GEOTECHNICAL INVESTIGATION

WATER TANK
POLEBRIDGE RANGER STATION
POLEBRIDGE, MONTANA

PREPARED
FOR
NATIONAL PARK SERVICE
LAKEWOOD, COLORADO

PREPARED
BY
NELSON ENGINEERING
JACKSON, WYOMING

AUGUST 2025
Project No. 25-048-01

TABLE OF CONTENTS

GENERAL AND PROJECT DESCRIPTION **1**

SCOPE OF SERVICES 1

SITE CONDITIONS **1**

SITE DESCRIPTION 1
GEOLOGIC AND SOILS MAPPING 2
SEISMIC HAZARD 2

SITE INVESTIGATIONS **2**

FIELD INVESTIGATIONS 2
LABORATORY INVESTIGATIONS 3
SOIL PROFILES 3
BH-1 3
BH-2 4
GROUNDWATER 4

ENGINEERING ANALYSIS AND RECOMMENDATIONS **4**

GENERAL 4
TANK SUBGRADE 4
EXCAVATIONS AND SHORING 5
TANK BACKFILL 5
SEISMIC DESIGN PARAMETERS 6

CONSTRUCTION OBSERVATION AND TESTING **6**

CONSTRUCTION CONSIDERATIONS 7
EARTHWORK AND SITE GRADING 7

GENERAL COMMENTS **9**

WARRANTY AND LIMITING CONDITIONS **10**

GENERAL AND PROJECT DESCRIPTION

A geotechnical investigation was performed for a proposed water tank at the Polebridge Ranger Station in West Glacier National Park, located 1.3 miles north of Polebridge, Montana. The tank site is on a hill above the North Fork Flathead River south of the Ranger Station. Preliminary project plans are in process, a buried 14,000-gallon water tank and associated piping and utilities are planned. Geotechnical recommendations and analysis included in this report are based on current project information.

Scope of Services

The scope of services for this investigation was to provide geotechnical recommendations based on a subsurface investigation for the proposed tank. The purpose of the subsurface investigation was to determine soils and groundwater characteristics. The results of the subsurface investigation and subsequent laboratory testing were utilized in an engineering analysis for recommendations for structural foundations and earthwork. Slope stability analyses were not conducted, as it is our engineering judgment that the existing and proposed slope geometry and composition indicate stability. Specific recommendations for drainage and surface water conveyance were not within the scope of work for this report.

The analysis and resulting recommendations contained herein are based on typical loads for the type of structure envisioned as per the design and plans in progress at the time of this report. In the final design phase of the project, it will be critical that structural loads be properly communicated to the geotechnical engineer to verify that the imposed loading conditions on the proposed foundation configuration do not cause excessive settlement, exceed the bearing capacity of the site soils, or exceed the seismic loading capacity of the foundation elements. The lateral earth pressure recommendations contained within this report are general in nature; it is critical that final retaining wall designs are reviewed by the geotechnical engineer for review and approval. For this report, it is assumed that foundation elements would not be subjected to unusual loading conditions such as eccentric loads or vibratory equipment. Unusual load conditions can induce settlement or reduce the bearing capacity of foundation elements.

SITE CONDITIONS

Site Description

The Polebridge Ranger Station is located within Glacier National Park at the confluence of Bowman Creek and the North Fork Flathead River. Access from Columbia Falls is provided by N Fork Road. The tank site is on a terrace south of the ranger station approximately 100 feet above the North Fork Flathead River. Access is provided by a gravel road on the east side the river. The tank site is an area cleared of trees on an east facing slope with nearly flat ground near the road that gradually steepens to approximately 15%. The existing water tank is located to the west and upslope of the proposed tank location. Vegetation is upland grass with surface cobbles. Conifer forest surrounds the cleared tank site.

Geologic and Soils Mapping

Surface geology is mapped on the USGS "Surficial Geologic Map of Glacier National Park, Montana," Paul E. Carrara, 1990. Mapped deposits within the drainage are "t3 – Till (late Pleistocene) – Unsorted subrounded to subangular bouldery rubble, consisting mainly of Belt Supergroup rocks, and minor amounts of sand, silt, and clay. Striated rocks are common. Found in the valleys of the North and Middle Forks Flathead River where it was deposited as a thick blanket of ground moraine by the large trunk glaciers that filled these valleys; here, its thickness exceeds 30m in places. Locally includes small areas of bedrock and colluvium. This unit is in places also overlain by the Glacier Peak G ash."

The USDA-NRCS Web-based Soil Survey of Flathead County has mapped the Risingwolf, very stony, dry-Kegsprings family-Worock family complex in the area of development. These soils are deep, well drained mixed volcanic ash over till deposits on 4 to 15 percent slopes that are composed of decomposed plant material, very gravelly loam, very gravelly medial loam, very gravelly sandy loam, extremely gravelly sandy loam.

Seismic Hazard

The Polebridge Ranger Station is in West Glacier National Park which borders the northern Intermountain Seismic Belt, a zone extending from southern Utah through eastern Idaho and western Montana. The USGS Earthquake Hazards Program has mapped Quaternary faults and folds in the United States as displayed on Google Earth. Mapping shows the Mission Valley Fault system, the Thompson Valley Fault, and the Jocko Fault in the locality. Journal of Structural Geology, Volume 28, Issue 7, "Neotecnic evolution and fault geometry change along a major extensional fault system in the Mission and Flathead Valleys, NW-Montana, M.H. Hofmann, M.S. Hendrix, M. Sperazza, and J.N. Moore, 2006, indicates the Mission Valley Fault is thought to be a potential source for earthquakes. The portion of the Mission Valley Fault system mapped as active in the Quaternary is approximately 45 miles to the south adjacent to Flathead Lake. Multiple minor earthquakes with epicenters near Flathead Fault have occurred in recent years (USGS Earthquake Database).

