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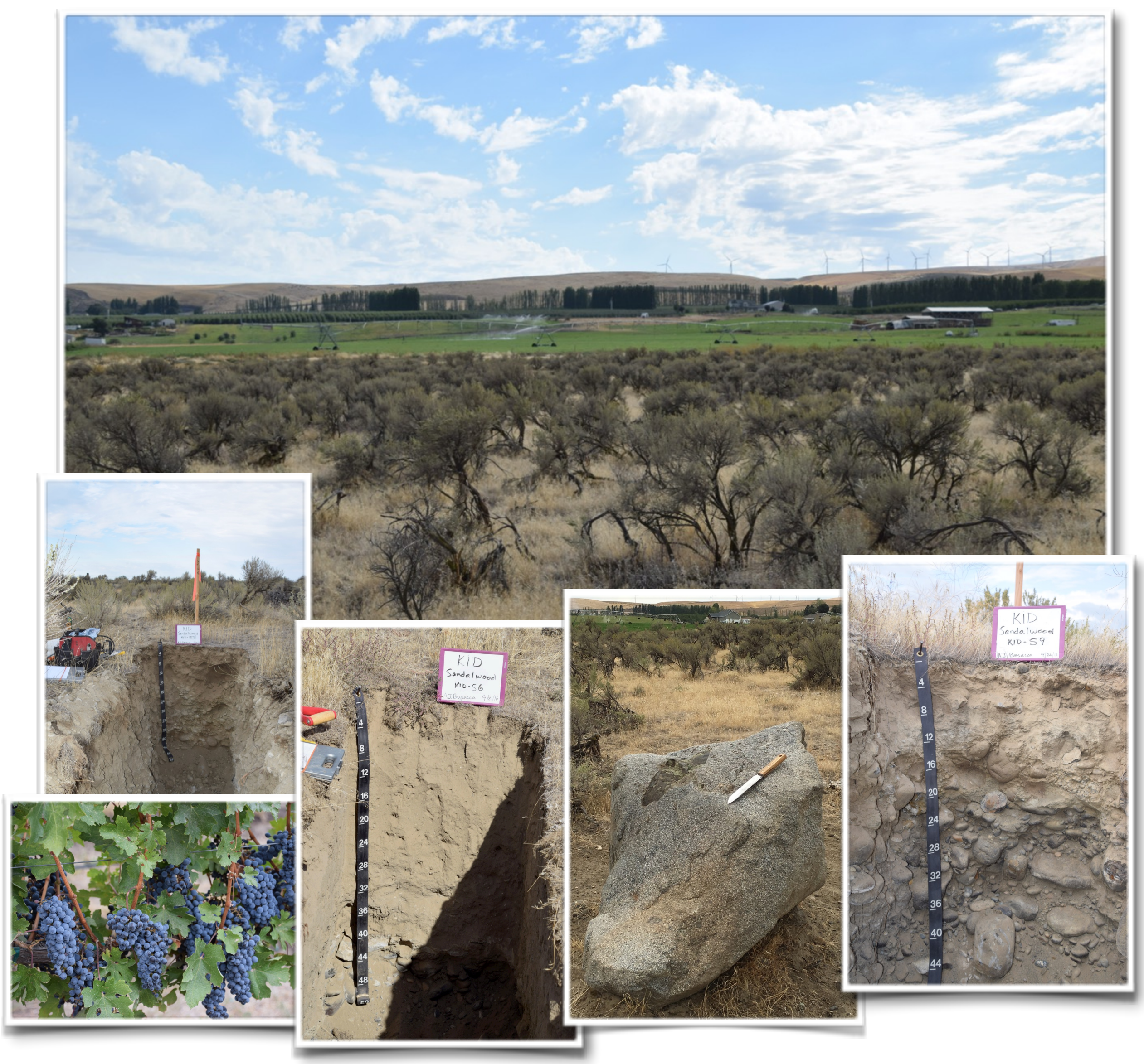
Evaluation of Land Parcels for Lease or Sale for Vineyard Development, Kennewick Irrigation District, Near Finley, Washington



INTRODUCTION TO THE PROJECT

In September of 2016, Vinitas Vineyard Consultants, LLC conducted an evaluation of viticultural site potential of eight parcels of land totaling about 320 acres. The parcels form a contiguous area and are about one mile south of the town of Finley in the greater Tri Cities area in Benton County, Washington. The parcels are in the Columbia Valley American Viticultural Area (AVA). The parcels are owned by Kennewick Irrigation District, which is planning on leasing them or selling them for vineyard, orchard, or other agricultural development. This is the report of the investigation. The primary purpose or charge was to evaluate the soils, climate, and terrain of the parcels for the potential to develop them for wine grape vineyards. A 'subjective ratings matrix of parcel condition' was created and is discussed. It's purpose is primarily to draw the reader's attention to various strengths and potential challenges to the development of each parcel, rather than serving as an absolute valuation of each parcel.

Figure 1 is a map of the K.I.D. parcels. The aerial image inset into Figure 1 shows the town of Finley to the north and the Columbia River about 2 miles to the east.

Vinitas Consultants was charged with examination of the parcels, including excavating soil pits, describing and sampling the soils, compiling and evaluating soils, climate, landscape, and other information about the parcels, and developing a subjective ratings matrix of parcel condition.

METHODS

Before fieldwork began, aerial photographs, topographic maps, and soil survey maps were used to plot approximate locations for about 10 backhoe pits to represent the diversity of soils on the parcels and to provide at least one detailed soil observation for each parcel.

Dr. Alan Busacca, manager of Vinitas, conducted the field work, analyzed the assembled data and information, and wrote this report. I made a reconnaissance visit on 20 September during which I walked the properties and staked out locations for the excavation of backhoe pits. I conducted the fieldwork on 21 and 22 September. Each pit location was surveyed with a GPS with an accuracy of about 15 feet and excavated using a backhoe to approximately four or five feet. Soil backhoe pit locations are shown on Figures 1-5 and also on the individual parcel figures contained in an Appendix.

I described the soils in the pits using standard terms and methods for soil survey (Schoeneberger and others, 2002). Appendices include maps of several soil properties for each parcel, the field description sheets of the soils in the observation pits, and the USDA-Natural Resources Conservation Service Official Soil Series Descriptions of the soils on the parcels.

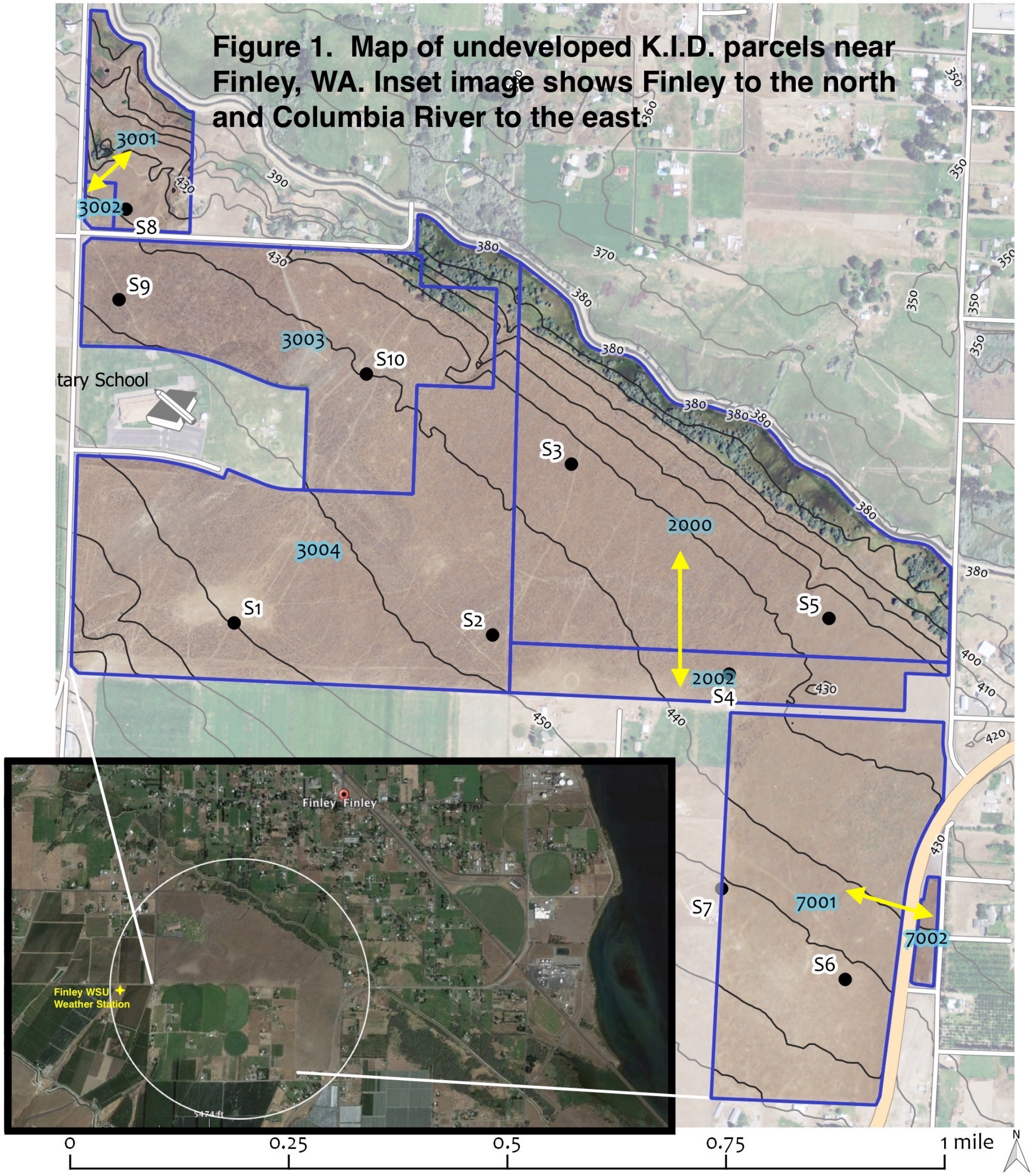


Figure 1. Map of undeveloped K.I.D. parcels near Finley, WA. Inset image shows Finley to the north and Columbia River to the east.

Kennewick Irrigation District Parcels

- ● Sample points
- —— 10 foot contours

Parcels

- 2000 - 86.1 acres
- 2002 - 17.0 acres
- 3001 - 13.9 acres
- 3002 - 1.1 acres
- 3003 - 51.0 acres
- 3004 - 88.8 acres
- 7001 - 60.9 acres
- 7002 - 1.7 acres

Scale 1:12,000
Map Projection: UTM, Zone 11
NAD 1983
Map prepared by Richard Rupp,
Palouse Geospatial
March 2017

