BACKHOE COMPANY: Gene S McMurrin BUCKET SIZE: 24 inches DATE: 7/11/17

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
TEST PIT NO. TH-#1 ELEVATION						
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			21.1		
					ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
	X			14.8		
5					SM/RK	Medium to orangish-brown, moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						
TEST PIT NO. TH-#2 ELEVATION						
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			33.5		
					ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
5					SM/RK	Medium to orangish-brown, moist to very moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1001.052.G | DEVON AVENUE SUBDIVISION | FIGURE NO. A-5

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 7/11/17

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
						TEST PIT NO. TH-#3 ELEVATION
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			26.6	ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
	X			15.1		
5					SM/RK	Medium to orangish-brown, moist to very moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater encountered at time of exploration
10						
15						
						TEST PIT NO. TH-#4 ELEVATION
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			20.5	ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
5					SM/RK	Medium to orangish-brown, moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1001.052.G | DEVON AVENUE SUBDIVISION | FIGURE NO. A-6

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 7/11/17

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
						TEST PIT NO. TH-#5 ELEVATION
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
5					SM/RK	Medium to orangish-brown, moist to very moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater encountered at time of exploration
10						
15						
						TEST PIT NO. TH-#6 ELEVATION
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
5					SM/RK	Medium to orangish-brown, moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1001.052.G | DEVON AVENUE SUBDIVISION | FIGURE NO. A-7

BACKHOE COMPANY: Gene S. McMurrin BUCKET SIZE: 24 inches DATE: 7/11/17

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
						TEST PIT NO. TH-#7 ELEVATION
0					ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, moist to very moist, medium stiff to stiff, sandy, clayey SILT
5					SM/RK	Medium to orangish-brown, moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater encountered at time of exploration
10						
15						
						TEST PIT NO. TH-#8 ELEVATION
0	X			19.9	ML	Dark brown, moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML	Medium to reddish-brown, moust to very moist, medium stiff to stiff, sandy, clayey SILT
5					SM/RK	Medium to orangish-brown, moist, medium dense to dense, clayey, silty SAND to highly weathered bedrock
						Total Depth = 5.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1001.052.G | DEVON AVENUE SUBDIVISION | FIGURE NO. A-8

MAXIMUM DENSITY TEST RESULTS

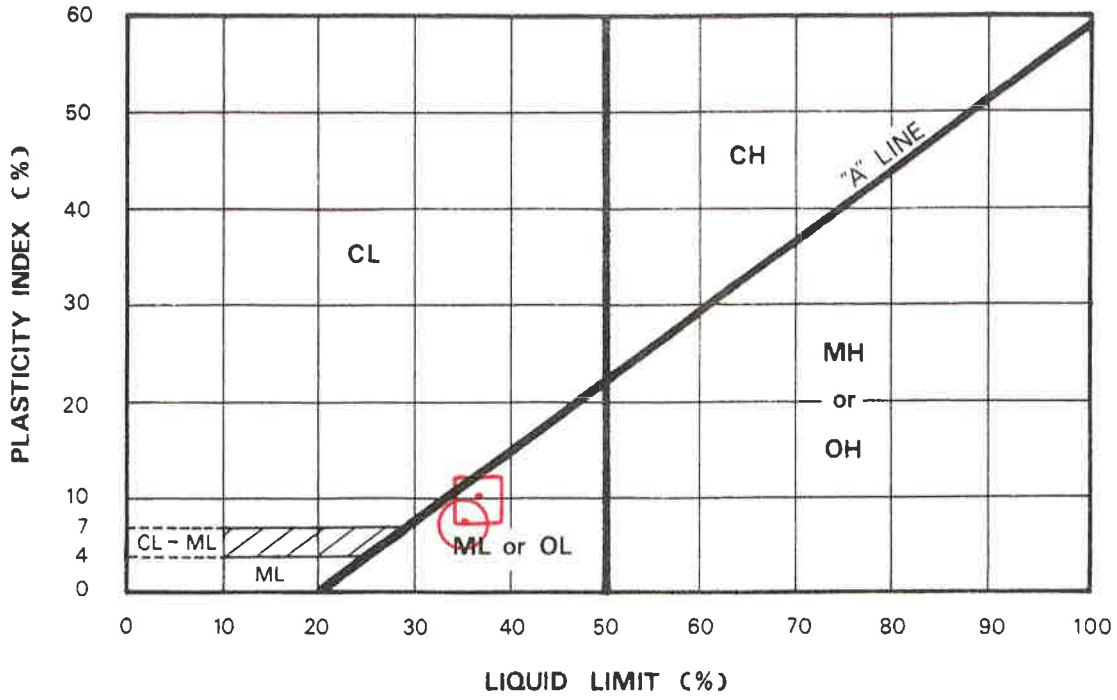
SAMPLE LOCATION	SOIL DESCRIPTION	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)
TH-#1 @ 1.5'	Medium to reddish-brown, sandy, clayey SILT (ML)	102.0	28.0
TH-#2 @ 1.5'	Medium to reddish-brown, sandy, clayey SILT (ML)	100.0	30.0

EXPANSION INDEX TEST RESULTS

SAMPLE LOCATION	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (pcf)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (%)	EXPANSION INDEX	EXPANSIVE CLASS.

MAXIMUM DENSITY & EXPANSION INDEX TEST RESULTS

PROJECT NO.: 1001.052.G | DEVON AVENUE SUBDIVISION | FIGURE NO.: A-9



KEY SYMBOL	BORING NO.	SAMPLE DEPTH (feet)	NATURAL WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	PASSING NO. 200 SIEVE %	LIQUIDITY INDEX	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	TH-#1	1.5	21.1	35.0	7.2	90.9		ML
▣	TH-#2	1.5	33.5	37.2	10.1	86.3		ML

