Soil Survey Report for Saucelito Canyon Vineyard Proposed Vineyard Site

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Introduction

Acknowledgements

A very special thanks to the Greenough Family.

On site soil samples, collected from the horizons of identified soils, were sent to A&L Western Laboratories of Modesto, CA for chemical analysis.

Viticulture History of Arroyo Grande

Arroyo Grande California is located south of San Luis Obispo amongst the central coast. The Chumash Indians were the original occupants of the central coast living in villages dotted throughout near water sources including areas in Arroyo Grande.

Sent from Spain, Fr. Junipero Serra was able to settle the region through a series of Catholic missions including Mission San Luis Obispo de Tolosa and Mission San Miguel. Under Mexican rule California land was made available to settlers in the form of grants as early as 1837. At this time the land was discovered to be fertile enough for crop production introducing the area to what would become a renowned grape vine producing region.

In 1879, Henry and Rosa Ditmas planted the first vineyard in the region. The grapes planted were Zinfandel and Muscat vines. In 1990 Arroyo Grande was granted American Viticulture Area status resulting in a considerable expansion of the local wine industry significantly increasing the vineyard acreage of the area.

Today, Arroyo Grande is home to a number of wineries including but not limited to Saucelito Canyon vineyard, the location of the performed order 1 soil survey. The distinct micro climates and diverse soils, combined with mild days and cool nights, make growing conditions ideal for producing multiple wine varietals from Zinfandel, Pinot Noir, and Grenache to Sauvignon Blanc and Viognier.
**Location**

Saucelito Canyon Vineyard is located five miles east of coastal Arroyo Grande situated along the western side of Saucelito Creek road. The vineyard site is located on a west facing stream terrace with slopes ranging from one to three percent throughout. The elevation of the area ranges from 956 feet to 974 feet (291.2 to 296.9 meters) above sea level. The mean annual precipitation is 16.82 inches (42.72 cm) with a mean annual temperature of 59.0 degrees Fahrenheit (15 degrees Celsius). The annual frost-free season is 200-300 days.

The soils within the vineyard contain alluvium over residuum sandstone parent material of the Santa Margarita Formation. The bedrock of the Santa Margarita formation is Miocene sandstone. The site is also derived of younger alluvium of the Holocene.

Five (5) different soil series were identified within the vineyard. A Taxonomic unit description was produced for each soil, providing a soil taxonomic nomenclature, representative pedon horizonation, and ranges in characteristics. Five (5) different map unit descriptions were distinguished within the vineyard, including morphological and environmental descriptions, soil map unit inclusions, hydrology, and land use suitability and land capability class. Soil map units are named by soil series, surface texture, and slope phase.
Map 1. Saucelito Canyon Vineyard Location, in San Luis Obispo County, CA
Materials and Methods

Materials

- Rounded shovel (used for scraping pit faces)
- Sharpshooter shovel (used in transect confirmation)
- Backhoe (used for mechanical pit digging)
- No. 10 soil sieve (used to separate fine and coarse soil fragments in the lab)
- 150 cm cloth tape (used to measure soil and horizon depths)
- Munsell color book (used to classify soil dry and moist color)
- Hand-held clinometer (used to measure slope)
- Water bottle (used to moisten soil for hand texturing)
- Soil knife or rock hammer (used to chip away at pit faces and obtain samples)
- Garmin GPS receiver (used to document latitude and longitude on location)

Standard Methods

Standard methods were used to produce morphological pedon descriptions. Soil classification and soil land use interpretations followed those discussed in the Soil Survey Manual (Soil Survey Staff, 2000), Keys to Soil Taxonomy, 11th edition (Soil Survey Staff, 2010) and the courseware for Soil Resource Inventory (Rice, 2005). Digital maps were produced from data collected for the study site using ArcGIS software by Environmental Systems Research Institute (ESRI).

The A & L Western Agriculture Laboratories, Modesto, CA performed comprehensive fertility assay analyses to determine the concentrations of the plant essential nutrients (measured in ppm) in the soils, soil organic matter (as a percentage), electrical conductivity (E.C. measured in dS m⁻¹), cation exchange capacity (CEC as meq 100g⁻¹ soil), and soil pH.
Procedures

The Saucelito Canyon Vineyard ranch future vineyard site was investigated using eighteen (18) soil pits to document soil morphological properties including soil structure, color, depth, presence of carbonates, and soil chemical characteristics. Pits were also used to obtain soil samples that were delivered to A & L Western Agriculture Laboratories for further soil chemical analysis and to classify the soils.

