TECHNICAL MEMORANDUM

To: Jim Wheeler, Development Planning Manager, City of Gresham, Oregon

From: David Gorman, PE, Ecological Engineering, LLC

Date: November 11, 2023

Subject: Veranda Master Plan and Subdivision – Wetland 1 and Local Significance of Wetlands

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Executive Summary

David Gorman, PE of Ecological Engineering carefully and thoughtfully investigated the role of Wetland 1 in the landscape on the Veranda Master Plan and Subdivision site located at 7928 SE 190th Drive in Gresham to determine if it contributed cool water to Kelley Creek during the summer months. Much of Mr. Gorman's focus was on the Veranda site soils because the relationship between wetland hydrology and its influence on groundwater is highly influenced by the type and characteristics of soil within the wetland. Wetland 1 soils consist of Cascade Silt Loam and Powell Silt Loam, both of which have a restrictive layer close to the ground surface that impedes water from moving from the wetland into the groundwater. Wetland 1 is isolated from the groundwater by the restrictive layer. These soils do not typically contain free water in the summer months because the total water capacity of the soil is low and evapotranspiration exceeds water inputs causing the soil to dry out, preventing the wetland from providing water to Kelley Creek. Due to the lack of a hydrologic connection between Wetland 1 and Kelley Creek during the summer months, when water temperatures are typically an issue resulting in a 303(d) water quality standard listing, Wetland 1 cannot be described as providing a water cooling benefit, improvement, or contribution to Kelley Creek.

Introduction

The purpose of this technical memorandum is to provide an expert opinion on the relationship between the wetlands on the site of the proposed Veranda Master Plan and Subdivision located at 7928 SE 190th Drive in Gresham, Oregon and Kelley Creek. More specifically, I will provide an expert opinion on the relationship between the hydrology of the wetlands onsite and the shallow groundwater and whether the wetlands provide cooling water to Kelley Creek during the hotter summer months. In support of my expert opinion I have conducted my own research on the hydrology of the wetlands, site topography, and site soils. I have also reviewed the documents in the file that include, but are not limited to, the following:

- Jurisdictional Wetland Delineation prepared by Schott & Associates
- Hydrogeologic Interpretation and Review of Geotechnical Investigation by GSI Water Solutions, Inc.

- Review of AKS Report ESRA-PV Mitigation Plan Technical Memorandum by GSI Water Solutions, Inc.
- Veranda Subdivision – Wetland 1 report by Pacific Habitat Services, Inc.
- Preliminary Geotechnical Report and Geologic Hazard Evaluation by Hardman Geotechnical Services, Inc.
- Natural Resources Staff Review of May 24, 2023 Submittals for Veranda Subdivision by City of Gresham
- Veranda Subdivision and Master Plan: Local Significance of Wetlands by City of Gresham

I am registered and licensed as a professional engineer in the fields of civil and environmental engineering in Oregon and Washington with 38 years of experience as a water resource engineer in Oregon and the Pacific Northwest. My entire career has been spent on issues related to surface water, shallow groundwater, water quantity and quality, and aquatic wetland habitat restoration. I currently work as an ecological engineer with a long standing focus on wetland and stream restoration (going back to 1995). For the last 17 years, I have been involved in the restoration of a 72 acre wetland, in the same HUC4 watershed as the Veranda site, with soils that are very similar to the soils on the Veranda Master Plan and Subdivision project site. One of my responsibilities on the 72 acre wetland restoration project was to thoroughly understand the hydrology of the wetland soils in an effort to enhance the wetland hydrology of the site.

Veranda Site Soils

The relationship between wetland hydrology and shallow groundwater is highly influenced by soil types. Veranda Master Plan and Subdivision (Veranda) soils include primarily Cascade Silt Loam at the upper site elevations and Powell Silt Loam at the lower elevations. Neither of these soils is mapped as hydric by the Natural Resource Conservation Service (NRCS). Much of this discussion will rely on and refer to NRCS Soil Survey Mapping included in Attachment B.

Both Cascade Silt Loam and Powell Silt Loam contain an NRCS identified “restrictive layer”, defined as “… a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment.” The NRCS has documented and reported the depth from the surface to the shallow most restrictive layer for each soil type. The shallow most restrictive layer tends to be the controlling layer. Cascade Silt Loam has a restrictive layer 69 centimeters (27 inches) below the ground surface. Powell Silt Loam, which is down slope from the Cascade Silt Loam on the site, has a restrictive layer 41 centimeters (16 inches) below the ground surface. These soils formed under similar conditions, have a similar restrictive layer, and have a similar hydrologic response as the 72 acre wetland restoration site soils I have been working with for 17 years and have monitored with shallow groundwater piezometers (wells) that recorded water level data on a daily basis.

A cross section and profile through the Veranda site is provided as Attachment A. The section was cut from the north property line through Wetland 1 and to Kelley Creek. It is drawn to scale to show the physical relationships between the slopes, soils, wetland, and Kelley Creek. There is no vertical or horizontal scale exaggeration. Site soils on top of the restrictive layer show up as a very thin band relative to the subsoils below it.

The hydrology of Wetland 1 on the Veranda site is driven by a combination of direct rainfall, surface water runoff from up slope, and shallow groundwater that is seasonally perched on the restrictive layer. The restrictive layer is a significant barrier to the flow of water downward into the subsoil and essentially isolates Wetland 1 from the underlying soil and groundwater. When sufficient rainfall and surface water runoff come into contact with Wetland 1 soils during the wetter months it will saturate the soils to some depth below the ground surface and above the restrictive layer. This is corroborated by the Schott & Associates Wetland Delineation in its description of Wetland 1 where it is stated “It is assumed the wetland is sustained by precipitation, seasonal high groundwater, and possibly hill slope seeps in the upper portion.

Table 1 below shows calculations of the estimated unit flow rates through the site soils above the restrictive layer for Cascade Silt Loam (Cascade) and Powell (Powel) Silt Loam. Flow rates were calculated using Darcy’s Law for flow through soils. Calculated flow rates are shown in the final column shaded green in units of cubic feet per second (cfs). As unit flow rates, these represent the flow that can be expected through the soil above the restrictive layer for every linear foot along a contour line when the soils are saturated. The Cascade soils, at 0.00203 cfs, convey more than 5 times the water conveyance capacity of the Powell soils, at 0.000378 cfs. The majority of Wetland 1 is located within mapped Powell series soils.

