Slopeside Engineering

December 15, 2021

Jackola Engineering and Architecture
2250 US 93 South
Kalispell, MT, 59901

Subject: **Geotechnical Investigation**
Woods Bay Dock Project
Woods Bay, Montana
Job No. 21-435

Dear Mr. Karl Henshaw,

At your request, Slopeside Engineering, LLC (Slopeside) has conducted a Geotechnical Investigation in the vicinity of planned dock at the Woods Bay fishing access site, in Woods Bay, Montana. The Vicinity Map, Figure 1, shows the general location of the site. The investigation was conducted to evaluate subsurface materials, observe conditions at the site, and develop recommendations for embedment depths of pipe piles supporting a floating dock. The investigation included a review of existing subsurface information for the site vicinity, subsurface explorations, field observations, and engineering analyses. This report describes the work accomplished and provides our conclusions and recommendations for use in the design and construction of the proposed project. Slopeside has strived to perform the investigation and develop recommendations in a manner consistent with the degree of care that is presently standard to the geotechnical engineering profession.

slopesideeng@gmail.com *406-270-3480* *181 Deerfoot Trail*
Kalispell, MT, 59901

PROJECT DESCRIPTION

The project site is located at the State of Montana, Fish, Wildlife, and Parks, Woods Bay fishing access, just north of 33401 Whitecap Lane, in Woods Bay, Montana. The location of the site is shown on the attached Vicinity Map, Figure 1. Available design details indicate a new floating dock with fixed piles as anchors, will be located adjacent to the existing boat launch. The dock will be a floating dock and will be connected to the piles in a way that allows for raising and lowering with the lake's water level. Pile loading was provided by Jackola Engineering and Architecture.

SITE DESCRIPTION

General

The project site is developed with an existing concrete boat ramp that will remain in place. A floating dock without pile anchors was previously at the planned new dock location. The dock is located in an area of the lakebed that is dry during low water levels and covered with up to about 7 ft of water during full pool.

Topography

Site observations indicate that in the vicinity of the planned dock, the ground surface slopes downward to the west at slopes flatter than 10H:1V. Signs of recent and/or past slope instability were not observed within the planned dock area. Significant wave action does appear to cause scour, erosion, and deposition in the upper 2 ft of soil.

Geology

The surficial geology of the site is glacial till and outwash deposited during alpine glaciation in this area. The till soils in the project area are ground or lateral moraine materials deposited over Precambrian bedrock. These glacial soils have generally experienced moderate to substantial preloading by the weight of glacial ice. Seepage is common, but relatively unpredictable in the till deposits. Seepage often occurs in the more weathered material near the ground surface and in random permeable zones.

Site Seismicity

The site lies within the Intermountain Seismic Belt and is mapped as a zone of potentially significant seismic ground movement. Subsurface materials encountered during this limited investigation indicate the site soils should be classified as Site Class C, in accordance with the International Building Code (IBC 2018). Based on the relatively dense nature of the soils, we anticipate the risk of liquefaction or lateral spreading is low.

SUBSURFACE CONDITIONS

General

Subsurface materials and conditions at the site were investigated on May 25, 2021, with two borings, designated B-1 and B-2. The borings were advanced to depths of 19.1 to 19.2 ft below the ground surface. The approximate locations of the subsurface explorations are shown on the Site Plan, Figure 2. Logs of the borings are provided on Figures 1A and 2A.

Soils

Near-surface soils generally consist of beach gravels and silty sand over Glacial Till soils. The Glacial Till soils are comprised of silty gravel with sand, cobbles, and boulders. The prominent strata are listed below and described more thoroughly in the following paragraphs:

1. **Poorly Graded GRAVEL**
2. **Silty SAND**
3. **GLACIAL TILL**

1. Poorly Graded GRAVEL: Beach gravels comprised of poorly graded gravel was encountered at the ground surface in both borings. The gravel is loose, subround and sorted. The gravel is relatively clean and is typically ¾ to 1½ inch in size, with some scattered coarse gravel and cobbles. The gravel extends to depths of 1 to 2 ft and is underlain by silty sand.

