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In particular, homeowners with property in the vicinity of the area described in the document should not rely on the document to evaluate any risk of damage to their property, but should retain the services of their own independent consultants.

Budinger & Associates

Proudly serving the Inland Northwest for over 40 years

Geotechnical Engineering
Environmental Engineering
Construction Material Testing
Subsurface Exploration
Special Inspection

Mr. Eric Lundin
Wandermere Estates Home Owners Association
C/O Web Properties
522 W. Riverside Avenue, Suite 600
Spokane, Washington 99201

May 5, 2017

Project S17206

Memorandum
Project: North Wandermere Estates Lane, Spokane, WA
Subject: Results of Limited Geotechnical Evaluation

We completed our limited geotechnical exploration and evaluation of the influence of landsliding on the HOA's improvements adjacent to the residence at 13811 North Wandermere Estates Lane. These improvements include the roadway, sidewalks, sanitary sewer, and storm sewer.

Our conclusions and recommendations for the site are presented on page 3 of this report; while, results of exploration are presented in the attached Figures and Appendices. Laboratory testing of representative soil samples is currently underway and not available for this memorandum. The results of that testing will not materially affect our conclusions and recommendations.

Project Description
Significant damage to the residence at 13811 North Wandermere Estates Lane has occurred. The west side of the house has dropped down as indicated by large cracks in the foundation walls and basement floors. The floors have separated from the walls enough to see daylight between them. A large crack in the floor at the south side of the house was about two feet deep in portions.

A scarp is present extending from the basement fracture southwest across the backyard of the residence to the south (13803 North Wandermere Estates Lane). Currently, there is no apparent damage to the foundation walls of that house. However, because the scarp indications are consistent with the damage to the northerly residence, it appears that land subsidence is occurring along the west side of both houses.

Scope
The scope of our services included the following tasks:

- Advanced 4 borings to sample soils down to underlying granite bedrock.
- Targeted areas of suspected voids, as indicated by ground penetrating radar surveys.
- Installed a slope inclinometer between the two residential structures to delineate the subsurface of sliding ground.
- Characterized subsurface conditions, including the soil, rock, and ground layer.
- Prepared conclusions and recommendations addressing stability of the HOA infrastructure, including measures to manage unstable slope conditions.

Test borings were drilled in 2006 after sections of retaining walls below the lots failed. Logs of those test borings are presented in an appendix.

Surface Conditions
The site is located at the top of a west-facing slope near the northeast corner of Wandermere Lake on the east side of Wandermere Golf Course, as illustrated in the attached *Vicinity Map*. Slopes below the area range from 30 to 70 percent. Specific site features including the street layout, and boring and inclinometer locations are illustrated in the attached *Site Plan*.

Geologic Setting
The site is located immediately northeast of the Five Mile Prairie area, north of Spokane. The geology of the area consists of Quaternary glaciofluvial flood deposits draped over the top of Cretaceous-age intrusive, granitic, bedrock (Washington Department of Natural Resources Dartford Geologic map 98-6 (1998, 1:24,000 scale)). Latah Formation is mapped above the site.

Since the site is located in the Spokane River Valley and is below the elevation of 1900 feet, the geology is dominated by glaciofluvial flood deposits consisting of sand and gravel. These deposits are thought to have been the result of catastrophic glaciofluvial flooding during the Ice Ages, or Pleistocene Epoch (2 million to 10,000 years ago). Large floods carved out much of the Spokane area and then deposited sand, gravel, and even boulders the size of cars in many areas. The topography is dominated by the older granitic bedrock.

A clay-rich thin layer was observed during drilling of B-4. There are several possible explanations for this, but we believe it is either the accumulation of fine-grained sediment in a quiet temporary pond environment, or illuviated clay, i.e. clay accumulated at the base of a granular layer by groundwater flushing of fines downward.

Subsurface Conditions
Four borings were extended along the west edge of the pavement for North Wandermere Estates Lane. Underlying the asphalt and base course for the road, the subsurface conditions reflect the geologic setting of fine- to coarse-textured glaciofluvial flood deposits overlain by man-placed fill of the same soil types. The encountered soil conditions are described in detail in the attached *Boring Logs*. A key to the soil and rock descriptions precedes the *Boring Logs*. We identified 5 distinct layers of soil and rock in the borings as described in the following sections.

Fill
Overlying native soil in all of the borings was *fill*, probably placed during the construction of the road. The *fill* in the borings generally consisted of silty sand, silty sand with gravel, and sand with gravel and cobbles. The *fill* ranged from loose to dense. The thickness of the *fill* was between 4 and 7 feet in the borings.

Sand
The predominant native soil is medium dense *Sand* encountered in all of the borings. The thickness of the *Sand* ranged from 2 to 26 feet in the borings, thickest in Boring B-4. The grains of the *Sand* were coarse to fine and generally angular to sub-angular. Gravel of varying sizes was encountered in some of the *Sand* unit.

Silty Sand
A relatively thin layer of *Silty Sand* was encountered in Boring B-3. This 2 ½ -foot thick layer was present at 9 ½ feet in depth. The *Silty Sand* ranged from loose to medium dense.

Silty Clay
One thin (1inch) layer of S*ilty Clay* was recovered in Boring 4 at 21 feet. Because it was so thin, this layer may not have been detected in the other borings where there were drilling intervals with no sampling. The significance of this layer, if present across the site, is that it could be a layer on which future land-sliding might occur.

Bedrock
Granitic bedrock was encountered at the site. Depths ranged from nine feet (Boring 2) to 31 feet (Boring 4). Contact with bedrock was encountered at the following approximate elevations in the borings:

Test Boring	Bedrock Elevation (feet)
1	1743
2	1765
3	1754
4	1732

The condition of the bedrock was generally observed to be strong, based on the strength of intact pieces.

Surface & Groundwater Hydrology
The roadway is asphalt paved with drainage controlled by curb and gutter directing water into a storm drainage system. No free groundwater was observed during the drilling, even though drilling was completed in a seasonally wet period (early spring). Springs were observed along the roadway south of the site.

