling Resistance	FIELD NOTES
									SAND, clayey to CLAY, sandy, with gravel - medium dense to dense, stiff to hard, dry to moist, gray to dark gray, EMBANKMENT MATERIAL, Zone 2, (SC/CL)							ST-14		
5656	65								GRAVEL, sandy, with cobbles - very dense, wet, dark gray to brown, ALLUVIUM, (GP)							SPT-15	13-37-48-50/5" 85	Grinding on cobbles, intermittent smooth drilling
									SAND, silty - medium dense, wet, gray to dark gray, ALLUVIUM (SM)									
									GRAVEL, sandy, with cobbles - very dense, wet, dark gray to dark brown, ALLUVIUM, (GP)									
5651	70															SPT-16	43-49-50/5" [R]	
									QUARTZITE - medium to thick bedded, medium to coarse grained, purple to grayish red, [Mutual Formation, Zm]		Jo	27.2°, O4, T1, R4					
					FD6						Jo	74.6°, O2, T1, R4						
											Jo	46.8°, O2, T2, R3						
		1	100	40	FD6		H4				Jo	20°, O3, T3, R3						
5646	75										Jo	23°, O1, T1, R3						
					FD6						Jo	59.7°, O1, T1, R4				SPT-17	50/1" [R]	
											Jo	58°, O1, T0, R4						
					FD0						Jo	20°, O1, T0, R4						
											Jo	63.3°, O3, T1, R4						
					FD4						Jo	0°, O4, T4, R3						
											Jo	52°, O2, T0, R4						
		2	92	75	FD0		H4				Jo	81°, O1, T0, R4						
											Be	76°, O1, T0, R5						
					FD6						Jo	72°, O2, T2, R5						
5641	80										Jo	56°, O3, T0, R1, H2						
					FD0						Jo	11°, O2, T0, R2						
											Jo	36°, O2, T0, R4						
					FD6													
					FD4						Jo	8°, O4, T1, R3						
											Jo	30°, O2, T1, R3						
		3	92	55	FD4		H4				Jo	42°, O2, T1, R3						
											Jo	31°, O1, T1, R4						
					FD5						Jo	40°, O1, T1, R4						Lost water circulation
5636	85										Jo	35°, O2, T2, R5						
					FD4						Jo	10°, O1, T2, R3						
											Jo	32°, O1, T1, R3						
					FD6						Jo	13°, O5, T1, R5						
											Jo	32°, O5, T3, R3						
					FD5						Jo	16°, O5, T3, R3						
		4	100	52							Jo	33°, O2, T2, R3						
					FD5		H4				Jo	25°, T2, O2, R4						
											Jo	22°, T3, O3, R3						
					FD1													
	90																	

Project: UTABA Retarding Dam

Project Location: Weber County, UT

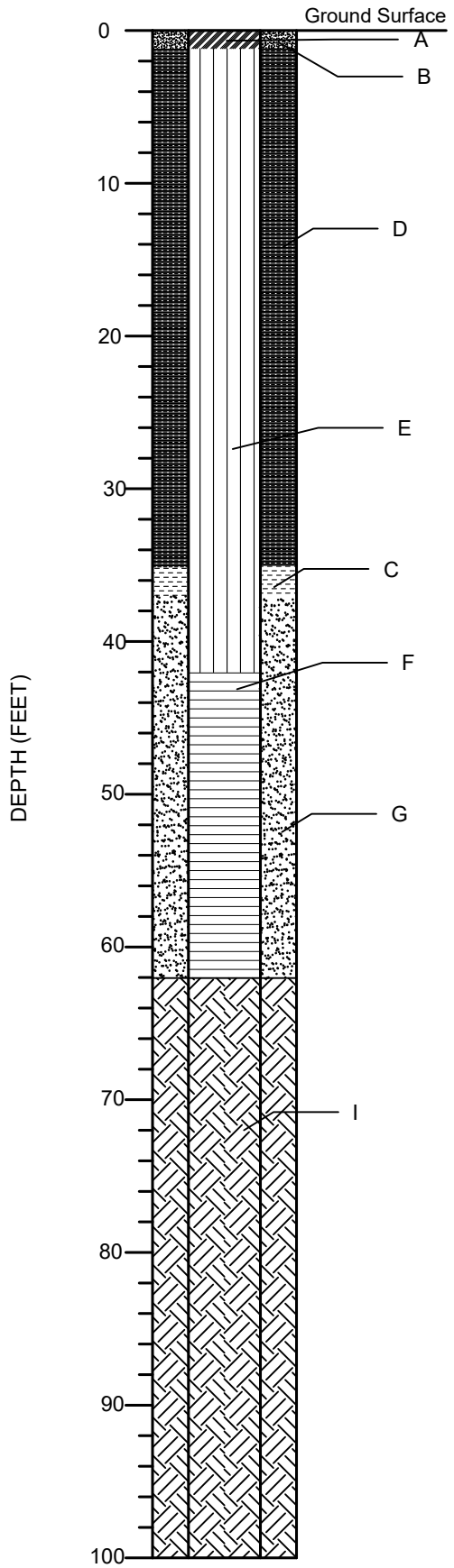
Project Number: 24-1762

LOG OF TEST HOLE 24-TH-01

Sheet 4 of 4

Date(s) Drilled	**Oct 24 2024** to **Oct 28 2024**	Logged By	**J. McFarlane/M. McNeil**	Checked By	**R. Buhler**
Drilling Method	**HSA / HQ Coring**	Drill Bit Size/Type	**4 1/4" Bullet Bit / H4 Coring Shoe**	Total Depth Drilled (feet)	**101.0**
Drill Rig Type	**CME 850**	Drilling Contractor	**ConeTec (Ryan, Tony)**	Hammer Weight/ Drop (lbs/in.)	**Automatic (SPT)**
Apparent Groundwater Depth (feet)	**57.5**	Latitude / Longitude	**41.38682 , -111.90982**	Ground Surface Elevation (feet)	**5721 (Approx.)**
Test Hole Backfill	**Grout**	Comments	**60 feet left of spillway on CL of dam. Piezometer located 10 feet left of test hole.**	Elevation Datum	**NAVD88**

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Recovery, %	RQD, %	Fracture Density	Weathering	Hardness	Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES: Type	Number	Sampling Resistance	FIELD NOTES
					FD1				QUARTZITE - medium to thick bedded, medium to coarse grained, purple to grayish red, [Mutual Formation, Zm]		Jo	25°, T2, O2, R3						
		5	43	8														
5626	95				FD5		H4				Jo	60°, O2, T1, R3						Driller indicated bit clogging in fractured zones
					FD5						Jo	19°, O3, T1, R3						
											Jo	20°, O1, T1, R4						
											Jo	86°, O2, T1, R3						
		6	10	0														Minimal recovery, losing circulation
5621	100																	
									Bottom of Hole at 101 feet									
5616	105																	
5611	110																	
5606	115																	
	120																	



LEGEND

Water level (casing rim) at 57.9 feet on 11/20/2024

- A Steel surface monument
- B Concrete surface seal
- C Bentonite Chips/Seal
- D Cement-Bentonite Grout
- E 2 -inch Schedule 40 PVC well casing
- F 2 -inch Schedule 40 PVC screen, 0.020 -inch slot width
- G 10-20 COLORADO SILICA sand backfill
- H PVC END CAP
- I Native Soil
- J
- K
- L

Monument/Casing Reference Elevation: 5721 feet
Ground Surface Elevation: 5721 feet
Casing Stickup: 0 feet
Test Hole Drilled Diameter: 8 inches
Base of Test Hole: 63 feet
Base of Piezometer: 62 feet

FIELD INSTALLATION NOTES

LOCATION

41.38682, -111.90982

MATERIALS USED:

10-20 Silica Sand (9 bags)
Bentonite Chips (1 bag)
Cement (3 bags)
Gel (1 bag)
0.02 Slotted Screen (10 ft)
Surface Mount (1)

GERHART COLE

PIEZOMETER CONSTRUCTION DETAILS

Client: Franson Civil	Location: 24-TH-01	Job No.: 24-1762
By: J. McFarlane	Project: Utaba Dam	B-8

Test Hole Location:	24-TH-01	Box Number:	1	Run(s):	1, 2	Depth(ft):	73.0 – 81.0



PHOTOGRAPHIC SUMMARY OF ROCK CORE

Utaba Dam (24-1762)

GERHART COLE

B-9

Notes:

1. This photo log is for information purposes only. It is intended to assist in showing features discussed in the attached field logs.

Reference: Log of Referenced Test Hole

Test Hole Location:	24-TH-01	Box Number:	2	Run(s):	3, 4	Depth(ft):	81.0 – 91.0



Notes:

1. This photo log is for information purposes only. It is intended to assist in showing features discussed in the attached field logs.

Reference: Log of Referenced Test Hole

PHOTOGRAPHIC SUMMARY OF ROCK CORE

Utaba Dam (24-1762)

GERHART COLE

Test Hole Location:	24-TH-01	Box Number:	3	Run(s):	5, 6	Depth(ft):	91.0 – 101.0



Notes:

1. This photo log is for information purposes only. It is intended to assist in showing features discussed in the attached field logs.

Reference: Log of Referenced Test Hole

PHOTOGRAPHIC SUMMARY OF ROCK CORE

Utaba Dam (24-1762)

GERHART COLE

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST HOLE 24-TH-401

Sheet 1 of 2

Date(s) Drilled	Oct 21 2024 to Oct 23 2024	Logged By	J. McFarlane	Checked By	R. Buhler
Drilling Method	HSA / HQ Coring	Drill Bit Size/Type	4 1/4" Bullet Bit / H4 Coring Shoe	Total Depth Drilled (feet)	33.0
Drill Rig Type	CME 850	Drilling Contractor	ConeTec (Ryan, Cam, Tony)	Hammer Weight/ Drop (lbs/in.)	Automatic (SPT)
Apparent Groundwater Depth (feet)	7.8	Latitude / Longitude	41.38643 , -111.90929	Ground Surface Elevation (feet)	5658 (Approx.)
Test Hole Backfill	Piezometer	Comments	16.5 feet right of spillway wall and 16.4 feet upstream of downstream spillway corner.	Elevation Datum	NAVD88

Elevation, feet	Depth, feet	ROCK CORE Run No.	Recovery, %	RQD, %	Fracture Density	Weathering	Hardness	Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES Type	Number	Sampling Resistance	FIELD NOTES
									GRAVEL, sandy, with cobbles and boulders - very dense, moist, brown to dark gray, cobbles up to 8 inches, boulders up to 18 inches, ALLUVIUM, (GP)									Sample dimensions - I.D. 2.5", O.D. 3"
									- cobble and boulder layer							MC-01	25-73-28-16 101	Grinding on cobble
5653	5								GRAVEL, sandy, with cobbles and boulders, with silt - medium dense to very dense, moist dark brown to dark gray, cobbles up to 4 inches, boulders up to 18 inches, ALLUVIUM, (GM)							MC-02	15-11-18-17 29	Grinding through cobbles
																SPT-03	19-16-24-25 40	
5648	10															SPT-04	35-25-48-50/2" 73	
		1	100	83					- cobble and boulder layer							SPT-05	50/2" [R]	
					FD6													
					FD6				QUARTZITE - medium to thick bedded, medium to coarse grained, brown to pink, [Mutual Formation]		Jo	43°, O1, T0, R5					
5643	15	2	90	22	FD6		H4				Jo	65°, O1, T0, R5						
											Jo	60°, O2, T0, R5						
					FD5						Jo	45°, O2, T0, R5						
											Jo	45°, O1, T1, R5						
					FD5						Jo	45°, O1, T1, R5						
											Jo	45°, O1, T1, R5						
					FD7						Jo	45°, O1, T1, R5						
					FD7						Jo	45°, O1, T1, R5						
					FD7						Jo	45°, O1, T1, R5						
5638	20	3	98	0	FD7		H4				Jo	45°, O1, T1, R5						
											Jo	27°, O1, T0, R4						
					FD7						Jo	45°, O1, T0, R4						
					FD7						Jo	45°, O1, T0, R5						
											Jo	62°, O1, T0, R5						
					FD7						Jo	45°, O1, T0, R5						
					FD5													
					FD7													
5633	25	4	83	22	FD7		H4				Jo	43°, O1, T4, R5						
											Jo	28°, O1, T1, R5						
					FD7						Jo	36°, O1, T0, R5						
					FD7													
					FD6						Jo	78°, O0, T0, R4						
											Jo	57°, O1, T0, R4						
					FD5													
	30										Jo	20°, O1, T0, R4						

Project: UTABA Retarding Dam

Project Location: Weber County, UT

Project Number: 24-1762

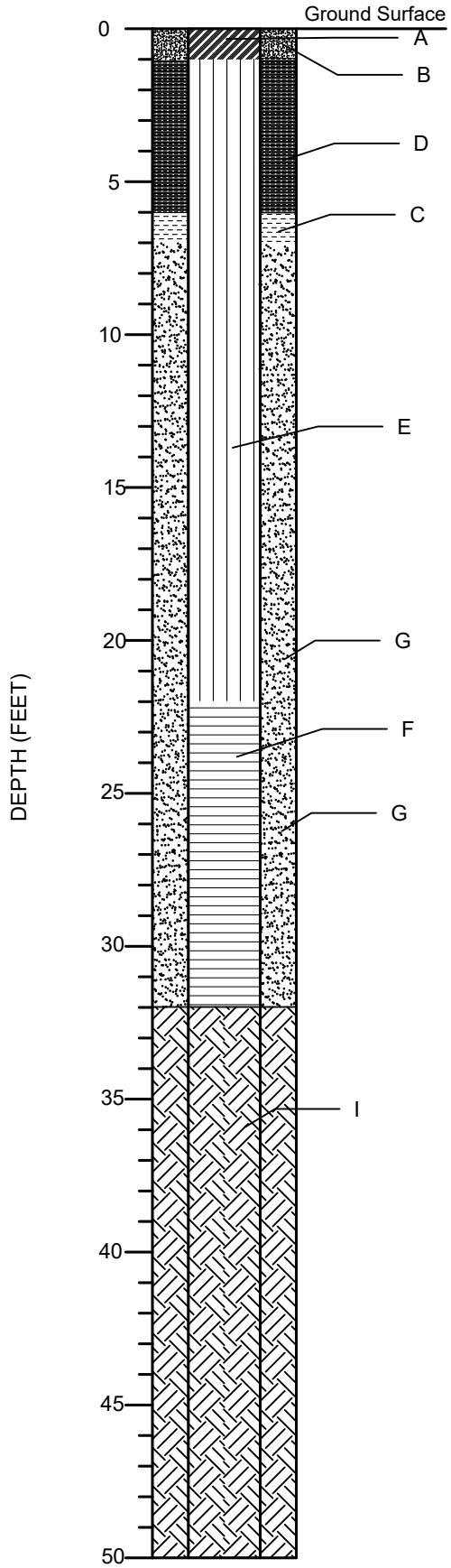
LOG OF TEST HOLE 24-TH-401

Sheet 2 of 2

Date(s) Drilled	Oct 21 2024 to Oct 23 2024	Logged By	J. McFarlane	Checked By	R. Buhler
Drilling Method	HSA / HQ Coring	Drill Bit Size/Type	4 1/4" Bullet Bit / H4 Coring Shoe	Total Depth Drilled (feet)	33.0
Drill Rig Type	CME 850	Drilling Contractor	ConeTec (Ryan, Cam, Tony)	Hammer Weight/ Drop (lbs/in.)	Automatic (SPT)
Apparent Groundwater Depth (feet)	7.8	Latitude / Longitude	41.38643 , -111.90929	Ground Surface Elevation (feet)	5658 (Approx.)
Test Hole Backfill	Piezometer	Comments	16.5 feet right of spillway wall and 16.4 feet upstream of downstream spillway corner.	Elevation Datum	NAVD88

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Recovery, %	RQD, %	Fracture Density	Weathering	Hardness	Lithology	MATERIAL DESCRIPTION	Discontinuity Drawing	Discontinuity Type	DISCONTINUITY DESCRIPTION	Point Load Test Results (psi)	Packer Test Intervals	SOIL SAMPLES: Type	Number	Sampling Resistance	FIELD NOTES
		5	100	23	FD5 FD5 FD6		H4		QUARTZITE - medium to thick bedded, medium to coarse grained, brown to pink, [Mutual Formation]		Jo Jo Me Jo Jo Jo Jo	36°, O1, T0, R4 34°, O1, T0, R4 25°, O1, T0, R4 19°, O1, T0, R4 71°, O1, T0, R4 6°, O1, T0, R4						
									Bottom of Hole at 33 feet									
5623	35																	
5618	40																	
5613	45																	
5608	50																	
5603	55																	
	60																	

GERHART COLE



LEGEND

Water level (casing rim) at 4.2 feet on 11/20/2024

- A Steel surface monument
- B Concrete surface seal
- C Bentonite Chips/Seal
- D Cement-Bentonite Grout
- E 2 -inch Schedule 40 PVC well casing
- F 2 -inch Schedule 40 PVC screen, 0.020 -inch slot width
- G 10-20 COLORADO SILICA sand backfill
- H PVC END CAP
- I Native Soil
- J
- K
- L

Monument/Casing Reference Elevation: 5658 feet
Ground Surface Elevation: 5658 feet
Casing Stickup: 0 feet
Test Hole Drilled Diameter: 4 1/4 inches
Base of Test Hole: 33 feet
Base of Piezometer: 32 feet

FIELD INSTALLATION NOTES

LOCATION

41.38643, -111.90929

MATERIALS USED:

10-20 Silica Sand (1 bag)
Bentonite Chips ($\frac{1}{3}$ bag)
Bentonite ($\frac{1}{3}$ bag)
Portland Cement (2 bags)
0.02 Slotted Screen (10 ft)
End Cap (1)

GERHART COLE

PIEZOMETER CONSTRUCTION DETAILS

Client: Franson Civil	Location: 24-TH-401	Job No.: 24-1762
By: J. McFarlane	Project: Utaba Dam	B-14

Test Hole Location:	24-TH-401	Box Number:	1	Run(s):	1, 2, 3	Depth(ft):	12.0 – 19.7



Notes:

1. This photo log is for information purposes only. It is intended to assist in showing features discussed in the attached field logs.

Reference: Log of Referenced Test Hole

PHOTOGRAPHIC SUMMARY OF ROCK CORE

Utaba Dam (24-1762)

GERHART COLE

Test Hole Location:	24-TH-401	Box Number:	2	Run(s):	3, 4	Depth(ft):	19.7 – 28.0



Notes:

1. This photo log is for information purposes only. It is intended to assist in showing features discussed in the attached field logs.

Reference: Log of Referenced Test Hole

PHOTOGRAPHIC SUMMARY OF ROCK CORE

Utaba Dam (24-1762)

GERHART COLE

Test Hole Location:	24-TH-401	Box Number:	3	Run(s):	5	Depth(ft):	28.0 – 33.0



Notes:

1. This photo log is for information purposes only. It is intended to assist in showing features discussed in the attached field logs.

Reference: Log of Referenced Test Hole

PHOTOGRAPHIC SUMMARY OF ROCK CORE

Utaba Dam (24-1762)

GERHART COLE

Project Name: UTABA Dam
Project Number: 24-1762
Engineer/Geologist: J. McFarlane/M. McNiel
Reviewed By: RRB

Location: 24-TH-01
Test ID: 24-TH-01-P-1
Date: 10/26/2024

Test Data (depths measured from ground surface)

Test Hole Diameter:	3.8	inches
	0.32	ft
Plunge Angle (from vertical):	0	degrees
Depth to Top of Test Zone:	75	ft
Depth to Bottom of Test Zone:	81	ft
Test Interval/Zone Length:	6.0	ft
Midpoint of Test Zone (head):	78.0	ft
Max. Test Head (at depth) (Pmax):	42.5	psi

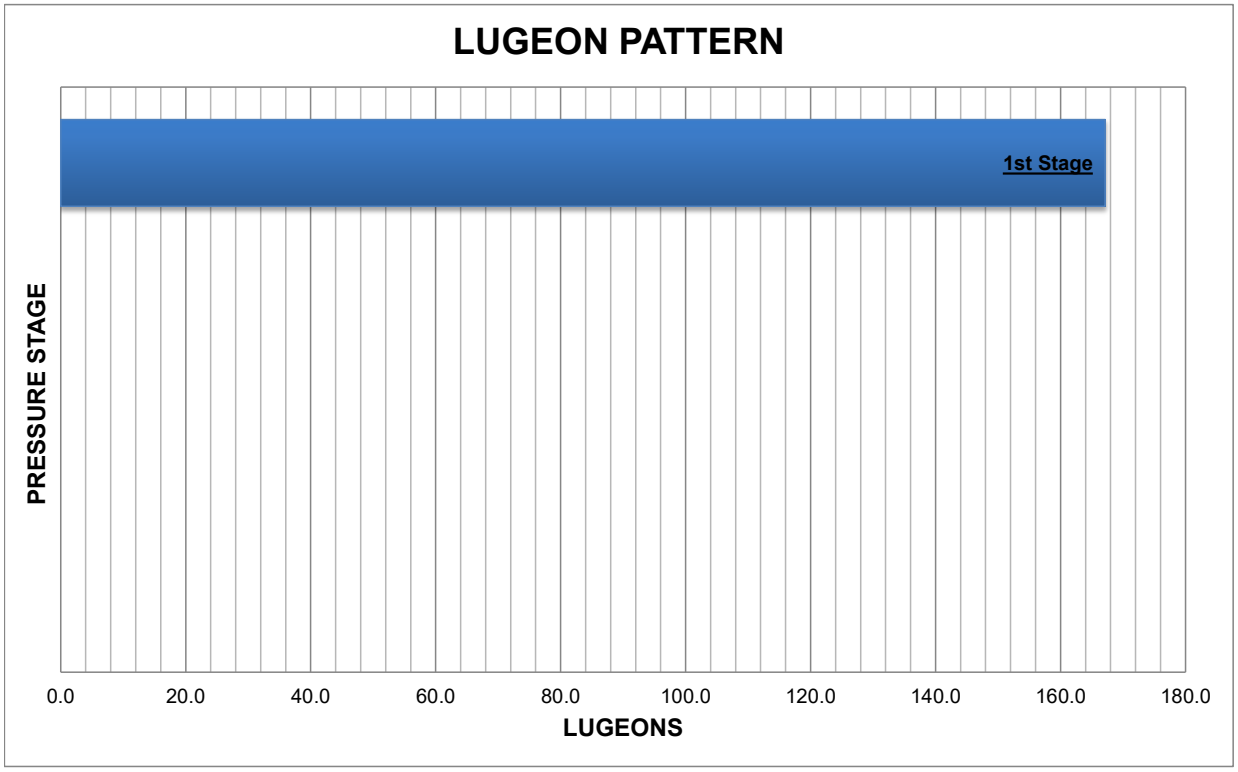
Packer Configuration

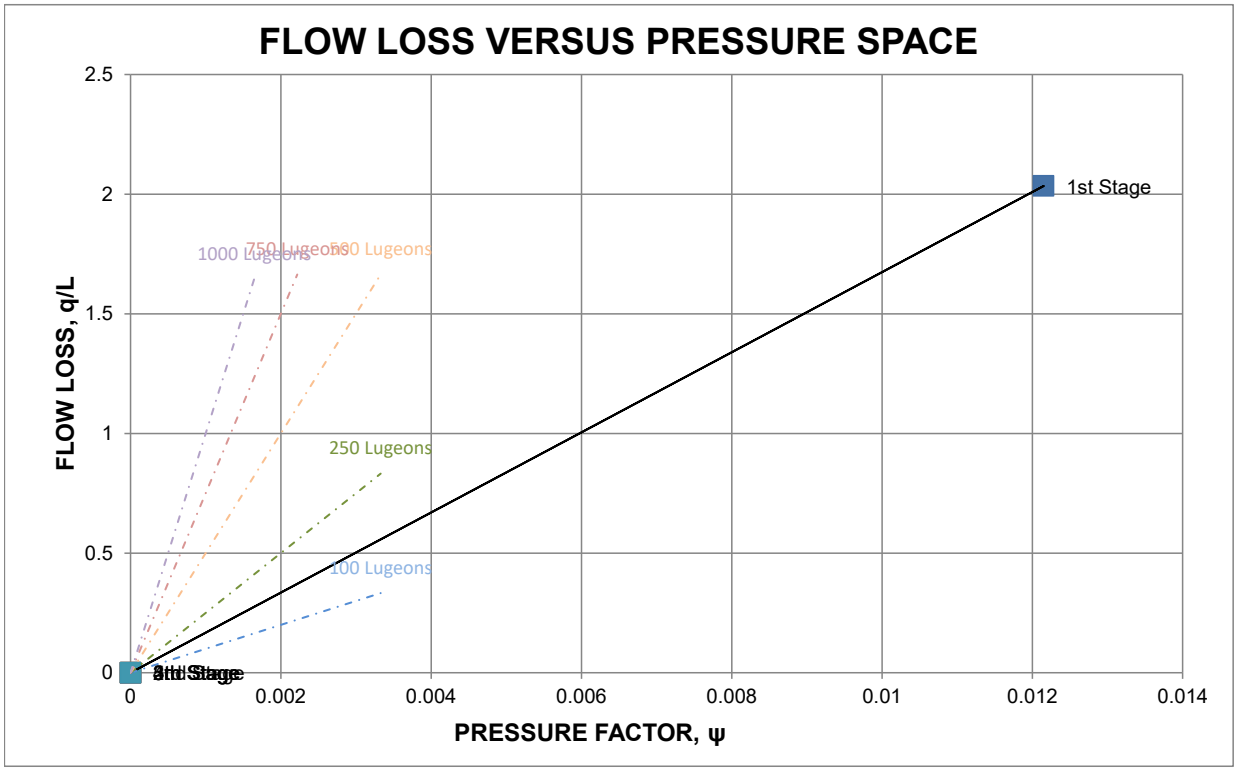
Number of Packers:	1	
Packer Type:	Pneumatic	
Packer Pressure	200	psi
Packer Length	24	inches

Notes: Could not progress to additional stages. Packer unable to seal bedrock and flows coming around the packer.

Target Test Pressure	Elapsed Time	Volume Gauge Reading	Measured Test Pressure	Measured Pressure in Feet Head of Water	▲ Volume (Water Take)	Flow Rate		Hydraulic Conductivity (K)			
psi	min	gallons	psi	ft (h_{total})	gallons	gal/min (Q_g)	ft^3/min (Q_f)	(lugeons)	(k-cm/sec)	(k-ft/min)	(k-ft/yr)
a	b	c	d	e	f	g	h	i	j	k	l
21.0	0	15586.2	22.5	51.9	- - -	- - -	- - -	- - -	- - -	- - -	- - -
21.0	1.0	15599.1	22.0	50.9	12.9	12.9	1.73	176.3	2.3E-03	4.5E-03	2,372.7
21.0	2.0	15611.5	22.1	51.1	12.4	12.4	1.66	168.3	2.2E-03	4.3E-03	2,265.6
21.0	3.0	15624.5	22.1	51.0	12.9	12.9	1.73	175.6	2.3E-03	4.5E-03	2,364.1
21.0	4.0	15636.3	22.0	50.8	11.9	11.9	1.59	162.0	2.1E-03	4.1E-03	2,181.0
21.0	5.0	15647.17	21.2	48.9	10.8	10.8	1.45	153.3	2.0E-03	3.9E-03	2,064.0
		1st Stage: Average		51	12.2	12.2	1.63	167.1	2.2E-03	4.3E-03	2249.5
		2nd Stage: Average								- - -	- - -
		3rd Stage: Average									
		4th Stage: Average									
		5th Stage: Average									

a = testing stages (0.5, 0.75, 1.0, 0.75, 0.5) x head + head
b = volume measurement time interval
c = measured at ground surface using in line hoses
d = measured at ground surface using pressure gauge
e = measured at depth using vibrating wire piezometer
f = change in volume (water take) over measured interval
g = flow rate over measurement interval
h = conversion: 'Q_g'/7.481
i : $\text{Lugeon Value} = \alpha \times \frac{q}{L} \times \frac{P_o}{P}$;a=12.42 & q[gpm], L[ft], P[psi] (Rozo 2010)
j = unit conversion: 'lugeons'x1.3x10-5 (Fell et al. 2005)
k = unit conversion: 'k-cm/sec' x 60 mins x 0.03281 ft
l = unit conversion: 'k-ft/min' x 60 mins x 24 hr x 365¼ days


LUGEON PATTERN
1st Stage
PRESSURE STAGE
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
LUGEONS


FLOW LOSS VERSUS PRESSURE SPACE
2.5
2
1.5
1
0.5
0
1st Stage
1000 Lugeons
750 Lugeons
500 Lugeons
250 Lugeons
100 Lugeons
FLOW LOSS, q/L
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
PRESSURE FACTOR, ψ

Project Name: UTABA Dam
Project Number: 24-1762
Engineer/Geologist: M. McNiel
Reviewed By:

Location: 24-TH-01
Test ID: 24-TH-01-P-2
Date: 10/26/2024

Test Data (depths measured from ground surface)

Test Hole Diameter:	3.8	inches
	0.32	ft
Plunge Angle (from vertical):	0	degrees
Depth to Top of Test Zone:	81	ft
Depth to Bottom of Test Zone:	91	ft
Test Interval/Zone Length:	10.0	ft
Midpoint of Test Zone (head):	86.0	ft
Max. Test Head (at depth) (Pmax):	44.5	psi

Packer Configuration

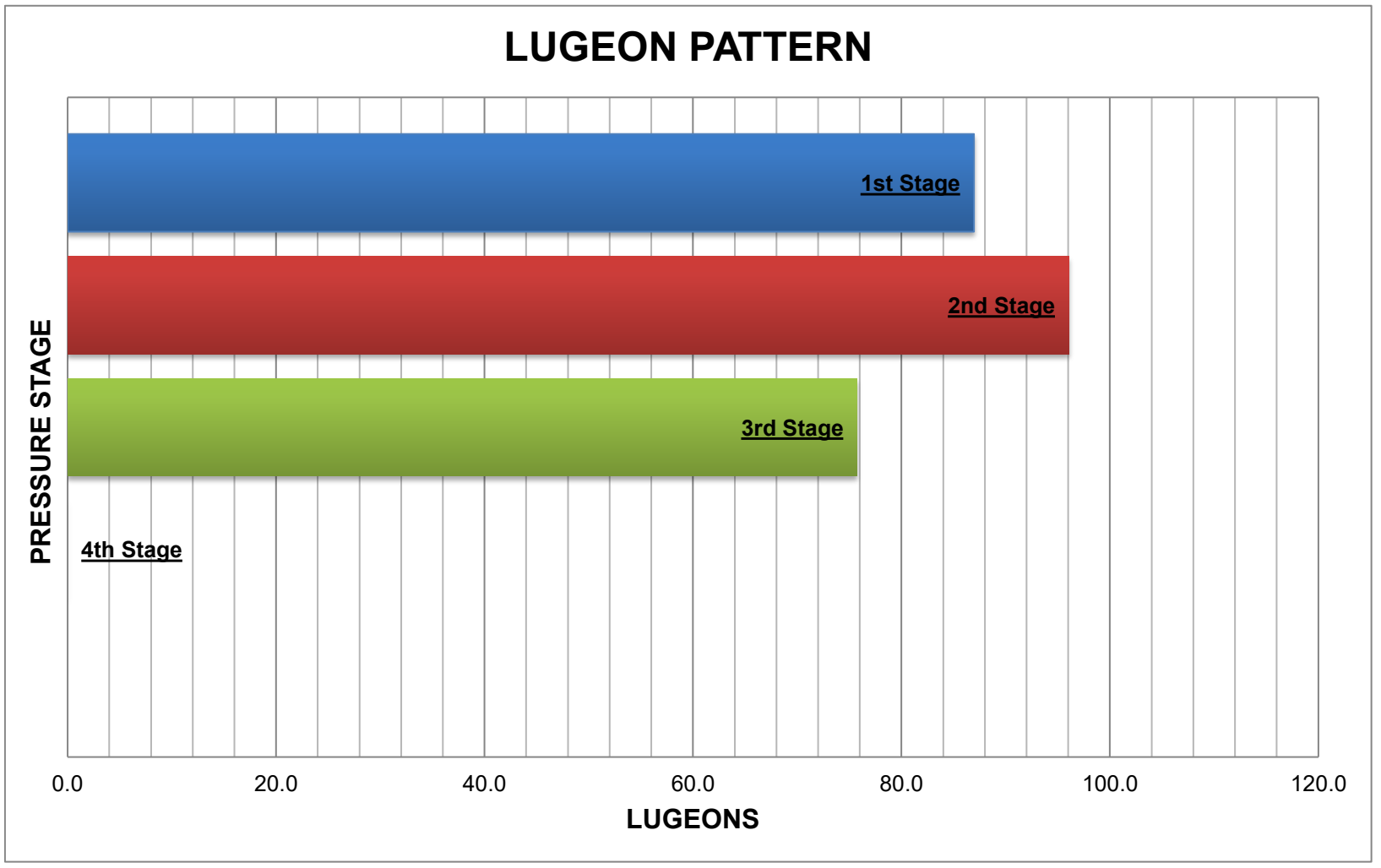
Number of Packers:	1	
Packer Type:	Pneumatic	
Packer Pressure	200	psi
Packer Length	24	inches

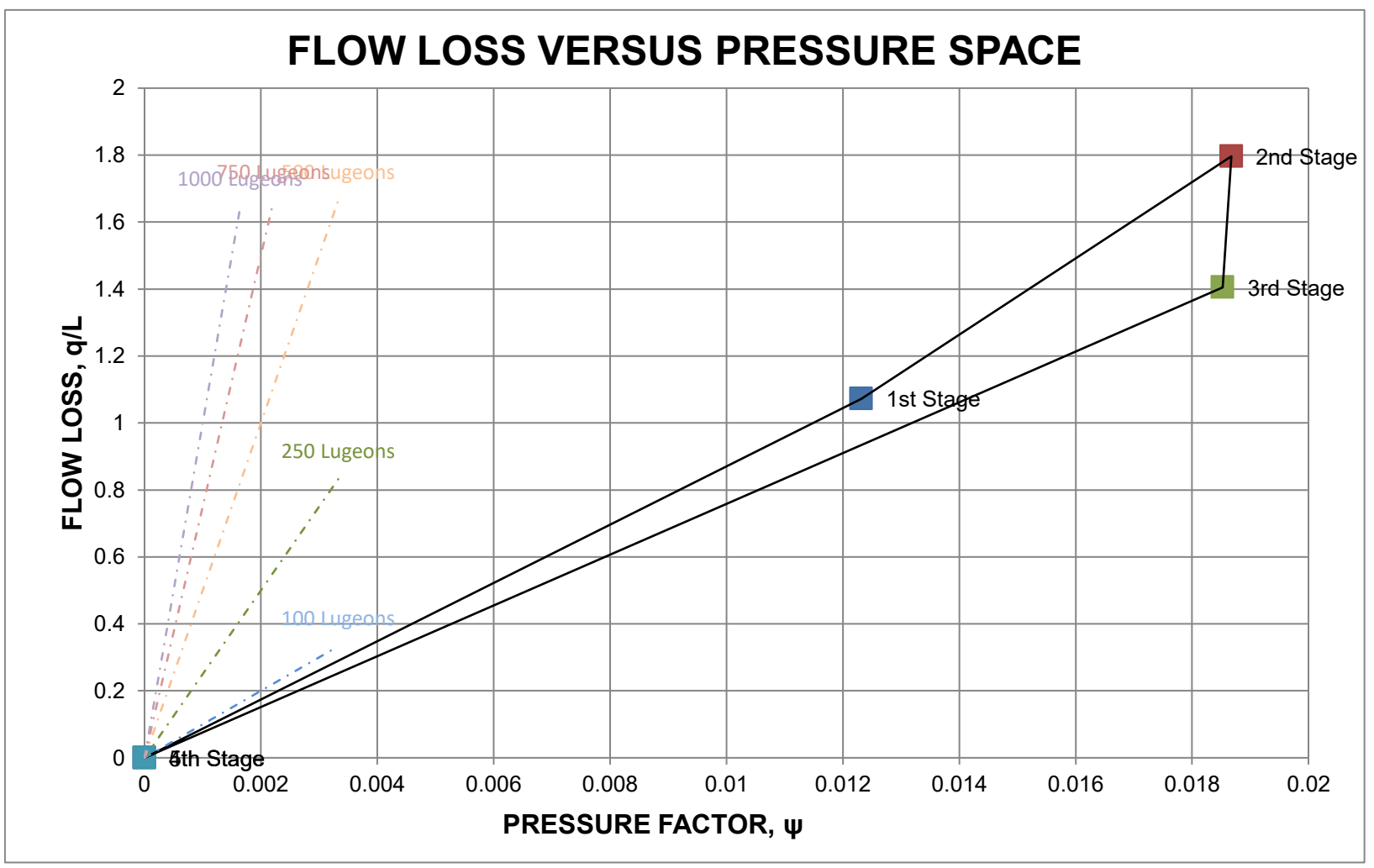
Notes: Unable to progress to the Max. Test Pressure due to water leaking around packer. Tested at 0.75*Max Test Pressure again.

Target Test Pressure	Elapsed Time	Volume Gauge Reading	Measured Test Pressure	Measured Pressure in Feet Head of Water	▲ Volume (Water Take)	Flow Rate		Hydraulic Conductivity (K)			
psi	min	gallons	psi	ft (h_{total})	gallons	gal/min (Q_g)	ft^3/min (Q_f)	(lugeons)	(k-cm/sec)	(k-ft/min)	(k-ft/yr)
a	b	c	d	e	f	g	h	i	j	k	l
22.3	0	15913.7	22.1	51.1	- - -	- - -	- - -	- - -	- - -	- - -	- - -
22.3	1.0	15923.8	22.0	50.8	10.0	10.0	1.34	82.2	1.1E-03	2.1E-03	1,106.0
22.3	2.0	15933.5	22.0	50.9	9.8	9.8	1.31	79.9	1.0E-03	2.0E-03	1,075.0
22.3	3.0	15945.4	22.2	51.2	11.9	11.9	1.59	96.5	1.3E-03	2.5E-03	1,299.1
22.3	4.0	15956.0	22.4	51.6	10.6	10.6	1.41	85.1	1.1E-03	2.2E-03	1,145.5
22.3	5.0	15967.35	22.5	51.8	11.4	11.4	1.52	91.1	1.2E-03	2.3E-03	1,225.9
		1st Stage: Average		51	10.7	10.7	1.43	87.0	1.1E-03	2.2E-03	1170.3
33.4	0.0	16048.5	33.3	76.8	- - -	- - -	- - -	- - -	- - -	- - -	- - -
33.4	1.0	16069.6	33.9	78.2	21.1	21.1	2.82	112.3	1.5E-03	2.9E-03	1,511.1
33.4	2.0	16086.5	33.5	77.3	16.9	16.9	2.26	90.9	1.2E-03	2.3E-03	1,223.3
33.4	3.0	16104.2	33.5	77.3	17.7	17.7	2.37	95.1	1.2E-03	2.4E-03	1,280.7
33.4	4.0	16120.8	33.7	77.7	16.6	16.6	2.22	89.0	1.2E-03	2.3E-03	1,198.5
33.4	5.0	16138.3	33.8	77.9	17.4	17.4	2.33	93.0	1.2E-03	2.4E-03	1,251.5
		2nd Stage: Average		78	18.0	18.0	2.40	96.1	1.2E-03	2.5E-03	1293.0
33.4	0.0	16299.7	33.7	77.7	- - -	- - -	- - -	- - -	- - -	- - -	- - -
33.4	1.0	16307.9	33.3	76.8	8.2	8.2	1.09	44.3	5.8E-04	1.1E-03	596.1
33.4	2.0	16324.0	33.2	76.6	16.1	16.1	2.15	87.4	1.1E-03	2.2E-03	1,176.5
33.4	3.0	16339.6	33.4	77.1	15.6	15.6	2.08	84.0	1.1E-03	2.2E-03	1,131.1
33.4	4.0	16354.6	33.6	77.6	15.1	15.1	2.01	80.7	1.0E-03	2.1E-03	1,086.0
33.4	5.0	16369.9	33.5	77.3	15.3	15.3	2.05	82.4	1.1E-03	2.1E-03	1,108.6
		3rd Stage: Average		77	14.1	14.1	1.88	75.8	9.8E-04	1.9E-03	1019.7
				0.0	- - -	- - -	- - -	- - -	- - -	- - -	- - -
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		4th Stage: Average		0	0.0	- - -	- - -	#DIV/0!	#DIV/0!	- - -	- - -
				0.0	- - -	- - -	- - -	- - -	- - -	- - -	- - -
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		5th Stage: Average									

a = testing stages (0.5, 0.75, 1.0, 0.75, 0.5) x head + head
b = volume measurement time interval
c = measured at ground surface using in line hoses
d = measured at ground surface using pressure gauge
e = measured at depth using vibrating wire piezometer
f = change in volume (water take) over measured interval

g = flow rate over measurement interval
h = conversion: 'Q_g'/7.481
i = $\text{Lugeon Value} = \alpha \times \frac{q}{L} \times \frac{P_0}{P}$;a=12.42 & q[gpm], L[ft], P[psi] (Rozo 2010)
j = unit conversion: 'lugeons'x1.3x10-5 (Fell et al. 2005)
k = unit conversion: 'k-cm/sec' x 60 mins x 0.03281 ft
l = unit conversion: 'k-ft/min' x 60 mins x 24 hr x 365¼ days


LUGEON PATTERN
PRESSURE STAGE
1st Stage
2nd Stage
3rd Stage
4th Stage
0.0
20.0
40.0
60.0
80.0
100.0
120.0
LUGEONS


FLOW LOSS VERSUS PRESSURE SPACE
FLOW LOSS, q/L
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1000 Lugeons
750 Lugeons
500 Lugeons
250 Lugeons
100 Lugeons
2nd Stage
3rd Stage
1st Stage
4th Stage
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
PRESSURE FACTOR, ψ

Project Name: UTABA Dam
Project Number: 24-1762
Engineer/Geologist: M. McNiel
Reviewed By: RRB

Location: 24-TH-01
Test ID: 24-TH-01-P-3
Date: 10/26/2024

Test Data (depths measured from ground surface)

Test Hole Diameter:	3.8	inches
	0.32	ft
Plunge Angle (from vertical):	0	degrees
Depth to Top of Test Zone:	91	ft
Depth to Bottom of Test Zone:	101	ft
Test Interval/Zone Length:	10.0	ft
Midpoint of Test Zone (head):	96.0	ft
Max. Test Head (at depth) (Pmax):	55.5	psi

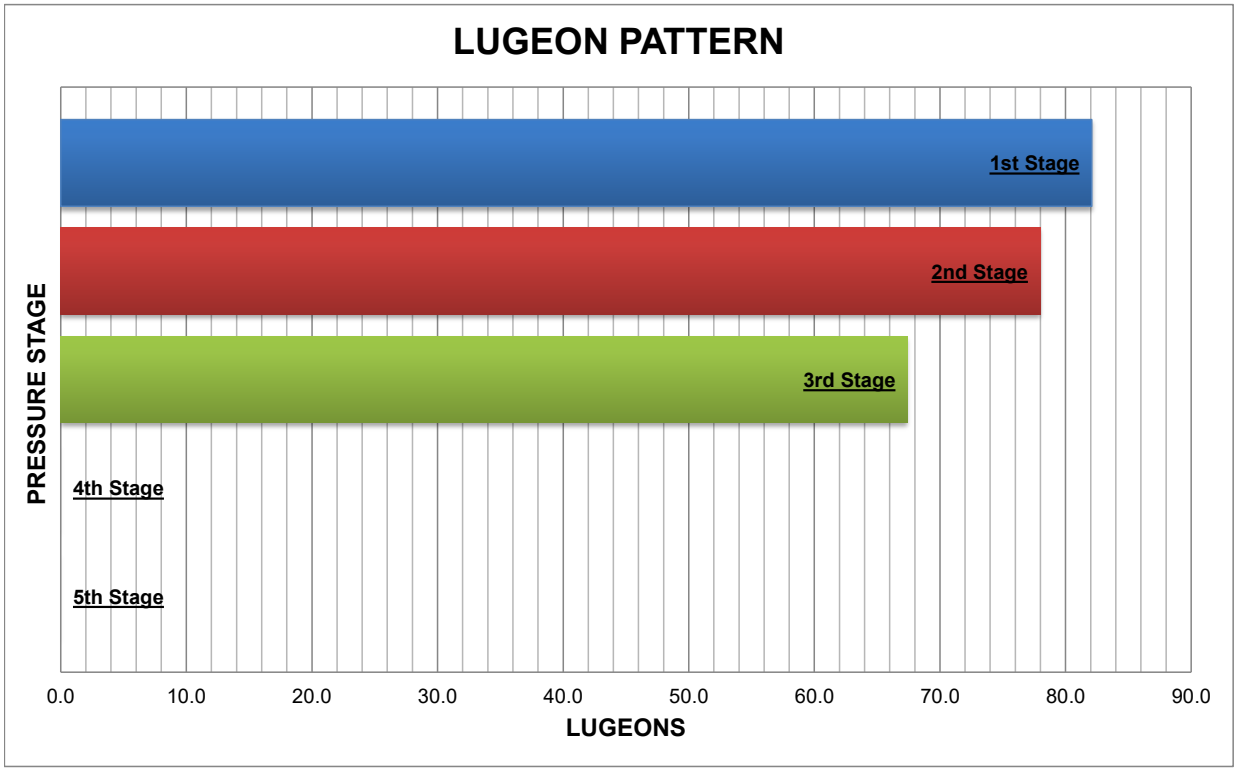
Packer Configuration

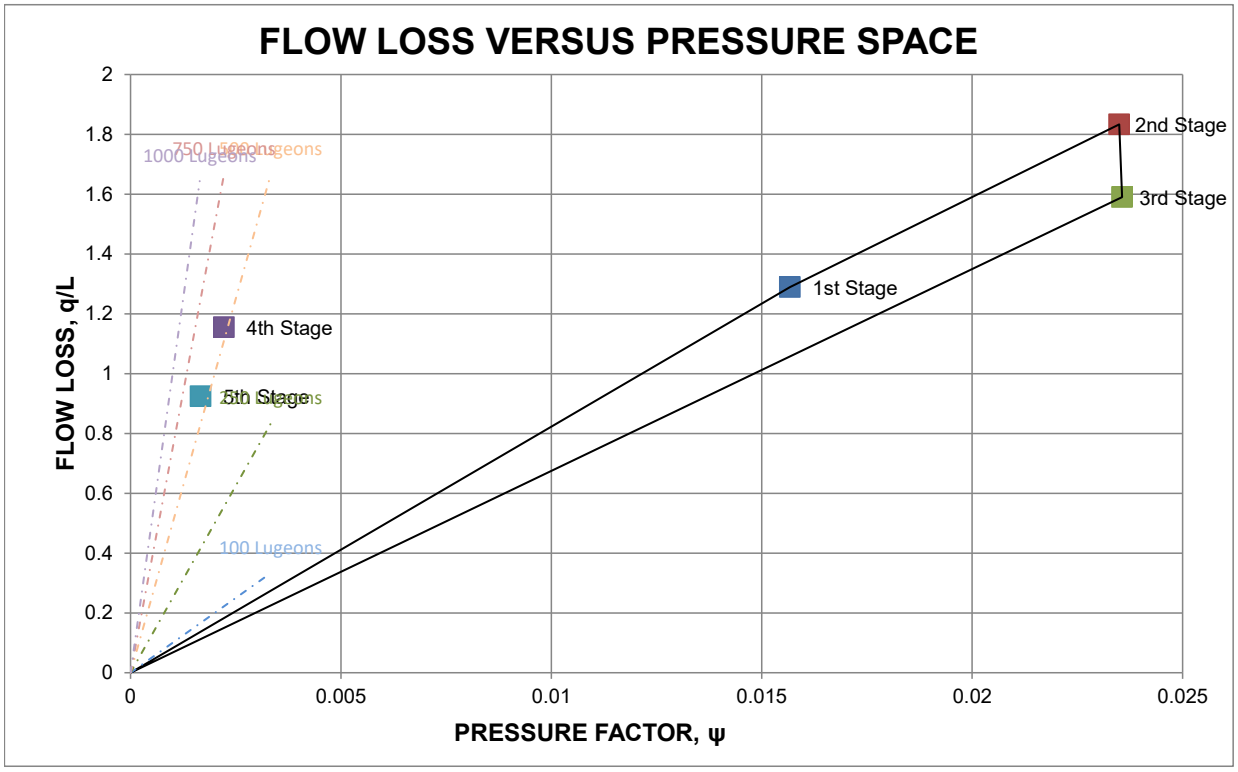
Number of Packers:	1	
Packer Type:	Pneumatic	
Packer Pressure	200	psi
Packer Length	24	inches

Notes: Unable to progress to the Max. Test Pressure due to water leaking around packer. Tested at 0.75*Max Test Pressure again.

Target Test Pressure	Elapsed Time	Volume Gauge Reading	Measured Test Pressure	Measured Pressure in Feet Head of Water	▲ Volume (Water Take)	Flow Rate		Hydraulic Conductivity (K)			
psi	min	gallons	psi	ft (h_{total})	gallons	gal/min (Q_g)	ft^3/min (Q_f)	(lugeons)	(k-cm/sec)	(k-ft/min)	(k-ft/yr)
a	b	c	d	e	f	g	h	i	j	k	l
27.8	0	16475.1	28.6	66.1	---	---	---	---	---	---	---
27.8	1.0	16484.9	27.9	64.4	9.8	9.8	1.31	63.1	8.2E-04	1.6E-03	849.5
27.8	2.0	16501.5	28.2	65.2	16.6	16.6	2.22	106.1	1.4E-03	2.7E-03	1,428.5
27.8	3.0	16515.8	28.7	66.3	14.3	14.3	1.91	89.4	1.2E-03	2.3E-03	1,203.6
27.8	4.0	16528.7	28.6	66.0	12.9	12.9	1.73	81.6	1.1E-03	2.1E-03	1,097.8
27.8	5.0	16539.5	27.8	64.1	10.8	10.8	1.45	70.2	9.1E-04	1.8E-03	944.7
1st Stage: Average				65	12.9	12.9	1.72	82.1	1.1E-03	2.1E-03	1104.8
41.6	0.0	16731.3	42.5	98.0	---	---	---	---	---	---	---
41.6	1.0	16748.8	42.8	98.7	17.4	17.4	2.33	73.4	9.5E-04	1.9E-03	987.7
41.6	2.0	16767.3	42.2	97.3	18.5	18.5	2.47	79.0	1.0E-03	2.0E-03	1,062.9
41.6	3.0	16786.3	42.1	97.1	19.0	19.0	2.54	81.4	1.1E-03	2.1E-03	1,095.9
41.6	4.0	16805.3	42.3	97.6	19.0	19.0	2.54	81.0	1.1E-03	2.1E-03	1,089.7
41.6	5.0	16823.0	42.4	97.9	17.7	17.7	2.37	75.2	9.8E-04	1.9E-03	1,011.6
2nd Stage: Average				98	18.3	18.3	2.45	78.0	1.0E-03	2.0E-03	1049.6
41.6	0.0	16986.3	42.1	97.1	---	---	---	---	---	---	---
41.6	1.0	17002.1	42.6	98.2	15.9	15.9	2.12	67.1	8.7E-04	1.7E-03	902.9
41.6	2.0	17016.9	42.5	98.0	14.8	14.8	1.98	62.7	8.2E-04	1.6E-03	844.5
41.6	3.0	17033.3	42.2	97.3	16.4	16.4	2.19	69.9	9.1E-04	1.8E-03	941.2
41.6	4.0	17049.9	42.7	98.6	16.6	16.6	2.22	70.2	9.1E-04	1.8E-03	944.5
41.6	5.0	17065.8	42.5	98.0	15.9	15.9	2.12	67.2	8.7E-04	1.7E-03	904.4
3rd Stage: Average				98	15.9	15.9	2.13	67.4	8.8E-04	1.7E-03	907.5
				0.0	---	---	---	---	---	---	---
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4th Stage: Average				0	0.0	---	---	#DIV/0!	#DIV/0!	---	---
				0.0	---	---	---	---	---	---	---
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
				0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
5th Stage: Average				0	0.0	---	---	#DIV/0!	#DIV/0!	---	---

a = testing stages (0.5, 0.75, 1.0, 0.75, 0.5) x head + head
b = volume measurement time interval
c = measured at ground surface using in line hoses
d = measured at ground surface using pressure gauge
e = measured at depth using vibrating wire piezometer
f = change in volume (water take) over measured interval
g = flow rate over measurement interval
h = conversion: 'Q_g'/7.481
i : $\text{Lugeon Value} = \alpha \times \frac{q}{L} \times \frac{P_2}{P}$;a=12.42 & q[gpm], L[ft], P[psi] (Rozo 2010)
j = unit conversion: 'lugeons'x1.3x10-5 (Fell et al. 2005)
k = unit conversion: 'k-cm/sec' x 60 mins x 0.03281 ft
l = unit conversion: 'k-ft/min' x 60 mins x 24 hr x 365¼ days


LUGEON PATTERN
PRESSURE STAGE
1st Stage
2nd Stage
3rd Stage
4th Stage
5th Stage
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
LUGEONS


FLOW LOSS VERSUS PRESSURE SPACE
FLOW LOSS, q/L
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1000 Lugeons
750 Lugeons
100 Lugeons
2nd Stage
3rd Stage
1st Stage
4th Stage
5th Stage
0
0.005
0.01
0.015
0.02
0.025
PRESSURE FACTOR, ψ

Project Name: UTABA Dam
Project Number: 24-1762
Engineer/Geologist: J. McFarlane
Reviewed By: RRB

Location: 24-TH-401
Test ID: 24-TH-401-P-1
Date: 10/22/2024

Test Data (depths measured from ground surface)

Test Hole Diameter:	3.8	inches
	0.32	ft
Plunge Angle (from vertical):	0	degrees
Depth to Top of Test Zone:	18	ft
Depth to Bottom of Test Zone:	28	ft
Test Interval/Zone Length:	10.0	ft
Midpoint of Test Zone (head):	23.0	ft
Max. Test Head (at depth) (Pmax):	16.0	psi

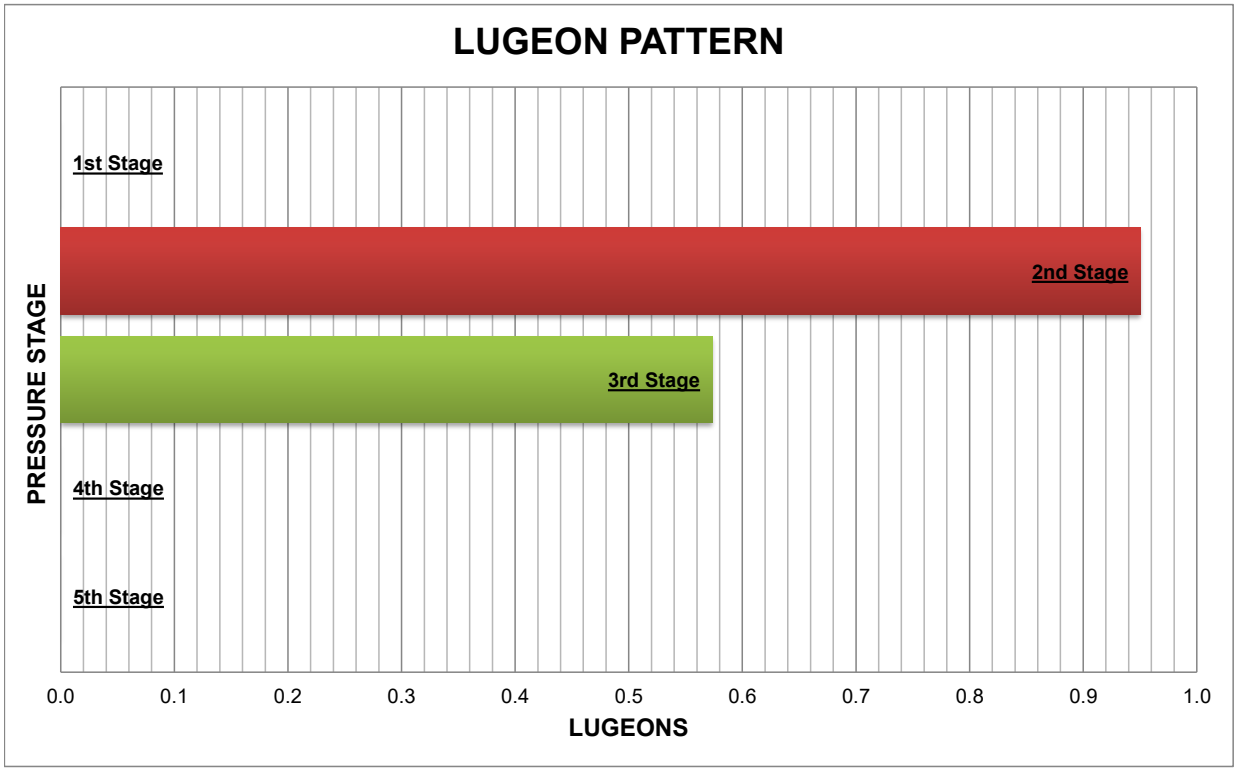
Packer Configuration

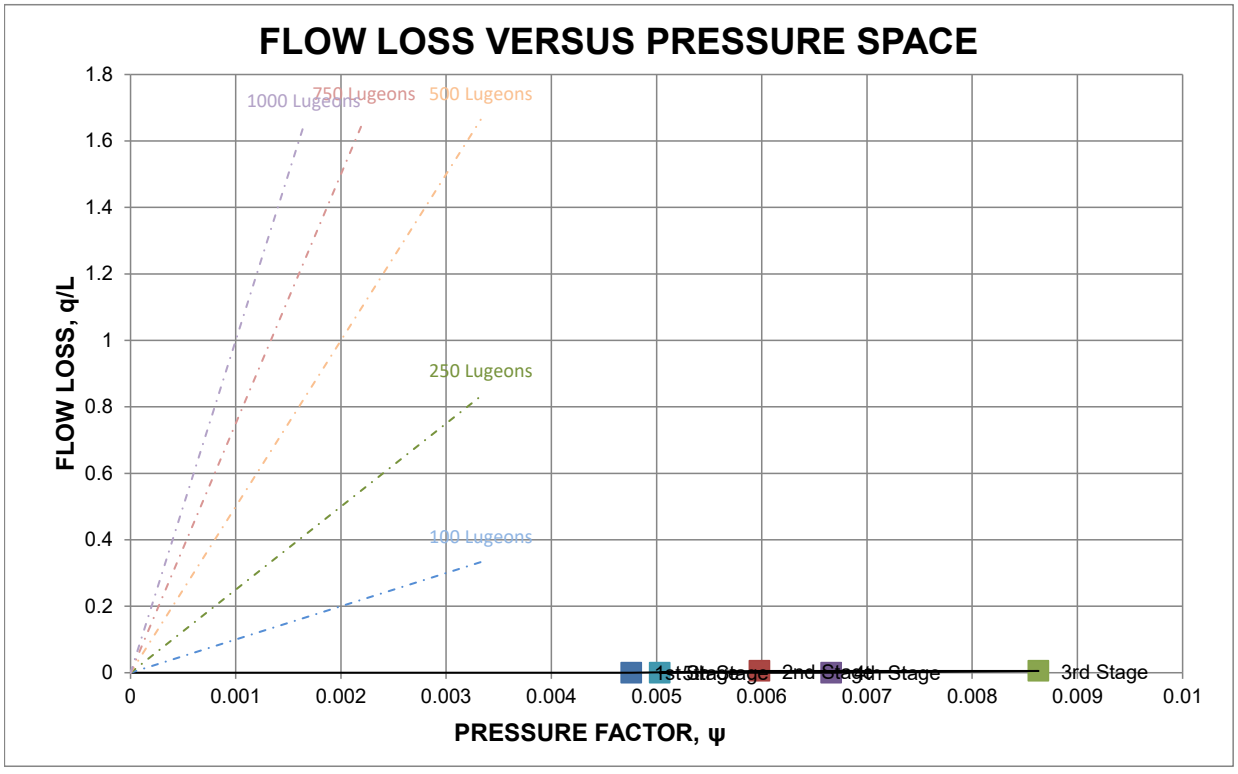
Number of Packers:	1	
Packer Type:	Pneumatic	
Packer Pressure	200	psi
Packer Length	24	inches

Notes: Unable to perform 5th stage at target pressure. Test pressure was not able to dissipate.

Target Test Pressure	Elapsed Time	Volume Gauge Reading	Measured Test Pressure	Measured Pressure in Feet Head of Water	▲ Volume (Water Take)	Flow Rate		Hydraulic Conductivity (K)			
psi	min	gallons	psi	ft (h_{total})	gallons	gal/min (Q_g)	ft^3/min (Q_f)	(lugeons)	(k-cm/sec)	(k-ft/min)	(k-ft/yr)
a	b	c	d	e	f	g	h	i	j	k	l
8.0	0	15454.3	8.7	20.1	---	---	---	---	---	---	---
8.0	1.0	15454.3	8.7	20.0	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	2.0	15454.3	8.6	19.8	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	3.0	15454.3	8.6	19.8	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	4.0	15454.3	8.5	19.7	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	5.0	15454.3	8.6	19.7	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
1st Stage: Average				20	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	0.0	15456.7	12.0	27.7	---	---	---	---	---	---	---
12.0	1.0	15456.7	10.7	24.6	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	2.0	15457.0	10.0	23.1	0.3	0.3	0.04	4.8	6.2E-05	1.2E-04	64.0
12.0	3.0	15457.0	10.5	24.3	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	4.0	15457.0	11.1	25.6	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	5.0	15457.0	11.6	26.8	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
2nd Stage: Average				25	0.1	0.1	0.01	1.0	1.2E-05	2.4E-05	12.8
16.0	0.0	15458.8	16.0	36.8	---	---	---	---	---	---	---
16.0	1.0	15459.1	16.6	38.3	0.3	0.3	0.04	2.9	3.7E-05	7.3E-05	38.6
16.0	2.0	15459.1	14.3	33.0	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
16.0	3.0	15459.1	15.9	36.7	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
16.0	4.0	15459.1	15.7	36.2	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
16.0	5.0	15459.1	15.3	35.3	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
3rd Stage: Average				36	0.1	0.1	0.01	0.6	7.5E-06	1.5E-05	7.7
12.0	0.0	15459.3	12.3	28.5	---	---	---	---	---	---	---
12.0	1.0	15459.3	10.5	24.2	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	2.0	15459.3	12.7	29.2	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	3.0	15459.3	12.6	29.1	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	4.0	15459.3	12.1	27.9	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
12.0	5.0	15459.3	12.2	28.1	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
4th Stage: Average				28	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	0.0	15459.3	9.2	21.2	---	---	---	---	---	---	---
8.0	1.0	15459.3	9.2	21.1	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	2.0	15459.3	9.1	21.1	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	3.0	15459.3	9.0	20.8	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	4.0	15459.3	9.1	20.9	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
8.0	5.0	15459.3	9.0	20.8	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
5th Stage: Average				21	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0

a = testing stages (0.5, 0.75, 1.0, 0.75, 0.5) x head + head
b = volume measurement time interval
c = measured at ground surface using in line hoses
d = measured at ground surface using pressure gauge
e = measured at depth using vibrating wire piezometer
f = change in volume (water take) over measured interval
g = flow rate over measurement interval
h = conversion: 'Q_g'/7.481
i : $\text{Lugeon Value} = \alpha \times \frac{q}{L} \times \frac{P_2}{P}$;a=12.42 & q[gpm], L[ft], P[psi] (Rozo 2010)
j = unit conversion: 'lugeons'x1.3x10-5 (Fell et al. 2005)
k = unit conversion: 'k-cm/sec' x 60 mins x 0.03281 ft
l = unit conversion: 'k-ft/min' x 60 mins x 24 hr x 365¼ days


LUGEON PATTERN
1st Stage
2nd Stage
3rd Stage
4th Stage
5th Stage
PRESSURE STAGE
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
LUGEONS


FLOW LOSS VERSUS PRESSURE SPACE
1000 Lugeons
750 Lugeons
500 Lugeons
250 Lugeons
100 Lugeons
FLOW LOSS, q/L
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
PRESSURE FACTOR, ψ
3rd Stage

Project Name: UTABA Dam
Project Number: 24-1762
Engineer/Geologist: J. McFarlane
Reviewed By: RRB

Location: 24-TH-401
Test ID: 24-TH-401-P-2
Date: 10/22/2024

Test Data (depths measured from ground surface)

Test Hole Diameter:	3.8	inches
	0.32	ft
Plunge Angle (from vertical):	0	degrees
Depth to Top of Test Zone:	28	ft
Depth to Bottom of Test Zone:	33	ft
Test Interval/Zone Length:	5.0	ft
Midpoint of Test Zone (head):	30.5	ft
Max. Test Head (at depth) (Pmax):	23.5	psi

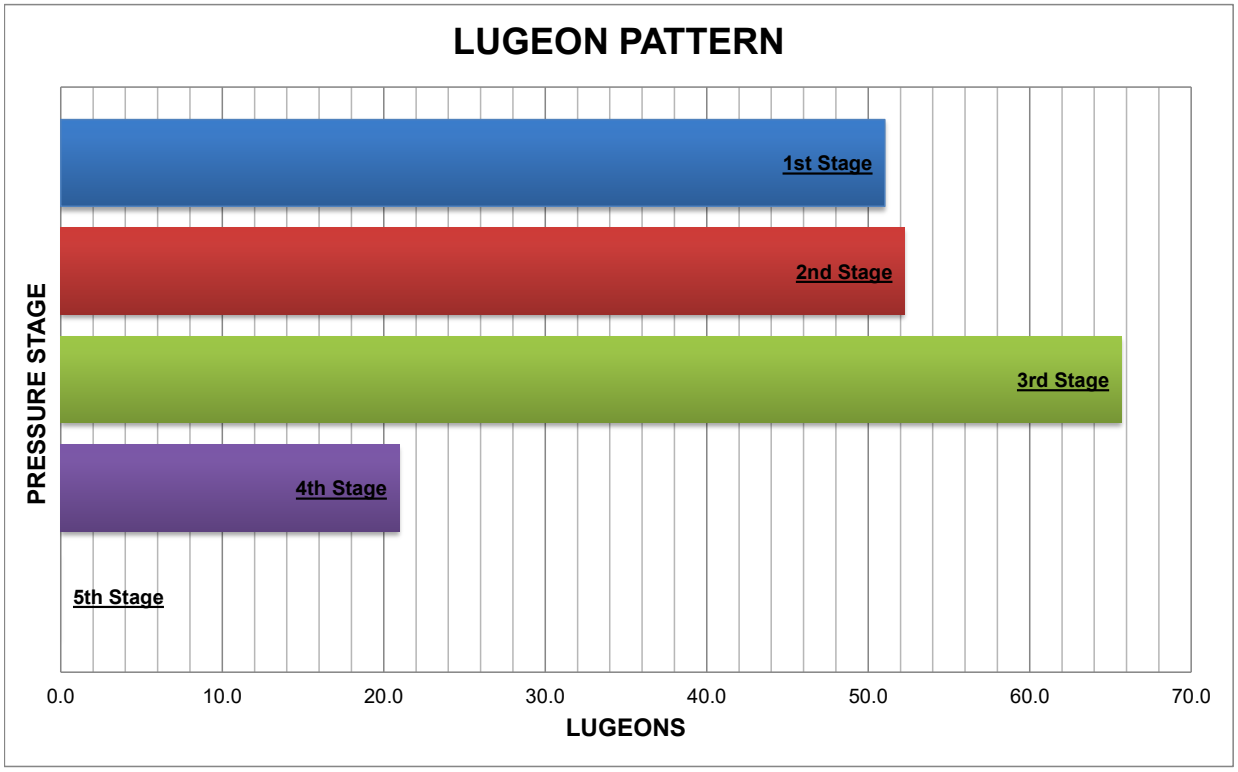
Packer Configuration

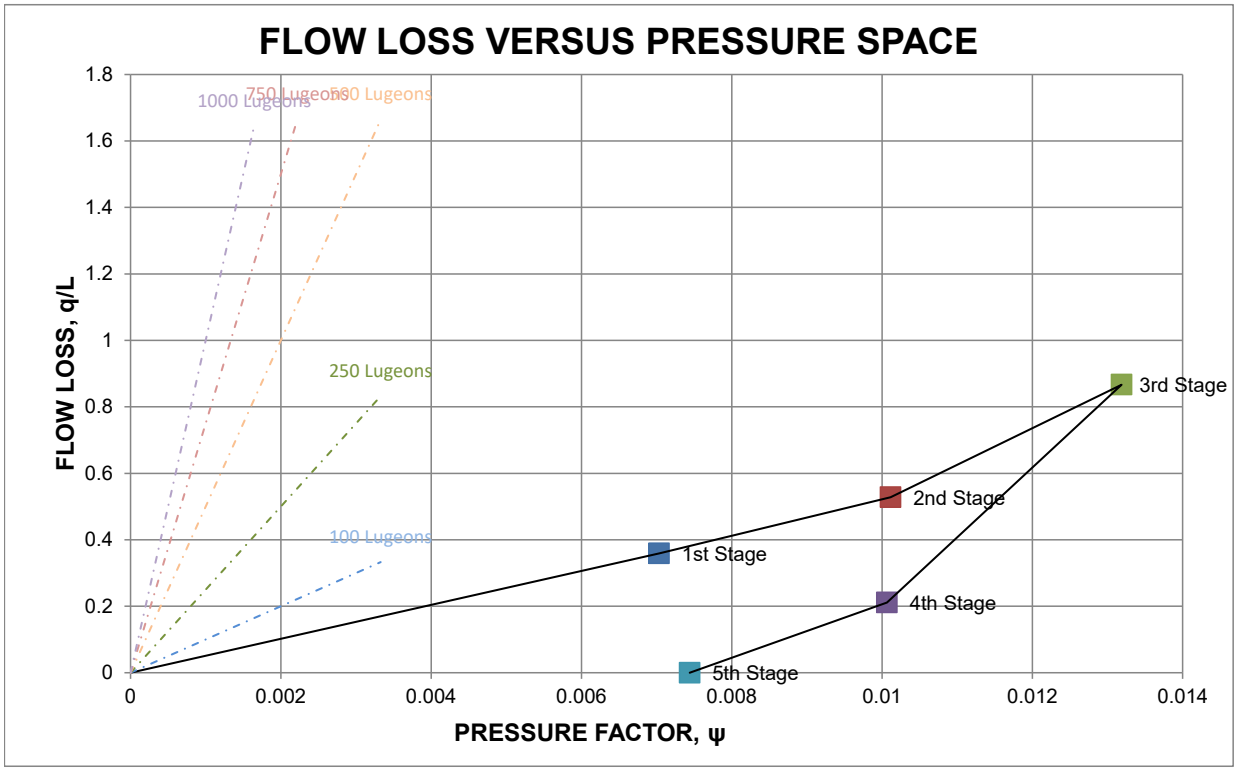
Number of Packers:	1	
Packer Type:	Pneumatic	
Packer Pressure	200	psi
Packer Length	24	inches

Notes: Unable to perform 5th stage at target pressure. Test pressure was not able to dissipate.