Table 1:
Veranda Master Plan and Subdivision
Perched Subsurface Flow Rate Calculations
Based on Soil Saturation to the Surface During Wet Season
Rates are unit flow rates based on 1-foot distance along contour lines

Soil	**K**	**A (unit)**	**Slope**	**Unit Q**	**Unit Q**	**Flow Width**	**Q Total**
	(FT/d)	**(SF)**		**(cfd)**	**(cfs)**	**(feet)**	**(cfs)**
Cascade	1.28385	2.25	0.089	0.257091	2.97559E-06	683	0.002032
Powell	0.87652	1.33	0.041	0.047797	5.53202E-07	683	0.000378

There are several reasons the Cascade soils can convey so much more water than the Powell soils, and they include the following:

- Cascade soils have a greater depth to the restrictive layer than the Powell soils, thereby creating a larger flow area.
- The Cascade soils on site are on a steeper slope than the Powell soils which produces a greater hydraulic gradient to push water through the soil.

- Cascade soils have a greater saturated hydraulic conductivity (K value in the table), which means that water can flow through them better than through the Powell soils.

The significance of this is that it helps to explain the location of Wetland 1. Much of Wetland 1 is located at the boundary of the Cascade and Powell soils because the Cascade soils can provide more than 5 times the water flow conveyance capacity of the Powell soils, resulting in a supply of subsurface water to the Powell soils and water in excess of the Powell soil conveyance capacity. The excess water will become surface water at the boundary between the two soils, as seeps, and contribute to hydrology of Wetland 1. This is evidenced by discharge flow from Wetland 1 to the roadside ditch during the wet season. However, due to the restrictive layer in the soils, little or no water seeps into the subsoils to become groundwater.

This concept is supported by the test pits that were excavated in numerous locations on the site by Hardman Geotechnical Services, Inc. Test pit 5 (TP-5) was excavated to a depth of 17 feet on August 1, 2023. The test pit log documented that no seepage or static groundwater was encountered. If the wetlands were replenishing groundwater on site, it would be expected that it would have been encountered in the test pits. Test pits 1-9 were dug to depths ranging from 17 to 19 feet and no seepage or static groundwater was encountered in any of the pits. The depth of the test pits is to an elevation that is generally at or below the bottom of Kelley Creek on the north side of the property. For groundwater to be supplying late summer cool water to Kelley Creek the static groundwater level in the pits would need to be fairly high in order to provide the hydraulic gradient necessary to push water through the soil to the creek.

Wetland 1 and the other wetlands are not replenishing the groundwater due to the restrictive layer under the wetland, and there is evidence that there is no water in Wetland 1 subsoil to provide late summer flow to Kelley Creek. Is it possible that Wetland 1 and its perched soil is providing cooler late summer flow to Kelley Creek? The answer is "no", as defined below.

Wetland 1 has an area of approximately 5 acres. Wetland hydrology only exists, jurisdictionally, if there is soil saturation within 12 inches of the surface. Any water at any time of year below the upper 12 inches is not considered wetland hydrology. According to the NRCS soil survey for the site soils (Available Water Storage, Attachment B), the available water storage in the site soils within the upper 12 inches is 5.13 (2.02 inches) and 5.99 centimeters (2.1 inches) for Cascade and Powell soils, respectively. This is the maximum amount of water that can be expected to be held within the soils and be available to contribute to wetland hydrology.

As the wet season transitions into the warm and dry season of summer, evapotranspiration increases. Evapotranspiration is the measurement of the combined water loss from evaporation from the soil and transpiration from the plants growing in the soil. Table 2 below presents a water balance for Wetland 1. A water balance is a ledger accounting for water inputs and losses from a system, such as a watershed, wetland, or reservoir. This water balance is focused on Wetland 1, but is valid for the entire site.

The way this water balance works is that at the beginning of the summer it assumes a starting initial soil water content of 2.1 inches for the month of June, which is the maximum soil water capacity of the soil. The actual starting soil water content in June could be much less than this amount and could range anywhere between 2.1 inches and no water within the upper 12 inches. Added to that is 1.61 inches of precipitation that may fall on the site during the month of June (this represents a mean precipitation value for June in this area). Subtracted from the sum of those is the evapotranspiration, giving the net available soil water at the end of June, which then becomes the initial soil water available for July. That is added to the precipitation for July and then the evapotranspiration is subtracted from that sum to give the net available soil water at the end of July (and beginning of August). The same process continues for August and September. Negative values indicate a deficit of available soil water and result in an initial soil water availability of zero for the following month.

The values in the water balance for soil water available is an NRCS measurement of water available for plant growth. Not all of the soil water available has the capacity to move through the ground under the force of gravity because it is bound to the soil (residual water). A significant portion of water in the soil is considered residual water and will remain in the soil unless utilized by plants and removed through transpiration or by evaporation.

Table 2: Wetland 1 (and all site wetlands) Typical Summer Water Balance

	Month			
Hydrogic Component	**June**	**July**	**August**	**September**
	(inch)	**(inch)**	**(inch)**	**(inch)**
Initial Soil Water Available	2.1	1.64	0	0
Precipitation	1.61	0.35	0.49	1.71
Evapotranspiration	2.07	6.31	4.39	17.9
Net Available Soil Water	1.64	-4.32	-3.9	-16.19

Notes:
1. Initial Soil Water Available in June = total soil water capacity
2. Precipitation values are mean (average) values from NWS Portland International Airport (2000-2023)
3. Evapotranspiration from US Bureau of Reclamation Hydromet/Agrimet Data for Grass at Aurora, Oregon Station
4. Net Available Soil Water = Initial Soil Water Available + Precipitation - Evapotranspiration

In this water balance, before the end of July, there is no longer any capacity for water to be available in Wetland 1, and the deficit of available soil water continues through September into October and beyond. The Schott & Associates wetland delineation and AKS data over several years both determined that there is no longer water available in Wetland 1 before the end of May. That wetland hydrology is not present in June. This indicates that the water balance is more conservative of an estimate than on-the-ground data showed. In either case, Wetland 1 soil does not store enough water and have the opportunity to be able to supply cool water to Kelley Creek in the summer. Put another way, the soils do not have capacity to support perched wetland hydrology during the warm summer months. It is common for the types of soils on the Veranda site, including those that are within Wetland 1, to dry out completely in early summer. Wetland 1 and the soils on the Veranda site are not capable of supplying cool water to Kelley Creek in the warm summer months. They are therefore unable to provide any cooling benefit to the creek.