Ground Penetrating Radar
We conducted ground penetrating radar (GPR) surveys along Wandermere Estates lane right-of-way from approximately home address 13803 to 13909. The surveys attempted to locate potential voids beneath the road that may be present due to an uphill spring and downhill developing landslide. We observed an existing retaining wall on the east side of the street across from home addresses 13803 and 13811. A spring was also present on the east side of the street approximately 50 feet south of the retaining wall. GPR surveys did not appear to indicate voids beneath the road.

Inclinometer
Between the front portions of the homes at 13803 and 13811, and up-slope of the existing scarp, we drilled a boring to a depth of 44 feet and installed casing for an inclinometer. The inclinometer casing extends 30 inches above ground surface. The lowest measurement depth from top of casing is 46 feet. The purpose of the inclinometer is to detect, locate, and measure horizontal displacement along a particular subsurface interval within a soil or rock mass. The measurements are taken continuously at 2-foot depth increments over the length of the casing. The rate of movement is observed by conducting the measurements over intervals of time.

Our first reading was taken on April 14, 2017. We accomplished a second reading on April 20, 2017. No discernible movement occurred during that period.

Conclusions
We did not observe subsurface conditions that would indicate current instability of the road and its underlying infrastructure. The presence of the thin clayey silt layer in Boring B-4 could indicate that a similar layer under the lots is enabling the current land subsidence as the strength of this layer may be less than is necessary to support the slope inclination. This condition may explain one reason for the land

subsidence. Additionally, rain and irrigation water infiltrates the exposed ground of the residential yards adding weight and a lubricating medium for slippage.

We conclude that the soil under the existing road is currently stable. However, the head-scarp of the active landslide is currently approximately 55 feet from the edge of curb. Progression of this scarp further toward the road, or development of secondary scarps would increase the risk of damage to the roadway and related improvements. Although no groundwater was observed in explorations, the location of the site relative to the surrounding terrain suggests that stability of slopes could be affected if subjected to water infiltration.

Recommendations
The following are recommended:

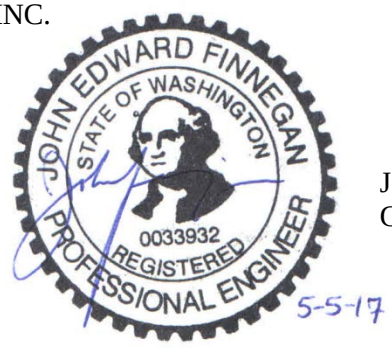
1. Capture and direct spring water on the uphill side of the road adjacent to the slide into the storm drainage system. In order to mitigate the current land subsidence, we recommend eliminating the potential for water to infiltrate exposed ground west of the road.
2. Assuming the 13811 home is removed, regrade the slope at the lowest practicable angle to the sidewalk.
3. Assuming the 13803 home is to be saved, consult with the homeowner to determine the appropriate means of stabilization.
4. Continue monitoring the inclinometer for slippage at least once per month.
5. Consider adding a second inclinometer on the north side of 13811.
6. For long-term monitoring, retain a surveyor to install and monitor approximately 5 ground surface points for vertical and horizontal displacement along the curb and sidewalk.

Limitations
Services were limited to the exploration and evaluation described herein. This report should not be used for other purposes. Geotechnical engineering for other civil, environmental, or permitting aspects of the project are beyond the scope of this involvement.

Enclosed is a document titled *Important Information About Your Geotechnical Engineering Report* to assist with understanding the context within which these services were conducted.

We appreciate the opportunity to offer this service. Please call if you have any questions.

Respectfully Submitted:
BUDINGER & ASSOCIATES, INC.