Target Test Pressure	Elapsed Time	Volume Gauge Reading	Measured Test Pressure	Measured Pressure in Feet Head of Water	▲ Volume (Water Take)	Flow Rate		Hydraulic Conductivity (K)			
psi	min	gallons	psi	ft (h_{total})	gallons	gal/min (Q_g)	ft^3/min (Q_f)	(lugeons)	(k-cm/sec)	(k-ft/min)	(k-ft/yr)
a	b	c	d	e	f	g	h	i	j	k	l
11.8	0	15462.0	12.1	27.9	---	---	---	---	---	---	---
11.8	1.0	15464.6	12.6	29.2	2.6	2.6	0.35	75.3	9.8E-04	1.9E-03	1,013.2
11.8	2.0	15467.0	12.7	29.3	2.4	2.4	0.32	67.4	8.8E-04	1.7E-03	906.8
11.8	3.0	15467.3	12.7	29.3	0.3	0.3	0.04	7.5	9.7E-05	1.9E-04	100.8
11.8	4.0	15469.7	12.7	29.3	2.4	2.4	0.32	67.4	8.8E-04	1.7E-03	907.6
11.8	5.0	15470.97	12.7	29.2	1.3	1.3	0.18	37.6	4.9E-04	9.6E-04	505.8
1st Stage: Average				29	1.8	1.8	0.24	51.0	6.6E-04	1.3E-03	686.8
17.6	0.0	15477.8	18.1	41.8	---	---	---	---	---	---	---
17.6	1.0	15481.8	18.0	41.4	4.0	4.0	0.53	79.5	1.0E-03	2.0E-03	1,070.2
17.6	2.0	15485.5	18.2	42.1	3.7	3.7	0.49	73.1	9.5E-04	1.9E-03	983.5
17.6	3.0	15489.2	18.5	42.7	3.7	3.7	0.49	72.0	9.4E-04	1.8E-03	969.7
17.6	4.0	15491.0	18.2	41.9	1.8	1.8	0.25	36.7	4.8E-04	9.4E-04	493.7
17.6	5.0	15491.0	18.4	42.3	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
2nd Stage: Average				42	2.6	2.6	0.35	52.3	6.8E-04	1.3E-03	703.4
23.5	0.0	15496.3	23.7	54.7	---	---	---	---	---	---	---
23.5	1.0	15501.6	23.7	54.6	5.3	5.3	0.71	80.4	1.0E-03	2.1E-03	1,082.1
23.5	2.0	15506.1	24.1	55.7	4.5	4.5	0.60	67.0	8.7E-04	1.7E-03	901.9
23.5	3.0	15510.6	23.5	54.2	4.5	4.5	0.60	68.9	9.0E-04	1.8E-03	926.8
23.5	4.0	15515.4	23.7	54.7	4.8	4.8	0.64	72.2	9.4E-04	1.8E-03	972.3
23.5	5.0	15518.0	23.9	55.1	2.6	2.6	0.35	39.9	5.2E-04	1.0E-03	536.7
3rd Stage: Average				55	4.3	4.3	0.58	65.7	8.5E-04	1.7E-03	884.0
17.6	0.0	15524.1	18.2	41.9	---	---	---	---	---	---	---
17.6	1.0	15524.9	18.0	41.5	0.8	0.8	0.11	15.9	2.1E-04	4.1E-04	213.8
17.6	2.0	15525.9	18.2	42.1	1.1	1.1	0.14	20.9	2.7E-04	5.3E-04	281.0
17.6	3.0	15527.0	18.2	42.0	1.1	1.1	0.14	20.9	2.7E-04	5.4E-04	281.6
17.6	4.0	15528.3	18.2	42.0	1.3	1.3	0.18	26.2	3.4E-04	6.7E-04	352.2
17.6	5.0	15529.4	18.2	41.9	1.1	1.1	0.14	20.9	2.7E-04	5.4E-04	281.9
4th Stage: Average				42	1.1	1.1	0.14	21.0	2.7E-04	5.4E-04	282.1
11.8	0.0	15530.1	12.8	29.5	---	---	---	---	---	---	---
11.8	1.0	15530.1	13.4	30.9	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
11.8	2.0	15530.1	13.5	31.1	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
11.8	3.0	15530.1	13.4	31.0	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
11.8	4.0	15530.1	13.4	30.9	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
11.8	5.0	15530.1	13.4	30.8	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0
5th Stage: Average				31	0.0	0.0	0.00	0.0	0.0E+00	0.0E+00	0.0

a = testing stages (0.5, 0.75, 1.0, 0.75, 0.5) x head + head
b = volume measurement time interval
c = measured at ground surface using in line hoses
d = measured at ground surface using pressure gauge
e = measured at depth using vibrating wire piezometer
f = change in volume (water take) over measured interval
g = flow rate over measurement interval
h = conversion: 'Q_g'/7.481
i : $\text{Lugeon Value} = \alpha \times \frac{q}{L} \times \frac{P_2}{P}$;a=12.42 & q[gpm], L[ft], P[psi] (Rozo 2010)
j = unit conversion: 'lugeons'x1.3x10-5 (Fell et al. 2005)
k = unit conversion: 'k-cm/sec' x 60 mins x 0.03281 ft
l = unit conversion: 'k-ft/min' x 60 mins x 24 hr x 365¼ days


LUGEON PATTERN
PRESSURE STAGE
1st Stage
2nd Stage
3rd Stage
4th Stage
5th Stage
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
LUGEONS


FLOW LOSS VERSUS PRESSURE SPACE
1000 Lugeons
750 Lugeons
500 Lugeons
250 Lugeons
100 Lugeons
1st Stage
2nd Stage
3rd Stage
4th Stage
5th Stage
FLOW LOSS, q/L
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
PRESSURE FACTOR, ψ

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-02

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	4	Approximate Width (feet)	5	Approximate Depth (feet)	2.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5701 (Approx.)
Comments	Upstream Face - 58 feet from upstream edge and 121 feet left of spillway wall			Latitude / Longitude	41.38701 , -111.90997

Elevation, feet / Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
0				GRAVEL, sandy, with clay, with cobbles and boulders - boulders up to 18 inches, organics to 0.5-ft., (GC)	Soil densities estimated based on excavation effort.
1		BULK-01			
2				Bottom of Hole at 2 feet	
3					
4					
5					

Date Taken:	10/21/2024
Photo Identification:	24-TP-02



Description:	View of 24-TP-02 sidewall and bottom.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-03

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	4	Approximate Width (feet)	5	Approximate Depth (feet)	2.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5699 (Approx.)
Comments	Downstream Face - 20 feet from downstream edge and 68 feet from left spillway wall			Latitude / Longitude	41.38682 , -111.90971

Elevation, feet / Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
0				GRAVEL, sandy, with clay, with cobbles and boulders - boulders up to 18 inches, Organics to 0.5-ft., (GM)	Soil densities estimated based on excavation effort
1		BULK-01			
2				Bottom of Hole at 2 feet	
3					
4					
5					

Date Taken:	10/21/2024
Photo Identification:	24-TP-03



Description:	View of 24-TP-03 sidewall and bottom.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-101a

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	20	Approximate Width (feet)	5	Approximate Depth (feet)	9.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	N-S
Groundwater Depth (feet)	5.5	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5698 (Approx.)
Comments	Abutment			Latitude / Longitude	41.38731 , -111.90995

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				COBBLES and BOULDERS, gravelly, with silt, some sand - dense, moist, brown to light brown, boulders up to 2 ft., (Colluvium)	Soil density estimated on excavation effort
	1					
	2					
	3				- organics to 3 ft deep	
	4					
5693	5					
	6				GRAVEL, with sand, with silt, with cobbles and boulders - very dense, wet, brown to dark brown, (GM), [Colluvium]	
	7					Sides of test pit caving due to water
	8				- boulders up to 2-3 ft	Could not continue excavation due to test pit side walls collapsing
	9				Bottom of Hole at 9 feet	
	10					

Date Taken:	10/21/2024
Photo Identification:	24-TP-101a



Description:	View of 24-TP-101a sidewall and bottom. Note water within test pit.

Date Taken:	10/21/2024
Photo Identification:	24-TP-101a



Description:	View of 24-TP-101a sidewall and bottom. Note water within test pit.

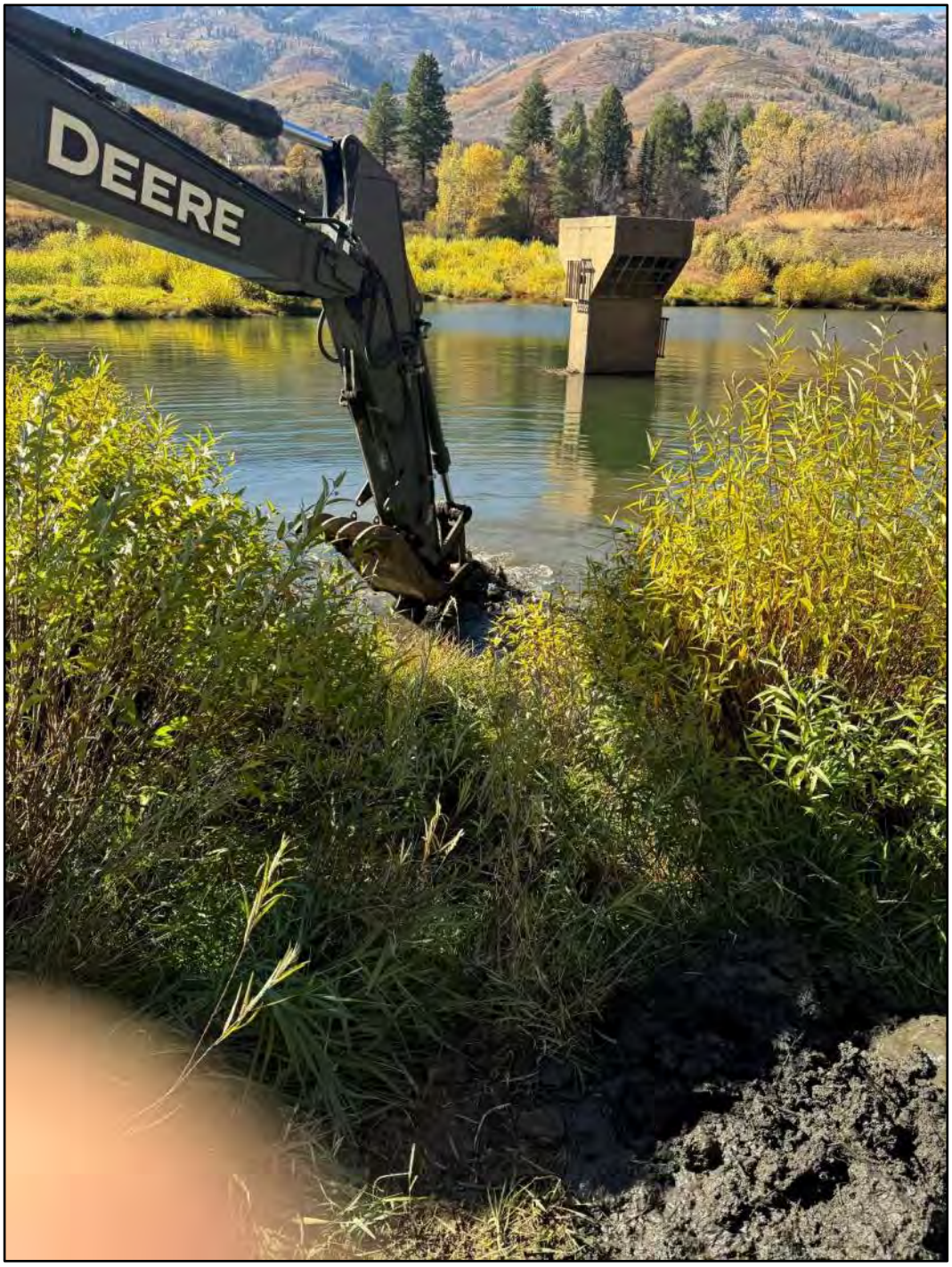
Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-101b

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	20	Approximate Width (feet)	5	Approximate Depth (feet)	5.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	N-S
Groundwater Depth (feet)	Within Reservoir	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5698 (Approx.)
Comments	Reservoir Basin			Latitude / Longitude	41.38721 , -111.91014

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				ELASTIC SILT, trace sand, trace cobbles - soft, wet, dark brown to black, (MH)	Soil densities estimated based on excavation effort
	1		BULK-01			
					- organics present	
	2					
	3				- cobbles and boulders up to 2 ft	
	4					
						Ceased excavation due to refusal on cobble and boulders
5693	5				Bottom of Hole at 5 feet	
	6					
	7					
	8					
	9					
	10					

Date Taken:	10/21/2024
Photo Identification:	24-TP-101b



Description:	View of 24-TP-101b excavation. Approximately 25 feet west of 24-TP-101

Date Taken:	10/21/2024
Photo Identification:	24-TP-101b

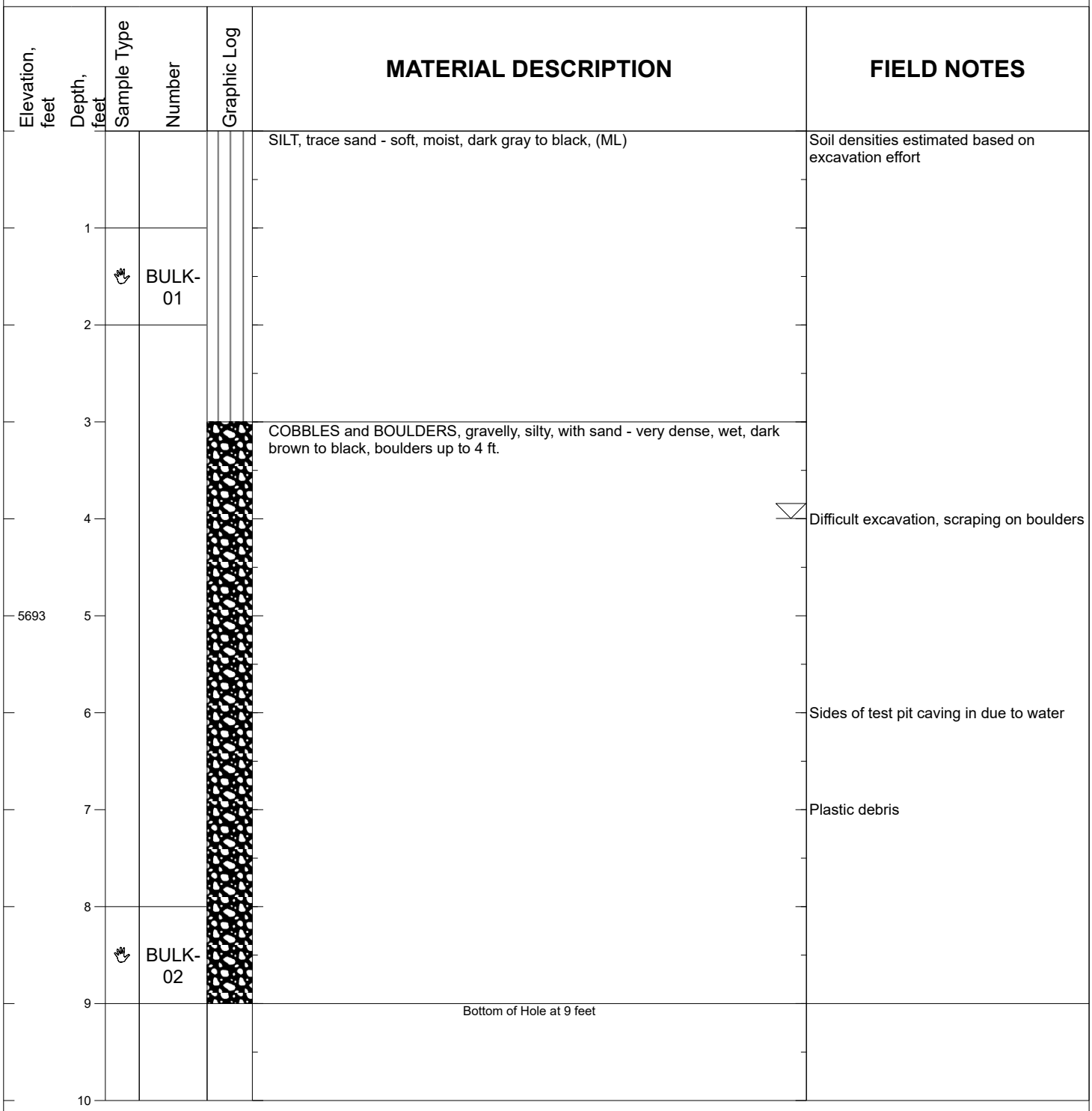


Description:	View of 24-TP-101b spoils pile.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-102a

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	15	Approximate Width (feet)	8	Approximate Depth (feet)	9.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	4	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5698 (Approx.)
Comments	Reservoir Basin			Latitude / Longitude	41.38694 , -111.91034



Date Taken:	10/21/2024
Photo Identification:	24-TP-102a



Description:	View of 24-TP-102 sidewall and bottom.

Date Taken:	10/21/2024
Photo Identification:	24-TP-102a



Description:	View of construction material within 24-TP-102a.

Date Taken:	10/21/2024
Photo Identification:	24-TP-102a



Description:	View of boulders within 24-TP-102a.

Project: Utaba Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-102b

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	15	Approximate Width (feet)	8	Approximate Depth (feet)	7.5
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Within Reservoir	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5698 (Approx.)
Comments	Reservoir Basin			Latitude / Longitude	41.38699 , -111.91032

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				ELASTIC SILT, trace sand - soft, wet, dark gray to black, organics, (MH)	Soil densities estimated based on excavation effort
	1					
	2					
	3					
	4					
5693	5					
			BULK-01			
	6				COBBLES and BOULDERS, with sand, with clay - dense, wet, boulders up to 3 ft.	Difficult excavation
	7					Ceased excavation due to refusal on cobbles and boulders
					Bottom of Hole at 7.5 feet	
	8					
	9					
5688	10					
	11					
	12					
	13					
	14					
	15					

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-103

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	15	Approximate Width (feet)	5	Approximate Depth (feet)	14.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	N-S
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5698 (Approx.)
Comments	Abutment			Latitude / Longitude	41.38651 , -111.91048

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				GRAVEL, clayey, with sand, with cobbles - medium dense to dense, moist, light brown to brown, (GM)	Soil densities estimated based on excavation effort
	1					
	2					Excavator scraping on cobbles
	3		BULK-01			
	4					
5693	5					
	6				CLAY, with sand, with gravel - medium dense, moist, brown to dark red, (CL)	
	7					
	8					
	9				- iron oxide staining	
5688	10					
	11		BULK-02			
	12					
	13					
	14				Bottom of Hole at 14 feet	Ceased excavation at 14-ft. due to stiff difficult excavation
	15					

GERHART COLE

Date Taken:	10/21/2024
Photo Identification:	24-TP-103



Description:	View of 24-TP-103 sidewall and bottom.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-104

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	20	Approximate Width (feet)	5	Approximate Depth (feet)	10.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5764 (Approx.)
Comments	North Park - Barrow Area			Latitude / Longitude	41.38537 , -111.91222

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				GRAVEL, clayey, with silt, with cobbles and boulders - dense, moist, light brown to brown, (GC)	Soil densities estimated based on excavation effort
	1					Difficult excavation, scraping on cobbles and boulders
	2					
	3		BULK-01			
	4					
5759	5					
	6					
	7		BULK-02			
	8				- boulder up to 3 ft	Very difficult excavation, large boulder
	9					
	10					Ceased excavation at 10-ft. due to difficult excavation

Bottom of Hole at 10 feet

GERHART COLE

Date Taken:	10/21/2024
Photo Identification:	24-TP-104



Description:	View of 24-TP-104 sidewall and bottom.

Date Taken:	10/21/2024
Photo Identification:	24-TP-104



Description:	View of 24-TP-104 spoils pile.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-105

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	20	Approximate Width (feet)	5	Approximate Depth (feet)	10.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5796 (Approx.)
Comments	North Park - Barrow Area			Latitude / Longitude	41.38525 , -111.91420

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				GRAVEL, sandy, clayey, with cobbles - dense, moist, light brown to brown, cobbles up to 12 inches, (GC)	Soil densities estimated based on excavation effort
	1					Difficult excavation, scraping on cobbles and boulders
	2					
			BULK-01			
	3					
	4				- boulders up to 2 ft	
5791	5					
	6					
	7					
	8					
	9					Difficult excavation, scraping on cobbles and boulders
	10					Ceased excavation at 10-ft. due to refusal conditions

Bottom of Hole at 10 feet

Date Taken:	10/21/2024
Photo Identification:	24-TP-105



Description:	View of 24-TP-105 sidewall and bottom.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-106

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	20	Approximate Width (feet)	6	Approximate Depth (feet)	10.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5777 (Approx.)
Comments	North Park - Barrow Area			Latitude / Longitude	41.38475 , -111.91331

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
					GRAVEL, sandy, with clay, with cobbles and boulders - dense, moist, light brown to brown, (GC)	Soil densities estimated based on excavation effort
	1					Difficult excavating, scraping on cobbles and boulders
	2					
	3					
	4				- boulder up to 2 ft	
5772	5		BULK-01			
	6					
	7					
	8					
	9		BULK-02			Ceased excavation due to difficult excavation
	10					

Bottom of Hole at 10 feet

Date Taken:	10/21/2024
Photo Identification:	24-TP-106



Description:	View of 24-TP-106 sidewall and bottom.

Date Taken:	10/21/2024
Photo Identification:	24-TP-106



Description:	View of 24-TP-106 spoils pile.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-107

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	20	Approximate Width (feet)	6	Approximate Depth (feet)	10.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5744 (Approx.)
Comments	North Park - Barrow Area			Latitude / Longitude	41.38493 , -111.91116

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				GRAVEL, clayey, with sand, with cobbles - dense, moist, light brown to brown, (GC)	Soil densities estimated based on excavation effort
	1					
	2					Difficult excavating, scraping on cobbles and boulders
			BULK-01			
	3					
	4					
5739	5					
	6					
	7					
	8					Difficult excavating
	9		BULK-02			Ceased excavation at 10-ft. due to excavation difficulty
	10					

Bottom of Hole at 10 feet

Date Taken:	10/21/2024
Photo Identification:	24-TP-107



Description:	View of 24-TP-107 sidewall and bottom.

Date Taken:	10/21/2024
Photo Identification:	24-TP-107



Description:	View of 24-TP-107 spoils pile.

Project: UTABA Retarding Dam
Project Location: Weber County, UT
Project Number: 24-1762

LOG OF TEST PIT 24-TP-201

Date(s) Excavated	10/21/2024	Logged By	M. McNeil	Checked By	R. Buhler
Approximate Length (feet)	15	Approximate Width (feet)	5	Approximate Depth (feet)	10.0
Excavation Equipment	John Deere 210 G	Excavation Contractor	Weber County Road Department (Travis)	Approximate Pit Trend	NE-SW
Groundwater Depth (feet)	Not Found	Date Measured	10/21/2024	Approximate Surface Elevation (feet)	5715 (Approx.)
Comments	Proposed Spillway Area			Latitude / Longitude	41.38600 , -111.90994

Elevation, feet	Depth, feet	Sample Type	Number	Graphic Log	MATERIAL DESCRIPTION	FIELD NOTES
	0				SAND, silty, with gravel - medium dense, moist, light brown to brown, (SM)	Soil densities estimated based on excavation effort
	1					
	2				- cobbles and boulders, tan to light brown	
	3				GRAVEL, sandy, with clay, with cobbles and boulders - dense, moist, tan to light brown, boulders up to 18 inches, (GC)	Difficult excavation, scraping on cobbles and boulders
	4					
5710	5					
	6					
	7					
	8		BULK-01			
	9					
	10					Ceased excavation at target depth

Bottom of Hole at 10 feet

Date Taken:	10/21/2024
Photo Identification:	24-TP-201



Description:	View of 24-TP-201 sidewall and bottom.

Appendix C

Field Studies Data: Seismic Survey

UTABA Dam (24-1762)

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Seismic Refraction Memo	C-1
Vs-100 Memo	C-17

GERHART COLE

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TECHNICAL MEMORANDUM

To:	Mr. Layne Jensen, PE & Mr. Chad Brown, PE Franson Civil Engineers 1276 South 820 East, Suite 100 American Fork, Utah 84003
From:	Tyler Jackson, EIT
Reviewed by:	Ryan Maw, PE, BCGE
Date:	October 13, 2024
Job Number:	24-1762
Subject:	Utaba Dam Seismic Refraction and Two-Dimensional (2D) Seismic Velocity Profiling



BACKGROUND

Gerhart Cole (GC) was retained by Franson Civil Engineers (Franson) to collect geotechnical data and develop two-dimensional (2D) seismic refraction profiles to support characterization of subsurface materials in the rehabilitation design of Utaba Dam on the North Fork of the Odgen River. This work was performed in general accordance with Work Authorization No. 24-1762 dated July 9, 2024. This technical memorandum (TM) addresses the results of the seismic refraction data collection and analyses, as well as the developed confined compression wave (Vp or P wave) and shear wave (Vs or S wave) 2D profiles.

FIELD METHODS: GEOPHYSICAL SURVEY

Non-invasive geophysical seismic refraction methods were used to obtain 2D seismic velocity profiles of subsurface conditions. Seismic refraction uses refractory testing methods to obtain data on the seismic velocities below linear arrays of geophones installed on the ground surface. Analysis of seismic refraction data produces a 2D seismic velocity ground model through tomographic inversion, which iteratively solves for a model that fits the observed body wave (e.g., compression or shear wave) arrival times. This 2D velocity model can be used to interpret depths and velocities of significant velocity contrasts.

The objective of the refraction survey was to measure the interface profiles and associated velocities between the softer surface soils and the stiffer potential bedrock materials at specified locations around the dam and at the abutments. The field data collection was completed from September 23, 2024, to September 24, 2024. It should be noted surface wave testing was completed on September 23,2024 at the site to develop a 1D interpretation of Vs left of the centerline on the crest of the dam (see separate TM on 1D Seismic Shear Wave Velocity Profiling).

Seven total Vp refraction surveys and four Vs refraction surveys were completed as part of this study. It is important to note that Vp will often not provide sufficient imaging of seismic

velocity contrasts in saturated soil layers. The first four arrays (e.g., Lines1, 2, 3-1, and 3-2) were supplemented with Vs refraction surveys due to their close proximity to the reservoir pool level in order to better delineate potential seismic velocity contrasts below the saturated soils.

The location of each linear array is described as follows:

- Line 1 spanned along the right abutment near the impervious blanket.
- Line 2 spanned parallel to and roughly 100 feet upstream of the dam crest.
- Line 3 spanned along the crest and was split into two subarrays at the emergency spillway.
    - Line 3-1 was to the south of the emergency spillway.
    - Line 3-2 was to the north of the emergency spillway.
- Line 4 traversed the centerline of the dam starting near the observed reservoir pool level and ended near the downstream toe, effectively creating a cross-section along the dam embankment.
- Line 5 spanned along the abutment and embankment materials on the downstream right groin of the existing dam.
- Line 6 spanned along the abutment and embankment materials on the downstream left groin of the existing dam.

Data was acquired and processed following ASTM D5777 (ASTM, 2011) that provides guidance on seismic refraction methods for subsurface investigations. The refraction results were processed using the SeisImager2D software suite for seismic refraction tomography produced by Geometrics, Inc (2023a and 2023b). The refraction results were then imported into Surfer (Golden Software, 2024) to develop plots of each 2D Vp and Vs profiles.

Seismic Refraction Array Description

The seismic refraction testing was performed utilizing vertically polarized 4.5-Hz geophones (Geospace Technologies GS-ONE installed in PC803 land cases) coupled to the ground surface with aluminum spikes inserted directly into the soil or stands where the exposed surface did not allow spike insertion. The Vs seismic refraction testing was performed with horizontally polarized GS-ONE geophones.

Field setup and geometrical configurations for each linear array were as follows:

- Line 1 consisted of 24 geophones with a common receiver spacing of 11.5 feet, resulting in a total array length of approximately 265 feet.
- Line 2 consisted of 24 geophones with a common receiver spacing of 16.4 feet, resulting in a total array length of about 375 feet.
- Line 3-1 consisted of 24 geophones with a common receiver spacing of 6.5 feet, resulting in a total array length of approximately 150 feet.
- Line 3-2 consisted of 24 geophones with a common receiver spacing of 11.5 feet, resulting in a total array length of about 265 feet.
- Line 4 consisted of 24 geophones with a common receiver spacing of 13.1 feet, resulting in a total array length of approximately 300 feet.
- Line 5 consisted of 24 geophones with a common receiver spacing of 9.8 feet, resulting in a total array length of about 225 feet.

- Line 6 consisted of 24 geophones with a common receiver spacing of 6.5 feet, resulting in a total array length of approximately 150 feet.

Vertically polarized geophones were used to record wavefields with a strong compression wave (i.e., Vp or P wave) component generated by striking a 16-pound sledgehammer against a circular aluminum strike-plate on the ground surface. Horizontally polarized geophones oriented orthogonally to the array length were used to record wavefields with a strong shear wave (i.e., Vs or S wave) component generated by striking a 16-pound sledgehammer against both ends of a wooden beam capped with steel plates oriented orthogonal to the array length to generate shots with opposing polarity.

A minimum of five individual shot records (i.e., hammer blows) were stacked at shot locations within each array to increase the signal-to-noise ratio. Wavefields were recorded for a total of 1 second with a -0.15 second trigger delay using a sampling rate of 31.25 microseconds. Coordinates for the first and last geophones in each refraction array were estimated in the field with a recreational grade GPS device. The end points are presented in Table 1 and plotted relative to aerial photography with a reported date of aerial imagery of June 6, 2022, in Figure 1.

REFRACTION PROCESSING

Selection of First Arrival Times

The first step in processing the refraction data involves picking the compression wave arrival times at each geophone for each shot location in the refraction array. To do this, GC utilized the Pickwin program from the SeisImager/2D software suite (Geometrics, 2023a). GC selected the first deviation from the background noise for each P-wave arrival time. For S-wave arrivals, GC overlayed shots with opposing polarity and selected the point where the two shots deviated from background noise (or crossed) in opposing directions.

Intercept Time Inversion

After choosing the first arrival times, GC generated initial layered velocity models (e.g., simple two- and three-layer models) for each refraction survey using the intercept time inversion method in the Plotrefa module of the SeisImager/2D software suite (Geometrics, 2023b). This method involves iteratively developing a layered velocity model with theoretical first arrival times that fits the observed first arrival times by solving for lines of best fit (e.g., constant velocity layers) bounded inside each analyst-specified layer while minimizing the root mean square error between the two sets of arrival times. The developed layered models were considered to be reasonable representations of anticipated subsurface conditions, and each fit their respective observed compression wave arrival times relatively well. As such, the layered velocity models were used as the initial models for tomographic inversion.

Tomographic Inversion

Tomographic inversion involves discretizing a simple initial layered velocity model into cells and iteratively searching for a single ‘best-fitting’ velocity model. This is done by calculating the theoretical ray paths through each candidate velocity model and comparing the

theoretical first arrival times with the first arrival times recorded in the field with the goal of minimizing the root mean square error of the theoretical model with the observations.

Each initial layered velocity model was discretized into a non-uniform grid of cells with 20 rows and one column per receiver (e.g., 24 columns). Candidate velocity models were generated based on the discretized initial velocity model. GC iteratively searched 20 velocity models until the tomographic inversion found a velocity model that provided an adequate fit to the observed arrival time data.

RESULTS AND DISCUSSION

The tomographic-inverted 2D seismic velocity profiles are depicted in Figures 2, 3, 4, 5, 6, and 7. The profiles have been plotted to correspond with plan view of the arrays (refer to Figure 1) so that the western-most (page left) end of the profile corresponds with the western-most (page left) end of the arrays. The elevations shown were based on the provided survey of points along the arrays and the horizontal offsets measured by GC in the field.

GC notes that certain assumptions are required when processing and interpreting seismic refraction, in this case Vp, data. The first is that subsurface layers are assumed to be horizontal, uniform, and isotropic, which in most geologic environments is not the case. While tomographic inversion helps reduce this uncertainty, it is important to consider this when interpreting seismic refraction data (especially with sloping layers or ground surface such as this site). Additionally, seismic refraction is limited to layer detection with a sudden, significant increase in the seismic velocity contrast with depth. This means that seismic refraction methods are unable to detect gradual/small increases in seismic velocity, within thin layers, and low velocity layers (i.e., layers with a decrease in seismic velocity or density with depth). Again, it is important to consider these potential limitations when interpreting seismic refraction data.

It is also important to consider the saturated condition of the in-situ soils when interpreting the Vp data. The compression wave velocity of water is approximately 4,800 feet/second. This value has been included as a contour line on the 2D Vp profiles for Lines 1, 2, 3, 4 and 5 to indicate potential water level depths that vary by location. We note that this contour varies across the profiles (in some cases undulating). These small changes represent distortions from data smoothing as well as the potential variability in moisture contents of site soils. The 4800 feet/second contour should be interpreted with a degree of uncertainty; it is anticipated that the depth to groundwater will be measured directly during subsequent field studies. Additionally, it is important to consider that the seismic velocity layering depicted below 4,800 feet/second may not be representative of subsurface site conditions since Vp refraction will often not provide sufficient imaging of seismic velocity contrasts in saturated soil layers. However, the profiles can still be beneficial to provide a rough estimation of the depth to these potentially stiffer layers.

Relative to the bedrock profiles at the sites, it should be recognized that Foti et al. (2018) denotes the typical seismic shear wave velocity (Vs) of competent rock seismic shear wave velocities (Vs) as 4,000 feet per second (ft/s). By assuming a poisons ratio of 0.33, this

equates to a Vp of 8,000 ft/s. Our analyses suggested two seismic velocity (Vp) layers with two main discernable impedance contrasts. The first was near surface with a range from 2,000 to 3,000 feet/second. The second deeper layer suggests values from 7,000 to 10,000 feet/second. The softer surface layer is most likely related to the embankment fill material and loose surface soils. The deeper velocity layer is most likely related to the dam foundation materials consisting of quartzite and sandstone. This is consistent with the layering of the dam embankment and foundation materials reported in the as-built construction plans (USDA Soil Conservation Service, 1961).

At Line 1, the Vs survey exhibits similar layering with a softer surface layer with a Vs of 500 to 1,000 feet/second (Vp of 2,000 to 4,5000 feet/second) and a stiffer layer with a Vs ranging from 2,000 to 2,500 feet/second (Vp of 8,000 to 10,000 feet/second). The data from the other Vs surveys did not indicate sharp velocity contrasts and are more uniform with a Vs ranging from roughly 1,000 to 1,500 feet/second.

The 2D Vs profile at Line 1 depicts a stiffer anomaly at approximately 132 feet from the east end of the array. We note that as this line runs through the impermeable blanket layer upstream along the right abutment, this change may represent the denser materials of the impermeable blanket layer or the potential location of a cutoff trench (see provided as-builts).

Figure 8 compares an extracted 1D Vs profile from the Line 3-2 Vs refraction extracted at the center location of the MASW array with the median 1D Vs profiles generated through surface wave testing (see 1D Seismic Shear Wave Velocity Profiling TM, Gerhart Cole, Inc 2024). The profiles do not agree on the depth of contrast for the major velocity contrast layers (the 1D shear wave testing suggests a more significant impedance contrasts between 45 feet and 50 feet), which is expected since the surface wave profiles represent an average profile spanning the dimensions of the MASW and MAM arrays while the shear wave refraction profile represents the Vs profile at a single point. However, the profiles do agree on a Vs value through the majority of the dam embankment of approximately 1,550 feet/second (we note the difference from the computed Vs30 as this value does not consider the bedrock below the embankment material) .

When comparing the Vp refraction for Lines 5 and 6, it is apparent that Line 6 is unable to detect the anticipated quartzite bedrock beneath the array that is reported in the as-built construction documentation. However, the bottom layer of Line 5 has a Vp of nearly 7,000 feet/second, which is within the expected range for the reported bedrock material of interbedded argillite and sandstone. In contrast, the deepest layer detected in Line 6 has a Vp of approximately 4,000 feet/second, which is lower than the expected Vp values of competent quartzite. This deeper layer in Line 6 may represent the talus layer reported in the as-built drawings. Since Line 6 was laid out with a shorter length than Line 5 due to the steep uphill slope encountered at the end of the line, it is anticipated that it was unable to penetrate and detect bedrock materials as deep as Line 5. We note these constraints relative to future planned field studies and drilled test holes that will be used to confirm the depth to and type of embankment materials and bedrock of the dam.

LIMITATIONS

The results of the geophysical data collection and analysis are subject to interpretation. The results presented constitute GC's professional opinion based on the available data at the time of development. If the project's design or manner of construction changes, or if conditions are found that are different from those described, we should be notified immediately so that we can make revisions as necessary.

This document was prepared solely for the use of the addressee (our Client) for the specified project and may not contain sufficient information for other parties or uses. Also, this document does not constitute a specification and should not be treated or referred to as such in project design drawings or documents.

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FIGURES

Figure 1 Seismic Refraction Survey Array Layout
Figure 2 Line 1 Vp and Vs 2D Profiles
Figure 3 Line 2 Vp and Vs 2D Profiles
Figure 4 Line 3 Vs and Vs 2D Profiles
Figure 5 Line 4 Vp 2D Profile
Figure 6 Line 5 Vp 2D Profile
Figure 7 Line 6 Vp 2D Profile
Figure 8 Comparison of Refraction and Surface Wave 1D Vs Profiles

TABLES

Table 1 Coordinates of Seismic Refraction Arrays

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ATSM D5777: Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation. (2011). ASTM International, West Conshohocken, PA. DOI:10.1520/D5777-00R11e1.

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Geometrics (2023b). Plotrefa Version 6.0.0.1. Geometrics Inc / OYO Corporation. Released January 31, 2023.

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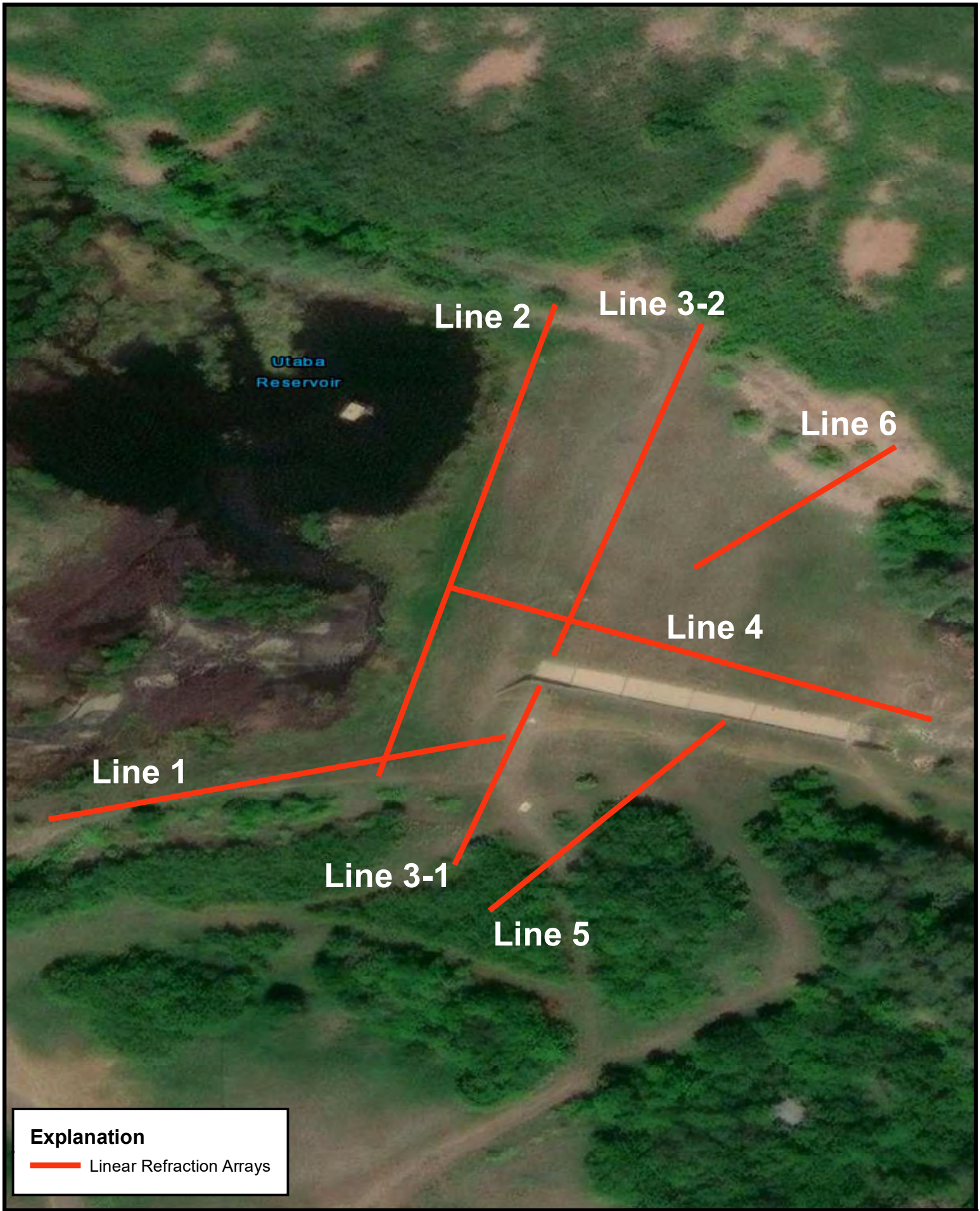
Gerhart Cole, Inc. (2024). Utaba Dam; One-Dimensional (1D) Seismic Shear Wave Velocity Profiling Technical Memorandum. Location: Weber County, Utah. Project Name: Utaba Dam. October 13, 2024.

Golden Software (2024). Surfer Version 27.2.282. Golden Software, LLC. Released April 20, 2024.

United States Department of Agriculture Soil Conservation Service (1961). As-Built Plans for the Construction of Utaba Retarding Dam. Weber County, Utah. Drawing No. 7-E-20355.



GERHART COLE

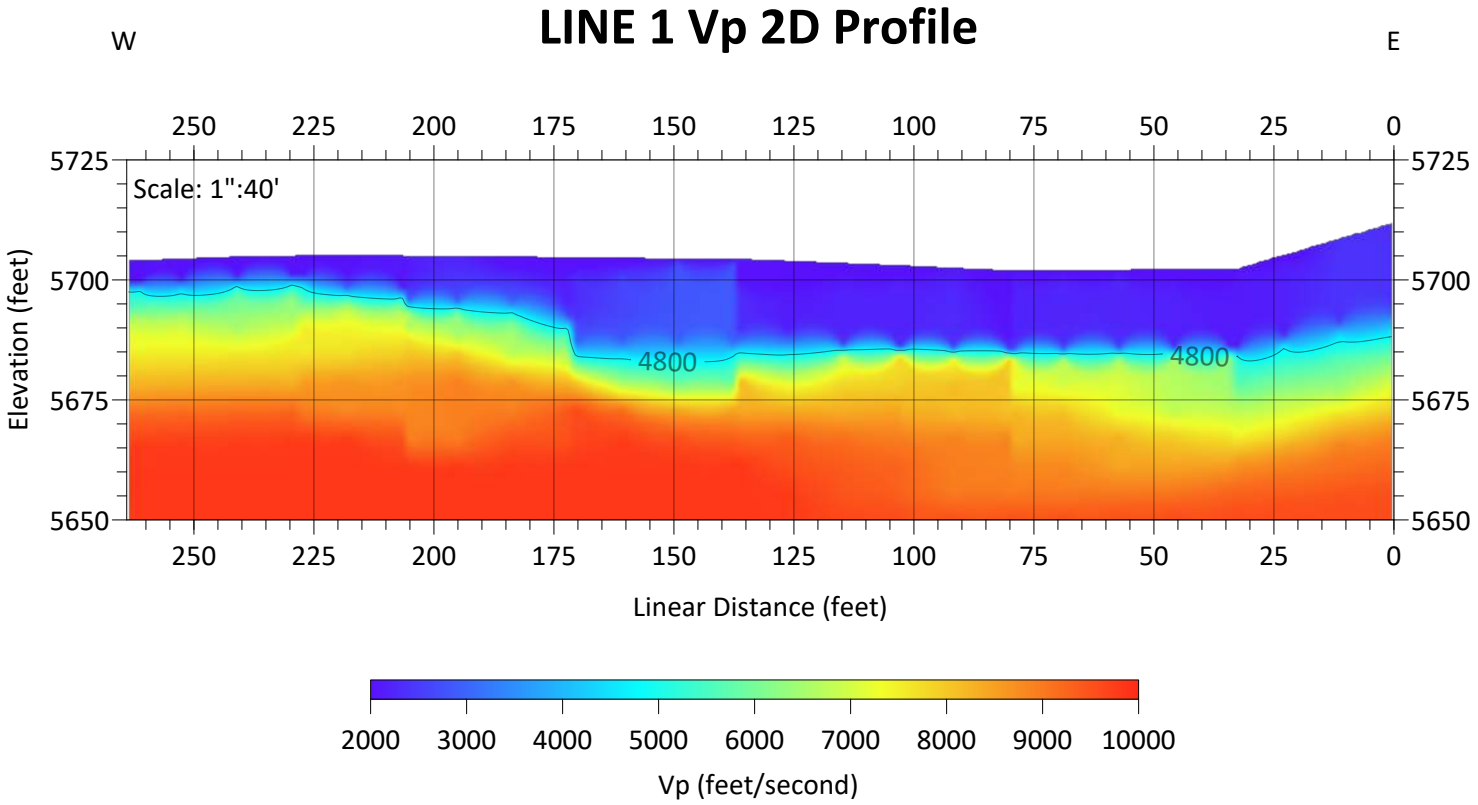
Seismic Refraction Survey Array Layout

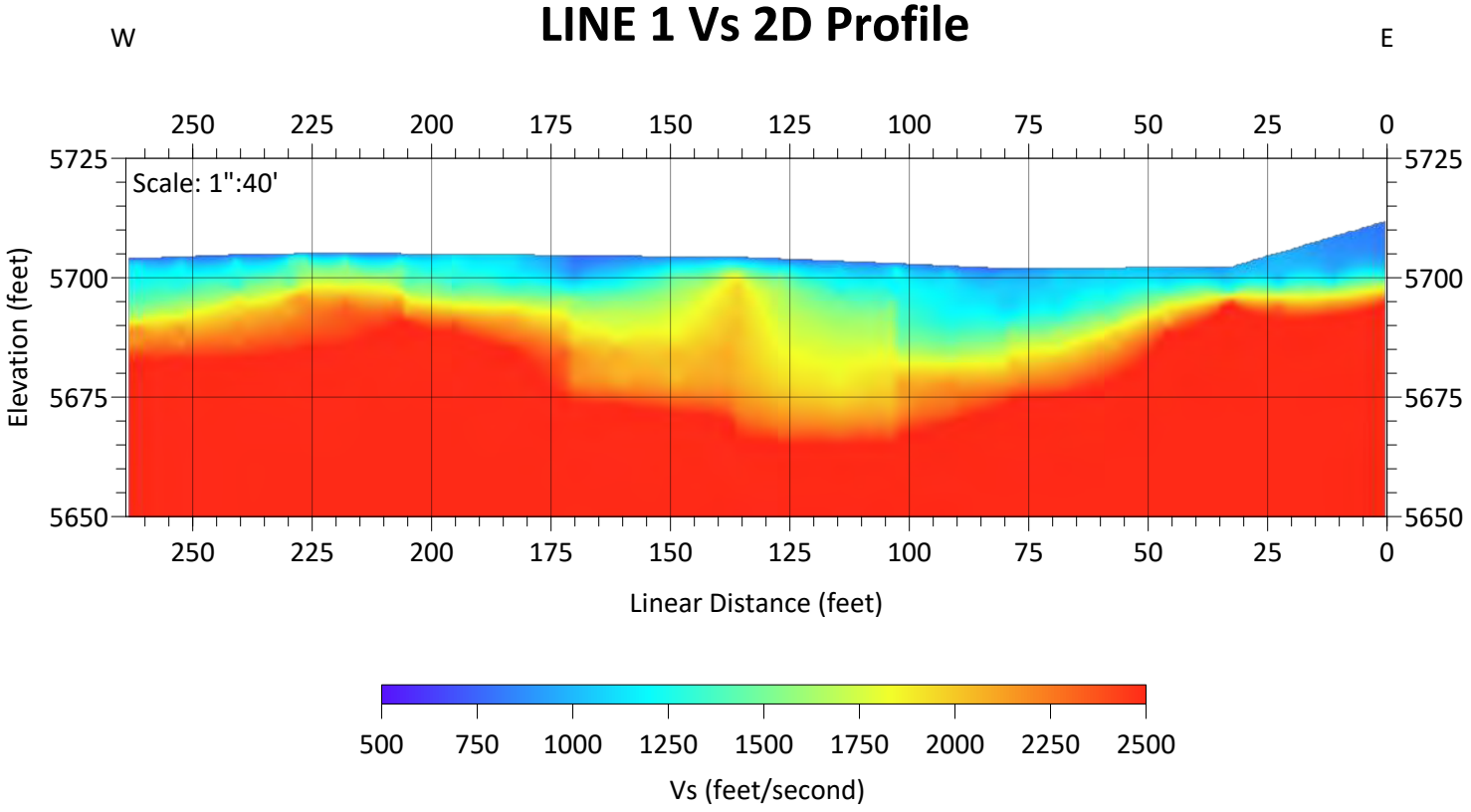
Utaba Dam

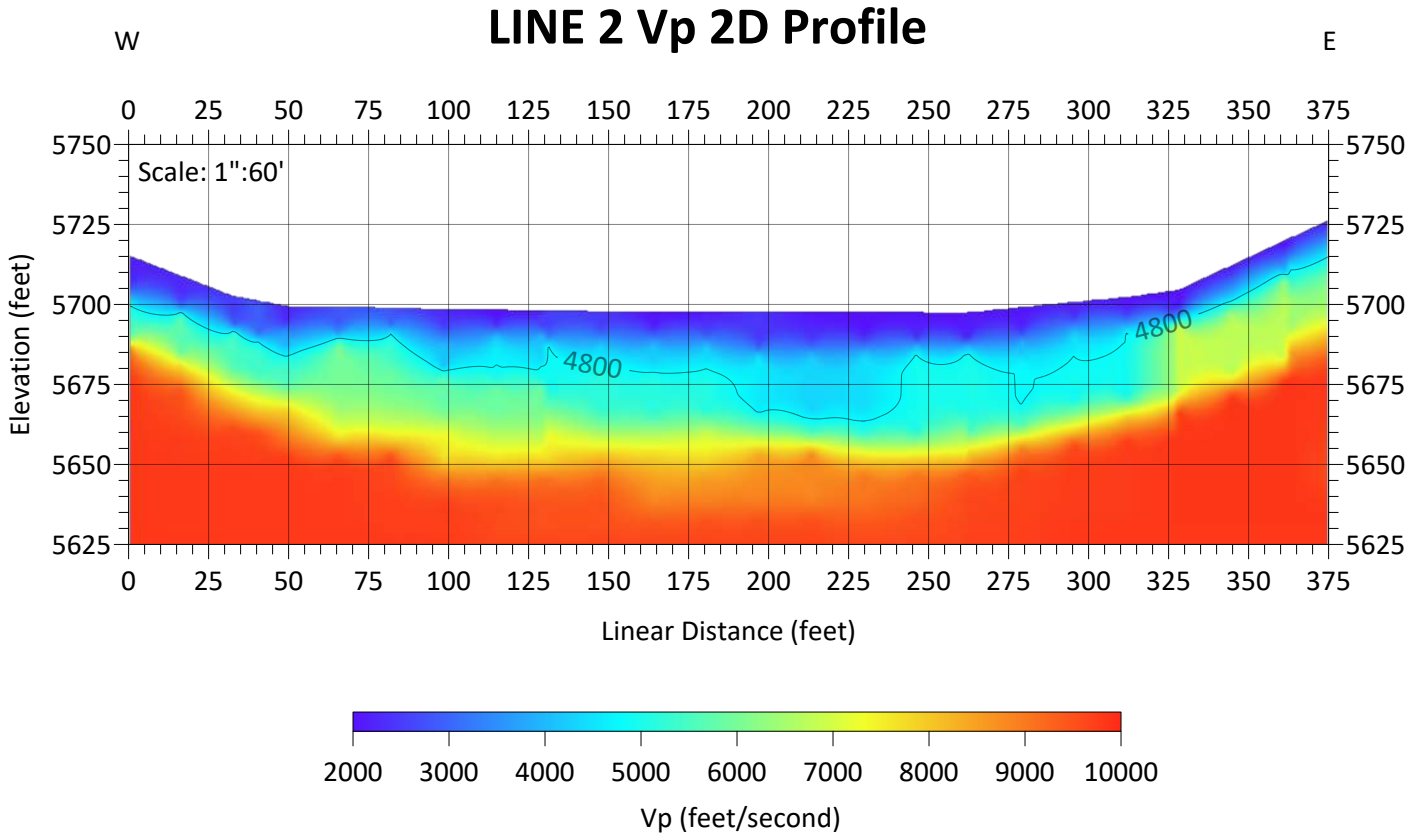
N

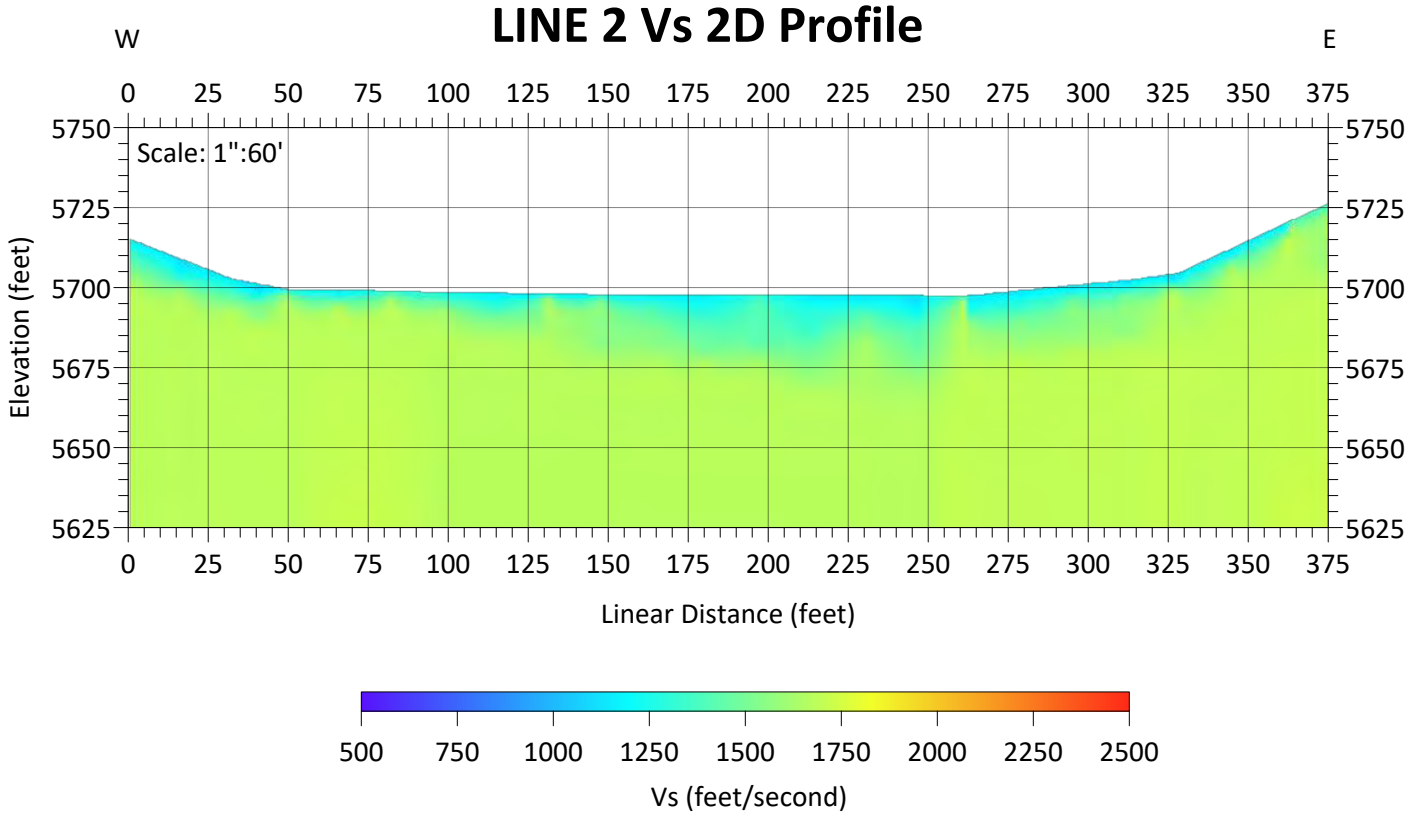
0 10 20 40 60 80 100 Feet

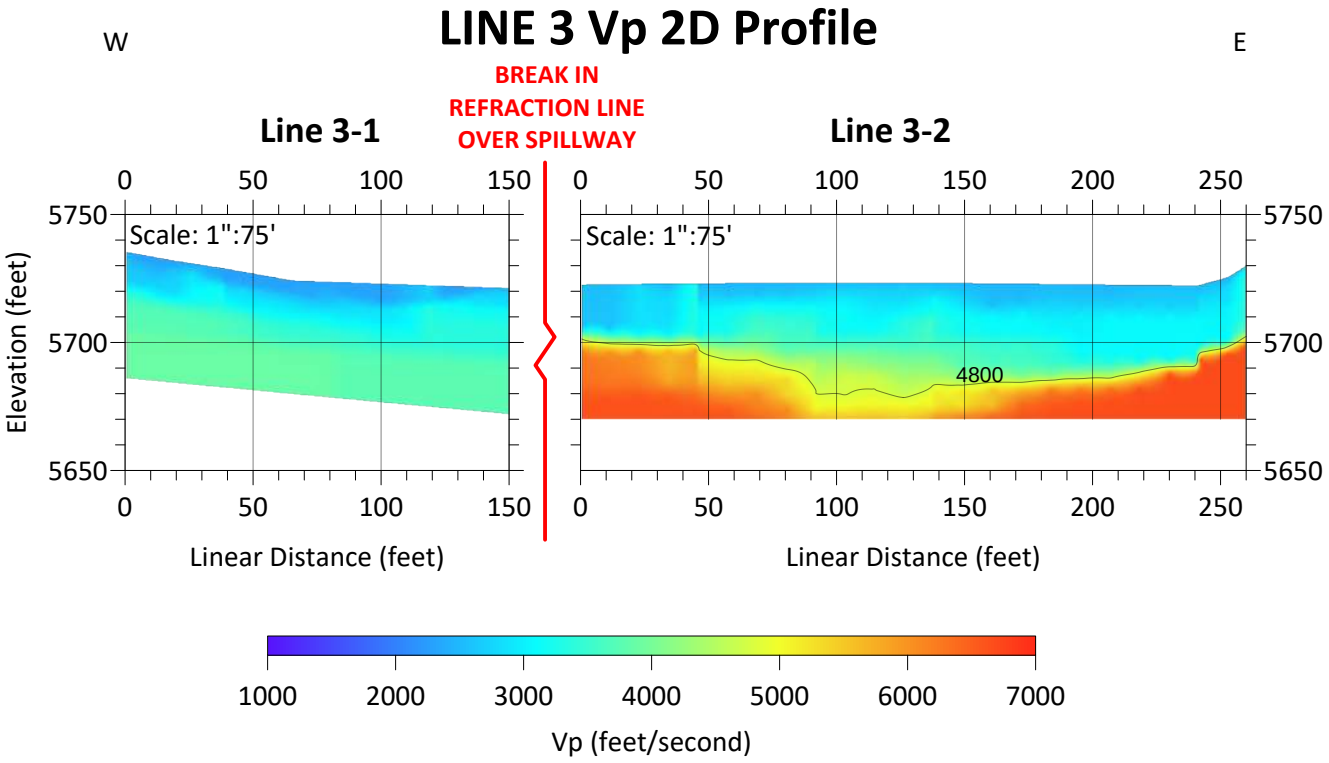
Figure 1C-8


LINE 1 Vp 2D Profile
W
E
250 225 200 175 150 125 100 75 50 25 0
5725
5700
5675
5650
Scale: 1":40'
4800
4800
Elevation (feet)
Linear Distance (feet)
2000 3000 4000 5000 6000 7000 8000 9000 10000
Vp (feet/second)


LINE 1 Vs 2D Profile
W
E
250 225 200 175 150 125 100 75 50 25 0
5725
5700
5675
5650
Scale: 1":40'
Elevation (feet)
Linear Distance (feet)
500 750 1000 1250 1500 1750 2000 2250 2500
Vs (feet/second)


LINE 2 Vp 2D Profile
W
E
Scale: 1":60'
Elevation (feet)
Linear Distance (feet)
4800
4800
Vp (feet/second)


LINE 2 Vs 2D Profile
W
E
Scale: 1":60'
Elevation (feet)
Linear Distance (feet)
Vs (feet/second)