SITE INVESTIGATIONS

Field Investigations

On July 8th and 9th, 2025, two borings, BH-1 and BH-2 were advanced at the locations shown on **Drawing #2 – Boring Location Map** in the Appendix. Borings were located using a GPS Unit. Boring locations and depths were selected to best determine subsurface conditions throughout the project. All borings were backfilled with drilling spoils after logging was completed.

Alpine Geotechnical of Kalispell, Montana, drilled borings with a truck-mounted Dietrich D50 Turbo drill rig. Borings were advanced using a 7.5-inch outer-diameter (O.D.) hollow stem auger (HSA) and/or a 4.5" overburden drilling eccentric casing (ODEX) bit. Sampling was performed with 2-inch split-barrel (split-spoon) samplers per ASTM D1586. Trent McCaffrey, a Professional Engineer at Nelson Engineering, logged the borings and directed the sampling. Soils were classified in the field and logged by the engineer. The soil

classifications, moisture conditions, and presence of organic or other notable features were recorded in the field logs. Bulk samples were sealed in plastic bags and transported to our laboratory for testing and further classification. Groundwater observations were made at the time of the boring advancement based on field observations of soil moisture conditions. Field observations and laboratory testing results are presented both on the boring logs and in the Laboratory Results sheets in the Appendix.

The stratification lines shown on the boring logs represent the approximate boundary between soil types. The actual in-situ transition may be either gradual or abrupt. Due to the nature and depositional characteristics of natural soils and fills, care should be taken in interpolating subsurface conditions beyond the location of the boreholes. Soil conditions can change rapidly in both the lateral and vertical directions. Groundwater conditions shown on the logs are only for the dates indicated.

The subsurface conditions were interpreted from the boreholes described at the site. The soil properties inferred from the field and laboratory analyses supported by our experience formed the basis for developing our conclusions and recommendations.

Laboratory Investigations

Samples obtained during the field investigation were taken to the laboratory where they were visually classified in accordance with ASTM Test Method D-2487-11, which is based on the Unified Soils Classification System. Engineering properties of concern at this location included bearing capacity, seismic response, shear strength, and site-specific construction recommendations that are influenced by soil type and condition.

The soil samples stored in our laboratory will be discarded 30 days after the date this report is submitted unless we receive a specific request to retain them.

Soil Profiles

Similar soil profiles were observed in the borings consisting of mixtures of clayey gravel, silty gravel, clayey sand, gravel, and cobble till deposits. Surficial soil in BH-1 was imported fill that consisted of about 4 feet of dry, dark brown, silty sand with gravel and organics. Rocky till was found in BH-2. Both boring sites and the entire cleared area had cobbles on the surface.

BH-1

Below topsoil were moist, very dense, clayey gravels to 11.5 feet. From 11.5 – 16.0 feet was moist to wet, very dense clayey sand with gravels. A perched water layer was found at 16 feet. From 16.0 – 25.5 feet was dry, very dense, pulverized gravels/cobbles. Composition was about 70% - 80% gravels and 20% - 30% sandy clay matrix. Angular and freshly fractured gravels returned in the split spoon indicated the presence of larger gravels and cobbles in the clayey sand with gravel and the pulverized gravel from 16 – 25.5 feet. There was no return in the split soon sample at 25.5 feet due to a hard cobble. SPT N was greater than 50 throughout these intervals indicating very dense gravels.

BH-2
Below topsoil, was dry to moist, medium dense, silty clayey gravel with sand to depths of about 8 feet. Moisture content increased between 8 to 10 feet of depth. Angular and freshly fractured gravels returned in the split spoons indicated the presence of larger gravels and cobbles at below a depth of 10 feet. A clayey gravel layer was found from 10 - 16 feet. This layer was moist and very dense with a composition of about 60% gravel and 40% sandy clay matrix. There was no return in the split spoon sample at 20 feet due to hard cobble. SPTs were in the 46 to > 50 range indicating dense to very dense gravels.

Groundwater
A perched saturated layer was discovered in BH-1 at 16-foot depth. A moist to saturated layer was found in BH-2 from 8 to 10-foot depth. The perched aquifer may arise from a leak in the existing tank, however it is most probably a natural aquifer. A monitoring well was installed in BH-1 to monitor groundwater conditions.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

General
Project plans by Nelson Engineering were in development at the time of this report. Plans call for a 14,253-gallon buried water storage tank. Plans show a cylindrical Fiber Reinforced Polymer (FRP) tank with a 26-foot length and a height of 10 feet. The tank will be buried about 15-17 feet deep. Minimum tank burial from top of tank to finished grade will be 42 inches for frost protection.

Groundwater
Current plans show the proposed tank to be at or below perched groundwater that was discovered in both borings as stated above. The source of the perched layer may be leak from the existing tank. This layer of water has the potential to saturate the surrounding soils, creating a buoyancy effect. During rainstorm events this layer may increase saturation of the soils creating an upward buoyant force. It is recommended to design the tank to mitigate these buoyant forces to prevent flotation of the tank. Installation of a drain at the groundwater layer is the recommended means to alleviate risk of buoyancy. Removing the existing tank prior to the proposed tank is advised to validate the source of the saturated layer. Other measures to mitigate the potential of floating the proposed tank include increasing the depth of the tank or increasing the weight of the tank.

Tank Subgrade
The tank shall be placed on the following subgrade section from top to bottom: 1) 8 inches of crushed aggregate meeting MDT standards or approved equivalent compacted to a minimum of 98% of the maximum density as determined by ASTMD-698 and 2) underlying native soils compacted to a minimum of 95% of the maximum density as determined by ASTMD-698 to a depth of 10 inches.