2. Silty SAND: Silty sand was encountered beneath the beach gravels in both borings advanced for this project. The silty sand soils are brown, medium dense, and wet. The sand is fine grained and contains scattered gravel. The sand extends to depths of 3 to 3.5 ft below the ground surface and is underlain by Glacial Till.

3. GLACIAL TILL: Glacial till comprised of silty gravel with varying percentages of sand, cobbles, and boulders was encountered beneath the silty sand in Borings B-1 and B-2. SPT blow counts of 58 blows per ft to 50 blows for 3 inches, indicate the Glacial Till soils are very dense. Visual observations indicate the Glacial Till is moist. The gravel in this soil unit is commonly fine to coarse and subround. Large boulders and rock fragments greater than 3 ft in size are present within this soil unit and should be anticipated during construction. Both borings were terminated in this soil unit at depths of 19.1 and 19.2 ft.

Groundwater

In the vicinity of the project, groundwater appears to correspond with the Flathead Lake level, and is commonly up to almost 7 ft above the ground surface at the western most planned pile location. It should be noted that groundwater seepage into the borings was slow due to the very dense Glacial Till soils.

ENGINEERING ANALYSIS and RECOMMENDATIONS

General

Based on discussions with the project team, we understand 14 inch outside diameter pipe piles with a minimum wall thickness of 0.625 inches (HSS14x0.625) are planned for the dock supports. The piles will be filled with structural concrete. Loading information provided by the project team indicates the westernmost piles (3 piles) will need to resist a 32.7 kip lateral load applied a maximum of 7 ft up from the ground surface. The remaining 4 piles will need to resist a 10 kip lateral load applied a maximum of 5.3 ft above the existing ground surface.

Pile Design and Construction

Soils encountered at the planned dock site consist of poorly graded gravel and silty sand to depths of 3 to 3.5 ft below the ground surface, where very dense Glacial Till soils were encountered. Due to the likelihood of encountering large cobbles, boulders, and possibly rock fragments at the pile locations, Slopeside recommends the piles be set in drilled shafts with a minimum diameter of 2 ft. Temporary casing of the drilled shaft will likely be necessary in the upper 5 to 10 ft. Depending on the speed of water infiltration, longer casing may be necessary, if caving of the sidewalls occurs.

Using the design loads and pile types provided by Jackola Engineering and Architecture, in addition to soil types encountered in the borings, Slopeside utilized LPile version 2019.11.09, created by Ensoft, Inc., to conduct lateral load resistance calculations to assist with recommended pile embedment depths. Based on this analysis, Slopeside recommends the piles resisting the 32.7 kip lateral load (3 westernmost piles) be embedded a minimum of 20 ft into very dense Glacial Till soils and the piles resisting the 10 kip lateral load (4 easternmost piles) be embedded a minimum of 15 ft into very dense Glacial Till. Due to anticipated soil types and freeze-thaw cycles occurring in the upper approximately 4 to 5ft of soil, Slopeside recommends the upper 5 ft of soil not be relied on for lateral support of the piles. Therefore, we anticipate embedment depths of 25 ft below ground surface for the 3 westernmost piles, and 20 ft for the 4 easternmost piles. Lateral deflection up to 1 inch should be anticipated at the ground surface; however, fixity should be anticipated 5 ft below the ground surface. The recommended embedment depths will also be sufficient to reduce the risk of frost heave adversely affecting the constructed piles.

Following drilling of the drilled shafts, structural concrete with a minimum compressive strength of 4,000psi shall be placed using tremie methods at the bottom of the shaft, and extend up to the ground surface. Care shall be taken to ensure all voids inside and outside of the pile are filled with concrete.

Construction Services and Quality Control

Geotechnical observation should be provided to monitor the pile construction stages of construction. Continuous Special Inspections to observe pile drilling and placement will be necessary to comply with the IBC 2018. These geotechnical services should ascertain that subsurface conditions are reasonably consistent with those determined by our investigation, and should ascertain that site and deep foundation preparation are consistent with our recommendations.