This collective information was used to classify the soils into five (5) different soil series using Soil Taxonomy. The surface soil textures and slope phases for these soil series were then used to group similar soil types located throughout the vineyards into five (5) different soil map units. The map units were then mapped and delineated on aerial photographic base maps.

Digital soil maps were produced using ESRI software and computer hardware. The aerial photograph, used as a raster image for the digitizing and vector data for the series of maps created, was obtained from the San Luis Obispo County aerial files and the Digital Elevation Model (DEM) was obtained from the city of San Luis Obispo’s county files. Soil map unit boundaries were digitized onto the aerial photograph by creating a polygon shapefile and using the editor tool to draw in the map units.
**Climate**

This Data was collected from 1998 to 2008 at the San Luis Obispo Regional ARPT collection station.

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<th>Jan</th>
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<td>1.52</td>
<td>2.78</td>
<td>16.82</td>
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**Table 1.** Average temperature and precipitation by month (Fahrenheit)

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<th></th>
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<th>Mar</th>
<th>Apr</th>
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<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
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<tbody>
<tr>
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<td>17.6</td>
<td>17.7</td>
<td>18.9</td>
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<td>25.7</td>
<td>24.3</td>
<td>21.3</td>
<td>18.2</td>
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<td>6.3</td>
<td>6.8</td>
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<td>12.3</td>
<td>12.4</td>
<td>11.7</td>
<td>9.3</td>
<td>7.0</td>
<td>4.2</td>
<td>8.2</td>
</tr>
<tr>
<td>Average Annual Temp. (°C)</td>
<td>10.9</td>
<td>11.6</td>
<td>12.6</td>
<td>13.2</td>
<td>15.4</td>
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<td>18.9</td>
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<td>18.7</td>
<td>16.8</td>
<td>14.2</td>
<td>11.2</td>
<td>15.0</td>
</tr>
<tr>
<td>Average Total Precipitation (cm)</td>
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<td>9.25</td>
<td>5.46</td>
<td>4.11</td>
<td>1.68</td>
<td>0.07</td>
<td>0.00</td>
<td>0.03</td>
<td>0.15</td>
<td>2.03</td>
<td>3.86</td>
<td>7.06</td>
<td>42.72</td>
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</table>

**Table 2.** Average temperature and precipitation by month (Celsius)
Figure 1. Average temperature by month (Fahrenheit)

Figure 2. Average total precipitation by month (in.)
Figure 3. Average temperature by month (Celsius)

Figure 4. Average total precipitation by month (cm)
Geology and Topography

The Geology of the Saucelito Canyon Vineyard proposed vineyard site consists of weathered sandstone from the Santa Margarita formation as well as younger alluvium of the Monterey formation. The Santa Margarita formation was formed at the end of the Miocene and beginning of the Pliocene (5 to 2 million years ago) and consists of sandstone formed from granite. Thick layers of pectin, oyster shells, and broken shell debris are found within this formation (Chipping, 1987).

The Monterey formation also appears in the western part of the site in the sandier soils. The Santa Margarita formation is found throughout the site location with indications of the Pliocene through the oyster shells found. Sediments of an alluvial fan are present due to the uplifting of the Hi Mountain to the east.

The Santa Margarita Formation is found throughout the soil survey site with the Monterey Formation to the west. Tar Spring Ridge is situated to the west of the site with Hi Mountain to the east. The topography of the soil survey site show little elevation change throughout the site.
Map 2. Saucelito Canyon Vineyard area geologic formations and Saucelito Canyon Vineyard soil survey location.
Map 3. Saucelito Canyon Vineyard topography at 40 foot contours.
Soil Taxonomic Unit Descriptions
Map 4. Representative Pedon locations at Saucelito Canyon Vineyard soil survey site.
BOTELLA SERIES

TAXONOMIC FAMILY NAME

Fine, mixed, superactive, thermic Pachic Argixerolls

The Botella series consists of very deep, well drained soils that formed in young alluvial deposits from siliceous sandstone of the Santa Margarita Formation. Botella soils are in valley bottoms, alluvial fans, and stream terraces and have slopes of 0 to 2 percent. The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is about 15 degrees C (59°F).

The Botella series is similar to the Alumrock, Arujo, Chico, Elkhorn, Havala, and Kawenga soils. Alumrock, Arujo and McCoy soils are underlain by a paralithic contact. Chico soils have a solum more than 80 inches deep and do not have a lithologic discontinuity and a C horizon. Elkhorn soils have shot or concretions in the Bt horizon. Havala soils do not have lithologic discontinuities, and organic matter is less than 1 percent from 10 to 20 inches deep. Kawenga soils have a paralithic contact at 40 to 60 inches.