William R. Clevenger
Engineering Geologist

John E. Finnegan, PE
Geotechnical Engineer, Principal

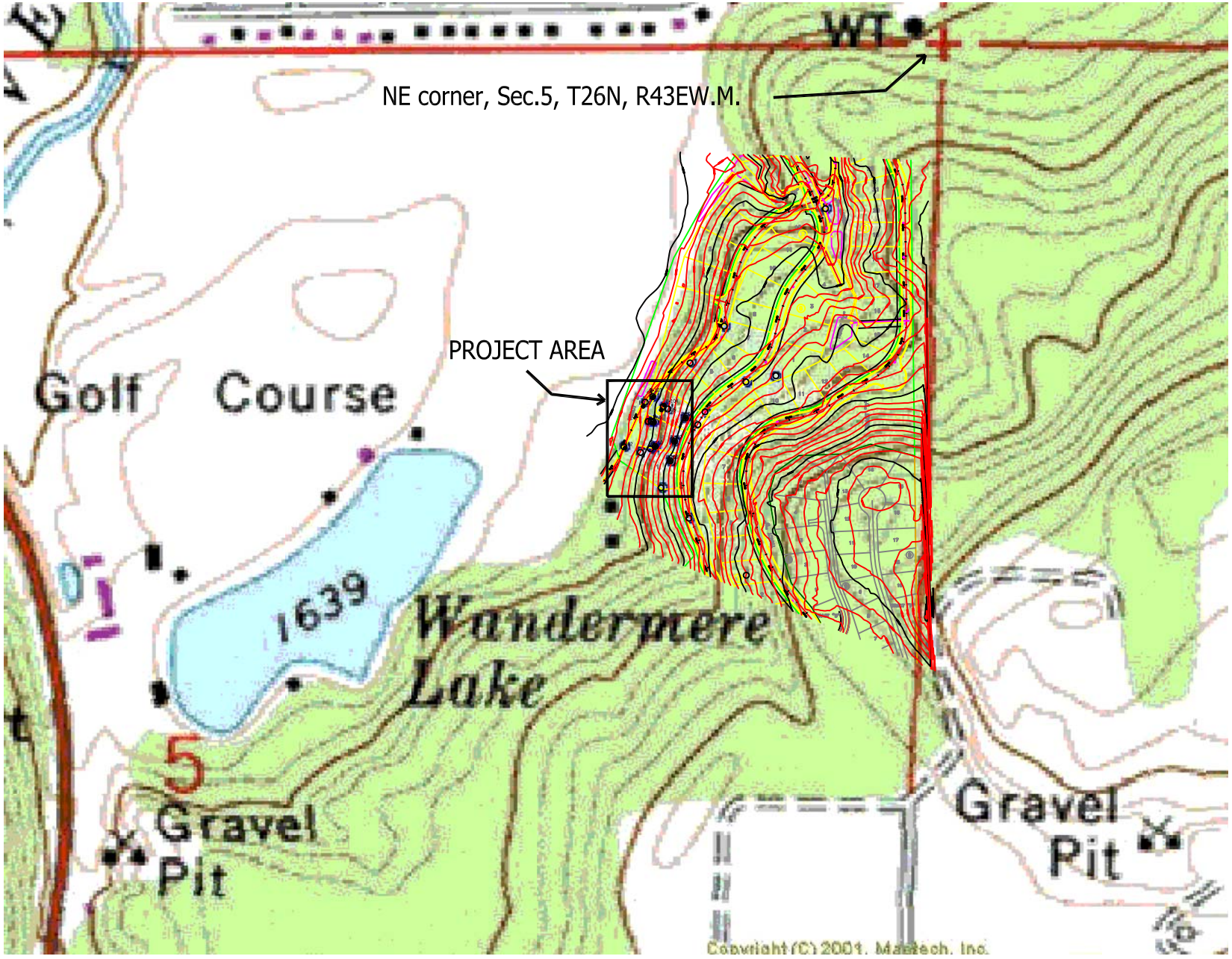
WRC/ra

Attachments

- Figure 1, Vicinity Map
- Figure 2, Site Plan
- Figure 3, Guide to Soil and Rock Descriptions
- Figure 4-1 to 4-5, Boring Logs
- Figure 5 – Inclinometer Results
- Appendix A – Field and Laboratory Methods
- Appendix B – 2006 Test Boring Logs
- Appendix C – Important Information About Your Geotechnical Engineering Report

Attachments

- Figure 1, Vicinity Map (1 page)
- Figure 2, Site Plan (1 page)
- Figure 3, Guide to Soil and Rock Descriptions (1 page)
- Figure 4-1 to 4-5, Boring Logs (5 pages)
- Figure 5, Inclinometer Results (1 page)



N

SCALE: 1"=500'

0 250 500

USGS DARTFORD QUADRANGLE
1972, PHOTO REVISED 1986

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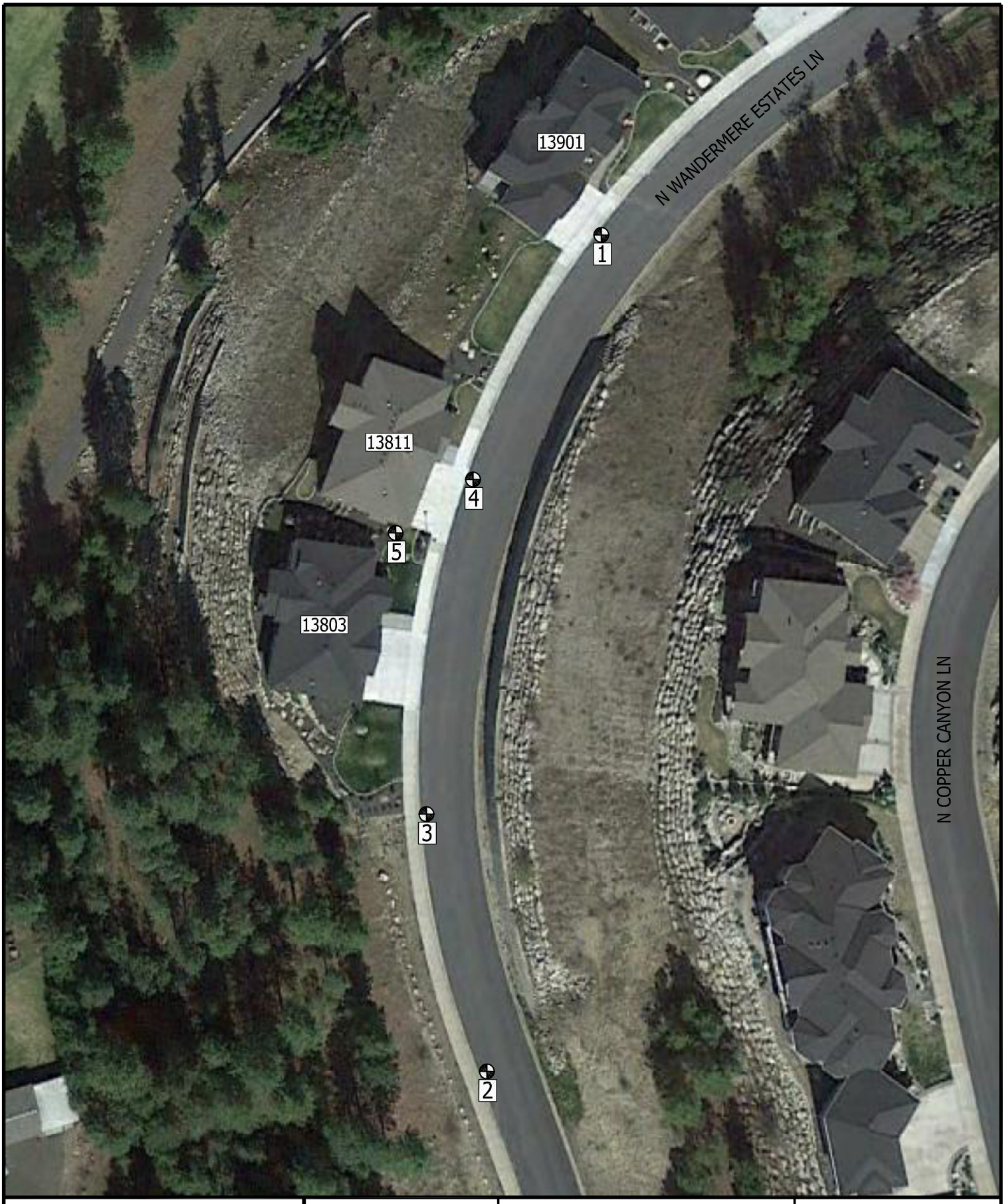
VICINITY MAP

North Wandermere Estate Lane
Wandermere, WA

FIGURE 1

Project Number S17206

Date 4/2017



N

SCALE: 1"=60'

