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296-7055

B97R0984
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B97R0993

16/25-07

Report of Geotechnical Engineering Services
Property Development
Carnation (King County), Washington

Prepared For:
Batt Construction, Inc.

Prepared By:
Icicle Creek Engineers, Inc.
Project No. 0164-001
July 28, 1997

I C E
Icicle Creek Engineers

Geotechnical, Geologic and Environmental Services

July 28, 1997

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Issaquah, Washington 98029

Report
Geotechnical Engineering Services
Property Development
Carnation (King County), Washington
File No. 0164-001

INTRODUCTION

This report presents the results of our geotechnical engineering services related to property development in Carnation (King County), Washington. Our services were completed in general accordance with our proposal dated July 22, 1997 and were authorized by Ron Batt on July 23, 1997. The subject property is shown relative to nearby physical features on the Vicinity Map, Figure 1.

PROJECT DESCRIPTION

The property is located north of the intersection of 320th Avenue NE and NE 55th Street and covers about 2.3 acres. The property is divided into seven building lots. Each lot will be developed with a two-story, single-family house using wood-frame construction. No grading is planned other than that needed to install foundations and shape the ground surface around the new houses.

BACKGROUND INFORMATION

We understand the King County Department of Development and Environmental Services (DDES) has requested that a liquefaction analysis be conducted for this property because it is in a Seismic Hazards area. We have discussed the scope of work with Steve Bottheim and Nancy Brown of DDES to determine that the appropriate level of investigation is conducted regarding the evaluation of liquefaction potential. In addition, we have reviewed a copy of DDES's letter to Batt Construction dated July 14, 1997 that describes the geotechnical information requested by the County. This letter pertains to five of the seven subject building lots. The lot addresses and associated permit numbers assigned by DDES are as follows:

- 31904 NE 55th Street - B97R0984
- 31910 NE 55th Street - B97R0985
- 31916 NE 55th Street - B97R0987
- 31928 NE 55th Street - B97R0992
- 31922 NE 55th Street - B97R0993

See also 5500 320th NE

Additional information provided by DDES includes a soils report conducted on a site in the vicinity of the subject building lots. The report, dated August 28, 1996, was completed by Associated Earth Sciences

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Post-it® Fax Note 7671	Date 7/30	# of pages ▶ 5
To Nancy Brown	From Kathy Killman	
Co./Dept. King Co. DDES	Co. Icicle Creek Eng.	
Phone #	Phone # 557-4358	
Fax # 296-7055	Fax # 557-4369	

for Build & Design Group for a site located north of Carnation on 320th Avenue NE approximately 700 feet north of the subject property.

SCOPE

The purpose of our services was to explore subsurface soil and ground water conditions at the site as a basis for developing geotechnical recommendations and design criteria for the proposed development. Our specific scope of services included:

1. Explore subsurface soil and ground water conditions by drilling two borings and excavating five test pits at the property.
2. Provide an assessment of liquefaction potential.
3. Provide earthwork criteria and site preparation recommendations for the building and the paved areas. This includes evaluation of the effects of weather and/or construction equipment on the workability of site soils.
4. Develop foundation design recommendations including allowable soil bearing pressures and settlement estimates for spread footings for the planned construction.
5. Provide recommendations for utility connections and slab-on-grade.

SITE CONDITIONS

SURFACE CONDITIONS

The property is located in the lower Snoqualmie valley at about Elevation 65 to 67 feet. The ground surface is nearly level with about 2 feet of topographic relief over the 2.3 acre area. Presently, the property is vacant and is used as pasture.

The property is bordered to the north, east and west by residential development. A strawberry field borders the property to the south.

No surface water was observed on the property.

SUBSURFACE CONDITIONS

The subsurface conditions at the site were explored by drilling two borings and excavating five test pits at the locations shown on the Site Plan, Figure 2. The borings were drilled on July 23, 1997 to a depth of 29 feet using a truck-mounted, hollow-stem auger drill rig owned and operated by GeoBoring and Development, Inc. Representative soil samples were obtained at 5-foot intervals using a 1.5-inch inside diameter, split-barrel sampler driven into the soil with a 140-pound hammer free-falling 30 inches unless otherwise noted on the logs. The number of blows to drive the sampler the last 12 inches, or other indicated distance, is recorded on the boring log. The test pits were excavated on July 23, 1997 to a depth of nine to eleven feet.

The borings and test pits were logged by an engineering geologist from our firm. Soils were classified according to the classification system described in Figure 3. A key to the boring and test pit log symbols is presented in Figure 3. The logs of the borings are presented in Figures 4 and 5. The logs of the test pits are presented in Figures 6 and 7. Observations of the ground water conditions were made as the borings and test pits were advanced or excavated.