REPRESENTATIVE PEDON

A representative pedon of the Botella series is an area of Botella sandy clay, 0 to 2 percent slopes. It is on a southwest facing stream terrace adjacent to Saucelito Canyon Vineyards; Tar Spring Ridge Quadrangle; San Luis Obispo County, CA. Latitude N 35° 10’52.1” and Longitude W 120° 23’38.4”. (Colors are for dry soil unless otherwise noted).

A 0 to 38 cm (0 to 15 in.); dark grayish brown (2.5Y 4/2) sandy loam, very dark gray (2.5Y 3/1) moist; moderate coarse angular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; slightly alkaline (pH 7.4); abrupt smooth boundary.

Bt1 38 to 48 cm (15 to 19 in.); olive brown (2.5Y 4/3) sandy clay, very dark gray (2.5Y 3/1) moist; strong coarse angular blocky structure; hard, friable, moderately plastic and moderately sticky; common fine and medium roots; moderately alkaline (pH 8.0); clear smooth boundary.

Ab 48 to 96 cm (19 to 38 in.); dark grayish brown (2.5Y 4/2) sandy loam, very dark gray (2.5Y 3/1) moist; moderate coarse angular blocky structure; slightly hard, very friable, nonplastic and slightly sticky; common medium and coarse and many very coarse roots; moderately alkaline (pH 8.0); gradual smooth boundary.
**Bt2** 96 to 200 cm (38 to 79 in.); light olive brown (2.5Y 5/3) sandy clay, very dark grayish brown (2.5Y 3/2) moist; strong coarse angular blocky structure; hard, friable, moderately plastic and moderately sticky; common fine and medium roots; moderately alkaline (pH 8.0).

**RANGE IN CHARACTERISTICS**

The A horizon is gray, dark gray, very dark gray, very dark grayish brown or very dark brown (10YR 5/1, 5/2, 5/3, 4/1, 4/2, 3/1, 3/2, 2/2 or N 5/, N 3/, 2.5Y 4/2, 3/2). Texture is sandy loam, loam, clay loam or silty clay loam. The transition from the A horizon to the B horizon is gradual and most pedons have an BA horizon or a AB horizon or both. The Bt and 2Bt horizons are gray, dark gray, very dark gray, dark grayish brown, very dark grayish brown or brown (10YR 5/1, 5/2, 5/3, 4/1, 4/2, 3/1, 3/2, 4/3, 3/3, 2.5Y 4/2, 3/2, N 5/, N 4/, N 3/). In most pedons value or chroma or both increase one unit in the lower part of the Bt horizon. This horizon is clay loam, silty clay loam, sandy clay loam, or sandy clay and has about 6 to 10 percent more total clay than the A horizon. It has weak to strong angular blocky, subangular blocky or prismatic structure. The C horizon is light gray, light brownish gray or grayish brown (10YR 7/1, 7/2, 7/3, 6/1, 6/2, 5/2, N 7/, N 6/, 2.5Y 7/2, 6/2, 5/2). This horizon is dominantly loam, clay loam, or sandy clay loam. In some pedons there are some strata of sandy loam and fine sandy loam of minor thickness. Some pedons do not have a C horizon.)
**Photo 1.** Botella sandy clay, 0 to 2 percent slopes representative pedon. (Photo taken May 13, 2011.)
Map 5. Botella sandy clay, 0 to 2 percent slopes soil map unit location at soil survey site, Saucelito Canyon Vineyard.
CALHI SERIES

TAXONOMIC FAMILY NAME:
Mixed, thermic Typic Xeropsamments

The Calhi series consists of very deep, well drained soils that formed from that formed in young alluvial deposits from siliceous sandstone of the Santa Margarita Formation. Calhi soils are on stream terraces and valley bottoms and have slopes from 0 to 2 percent. The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F).

Similar soils to the Calhi series are the Arnold, Briones, Corralitos, Delhi, Dello, and Tujunga series. Arnold soils are neutral to strongly acid and have a paralithic contact at depths of 40 to 60 inches. Briones soils have a paralithic contact at depths of 20 to 40 inches. Corralitos soils are stratified and are neutral to strongly acid. Delhi soils are non-effervescent and slightly acid to mildly alkaline. Dello soils have mottles within 20 inches of the surface and are seasonally saturated. Tujunga soils are stratified, have some rock fragments, and are noneffervescent.

REPRESENTATIVE PEDON:
A representative pedon of the Calhi series is an area of Calhi loamy sand, 0 to 2 percent slopes. It is on a southwest facing stream terrace adjacent to Saucelito Canyon Vineyards; Tar Spring Ridge Quadrangle; San Luis Obispo County, CA. Latitude N 35° 10'53.7" and Longitude W 120° 23’45.6”. (Colors are for dry soil unless otherwise noted).