Summary and Conclusions

The following points briefly summarize the substantive and important issues regarding the relationship of Wetland 1 and its potential for providing cool water to Kelley Creek during the thermally critical summer months and responses to the GSI Technical Memorandum dated October 31, 2023.

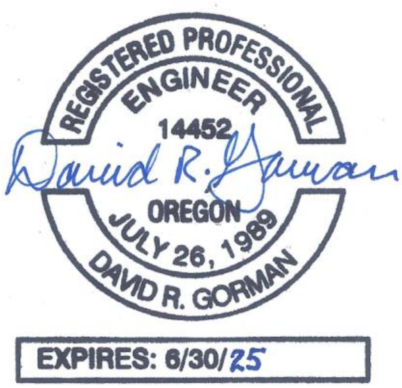
1. The relationship between wetland hydrology and shallow groundwater is highly influenced by soil types. Veranda site soils include primarily Cascade Silt Loam at the upper site elevations and Powell Silt Loam at the lower elevations. Neither of these soils is mapped as hydric by the Natural Resource Conservation Service (NRCS). Both Cascade Silt Loam and Powell Silt Loam contain an NRCS identified "restrictive layer", defined as "… a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impedes the movement of water.
2. Based on my analysis, Wetland 1 and the other onsite wetlands are not replenishing groundwater due to the restrictive layer under the wetland that is present in Veranda site soils, and there is strong evidence that there is no available water in Wetland 1 soils during the summer months to provide summer flow to Kelley Creek.
3. According to NRCS, and consistent with my experience working locally with these types of soils, there is not capacity for perched wetland hydrology to be present in Wetland 1 during the warm summer months. It is common for the types of soils on the Veranda site, including those that are within Wetland 1, to dry out completely in early summer. The soils on the Veranda site are, including those within Wetland 1, are not capable of supplying cool water to Kelley Creek in the warm summer months and are therefore unable to provide any cooling effect to the creek. This is supported by data collected by Schott & Associates and AKS which documents a lack of wetland hydrology starting in early May.
4. The GSI Technical Memorandum dated October 31,2023 claims that subsurface water from Wetland 1 will not flow to Kelley Creek on the upstream side of the culvert under 190th Drive, but will instead flow to Kelley Creek west of 190th Drive. However, the hydraulic gradient (slope) from Wetland 1 to the upstream side of the culvert is approximately 0.037 while the hydraulic gradient from Wetland 1 to Kelley Creek west of 190th is approximately 0.018. Water will tend to flow in the direction of the steeper gradient, which is to the upstream side of the culvert. The assertion that subsurface water from Wetland 1 flows under 190th Drive ignores the fact that Wetland 1 water is perched on a soil restrictive layer that is only approximately 16 inches below ground. Any wet weather subsurface flow from Wetland 1 will be intercepted by the ditch on the east side of 190th Drive and become surface flow to the north. As has been noted above, there will be no subsurface flow from Wetland 1 during the warmer dryer months of the year due to a lack of soil capacity to hold water.
5. The GSI Technical Memorandum dated October 31, 2023 claims that "Cool water that has infiltrated to the groundwater table and flows to Kelley Creek helps to cool stream temperatures." This assertion is very general in nature and neglects to consider the site specific relationship between Wetland 1 and the groundwater table. Wetland 1 is perched on a restrictive layer that is only about 16 inches below the ground surface. The restrictive

layer isolates Wetland 1 from the groundwater and prevents the flow of water from Wetland 1 into the groundwater. The lack of groundwater in the numerous test pits that were dug onsite corroborates the lack of relationship between the wetland and the groundwater. While I agree with the GSI statement that "In addition to providing an overall temperature benefit to the stream, areas of groundwater inflows are important cool water refuges (called 'cold water refugia') where juvenile salmon and other cold-water fish species congregate when ambient water temperatures are high", this statement is very general in nature. It does not account for the features of the Veranda site, including the soil types, soil water storage capacity, and the location of Wetland 1 on the landscape. The claims made by GSI are not relevant to the Veranda site.

6. I have determined that there is no direct hydrologic connection between Wetland 1 and groundwater and that Wetland 1 provides no water quality improvement of the temperature in Kelley Creek.
7. In its review of the Hardman Geotechnical Services, Inc. report dated August 2, 2023, the GSI Technical Memorandum dated October 31, 2023 claims that "Test pits were excavated in August at the height of the dry season under severe drought conditions, and therefore it would be anticipated that groundwater levels would be low. The lack of groundwater in TP-5 at a depth of 17 feet only demonstrates that the groundwater table in the dry season is below the bottom of the test pit and the test pit was not excavated deep enough to encounter groundwater. Groundwater is still present and is flowing towards the creek regardless of whether it is observed in a test pit." I agree that the lack of groundwater at a depth of 17 feet demonstrates that the groundwater water table in the dry season is below the bottom of the test pit and the test pit was not excavated deep enough to encounter groundwater. However, I disagree with the assertion that groundwater is still present and is flowing towards the creek regardless of whether it is observed in a test pit. Groundwater, like surface water, needs a slope or hydraulic gradient to cause it to move. The movement of water is ultimately driven by gravity. The smaller the hydraulic gradient is, the lower the flow rate will be, all other things being equal. If the groundwater table is below the level of the bottom of the creek, as was documented by the test pits, there is zero hydraulic gradient to move groundwater into the creek. In fact, if the groundwater table is below the bottom of the creek, it would be expected that water is flowing *from* Kelley Creek to the groundwater. For groundwater from the Veranda site to be supplying water to Kelley Creek during August, as well as the rest of the summer months, it would have had to be present in the test pits at a static water elevation above the bottom of the creek.
8. The GSI Technical Memorandum dated October 31, 2023 claims that "If Wetland 1 and its swale (and other wetlands) were removed, less cool water will reach Kelley Creek during the summer season." I disagree with this assertion for two reasons. The first is that Wetland 1 is isolated from the groundwater table by the restrictive layer common to both Cascade and Powell Silt Loam soils, and therefore, even in the wet season, does not supply or replenish water to the groundwater table. The second is that, by the summer season, Wetland 1 has no or virtually no water in the soil to supply to Kelley Creek.
9. Monitoring groundwater levels over a one year period is not necessary to document the hydrology of Wetland 1 and its absence during the warmer summer months. Data gathered