REDMOND GEOTECHNICAL SERVICES
PO BOX 20547 • PORTLAND, OREGON 97294

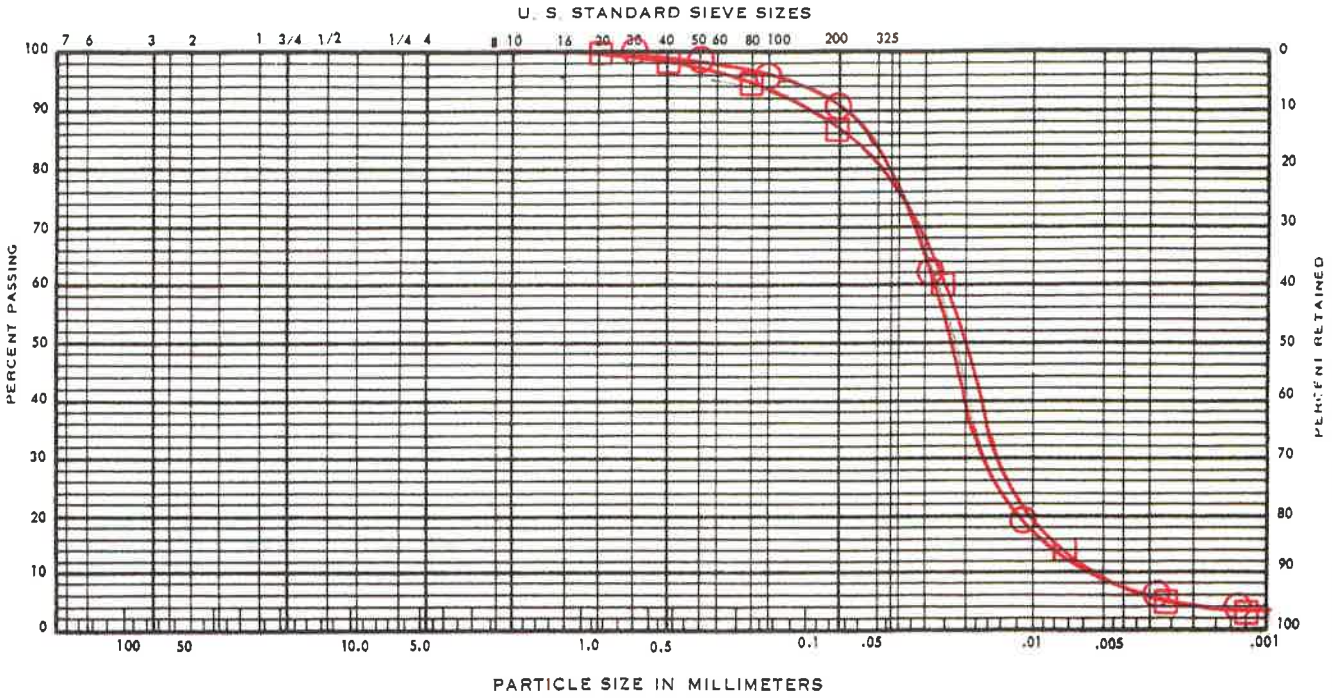
PLASTICITY CHART AND DATA

DEVON AVENUE SUBDIVISION
TL 300, 6719 DEVON AVENUE SE

PROJECT NO.	DATE	
1001.052.G	8/11/17	Figure A-10

UNIFIED SOIL CLASSIFICATION SYSTEM

(ASTM D 422-72)



COBBLES	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

KEY SYMBOL	BORING NO.	SAMPLE DEPTH (feet)	ELEV. (feet)	UNIFIED SOIL CLASSIFICATION SYMBOL	SAMPLE DESCRIPTION
⊖	TH-#1	1.5		ML	Medium to reddish-brown, sandy, clayey SILT
⊟	TH-#2	1.5		ML	Medium to reddish-brown, sandy, clayey SILT

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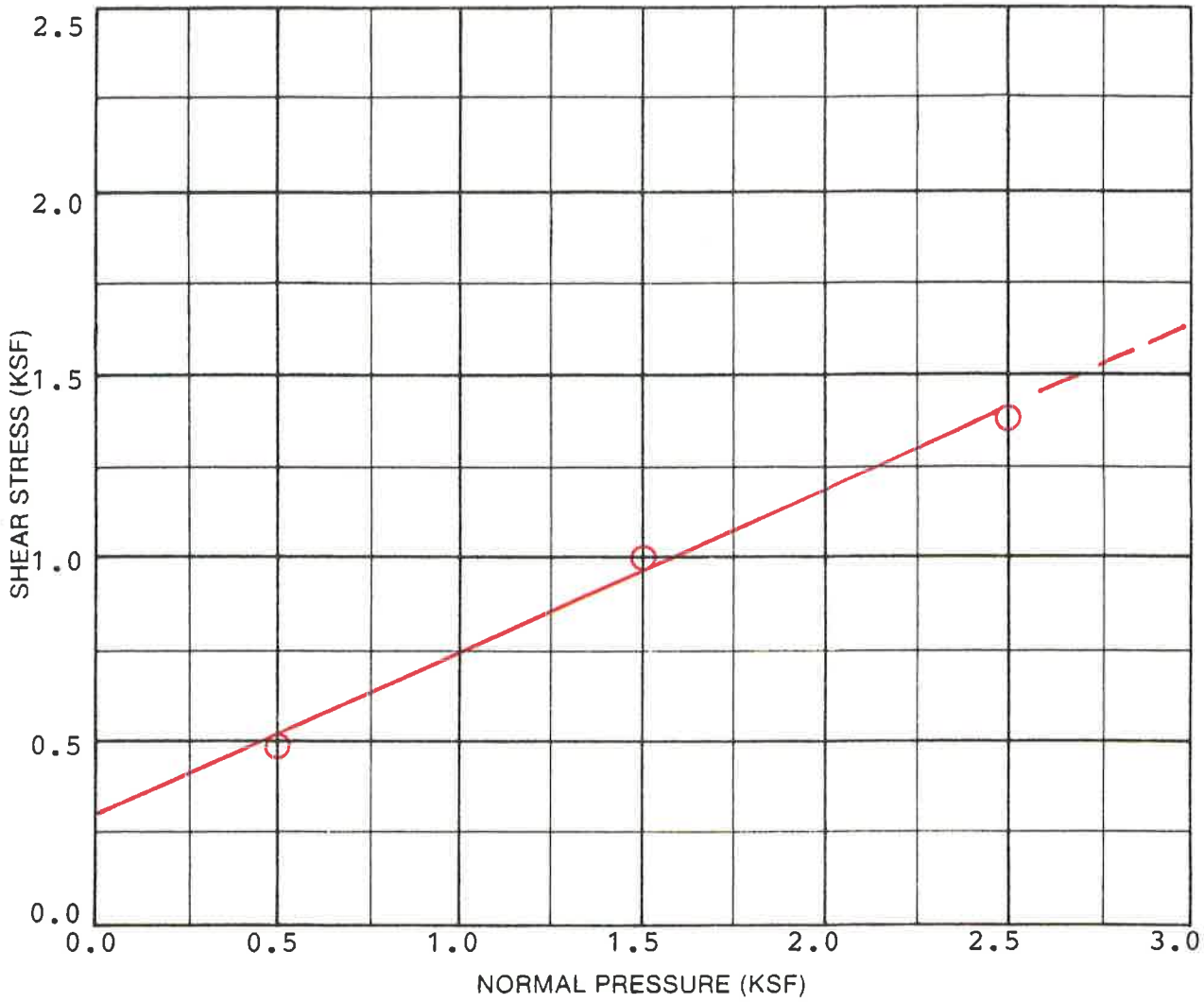
PO Box 20547 • Portland, Oregon 97294

GRADATION TEST DATA

DEVON AVENUE SUBDIVISION
TL 300, 6719 DEVON AVENUE SE

PROJECT NO.	DATE	FIGURE A-11



SAMPLE DATA	
DESCRIPTION: Medium to reddish-brown, sandy, clayey SILT (ML) (Remolded)	
BORING NO.: TH-#2	
DEPTH (ft.): 1.5'	ELEVATION (ft):
TEST RESULTS	
APPARENT COHESION (C): 300 psf	
APPARENT ANGLE OF INTERNAL FRICTION (Φ): 22°	

TEST DATA				
TEST NUMBER	1	2	3	4
NORMAL PRESSURE (KSF)	0.5	1.5	2.5	
SHEAR STRENGTH (KSF)	0.5	1.0	1.4	
INITIAL H_2O CONTENT (%)	30.0	30.0	30.0	
FINAL H_2O CONTENT (%)	30.6	26.1	20.9	
INITIAL DRY DENSITY (PCF)	90.0	90.0	90.0	
FINAL DRY DENSITY (PCF)	90.4	94.6	99.8	
STRAIN RATE: 0.02 inches per minute				