**C1** 0 to 28 cm (0 to 11 in.); light brownish gray (2.5Y 6/2) loamy sand, grayish brown (2.5Y 5/2) moist; single grained; loose; many fine and very fine roots; moderately alkaline (pH 8.4); clear wavy boundary.

**C2** 28 to 53 cm (11 to 21 in.); gray (2.5Y 6/1) loamy sand, gray (2.5Y 5/1) moist; single grained; loose; common fine roots; moderately alkaline (pH 8.4); gradual wavy boundary.

**C3** 53 to 150 cm (21 to 60 in.); light gray (2.5Y 7/1) sand, gray (2.5Y 6/1) moist; single grained; loose; few fine roots; moderately alkaline (pH 8.4).
RANGE IN CHARACTERISTICS

Texture is relatively uniform throughout the profile and is sand, fine sand, loamy sand or loamy fine sand. Very coarse sand is less than 5 percent and very coarse and coarse sand combined is less than 25 percent. Silt ranges from about 5 to 18 percent and clay from 4 to 8 percent. Some pedons have slightly darkened A horizons and in other pedons the profile consists of a series of C horizons. The soil is light gray to pale brown or pale yellow (10YR 7/2, 6/1, 6/2, 6/3; 2.5Y 7/2, 6/2, 7/4). Organic matter is less than 1 percent below a depth of 5 inches or in all parts and decreases regularly with depth. The soil is moderately to very strongly alkaline. It is slightly to moderately effervescent in all parts or in all parts below a depth of 10 inches and above any unrelated horizon that may be present below a depth of 40 inches. Lime is disseminated or segregations are very fine deep in the profile.

Photo 2. Calhi loamy sand, 0 to 2 percent slopes representative pedon. (Photo taken May 13, 2011).
Map 6. Calhi loamy sand, 0 to 2 percent slopes soil map unit location at soil survey site, Saucelito Canyon Vineyard.
CHUALAR SERIES

TAXONOMIC FAMILY NAME:

Fine-loamy, mixed, superactive, thermic Typic Argixerolls

The Chualar series consists of very deep, well drained soils that formed in young alluvial deposits from siliceous sandstone of the Santa Margarita Formation. Chualar soils are on valley bottoms, alluvial deposits and on stream terraces and have slopes from 0 to 2 percent. The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F).

The Chualar series is similar to the Ballard, Bohna, Chuloak (T), Franciscan, Gilroy, Sagaser, Shimmon, and Soper series. Ballard soils have less than 20 percent coarse and very coarse sand particles and have weakly developed (minimal) Bt horizons. Bohna and Sagaser soils have a paralithic contact at depth of 40 to 60 inches. Chuloak soils have temperatures in which the difference between mean summer and mean winter is greater than 30 degrees F. Franciscan soils are moderately deep to a lithic contact. Gilroy, Shimmon and Soper soils have bedrock at depths of 20 to 40 inches.

REPRESENTATIVE PEDON:

A representative pedon of the Chualar series is an area of Chualar sandy clay loam, 0 to 2 percent slopes. It is on a southwest-facing stream terrace adjacent to Saucelito Canyon Vineyards; Tar Spring Ridge Quadrangle; San Luis Obispo County, CA. Latitude N 35°10’51.3” and Longitude W 120°23’39.0”. (Colors are for dry soil unless otherwise noted).

A 0 to 36 cm (0 to 14 in.); grayish brown (2.5Y 5/2) loamy sand, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; soft, very friable, nonplastic and nonsticky; many very fine and fine roots; neutral (pH 7.2); abrupt smooth boundary.

E 36 to 53 cm (14 to 21 in.); light brownish gray (2.5Y 6/2) sand, dark grayish brown (2.5Y 4/2) moist; single grained; soft, loose, nonplastic and nonsticky; few very fine roots; moderately alkaline (pH 8.1); very abrupt smooth boundary.

Bt1 53 to 81 cm (21 to 32 in.); dark gray (2.5Y 4/1) sandy clay loam, black (2.5Y 2.5/1) moist; moderate medium angular blocky structure; slightly hard, friable, moderately plastic and moderately sticky; few fine and medium roots; slightly alkaline (pH 7.8); gradual wavy boundary.
**Bt2** 81 to 200 cm (32 to 80 in.); grayish brown (2.5Y 5/2) sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak medium angular blocky structure, slightly hard, friable, slightly plastic and slightly sticky; few fine and medium roots; moderately alkaline (pH 7.9).

