Site Evaluation and Soil Investigation for Vineyard Suitability, [redacted] Turner, Oregon

For: [redacted]

May 3, 2019

By: Andy Gallagher, Red Hill Soils
Corvallis, Oregon

Andy Gallagher, Soil Scientist PO Box 2233 Corvallis, OR 97333
Red Hill Soils
541-745-7878 avg@redhillsoil.com

INTRODUCTION

This report provides more detailed soil information for vineyard suitability of the future [redacted] near Turner, Oregon. Detailed soil mapping in other vineyards of the Willamette Valley has demonstrated that soils are much more diverse than they are shown at the scale of the NRCS soil survey. Soil diversity and soil quality within the vineyard can profoundly affect wine grape management and quality. A more precise soil map of relevant soil properties is needed to support decision making in existing and new plantings and to meet the intensive management associated with wine grape production.

In this investigation soils were sampled to accurately classify the soils and determine suitability for vineyards. This report gives the results of soil investigations and provides interpretations for vineyard development.

Soil investigations included soil borings from soil pits made across the slopes to sample soil profiles and to classify soils and to record soil properties including parent material, drainage class, depth to bedrock, depth to gravel, surface thickness, soil texture of the surface and the subsoil and available water holding capacity. Borings locations were recorded with a global positioning system (GPS). Surface and subsoil layers were sampled for laboratory analysis and the results will be reported in a subsequent report since the analysis would not be completed before the closing date of the real estate sale.

Previous Soil Mapping

Figure 1. Previous soil map by NRCS, orange line is boundary of project area, and yellow lines are soil boundaries.

R[2] *ed*

Hill Soils

The previous NRCS soil survey map of the site showed predominantly shallow Witzel soils with smaller areas of moderately deep Nekia soils in both a stony silty clay loam phase and a silty clay loam phase. Abiqua silt loam was previously mapped in the northeast corner of the property (See NRCS soil map Figure 1).

Geology and Terrain

The geology of this site is Columbia River Basalt. Slopes on the surveyed area are generally less than 30 percent gradient except for one small area in the wooded section. The slope aspect is southeast, south and southwest. There is about 200 feet of vertical relief with an elevation range from 620 feet up to about 820 feet above sea level Figure 2. Slope aspect is predominantly east, southeast and south. There is a small area in the northwest corner with a northwest aspect that was not in the surveyed area.

Figure 2. Topographic map (25 ft contour interval)

200 400 600 800 1000 1200 1400 **Soil Mapping and Sampling**

Eleven soil borings were made on approximately 32 acres for an average of one sample per three acres. Borings were made with soil pits about 5 to 6 feet deep or to the contact with hard bedrock if shallower. A tile probe was inserted in the bottom of soil pits to test for bedrock depth below the excavated pit depth.

Soils were classified according to USDA-Soil Taxonomy. Soil characteristics were compared to the current Official Series Descriptions (OSD's) from the USDA-NRCS. Slopes were classified using a digital elevation model for slope gradient and slope aspect. Soil colors were determined using a Munsell Color Chart. Available water holding capacity (AWHC) for each soil was estimated based on soil texture, structure,

coarse fragments, depth to rock and available water retention data for these soil series. Effective rooting depth for each profile was assumed to be that of the deepest observed roots or the lowest depth of distinctive rhizosphere soil morphology.

RESULTS

Data from eleven soil borings are presented in Table 1. Soil boring locations are shown on Figure 2 and 3 and GPS coordinates are in Table 2.

Soils are much deeper than they were previously mapped. The Witzel soil that dominates the NRCS map is stony and shallow and has low water holding capacity. By contrast in the revised map the deep and very deep Saum and Jory soils, which were not previously mapped here, have 5 to 6 times as much available water holding capacity. This is the difference between a site that can be farmed without irrigation to one that should be irrigated.

More than 90 percent of the soils observed in this sampling are well drained including Jory, Saum, Gelderman and Witzel and formed from colluvium and residuum of Columbia River basalt. There is about an acre of very poorly drained soils ("wet" in Figure 3) in the northeast corner and there are moderately well drained soils fringing this ponded area. Depth to bedrock ranges from very shallow to very deep (<10 to more than 60 inches) to hard fractured basalt. These are the classic Red Hill Soils of the Willamette Valley. This soil association makes up many of the best vineyards in the Eola Hills, Dundee Hills, and Chehalem Mountain AVAs.