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DIRECT SHEAR TEST DATA

DEVON AVENUE SUBDIVISION
TL 300, 6719 DEVON AVENUE SE

PROJECT NO	DATE	Figure A-12

RESULTS OF R (RESISTANCE) VALUE TESTS

SAMPLE LOCATION: TH-#1

SAMPLE DEPTH: 1.5 feet bgs

Specimen	A	B	C
Exudation Pressure (psi)	219	329	431
Expansion Dial (o.ooo1")	0	1	3
Expansion Pressure (psf)	0	3	9
Moisture Content (%)	30.6	27.4	22.1
Dry Density (pcf)	93.4	98.2	102.6
Resistance Value, "R"	17	29	37
"R"-Value at 300 psi Exudation Pressure = 28			

SAMPLE LOCATION: TH-#2

SAMPLE DEPTH: 1.5 feet bgs

Specimen	A	B	C
Exudation Pressure (psi)	208	326	439
Expansion Dial (0.0001")	0	2	5
Expansion Pressure (psf)	0	6	15
Moisture Content (%)	32.3	28.6	23.9
Dry Density (pcf)	92.1	96.1	100.7
Resistance Value "R"	15	27	35
"R"-Value at 300 psi Exudation Pressure = 26			

Division 004 Appendix C - Infiltration Testing

Location: TL 300, 6719 Devon Avenue SE	**Date:** July 11, 2017	**Test Hole:** TH-#2
Depth to Bottom of Hole: 3.0 feet	**Hole Diameter:** 6 inches	**Test Method:** Encased Falling Head
Tester's Name: Daniel M. Redmond, P.E., G.E. **Tester's Company:** Redmond Geotechnical Services, LLC		**Tester's Contact Number:** 503-285-0598

Depth (feet)	Soil Characteristics
0-0.5	Dark brown Topsoil
0.5-3.0	Medium to reddish-brown, sandy, clayey SILT (ML)

Time	Time Interval (Minutes)	Measurement (inches)	Drop in Water (inches)	Infiltration Rate (inches/hour)	Remarks
10:00	0	24.00	----		Filled w/12" water
10:20	20	24.50	0.50	1.50	
10:40	20	24.92	0.42	1.26	
11:00	20	25.27	0.35	1.05	
11:20	20	25.57	0.30	0.90	
11:40	20	25.83	0.26	0.78	
12:00	20	26.06	0.23	0.69	
12:20	20	26.27	0.21	0.63	
12:40	20	26.47	0.20	0.60	

Infiltration Test Data Table

Division 004 Appendix C - Infiltration Testing

Location: TL 300, 6719 Devon Avenue SE	**Date:** July 11, 2017	**Test Hole:** TH-#3
Depth to Bottom of Hole: 2.0 feet	**Hole Diameter:** 6 inches	**Test Method:** Encased Falling Head
Tester's Name: Daniel M. Redmond, P.E., G.E. **Tester's Company:** Redmond Geotechnical Services, LLC		**Tester's Contact Number:** 503-285-0598

Depth (feet)	Soil Characteristics
0-0.5	Dark brown Topsoil
0.5-2.0	Medium to reddish-brown, sandy, clayey SILT (ML)

Time	Time Interval (Minutes)	Measurement (inches)	Drop in Water (inches)	Infiltration Rate (inches/hour)	Remarks
10:20	0	12.00	----		Filled w/12" water
10:40	20	12.70	0.70	2.10	
11:00	20	13.22	0.52	1.56	
11:20	20	13.66	0.44	1.32	
11:40	20	14.04	0.38	1.14	
12:00	20	14.37	0.33	0.99	
12:20	20	14.67	0.30	0.90	
12:40	20	14.95	0.28	0.84	
1:00	20	15.22	0.27	0.81	

Infiltration Test Data Table

Appendix "B"

Geologic Hazard Assessment

NORTHWEST GEOLOGICAL SERVICES, INC.
Consulting Geologists and Hydrogeologists
2505 N.E. 42nd Avenue, Portland, Oregon 97213-1201
503-249-1093 ngs@teleport.com

Redmond Geotechnical Services, LLC 27 July 2017
P.O. Box 20547
Portland, Oregon 97294

Attn: Dan Redmond

Geological Assessment
8S/3W-22C Tax Lot 300
Salem, Marion County, Oregon

Dear Dan:

The purpose of this letter is to present Northwest Geological Services, Inc. (NGS') Geologic Hazard Assessment for the above referenced property. This study includes the engineering geology tasks required by Salem and Marion County to develop in areas that appear to have potential geologic hazards. We understand that our services are in support of your client's efforts to partition and develop the property for residential use. The current proposal is to partition the site into approximately 80 residential lots with access streets, and infrastructure as needed. The work for this study was done in accordance with your email authorization of 28 June 2017.

1. SCOPE OF STUDY

The scope of our study was limited to the engineering geologic consultation necessary to assess potential slope hazards, as required by Salem and Marion County. Specifically, our work included:

- Obtain and review LIDAR and historic aerial photographs of the site;
- Obtain and review well logs for the site area;
- Review available geologic and geologic hazard investigations of the site and site area;
- Conduct a geologic reconnaissance of the site and adjacent area;
- Evaluate the potential landslide hazards using the information developed; and,
- Prepare this letter describing our work, findings and recommendations.

Our work did not include some items the County may request for Geological Assessments of slope hazard areas. Specifically, the excluded items are: site grading plans showing cuts and fills; and geologic cross sections showing subsurface conditions. We understand the grading plan will be developed as part of the plans for the building permit application for the site. In our opinion, the geology of the site is simple (Sections 3 and 4) and a cross section is not required to comprehend the subsurface conditions. Nor is a grading plan necessary to asses the stability of the natural slopes. However, those items should be developed in the Geotechnical report for the site.

2. SITE SETTING

The site is south of Battle Creek, north of Rees Hill Rd. and west of Devon Ave SE (Figures 1 and 2) in the northeast corner of the southwest quarter of Section 22, T8S/R3W. The 19.89 acre property is currently accessed from Devon Ave SE. City of Salem Zoning Map 8322S (S ½ 22-8S3W) shows the site is zoned RA (Residential Agricultural). The site is in the South Salem Hills Ground Water Limited Area.

2.1 Location and Physiography

The property is south of Battle Creek and straddles the summit of Reese Hill, a NE-SW ridge that extends from Hylo Rd. SE northeast to Battle Creek (Figures 1 and 2). An intermittent tributary of Battle Creek extend N-S just west of the site. Elevations at the site range from about 652 ft in the south central area (i.e., Reese Hill) down to about 546 ft at the NW corner (Figures 1 and 4). Overall slopes are gentle, but local steep areas occur (Figures 1, 2, 4 and Section 3.2). The overall slope west from the crest of Reese Hill averages 11% to 14%. The slope east towards Devon Ave SE averages 4% to 7%. Both west and east slopes have locally irregular topography with small scale areas of slope up to 30% or rarely 50% (Figure 4). These declivities are 4 to 6 ft high by 20 to 50 ft wide mounds. They lack corresponding uphill depressions as one would expect of slope failures.[1]

The west northeast parts of the site – the areas with irregular topography – are currently covered by mixed conifer and deciduous trees with understory brush (Figure 2). The mature trees have significant root mounds because of the shallow site soils (Figures 4 and 7). Additionally, many of the irregularities appear to be remnants of the former prune orchards. The central and east parts of the site are cleared field with scattered mature Douglas Firs in the SW corner. The existing residence and outbuildings are located in the SW corner (Figure 2).