0 30 60

IMAGERY DATE: 4/2016

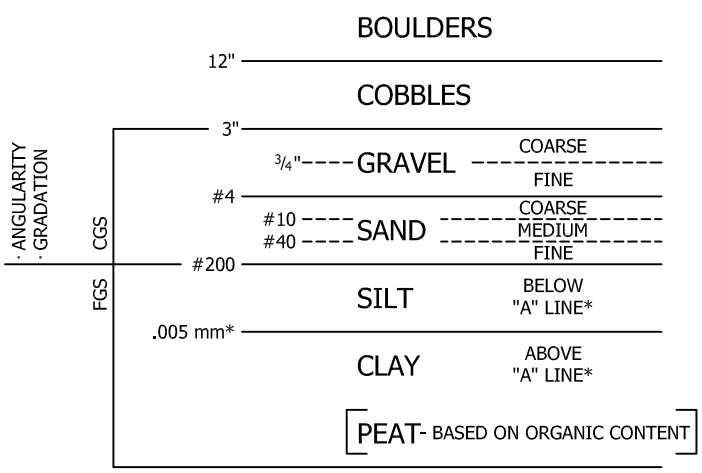
Budinger & Associates

SITE PLAN	FIGURE 2
NORTH WANDERMERE ESTATES LANE WANDERMERE, WASHINGTON	PROJECT NUMBER S17206
	DATE: 4/2017

GUIDE TO SOIL & ROCK DESCRIPTIONS

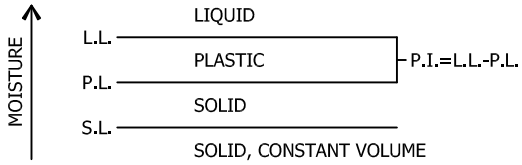
REF: WSDOT GEOTECHNICAL DESIGN MANUAL (GDM) 46-03, CHAPTER 4

SOIL CLASSIFICATION

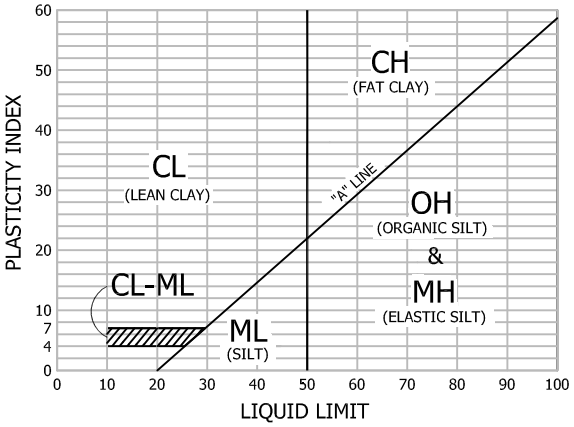


** SEE PLASTICITY CHART*
CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FGS - FINE GRAINED SOIL - 50% MORE PASSES, #200 SIEVE
FINES - PORTION FINER THAN #200 SIEVE

ATTERBERG LIMITS



PLASTICITY CHART



NOTE - CHART APPLIES TO FGS AND MINUS #40 SIEVE FRACTION OF CGS

GUIDE TO SOIL DESCRIPTION MODIFIERS, MOISTURE, AND CONDITION PRESENTED ON LOGS

MODIFIER	ESTIMATED PERCENTAGE OF MATERIAL	
SUFFIX "LY" OR "Y"	30% OR MORE FOR COARSE PARTS IN FGS GREATER THAN 10% FOR FINES IN CGS	
WITH	15% - 29% FOR COARSE PARTS	
SMALL AMOUNT	10% - 15% FOR COARSE PARTS	NOT INCLUDED IN GDM
TRACE/OCCASIONAL	1% - 10%	

NOTE - BOUNDARIES APPLY ONLY TO CLASSIFICATIONS FROM LABORATORY TESTING. VISUAL ESTIMATES OF MATERIAL PERCENTAGES TYPICALLY VARY 0 TO 10% FROM THOSE DETERMINED BY LABORATORY TESTING.

MOISTURE

DRY
MOIST
SATURATED OR WET

SOIL CONDITION

CGS:
- VERY LOOSE
- LOOSE
- MEDIUM DENSE
- DENSE
- VERY DENSE

FGS:
- VERY SOFT
- SOFT
- MEDIUM STIFF
- STIFF
- VERY STIFF
- HARD

SAMPLES

- STANDARD 2" PENETRATION TEST SAMPLER WITH BLOWS PER FOOT
- 3" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
- DRILL CUTTING SAMPLE
- BULK SAMPLE
- THIN-WALLED TUBE SAMPLE
- DIAMOND CORE RUN WITH % RECOVERY & ROCK QUALITY DESIGNATION
- 4" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
- R — REFUSAL OF SAMPLE (50+ BLOWS PER 6")

ROCK WEATHERING	ROCK CONDITION
FRESH	EXTREMELY WEAK
SLIGHTLY WEATHERED	VERY WEAK
MODERATELY WEATHERED	MODERATELY WEAK
HIGHLY WEATHERED	MODERATELY STRONG
COMPLETELY WEATHERED	STRONG
RESIDUAL SOIL	VERY STRONG

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FIGURE 3

TEST BORING 1

Date of Boring: 3-29-17
Driller: Budinger & Assoc., Inc.
Type of Drill: RikKits K40
Location: N Wand Est Ln, 12' W CL, 80' S of 13901 NE prop cor
Surface: asphalt concrete pavement

Elevation: 1762 ft
Logged by: E. Hageman
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0			2 in asphalt concrete pavement	
	R	moist, grayish brown, very dense	6 in base: GRAVEL with Sand	
			SAND with Gravel and Cobbles, medium, subangular (Probable Fill)	
5		medium dense		
	17 (40%)			
		gray	Granite BOULDER	
10		dry, brownish gray,	SAND, medium to fine, subangular	
	24 (80%)	medium dense		
15	22 (80%)			
		brown to gray	GRANITE	
20	R (0%)			
25		no free groundwater observed	End of Boring @ 25 ft	
30				
35				
40				
45				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED)
3" SPLIT SPOON PENETRATION, BLOWS/FT