The U.S. Geological Survey (Booth, D.R., 1990, Map I-1745) has mapped this area as underlain by native soils consisting of Younger Alluvium deposited by the Snoqualmie River. Younger Alluvium is described as "moderately sorted deposits of cobble gravel and pebbly sand along rivers and streams."

Our borings encountered alluvial type soils (river deposits) to the full depth of the explorations (29 feet). These soils consist of stratified (layered) silt, silty sand, sand and gravel. Borings B-1 and B-2 encountered alluvial soils that suggest that the layering of the alluvial soils is laterally discontinuous below

a depth of about 5 feet. Boring B-1 encountered 5 feet of loose silty fine sand at the surface underlain by very loose silty fine sand and soft sandy silt to a depth of about 20 feet. The soils graded to a medium dense gravel from 20 feet to the completion depth of Boring B-1 at 29 feet. Boring B-2 encountered 5 feet of soft sandy silt and loose fine sand with silt underlain by medium dense gravel with variable amounts of silt and sand to the completion depth of the boring at 29 feet.

The test pit explorations were completed to evaluate the uniformity of the surficial soils (to a depth of 9 to 11 feet) across the property. The test pit explorations encountered relatively uniform surficial soil conditions across the property consisting of about 5 feet of soft sandy silt and loose silty sand. The soil in the test pits typically graded to medium dense at a depth of about five feet.

except @ TP 3-5 and B1

Ground water was generally observed at an approximate depth of 6 to 9.5 feet below the ground surface in the boring and test pit explorations. We expect that during the late winter and early spring that the ground water table may be five to seven feet below the ground surface.

basis?

SEISMICITY

The Puget Sound region is a seismically active area and has experienced thousands of earthquakes. The largest earthquake recorded in the Puget Sound region was the 7.1-magnitude earthquake northeast of Olympia in 1949. The second largest recorded earthquake was a 6.5-magnitude earthquake south of Seattle in 1965. On the basis of past earthquake activity, the UBC (International Conference of Building Officials, 1991) has assigned the Puget Sound region a Zone 3 rating for seismic activity on a scale of 1 (lowest) to 4 (highest).

The project site is classified as a Soil Profile Type S3, as indicated by the 1991 UBC.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The property is underlain by alluvial soils that contain layers in a loose condition and are moderately susceptible to liquefaction under earthquake conditions. However, these layers with a moderate risk of liquefaction are relatively thin and are discontinuous based on the results of our explorations. The lateral discontinuity of the liquefiable layers further reduces the risk that ground settlements could occur during an earthquake.

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In our opinion, the interlayering of soft and loose soils with the medium dense gravel deposits pose a greater risk of differential settlement caused by the new building loads rather than liquefaction induced settlements. Designing foundations to accommodate for the differential settlement, such as use of a low soil bearing pressure or a mat foundation, should also reduce the risk of appreciable damage to these structures during an earthquake, in our opinion.

LIQUEFACTION POTENTIAL AND MITIGATION

Because the property soils are susceptible to liquefaction does not necessarily mean that liquefaction will occur during an earthquake. Liquefaction requires a set of conditions including specific ground motion, duration and other dynamic conditions that triggers the loss of soil shear strength. It is our opinion that the soils that underlie that property have a moderate potential for liquefaction because of grain size characteristics and lateral discontinuity of the soil layering. This means that the specific set of conditions that will trigger liquefaction are limited as compared to a site with a high liquefaction potential.

Liquefaction typically results in loss of soil strength and bearing capacity and may result in settlement of the ground surface or building footings. The amount of settlement resulting from liquefaction will depend on the effectiveness of the surficial layer to act as a floating diaphragm above the liquefied soils. This is difficult to evaluate; however, we believe that the 6 to 9.5 foot thick, nonsaturated silty layer that

mantles the property represents a favorable condition and will reduce the potential for liquefaction induced settlement. In addition, the loose soil layers consist of silty fine sand that is well-graded (i.e., a wide range of particle sizes). The well-graded condition of the loose soils reduces liquefaction potential. Case history studies support that most liquefaction failures involve uniformly graded soils (i.e., grains are same size).

During an earthquake, lateral spreading of liquefied soils may occur. Lateral spreading can cause significant ground settlement, even without the weight of a structure. However, lateral spreading requires that the liquefied zone of soil is laterally continuous and intersect an area, such as a lake or river bottom, for the soils to flow to. As previously discussed, the soils that underlie the property appear to be laterally discontinuous. Therefore, lateral spreading is not likely to occur, in our opinion.

For a low risk level of settlement damage to the houses from an earthquake, we recommend that the houses be supported on conventional spread footings using a reduced soil bearing pressure as discussed later in this report. The footings should be structurally tied together to provide rigidity to the foundation system to accommodate differential settlement.