There are no drainage ways on the site. Drainage is by sheet runoff and via small, shallow declivities developed during past logging and farming of the property. Drainage is towards an unnamed tributary of Battle Creek[2] located about just west of the site and Powell Creek east of the site (Figures 1).

The geology of the area around the site (Section 2.3) is very well known. It was mapped by the State (Bella, 1981), for a Portland State MS thesis (Hoffman, 1981), by the USGS (Beeson and Tolan, 2001) and by us for Chinook Estates and Marion County (NGS, 1994, 1997). Figure 5 shows our mapping of the area around the site.[3] All studies found the site underlain by Miocene volcanic rocks of the Columbia River Basalt (Figures 3 and 4) and pre-basalt sedimentary strata at considerable depth (Section 2.3).

2.2 Site Area Geology

The site lies on the north flank of the west Salem Hills. These hills are an anticlinal uplift that extends from the Willamette River north about 10 miles to Salem and from the

1 The detailed topography (Figures 4 and 7) is interpreted from LIDAR flown for DOGAMI in 2009. Reconnaissance and digital images indicate that site clearing has smoothed or removed some irregularities.

2 Informally called Champion Swale by the City and shown as that on the City LIDAR (figures 4 and 7).

3 The geologic interpretation shown on Figure 5 is based on surficial geologic mapping, aerial photo interpretation, and our evaluation of over 200 water well logs (NGS, 1997). Identification of basalt flows is based on our previous experience and several chemical analyses done by Hoffman (1981).

river to east of I-5. Bella (1981) mapped the site as underlain by Columbia River Basalt (CRB), in substantial agreement with earlier mapping by the U.S. Geological Survey (Fox-worthy, 1970). Both studies found the CRB to be at least 350 ft thick in the site area. Our mapping (Figure 5) and review of well logs in the area indicates that the CRB is at least 350 to 400 ft thick beneath the site. The review also suggests the basalt dips gently north and northeast towards Salem.

Mapping by Hoffman (1981) identified the individual flows within the CRB. The east part of the site is underlain by the youngest hi-magnesium flow of the Grande Ronde Basalt (now known as the Sentinel Bluffs). The Winter Water flow of the Grande Ronde Basalt underlies the steeper slopes marginal to the unnamed drainage west of the site (Figures 4 and 5).

In the site area, the upper few feet of the basalt bedrock underlying ridges and hillsides is generally weathered or decomposed to a hard, red-brown gritty, silty clay or clayey silt. However, the original volcanic texture of the basalt is preserved by the weathering. Thus, the basalt is generally recognizable, even when decomposed.[4] The distinction is important, because the marine sedimentary strata are often involved in slope failures. The weathered basalt is generally not involved in slope failures, except where its physical properties have been ignored during development.

2.3 State and City Estimates of Landslide Hazard Susceptibility

The State conducted assessments of potential landslide hazards for Salem and Marion County. These included notably slide-prone parts of the area (OFR O-77-4 by Schlicker, 1977), the west Salem Hills (IMS-6 by Harvey and Peterson, 1998) and IMS-17 (Hofmeister and others, 2000). These assessments were based on the available geologic studies, including the aforementioned NGS studies, information about soils strength and GIS modeling using the USGS topographic DEM.

IMS-6 does not extend east to the site nor is the site in an active or inactive landslide area (e.g., as defined by OFR O-77-4). IMS-17 estimates the site ranges from very low to moderate relative risk of earth-induced landsliding (Figure 6). The latest State estimates are incorporated into SLIDO[5] that shows no nearby active, historic or prehistoric landslides. However, the SLIDO landslide susceptibility map shows no to moderate landslide hazard in agreement with IMS-17 estimates.

In our experience, IMS-6 estimates for water induced landslide risks in areas similar to the site are generally Category 4. Thus, were this site within the area covered by IMS-6, it would likely have a low to moderate risk of water induced landslides.

The City of Salem provides Landslide Hazard Maps based on slope (generally from LIDAR) and available risk assessments from various government sources (Figure 7). Salem's map assigns 2 to 3 landslide hazard points (low to moderate) to the site.

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4 However, the relict volcanic texture in soils derived from weathering of volcanic units can be hard to see on a cloudy or rainy day. Thus, some investigators have incorrectly mapped decomposed Columbia River Basalt as weathered tuffaceous sedimentary strata, Willamette Silt, or even landslide deposits.

5 SLIDO is Oregon State DOGAMI's Statewide Landslide Information Layer for Oregon. SLIDO compiles available DOGAMI & USGS geologic and hazard mapping: http://www.oregongeology.org/sub/slido/

3. SITE SPECIFIC STUDIES

3.1 Previous Site Development

We reviewed available historic topographic maps and aerial photographs[6] for indications of slope failures at and near the site. The aerial photographs were also reviewed to identify potential areas of cut or fill made during previous use or development of the site.

The maps and photos show that the site has a long history of use as orchard and pasture. The 1936 (Figure 8) and 1944 aerial photos, and the 1950s topographic map and aerial photos show the site as mostly prune orchard typical of the area (Meyering, 2008) with a residence in the southwest part. By 1955, the summit area was cleared of trees and used as pasture. The 1967 photos show the orchard was mostly cut with a few conifers starting in the NW and along Devon Ave SE. A few fruit tree remained along the west end of the site. Most of the site appears fallow and unused in 1967 and in 1976. However, the 1971 and 1985 photos show the east 1/3 of the site around the residence mowed, presumably for hay and/or fire control. The remainder appears to be brush and conifers. The 1990 and 1994 images show only a 2 to 3 acre area around the residence was maintained as yard. The remainder was brush and maturing conifers with a few trails cleared through the site. Digital imagery shows that from 2010 through the summer of 2016 the site was progressively cleared, trees thinned and topography between the trees smoothed.

In summary, the historic maps and photos show the site has been farm and/or orchard with a residence since the 1930s. Properties north, east and south have also been small farms and/or low-density residential. Property to the west has been intermittently logged and cleared as wood lot.

No signs of slope instability or failure were observed on the aerial photographs we examined. The resolution of the aerial photos is adequate to see vehicles on roads and relatively minor earthworks. Consequently, we believe that any significant slope failure should have been identifiable on the photos we reviewed.

3.2 Surface and Subsurface Observations

We conducted a walking reconnaissance of the site, and observed road cuts and accessible excavations in the site neighborhood. As noted, we previously mapped the site area and also conducted an assessment of TL 200 immediately north (NGS, 2008), so we reviewed maps and notes our previous work for this study.

At the highest site elevations, the surficial soils are mostly derived from weathering of the basalt bedrock with an admixture of loess blown up from the Willamette floodplain. These soils generally have a thin topsoil of fine to medium sandy clayey SILT with abundant organic material and occasional pebbles, cobbles and boulders of weathered rock. On slopes below the ridgetop, soils are decomposed basalt: red brown, stiff to hard silty sandy CLAY to sandy clayey SILT with sparse to abundant rock fragments.