10 20 30 40 50 60 70 80 90

+100

+100

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1101 North Fancher Road
Spokane Valley, WA 99212

BORING LOGS

FIGURE 4-1

Project: N Wandermere Estates Lane
Location: Wandermere, WA
Number: S17206

TEST BORING 2

Date of Boring: 3-30-17
Driller: Budinger & Assoc., Inc.
Type of Drill: RikKits K40
Location: N Wand Est Ln, 12' W CL, 140' S of 13803 SE prop cor
Surface: asphalt concrete pavement

Elevation: 1774 ft
Logged by: E. Hageman
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0			2 in asphalt concrete pavement	
	58 (100%)	dry, brown, dense	6 in base: GRAVEL with Sand	
		dry, brownish gray, loose	SILTY SAND with Gravel, medium to fine, subangular (Fill)	
5	28 (70%)			
	7 (50%)		SAND with Gravel and Debris (wire at 4½ ft), medium to fine, subangular (Fill)	
		dry, brownish gray, loose to medium dense	SAND with Gravel, medium, subangular	
10	R (80%)	brown to gray	GRANITE	
15	R (0%)	no free groundwater observed	End of Boring @ 15 ft	
20				
25				
30				
35				
40				
45				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

+100

+100

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1101 North Fancher Road
Spokane Valley, WA 99212

BORING LOGS **FIGURE 4-2**

Project: N Wandermere Estates Lane
Location: Wandermere, WA
Number: S17206

TEST BORING S17206 BORING LOGS.GPJ BUDINGER.GDT 4/21/17

TEST BORING 3

Date of Boring: 3-30-17
Driller: Budinger & Assoc., Inc.
Type of Drill: RikKits K40
Location: N Wand Est Ln, 12' W CL, 10' S of 13803 SE prop cor
Surface: asphalt concrete pavement

Elevation: 1766 ft
Logged by: E. Hageman
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION
0			2 in asphalt concrete pavement
	40 (90%)	dry, brown, medium dense	6 in base: GRAVEL with Sand
	25 (80%)	dry, brownish gray, medium dense	SILTY SAND with Gravel, coarse to fine, subaangular to angular (Fill)
5	15 (80%)	loose	SAND with Gravel, coarse to fine, subangular (Probable Fill)
	9 (100%)	moist, brown, loose	SILTY SAND, fine, subangular (Possible Fill)
		slightly moist, brownish gray, loose	SAND, medium to fine, subangular
		moist	
10	17 (90%)	moist, brown, loose to medium dense	SILTY SAND, fine
	12 (90%)		
		brown to gray	GRANITE
15	R (0%)		
		no free groundwater observed	End of Boring @ 18.5 ft
20			
25			
30			
35			
40			
45			

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

+100

TEST BORING S17206 BORING LOGS.GPJ BUDINGER.GDT 4/21/17

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Spokane Valley, WA 99212

BORING LOGS **FIGURE 4-3**

Project: N Wandermere Estates Lane
Location: Wandermere, WA
Number: S17206

TEST BORING 4

Date of Boring: 3-30-17
Driller: Budinger & Assoc., Inc.
Type of Drill: RikKits K40
Location: N Wand Est Ln, 12' W CL, 40' S of 13811 NE prop cor
Surface: asphalt concrete pavement

Elevation: 1763 ft
Logged by: B. Clevenger
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION
0			2 in asphalt concrete pavement
	72 (90%)	moist, grayish brown, dense	6 in base: GRAVEL with Sand
	21 (10%)	medium dense	SILTY SAND, medium to coarse, subangular (Fill)
5	44 (30%)	moist, grayish brown, medium dense	SAND, coarse to medium, subangular (Possible Fill)
	13 (60%)		
10	27 (75%)	moist, gray, medium dense	SAND with Gravel, medium, subangular
	15 (85%)	moist, brownish gray, medium dense	SAND, medium to fine, subangular
15	25 (100%)		
	17 (100%)		
20	26 (100%)		
	16 (75%)	brown brownish gray	1 inch CLAYEY SILT lense at 21 ft
25	27 (100%)		
	13 (100%)		
30	31		
	R	brown to gray	GRANITE
35			
		no free groundwater observed	End of Boring @ 38 ft
40			
45			

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

+100

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Spokane Valley, WA 99212

BORING LOGS **FIGURE 4-4**

Project: N Wandermere Estates Lane
Location: Wandermere, WA
Number: S17206

TEST BORING S17206 BORING LOGS.GPJ BUDINGER.GDT 4/21/17

TEST BORING 5

Date of Boring: 3-31-17
Driller: Budinger & Assoc., Inc.
Type of Drill: RikKits K40
Location: 13811 N Wand Est Ln, SE corner of residence
Surface: gravel

Elevation: 1763 ft
Logged by: E. Hageman
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		moist, grayish brown, loose to medium dense	SAND with Silt, medium, subangular to subrounded	
5				
10		moist, grayish brown, medium dense	SAND, medium fo fine, subangular	
15				
20		moist, brownish gray, medium dense	SAND, fine, subangular	
25				
30			medium to fine	
35				
40		brown to gray	GRANITE	
45		no free groundwater observed	2.75 in inclinometer set to 44 ft End of Boring @ 44 ft	