Alternatively, the houses could be supported on a mat foundation. A mat foundation consists of a structural slab with thickened edges that uniformly distributes the load of the structure to the underlying soil.

Based on our experience in building construction in the Snoqualmie River valley, we understand that most of the buildings, including the fire station (built in 1992), police station (remodeled in 1996) and elementary school in the town of Carnation are supported on spread footings and consequently, would be exposed to the same liquefaction risk as the subject property provided the subsurface conditions are similar, which we believe to be the case.

GEOTECHNICAL EVALUATION

Site Preparation

The surficial soil at the project site consists of moisture-sensitive silty soil that will be difficult for equipment operation during wet weather. This soil will also be difficult to compact if allowed to become wet. We recommend that site preparation and earthwork be accomplished during dry weather if possible.

We recommend that all vegetation be cleared and the sod stripped from all building areas. The depth of stripping can be expected to average about 3 inches. The sod should also be stripped from all pavement areas where the thickness of fill above existing grade will be less than 18 inches. Where fill thicknesses in pavement areas will be 18 inches or more, the sod layer may be left in place. In these areas, vegetation should be cut as short as possible and the clippings removed prior to fill placement.

We recommend that all building, slab and pavement subgrade areas be thoroughly proofrolled with heavily loaded rubber-tired construction equipment if site preparation is done during extended dry weather conditions. Any areas which rut or weave during proofrolling should be excavated and replaced with compacted structural fill. If site preparation is done during wet weather, it will be preferable not to proofroll the exposed surface, as this activity could damage the subgrade. In wet weather, construction traffic should be kept off the exposed subgrade soil. We recommend that all sod and soil stripped from the site either be wasted off site or used for landscaping.

Earthwork

We recommend that structural fill for building pads, for subbase for pavements, for repair of soft subgrade conditions and for placement below and around foundations, consist of pit run sand and gravel. If the structural fill is placed during wet weather, we recommend that the material consist of well-graded, free-draining sand and gravel free of organic matter or debris. The maximum particle size should be 4 inches. The material should contain less than 5 percent fines (soil passing the U.S. No. 200 sieve) by weight relative to the portion finer than the 3/4-inch sieve. If earthwork is done during generally dry weather

TO: STEVE BOTTHIEM

conditions, the fines content may be increased slightly. Up to about 10 percent fines is usually acceptable for dry weather earthwork, providing the fines are well mixed throughout the soil and are not present as lumps or balls.

Structural fill should be placed in horizontal lifts which are 10 inches or less in loose thickness. It may be desirable to place a geotextile beneath the fill to reduce the possibility of fill disturbance due to pumping, particularly if filling is done during wet weather. This should be a field decision. We recommend that the initial lift be uniformly compacted to at least 92 percent and each successive lift to 95 percent of the maximum dry density (MDD) determined in accordance with the ASTM D-1557 test method.

Shallow Foundation Support

Spread footings: Conventional shallow spread footing design is appropriate for support of residential and other lightly loaded buildings. For uniform support of the new house, we recommend that footings be supported on a pad of compacted structural fill. We recommend overexcavating to a depth of at least 2 feet or to firm bearing material in footing areas and replacement with compacted structural fill. For footings supported on structural fill, the zone of structural fill should extend laterally out from the footing edges a distance at least equal to the thickness of the structural fill. Structural fill placed beneath footings should be compacted to at least 95 percent of the MDD.

The depth of embedment below the lowest adjacent finished grade for all exterior and interior footings should be at least 18 inches and 12 inches, respectively. We recommend a footing width of at least 16 inches for continuous wall footings and 18 inches for isolated column footings. For footings designed and constructed according to the above criteria, we recommend an allowable bearing pressure of 1,000 pounds per square foot. This value applies to the total of all dead plus long-term live loads, exclusive of the weight of the footing and any overlying backfill. This value may be increased by one-third when considering wind or seismic loads.

We recommend that the footings be structurally connected across the building footprint to provide rigidity to the foundation system. This could be accomplished by substituting interior strip footings for individual column footings.

We estimate that postconstruction settlements for interior column and perimeter wall footings will range from about ½ to 1 inch, depending on the total load, thickness of structural fill below the footing, and subsurface soil conditions. We expect that differential settlements along wall footings will be less than ½ inch in 50 feet. Foundation settlements are expected to be substantially complete within a few weeks after application of structural loads.

Mat Foundation: A structural mat, or raft foundation may be used to support the houses to reduce the potential for damage caused by differential settlement. The weight of the structure should be distributed evenly across the foundation slab. The raft foundation should be supported on a minimum of 12 inches of compacted structural fill. A vapor barrier is not required beneath the mat if the structural fill consists of clean free-draining sand and gravel; however, we recommend that it be provided as an added protection against upward migration of moisture into the slab.