Four test pits were excavated on 11 July 2017 to assess site soils (Figure 7). TP-1, -2 and -4 found severely weathered Sentinel Bluffs basalt at 3 ft, 3.5 ft and 2.5 ft, respectively. TP-3 found small boulders of weathered Winter Water basalt at 1 ft. The boulders were in a

6 Stereo pairs of aerial photos taken in 1936, 1944, 1955, 1967, 1971, 1976, 1985, 1990 and 2000 were reviewed. We also reviewed USGS, Google Earth and Earth Explorer imagery from 1994-2016.

matrix of severely weathered to decomposed basalt. Practical refusal with the small excavator was reached at depths of 3 to 5 ft in all test pits.

Soils above the weathered basalt were 1 to 2 ft of medium, red brown fine sandy SILT (loess) in TP-1 and -4. Weathered basalt in TP-3 was overlain by medium, red brown clayey SILT that graded to stiff at 2.5 ft and to hard decomposed basalt from 2.5 to 3.5-4 ft. In TP-4 the basalt was overlain by 1 ft of organic SILT topsoil.

The complete natural weathering profile is exposed north of the site in an excavation along Sahalee Dr SE. (Figure 4). About 1/4 mile north of the site, excavations for Lone Oak Rd SE expose unweathered Sentinel Bluffs and Winterwater basalt at depths of 8 to 15 ft.

In summary, soils exposed in the test pits at the site are consistent with soils in the surrounding area: thin, competent surficial soils derived mostly from in-situ weathering of the basalt with an admixture of loess along ridges and uplands. Valley soils are also competent, thin and a mix of colluvium and decomposed basalt.

3.3 Ground Water Observations

No seeps or springs were observed at the site. Springs have been reported at the contact between Sentinel Bluffs and Winterwater Basalt on neighboring properties. The nearest recorded spring is south of the site just south of Rees Hill Rd SE.

Driller's logs of nearby wells indicate that the regional water table is below the elevation of the Battle Creek flood plain. Most wells have modest yields and depths to water of 170 to 250 ft. However, local perched zones occur between the basalt flows. Such perched zones supply the aforementioned springs.

We suspect that the relatively clayey, moderately-low-permeability soils saturate quickly during heavy precipitation. That is because the severely weathered top of the basalt bedrock is shallow and relatively impervious compared to the overlying soils.

4. Interpretation of Site Conditions

The reconnaissance, test pits, area roadcuts and excavations, and historic aerial photographs, confirm that the site is underlain by bedrock consisting of Columbia River Basalt, as mapped previously (NGS, 1994, 1997, 2008). The top of the Basalt is severely weathered to decomposed, but it is still relatively competent material. The relatively fresh bedrock on the slopes is typically covered by 3 to 5 ft of soils (decomposed rock). However, basalt crops out locally and may be found near ground surface anywhere in the immediate site area.[7]

Typically, the soils derived from the basalt creep on moderate and steep slopes. Curved and pistol-butted trees are present on the steepest slopes at the site and these trees are consistent with soil creep. However, the 60 to 80 year-old firs are erect at the tops, indicating that creep is slow enough for the trees to keep up with it.

Available information indicates that the Basalt extends for 350 to 400 ft depth below the site. Site mapping indicates that the flows dip gently north beneath the site. Together

[7] Except that bedrock is at greater depths below the alluvium of the Battle Creek floodplain, north of the site, and its tributaries east and west of the site.

with the competent nature of the site materials, it seems most unlikely to us that there is any significant risk of slope failure involving the bedrock. This interpretation is **supported** by a complete lack of evidence that the site has suffered from slope instability in the past.

However, a few cuts for roads in the area have failed locally where they were too steep or became locally saturated during intense storms. Additionally, our previous experience in the area indicates that careful design and construction is required to use local soils as fill.

5. Conclusions and Recommendations

We found no evidence that slopes at the site have ever failed, nor indication that they will fail under the expected range of future conditions. The site and neighbors have survived severe rainfall events in 1964, 1974, 1994, 1996, 2003, 2006 and most recently December 2016. Numerous slides occurred at other sites in the Salem region during these severe storms.

Even though the site soils have not failed, they do creep, and similar soils have failed locally in overly-steep excavations (NGS, 2008). Consequently, we recommend that foundations be placed on competent material. Foundations and retaining walls should be designed by a qualified professional to withstand forces from soil creep and lateral loads from earthquakes. Given the thin soils and shallow depth to weathered bedrock, this requirement should not be onerous.

Cuts higher than 4 ft and steeper than 1V:2H, and fills more than 2 ft thick, should be designed by a qualified professional and the design reviewed by a geotechnical engineer. Walls, including retaining walls or foundation walls higher than 4 ft, should also be designed by a qualified professional and the design reviewed by a geotechnical Engineer.

Additionally, we recommend against infiltration of large volumes of water into the small volumes of ground, particularly during intense rainfall events such as those noted above. Some slope failures in the Eola and Salem Hills have been caused by injection of large volumes of storm water. Consequently, it is our opinion that surface runoff from roofs and pavements should be dispersed over a broad area to simulate natural conditions. If it is found necessary to dispose of large amounts runoff to the soil, the location and method should be thoroughly evaluated by a qualified professional. Your geotechnical Engineer should also review any such plans.

In our opinion, if you follow the above recommendations, partitioning and development of TL 300 for single family residences as you propose (Figure 9) should not increase the potential for slope hazards on the site or adjacent properties.

6. LIMITATIONS AND LIABILITY

We call your attention to the paragraphs on Warranty and Liability in the General Conditions (dated 1/2016) approved previously by you. Interpretations and recommendations presented herein are based on limited data and observations. Actual subsurface conditions may vary from those inferred from the limited information available to us. If site excavations for development find conditions to differ significantly from those inferred

herein, you should contact us and provide an opportunity for us to review our recommendations for the site.

We thank you for the opportunity to assist you with your project. Please contact us if you have questions about the report.

Yours very truly,
Northwest Geological Services, Inc.

Clive F. (Rick) Kienle, Jr., PhD, CEG
Principal Geologist and Vice President

NGS Reference 235.96-1

7. REFERENCES

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8S/3W-22C Tax Lot 300		
Salem, Marion County, Oregon		
Landslide Hazard Study		
	Site Location Map	
NGS, Inc.	July 2017	Figure 1

8S/3W-22C Tax Lot 300
Salem, Marion County, Oregon
Landslide Hazard Study
Oblique View 23 July 2016 Aerial Image