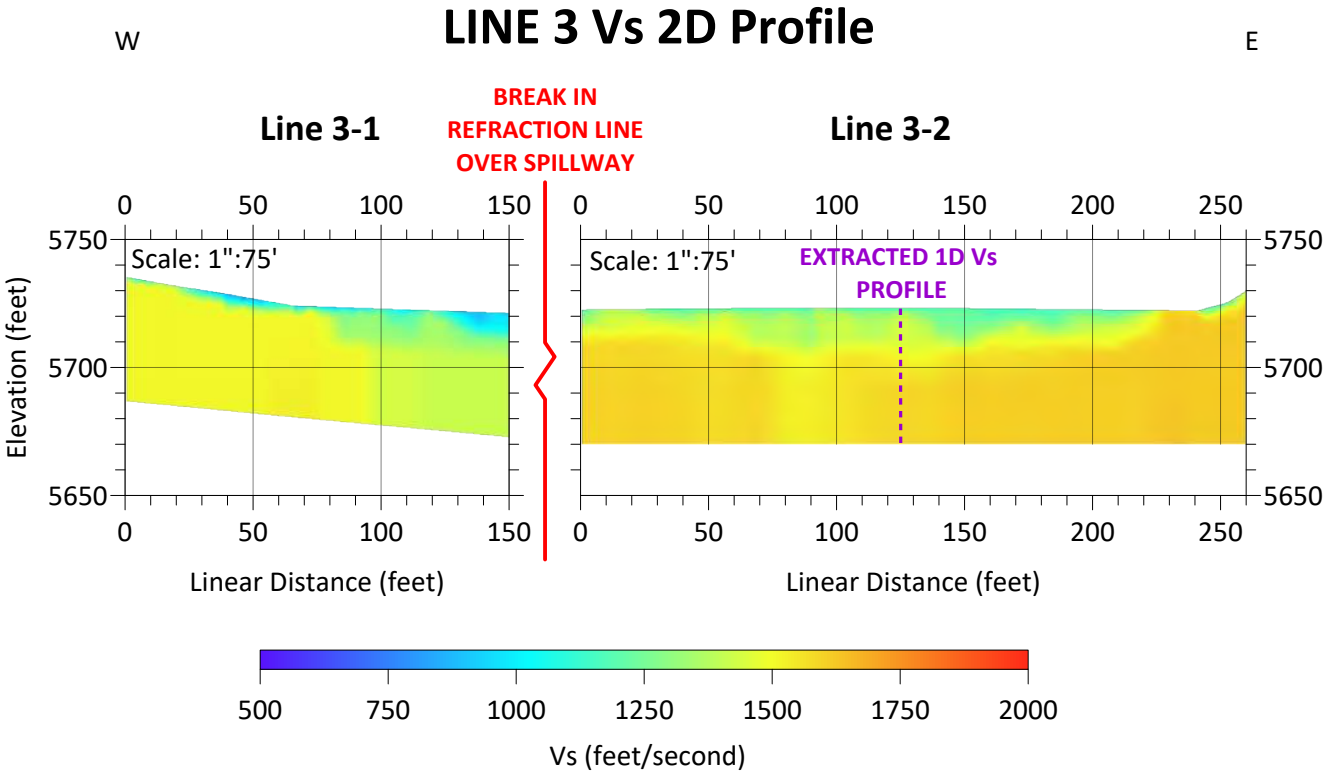
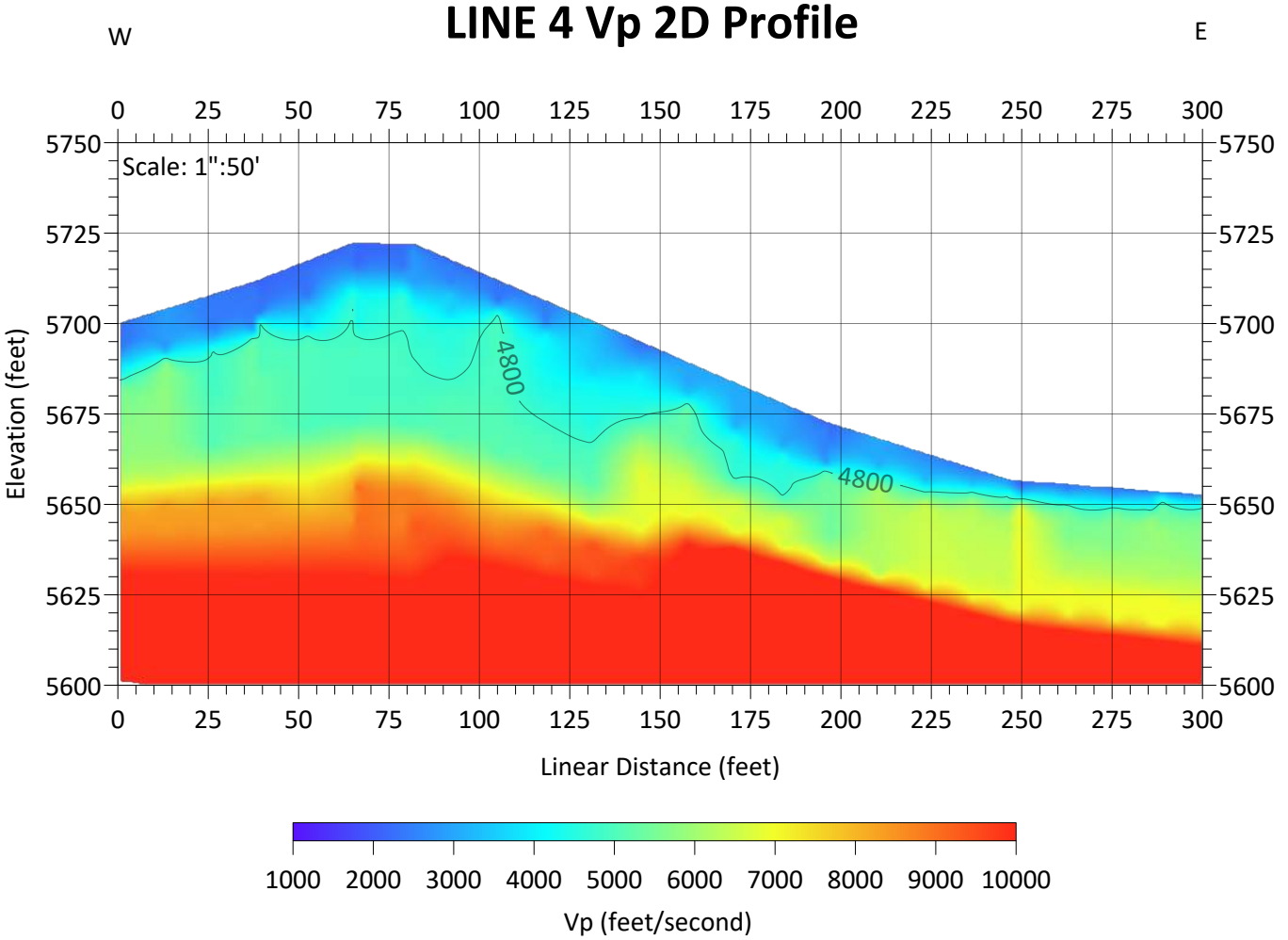
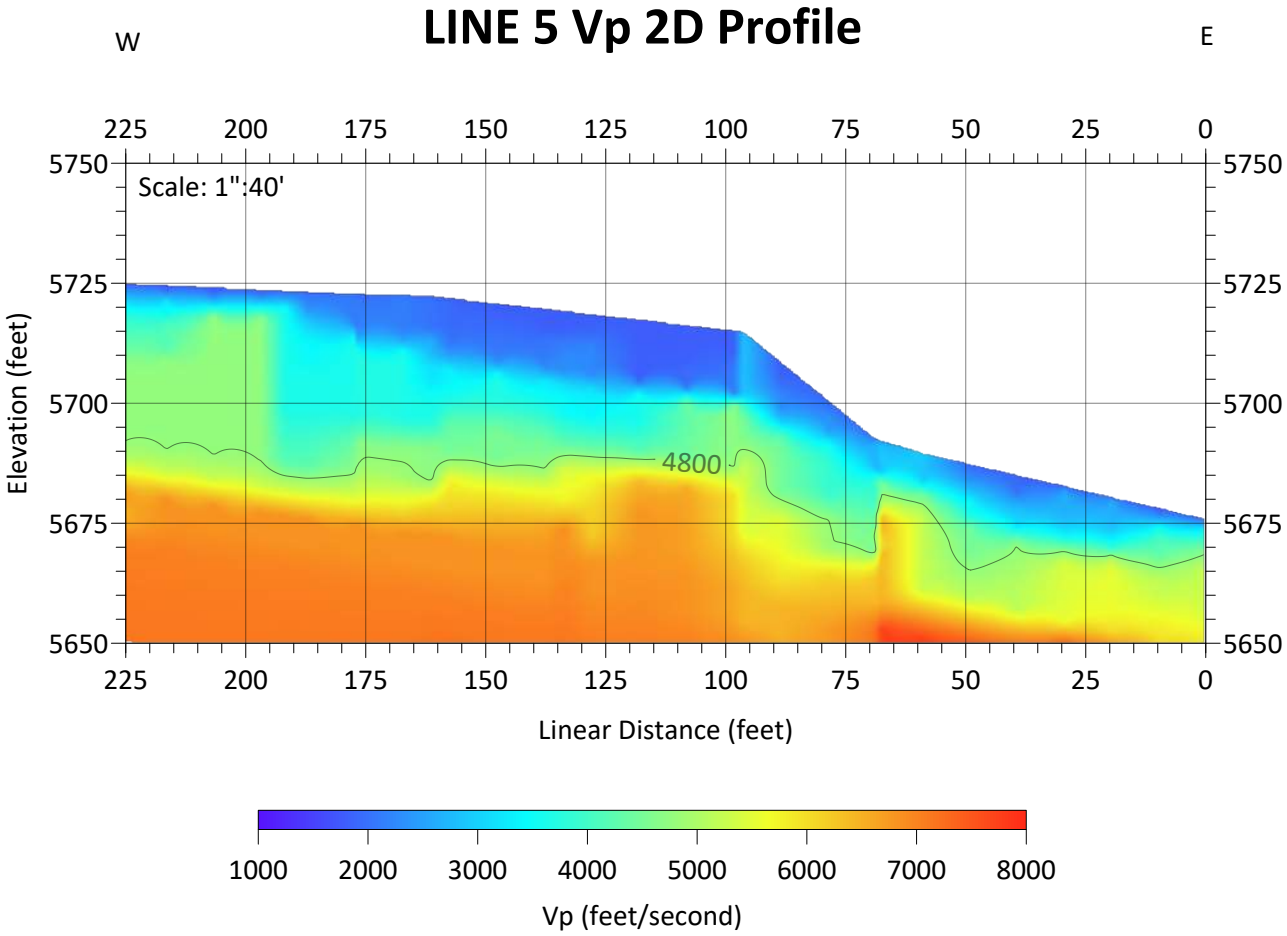
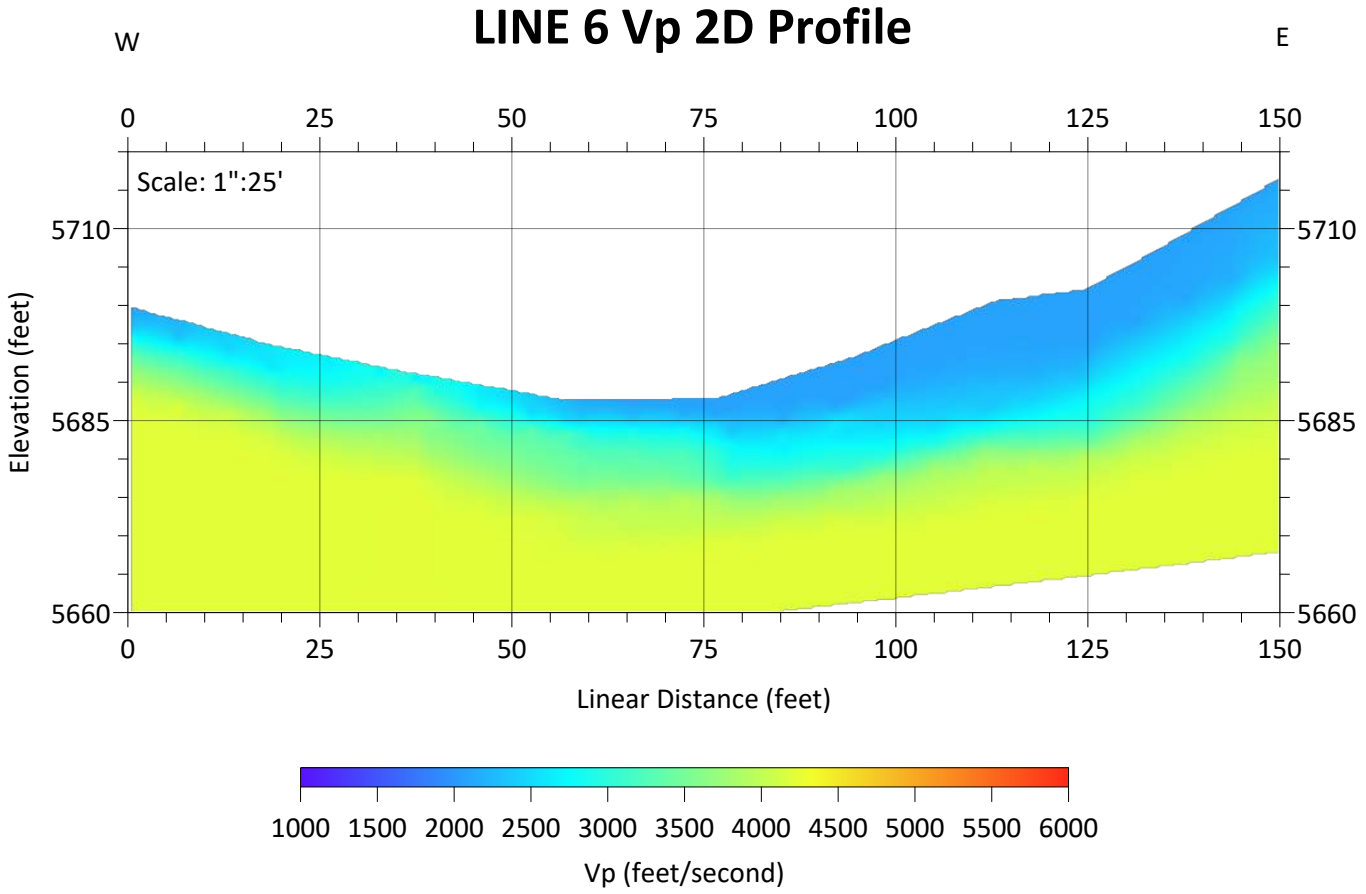


Figure 4: Line 3 Vp and Vs 2D Profiles

LINE 4 Vp 2D Profile




LINE 5 Vp 2D Profile
W
E
Scale: 1":40'
Elevation (feet)
Linear Distance (feet)
4800
225
200
175
150
125
100
75
50
25
0
5750
5725
5700
5675
5650
1000
2000
3000
4000
5000
6000
7000
8000
Vp (feet/second)


LINE 6 Vp 2D Profile
W
E
Scale: 1":25'
0
25
50
75
100
125
150
5710
5685
5660
Elevation (feet)
Linear Distance (feet)
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Vp (feet/second)

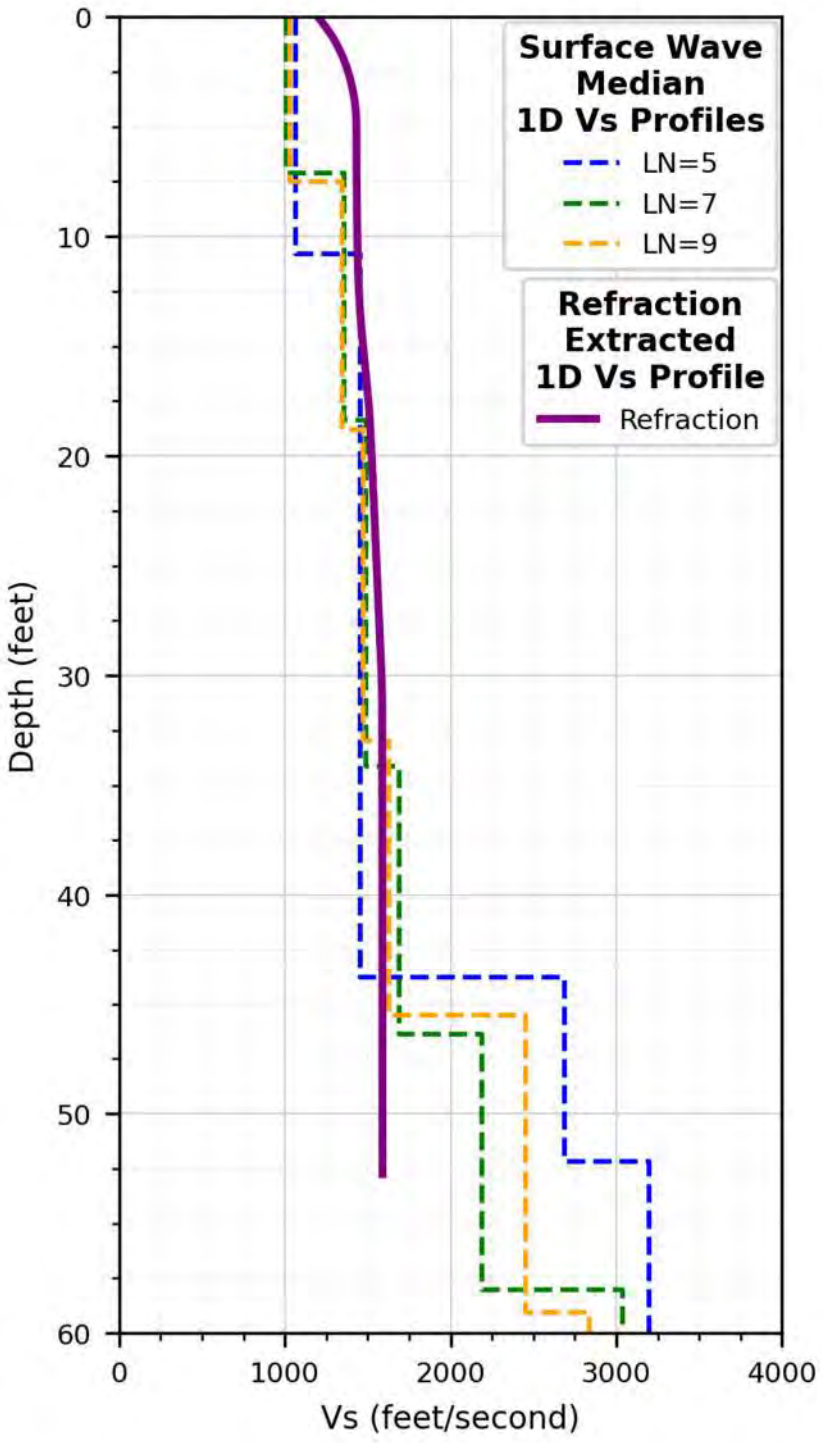


Figure 8. Comparison of median 1D Vs profiles generated with surface wave testing from the 1D Seismic Shear Wave Velocity (Vs) Profiling Technical Memorandum with the Line 3-2 shear wave refraction testing extracted at the center location of the MASW array. Note that the refraction testing did not detect a stiffer Vs contrast at depth while the surface wave Vs profiles detected two distinct velocity contrasts between 45 and 60 feet.

Table 1: Coordinates of Seismic Refraction Arrays
Utaba Dam
24-1762

Array Point	Geophysics Array ID	Date Recorded	Latitude (decimal degree)	Longitude (decimal degree)	Elevation (feet)
Line 1 Start	Line 1	09/24/24	41.386501	-111.909964	5712
Line 1 End	Line 1	09/24/24	41.386333	-111.910892	5704
Line 2 Start	Line 2	09/24/24	41.386420	-111.910223	5716
Line 2 End	Line 2	09/24/24	41.387378	-111.909863	5721
Line 3-1 Start	Line 3-1	09/23/24	41.386242	-111.910066	5735
Line 3-1 End	Line 3-1	09/23/24	41.386630	-111.909894	5721
Line 3-2 Start	Line 3-2	09/24/24	41.386665	-111.909867	5723
Line 3-2 End	Line 3-2	09/24/24	41.387339	-111.909566	5730
Line 4 Start	Line 4	09/24/24	41.386804	-111.910080	5700
Line 4 End	Line 4	09/24/24	41.386536	-111.909099	5654
Line 5 Start	Line 5	09/23/24	41.386532	-111.909519	5676
Line 5 End	Line 5	09/23/24	41.386148	-111.909997	5724
Line 6 Start	Line 6	09/23/24	41.386843	-111.909582	5700
Line 6 End	Line 6	09/23/24	41.387090	-111.909172	5713

Notes:
1) Array points not surveyed; locations estimated in the field with a handheld GPS with an accuracy less than 10 feet.

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TECHNICAL MEMORANDUM

To:	Mr. Layne Jensen, PE & Mr. Chad Brown, PE Franson Civil Engineers 1276 South 820 East, Suite 100 American Fork, Utah 84003
From:	Tyler Jackson, EIT
Reviewed by:	Ryan Maw, PE, BCGE
Date:	October 13, 2024
Job Number:	24-1762
Subject:	Utaba Dam One-Dimensional (1D) Seismic Shear Wave Velocity (Vs) Profiling



BACKGROUND

Gerhart Cole (GC) was retained by Franson Civil Engineers (Franson) to collect geotechnical data and develop 1D shear wave velocity (Vs) profiles to be used for seismic site classification in the rehabilitation design of Utaba Dam on the North Fork Ogden River. This work was performed in general accordance with Work Authorization No. 24-1762 dated July 9, 2024. This technical memorandum (TM) addresses the results of the surface wave data collection and analysis, as well as the developed shear wave (Vs) velocity profiles.

FIELD METHODS: GEOPHYSICAL SURVEY

Non-invasive geophysical surface methods were used to obtain one dimensional (1D) Vs profiles and complete subsurface imaging at the tested location. The field methods used multi-channel analysis of surface waves (MASW) and microtremor array measurement (MAM) testing methods to obtain data and develop the Rayleigh surface wave dispersive properties beneath the arrays. This observed dispersion data was then used in the Dinver module of the Geopsy 2.10.1 software suite (Wathelet, 2020) to screen candidate ground models against and obtain a suite of layered ground models that provide a 'best fit' to the observed data.

The objective of the data collection was to develop a 1D Vs profile to a minimum depth of 100 ft for reference in seismic site classification. The inversion of surface wave dispersion data is sensitive to the number of layers specified for each model. Reported herein are the 1D Vs profiles created from three individual interpretations of the surface wave dispersion data with varying numbers of layers (e.g., 5, 7, and 9 layers).

The MASW and MAM testing followed guidance provided in "Guidelines for the Good Practice of Surface Wave Analysis: A Product of the InterPACIFIC Project" written by Foti et al. (2018). Our field study to develop the 1D Vs profiles was completed on September 23 , 2024. It should be noted that supplemental seismic refraction profiling was

completed to characterize potential depth to bedrock around the site (see separate TM on seismic refraction).

MASW Testing

MASW testing was performed utilizing 4.5-Hz vertical geophones (Geospace Technologies GS-ONE installed in PC803 land cases) coupled to the ground surface with aluminum spike bases inserted directly into site soils. A single line of 24 geophones was placed along the crest of the dam 50 feet to the left of the concrete. A linear array with a common spacing of 6.6 feet (~2 meters) between successive geophones was used, resulting in a total array length of about 150 feet.

Vertical geophones were used to record wavefields with a predominant Rayleigh wave content that was actively generated by striking a circular aluminum strike-plate with a 16-pound sledgehammer at three distinct shot locations (15 feet, 30 feet, and 50 feet) relative to the first geophone on either side of the array. Five distinct blows were recorded per shot location for subsequent stacking to support an increase in the signal-to-noise ratio. Wavefields were recorded for a total of 2.0 seconds with a 0.25 second pre-trigger delay using a sampling rate of 2.0 milliseconds. Coordinates for the first and last geophones in each MASW array were estimated in the field with a recreational grade GPS. The end points are presented in Table 1 and plotted relative to aerial photography, with a reported date of aerial imagery of June 6, 2022, in Figure 1.

MAM Testing

MAM testing was performed using a single circular array centered at the midpoint of the MASW array with an aperture (i.e., largest spacing between sensors) of 160 feet. The MAM array is henceforth referred to as MAM C50. The MAM C50 array was comprised of eight broadband three-component seismometers (Nanometrics Incorporated Trillium Compact Horizon 120 s). Each seismometer has a flat frequency response between 0.0083 Hz (i.e., a period of 120 seconds) and 100 Hz. These sensors were used to record passive ambient seismic noise (e.g., generated by anthropogenic vibrations such as traffic construction as well as wind, tides, and other natural longer wavelength sources).

For the MAM C50 passive array, each seismometer was leveled and oriented to north. Additionally, sensors were buried whenever possible to provide better coupling to the ground surface. Where not possible to bury, sensors were placed on tripod leveling feet and covered with a weighted bucket to reduce potential influence of wind vibrations and temperature fluctuations. Acquisition systems for the Trillium Compact Horizon 120s seismometers were Nanometrics, Inc. Pegasus digitizers (24-bit, 135 decibel dynamic range, internal clock, and external GPS receiver accurate to <100 microseconds). Coordinates for MAM stations recorded in the field with a recreational grade GPS are presented in Table 1 and MAM station locations plotted relative to aerial photography, with a reported date of aerial imagery of June 6, 2022, in Figure 1.

DISPERSION PROCESSING AND INVERSION

Dispersion Processing

The MASW data was analyzed using the frequency domain beamformer method (Zywicki, 1999) coupled with the multiple source-offset technique for identifying near-field contamination and quantifying dispersion uncertainty (Cox and Wood, 2011; Vantassel and Cox, 2022). Rayleigh dispersion data influenced by near-field effects and/or significant offline noise was interactively trimmed prior to calculating dispersion statistics using the *swprepost* and *swprocess* python packages (Vantassel and Cox, 2021 and 2022).

Three-component beamforming (Wathelet et al., 2018) was used to generate Rayleigh wave dispersion data for the MAM C50 array. Each recording period (approximately 210 minutes) was divided into 30 second time windows to provide a minimum of 20 cycles per window for the minimum targeted frequency (0.67 Hz). The MAM data was also interactively trimmed to remove nonsensical data and isolate the dispersion trends prior to calculating dispersion statistics.

The passive dispersion data from the MAM survey was combined with the corresponding active dispersion data from the MASW survey. The combined data was used to compute statistical representations of the dispersion data (i.e., mean and + / - one standard deviation) following the recommendations of Vantassel and Cox (2022).

Dispersion Inversion

The inversion of surface wave data was performed in the Dinver module of the Geopsy software (Wathelet, 2020). This process involves finding layered earth models with theoretical dispersion curves that best match the observed dispersion data. Dispersion inversion is an ill-posed (i.e., contains more unknowns than knowns) and non-linear problem without a unique solution. Geopsy uses a Neighborhood Algorithm to search and screen candidate ground models based on the quantitative misfit of each ground model's theoretical dispersion curve to the observed dispersion data. The fit of the data is characterized by relative dispersion data misfit values. There are no definitive "good" or "bad" misfit values, but misfit values less than 1.0 indicate that, on average, the theoretical dispersion curve falls within + / - one standard deviation of the observed data (Teague and Cox, 2016). Stated simply, models with lower misfit values provide a closer fit to the observed data than models with larger misfit values.

To help limit the error from analyst choice and reduce potential epistemic uncertainty (i.e., not knowing how many layers to solve for), GC utilized several layering number (LN) parameterizations (e.g., LN = 5, 7, and 9) to solve for ground models with specific numbers of layers. Each parameterization had a set number of layers, with the number of layers denoted by the number after the LN in the parameterization title (i.e., LN = 5 results in ground models with 5 layers). The number of trial models necessary to search the entire parameter space during inversion and obtain a large number of acceptable models is site-specific. For the inversion, GC searched approximately 60,000 candidate layered ground models for each trial. GC performed three trials with unique starting models for each parameterization to increase the likelihood of converging to the global lowest-misfit solution. For consistency between parameterizations, the 100 lowest misfit (100-best) layered ground

models were extracted for further analysis and to quantify Vs uncertainty. These layered ground models are presented and discussed in more detail below.

DISCUSSION AND RESULTS

The lowest theoretical dispersion misfit value of 0.08 was achieved with the LN=5 median profile on the crest of the dam, which resulted in a computed average shear wave velocity over the top 30 meters or 98.5 feet (i.e., Vs30) of 1,950 feet per second.

The LN = 5 median 1D Vs profile provides similar layering information to the layering described in the as-built construction documentation (USDA Soil Conservation Service 1961). At the center of the MASW array, the as-builts describe embankment fill to a depth of approximately 50 feet with a potential talus layer to a depth of approximately 55 feet underlain by interbedded argillite and sandstone layers. In the Vs profile, there are transitions to stiffer layers near these depths with Vs that are in the expected range of each material.

It should be noted that the other median profiles from the other layering parametrizations (e.g., LN = 7 and LN = 9) resulted in low misfit values and reasonable Vs profiles. These additional profiles may also be considered to account for potential uncertainty related to site conditions and/or layering parameterization used in the inversion. All three median profiles are included in Figure 2 and are tabulated in Table 2.

GC notes that since surface waves are generally able to profile a maximum depth of half of their wavelength (Foti et al., 2015), the resolution depth of the Vs profiles derived from surface wave testing is approximately half of the maximum resolution wavelength. At depths greater than d_res (e.g., 161 feet), the Vs profiles are constrained by less reliable dispersion data and should not be used without additional verification of subsurface conditions.

LIMITATIONS

The results of the geophysical data collection and analysis are subject to interpretation. The results presented constitute GC's professional opinion based on the available data at the time of development. If the project's design or manner of construction changes, or if conditions are found that are different from those described, we should be notified immediately so that we can make revisions as necessary.

This document was prepared solely for the use of the addressee (our Client) for the specified project and may not contain sufficient information for other parties or uses. Also, this document does not constitute a specification and should not be treated or referred to as such in project design drawings or documents.

We represent that our services are performed within the limitations prescribed by our Client, in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation expressed or implied, and no warranty or guarantee is included or intended. We do not assume responsibility for the accuracy of information provided by others.

FIGURES

Figure 1 Surface Wave Survey Array Layout
Figure 2 1D Ground Models from Inversion Based on a Fundamental Mode Interpretation of the Observed Rayleigh wave Dispersion Data

TABLES

Table 1 Coordinates of MASW and MAM Arrays
Table 2 Surface Wave Tabulated Median 1D Vs Profiles

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Cox, B. R., and Wood, C. M. (2011). Surface Wave Benchmarking Exercise: Methodologies, Results, and Uncertainties. Geo-Risk 2011: Risk Assessment and Management 845–852.

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Surface Wave Survey Array Layout

Utaba Dam

N

0 10 20 40 60 80 100
Feet

Figure 9-23

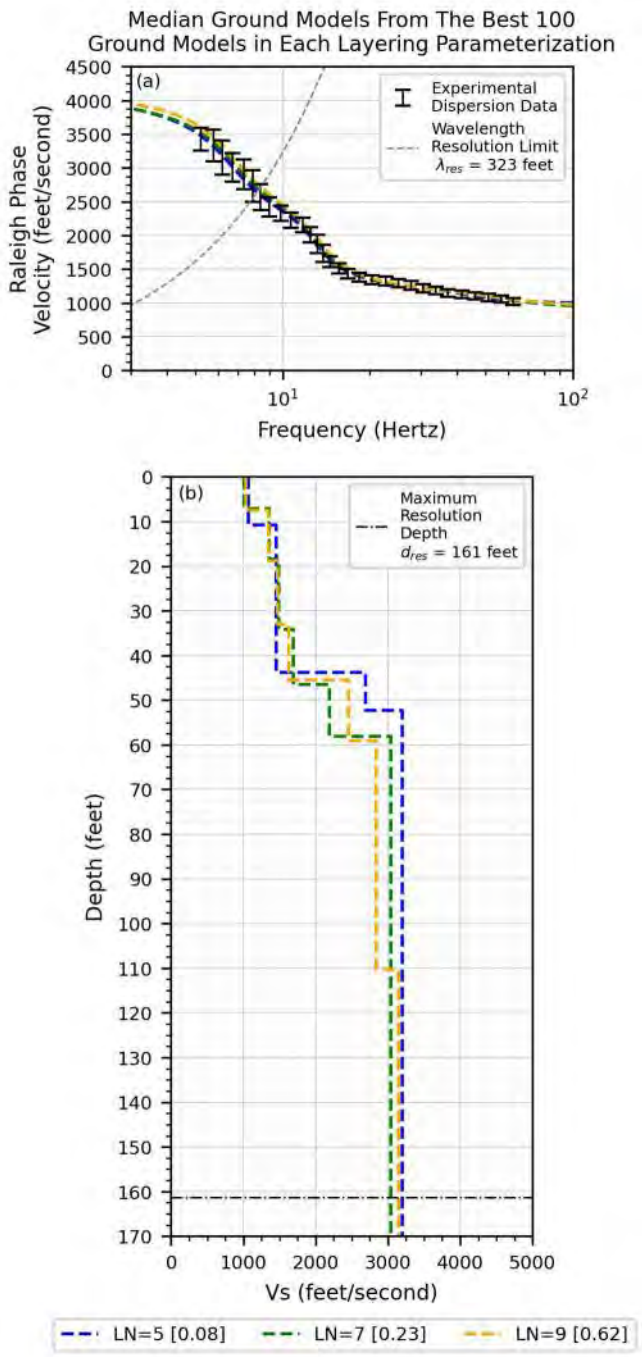

Figure 2. 1D ground models from surface wave inversion based on a fundamental mode interpretation of the observed Rayleigh wave dispersion data at the site. For each inversion layering parameterization (i.e., LR = 5, 7, and 9), the ground models are presented in terms of the: (a) Rayleigh dispersion curves and (b) corresponding 1D Vs profiles for the median of the 100 lowest misfit ground models. The resolution depth of 161 feet is shown on the 1D Vs profiles. Use caution (additional verification of subsurface conditions required) when interpreting the data below this depth, as it was constrained by less reliable dispersion data during inversion processing.

Table 1: Coordinates of MASW and MAM Arrays
Utaba Dam
24-1762

Array Point	Geophysics Array Name	Date Recorded	Latitude (Decimal Degree)	Longitude (Decimal Degree)
MASW Line Start	MASW	09/23/24	41.387183	-111.909659
MASW Line End	MASW		41.386790	-111.909814
MAM C50-01	MAM C50		41.387216	-111.909708
MAM C50-02	MAM C50		41.387153	-111.909553
MAM C50-03	MAM C50		41.386997	-111.909528
MAM C50-04	MAM C50		41.386816	-111.909711
MAM C50-05	MAM C50		41.386797	-111.909867
MAM C50-06	MAM C50		41.386949	-111.910021
MAM C50-07	MAM C50		41.387111	-111.909954
MAM C50-08	MAM C50		41.387012	-111.909750

Notes:
1) Array points not surveyed; locations estimated in the field with a handheld GPS with an accuracy less than 10 feet. No elevation data available.

Table 2: Surface Wave Tabulated Median 1D Vs Profiles

Utaba Dam

24-1762

LN = 5		LN = 7		LN = 9	
Depth (feet)	Vs (feet/second)	Depth (feet)	Vs (feet/second)	Depth (feet)	Vs (feet/second)
0	1063	0	1007	0	1027
11	1063	7	1007	7	1027
11	1455	7	1357	7	1343
44	1455	18	1357	19	1343
44	2682	18	1484	19	1469
52	2682	34	1484	33	1469
52	3192	34	1689	33	1623
161	3192	46	1689	45	1623
		46	2187	45	2452
		58	2187	59	2452
		58	3037	59	2833
		161	3037	110	2833
				110	3145
				161	3145

Notes:

1) LN refers to parameterization layering number; this is the number of layers specified in each ground model during inversion.

2) The three median 1D Vs profile are truncated at the resolution depth of the surface wave survey, which is a depth of 161 feet.

3) Each median 1D Vs profile can be used as separate base-case Vs profiles to calculate Vs30 by the designer.

Appendix D

Summary of Laboratory Test Results
UTABA Dam (24-1762)

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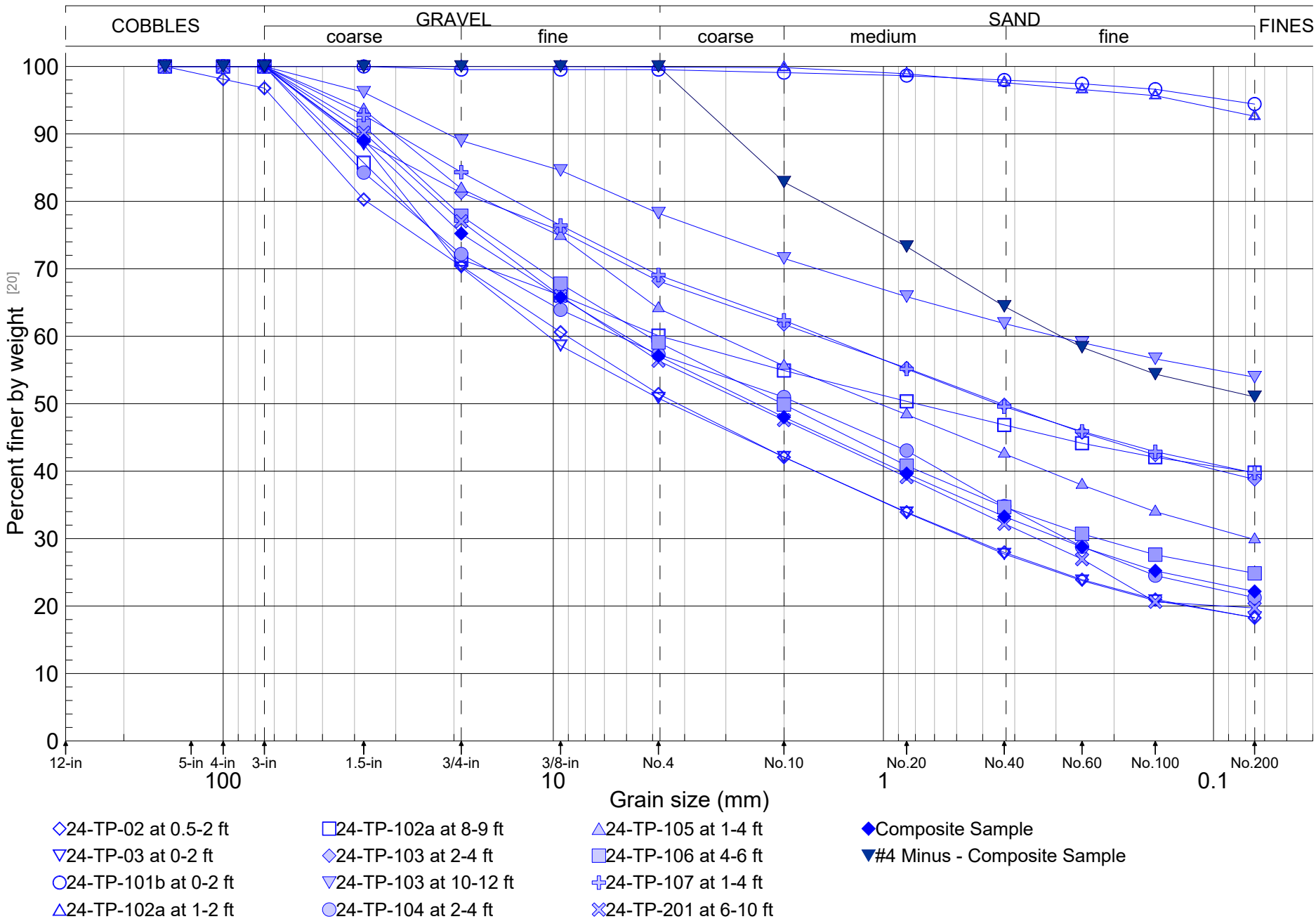

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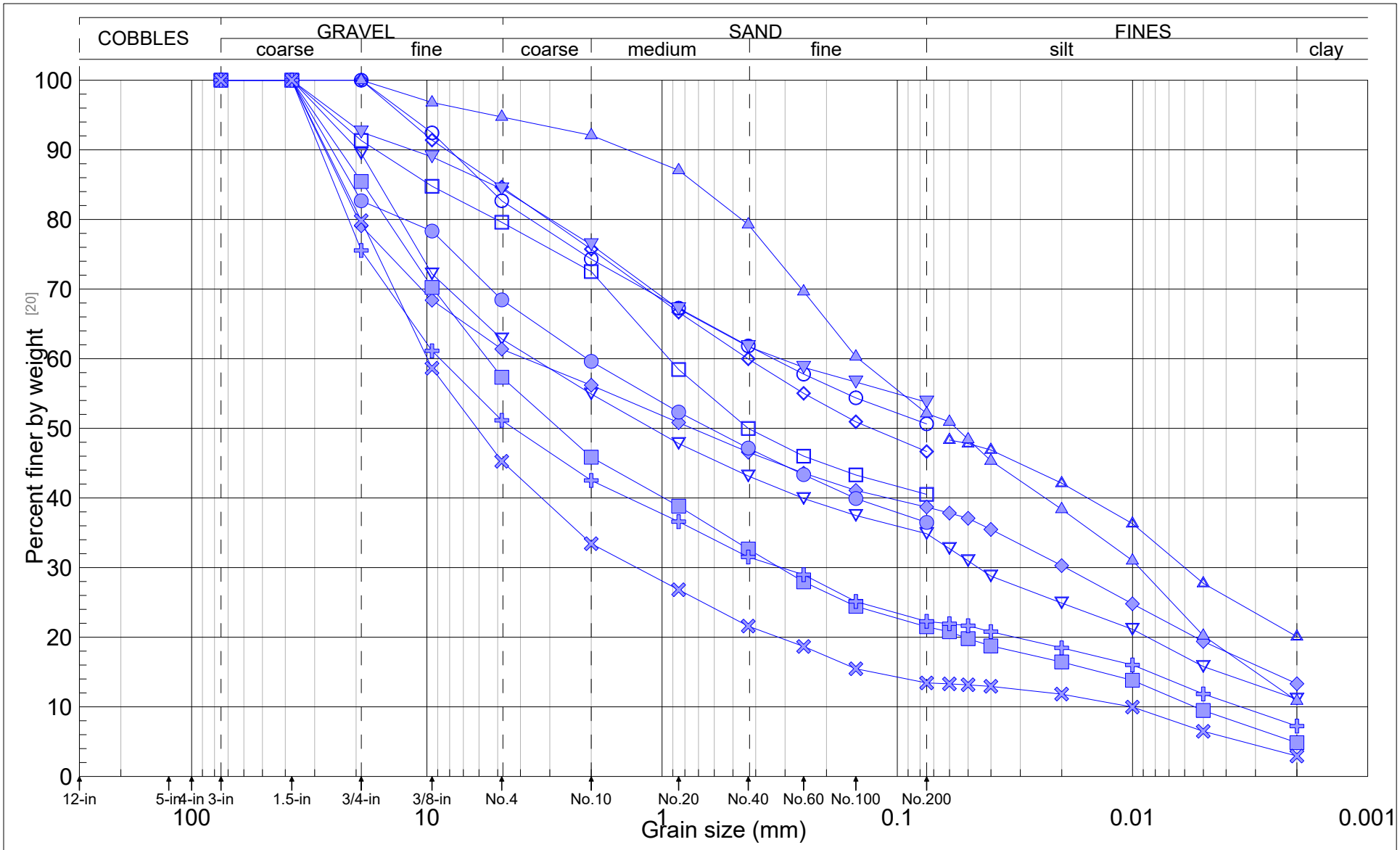
Grain-Size Analysis

Utaba Dam



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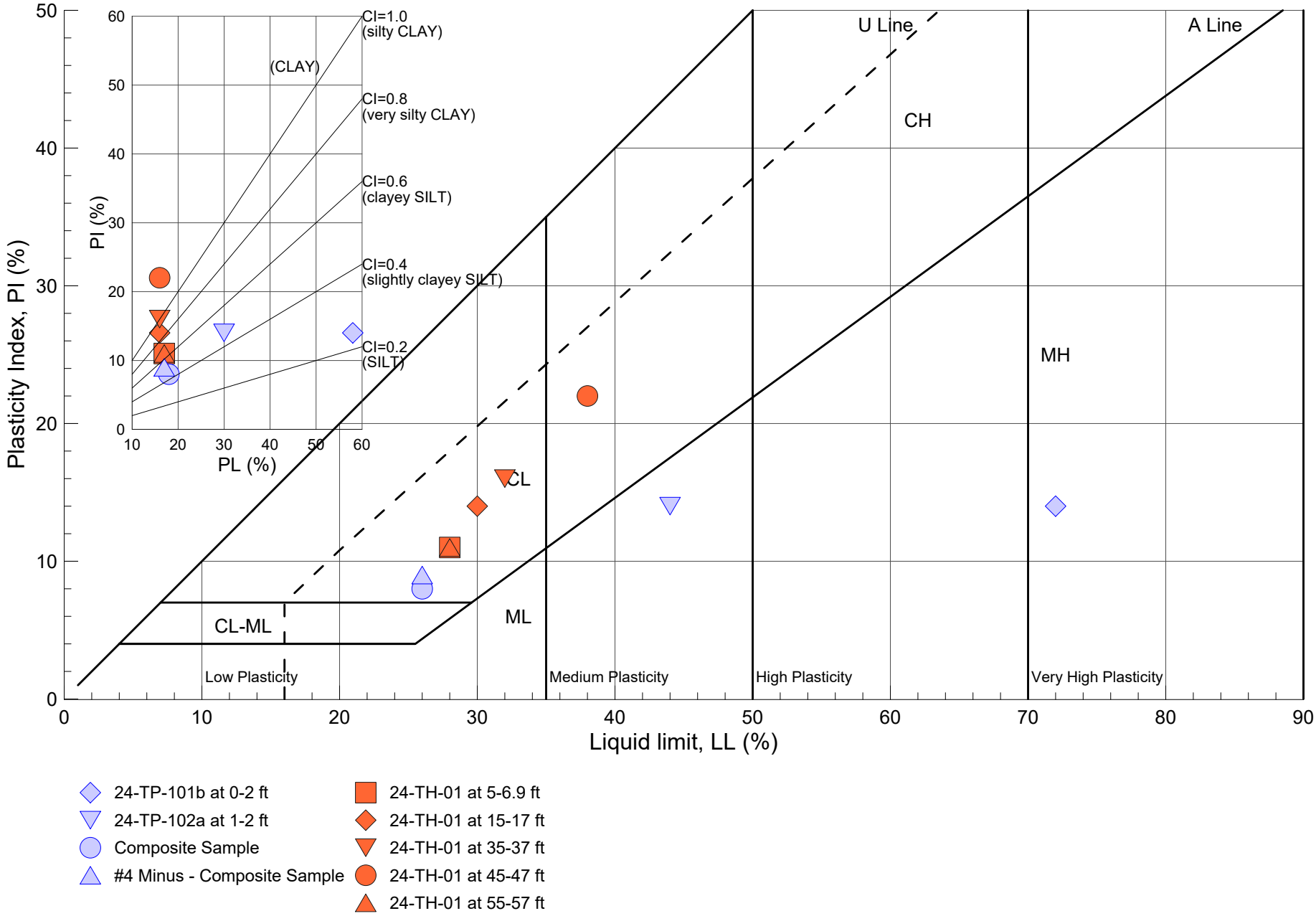
Grain-Size Analysis

Utaba Dam



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Casagrande's Plasticity Chart (Atterberg Limits)

Utaba Dam

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*

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After ASTM D2974 C

Project: **Utaba Dam**

No: **24-1762**

\\Server19\company\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_TP_OC.xlsx]1

Sample Info.	Sample:	**24-TP-101B**					
	Depth:	**0-2 ft**					
	Date Sampled:	**21-Oct-24**					
	Date tested:	**26-Nov-24**					
	Laboratory sample description:	**bn - dk bn silt**					
Moisture & Organics	Wet soil + tare (g)	319.79					
	Dry soil + tare (g)	293.77					
	Ash+tare (g)	291.09					
	Tare (g)	271.69					
	Dry soil (g)	22.1					
	Ash mass (g)	19.4					
	Moisture content, w (%)	117.8					
Results	Ash content (%)	87.9					
	Organic matter (%)	12.1					
Comments							
QC/QA	Tested By:	JC					
	Reduced By:	AT					
	Reviewed By:	JC					

g_m=Ws/453.6/V ; g_d = g_m/(1+w)

Triaxial Test - Isotropic Consolidated Sheared Undrained Measuring Pore Pressure (CIU-PP)* - After ASTM D4767 and USBR 5750

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Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 14-Nov-24
Tested by: AT
Reduced by: JC
Checked by: ZMG

TH/TP/Sample: 24-TH-01
Depth: 35-37 ft
Laboratory sample description: lt bn - bn silt
USCS classification: not requested
Sample type: Rel. undisturbed, Shelby Tube

Multi-Staged

	Test Number	S1	15 psi	S2	29 psi	S3	70 psi
		Initial	Bef. Shr. MethodB [e]	Initial	Bef. Shr. MethodB [e]	Initial	Bef. Shr. MethodB [e]
Unit weight data	0°	5.721					
	Sample ht., H (in) 120°	5.744					
	240°	5.727					
	Avg. height, Havg (in)	5.730					5.210
	Avg. height, Havg (cm)	14.555					13.234
	ΔHsc (in) [a]						0.000
	top	2.867					
	Sample dia., D (in) mid	2.871					
	bot	2.869					
	Avg. dia., Davg (in)	2.869					2.903
	Avg. dia., Davg (cm)	7.288					7.374
	Avg. area, Aavg (in^2)	6.466					6.620
	Avg. area, Aavg (cm^2)	41.719					42.707
	Wt. rings + wet soil (g)	1280.07					1280.42
	Wt. rings (g)	0.00					0.00
	Volume, Vo (in^3)	37.1					34.5
	Vo (cm^3)	607.2					565.2
	Vo (ft^3)	0.0214					0.0200
Moisture	Wet soil + tare (g)	159.36					1475.12
	Dry soil + tare (g)	156.35					1330.70
	Tare (g)	119.20					195.24
	Moisture content, w (%)	8.1					12.7
Phase Relationships	Gs, assumed	2.70					2.70
	Mass total (g)	1280.1					1280.4
	Mass of solids (g)	1184.1					1135.9
	Volume (cm^3)	607.2					565.2
	Volume of water (cm^3)	95.9					144.5
	Volume of solids (cm^3)	438.6					420.7
	Volume of voids (cm^3)	168.7					144.5
	Volume of air (cm^3)	72.7					0.0
	Void ratio, e	0.385					0.343
	Porosity, n	0.278					0.256
	Volumetric moisture, T	0.158					0.256
	Saturation, S (%) [c]	56.89					100.00
	Dry density (gm/cm^3)	1.950					2.010
	Wet unit wt., gm (pcf)	131.6					141.4
	Dry unit wt., gd (pcf)	121.7					125.5

Notes:

[a] ΔHsc (in) = change in height during saturation and consolidation

[b] ΔVs = change in volume during saturation, ΔVc = change in volume during consolidation

[c] Saturation before shear set to 100% for phase calculations

[d] Before shear Aavg using method A; where Ac (Method A) = (Vo-DVs - DVc)/(Ho-DHsc)

[e] Before shear Aavg using method B; where Ac (Method B) = (Vwf + Vs)/Hc

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

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Project:	**Utaba Dam**	**TH/TP/Sample:**	**24-TH-01**
No:	**24-1762**	**Depth:**	**35-37 ft**
Location:	Weber County, Utah	Laboratory sample description:	lt bn - bn silt
Date:	14-Nov-24	USCS classification:	not requested
Tested by:	AT	Sample type:	Rel. undisturbed, Shelby Tube

J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01@35ft_TX_CU3pts.xlsx]SUM

	Test Number	S1 at 15 psi	S2 at 29 psi	S3 at 70 psi
Test information	Total backpressure (psi)	44.0	44.0	44.0
	Skempton B	0.96	0.96	0.96
	t-90 (min)	10.0	72.0	135.0
	t-100 (min)	18.5	102.0	182.3
	t-50 (min)	2.3	16.8	31.5
	Strain rate (%/hr)	1.20	1.20	1.20
	Strain rate (%/min)	0.02	0.02	0.02
	Membrane correction	Yes	Yes	Yes
	Filter paper correction	No	No	No
Max principal stress ratio (s1/s3), failure criteria	Strain at failure, ef (%)	4.04	3.97	5.32
	Time to failure, tf (min)	202.0	198.4	265.8
	Obliquity, s'1/s'3	4.332	4.013	3.623
	Excess pore pressure, u (psi)	10.10	16.23	35.67
	q = q' = (s1-s3)/2 (psi)	8.16	19.24	45.02
	p' = (s'1+s'3)/2 (psi)	13.05	32.02	79.35
	p = (s1+s3)/2 (psi)	23.16	48.24	115.02
	Effective major principal stress, s'1 (psi)	21.21	51.26	124.38
	Effective minor principal stress, s'3 (psi)	4.90	12.77	34.33
	Total major principal stress, s1 (psi)	31.31	67.48	160.05
	Total minor principal stress, s3 (psi)	15.00	29.00	70.00
	Skemption A at failure, Af	0.62	0.42	0.40
	Secant friction angle, phi-s (deg)	38.7	36.9	34.6
		Effective stress	Total stress	
	Friction angle, phi (deg)	33.6	23.0	
	Cohesion intercept, c (psi)	1.4	0.0	
Peak deviator stress (s1-s3), failure criteria	Strain at failure, ef (%)	4.04	4.17	16.43
	Time to failure, tf (min)	202.0	208.4	821.5
	Deviator stress, s1-s3 (psi)	16.31	38.84	105.18
	Excess pore pressure, u (psi)	10.10	16.08	24.68
	q = q' = (s1-s3)/2 (psi)	8.16	19.42	52.59
	p' = (s'1+s'3)/2 (psi)	13.05	32.34	97.91
	p = (s1+s3)/2 (psi)	23.16	48.42	122.59
	Effective major principal stress, s'1 (psi)	21.21	51.77	150.50
	Effective minor principal stress, s'3 (psi)	4.90	12.92	45.32
	Total major principal stress, s1 (psi)	31.31	67.84	175.18
	Total minor principal stress, s3 (psi)	15.00	29.00	70.00
	Skemption A at failure, Af	0.62	0.41	0.23
	Secant friction angle, phi-s (deg)	38.7	36.9	32.5
		Effective stress	Total stress	
	Friction angle, phi (deg)	31.3	25.0	
	Cohesion intercept, c (psi)	2.3	0.0	
	Photo of sample after shearing	S1 at 15 psi	S2 at 29 psi	S3 at 70 psi

Comments:

Multi-Staged

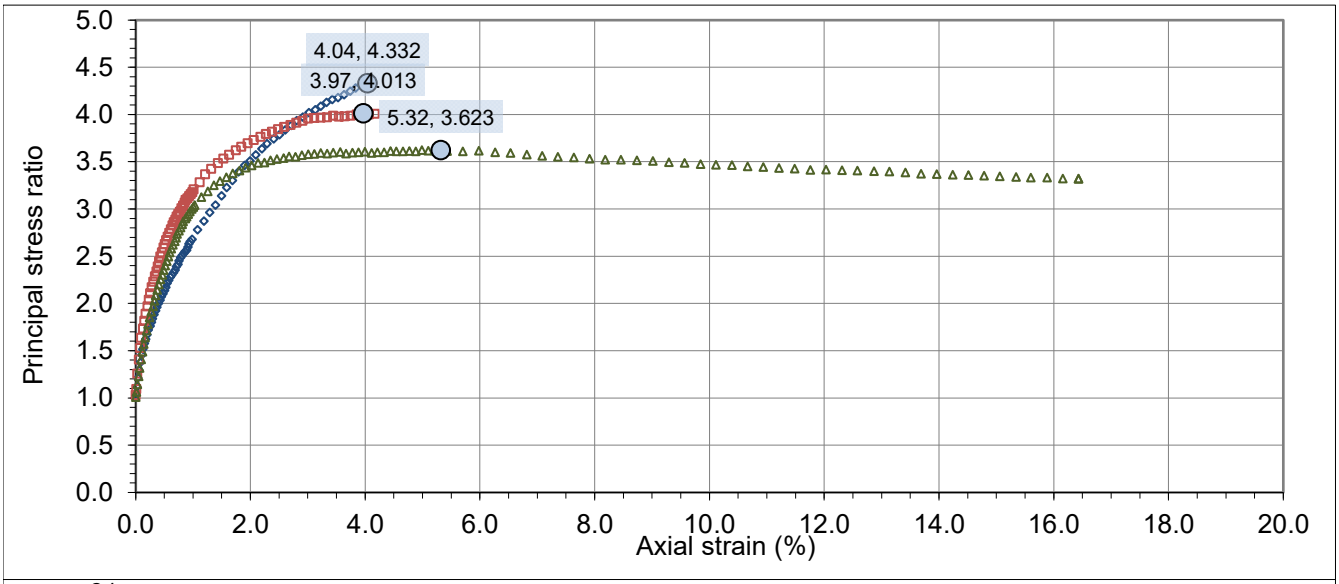


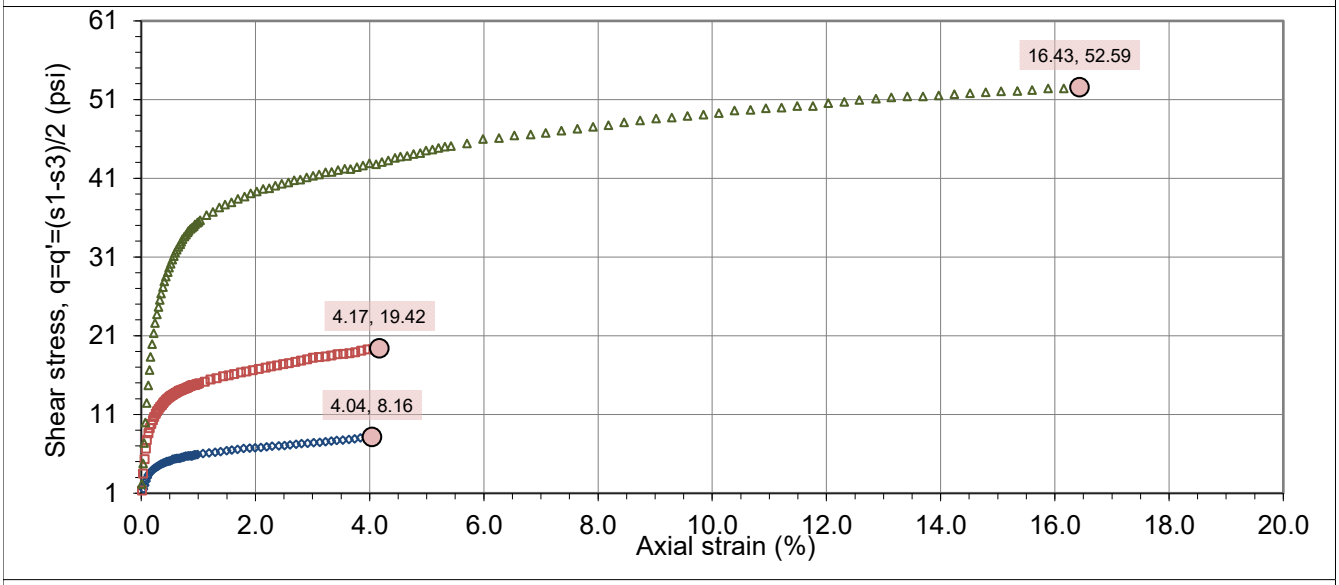
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

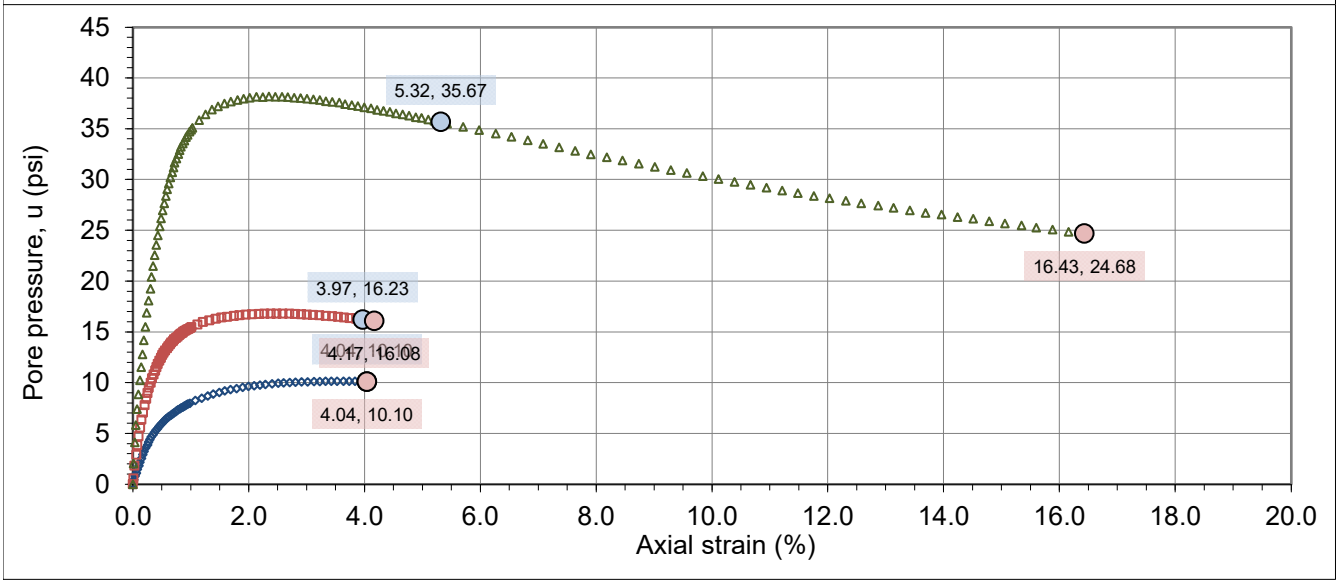
GERHART COLE

Project: Utaba Dam
No: 24-1762

TH/TP/Sample: 24-TH-01
Depth: 35-37 ft







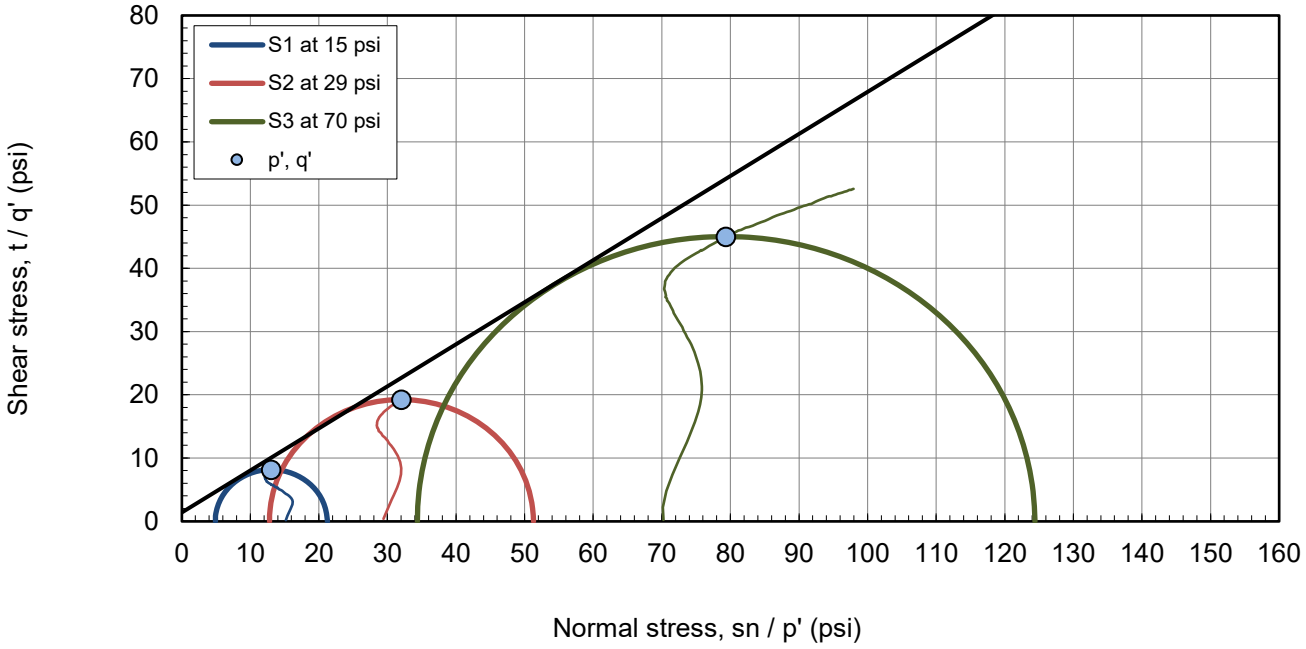
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project: Utaba Dam
No: 24-1762

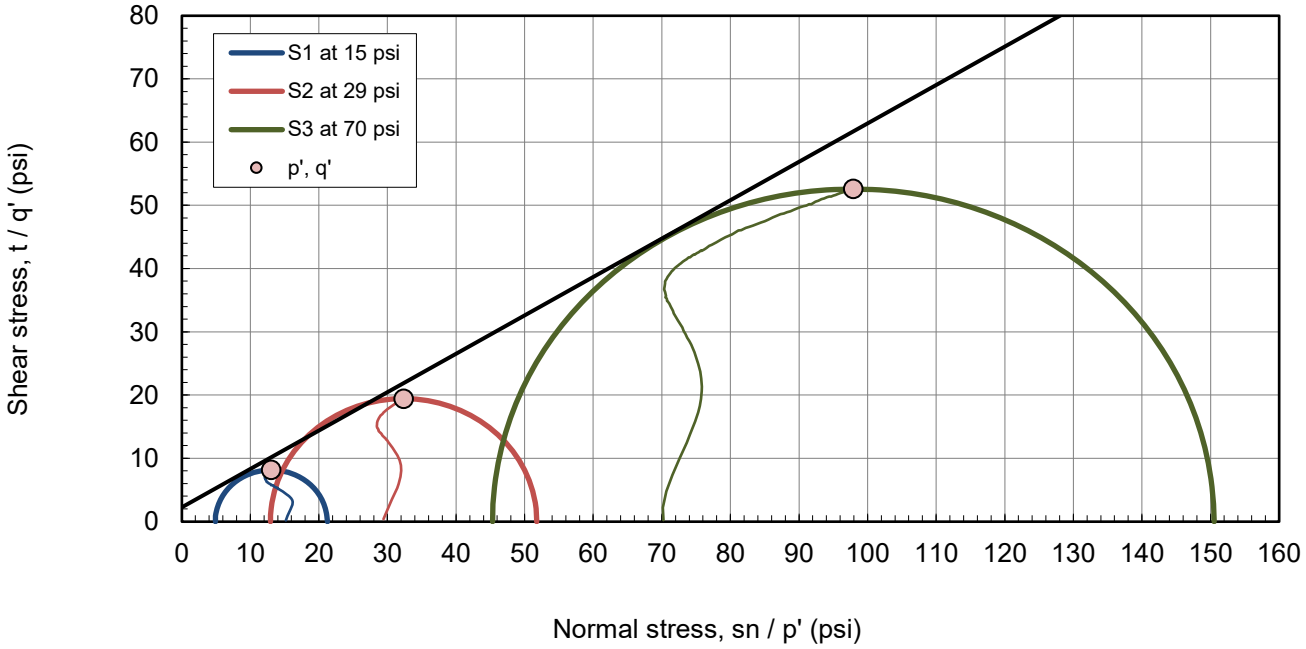
TH/TP/Sample: 24-TH-01
Depth: 35-37 ft

Effective stress results



Max principal stress ratio (s'1/s'3), failure criteria Mohr and p' - q' space plots