We estimate that settlement of the mat foundation will be 1 to 2 inches. Differential settlement of ½ inch in 25 feet may occur. We expect that settlements will be complete within a few weeks after application of structural loads.

Slab-on-Grade

We recommend that at least 4 inches of clean sand and gravel or crushed rock containing less than 3 percent fines be placed beneath on-grade floor slabs to provide uniform support and a capillary break. An impermeable vapor barrier should be placed between the slab and the free-draining sand and gravel.

Utility Connections

If a mat foundation is used, we recommend that utilities installed under the mat foundation should be connected directly to the foundation. Flexible or telescoping couplings should be used to connect the utilities along the edges of the mat foundation.

Permanent Drainage

We recommend that pavement surfaces be sloped away from building areas to direct drainage away from foundations and floor slabs. We recommend that all roof drains be connected to tightline disposal systems leading off site.

USE OF THIS REPORT

We have prepared this report for use by Batt Construction, Inc. in design of a portion of this project. If there are changes in the loads, grades, location, configuration or type of construction for the facilities, the conclusions and recommendations presented may not be applicable. If design changes are made, we should be retained to review our conclusions and recommendations relative to the new conditions. When the design has been finalized, we recommend that we review the final design and specifications to see that our recommendations have been interpreted and implemented as intended.

The data and report should be provided to prospective contractors for their bidding or estimating purposes, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Our scope does not include services related to construction safety precautions and our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

There are possible variations in subsurface conditions between the explorations and also with time. A contingency for unanticipated conditions should be included in the budget and schedule. Construction monitoring and testing is important to confirm that the conditions encountered are consistent with those indicated by the explorations and to evaluate whether or not earthwork and foundation installation activities comply with the intent of contract plans and specifications. For consistency in the interpretation of subsurface conditions and the application of design recommendations, we should be retained to provide construction monitoring and consultation services during earthwork and foundation installation activities.

Within the limitations of scope, schedule and budget, our services have been accomplished in accordance with generally accepted practices in this area at the time the report was prepared. No warranties or other conditions, express or implied, should be understood.

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We trust this information meets your present needs. If you have any questions or if we can be of further assistance to you, please call.

BRIAN R. BEAMAN
STATE OF WASHINGTON
24010
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 10.30.98

Yours very truly,

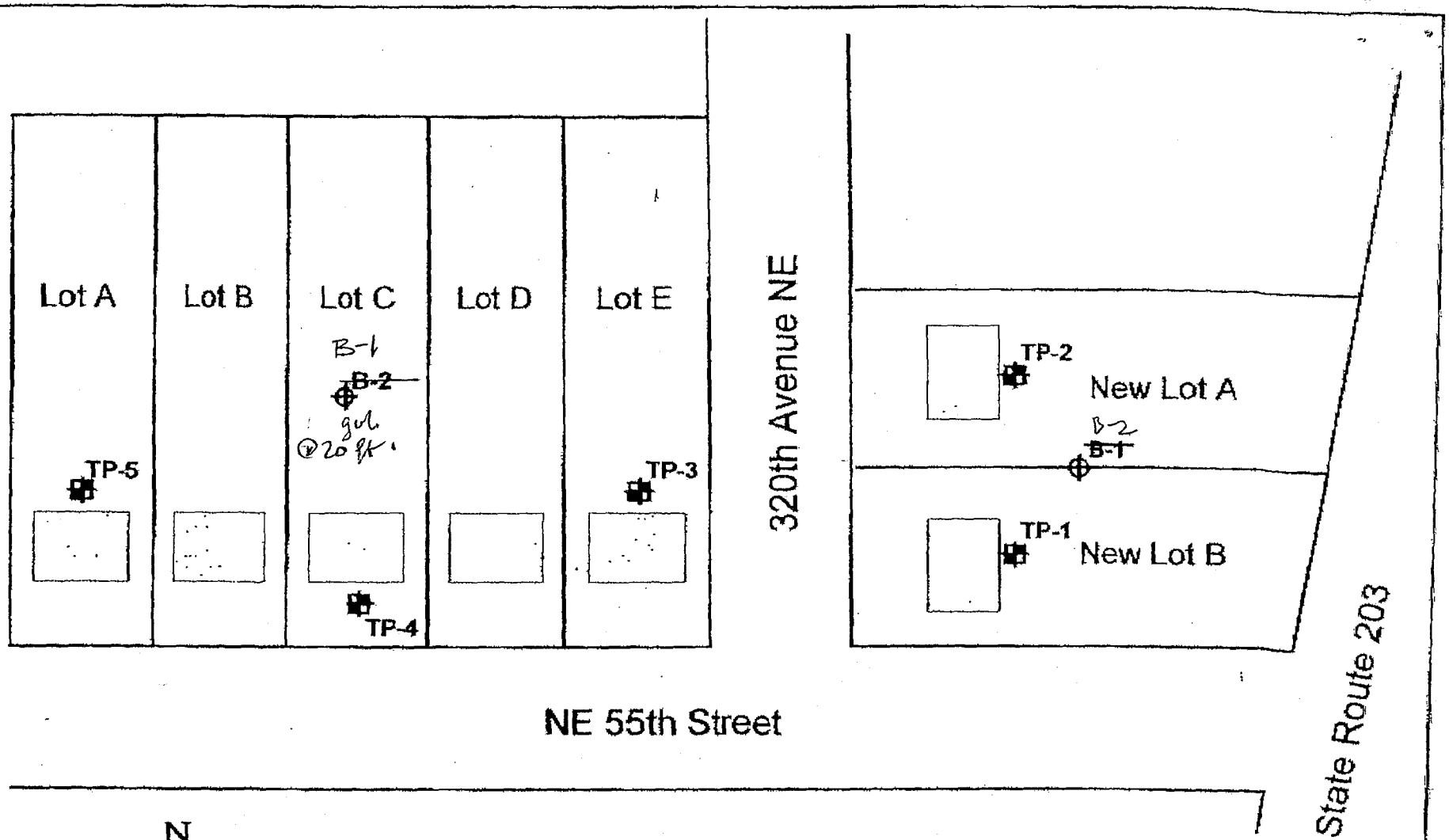
Icicle Creek Engineers, Inc.