NGS, Inc.	July 2017	Figure 2

N E SSE

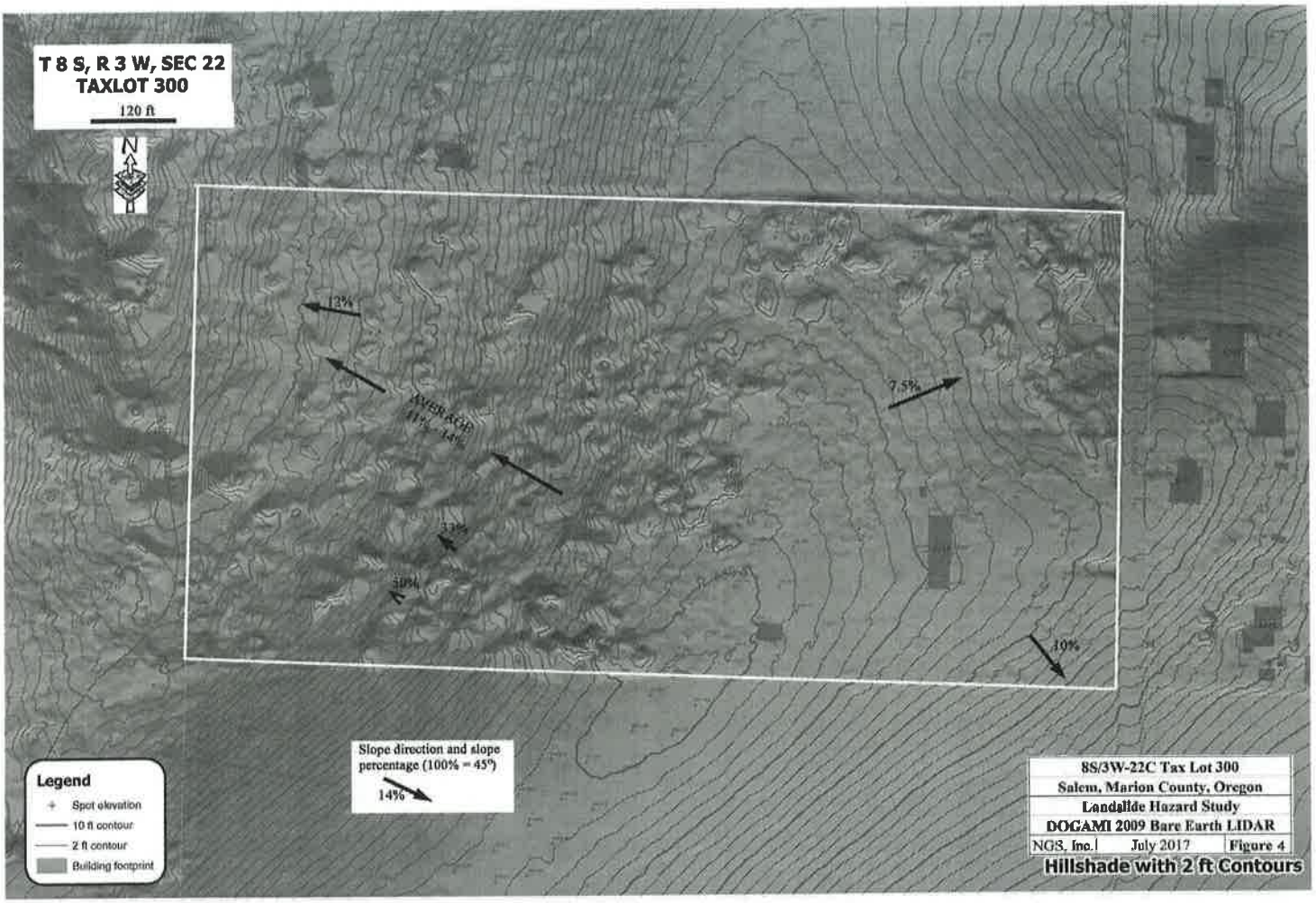
Panorama of central part of site looking N (on left) and around to SSE (on right). Note brush mound at far right behind vehicle.

Mature Douglas Firs at the East end of the site show slight curvature from moderate creep in the thin site soil.

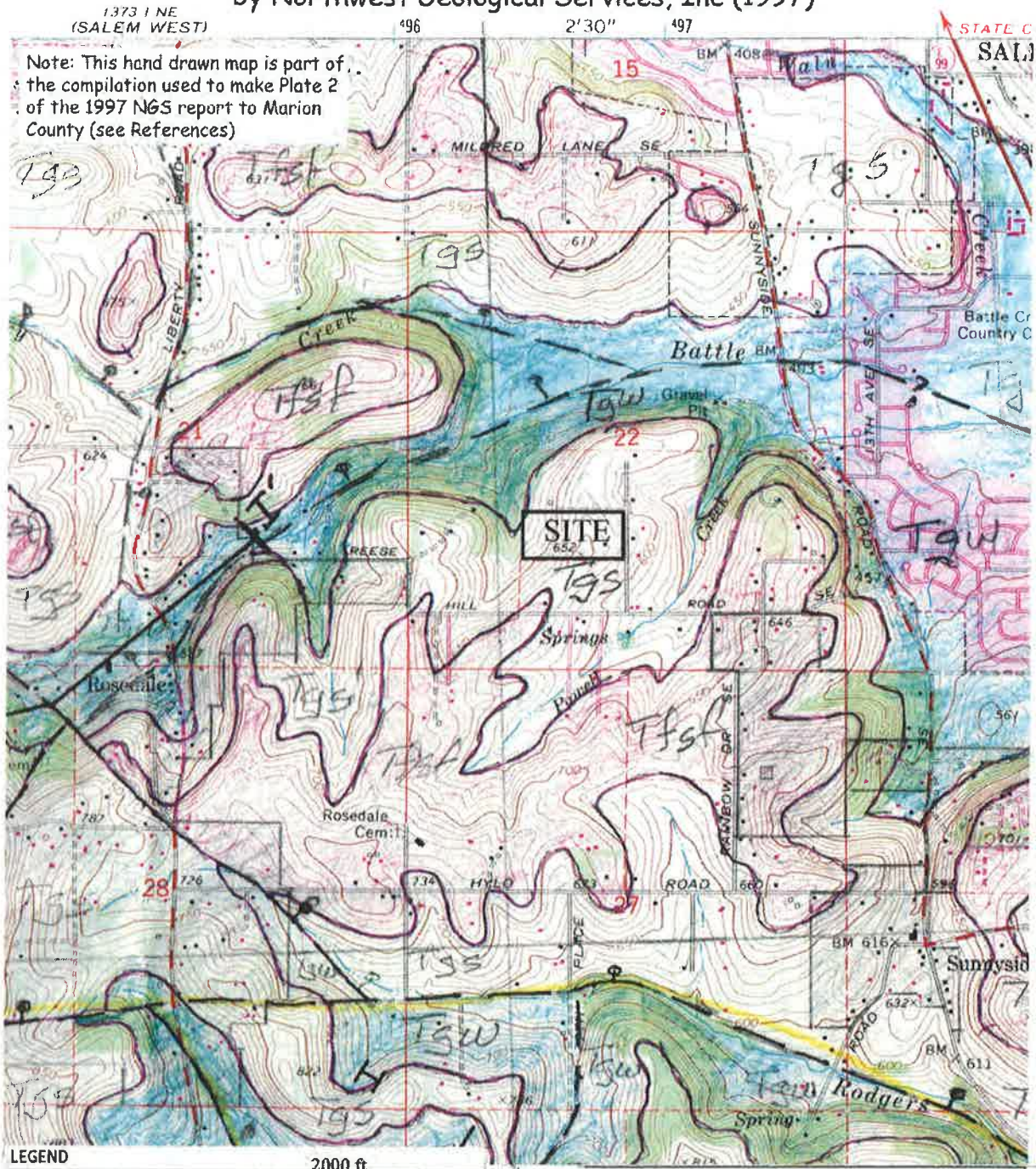
Smooth topography in NE part of site is typical of the entire site with exception of brush-covered piles of soil and woody debris left from clearing old orchard.