**RANGE IN CHARACTERISTICS**

The A horizon is 2.5Y 5/3, 5/2, 4/3, 4/2, 3/3; 7.5YR 5/4, 5/2, 4/4, 4/2 or 3/2. Moist colors have values or chromas of 3 or less. It is sandy loam or loam and it is slightly acid or neutral. In some pedons, the A horizon is slightly alkaline because of soil amendments, irrigation water or other cultural measures. It has weak or moderate granular or subangular blocky structure and is slightly hard or hard. Organic matter content is 1 to 4 percent to a depth of more than 10 inches and decreases irregularly and is less than 1 percent at a depth of 20 inches. The lower boundary is diffuse or there is a transitional AB or BA horizon. The Bt horizon is 2.5Y 6/6, 6/4, 5/2, 5/4; 2.5Y 4/2, 5/3, 5/4. It is heavy sandy loam or sandy clay loam and average 15 to 35 percent clay. This horizon is massive or has weak to moderate angular blocky structure. It is slightly acid to slightly alkaline in the upper part and is moderately alkaline in the lower part of some pedons.
Photo 3. Chualar sandy clay loam, 0 to 2 percent slopes representative pedon. (Photo taken May 13, 2011.)
Map 7. Chualar sandy clay loam, 0 to 2 percent slopes, soil map unit location at soil survey site, Saucelito Canyon Vineyard.
LIVEOAK SERIES

TAXONOMIC FAMILY NAME:

Fine-loamy, mixed, superactive, thermic Typic Haploxerolls

The Liveoak series consists of very deep, well drained soils that formed from young alluvial deposits from siliceous sandstone of the Santa Margarita Formation. Liveoak soils are on alluvial terraces and stream terraces and have slopes from 0 to 2 percent. The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F).

The Liveoak series is similar to the Saurin and Tisdale series in the same family, and similar to the Pfeiffer and San Andreas series. The Saurin and Tisdale soils have bedrock at 20 to 40 inches. The Pfeiffer and San Andreas soils have less than 20 percent clay throughout.

REPRESENTATIVE PEDON:

A representative pedon of the Liveoak series is an area of Liveoak sandy clay loam, 0 to 2 percent slopes. It is on a southwest facing stream terrace adjacent to Saucelito Canyon Vineyards; Tar Spring Ridge Quadrangle; San Luis Obispo County, CA. Latitude N 35°10’54.9” and Longitude W 120°23’44.3”. (Colors are for dry soil unless otherwise noted).

A1 0 to 38 cm (0 to 15 in.); dark grayish brown (10YR 4/2) sandy clay loam, very dark gray (10YR 3/1) moist; weak medium and fine subangular blocky structure; slightly hard, friable, nonplastic and nonsticky; many very fine and fine roots; slightly alkaline (pH 7.6); clear smooth boundary.

A2 38 to 200 cm (15 to 80 in.); brown (10YR 5/3) sandy clay loam, dark grayish brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, very friable, nonplastic and nonsticky; common very fine and fine roots; moderately alkaline (pH 8.0).
RANGE IN CHARACTERISTICS:

The A horizon has dry color of 10YR 5/4, 5/3, or 5/2, 4/4, 4/3, 4/2, 3/4 and moist colors of 10YR 3/3, 3/2 or 7.5YR 3/2. Texture is sandy loam or sandy clay loam. Clay content ranges from 14 to 25 percent. Rock fragments mostly gravel range from 0 to 5 percent. Reaction ranges from slightly acid to slightly alkaline.

Photo 4. Liveoak sandy clay loam, 0 to 2 percent slopes representative pedon. (Photo taken May 13, 2011.)
Map 8. Liveoak sandy clay loam, 0 to 2 percent slopes soil map unit location at soil survey site, Saucelito Canyon Vineyard.
STILL SERIES

TAXONOMIC FAMILY NAME:

Fine, mixed, superactive, thermic Cumulic Haploxerolls

The Still series consists of very deep, well drained soils that formed from young alluvial deposits from siliceous sandstone of the Santa Margarita Formation. Still soils are on floodplains, valley bottoms, and stream terraces and have slopes from 0 to 2 percent. The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F).

The Still series is similar to the Elder, Linne, Marimel, Mocho, Salinas, San Benito, Sorrento and Vina series. Elder soils contain less than 18 percent clay. Linne and San Benito soils are less than 40 inches deep to a paralithic contact and have horizons with segregated lime. Marimel soils are somewhat poorly drained and have mottles in the lower part of the profile. Mocho soils have mollic epipedons less than 20 inches thick and are calcareous throughout. Salinas soils have horizons with segregated lime and the Organic matter decreases regularly with increasing depth. Sorrento soils have mollic epipedons less than 20 inches thick and the organic matter decreases regularly with increasing depth. Vina soils are both hard and massive below depths of 10 to 18 inches.