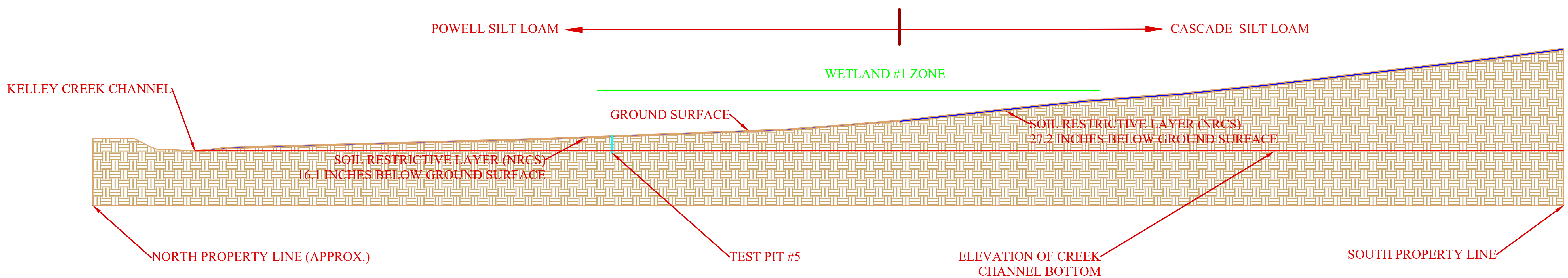
by Schott & Associates and AKS over the course of more than one year has documented the lack of wetland hydrology during the late spring and summer.

10. Due to the lack of a hydrologic connection between Wetland 1 and Kelley Creek during the summer months when water temperatures are typically an issue resulting in a 303(d) water quality standard listing, Wetland 1 cannot be described as providing a water cooling benefit, improvement, or contribution to Kelley Creek.