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

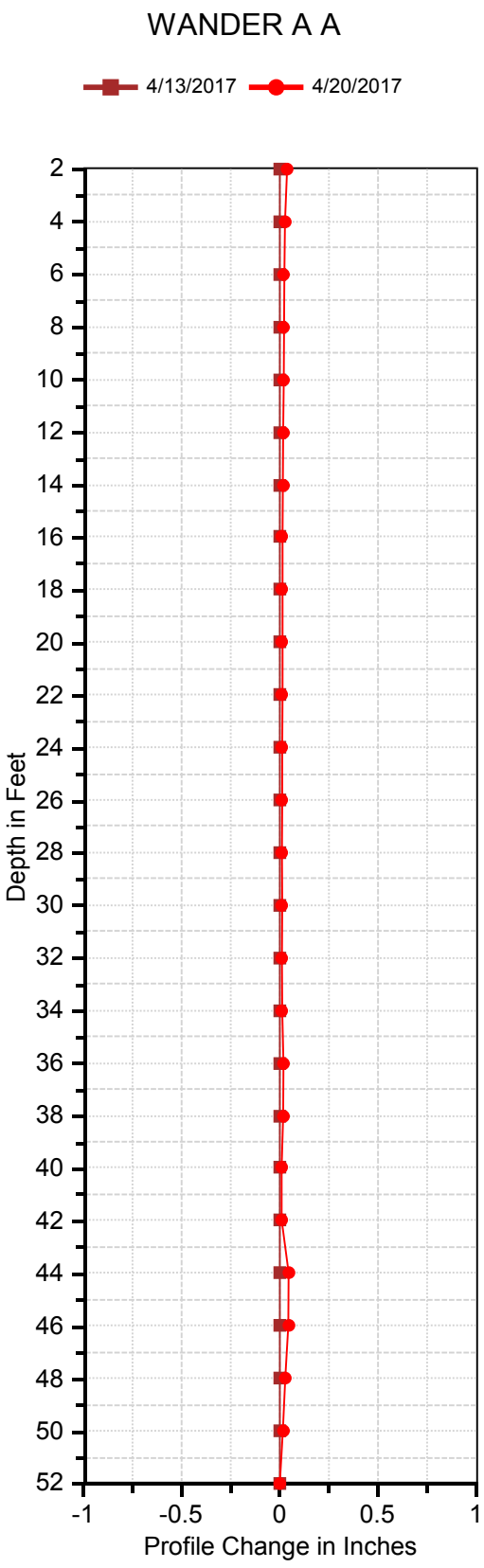
10 20 30 40 50 60 70 80 90

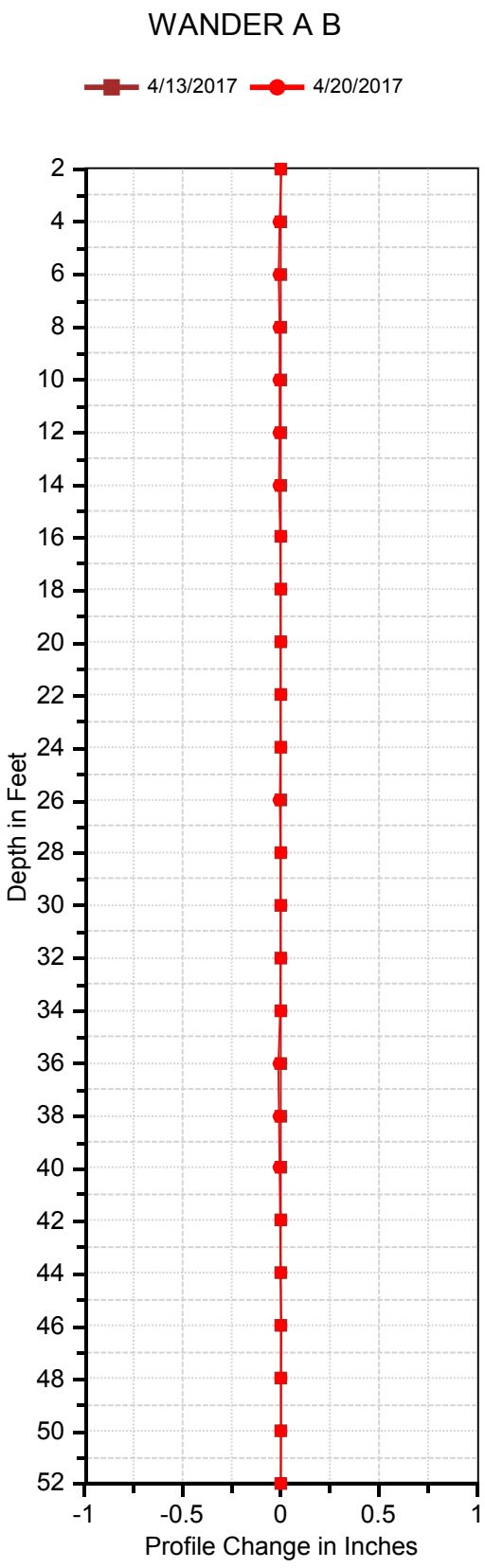
TEST BORING S17206 BORING LOGS.GPJ BUDINGER.GDT 4/21/17

Budinger & Associates
1101 North Fancher Road
Spokane Valley, WA 99212

BORING LOGS **FIGURE 4-5**

Project: N Wandermere Estates Lane
Location: Wandermere, WA
Number: S17206


WANDER A A
4/13/2017
4/20/2017
Depth in Feet
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
-1
-0.5
0
0.5
1
Profile Change in Inches


WANDER A B
4/13/2017
4/20/2017
Depth in Feet
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
-1
-0.5
0
0.5
1
Profile Change in Inches

Appendices

- Appendix A, Field and Laboratory Methods (2 pages)
- Appendix B, 2006 Test Boring Logs (10 pages)
- Appendix C, Important Information About Your Geotechnical Engineering Report (2 pages)

FIELD EXPLORATION

The fieldwork was conducted by geologist Bill Clevenger and engineering technician Ethan Hageman on March 29 & 30, 2017 supervised by principal geotechnical engineer John Finnegan, PE. The field activities generally consisted of the following:

- Reconnaissance of the site and surrounding area;
- Drilling and logging subsurface conditions in 4 test borings and 1 slope inclinometer using air rotary;
- Obtaining split-spoon and cutting samples of the soils.

Results are presented in Figures listed in the *Table of Contents*.

Test Borings

Air rotary drilling. Borings were drilled with a Hammer K40 drill rig by the air rotary method using 3 ½ -inch outside diameter casing. The air rotary method involves circulating air through a specially designed pilot bit that engages with a casing bit during drilling, but disengages upon reversal of rotation to allow retrieval of the drill stem at desired sampling depths.