REPRESENTATIVE PEDON:

A representative pedon of the Still series is an area of Still sandy clay, 0 to 2 percent slopes. It is on a southwest-facing stream terrace adjacent to Saucelito Canyon Vineyards; Tar Spring Ridge Quadrangle; San Luis Obispo County, CA. Latitude N 35°10’49.6” and Longitude W 120°23’41.6”. (Colors are for dry soil unless otherwise noted).

**A1** 0 to 43 cm (0 to 17 in.); very dark grayish brown (10YR 3/2) sandy clay, black (10YR 2/1) moist; moderate coarse prismatic breaking into strong medium subangular blocky structure; slightly hard, firm, moderately plastic and moderately sticky; many fine and very fine roots; neutral (pH 6.8); clear smooth boundary.

**A2** 43 to 76 cm (17 to 30 in.); dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine subangular blocky structure; slightly hard, firm, moderately plastic and moderately sticky; many very fine, fine, and medium roots; neutral (pH 7.3); clear smooth boundary.

**A3** 76 to 200 cm (30 to 80 in.); grayish brown (10YR 5/2) clay loam; very dark grayish brown (10YR 3/2) moist; weak medium and fine subangular blocky structure; slightly hard, friable, moderately plastic and slightly sticky; many medium and few coarse roots; slightly alkaline (pH 7.5).
RANGE IN CHARACTERISTICS

The A horizon is grayish brown, dark grayish brown or dark gray (2.5Y 5/2, 4/2; 10YR 5/2, 5/1, 4/2, 4/1, 3/1) dry and very dark grayish brown or very dark gray (2.5Y 3/2; 10YR 3/1, 3/2) moist. It is sandy clay, clay loam, sandy clay loam, gravelly sandy clay loam or gravelly clay loam. This horizon is slightly acid or neutral. The C horizon, if present, is brown or grayish brown (2.5Y 5/2; 10YR 6/2, 5/2, 5/3) dry and very dark grayish brown, very dark gray or dark brown (10YR 3/1, 3/2, 3/3; 2.5Y 3/2) moist. Some pedons have mottles below 30 inches that are brown, dark brown, or yellowish brown (10YR 5/3, 4/3) dry. The 10- to 40-inch control section is clay loam, loam, or gravelly loam or gravelly clay loam. This horizon is slightly acid to moderately alkaline.
Photo 5. Still sandy clay, 0 to 2 percent slopes representative pedon. (Photo taken May 13, 2011.)
Map 9. Still sandy clay, 0 to 2 percent slopes soil map unit location at soil survey site, Saucelito Canyon Vineyard.
Soil Map Unit Descriptions
Map 10. Saucelito Canyon Vineyard soil survey site map units and representative pedons.
**Botella sandy clay, 0 to 2 percent slopes.** This very deep, well drained, moderate to moderately slowly permeable soil is on stream terraces. It is formed in material weathered from siliceous sandstone of the Santa Margarita Formation and young alluvium. The mapped area was irregular in shape and approximately 0.27 acres.

The existing vegetation consists of wild oats (*Avena fatua*), filaree (*Erodium cicutarium*), blue-eyed grass (*Sisyrinchium bellum*), coast live oak (*Quercus agrifolia*), valley oak (*Quercus lobata*), purple vetch (*Vicia villosa*), coyote brush (*Baccharis pilularis*), poison oak (*Rhus toxicodendron*), California poppy (*Eschscholzia californica*), matilija poppy (*Romneya coulteri*), deer grass (*Muhlenbergia rigens*), giant red Indian paintbrush (*Castilleja miniata*), California sagebrush (*Artemesia californica*), black sage (*Salvia mellifera*), and hummingbird sage (*Salvia spathacea*). Elevation ranges from approximately 295 to 299 meters (968 to 980 ft.). The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F). Annual frost free season is approximately 200 to 300 days per year.

This soil has been used as rangeland for sheep and as wildlife habitat. Typically the surface is dark grayish brown (2.5Y 4/2) sandy loam about 38 cm (15 in.) deep. This is underlain by layers of olive brown (2.5Y 4/3) sandy clay to a depth of 48 cm (19 in.), and by a layer of dark grayish brown (2.5Y 4/2) sandy loam to a depth of 96 cm (38 in.) with light olive brown (2.5Y 5/3) sandy clay to a depth of 152 cm (60 in.). This profile is slightly alkaline at the surface and becomes moderately alkaline as the depth increases. Hydraulic conductivity of this soil is high at the surface and the available water holding capacity is high. Surface runoff is negligible and the hazard of water erosion is low. The effective rooting depth is generally greater than 200 cm (80 in.), or very deep.