Excavations and Shoring

Excavation for tank construction is estimated to be on the order 15 to 17 feet. The following recommendations are preliminary in nature and apply to the schematic level design only. Final designs and construction plans for excavations shall address slope stability of excavations for the tank site and dimensions selected in final design. Excavated cuts of maximum 2(H):1(V) slope are anticipated, if seeps are encountered dewatering and drainage measures must be implemented and slope stability evaluated by the contractor. Rockfall from steep excavation slopes will be a hazard. Safety measures to prevent rock fall from excavation slopes are the responsibility of the contractor performing the work. Due to the perched groundwater layer found in the borings, dewatering sumps and pumps may be required to excavate to proposed tank depth. Saturated soils are more likely to collapse and should be removed from the slope as excavation progresses.

Stabilizing excavation slopes, vertical soil cuts, and other features may be required for foundation and underground tank construction. Both slope cut and shoring may be utilized. Shoring design and construction are typically delivered by specialty design-build contractors. Shoring design should be performed by experienced licensed engineers. Shoring construction should be performed by experienced geostructural contractors.

Soil nail walls or soldier pile walls with tiebacks are commonly utilized. Excavation safety is the responsibility of the contractor.

Conservatively assigned soil properties appropriate for shoring design based on soil properties found in the borings are given in the table below. Note that soil profiles may vary from those found in the borings. Shoring designers are responsible for designs that address all aspects and may determine that additional investigations may be necessary for adequate shoring design.

Soil Properties for Shoring

Soil Type:	Dense to Very Dense Silty Clayey Gravel	Dense to Very Dense Silty Clayey Sand
Moist Unit Weight (γ) =	135 lbs./ft^3	125 lbs./ft^3
Cohesion (c) =	0 lbs./ft^2	0 lbs./ft^2
Effective Friction Angle (Φ') =	34°	32°

Tank Backfill

Tank walls may be backfilled with native silty clayey gravel with sand excavated from within the tank footprint. Tank manufacturers backfill recommendations shall be followed; larger particles and rocks shall be removed per the backfill recommendations. Tank backfill shall be compacted to a minimum of 93% of the maximum density as determined by ASTM D-698.

Seismic Design Parameters
The 2024 International Building Code (IBC) designates site class per ASCE 7-22 Chapter 20. At this site, soil properties are not known in sufficient detail to determine the site class. Therefore, seismic coefficients and design spectra shall be determined using the most critical site conditions of Site Class C, CD, and D at the site coordinates, Latitude of **43.783°** and a Longitude of**-114.280°**.

Construction Observation and Testing
The recommendations provided in this report are based on subsurface conditions disclosed by the investigation and our general experience in the project area. Interpolated subsurface conditions should be verified in the field during construction. The following items shall be conducted prior/during construction by a representative of Nelson Engineering to verify compliance with the geotechnical and civil engineering recommendations provided herein, as applicable. The project structural and geotechnical engineers may upgrade any condition as deemed necessary during the development of the proposed improvement(s).

- Review of final approved grading and structural plans prior to the start of work for compliance with geotechnical recommendations.
- Observation of foundation excavation prior tank placement and removal of excavation equipment.
- Field observation of any "field change" condition involving soils.
- Walk through final drainage detailing prior to final approval.

The project soils engineer may at their discretion deepen the foundation or locally recommend additional steel reinforcement to upgrade any condition as deemed necessary during site observations. Nelson Engineering shall, prior to the issuance of the certificate of occupancy, issue in writing that the above inspections have been conducted by a representative of their firm, and the design considerations of the project soils report have been met. The field inspection protocol specified herein is considered the minimum necessary for Nelson Engineering to have exercised due diligence in the soils engineering design aspect of this building. Nelson Engineering assumes no liability for structures constructed utilizing this report not meeting this protocol.

CONSTRUCTION CONSIDERATIONS

Earthwork and Site Grading

Excavation work and heavy equipment access can be difficult when surficial soils are wet. A protracted period of wet conditions can be expected during and after seasonal snowmelt. **Placement of gravel surfacing and/or free-draining native material supported by geosynthetics will be required to provide construction access when ground conditions are wet.** General recommendations for earthwork suitability, placement, and compaction procedures are provided below:

- Within the tank footprint, all organic material, deleterious undocumented fill, and debris should be stripped and removed. Loose and disturbed native soils should be scarified, moisture-conditioned, and compacted. Finish surfaces shall be sloped away from foundations at a minimum of five percent.

- Fill materials shall not be placed, spread, or compacted while the ground is frozen or during unfavorable weather conditions. Fill materials should be at the proper moisture content prior to compaction. Fill shall not contain **frozen soil**. Once placed, fills beneath footings shall be protected from moisture infiltration and frost until backfilled.

- Native subgrade shall be compacted with vibratory equipment appropriate for the soil types. Where soft and loose or over moist areas are encountered that do not improve with repeated compactive effort, replace native soils with structural fill.

- Ponding of water and water infiltration due to snowmelt and rainfall into footing, slab, pavement, and hardscape subgrades shall be prevented. Moisture infiltration and subsequent freezing of soils shall be prevented. Frost heave and excessive settlement may result from moisture infiltration.

- Soils containing clay and silt are present that will exhibit undesirable engineering properties when wetted. Every effort should be made to ensure that moisture from precipitation or other sources does not infiltrate foundation bearing, slab, and roadway subgrade during construction. Grading during construction shall be provided to drain storm water from the exposed excavations during precipitation and snowmelt events. In case of rain or snow, excavation work shall stop and exposed soils shall be covered to prevent moisture infiltration. If moisture has been allowed to infiltrate the subgrade and bearing soils, filling and excavation operations shall not resume until Nelson Engineering approves the moisture and density conditions of the subgrade soils.