CONCLUSION

The foregoing recommendations present our initial geotechnical input for design and construction of the project. In order for these recommendations to be properly incorporated in the subsequent design and construction stages we recommend that our geotechnical engineering staff remain involved with the project to ascertain that our recommendations have been properly interpreted both during design and construction. These services will reduce the potential for misinterpretation of subsurface conditions and geotechnical design recommendations that are

important in the preparation of project plans, specifications and bid documents.

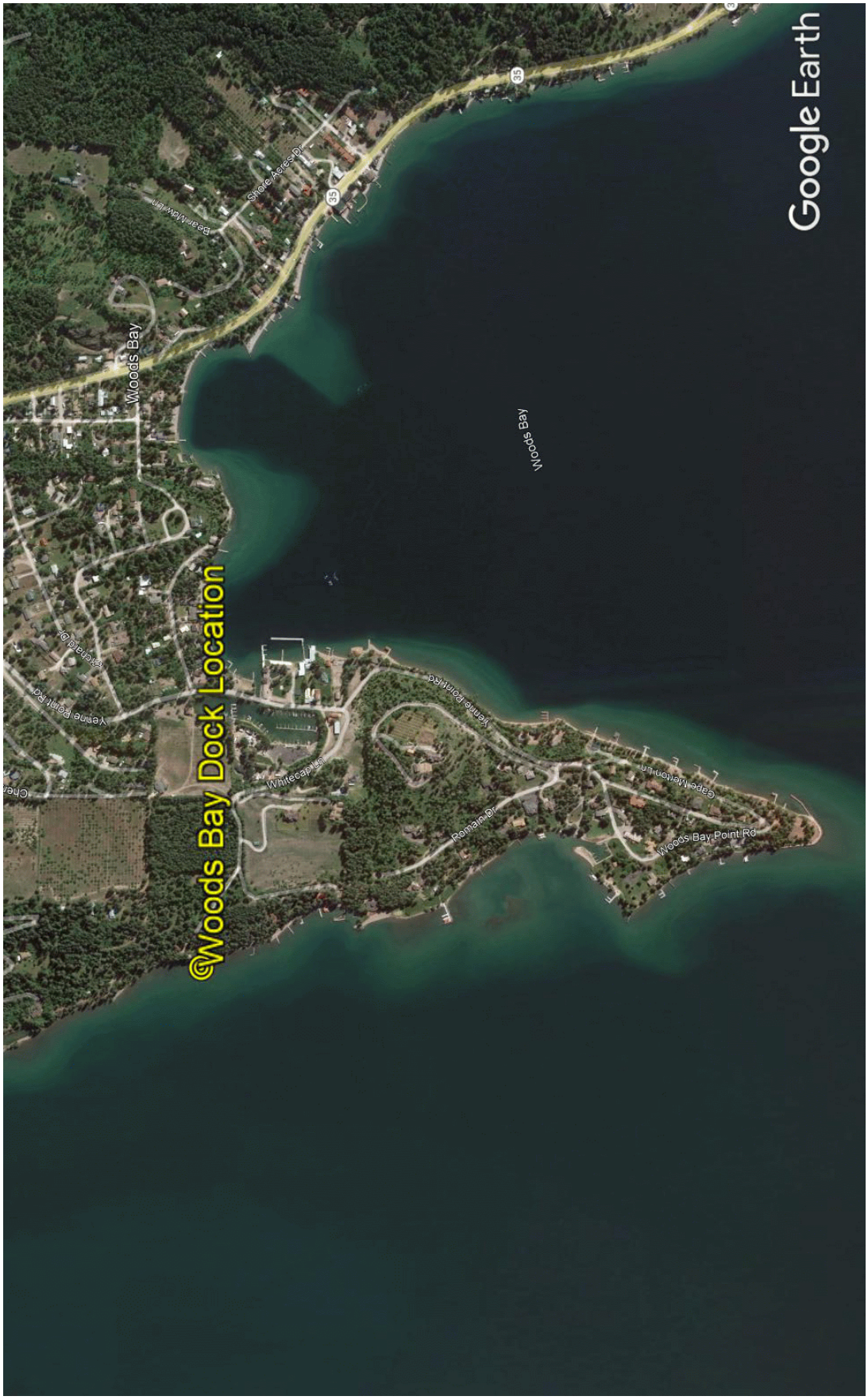
LIMITATIONS

Slopeside Engineering, LLC, has strived to prepare this report in accordance with generally accepted geotechnical engineering practices in this area solely for use by the client for design purposes and is not intended as a construction or bid document representing subsurface conditions in their