Brian R. Beaman, P.E., P.G.
Principal Engineer/Geologist

Document ID: 0164001.REP

Three copies submitted

Attachments



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Site Plan - Figure 2

Unified Soil Classification System

MAJOR DIVISIONS			Soil Classification and Generalized Group Description	
Coarse-Grained Soils	GRAVEL More than 50% of coarse fraction retained on the No. 200 sieve	CLEAN GRAVEL	GW	Well-graded gravels
			GP	Poorly-graded gravels
		GRAVEL WITH FINES	GM	Gravel and silt mixtures
			GC	Gravel and clay mixtures
More than 50% retained on the No. 200 sieve	SAND More than 50% of coarse fraction passes the No. 200 sieve	CLEAN SAND	SW	Well-graded sand
			SP	Poorly-graded sand
		SAND WITH FINES	SM	Sand and silt mixtures
			SC	Sand and clay mixtures
Fine-Grained Soils	SILT AND CLAY Liquid Limit less than 50	INORGANIC	ML	Low-plasticity silts
			CL	Low-plasticity clays
		ORGANIC	OL	Low plasicity organic silts and organic clays
More than 50% passing the No. 200 sieve	SILT AND CLAY Liquid Limit greater than 50	INORGANIC	MH	High-plasticity silts
			CH	High-plasticity clays
		ORGANIC	OH	High-plasticity organic silts and organic clays
Highly Organic Soils	Primarily organic matter with organic odor		PT	Peat

Notes. 1) Soil classification based on visual classification of soil in general accordance with ASTM D2488-90
2) Soil classification using laboratory tests is based on ASTM D2487-90
3) Description of soil density or consistency is based on interpretation of blow count data and/or test data.

Soil Particle Size Definitions

Component	Size Range
Boulders	Greater than 12 inch
Cobbles	3 inch to 12 inch
Gravel	3 inch to No. 4 (4.78 mm)
Coarse	3 inch to 3/4 inch
Fine	3/4 inch to No. 4 (4.78 mm)
Sand	No. 4 (4.78 mm) to No. 200 (0.074mm)
Coarse	No. 4 (4.78 mm) to No. 10 (2.0 mm)
Medium	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Less than No. 200 (0.074 mm)

Soil Moisture Modifiers

Soil Moisture	Description
Dry	Absence of moisture
Moist	Damp, but no visible water
Wet	Visible water

Key to Boring Log Symbols

Sampling Method	Boring Log Symbol	Description
Blows required to drive a 2.4 inch I.D. split-barrel sampler 12-inches or other indicated distances using a 300-pound hammer falling 30 inches.	34	Location of relatively undisturbed sample
	12	Location of disturbed sample
	21	Location of sample attempt with no recovery
Blows required to drive a 1.5-inch I.D. split barrel sampler (SPT - Standard Penetration Test) 12-inches or other indicated distances using a 140-pound hammer falling 30 inches.	14	Location of sample obtained in general accordance with Standard Penetration Test (ASTM D-1586) test procedures.
	30	Location of SPT sampling attempt with no recovery.
Pushed Sampler	P	Sampler pushed with the weight of the hammer or against weight of the drilling rig.
Grab Sample	G	Sample obtained from drill cuttings.