Map background: National Agricultural Imagery Program, 2015

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

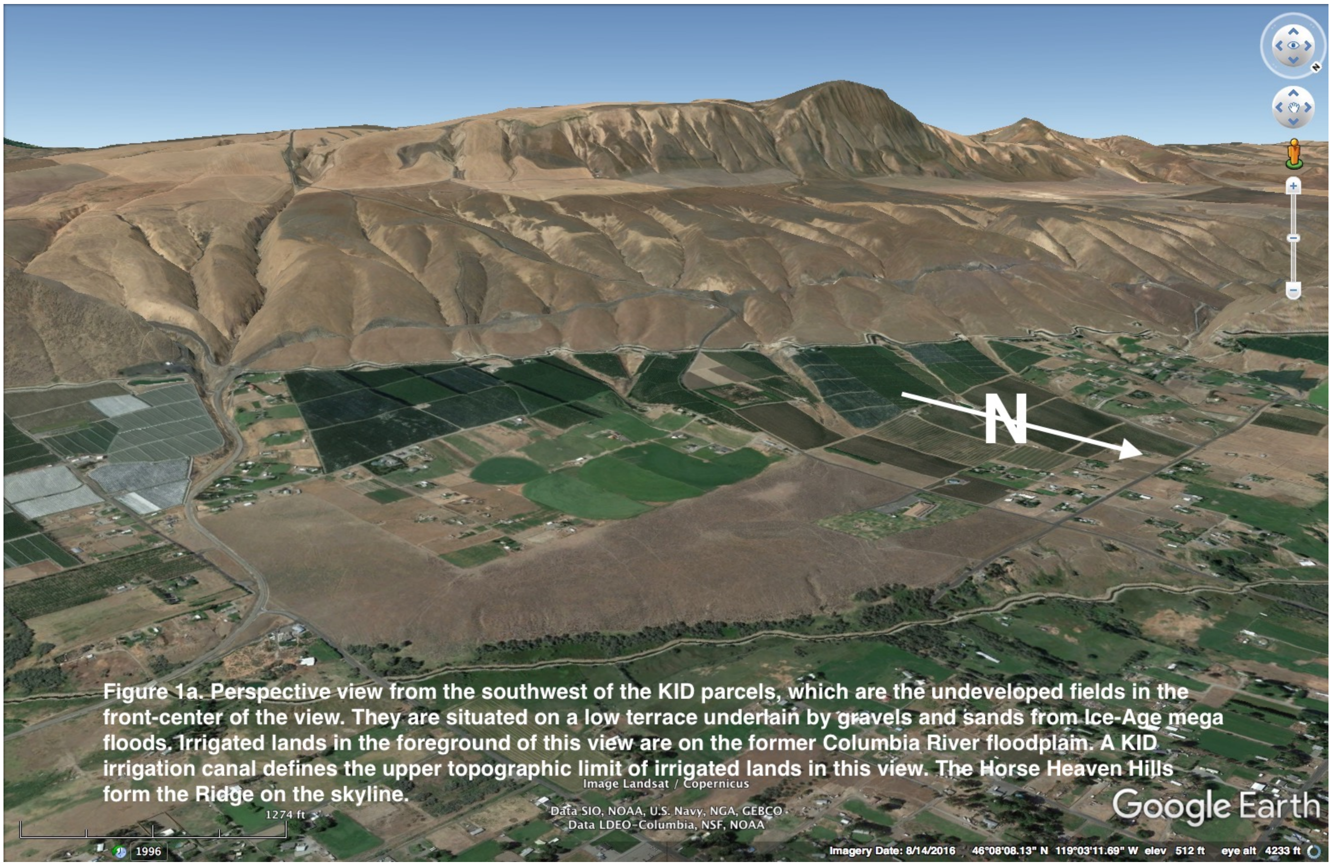


Figure 1a. Perspective view from the southwest of the KID parcels, which are the undeveloped fields in the front-center of the view. They are situated on a low terrace underlain by gravels and sands from Ice-Age mega floods. Irrigated lands in the foreground of this view are on the former Columbia River floodplain. A KID irrigation canal defines the upper topographic limit of irrigated lands in this view. The Horse Heaven Hills form the Ridge on the skyline.

The soil profiles were photographed; various close-ups of special features were taken of the soils and sediments, and selected photographs were taken of the landscape of the parcels. All of the photographs are numbered. Descriptions of the numbered photographs can be found on my field soil description sheets in the Appendix. Digital files of the photographs are available with this report.

Soils were sampled for laboratory analysis. This typically consists of a sample of the 'fine earth fraction' (soil particles sand sized and smaller: <0.08 in). Because of the high content of gravels (0.08 - 3.0 inches), cobbles (3.0 - 10.0 inches) and even stones (10.0 - 25 inches) in the soils, samples for the lab were collected generally from the upper part of the profile that was less gravelly, generally the 0-12" depth or the 0-15" depth. Even then, these required sieving in the field. In two of the soil pits, lower gravel contents in the deeper profile allowed collection and analysis of a second depth increment, from 12-24" and 15-30".

Soil samples were collected into plastic sample bags and were kept moist until analysis. Soiltest Incorporated of Moses Lake, Washington analyzed the samples for particle size distribution, nitrate and ammonium nitrogen, extractable major and minor elements, organic matter, pH, electrical conductivity, calcium carbonate content, and effervescence. Results are organized in Table 1.

Dr. Richard Rupp of Palouse Geospatial made the maps that accompany this report in an appendix, including those of the spatial patterns of the soils and of the landscape properties of slope steepness and aspect. Table 2 summarizes the slopes and aspects of the parcels by slope and aspect classes (0-2%, 2-5%, 5-8%, 8-15% and >15% for slope; and flat (0-2%), N, NE, E, SE, S, SW, W, and NW in 45º wedges for aspect); and acreages and percentages of soil types as mapped in the Benton County Soil Survey (Rasmussen and others, 1971).

Key sources of information used to prepare this report were the Benton County Soil Survey (Rasmussen, 1971), the research paper by Meinert and Busacca on the terroir of the nearby Red Mountain AVA (Meinert and Busacca, 2002), the soils map of Washington state by Boling, Frazier and Busacca, 1998) and the USDA Field Book for Describing and Sampling Soils (Schoeneberger and others, 2002). For technical information on viticulture the following reference works were consulted: The Production of Grapes and Wine in Cool Climates (Jackson and Schuster, 2001), General Viticulture (Winkler, and others, 1974), Viticulture Volume 2 Practices (Coombe and Dry, eds, 1999), Wine Science (Jackson, 2000), and Viticulture and Environment (Gladstones, 1999).

RESULTS AND MAJOR FINDINGS

Geographic Setting of the Parcels

Kennewick Irrigation District owns eight parcels just south of Finley, Washington in the Tri Cities area of Benton County. The parcels have been grazed for many years but never farmed and have a cover of native vegetation consisting of the perennial plants Wyoming big sagebrush (*Artemisia tridentata ssp. Wyomingensis*), Sandberg bluegrass (*Poa sandbergii*), scattered bluebunch wheatgrass (*Pseudoroegneria spicata spicata*) and needle-and-thread grass (*Stipa comata*), and rabbitbrush (*Chrysothamnus nauseosus*). Some parts of each parcel have a heavy cover of the introduced weedy annual Cheatgrass or Downey brome (*Bromus tectorum*).

Overall, the landscape of the entire set of parcels can be described as a broad, low bench or terrace of outburst-flood gravel that drops about 50 feet down a bluff break to low-lying lands to the north and northeast that represent the former floodplain of the modern Columbia River. The northern property lines of parcels 3001, 3003, 3004 and 2000 terminate on the floodplain at the irrigation canal of the Columbia Irrigation District. A few acres of land on both parcels 3004 and 2000 are on the flat low floodplain (Figure 1) and have a high water table. The entire set of parcels generally slope gently to the northeast (Figure 4) with an inclination of less than 5% over most of their area (Figure 5).

Climatic Characteristics of the Parcels

The WSU AgWeatherNet (http://www.weather.wsu.edu/) weather network provides long-term climate data for more than 175 mostly agricultural sites in Washington. Table 2 is a summary of the means of nine years of climate data (2008-2016) for the AgWeatherNet Finley weather station. It is fortunate for this report and for prospective buyers or lessees of the parcels that the WSU Finley weather station is located only about 1000 feet west of the nearest corner of the group of K.I.D. parcels (Figure 1).

Referring to Table 2, several climatic characteristics of the Finley weather station site and the K.I.D. parcels are worth noting: the annual average air temperature for 9 years of record is 54.7°F, annual average pan evaporation (ETo in Table 2) is a little more than 47 inches, and annual average precipitation is 6 inches, with a range from a low of 3.9 inches in 2008 to a high of 9.7 inches in 2010. The extreme minimum temperature recorded between 2008 and 2016 was -2.3°F and the extreme maximum temperature was 109.2°F.

The annual solar radiation at the Finley station is almost 5500 MJ/m^2 (Table 2) compared to about 5700 at Red Mountain. These are very high annual values for the 46°N latitude. These are arguably among the very sunny locations in the state because of their rain shadow position in the lee of the Cascade Mountains and the largely cloud-free summer growing season. Low natural rainfall, moderate winds, and extreme sunshine create opportunities for grape growers to induce controlled water stress in vines to enhance grape quality (Casassa and others, 2015). Stresses of various kinds (water stress, for example) if appropriately controlled are thought to contribute in a positive way to fruit character and quality (Keller, 2015). Therefore, the extraordinarily low natural rainfall and high solar radiation, combined with district irrigation water that is deeded with sale or lease of these parcels, are factors contributing to the potential, if planted to wine grapes, to produce distinctive, high-quality grapes.

Because the parcels are being evaluated and rated primarily for their potential to grow wine grapes, Figure 2 plots growing degree-days from April 1 to October 31 (used as the standard 'growing season' for wine grapes) for the 9 year period for the Benton City weather station, located within the Red Mountain AVA area, and for the Finley weather station and K.I.D. parcels. Plotting data for the two sites in Figure 2 provides a ready comparison of the growing-season warmth for wine grapes at the Finley parcels with that of the very highly regarded Red Mountain wine-grape district only about 20 miles to the west-northwest. Growing degree-days (Winkler and others, 1974) is an arithmetic summation of daily high temperatures above a base of 50°F through the growing season. Annual GDD totals above about 3000 place AVAs such as Red Mountain, WA and Napa, CA in 'Winkler Region III' (3001-3500 degree-days) where even later-ripening red-grape varieties such as Cabernet Sauvignon, Nebbiolo, and Petit Verdot will reach not just sugar ripeness but reach full physiological maturity of flavors and seed and skin tannins.

The warm growing season in the Northwest produced 3457 degree-days at Red Mountain almost at the upper limit of Winkler Region III and the average of the years 2008 to 2015 is slightly less intense 3070 degree-days (Figure 2). How does the K.I.D. Finley property compare to the 'Gold Standard' of Red Mountain? In 2016 it registered just roughly 50 degree-days fewer than Red Mountain at 3405 and actually registered a *higher average* of 3212 degree-days compared to the 3070 of Red Mountain for the years 2008 to 2015. Thus the K.I.D. parcels pass an initial screening for grape-growing climate with highest marks.

A factor in growing wine grapes as well as many other crops in virtually every part of eastern Washington is the occurrence of Arctic cold high-pressure systems every five to ten years in winter that are associated with temperatures as low as -10°F for several days. These can damage the buds and canes or even kill completely above-ground trunk of grapevines. In frost or freeze prone areas, growers have learned to reduce or minimize the damage by using wind machines and newer towerless forced cold air displacement systems (called SIS systems) in vineyards.

Regardless of whether or not alternative measures of freeze mitigation are installed, it is instructive to compare long-term *extreme minimum temperatures* for different grape-growing areas or reference weather stations to get a sense of the severity of freeze hazard: This is made more difficult to judge because different weather stations in the AgWeatherNet system were installed in different years. That is, the 'extreme minimum temperature' record covers almost 30 years for some stations, whereas for others it is as few as 10 years. Nevertheless, for Finley the extreme low temperature record is -2.3°F (2007-2017), for Benton City (Red Mountain) it is -16.8°F (1996-2017), for the WSU Prosser Research Station it is -13°F (1989-2017), and for Walla Walla it is -6.7°F (2007-2017).

It is *possible but unproven by this limited comparison* that a site such as K.I.D. Finley has a lower frequency and lesser severity of killing low temperatures than do other stations reported here because of a 'lake effect' on it's site climate because of its proximity to the Columbia River. Land adjacent to deep bodies of water such as Lake Chelan (which is almost 1500' deep!) experience what is called a 'lake effect'. A large mass of water moderates the temperature of the air over the lake and of the air over lands along the lake and a certain distance away from it. The impact is that if there is a lake effect, the growing conditions on the lake-effected lands will be slightly to somewhat cooler in summer than adjacent non lake-effected lands. More crucial to viticultural suitability in many lake effects areas such as Lake Chelan is that the air temperature over the land will be slightly to moderately warmer in winter.

All this being said, unfortunately, the reservoir of the Columbia River adjacent to the parcels is only about 50 feet or less deep, so a lake effect, if any at all, would be very small, perhaps a degree or two at most. This is a consideration still, especially as eastern Washington has just come through a significant freeze period in January 2017 that resulted in overnight low temperatures at Touchet, WA of -15°F and -13°F on the 12th and 13th of the month. These temperatures are low enough to kill to a grapevine at least to the ground if not to kill the roots as well, depending on snow pack and other factors for insulation, even a fully dormant and cold hardy variety.

Temperatures on those nights at the WSU AgWeatherNet (AWN) station at Wallula across the river at an elevation of 383′ were less severely cold at -1.6°F and -4.2°F than at the town of Touchet, which is in a very air-constricted down valley part of the Walla Walla Valley. At the AWN Finley station temperatures on those nights were warmer than at the Wallula weather station at -1.5°F and 0.0°F. Obviously these are only a snapshot of two cold nights in one winter and not an examination of long-term (several years or decades) regional patterns of warm and cold areas.

Geologic Setting of the Parcels

The parcels are underlain at great depth by Miocene-age basalts (black volcanic lava-flow rocks) of the Columbia River Basalt Group. This bedrock is covered by tens if not hundreds of feet of gravelly to sandy sediments deposited from cataclysmic floods from glacial Lake Missoula in northern Idaho and western Montana (see Meinert and Busacca (2002) for a brief summary or Allen and others (2009) for a book-length treatment of this amazing geologic story and episode in the history of science). This giant lake (estimated largest size was about 500 mi^3) formed when glaciers blocked its river valley during the Late Pleistocene-age (Ice Ages) about 20,000 to 14,000 years ago. The lake filled with water behind an ice dam that at times was 2,000 feet high, then emptied itself suddenly and violently by a mechanism that remains obscure. And it filled and emptied not once but many times over a period of 6,000 years or so. The floods, among the larger if not the largest flows of water in Earth history, coursed downslope across eastern Washington from the vicinity of today's Spokane and were forced through Wallula Gap, the tall, narrow canyon of the Columbia River just downstream from the site of these parcels, from where they passed eventually out to the Pacific Ocean.