entirety. The conclusions and recommendations presented are based upon the data obtained during the investigation as applied to the proposed design and construction details discussed in this report. The nature and extent of variations between the subsurface explorations may not become evident until construction. If variations are then exposed, it will be necessary to reevaluate the recommendations of this report.

If changes in the concept, design data, or location of the structures are planned, the recommendations contained in this report shall not be considered valid unless the changes are reviewed by our geotechnical engineer, and a written response is provided.

Sincerely,

Joshua C. Smith, P.E.
Principal Geotechnical Engineer



Project:	Woods Bay Dock Woods Bay, Montana	**Job Number:** **Date:**	21-435 December 3, 2021

Vicinity Map

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FIGURE 1

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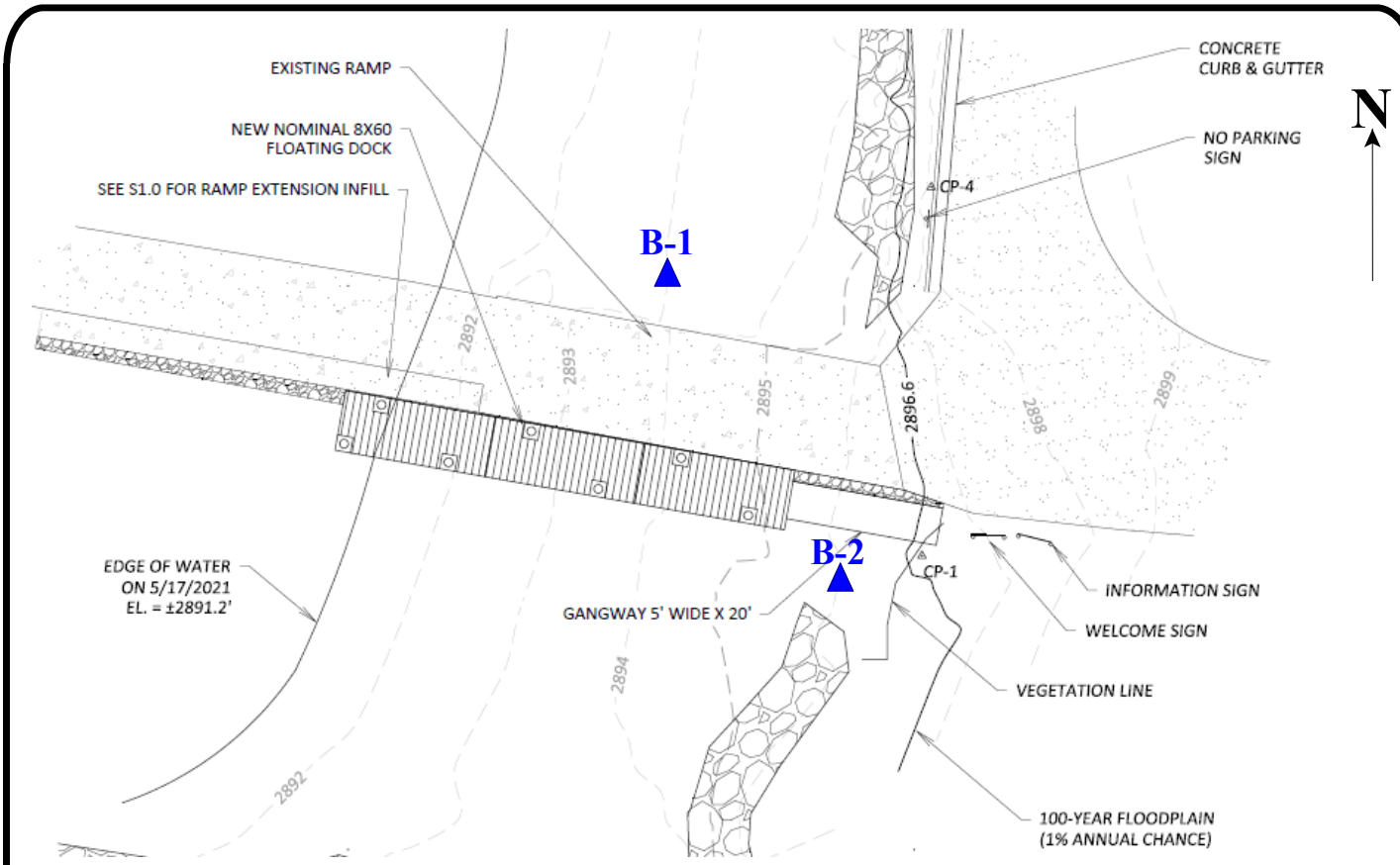

