Soil Investigations for Vineyard Potential for the

Smith Property

51 Acres on Amity Road
Yamhill County
Amity, Oregon

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INTRODUCTION AND BACKGROUND

Soil diversity and soil quality within the vineyard can profoundly affect winegrape management and quality. Winegrowers use soil information to guide vineyard development and management. Winemakers are emphasizing the soil and site characteristics in their wines and are providing this information to wine drinkers who are increasingly discriminating. Site selection is a critical first step in the production of fine wine, and site specific soil and terrain information are major drivers of site selection.

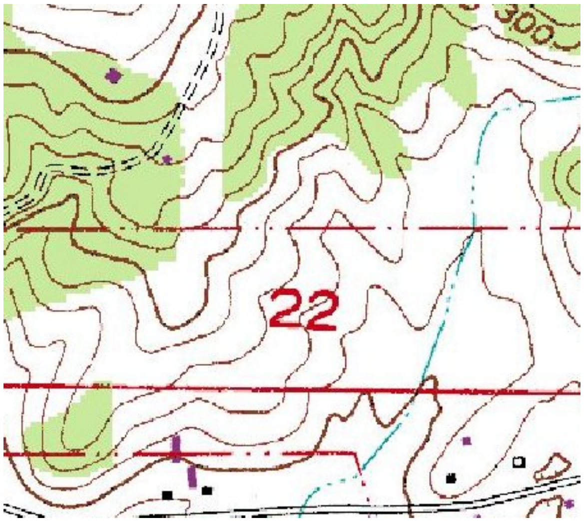
This soil investigation was done to provide a high intensity soil survey and interpretations to guide development and management on approximately 51 acres on Amity Road east of Amity in Yamhill County, Oregon. Soils here are significantly different than they are shown at the 1:20,000 scale of the county soil survey. Much of the site has seasonally high water table and soils tend to be deeper than they were previously mapped. This report provides detailed site-specific soil information and identifies soil management issues such as depth to bedrock, available water holding capacity, soil drainage conditions and accurate soil classification.

This site has been used as cropland and has extensive artificial drainage lines installed (see diagram). There are scattered woodlots on the stony ridges and sideslopes bordering the cropland.

Geology and Topography

The topography of the property consists of gently sloping ridge crests and steep side slopes of the Eola Hills. The topography and soils are influenced here by landslide and debris flows. These past slides occur on the contact between the Columbia River Basalt and the underlying marine sedimentary rocks. The ridge and shoulder slopes have extensive basaltic and hard sandstone debris overlying colluvium and residuum of sedimentary rocks. Much of the survey area is south-, southwest- and southeast-facing and 5 to 30 percent slope gradients. There may be small areas of slopes steeper than 30 percent in the woods that are too steep for conventional viticulture. The property is underlain by soft, strongly weathered siltstone and basalt in places. Elevation of the surveyed area ranges from about 200 to 320 feet above sea level (see attached topographic map).

Figure 1. Topographic map of site
(from USGS 7.5 min quadrangle)



Previous Soil Mapping

The Soil Survey of Yamhill County Area (SCS, 1974) mapped primarily well drained Steiwer (St) on the slopes on the west side, Willakenzie (WkB) and moderately well drained to somewhat poorly drained Hazelair soils (HcD) were mapped on the hillslopes of the middle and east side of the property (Figure 2). Moderately well drained Carlton soils (CaD) were mapped on the footslopes. Poorly drained Panther soils (PaD) were mapped in the heads of narrow drainageways on hillslopes. Poorly drained Cove (Cs) and Wapato (Wc) soils were mapped on the alluvial bottomland on the south fringe of the property and a small area of Stony Land (SL) was mapped on the rocky bench on the north property line. The soils in this foothill setting are usually moist but are dry for 45 to 60 consecutive days during the summer between depths of 4 and 12 inches.

METHODS

This investigation was done in October 2009 when soil profile conditions were dry. Soil profiles were observed and described from 22 soil pits that were 60 inches or more deep except where hard bedrock was encountered. Soils were classified and soil properties were recorded including soil drainage, depth to bedrock and rock type, surface thickness, soil texture of the surface and the subsoil. The average sampling intensity was high intensity, approximately one boring per two acres. Boring locations were recorded using a GPS receiver an accuracy of about 1 m. Revised map and acreage calculations were made in AUTOCAD based on GPS locations. Orthophotograph and a topographic map of the site were used to refine delineations.

Figure 2. Previous NRCS Soil Map

Yamhill Area, Oregon (OR679)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CaD	Carlton silt loam, 12 to 20 percent slopes	6.4	12.4%
Cs	Cove silty clay loam, thick surface	1.2	2.3%
DuC	Dupee silt loam, 3 to 12 percent slopes	0.0	0.0%
HcD	Hazelair silty clay loam, 7 to 20 percent slopes	14.9	28.8%
PaD	Panther silty clay loam, 4 to 20 percent slopes	1.9	3.7%
SL	Stony land	0.2	0.4%
StD	Steiwer silty clay loam, 5 to 20 percent slopes	20.4	39.6%
Wc	Wapato silty clay loam	3.6	6.9%
WkB	Willakenzie silty clay loam, moderately shallow, 2 to 7 percent slopes	3.1	5.9%
Totals for Area of Interest		**51.6**	**100.0%**

RESULTS

Summary soil data and best-match classification are provided for each of the soil borings (Table 1). Revised soil classification and important soil properties are displayed in Maps 1-6. Soils that are named for each boring are the closest match of established NRCS soil series, and are managed similarly to the named soil series. Soils summaries are provided that describe the properties of the established soil series. Additional information about these soils is available from the Soil Survey of the Yamhill County Area and on the internet (http://ortho.ftw.nrcs.usda.gov/osd/osd.html).

There are approximately 46 acres of soils that are suitable to planting vineyards on this parcel. Soils that are not included in this estimate are the poorly drained Wapato, Cove and Panther soils that are generally considered to be too wet and low lying to be used for growing high quality winegrapes. Some of this plantable acreage, approximately five acres, will need to have stones picked during site preparation and in subsequent years.

Approximately seven acres will need to be logged and woody forest debris removed during site preparation, if the woodlots are going to be converted to vineyards. Rules for converting forest land to crop land can be obtained from the Oregon Department of Forestry.