Laboratory Tests

Test	Description
Density	DN
Grain Size	GS
Percent Fines	PF
Atterberg Limits	AL
Hydrometer Analysis	HA
Consolidation	CN
Compaction	CP
Permeability	PM
Unconfined Unconsolidated	UU
Confined Unconsolidated	CU
Confined Consolidated	CC
Chemical Analysis	CA

Depth (feet) (1)	Soil Group Symbol (2)	Test Pit Description (3)
Test Pit TP-1		
0.0 - 0.3		Sod and topsoil
0.3 - 2.0	ML	Brown sandy SILT (soft, moist)
2.0 - 3.5	SM	Brown silty fine SAND (loose, moist)
3.5 - 7.0	SP	Brown fine to medium SAND (loose to medium dense, moist)
		Grades to fine to medium SAND with gravel at 5.5 feet
7.0 - 9.0	GP-GW	Brown fine to coarse GRAVEL with sand and a trace of silt (medium dense, moist to wet)
		Test pit completed at 9.0 feet on 07/23/97
		Moderate caving of test pit sidewall from 4.0 to 9.0 feet
		Ground water seepage observed at 8.5 feet
		Probed 1.5 feet with 1/2-inch diameter steel probe rod at 2.0 feet
Test Pit TP-2		
0.0 - 0.3		Sod and topsoil
0.3 - 1.5	ML	Brown sandy SILT (soft, moist)
1.5 - 3.0	SP-SM	Brown fine SAND with silt (loose, moist)
3.0 - 7.5	SP	Brown fine to medium SAND with occasional gravel (loose to medium dense, moist)
7.5 - 9.0	GP-GW	Brown fine to coarse GRAVEL with sand and a trace of silt (medium dense, moist)
		Test pit completed at 9.0 feet on 07/23/97
		Severe caving of test pit sidewall from 3.0 to 9.0 feet
		No free ground water observed
		Probed 1.0 to 2.0 feet with 1/2-inch diameter steel probe rod at 2.0 feet
		Disturbed soil sample obtained at 2.0 feet
Test Pit TP-3		
0.0 - 0.3		Sod and topsoil
0.3 - 1.5	ML	Brown SILT with fine sand (soft, moist)
1.5 - 5.0	SM	Brown silty fine SAND with occasional layers of silt (loose, moist)
5.0 - 9.0	SM/ML	Gray and brown mottled layered silty fine SAND and sandy SILT (loose/soft, wet)
		Test pit completed at 9.0 feet on 07/23/97
		Ground water seepage observed at 8.5 feet
		Probed 2.0 feet with 1/2-inch diameter steel probe rod at 2.0 feet
		Disturbed soil sample obtained at 8.0 feet
Test Pit TP-4		
0.0 - 0.3		Sod and topsoil
0.3 - 1.0	ML	Brown SILT with fine sand (soft, moist)
1.0 - 2.0	SM	Brown silty fine SAND (loose, moist)
2.0 - 10.0	SM/ML	Gray, brown and orange mottled layered silty fine SAND and sandy SILT with occasional organic material and layers of fine to medium sand (loose/soft, moist to wet)
		Test pit completed at 10.0 feet on 07/23/97
		Slight caving of test pit sidewall from 3.0 to 6.0 feet
		Ground water seepage observed at 9.5 feet
		Probed 2.0 to 3.0 feet with 1/2-inch diameter steel probe rod at 2.0 feet
		Disturbed soil samples obtained at 1.5 and 7.0 feet

See Notes on Figure 7.

Icicle Creek Engineers Test Pit Logs - Figure 6

Depth (feet) (1)	Soil Group Symbol (2)	Test Pit Description (3)
Test Pit TP-5		
0.0 - 0.3		Sod and topsoil
0.3 - 1.0	ML	Brown SILT with fine sand (soft, moist)
1.0 - 2.0	SP-SM	Brown fine SAND with silt (loose, moist)
2.0 - 9.5	ML/SM/SP-SM	Gray, brown and orange mottled layered sandy SILT, silty fine SAND and fine to medium SAND with silt, occasional organic material (soft/loose, moist to wet)
9.5 - 11.0	ML	Blue-gray SILT with fine sand (soft, wet)
		Test pit completed at 11.0 feet on 07/23/97
		No ground water seepage observed
		Probed 1.5 to 2.5 feet with 1/2-inch diameter steel probe rod at 2.0 feet
		Disturbed soil sample obtained at 10.0 feet

(1) The depths on the test pit logs are shown in 0.1 foot; however, these depths are based on approximate measurements across the length of the test pit and should be considered accurate to 0.5 foot. The depths are relative to the adjacent ground surface.
(2) The soil group symbols are based on the soil classification system described in Figure 3.
(3) The test pit locations are shown in Figure 2.