Decomposed Sentinel Bluff basalt spoils from test pit TP-1

8S/3W-22C Tax Lot 300		
Salem, Marion County, Oregon		
Landslide Hazard Study		
Site Photographs		
NGS, Inc.	July 2017	Figure 3


T 8 S, R 3 W, SEC 22
TAXLOT 300
120 ft
N
13%
AVERAGE
11% - 14%
33%
30%
7.5%
10%
Slope direction and slope percentage (100% = 45°)
14%
Legend
Spot elevation
10 ft contour
2 ft contour
Building footprint
8S/3W-22C Tax Lot 300
Salem, Marion County, Oregon
Landslide Hazard Study
DOGAMI 2009 Bare Earth LIDAR
NG3, Inc. | July 2017 | Figure 4
Hillshade with 2 ft Contours

Portion of Geologic Map of Sidney Quadrangle by Northwest Geological Services, Inc (1997)



LEGEND

2000 ft

N

Geologic Bedrock Units

Tfs - Basalt of Silver Falls (Frenchman Springs Mamber, Wanapum Basalt)

Tfg - Basalt of Gingko (Frenchman Springs Mamber, Wanapum Basalt)

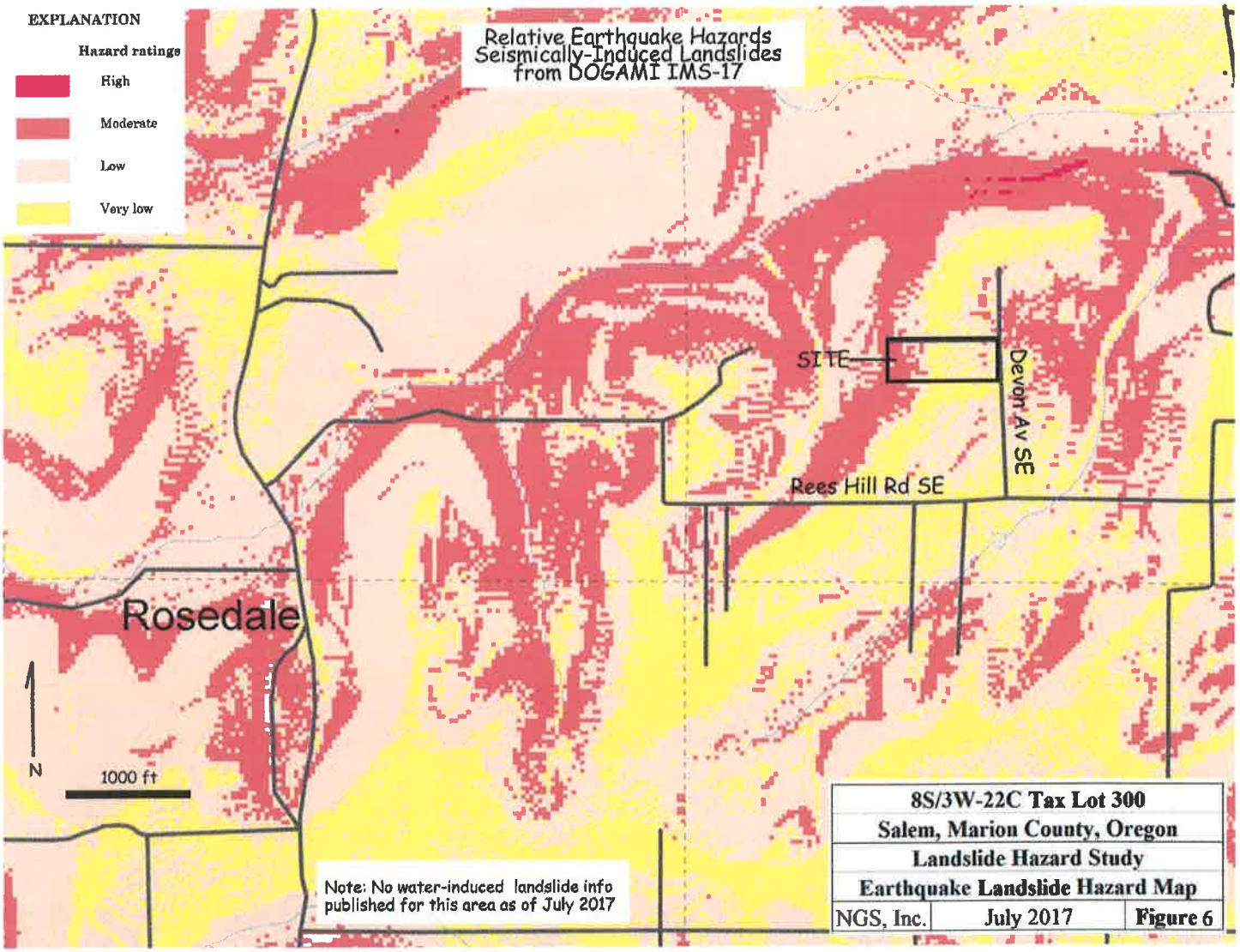
Tgs - Sentinel Bluff Basalt (Grand Ronde Basalt)

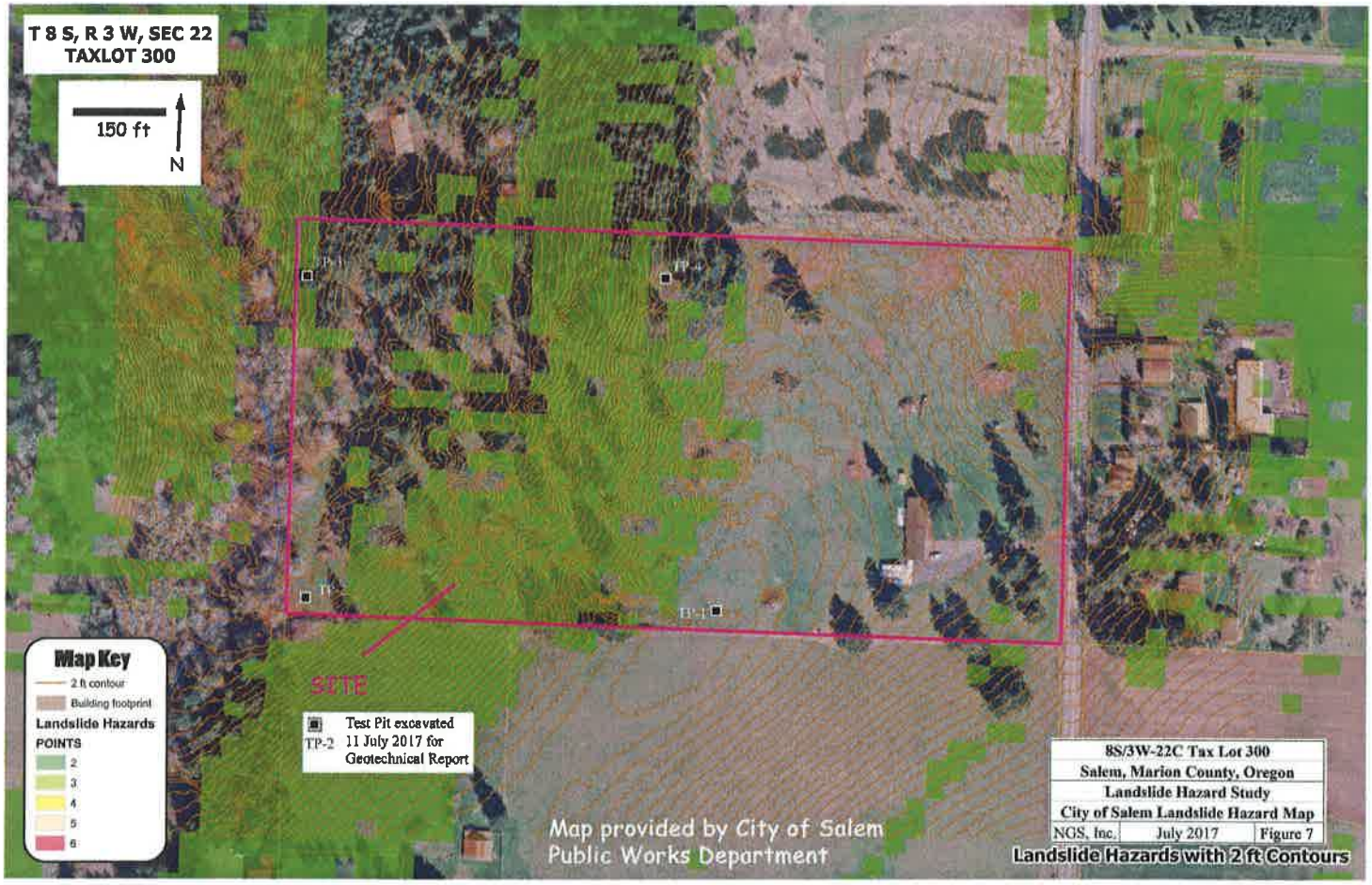
Tgw - Winterwater Basalt (Grande Ronde Basalt)