There are about 23 acres of soils with excellent to good vineyard potential with proper management. Of these 17 acres have excellent potential and are suitable to non-irrigated vineyards, about 2.5 acres are shallow soils and would typically be irrigated and have excellent potential as irrigated vineyard, but they present higher risk if dry farmed. About three acres are seasonally wet and moderately well drained and should be artificially drained.

Soil Classifications and Soil Series Summaries

Gelderman silty clay loam

Depth to soft weathered basalt bedrock: 20 to 40 inches Depth to Seasonally High-Water Table: > 40 inches and typically >60 inches.
AWHC: 4 to 8 inches
The Gelderman soil series is well drained, moderately deep to weathered basalt; the soil formed in colluvium and residuum from basalt. These soils have less AWHC than the deeper Jory soils and Saum soils and are suited to either irrigated and non irrigated viticulture. On this site they occur in the slight swale that dissects the bedrock bench on the east part of the property.

Jory silty clay loam

Depth to Weathered Basalt Bedrock: 60 to 80 inches
Depth to Hard Basalt Bedrock: 60 to 80 inches
Depth to Seasonally High-Water Table: greater than 60 inches and typically greater than 60 inches
AWHC: 10 to 12 inches
The Jory soils are very deep, well drained soils that formed in colluvium and residuum from basalt. They are deep dark reddish colored and are silty clay loam in the upper part and very firm well-structured clay in the subsoil. The subsoil is a clayey paleosol or ancient soil. These soils have excellent vineyard potential and

they have the potential to produce higher vine vigor than the shallower basaltic soils. Devigorating rootstocks and cover crops can be used to help control vigor. The Jory and Saum soils are mapped together in Figure 3 and could be mapped separately with more intensive soil mapping but will manage very similarly.

Saum silt clay loam

Depth to Weathered Basalt Bedrock: 40 to 60 inches
Depth to Hard Basalt Bedrock: 40 to 60 inches
Depth to Seasonally High-Water Table: greater than 60 inches and typically greater than 60 inches
AWHC: 8 to 10 inches
The Saum series consists of deep, well drained soils that formed in colluvium and residuum from basalt. T h e s e s o i l s have the potential to produce higher vine vigor than the shallower basaltic soils. Devigorating rootstocks and cover crops can be used to help control vigor. Hard basalt bedrock on the Saum soils of this site are at about four feet deep.

Parrett and Stayton soils moderately wet phase

Depth to soft weathered basalt bedrock: 15 to 30 inches Depth to Seasonally High-Water Table: moderately well drained 15 to 30 inches AWHC: 2 to 4 inches Though named Parrett and Stayton, these two soil series are well drained and therefor are only similar in depth and parent material to what is found here since the soils found here are seasonally wet and there is no other established soil series that is more similar. Parrett is moderately deep, and Stayton is shallow. More sampling is needed to delineate these two soils within this area.

This area is unique in being shallow to moderately shallow to a hard bedrock bench and having a high seasonal water table. There is subsurface water feeding these soils from upslope and from the very poorly drained pond that creates a unique situation. These soils are low to moderately low available water holding capacity based on what the soil can store, but the continued addition of water from upslope will keep the soil moist later in the season than soils of similar depth that are on hillslopes. It is not known how long this subsurface watering continues into the growing season, and this perhaps should be explored in July and August to see if

the soils are still moist which would perhaps reduce or eliminate need for irrigation on these three acres.

Witzel stony loam

Depth to soft weathered basalt bedrock: 12 to 20 inches
Depth to Seasonally High-Water Table: > 40 inches
AWHC: 1 to 3 inches
The Witzel soil series is well drained, shallow, stony; the soil formed in colluvium and residuum from basalt. These soils have less AWHC than the other soils mapped here and tend to be droughty if not irrigated.

Table 1. Summary soil boring data

Boring	Soil name	Depth to basalt	Drainage Class	Available water holding capacity	Vine Vigor Potential
1	Witzel	20	well	2	low
2	Gelderman	37	Well	8	moderate
3	Witzel	15	Well	2	very low
4	Jory	72	Well	11	high
5	Jory	>78	well	>11	high
6	Saum	>62	Well	10	High
7	Saum	>60	well	10	high
8	Witzel	12	well	1	Very low
9	Jory	>60	well	10	high
10	Saum	>65	well	10	High
11	Parrett (mod well drained)	23	Moderately well	4	Mod low

Bedrock (R horizon)