Soil Samples

Standard penetration tests - ASTM D 1586. To obtain samples of soil, Standard Penetration Tests (SPT) were conducted by driving a 2-inch outside diameter split-spoon sampler with a 140-pound hammer actuated by a Mobile automatic hammer to provide a test of penetration resistance. The resulting blow count for each foot of sampler advancement, representing uncorrected N-values, is presented in the *Boring Logs*. The energy ratio (ER) is much higher with the automatic hammer compared to the reference cathead/rope system. Consequently, to correct N-values, use an estimated ER of 1.2 to reflect the greater energy imparted by the automatic hammer.

3-inch split spoon samples (3"SS) - ASTM D 3550. Some of the split spoon samples were obtained with a 3.0-inch outside by 2.4-inch inside diameter split spoon barrel sample similar to the 2-inch SPT described above. Blow counts with the 3"SS do not represent N-values since the end area of the 3-inch sampler is approximately twice that of the standard sampler. Uncorrected N-values can be approximated by multiplying the observed blow counts (in blows per foot) by 0.55 for the 3-inch split-spoon. As with SPT sampling, N-values should be corrected by using an ER of 1.2 to reflect the energy of the automatic hammer.

Soil Classification

WSDOT Soil and Rock Classification and Logging – GDM, Chapter 4 Field description of soils is done in accordance with the Washington State Department of Transportation, Geotechnical Design Manual (GDM), M 46-10, September 2015. The soil descriptions presented in the *Boring Logs* are intended to comply with the GDM. Soil descriptions are briefly covered in *Guide to Soil and Rock Descriptions.*

Location

Horizontal & vertical control. Exploration locations were selected based on relatively even spacing along the street. Test boring locations were determined using visual reference from Google Earth satellite

photography. Test boring locations can be considered accurate to within 5-feet and 2-feet horizontal and vertical, respectively.

LABORATORY ANALYSIS

Laboratory testing was performed on representative samples of the soils encountered to provide data used in our assessment of soil characteristics.

Tests were conducted, where practical, in accordance with nationally recognized standards (ASTM, AASHTO, etc.), which are intended to model in-situ soil conditions and behavior. The results are presented in Tables and Figures as listed in *Contents*.

Index Parameters

Moisture content - AASHTO T-265. Moisture contents were determined by direct weight proportion (weight of water/weight of dry soil) determined by drying soil samples in an oven until reaching constant weight.

Gradation - AASHTO T-27 & T-11. Gradation analysis was performed by the mechanical sieve method. The mechanical sieve method is utilized to determine particle size distribution based upon the dry weight of sample passing through sieves of varying mesh sizes. The results of gradation are provided in *Grain Size Distribution Results*.

TEST BORING 101

Date of Boring: 8-21-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: E. edge of cart path, 15 ft S. of manhole
Surface: grass and weeds

Elevation: 1676 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		moist, light brown, loose to medium dense	SAND, small amount Silt, trace Gravel, fine to medium, subangular	
5	11 (25%)			
10	10 (67%)	moist, brown, loose to medium dense	SAND, small amount gravel, trace Silt, occasional Cobbles/Boulders, medium, subangular	
15	14 (85%)			
	13 (85%)	moist, light brown, medium stiff	CLAY, small amount organics (laminated fibers), very slow dilatancy	
		dry, white/gray, very dense	SAND (granitic), possibly weathered granite	
20		white/gray, strong	GRANITE, moderately weathered	
25		no free groundwater observed	End of Boring @ 23 ft	
30				
35				
40				
45				
50				
55				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

LWWWT S06309 BORING LOGS.GPJ BUDINGER.GDT 11/7/06

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BORING LOGS **FIGURE 5-1**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 102

Date of Boring: 8-21-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: E. edge of cart path, 150 ft. SW of manhole
Surface: grass and weeds

Elevation: 1667 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		moist, brown, loose to medium dense	SAND, some Silt, trace Gravel, fine to medium, subangular	
5	8 (85%)			
10			BOULDER	
		moist, light brown, loose	SAND, some Gravel, fine to coarse, subangular to subrounded	
15		moist, brown, loose to medium dense	SANDY SILT (Sand is fine to medium sand)	
		white/gray, very strong	GRANITE, fresh to slightly weathered	
20		no free groundwater observed	End of Boring @ 19 ft	
25				
30				
35				
40				
45				
50				
55				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

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BORING LOGS **FIGURE 5-2**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 103

Date of Boring: 8-22-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: E. edge of cart path, 60 ft. NE of manhole
Surface: grass and weeds

Elevation: 1680 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION
0		moist, light brown, loose to medium dense	SAND, trace Silt
5			BOULDER
10		moist, brown, loose	SAND, some Gravel, fine to coarse, subangular to subrounded
	9 (67%)		
15		moist, light brown, medium stiff	CLAY
			SAND, some Gravel
		moist, light brown, loose	GRAVEL, some Sand, fine to medium
	21 (0%)		
20			SILTY CLAY
			SAND, some Gravel
			SILTY CLAY
	36 (0%)		(Silt decreases with depth)
25			SAND, some Gravel
		white/gray, strong	GRANITE, slightly weathered
30		no free groundwater observed	End of Boring @ 28 ft
35			
40			
45			
50			
55			

SOIL LOG

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

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BORING LOGS **FIGURE 5-3**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 104

Date of Boring: 8-22-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: ~75 ft. E of manhole, N. of wall failure
Surface: sand and gravel (temporary road)

Elevation: 1712 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing to 7 ft, 3" open hole to 14'

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, light brown to brown, loose to medium dense	SAND, small amount Silt, trace to small amount Gravel	
5	R (0%)	white/gray, strong	GRANITE, slightly weathered (at 7 ft, start 3" open hole drilling)	
10				
15		no free groundwater observed	End of Boring @ 14 ft	
20				
25				
30				
35				
40				
45				
50				
55				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

+100

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BORING LOGS **FIGURE 5-4**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 105

Date of Boring: 8-22-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: ~70 ft. ESE of manhole, N. of wall failure
Surface: sand and gravel (temporary road)

Elevation: 1712 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 3" open hole

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, light brown to brown, loose to medium dense	SAND, some Gravel, small amount Silt	
5			BOULDER	
10	14 (23%)	slightly moist, light brown, loose	SAND, small amount Gravel, fine to medium	
15		white/gray, strong	GRANITE, slightly weathered	
20				
25		no free groundwater observed	End of Boring @ 25 ft	
30				
35				
40				
45				
50				
55				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