Several of the soils on this parcel (Helmick, Chehulpum, and Ritner) are known to be droughty especially in establishment years before vines have a mature root system, and micro-irrigation is recommended for most of this site. Water availability for irrigation should be determined and an irrigation system installed prior to planting the vineyard.

Soil Map Unit Summaries

Ca Carlton Soils

This unit consists of deep, moderately well to somewhat poorly drained soils seasonal high water table at a depth of 20 to 30 inches, on foot slopes, formed in colluvium and residuum derived from sandstone and tuffaceous materials. Carlton soils occur on smooth convex low hills, they have thick dark surfaces and weakly developed loamy subsoil (B-horizons). These soils have moderately slow to slow permeability. A water table is at its uppermost limit from November through May. Available water holding capacity is medium to medium high. When artificially drained these soils are suited to growing winegrapes. Vigor is moderately high on Carlton soils.

Ch Chehulpum Soils

Chehulpum soils are weakly developed and are shallow (12 to 20 inches) to weathered siltstone. Available water holding capacity is low and vine vigor is low on these soils. Winegrapes grown on these soils need vigorous rootstocks and irrigation during establishment and during summer drought. Siltstone is typically highly fractured and rooting is deep. These small areas may include areas where soils are thinner and rock outcrops of the surface.

Hm Helmick Soils and Hazelair Soils

The Helmick soil series consists of moderately well to somewhat poorly drained, silty clay loam over clay soils that formed in stratified medium and moderately fine textured mixed materials in the upper part and older very clayey material of unknown origin and underlain by partially consolidated tuffaceous sandstone and siltstone and micaceous siltstone and sandstone. On lower soils these soils formed on old debris flows. Helmick soils are deep to weathered siltstone. These soils have medium to rapid runoff and very slow permeability. The Hazelair soils are similar to Helmick in the upper profile, but they are moderately deep to siltstone and have slightly less available water holding capacity.

One main departure from the typical soil series range of properties in some of these soils is a high content of gravel, cobbles and stones that are both overlying the smectitic layers and in some cases embedded in that layer on this site. Differing particle sizes of coarse fragments in different layers indicates multiple deposits of cobbly clay and gravelly clay earth flow deposits. Rock removal will be needed during site preparation and repeated rock picking will be needed over time as rocks are brought to the surface via soil tillage and other operations. This is not typical Helmick and Hazelair soils.

For example boring 21 has:

Horizon	Depth	Texture
A	0 to 9 inches	cobbly clay loam
AB	9 to 24 inches	very cobbly clay loam
2BCt1	24 to 37 inches	very cobbly clay , smectite
3BCt2	37 to 50 inches	very stony clay
4BCrt	50 to 60 inches	clay, coarse moderate angular blocky structure
4Cr1	60 to 69 inches	variegated weathered siltstone
4Cr2	69 +	massive clay

There are four distinct parent materials in this sample. The subsoil has a color of strong brown to yellowish brown to olive yellow with gray mottles (redoximorphic features). Few fine distinct yellowish or reddish brown mottles are in the solum, in some pedons, and mottles with chroma of 2 or less are at depths of less than 30 inches. The clayey substratum has a predominantly olive yellow hue that ranges from bright to dull color chroma and is 60 to 70 percent clay that is predominantly smectite, high shrink-swell clay. The lower part of the soil contains few to many weathered siltstone or sandstone fragments. These soils occur on side slopes, drainage swales and benches. These soils are wet in the winter and spring and tend to be droughty in the late summer. On lower slope positions and in more concave slopes these soils are more poorly drained and grade into Chehalem and Panther soil.

Hv Helvetia

Helvetia soils are moderately well drained and have silty Missoula flood deposits overlying older alluvium. They are often located at the upper extent of the silty deposits on the hillslopes. They have clayey subsoils and very deep profiles. These soils can have high vine vigor potential. On this site the extent of these soils is quite limited. They probably have inclusions of Carlton soils and can be blocked with Carlton soils.

Pa Panther and Chehalem Soils
The Panther soils are poorly drained and very clayey. Panther soils typically occur on foot slopes, in drainage swales and at inflection points where slopes change gradient. Terrain and vegetation are used to help delineate the boundaries of these soils where they are observed in soil borings. Sedge, rushes and grasses are the typical vegetation where Panther soils occur, although on this site the soils were tilled and there was no vegetation. Panther soils are not usually included in the area of suitable acres, even though they are sometimes planted in other vineyards, the results are often poor and suitable vineyard management techniques for these soils have not been yet been demonstrated. These soils tend to be very wet in spring and dry out early in summer.

This Chehalem soil consists of deep, somewhat poorly drained soils formed in colluvium and residuum derived from sandstone, siltstone and tuffaceous materials. Chehalem soil is somewhat poorly drained with seasonal high water table at depths of 12 to 20 inches. These soils have thick dark surface with mottled clayey subsoil. They occupy the gently to moderately sloping foot slopes and toe slope (concave) slope positions. There are small areas where these soils are poorly drained and are transitional to Panther soils. The Chehalem soils are usually not suited for vineyards because they typically occur in lower lying positions where frost hazard is high. There are inclusions of soils that are loamy and moderately deep to siltstone in this unit (like boring five).

Ri Ritner Soils
Ritner soils occupy the wooded ridgecrest on the north part of the parcel. These soils have a stony and gravelly layer in the upper part of the profile and basalt is moderately deep (20 to 40 inches). There are basalt stones on the surface in this area. Part of this map unit includes soils with high amounts of basalt debris overlying siltstone, so the soils are like Ritner in the upper three to four of profile and more like Steiwer with siltstone underlying the stony soil. These soils are well drained and AWHC is moderately low.

SL Stony Land
These small areas are piles of rock and may include basalt outcrops.

Si Sitton Soils

The Sitton soils consist of very deep, well drained soils that formed in colluvium weathered from sandstone. Sitton soils are on ridge crests, side slopes of hills and foot slopes. These soils have moderately slow permeability. Sitton is a recently established soil series for soils similar to Willakenzie, but that are deeper. Because these soils are very deep they have moderately high available water holding capacity and produce more vine vigor than the moderately deep Willakenzie soils. There is only one boring that fit the properties of Sitton, more detailed mapping may help delineate the extent of the Sitton soils, which are contrasting in drainage class and texture to the adjacent Helmick soils.