Gophers have modified conditions in some areas with burrows in the upper horizons of the soil profile.

These soils have level to gentle slopes. They are suited for irrigated and dry-farmed vineyards, tree crops, and vegetable crops. Proper tillage and residue incorporation help to maintain soil structure, fertility, and hydraulic conductivity. These soils are also used for wildlife habitat and rangeland. If the area were considered for dwellings without basements, the moderate rating should be noted. Design for dwellings without basements should consider the moderate shrink-swell rating. If the area were considered for dwellings with basements, the moderate rating should be noted. Design for dwellings with basements should consider the moderate shrink-swell rating. If the area were considered for local roads and streets, the moderate rating should be noted. Design for local roads and streets should consider the moderate shrink-swell rating. If the area were considered for camp areas, the moderate rating should be noted. Design for camp areas should consider the moderate dusty and small stones rating.

The Botella soil is in the Land Capability Class II, irrigated or dryland.
Photo 6. Botella sandy clay, 0 to 2 percent slopes soil map unit. (Photo taken February 1, 2011.)
**Calhi loamy sand, 0 to 2 percent slopes.** This very deep, well drained, moderately rapid to rapidly permeable soil is on stream terraces. It is formed in material weathered from siliceous sandstone of the Santa Margarita Formation and young alluvium. The mapped area was irregular in shape and approximately 0.37 acres.

The existing vegetation consists of wild oats (*Avena fatua*), filaree (*Erodium cicutarium*), blue-eyed grass (*Sisyrinchium bellum*), coast live oak (*Quercus agrifolia*), valley oak (*Quercus lobata*), purple vetch (*Vicia villosa*), coyote brush (*Baccharis pilularis*), poison oak (*Rhus toxicodendron*), California poppy (*Eschscholzia californica*), matilija poppy (*Romneya coulteri*), deer grass (*Muhlenbergia rigens*), giant red Indian paintbrush (*Castilleja miniata*), California sagebrush (*Artemesia californica*), black sage (*Salvia mellifera*), and hummingbird sage (*Salvia spathacea*). Elevation ranges from approximately 292 to 293 meters (960 to 963 ft.). The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F). Annual frost free season is 200 to 300 days per year.

This soil has been used as rangeland for sheep and as wildlife habitat. Typically the surface layer is light brownish gray (2.5Y 6/2) loamy sand about 30 cm (12 in.) deep. This is underlain by layers of gray (2.5Y 6/1) loamy sand about 50 cm (20 in.) deep and light gray (2.5Y 7/1) sand to a depth of about 152 cm (60 in.). The soil is moderately alkaline throughout soil profile. Hydraulic conductivity of the soil is high, and the available water holding capacity is low. Surface runoff is low or very low, and the hazard of water erosion is low. The effective rooting depth is greater than 200 cm (80 in.), or very deep.

Southern Fire Ants (*Solenopsis xyloni*) have modified conditions with colonies in upper horizons of soil profile throughout mapped area. Gophers have modified conditions in some areas with burrows in the upper horizons of the soil profile.

These soils have level to gentle slopes. They are suited for irrigated vineyards and tree crops. Proper tillage and residue incorporation help to maintain soil structure, fertility, and hydraulic conductivity. These soils are also used for wildlife habitat and rangeland. These soils harbor unique plant and animal communities. These soils are poorly suited for dwellings with or without basements, local roads and streets, urban development, septic tank absorption fields and treatment of wastewater. Design for camp areas should consider the moderate rating for sand.

The Calhi soil is in the Land Capability Class II irrigated, or Class III dryland.
Photo 7. Calhi loamy sand, 0 to 2 percent slopes soil map unit. (Photo taken February 1, 2011.)
Chualar sandy clay loam, 0 to 2 percent slopes. This very deep, well drained, moderately permeable soil is on stream terraces. It is formed in material weathered from siliceous sandstone of the Santa Margarita Formation and young alluvium. The mapped area was irregular in shape and approximately 0.41 acres.

The existing vegetation consists of wild oats (*Avena fatua*), filaree (*Erodium cicutarium*), blue-eyed grass (*Sisyrinchium bellum*), coast live oak (*Quercus agrifolia*), valley oak (*Quercus lobata*), purple vetch (*Vicia villosa*), coyote brush (*Baccharis pilularis*), poison oak (*Rhus toxicodendron*), California poppy (*Eschscholzia californica*), matilija poppy (*Romneya coulteri*), deer grass (*Muhlenbergia rigens*), giant red Indian paintbrush (*Castilleja miniata*), California sagebrush (*Artemesia californica*), black sage (*Salvia mellifera*), and hummingbird sage (*Salvia spathacea*). Elevation ranges from approximately 292 to 293 meters (962 to 966 ft.). The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F). Annual frost free season is 200 to 300 days per year.