Effective stress results



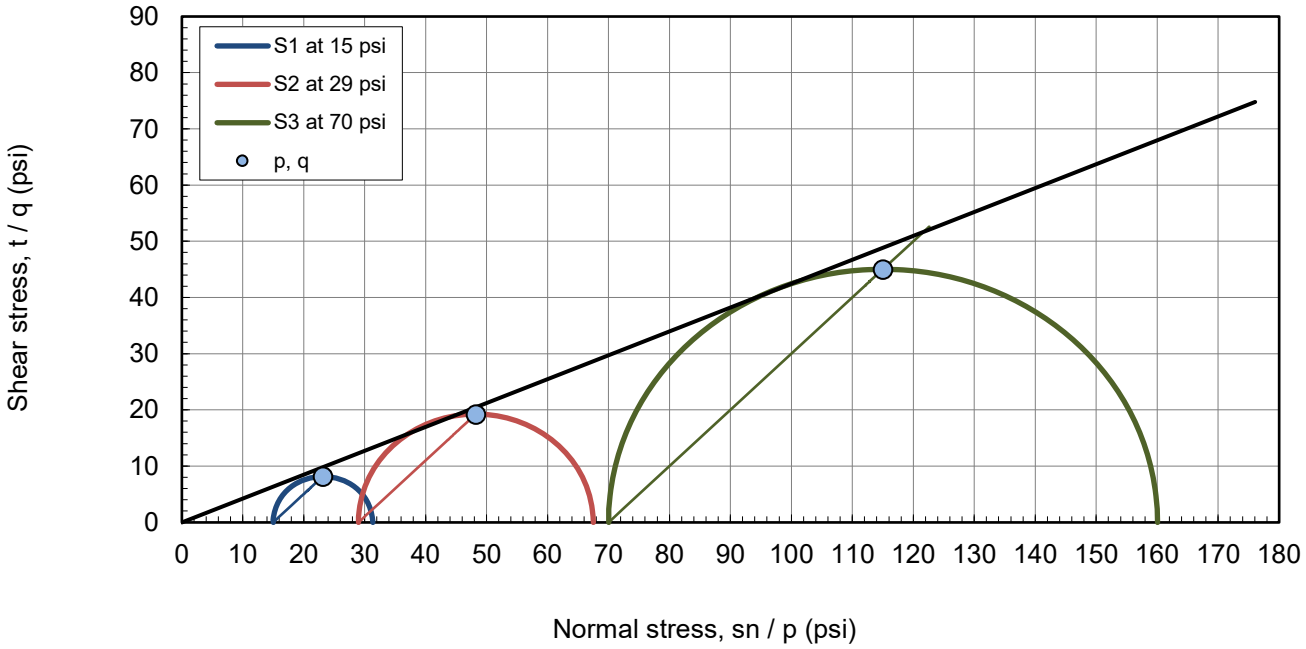
Peak deviator stress (s1-s3), failure criteria Mohr and p' - q' space plots

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

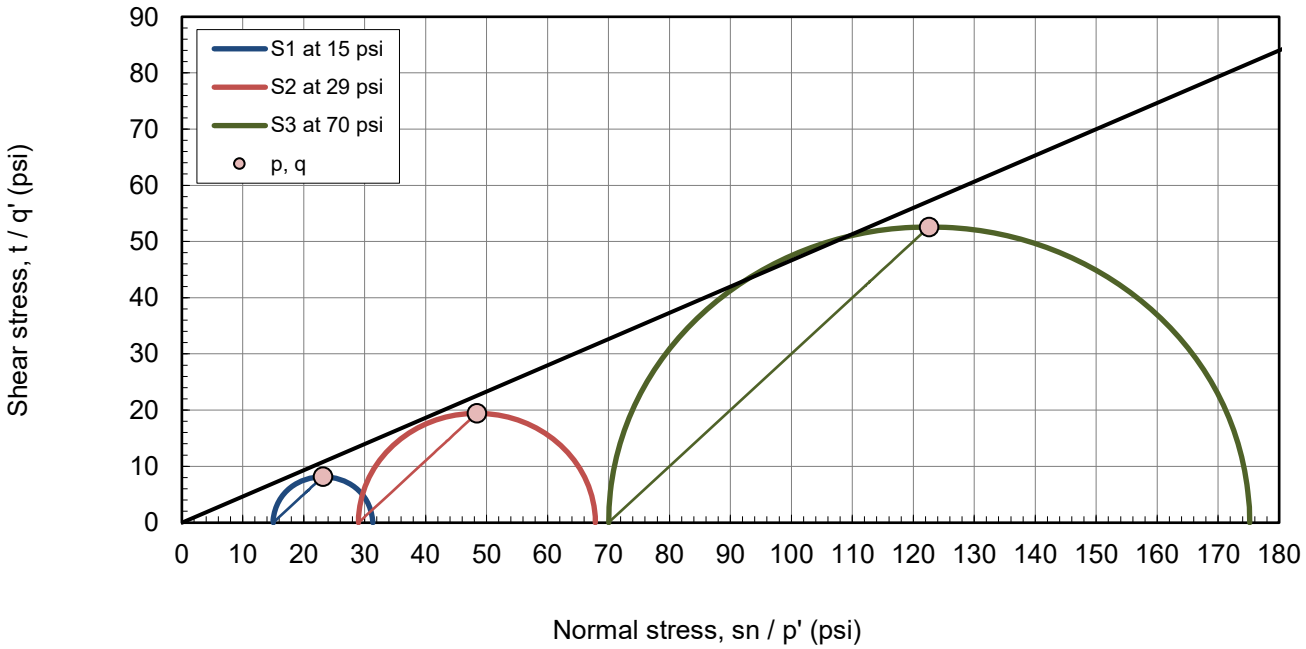
Project: Utaba Dam
No: 24-1762
TH/TP/Sample: 24-TH-01
Depth: 35-37 ft

Total stress results



Max principal stress ratio (s1/s3), failure criteria Mohr and p - q space plots - effective stress results

Total stress results



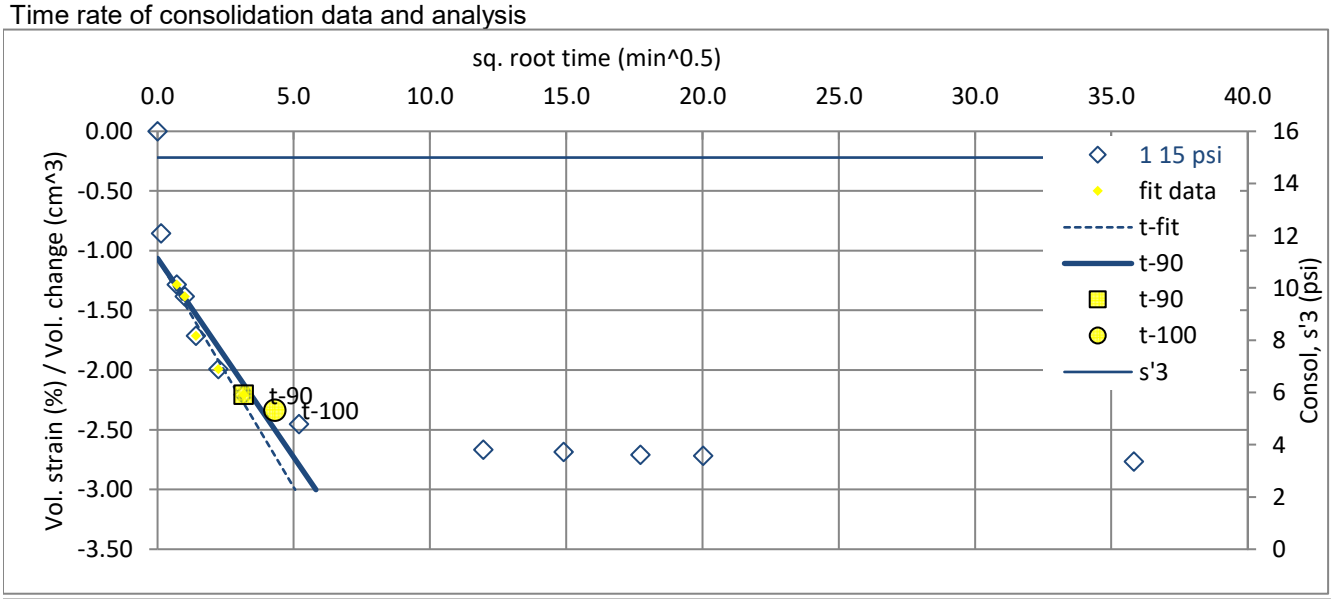
Peak deviator stress (s1-s3), failure criteria Mohr and p - q space plots

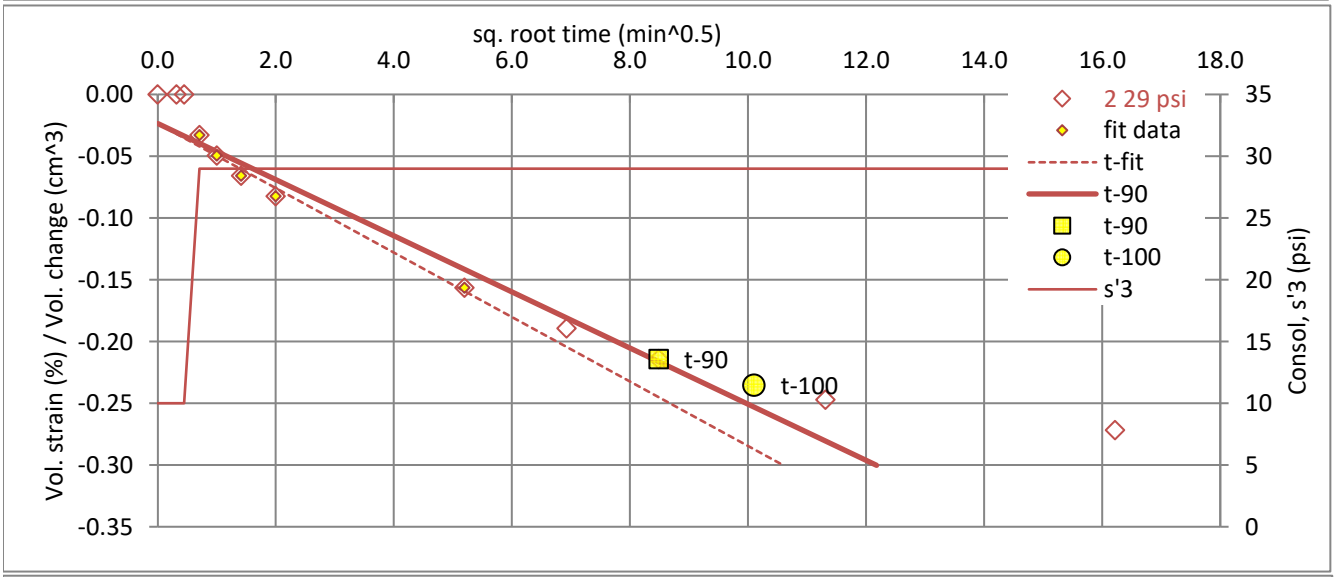
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

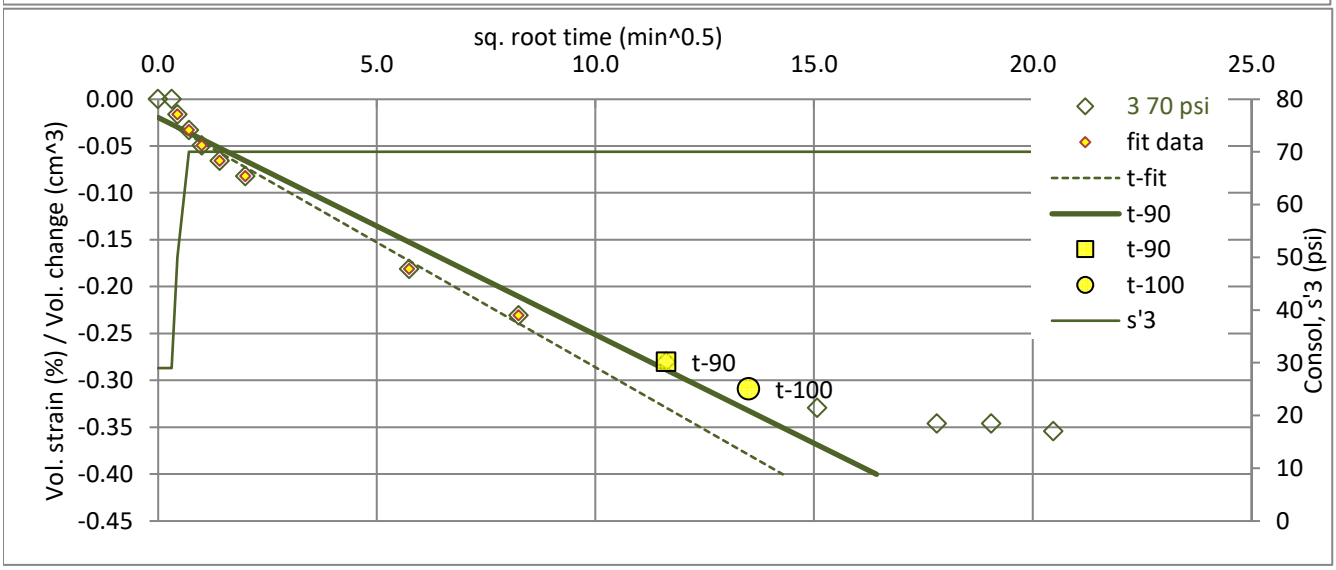
GERHART COLE

Project: Utaba Dam **TH/TP/Sample:** 24-TH-01
No: 24-1762 **Depth:** 35-37 ft

Time rate of consolidation data and analysis







Triaxial Test - Isotropic Consolidated Sheared Undrained Measuring Pore Pressure (CIU-PP)* - After ASTM D4767 and USBR 5750

GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 14-Nov-24
Tested by: AT
Reduced by: AT
Checked by: ZMG

TH/TP/Sample: 24-TH-01
Depth: 45-47 ft (~46.5 ft)
Laboratory sample description: dk yl bn - lt bn gravely clay
USCS classification: not requested
Sample type: Rel. undisturbed, Shelby Tube

	Test Number	S1	20 psi	S2	38 psi	S3	78 psi
		Initial	Bef. Shr. MethodB [e]	Initial	Bef. Shr. MethodB [e]	Initial	Bef. Shr. MethodB [e]
Unit weight data	Sample ht., H (in) 0°	5.742					
	Sample ht., H (in) 120°	5.708					
	Sample ht., H (in) 240°	5.744					
	Avg. height, Havg (in)	5.731					5.301
	Avg. height, Havg (cm)	14.557					13.465
	ΔHsc (in) [a]						0.000
	Sample dia., D (in) top	2.871					
	Sample dia., D (in) mid	2.821					
	Sample dia., D (in) bot	2.899					
	Avg. dia., Davg (in)	2.853					3.028
	Avg. dia., Davg (cm)	7.247					7.691
	Avg. area, Aavg (in^2)	6.393					7.200
	Avg. area, Aavg (cm^2)	41.244					46.454
	Wt. rings + wet soil (g)	1338.22					1332.58
	Wt. rings (g)	0.00					0.00
	Volume, Vo (in^3)	36.6					38.2
	Vo (cm^3)	600.4					625.5
	Vo (ft^3)	0.0212					0.0221
Moisture	Wet soil + tare (g)	276.81					1093.52
	Dry soil + tare (g)	270.77					986.34
	Tare (g)	197.48					195.72
	Moisture content, w (%)	8.2					13.6
Phase Relationships	Gs, assumed	2.70					2.70
	Mass total (g)	1338.2					1403.9
	Mass of solids (g)	1236.3					1236.3
	Volume (cm^3)	600.4					625.5
	Volume of water (cm^3)	101.9					167.6
	Volume of solids (cm^3)	457.9					457.9
	Volume of voids (cm^3)	142.5					167.6
	Volume of air (cm^3)	40.6					0.0
	Void ratio, e	0.311					0.366
	Porosity, n	0.237					0.268
	Volumetric moisture, T	0.170					0.268
	Saturation, S (%) [c]	71.50					100.00
	Dry density (gm/cm^3)	2.059					1.977
	Wet unit wt., gm (pcf)	139.2					140.1
	Dry unit wt., gd (pcf)	128.6					123.4

Multi-Staged Test

Notes:

[a] ΔHsc (in) = change in height during saturation and consolidation

[b] ΔVs = change in volume during saturation, ΔVc = change in volume during consolidation

[c] Saturation before shear set to 100% for phase calculations

[d] Before shear Aavg using method A; where Ac (Method A) = (Vo-DVs - DVc)/(Ho-DHsc)

[e] Before shear Aavg using method B; where Ac (Method B) = (Vwf + Vs)/Hc

J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01@45ft_TX_CU3pts.xlsx]MD

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project:	**Utaba Dam**	**TH/TP/Sample:**	**24-TH-01**
No:	**24-1762**	**Depth:**	**45-47 ft**
Location:	Weber County, Utah	Laboratory sample description:	dk yl bn - lt bn gravely clay
Date:	14-Nov-24	USCS classification:	not requested
Tested by:	AT	Sample type:	Rel. undisturbed, Shelby Tube

J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01@45ft_TX_CU3pts.xlsx]SUM

	Test Number	S1 at 20 psi	S2 at 38 psi	S3 at 78 psi
Test information	Total backpressure (psi)	39.0	39.0	39.0
	Skempton B	0.95	0.95	0.95
	t-90 (min)	60.0	181.0	69.0
	t-100 (min)	94.1	292.4	132.3
	t-50 (min)	14.0	42.3	16.1
	Strain rate (%/hr)	1.20	1.20	1.20
	Strain rate (%/min)	0.02	0.02	0.02
	Membrane correction	Yes	Yes	Yes
	Filter paper correction	No	No	No
Max principal stress ratio (s1/s3), failure criteria	Strain at failure, ef (%)	2.27	2.76	4.02
	Time to failure, tf (min)	113.7	138.1	200.8
	Obliquity, s'1/s'3	4.534	3.331	3.047
	Excess pore pressure, u (psi)	10.94	13.05	30.67
	q = q' = (s1-s3)/2 (psi)	16.01	29.09	48.44
	p' = (s'1+s'3)/2 (psi)	25.07	54.04	95.78
	p = (s1+s3)/2 (psi)	36.01	67.09	126.44
	Effective major principal stress, s'1 (psi)	41.08	83.12	144.22
	Effective minor principal stress, s'3 (psi)	9.06	24.95	47.33
	Total major principal stress, s1 (psi)	52.02	96.17	174.89
	Total minor principal stress, s3 (psi)	20.00	38.00	78.00
	Skemption A at failure, Af	0.34	0.22	0.32
	Secant friction angle, phi-s (deg)	39.7	32.6	30.4
		Effective stress	Total stress	
	Friction angle, phi (deg)	27.3	20.8	
	Cohesion intercept, c (psi)	5.0	4.4	
Peak deviator stress (s1-s3), failure criteria	Strain at failure, ef (%)	3.97	4.11	15.87
	Time to failure, tf (min)	198.5	205.5	793.5
	Deviator stress, s1-s3 (psi)	38.57	60.96	106.87
	Excess pore pressure, u (psi)	8.22	11.41	23.35
	q = q' = (s1-s3)/2 (psi)	19.29	30.48	53.43
	p' = (s'1+s'3)/2 (psi)	31.07	57.07	108.08
	p = (s1+s3)/2 (psi)	39.29	68.48	131.43
	Effective major principal stress, s'1 (psi)	50.35	87.55	161.52
	Effective minor principal stress, s'3 (psi)	11.78	26.59	54.65
	Total major principal stress, s1 (psi)	58.57	98.96	184.87
	Total minor principal stress, s3 (psi)	20.00	38.00	78.00
	Skemption A at failure, Af	0.21	0.19	0.22
	Secant friction angle, phi-s (deg)	38.4	32.3	29.6
		Effective stress	Total stress	
	Friction angle, phi (deg)	26.4	21.7	
	Cohesion intercept, c (psi)	6.0	5.3	
	Photo of sample after shearing	S1 at 20 psi	S2 at 38 psi	S3 at 78 psi

Comments:
Depth ~46.5 ft.
Consolidated using panels.

Multi-Staged

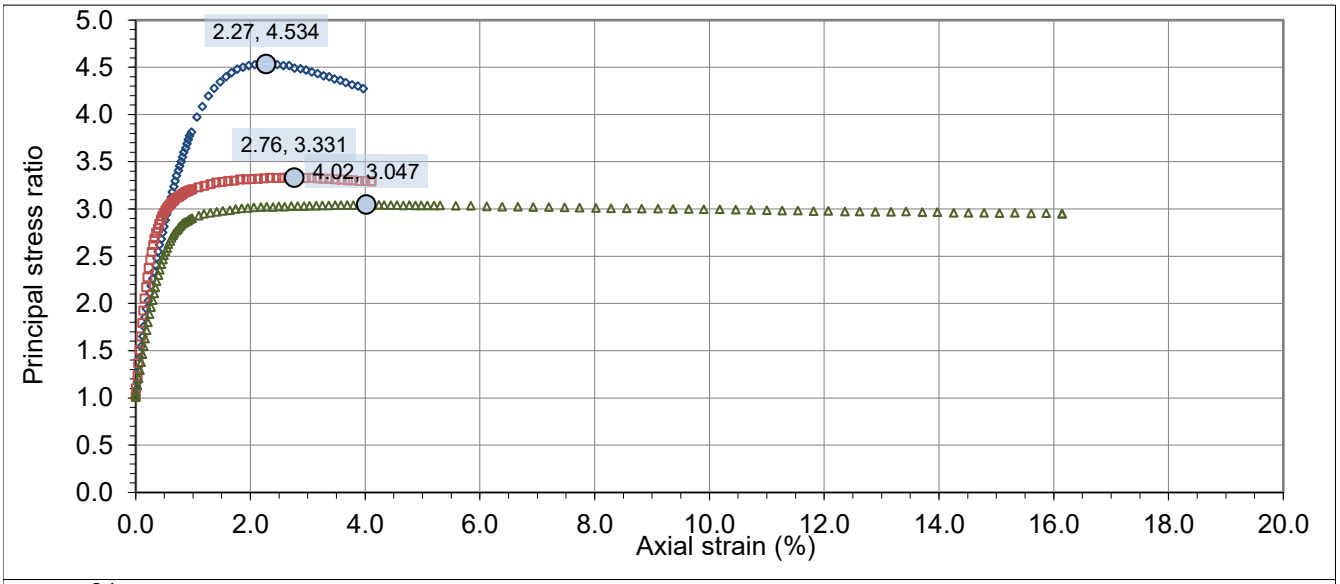


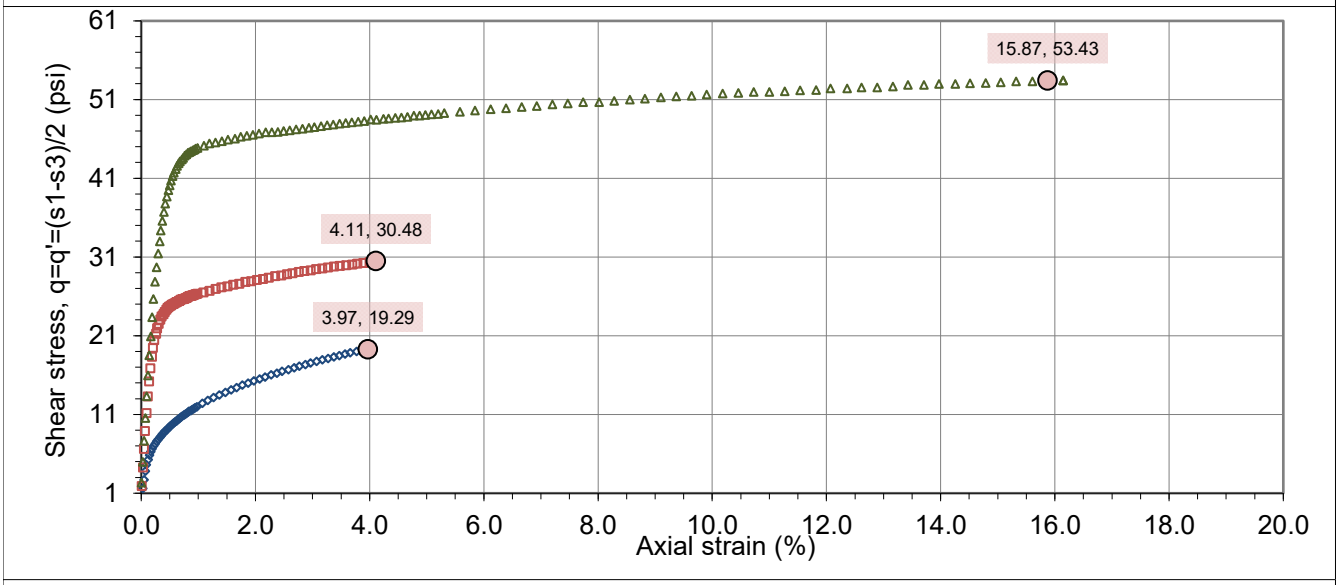
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

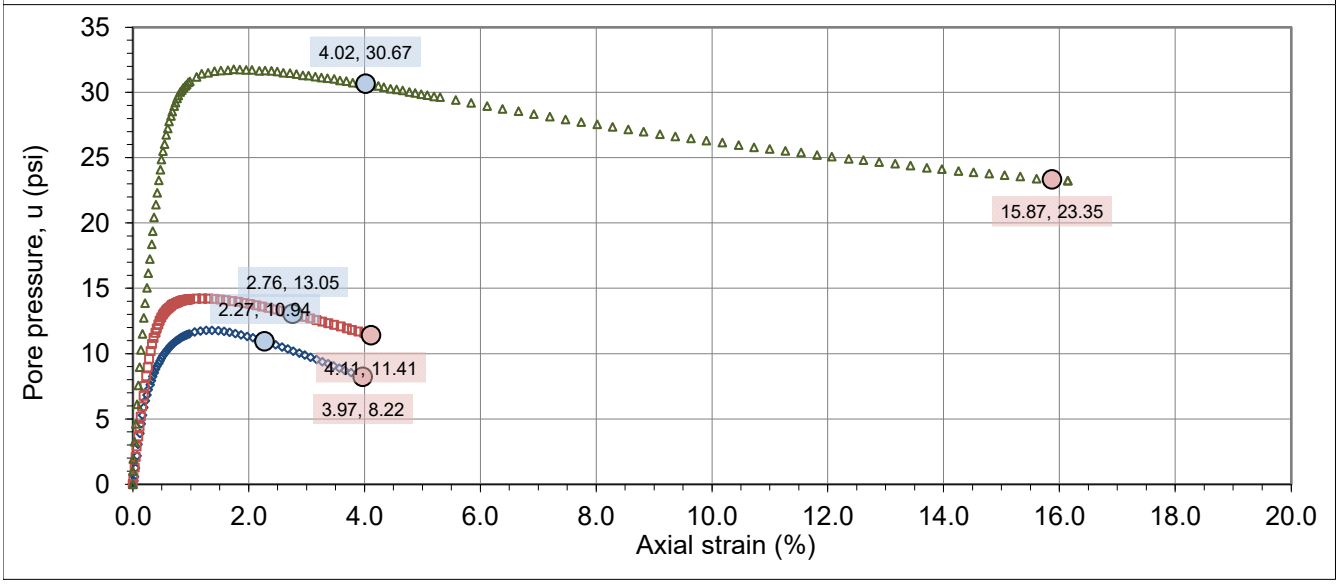
GERHART COLE

Project: Utaba Dam
No: 24-1762

TH/TP/Sample: 24-TH-01
Depth: 45-47 ft







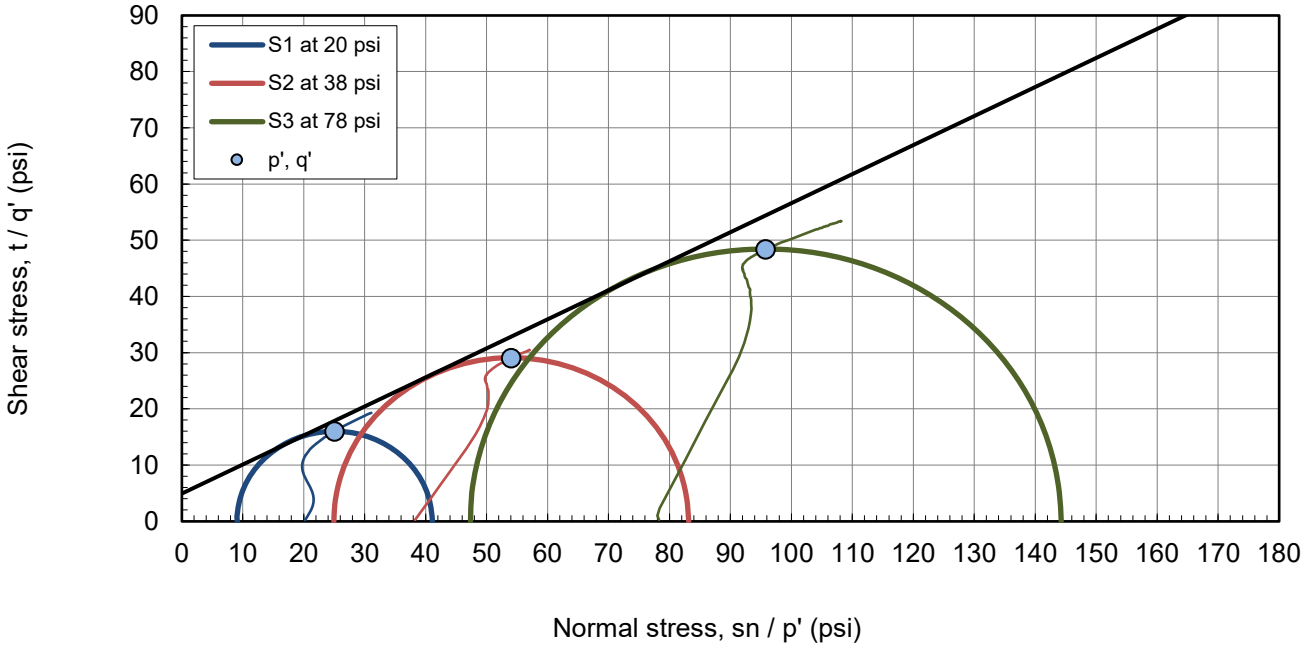
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project: Utaba Dam
No: 24-1762

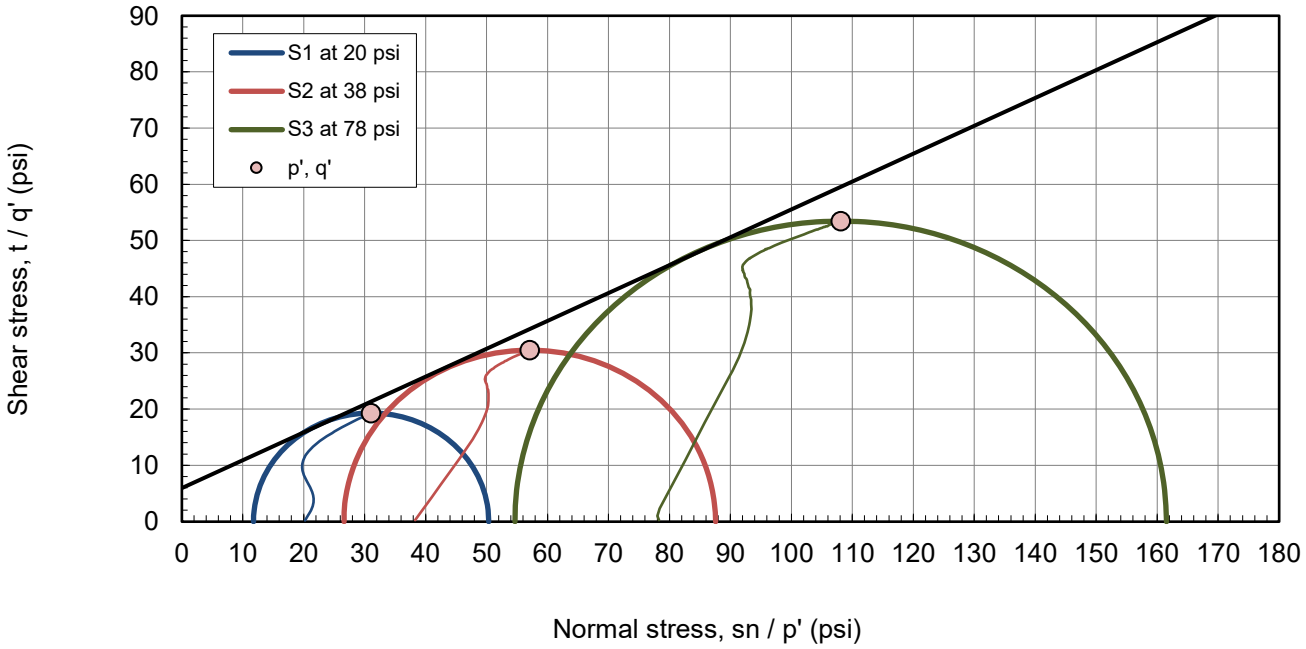
TH/TP/Sample: 24-TH-01
Depth: 45-47 ft

Effective stress results



Max principal stress ratio (s'1/s'3), failure criteria Mohr and p' - q' space plots

Effective stress results



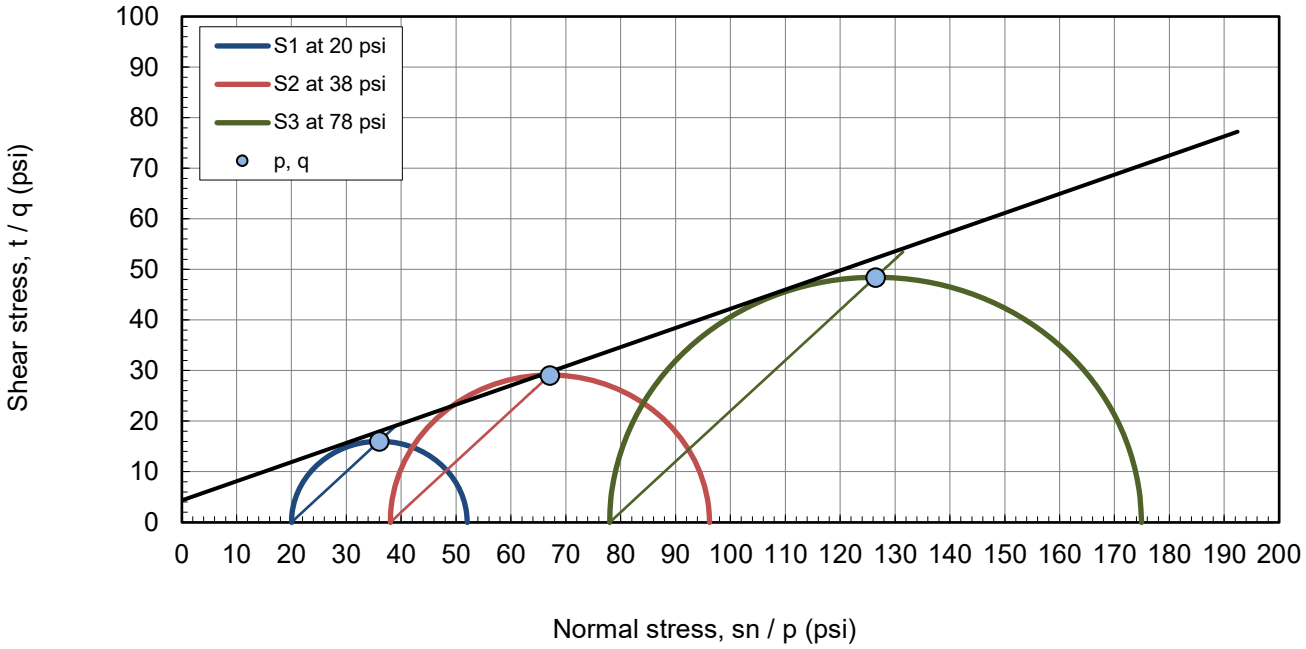
Peak deviator stress (s1-s3), failure criteria Mohr and p' - q' space plots

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

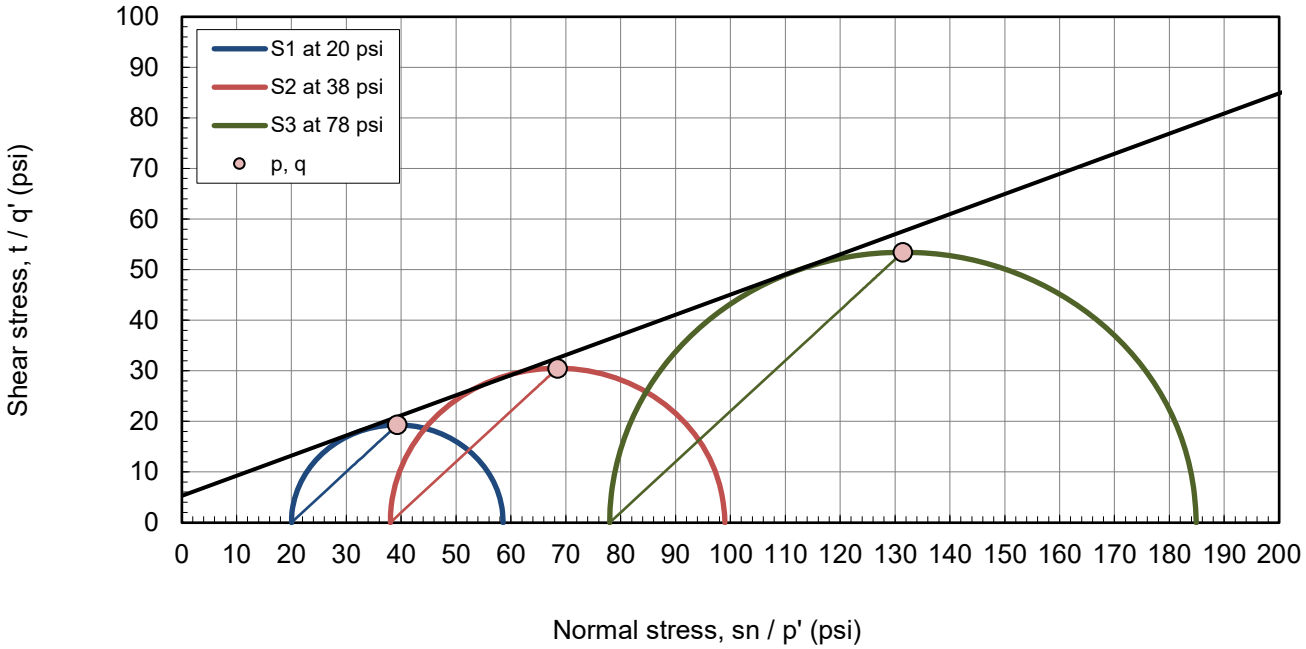
Project: Utaba Dam
No: 24-1762
TH/TP/Sample: 24-TH-01
Depth: 45-47 ft

Total stress results



Max principal stress ratio (s1/s3), failure criteria Mohr and p - q space plots - effective stress results

Total stress results



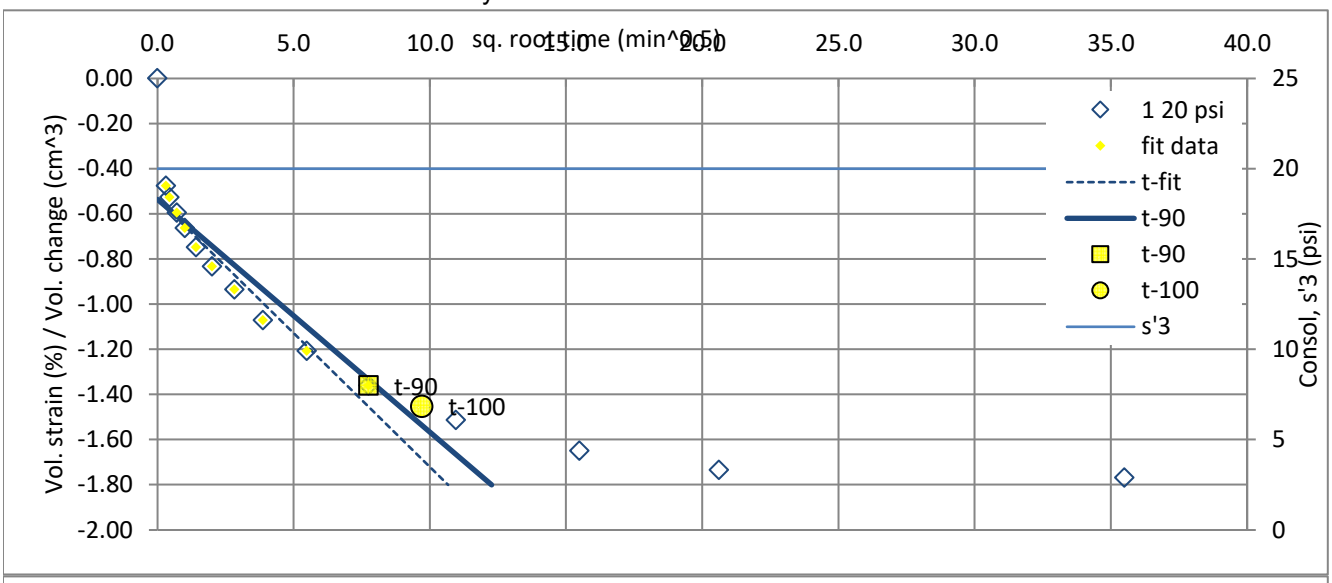
Peak deviator stress (s1-s3), failure criteria Mohr and p - q space plots

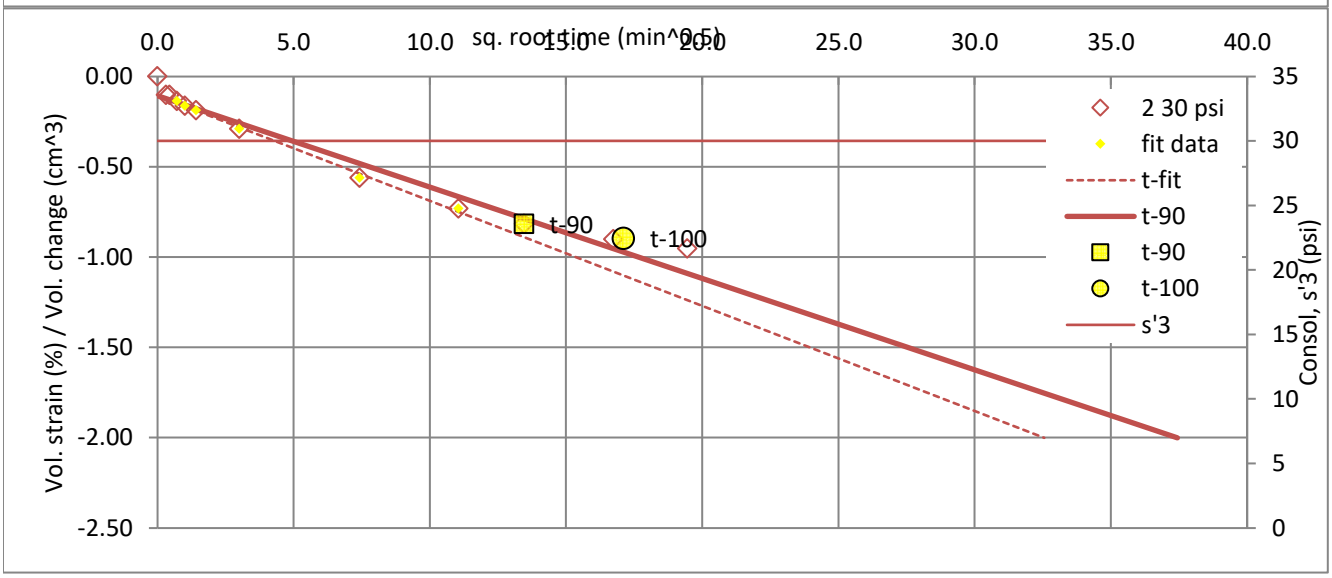
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

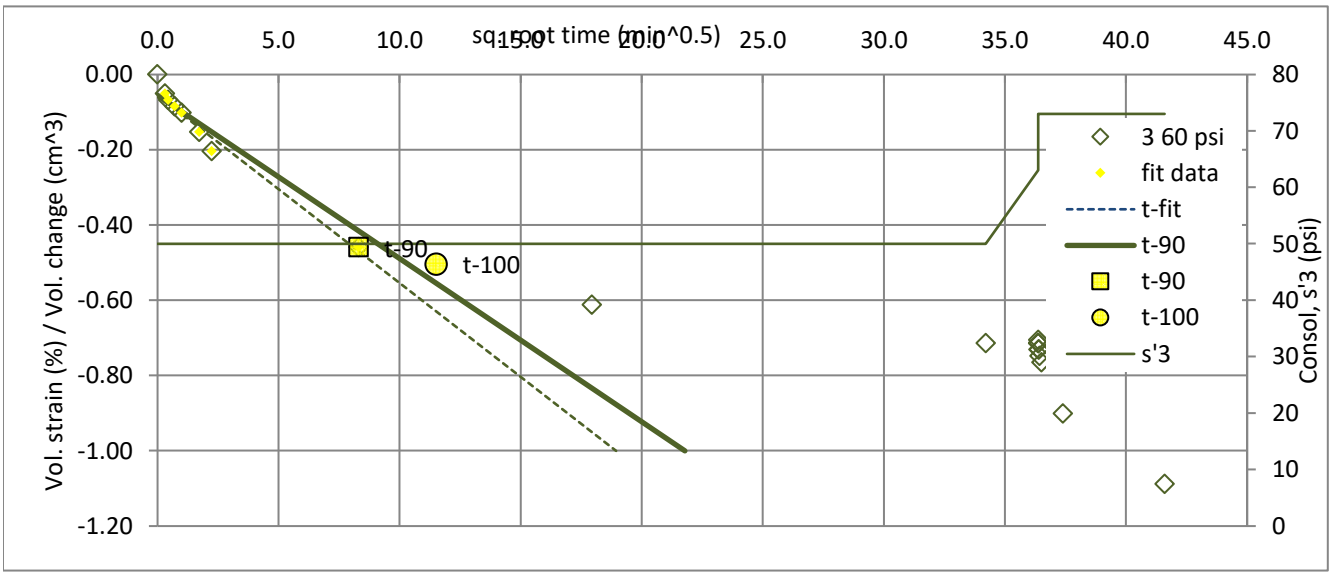
GERHART COLE

Project: Utaba Dam **TH/TP/Sample:** 24-TH-01
No: 24-1762 **Depth:** 45-47 ft

Time rate of consolidation data and analysis







Triaxial Test - Isotropic Consolidated Sheared Undrained Measuring Pore Pressure (CIU-PP)* - After ASTM D4767 and USBR 5750

GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 03-Dec-24
Tested by: MPK
Reduced by: AT
Checked by: JC

TH/TP/Sample: Composite Sample
Depth: -
Laboratory sample description: dk bn - bn gravelly clay
USCS classification: not requested
Sample type: Remolded to 95% of st. Proctor at OMC.

	Test Number	S1	30 psi	S2	60 psi	S3	150 psi
		Initial	Bef. Shr. Method B [e]	Initial	Bef. Shr. Method B [e]	Initial	Bef. Shr. Method B [e]
Unit weight data	Sample ht., H (in) 0°	5.894		5.923		5.972	
	120°	5.900		5.895		5.980	
	240°	5.910		5.898		5.951	
	Avg. height, Havg (in)	5.901	5.851	5.905	5.795	5.967	5.947
	Avg. height, Havg (cm)	14.989	14.862	15.000	14.720	15.157	15.106
	ΔHsc (in) [a]		0.050		0.110		0.020
	Sample dia., D (in) top	2.817		2.813		2.807	
	mid	2.816		2.814		2.812	
	bot	2.816		2.807		2.810	
	Avg. dia., Davg (in)	2.816	2.810	2.812	2.779	2.810	2.708
	Avg. dia., Davg (cm)	7.153	7.136	7.143	7.060	7.137	6.879
	Avg. area, Aavg (in^2)	6.229	6.200	6.211	6.068	6.200	5.761
	Avg. area, Aavg (cm^2)	40.188	39.998	40.069	39.145	40.003	37.168
	Wt. rings + wet soil (g)	1287.76	1315.81	1275.12	1291.68	1276.63	1281.23
	Wt. rings (g)	0.00	0.00	0.00	0.00	0.00	0.00
	Volume, Vo (in^3)	36.8	36.3	36.7	35.2	37.0	34.3
	Vo (cm^3)	602.4	594.5	601.0	576.2	606.3	561.5
	Vo (ft^3)	0.0213	0.0210	0.0212	0.0203	0.0214	0.0198
Moisture	Wet soil + tare (g)	898.51	1511.44	490.48	1411.03	490.48	1477.84
	Dry soil + tare (g)	830.12	1355.96	459.13	1263.92	459.13	1345.64
	Tare (g)	195.77	195.96	196.98	119.81	196.98	196.61
	Moisture content, w (%)	10.8	13.4	12.0	12.9	12.0	11.5
Phase Relationships	Gs, assumed	2.65	2.65	2.65	2.65	2.65	2.65
	Mass total (g)	1287.8	1318.2	1275.1	1285.4	1276.6	1271.5
	Mass of solids (g)	1162.4	1162.4	1138.9	1138.9	1140.3	1140.3
	Volume (cm^3)	602.4	594.5	601.0	576.2	606.3	561.5
	Volume of water (cm^3)	125.3	155.8	136.2	146.4	136.4	131.2
	Volume of solids (cm^3)	438.7	438.7	429.8	429.8	430.3	430.3
	Volume of voids (cm^3)	163.7	155.8	171.2	146.4	176.0	131.2
	Volume of air (cm^3)	38.4	0.0	35.0	0.0	39.7	0.0
	Void ratio, e	0.373	0.355	0.398	0.341	0.409	0.305
	Porosity, n	0.272	0.262	0.285	0.254	0.290	0.234
	Volumetric moisture, T	0.208	0.262	0.227	0.254	0.225	0.234
	Saturation, S (%) [c]	76.54	100.00	79.54	100.00	77.46	100.00
	Dry density (gm/cm^3)	1.930	1.955	1.895	1.977	1.881	2.031
	Wet unit wt., gm (pcf)	133.5	138.4	132.5	139.3	131.4	141.4
	Dry unit wt., gd (pcf)	120.5	122.1	118.3	123.4	117.4	126.8

Notes:

[a] ΔHsc (in) = change in height during saturation and consolidation

[b] ΔVs = change in volume during saturation, ΔVc = change in volume during consolidation

[c] Saturation before shear set to 100% for phase calculations

[d] Before shear Aavg using method A; where Ac (Method A) = (Vo-DVs - DVc)/(Ho-DHsc)

[e] Before shear Aavg using method B; where Ac (Method B) = (Vwf + Vs)/Hc

J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_Composite_TX_CU3pts.xlsx]MD

Compaction specifications:	Target	As Compacted Avg.
gd (pcf)	119.2	118.7
w (%)	11.2	11.6

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project:	**Utaba Dam**	**TH/TP/Sample:**	**Composite Sample**
No:	**24-1762**	**Depth:**	**-**
Location:	Weber County, Utah	Laboratory sample description:	dk bn - bn gravelly clay
Date:	03-Dec-24	USCS classification:	not requested
Tested by:	MPK	Sample type:	Remolded to 95% of st. Proctor

J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_Composite_TX_CU3pts.xlsx]SUM

	Test Number	S1 at 30 psi	S2 at 60 psi	S3 at 150 psi
Test information	Total backpressure (psi)	60.0	60.0	65.0
	Skempton B	0.96	0.95	0.95
	t-90 (min)	1.4	2.1	2.9
	t-100 (min)	5.1	4.1	4.4
	t-50 (min)	0.3	0.5	0.7
	Strain rate (%/hr)	1.20	1.20	1.20
	Strain rate (%/min)	0.02	0.02	0.02
	Membrane correction	Yes	Yes	Yes
	Filter paper correction	No	No	No
Max principal stress ratio (s1/s3), failure criteria	Strain at failure, ef (%)	13.14	15.31	11.09
	Time to failure, tf (min)	657.0	765.3	554.6
	Obliquity, s'1/s'3	4.221	3.564	3.860
	Excess pore pressure, u (psi)	23.89	46.10	115.15
	q = q' = (s1-s3)/2 (psi)	9.85	17.82	49.84
	p' = (s'1+s'3)/2 (psi)	15.96	31.73	84.68
	p = (s1+s3)/2 (psi)	39.85	77.82	199.84
	Effective major principal stress, s'1 (psi)	25.81	49.55	134.52
	Effective minor principal stress, s'3 (psi)	6.11	13.90	34.85
	Total major principal stress, s1 (psi)	49.69	95.64	249.67
	Total minor principal stress, s3 (psi)	30.00	60.00	150.00
	Skemption A at failure, Af	1.21	1.29	1.16
	Secant friction angle, phi-s (deg)	38.1	34.2	36.1
		Effective stress	Total stress	
	Friction angle, phi (deg)	35.9	14.3	
	Cohesion intercept, c (psi)	0.0	0.0	
Peak deviator stress (s1-s3), failure criteria	Strain at failure, ef (%)	1.17	1.67	14.86
	Time to failure, tf (min)	58.7	83.6	742.9
	Deviator stress, s1-s3 (psi)	24.62	38.64	100.52
	Excess pore pressure, u (psi)	17.91	37.48	114.71
	q = q' = (s1-s3)/2 (psi)	12.31	19.32	50.26
	p' = (s'1+s'3)/2 (psi)	24.40	41.84	85.55
	p = (s1+s3)/2 (psi)	42.31	79.32	200.26
	Effective major principal stress, s'1 (psi)	36.71	61.16	135.81
	Effective minor principal stress, s'3 (psi)	12.09	22.52	35.29
	Total major principal stress, s1 (psi)	54.62	98.64	250.52
	Total minor principal stress, s3 (psi)	30.00	60.00	150.00
	Skemption A at failure, Af	0.73	0.97	1.14
	Secant friction angle, phi-s (deg)	30.3	27.5	36.0
		Effective stress	Total stress	
	Friction angle, phi (deg)	34.0	14.1	
	Cohesion intercept, c (psi)	0.0	1.1	
	Photo of sample after shearing	S1 at 30 psi	S2 at 60 psi	S3 at 150 psi

Comments:



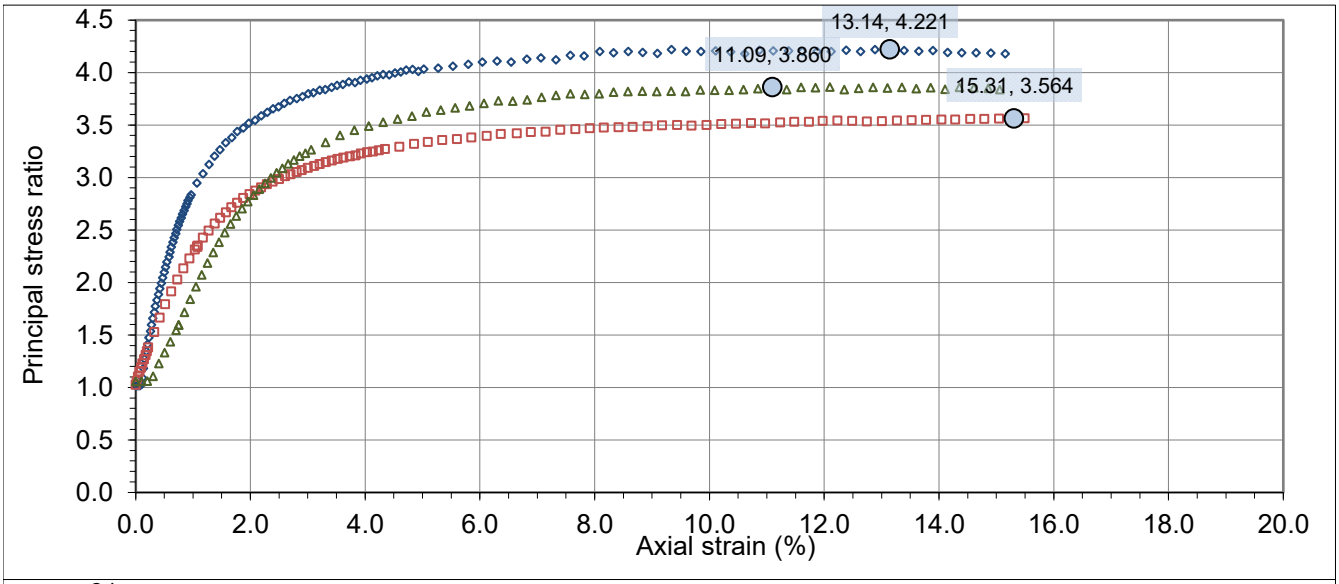


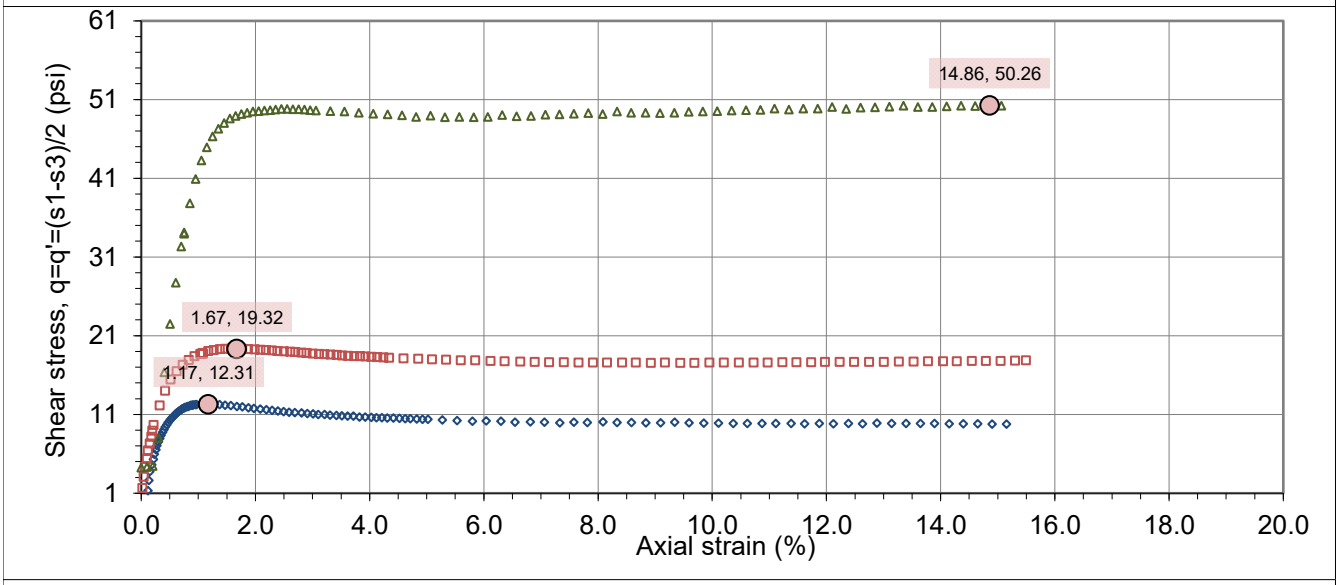
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

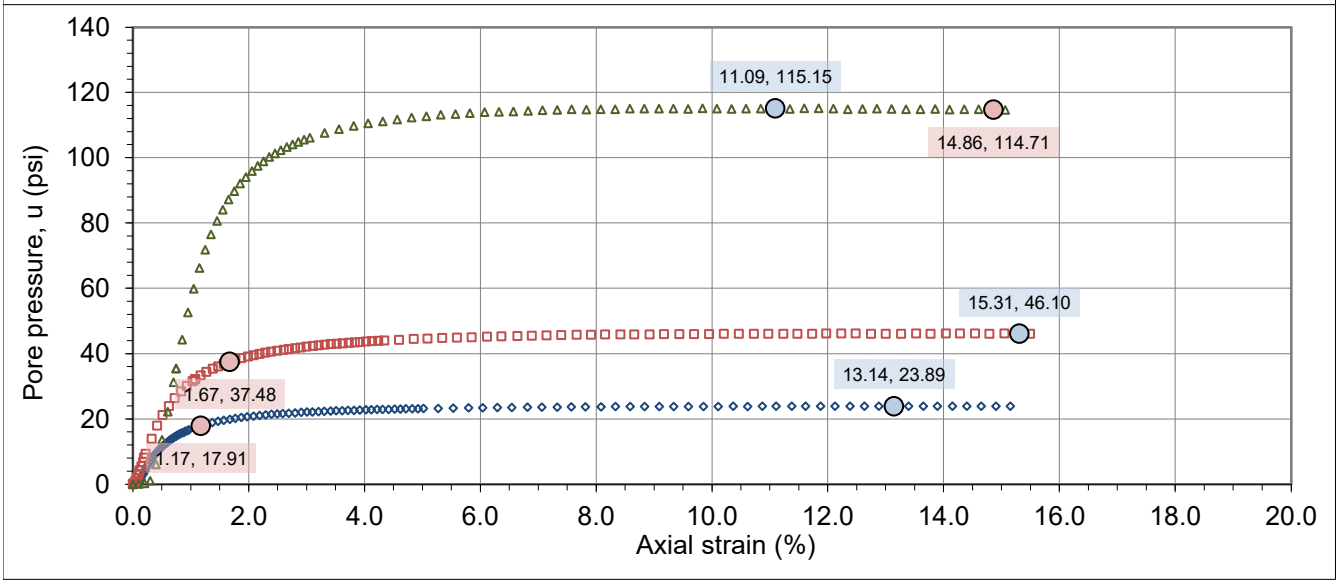
GERHART COLE

Project: Utaba Dam
No: 24-1762

TH/TP/Sample: Composite Sample
Depth: -







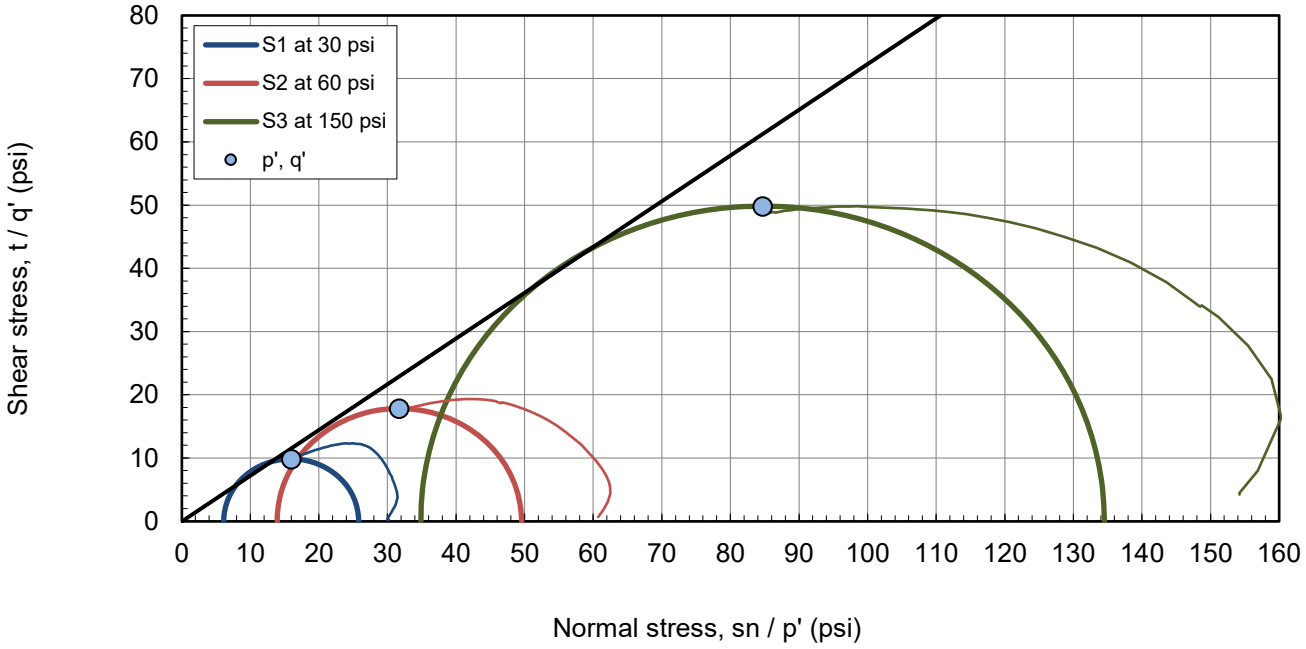
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project: Utaba Dam
No: 24-1762

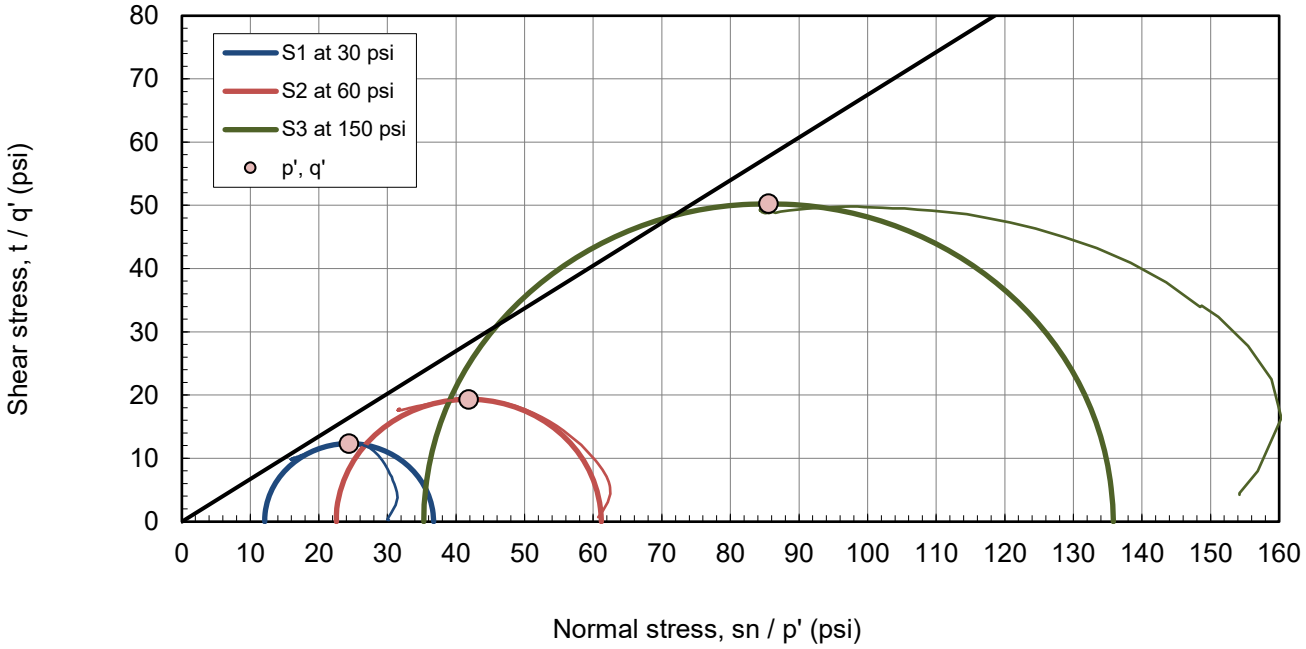
TH/TP/Sample: Composite Sample
Depth: -

Effective stress results



Max principal stress ratio (s'1/s'3), failure criteria Mohr and p' - q' space plots