Structural Fill: Approved structural fills are Gravels (USCS classification GW or GP) Clean Rock, and Crushed Concrete. Clean Rock and Crushed Concrete may be utilized at and below the water table if approved and inspected by NE.

Gravels shall have the following characteristics: 6-inch maximum particle size with no more than 40% greater than 2" and no more than 5% fines passing the #200 sieve. Structural fill shall be placed in layers of not more than 8 inches in thickness. Where placed on slopes, fill shall be keyed into the slope in near vertical steps of 16-inch maximum height. Each layer of structural fill should be moisture conditioned to within 2% of optimum moisture content and compacted to a minimum density of 95% of the maximum dry density as determined by ASTM Designation D 698. The maximum density of material containing more than 30% oversize (greater than ¾" diameter) cannot be determined by use of the ASTM Designation D 698. In this case, a field maximum density may be determined by a test strip method. The material shall be compacted at or near optimum moisture content and a field density test shall be taken after each pass of the compaction equipment. This sequence shall continue until the maximum field density is achieved. This maximum field density shall be used for subsequent field compaction tests. Enough density tests should be taken to monitor proper compaction. Where a proctor cannot be performed on structural fill, lift compaction shall be verified via proof rolling with loaded rubber-tired equipment observed and approved of by NE.

Crushed Concrete shall meet the gradation requirements of gravels and shall be free of all debris and rebar. Gradation and rock source and compaction methods shall be submitted to Nelson Engineering for approval prior to use.

Clean Rock consisting of hard durable crushed or screened rock of 3/4”-4” may be used as Structural Fill with prior notice and approval of gradation and source by this office. Clean Rock may be used beneath the water table with approval from NE.

Crushed Concrete and Clean Rock fill compaction testing shall consist of proof rolling with loaded rubber-tired equipment observed and approved of NE.

- Safety of construction personnel including safe trenches and excavations are the responsibility of the contractor. Excavations for foundations shall conform to the applicable OSHA trenching and excavation standards. Excavations and utility trenches shall be laid back to safe slopes or properly shored. Excavations and shoring operations shall be conducted in accordance with the most recent versions of the OSHA Construction Standards for Excavations, Part 1926, Subpart P. Excavations for utilities shall be shored if the proper slope cannot be maintained.

- Backfill placed against structures (i.e., pipes and walls) shall be properly placed in a manner that will not damage these structures. In no case shall material greater than 6 inches in diameter bear directly on or against these structures. Placing oversized material against rigid surfaces can damage the structure and interferes with proper compaction.

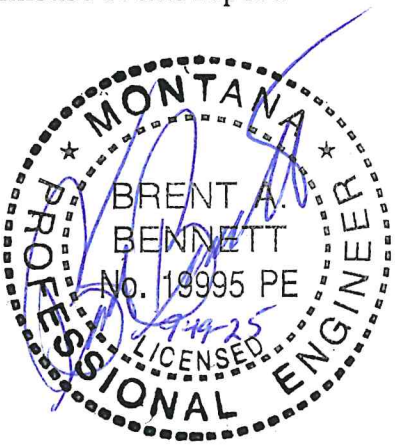
GENERAL COMMENTS

It is critical that the owner, architect, structural engineer, and entire design team review this report. When project plans and specifications are complete, a consultation with this office should be arranged to ensure compliance with this report. Additional or supplementary recommendations concerning foundations and earthwork may be required at this time. Concrete testing and special inspections should be performed prior to and during placement of all concrete to ensure concrete and reinforcing steel bar comply with project plans and specifications.

WARRANTY AND LIMITING CONDITIONS

This report was prepared for use by the National Park Service ("Client"). The scope of work was specifically prepared for and limited to the specific purpose of providing geotechnical recommendations for project described. The report is for the sole use of the named client and the design and construction team for this project. This report is non-transferable to future property owners without the written consent of both Nelson Engineering and the client. This report has been prepared based on a limited amount of data. Actual site conditions may vary. These services have been performed in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in this locality at the time the report was prepared. No other warranty is made or implied. This report is site-specific. The report is limited to the information available at the time it was prepared. In the event additional information is provided to Nelson Engineering following this report, it will be forwarded to the client in the form received for evaluation by the client. Use or misuse of this report, or reliance upon the findings hereof by any parties other than the Client, is at their own risk. Neither the Client nor Nelson Engineering may make any representation of warranty to such other parties as to the accuracy or completeness of this report or the suitability of its use by other parties for any purpose whatsoever, known, or unknown, to the Client or Consultant. Neither Client nor Nelson Engineering shall have any liability to or indemnify or hold harmless third parties for any losses incurred by the actual or use or misuse of this report.

