



GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING  
CONSTRUCTION TESTING & INSPECTION

June 19, 2023

Krazan Project No. 062-23011  
Page 1 of 4

**City of Olympia**

601 Fourth Avenue East  
Olympia, WA 98501

**Attn: Diane Utter, P.E., Parks Project Engineer**

Email: [dutter@ci.olympia.wa.us](mailto:dutter@ci.olympia.wa.us)

Phone: 360-753-8282

**RE: Limited Geotechnical Engineering Investigation  
Kaiser Woods Park Development – Road Improvement**  
2549 Black Lake Boulevard SW  
Olympia, WA

Dear Ms. Utter,

Per your request, we have prepared this limited geotechnical engineering investigation for the proposed Kaiser Woods Park Development – Road Improvements project located near 2549 Black Lake Boulevard SW in Olympia, WA.

**Introduction and Scope**

The site is currently developed with gravel surface road. We understand that the proposed development will include design and construction of a new 20-foot wide paved road. The road will be about 1,150 feet long with a parking lot at the west end. The parking lot will cover an area of roughly 7,600 square feet.

We have been requested to prepare a limited geotechnical engineering letter addressing the California Bearing Ratio of the near surface soils for the proposed road improvement project.

Our services were performed in general accordance with our proposal for this project, dated April 18, 2023 (Krazan proposal number G23013.2WAT), and included the following:

- Exploration of the near surface soil conditions by performing six (6) Dynamic Cone Penetrometer (DCP) tests along the proposed roadway alignment to evaluate subgrade conditions for the widening of the existing gravel road;
- Obtain near surface soil samples utilizing hand tools;
- Provide laboratory testing;

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- Provide a site plan showing the locations of DCP testing and soil sampling;
- Provide a recommended CBR value for use in the road design.

### **Site Surface Conditions**

The explored site follows the gravel surface road from an elevation of around 140 feet in the east to 230 feet in the west. Beginning on the east side, the areas on either side of the road are typically covered in low lying grass containing visible gravel and rock spalls, which then grades into moderate to steep slopes composed of either bedrock or piles of rock spalls, which are vegetated with grass and bushes.

Towards the center of the area from STA 15 + 50.00 to STA 17 + 50.00, the sides of the road narrow, and the road appears to have been built upon a ridge of rock spall fill over bedrock. Around 10 feet beyond the southern side of the road in this area is a steep embankment ranging from approximately 5 to over 15 feet in height. The surrounding area contains grass cover, bushes, and heavily forested regions, which extends up to the western side of the project. There are exposures of rock spalls and bedrock in the surface of the road.

### **Geologic Setting**

The Geologic Map of the of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington by Timothy J. Walsh et al. (Washington Department of Natural Resources - Division of Geology and Earth Resources, OFR 2003-25, 2003) indicates that the site vicinity is underlain by Crescent Formation basalt (Ev<sub>c</sub>) near contacts with Vashon till (Qgt) and Vashon recessional outwash (Qgo).

### **Field Investigation and Findings**

We visited the site on May 22, 2023 to explore the near surface soil conditions by performing United States Army Corps of Engineers (USACE) DCP testing. A total of six (6) DCP tests were performed. The approximate DCP test locations are shown on the Site Plan (Figures 1A and 1B). The DCP testing generally started from the existing ground surface, and were performed as close as possible to the shoulder of the existing road. Hand tools were utilized as needed.

All field work was performed by two (2) Kraزان engineering technicians under the supervision of a Kraزان engineer. The DCP test holes were logged in the field and subsurface soil samples were collected, sealed in plastic bags, and transported to our laboratory for evaluation.