Geologic Structures

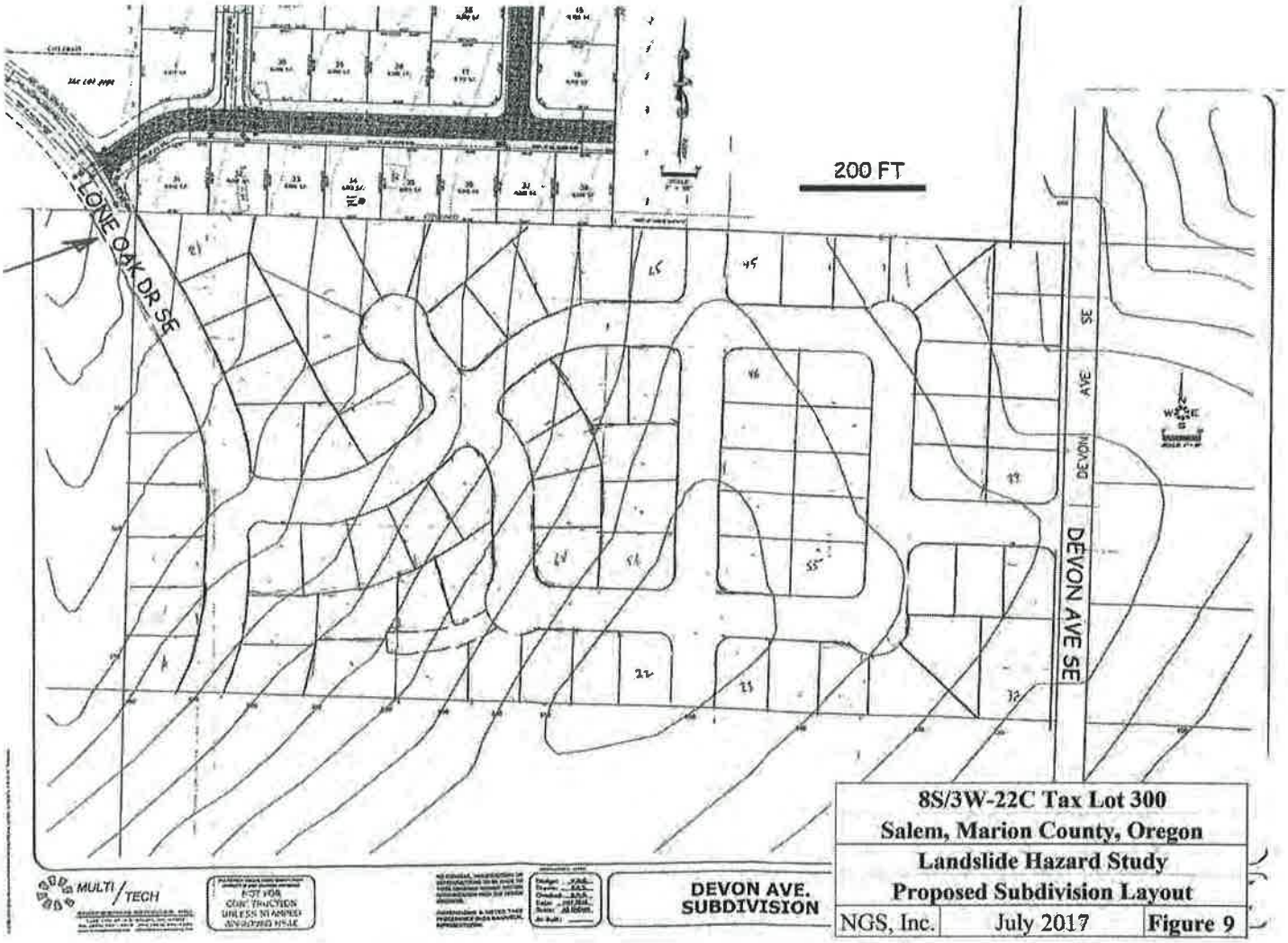
Normal Fault, ball on down side, dashed where approximate

8S/3W-22C Tax Lot 300		
Salem, Marion County, Oregon		
Landslide Hazard Study		
Area Geologic Map		
NGS, Inc.	July 2017	**Figure 5**


EXPLANATION
Hazard ratings
High
Moderate
Low
Very low
Relative Earthquake Hazards
Seismically-Induced Landslides
from DOGAMI IMS-17
SITE
Devon Av SE
Rees Hill Rd SE
Rosedale
N
1000 ft
Note: No water-induced landslide info published for this area as of July 2017
8S/3W-22C Tax Lot 300
Salem, Marion County, Oregon
Landslide Hazard Study
Earthquake Landslide Hazard Map
NGS, Inc.
July 2017
Figure 6


T 8 S, R 3 W, SEC 22
TAXLOT 300
150 ft
N
TP-1
TP-4
TP-3
B-1
SITE
Map Key
2 ft contour
Building footprint
Landslide Hazards
POINTS
2
3
4
5
6
TP-2 Test Pit excavated 11 July 2017 for Geotechnical Report
Map provided by City of Salem Public Works Department
8S/3W-22C Tax Lot 300
Salem, Marion County, Oregon
Landslide Hazard Study
City of Salem Landslide Hazard Map
NGS, Inc. July 2017 Figure 7
Landslide Hazards with 2 ft Contours

8S/3W-22C Tax Lot 300		
Salem, Marion County, Oregon		
Landslide Hazard Study		
1936 Aerial Photograph		
NGS, Inc.	July 2017	Figure 8



8S/3W-22C Tax Lot 300
Salem, Marion County, Oregon
Landslide Hazard Study
Proposed Subdivision Layout

NGS, Inc.	July 2017	**Figure 9**