Project:	Woods Bay Dock Woods Bay, Montana	**Job Number:** **Date:**	21-435 December 6, 2021

Site Plan

Slopeside Engineering, LLC
Kalispell, MT
FIGURE 2

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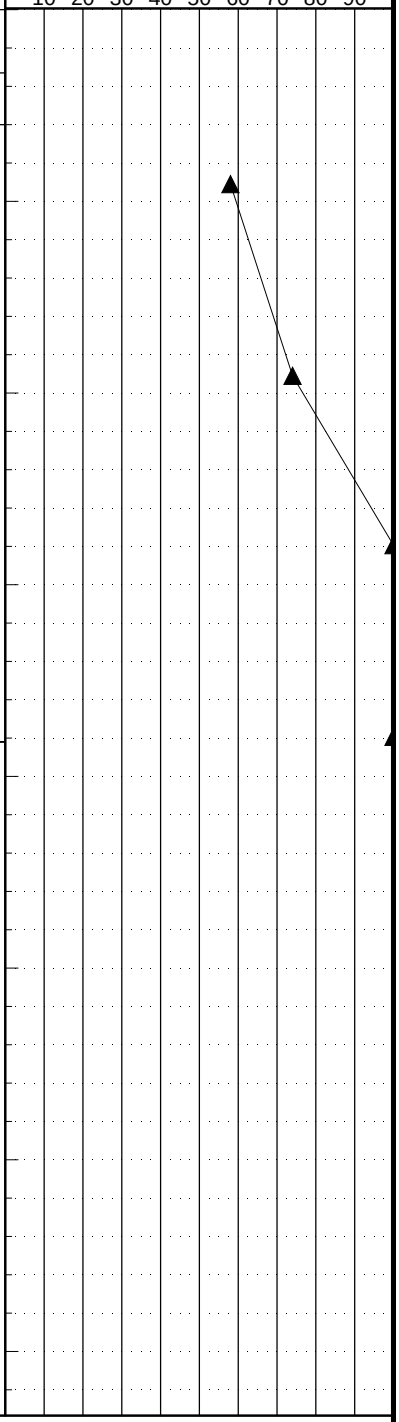
BORING LOG B-1

PROJECT: Woods Bay Dock Project | **PROJECT NO.:** 21-435
CLIENT: Jackola Engineering and Architecture | **DATE:** May 25, 2021
LOCATION: See Site Plan | **ELEVATION:** 2,893ft
SUBCONTRACTOR: Crowley Environmental Drilling | **LOGGED BY:** Joshua Smith
METHOD: Mobile B61 - Hollowstem Auger | **GW:** ▽ 1ft May 25, 2021
GW(2): ▽

DEPTH (feet)	SAMPLERS	SAMPLE NO.	DEPTH (feet)	SOIL TYPE	MATERIAL DESCRIPTION
0					
			1.0		Poorly Graded GRAVEL; loose, medium size (1 inch), damp, subround, scattered cobbles and boulders (Beach Gravel)
					Silty SAND; medium dense, brown, fine grained sand, wet
			3.0		Silty GRAVEL with Sand, Cobbles, and Boulders; very dense, fine to coarse and subround gravel, gray, moist
5		S-1			
10		S-2			
15		S-3			
		S-4			
20					Boring terminated at 19.1 ft.
25					
30					
35					

TEST RESULTS

Plastic Limit ⊢——⊣ Liquid Limit
Water Content ● (percent)
N-values ▲ (Blows per foot)
10 20 30 40 50 60 70 80 90



This information pertains only to this boring and should not be interpreted as being indicative of the site.