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Boring B-1

BRB. 07/24/97

Approximate Ground Surface Elevation: 66 feet

Logged by: KSK

Project Name: Bait Construction

ICE Project No. 0164-001

Depth in Feet	Soil Profile: Description	Graphic Log	Sample Data: Group Symbol	Blow Count	Sample Location	Penetration Resistance (Blows/foot - ●) 20 40 60 80 / Moisture Content (Percent - ■) 20 40 60 80	Laboratory Testing	Piezometer Installation - Ground Water Data
0	Brown silty fine SAND (loose, moist)							No piezometer installed
1								Bentonite Backfill
2								
3								Soil/Bentonite Backfill
4			SM	5		●		
5	Brown and gray silty fine SAND and sandy SILT (very loose and soft, wet)							Ground water encountered at 5 feet at the time of drilling
6								
7								
8								
9			SM/ML	0		●		
10								
11								
12								
13								
14			SM/ML	1		●		
15								
16								
17								
18								
19	grades to brown and medium stiff		SM/ML	6		●		
20								

See Figure 3 for explanation of symbols

Icicle Creek Engineers

Boring Log Figure 4

Boring B-1

Logged by: KSK

Project Name: Batt Construction

ICE Project No. 0164001

Depth in Feet	Soil Profile: Description	Graphic Log	Sample Data: Group Symbol	Blow Count	Sample Location	Penetration Resistance (Blows/foot - ●) 20 40 60 80 / Moisture Content (Percent - ■) 20 40 60 80	Laboratory Testing	Piezometer Installation + Ground Water Data
20	Brown fine GRAVEL (very dense, wet)							
21								
22								Soil/Bentonite Backfill
23			GP	50/3*		●		
24								
25	Brown fine to coarse GRAVEL (medium dense, wet)							
26								
27								
28								
29			GW	18		●		
30	Boring completed at 29 feet on 07/23/97 Ground water observed at 6 feet at the time of drilling * Blow counts may not be representative because of the presence of gravel							
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

See Figure 3 for explanation of symbols

Icicle Creek Engineers

Boring Log Figure 4

14

BRB: 07/24/97

Boring B-2

Approximate Ground Surface Elevation: 66 feet

Logged by: KSK

Project Name: Batt Construction

ICE Project No. 0164-001

Depth in Feet	Soil Profile: Description	Graphic Log	Sample Data: Group Symbol	Blow Count	Sample Location	Penetration Resistance (Blows/foot - ●) 20 40 60 80 / Moisture Content (Percent - ■) 20 40 60 80	Laboratory Testing	Piezometer Installation - Ground Water Data
0	Brown sandy SILT with occasional roots (soft, moist)							No piezometer installed
1								Bentonite Backfill
2								
3			ML					Soil/Bentonite Backfill
4	Brown fine SAND with silt (loose, moist)		SP/SM	5		●		
5	Brown silty fine to coarse GRAVEL with sand (dense, wet)							
6								
7								
8								
9			GM	56*		●		Ground water encountered at 9.5 feet at the time of drilling
10								
11	Brown fine GRAVEL with sand and thin layers of silt (medium dense, wet)							
12								
13								
14			GP	29		●		
15								
16	Mottled brown and gray silty fine to medium SAND with gravel and a trace of organic matter (medium dense, wet)							
17								
18								
19			SM	45*		●		
20								