Effective stress results



Peak deviator stress (s1-s3), failure criteria Mohr and p' - q' space plots

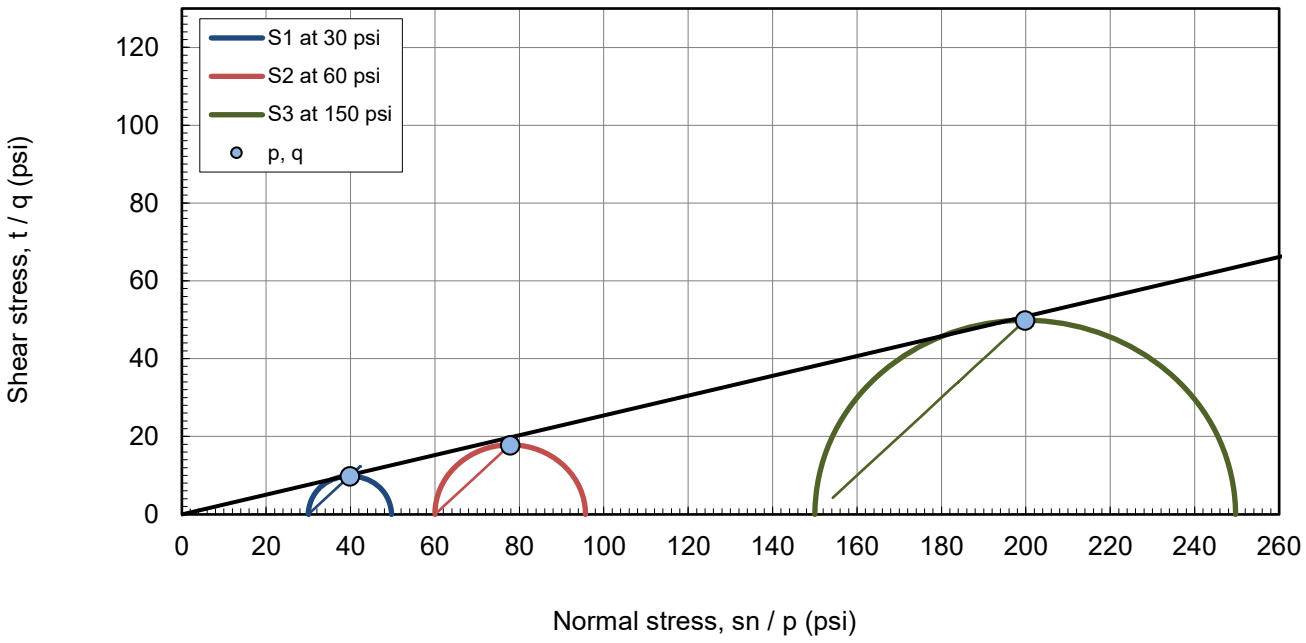
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project: Utaba Dam
No: 24-1762

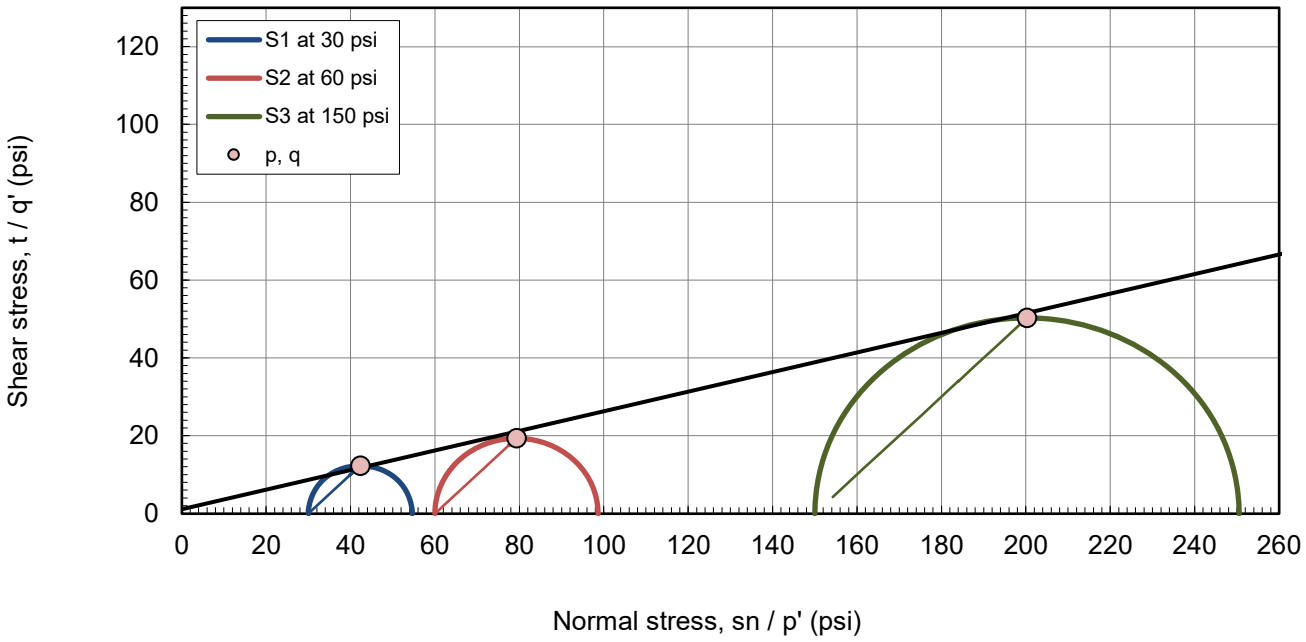
TH/TP/Sample: Composite Sample
Depth: -

Total stress results



Max principal stress ratio (s1/s3), failure criteria Mohr and p - q space plots - effective stress results

Total stress results



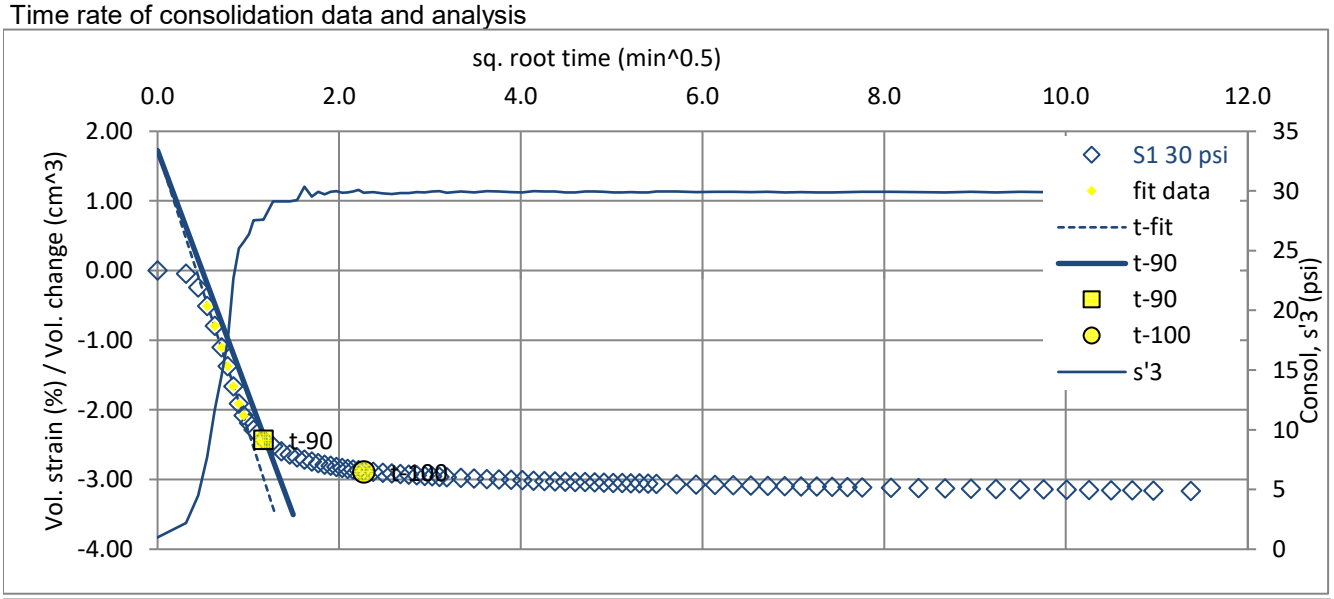
Peak deviator stress (s1-s3), failure criteria Mohr and p - q space plots

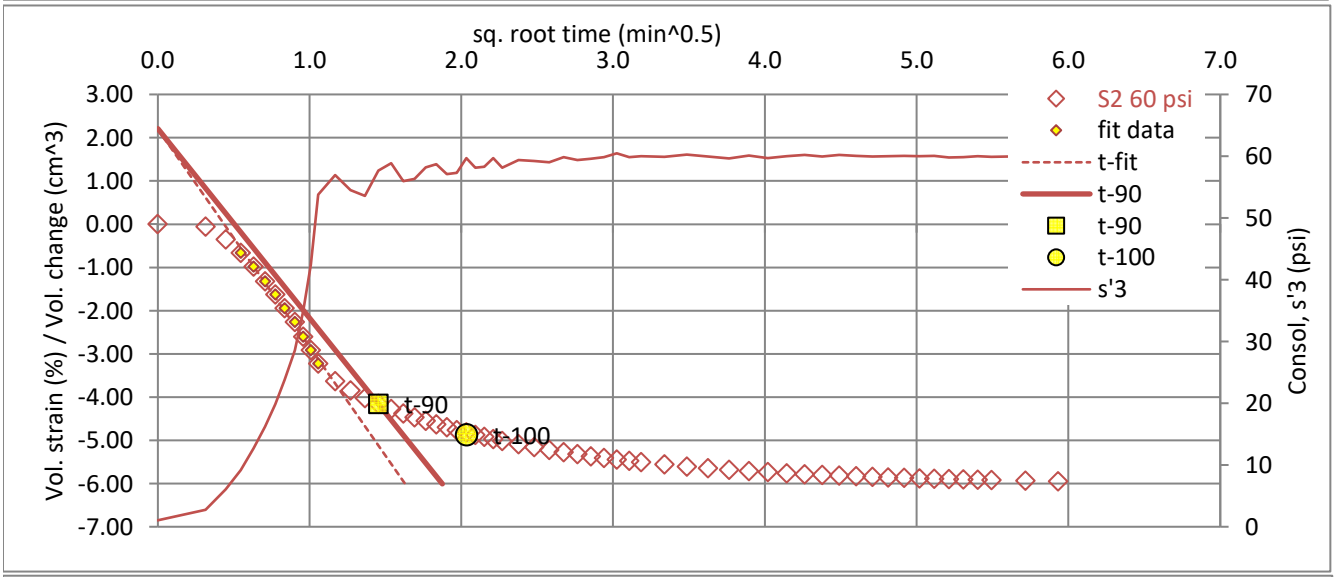
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

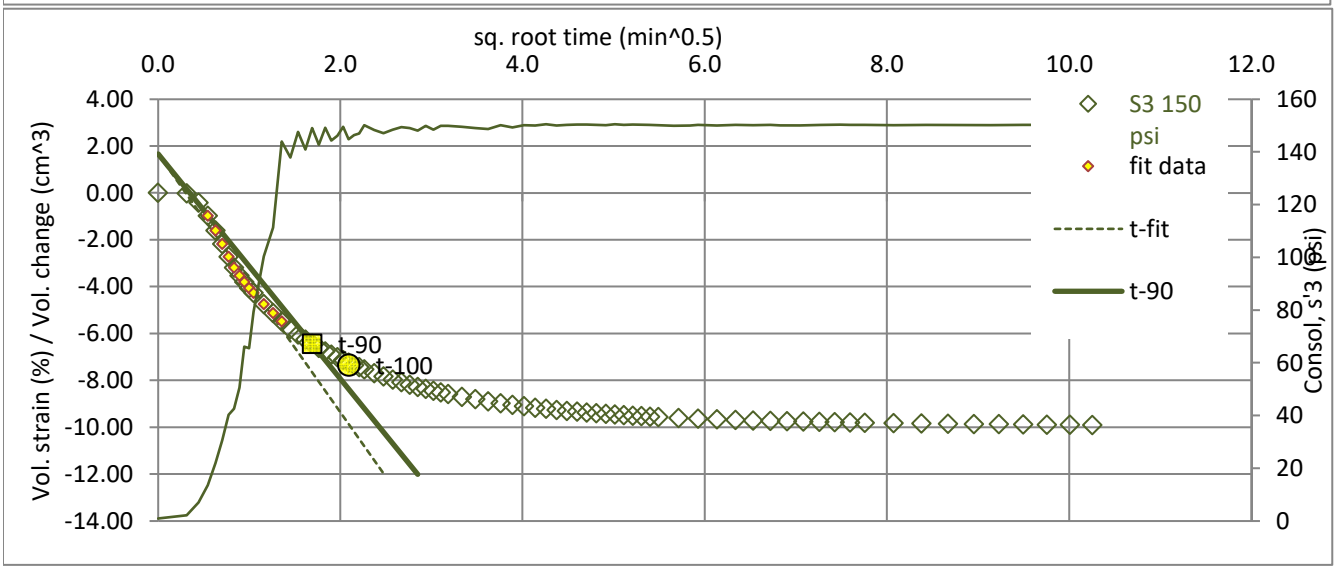
GERHART COLE

Project: Utaba Dam **TH/TP/Sample: Composite Sample**
No: 24-1762 **Depth: -**

Time rate of consolidation data and analysis







Triaxial Test - Isotropic Consolidated Sheared Undrained Measuring Pore Pressure (CIU-PP)* - After ASTM D4767 and USBR 5750

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762
Location: Weber County, Utah
Date: 06-Jan-25
Tested by: JC
Reduced by: JC
Checked by: ZMG

TH/TP/Sample: #4 Minus - Composite Sample
Depth: -
Laboratory sample description: bn - dk bn gravelly clay
USCS classification: not requested
Sample type: Remolded at 95% St. proctor, OMC. Split over the #4 sieve.

	Test Number	S1	30 psi	S2	60 psi	S3	150 psi
		Initial	Bef. Shr. Method B [e]	Initial	Bef. Shr. Method B [e]	Initial	Bef. Shr. Method B [e]
Unit weight data	0°	5.915		5.925		5.994	
	Sample ht., H (in) 120°	5.926		5.924		5.998	
	240°	5.906		5.925		5.980	
	Avg. height, Havg (in)	5.916	5.916	5.925	5.855	5.991	5.961
	Avg. height, Havg (cm)	15.026	15.026	15.049	14.871	15.216	15.140
	ΔHsc (in) [a]		0.000		0.070		0.030
	top	2.805		2.803		2.804	
	Sample dia., D (in) mid	2.803		2.802		2.798	
	bot	2.802		2.811		2.802	
	Avg. dia., Davg (in)	2.803	2.762	2.805	2.749	2.801	2.685
	Avg. dia., Davg (cm)	7.120	7.016	7.123	6.983	7.113	6.821
	Avg. area, Aavg (in^2)	6.172	5.993	6.177	5.937	6.160	5.664
	Avg. area, Aavg (cm^2)	39.818	38.665	39.854	38.303	39.740	36.543
	Wt. rings + wet soil (g)	1246.60	1271.02	1246.64	1266.51	1245.80	1249.10
	Wt. rings (g)	0.00	0.00	0.00	0.00	0.00	0.00
	Volume, Vo (in^3)	36.5	35.5	36.6	34.8	36.9	33.8
	Vo (cm^3)	598.3	581.0	599.7	569.6	604.7	553.3
	Vo (ft^3)	0.0211	0.0205	0.0212	0.0201	0.0214	0.0195
Moisture	Wet soil + tare (g)	409.57	1390.16	414.12	838.69	405.69	837.06
	Dry soil + tare (g)	379.63	1219.48	389.80	747.65	373.06	757.35
	Tare (g)	145.07	119.47	197.94	117.39	116.53	145.26
	Moisture content, w (%)	12.8	15.5	12.7	14.4	12.7	13.0
Phase Relationships	Gs, assumed	2.70	2.70	2.70	2.70	2.70	2.70
	Mass total (g)	1246.6	1277.0	1246.6	1266.2	1245.8	1249.1
	Mass of solids (g)	1105.5	1105.5	1106.4	1106.4	1105.2	1105.2
	Volume (cm^3)	598.3	581.0	599.7	569.6	604.7	553.3
	Volume of water (cm^3)	141.1	171.5	140.2	159.8	140.6	143.9
	Volume of solids (cm^3)	409.4	409.4	409.8	409.8	409.3	409.3
	Volume of voids (cm^3)	188.9	171.5	190.0	159.8	195.4	143.9
	Volume of air (cm^3)	47.7	0.0	49.7	0.0	54.8	0.0
	Void ratio, e	0.461	0.419	0.464	0.390	0.477	0.352
	Porosity, n	0.316	0.295	0.317	0.281	0.323	0.260
	Volumetric moisture, T	0.236	0.295	0.234	0.281	0.232	0.260
	Saturation, S (%) [c]	74.72	100.00	73.83	100.00	71.96	100.00
	Dry density (gm/cm^3)	1.848	1.903	1.845	1.942	1.828	1.998
	Wet unit wt., gm (pcf)	130.1	137.2	129.8	138.8	128.6	141.0
	Dry unit wt., gd (pcf)	115.4	118.8	115.2	121.3	114.1	124.7

Notes:

[a] ΔHsc (in) = change in height during saturation and consolidation

[b] ΔVs = change in volume during saturation, ΔVc = change in volume during consolidation

[c] Saturation before shear set to 100% for phase calculations

[d] Before shear Aavg using method A; where Ac (Method A) = (Vo-DVs - DVc)/(Ho-DHsc)

[e] Before shear Aavg using method B; where Ac (Method B) = (Vwf + Vs)/Hc

\\Server19\company\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-12-17_#4MinusComposite_TX_CU3pts.xlsx]MD

Compaction specifications:	Target	As Compacted Avg.
gd (pcf)	114.5	114.9
w (%)	13.2	12.7

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project: **Utaba Retarding Dam** | **TH/TP/Sample:** **#4 Minus - Composite Sample**
No: **24-1762** | **Depth:** **-**
Location: Weber County, Utah | Laboratory sample description: bn - dk bn gravelly clay
Date: 06-Jan-25 | USCS classification: not requested
Tested by: JC | Sample type: Remolded at 95% St. proctor, C

er19\company\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-12-17_#4MinusComposite_TX_CU3pts.xlsx]SUM

	Test Number	S1 at 30 psi	S2 at 60 psi	S3 at 150 psi
Test information	Total backpressure (psi)	50.0	65.0	55.0
	Skempton B	0.97	0.95	0.95
	t-90 (min)	1.6	4.4	3.9
	t-100 (min)	4.9	9.2	6.2
	t-50 (min)	0.4	1.0	0.9
	Strain rate (%/hr)	1.20	1.20	1.20
	Strain rate (%/min)	0.02	0.02	0.02
	Membrane correction	Yes	Yes	Yes
	Filter paper correction	No	No	No
Max principal stress ratio (s1/s3), failure criteria	Strain at failure, ef (%)	10.48	11.66	11.23
	Time to failure, tf (min)	524.1	583.0	561.7
	Obliquity, s'1/s'3	3.893	3.896	3.812
	Excess pore pressure, u (psi)	23.93	47.94	118.11
	q = q' = (s1-s3)/2 (psi)	8.77	17.46	44.84
	p' = (s'1+s'3)/2 (psi)	14.84	29.51	76.72
	p = (s1+s3)/2 (psi)	38.77	77.46	194.84
	Effective major principal stress, s'1 (psi)	23.62	46.97	121.56
	Effective minor principal stress, s'3 (psi)	6.07	12.06	31.89
	Total major principal stress, s1 (psi)	47.55	94.91	239.67
	Total minor principal stress, s3 (psi)	30.00	60.00	150.00
	Skemption A at failure, Af	1.36	1.37	1.32
	Secant friction angle, phi-s (deg)	36.2	36.3	35.8
		Effective stress	Total stress	
	Friction angle, phi (deg)	35.6	13.3	
	Cohesion intercept, c (psi)	0.2	0.0	
Peak deviator stress (s1-s3), failure criteria	Strain at failure, ef (%)	1.57	1.48	15.00
	Time to failure, tf (min)	78.4	73.8	750.0
	Deviator stress, s1-s3 (psi)	21.61	39.85	90.62
	Excess pore pressure, u (psi)	19.02	37.50	117.57
	q = q' = (s1-s3)/2 (psi)	10.81	19.92	45.31
	p' = (s'1+s'3)/2 (psi)	21.79	42.43	77.74
	p = (s1+s3)/2 (psi)	40.81	79.92	195.31
	Effective major principal stress, s'1 (psi)	32.60	62.35	123.05
	Effective minor principal stress, s'3 (psi)	10.98	22.50	32.43
	Total major principal stress, s1 (psi)	51.61	99.85	240.62
	Total minor principal stress, s3 (psi)	30.00	60.00	150.00
	Skemption A at failure, Af	0.88	0.94	1.30
	Secant friction angle, phi-s (deg)	29.7	28.0	35.6
		Effective stress	Total stress	
	Friction angle, phi (deg)	33.6	12.9	
	Cohesion intercept, c (psi)	0.0	1.9	
	Photo of sample after shearing	S1 at 30 psi	S2 at 60 psi	S3 at 150 psi

Comments:



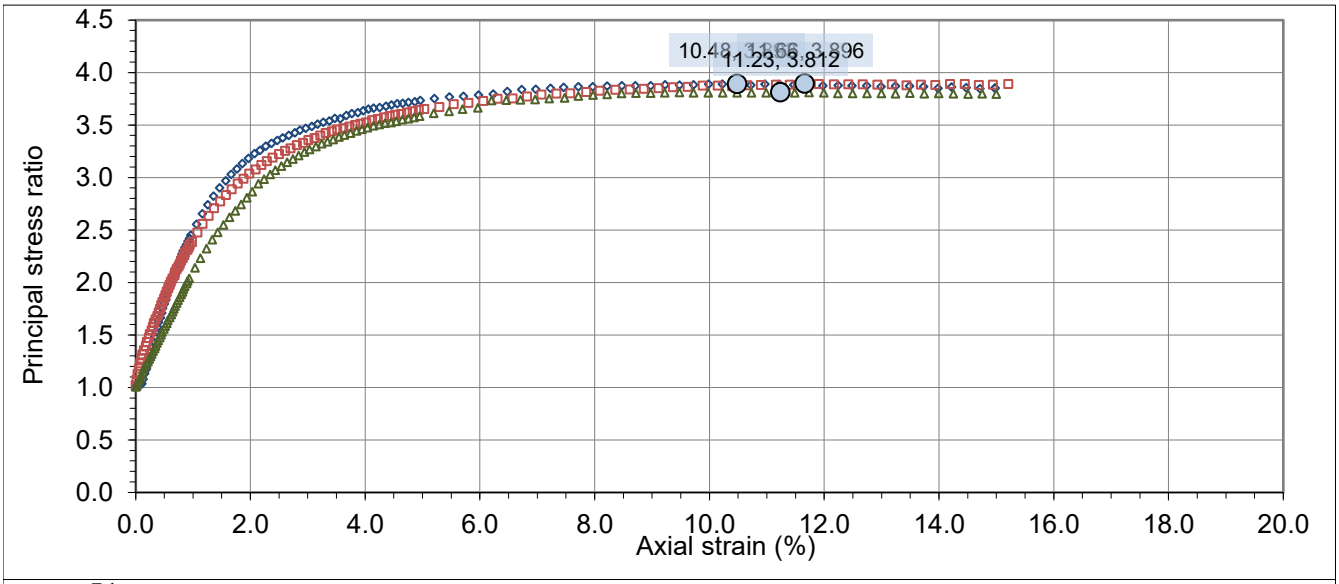


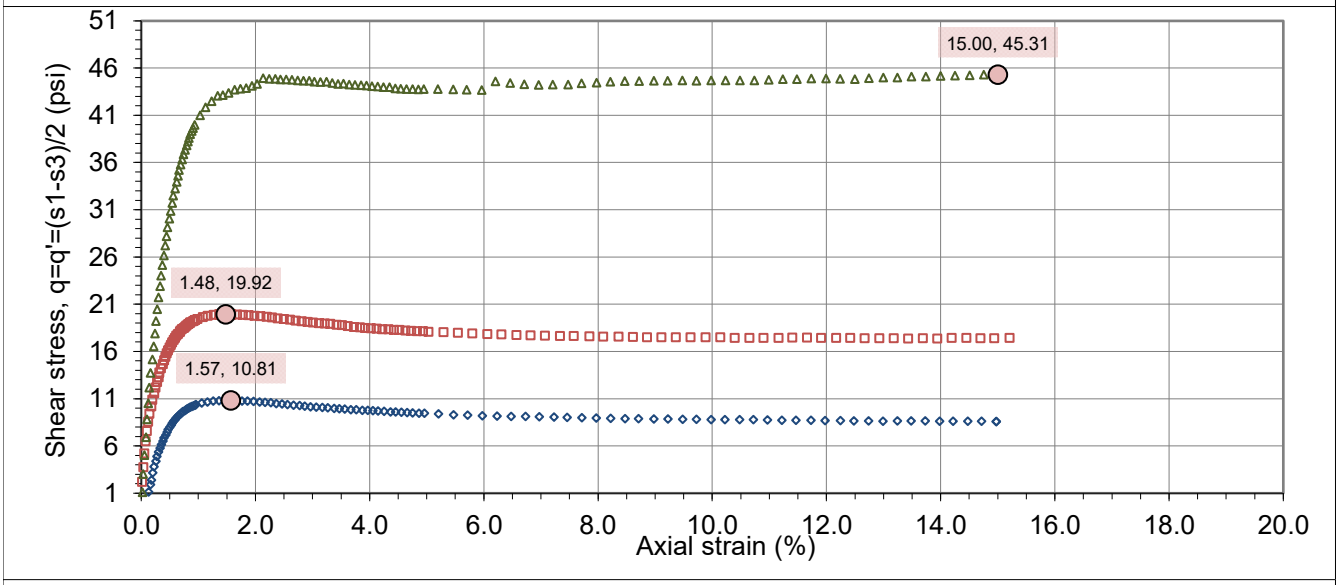
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

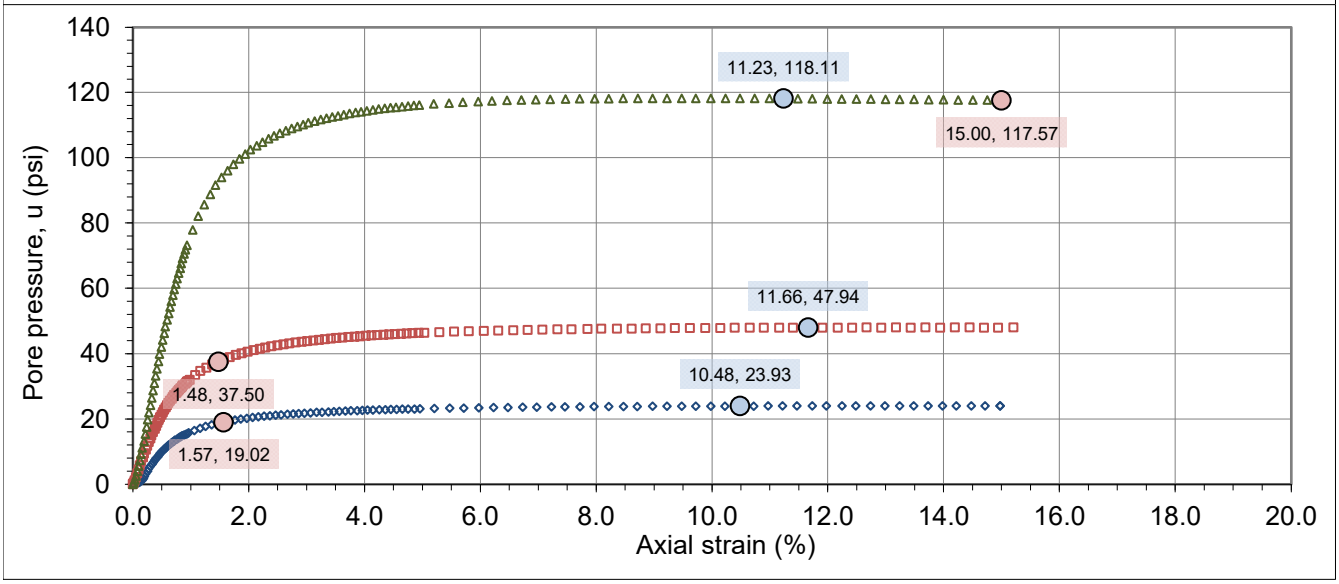
GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762

TH/TP/Sample: #4 Minus - Composite Sample
Depth: -







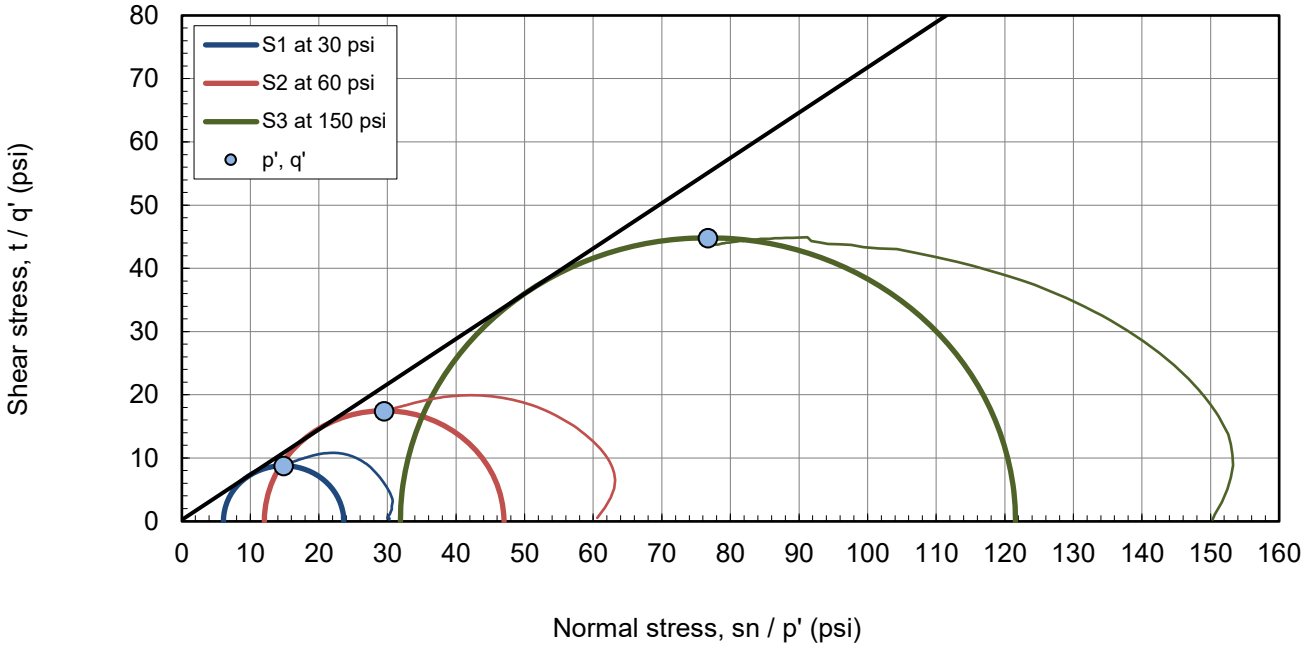
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762

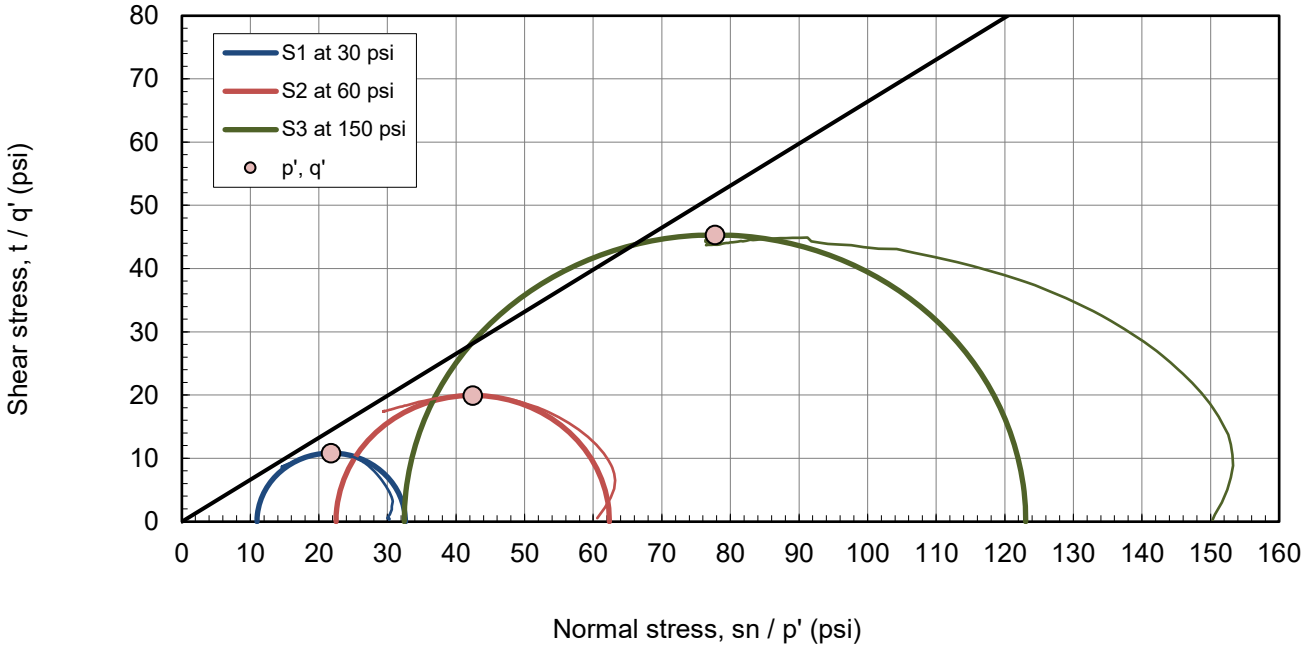
TH/TP/Sample: #4 Minus - Composite Sample
Depth: -

Effective stress results



Max principal stress ratio (s'1/s'3), failure criteria Mohr and p' - q' space plots

Effective stress results



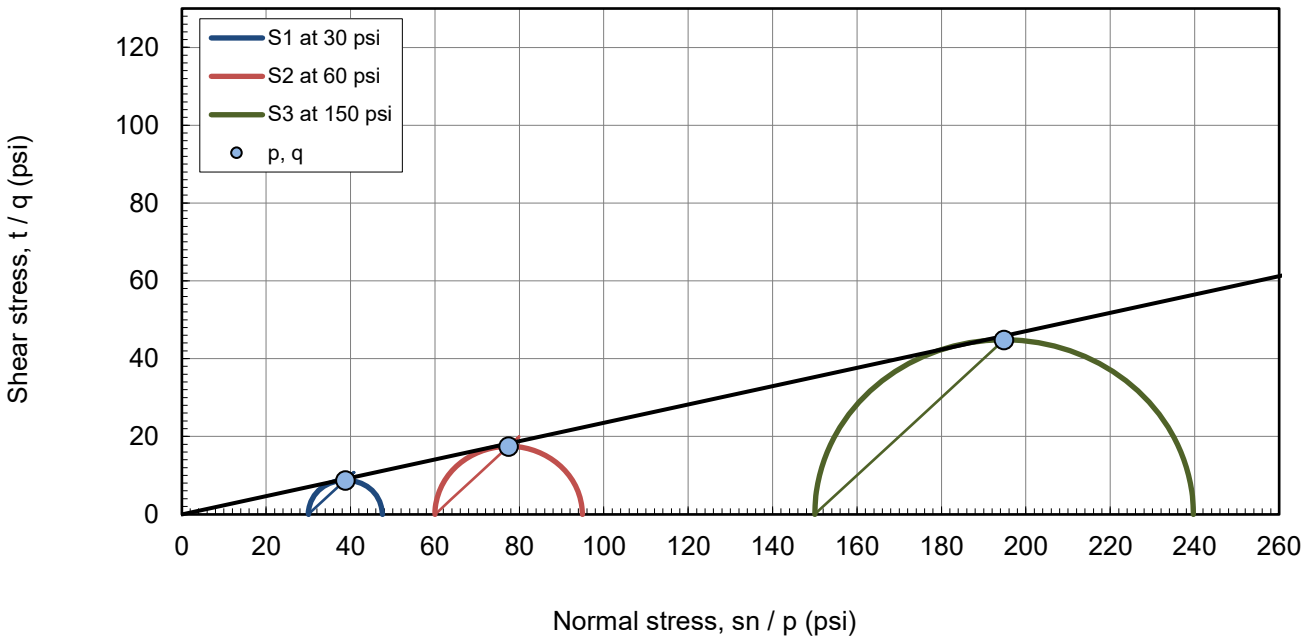
Peak deviator stress (s1-s3), failure criteria Mohr and p' - q' space plots

Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

GERHART COLE

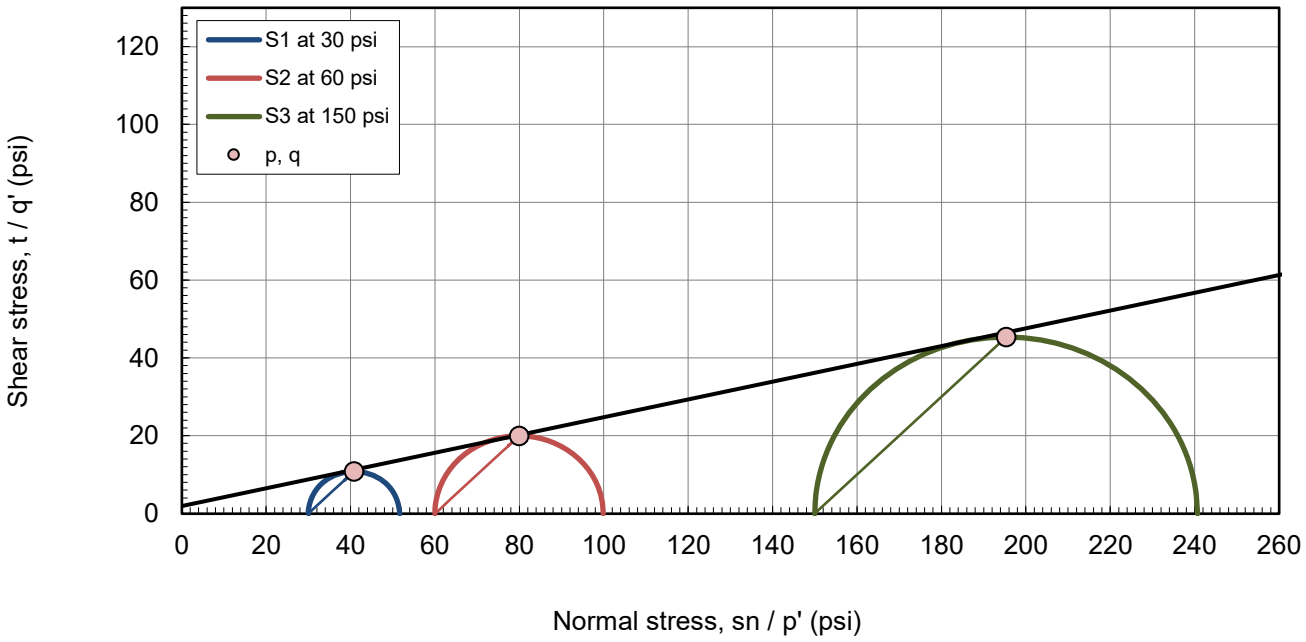
Project: Utaba Retarding Dam — **TH/TP/Sample:** #4 Minus - Composite Sample
No: 24-1762 — **Depth:** -

Total stress results



Max principal stress ratio (s1/s3), failure criteria Mohr and p - q space plots - effective stress results

Total stress results



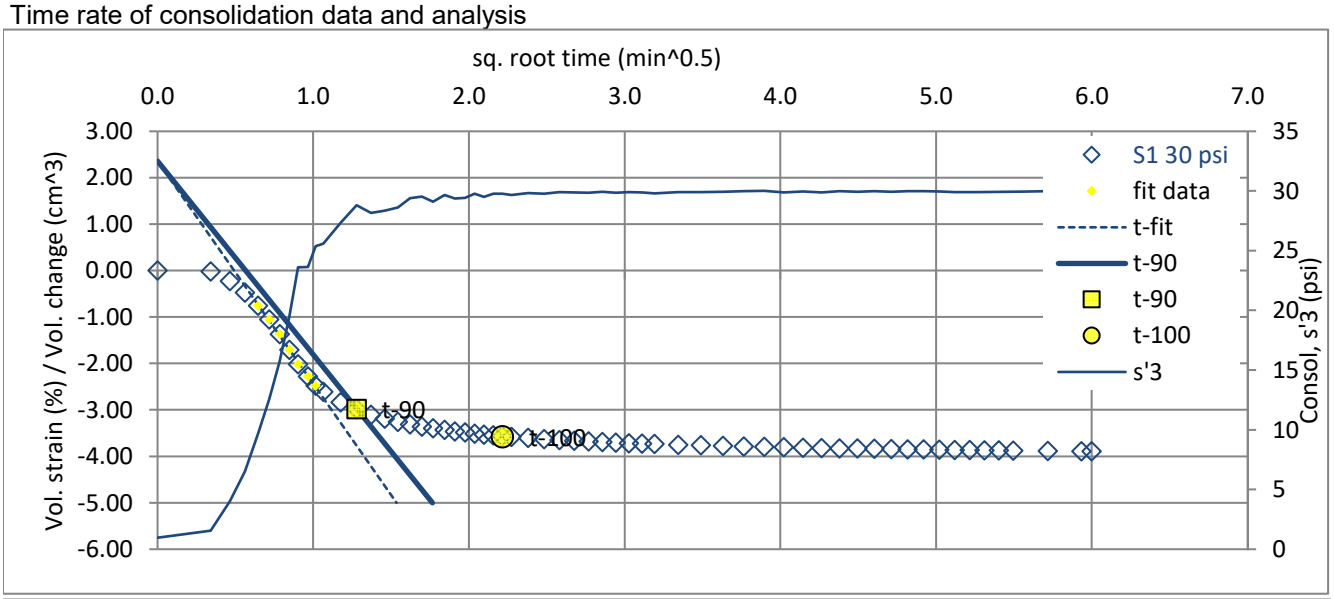
Peak deviator stress (s1-s3), failure criteria Mohr and p - q space plots

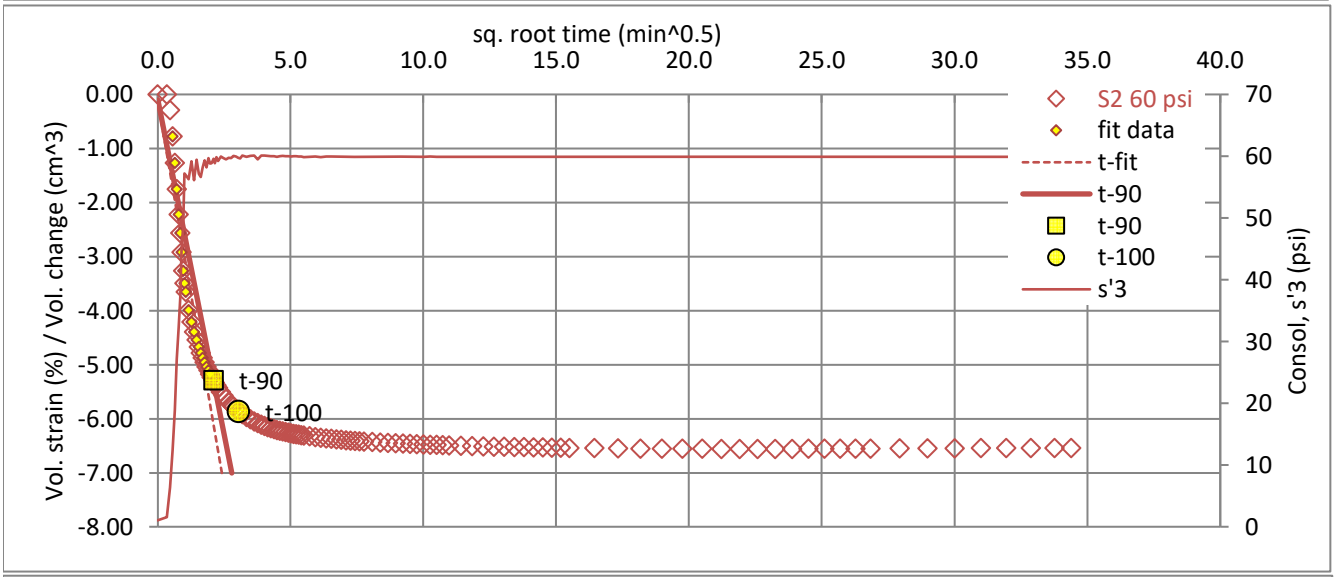
Triaxial Test - Isotropic Consolidated Sheared Undrained
Measuring Pore Pressure (CIU-PP) *- After ASTM D4767 and USBR 5750*

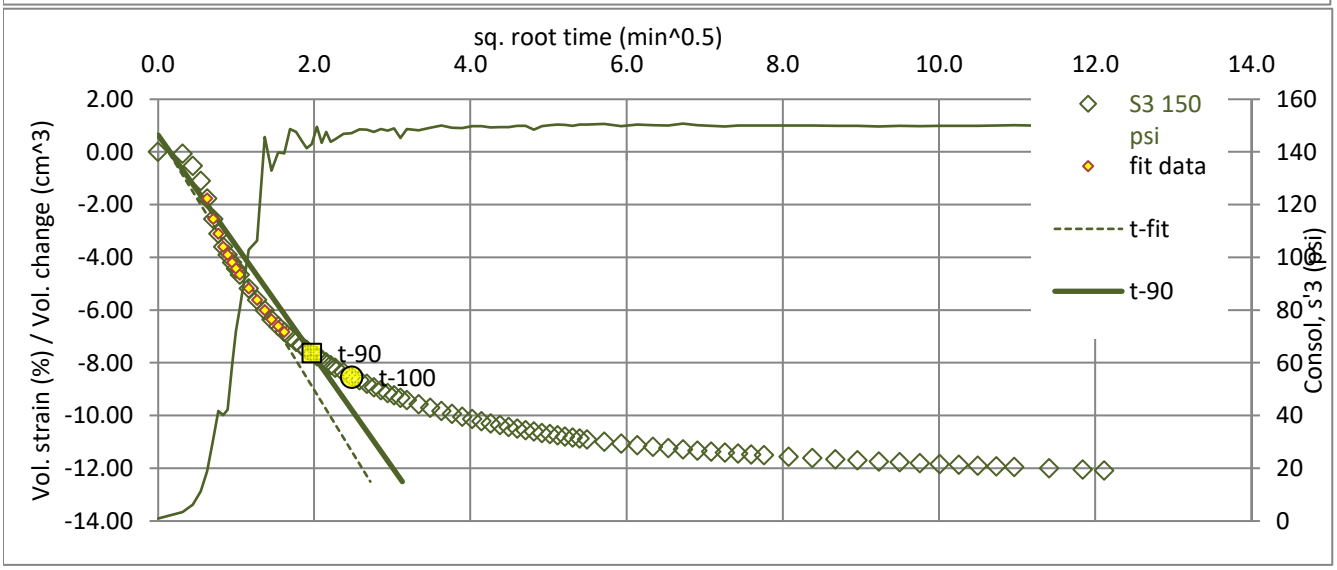
GERHART COLE

Project: Utaba Retarding Dam **TH/TP/Sample: #4 Minus - Composite Sample**
No: 24-1762 **Depth: -**

Time rate of consolidation data and analysis







Pinhole Dispersion Test*

After ASTM D4647 and USBR 5410

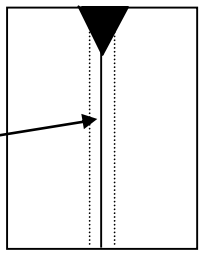
GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 20-Nov-24
Tested by: TK
Reduced by: JC
Checked by: ZMG

TH/TP/Sample: 24-TH-01
Depth: 60-61 ft
Laboratory sample description: dk gy - bk sandy clay
USCS classification: Not requested
Compaction specifications: Rel. undisturbed, shelby tube

Test type / method: Method A
Sample type: Remolded
Moisture content (%): 26
Dry unit weight (pcf): 100.6

Target moisture content (%): N/A
Target dry unit weight (pcf): N/A
Specimen After Test
Final Hole (mm): 1.0



Dispersive Classification: ND1 - Nondispersive

Clock Time	Head (in)	Flow			Turbidity From Side						Completely Clear From Top	Particles Falling			Remarks
		ml	sec	Rate (ml/sec)	Very Dark	Dark	Moderately Dark	Slightly Dark	Barely Visible	Completely Clear		None	Few	Heavy	
12:00	2	17.0	60	0.3					X			X			
	2	18.0	60	0.3					X			X			
	2	19.0	60	0.3						X	X	X			
	2	14.0	60	0.2						X	X	X			
	2	19.0	60	0.3						X	X	X			
	2	33.0	120	0.3						X	X	X			
	2	25.0	120	0.2						X	X	X			
	7	44.0	60	0.7						X	X	X			
	7	37.0	60	0.6						X	X	X			
	7	32.0	60	0.5						X	X	X			
	7	42.0	60	0.7						X	X	X			
	7	38.0	60	0.6						X	X	X			
	15	61.0	60	1.0						X	X	X			
	15	58.0	60	1.0						X	X	X			
	15	65.0	60	1.1						X	X	X			
	15	63.0	60	1.1						X	X	X			
	15	58.0	60	1.0						X	X	X			
	40	82.0	60	1.4						X	X	X			
	40	78.0	60	1.3						X	X	X			
	40	75.0	60	1.3						X	X	X			
	40	67.0	60	1.1						X	X	X			
	40	63.0	60	1.1						X	X	X			

Pinhole Dispersion Test*

After ASTM D4647 and USBR 5410

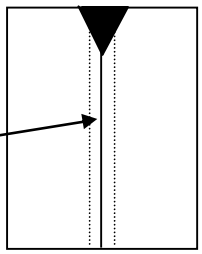
GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 09-Dec-24
Tested by: AT
Reduced by: AT
Checked by: JC

TH/TP/Sample: Composite Sample
Depth: -
Laboratory sample description: bn - dk bn clay
USCS classification: Not requested
Compaction specifications: 95% of St. Proctor at OMC

Test type / method: Method A
Sample type: Remolded
Moisture content (%): 10.2
Dry unit weight (pcf): 120.1

Target moisture content (%): 11
Target dry unit weight (pcf): 119
Specimen After Test
Final Hole (mm): 1.0



Dispersive Classification: ND1 - Nondispersive

Clock Time	Head (in)	Flow			Turbidity From Side						Completely Clear From Top	Particles Falling			Remarks
		ml	sec	Rate (ml/sec)	Very Dark	Dark	Moderately Dark	Slightly Dark	Barely Visible	Completely Clear		None	Few	Heavy	
12:05	2	26.0	60	0.4					X				X		
	2	21.0	60	0.4					X			X			
	2	20.0	60	0.3					X			X			
	2	21.0	60	0.4					X			X			
	2	21.0	60	0.4					X			X			
	2	21.0	180	0.1						X	X	X			
	2	19.0	120	0.2						X	X	X			
	7	28.0	60	0.5			X						X		Redrilled hole.
	7	19.0	60	0.3					X				X		
	7	11.0	60	0.2					X			X			
	7	5.0	60	0.1						X	X	X			Redrilled hole.
	7	28.0	60	0.5			X						X		
	15	36.0	60	0.6				X				X			
	15	54.0	60	0.9					X			X			
	15	84.0	60	1.4					X				X		
	15	72.0	60	1.2						X	X	X			
	15	82.0	60	1.4						X			X		
	40	121.0	60	2.0					X				X		
	40	127.0	60	2.1						X			X		
	40	123.0	60	2.1						X	X	X			
	40	129.0	60	2.2						X	X	X			
	40	129.0	60	2.2						X	X	X			

Laboratory Compaction Characteristics of Soil

after ASTM D698 / D1557

GERHART COLE

Project: Utaba Dam
No: 24-1762
Date: 22-Nov-24
Tested by: LL
Reduced by: LL
Reviewed by: JAS

Comments:

TH/TP/Sample: Composite Sample
Depth: -
Location: Weber County, Utah

Test Summary

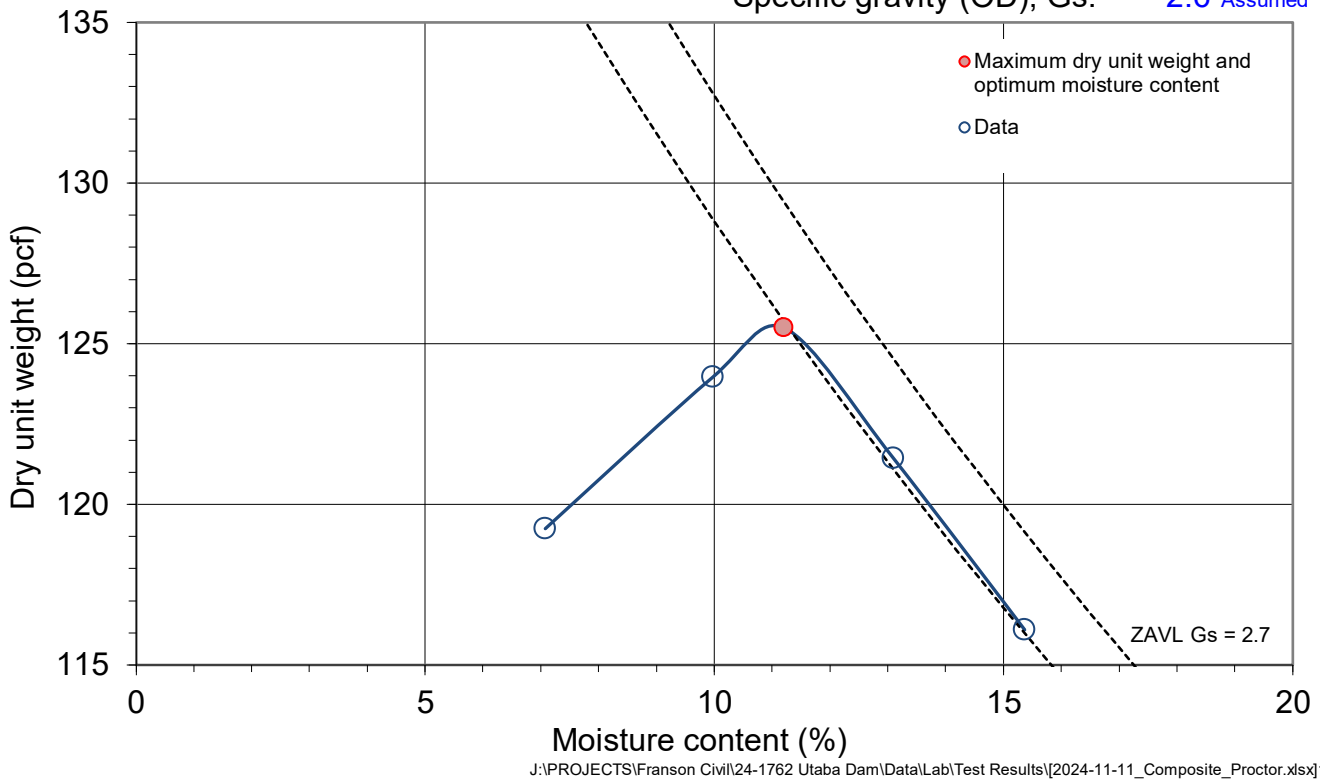
Laboratory sample description: dk bn - bn gravelly clay
Method: ASTM D698 B
Engineering Classification: Not requested
Mold volume (ft^3): 0.0333
As-received moisture content (%): Not requested
Preparation method: Moist
Optimum moisture content (%): 11.2
Rammer: Manual
Maximum dry unit weight (pcf): 125.5
Rock Correction: Yes

Point Number	As is	+3	+6	+9
Wt. mold + wet soil (g)	6170.4	6301.1	6316.3	6265.1
Wt. mold (g)	4239.70	4239.70	4239.70	4239.70
Moist unit wt., gd (pcf)	127.69	136.34	137.34	133.95
Wet soil + tare (g)	484.29	604.77	655.16	638.41
Dry soil + tare (g)	460.11	567.69	601.86	572.76
Tare (g)	118.42	195.80	194.67	145.50
Moisture content, w (%)	7.1	10.0	13.1	15.4
Dry unit wt., gd (pcf)	119.3	124.0	121.4	116.1

*Correction of Unit Weight and Water Content for Soils Containing Oversize Particles

(ASTM D4718)

Oversized fraction, +1/2-in. (%): 31.3
Corrected moisture content (%): 8.4
Moisture content, +1/2-in. (%): 2.1
Corrected dry unit weight (pcf): 135.1
Sieve for oversized fraction: 1/2-in.
Specific gravity (OD), Gs: 2.6 Assumed



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Laboratory Compaction Characteristics of Soil

after ASTM D698 / D1557

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762
Date: 17-Dec-24
Tested by: JAS
Reduced by: JAS
Reviewed by: AT

Comments:

TH/TP/Sample: #4 Minus Composite
Depth: -
Location: Weber County, Utah

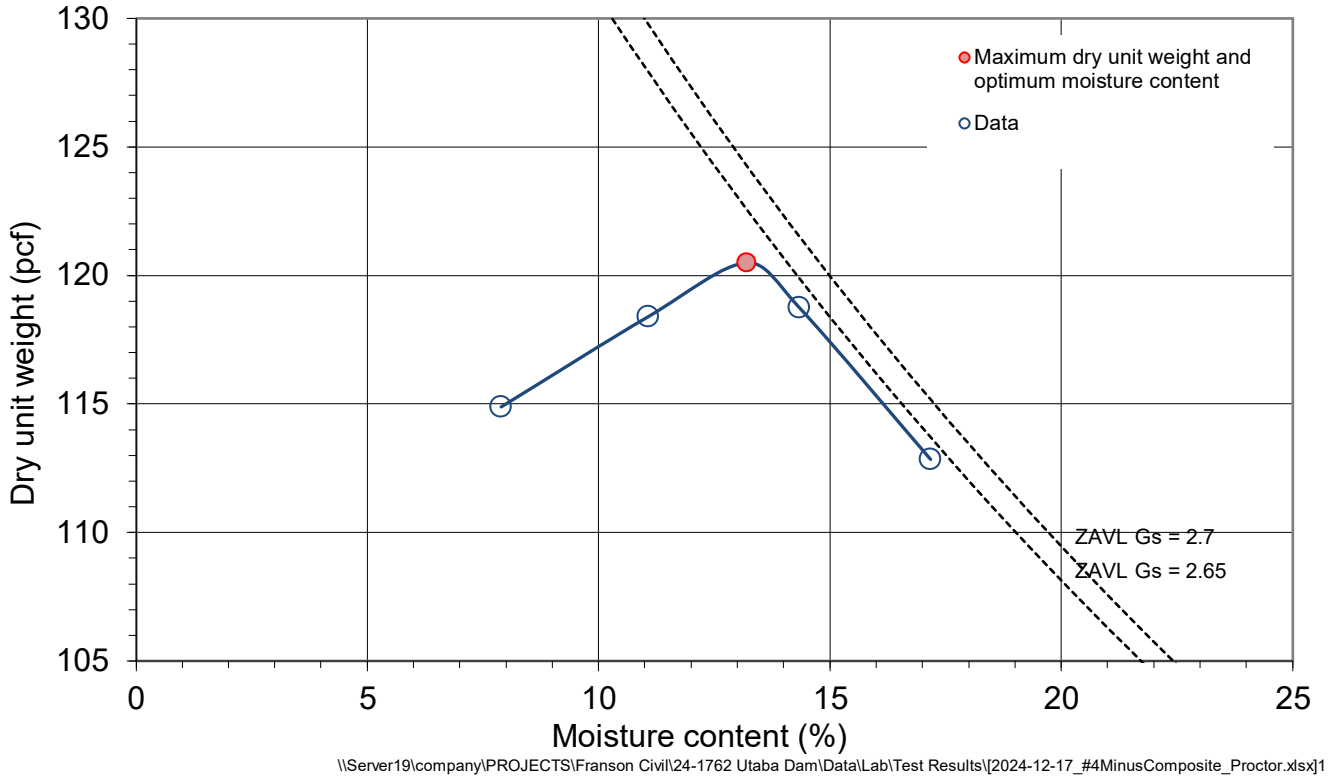
Test Summary

Method: ASTM D698 A
Mold volume (ft^3): 0.0333

Optimum moisture content (%): 13.2
Maximum dry unit weight (pcf): 120.5

Laboratory sample description: lt bn - bn gravel
Engineering Classification: Not requested
As-received moisture content (%): Not requested
Preparation method: Moist
Rammer: Manual
Rock Correction: No

Point Number	As-is	+3	+6	+9
Wt. mold + wet soil (g)	6114.2	6228.5	6292.9	6239.1
Wt. mold (g)	4239.80	4239.80	4239.80	4239.80
Moist unit wt., gd (pcf)	123.96	131.52	135.79	132.23
Wet soil + tare (g)	978.50	1103.81	877.11	995.37
Dry soil + tare (g)	916.22	1013.18	785.31	866.59
Tare (g)	126.93	194.30	144.98	116.64
Moisture content, w (%)	7.9	11.1	14.3	17.2
Dry unit wt., gd (pcf)	114.9	118.4	118.8	112.8



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Particle-Size Analysis of Soils with Hydrometer*

(after ASTM D422/D4221)

GERHART COLE

Project: Utaba Dam
No: 24-1762
Date: 27-Nov-24
Tested by: TK
Reduced by: AT
Reviewed by: JC

TH/TP/Sample: 24-TH-01
Depth: 20-21.7 ft
Location: Weber County, Utah
Laboratory sample description: dk bn - bn clay
Comments:

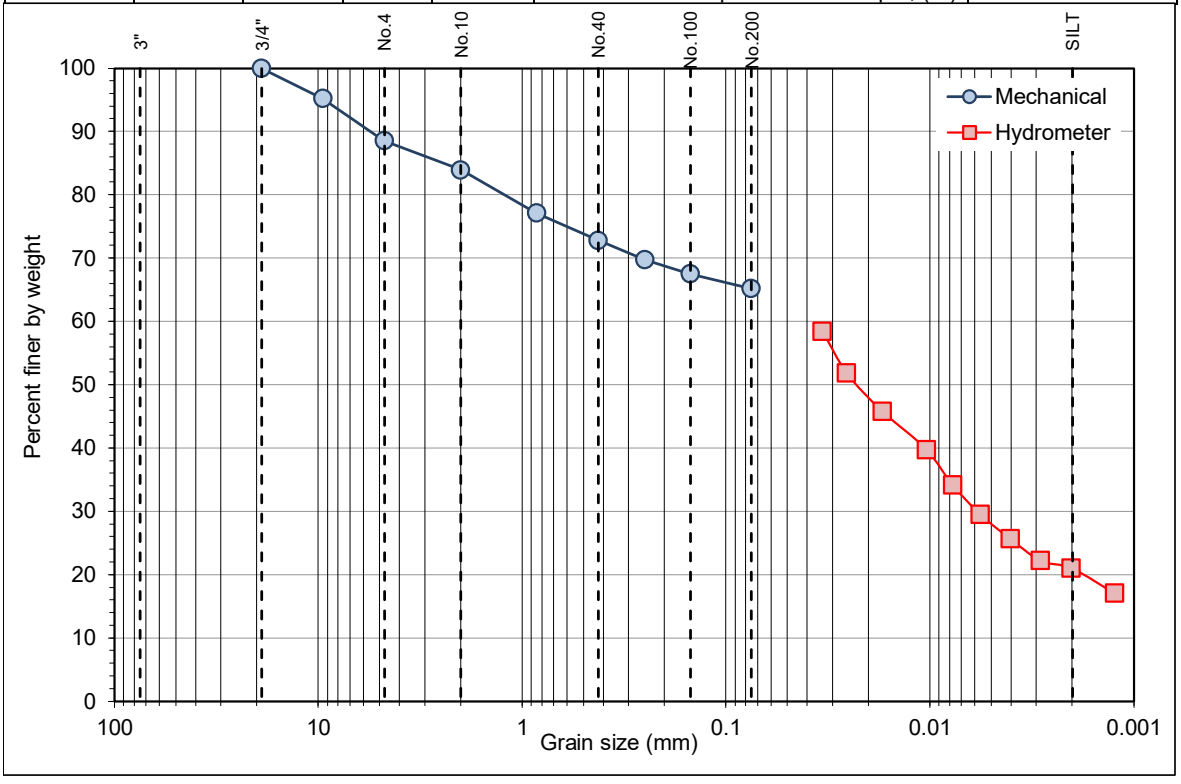
Split sieve:	Yes	
Split sieve:	3"	
	Moist	Dry
Total sample wt. (g):	313.43	284.48
+3" Coarse fraction (g):		-
-3" Split fraction (g):	313.43	284.48
Hydrometer fraction (g):	75.72	75.43
Split fraction:	1.000	

Moisture data	C.F.(+3")	S.F.(-3")	Hyd.(-No.10)
Moist soil + tare (g):	-	456.12	158.48
Dry soil + tare (g):	-	427.17	158.42
Tare (g):	-	142.69	142.69
Moisture content (%):	0.00	10.18	0.38

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.164
Gs:	2.7	Assumed	Intercept:	16.3
Hydrometer Seral #:	626325		a:	0.99
Dispersion period (min):	10		Hyd. fraction:	83.91
			Dispersion device:	Air-jet

Sieve	Grain Size (mm)	Accum. Wt. Ret. (g)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Composite Correction	Grain Size (mm)	% Soil in Suspension
12"	300	-	-		1	22.1	59	5.9	0.03373	58.46
8"	200	-	-		2	22.1	53	5.9	0.02556	51.86
6"	150	-	-		5	22.1	47.5	5.9	0.01710	45.81
4"	100	-	-		15	22.1	42	5.9	0.01038	39.76
3"	75	-	-	<=Split	30	21.7	37	6.0	0.00769	34.12
1.5"	37.5	-	-		60	21.2	33	6.2	0.00564	29.53
3/4"	19	-	100.0		120	22.7	29	5.7	0.00404	25.68
3/8"	9.5	13.59	95.2		250	22.3	26	5.8	0.00287	22.23
No.4	4.75	32.63	88.5		500	23.5	24.5	5.4	0.00202	21.02
No.10	2	45.77	83.9	<=hyd Split	1440	21.6	21.5	6.0	0.00124	17.03
No.20	0.85	6.14	77.1							
No.40	0.425	10.00	72.8							
No.60	0.25	12.75	69.7							
No.100	0.15	14.77	67.5							
No.200	0.075	16.86	65.2							

With Dispersion Agent:	0.002	21
Without Dispersion Agent:	0.002	2
% Dispersion of the 0-µm, (%):	11	



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Particle-Size Analysis of Soils with Hydrometer*

(after ASTM D422/D4221)