Groundwater seepage into drilled boring is extremely slow, even though we were only 1 ft above lake level at time of drilling.

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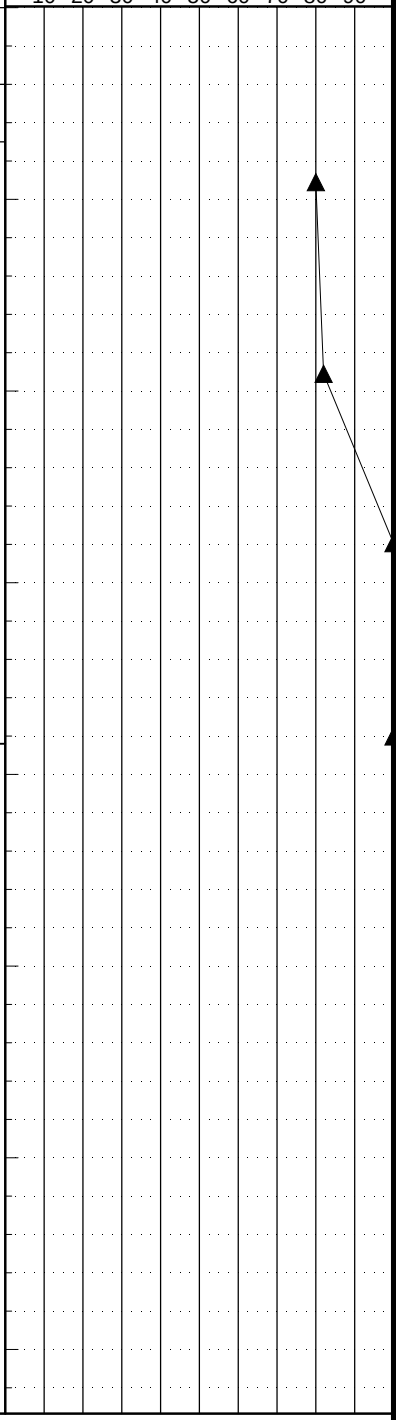
BORING LOG B-2

PROJECT: Woods Bay Dock Project
PROJECT NO.: 21-435
CLIENT: Jackola Engineering and Architecture
DATE: May 25, 2021
LOCATION: See Site Plan
ELEVATION: 2,896ft
SUBCONTRACTOR: Crowley Environmental Drilling
LOGGED BY: Joshua Smith
METHOD: Mobile B61 - Hollowstem Auger
GW: ▽ 4 May 25, 2021
GW(2): ▽

DEPTH (feet)	SAMPLERS	SAMPLE NO.	DEPTH (feet)	SOIL TYPE	MATERIAL DESCRIPTION
0					
					Poorly Graded GRAVEL; loose, medium size (1 inch), damp, subround, scattered cobbles and boulders (Beach Gravel)
			2.0		Silty SAND; medium dense, brown, fine grained sand, very moist
			3.5		Silty GRAVEL with Sand, Cobbles, and Boulders; very dense, fine to coarse and subround gravel, gray, moist to very moist
5		S-1 ▽			
10		S-2			
15		S-3			
20		S-4			Boring terminated at 19.2 ft.
25					
30					
35					

TEST RESULTS

Plastic Limit ⊢——⊣ Liquid Limit
Water Content ● (percent)
N-values ▲ (Blows per foot)
10 20 30 40 50 60 70 80 90



This information pertains only to this boring and should not be interpreted as being indicative of the site.

Groundwater seepage into drilled boring is extremely slow, even though we were only 4 ft above lake level at time of drilling.