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BORING LOGS **FIGURE 5-5**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 106

Date of Boring: 8-22-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: top tier of wall, 30 ft W. of road, 20 N. of power box
Surface: sand and gravel

Elevation: 1761 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION
0		moist, dark brown, loose	SAND, some Gravel, trace Silt and Boulders, fine to coarse, subangular
5	24 (16%)		(at 6-7 ft, Boulder)
10	15 (0%)	slightly moist, light brown/grey, loose	
15	51 (92%)		SILTY SAND
20	15 (100%)	very moist, dark brown, loose to medium dense	SAND, fine to medium
25	21 (92%)		
30			
35	R (10%)	slightly moist, light brown/gray, loose	SAND, some Gravel, fine to medium, subangular
40		white/gray, strong	GRANITE, slightly weathered
45		no free groundwater observed	End of Boring @ 45 ft
50			
55			

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED)
3" SPLIT SPOON PENETRATION, BLOWS/FT

10 20 30 40 50 60 70 80 90

+100

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BORING LOGS

FIGURE 5-6

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

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TEST BORING 107

Date of Boring: 8-23-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: top tier of wall, 30 ft W. of road, 60 ft S. of power box
Surface: sand and gravel

Elevation: 1761 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION
0		slightly moist, dark brown, loose	SAND, small amount Gravel, medium to coarse, subangular
5	35 (0%)		
10	25 (75%)		(at 8-13.5 ft, zone of increased Gravel)
15	16 (33%)	moist, dark brown, loose to medium dense	SAND, small amount Gravel, trace Silt, fine to coarse
20	18 (93%)		
25			
30	26 (85%)		
35			
40	34 (85%)		
45	R (0%)	moist, dark brown, loose	SAND, some Gravel, medium to coarse, subangular
50		white/gray, medium strong	GRANITE, slightly weathered
55		no free groundwater observed	End of Boring @ 50 ft

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED)
3" SPLIT SPOON PENETRATION, BLOWS/FT

10 20 30 40 50 60 70 80 90

+100

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BORING LOGS **FIGURE 5-7**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 108

Date of Boring: 8-23-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: top tier of wall, 30 ft W. of road, 160 ft S. of powerbox
Surface: sand and gravel

Elevation: 1763 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, brown, loose to medium dense	SAND, some Gravel, occasional Boulders, fine to coarse, subangular	
5			(at 4-6 ft, Boulder)	
10	17 (67%)			
15		moist, red brown, loose to medium dense	SAND, trace to small amount Silt, fine to medium	
20	22 (93%)		(at 13-17 ft, zone of increased Silt)	
25	23 (87%)			
30		white/gray, strong to medium strong	GRANITE, slightly weathered	
35		no free groundwater observed	End of Boring @ 35 ft	
40				
45				
50				
55				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED) ◪
3" SPLIT SPOON PENETRATION, BLOWS/FT ■

10 20 30 40 50 60 70 80 90

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BORING LOGS **FIGURE 5-8**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 109

Date of Boring: 8-23-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: 2nd tier of wall, 80 ft SE of manhole
Surface: sand and gravel

Elevation: 1715 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		slightly moist, dark brown, loose to medium dense	SAND, small amount Gravel, trace Silt, subanugular-subrounded, fine	
5	6 (85%)			
		moist, dark brown, loose to medium dense	SAND, small amount Silt and Gravel, fine to medium	
10	4 (67%)			
15	10 (50%)	slightly moist, dark brown, loose to medium dense	SAND, some Gravel, trace Silt, subangular-subrounded, fine to coarse	
20		white/gray, strong to medium strong	GRANITE, slightly weathered	
		no free groundwater observed	End of Boring @ 21 ft	
25				
30				
35				
40				
45				
50				
55				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED)
3" SPLIT SPOON PENETRATION, BLOWS/FT

10 20 30 40 50 60 70 80 90

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BORING LOGS **FIGURE 5-9**

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

TEST BORING 110

Date of Boring: 8-23-06
Driller: Budinger & Assoc., Inc.
Type of Drill: Mobile B-57 with automatic SPT hammer
Location: 100 ft W. of road, southern end of wall
Surface: sand and gravel

Elevation: 1748 ft
Logged by: J. Finnegan/E. Olson
Size of hole: air rotary overburden system, 4.5 in O.D. casing

DEPTH	SAMPLES RQD, BLOW COUNTS N (% RECOVERY)	MOISTURE, COLOR, CONDITION	DESCRIPTION
0		slightly moist, light brown to gray, loose to medium dense	GRAVEL, small amount Sand, medium to coarse
5	12 (67%)		
	13 (75%)	slightly moist, light brown, loose to medium dense	SAND, some Gravel, trace Silt, subangular, fine to coarse
			SILTY SAND, fine to medium
10	11 (67%)	moist, dark brown, medium dense	SAND, small amount Gravel, trace Silt, subangular, fine to coarse
		slightly moist, dark brown, loose to medium dense	
15	R (0%)		
			BOULDER
		slightly moist, dark brown, loose to medium dense	SILTY SAND, some Gravel, subangular-subrounded, fine
20	R (33%)		
25			
		moist, dark brown, medium dense	SAND, small amount Gravel and Silt, medium to coarse
30	12 (67%)		
35			
40	18 (50%)	moist, brown, medium dense	SAND, some Silt, trace Clay
45	28 (85%)	very moist, brown, medium to stiff	SILT, small amount Sand, trace Clay
		white/gray, strong to medium strong	GRANITE, slightly weathered
50		no free groundwater observed	End of Boring @ 50 ft
55			

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○
STANDARD PEN TEST, N-VALUE (OBSERVED)
3" SPLIT SPOON PENETRATION, BLOWS/FT

10 20 30 40 50 60 70 80 90

+100

+100

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BORING LOGS

FIGURE 5-10

Project: Wandermere Estates Wall Repair
Location: Spokane, WA
Number: S06309

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Important Information About Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes. The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one -not even you* -should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on a Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes-even minor ones-and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Options

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ-sometimes significantly-from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not over-rely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from the judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled “limitations” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth
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