Wa Wapato Soils

Wapato soils are poorly drained bottom land soils that are frequently flooded and ponded in the rainy season. These soils have silty upper profiles and may have clayey substrata as they do on this site. There is a buried dark clayey soil at a depth of 32 inches at sample 2. The buried soils is like a Cove Clay soil but in this case it has a thick recent deposit of siltier material (since historical agricultural times). These soils are not considered vineyard soils because they are too wet and low lying.

Depth to Very Gravelly Layer

This site has had basaltic debris deposited over parts of the hill slope in past land slides and earth flows. In some cases like some of the soils mapped Helmick the stones are entrained in a clayey soil matrix and may be in several layers, feet thick. A very gravelly layer is a layer that has more than 35 percent gravel, cobbles or stones. The shallower the layer is the lighter the color on the map. On the upper portions of the slopes there are more stones and they are on the surface and in the upper profile overlying either basalt rock or sedimentary rocks. The depth of rocks and amount of rocks affects site preparation decisions and costs as well as ongoing costs of rock removal. One practical decision that can be made based on this map is whether and how deep to subsoil (rip). If subsoils have high stone content then ripping deeply risks bringing these stones to the surface and increases (in some cases substantially) the cost of site preparation. Therefore prudence should be used when planning site preparation treatments.

Depth to Smectite Clay (2:1 Clay) Layer

The Helmick, Hazelair, Panther and Chehalem soils have smectitic clays in the subsoil. These clay layers have high shrink-swell capacities and are given to swelling when wet and cracking when dry. They often have very low hydraulic conductivity and tend to perch water in the rainy season. Artificial drainage of these soils is usually accomplished on vineyards as part of site preparation. This site has been extensively tile drained in the past. The smectitic clay layers here are associated with clayey earth flow deposits in some cases where the layer has high content of basalt and sandstone stones.

Depth to Bedrock (Cr- and R horizons)

The depth to weathered bedrock on Table 1 is the depth to the top of the Cr-horizon. The Cr-horizon on this site is soft sedimentary rock including siltstones and silty very fine sandstones that retain rock structure and appearance but that are soft enough to be dug with hand tools. Depth to R horizon is the depth to hard bedrock that can't be dug with hand tools. R horizons are generally more difficult for roots to grow into and the harder rock retains little or no available water except where soil material has filled in fissures.

The depth to soft, weathered sedimentary rocks range from rock outcrops on the surface to more than 100 inches. Depth to bedrock, affects the total rooting volume of the soil and hence shallower soils tend to have a smaller rooting depth and lower available water holding capacity. Root presence was determined by observed roots in soil samples or by presence of soil morphology that is indicative of the roots presence, such as illuvial clay films and organic coatings in the rock fissures. Soil depth to bedrock can be used as a factor in designing vineyard blocks and in identifying areas that are likely to be droughty. Rooting is moderately deep to very deep depending on the consistency and degree of fracture of the underlying rocks. On soils that are moderately shallow because the surface horizons are eroded, the soils are difficult to manage both because they are shallow and also because the cut soils have poorer growing conditions related to poorer tilth, less organic matter and lower nutrient status.

Table 1. Soil Boring Data

Boring	Soil Name	Slope	Depth to Very gravelly layer	Depth to Smectite (2:1 clay layer)	Depth soft bedrock	Depth to Hard bedrock	Depth to Seasonal High Water Table	Available Water Holding Capacity
		(%)	(IN)	(IN)	(IN)	(IN)	(IN)	(IN water)
1	Helmick	5	48	20	>100	60	20	9
2	Wapato	1	60	60	>60	60	6	9
3	Carlton	5	60	60	>60	60	36	11
4	Steiwer	9	60	60	24	60	60	4
5	Inclusion	8	12	60	28	30	12	5
6	Hazelair	10	60	16	38	60	16	6
7	Chehulpum	8	0	60	6	12	60	1
8	Helmick	7	60	12	45	50	12	6
9	Outcrop	12	60	60	6	6	60	1
10	Helmick	10	60	24	42	60	24	6
11	Sitton	8	60	60	60	60	60	10
12	Ritner	8	0	60	40	40	60	6
13	Ritner	5	18	60	38	38	60	5
14	Hazelair	2	0	18	33	60	18	5
15	Carlton	5	60	60	60	60	24	10
16	Chehalem-Panther	4	60	40	60	60	12	9
17	Helmick	6	60	27	60	60	18	9
18	Helvetia		60	60	60	60	20	9
19	Helmick		36	23	60	60	20	9
20	Helmick		19	19	60	60	20	9
21	Helmick-Stony Phase	12	9	24	60	60	24	9
22	Helmick-Stony Phase	15	0	35	>96	>96	35	9

Available Water Holding Capacity (AWHC)

Reported AWHC is the amount of the water (in inches) that can be stored in the soil profile that is available for plant uptake; it represents the amount of water held between field moisture capacity and the permanent wilting point. 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. Clay soils hold more total water, but have less available water than loamier soils. Clay soils have extremely fine micropores that can retain water at highly negative matric potentials. As soil moisture potentials become more negative (as soils dry), clayey soils hold more total water than coarser textured soils, because a larger percentage of the pores are small and are not freely drained. Since the majority of grape roots are in the upper soil profile, the AWHC values for the upper root zone provides a useful relative scale of the variability in water supply available to the vine for the classes used here.

Potentially droughty areas of the vineyard are shallow to moderately shallow soils that have low to moderately low AWHC (1 to 4 inches). There are several such areas on the upper parts of the hillslopes where soils are shallow or where very stony and moderately shallow. These soils are droughty in most years. Where soils have moderately low AWHC and tend towards droughty, water management options include micro-irrigation, vine spacing, use of drought-tolerant rootstocks, and managed competition from cover crops and selected native vegetation. Moderately deep soils are estimated to have moderate amounts of available water (5 to 7 inches). These soils can be droughty in drier years. Soils with higher AWHC can be managed under dry-land conditions. Rootstocks that reduce vigor are usually favored on such soils.