Evidence of the unusual nature and distant origin of the floods can be found on the parcels: in several places I noted groups of boulders or single boulders rock types like granodiorite (see photo on title page as well as photo next page) that are exotic to the Columbia Plateau, having been gouged out of their bedrock by glaciers in today's British Columbia!) and that were rafted into the Pasco Basin encased in icebergs (Last and others, 2004). The icebergs were stranded on the gravel bar that forms the property as the floodwaters receded and then melted, leaving their rock 'passengers' behind.

Literally billions of tons of gravel, sand and silt were carried by the floods and the sands and gravels were laid down over the K.I.D. site as bed load in the floods. Consequently all of the

soils that I will discuss in detail parcel by parcel below are dominated by the gravelly to extremely gravelly and cobbly sediments. The gravelly sediments have been modified by the addition of about 3 inches to as many as 30 inches of wind-transported sands (blow sand) and silts (dustfall called loess) that were deposited and mixed into the surface since the end of the Ice Age about 14,000 years ago.These sandy and gravelly sediments form the dominant parent material from which the soils have formed.

Evaluation of Viticultural Potential of the Parcels

The K.I.D.-owned land near Finley consists of eight parcels (Figure 1). This is primarily an evaluation of potential for planting and farming wine grapes, with other potential agricultural uses (orchard crops, row crops, etc.) secondary. In looking at the parcel sizes and shapes and in walking over the land I made a decision that parcels 3001 and 3002 should be considered as a single unit for evaluation. Similarly, I grouped parcels 2000 and 2002 into a single unit for evaluation because, at roughly 300 feet wide (Figure 1), parcel 2002 is not farmable nor useful for other purposes as a stand alone piece of land. And finally, I grouped parcels 7001 and 7002 into a single unit for evaluation for the same reason. Parcels 3003 and 3004 I considered to be of a reasonable size and shape to stand as platted. Double-headed arrows in Figures 1-5 show and remind us which of the parcels are grouped and which stand alone.

Because of the dramatic power of the mega floods that flowed over this area, it is perhaps not surprising that the entire set of parcels, to a reasonable degree, all are underlain by one soil type, the Finley Series

The most basic characteristic of each parcel is what soil type or *soil series* occurs on each parcel. Official soil series descriptions (OSDs) of the two principal mapped soils, Finley and Pasco are in Appendix 1 at the end of this report. OSDs are soil descriptions made at 'type locations' for the official record of the soil type, but were not taken on the K.I.D. parcels.

Copies of the field description sheets of the soils in the observation pits on the K.I.D. parcels are in Appendix 2. I made these notes of soil features and properties using soil scientists' shorthand. Soil pit locations are listed in the upper right of the description sheets and these pit numbers are shown on the maps in Figures 1-5.

In this part of the report, first I discuss the profile characteristics of the OSDs and compare and contrast them with the features of the actual soils I observed in the backhoe pits. That is, the sequence of soil horizons and geologic layers are discussed that characterize different soil series and constitute the physical medium of the vine-rooting zone.

Next I interpret the laboratory analyses of the soils' physical and chemical properties, nutrient status, etc. These data are organized in Table 1 by soil pit number and sample depth.

Next I comment briefly on each parcel with regard to benefits and limitations for vineyard development such as specific soil features, elevation, slope steepness and aspect (slope direction) as they relate to water and air drainage, potential freeze hazard or lack thereof, sunlight interception, grapevine planting options, and other land development decisions. I refer in this section to Table 3 that includes statistics on the acreages and percentages of soil mapping units; eight aspect classes that divide the compass into segments of 45° each (north: 22.5° on either side of true north, northeast, east, southeast, south, southwest, west, and northwest); and five slope classes 0-2%, 2-5%, 5-8%, 8-15%, and >15%.

The report concludes with the subjective site quality ratings for vineyard development in Table 4.

Soil Characteristics

The soil survey of the Benton County, Washington area (Rasmussen and others, 1971) includes the area of this study and is available on line at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx . As mapped by USDA, three soil series are recognized on eight parcels: Finley, Pasco, and Warden. On the ground, soils of the Warden series occupied no more than half an acre in the southwest corner of parcel 3004 so I do not show it on the soil map in Figure 3 and will not consider them further.

Pasco series soils are formed in layered silt loam and sandy loam sediments on the floodplain of the Columbia River and occupy less than an acre of parcel 3004 and about 4 acres of parcel 2000.. They are somewhat poorly drained, have a high water table, and are used primarily for irrigated pasture. Because they occupy only a small area on two parcels and are not used for vineyards, I did not dig a soil pit nor make a soil description for this project and I will not consider them further.

Soils in the ten soil observation pits matched the official series description of the Finley series to a reasonable degree. The soil survey map sheet from which we took the digital line work

to produce Figure 3 includes five different mapping units of the Finley soil. Three of these are defined on the basis of the soil type combined with slope class. The other two are defined on the basis of having gravel (rounded rock 0.08 inches to 3 inches in diameter) in the surface layer and on the land surface (Finley gravelly fine sandy loam, 2-5% slopes) or having stones (rounded rock greater than 10 inches in diameter) in the surface layer and on the land surface Finley stony fine sandy loam, 0-20% slopes).

Soils in pits S4 and S5 matched the concept and features of the Finley series soil quite closely as can be judged by comparing a photo of the soil in S4 (photo 55 this page[1]) with the OSD of the Finley soil in Appendix 1 and with my soil profile description of soil S4 in Appendix S2. The Finley series soils are *Aridisols*, true desert soils with minimal darkening and minimal accumulations of organic matter in the topsoil or A horizons. They lack most features of stronger chemical weathering of the parent sediments because of the very low rainfall and high evapotranspiration which limits soil development mainly to the accumulation in the subsoil of calcium carbonate (lime) and opaline silica (soil-formed masses of solid Si that cement sands and gravels together). In the photo, whitish coatings of lime and minor silica can be seen coating the undersides of the stones from 25 inches to the bottom of the pit.

Soils in the other eight pits had a lime- or lime and silica-cemented hardpan at varying depths beneath the land surface. This hardpan is called a 'duripan' in soil science nomenclature and noted in the 'horizon' column of the field sheets in Appendix 2 with the shorthand designation 'Bkqm', 'Bkm', Bkmb', '2Bk(m)' and other variants. The "m" in every case denotes the cementation. In all cases, the zone of cementation occurs in a very gravelly to extremely gravelly and cobbly subsurface horizon, beneath essentially non gravelly or much less gravelly, loamy upper soil horizons.

The depth to the hardpan ranged from a shallow of 7 inches to a deep of 43 inches in the order: S9@7" (see photos 113 & 114, duripan extends from 7" to 18"; a second, stronger, duripan was observed at 52 inches but is below the view in this photo); S3@12"; S7@15" and 32"; S8@15"; S1@21"; S10@22" (photo 91); S6@40"; and S2@43". The degree of hardness and

[1] NOTE: numbers on photos (i.e. 'KID Finley 55' are keyed to notes and comments on the field soil description sheets in Appendix 2. The full set of photographs taken during field work is available in Appendix 4)

continuity of the hardpans also varied from weakly cemented in S2, S8 and S9, moderately

cemented in S1, S3, and S7, and strongly cemented in S6 and S10.

<u>Soil Physical and chemical properties</u>

Soil Texture- Eleven of 12 soil samples had textures of the fine earth (sand, silt, and clay) of sandy loam and one had a texture of loamy sand (Table 1). Gravel content of the horizons from which these samples were collected had field visual estimates of gravel content that ranged from 2% to 20% (Table 1).

Clay content of all soils is extremely low, ranging from 1% to 3%. Silt content, contributed from finer flood alluvium and from loess, ranges from about 20% to almost 50% (Table 1). The sand in these soils is overwhelmingly medium, fine and very fine sands. Finer grades of sand combined with moderate to high silt contents creates the generally loamy textures and favorable water holding capacities of the surface and near-surface horizons in these soils, where the dominant rooting typically occurs in vineyards under drip irrigation.

Seasonally High Water Table (Soil Drainage Interpretation)- All of the soils discussed and all of the K.I.D. parcels under consideration for wine grapes are well drained to excessively well drained and no water table exists or would be expected to develop under drip irrigation. This assumes that hardpans would be shattered by ripping. Because the lime and silica cements are hard and brittle, ripping is considered to be a permanent treatment. With the good internal soil drainage character in these sandy and gravelly soils and assuming the hardpan layers are shattered in preparing the parcels, problems of excessive root-zone wetness and poor root-zone aeration would not occur under drip irrigation.

Soil Nutrients and Chemical Analysis- The nutrient status, physical and chemical properties of the observation-pit soils are summarized in Table 1. There were no surprises and no important chemical imbalances or other problems of a major nature in any of the soils found in assessing the lab results in Table 1.

Organic Matter- The organic matter content of surface samples ranges from about 0.5% to 1.3%. This is consistent with the Aridic soil moisture regime of these soils and the sagebrush-steppe (sage-dotted grassland) vegetation under which these soils formed. Organic matter content of these soils thus is low and highly suitable for wine grapes because they cannot provide excess Nitrogen nutrition to drive excess vine vigor.

Reaction and pH- pH values for all subsurface samples show the buffering influence of calcium carbonate (lime) because the majority of values are around 7.7 - 8.2 (8.2 pH is the equilibrium value for soils with free lime.) The average pH of all surface soil samples is about 7.8 because carbonates have been leached from the surface horizons by natural weathering processes.

Soil pH affects availability and uptake of nutrient ions; most soils texts and fertilizer guides reproduce a chart that graphically shows availability of major and minor nutrient ions as a function of pH. The macronutrient ions N, P, K, S, Ca, and Mg are reasonably optimally available at the pH range of the majority of surface horizons. The availability of micronutrient ions Fe, Mn, B, and Cu diminishes as soil pH approaches 8 (Jackson, 2000), suggesting that newly planted grapevines on these parcels be monitored by petiole analysis and checking for deficiency symptoms for these elements.

Exchangeable Ions-

Calcium, Magnesium, and Sodium- The cation balance is ‘normal’ in all of the soils tested, that is, calcium dominates the exchange complex of clays and organic matter, occupying about 80 percent to 90 percent of the exchange sites, magnesium occupies about 10 to 20 percent, and sodium about one percent (Table 1). Ca, Mg, and Na (along with K, whose availability to plants is measured here by a different technique and not included in the exchangeable ions) are the most common cations on ion exchange sites in soils. Where Ca and

Mg dominate and Na occupies less than about 15 % of exchange sites, as they do in all of the soil samples analyzed here, normal physiological function of grapevines and other perennial crops is promoted.

No damaging 'sodic' soil conditions (Na > 15% of exchange ions) were found in any of the samples measured. No saline soil samples or soil conditions were found in any parcels, judging by electrical conductivity measurements that were universally much less than 1.2 mmhos/cm (> 3 is the threshold for saline soils).

Macro and Micro Nutrient Ions- Soil test values for nitrogen and plant inorganic nutrients are at best a general indicator of sufficiency, deficiency, or excess for different crops. Leaf or petiole analysis is superior for perennial crops, but there is no alternative to soil tests in cases such as this where land is fallow or where the target crop is not yet planted.

Nitrogen- Nitrate and ammonium nitrogen contents of all soil samples fall in the 'low' soil test range less than 10 ppm (which is the same as mg/kg), which is to be expected under native conditions of desert grasses and shrubs. Low native or starting contents of nitrogen is highly desirable to control vigor in young vines and is easily amended to proper levels with compost incorporation or judicious fertilizer additions.

Potassium- Soil test values for 'Olsen' extractable potassium average about 250-600 ppm for all samples (Table 1). Comparison with the soil test interpretation tables suggests that soil potassium is in the medium to high range for all samples. Soil test potassium levels are thus not of initial concern to vineyard development.

Phosphorous- Phosphorus has typically not been shown to be limiting for grapes at any soil test value, apparently because grape roots can 'mine' P from soils even at very low levels. Nevertheless, soil test values for 'Olsen' extractable phosphorus of surface samples ranged from about 7 to 22 ppm (Table 1). Good viticultural practice suggests that soil phosphorus should be monitored in petiole samples of young vines in case deficiencies are encountered.

Sulfur- Extractable sulfur content ranges from about 4-10 ppm across surface and subsurface samples, which is in the medium range of soil test tables.