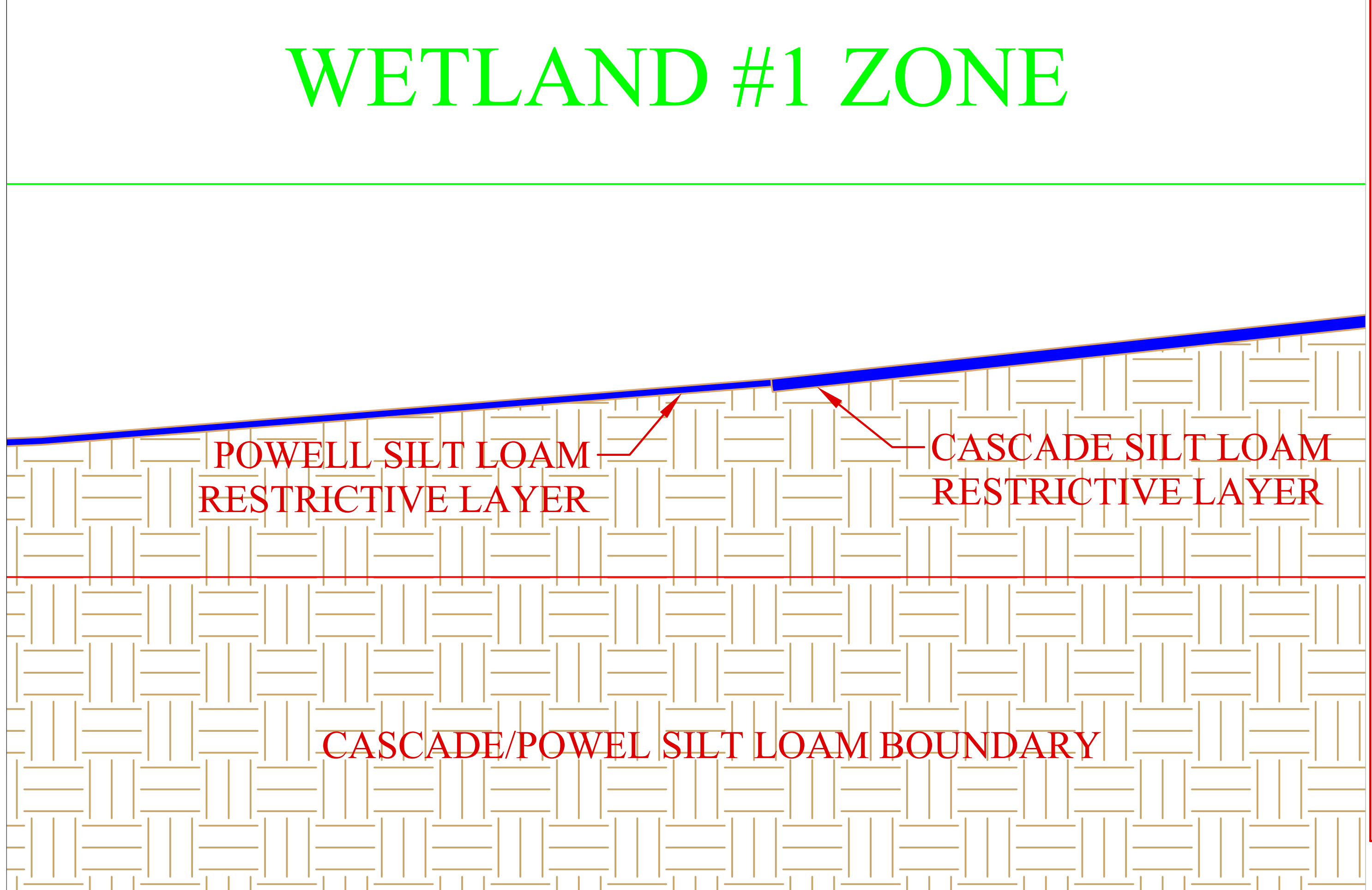


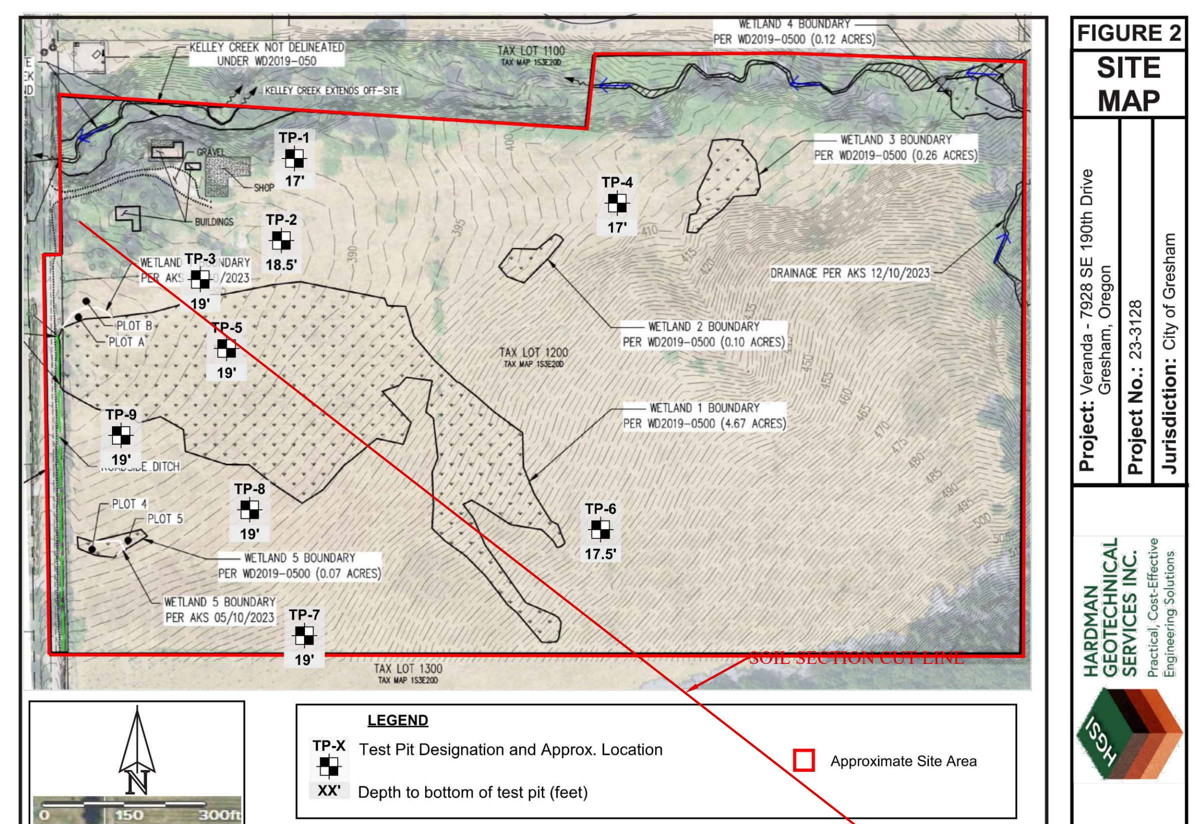
ATTACHEMENT A

SITE TOPOGRAPHY, SECTION, AND SOIL PROFILE



SOIL SECTION THROUGH SITE





SOIL SECTION CUT LOCATION

Ecological Engineering, LLC
Aquatic Habitat Restoration Engineering
2016 SE HENKLE ROAD
CORBETT, OR 97019
PH (503) 704-6013
dgorman@hevanet.com

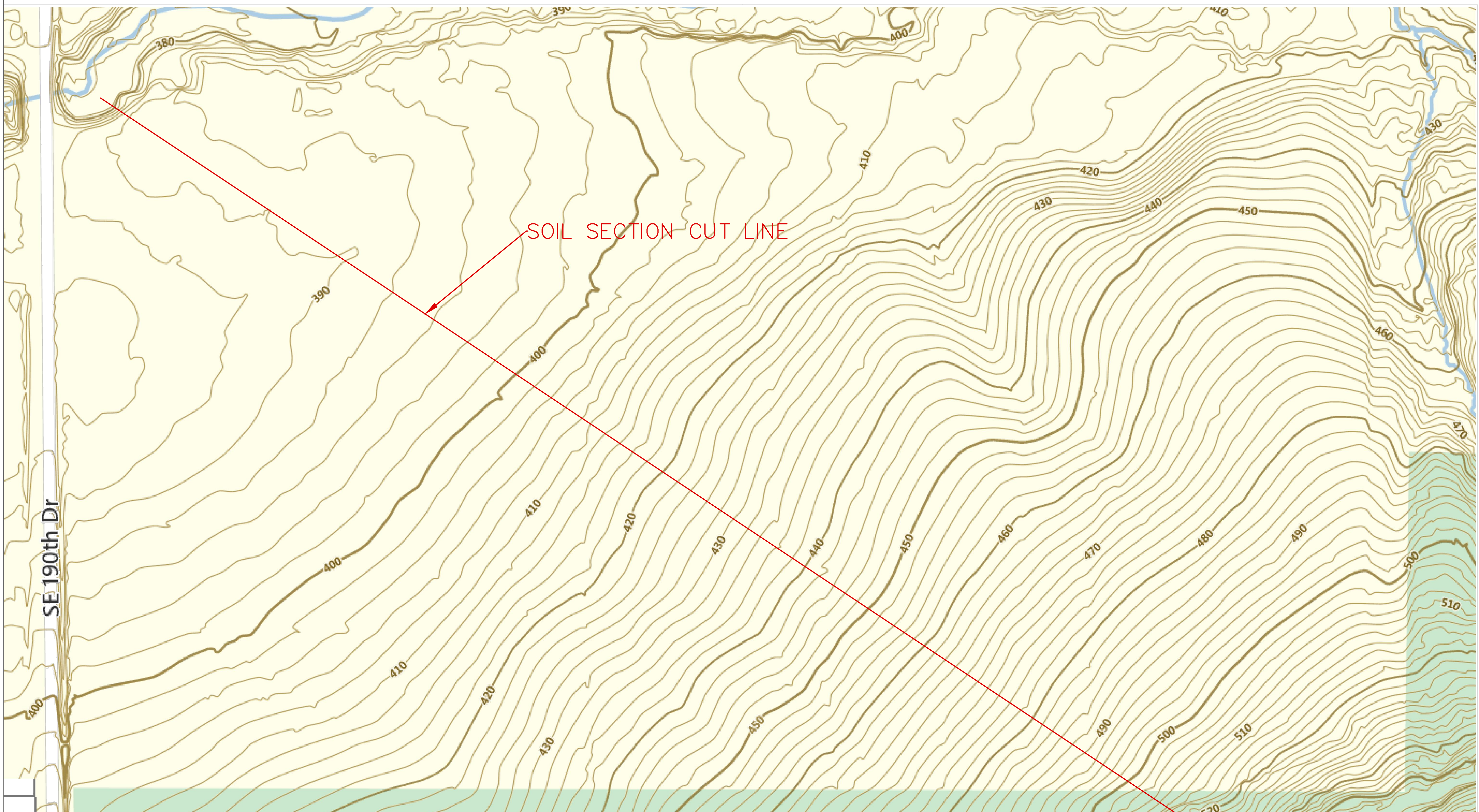
REGISTERED PROFESSIONAL ENGINEER 14,452 OREGON JULY 26, 1989 DAVID R. GORMAN EXPIRES: 6-30-25