Varying the cover crop mixture, customizing the mowing and tillage treatments and adjusting vine spacing to match the vine vigor potential of the soil can provide managed competition towards achieving balanced vine growth. For example: more vigorous grass cover crops can be used to compete with the vines for water in deeper soils. In droughty soils, less competitive cover crops may be more appropriate. Alternate row tillage can be used to further reduce competition in low vigor potential soils. Mulching in the vine row will help conserve soil moisture.

Seasonally High Water Table (Soil Drainage Interpretation)

Soils with wet subsoil include the somewhat poorly to moderately well drained Helmick, Carlton, the somewhat poorly drained Hazelair and Chehalem and the poorly drained Panther, Wapato and Cove soils. Artificially draining the wet soils can reduce the amount of subsurface flow and runoff in the winter and reduce water erosion, a potential management issue on this site. Typically in draining very clayey soils the drainage strategy is to install intercept drainage lines upslope of these soils and to direct water around these soils. This site has already been artificially drained (diagram attached).

Caution: d*eep tillage should not be done on this site, since doing so would destroy the plastic drainage pipe and disable the drainage network.*

Microblocks

The net influence of soil on wine is the result of the effects of the soil profile as a whole, as opposed to one or a few soil factors. The idea that similar soils will yield similar influences on wine is one basis for blocking by soil type. Using precision thematic maps and very precise soil location data (latitude and longitude) the blocks can be designed to a microblock level, (sub-acre capability), to a point where block size is limited by practical concerns such as winemaking equipment and logistics of harvesting. The benefits of microblocking derive from allowing growers to apply management to a set of known soil conditions, and by allowing more informed evaluations of vine response and wine quality induced by those conditions. This capability is more fully realized when GIS solutions are used to design blocks. For example a solution to soil variability within the vineyard could be as simple as generating latitude and longitude coordinates to translate digital microblock boundaries back onto the vineyard using GPS to locate points on the ground. Important variability that can be captured with precision blocking on this site includes several different parent materials, there are basaltic rocks, sedimentary rocks, landslide deposits and Missoula Flood deposits all within about 50 acres. Soils of varying AWHC often have varying vine vigor and ripen at different times.


SMITH VINEYARD
Pa
16
6
Hm
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7
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17
Hv
Rt
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10
14
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SL
Wc
Ca
15
18
11
20
Hm
19
Si
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2
Wc
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21
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3
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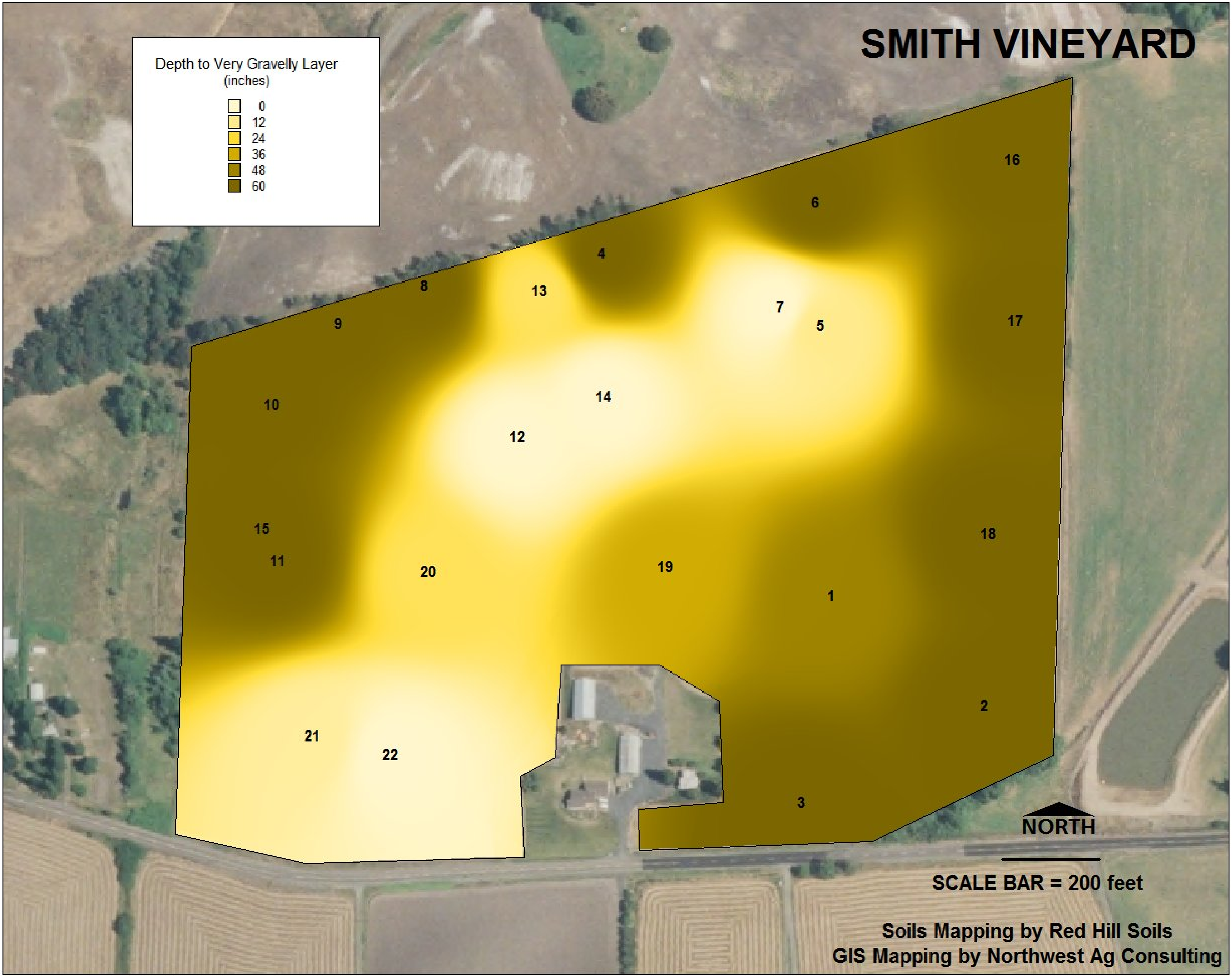
NORTH
SCALE BAR = 200 feet
Soils Mapping by Red Hill Soils
GIS Mapping by Northwest Ag Consulting