Micronutrients: Iron, Boron, Zinc, Manganese, and Copper- All five of these ions become less available as pH increases above about 7.5, so availability may be a general concern on the K.I.D. parcels, although these nutrients are generally easily amended as needed with foliar sprays for some and fertigation for others.

Extractable *iron* in surface samples ranges from 4 ppm to about 10 ppm in the tested soils. Sufficiency for iron is in the range of 2.5-4.5 ppm, suggesting that iron may become deficient in young vines and should be monitored.

Boron is extracted from the tested soil samples at contents ranging from about 0.1 ppm to 0.4 ppm, which is in the low to medium range of nutrition guidelines for perennial crops in eastern Washington. *Zinc* is extracted from the soils at levels ranging from 0.1 ppm to 0.3 ppm. The analysis guidelines are incomplete for zinc but the low values in the tested soils suggest that zinc may be a limiting micronutrient in grape cultivation on the ranches.

Manganese extracted from the soils ranges from about 0.3 ppm to over 4 ppm and averages about 0.7 ppm for all samples. Guidelines show that > 1.5 ppm is sufficient for manganese, suggesting that soils of the parcels may be naturally low in this micronutrient, which, like Zn also may need monitoring to avert deficiency in vineyards.

*Coppe*r extracted from the soils ranges from about 0.2 to 0.6 ppm. Since the general guideline is for soils to supply > 0.6 ppm, these soils also may need monitoring to avert deficiency in the young vineyards.

<u>Wind and Water Erosion</u>

Winds can be very strong in spring and fall in the Finley area with gusts over 40 mph (Table 2). Wind erosion can be especially severe in the fall when the soils are dry and winds are strong because the soils have very little soil structure because of their uniformly low contents of clay and organic matter in surface horizons. Therefore wind erosion poses a hazard to successful viticulture but one that can be successfully controlled by seeding cover crops in the drive rows and using microject sprinklers if needed, to irrigate cover crops. Given the low slope angles generally less than 5% and expected high infiltration rates on the parcels, water erosion issues are not foreseen.

<u>Parcel-Specific Interpretations</u>

A large number of maps were generated for this project. Figures 1 to 5 show all of the parcels together and their soils, slope classes and aspect classes. More detailed maps of each parcel or parcel group are included in Appendix 3.

Parcel 3003- K.I.D. parcel 3003 adjoins Finley Elementary school on 2 sides, which may pose some issues relative to use of agrichemicals in proximity to the school. Also, at 50 acres it is the second smallest parcel in the group (Table 3). It does have paved roads on 2 sides, which is a plus. In part because of its small size, the parcel has less than about 20 feet of relief. The flatness of the slope may increase the frost/freeze hazard and require installation of wind machines or SIS systems to mitigate the hazard).

Shallow depth to hardpan in the 2 soil pits on the parcel may be a concern. Although hardpans can be effectively ripped with large equipment, large ripper shanks on powerful tractors can churn the soil excessively by pulling up shallow cobbles and even boulders in these Finley soils, so extra care must be taken to avoid unwanted soil damage if the soils are ripped.

Parcel 3004- K.I.D. parcel 3004 adjoins Finley Elementary school on 1side to the north of it. Again, this may pose some issues relative to use of agrichemicals. It adjoins South Nine Canyon Road on the west providing excellent access for equipment.

This parcel, like 3003, also has a very smooth shape and gentle slopes; however the elevation difference from the top of the parcel to the lower edge of the farmable part exceeds 50 feet, which may aid cold air drainage somewhat.

Depth to hardpan in the two soil pits is deeper at 21" and 43", although this sample size is too small to judge depth over the entire almost 90 acres. In the county soil survey, more than half of this parcel was mapped as having abundant surface stones (rocks greater than 10") although my time on the parcel was too limited to confirm whether this is accurate. It would be an additional cost to clear surface stones by mechanical raking or other means if the survey mapping is accurate.

Parcels 2000 & 2002- K.I.D. parcels 2000-2002 have a distinctly triangular shape and more than about 20 percent of the combined parcels occur on the sloping bluff bank that falls to the floodplain and on the floodplain itself.

On the positive side, this area of steeper incline may provide additional variety for vineyard design including the slope where smaller, more specialized vineyard blocks may be planted. On the negative side, perhaps as many as 10 acres of this largest parcel group at about 100 acres would be unplantable at the base of the slope and on the flat, wet ground that has Pasco soils on the floodplain.

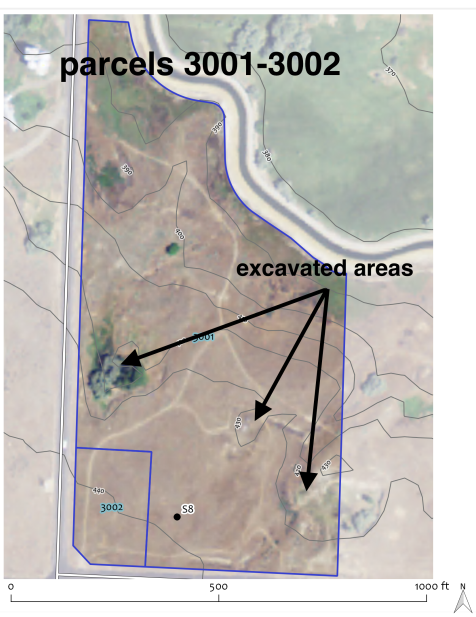
The relief on the parcel totals almost 70 feet from southwest to northeast, aiding cold air drainage. Mature trees line the lower part of the bluff bank and if vineyard is planted on this parcel should be removed to let cold air fall away to the floodplain.

Some comments on the soils in the 3 soil pits on the parcel group and on the soil survey mapping: The soils in pits S4 (photo 55, page 11) and S5 were the only two of the ten pits that lacked hardpans at any depth; however, pit S3 on the northwest of the parcel had a moderately cemented pan at 12 inches. Regarding the county soil survey map, I make the same comment as above that more than half of the 100 acres was mapped as having a stony surface and if confirmed this will require additional land preparation before installing vineyards. Both of these aspects of the soils suggests that additional reconnaissance of the soils would be prudent.

This parcel group adjoins the paved South Finley Road for access.

Parcels 7001 & 7002- K.I.D. parcel 7001 has a nearly rectangular shape and is about 60 acres in size. I grouped it with parcel 7002, which is only about 2 acres in size and which is across Highway 397 from 7001. It's rectangular shape, 60-acre gross size, and smooth fall of about 45 feet from northwest to southeast make it attractive for simple layout and farming of vineyard blocks.

Although soil pit S6 was more than 40 inches to a hardpan and the horizons about it were uniform sandy loam, soil pit S7 had dual hardpans at 15" and 32", again suggestion that additional site-specific work to characterize the soils and map the extent of the hardpan, or plans to carefully rip the parcel, are in order.



Parcels 3001 & 3002- K.I.D. parcels 3001-3002 are not only by far the smallest parcels of the group at a combined size of about 15 acres, but also parcel 3001 was mined extensively in the past for gravel, leaving it with a potentially plantable acreage that is only about one-third that size. For this reason, it received by far the lowest score in the ratings matrix (Table 4) for vineyard potential; however, it may be a great site for an equipment yard for vineyards on parcels 3003 or 3004. Zoning for this parcel would allow a winery under 3,000 square feet, or of a larger size with a conditional use permit, thus it may be of high value for a gravity-fed winery and/or a tasting room utilizing estate grapes from adjoining vineyard parcels.

Subjective Ratings Matrix of Site Quality for Wine Grape Vineyards

I created a 'subjective ratings matrix of parcel condition' in Table 4. For any person or business who is interested in possibly investing in these parcels, my purpose is primarily to draw their attention to various strengths and potential challenges to the development of each parcel, rather than serving as an absolute valuation of each parcel.

Criteria that I used are my own. I had no 'cookbook' or 'formula' to follow in their selection. In order to front load some of the best aspects of these parcels into the matrix, I included growing region climate and deeded water for irrigation and all parcels and of course all of the parcels received the maximum score for these measures.

Also in recognition of the range of quality sites available within the district as to greater relief for cold air drainage on some land than on these parcels, my 'Regional Cold Air Drainage Factor 1" has potential scores that range from 1 (low) to 4 (high). Because of the flat nature of these parcels and the small amount of fall on most of them, I scored all 5 as "1".

This acknowledges that other parcels with the same kinds of soils and regional grape climate but that are higher in elevation and have steeper slopes and lands that fall away for many vertical feet below than would have a higher, perhaps a much higher ceiling to their grape quality potential.

As configured, a 'perfect' score for potential grape land in this region or district is 29 points. I scored parcel 3003 at 21 points, parcel 3004 at 23 points, parcels 2000-2002 at 18 points, parcels7001-7002 at 26 points, and parcels 3001-3002 at 12 points. Again, the purpose of the rating scheme is to make a *subjective* comparison of the potentials and limitations of the parcels and to stimulate thoughtful analysis on the part of prospective auction bidder/ buyers.

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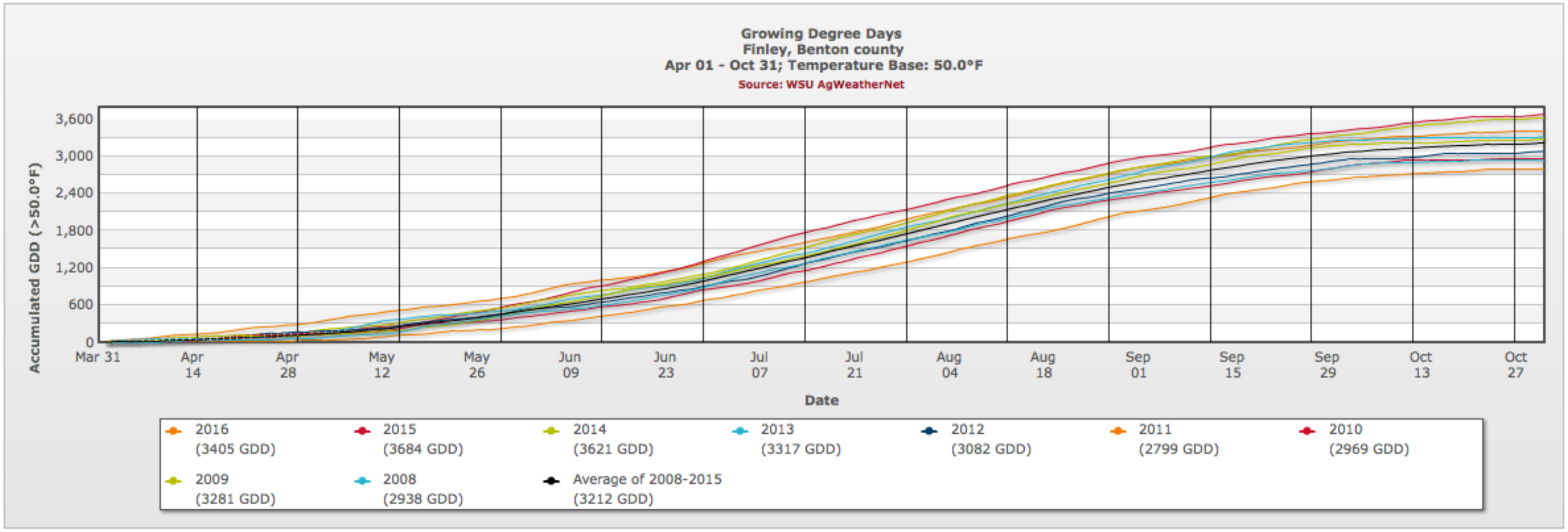
FIGURES 2-5