Prepared By:
Trent McCaffrey, PE
Geotechnical Engineer

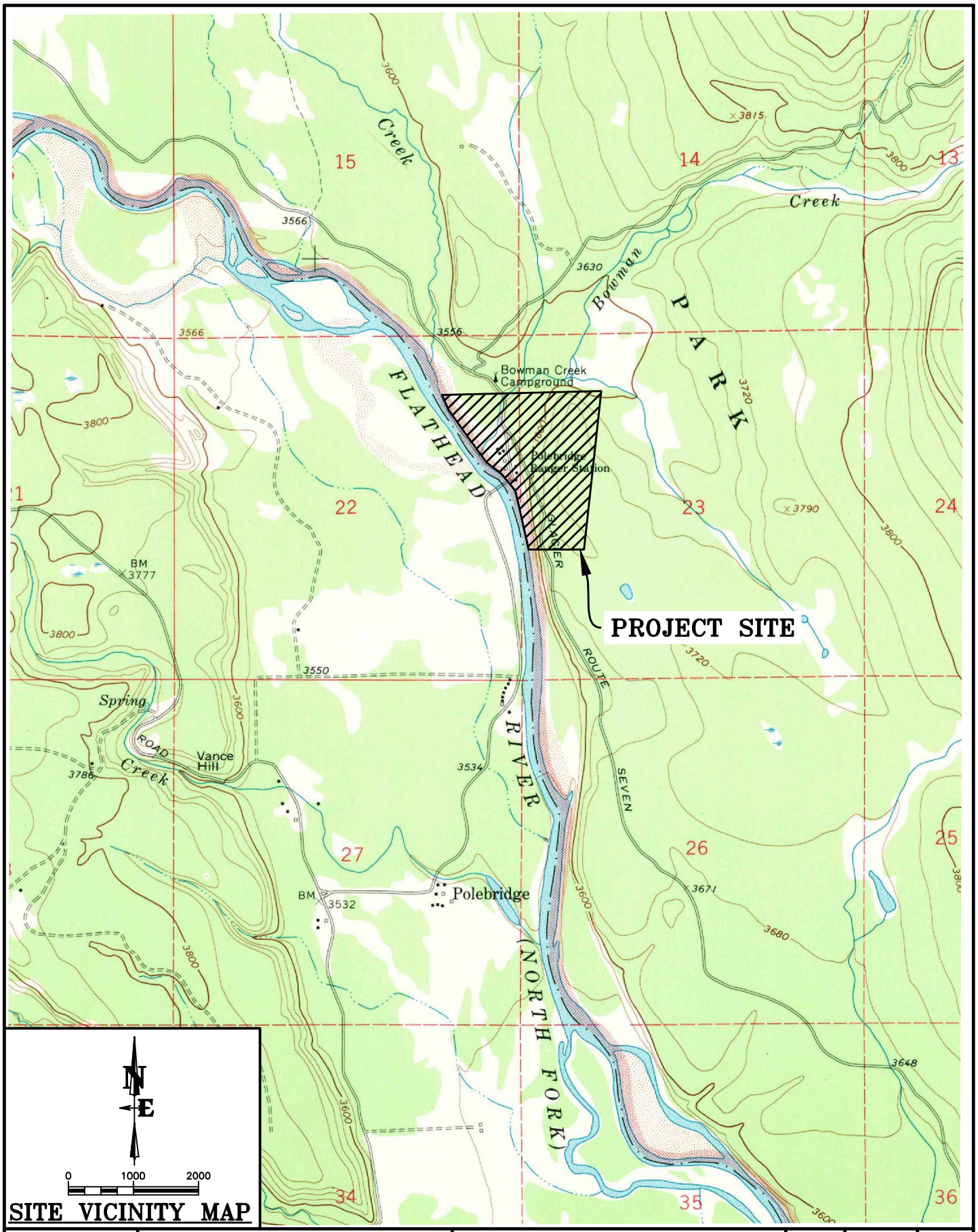


Reviewed By:
Brent Bennett, PE
Geotechnical Engineer

Philip Gyr, PE
Principal Geotechnical Engineer

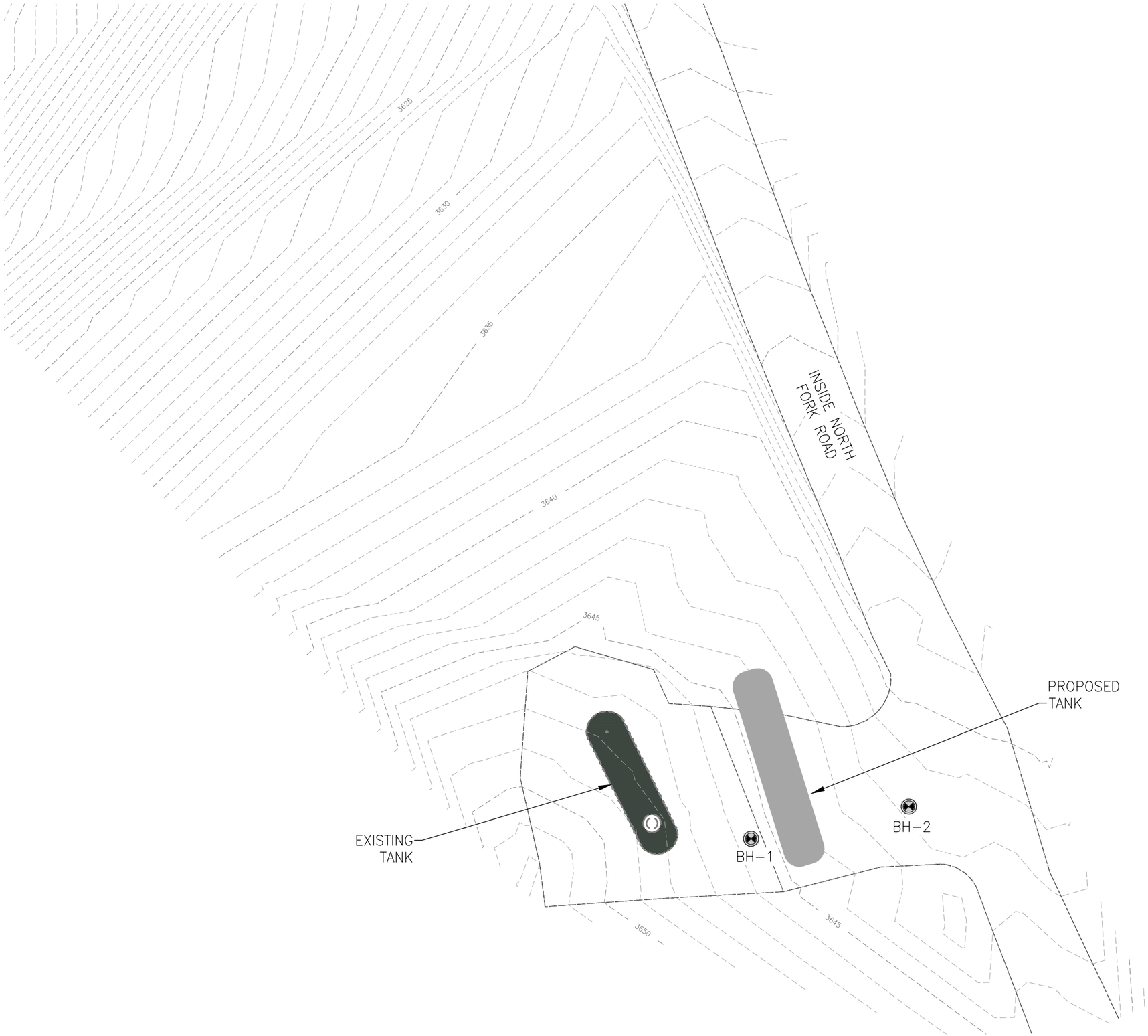
APPENDIX

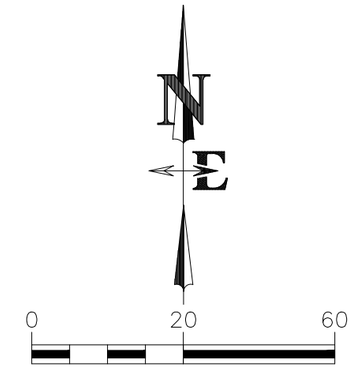
DRAWINGS



SITE VICINITY MAP

DRAWING NO	TITLE				
1	POLEBRIDGE RANGER STATION	NELSON ENGINEERING	DATE	8/11/2025	REV.
JOB NO			SURVEYED	–	
25-048-01	GEOTECHNICAL INVESTIGATION	P.O. BOX 1599, JACKSON WYOMING (307) 733-2087	DRAWN	TM	
			CHECKED	PG	
			APPROVED	PG	





NOTES:

1. SURVEY BY NATIONAL PARK SERVICE.
2. SITE PLAN BY NELSON ENGINEERING.
3. BORINGS LOCATED WITHIN ±3 FEET BY GPS.
4. MONITORING WELL INSTALLED IN BH-1.