The DCP consists of a 5/8-inch diameter steel rod with a 60-degree cone at the end. The DCP is driven into the soil by dropping a 17.6 lb. sliding hammer from a height of 22.6 inches. The number of blows to drive the cone to at least every 25 mm into the soils are recorded. This is continued to a desired depth (36 inches typical) or refusal, whichever occurs first. From the penetrations data, DCP Index is obtained as mm per blow. The California Bearing Ratio (CBR) is then estimated by utilizing the following equation:

*Log CBR = 2.46 - 1.12 (Log DCP); where DCP in this equation is the DCP Index.*

DCP-1 was conducted to a depth of about 18 inches below existing ground surface (bgs) with blows per inch (bpi) exceeding 50 at refusal. The DCP indexes ranged from 0.5 to 1.2 indicating CBR of 100. At this test location, about 6 inches of organic topsoil was observed. Soils exposed underlying the organic topsoil generally consisted of moist, dense to very dense, brown silty sand with gravel and cobbles up to 10 inches.

DCP-2 was conducted to a depth of about 10 inches bgs with blows per inch (bpi) exceeding 50 at refusal. The DCP indexes ranged from 0.5 to 1.3 indicating CBR of 100. At this test location, about 4 inches of organic topsoil was observed. Soils exposed underlying the organic topsoil generally consisted of moist, dense to very dense, brown silty sand with gravel and cobbles. Bedrock was exposed on the road and to the north of this test location.

DCP-3 was conducted to a depth of about 16 inches bgs with blows per inch (bpi) exceeding 50 at refusal. The DCP indexes ranged from 0.4 to 1.3 indicating CBR of 100. At this test location, about 6 inches of organic topsoil was observed. Soils exposed underlying the organic topsoil generally consisted of moist, dense to very dense, brown silty sand with gravel.

DCP-4 was conducted to a depth of about 9 inches bgs with blows per inch (bpi) exceeding 50 at refusal. The DCP indexes ranged from 0.5 to 1.3 indicating CBR of 100. At this test location, about 4 inches of organic topsoil was observed. Soils exposed underlying the organic topsoil generally consisted of moist, dense to very dense, brown silty sand with gravel and angular rock spalls.

DCP-5 was conducted to a depth of about 19 inches where DCP and hand tools refusal was encountered. The DCP indexes ranged from 0.5 to 1.2 indicating CBR of 100. At this test location, the upper 10 inches consisted of angular rock spalls, which was excavated utilizing hand tools, and then the DCP test was performed. Moist, dense to very dense, brown silty sand with gravel was exposed to the maximum explored depth.

DCP-6 was conducted to a depth of about 16 inches where DCP and hand tools refusal was encountered. The DCP indexes ranged from 0.5 to 3.1 indicating CBR of 80 to 100. At this test location, about 6 inches of organic topsoil was observed. Soils exposed underlying the organic topsoil generally consisted of moist, dense to very dense, brown silty sand with angular volcanic rocks.

### **Laboratory Testing**

The laboratory testing program consisted of grain size analyses on a sample from DCP-1 and DCP-3. Test results were used primarily for soil classification and as criteria for determining the engineering suitability of the subsurface materials encountered. Our laboratory tests indicated that the percentage of gravel ranged from 36.1 to 41.0 sand ranged from 40.5 to 45.1, and silt and clay (passing no. 200 sieve) was about 18. The laboratory test results are provided as an attachment with this letter.

### **Conclusions and Recommendations**

The on-site soils consisted of gravel, cobbles and rock spalls, which may generally inflate the bpi from the DCP tests. Additionally, the CBR based on field tests generally will be higher than laboratory CBR values as laboratory CBR values are obtained in soaked conditions near 100 percent saturation to simulate worse-case scenario. Our laboratory tests indicated the site soils to be silty sand with gravel and silty gravel with sand. Saturated conditions were not noted during our explorations and the soils were in dense to very dense conditions. Based on our experience with similar soils, the CBR values may range from 20 to 60 in soaked conditions. We recommend that a CBR design value of no more than 50 be utilized for the pavement section design.