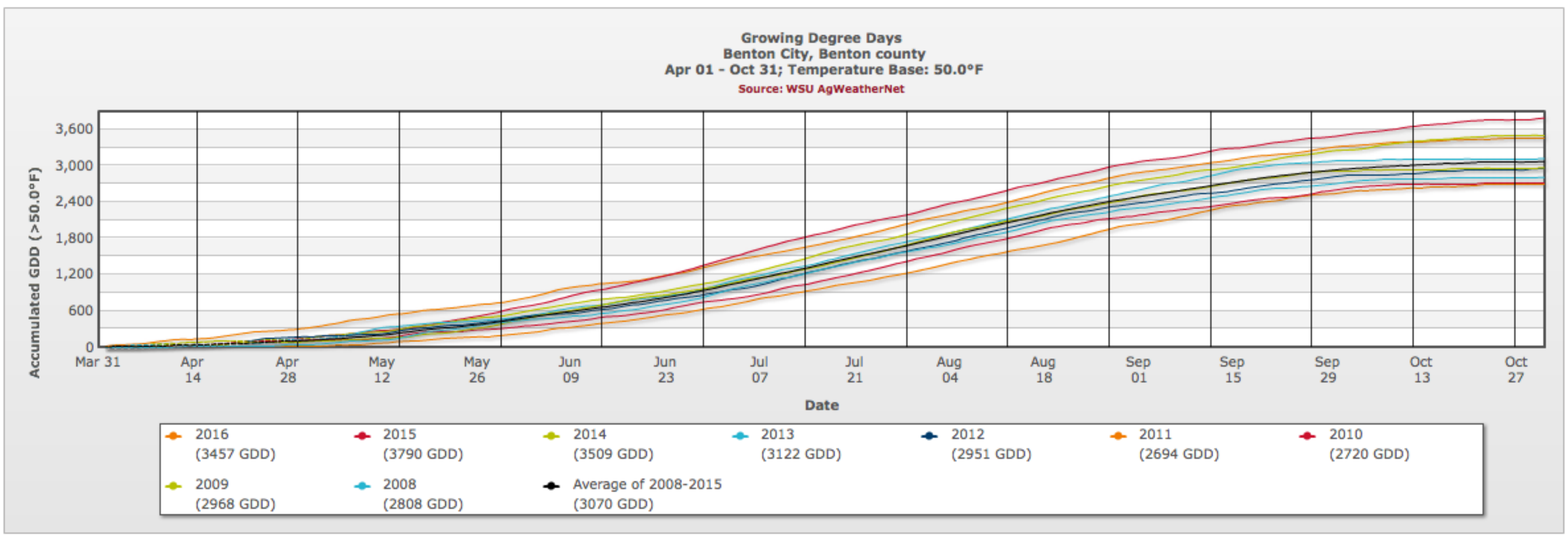


Figure 2. Growing Degree Day Accumulation (50°F) From April 1 through October 31 for the years 2008-2016 for Finley and Benton City (Red Mountain) WSU AgWeatherNet Stations (http://weather.wsu.edu/)