SMITH VINEYARD
Depth to Very Gravelly Layer
(inches)
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24
36
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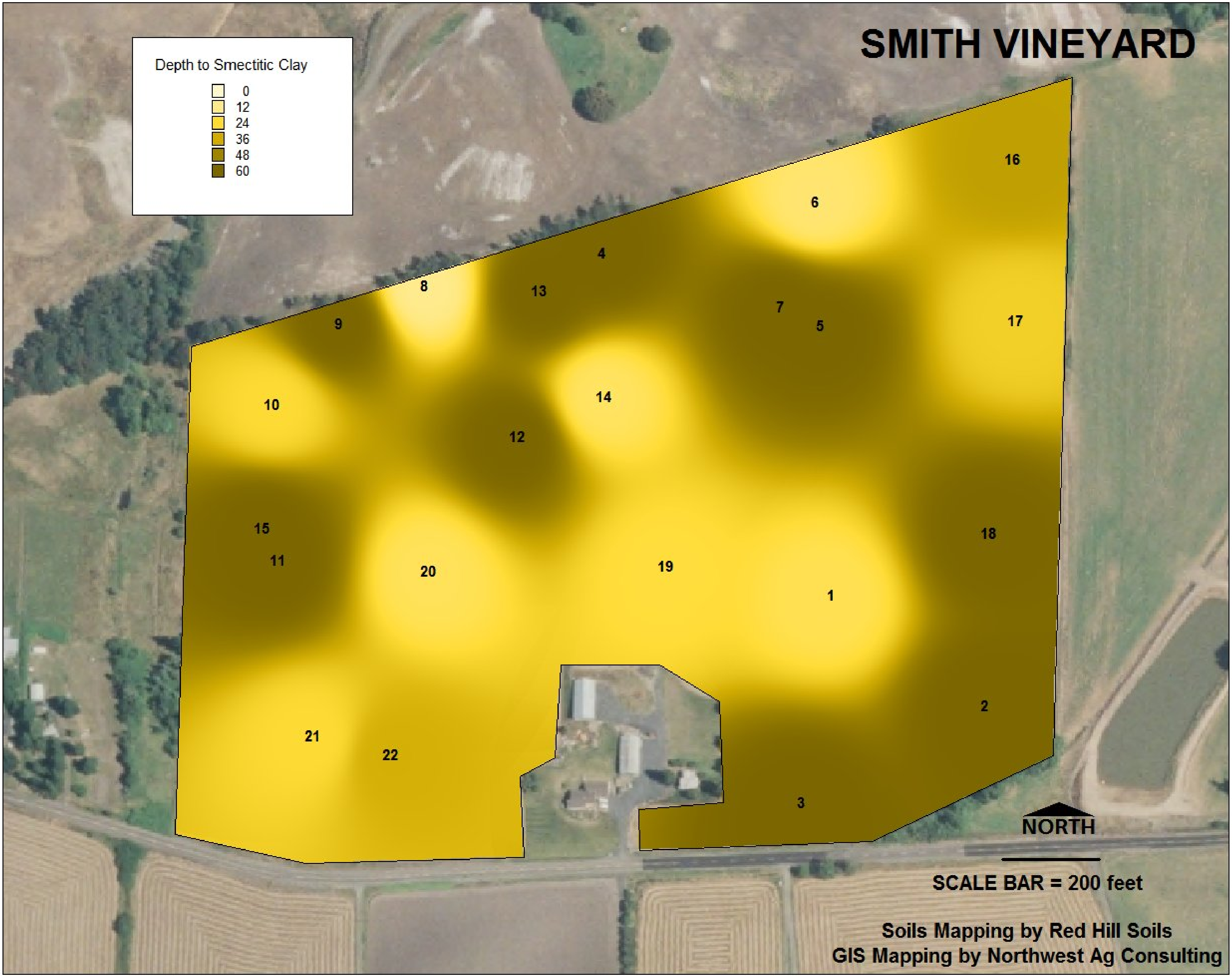
NORTH
SCALE BAR = 200 feet
Soils Mapping by Red Hill Soils
GIS Mapping by Northwest Ag Consulting


SMITH VINEYARD
Depth to Smectitic Clay
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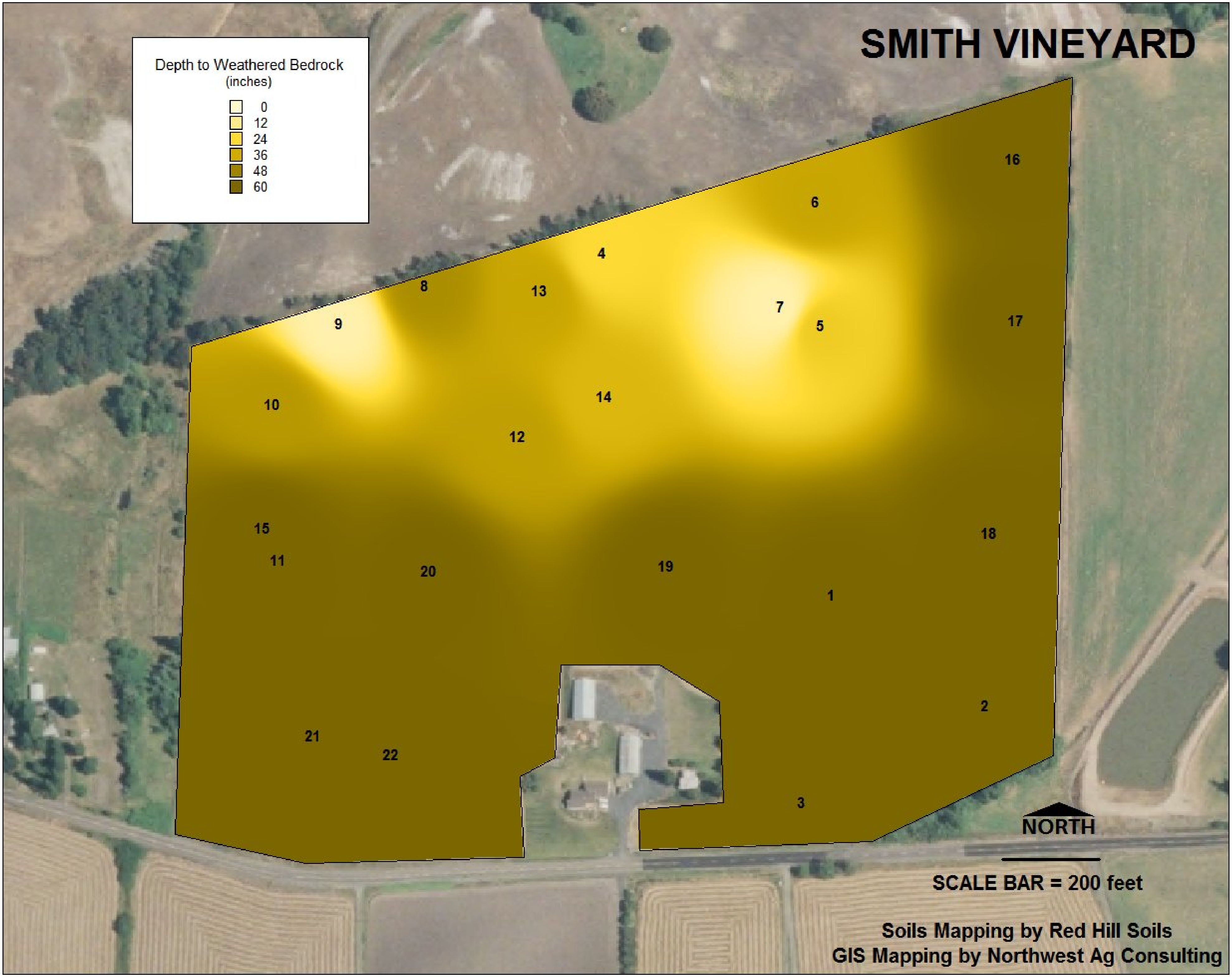
NORTH
SCALE BAR = 200 feet
Soils Mapping by Red Hill Soils
GIS Mapping by Northwest Ag Consulting