Basaltic soils in this region are classified largely on the depth to bedrock. Jory soils are very deep (>60 inches and may be as deep as 100 inches), Saum soils are deep (40 to 60 inches), Parrett and Gelderman soils are moderately deep (20 to 40 inches), These soils have reddish brown clay subsoil overlying bedrock. The shallow member of the volcanic soil's association is Witzel gravelly loam and Stayton silty loam and these are from 12 to 20 inches depth to bedrock, Witzel is stony and Stayton is not. The harder basalt rocks restrict roots to the space in fissures in the rock and limit available water holding capacity. The bedrock in the Witzel and Stayton soil areas is hard and in most cases prevented excavation into the rock. The bedrock in the Gelderman soil is more weathered, softer and allows more rooting and available water holding capacity.

Available Water Holding Capacity (AWHC)

The AWHC values reported are the AWHC (Table 1) in the soil above the rock contact and represents an estimate of the water that can be stored in the soil profile that is available for plant uptake, which is the amount of water held between field moisture capacity and the permanent wilting point (reported in inches of water). For soils where the roots extend deeper into bedrock fissures the AWHC is the best estimate and is probably an underestimate. The value reported is calculated from a model based on the sum of the weighted average AWHC for each soil horizon, using values reported in the literature and measured soil profile data at each numbered point.

The AWHC is a function of soil depth, texture, organic matter, bulk density, porosity, and soil osmotic potential. Root restricting layers decrease the depth of the soil profile and the AWHC. The hard bedrock though fissured restricts the volume of water the soil can hold in rocky layers.

Clay soils can hold more “total” water because they have greater pore space at a given bulk density, however because their average pore volume is smaller, clay soils hold a greater proportion water that is unavailable at greater soil moisture tension compared to silt loam Since the majority of grape roots are in the upper soil profile, it can be assumed that the AWHC values for the upper five feet provide a useful relative scale of the variability in water supply available to the vine for the classes used here.

In an NRCS vineyard soil study that included pedons from around the Willamette Valley, the water retention measurements for whole soils show that on a volumetric water basis, AWHC values for Jory soils ranged from 0.08 to 0.15 (inches AWHC per inch depth). Organic matter content and silt content are positively correlated with AWHC.

The shallow Witzel soils have the least AWHC and the very deep Jory soils have the most AWHC. This variability can be addressed with blocking and management practices including can be addressed by combinations of micro-irrigation, vine spacing, use of drought tolerant rootstocks, and managed competition from cover crops and weeds. Soils with higher AWHC can be managed under dry land conditions, and a rootstock selection may favor those that reduce vigor.

Managed competition involves selecting combinations of cover crop mixtures, mowing and tillage options that are suitable to the soil water and soil productivity balance. More vigorous grass cover crops can help reduce water available to vines in deep soils, and in droughty soils less competitive cover crops may be more appropriate and alternate row tillage can be used to further reduce competition. Mulching in the vine row will help conserve soil moisture and may be especially useful on all soils in the establishment year before vines have put down a deep root system.

Soil Drainage

The soils on this property are predominantly well drained. There is an area in the northeast corner of the property where there is a very poorly drained, ponded area and soils around the fringe of this wetland have seasonal high-water table at 12 to 24 inches. The water table in the fringe area soils was not present on the day of sampling (April 29) but the soils are very moist and have morphology that indicates a seasonal high- water table. This area is receiving subsurface flow from the west and these soils will benefit from this flow in increasing the plant available water to a level that is greater than indicated by the moderately shallow depth of boring 11. Vineyards should not be planted in the bottoms of drainage way shown on Figure 3, nor in the wet soil area. Short term concentrated flows of surface runoff can cause severe erosion in these drainage areas, which are best left in grass and subsurface drainage lines can be installed to safely transmit water downslope to the ponded area. There may be a seasonally high water table in soils in the drainageway we did not sample there.

Site Preparation

Most of the cleared areais growing grass pasture or hay and site preparation needed is minimal except in areas where there are a lot of rocks in the surface layer. The soils have natural strong structure and can be planted with minimal tillage. Chisel plowing or disking followed by picking up rocks is probably the minimal site preparation strategy for the cleared areas.

The Witzel soil map unit has high content of rock in the surface soil. Deep tillage should be avoided on the Witzel soils since rocks would be brought to the surface and result in an expensive rock removal job and do little to improve the site. Slope shaping should be avoided because it tends to increase within block variability since the cut soils get shallower and the filled soils get deeper. It is best to disturb surface soil as little as possible.