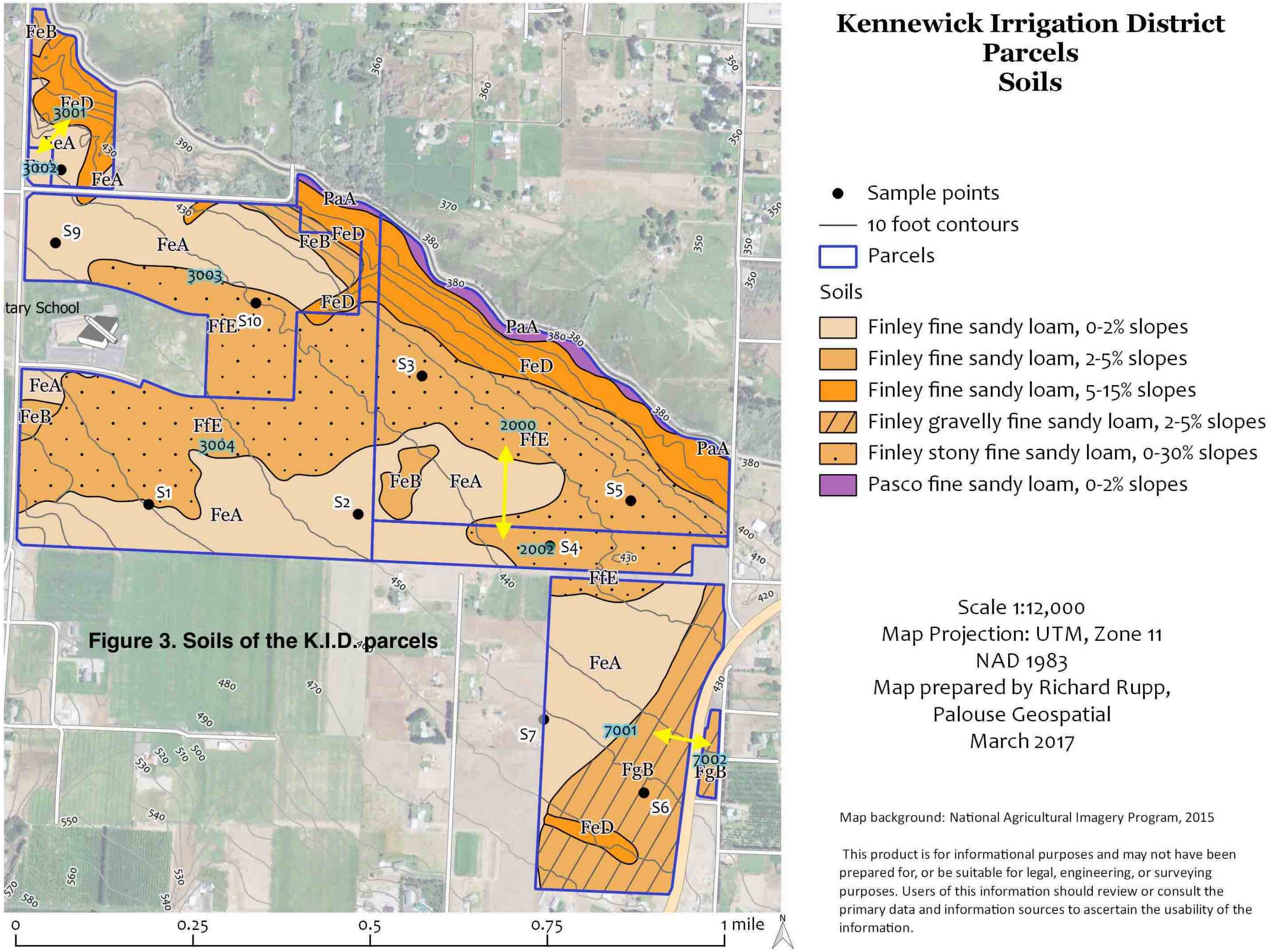


Figure 3. Soils of the K.I.D. parcels

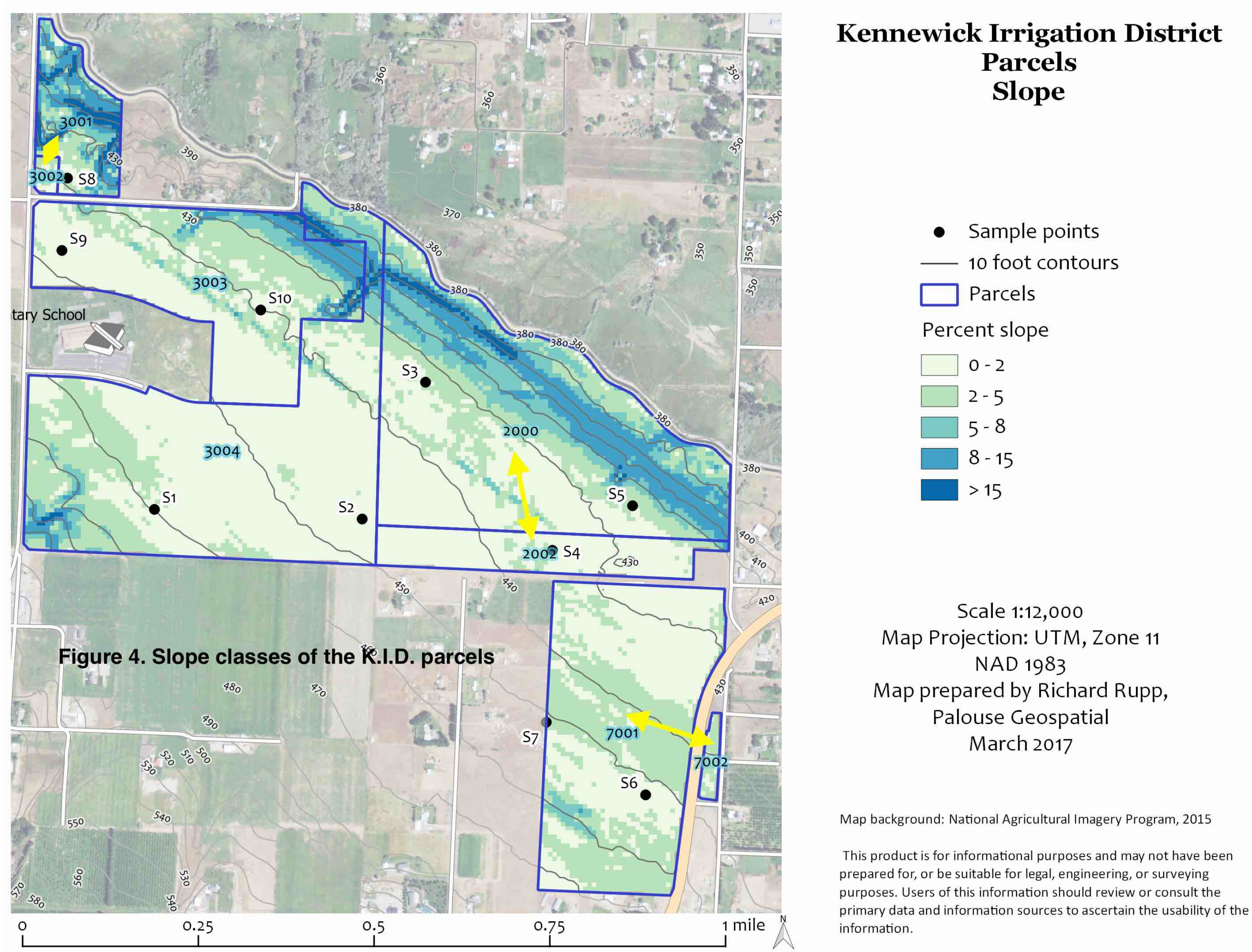


Figure 4. Slope classes of the K.I.D. parcels

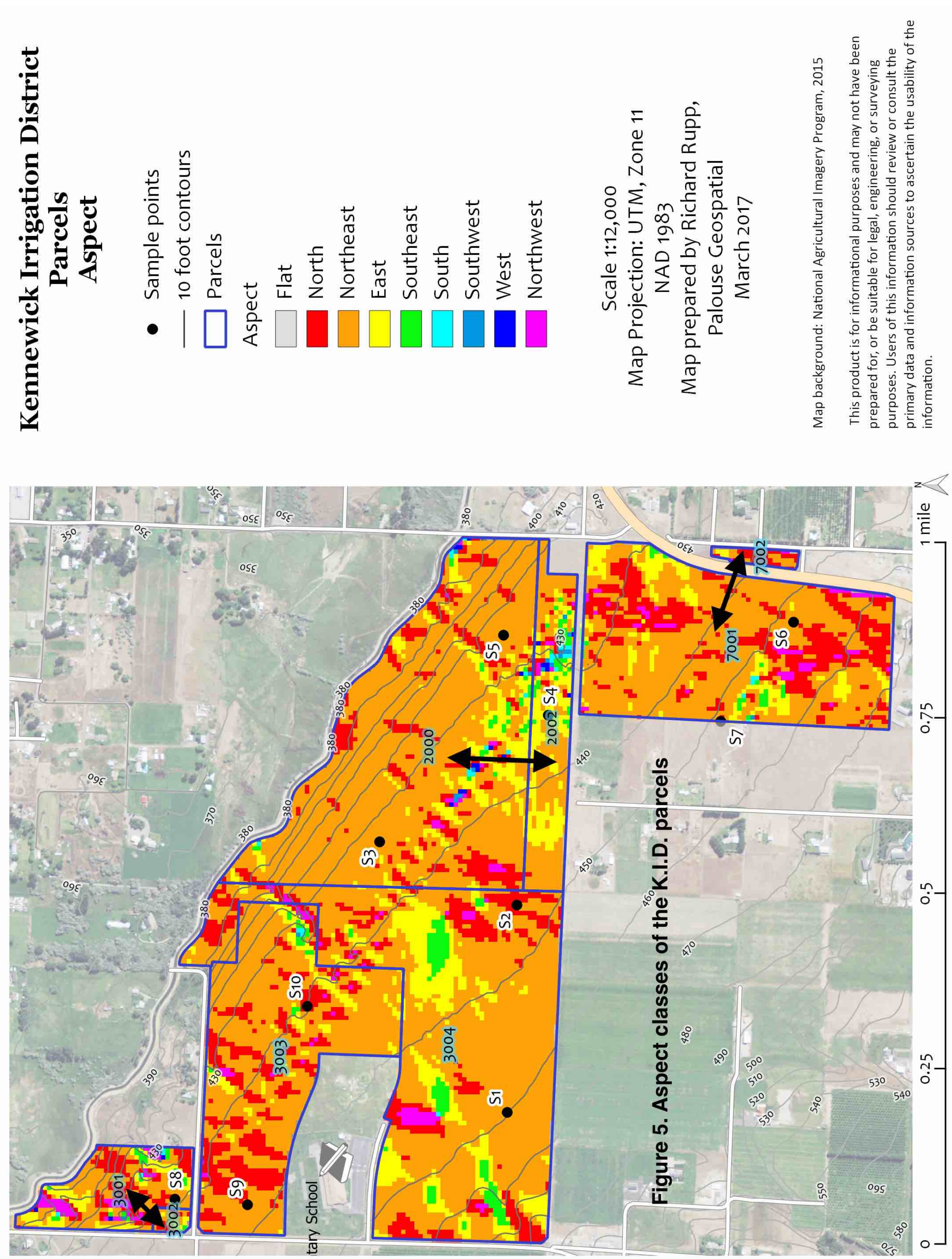


Figure 5. Aspect classes of the K.I.D. parcels

Tables 1-3

Table 1. K.I.D. FINLEY PARCELS SOILS LAB DATA

KENNEWICK IRRIGATION DISTRICT
2015 S ELY ST
KENNEWICK, WA 99337

SOIL ANALYSIS REPORT - Soiltest Farm Consultants, Inc., Moses Lake, WA

DATE REC: 10/10/16

ATTN: CHARLES FREEMAN, ALAN BUSACCA

SAMPLE ID	DEPTH	LAB	NO_3-N	NH_4-N	OLSEN P	OLSEN K	S	B		Zn	Mn	Cu	Fe	
	inches	NO	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	pH
KID S1	0-12	27258	4.6	0.8	14	403	7	0.17		0.2	0.8	0.5	7	7.9
KID S2	0-15	27259	3.1	0.9	12	297	6	0.24		0.2	0.6	0.6	6	7.9
KID S3	0-12	27260	3.3	1.2	12	345	7	0.16		0.3	0.9	0.4	6	7.6
KID S4-1	0-12	27261	10.2	3.8	22	580	10	0.41		0.7	4.4	0.3	10	7.2
KID S4-2	12-24	27262	1.0	0.8	5	253	6	0.16		0.1	0.2	0.5	5	8.1
KID S5	0-15	27263	3.8	1.3	14	350	5	0.20		0.2	0.5	0.3	7	7.7
KID S6-1	0-15	27264	2.2	0.7	7	279	3	0.16		0.1	0.3	0.2	4	8.2
KID S6-2	15-30	27265	0.6	1.5	4	140	3	0.11		0.0	0.2	0.3	2	8.5
KID S7	0-15	27266	1.6	0.6	9	401	4	0.25		0.1	0.6	0.3	7	8.2
KID S8	0-15	27267	0.8	1.1	11	361	7	0.12		0.2	0.6	0.4	6	7.7
KID S9	0-7	27268	1.4	1.2	10	241	7	0.11		0.2	0.7	0.5	6	7.6
KID S10	0-15	27269	3.6	1.6	10	325	6	0.27		0.3	1.5	0.3	8	7.8

SAMPLE ID	DEPTH	Ca	Mg	Na	CEC	SAT'D PASTE ELECTRICAL CONDUC-TIVITY	ORGANIC MATTER	EFFERVES-CENCE	$CACO_3$	SAND	CLAY	SILT	TEXTURE CLASS	FIELD EST'D GRAVEL & COBBLE CONTENT
	inches	meq/100g	meq/100g	meq/100g	meq/100g	mmhos/cm	%	presence/ab-sence of $CACO_3$	%	%	%	%	OF FINE EARTH FRACTION	%
KID S1	0-12	6.4	1.5	0.04	12.2	0.38	0.5	0	0.3	65.0	32.0	3.0	SANDY LOAM	15
KID S2	0-15	13.2	1.5	0.05	13.9	0.31	1.1	0	0.6	49.0	47.0	4.0	SANDY LOAM	5-15
KID S3	0-12	5.6	1.7	0.04	18.5	0.56	0.7	0	0.5	61.0	37.0	2.0	LOAMY SAND	10
KID S4-1	0-12	5.3	1.4	0.05	12.8	0.17	1.2	0	0.6	71.0	28.0	1.0	SANDY LOAM	10-20
KID S4-2	12-24	5.5	1.4	0.04	13.9	0.22	0.2	0	0.6	75.0	24.0	1.0	SANDY LOAM	10-20
KID S5	0-15	5.0	1.3	0.03	13.9	0.23	0.5	0	0.6	75.0	23.0	2.0	SANDY LOAM	20
KID S6-1	0-15	7.4	1.0	0.03	13.2	0.23	0.5	0	0.7	63.0	35.0	2.0	SANDY LOAM	2
KID S6-2	15-30	12.7	1.1	0.04	12.7	0.29	0.4	1	1.2	67.0	31.0	2.0	SANDY LOAM	2
KID S7	0-15	7.2	1.1	0.03	12.1	0.11	0.8	0	0.8	69.0	28.0	3.0	SANDY LOAM	15
KID S8	0-15	5.6	1.7	0.03	14.4	0.12	0.8	0	0.6	57.0	41.0	2.0	SANDY LOAM	5
KID S9	0-7	7.1	1.7	0.04	15.1	0.20	1.0	0	0.4	63.0	32.0	5.0	SANDY LOAM	15
KID S10	0-15	6.1	1.4	0.04	14.4	1.33	1.3	0	0.6	63.0	35.0	2.0	SANDY LOAM	10

Table 2. Key Climatic Characteristics of the WSU AgWeatherNet *Finley* Weather Station

Finley, Benton County, Washington

January 01, 2008 through December 31, 2016

The quality assurance date is Jan 01, 2008, and data will be displayed starting with the QA date. For access to data that have not been through the complete quality assurance process, please contact AgWeatherNet.

Show All **entries per page** **Search:**

Showing 1 to 9 of 9 entries Column visibility Print Previous 1 Next

Details for 2008 to 2016

Date	Avg Air Temperature Min °F	Avg Air Temperature Avg °F	Avg Air Temperature Max °F	Avg DP °F	Avg RH %	Avg LW u.	Wind Avg Dir °	Wind Avg Speed mph	Wind Max Gust mph	Soil Temp Avg 2 in. °F	Soil Temp Avg 8 in. °F	Tot Prec in	Total Solar Rad MJ/m²	Ref. ET ETo in	Ref. ET ETr in
2008	42.0	53.1	63.9	36.2	58.1	0.08	SW	5.2	43.2	NA	56.9	3.87	5547	45.20	61.95
2009	42.7	53.8	64.7	36.4	57.8	0.08	SW	6.0	46.4	NA	55.9	4.89	5496	50.21	70.82
2010	44.1	54.5	64.9	39.2	61.4	0.10	SW	5.5	42.9	NA	55.1	9.60	5278	46.51	64.89
2011	42.2	53.1	64.0	36.8	58.0	0.05	SW	5.7	43.2	NA	55.7	4.13	5516	47.10	65.78
2012	43.8	54.7	65.6	38.4	58.6	0.08	SW	5.6	44.7	NA	56.9	8.85	5481	48.24	67.30
2013	43.4	54.1	65.0	39.2	61.8	0.08	SW	5.1	40.0	NA	56.5	5.30	5527	46.43	63.40
2014	45.5	55.8	66.5	40.6	61.4	0.06	SW	5.2	39.6	NA	58.4	5.22	5477	48.02	65.95
2015	46.1	57.1	68.3	41.8	62.0	0.06	SW	4.6	35.7	NA	60.7	4.28	5446	47.65	65.04
2016	45.3	55.9	66.8	40.6	62.1	0.05	SW	4.8	35.0	NA	59.0	8.13	5529	46.52	63.55

Summary for 2008 to 2016

	Extreme Minimum	Average Minimum	Average	Average Maximum	Extreme Maximum	Total
8" Soil Temperature	32.0°F	34.8°F	57.2°F	80.8°F	85.1°F	NA
Air Temperature	-2.3°F	43.9°F	54.7°F	65.5°F	109.2°F	NA
Alfalfa Evapotranspiration	0.00 in	0.01 in	0.18 in	0.52 in	0.69 in	588.67 in
Dewpoint Temperature	-11.8°F	33.0°F	38.8°F	44.7°F	75.8°F	NA
Grass Evapotranspiration	0.00 in	0.00 in	0.13 in	0.36 in	0.45 in	425.88 in
Precipitation	0.00 in	0.00 in	0.02 in	0.55 in	1.14 in	54.27 in
Relative Humidity	8%	40%	60%	82%	100%	NA
Solar Radiation	0.34 MJ/m²	0.78 MJ/m²	14.99 MJ/m²	31.04 MJ/m²	31.60 MJ/m²	49297 MJ/m²
Wind Speed	0.4 mph	1.2 mph	5.3 mph	16.7 mph	22.9 mph	NA

Annual Averages for Period of Record

January 01, 2008 - December 31, 2016

Avg Air Temperature Min °F	Avg Air Temperature Avg °F	Avg Air Temperature Max °F	Avg DP °F	Avg RH %	Avg LW u.	Wind Avg Dir °	Wind Avg Speed mph	Wind Max Gust mph	Avg 2 in. Soil Tmp °F	Avg 8 in. Soil Tmp °F	Tot Prec in	Total Solar Rad MJ/m²	Ref. ET ETo in	Ref. ET ETr in
43.9	54.7	65.5	38.8	60.1	0.07	SW	5.3	46.4	NA	57.2	6.02	5472	47.28	65.35

Table 3. K.I.D. FINLEY STATISTICS BY PARCELS AND PARCEL GROUPS

	Parcel Groups									
	3003		3004		2000-2002		7001-7002		3001-3002	
Soils	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Finley fine sandy loam, 0 - 2% slopes	27.6	54.1%	33.3	37.5%	20.4	20.2%	26.2	41.9%	5.0	34.2%
Finley fine sandy loam, 2 - 5% slopes	3.4	6.7%	1.7	1.9%	2.9	2.9%			1.6	11.0%
Finley fine sandy loam, 5 - 15% slopes	2.4	4.7%	4.8	5.4%	22.1	21.9%	2.2	3.5%	7.5	51.4%
Finley stony fine sandy loam, 0 - 30 % slopes	17.6	34.5%	48.4	54.4%	51.5	51.1%	2.4	3.8%	0.5	3.4%
Finley gravelly fine sandy loam, 2 - 5% slopes							31.8	50.8%		
Pasco fine sandy loam, 0 - 2% slopes			0.7	0.8%	3.9	3.9%				
Total[1]	51.0		88.9		100.8		62.6		14.6	
Aspect Classes	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Flat	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
North	12.4	24.4%	11.5	12.9%	11.0	12.1%	15.6	25.0%	3.6	24.1%
Northeast	33.9	66.7%	59.1	66.5%	72.6	76.1%	38.4	61.5%	6.4	42.9%
East	3.4	6.6%	13.8	15.5%	13.5	9.3%	5.9	9.4%	2.7	18.2%
Southeast	0.4	0.8%	3.2	3.6%	1.8	0.9%	0.7	1.1%	0.6	3.8%
South	0.1	0.1%	0.0	0.0%	0.5	0.3%	0.2	0.3%	0.1	0.8%
Southwest	0.0	0.0%	0.0	0.0%	0.4	0.2%	0.0	0.0%	0.0	0.2%
West	0.0	0.0%	0.0	0.0%	0.5	0.4%	0.0	0.0%	0.1	0.7%
Northwest	0.7	1.3%	1.4	1.5%	0.7	0.6%	1.7	2.7%	1.4	9.4%
Total[1]	50.8		88.9		100.9		62.4		15.0	
Slope Classes (% slope)	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
0 - 2	25.9	50.9%	57.9	65.2%	44.4	34.7%	31.9	51.1%	1.5	9.9%
2 - 5	16.0	31.4%	22.6	25.4%	21.8	24.2%	29.2	46.8%	4.1	27.1%
5 - 8	3.5	6.8%	4.9	5.5%	16.9	20.0%	1.3	2.0%	2.6	17.6%
8 - 15	4.5	8.9%	2.5	2.8%	16.1	19.0%	0.0	0.0%	4.2	27.8%
> 15	1.0	1.9%	1.0	1.1%	1.7	2.1%	0.0	0.0%	2.7	17.7%
Total[1]	50.8		88.9		100.9		62.4		15.0	

[1]Small differences in acreage totals for soils vs slope groups vs aspect groups are due to computational differences for raster and vector data

Table 4 Subjective Parcel Rating Matrix

Table 4. Subjective Ratings Matrix of Site Quality *For Wine-Grape Vineyards*, Kennewick Irrigation District Finley Parcels