LENNAR

VERANDA MASTER PLAN AND SUBDIVISION
7928 SE 190TH DRIVE
GRESHAM, OREGON

SITE SOIL SECTION

FIELDWORK DATE: NOVEMBER 2023	
DESIGN:	DG
DRAWN:	DG
CHECKED:	DG
PROJECT NUMBER	--
REVISION 1	DATE 11-3-23
SHEET NUMBER	SHT 1 OF 2



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VERANDA MASTER PLAN AND SUBDIVISION
7928 SE 190TH DRIVE
GRESHAM, OREGON

SITE TOPOGRAPHY

FIELDWORK DATE: NOVEMBER 2023	
DESIGN:	DG
DRAWN:	DG
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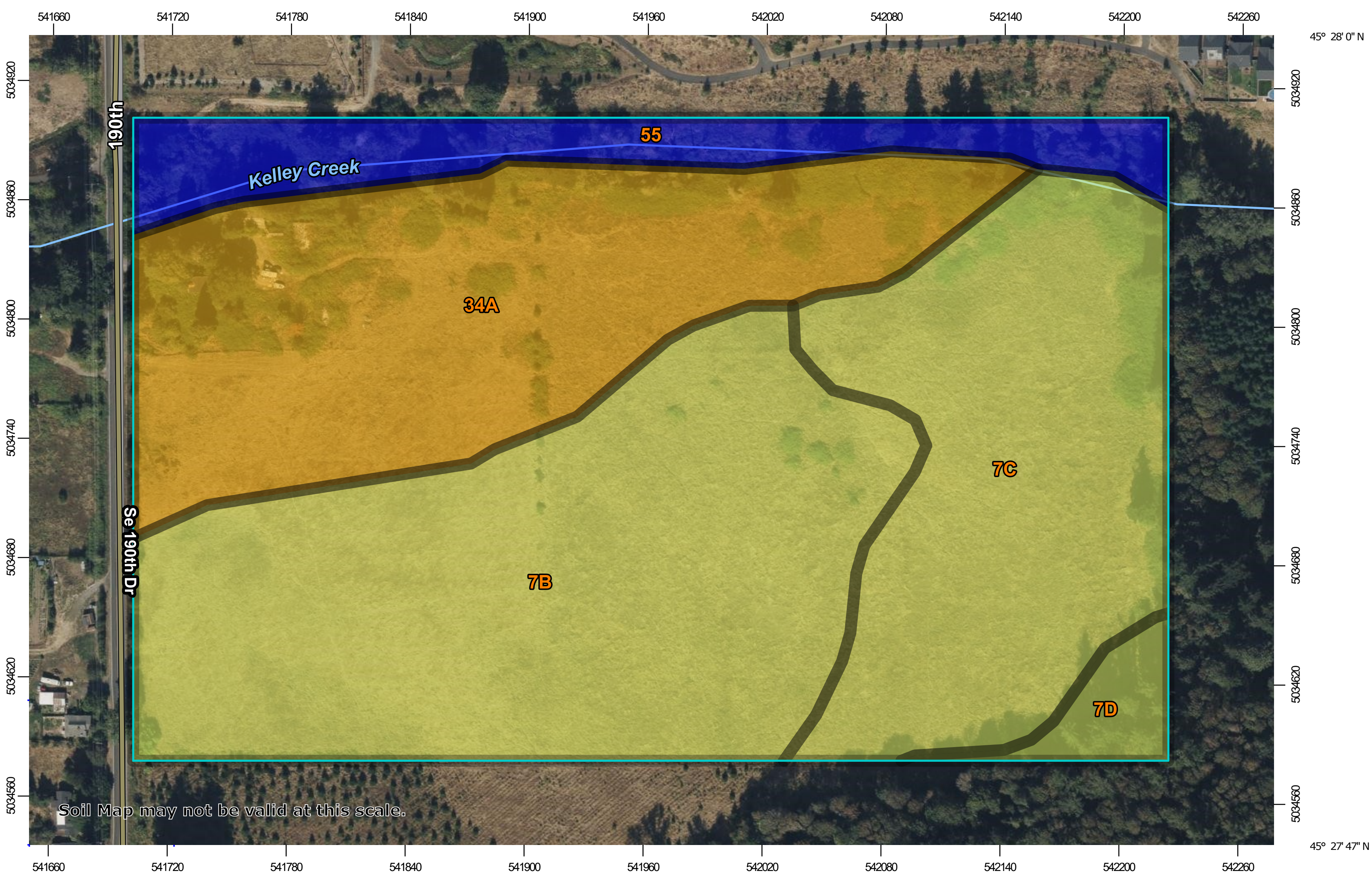
PROJECT NUMBER --	
REVISION 1	DATE 11-3-23
SHEET NUMBER	SHT 2 OF 2

ATTACHEMENT B

NATURAL RESOURCE CONSERVATION SERVICE

SOIL SURVEY REPORTS

Depth to Any Soil Restrictive Layer—Multnomah County Area, Oregon
(Veranda - 7928 SE 190th Dr., Gresham, OR)



Map Scale: 1:2,870 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 40, 80, 160, 240

Feet: 0, 100, 200, 400, 600

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Soil Rating Lines

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Soil Rating Points

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 22, Sep 7, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2022—Oct 11, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Depth to Any Soil Restrictive Layer

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
7B	Cascade silt loam, 3 to 8 percent slopes	69	15.2	36.3%
7C	Cascade silt loam, 8 to 15 percent slopes	69	10.0	24.0%
7D	Cascade silt loam, 15 to 30 percent slopes	69	0.9	2.1%
34A	Powell silt loam, 0 to 3 percent slopes	41	12.0	28.6%
55	Wapato silt loam	>200	3.8	9.0%
Totals for Area of Interest			**41.9**	**100.0%**

Description

A "restrictive layer" is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers.