### **Closure**

We appreciate the opportunity to provide service to you on this project. If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,

**KRAZAN & ASSOCIATES, INC.**

6/19/23

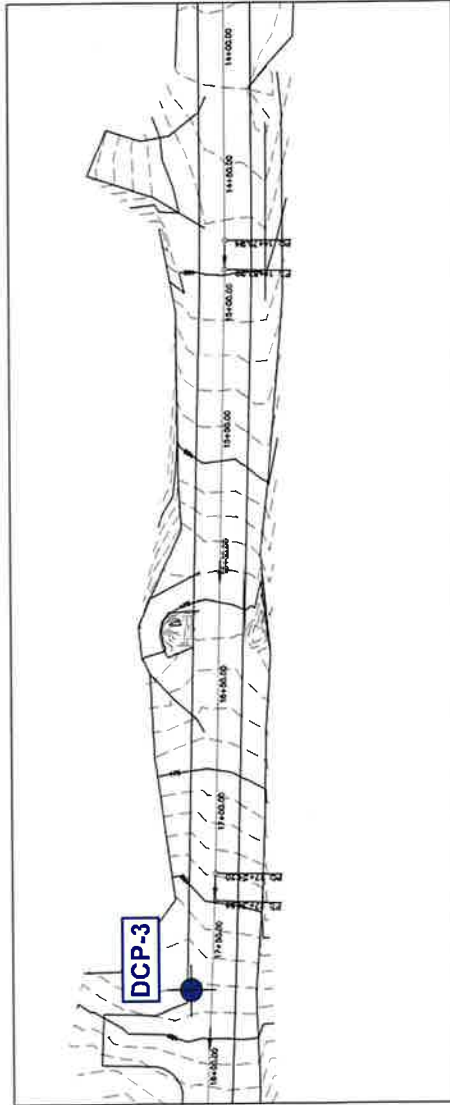
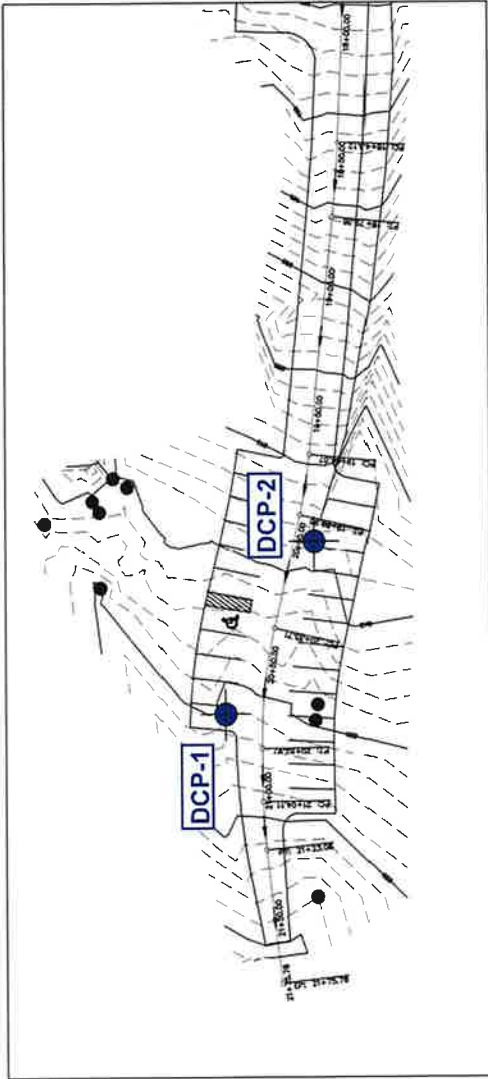


Vijay Chaudhary, P.E.  
Project Engineer

KC:VC

**Attachments:                      Site Plan (Figures 1A and 1B)  
   Laboratory Results**

# Site Plan



Reference: "Kaiser Woods Park Development Sheet 1," prepared by  
 Diane Utter, dated March 31, 2023.