Site Condition		*Rating Points*	*K.I.D. Parcel Groups*					
			3003	*3004*	*2000 - 2002*	*7001 - 7002*	*3001 - 3002*	*All Parcels Average Score (Max)*
Growing Degree-Day Climate Suitable for Late-Ripening Wine Grape Varieties	Winkler Region III	4	4	4	4	4	4	4 (4)
Soils 1: Cemented hardpan (added expense to prepare fields)[A]	No pan or pan ≥40" Pan 20"-40" Pan at ≤20"	3 2 1	1	2	2	2	1	1.4 (3)
Soils 2: Percentage of Soil Types Unsuited for Wine Grapes	0% Unsuited (Pasco series) 1-5% Unsuited (Pasco series)	3 2	3	3	2	3	3	2.8 (3)
Unfarmable land below slope break with high water tables and high freeze hazard	<1% water table and freeze hazard 1-10% water table and freeze hazard >10% water table and freeze hazard	3 2 1	2	2	1	3	1	1.8 (3)
Percentage of Parcel Having Slopes Readily Farmable (<8%) for Wine Grapes	>90% readily farmable slopes (<8%) 70-90% readily farmable slopes <70% readily farmable slopes	2 1 0	2	2	1	2	0	1.4 (2)
Regional Cold Air Drainage 1: Topographic Relief Within Parcel	excellent - >200' topo graphic relief good - 100' to 200' relief moderate to poor - <100' relief	4 2.5 1	1	1	1	1	1	1 (4)
Cold Air Drainage 2: Absolute Elevation of Parcel	better - mean elevation ca. 450' good - mean elevation ca. 440' moderate - mean elevation ca. 430'	3 2 1	2	3	1	3	1	2 (3)
Parcel Size/Shape Suited to Industrial-Scale Vineyard Layout	Excellent - Good - Poor -	4 2 -4	2	4	4	4	-4	2 (4)
Irrigation Water Deeded	All parcels have water	4	4	4	4	4	4	4 (4)
	Parcel Rating	30 max	21	25	20	26	11	

[A] This rating element is based on limited observations of 1-2 soil pits per parcel and is subject to higher uncertainty

Appendix 1

Official Series Descriptions of the Mapped Soils

FINLEY SERIES

The Finley series consists of very deep, well drained soils formed in gravelly alluvium with a mixture of loess in the surface. Finley soils are on alluvial fans and outwash terraces. Slopes are 0 to 50 percent. The average annual precipitation is about 7 inches and average annual temperature is 50 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, mesic Xeric Haplocambids

TYPICAL PEDON: Finley fine sandy loam - range. (Colors are for dry soil unless otherwise noted.)

A--0 to 3 inches; grayish brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; slightly alkaline (pH 7.8); abrupt smooth boundary. (2 to 6 inches thick)

AB--3 to 13 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; common fine roots; slightly alkaline (pH 7.8); clear wavy boundary. (0 to 12 inches thick)

Bw--13 to 22 inches; light brownish gray (10YR 6/2) very gravelly loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; few fine roots; common fine pores; 60 percent gravel; some rock fragments have silica and lime coatings on the lower side; slightly alkaline (pH 7.8); abrupt wavy boundary. (8 to 18 inches thick)

Bk--22 to 28 inches; light brownish gray (10YR 6/2) extremely gravelly loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; few fine roots; 80 percent gravel, cobbles and stones; strongly effervescent; some rock fragments have silica and lime coatings on the lower side; moderately alkaline (pH 8.0); clear wavy boundary. (0 to 14 inches thick)

2C--28 to 60 inches; multicolored, extremely gravelly sand; single grain; loose, nonsticky and nonplastic; 60 percent gravel, 20 percent cobbles; strongly effervescent; moderately alkaline (pH 8.0).

TYPE LOCATION: Benton County, Washington; 50 feet east of Nine Canyon Rd. and 300 feet south of the Teril Rd., in the northwest 1/4 southwest 1/4, Sec. 27, T. 8 N., R. 30 E., W.M.

COMPETING SERIES: These are the Cewat, Darkcanyon, Drinkwater, Felcher, Kiona, Minat, Nibbs, Veet, Veta and Wifton series. Kiona soils do not have the sandy 2C horizon within the particle-size control section. Cewat, Darkcanyon, and Felcher soils have a lithic contact at a depth of 20 to 40 inches. Drinkwater soils have 20 to 35 percent clay in the particle-size control section and lack a sandy C horizon. Minat and Wifton soils do not have a sandy 2C horizon and have a mean annual soil temperature of 47 to 50 degrees F. Nibbs soils have 15 to 25 percent clay in the Bw horizon part of the particle-size control section and the average annual soil temperature is 47 to 49 degrees F. Veet soils do not have a sandy 2C horizon and lack lime and silica coatings on the bottom of rock fragments in the Bw horizon. Veta soils do not have a sandy 2C horizon.

GEOGRAPHIC SETTING: Finley soils are on alluvial fans and terraces at elevations of 300 to 2,300 feet. They formed in gravelly alluvium with a mixture of loess in the surface. Slopes are 0 to 50 percent. The coarse fragments are dominantly basalt. These soils occur in an arid climate with hot, dry summers and cool, moist winters. The average annual precipitation is 6 to 10 inches. The average January temperature is 29 degrees F. The average July temperature is 71 degrees F. The average annual temperature is 49 to 53 degrees F. The frost-free season is 135 to 200 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Burbank, Ephrata, Neppel, and Scooteney soils on terraces. Burbank soils are sandy-skeletal. Ephrata and Neppel soils are coarse-loamy over sandy or sandy-skeletal. Scooteney soils are coarse-loamy.

DRAINAGE AND PERMEABILITY: Well drained; very slow to medium runoff; moderately rapid permeability in the upper part, and very rapid below.

USE AND VEGETATION: Used for irrigated cropland and range. Common crops are winter wheat, grapes, mint, corn, alfalfa hay and pasture. Native vegetation is bluebunch wheatgrass, needle and thread, Thurber needlegrass, Sandberg bluegrass, Cusicks bluegrass and Wyoming big sagebrush.

DISTRIBUTION AND EXTENT: Central Washington. Series is of moderate extent.

PASCO SERIES

Typically, Pasco soils have grayish brown silt loam A horizons and grayish brown and gray silt loam and very fine sandy loam C horizons.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, calcareous, mesic Cumulic Endoaquolls

TYPICAL PEDON: Pasco silt loam, pasture. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; few fine faint mottles; weak fine and medium granular structure; soft, friable, slightly sticky, slightly plastic; many roots; few fine pores; slight effervescence with dilute HCl; moderately alkaline (pH 8.2); clear smooth boundary. (4 to 12 inches thick)

A1--6 to 20 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; common medium faint mottles; massive; soft, friable, slightly sticky, slightly plastic; common roots; few fine pores; slight effervescence with dilute HCl; moderately alkaline (pH 8.4); clear wavy boundary. (4 to 16 inches thick)

A2--20 to 33 inches; grayish brown (10YR 5/2) heavy silt loam, very dark gray (10YR 3/1) moist; weak medium prismatic structure; slightly hard, friable, sticky, slightly plastic; common roots; common fine pores; slight effervescence with dilute HCl; moderately alkaline (pH 8.0); clear wavy boundary. (4 to 16 inches thick)

AC1--33 to 52 inches; gray (10YR 5/1) very fine sandy loam, very dark gray (10YR 3/1) moist; common medium faint mottles; massive; soft, very friable, slightly sticky, slightly plastic; common roots; slight effervescence with dilute HCl; mildly alkaline (pH 7.8); clear wavy boundary. (4 to 20 inches thick)

AC2--52 to 62 inches; gray (10YR 5/1) heavy silt loam, very dark brown (10YR 2/2) moist; massive; slightly hard, friable, sticky, slightly plastic; few roots; common fine pores; slight effervescence with dilute HCl; mildly alkaline (pH 7.8).

TYPE LOCATION: Benton County, Washington; 1 mile west of the Richland Wye and 700 feet north of Highway U.S. 410, NW1/4 SW1/4 section 24, T.9N., R.28E., WM.

RANGE IN CHARACTERISTICS: The mean annual soil temperature at 20 inches is 47 to 55 degrees F. The mollic epipedon is 24 to more than 40 inches thick. These soils are typically calcareous throughout but may be noncalcareous in the upper 10 inches. They are mildly alkaline to strongly alkaline, becoming less alkaline with depth.

The A horizon has hue of 2.5Y or 10YR, value of 2 or 3 moist and 4 or 5 dry. It has weak fine granular to weak thin platy structure.

The C horizon has hue of 2.5Y or 10YR, value of 2 or 3 moist, 4 or 5 dry, and chroma of 1 or 2 moist or dry. It is weak medium prismatic or weak medium subangular blocky structure.

Some pedons are massive. In some pedons the C horizon is stratified with lenses of fine sandy loam about 1 to 3 inches thick. Mottles occur in some pedons below 20 inches.

COMPETING SERIES AND THEIR DIFFERENTIAE: These are the Caldwell, Covello, Hermiston, Keigley, Kittitas, Onyx, Pedigo, Red Rock, and Zillah series. Caldwell, Keigley, Kittitas and Red Rock soils have fine, silty control sections. Covello, Hermiston, Pedigo and Onyx soils lack evidence of wetness associated with Aquolls. Zillah soils are noncalcareous in some parts between 10 and 20 inches.

GEOGRAPHIC SETTING: These soils are in basins and low flat areas adjacent to the Columbia River and its tributaries at elevations of 250 to 700 feet. Slope gradients range from 0 to 3 percent. Pasco soils formed in recent alluvium accumulating under ponded drainage conditions. The climate is arid to semiarid; the mean annual temperature is 54 degrees F.; and the average annual precipitation is 6 to 10 inches. The frost free season is 136 to 190 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Burbank, Esquatzel, and Beverly soils. Burbank and Beverly soils lack mollic epipedons,are underlain by outwash gravels and cobbles at depths of less than 40 inches, and are well drained. Esquatzel soils are noncalcareous to depths of about 24 inches and are well drained.

DRAINAGE AND PERMEABILITY: Somewhat poorly and moderately well drained; very slow runoff or ponded; moderate permeability.

USE AND VEGETATION: Pasture, hay, orchards and wildlife. The native vegetation is sedges, saltgrass, willow, bluebunch wheatgrass, and blue grass.

DISTRIBUTION AND EXTENT: North central and central Washington and Oregon. Pasco series is of small extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Portland, Oregon

SERIES ESTABLISHED: Franklin County, Washington, 1914.

REMARKS: These soils were formerly classified as Alluvial soils.

Appendix 2

Soils Field Description Sheets

VINITAS CONSULTANTS, LLC

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

AJ Busacca

NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Soil type: Finley stony fine sandy loam, hardpan variant | File No.

Area: KID Sandalwood (Finley) | Date: 9/22/16 | Stop No.: S1

Classification

Location

N. veg. (or crop) | Climate

Parent material

Physiography

Relief | Drainage: v well/excessively well | Salt or alkali: ∅

Elevation: ~455' | Gr. water: v deep | Stoniness: ~0 surface

Slope: 1-2% | Moisture

Aspect: NNE | Root distrib.: throughout | % Clay *

Erosion: severe potential wind | % Coarse fragments * | % Coarser than V.F.S. *

Permeability: v high

Additional notes

GPS: 46° 08.4212'N ; 119° 03.0609'W

photos#: 91-100 landscape, profile, ice-rafted boulder,

sample 0-12" (no deeper sample taken)

* Control section average

Horizon	Depth in	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	gravel description c cementation
A	0-3	10YR 5/2	10YR 3/2	Fsl	VI f gr						
Bw	3-12	10YR 5/2	10YR 3/2	gr/cb Fsl	VI m-c sbk						15% sized to 6"
2Bk	12-21	10YR 6/1	10YR 5/2	vgr Fsl	—						55-60% sized to 3"
2Bk(m)	21-28	10YR 8/3	10YR 6/4	gr l-sil?	—	slackwater sediment!					moderately cemented, discontinuous
2BCk	28-37	gray sand, carbonates on undersides of gr		extr. grtch sand	—						~25% sized to 2-3"
2C	37-46"+	gray sand gravel uncoated			—						80% imbricated gravel + cobbles; gravel avg 2", cobbles up to 8"

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-Soils-232G
5-86

SOIL DESCRIPTION

AJ Busacca

Soil type	Finley Fine sandy loam	File No.	
Area	KID Sandalwood (Finley)	Date 9/21/16	Stop No. SZ
Classification			
Location			
N. veg. (or crop)		Climate	
Parent material			
Physiography			
Relief	slight coppicing	Drainage	well to excessively well
Salt or alkali	∅		
Elevation	~245'	Gr. water	v deep
Stoniness	<2% surface		
Slope	<1°	Moisture	
Aspect	NNE	Root distrib.	throughout
% Clay *			
Erosion	severe wind unprotected	% Coarse fragments *	
% Coarser than V.F.S. *			
Permeability	very high		