This theme presents the depth to any type of restrictive layer that is described for each map unit. If more than one type of restrictive layer is described for an individual soil type, the depth to the shallowest one is presented. If no restrictive layer is described in a map unit, it is represented by the "greater than 200" depth class.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

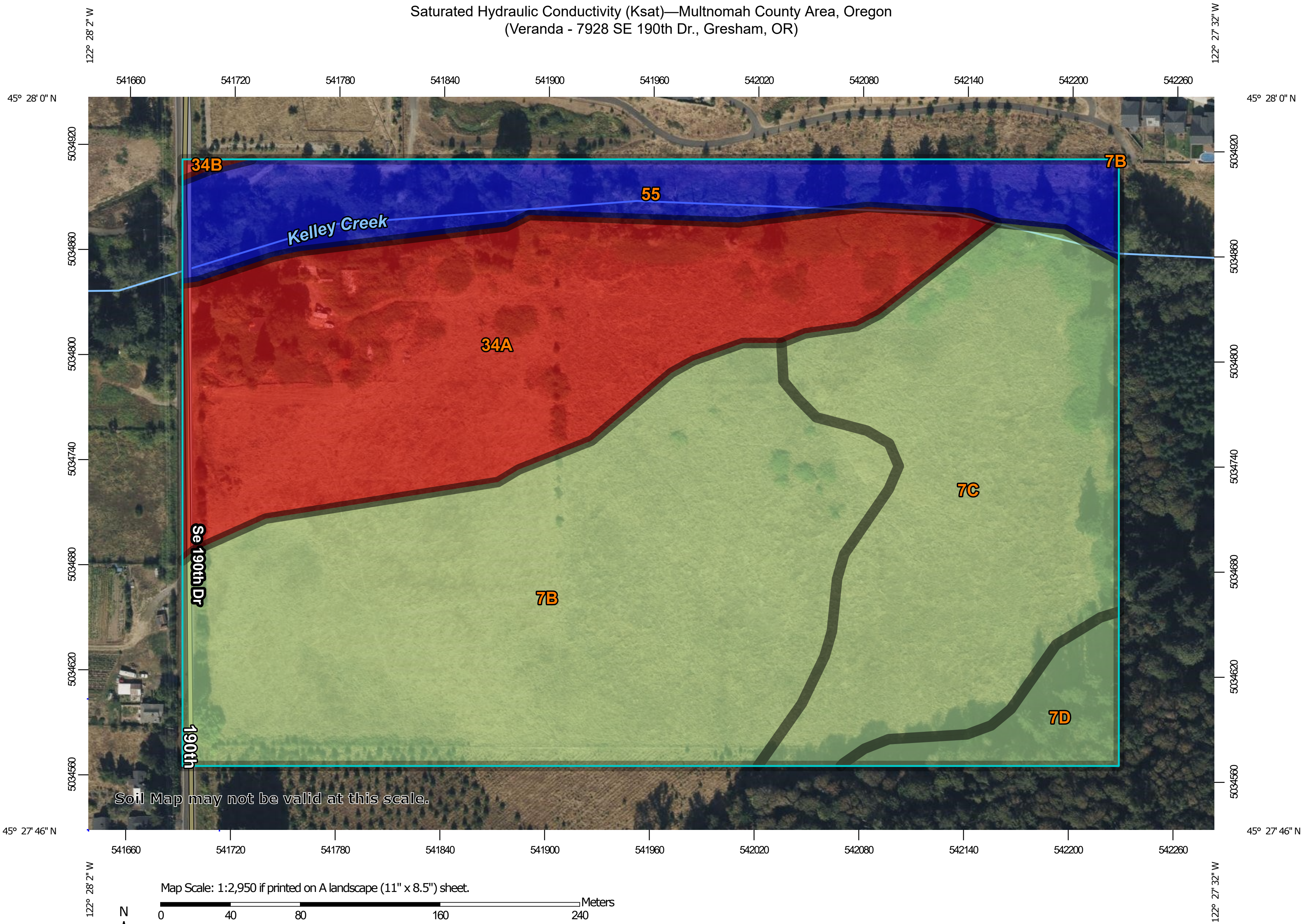
Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

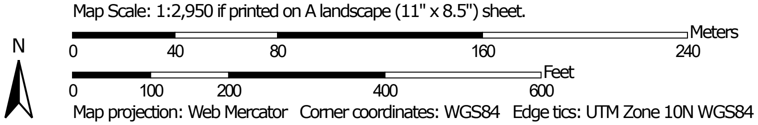
Tie-break Rule: Lower

Interpret Nulls as Zero: No

Saturated Hydraulic Conductivity (Ksat)—Multnomah County Area, Oregon
(Veranda - 7928 SE 190th Dr., Gresham, OR)



Map Scale: 1:2,950 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 3.0922

> 3.0922 and <= 4.5292

> 4.5292 and <= 4.7408

Not rated or not available

Soil Rating Lines

<= 3.0922

> 3.0922 and <= 4.5292

> 4.5292 and <= 4.7408

Not rated or not available

Soil Rating Points

<= 3.0922

> 3.0922 and <= 4.5292

> 4.5292 and <= 4.7408

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

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Local Roads

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Aerial Photography

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Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2022—Oct 11, 2022

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Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
7B	Cascade silt loam, 3 to 8 percent slopes	4.5292	16.6	35.9%
7C	Cascade silt loam, 8 to 15 percent slopes	4.5292	10.4	22.6%
7D	Cascade silt loam, 15 to 30 percent slopes	4.5292	1.4	3.1%
34A	Powell silt loam, 0 to 3 percent slopes	3.0922	12.4	26.8%
34B	Powell silt loam, 3 to 8 percent slopes	3.0922	0.1	0.1%
55	Wapato silt loam	4.7408	5.3	11.5%
Totals for Area of Interest			**46.1**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