SMITH VINEYARD
Depth to Weathered Bedrock
(inches)
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24
36
48
60
16
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4
8
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9
10
14
12
15
18
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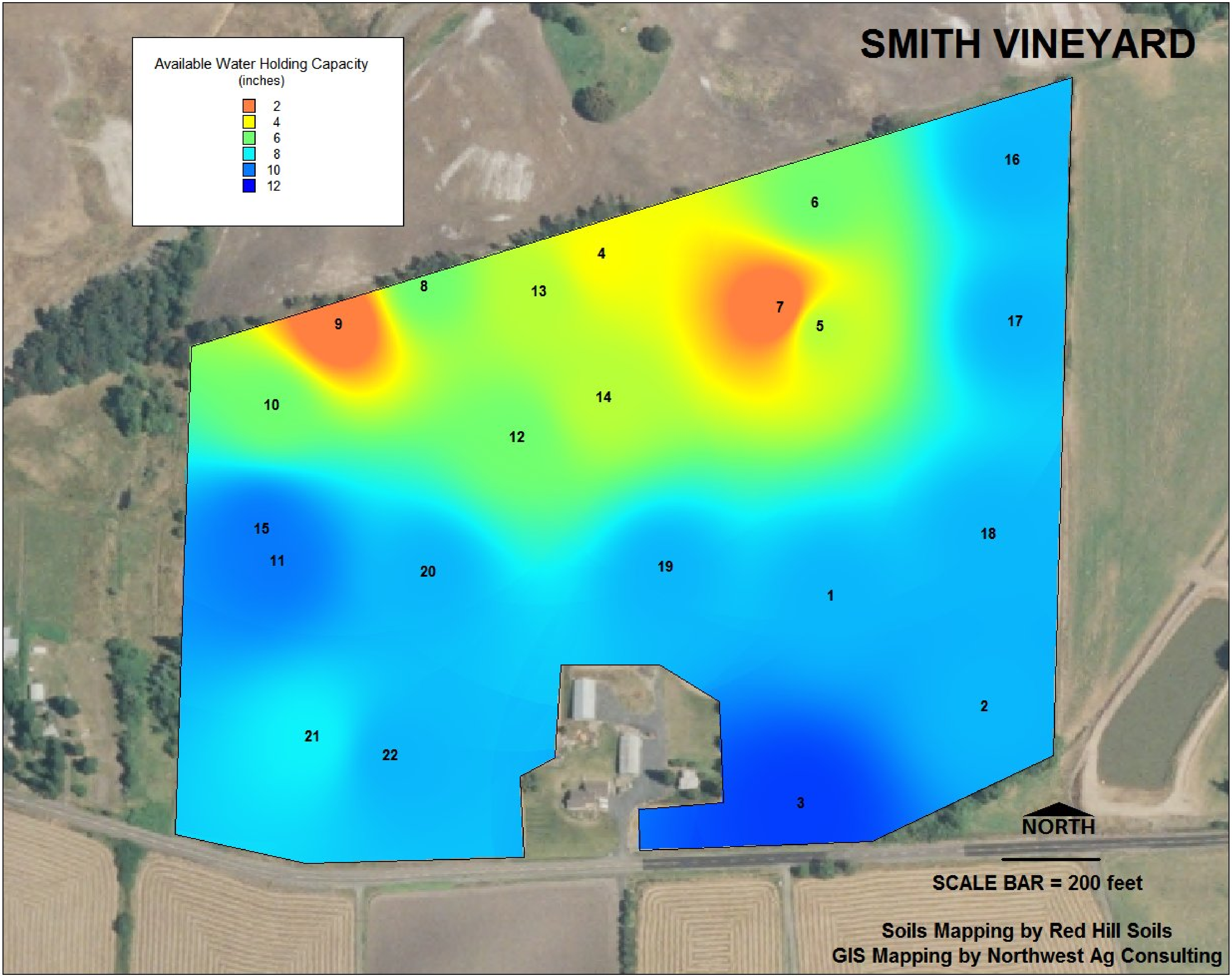
NORTH
SCALE BAR = 200 feet
Soils Mapping by Red Hill Soils
GIS Mapping by Northwest Ag Consulting