Additional notes

photos 63-68

GPS : 46° 08.4159'N ; 119° 02.6912'W

samples 0-15" only

* Control section average

Horizon	Depth in	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	gravel descrip.
A	0-4	10YR5/2	10YR4/2	fsl	1 fgr						<5% gravel
Bw	4-15	10YR5/2	10YR4/2	sl gr fsl	1 m-c sbk						<15% gravel to 2"
2BK	15-43"	10YR5/2	10YR4/2	—	—						65% gravel 0.5" to 5" dia
3BKm	43-48"+	—	—	—	—						>75% 5 to 15" cemented

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Soil type: Finley stony fine sandy loam / Busacca — File No.:

Area: KID Sandalwood — weak, discontinuous hardpan — Date: 9/22/16 — Stop No.: KID-S3

Classification: (Finley)

Location:

N. veg. (or crop): — Climate:

Parent material:

Physiography:

Relief: coppice mounds 30-40 cm high — Drainage: v. well — Salt or alkali: ∅

Elevation: ~435' — Gr. water: v deep — Stoniness: surface ~2%

Slope: <1° — Moisture:

Aspect: NNE — Root distrib.: throughout — % Clay *:

Erosion: severe potential wind — % Coarse fragments *: — % Coarser than V.F.S. *:

Permeability: v. high

Additional notes:

GPS 46° 08.5875' N; 119° 02.5849' W

photos # 79-90, landscape; bluff edge ~100' N; coppice mounds; surface stones (up to 40cm); spoil pile; profile sample:

0-12"

(no samples taken deeper)

* Control section average

Horizon	Depth	Color: Dry	Color: Moist	Texture	Structure	Consistence: ~~Dry~~ roots	Consistence: Moist	Consistence: Wet	Reaction / Boundary — gravel description
A	0-4	10YR 5/2	10YR 4/2	fsl		3vF			<5% fine
Bw	4-12	10YR 5/2	10YR 4/2	sl gr fsl		1vF 2m			~10% fine-mod gr
2Bk(m)	12-28	10YR 7/2	10YR 4/3	extr. gr + cb loam		2m			>85% gr + cb
2C	28-52"+	extremely gravelly + cobbly gray sand		extr. gr + cb sand		2m			" " "

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Soil type: Finley fine sandy loam Busacca			File No.
Area: KID Sandalwood (Finley)	Date: 9/21/16		Stop No. S4
Classification			
Location			
N. veg. (or crop)		Climate	
Parent material			
Physiography			
Relief: smooth	Drainage: excessively well to very well	Salt or alkali: Ø	
Elevation: ~430'	Gr. water: v deep	Stoniness: Ø surface	
Slope: <1°	Moisture		
Aspect: NNE	Root distrib.: throughout	% Clay *	
Erosion: severe if unprotected wind	% Coarse fragments *	% Coarser than V.F.S. *	
Permeability: v high			

Additional notes

photos # 55-62 landscapes & profile

GPS 46°08.3831'N ; 119°02.3517'W

samples 0-12", 12-24"

* Control section average

Horizon	Depth in.	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	gravel description		
A	0-4	10YR 5/2	10YR 4/2	sl gr fsl	1 vf gr					cs	~5-10%		
Bw	4-12	10YR 5/2	10YR 4/2	gr fsl	1 m-c sbk					gs	10-20%		
Bk	12-24	10YR 5.5/2	10YR 4/2	gr fsl	"					aw	10-20% rounded < 4"		
2Bk	24-48	10YR 9/1 gravel gray coatings	10YR 8/2	extr. gr sand	—					—	75-90% up to 8", open work in lower part		

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Busacca

Soil type: Finley stony FSl | File No.

Area: KID - Sandalwood (Finley) | Date: 9/21/16 | Stop No. S5

Classification

Location

N. veg. (or crop) | Climate

Parent material

Physiography

Relief	smooth	Drainage	excessively well	Salt or alkali	∅
Elevation	~425'	Gr. water	v deep	Stoniness	<2%
Slope	<1%	Moisture	D		
Aspect	NNE	Root distrib.	throughout	% Clay *	
Erosion	high potential wind	% Coarse fragments *		% Coarser than V.F.S. *	

Permeability: v high

Additional notes

photos # 46-47 landscape - note abundance of cobbles & little fine earth in pile and note glacial erratic boulders in distance and note bluff edge; 48-54 profile incl. close ups of open-work gravel in 2BK1 & 2BK2

GPS: 46° 08.4410' N; 119° 02.2113' W

single sample 0-12"

* Control section average

Horizon	Depth in.	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	gravel description
A	0-4	10YR5/2	10YR4/2	fsl							<5% fine
Bw	4-8'	"	"	gr fsl							20% fine
2BK1	8-24	10YR5/2 matrix 10YR9/1 carb. on stones	10YR4/2 10YR8/2	extr gr sand							60% fine-med. gravel (1-4")
2BK2	24-48"+	10YR5/1 gray sand	10YR4/1	"							*85-90% coarse gravel + cobbles
		10YR 9/1 carb coats on stones	10YR 8/2	"							*85-90%

*see photos for openwork avalanche gravel, imbricated

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Busacca

Soil type	Finley Fsl deep, hardpan variant	File No.	
Area	KID Sandalwood (Finley)	Date 9/21/16 ✓	Stop No. S6
Classification			
Location			
N. veg. (or crop)	weedy native, never farmed	Climate	
Parent material	loess + eolian sand over Missoula flood gravel		
Physiography			

Relief	slight undulating	Drainage	excessively - well	Salt or alkali	none
Elevation	~455'	Gr. water	v. deep	Stoniness	0-2% surface
Slope	1°	Moisture			
Aspect	NNE	Root distrib.	throughout top 40"	% Clay *	
Erosion	severe wind, after fire (potential)	% Coarse fragments *		% Coarser than V.F.S. *	
Permeability	high				

Additional notes

GPS pt taken 46° 08.0830N ; 119° 02.1749 W

photos #31-37 soil profile + site; #38 non-stony surface

#39, 40 closeups of hardpan 40"-46"

samples 0-15", 15-30"

* Control section average

Horizon	Depth (inches)	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	gravel description
A	0-4	10YR5/2	10YR4/2	fsl	sg → vf gr					gs	<2% VF
AB	4-15	10YR5/2	10YR4/2	fsl	sg → vf sbk					gs	<2% VF
Bw	15-28	10YR5/2	10YR4/2	fsl	"					gs	<2% VF
Bk	28-40	10YR 5.5/2	10YR 4/2	sl gr. fsl	"					aw	10% Fine (<1")
2Bkqm	40-44	10YR 8/1 + 7/2	10YR 8/2 + 4/2	–	laminar cap w/ ribbons					aw	80% v coarse (1-3", 3-8", 8"+)
2C	44-54+"	-	-	extremely gravelly sand cobbly sand	–						

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION Busacca

Soil type Finley shallow fsl — File No.

Area KID Sandalwood (Finley) — Date 9/21/16 — Stop No. S7

Classification

Location

N. veg. (or crop) — Climate

Parent material

Physiography

Relief Smooth — Drainage excessively well — Salt or alkali ∅

Elevation — Gr. water v. deep — Stoniness ~ 0% surface

Slope <1° — Moisture

Aspect NNE — Root distrib. — % Clay *

Erosion potential wind if no veg. cover — % Coarse fragments * — % Coarser than V.F.S. *

Permeability high

Additional notes

GPS 46° 08.1699'N; 119° 02.3548'W

photos # 41-42 landscape; # 43-45 profile

single sample 0"–15"

* Control section average

Horizon	Depth in.	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	~~Reaction~~ roots	Boundary	gravel descr., cementation
A	0-4	10YR5/2	10YR4/2	fsl	vl f gr				3vf	cs	<5% fine
Bw	4-15	10YR5/2	10YR4/2	gr fsl	vl m sbk				1vf 2f,m	cw	20% med. -coarse (1-5")
2Bk(m)	15-24	10YR 9/1 CaCO3 coatings	10YR9/2	–	–				1f,m	ci	weak cementation 80% gravel + cobbles 1"-10"
3BC	24-32	–	–		–					ai	70% gr. + cobb 3"-15"
3Kmb	32-48"+	–	–		–						strongly cemented >80% 3"-15"

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION Busacca

Soil type: Finley fine sandy loam, weak hardpan variant
File No.:
Area: KID Sandalwood (Finley)
Date: 9/22/16
Stop No.: 58
Classification:
Location:
N. veg. (or crop):
Climate:
Parent material:
Physiography:
Relief: slight coppicing ~8"
Drainage: v well / excessively well
Salt or alkali: ∅
Elevation: ~443'
Gr. water: v deep
Stoniness: ∅ surface
Slope: < 1°
Moisture:
Aspect: NNE
Root distrib.: Throughout
% Clay *:
Erosion: severe potential wind
% Coarse fragments *:
% Coarser than V.F.S. *:
Permeability:
Additional notes:

GPS: 46° 08.8291' N ; 119° 03.2307' W

photos: 101 - 107

samples: 0 - 15"

This parcel potential gravity-fed winery site w/ small vineyard

* Control section average

Horizon	Depth	Color: Dry	Color: Moist	Texture	Structure	Consistence: Dry (roots)	Consistence: Moist	Consistence: Wet	Reaction	Boundary	gravel
A	0-4"	10YR 5/2	10YR 4/2	fsl		3vf					<5%
Bw	4-15	10YR 5/2	10YR 4/2	fsl							<5%
2Bk/Bk(m)	15-30	CaCO3 coatings 10YR 9/2	10YR 7/3	extr. gr. —							>75% gr + cobbles to 6"
2BCk	30-48"	carb. coats on underside of gravels		extr. gr sand							>80% gr + cobbles to 8"
2C	48"+	gray sand no coats on gravels									

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NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Soil type: Finley gravelly fsl, shallow weak pan   Busacca   File No.:
Area: KID Sandalwood   Date: 9/22/16   Stop No.: S9
Classification: (Finley)
Location:
N. veg. (or crop):   Climate:
Parent material:
Physiography:
Relief: slight coppice   Drainage: Salt or alkali: ∅
Elevation: 447'   Gr. water: Stoniness: 5%–10% locally
Slope: <1°   Moisture:
Aspect: NNE   Root distrib.:   % Clay *:
Erosion: severe potential wind   % Coarse fragments *:   % Coarser than V.F.S. *:
Permeability:
Additional notes: GPS: 46° 08.7392' N; 119° 03.2372' W
photos #: 108 -
last photos of upper & lower hardpans
sample: 0-7"
* In most or all pits there are gravels from 2 or 3 diff. flood bursts and in some pits like this, diff glacial epochs

* Control section average

Horizon	Depth (in)	Color: Dry	Color: Moist	Texture	Structure	Consistence: Dry	Consistence: Moist	Consistence: Wet	Reaction	Boundary	gravel % / cementation
A	0-2	10YR5/2	10YR4/2	gr fsl							5% to 3" dia
Bw	2-7	10YR5/2	10YR4/2	gr fsl							10% to 5" dia
2Bkm	7-18	10YR7/2	10YR5/2.5	v.gr. +cb sil							50% to 10" dia; aha! funny yellowish matrix here and
2Bck	18-52	gray sand matrix $CaCO_3$ coats on undersides of gravel in 2Bck		extr. gr+cb+st sand							>80% gr+cb & stones to 15" dia
3Bkmb	* 52"+			"							

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U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NRCS-Soils-232G
5-86

SOIL DESCRIPTION

Soil type	Finley Fine sandy loam Busacca			File No.	
Area	KID Sandalwood (Finley)	Date	9/22/16	Stop No.	S10
Classification					
Location					
N. veg. (or crop)				Climate	
Parent material					
Physiography					
Relief	flat	Drainage	v well/excessively	Salt or alkali	∅
Elevation	~441'	Gr. water	v deep	Stoniness	~∅
Slope	<1°	Moisture			
Aspect	NNE	Root distrib.	throughout	% Clay *	
Erosion	severe potential wind	% Coarse fragments *		% Coarser than V.F.S. *	
Permeability					

Additional notes

GPS: 46° 08. 6717'N ; 119° 02. 8811'W

photos #: 116-123

sample: 0-15"

* Control section average

Horizon	Depth in	Color Dry	Color Moist	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	gravel description + cementation
A	0-4	10YR5/2	10YR4/2	sl gr fsl	v1 fgr					gs	1% to 2" dia gravel
Bw	4-15	10YR5/2	10YR4/2	sl gr fsl	v1 m-c sbk					c w	5% to 4" dia gravel
2BK	15-22	10YR6/2	10YR5/3	vgr l	–					cw	~35% gravel to 5" dia
3Bkmb	22-40"+	10YR7/2 → 10YR6/3 (matrix) 10YR9/1 → 7/2 cb coats			–					–	extr grav ~70% to 20" dia strongly cemented pan