GERHART COLE

Project: Utaba Dam **TH/TP/Sample:** 24-TH-01

No: 24-1762 **Depth:** 20-21.7 ft

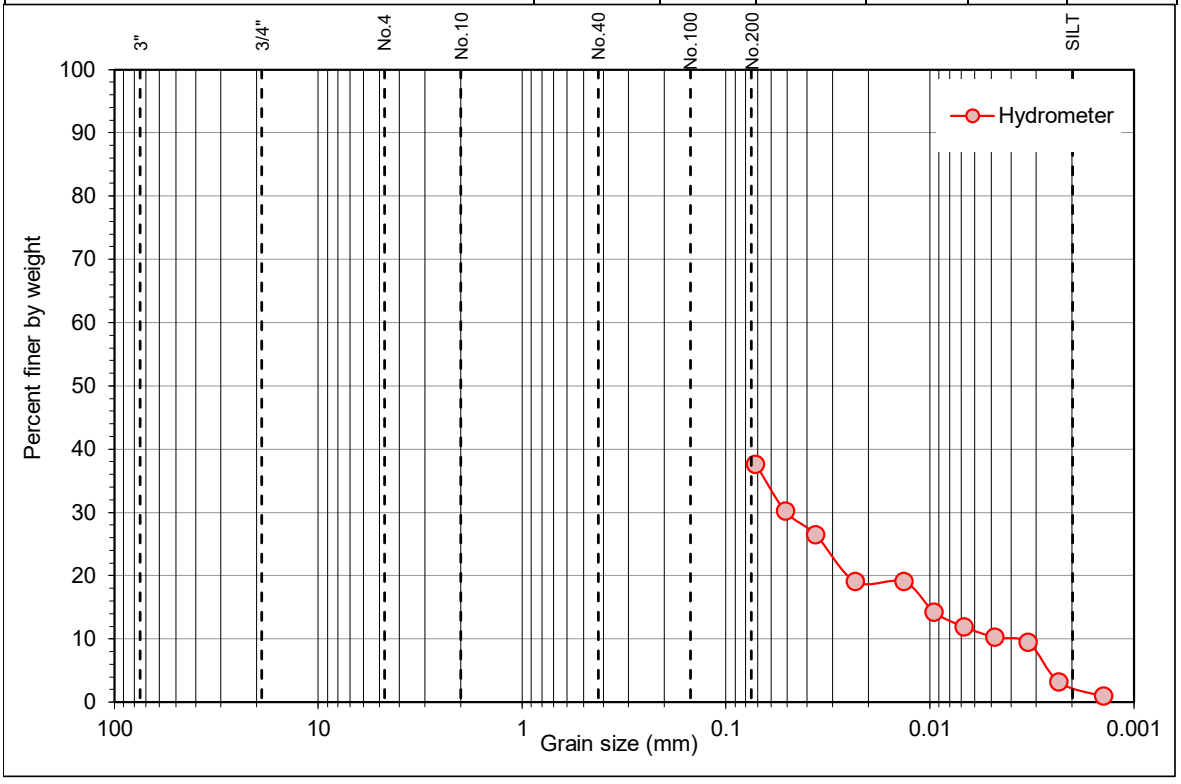
Without Dispersion Agent

	Moist	Dry
Split sieve:	Yes	
Split sieve:	3"	
Total sample wt. (g):	313.43	284.48
+3" Coarse fraction (g):		
-3" Split fraction (g):	313.43	284.48
Hydrometer fraction (g):	25.17	22.35
Split fraction:	1.000	

Moisture data	C.F.(+3")	S.F.(-3")	MC.(-No.10)
Moist soil + tare (g):	-	-	239.61
Dry soil + tare (g):	-	-	234.46
Tare (g):	-	-	193.59
Moisture content (%):	0.00	0.00	12.60

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.164
Gs:	2.7	Assumed	Intercept:	16.3
Hydrometer Seral #:	626325		a:	0.99
Dispersion period (min):	0		Hyd. fraction:	83.91
			Dispersion device:	NA

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Composite Correction	Grain Size (mm)	% Soil in Suspension
0.5	21.5	10	-0.1	0.07149	37.60
1	21.5	8	-0.1	0.05111	30.17
2	21.5	7	-0.1	0.03634	26.46
5	21.5	5	-0.1	0.02323	19.04
15	21.5	5	-0.1	0.01341	19.04
30	22.1	3.5	-0.3	0.00949	14.24
60	21.7	3	-0.2	0.00676	11.87
120	21.9	2.5	-0.3	0.00478	10.27
250	22.7	2	-0.5	0.00329	9.43
500	23.6	0	-0.9	0.00233	3.16
1440	21.9	0	-0.3	0.00140	0.99



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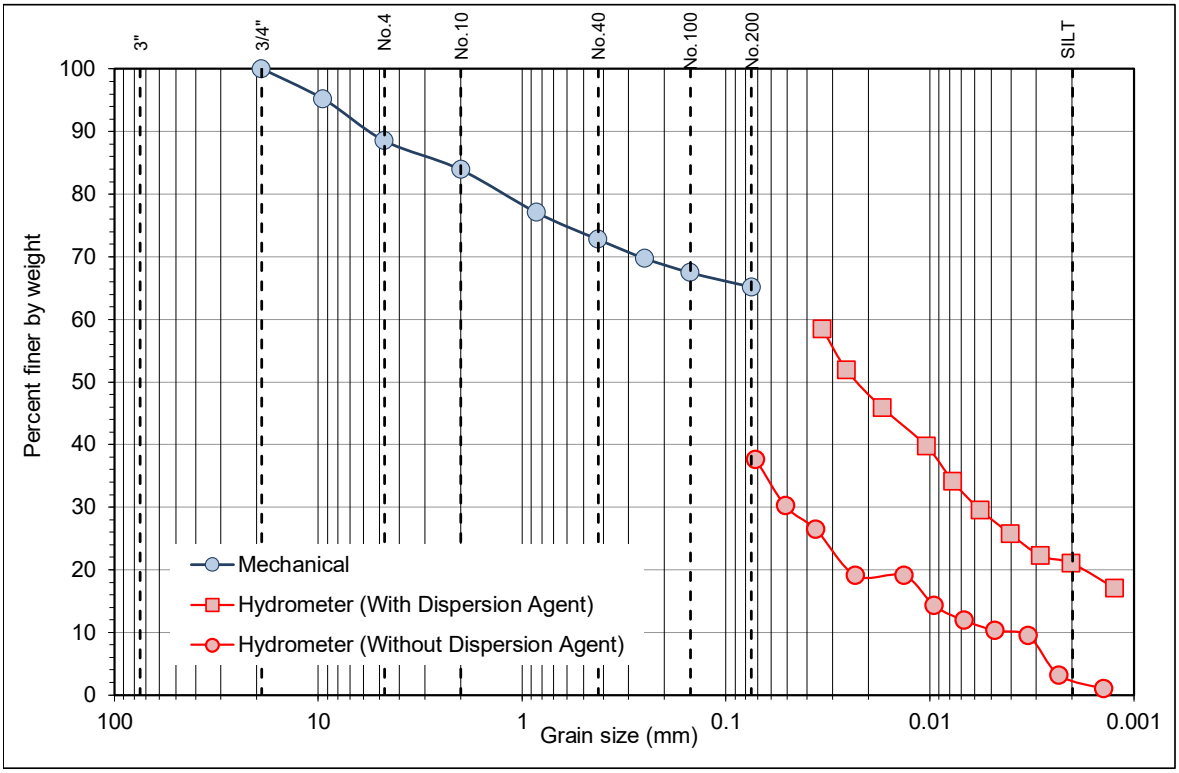
Particle-Size Analysis of Soils with Hydrometer*

(after ASTM D422/D4221)

GERHART COLE

Project: Utaba Dam **TH/TP/Sample:** 24-TH-01

No: 24-1762 **Depth:** 20-21.7 ft



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Compressive Strength - Unconfined Compression of Intact Rock Core (UCS)*

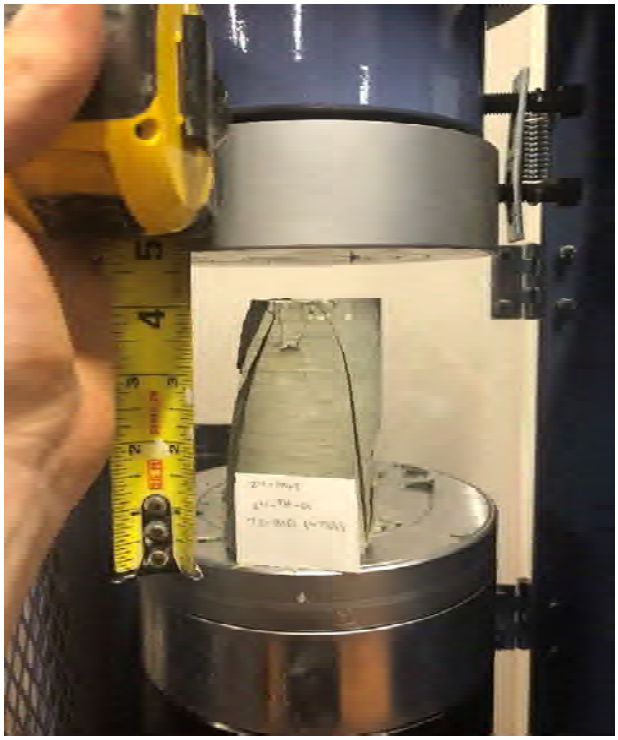
After ASTM D7012 Method C

GERHART COLE

Project Name:	**Utaba Dam**	**Test Hole/Pit:**	**24-TH-01**
Project Number:	**24-1762**	**Depth:**	**76-81 ft (~77 ft)**
Location:	Weber County, Utah	Sample Type	HQ
Date Sampled:	26-Oct-24	Lithology:	Not reported
Date Tested:	13-Nov-24	Formation:	Not reported
Tested by:	SF	Moisture Condition:	As Received
Reduced by:	SF	Load Direction - from horizontal (Deg):	90
Reviewed by:	LL		

inson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01_401_UCS-RockCore_Peak_Gilson.xlsm]1

Sample Height, H (in):	0°	4.17
	120°	4.14
	240°	4.15
Avg. height, Havg (in)		4.15
Sample Height, H (mm):		105.49
Sample Diameter, D (in):	0°	2.40
	90°	2.40
Avg. dia., Davg (in)		2.40
Sample Diameter, D (mm):		60.96
Area, A (in^2):		4.52
Volume, V (ft^3):		0.0109
Mass, M (g):		825.92
Weight, W (lb):		1.82
Unit Weight (pcf):		167.5
Height to Diameter Ratio H/D:		1.7
Failure Load (lb):		24,046.0
Time to Failure (s):		350
Loading Rate (psi/s):		15.2
Uniaxial Compressive Strength, σ_u (psi):		5315.3
Uniaxial Compressive Strength, σ_u (MPa):		36.648



Notes:

Compressive Strength - Unconfined Compression of Intact Rock Core (UCS)*

After ASTM D7012 Method C

Project Name:	**Utaba Dam**	**Test Hole/Pit:**	**24-TH-01**
Project Number:	**24-1762**	**Depth:**	**86-91 ft (~90 ft)**
Location:	Weber County, Utah	Sample Type	HQ
Date Sampled:	Not reported	Lithology:	Not reported
Date Tested:	13-Nov-24	Formation:	Not reported
Tested by:	SF	Moisture Condition:	As Received
Reduced by:	SF	Load Direction - from horizontal (Deg):	90
Reviewed by:	LL		

inson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01_401_UCS-RockCore_Peak_Gilson.xlsm]2

Sample Height, H (in):	0°	4.91
	120°	4.93
	240°	4.89
Avg. height, Havg (in)		4.91
Sample Height, H (mm):		124.71
Sample Diameter, D (in):	0°	2.40
	90°	2.40
Avg. dia., Davg (in)		2.40
Sample Diameter, D (mm):		60.96
Area, A (in^2):		4.52
Volume, V (ft^3):		0.0129
Mass, M (g):		981.52
Weight, W (lb):		2.16
Unit Weight (pcf):		168.3
Height to Diameter Ratio H/D:		2.0
Failure Load (lb):		53,742.1
Time to Failure (s):		789
Loading Rate (psi/s):		15.1
Uniaxial Compressive Strength, σ_u (psi):		11879.6
Uniaxial Compressive Strength, σ_u (MPa):		81.907



Notes:

Compressive Strength - Unconfined Compression of Intact Rock Core (UCS)*

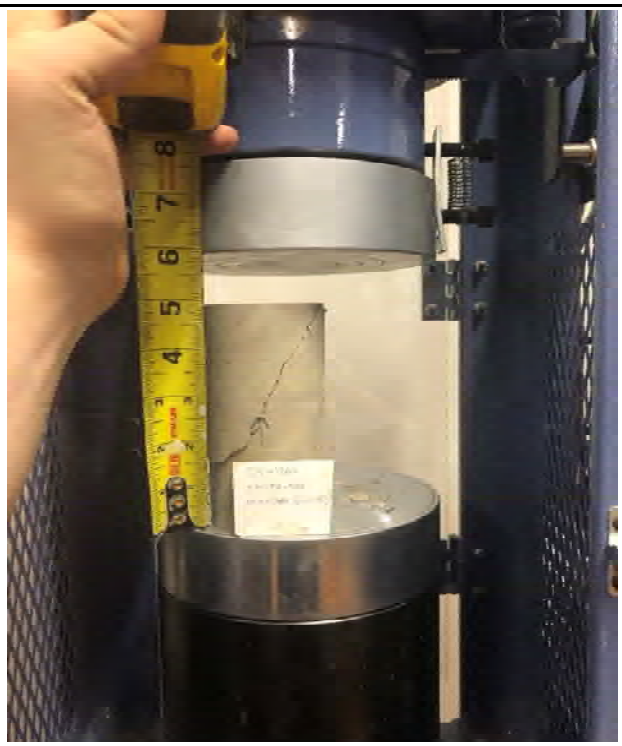
After ASTM D7012 Method C

GERHART COLE

Project Name:	**Utaba Dam**	**Test Hole/Pit:**	**24-TH-401**
Project Number:	**24-1762**	**Depth:**	**23-28 ft (~24 ft)**
Location:	Weber County, Utah	Sample Type	HQ
Date Sampled:	Not reported	Lithology:	Not reported
Date Tested:	13-Nov-24	Formation:	Not reported
Tested by:	SF	Moisture Condition:	As Received
Reduced by:	SF	Load Direction - from horizontal (Deg):	90
Reviewed by:	AT		

inson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01_401_UCS-RockCore_Peak_Gilson.xlsm]3

Sample Height, H (in):	0°	4.93
	120°	4.92
	240°	4.93
Avg. height, Havg (in)		4.93
Sample Height, H (mm):		125.14
Sample Diameter, D (in):	0°	2.40
	90°	2.40
Avg. dia., Davg (in)		2.40
Sample Diameter, D (mm):		60.96
Area, A (in^2):		4.52
Volume, V (ft^3):		0.0129
Mass, M (g):		974.44
Weight, W (lb):		2.15
Unit Weight (pcf):		166.6
Height to Diameter Ratio H/D:		2.1
Failure Load (lb):		29,774.2
Time to Failure (s):		386
Loading Rate (psi/s):		17.0
Uniaxial Compressive Strength, σ_u (psi):		6581.5
Uniaxial Compressive Strength, σ_u (MPa):		45.378



Notes:

Compressive Strength - Unconfined Compression of Intact Rock Core (UCS)*

After ASTM D7012 Method C

Project Name:	**Utaba Dam**	**Test Hole/Pit:**	**24-TH-401**
Project Number:	**24-1762**	**Depth:**	**28-33 ft (~30 ft)**
Location:	Weber County, Utah	Sample Type	HQ
Date Sampled:	Not reported	Lithology:	Not reported
Date Tested:	13-Nov-24	Formation:	Not reported
Tested by:	SF	Moisture Condition:	As Received
Reduced by:	SF	Load Direction - from horizontal (Deg):	90
Reviewed by:	AT		

nson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01_401_UCS-RockCore_Peak_Gilson.xlsm]4

Sample Height, H (in):	0°	3.24
	120°	3.27
	240°	3.25
Avg. height, Havg (in)		3.25
Sample Height, H (mm):		82.63
Sample Diameter, D (in):	0°	2.40
	90°	2.40
Avg. dia., Davg (in)		2.40
Sample Diameter, D (mm):		60.96
Area, A (in^2):		4.52
Volume, V (ft^3):		0.0085
Mass, M (g):		656.98
Weight, W (lb):		1.45
Unit Weight (pcf):		170.1
Height to Diameter Ratio H/D:		1.4
Failure Load (lb):		17,727.8
Time to Failure (s):		388
Loading Rate (psi/s):		10.1
Uniaxial Compressive Strength, σ_u (psi):		3918.7
Uniaxial Compressive Strength, σ_u (MPa):		27.019



Notes:

Determination of the Point Load Strength Index of Rock*

After ASTM D 5731

GERHART COLE

Project: Utaba Dam

No: 24-1762

Location: Weber County, Utah

Date: 20-Nov-24

Sample Info.	Test Hole/Pit:	24-TH-01	24-TH-01	24-TH-01	24-TH-01
	Sample:	RC-1	RC-1	RC-2	RC-2
	Depth:	~73.5 ft	~75.75 ft	~78.5 ft	~80.5 ft
	Date Sampled:	28-Oct-24	28-Oct-24	28-Oct-24	28-Oct-24
	Sample type	Core	Core	Core	Core
	Moisture condition:	As received	As received	As received	As received
Test Data	Distance between platen points, D (in.):	2.362	2.362	2.362	2.362
	D (mm):	60.0	60.0	60.0	60.0
	Distance to nearest end, L (in):	1.5	0.8	3.4	4.0
	Smallest specimen width, W (in.):	N/A	N/A	N/A	N/A
	W (mm):	N/A	N/A	N/A	N/A
	Equivalent core area, D_e^2 (mm^2):	3599	3599	3599	3599
	Failure Pressure P_f, (psi):	1468	1854	1854	2822
	Failure load, P (lbf):	2157	2724	2724	4147
	P (N):	9595	12118	12118	18445
	Effective area of jack piston A_e, (cm^2):	9.48	9.48	9.48	9.48
	Effective area of jack piston A_e, (in^2):	1.47	1.47	1.47	1.47
Test Results	Point load strength index, I_s (MPa):	2.67	3.37	3.37	5.12
	Size correction factor, F:	1.09	1.09	1.09	1.09
	PLSI 50mm equivalent, $I_{s(50)}$ (MPa):	2.89	3.65	3.65	5.56
	Strength Conversion factor, K:	24.5	24.5	24.5	24.5
	Uniaxial compressive strength, s_c (MPa):	70.9	89.5	89.5	136.3
	Uniaxial compressive strength, s_c (psi):	10,282	12,986	12,986	19,766
	Testing Apparatus:	RocSci	RocSci	RocSci	RocSci
	Break type:	⊥	⊥	⊥	⊥
	Photo before break:				
	Photo after break:				
QC/QA	Tested By:	SF	SF	SF	SF
	Reduced By:	SF	SF	SF	SF
	Reviewed By:	AT	AT	AT	AT

Notes: _____

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Determination of the Point Load Strength Index of Rock*

After ASTM D 5731

GERHART COLE

Project: Utaba Dam

No: 24-1762

Location: Weber County, Utah

Date: 20-Nov-24

Sample Info.	Test Hole/Pit:	24-TH-01	24-TH-01	24-TH-401	24-TH-401
	Sample:	RC-4	RC-5	RC-1	RC-2
	Depth:	~90.3 ft	~95 ft	~12.75 ft	~16.3 ft
	Date Sampled:	28-Oct-24	28-Oct-24	28-Oct-24	28-Oct-24
	Sample type	Core	Core	Core	Core
	Moisture condition:	As received	As received	As received	As received
Test Data	Distance between platen points, D (in.):	2.362	2.362	2.362	2.362
	D (mm):	60.0	60.0	60.0	60.0
	Distance to nearest end, L (in):	0.5	1.0	1.1	1.0
	Smallest specimen width, W (in.):	N/A	N/A	N/A	N/A
	W (mm):	N/A	N/A	N/A	N/A
	Equivalent core area, D_e^2 (mm^2):	3599	3599	3599	3599
	Failure Pressure P_f, (psi):	1981	1569	3078	754
	Failure load, P (lbf):	2911	2305	4523	1108
	P (N):	12948	10255	20119	4928
	Effective area of jack piston A_e, (cm^2):	9.48	9.48	9.48	9.48
	Effective area of jack piston A_e, (in^2):	1.47	1.47	1.47	1.47
Test Results	Point load strength index, I_s (MPa):	3.60	2.85	5.59	1.37
	Size correction factor, F:	1.09	1.09	1.09	1.09
	PLSI 50mm equivalent, $I_{s(50)}$ (MPa):	3.90	3.09	6.07	1.49
	Strength Conversion factor, K:	24.5	24.5	24.5	24.5
	Uniaxial compressive strength, s_c (MPa):	95.7	75.8	148.6	36.4
	Uniaxial compressive strength, s_c (psi):	13,875	10,989	21,559	5,281
	Testing Apparatus:	RocSci	RocSci	RocSci	RocSci
	Break type:	⊥	⊥	⊥	⊥
	Photo before break:				
	Photo after break:				
QC/QA	Tested By:	SF	SF	SF	SF
	Reduced By:	SF	SF	SF	SF
	Reviewed By:	AT	AT	AT	AT

Notes: _____

J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_24-TH-01_401_PL.xlsm]2

Determination of the Point Load Strength Index of Rock*

After ASTM D 5731

GERHART COLE

Project: Utaba Dam

No: 24-1762

Location: Weber County, Utah

Date: 20-Nov-24

Sample Info.	Test Hole/Pit:	24-TH-401	24-TH-401	24-TH-401	24-TH-401
	Sample:	RC-3	RC-3	RC-4	RC-5
	Depth:	~19.25 ft	~22.6 ft	~25 ft	~29.5 ft
	Date Sampled:	23-Oct-24	23-Oct-24	23-Oct-24	23-Oct-24
	Sample type	Core	Core	Core	Core
	Moisture condition:	As received	As received	As received	As received
Test Data	Distance between platen points, D (in.):	2.362	2.362	2.362	2.362
	D (mm):	60.0	60.0	60.0	60.0
	Distance to nearest end, L (in):	0.8	0.0	2.1	0.9
	Smallest specimen width, W (in.):	N/A	N/A	N/A	N/A
	W (mm):	N/A	N/A	N/A	N/A
	Equivalent core area, D_e^2 (mm^2):	3599	3599	3599	3599
	Failure Pressure P_f, (psi):	380	464	592	1500
	Failure load, P (lbf):	558	682	870	2204
	P (N):	2484	3033	3869	9804
	Effective area of jack piston A_e, (cm^2):	9.48	9.48	9.48	9.48
	Effective area of jack piston A_e, (in^2):	1.47	1.47	1.47	1.47
Test Results	Point load strength index, I_s (MPa):	0.69	0.84	1.08	2.72
	Size correction factor, F:	1.09	1.09	1.09	1.09
	PLSI 50mm equivalent, $I_{s(50)}$ (MPa):	0.75	0.91	1.17	2.96
	Strength Conversion factor, K:	24.5	24.5	24.5	24.5
	Uniaxial compressive strength, s_c (MPa):	18.4	22.4	28.6	72.4
	Uniaxial compressive strength, s_c (psi):	2,662	3,250	4,146	10,506
	Testing Apparatus:	RocSci	RocSci	RocSci	RocSci
	Break type:	⊥	⊥	⊥	⊥
	Photo before break:				
	Photo after break:				
QC/QA	Tested By:	SF	SF	SF	SF
	Reduced By:	SF	SF	SF	SF
	Reviewed By:	AT	AT	AT	AT

Notes: ~22.6 ft irregular shape, not complete cylinder (see photo)

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Determination of the Point Load Strength Index of Rock*

After ASTM D 5731

GERHART COLE

Project: Utaba Dam

No: 24-1762

Location: Weber County, Utah

Date: 20-Nov-24

Sample Info.	Test Hole/Pit:	24-TH-401	24-TH-401
	Sample:	RC-5	RC-5
	Depth:	~30 ft	~31.6 ft
	Date Sampled:	23-Oct-24	23-Oct-24
	Sample type	Core	Core
	Moisture condition:	As received	As received
Test Data	Distance between platen points, D (in.):	2.362	2.362
	D (mm):	60.0	60.0
	Distance to nearest end, L (in):	1.0	0.8
	Smallest specimen width, W (in.):	N/A	N/A
	W (mm):	N/A	N/A
	Equivalent core area, D_e^2 (mm^2):	3599	3599
	Failure Pressure P_f, (psi):	484	2463
	Failure load, P (lbf):	711	3619
	P (N):	3164	16099
	Effective area of jack piston A_e, (cm^2):	9.48	9.48
	Effective area of jack piston A_e, (in^2):	1.47	1.47
Test Results	Point load strength index, I_s (MPa):	0.88	4.47
	Size correction factor, F:	1.09	1.09
	PLSI 50mm equivalent, $I_{s(50)}$ (MPa):	0.95	4.85
	Strength Conversion factor, K:	24.5	24.5
	Uniaxial compressive strength, s_c (MPa):	23.4	118.9
	Uniaxial compressive strength, s_c (psi):	3,390	17,251
	Testing Apparatus:	RocSci	RocSci
	Break type:	⊥	⊥
	Photo before break:		
	Photo after break:		
QC/QA	Tested By:	SF	SF
	Reduced By:	SF	SF
	Reviewed By:	AT	AT

Notes:

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Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 3-Dec-24
Tested by: JC
Reduced by: JC
Reviewed by: AT

TH/TP/Sample: Composite
Depth: -
Laboratory sample description: bn - dk bn clay
USCS classification: Not requested
Sample type: Remolded
Comments: Recompacted to 95% of St. Proctor at OMC.

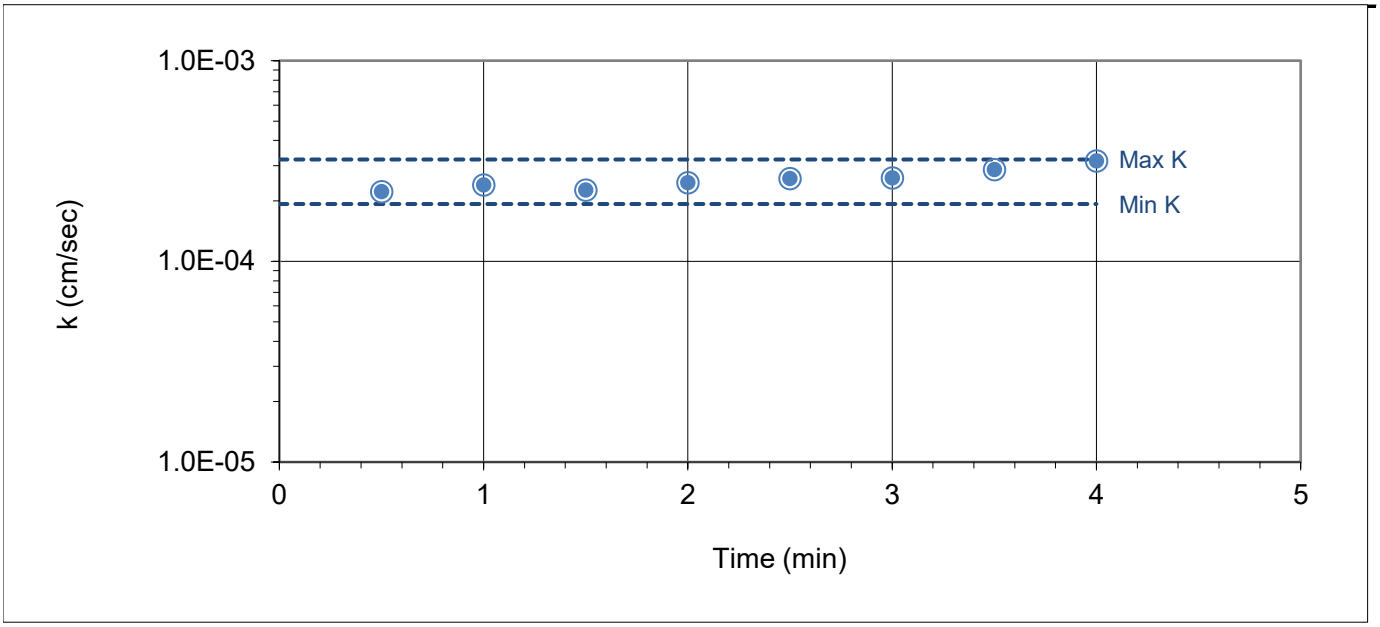
	Initial (o)	Final (f)
Sample Length, L (in)	3.012	3.010
Sample Diameter, D (in)	2.804	2.633
Sample Length, L (cm)	7.650	7.646
Sample Area, A (cm^2)	39.825	35.128
Sample Volume, V (cm^3)	304.68	268.59
Wt. Rings + Wet Soil (g)	643.10	665.38
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	898.51	862.39
Dry Soil + Tare (g)	830.12	778.04
Tare (g)	195.77	197.53
Mass of solids, Ms (g)	580.51	580.51
Moisture Content, w (%)	10.78	14.53
Wet Unit Wt., g_m (pcf)	131.8	154.7
Dry Unit Wt, g_d (pcf)	118.9	135.0
Volume solids (cm^3)	215.01	215.01
Volume of voids (cm^3)	89.68	53.59
Void ratio, e	0.42	0.39
Porosity, n	0.29	0.28
Volumetric moisture, T	0.21	0.28
Saturation, S (%)	69.8	100.0
Phase Relaionships for Assumed Gs =		2.7

[a] Saturation set to 100% for phase calculations

Cell No. / Base No. / Top No.	C1	C2	C3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		49	
Effective horiz. con. stress (psi)		20	
Effective vert. con. stress (psi)		20	
		Initial (o)	Final (f)
B value		0.33	0.96
External Burette (cm^3)		1.00	47.50
Cell Pressure (psi)		2.0	69.0
System volume coefficient (cm^3/psi)		0.16	
System volume change (cm^3)		10.41	
Net sample volume change (cm^3)		-36.09	
Base burette ground length, l_b (cm)		70.0	
Top burette ground length, l_t (cm)		69.9	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.806	3.806
Conversion, reading to cm head (cm/rd)		1.156	

K average last 8 values = 2.6E-04

b - K corrected to 20ºC



J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_Kbp_FRhead.xlsx]20 psi

Project: Utaba Dam **TH/TP/Sample:** Composite

No: 24-1762 **Depth:** -

Location: Weber County, Utah Laboratory sample description: bn - dk bn clay

Permeability Data

time (min)	time (sec)	Burrett reading Base	Burrett reading Top	hp (psi)	$h_{(i/f)}$ (cm)	i	K (cm/sec)	Avg. Temp (ºC)	Visc. Ratio Rt	Pore Vol	K^b (cm/sec)
	[pipet]	1.10	22.70	0.0	25.1	3.3					
0.5	30	1.90	21.95	0.0	23.3	3.0	2.3E-04	21.8	0.96	0.01	2.2E-04
0.5	30	2.70	21.20	0.0	21.5	2.8	2.5E-04	21.8	0.96	0.02	2.4E-04
0.5	30	3.35	20.50	0.0	19.9	2.6	2.4E-04	21.8	0.96	0.02	2.3E-04
0.5	30	4.00	19.80	0.0	18.4	2.4	2.6E-04	21.6	0.96	0.03	2.5E-04
0.5	30	4.70	19.20	0.0	16.9	2.2	2.7E-04	21.5	0.96	0.04	2.6E-04
0.5	30	5.30	18.60	0.0	15.5	2.0	2.7E-04	21.3	0.97	0.05	2.6E-04
0.5	30	5.90	18.00	0.0	14.1	1.8	2.9E-04	21.2	0.97	0.05	2.9E-04
0.5	30	6.50	17.40	0.0	12.7	1.7	3.3E-04	21.1	0.97	0.06	3.2E-04

K average last 8 values = 2.6E-04

b - K corrected to 20ºC

Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 3-Dec-24
Tested by: JC
Reduced by: JC
Reviewed by: AT

TH/TP/Sample: Composite
Depth: -
Laboratory sample description: bn - dk bn clay
USCS classification: Not requested
Sample type: Remolded
Comments: Recompacted to 95% of St. Proctor at OMC.

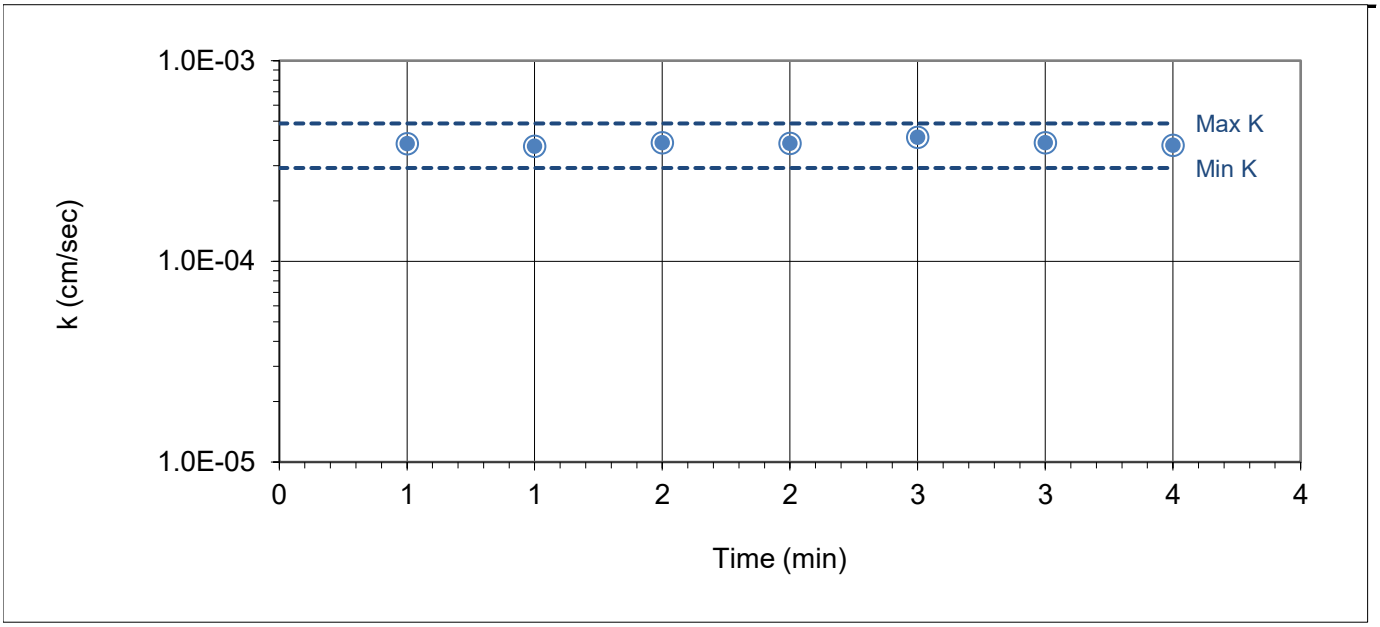
	Initial (o)	Final (f)
Sample Length, L (in)	3.012	3.010
Sample Diameter, D (in)	2.804	2.679
Sample Length, L (cm)	7.650	7.646
Sample Area, A (cm^2)	39.825	36.363
Sample Volume, V (cm^3)	304.68	278.04
Wt. Rings + Wet Soil (g)	643.10	665.38
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	898.51	862.39
Dry Soil + Tare (g)	830.12	778.04
Tare (g)	195.77	197.53
Mass of solids, Ms (g)	580.51	580.51
Moisture Content, w (%)	10.78	14.53
Wet Unit Wt., g_m (pcf)	131.8	149.4
Dry Unit Wt, g_d (pcf)	118.9	130.4
Volume solids (cm^3)	215.01	215.01
Volume of voids (cm^3)	89.68	63.03
Void ratio, e	0.42	0.39
Porosity, n	0.29	0.28
Volumetric moisture, T	0.21	0.28
Saturation, S (%)	69.8	100.0
Phase Relaionships for Assumed Gs =		2.7

[a] Saturation set to 100% for phase calculations

Cell No. / Base No. / Top No.	C1	C2	C3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		49	
Effective horiz. con. stress (psi)		10	
Effective vert. con. stress (psi)		10	
		Initial (o)	Final (f)
B value		0.33	0.96
External Burette (cm^3)		1.00	36.50
Cell Pressure (psi)		2.0	59.0
System volume coefficient (cm^3/psi)		0.16	
System volume change (cm^3)		8.86	
Net sample volume change (cm^3)		-26.64	
Base burette ground length, l_b (cm)		70.0	
Top burette ground length, l_t (cm)		69.9	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.806	3.806
Conversion, reading to cm head (cm/rd)		1.156	

K average last 7 values = 3.9E-04

b - K corrected to 20ºC



J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_Kbp_FRhead.xlsx]10 psi

Project: Utaba Dam **TH/TP/Sample:** Composite

No: 24-1762 **Depth:** -

Location: Weber County, Utah Laboratory sample description: bn - dk bn clay

Permeability Data

time (min)	time (sec)	Burrett reading Base	Burrett reading Top	hp (psi)	$h_{(i/f)}$ (cm)	i	K (cm/sec)	Avg. Temp (ºC)	Visc. Ratio Rt	Pore Vol	K^b (cm/sec)
	[pipet]	0.90	23.10	0.0	25.8	3.4					
0.5	30	2.25	21.75	0.0	22.6	3.0	3.9E-04	20.6	0.99	0.02	3.9E-04
0.5	30	3.40	20.60	0.0	20.0	2.6	3.8E-04	20.4	0.99	0.03	3.8E-04
0.5	30	4.50	19.60	0.0	17.6	2.3	3.9E-04	20.3	0.99	0.04	3.9E-04
0.5	30	5.35	18.65	0.0	15.5	2.0	3.8E-04	19.4	1.02	0.05	3.9E-04
0.5	30	6.20	17.80	0.0	13.5	1.8	4.1E-04	19.6	1.01	0.06	4.2E-04
0.5	30	6.90	17.10	0.0	11.9	1.6	3.9E-04	19.7	1.01	0.07	3.9E-04
0.5	30	7.50	16.50	0.0	10.5	1.4	3.8E-04	19.6	1.01	0.07	3.8E-04

K average last 7 values = 3.9E-04

b - K corrected to 20ºC

Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Dam
No: 24-1762
Location: Weber County, Utah
Date: 3-Dec-24
Tested by: JC
Reduced by: JC
Reviewed by: AT

TH/TP/Sample: Composite
Depth: -
Laboratory sample description: bn - dk bn clay
USCS classification: Not requested
Sample type: Remolded
Comments: Recompacted to 95% of St. Proctor at OMC.

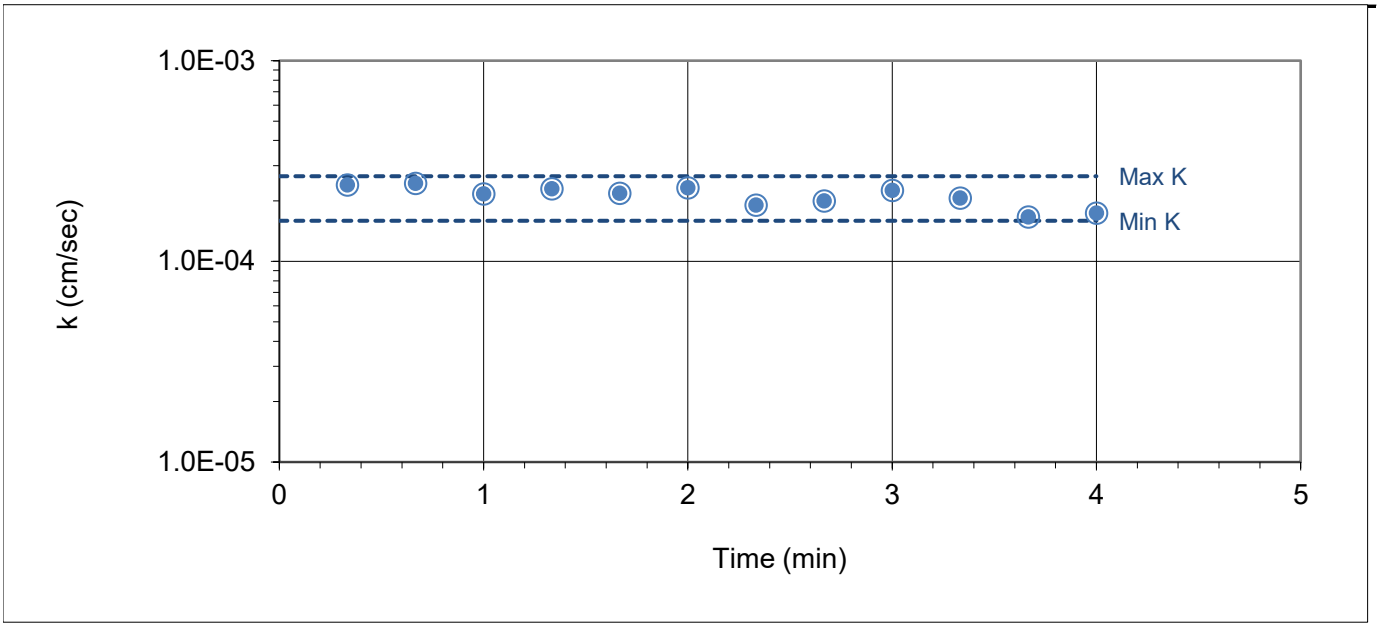
	Initial (o)	Final (f)
Sample Length, L (in)	3.012	3.010
Sample Diameter, D (in)	2.804	2.765
Sample Length, L (cm)	7.650	7.646
Sample Area, A (cm^2)	39.825	38.733
Sample Volume, V (cm^3)	304.68	296.16
Wt. Rings + Wet Soil (g)	643.10	665.38
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	898.51	862.39
Dry Soil + Tare (g)	830.12	778.04
Tare (g)	195.77	197.53
Mass of solids, Ms (g)	580.51	580.51
Moisture Content, w (%)	10.78	14.53
Wet Unit Wt., g_m (pcf)	131.8	140.3
Dry Unit Wt, g_d (pcf)	118.9	122.5
Volume solids (cm^3)	215.01	215.01
Volume of voids (cm^3)	89.68	81.16
Void ratio, e	0.42	0.39
Porosity, n	0.29	0.28
Volumetric moisture, T	0.21	0.28
Saturation, S (%)	69.8	100.0
Phase Relaionships for Assumed Gs =		2.7

[a] Saturation set to 100% for phase calculations

Cell No. / Base No. / Top No.	D1	D2	D3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		49	
Effective horiz. con. stress (psi)		5	
Effective vert. con. stress (psi)		5	
		Initial (o)	Final (f)
B value		0.33	0.96
External Burette (cm^3)		1.00	17.60
Cell Pressure (psi)		2.0	54.0
System volume coefficient (cm^3/psi)		0.16	
System volume change (cm^3)		8.08	
Net sample volume change (cm^3)		-8.52	
Base burette ground length, l_b (cm)		70.5	
Top burette ground length, l_t (cm)		70.5	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.324	3.409
Conversion, reading to cm head (cm/rd)		1.156	

K average last 12 values = 2.1E-04

b - K corrected to 20ºC



J:\PROJECTS\Franson Civil\24-1762 Utaba Dam\Data\Lab\Test Results\[2024-11-11_Kbp_FRhead.xlsx]5 psi

Project: Utaba Dam | **TH/TP/Sample:** Composite

No: 24-1762 | **Depth:** -

Location: Weber County, Utah | Laboratory sample description: bn - dk bn clay

Permeability Data

time (min)	time (sec)	Burrett reading Base	Burrett reading Top	hp (psi)	$h_{(i/f)}$ (cm)	i	K (cm/sec)	Avg. Temp (ºC)	Visc. Ratio Rt	Pore Vol	K^b (cm/sec)
	[pipet]	1.10	23.05	0.0	25.4	3.3					
0.3	20	1.70	22.40	0.0	23.9	3.1	2.5E-04	21.6	0.96	0.01	2.4E-04
0.3	20	2.30	21.80	0.0	22.5	2.9	2.5E-04	21.6	0.96	0.01	2.5E-04
0.3	20	2.80	21.30	0.0	21.4	2.8	2.2E-04	21.5	0.96	0.02	2.2E-04
0.3	20	3.30	20.80	0.0	20.2	2.6	2.4E-04	21.3	0.97	0.02	2.3E-04
0.3	20	3.75	20.35	0.0	19.2	2.5	2.3E-04	21.2	0.97	0.03	2.2E-04
0.3	20	4.20	19.90	0.0	18.1	2.4	2.4E-04	20.9	0.98	0.03	2.3E-04
0.3	20	4.55	19.55	0.0	17.3	2.3	1.9E-04	20.8	0.98	0.04	1.9E-04
0.3	20	4.90	19.20	0.0	16.5	2.2	2.0E-04	20.8	0.98	0.04	2.0E-04
0.3	20	5.25	18.80	0.0	15.7	2.0	2.3E-04	20.7	0.98	0.05	2.3E-04
0.3	20	5.60	18.50	0.0	14.9	2.0	2.1E-04	20.6	0.99	0.05	2.1E-04
0.3	20	5.85	18.25	0.0	14.3	1.9	1.7E-04	20.6	0.99	0.05	1.7E-04
0.3	20	6.10	18.00	0.0	13.8	1.8	1.8E-04	20.4	0.99	0.06	1.7E-04

K average last 12 values = 2.1E-04

b - K corrected to 20ºC

Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762
Location: Weber County, Utah
Date: 6-Jan-25
Tested by: JC
Reduced by: JC
Reviewed by: AT

TH/TP/Sample: #4 Minus Composite
Depth: -
Laboratory sample description: bn - dk bn gravelly clay
USCS classification: Not requested
Sample type: Laboratory Compacted
Comments: 95% Std. Proctor, OMC

	Initial (o)	Final (f)
Sample Length, L (in)	3.971	3.925
Sample Diameter, D (in)	2.810	2.805
Sample Length, L (cm)	10.085	9.970
Sample Area, A (cm^2)	40.010	39.861
Sample Volume, V (cm^3)	403.52	397.40
Wt. Rings + Wet Soil (g)	830.72	857.07
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	409.57	1054.30
Dry Soil + Tare (g)	379.63	930.54
Tare (g)	145.07	197.79
Mass of solids, Ms (g)	736.69	736.69
Moisture Content, w (%)	12.76	16.89
Wet Unit Wt., g_m (pcf)	128.5	134.6
Dry Unit Wt, g_d (pcf)	114.0	115.2
Volume solids (cm^3)	272.85	272.85
Volume of voids (cm^3)	130.67	124.55
Void ratio, e	0.48	0.46
Porosity, n	0.32	0.31
Volumetric moisture, T	0.23	0.31
Saturation, S (%)	72.0	100.0
Phase Relaionships for Assumed Gs =		2.7

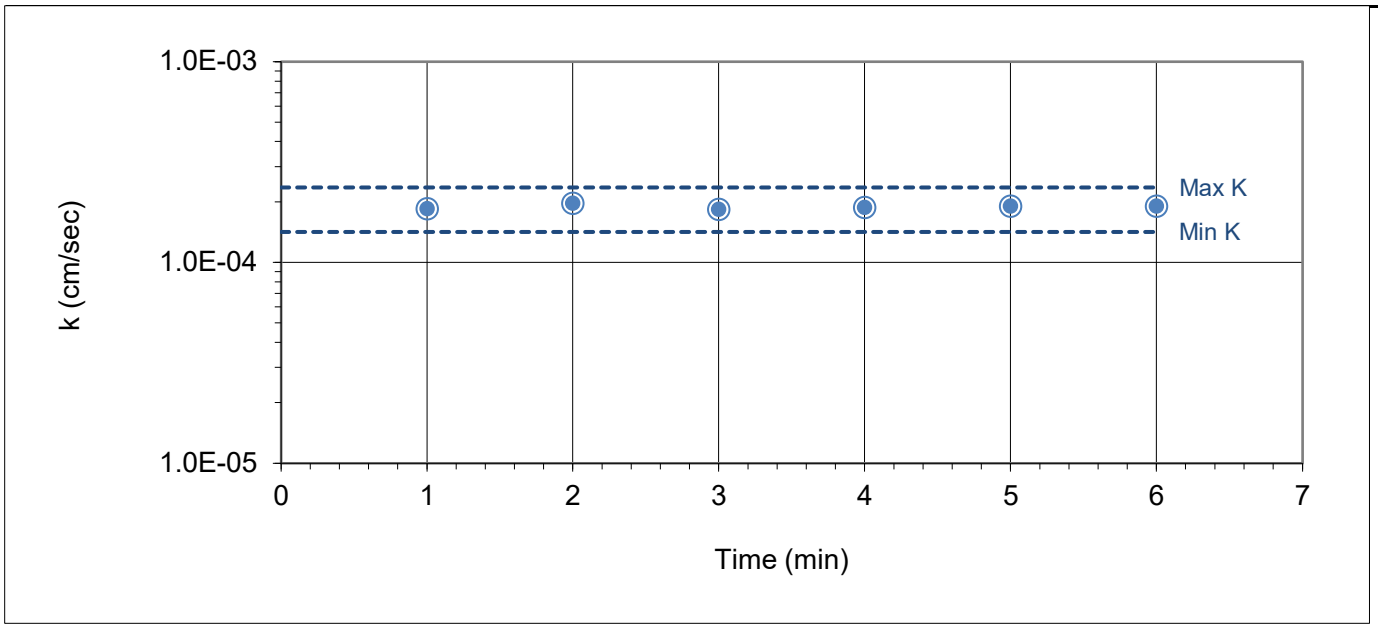
[a] Saturation set to 100% for phase calculations

Optimum moisture content (%) 13.2
Maximum dry unit weight (pcf) 120.5

Cell No. / Base No. / Top No.	D1	D2	D3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		59	
Effective horiz. con. stress (psi)		5	
Effective vert. con. stress (psi)		5	
		Initial (o)	Final (f)
B value		0.23	0.96
External Burette (cm^3)		1.30	18.80
Cell Pressure (psi)		2.0	64.0
System volume coefficient (cm^3/psi)		0.18	
System volume change (cm^3)		11.38	
Net sample volume change (cm^3)		-6.12	
Base burette ground length, l_b (cm)		70.5	
Top burette ground length, l_t (cm)		70.5	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.324	3.409
Conversion, reading to cm head (cm/rd)		1.156	

K average last 6 values = 1.9E-04

b - K corrected to 20ºC



Project: Utaba Retarding Dam | **TH/TP/Sample:** #4 Minus Composite

No: 24-1762 | **Depth:** -

Location: Weber County, Utah | Laboratory sample description: bn - dk bn gravelly clay

Permeability Data

time (min)	time (sec)	Burrett reading Base	Burrett reading Top	hp (psi)	$h_{(i/f)}$ (cm)	i	K (cm/sec)	Avg. Temp (ºC)	Visc. Ratio Rt	Pore Vol	K^b (cm/sec)
	[pipet]	1.00	23.80	0.0	26.4	2.6					
1.0	60	2.10	22.65	0.0	23.8	2.4	1.9E-04	20.5	0.99	0.01	1.9E-04
1.0	60	3.20	21.60	0.0	21.3	2.1	2.0E-04	20.4	0.99	0.02	2.0E-04
1.0	60	4.10	20.70	0.0	19.2	1.9	1.9E-04	20.3	0.99	0.02	1.8E-04
1.0	60	4.90	19.85	0.0	17.3	1.7	1.9E-04	20.2	1.00	0.03	1.9E-04
1.0	60	5.65	19.10	0.0	15.5	1.6	1.9E-04	19.9	1.00	0.04	1.9E-04
1.0	60	6.30	18.40	0.0	14.0	1.4	1.9E-04	20.0	1.00	0.04	1.9E-04

K average last 6 values = 1.9E-04

b - K corrected to 20ºC

Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762
Location: Weber County, Utah
Date: 6-Jan-25
Tested by: JC
Reduced by: JC
Reviewed by: AT

TH/TP/Sample: #4 Minus Composite
Depth: -
Laboratory sample description: bn - dk bn gravelly clay
USCS classification: Not requested
Sample type: Laboratory Compacted
Comments: 95% Std. Proctor, OMC

	Initial (o)	Final (f)
Sample Length, L (in)	3.971	3.925
Sample Diameter, D (in)	2.810	2.797
Sample Length, L (cm)	10.085	9.970
Sample Area, A (cm^2)	40.010	39.633
Sample Volume, V (cm^3)	403.52	395.12
Wt. Rings + Wet Soil (g)	830.72	857.07
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	409.57	1054.30
Dry Soil + Tare (g)	379.63	930.54
Tare (g)	145.07	197.79
Mass of solids, Ms (g)	736.69	736.69
Moisture Content, w (%)	12.76	16.89
Wet Unit Wt., g_m (pcf)	128.5	135.4
Dry Unit Wt, g_d (pcf)	114.0	115.9
Volume solids (cm^3)	272.85	272.85
Volume of voids (cm^3)	130.67	122.27
Void ratio, e	0.48	0.46
Porosity, n	0.32	0.31
Volumetric moisture, T	0.23	0.31
Saturation, S (%)	72.0	100.0
Phase Relaionships for Assumed Gs =		2.7

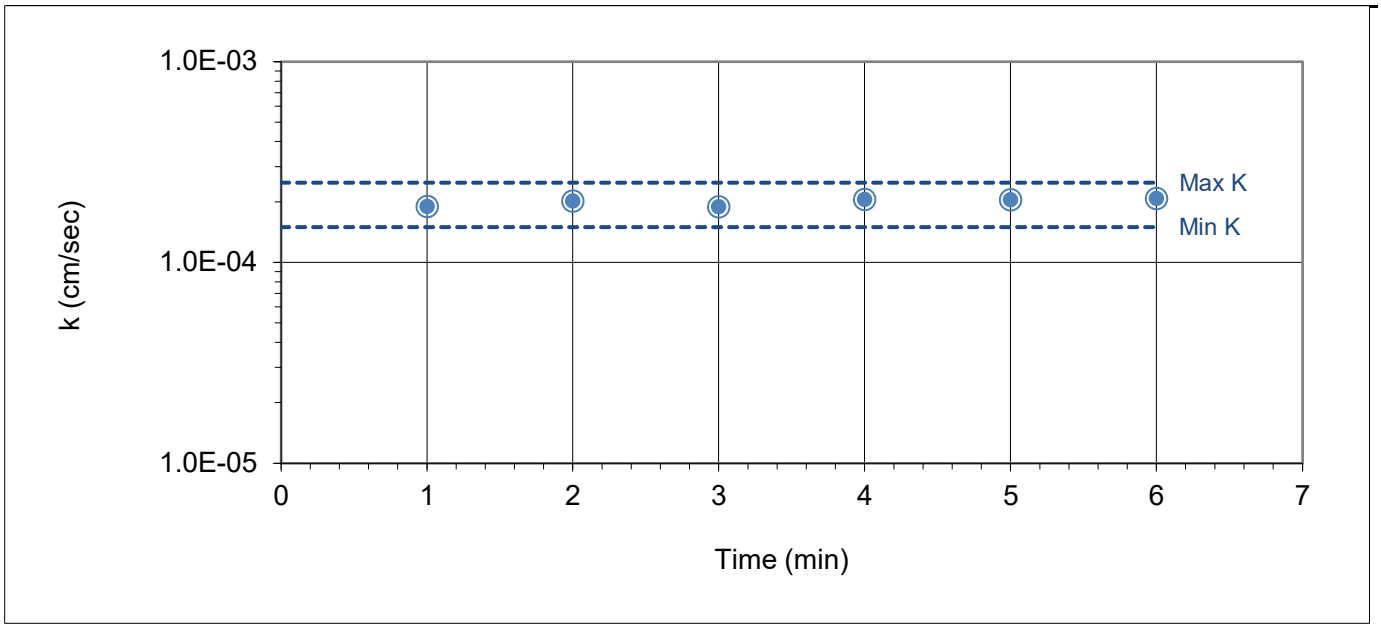
[a] Saturation set to 100% for phase calculations

Optimum moisture content (%) 13.2
Maximum dry unit weight (pcf) 120.5

Cell No. / Base No. / Top No.	D1	D2	D3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		59	
Effective horiz. con. stress (psi)		10	
Effective vert. con. stress (psi)		10	
		Initial (o)	Final (f)
B value		0.23	0.96
External Burette (cm^3)		1.30	22.00
Cell Pressure (psi)		2.0	69.0
System volume coefficient (cm^3/psi)		0.18	
System volume change (cm^3)		12.29	
Net sample volume change (cm^3)		-8.41	
Base burette ground length, l_b (cm)		70.5	
Top burette ground length, l_t (cm)		70.5	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.324	3.409
Conversion, reading to cm head (cm/rd)		1.156	

K average last 6 values = 2.0E-04

b - K corrected to 20ºC



Project: Utaba Retarding Dam | **TH/TP/Sample:** #4 Minus Composite

No: 24-1762 | **Depth:** -

Location: Weber County, Utah | Laboratory sample description: bn - dk bn gravelly clay

Permeability Data

time (min)	time (sec)	Burrett reading Base	Burrett reading Top	hp (psi)	$h_{(i/f)}$ (cm)	i	K (cm/sec)	Avg. Temp (ºC)	Visc. Ratio Rt	Pore Vol	K^b (cm/sec)
	[pipet]	1.00	23.50	0.0	26.0	2.6					
1.0	60	2.10	22.35	0.0	23.4	2.3	1.9E-04	20.2	1.00	0.01	1.9E-04
1.0	60	3.20	21.30	0.0	20.9	2.1	2.0E-04	20.2	1.00	0.02	2.0E-04
1.0	60	4.10	20.40	0.0	18.8	1.9	1.9E-04	20.1	1.00	0.02	1.9E-04
1.0	60	4.95	19.50	0.0	16.8	1.7	2.1E-04	20.0	1.00	0.03	2.1E-04
1.0	60	5.70	18.70	0.0	15.0	1.5	2.0E-04	19.8	1.01	0.04	2.1E-04
1.0	60	6.40	18.00	0.0	13.4	1.3	2.1E-04	19.7	1.01	0.04	2.1E-04

K average last 6 values = 2.0E-04

b - K corrected to 20ºC

Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762
Location: Weber County, Utah
Date: 6-Jan-25
Tested by: JC
Reduced by: JC
Reviewed by: AT

TH/TP/Sample: #4 Minus Composite
Depth: -
Laboratory sample description: bn - dk bn gravelly clay
USCS classification: Not requested
Sample type: Laboratory Compacted
Comments: Recompacted to 95% of St. Proctor at OMC.

	Initial (o)	Final (f)
Sample Length, L (in)	3.971	3.925
Sample Diameter, D (in)	2.810	2.781
Sample Length, L (cm)	10.085	9.970
Sample Area, A (cm^2)	40.010	39.185
Sample Volume, V (cm^3)	403.52	390.65
Wt. Rings + Wet Soil (g)	830.72	857.07
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	409.57	1054.30
Dry Soil + Tare (g)	379.63	930.54
Tare (g)	145.07	197.79
Mass of solids, Ms (g)	736.69	736.69
Moisture Content, w (%)	12.76	16.89
Wet Unit Wt., g_m (pcf)	128.5	137.0
Dry Unit Wt, g_d (pcf)	114.0	117.2
Volume solids (cm^3)	272.85	272.85
Volume of voids (cm^3)	130.67	117.80
Void ratio, e	0.48	0.46
Porosity, n	0.32	0.31
Volumetric moisture, T	0.23	0.31
Saturation, S (%)	72.0	100.0
Phase Relaionships for Assumed Gs =		2.7

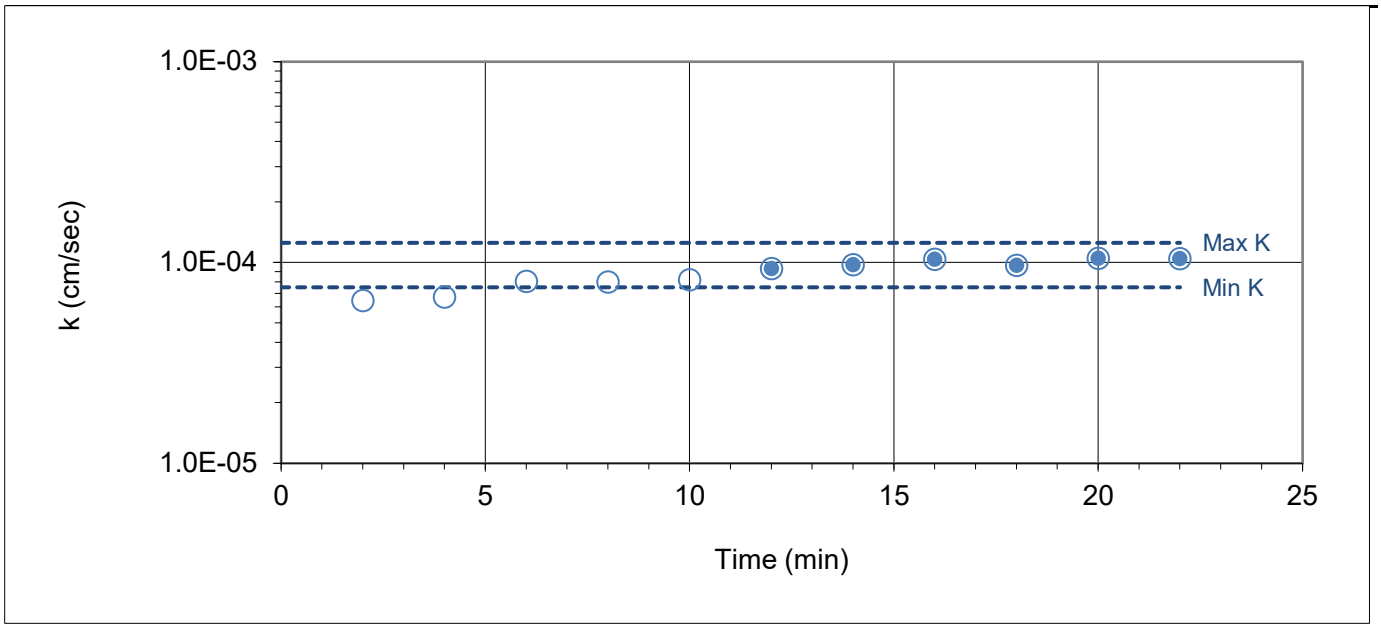
[a] Saturation set to 100% for phase calculations

Optimum moisture content (%) 13.2
Maximum dry unit weight (pcf) 120.5

Cell No. / Base No. / Top No.	D1	D2	D3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		59	
Effective horiz. con. stress (psi)		20	
Effective vert. con. stress (psi)		20	
		Initial (o)	Final (f)
B value		0.23	0.96
External Burette (cm^3)		1.30	28.30
Cell Pressure (psi)		2.0	79.0
System volume coefficient (cm^3/psi)		0.18	
System volume change (cm^3)		14.13	
Net sample volume change (cm^3)		-12.87	
Base burette ground length, l_b (cm)		70.5	
Top burette ground length, l_t (cm)		70.5	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.324	3.409
Conversion, reading to cm head (cm/rd)		1.156	

K average last 6 values = 1.0E-04

b - K corrected to 20ºC



Project: Utaba Retarding Dam | **TH/TP/Sample:** #4 Minus Composite

No: 24-1762 | **Depth:** -

Location: Weber County, Utah | Laboratory sample description: bn - dk bn gravelly clay

Permeability Data

time (min)	time (sec)	Burrett reading Base	Burrett reading Top	hp (psi)	$h_{(i/f)}$ (cm)	i	K (cm/sec)	Avg. Temp (ºC)	Visc. Ratio Rt	Pore Vol	K^b (cm/sec)
	[pipet]	1.50	23.90	0.0	25.9	2.6					
2.0	120	2.30	23.15	0.0	24.1	2.4	6.6E-05	20.7	0.98	0.01	6.5E-05
2.0	120	3.05	22.40	0.0	22.4	2.2	6.8E-05	20.7	0.98	0.01	6.7E-05
2.0	120	3.85	21.55	0.0	20.5	2.1	8.2E-05	20.6	0.99	0.02	8.1E-05
2.0	120	4.60	20.80	0.0	18.7	1.9	8.1E-05	20.6	0.99	0.02	8.0E-05
2.0	120	5.30	20.10	0.0	17.1	1.7	8.3E-05	20.5	0.99	0.03	8.2E-05
2.0	120	6.00	19.35	0.0	15.4	1.5	9.5E-05	20.5	0.99	0.03	9.3E-05
2.0	120	6.70	18.70	0.0	13.9	1.4	9.8E-05	20.2	1.00	0.04	9.7E-05
	[pipet]	1.50	23.60	0.0	25.5	2.6					
2.0	120	2.70	22.40	0.0	22.8	2.3	1.1E-04	20.6	0.99	0.05	1.0E-04
2.0	120	3.70	21.40	0.0	20.5	2.1	9.8E-05	20.6	0.99	0.06	9.7E-05
2.0	120	4.65	20.45	0.0	18.3	1.8	1.0E-04	19.7	1.01	0.06	1.0E-04
2.0	120	5.50	19.60	0.0	16.3	1.6	1.0E-04	19.9	1.00	0.07	1.0E-04

K average last 6 values = 1.0E-04

b - K corrected to 20ºC

Hydraulic Conductivity Test - Back Pressure, Flexible Wall

after ASTM D5084 Method C

GERHART COLE

Project: Utaba Retarding Dam
No: 24-1762
Location: Weber County, Utah
Date: 31-Dec-25
Tested by: JC
Reduced by: JC
Reviewed by: ZMG

TH/TP/Sample: 24-TH-01
Depth: 45-47 ft
Laboratory sample description: bn - dk bn clay
USCS classification: Not requested
Sample type: Undisturbed
Comments: 1" gravel, large voids in sample. Voids filled with cuttings.