The sparsely forested sections are a different case, and stumps of mature oaks maples and Douglas fir would need to be pulled and piled with a minimal amount of soil disturbance. Typically, wooded areas that are cleared would be subsoiled about 24 inches to get the larger woody roots out of the ground that did not come up with stump pulling operation. It would make sense to apply lime prior to this 24-inch deep tillage if timing works out and if soil analysis indicates liming is needed.

There are slopes on this parcel that are between 12 and 30 percent slopes where soil erosion presents a severe hazard if the soils are worked late in fall and cover is not established before winter. Cover crop establishment in October is important and placing straw bales in any erosion channels that form in winter can save a small problem from getting a lot worse

Soil Quality and Soil Conservation

Soil quality involves managing the physical, chemical and biological components of the soil towards the goal of overall soil health. Healthy soil has an active and healthy biotic community; it has good tilth and nutrient balance. Tilth is the physical condition of the soil relative to ease of tillage, its suitability as a seedbed and its impedance to seedling emergence and root penetration. Organic soil amendments and additions of calcium as either lime or gypsum can improve soil aggregation, tilth and nutrient status of the soil and can stimulate the biotic community.

Maintaining high soil organic matter is a soil quality target that can be met by using cover crops and compost additions. Since the deeper soils have more potential for vigor more aggressive use of cover crops can be used on the deeper Jory and Saum soils.

Historical records for the Willamette Valley have documented very severe erosion on foothill soils where soils were left unprotected or with poorly established vegetation in the winters when large runoff events occurred. These severe erosion events can be triggered by intense rain falling on saturated or frozen soils, or by rain on snow events. Such conditions may only have a calculated return period of 10 or 20 years, but if a grower is caught with sloping bare ground at such an unfortunate time, a lifetime's worth of soil development can be lost in one year. Soil loss rates from 10 to 100 tons acre^{-1} year^{-1} have been recorded for such events in the Willamette Valley.

Therefore it is critical to protect these soils from erosion. Cover crops are typically used to control erosion in winter rainy season. Various cover crop mixes are available to provide both cover and suitable level of competition with wine grapes.

There are remnant native prairie species growing in the area of the Witzel soil hill around boring 8 that would be of interest to those working on conserving native habitat. There is a lot of poison oak in this area that is about 12 inches tall that is poised to take off if it is not mowed or grazed. I recommend mowing this area around July or August to allow the natives to produce seed and to control the poison oak brush. It would be good to have a biologist evaluate this area for its potential as prairie or Oak Savannah habitat. It is extremely rocky and very shallow so that site preparation is difficult, and vines would struggle here without irrigation.

Table 2. Location of soil borings

Boring	Latitude	Longitude
1	44.775045	-122.967447
2	44.774460	-122.968729
3	44.774453	-122.968249
4	44.774228	-122.969874
5	44.774340	-122.970847
6	44.775395	-122.973166
7	44.776390	-122.974074
8	44.776152	-122.972714
9	44.775925	-122.970314
10	44.775295	-122.969084
11	44.776130	-122.967812

Additional Soil Mapping Needs

Prior to vineyard design and blocking it is recommended that additional soil mapping be done to refine soil boundaries. A sampling intensity of one boring per acre is recommended on plantable acres to address the level of variability in soil depth and drainage.

Table 3. Soil Map units and properties.

Map unit	Soil names	Depth class	Draina ge class	Acres	Vineyard potential
A	Jory and Saum	Deep -very deep	Well	15.0	Excellent with or without irrigation, high vigor potential
B	Gelderman	Moderat ely deep	Well	2.4	Excellent with or without irrigation, moderate vigor potential
C	Witzel	shallow	Well	2.6	Excellent with irrigation, high risk without irrigation
D	Stayton and Parrett -Mod wet Phase	Shallow to moderat ely deep	Moderat ely well	2.8	Good, needs artificial drainage, moderate risk without irrigation,

E	Very Steep	--	--	2.3	Too steep for safe tractor operation and severe erosion hazard
F	Drainage	--	--	2.4	Avoid planting in natural drainage, concentrated flow, severe erosion hazard
wet	Very poorly drained area	--	Very poor	1.0	Too wet for winegrapes
pad	Paved area	--	--	2.85	Compacted gravel paved pad not suitable as is, but could possibly be reclaimed

Figure 3. Revised Soil Map

700 ft

0 200 400 600 800 1000 1200 1400