SMITH VINEYARD
Available Water Holding Capacity
(inches)
2
4
6
8
10
12
16
6
4
8
13
9
7
5
17
10
14
12
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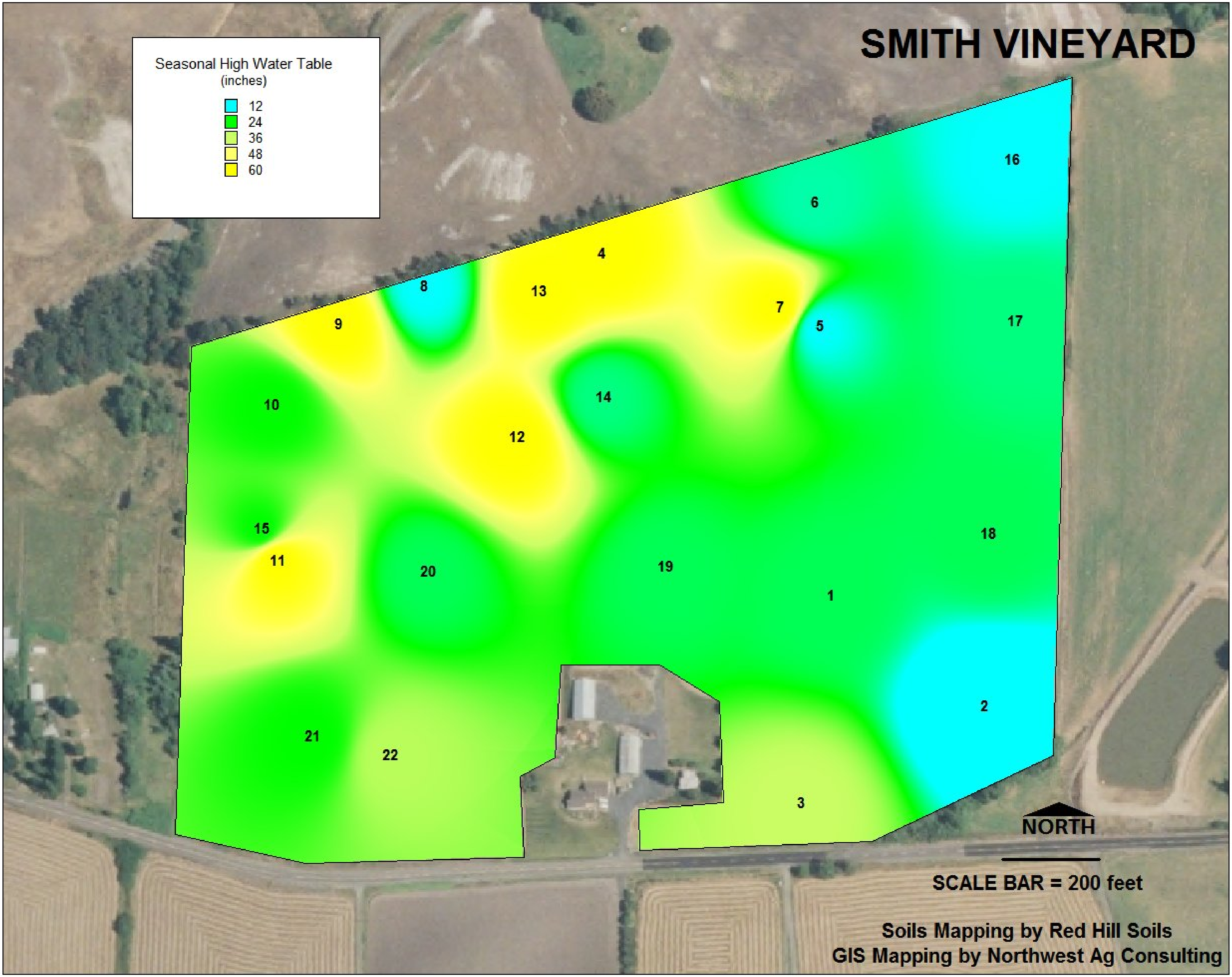
NORTH
SCALE BAR = 200 feet
Soils Mapping by Red Hill Soils
GIS Mapping by Northwest Ag Consulting


SMITH VINEYARD
Seasonal High Water Table
(inches)
12
24
36
48
60
16
6
4
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5
17
9
14
10
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15
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2
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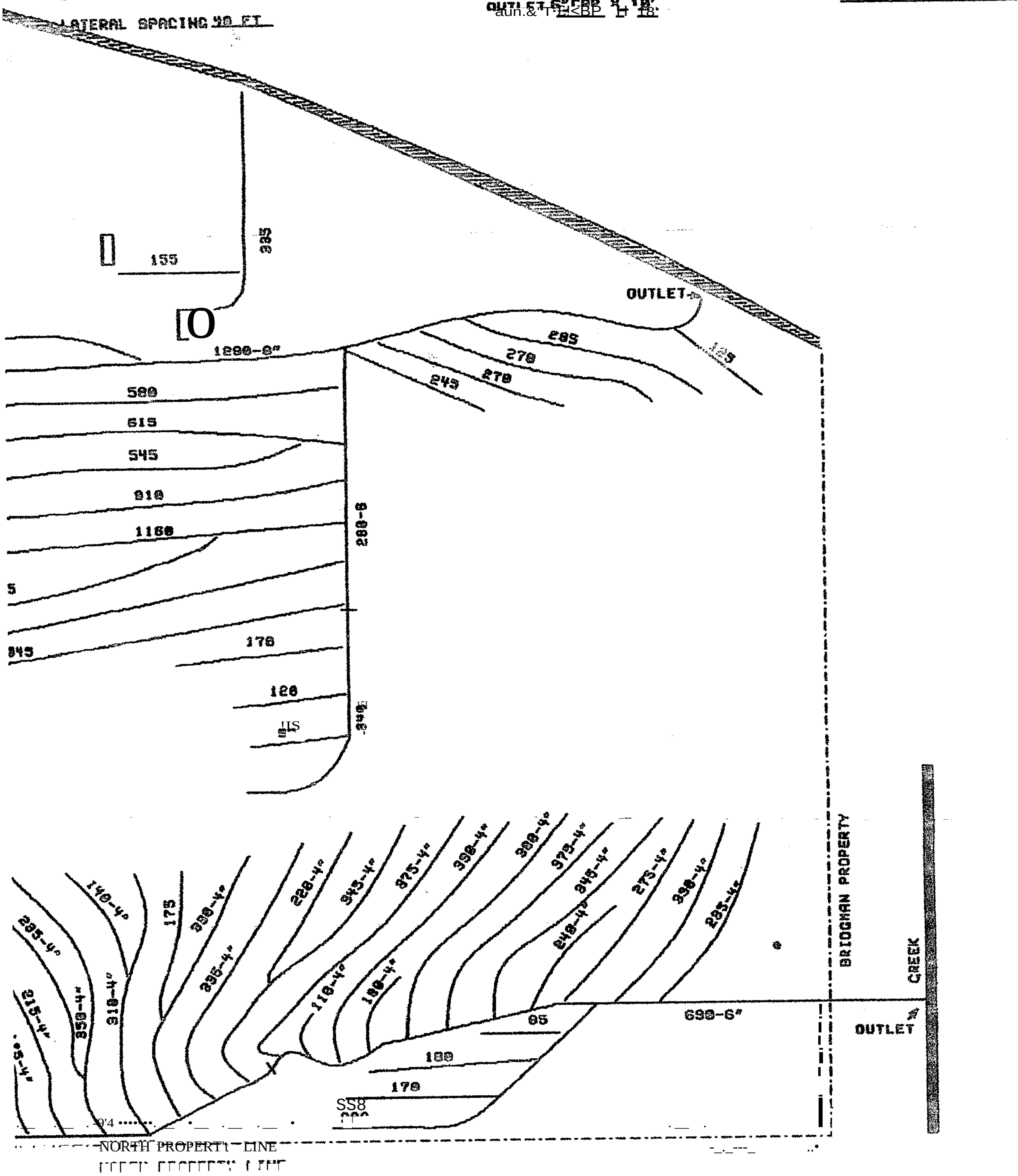
22
3
NORTH
SCALE BAR = 200 feet
Soils Mapping by Red Hill Soils
GIS Mapping by Northwest Ag Consulting