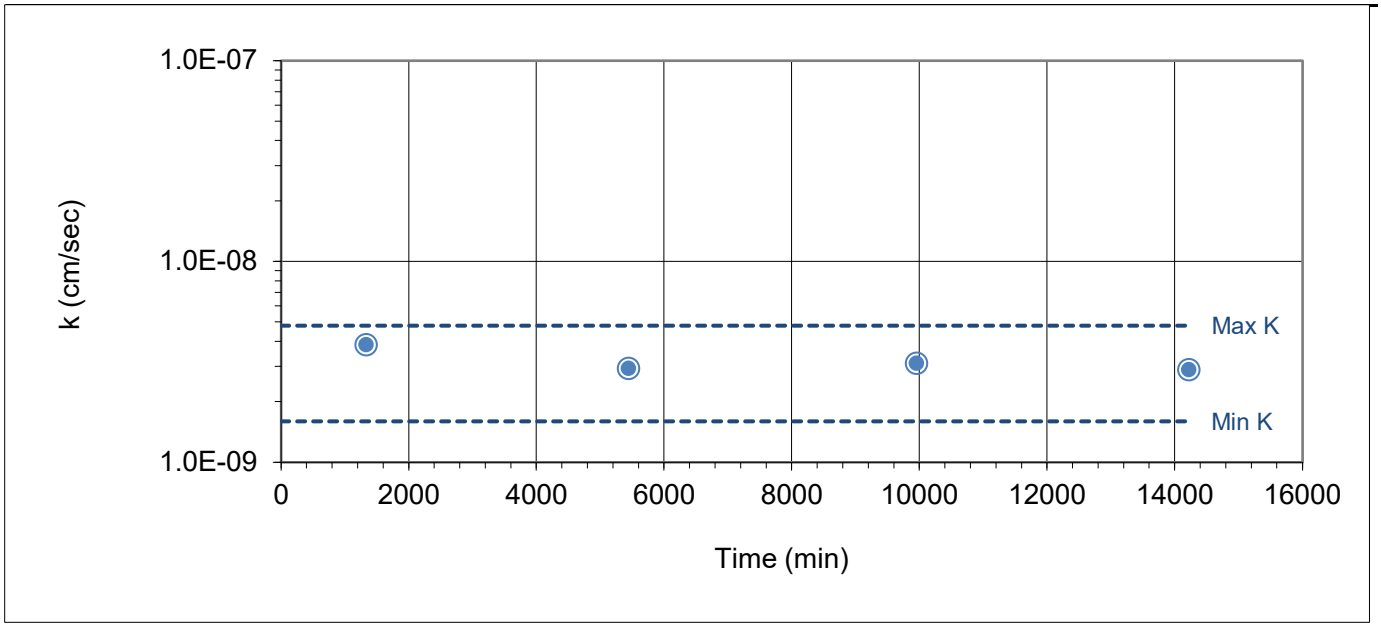
	Initial (o)	Final (f)
Sample Length, L (in)	5.741	5.688
Sample Diameter, D (in)	2.867	2.861
Sample Length, L (cm)	14.582	14.448
Sample Area, A (cm^2)	41.650	41.488
Sample Volume, V (cm^3)	607.34	599.44
Wt. Rings + Wet Soil (g)	1360.42	1354.60
Wt. Rings (g)	0.00	0.00
Wet Soil + Tare (g)	656.14	1769.25
Dry Soil + Tare (g)	584.73	1619.49
Tare (g)	197.39	416.35
Mass of solids, Ms (g)	1148.65	1148.65
Moisture Content, w (%)	18.44	12.45
Wet Unit Wt., g_m (pcf)	139.8	141.1
Dry Unit Wt, g_d (pcf)	118.1	125.5
Volume solids (cm^3)	425.43	425.43
Volume of voids (cm^3)	181.92	174.01
Void ratio, e	0.43	0.34
Porosity, n	0.30	0.25
Volumetric moisture, T	0.30	0.25
Saturation, S (%)	100.0	100.0
Phase Relaionships for Assumed Gs =		2.7

[a] Saturation set to 100% for phase calculations

Cell No. / Base No. / Top No.	E1	E2	E3
gw (gm/cm^3)		1.00	Assumed
Permeant liquid used		deaired	
Total backpressure (psi)		50	
Effective horiz. con. stress (psi)		35	
Effective vert. con. stress (psi)		35	
		Initial (o)	Final (f)
B value		0.27	0.96
External Burette (cm^3)		1.70	26.80
Cell Pressure (psi)		2.0	84.0
System volume coefficient (cm^3/psi)		0.21	
System volume change (cm^3)		17.20	
Net sample volume change (cm^3)		-7.90	
Base burette ground length, l_b (cm)		70.5	
Top burette ground length, l_t (cm)		70.5	
Pipet area, api / apo (cm^2)		0.865	0.865
Annulus area, aai / aao (cm^2)		3.308	3.460
Conversion, reading to cm head (cm/rd)		1.156	

K average last 4 values = 3.2E-09

b - K corrected to 20°C



Project: Utaba Retarding Dam **TH/TP/Sample:** 24-TH-01

No: 24-1762 **Depth:** 45-47 ft

Location: Weber County, Utah Laboratory sample description: bn - dk bn clay

Permeability Data

time	time	Burrett reading		hp	$h_{(i/f)}$	i	K	Avg. Temp	Visc. Ratio	Pore	K^b
(min)	(sec)	Base	Top	(psi)	(cm)		(cm/sec)	(ºC)	Rt	Vol	(cm/sec)
	[pipet]	1.50	23.80	2.0	166.4	11.5					
1330.0	79800	1.65	23.65	2.0	166.0	11.5	3.9E-09	20.9	0.98	0.00	3.9E-09
4110.0	246600	2.00	23.30	2.0	165.2	11.4	3.0E-09	20.7	0.98	0.00	2.9E-09
4515.0	270900	2.35	22.85	2.0	164.3	11.4	3.1E-09	20.1	1.00	0.00	3.1E-09
4266.0	255960	2.65	22.45	2.0	163.5	11.3	2.9E-09	20.2	1.00	0.01	2.9E-09

K average last 4 values = 3.2E-09

b - K corrected to 20ºC

11/18/2024

Work Order: 24K0795
Project: [none]

Gerhart Cole, Inc.
Attn: Zach Gibbs
7657 South Holden Street
Midvale, UT 84047

Client Service Contact: 801.262.7299

The analyses presented on this report were performed in accordance with the National Environmental Laboratory Accreditation Program (NELAP) unless noted in the comments, flags, or case narrative. If the report is to be used for regulatory compliance, it should be presented in its entirety, and not be altered.

Approved By:

Reed Hendricks, Lab Director

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Certificate of Analysis

Gerhart Cole, Inc.
Zach Gibbs
7657 South Holden Street
Midvale, UT 84047

PO#:
Receipt: **11/12/24 13:35 @ 18.5** °C
Date Reported: 11/18/2024
Project Name: **[none]**

Sample ID: **24-1762 24-TP-03 0-2ft**

Matrix: **Solid**
Lab ID: **24K0795-01**
Date Sampled: **10/24/24 0:00**
Sampled By: **Client**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	36	mg/kg dry	11	EPA 300.0	11/14/24	11/14/24	
pH	7.2	pH Units	0.1	EPA 9045D	11/12/24 16:31	11/12/24 18:30	
Sulfate, Soluble (IC)	ND	mg/kg dry	11	EPA 300.0	11/14/24	11/14/24	
Total Solids	94.0	%	0.1	CTF8000	11/12/24	11/12/24	SPH
Metals							
Sulfur, Total	104	mg/kg dry	18.7	EPA 6010D/3050B	11/13/24	11/14/24	

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Zach Gibbs
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Midvale, UT 84047

PO#:
Receipt: **11/12/24 13:35 @ 18.5** °C
Date Reported: 11/18/2024
Project Name: **[none]**

Sample ID: **24-1762 24-TP-101b 0-2ft**

Matrix: **Solid**
Lab ID: **24K0795-02**
Date Sampled: **10/24/24 0:00**
Sampled By: **Client**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	78	mg/kg dry	22	EPA 300.0	11/14/24	11/14/24	
pH	6.7	pH Units	0.1	EPA 9045D	11/12/24 16:31	11/12/24 18:32	
Sulfate, Soluble (IC)	ND	mg/kg dry	22	EPA 300.0	11/14/24	11/14/24	
Total Solids	45.4	%	0.1	CTF8000	11/12/24	11/12/24	SPH
Metals							
Sulfur, Total	823	mg/kg dry	15.4	EPA 6010D/3050B	11/13/24	11/14/24	

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PO#:
Receipt: **11/12/24 13:35 @ 18.5** °C
Date Reported: 11/18/2024
Project Name: **[none]**

Sample ID: **24-1762 24-TP-102a 1-2ft**

Matrix: **Solid**
Lab ID: **24K0795-03**
Date Sampled: **10/24/24 0:00**
Sampled By: **Client**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	54	mg/kg dry	16	EPA 300.0	11/14/24	11/14/24	
pH	6.6	pH Units	0.1	EPA 9045D	11/12/24 16:31	11/12/24 18:33	
Sulfate, Soluble (IC)	59	mg/kg dry	16	EPA 300.0	11/14/24	11/14/24	
Total Solids	64.3	%	0.1	CTF8000	11/12/24	11/12/24	SPH
Metals							
Sulfur, Total	274	mg/kg dry	29.8	EPA 6010D/3050B	11/13/24	11/14/24	

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Zach Gibbs
7657 South Holden Street
Midvale, UT 84047

PO#:
Receipt: **11/12/24 13:35** @ **18.5** °C
Date Reported: 11/18/2024
Project Name: **[none]**

Report Footnotes

Abbreviations

ND = Not detected at the corresponding Minimum Reporting Limit (MRL).
1 mg/L = one milligram per liter or 1 mg/kg = one milligram per kilogram = 1 part per million.
1 ug/L = one microgram per liter or 1 ug/kg = one microgram per kilogram = 1 part per billion.
1 ng/L = one nanogram per liter or 1 ng/kg = one nanogram per kilogram = 1 part per trillion.
On calculated parameters, there may be a slight difference between summing the rounded values shown on the report vs the unrounded values used in the calculation.

Flag Descriptions

SPH = Sample submitted past method specified holding time.

CHEMTECH - FORD ANALYTICAL LABORATORY

CHAIN OF CUSTODY

COMPANY: Gerhart Cole
ADDRESS: 7657 s. Holden St.
CITY/STATE/ZIP: Midvale, Utah 84047
PHONE #: 801.791.3641 **FAX:**
CONTACT: Zach Gibbs **PROJECT:**
EMAIL: zachg@gerhartcole.com

BILLING ADDRESS:
BILLING CITY/STATE/ZIP:
PURCHASE ORDER #:

CHEMTECH-FORD LABORATORIES

TURNAROUND REQUIRED:* Standard
** Expedited turnaround subject to additional charge*

24K0795

Lab Use Only	CLIENT SAMPLE INFORMATION					TESTS REQUESTED					Bacteria			
	LOCATION / IDENTIFICATION	DATE	TIME	MATRIX	Field: Residual Chlorine	pH	Sulfates and Chlorides	Total Sulphur			Total Coliform + E. coli (Present/Absent)	Total Coliform + E. coli (Enumerated)	HPC (Plate Count)	E. Coli Only
01	24-1762 24-TP-03 0-2ft	10/24				X	X	X						
02	2. 24-1762 24-TP-101b 0-2ft	1				X	X	X						
03	3. 24-1762 24-TP-102a 1-2ft					X	X	X						
	4.													
	5.													
	6.													
	7.													
	8.													
	9.													
	10.													

GA 1352

Sample Receipt Conditions:

- (✓) Correct Containers
- (✓) COC Included
- (✓) COC Complete
- (✓) Sufficient Sample Volume
- ( ) Headspace Present (VOC)
- ( ) Temperature Blank
- (✓) Received within Hold

- ( ) Custody Seals Present
- (✓) Containers Intact
- (✓) COC and Labels Match
- ( ) Received on Ice

Checked by: W

Sampled by: [print]
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ON ICE NOT ON ICE Temp (C°): 18.5

Special Instructions:

Samples received outside the EPA recommended temperature range of 0-6 C° may be rejected.

Relinquished by: [signature]	Date/Time 11/12/24	Received by: [signature]	Date/Time 11/12/24 1335
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time

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Amended

12/6/2024

Work Order: 24K1859
Project: 24-1762

Gerhart Cole, Inc.
Attn: Zach Gibbs
7657 South Holden Street
Midvale, UT 84047

Client Service Contact: 801.262.7299

The analyses presented on this report were performed in accordance with the National Environmental Laboratory Accreditation Program (NELAP) unless noted in the comments, flags, or case narrative. If the report is to be used for regulatory compliance, it should be presented in its entirety, and not be altered.

NELAP ACCREDITED TNI LABORATORY

Approved By:

Reed Hendricks, Lab Director

CHEMTECH-FORD
LABORATORIES

Gerhart Cole, Inc.
7657 South Holden Street
Midvale, UT 84047

Project: 24-1762
Project Manager: Zach Gibbs

Laboratory ID	Sample Name
24K1859-01	**Composite Sample**

Amended Report Narrative

Report Changes:

Per request of Gerhart Cole, Soluble Ca, Mg, Na and K are added.

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Amended **Certificate of Analysis** ***Amended***

Gerhart Cole, Inc.
Zach Gibbs
7657 South Holden Street
Midvale, UT 84047

PO#:
Receipt: **11/22/24 13:36** @ **21.9** °C
Date Reported: 12/6/2024
Project Name: **24-1762**

Sample ID: **Composite Sample**

Matrix: **Solid**
Lab ID: **24K1859-01**
Date Sampled: **11/22/24 13:05**
Sampled By: **Client**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Calculations							
Sodium Adsorption Ratio	0.1	None	0.1	Calculation	12/5/24	12/5/24	
Inorganic							
Chloride, Soluble (IC)	32	mg/kg dry	11	EPA 300.0	11/25/24	11/25/24	
pH	6.0	pH Units	0.1	EPA 9045D	11/22/24 15:32	11/22/24 17:33	
Sulfate, Soluble (IC)	ND	mg/kg dry	11	EPA 300.0	11/25/24	11/25/24	
Total Solids	93.4	%	0.1	CTF8000	11/25/24	11/25/24	
Metals							
Sulfur, Total	133	mg/kg dry	19.0	EPA 6010D/3050B	11/25/24	11/25/24	
Calcium, Soluble	44.7	mg/kg dry	2.1	EPA 6010D/3050B	12/4/24	12/4/24	
Magnesium, Soluble	115	mg/kg dry	16.1	EPA 6010D/3050B	12/4/24	12/4/24	
Sodium, Soluble	ND	mg/kg dry	21.4	EPA 6010D/3050B	12/4/24	12/4/24	
Metals, Dissolved							
Potassium, Soluble	156	mg/kg	5.0	EPA 6010D/3050B	12/4/24	12/4/24	

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Amended **Certificate of Analysis** ***Amended***

Gerhart Cole, Inc.
Zach Gibbs
7657 South Holden Street
Midvale, UT 84047

PO#:
Receipt: **11/22/24 13:36** @ **21.9** °C
Date Reported: 12/6/2024
Project Name: **24-1762**

Report Footnotes

Abbreviations

ND = Not detected at the corresponding Minimum Reporting Limit (MRL).
1 mg/L = one milligram per liter or 1 mg/kg = one milligram per kilogram = 1 part per million.
1 ug/L = one microgram per liter or 1 ug/kg = one microgram per kilogram = 1 part per billion.
1 ng/L = one nanogram per liter or 1 ng/kg = one nanogram per kilogram = 1 part per trillion.
On calculated parameters, there may be a slight difference between summing the rounded values shown on the report vs the unrounded values used in the calculation.

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CHAIN OF CUSTODY

COMPANY: Gerhart Cole

ADDRESS: 7657 s. Holden St.

CITY/STATE/ZIP: Midvale, Utah 84047

PHONE #: 801.791.3641 FAX:

CONTACT: Zach Gibbs PROJECT: 24-1762

EMAIL: zachg@gerhartcole.com

BILLING ADDRESS:

BILLING CITY/STATE/ZIP:

PURCHASE ORDER #:

CHEMTECH-FORD LABORATORIES

TURNAROUND REQUIRED:* Standard

* Expedited turnaround subject to additional charge

W- 46, 1352

Sample Receipt Conditions:

( ) Custody Seals Present
(N) Containers Intact
(N) COC and Labels Match
( ) Received on Ice
(N) Correct Containers
(N) COC Included
(N) COC Complete
(Y) Sufficient Sample Volume
( ) Headspace Present (VOC)
( ) Temperature Blank
(N) Received within Hold
Checked by: M

24K1859

Lab Use Only	CLIENT SAMPLE INFORMATION					TESTS REQUESTED				Bacteria			
	LOCATION / IDENTIFICATION	DATE	TIME	MATRIX	Field: Residual Chlorine	pH	Sulfates and Chlorides	Total Sulphur		Total Coliform + E. coli (Present/Absent)	Total Coliform + E. coli (Enumerated)	HPC (Plate Count)	E. Coli Only
01	1. Composite sample	11/22/2024	13:05	soil		X	X	X					
	2.												
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	10.												

Soluble Ca, Mg, Na, K added per Zach Gibbs

Sampled by: [print]

Sampled by: [signature]

ON ICE NOT ON ICE Temp (C°): 21.9

Special Instructions:

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Relinquished by: [signature]	Date/Time 11/22/24 13:36	Received by: [signature]	Date/Time 11/22/24 1336
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time

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Ute Ladies-tresses Survey Memoranda

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 22, 2024

TO: Landon Richins, Environmental Specialist, Franson Engineering; Derek Hamilton, Water Resources Coordinator, NRCS.

CC: Scott Evans, Owner, Cirrus Ecological Solutions; Adam Clifford, Wildlife Biologist, Cirrus Ecological Solutions; Layne Jensen, Professional Engineer, Franson Engineering.

FROM: John Stewart, Botanist, Cirrus Ecological Solutions.

RE: ULT surveys at Utaba Dam rehabilitation site

On August 3, 2024, a survey was conducted for Ute ladies' tresses orchid (*Spiranthes diluvialis*) within the project area for the Utaba Dam rehabilitation project.

Background

Ute ladies'-tresses was federally listed as threatened on January 17, 1992 (57 FR 2048). Critical habitat has not been designated for this species.

Ute ladies'-tresses is a perennial orchid with stems that arise from thickened roots. The bloom consists of 3 to 15 small white- or ivory-colored flowers clustered into a spike arrangement at the top of the stem. Depending on location, the species may flower as early as early July or as late as early October (Sheviak 1984, Jennings 1989, and Coyner 1990 as cited in USDI-BLM 2017). Mature plants may remain dormant for one or more growing seasons without producing aboveground shoots or may exhibit vegetative shoots only. Bumblebees are one of the main pollinators for Ute ladies'-tresses and population numbers can affect how many and when flowering occurs.

Habitat Characteristics

Ute ladies'-tresses may be found in moist to wet soils in mesic or wetland habitat associated with springs, lakes, and perennial streams. The elevation range of occupied habitat is 700 to 7,000 feet throughout the species range. Most occurrences are along riparian edges, gravel bars, old oxbows, and moist to wet meadows. Some localities are near freshwater lakes and springs/groundwater discharge zones. Ute ladies'-tresses is adapted to disturbances caused by water movement through flood plains over time. The species occurs primarily in areas where the vegetation is relatively open and not very dense. It often grows on point

bars and other recently created riparian habitat. The orchid appears to require permanent subirrigation, with the water table holding steady throughout the growing season and into late summer and early autumn (USFWS 1995).

Populations appear to fluctuate dramatically from year to year, making it difficult to assess population status and distribution. The genus *Spiranthes* may also undergo a dormant period that may last 7–10 years, with no evidence of above-ground structures. Nothing is known about the dormancy-triggering mechanisms. In order to locate this species, potential habitat should be surveyed multiple years due to potential dormancy.

Ute Ladies'-tresses Orchid Survey/Habitat Assessment

The survey for Ute ladies'-tresses orchid was completed following the protocol developed by the USFWS (1992). Note that this protocol requires 3 years of surveys if suitable habitat is identified because the species may not flower every year. Important elements of the survey protocol included the following:

- Evaluation of the study area to determine where potentially suitable habitat exists using a combination of aerial imagery, existing information, and field reconnaissance.
- Scheduling field surveys corresponding to flowering in other known populations, typically beginning in the later part of July and extending into mid-to-late August, depending on conditions.
- Completing pedestrian surveys providing 100 percent coverage in suitable habitat using closely-spaced transects.
- Recording population information if any occurrences of Ute ladies'-tresses orchid are located.

Surveys Results

ULT was not found in the Utaba Reservoir survey area.

Potentially suitable habitat for Ute ladies'-tresses orchid was identified in the project survey. This habitat occurs in three habitat areas as shown in Figures 1 and 2.

Habitat 1 is a small riparian wetland area along the North Fork of the Ogden River (Photo 1). This habitat is characterized by creeping bentgrass (*Agrostis stolonifera*), sedge (*Carex* spp.), monkey flower (*Mimilis tilingii*).

Habitat 2 is a narrow seep along the toe of the mountain where the road cut intercepts groundwater and creates a wetland along the edge of the road (Photo 2). This habitat is characterized by creeping bentgrass, northern green bog orchid (*Platanthera aquilonis*), sedge, and willow (*salix spp*.)

Habitat 3 is a series of wetlands along the east side of the project area at the toe of the mountain. Groundwater discharge creates a wetland community. This wetland habitat is characterized by a community of tall (3 to 4 feet tall), dense wetland plants, including lesser panicled sedge (*Carex diandra*), cutleaf water parsnip (*Berula erecta*), and small-fruited bullrush (*scirpus microcarpus*) (Photos 3 and 4). Hydrology is very wet with areas of standing water during the August survey. The wetland community in these wetlands may be too tall and dense to represent potential habitat for Ute ladies'-tresses. Much of this habitat extends beyond the project area.

Discussion

Ute ladies'-tresses was not found in the project area. Potentially suitable wetland habitat was found in the project area. Habitat areas 1 and 2 were evaluated to represent potentially suitable habitat. Habitat areas 3 may be unsuitable habitat because the wetland vegetation is tall and dense. If USFWS concurs that habitat 3 is not suitable, additional surveys in years 2 and 3 may not be required in these areas.

References

U.S. Fish and Wildlife Service (USFWS). 1992. Interim Survey Requirements for Ute Ladies-tresses Orchid (*Spiranthes diluvialis*). Revised 2017.

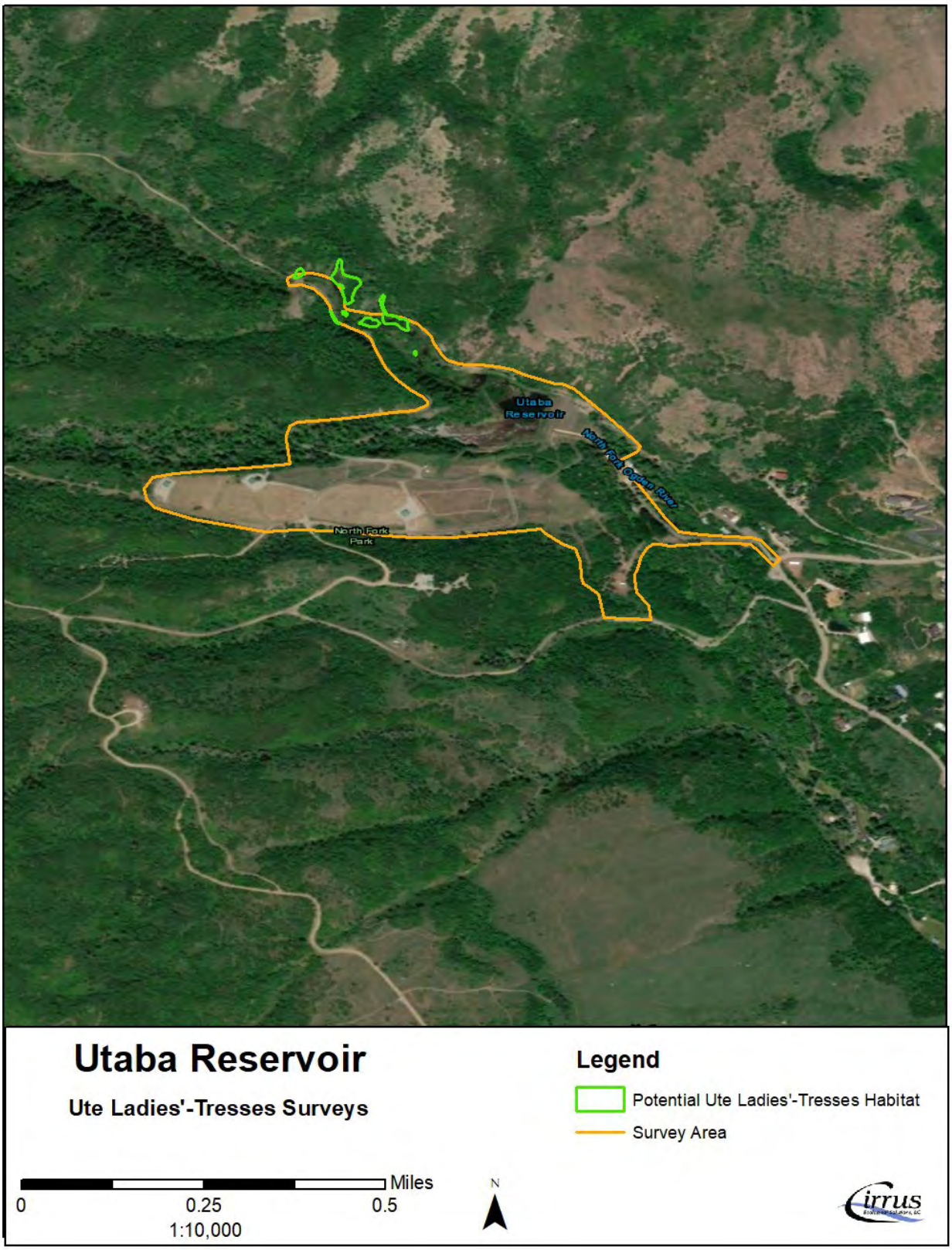

Figure 1. Overview of potentially suitable Ute ladies'-tresses habitat within the Utaba Reservoir project area.

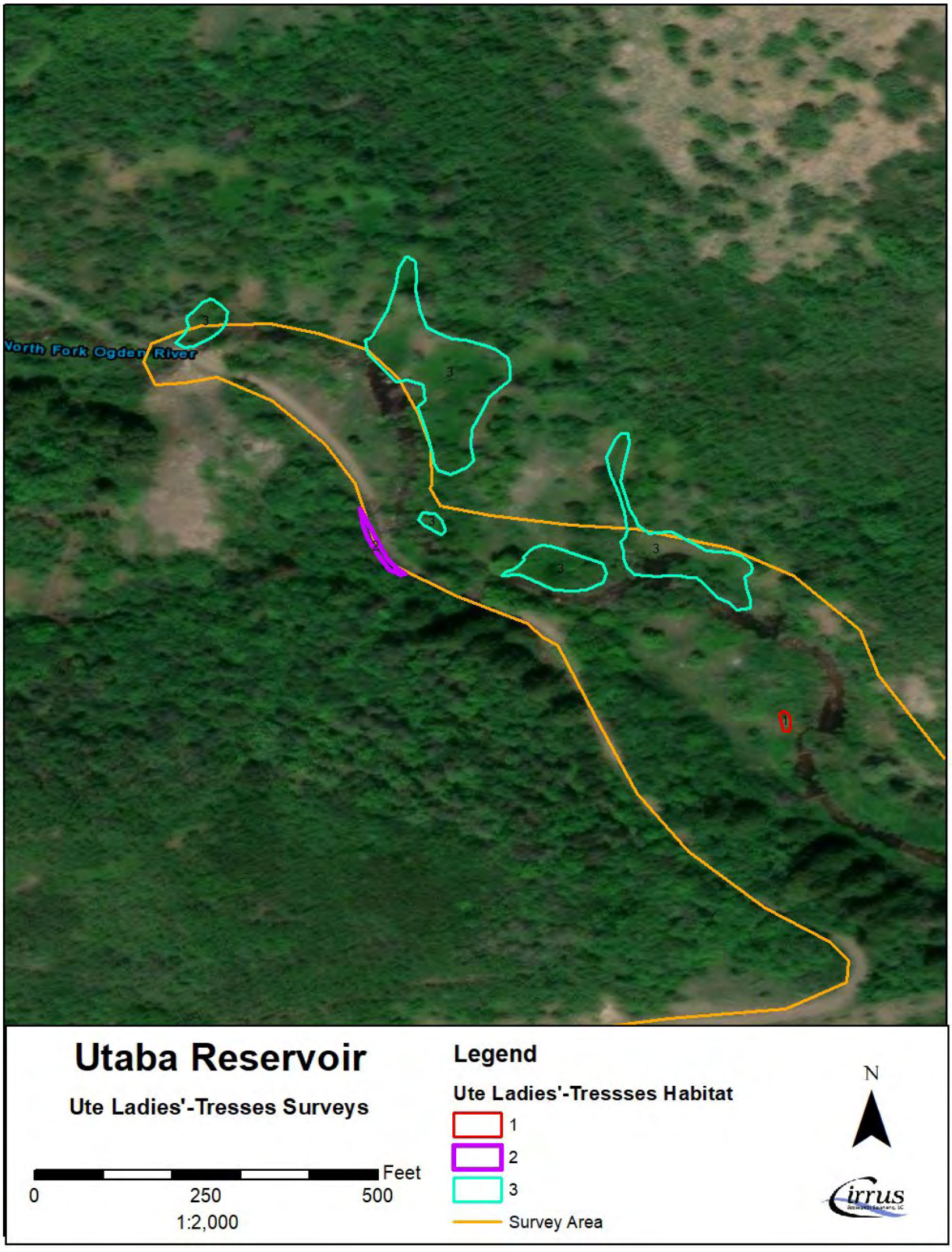

Figure 2. Detail showing potentially suitable Ute ladies'-tresses habitat within the Utaba Reservoir project area.



Photo 1. Area 1 habitat.



Photo 2. Area 2 habitat.



Photo 3. Area 3 habitat.



Photo 4. Area 3 habitat.

From:	Landon Richins
To:	Hamilton, Derek - FPAC-NRCS, UT
Subject:	FW: Utaba Plan-EA ULT Site Visit with NRCS/USFWS
Date:	Wednesday, May 7, 2025 2:30:56 PM
Attachments:	Utaba wetlands.pdf ULT_2025_Survey_Area.kmz ULT_2025_Survey_Buffer.kmz

---

Derek,

See the email below with Cirrus's write-up for the 2025 ULT survey, as promised. Cirrus is surveying the entire area (see the attached KMZ) we identified yesterday. I have provided them with the same survey area and John says he knows what he needs to do. I can pass this along to Rita as well if you'd like me to.

Thanks,

Landon

Landon Richins

Franson Civil Engineers
Office: 801.756.0309 | Direct: 801.938.7585

From: John Stewart <jstewart@cirruses.com>
Sent: Wednesday, May 7, 2025 12:30 PM
To: Landon Richins <lrichins@fransoncivil.com>; Scott Evans <sevans@cirruses.com>
Subject: Fw: Utaba Plan-EA ULT Site Visit with NRCS/USFWS

Landon,

During the 2024 ULT surveys for the Utaba project, I surveyed the riparian corridor along the North Fork of the Odgen River. The ULT habitat polygons that I identified represent potential habitat for ULT. Many of the wetland communities were too dense or seasonally dry to be typical ULT habitat, but they were none-the-less included in the survey. The entire wetland area along the river was inspected during the survey. **The plan is to re-survey the entire area again this year,** with emphasis on the ULT polygons that were identified. The map with the wetlands report (attached) provides visual of the different wetland types that will be surveyed. I went a few hundred feet above the culvert road crossing at the north end of the project area and will be sure **to go the 300 feet** this year.

I did visit known ULT populations prior to the survey and verified that they were in

flower. One was in Cache Valley, and the other in Idaho near Ashton Reservoir.

Please let me know if you have any questions.

Thanks,
John

Yellow-billed Cuckoo Survey Memoranda

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: August 22, 2024

TO: Landon Richins, Environmental Specialist, Franson Engineering; Derek Hamilton, Water Resources Coordinator, NRCS.

CC: Scott Evans, Owner, Cirrus Ecological Solutions; John Stewart, Botanist Cirrus Ecological Solutions; Layne Jensen, Professional Engineer, Franson Engineering.

FROM: Adam Clifford, Wildlife Biologist, Cirrus Ecological Solutions.

RE: Western yellow-billed cuckoo habitat surveys

On July 10, 2024, personnel from Cirrus Ecological Solutions, LC conducted habitat surveys for western yellow-billed cuckoos associated with the preparation of the Plan-EA for the Utaba Dam rehabilitation project.

Western Yellow-billed Cuckoo Habitat Survey

The western yellow-billed cuckoo (WYBCU; *Coccyzus americanus*) was listed as Threatened under the Endangered Species Act in 2014. Because the Utaba Dam rehabilitation project (Project) has several streams, rivers, and riparian habitat in the Project area, habitat surveys were conducted to determine if the area contains suitable habitat for WYBCU. According to the U.S. Fish and Wildlife Service (FWS), areas that meet the minimum criteria for suitable habitat should be (1) avoided by 0.5 mile, or (2) surveyed, and/or (3) carried forward for evaluation of potential effects.

The FWS provides guidelines for the identification of suitable habitat for WYBCU in Utah to assist with these surveys (FWS 2015). The methods are stated as follows:

> Step 1: Identify and delineate all riparian habitats within 0.5 mile of the proposed action, below the elevation of 8,500 feet.
>
> Step 2: Identify suitable WYBCU breeding and nesting habitat, including associated foraging areas.

Riparian patches used by breeding and nesting cuckoos vary in size and shape, ranging from a relatively contiguous stand of mixed native/exotic vegetation to an irregularly shaped mosaic of dense vegetation with open areas. The following parameters characterize suitable breeding and nesting cuckoo habitat:

- Vegetation that is predominantly multi-layered, with riparian canopy trees and at least one layer of understory shrubby vegetation;
- Patches of multi-layered vegetation (as described above) that are at least 12 acres (5 ha) or greater in extent and separated from other patches of suitable habitat by at least 300 meters;
- Somewhere within a patch, the multi-layered riparian vegetation (as described above) should be at least 100 meters wide by 100 meters long. This is to avoid patches that may be long enough to meet the minimum area (12 acres) but are so narrow that they are unsuitable-- 750 m x 75 m (length x width) for example; and
- Open areas, or gaps of multi-layered vegetation within a patch are less than 300 meters.

The Project area is within the elevation guideline of less than 8,500 feet; the Utaba Reservoir has an elevation of 5,692 feet. There is multi-layered riparian vegetation surrounding the North Fork of the Ogden River and Cutler Creek. Each habitat corridor (green and yellow polygons in Figure 1) is greater than 12 acres contains patches that are 100 meters wide by 100 meters long, thus fulfilling the guideline for habitat patch size They also contain gaps of less than 300 meters which are used as foraging habitat. See Figure 1 for more detail.

Based on the survey results detailed above and in Figure 1, there are 3 areas meeting the requirements for suitable habitat for the WYBCU. These can be seen in the green polygons in Figure 1 and have a total area of 72 acres. The yellow polygon in Figure 1 has not been surveyed for suitable habitat due to access issues during the surveys on July 10. While there have not been any WYBCU observations within 0.5 miles of the Project, there have been observations within 10 miles to the south (UDWR 2024).

The suitable habitat south of the Utaba Reservoir along the North Fork of the Ogden River contains several private residences. These areas are less likely to provide suitable habitat for WYBCU, due to ongoing disturbance and large gaps in the habitat patches, which could discourage WYBCU from nesting.

As stated above, areas that meet the suitable habitat criteria should be surveyed for WYBCU before Project implementation. While the Project would not directly impact any suitable habitat, the 0.5-mile buffer protects WYBCU from the impacts of noise disturbance during Project implementation (FWS 2015).

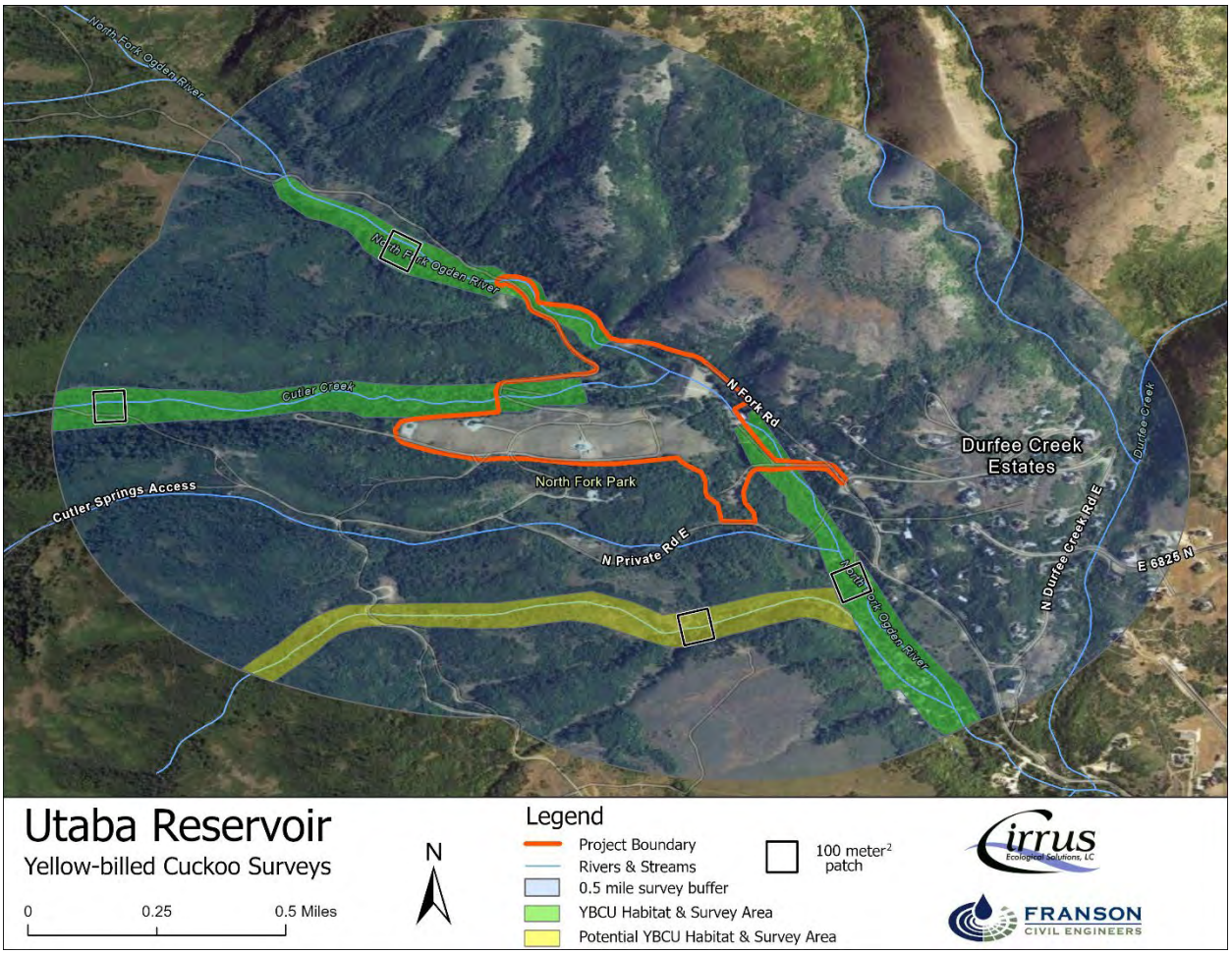

Figure 1. Overview of suitable and potentially suitable WYBCU habitat surrounding the Utaba Reservoir.

References

FWS (U.S. Fish and Wildlife Service). 2015. Guidelines for the identification of suitable habitat for WYBCU in Utah. Available at [https://www.fws.gov/sites/default/files/documents/yellow-billed-cuckoo-guidelines-identification-suitable-habitat-utah-2015_0.pdf]. Accessed July 9, 2024.

UDWR (Utah Division of Wildlife Resources). 2024. Utah Natural Heritage Program Online Species Search Report. Available at [https://dwrapps.utah.gov/HeritageDataRequest/Reports?id=15840]. Accessed August 8, 2024.

From: Weiss, Dannette T
To: Landon Richins
Cc: Hamilton, Derek - NRCS, Salt Lake City, UT; Layne Jensen
Subject: Re: [EXTERNAL] Utaba Dam Watershed Plan-EA - Section 7 Habitat Suitability and Project Update
Date: Thursday, December 12, 2024 8:18:00 PM

Hi Landon,

Thank you for your patience for the delay in responding.

Based on the information you provided below, the discussion during our meeting on 11/26, and the additional information that you supplied via email on 11/26, I agree with the decision to not survey the two suitable habitat areas below the dam.

However, I will need to know how the project will be handled if cuckoos are detected.

Please remind the contractor conducting the presence/absence surveys that if they do detect a cuckoo, they need to contact our office as soon as possible.

I hope this answers all of your questions, please let me know if you require further assistance.

Regards,

Dannette

Note: Due to unusually high office-wide workload through the end of the calendar year, my responses to emails may take longer than usual. Please allow extra time for our office's response. We appreciate your patience.

From: Landon Richins <lrichins@fransoncivil.com>
Sent: Friday, November 8, 2024 9:45 AM
To: Reisor, Rita S <rita_reisor@fws.gov>; Weiss, Dannette T <dannette_weiss@fws.gov>
Cc: Hamilton, Derek - FPAC-NRCS, UT <derek.hamilton@usda.gov>; Layne Jensen <ljensen@fransoncivil.com>
Subject: [EXTERNAL] Utaba Dam Watershed Plan-EA - Section 7 Habitat Suitability and Project Update

This email has been received from outside of DOI - Use caution before clicking on links, opening attachments, or responding.

Rita and Dannette,

Good Morning! I hope you are both doing well. It has been a while since we last communicated. I am emailing you to provide you an update on the Utaba Dam Rehabilitation Watershed Plan-EA project in Weber County. I know that Dannette has been a participant during the scoping meetings for the project, but I do not think that Rita was able to attend the Agency Scoping Meeting. To remind you, the lead agency on the project is NRCS (hence the "Watershed Plan" part of the project).

During scoping, Dannette had coordinated with Derek Hamilton with NRCS on the early Section 7 work that would need to be done prior to the geotechnical field study. We prepared a BA for this geotechnical work which had a "no effect" determination for the potentially present species. NRCS sent you a courtesy copy last month prior to the work taking place. All went well and as planned with the geotechnical. Thank you for your collaboration on that front.

Now that the geotechnical work is complete, we are beginning to plan for the Section 7 work that will have to be completed in 2025 for the full Proposed Action. This will include survey work and the development of a full BA. The Proposed Action has not yet been developed, as we are still awaiting the findings/report of the geotechnical work, which we expect sometime in January. Once we have that, the alternative development process will continue. During the scoping meeting, we discussed the habitat suitability and presence/absence field surveys that were conducted by Cirrus Ecological Solutions in 2024 for the two Federally listed species that may be present in the study area: the Western Yellow-Billed Cuckoo and the Ute Ladies'-tresses (I bet you didn't see that one coming,).

We have been discussing suitable habitat findings and planned field work for 2025 with Derek, and, because of those conversations, Derek has asked us to communicate this with you to keep you in the loop and seek your support. For simplicity's sake, I will take it one species at a time.

<u>Western Yellow-Billed Cuckoo</u>

- A habitat suitability survey was conducted by Cirrus Ecological Solutions, LC in July 2024, within a 0.5-mile buffer of the action area. The survey memo from Cirrus is attached to this email for your reference. The survey identified three areas of suitable WYBC habitat and one potential WYBC habitat area (although they could not confirm because they were not provided access by the landowners for the survey).
- As you will see, two of the four identified areas of suitable habitat exist upstream of the dam and two areas exist downstream of the dam. The two areas upstream of the dam are planned to be surveyed in the WYBC survey window(s) in 2025, following USFWS protocol, for presence/absence of the species.
- We do not plan to survey the two corridors downstream of the dam because, although they likely meet the 100x100 meter multi-layer vegetation requirement, they cut through significant human development including several residences, summer camps (active during the time the WYBC could theoretically be present in Utah), and active road corridors. Because of the extremely shy nature of the WYBC, we do not believe that the corridors identified downstream of the dam would constitute suitable WYBC habitat and thus, do not need to be surveyed for P/A for the project. Where the bird is already rare in Utah, it is unlikely that any that may be in

the area would choose such an active area to live in.
- Of course, as I mentioned earlier, there are also survey access hurdles that could be insurmountable in one of the areas as well. We contacted the landowners prior to the initial survey and were denied access through the logical entrance point to the corridor, This could prevent us from surveying one of the downstream corridors regardless of whether it is treated as suitable or unsuitable. There may be access via a longer walking/hiking path, but it is not guaranteed either at this point.
- It is not expected that any Proposed Actions would have an impact to suitable WYBC habitat.

To sum up, **our plan is to survey the upstream areas and consider them suitable WYBC habitat and to leave the downstream areas alone and consider them to be unsuitable due to high human activity.** Let us know if you have any questions or concerns with this plan.

Ute Ladies'-Tresses

- A presence/absence and habitat suitability survey were conducted by Cirrus Ecological Solutions, LC in August 2024, during the ULT blooming window and within a 300-ft buffer of the action area. The survey memo from Cirrus is attached to this email for your reference. The survey identified three "areas" of potential ULT habitat and no individuals in the Action Area. However, Cirrus sought clarification on the actual suitability of these sites. Figures showing the location of these three areas (all upstream of the dam and outside of the area where any ground disturbance is likely) are included in the memo.
- Area/Habitat 1 in the survey is, in our view, likely unsuitable because it exists below the OHWM and is seasonally inundated with water when the reservoir is full. Certainly, when it is inundated, it is not suitable habitat. We have planned to treat this area as unsuitable ULT habitat moving forward.
- Area/Habitat 2 in the survey is likely suitable habitat. We plan to treat it as such in the full BA and section 7 analysis. The area would not be impacted by construction as it exists outside of the Action Area itself but within the 300-foot buffer.
- Area/Habitat 3 in the survey is, in our view, likely unsuitable because it is characterized by a community of tall (3 to 4 ft) and dense wetland plants (photos in the attached memo as well). The vegetative community in this area is likely too tall and dense to represent suitable ULT habitat, further information on this conclusion is presented in the Cirrus memo. For this reason, we also plan to treat these areas as unsuitable in the full BA and section 7 analysis.

To sum up, **our plan is to treat only Area 2 as suitable ULT habitat and to dismiss Area 1 because it is seasonally inundated and Area 2 because of the dense and tall wetland vegetation**. Let us know if you have any questions or concerns with this plan.

Please let us know your thoughts on this plan as soon as you are able, as we are working to determine the financial scope of Section 7 work for the remainder of the project and would like to direct Cirrus as necessary for their upcoming survey work. If you would prefer to meet to discuss this, we are happy to make ourselves available. We are in routine communication with Derek about the Section 7 work and he is aware of all the previously disclosed plans. He asked us to send this plan to you and

get your thoughts now, in writing, so we are prepared to move forward in 2025.

Also, please note that when we prepare a BA for the Proposed Action, you will be notified of its availability, and we will request comment/concurrence on it at that time. Because it will be of a different nature than the "short form" BA for the geotechnical work, it will not be provided as just a courtesy copy, but rather will involve your input as well. The information in this email will be included in the BA. Additionally, by coordinating on these details now, we should be able to provide an initial BA that is more acceptable to you from the get-go.

I know we are early on this (considering WYBC surveys cannot occur until May), but it is because we are looking to give you ample time to consider our plan and give us your thoughts. Of course, we feel confident in what we have presented and believe that it is the most feasible action, but would certainly like either your concurrence or a suggested alternate course of action for the project.

I apologize for the lengthy email, lots of information to get out to you! Again, please reach out to me with any questions. I have copied Derek on this email as well and will continue to do so as the project continues. Derek is a very busy guy, so he asked us to be his Section 7 liaison for this project as long as we keep him in the loop .

Thanks again!

Sincerely,

Landon Richins

Landon Richins | lrichins@fransoncivil.com

Franson Civil Engineers
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Wetlands Field Determination Report

Utaba Reservoir Aquatic Resources Inventory

In Support of the
Utaba Dam Rehabilitation Plan – EA

Prepared for:

Franson Civil Engineers, Inc.
1276 South 820 East, Suite 100
American Fork, Utah 84003

Prepared by:

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965 South 100 West, Suite 200
Logan, Utah 84321
(435) 787-1490

February 25, 2025



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1.0 INTRODUCTION

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance from Weber County as the project sponsor, is considering a proposed rehabilitation of the Utaba Retarding Dam, located just downstream of the confluence of Cutler Creek and the North Fork of the Ogden River. The dam is currently out of compliance with state and NRCS dam safety standards. This project would seek to bring the dam into compliance with these standards and to reduce the possibility of dam failure.

An environmental assessment (EA) is being prepared to analyze the effects of the proposed project. The lead engineering firm, Franson Civil Engineers, Inc., retained Cirrus Ecological Solutions, LC to complete an aquatic resources inventory of the project area to provide baseline information for the EA analysis. Utaba Reservoir is located in northern Weber County, Utah, as shown in Figure 1 (Appendix A).

2.0 OBJECTIVE

The objective of the aquatic resources inventory is to develop a baseline inventory of aquatic resources in the project area. This inventory includes a map of the aquatic resources in the project area based on aerial imagery and field verification. The inventory also includes a description of the wetland types and an estimate of the area of each.

3.0 METHODOLOGY

A reconnaissance survey of the project area was completed on August 1, 2024. The different types of wetlands in the project area were noted during the site visit. Subsequently, aquatic resources within the project area were mapped using aerial images representing the range of seasonal and yearly hydrologic conditions. Each aquatic resource was given a unique identifier and classified using the Cowardin classification system (FGDC 2013). The acreage of each aquatic resource was calculated using GIS.

Note that this inventory did not include a jurisdictional wetland delineation. Therefore, the methodology outlined by the Army Corps of Engineers to evaluate and document the presence of hydrophytic vegetation, hydric soils, and wetland hydrology was not implemented. This work identifies and maps aquatic resources in the project area based on aerial imagery interpretation. The mapping associated with this work presents a conservative depiction of aquatic resources, meaning, it likely over represents the acreage of wetlands that would be delineated by the completion of a jurisdictional wetland delineation.

4.0 RESULTS

AQUATIC RESOURCES

Photographs showing representative aquatic resources within the project area are shown in Appendix B. Figure 2 (Appendix A) shows the locations where the photos were taken. A total of 13.21 acres of aquatic resources were identified in the project area (Table 1). Aquatic resources include stream channels, scrub-shrub wetlands, palustrine emergent wetlands, and open water (Figures 3-5, Appendix A). The primary source of water supporting the wetland vegetation includes the North Fork of the Ogden River, Cutler Creek, and groundwater discharge from springs.

The Utaba Reservoir dam impounds the water from the streams. The streams flow into the reservoir in a delta-like area that supports a wider willow riparian community. There is lateral stream channel migration in the delta area due to erosion and sediment deposition. The willow shrub community extends upstream from the reservoir and comprises the riparian corridor along the river which is wider in some places and more restricted in others.

Table 1. List of aquatic resources, their classification, characteristic vegetation type, and acres.				
Id	**Wetland Type**	**Cowardin Classification**	**Characteristic Vegetation**	**Acres**
1	Stream Channel	Riverine, Upper perennial, Unconsolidated shore, Cobble-gravel/sand, Permanently flooded	Unvegetated	1.05
2	Stream Channel	Riverine, Upper perennial, Unconsolidated shore, cobble-gravel, Permanently flooded	Unvegetated	0.11
3	Stream Channel	Riverine, Upper perennial, Unconsolidated shore, cobble-gravel, Permanently flooded	Unvegetated	0.69
4	Stream Channel	Riverine, Upper perennial, Unconsolidated shore, cobble-gravel, Permanently flooded	Unvegetated	0.19
Total Stream Channel				**2.04**
5	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.01
6	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.10
7	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.12
8	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.22
9	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.05
10	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.30
11	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.29
12	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.18
13	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally flooded	Willows	1.89
14	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally flooded	Willows	4.25
15	Scrub-shrub	Palustrine, Scrub-shrub, Broad-leaf deciduous, Seasonally saturated	Willows	0.13
Total Scrub-Shrub				**7.54**
16	Palustrine Emergent Marsh	Palustrine, Emergent, Persistent, Seasonally flooded/saturated	Sedges, forbs	0.02
17	Palustrine Emergent Marsh	Palustrine, Emergent, Persistent, Seasonally flooded/saturated	Sedges, forbs	0.08
18	Palustrine Emergent Marsh	Palustrine, Emergent, Persistent, Seasonally flooded/saturated	Sedges, forbs	2.14
19	Palustrine Emergent Marsh	Palustrine, Emergent, Persistent, Seasonally flooded/saturated	Sedges, forbs	0.05
Total Palustrine Emergent Marsh				**2.29**
20	Open Water	Palustrine, Unconsolidated bottom, Mud, Seasonally flooded	Unvegetated	1.34
	Total Open Water			**1.34**
	Total			**13.21**

The toe of the mountain on the north side of the North Fork of the Odgen River is a zone of groundwater discharge. This area supports predominantly wetland meadows that are comprised of dense stands of bullrush and wetland forbs. These wetland meadows extend upslope outside of the project area. Each of the aquatic resource types are detailed below.

Stream Channels

The primary stream channel in the project area is the North Fork of the Ogden River (Figures 3 and 4, Appendix A). The stream is impounded by the dam that creates the Utaba Reservoir. Above the reservoir and below the dam, the channel is well defined with an associated riparian fringe. As the stream enters the reservoir, it forms a wide delta and is characterized primarily as a willow-dominated community. The stream channel migrates in response to erosion and sediment deposition. High water levels in the reservoir in the spring often inundate much of the delta area during wet years.

Cutler Creek is a smaller stream channel that also flows into Utaba Reservoir Figure 5, Appendix A. It has a similar morphology as the North Fork of the Ogden River. Above the reservoir, the stream channel is defined. As Cutler Creek approaches the reservoir, the channel gradient decreases and there is a wider delta area (i.e., floodplain) that supports a willow community.

Scrub-Shrub Wetlands

Scrub-shrub willow dominated wetlands occur throughout the project area (Figures 3-5, Appendix A). There are stands of willow in the stream deltas noted above. These communities are dynamic. During the early summer runoff of wet years, the reservoir water level rises and can inundate much of the area that supports willows. Later in the summer and in dry years, the water level in the reservoir goes down as water is released and the deltas are exposed. Much of the riparian community along the streams is also characterized by willows.

Palustrine Emergent Wetlands

Palustrine emergent wetlands occur in multiple locations in the project area (Figures 3-5, Appendix A). A zone of groundwater discharge occurs at the base of the mountains along the north side of the project area (Figures 3 and 4, Appendix A). The springs and seeps support an herbaceous wetland community characterized by tall (3 to 4 feet tall), dense wetland plants, including lesser panicled sedge (*Carex diandra*), cutleaf water parsnip (*Berula erecta*), and small-fruited bullrush (S*cirpus microcarpus*).

Palustrine emergent wetlands also occur along the North Fork of the Ogden River in low lying areas (Figures 3 and 4, Appendix A). These communities include reed canary grass (*Phalaris arundinacea*), creeping bentgrass (*Agrostis stolonifera*), and sedges (*Carex* spp.).

An additional zone of groundwater discharge occurs along a section of the road that follows the North Fork of the Ogden River. The road cut in the slope intercepts shallow ground water and creates a seepy area along the west edge of the road. Characteristic vegetation includes creeping bentgrass, northern green bog orchid (*Platanthera aquilonis*), sedge (*Carex* spp.), and willow (*Salix spp*.)

The areas which support riparian/wetland vegetation would be likely be classified as wetlands because they (A) exhibit riparian vegetation, (B) have naturally-occurring hydrology, and (C) are likely underlain by hydric soils. These sites would likely be considered Waters of the U.S. as they are adjacent to the North Fork of the Ogden River, which is a tributary to the Ogden River, which discharges in the Great Salt Lake.

5.0 REFERENCES

FGDC (Federal Geographic Data Committee). 2013. Classification of wetlands and deepwater habitats of the United States. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, DC.

APPENDIX A: FIGURES

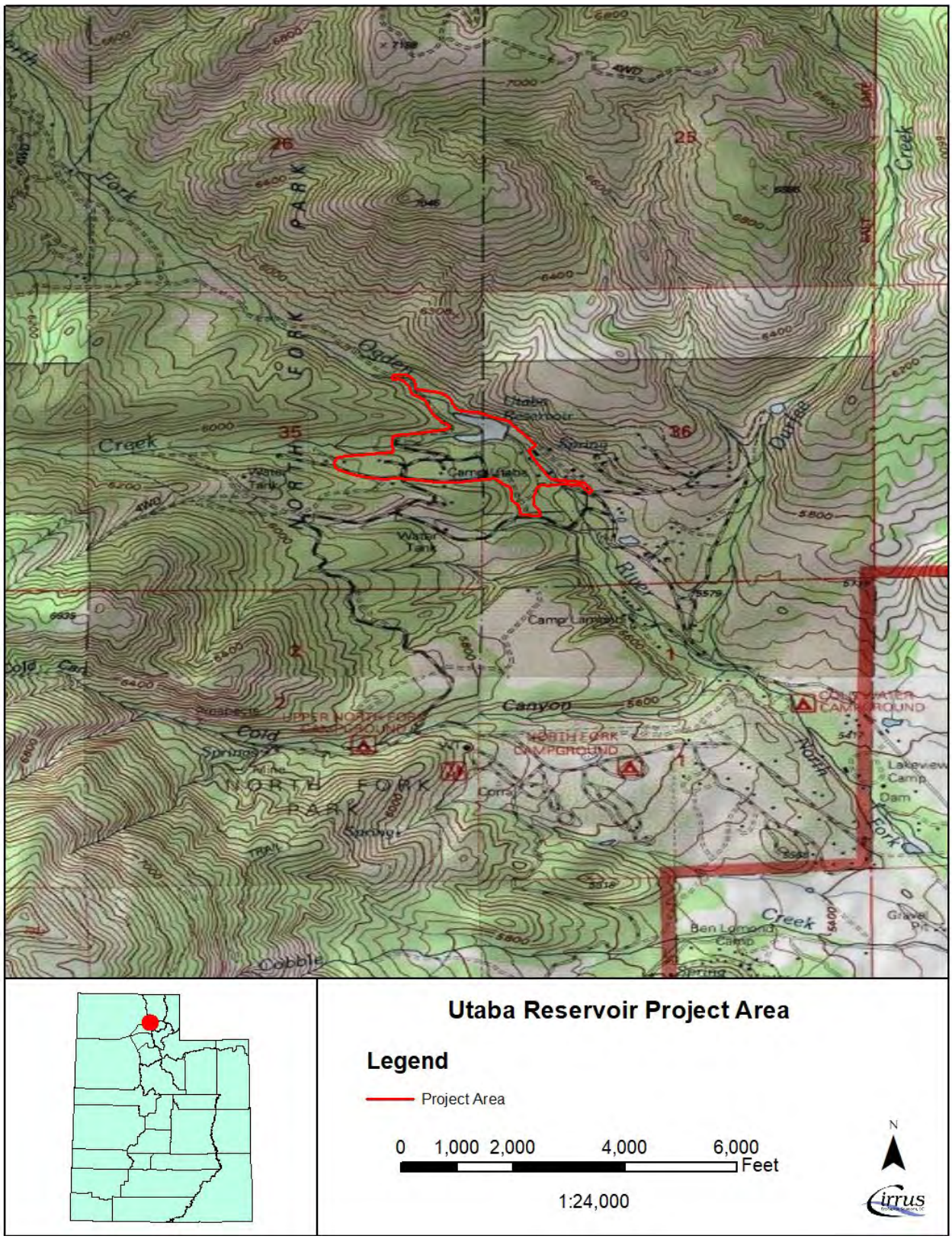

Figure 1. Utaba Reservoir project area location map.

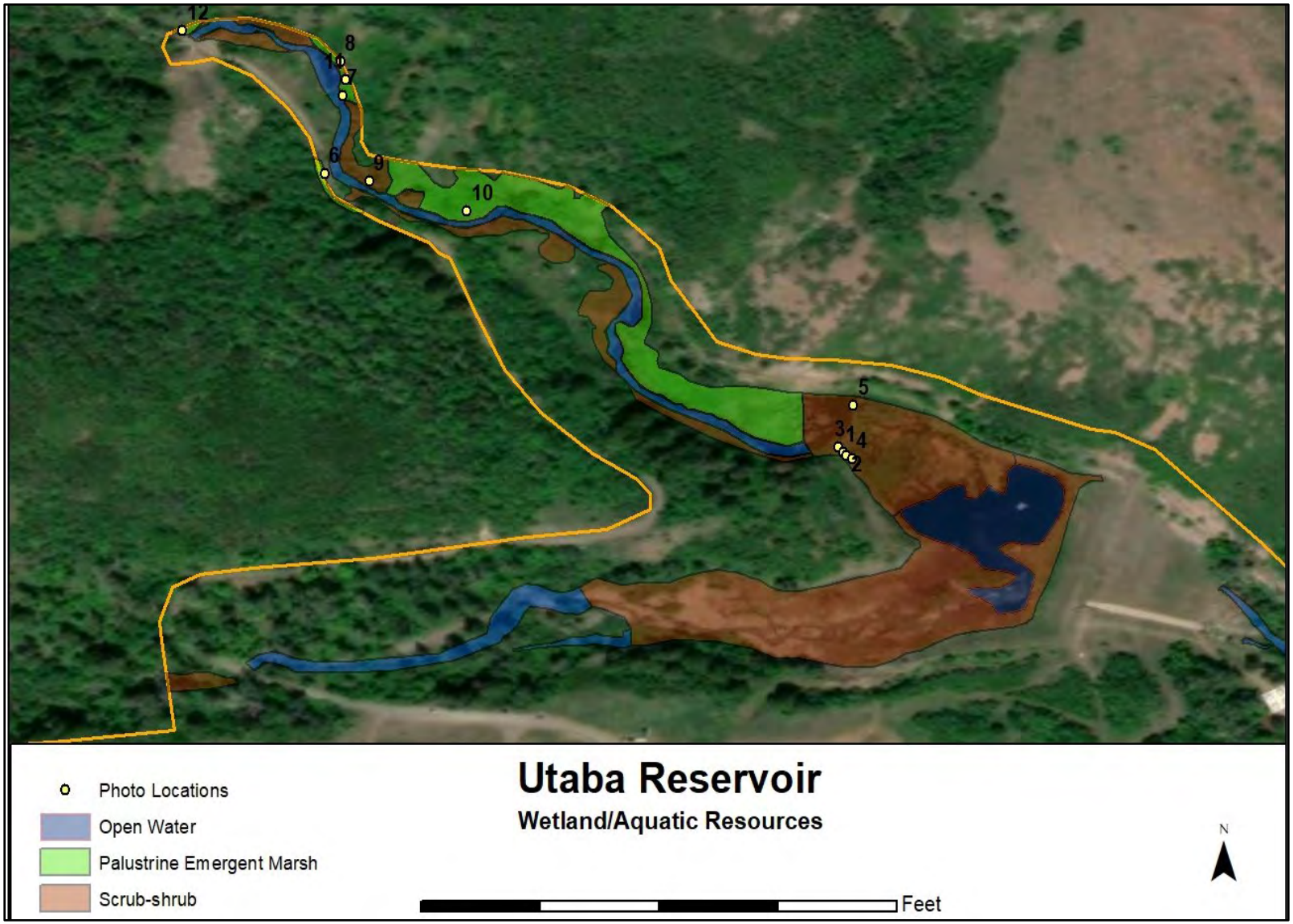

Figure 2. Aquatic Resources in the Utaba Reservoir project area- overview map with photo locations.

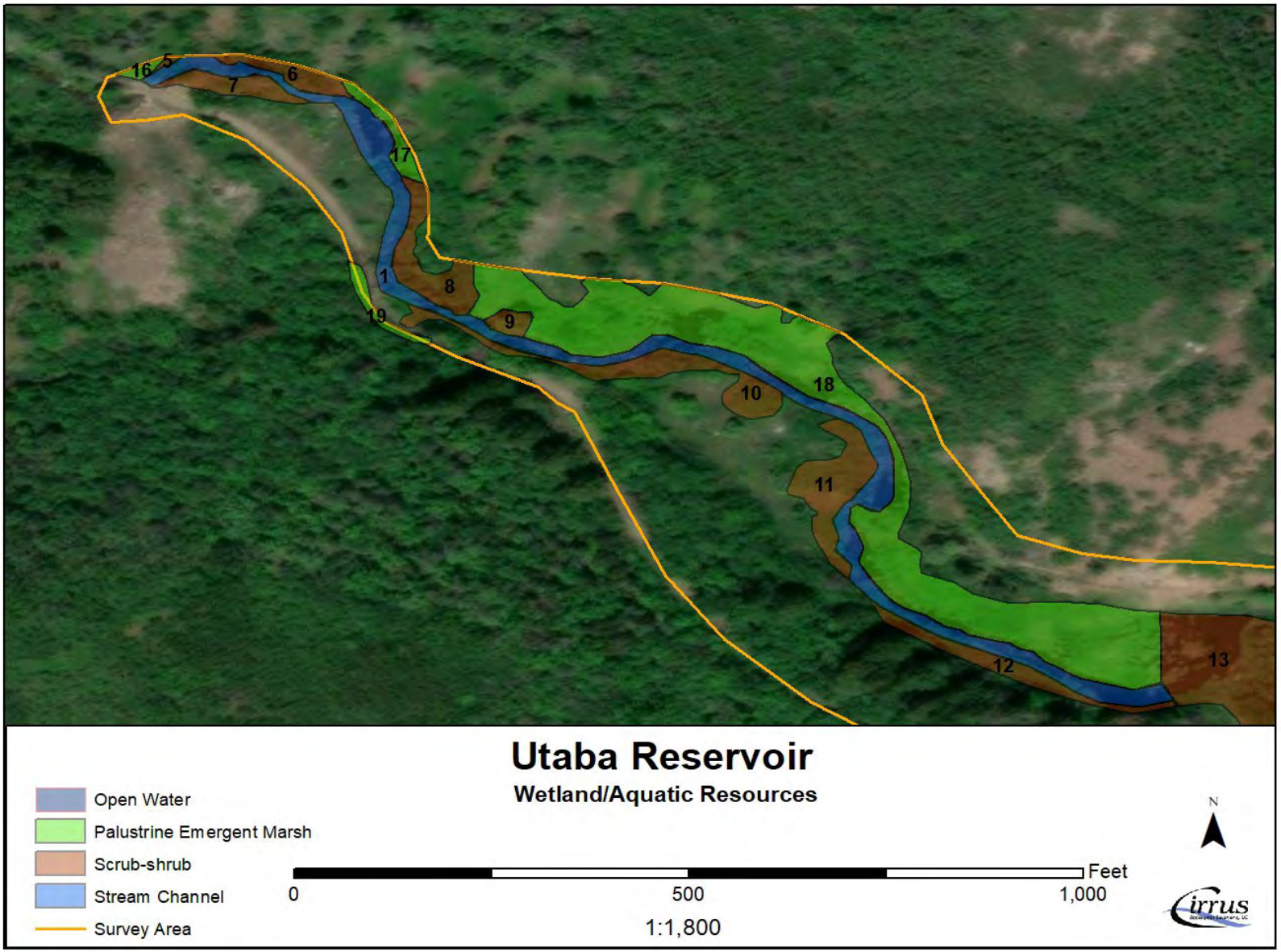

Figure 3. Utaba Reservoir Aquatic Resources, detail map 1.