### LEGEND



**DCP-1** Number and Approximate Location of DCPs



Project: Kaiser Woods Park Development

Date: May 2023

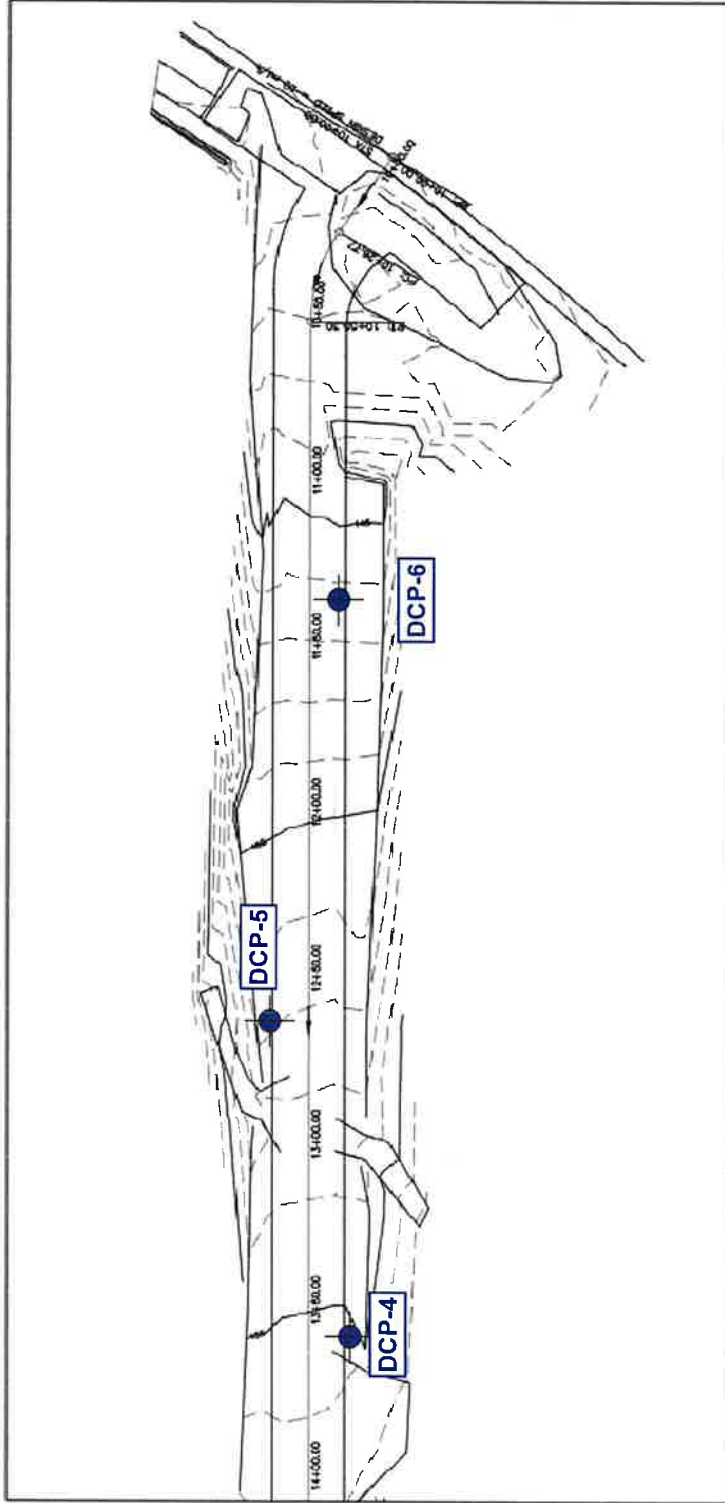
Project Number: 062-23011

Drawn By: KC

Not To Scale

Figure 1A

Site Plan



Reference: "Kaiser Woods Park Development Sheet 2," prepared by Diane Utter, dated March 31, 2023.