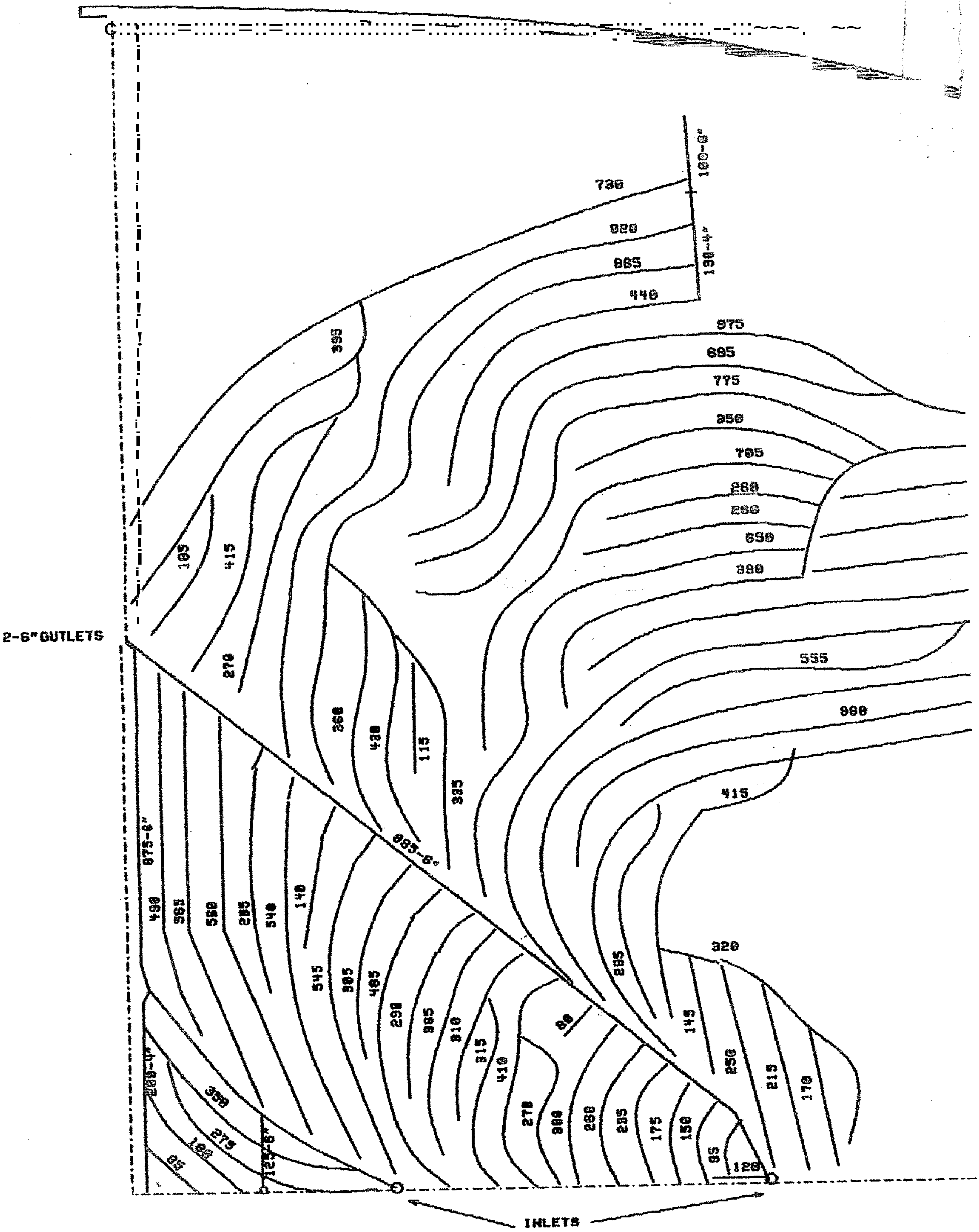
NEEDY TILE CO

CUSTOMER [illegible]
ADDRESS [illegible] RD
AMITY [illegible]
DATE AUGUST 30 1989
INVOICE NO. 3752
LATERAL SPACING 50 FT

6" TILE 4345 FT
4" TILE 30,000 FT
CONNECTIONS 110 [illegible]
OUTLET 6" CAP X 10'

INSTALLED BY KENNY + HOES PLOW





2-6" OUTLETS
INLETS