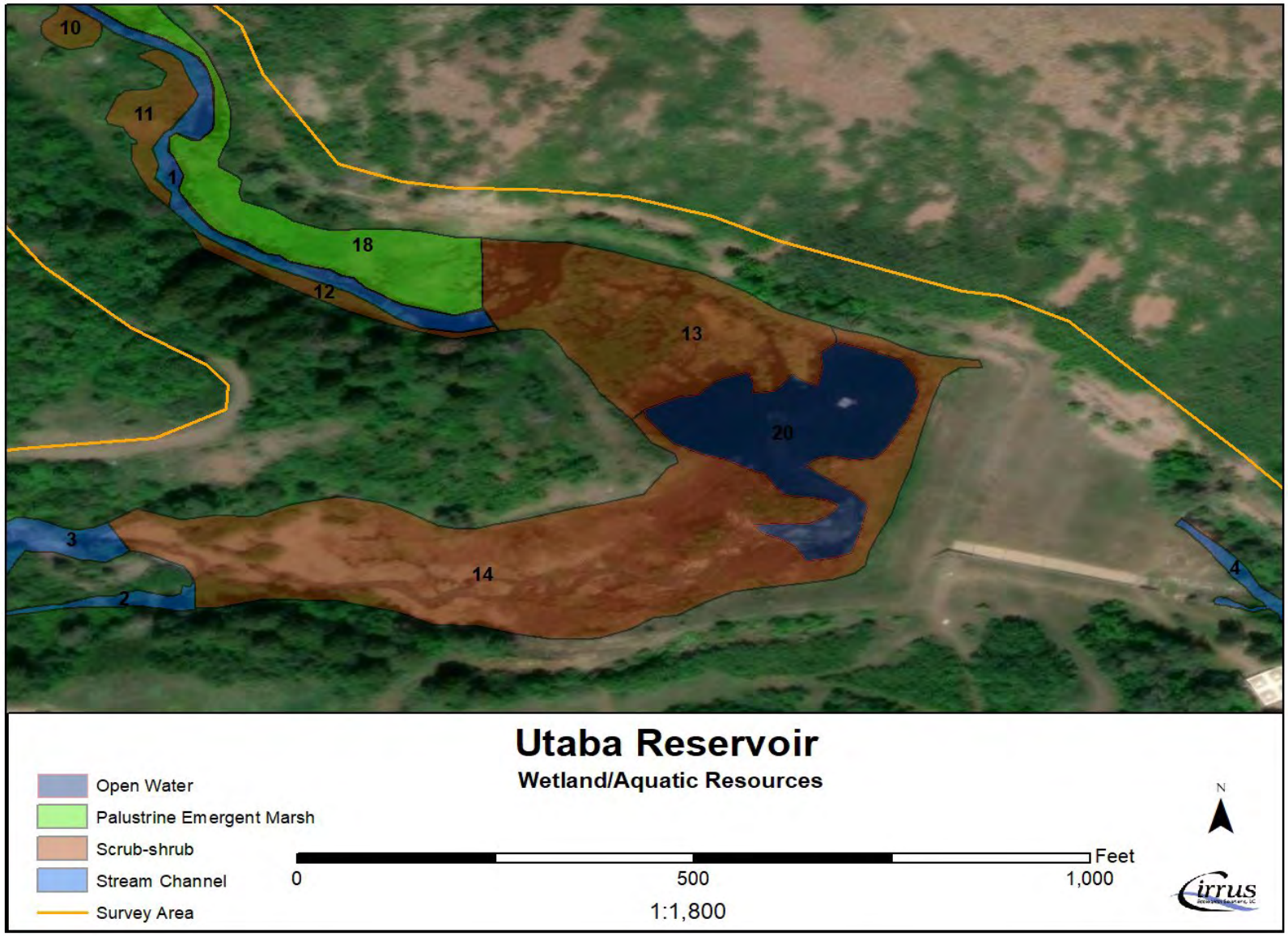

Figure 4. Utaba Reservoir Aquatic Resources, detail map 2.

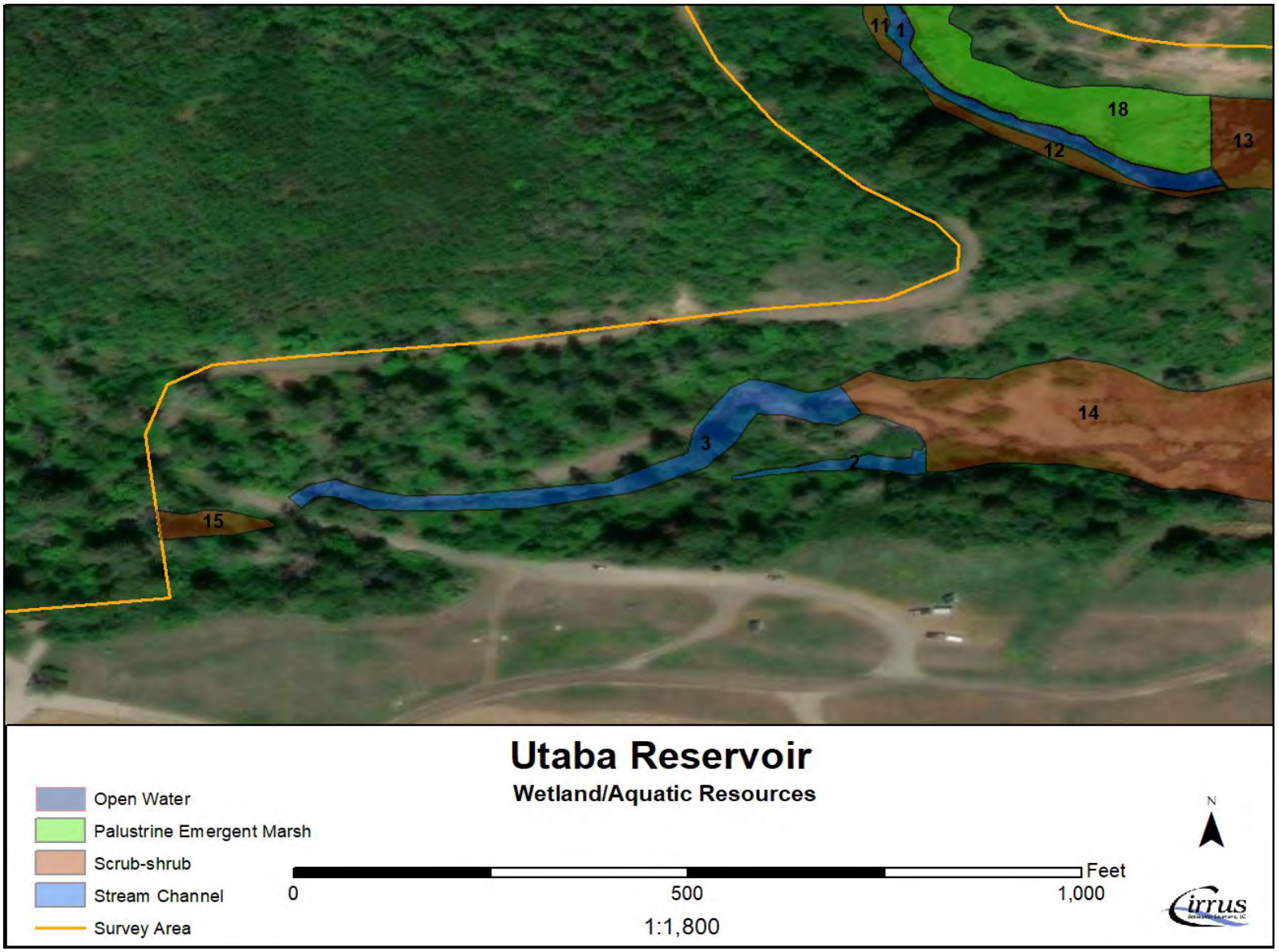

Figure 5. Utaba Reservoir Aquatic Resources, detail map 3.

APPENDIX B: PHOTOGRAPHS



Photo 1. Scrub-shrub willow-dominated wetland in the North Fork Odgen River delta at top of Utaba Reservoir, looking downstream.



Photo 2. Scrub shrub willow dominated wetland in the North Fork Odgen River delta area at the top of Utaba Reservoir showing the braided stream channel.



Photo 3.North Fork Ogden River showing scrub-shrub willow wetlands in delta area above Utaba Reservoir.



Photo 4. North Fork Ogden River showing scrub-shrub willow wetlands in delta area above Utaba Reservoir.



Photo 5. North Fork Ogden River showing braided channel at top of Utaba Reservoir looking upstream.



Photo 6. Narrow palustrine emergent wetland along the edge of the road associated with a spring at the toe of the slope.



Photo 7. Palustrine emergent wetland on the north edge of project area supported by a spring in a zone of groundwater discharge at the toe of the slope.



Photo 8. Groundwater discharge area along north edge of the project area showing palustrine emergent and shrub-scrub wetland intermixed.



Photo 9. North Fork Ogden River showing an area of palustrine emergent wetland.



Photo 10. Palustrine emergent and scrub-shrub wetland along the North Fork Ogden River.



Photo 11. Palustrine emergent wetlands in the ground water discharge zone along the north edge of the project area.



Photo 12. Groundwater discharge area at toe of slope, north side of project area.

NRCS Custom Soil Resource Report – Web Soil Survey

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Morgan Area, Utah - Morgan County and Part of Weber County

Utaba Dam Rehabilitation Supplemental Watershed Plan-EA



August 21, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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SfG—Smarts loam, 40 to 60 percent slopes.....17
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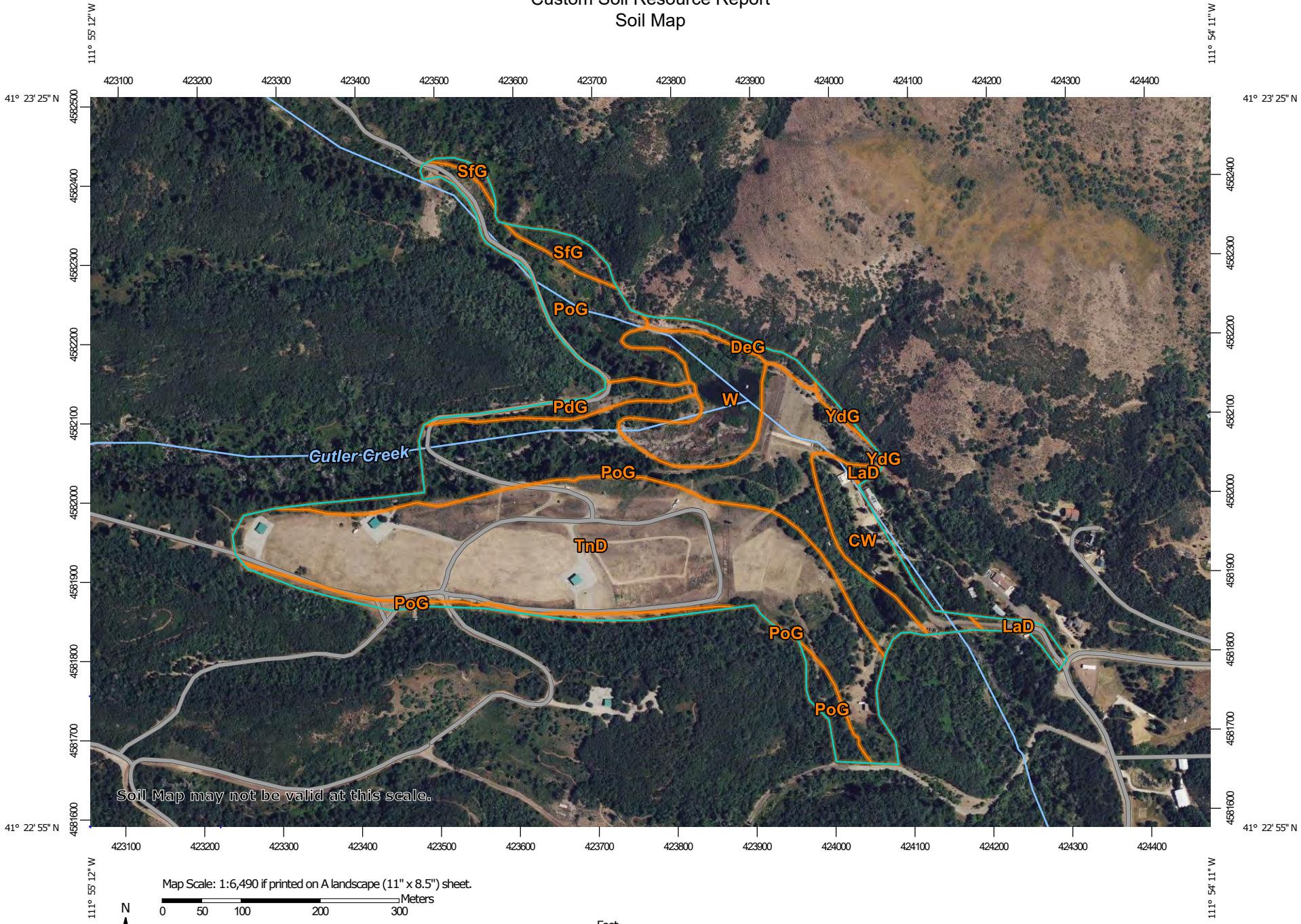
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:6,490 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 300 600 1200 1800

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Morgan Area, Utah - Morgan County and Part of Weber County
Survey Area Data: Version 16, Sep 8, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 22, 2022—Jul 11, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CW	Cumulic Haploborolls, wet	3.1	5.1%
DeG	Durfee stony loam, 30 to 70 percent slopes	0.9	1.4%
LaD	Lamondi stony loam, 3 to 15 percent slopes	0.7	1.1%
PdG	Patio gravelly loam, 40 to 60 percent slopes	1.5	2.5%
PoG	Poleline stony loam, 40 to 70 percent slopes	21.9	35.6%
SfG	Smarts loam, 40 to 60 percent slopes	1.2	1.9%
TnD	Trojan loam, warm, 8 to 15 percent slopes	27.2	44.2%
W	Water	4.8	7.7%
YdG	Yeates Hollow-Smarts complex, 30 to 70 percent slopes	0.2	0.3%
Totals for Area of Interest		**61.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas

are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Morgan Area, Utah - Morgan County and Part of Weber County

CW—Cumulic Haploborolls, wet

Map Unit Setting

National map unit symbol: k028
Elevation: 5,200 to 7,460 feet
Mean annual precipitation: 18 to 22 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 70 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Cumulic haploborolls, wet, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cumulic Haploborolls, Wet

Setting

Landform: Drainageways, flood plains
Landform position (three-dimensional): Dip, talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium derived from mixed sources

Typical profile

H1 - 0 to 60 inches: stratified silty clay to silt loam to very fine sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.06 to 19.98 in/hr)
Depth to water table: About 10 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B/D
Ecological site: R047XA006UT - Semi-wet Fresh Streambank (narrowleaf cottonwood)
Hydric soil rating: Yes

Minor Components

Cumulic haploxerolls

Percent of map unit: 3 percent

Fluvaquentic haploborolls

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Dip, talf

Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Canburn

Percent of map unit: 2 percent
Landform: Flood plains
Landform position (three-dimensional): Dip, talf
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Utaba

Percent of map unit: 2 percent

DeG—Durfee stony loam, 30 to 70 percent slopes

Map Unit Setting

National map unit symbol: k02q
Elevation: 5,200 to 7,220 feet
Mean annual precipitation: 18 to 22 inches
Frost-free period: 80 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Durfee and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Durfee

Setting

Landform: Mountainsides, mountain slopes
Landform position (three-dimensional): Mountainflank, mountainbase
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from sandstone and quartzite

Typical profile

A11, A12 - 0 to 12 inches: very cobbly loam
B1 - 12 to 16 inches: extremely cobbly loam
B21t - 16 to 25 inches: extremely gravelly clay loam
B22tB23tB3t - 25 to 60 inches: extremely gravelly clay

Properties and qualities

Slope: 30 to 70 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R047XA406UT - Mountain Gravelly Loam (mountain big sagebrush)
Hydric soil rating: No

Minor Components

Henefer

Percent of map unit: 3 percent

Manila

Percent of map unit: 3 percent

Yeates hollow

Percent of map unit: 3 percent

Foxol

Percent of map unit: 3 percent

St marys

Percent of map unit: 3 percent

LaD—Lamondi stony loam, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: k043
Elevation: 5,100 to 6,890 feet
Mean annual precipitation: 18 to 22 inches
Frost-free period: 70 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Lamondi and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lamondi

Setting

Landform: Alluvial fans
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Slope alluvium and colluvium derived from argillite, phyllite, schist, and quartzite

Typical profile

A11 - 0 to 3 inches: gravelly loam
A12 - 3 to 10 inches: cobbly loam
A13 - 10 to 21 inches: very stony loam
B21, B22 - 21 to 52 inches: extremely stony loam
B3 - 52 to 60 inches: extremely gravelly loam

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R047XA410UT - Mountain Gravelly Loam (oak)
Hydric soil rating: No

Minor Components

Fluvaquentic haploborolls

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Dip, talf
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Yeates hollow

Percent of map unit: 3 percent

Trojan

Percent of map unit: 3 percent

Kahler

Percent of map unit: 3 percent

Kahler

Percent of map unit: 3 percent

PdG—Patio gravelly loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: k057
Elevation: 5,200 to 7,000 feet

Mean annual precipitation: 18 to 22 inches
Frost-free period: 70 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Patio and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Patio

Setting

Landform: Mountainsides
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium over residuum weathered from mixed sources

Typical profile

A11 - 0 to 9 inches: very gravelly loam
A12 - 9 to 13 inches: gravelly loam
B2 - 13 to 26 inches: very gravelly clay loam
R - 26 to 30 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 36 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: R047XA406UT - Mountain Gravelly Loam (mountain big sagebrush)
Hydric soil rating: No

Minor Components

Poline

Percent of map unit: 3 percent

Smarts

Percent of map unit: 3 percent

Nordic

Percent of map unit: 2 percent

Rock outcrop

Percent of map unit: 2 percent

PoG—Poleline stony loam, 40 to 70 percent slopes

Map Unit Setting

National map unit symbol: k059
Elevation: 5,080 to 9,000 feet
Mean annual precipitation: 22 to 35 inches
Farmland classification: Not prime farmland

Map Unit Composition

Poleline and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poleline

Setting

Landform: Mountainsides
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium over residuum weathered from mixed sources

Typical profile

A11 - 0 to 4 inches: gravelly loam
A12 - 4 to 8 inches: gravelly silt loam
A13, A14 - 8 to 24 inches: gravelly loam
B21, B22 - 24 to 48 inches: very gravelly loam
R - 48 to 52 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 70 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.01 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R047XA510UT - High Mountain Loam (bigtooth maple)
Hydric soil rating: No

Minor Components

Broad canyon
Percent of map unit: 3 percent

Rock outcrop
Percent of map unit: 3 percent

Nagisty
Percent of map unit: 3 percent

Patio
Percent of map unit: 3 percent

Nordic
Percent of map unit: 3 percent

SfG—Smarts loam, 40 to 60 percent slopes

Map Unit Setting
National map unit symbol: k05p
Elevation: 5,200 to 7,540 feet
Mean annual precipitation: 18 to 22 inches
Frost-free period: 70 to 90 days
Farmland classification: Not prime farmland

Map Unit Composition
Smarts and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Smarts

Setting
Landform: Mountainsides
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from argillite, phyllite, and schist

Typical profile
A11 - 0 to 8 inches: loam
A12 - 8 to 18 inches: gravelly loam
A13 - 18 to 26 inches: very gravelly loam
B21t, B22t - 26 to 72 inches: very gravelly clay loam

Properties and qualities
Slope: 40 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R047XA434UT - Mountain Loam (shrub)
Hydric soil rating: No

Minor Components

Fluvaquentic haploborolls

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Dip, talf
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Fluventic haploxerolls

Percent of map unit: 3 percent

Poleline

Percent of map unit: 3 percent

Yeates hollow

Percent of map unit: 3 percent

Durfee

Percent of map unit: 3 percent

TnD—Trojan loam, warm, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: k064
Elevation: 5,070 to 5,870 feet
Mean annual precipitation: 18 to 22 inches
Frost-free period: 90 to 100 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Trojan and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Trojan

Setting

Landform: Stream terraces, alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Concave, convex
Parent material: Alluvium derived from mixed sources

Typical profile

Ap1, Ap2 - 0 to 16 inches: loam
B21tB22tB23t - 16 to 48 inches: gravelly clay loam
C - 48 to 60 inches: very cobbly clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R047XA430UT - Mountain Loam (mountain big sagebrush)
Hydric soil rating: No

Minor Components

Trojan

Percent of map unit: 4 percent

Brownlee

Percent of map unit: 3 percent

Bownlee

Percent of map unit: 3 percent

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

YdG—Yeates Hollow-Smarts complex, 30 to 70 percent slopes

Map Unit Setting

National map unit symbol: k06c
Elevation: 5,200 to 7,400 feet
Mean annual precipitation: 18 to 22 inches
Farmland classification: Not prime farmland

Map Unit Composition

Yeates hollow and similar soils: 55 percent
Smarts and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yeates Hollow

Setting

Landform: Ridges, mountainsides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountainflank, interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium and/or slope alluvium over residuum weathered from conglomerate

Typical profile

A1 - 0 to 13 inches: very cobbly loam
B21t, B22t - 13 to 29 inches: very cobbly clay loam
B23t - 29 to 42 inches: extremely cobbly clay loam
R - 42 to 46 inches: unweathered bedrock

Properties and qualities

Slope: 30 to 70 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: R047XA406UT - Mountain Gravelly Loam (mountain big sagebrush)
Hydric soil rating: No

Description of Smarts

Setting

Landform: Mountainsides

Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from argillite, phyllite, and schist

Typical profile

A11 - 0 to 8 inches: loam
A12 - 8 to 20 inches: very cobbly silt loam
B21t, B22t - 20 to 44 inches: very cobbly clay loam
R - 44 to 48 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R047XA434UT - Mountain Loam (shrub)
Hydric soil rating: No

Minor Components

Yeates hollow

Percent of map unit: 4 percent

Foxol

Percent of map unit: 3 percent

Rock outcrop

Percent of map unit: 3 percent

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USFWS IPaC Official Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
Phone: (801) 975-3330 Fax: (801) 975-3331

In Reply Refer To: 06/03/2025 20:42:21 UTC
Project Code: 2024-0135067
Project Name: Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)

(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see https://www.fws.gov/program/migratory-bird-permit/what-we-do.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

PROJECT SUMMARY

Project Code: 2024-0135067

Project Name: Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Project Type: Dam - Maintenance/Modification

Project Description: NRCS project to rehabilitate and improve life of Utaba Dam. Polygon generated for proposal to be contractor for environmental document and engineering services.

Utaba Dam is located in Weber County, Utah, latitude 41.387128º, longitude -111.910519º. Utaba Dam was constructed in 1962 under Public Law 566 as a significant hazard potential dam. The evaluated life of Utaba Dam is 50 years.

Utaba is currently classified as a significant hazard potential dam but has been determined by NRCS to be out of compliance with current NRCS and state dam safety criteria, and performance standards. Utah dam safety is in the process of upgrading Utaba Dam to a more representative high hazard class. The hazard class change is due mostly to development downstream and changes in state and NRCS requirements.

The need for the project is to upgrade the dam to meet current NRCS and State dam safety standards to reduce the risk to life and property and extend the service life of the dam and to allow it to continue to provide protection from floods.

Some of the essential changes to make the structure meet requirements is adding material to get a wider top width, replace the primary outlet pipe with a larger pipe, and replace the auxiliary spillway to provide more flow capacity. Sedimentation has also reduced the retention volume of the structure and subsequently its effectiveness as a flood control structure. Significant deterioration of the concrete in the auxiliary spillway has been observed. Preliminary planning has shown that the sponsor would like to explore adapting the facilities to be able to use it as a water source for aerial wildland fire fighting efforts and create better access for the county to get equipment to the dam and to the outlet works for operation and maintenance.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@41.3862764,-111.91171371499274,14z



Counties: Weber County, Utah

ENDANGERED SPECIES ACT SPECIES

There is a total of 6 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 1 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Canada Lynx *Lynx canadensis* Population: Wherever Found in Contiguous U.S. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. This species only needs to be considered under the following conditions: ▪ Species may be present based on transient occurrence as it moves through or too suitable habitat. Effects should be considered to species and projects should consult with the Service, however, depending on the project, consultation may not be necessary. Species profile: https://ecos.fws.gov/ecp/species/5123	Threatened

BIRDS

NAME	STATUS
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/9743	Proposed Threatened
Suckley's Cuckoo Bumble Bee *Bombus suckleyi* Population: No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10885	Proposed Endangered

FLOWERING PLANTS

NAME	STATUS
Ute Ladies'-tresses *Spiranthes diluvialis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2159	Threatened

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Franson Civil Engineers
Name: Landon Richins
Address: 1276 South 820 East, Suite 100
City: American Fork
State: UT
Zip: 84003
Email lrichins@fransoncivil.com
Phone: 8017560309

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Natural Resources Conservation Service
Name: Derek Hamilton
Email: derek.hamilton@usda.gov
Phone: 3853214987

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

NOT FOR CONSULTATION

Location

Weber County, Utah



Local office

Utah Ecological Services Field Office

(801) 975-3330
(801) 975-3331

2369 West Orton Circle, Suite 50

West Valley City, UT 84119-7603

NOT FOR CONSULTATION

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

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2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Canada Lynx Lynx canadensis There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
North American Wolverine Gulo gulo luscus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Threatened

Birds

NAME	STATUS
Yellow-billed Cuckoo Coccyzus americanus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3911	Threatened

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Ute Ladies'-tresses Spiranthes diluvialis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2159	Threatened

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Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

There are likely bald eagles present in your project area. For additional information on bald eagles, refer to Bald Eagle Nesting and Sensitivity to Human Activity

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

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NAME	BREEDING SEASON
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Golden Eagle *Aquila chrysaetos* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds Dec 1 to Aug 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12

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(0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

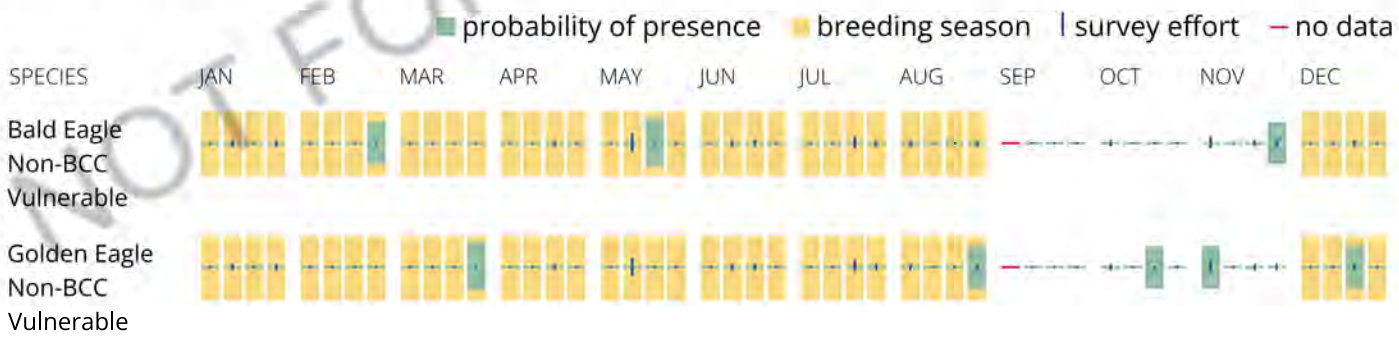
Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



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What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs of bald and golden eagles in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur. Please contact your local Fish and Wildlife Service Field Office if you have questions.

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Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-

golden-eagles-may-occur-project-action

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

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NAME	BREEDING SEASON
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Broad-tailed Hummingbird *Selasphorus platycercus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 25 to Aug 21
California Gull *Larus californicus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 1 to Jul 31
Cassin's Finch *Haemorhous cassinii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9462	Breeds May 15 to Jul 15
Clark's Nutcracker *Nucifraga columbiana* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Jan 15 to Jul 15

Evening Grosbeak Coccothraustes vespertinus — Breeds May 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Flammulated Owl Psiloscops flammeolus — Breeds May 10 to Aug 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/7728

Golden Eagle Aquila chrysaetos — Breeds Dec 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Lewis's Woodpecker Melanerpes lewis — Breeds Apr 20 to Sep 30
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9408

Long-eared Owl asio otus — Breeds Mar 1 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3631

Olive-sided Flycatcher Contopus cooperi — Breeds May 20 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3914

Virginia's Warbler Leiothlypis virginiae — Breeds May 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9441

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Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read

"Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

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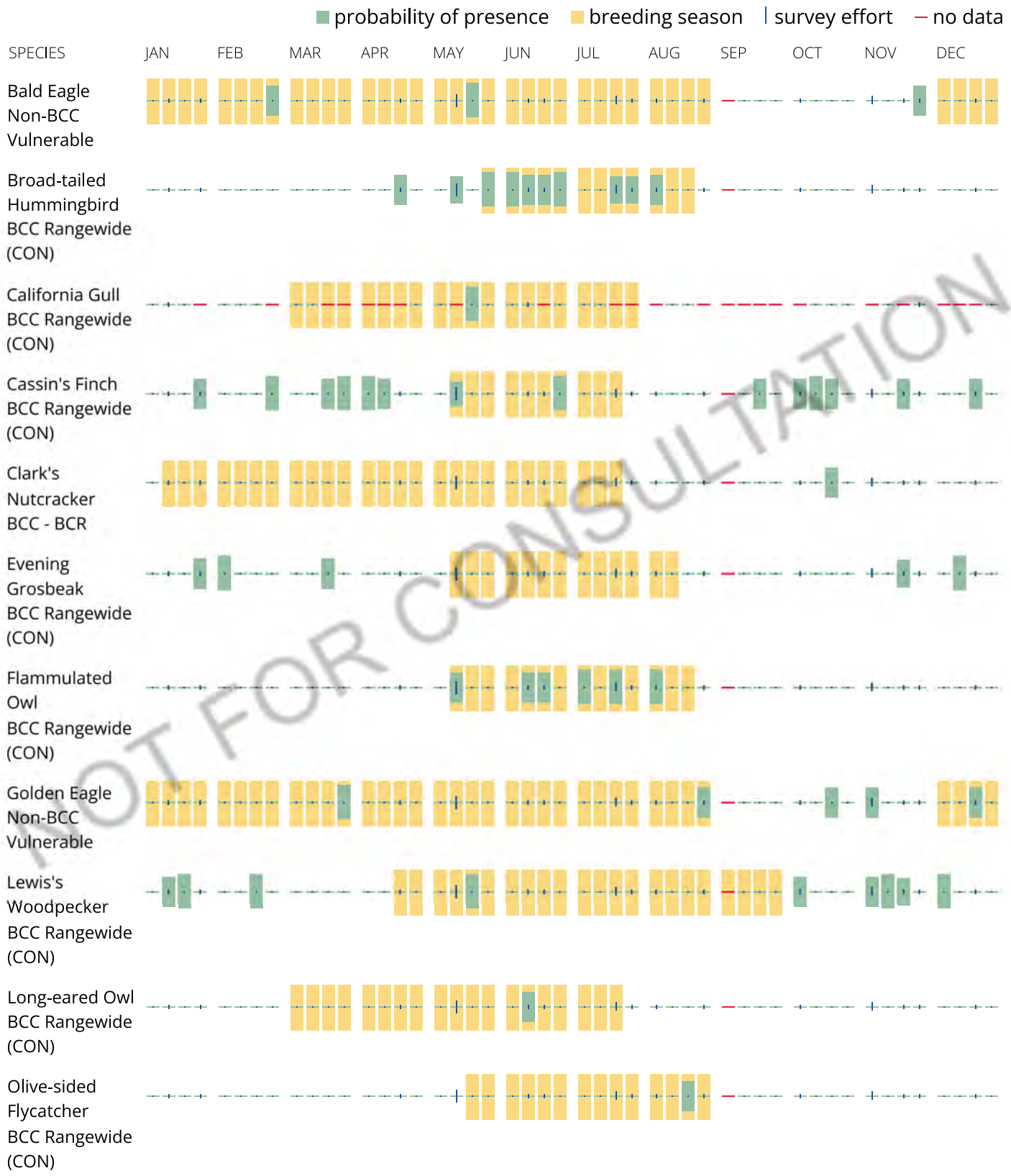
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



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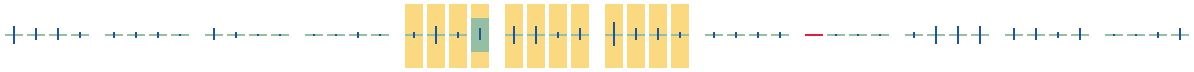

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird

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on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key

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component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

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Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

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Utah Natural Heritage Online Species Search Report

Utah Division of Wildlife Resources
Utah Natural Heritage Program
1594 W. North Temple
PO Box 146301
Salt Lake City, UT 84116

Report Number: 15895
August 26, 2024

Utah Natural Heritage Program Online Species Search Report

Project Information

Project Name

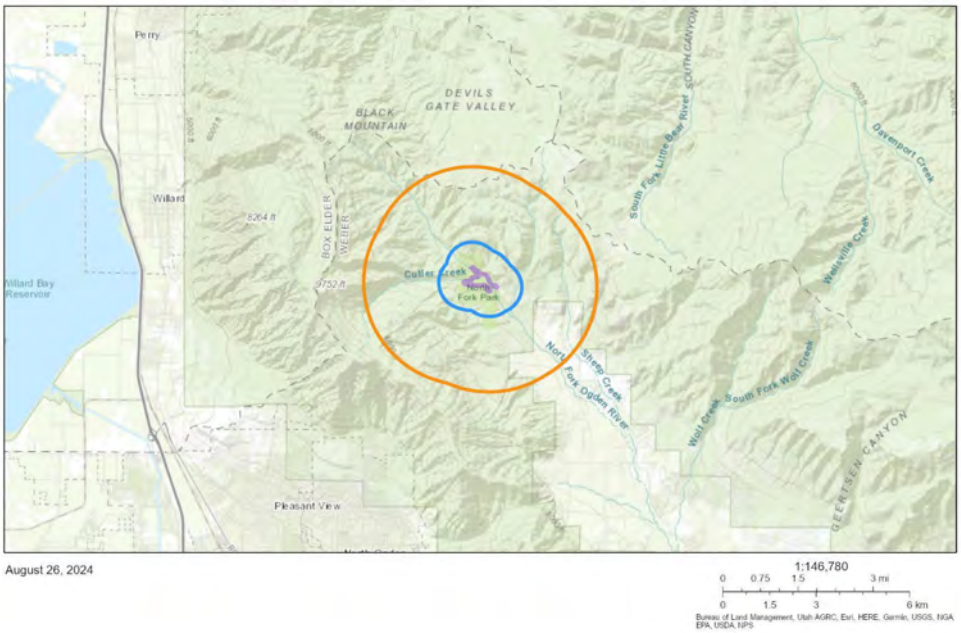
Utaba Dam Rehabilitation Supplemental Watershed Plan-Environmental Assessment

Project Description

NRCS project to rehabilitate and improve life of Utaba Dam. Polygon generated for proposal to be contractor for environmental document and engineering services. Utaba Dam is located in Weber County, Utah, latitude 41.387128?, longitude -111.910519?. Utaba Dam was constructed in 1962 under Public Law 566 as a significant hazard potential dam. The evaluated life of Utaba Dam is 50 years. Utaba is currently classified as a significant hazard potential dam but has been determined by NRCS to be out of compliance with current NRCS and state dam safety criteria, and performance standards. Utah dam safety is in the process of upgrading Utaba Dam to a more representative high hazard class. The hazard class change is due mostly to development downstream and changes in state and NRCS requirements. The need for the project is to upgrade the dam to meet current NRCS and State dam safety standards to reduce the risk to life and property and extend the service life of the dam and to allow it to continue to provide protection from floods. Some of the essential changes to make the structure meet requirements is adding material to get a wider top width, replace the primary outlet pipe with a larger pipe, and replace the auxiliary spillway to provide more flow capacity. Sedimentation has also reduced the retention volume of the structure and subsequently its effectiveness as a flood control structure. Significant deterioration of the concrete in the auxiliary spillway has been observed. Preliminary planning has shown that the sponsor would like to explore adapting the facilities to be able to use it as a water source for aerial wildland fire fighting efforts and create better access for the county to get equipment to the dam and to the outlet works for operation and maintenance.

Location Description

Weber County, Utah. Upstream of Pineview Reservoir at the confluence of the North Fork of the Ogden River with Cutler Creek.



Animals within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Bald Eagle	Haliaeetus leucocephalus	SGCN		1983
Bonneville Cutthroat Trout	Oncorhynchus clarkii utah	SGCN		2006

Plants within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Animals within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Bald Eagle	Haliaeetus leucocephalus	SGCN		1983
Bonneville Cutthroat Trout	Oncorhynchus clarkii utah	SGCN		2022
Greater Sage-grouse	Centrocercus urophasianus	SGCN		1999

Plants within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Definitions

State Status

SGCN	Species of greatest conservation need listed in the Utah Wildlife Action Plan

U.S. Endangered Species Act

LE	A taxon that is listed by the U.S. Fish and Wildlife Service as "endangered" with the probability of worldwide extinction
LT	A taxon that is listed by the U.S. Fish and Wildlife Service as "threatened" with becoming endangered
LE;XN	An "endangered" taxon that is considered by the U.S. Fish and Wildlife Service to be "experimental and nonessential" in its designated use areas in Utah
C	A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a "candidate" for listing as endangered or threatened
PT/PE	A taxon "proposed" to be listed as "endangered" or "threatened" by the U.S. Fish and Wildlife Service

Disclaimer

The information provided in this report is based on data existing in the Utah Division of Wildlife Resources' central database at the time of the request. It should not be regarded as a final statement on the occurrence of any species on or near the designated site, nor should it be considered a substitute for on-the-ground biological surveys. Moreover, because the Utah Division of Wildlife Resources' central database is continually updated, any given response is only appropriate for its respective request.

The UDWR provides no warranty, nor accepts any liability, occurring from any incorrect, incomplete, or misleading data, or from any incorrect, incomplete, or misleading use of these data.

The results are a query of species tracked by the Utah Natural Heritage Program, which includes all species listed under the U.S. Endangered Species Act and species on the Utah Wildlife Action Plan. Other significant wildlife values might also be present on the designated site. Please contact UDWR's regional habitat manager if you have any questions.

For additional information about species listed under the Endangered Species Act and their Critical Habitats that may be affected by activities in this area or for information about Section 7 consultation under the Endangered Species Act, please visit https://ecos.fws.gov/ipac/ or contact the U.S. Fish and Wildlife Service Utah Ecological Services Field Office at (801) 975-3330 or utahfieldoffice_esa@fws.gov.

Please contact our office at (801) 538-4759 or habitat@utah.gov if you require further assistance.

Your project is located in the following UDWR region(s): Northern region

Report generated for:
Landon Richins
Franson Civil Engineers
1276 South 820 East, Suite 100
American Fork, UT 84003
(801) 756-0309
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Redacted Cultural Resources Inventory Report

COVER PAGE
Must Accompany All Project Reports
Submitted to the Utah SHPO

SHPO Project Number: U24HO0596

Report Title: **A Cultural Resource Inventory for the Utaba Dam Rehabilitation Plan and Environmental Assessment Project, Weber County, Utah**

Report Date: July 2024
Report Author(s): Jon Baxter

Record Search Date(s): 07/11/24
Intensive Acres Surveyed (<15m intervals): 61
USGS 7.5' Series Map Reference(s): Mantua, North Ogden, Huntsville, Utah

Org. Project Number: 24-30
County(ies): Weber
Principal Investigator: Jon Baxter
Field Supervisor(s): Jon Baxter
Recon/Intuitive Acres Surveyed (>15m intervals): 0

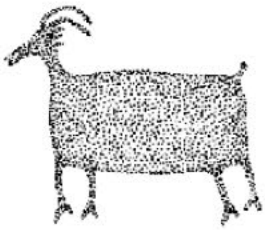
REDACTED PURSUANT TO 16 USC 470hh

Sites Reported	Count	Smithsonian Trinomials
Revisits (no updated site forms)	0	
Updates (updated site forms provided)	0	
New recordings (site forms provided)	2	42WB593, 42WB594
Total Count of Archaeological Sites in APE	2	42WB593, 42WB594
Historic Structures (structures forms provided)	11	In connection with 42WB593
Total National Register Eligible Sites	1	42WB593

*Please list all site numbers per category. Number strings are acceptable (e.g. "42TO1-13; 42TO15"). Cells should expand to accommodate extensive lists. Sites where a UASF is provided but site was not relocated can be listed in *italics*.

Checklist of Required Items for Submittal to SHPO

- ☒ "Born Digital" Report in a PDF/A format
  - ☒ SHPO Cover Sheet
  - ☒ File Name is the SHPO Project Number with no hyphens or landowner suffixes
- ☒ "Born Digital" Site forms in PDF/A format
  - ☒ UASF with embedded maps and photos
  - ☒ File name is Smithsonian Trinomial without leading zeros (e.g. 42TO13 not 42TO00013)
  - ☒ Photo requirements (including size and quality)
- ☒ Archaeological Site Tabular Data
  - ☒ Single spreadsheet for each project
  - ☒ Follows UTSHPO template (info here: https://goo.gl/7SLMqj)
- ☒ GIS data
  - ☒ Zipped polygon shapefile or geodatabase of survey (if different from APE) or other activity area with required field names and variable intensity denoted
  - ☒ Zipped polygon shapefile or geodatabase of site boundaries with the required field name



BIGHORN ARCHAEOLOGICAL CONSULTANTS, LLC
1712 NORTH 320 WEST, OREM, UTAH 84057
(801) 368-8091

Report Number 24-30

A Cultural Resource Inventory for the Utaba Dam Rehabilitation Plan and Environmental Assessment Project, Weber County, Utah

Prepared by

Jon R. Baxter
Bighorn Archaeological Consultants, LLC

Prepared for

Natural Resources Conservation Service
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Salt Lake City, UT 84138

and

Franson Civil Engineers
1276 S 820 E, Suite 100
American Fork, UT 84003

Utah State Project Number U24HO0596

July 2024

Abstract

Project Title: A Cultural Resource Inventory of the Utaba Dam Rehabilitation Plan and Environmental Assessment Project, Weber County, Utah

Project Description: Weber County, in conjunction with Natural Resources Conservation Service (NRCS), is initiating the planning and environmental compliance process for the rehabilitation of the Utaba Dam built in 1962.

Location: The proposed Area of Potential Effect (APE) is located alongside the North Fork of the Ogden River on privately held lands. Specifically, the APE is within T8N R1W, Sections 35-36 (USGS 7.5' Topographic Quad: Mantua, Utah).

Number of Surveyed Acres: 61acres

Number of Sites: Two new cultural sites were recorded, and one isolated find.

List of Register Listed Properties: N/A

List of Register Eligible Properties: 42WB593

List of Ineligible Sites: 42WB594

List of Unevaluated Sites: N/A

Comments: At the request of Franson, Bighorn has completed a cultural resource inventory for the proposed Utaba Dam Rehabilitation Project, Weber County, Utah. Examination of the proposed project area resulted in the discovery of two new cultural sites (42WB593, 42WB594), and identifying one isolated find. A total of 61 acres was inventoried.

Site 42WB593 is the historic Camp Utaba and has been in use since the early 1920s. The camp consists of 22 features, the majority being residential cabins of various sizes. Bighorn recommends that Site 42WB593 be considered eligible for nomination to the NRHP under Criterion A. Site 42WB594 is the Utaba historic earthen dam built in 1962. Bighorn recommends that Site 42WB594 be considered ineligible for the NRHP.

In addition to the field inventory, Bighorn reviewed archaeological site and historic structure records held by the Utah SHPO (SEGO and HUB Databases) for the broader APE. Although the database research indicated three documented ineligible/non-contributing historical buildings are located within the dam breach scenario, other unknown properties could be affected by flooding under the No Action alternative scenario.

For the eligible archaeological site, the boundary of the breach zone is a very conservative estimate of the area that might be impacted by a breach of the Utaba Dam. The majority of the area within the breach zone will not be impacted by flooding. Further modeling of a dam breach will refine the potential area impacted. However, the modeling cannot be completed until geotechnical data

is gathered. The geotechnical data cannot be gathered until this report has been prepared and accepted. The site is approximately 1300 feet from the North Fork Ogden River and if flood water did reach the site the water would be shallow and slow moving such that erosion of the site would not occur. The site would experience similar flooding based on existing conditions in the event the current dam breached. As such, effects are the same for the Action and No Action alternatives.

The rehabilitation of the dam is expected to include raising the dam and widening the crest of the dam. These changes will result in the downstream toe of the dam extending 50 to 100 feet farther downstream of the current toe of the dam. The principal and auxiliary spillways will be replaced. A new auxiliary spillway will be moved off the dam and constructed either on the north or south side of the dam. The new auxiliary spillway will be constructed within 150 feet of the dam.

The rehabilitation of the dam will eliminate a fire ring used by Camp Utaba. No other permanent facilities of Camp Utaba will be eliminated by the construction. The access road through Camp Utaba may be used to access the dam during construction. No permanent structures other than the road will be impacted by construction. The road and some walkways will likely require repair if the road is used for construction access.

The content provided here represents the Bighorn's viewpoints and suggestions. The NRCS will make official determinations regarding eligibility for newly documented sites, as well as assessments related to their impact on the direct APE and the No Action/Dam Breach scenario APE. These determinations will be communicated separately.

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Appendix A – Project, Cultural Sites, Isolated Find, and Historic Structures Location Map

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Introduction

Bighorn has completed a cultural resource inventory for the proposed Utaba Dam Rehabilitation Project, Weber County, Utah. Part of the funding is through the NRCS PL 83-566 Rehab program. Issuance of such federal funding by the NRCS invokes the National Historic Preservation Act and its implementing regulations at 36 CFR §800 for the consideration of historic properties in project planning and execution. The project was undertaken at the request of Franson Civil Engineers (Franson) to assist in fulfilling requirements under various federal and state environmental protection laws. Bighorn completed the inventory under Utah Project Number U2HO0596. Fieldwork was completed by Jon Baxter on 13 July 2024.

Weber County, in conjunction with NRCS, is initiating the planning and environmental compliance process for the rehabilitation of the Utaba Dam. Utaba Dam creates a small reservoir that removes debris and reduces peak flows in the North Fork of the Ogden River during spring runoff and storm events. The dam was built in 1962 and needs to be brought into compliance with current dam safety standards amongst other needs.

Project Location

The APE is located north-central Weber County, Utah, on privately held lands (Figure 1). Specifically, the APE is within T8N R1W, Sections 35-36 (USGS 7.5' Topographic Quad: Mantua, Utah). The direct APE totals 61 acres.

The APE as defined by the NRCS under 36 CFR §800.4 also includes the areas that could be potentially flooded and damaged if no action is taken (i.e., the No Action alternative) as well as the area that could be flooded if the dam improvements under the Preferred Alternative breaches (see Figure 1). This additional APE contains 4,307 acres. This APE was not included in the survey area for the undertaking but was reviewed through archival research.

Environment

The proposed project is located within the north-central Weber County, Utah in the North Fork Park area. This physiographic subdivision of Utah is between 5,600- and 5,800-feet elevation above sea level. The area is characterized as a complex area of Cambrian, Geersten Canyon Quartzite. This area is named after the North Fork Ogden River in this area. Soils in the area consist of lacustrine with alluvium along the river bottoms. Alluvial soils are deep and quite gravelly. Vegetation in the area includes cottonwood, willow, bluegrass, sagebrush and various bunch grasses and forbs.

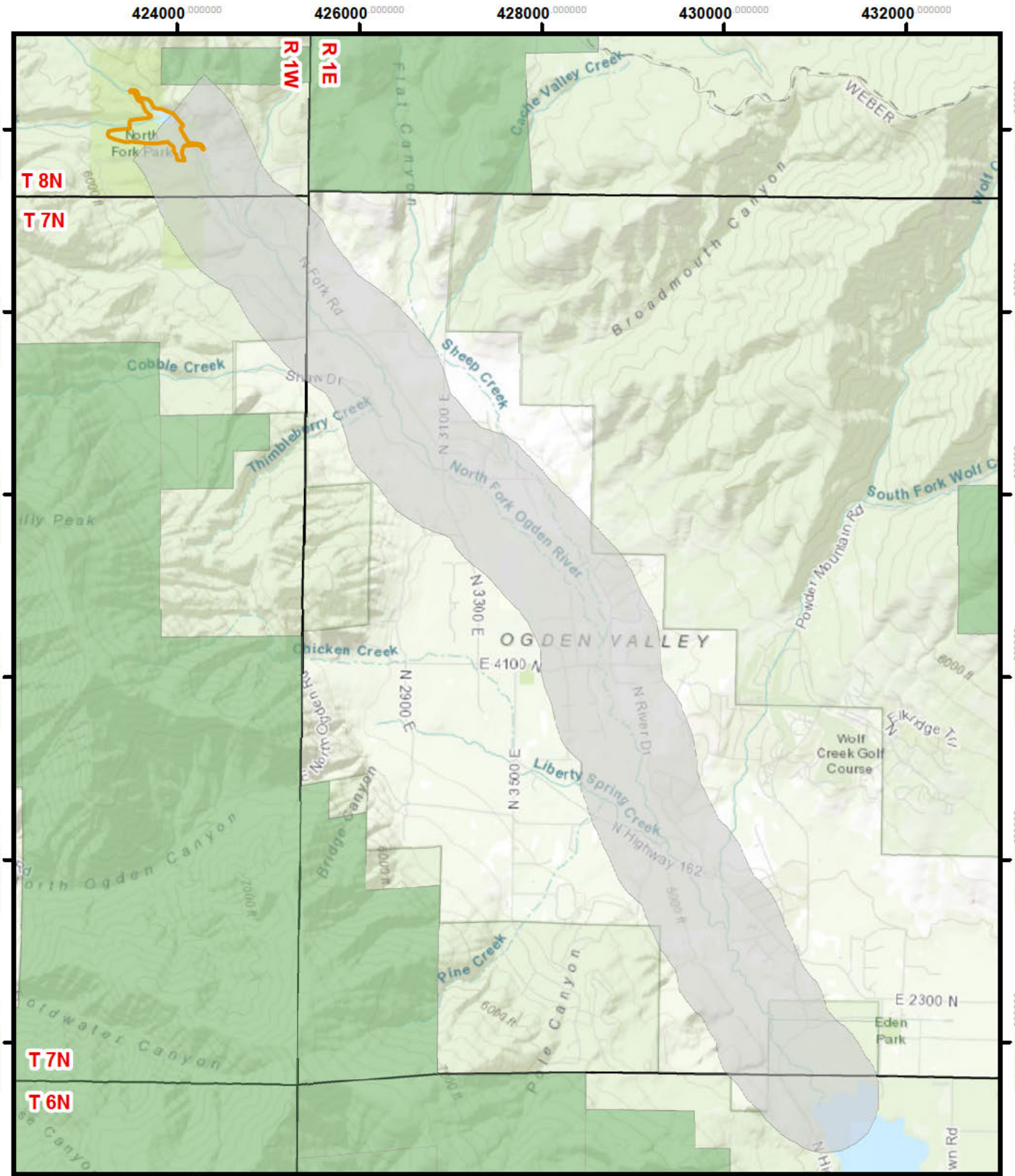

Figure 1. Project Location Map

07/16/24

Cultural Context

The prehistory of the area of the Basin and Range region (Eastern Great Basin) can be broken down into a series of developmental stages based on changing technologies, economics, and social systems. Table 1 provides an overview of these phases. For more information refer to general syntheses of the regional prehistory (Jennings 1978; Madsen 1982; Geib 1996; Aikens & Madsen 1986; Madsen 1979; Simms 1986). For more information on the history of the area refer to historic syntheses of the area (Antrei 1999).

Table 1. Cultural Phases of the Eastern Great Basin

Cultural Phase	Sub-phase	Approximate Time Period
Paleoindian	N/A	20,000 – 6,500 BC
Archaic	Early Archaic	6,500 – 3,500 BC
	Middle Archaic	3,500 – 1,500 BC
	Late Archaic	1,500 BC – AD 400
Formative (Fremont)	N/A	AD 400 - 1350
Late Prehistoric (Southern Paiute / Ute)	Late Prehistoric	AD 1350 – 1700
	Protohistoric	AD 1700 – 1850
	Historic	Post AD 1850
Historic (Euro-American)	Early Exploration	AD 1776-1858
	Mormon Settlement, Farming, Ranching & Mining	AD 1858-1870 AD 1870-1950s



Figure 2. General project overview facing northeast.



Figure 3. General project overview facing south.

Previous Research

Prior to initiating fieldwork, Bighorn conducted a ½ mile buffer search around the APE for reported projects, previously recorded cultural sites, and structures from the Utah State Historic Preservation Office SEGO Database on 11 July 2024.

Field Survey Area

SEGO results indicated one cultural resource inventory had been conducted in the vicinity of the current survey area (Table 2). However, no archaeological sites or historic structures were recorded.

Table 2. Previous Cultural Resource Inventories within ½ Mile of the Proposed Project

Project Name	Project Number	Company
Cultural resources Inventory for the Ogden Valley Well Environmental Assessment Project, Weber County, Utah	U15ST0375	SWCA

General Land Office (GLO) maps, aerial photographs, Master Title Plats, and the Historic Index of the area were also reviewed for historic features, such as roads, trails, mining claims, or land patents. One GLO dated 1890 depicted the "North Fork of Ogden Road" running northwest to southeast in Sections 35-36 (T8N, R1W).

No Action/Dam Breach Area of Potential Effects

In addition to reviewing project, site, and structures files for the field survey area, Bighorn reviewed site and structures records held by the Utah SHPO (SEGO and HUB Databases) for the broader APE. These properties could be affected by flooding under the No Action alternative. This search indicates that one archaeological site is known to be present in the APE, excluding those newly located in the survey area and reported in the Inventory Results section of this report. The previously reported site is as follows (Table 3) (see also Appendix A for locations):

Table 3. Previously Recorded Sites within 2,000 feet of the No Action/Breach Zone APE

Site Number	Site Type	Cultural Affiliation	Eligibility
42WB473	Prehistoric Lithic Scatter	Archaic	Eligible

Beyond the one previously reported archaeological site, three primary buildings (Property Record #255825, 255827, 255826) dating to the historic period were identified in the APE. (See Appendix A displaying their locations). Additional historical outbuildings are likely present in the area but are not enumerated here due to lack of information about their specific ages or have not been documented previously. Of the three known historical buildings, all are recommended ineligible/non-contributing.

Inventory Methods

The cultural resource inventory for the proposed Utaba Dam Rehabilitation Plan and Environmental Assessment Project, Weber County, Utah involved a pedestrian survey to identify cultural resources within the proposed area of potential effects (APE). The project was inventoried by walking multiple 15-m (50 ft) wide pedestrian transects around the reservoir area to provide intensive coverage. The area inventoried consisted of 61 acres.

Cultural resource encountered during the inventory were recorded as sites or isolates, as defined in the National Register Bulletin No. 16A as the "location of a significant event, a prehistoric occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the

location itself possesses historic, cultural, or archaeological value regardless of any existing structure." To clarify, historic, prehistoric, or archaeological features or any archaeological or historic anomaly that contains, at a minimum, greater than ten artifacts in a 10-meter diameter area, multiple features, a single feature for which sufficient information is available to raise the possibility that it may be significant, or a combination of a feature and artifacts were considered a site. All other cultural materials that do not meet the above criteria were considered isolated artifacts, or single artifacts or features of which little is known and possessing no possibility for significance to be determined.

Each site and/or isolated find is recorded using data obtained from a Trimble Geo 7X global positioning system (GPS) and based on NAD 83. All GPS data will be submitted to the appropriate agency to incorporate into their databases. All newly recorded sites were evaluated against the criteria set forth by the National Register of Historic Places (NRHP).

The evaluation considered the four criteria of the National Register as listed in 36 CFR §60.4 and followed the guidelines issued by the National Park Service (NPS) in Bulletin 15, *How to Apply the National Register Criteria for Evaluation* (NPS). The National Register criteria state that a resource may be considered eligible for listing on the Register if it:

Criterion A – is associated with events that have made a significant contribution to the broad patterns of our history; OR
Criterion B – is associated with the lives of persons significant in our past; OR
Criterion C – embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual distinction; OR
Criterion D – has yielded, or may be likely to yield, information important in prehistory or history.

Resources considered potentially eligible for the National Register pursuant to one of the above criteria are also to be assessed for integrity of location, design, setting, materials, workmanship, feeling, and association. To be eligible for listing on the National Register, the resource must possess integrity of those elements directly related to the criterion or criteria under which it would be determined eligible.

The field inventory was completed by Jon Baxter (PLPCO #137) who is one of the Principal Investigators at Bighorn. He received both his MA and BS degrees in Anthropology from Brigham Young University and has over 28 years of experience in archaeology and cultural resource management in Utah, Arizona, Idaho, Wyoming, and Nevada. All work was conducted in accordance with Utah SHPO and NRCS cultural resource inventory standards.

Inventory Results

Examination of the proposed project area resulted in the discovery of two new cultural sites (42WB593, 42WB594). In addition, one isolated linear find was recorded (Appendix A).

Newly Recorded Sites

42WB593

Site 42WB593 is the historic Camp Utaba. Located in the Wasatch Mountains and north of Liberty, Utah is a small retreat area that has been set aside by the Utah Association of American Baptists Churches (UAABC) for Worship, Renewal and Revival. The camp has been in use since 1923. A review of historic maps and aerial photographs of the area support that the camp was existing pre-1958, and digital newspaper since 1926 (stating camp was bought three years previous). The site is located within a 270 x 165 m (44,550 m2) area, northwest of Liberty, Utah along North Fork Ogden River. Soils in the area consist of lacustrine with alluvium along the river bottoms. Alluvial soils are deep and quite gravelly. Vegetation in the area includes cottonwood, willow, bluegrass, sagebrush and various bunch grasses and forbs. The site is in stable condition and has been impacted by erosion.

The historic camp is located in north-central Weber County, Utah, and alongside the North Fork, one of the principal tributaries of the Ogden River. The camp consists of 22 features, the majority being residential cabins of various sizes. The dates of the cabins were noted from historic aerial images and speaking with the camp director (Scott Blank, personal communication 2024). All features were historic, however several had small additions to major overhauls. Features 1-7 had minor modifications on the original foundation. Feature 8 had been partially rebuilt. Features 9-12 are located on original foundations but have been rebuilt around 10 years ago. Feature 13 is original shed and building location with minor changes. Features 14 and 15 were built around 1980 to look like originals. Features 16-18 are not in their original location and built around 1980. Features 19-20 were demolished to the studs and rebuilt on original foundations around 10 years ago. Features 21 is located in the original location and has had utility upgrades. Feature 22 is also in the original location but has had three additions over the last 20 years and the interior has been redone with modern amenities.

Bighorn recommends that Site 42WB593 be considered eligible for nomination to the NRHP under Criterion A. The site is known to have played an important role in historical events of the area. It is the only American Baptist Camp located in Utah and has been a historically important religious and outdoor recreation gathering place since the 1940s. However, the site is not associated with any other significant historical feature or persons and not eligible under Criterion B. Furthermore, the site is not eligible under Criterion C as it does not exhibit unique construction and engineering designs or embody the work of a master. As a result, the site has not yielded, nor is it likely to yield, information important in history regarding settlement studies, ethnicity, consumerism and subsistence, and/or other significant regional research questions. In addition, the site exhibits no potential for data due to the geography of a constricted, small canyon. The depth potential is very low as trash would have been removed from the area to remain uncluttered, uncontaminated, and clean. The upper cabins are located on an incline and above the canyon has been graded for a new public campground. Therefore, it is not eligible under Criterion D. It appears to retain overall integrity of location, design, setting, and feeling, with intact features that are present amongst native vegetation. The site also maintains integrity of materials, workmanship, and association as demonstrated by the intact cabins.

42WB594

Site 42WB594 is the Utaba historic earthen dam built in 1962. Originally identified as a moderate hazard dam, its hazard designation was reviewed in 2019, and a recommendation was made to raise the hazard rating to high due to hazard creep, resulting from increased development below the dam. The dam was built strictly as a flood control structure. It is not used for recreation or water supply (irrigation or municipal). A significant portion of the watershed above the reservoir is bare rock. As a result, thunderstorm events create very high flows in the drainage in a short period of time. The reservoir storage created by the dam reduces the flow rate in the North Fork Ogden River before it reaches developed areas. A secondary purpose of the reservoir/dam is to remove debris from flood events that could potentially block downstream culverts or bridges. Debris blockages impact flood damage as much or more than the flow rate. If a culvert is blocked the flood water leaves the channel and floods adjacent areas even if the channel and culvert would normally have sufficient capacity to prevent any flooding.

A review of historic maps, aerial photographs, and historic newspaper supports that in the summer of 1961, a bid of $135,668 submitted by the Waterfall Construction Company to build the dam and be approved by the Soil Conservation Service. The Utah Water Rights records and Dam Safety Database indicated it was completed in 1962. The site is located within a 135 x 130 m (17,550 m2) area (estimation based off water in reservoir), northwest of Liberty, Utah along North Fork Ogden River. Soils in the area consist of lacustrine with alluvium along the river bottoms. Alluvial soils are deep and quite gravelly. Vegetation in the area includes cottonwood, willow, bluegrass, sagebrush and various bunch grasses and forbs. The site is in stable condition and has been impacted by erosion.

The historic dam is located in north-central Weber County, Utah, and comprises the entire drainage of the North Fork, one of the principal tributaries of the Ogden River. The actual dam consists of a U-shaped earthen berm that measures approximately 314 ft. (96 m) in length and 71 ft. (21 m) tall that forms the reservoir basin to the northwest. The berm is about 328 ft. (100 m) wide and the crest at the top of the berm is about 16 ft. (5 m) wide. A concrete principal spillway riser rises out of the reservoir which connects at the base to an outlet conduit pipe where it discharges at the principal spillway outlet structure. On the western portion of the earthen dam is the auxiliary spillway inlet structure made of concrete 7 inches thick. The spillway proceeds downslope (southeast) to the auxiliary spillway outlet structure. An earthen berm measuring 180 ft. (55 m) in length by 22 ft. (7 m) wide extends off the auxiliary spillway outlet structure on the south side of the river to protect Utaba Camp.

Site 42WB594 is a historic earthen dam dating from the mid-20th century. It appears to retain overall integrity of location, design, setting, and feeling, with intact features that are present amongst native vegetation. The site also maintains integrity of materials, workmanship, and association as demonstrated by the intact earthen dam and related features. However, the site is not associated with significant events or individuals in history. The dam is not distinctive in character, exhibit a unique construction or engineering design of construction, or embody the work of a master. It represents a standard earthen dam built in 1962 as a flood retarding/flood control dam with funding from the Soil Conservation Service and is one of dozens built throughout the

west from the 1940s-1980s. These earthen dams did not make a significant contribution to a broad pattern in history, and are rather standard examples of flood retarding dams, whose construction methods have not changed significantly over time. The site is unlikely to provide additional information important in understanding the history of the area. As such, it is recommended not eligible for the NRHP.

Isolated Find

One isolated find (IF) was identified within the APE during fieldwork. The IF includes a two-track alignment located on the northeast side of the North Creek Ogden River, similar to the same orientation of the GLO dated 1890 that depicted the "North Fork of Ogden Road" running northwest to southeast in Sections 35-36 (T8N, R1W).

Bighorn recommends the isolated occurrence ineligible for the National Register under all criteria. The alignment does not appear to be associated with any specific historic period events of importance or with any identifiable persons of historic significance. It also does not represent a type, style, manner of construction, work of a master, or resource of high artistic value and does not appear to be associated with established cultural resource districts or landscapes to which they may contribute. Lastly, the alignment has not yielded information important to improving our understanding of the past and does not appear to have the potential to do so with additional on-site investigation.

Table 4. Isolated Find

Isolated Find	Class	Description	Measurements	Est. Age	SHPO Number	Location
1	Historic	Two-track GLO Road	157 x 4 meters	1890 GLO	U24HO0596	[redacted]



Figure 4. Isolated Find Looking North.



Figure 5. Isolated Find Looking South.

Findings for the No Action/Dam Breach APE

The APE for the No Action alternative and Preferred Alternative Dam Breach scenario includes those lands that could be inundated or otherwise experience flood impacts if no action is taken to address current dam deficiencies, or if the renovated dam breaches. No field inventory was required for the No Action/Dam Break APE but did include identifying cultural resources in that broader APE through archival research. As discussed in the Previous Research section of this report, the broader APE identified one eligible archaeological site and three structures recommended ineligible/non-contributing.

Summary and Recommendations

At the request of Franson, Bighorn has completed a cultural resource inventory for the proposed Utaba Dam Rehabilitation Project, Weber County, Utah. Examination of the proposed project area resulted in the discovery of two new cultural sites (42WB593, 42WB594), and identifying one isolated find. A total of 61 acres was inventoried.

Site 42WB593 is the historic Camp Utaba and has been in use since the early 1920s. The camp consists of 22 features, the majority being residential cabins of various sizes. Bighorn recommends that Site 42WB593 be considered eligible for nomination to the NRHP under Criterion A. Site 42WB594 is the Utaba historic earthen dam built in 1962. Bighorn recommends that Site 42WB594 be considered ineligible for the NRHP.

In addition to the field inventory, Bighorn reviewed archaeological site and historic structure records held by the Utah SHPO (SEGO and HUB Databases) for the broader APE. Although the database research indicated three documented ineligible/non-contributing historical buildings are located within the dam breach scenario, other unknown properties could be affected by flooding under the No Action alternative scenario.

For the eligible archaeological site, the boundary of the breach zone is a very conservative estimate of the area that might be impacted by a breach of the Utaba Dam. The majority of the area within the breach zone will not be impacted by flooding. Further modeling of a dam breach will refine the potential area impacted. However, the modeling cannot be completed until geotechnical data is gathered. The geotechnical data cannot be gathered until this report has been prepared and accepted. The site is approximately 1300 feet from the North Fork Ogden River and if flood water did reach the site the water would be shallow and slow moving such that erosion of the site would not occur. The site would experience similar flooding based on existing conditions in the event the current dam breached. As such, effects are the same for the Action and No Action alternatives.

The rehabilitation of the dam is expected to include raising the dam and widening the crest of the dam. These changes will result in the downstream toe of the dam extending 50 to 100 feet farther downstream of the current toe of the dam. The principal and auxiliary spillways will be replaced. A new auxiliary spillway will be moved off the dam and constructed either on the north or south side of the dam. The new auxiliary spillway will be constructed within 150 feet of the dam.

The rehabilitation of the dam will eliminate a fire ring used by Camp Utaba. No other permanent facilities of Camp Utaba will be eliminated by the construction. The access road through Camp Utaba may be used to access the dam during construction. No permanent structures other than the road will be impacted by construction. The road and some walkways will likely require repair if the road is used for construction access.

The content provided here represents the Bighorn's viewpoints and suggestions. The NRCS will make official determinations regarding eligibility for newly documented sites, as well as assessments related to their impact on the direct APE and the No Action/Dam Breach scenario APE. These determinations will be communicated separately.

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Appendix A
Project, Cultural Sites, Isolated Find, and Historic Structures Location Map

Redacted pursuant to 16 USC 470hh