See Figure 3 for explanation of symbols

Icicle Creek Engineers

Boring Log Figure 5

BRB: 07/24/97

Boring B-2

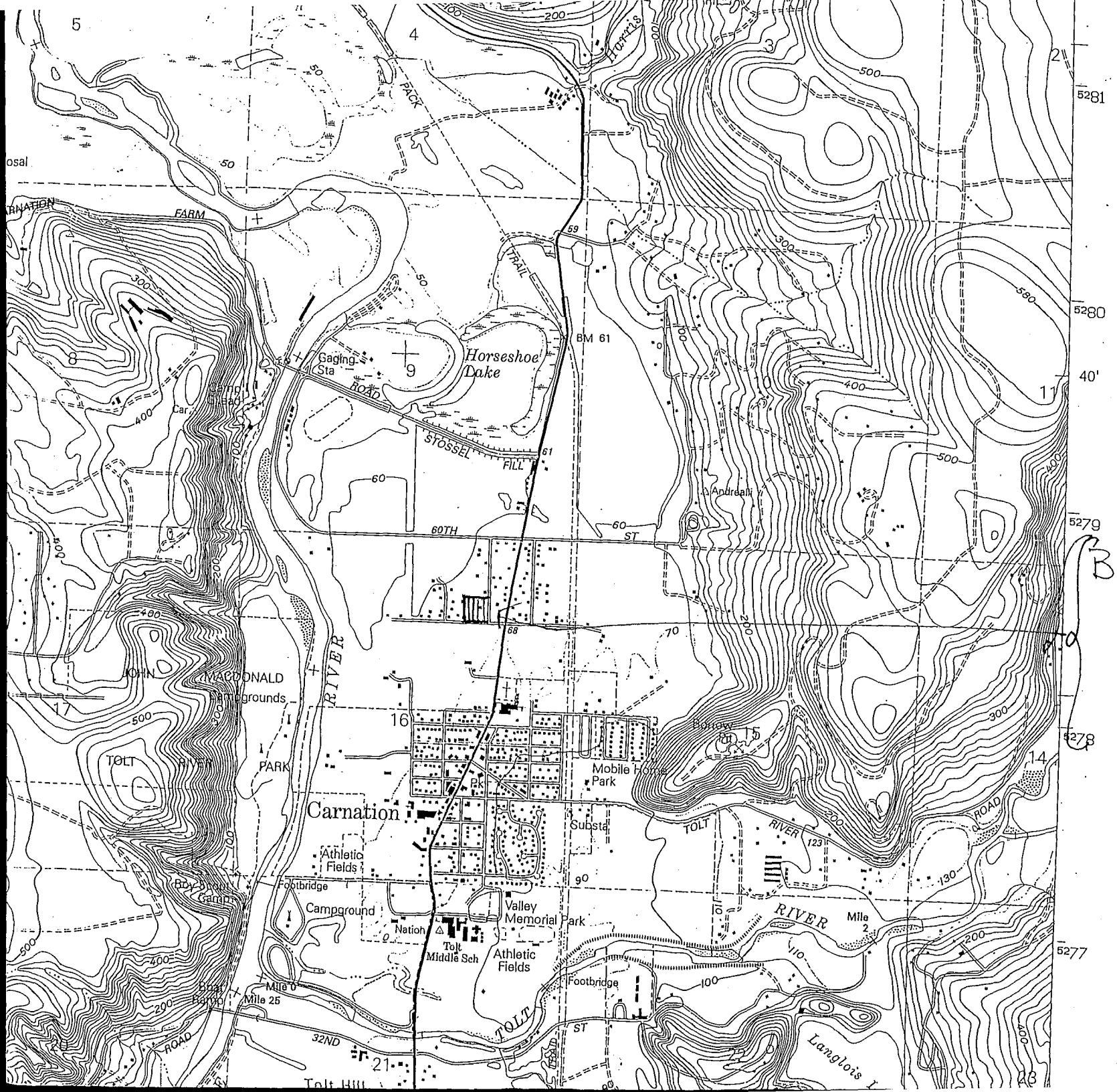
Logged by: KSK

Project Name: Batt Construction

ICE Project No. 0164001

Depth in Feet	Soil Profile: Description	Graphic Log	Sample Data: Group Symbol	Blow Count	Sample Location	Penetration Resistance (Blows/foot - ●) 20 40 60 80 / Moisture Content (Percent - ■) 20 40 60 80	Laboratory Testing	Piezometer Installation - Ground Water Data
20	Brown fine SAND grading to fine to coarse sand with gravel (very dense, wet)							Soil/Bentonite Backfill
21								
22								
23			SP					
24	Brown silty fine to coarse GRAVEL with sand (very dense, wet)		GM	50/3*		●		
25								
26	Brown fine to coarse SAND with a trace of gravel (dense, wet)							
27								
28								
29			SP	61		●		
30	Boring completed at 29 feet on 07/23/97 Ground water observed at 9.5 feet at the time of drilling * Blow count may not be representative because of the presence of gravel							
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

See Figure 3 for explanation of symbols


Horseshoe Lake
Gaging Sta
BM 61
STOSSEL
ROAD
FILL
60TH
ST
FARM
TRAIL
PACK
Andreani
JOHN MACDONALD
Campgrounds
TOLT RIVER
PARK
RIVER
Carnation
Athletic Fields
Footbridge
Campground
Valley Memorial Park
Tolt Middle Sch
Athletic Fields
Mobile Home Park
Substa
Borrow Pit
TOLT RIVER
ROAD
Mile 2
Footbridge
Mile 0
Mile 25
Boat Ramp
32ND
ST
Tolt Hill
Langlois
5281
5280
40'
5279
5278
5277
B97R0984
0985
0987
0992
0993