**LEGEND**



**DCP-1** Number and Approximate Location of DCPs



Project: Kaiser Woods Park Development

Date: May 2023

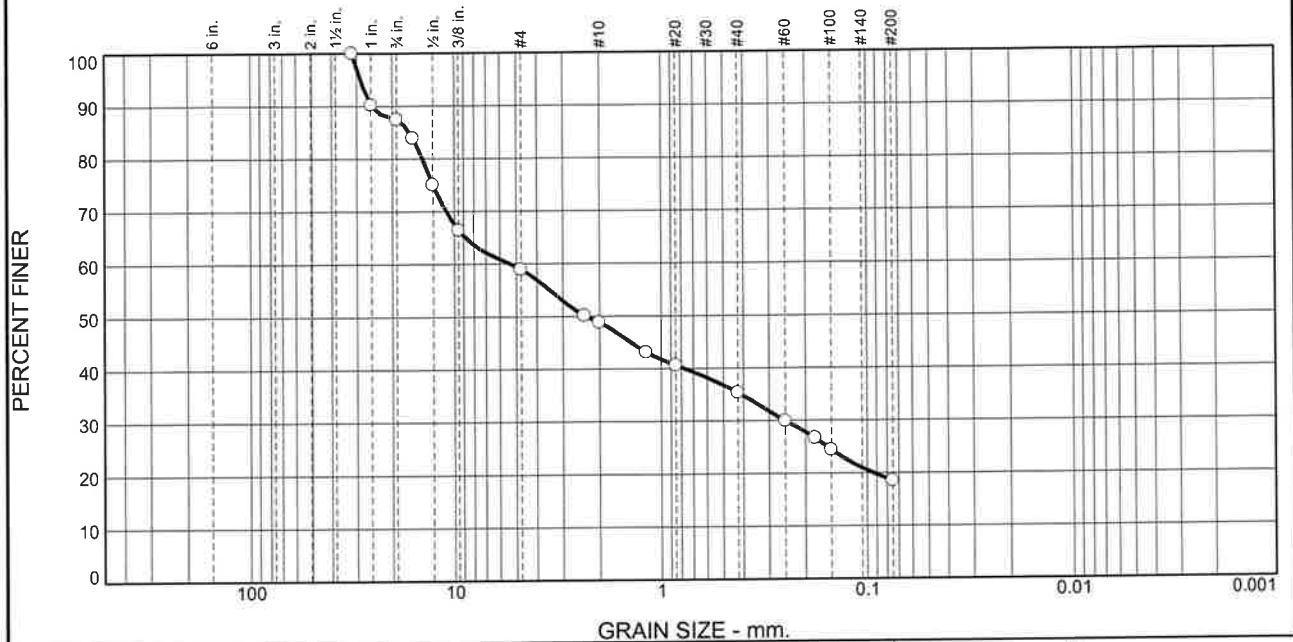
Project Number: 062-23011

Drawn By: KC

Not To Scale

Figure 1B

## Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	12.5	28.5	10.2	13.5	16.8	18.5	

Test Results (ASTM C117 & ASTM C136)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 1/4"	100.0		
1"	90.2		
3/4"	87.5		
5/8"	83.8		
1/2"	75.0		
3/8"	66.4		
#4	59.0		
#8	50.2		
#10	48.8		
#16	43.1		
#20	40.6		
#40	35.3		
#60	29.9		
#80	26.6		
#100	24.4		
#200	18.5		

\* (no specification provided)

**Material Description**

Brown Silty Gravel with Sand  
Sampled by K.Carambot

**Atterberg Limits (ASTM D 4318)**

PL= NP      LL= NV      PI= NP

**Classification**

USCS (D 2487)= GM      AASHTO (M 145)= A-1-b

**Coefficients**

D<sub>90</sub>= 25.2122      D<sub>85</sub>= 16.5210      D<sub>60</sub>= 5.3180  
D<sub>50</sub>= 2.3190      D<sub>30</sub>= 0.2523      D<sub>15</sub>=  
D<sub>10</sub>=      C<sub>u</sub>=      C<sub>c</sub>=

**Remarks**

Sample ID: 23L272  
Sample Date: 5/22/23  
Sample Location: DCP-1

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Date Received: 5/22/23      Date Tested: 5/23/23  
Tested By: I.Teriong  
Checked By: V.Chaudhary  
Title: Project Engineer