		REV.
DATE	8/8/2025	
SURVEYED	NPS	
ENGINEERED	TM	
DRAWN	AP	
CHECKED	PG	
APPROVED	PG	

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733-2087

DRAWING TITLE
BOREHOLE LOCATION MAP
POLEBRIDGE RANGER STATION

JOB TITLE
WATER TANK
POLEBRIDGE RANGER STATION
GEOTECHNICAL INVESTIGATION

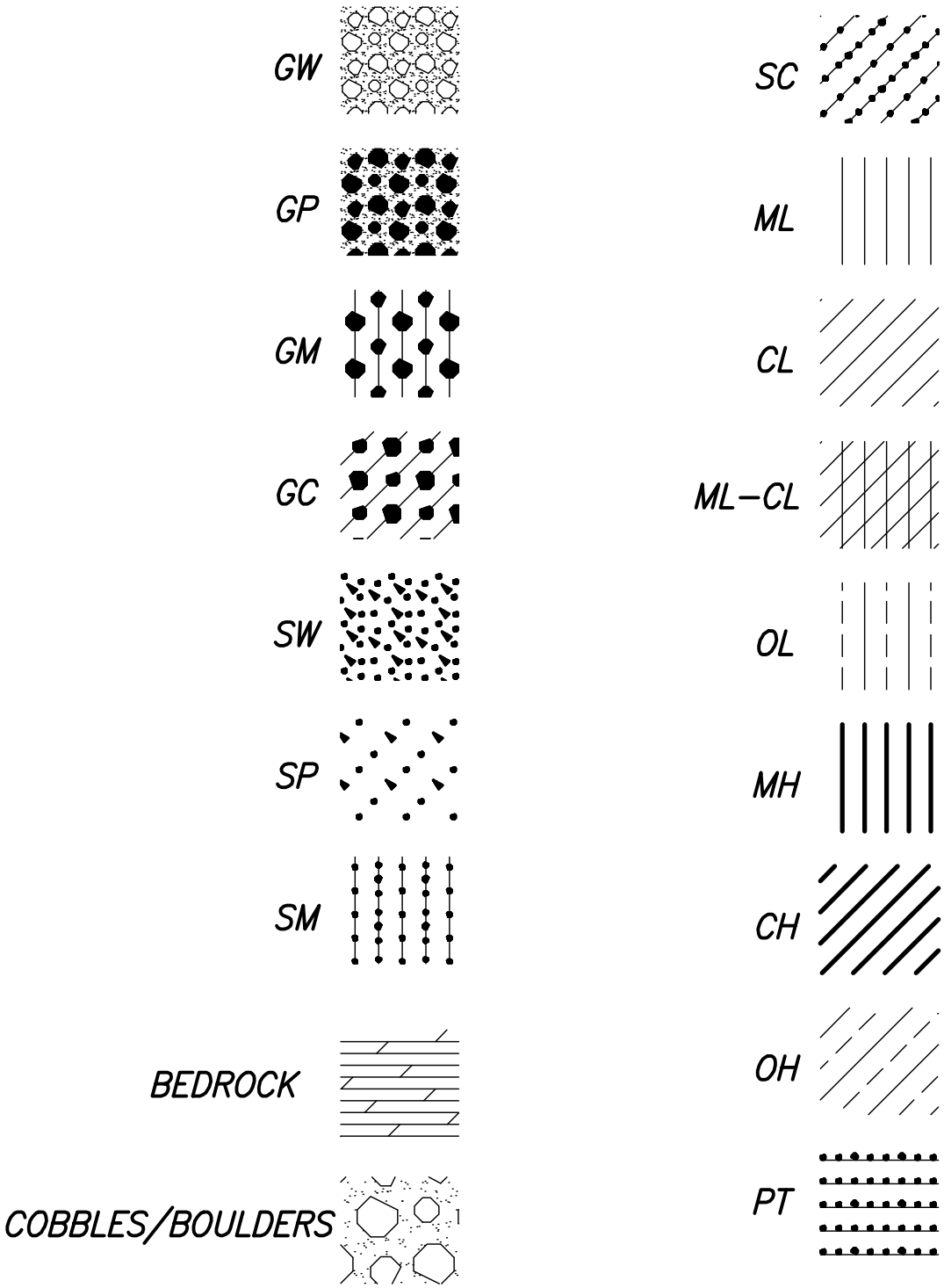
DRAWING NO 2

JOB NO 25-048-01

C:\ACADTEMP\AcPublish_23824\Polebridge BHLOCMapdwg (Water Tank BHLOCMAP) - Aug 28 2025 10:39:53 am PLOTTED BY gyr DWG FORMAT: 25.0

BORING LOGS

SOIL GRAPHICS



NOTE: ANGLED DEMARCATIONS ON THE LOGS INDICATE APPROXIMATE OR POORLY DEFINED BOUNDARIES BETWEEN SOIL TYPES.

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733-2087

GEOTECHNICAL GENERAL NOTES

CORRECTED SPT: Standard Penetration Test values corrected to $N1_{60}$ correcting for theoretical free-fall hammer energy and overburden pressure per 7th edition of the AASHTO Bridge Design Specifications.

DRILLING, SAMPLING, AND SOIL PROPERTIES ABBREVIATIONS AND SYMBOLS

N: Standard Penetration Test
U_c: Unconfined compressive strength, Pounds/ft^2 (PSF)
Pp: Pocket Penetrometer values, Ton/ft^2 (TSF)
FILGC: Fragments indicate gravels and cobbles larger than split spoon diameter.
w: Water content, %
LL: Liquid limit, %
PI: Plasticity index, %
gd: In-situ dry density, lbs/ft^3 (PCF)
: Ground water level
GS: Ground surface
SAA: Same as above
SS: Split-Spoon Sample
ST: Shelby Tube Sampler
CS: Cylindrical Brass Lined Sample

Monitoring Well, diagonal hatching indicates screen and sand packed interval

SOIL RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

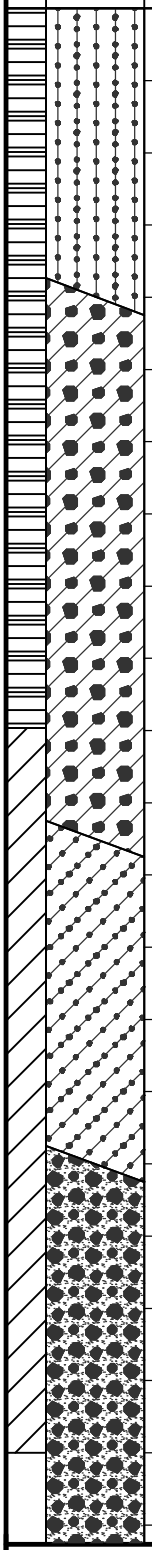
Non-Cohesive Soils	SPT	Cohesive Soils	Pp-(tons/ft^2)
Very Loose	0 - 4	Very Soft	0 - 0.25
Loose	4 - 10	Soft	0.25 - 0.50
Slightly Compact	8 - 15	Medium Stiff	0.50 - 1.00
Medium Dense	10 - 30	Stiff	1.00 - 2.00
Dense	30 - 50	Very Stiff	2.00 - 4.00
Very Dense	50+	Hard	4.00+

PARTICLE SIZE

Boulders:	12 in.+	**Coarse Sand:**	5 mm(#4)-2 mm(#10)	**Silts and Clays:** **<#200**
Cobbles:	12 in.-3in.	**Medium Sand:**	2 mm(#10)-0.4mm(#40)	
Gravel:	3in.-5mm(#4)	**Fine Sand:**	0.4mm(#40)-0.075mm(#200)	

PROJECT NAME: **POLEBRIDGE WATER TANK**		**DRILL HOLE No. BH–1**	PAGE: **1 OF 2**
DATE STARTED / FINISHED: **7/8/2025**		DRILLER: **ALPINE GEOTECHNICAL**	
LOGGED BY: **TRENT McCAFFREY**		DRILL TYPE: **TRUCK–MOUNTED DIETRICH D50 TURBO**	
BOREHOLE LOCATION/ELEVATION: **SEE BOREHOLE LOCATION MAP**		HOLE DIAMETER: **4.5" ODEX & 7.5" O.D. HSA**	
		HAMMER TYPE: **140# AUTOMATIC**	

This log is part of a report prepared by Nelson Engineering for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with passage of time. The data presented is a simplification of actual conditions encountered.



WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY %	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (PCF)	MOISTURE (%)	REMARKS
								0'–4.0' DRY, DARK BROWN, SILTY SAND WITH GRAVEL, IMPORTED FILL, ORGANICS, MEDIUM DENSE						*GENTLE EAST FACING SLOPE WITH VEGETATION AND SURFACE COBBLES.*
		1												
		2												
		3												*SMOOTH, EASY DRILLING FROM GS TO 4'*
		4												
		5	16			BH1–1 2" SS	56	*5.0'–6.5' 0"–10", MOIST, GRAY/BROWN, CLAYEY GRAVEL WITH SAND, VERY DENSE, ANGULAR TO SUB–ANGULAR GRAVEL, ~70% GRAVEL, ~30% SANDY CLAY MATRIX, MAX GRAVEL DIAMETER OF 2"*			51			*HARD DRILLING FROM FROM 5' – 9'*
		6	15											
			15											
		7												*SMOOTH, EASY DRILLING FROM 7' – 10'*
		8												
		9												
		10	31			BH1–2 2" SS	39	*10'–11.5' 0"–7", MOIST, GRAY/BROWN/PINK, CLAYEY GRAVEL WITH SAND, VERY DENSE, ANGULAR TO SUB–ANGULAR GRAVEL, ~80% GRAVEL, ~20% SANDY CLAY MATRIX, MAX GRAVEL DIAMETER OF 2"*			58			
			24											
		11	16											*ODEX NOT BLOWING OUT RETURN*
		12												
		13												*HARD DRILLING FROM 11' – 15'*
		14												
		15	36			BH1–3 2" SS	50	*15'–16' 0"–9", WET, GRAY/PINK/BROWN, CLAYEY SAND WITH GRAVEL, VERY DENSE, ANGULAR TO SUB–ANGULAR GRAVEL, ~60% CLAYEY SAND MATRIX, ~40% GRAVEL, FILGC*			>50			*PERCHED WATER LAYER AT 16'*
			50/3"											
		16												
		17												*SWITCH FROM ODEX TO HOLLOW STEM AUGER AT 16'*
		18												
		19												*BIT GRINDING FROM 16' – 25'*
		20	50/3"			BH1–4 2" SS	6	*20'–21.5' 0"–1", DRY, GRAY/LIGHT BROWN, PULVERIZED GRAVEL, VERY DENSE, FILGC*			>50			
		21												

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733–2087

CLIENT: **NATIONAL PARK SERVICE**
INTERIOR REGIONS 6, 7, & 8
LAKEWOOD, COLORADO

WELL LOG	GRAPHIC LOG	(FT)	SAMPLES DRIVE	SAMPLES UNDISTURBED	SAMPLES BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (PCF)	MOISTURE (%)	REMARKS
		22												
		23												
		24												
		25	50 2"			BH1-5 2" SS	0	25'-25.5' NO RETURN, BOULDER/COBBLE			>50			BOTTOM OF BORING AT 25.5'
		26						MONITORING WELL CONSTRUCTION: LENGTH OF PIPE = 20' (1.5"ø PVC, FLUSH MOUNTED) PVC FROM 0' TO 10' SLOTTED PVC FROM 10' TO 20' PIPE STICKUP = -0.5'						
		27												
		28												
		29												
		30												
		31												
		32												
		33												
		34												
		35												
		36												
		37												
		38												
		39												
		40												
		41												
		42												
		43												
		44												

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733-2087

CLIENT: NATIONAL PARK SERVICE
INTERIOR REGIONS 6, 7, & 8
LAKEWOOD, COLORADO

PROJECT NAME: **POLEBRIDGE WATER TANK**		**DRILL HOLE No. BH–2**	PAGE: **1 OF 2**
DATE STARTED / FINISHED: **7/9/2025**		DRILLER: **ALPINE GEOTECHNICAL**	
LOGGED BY: **TRENT McCAFFREY**		DRILL TYPE: **TRUCK–MOUNTED DIETRICH D50 TURBO**	
BOREHOLE LOCATION/ELEVATION: **SEE BOREHOLE LOCATION MAP**		HOLE DIAMETER: **4.5" ODEX & 7.5" O.D. HSA**	
		HAMMER TYPE: **140# AUTOMATIC**	

This log is part of a report prepared by Nelson Engineering for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with passage of time. The data presented is a simplification of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY %	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	CORRECTED SPT	DRY DENSITY (PCF)	MOISTURE (%)	REMARKS
		1												GENTLE EAST FACING SLOPE WITH VEGETATION AND SURFACE COBBLES. ADJACENT TO ROADWAY.
		2												
		3												
		4												HARD DRILLING. BIT GRINDING FROM 0' – 5'
		5	9			BH2–1 2" SS	28	5.0'–6.5' 0"–5", DRY TO MOIST, GRAY/BROWN/PINK, SILTY GRAVEL WITH SAND, VERY DENSE, ANGULAR TO SUB–ANGULAR GRAVEL, ~50% GRAVEL, ~50% SANDY SILT MATRIX, MAX GRAVEL DIAMETER OF 2"			56			
		6	14 19											MOIST SOILS FROM 8' – 10' CAUSED ODEX DRILL BIT TO BREAK. SWITCHED TO HSA AND MOVED BORING 2.5 FEET TO THE NORTHEAST.
		7												
		8												
		9												
		10	7			BH2–2 2" SS	50	10'–11.5' 0"–9", MOIST, BROWN/TAN, CLAYEY GRAVEL WITH SAND, VERY DENSE, ~60% GRAVEL, ~40% SANDY CLAY MATRIX, FILGC			62			
		11	19 24											SMOOTH, EASY DRILLING FROM 6' – 10'
		12												
		13	22			BH2–3 2" SS	50	15'–16.5' 0"–9", MOIST, GRAY/PINK/BROWN, CLAYEY GRAVEL WITH SAND, DENSE, ~40% SANDY CLAY MATRIX, ~60% GRAVEL, FILGC			46			HARD BIT GRINDING, DRILLING FROM 11' – 15'
		14	13 17											
		15												AUGER BOUNCING ON COBBLE/ BOULDER AT 13' AND 15'
		16												
		17												
		18												BIT GRINDING FROM 16' – BOTTOM OF BORING
		19												
		20	50 2"			BH2–4 2" SS	0	20'–20.5' NO RETURN, BOULDER/COBBLE			>50			BOTTOM OF BORING AT 20.5'
		21												

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733–2087

CLIENT: **NATIONAL PARK SERVICE**
INTERIOR REGIONS 6, 7, & 8
LAKEWOOD, COLORADO