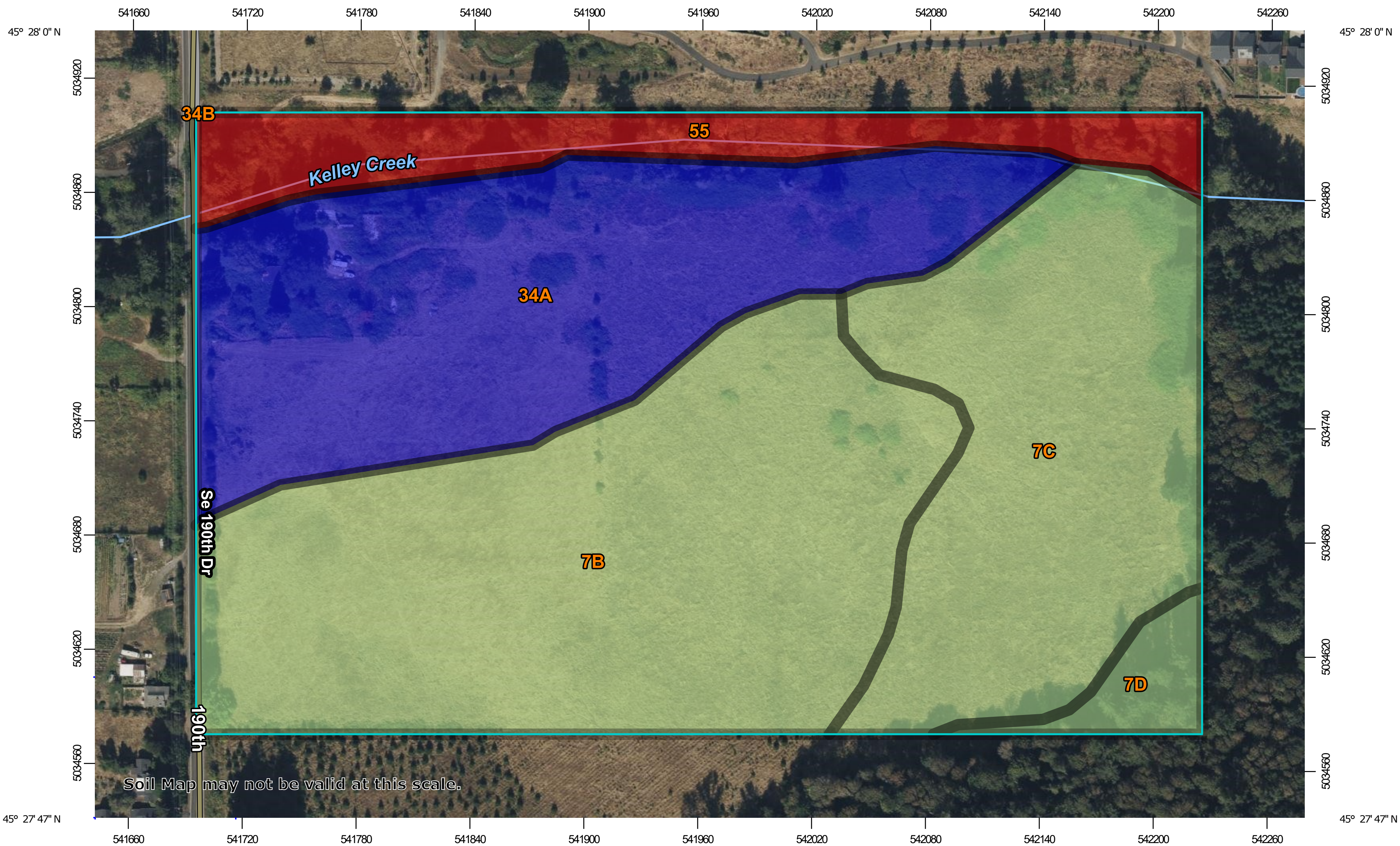
Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): All Layers (Weighted Average)

Available Water Storage—Multnomah County Area, Oregon
(Veranda Soil Water Storage)



Map Scale: 1:2,910 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 40, 80, 160, 240

Feet: 0, 100, 200, 400, 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 4.62
- > 4.62 and <= 5.13
- > 5.13 and <= 5.99
- Not rated or not available

Soil Rating Lines

- <= 4.62
- > 4.62 and <= 5.13
- > 5.13 and <= 5.99
- Not rated or not available

Soil Rating Points

- <= 4.62
- > 4.62 and <= 5.13
- > 5.13 and <= 5.99
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 22, Sep 7, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2022—Oct 11, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Available Water Storage

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
7B	Cascade silt loam, 3 to 8 percent slopes	5.13	15.6	36.3%
7C	Cascade silt loam, 8 to 15 percent slopes	5.13	10.1	23.5%
7D	Cascade silt loam, 15 to 30 percent slopes	5.13	1.0	2.3%
34A	Powell silt loam, 0 to 3 percent slopes	5.99	12.2	28.5%
34B	Powell silt loam, 3 to 8 percent slopes	5.99	0.0	0.0%
55	Wapato silt loam	4.62	4.0	9.3%
Totals for Area of Interest			**43.0**	**100.0%**

Description

Available water storage (AWS) is the total volume of water (in centimeters) that should be available to plants when the soil, inclusive of rock fragments, is at field capacity. It is commonly estimated as the amount of water held between field capacity and the wilting point, with corrections for salinity, rock fragments, and rooting depth. AWS is reported as a single value (in centimeters) of water for the specified depth of the soil. AWS is calculated as the available water capacity times the thickness of each soil horizon to a specified depth.

For each soil layer, available water capacity, used in the computation of AWS, is recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For the derivation of AWS, only the representative value for available water capacity is used.

The available water storage for each map unit component is computed as described above and then aggregated to a single value for the map unit by the process described below.

A map unit typically consists of one or more "components." A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated (e.g., available water storage), the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the process is to derive a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for the map units can be generated. Aggregation is needed because map units rather than components are delineated on the soil maps.

The composition of each component in a map unit is recorded as a percentage. A composition of 60 indicates that the component typically makes up approximately 60 percent of the map unit.

For the available water storage, when a weighted average of all component values is computed, percent composition is the weighting factor.

Rating Options

Units of Measure: centimeters

Aggregation Method: Weighted Average

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Sum)

Top Depth: 1

Bottom Depth: 12

Units of Measure: Inches