Source of Sample: DCP-1      Depth: 6"-12"  
Sample Number: 23L272

Date Sampled: 5/22/23

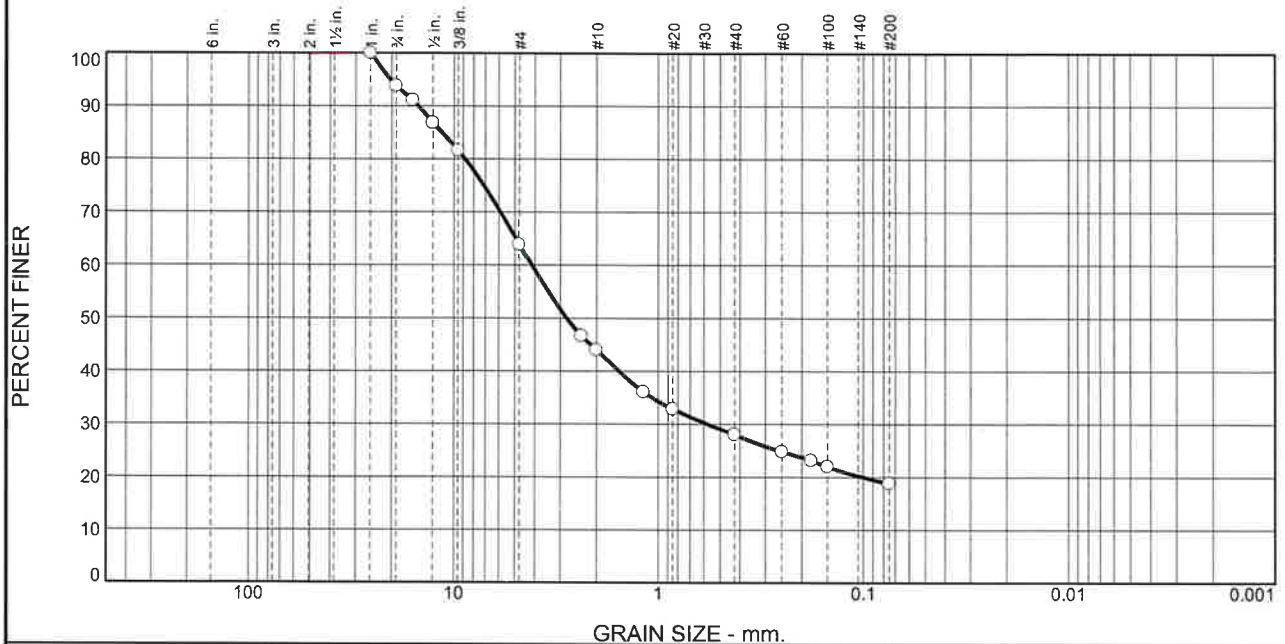


Client: City of Olympia  
Project: Kaiser Wood Park Development - Road Improvement

Project No: 062-23011

Figure

## Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.2	29.9	19.9	16.0	9.2	18.8	

Test Results (ASTM C117 & ASTM C136)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	93.8		
5/8"	91.1		
1/2"	86.8		
3/8"	81.6		
#4	63.9		
#8	46.6		
#10	44.0		
#16	36.1		
#20	32.9		
#40	28.0		
#60	24.8		
#80	23.2		
#100	22.0		
#200	18.8		

\* (no specification provided)

**Material Description**

Brown Silty Sand with Gravel.  
Sampled by K.Carambot

**Atterberg Limits (ASTM D 4318)**

PL= NP      LL= NV      PI= NP

**Classification**

USCS (D 2487)= SM      AASHTO (M 145)= A-1-b

**Coefficients**

D<sub>90</sub>= 14.9334      D<sub>85</sub>= 11.5059      D<sub>60</sub>= 4.1390  
D<sub>50</sub>= 2.7973      D<sub>30</sub>= 0.5739      D<sub>15</sub>=  
D<sub>10</sub>=              C<sub>u</sub>=              C<sub>c</sub>=

**Remarks**

Sample ID: 23L271  
Sample Date: 5/22/23  
Sample Location: DCP-3

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Date Received: 5/22/23      Date Tested: 5/23/23  
Tested By: I.Teriong  
Checked By: V.Chaudhary  
Title: Project Engineer

Source of Sample: DCP-3  
Sample Number: 23L271

Depth: 8"-14"

Date Sampled: 5/22/23



Client: City of Olympia  
Project: Kaiser Wood Park Development - Road Improvement

Project No: 062-23011

Figure