This soil has been used as rangeland for sheep and as wildlife habitat. Typically the surface is grayish brown (2.5Y 5/2) loamy sand about 36 cm (14 in.) deep. This is underlain by layers of light brownish gray (2.5Y 6/2) sand to a depth of 53 cm (21 in.), and a layer of dark gray (2.5Y 4/1) sandy clay loam to a depth of 81 cm (32 in.) with grayish brown (2.5Y 5/2) sandy loam to a depth of 152 cm (60 in.). This profile is neutral in soil acidity at the surface and becomes moderately alkaline as the depth increases. Hydraulic conductivity of the soil is moderate and the available water holding capacity is high. Surface runoff is negligible to low and the hazard of water erosion is low. The effective rooting depth is generally greater than 200 cm (80 in.), or very deep.

Gophers have modified conditions in some areas with burrows in the upper horizons of the soil profile.

These soils have level to gentle slopes. They are suited for irrigated and dry-farmed vineyards, tree crops, and vegetable crops. Proper tillage and residue incorporation help to maintain soil structure, fertility, and hydraulic conductivity. These soils are also used for wildlife habitat and rangeland. If the area were considered for dwellings without basements, the moderate rating should be noted. Design for dwellings without basements should consider the moderate shrink-swell rating. If the area were considered for dwellings with basements, the moderate rating should be noted. Design for dwellings with basements should consider the moderate shrink-swell rating. If the area were considered for local roads and streets, the moderate rating should be noted. Design for local roads and streets should consider the moderate shrink-swell rating. If the area were considered for camp areas, the moderate rating should be noted. Design for camp areas should consider the moderate dusty and small stones rating.

The Chualar soil is in the Land Capability Class I, irrigated or dryland.
Photo 8. Chualar sandy clay loam, 0 to 2 percent slopes soil map unit. (Photo taken February 1, 2011.)
Liveoak sandy clay loam, 0 to 2 percent slopes. This very deep, well drained, moderately permeable soil is on stream terraces. It is formed in material weathered from siliceous sandstone of the Santa Margarita Formation and young alluvium. The mapped area was irregular in shape and approximately 1.7 acres.

The existing vegetation consists of wild oats (*Avena fatua*), filaree (*Erodium cicutarium*), blue-eyed grass (*Sisyrinchium bellum*), coast live oak (*Quercus agrifolia*), valley oak (*Quercus lobata*), purple vetch (*Vicia villosa*), coyote brush (*Baccharis pilularis*), poison oak (*Rhus toxicodendron*), California poppy (*Eschscholzia californica*), matilija poppy (*Romneya coulteri*), deer grass (*Muhlenbergia rigens*), giant red Indian paintbrush (*Castilleja miniata*), California sagebrush (*Artemesia californica*), black sage (*Salvia mellifera*), and hummingbird sage (*Salvia spathacea*). Elevation ranges from approximately 291 to 294 meters (956 to 964 ft.). The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F). Annual frost free season is 200 to 300 days per year.

This soil has been used as rangeland for sheep and as wildlife habitat. Typically the surface is dark grayish brown (10YR 4/2) sandy clay loam about 38 cm (15 in.) deep. This is underlain by a layer of brown (10YR 5/3) sandy clay loam to a depth of 152 cm (50 in.). The profile is slightly alkaline at the surface and becomes moderately alkaline as depth increases. Hydraulic conductivity of the soil is moderate and the available water holding capacity is high. Surface runoff is negligible to low, and the hazard of water erosion is low. The effective rooting depth is generally greater than 200 cm (80 in.), or very deep.

Gophers have modified conditions in some areas with burrows in the upper horizons of the soil profile.

These soils have level to gentle slopes. They are suited for irrigated and dry-farmed vineyards, tree crops, and vegetable crops. Proper tillage and residue incorporation help to maintain soil structure, fertility, and hydraulic conductivity. These soils are also used for wildlife habitat and rangeland. If the area were considered for dwellings without basements, the moderate rating should be noted. Design for dwellings without basements should consider the moderate shrink-swell rating. If the area were considered for dwellings with basements, the moderate rating should be noted. Design for dwellings with basements should consider the moderate shrink-swell rating. If the area were considered for local roads and streets, the moderate rating should be noted. Design for local roads and streets should consider the moderate shrink-swell rating. If the area were considered for camp areas, the moderate rating should be noted. Design for camp areas should consider the moderate dusty and small stones rating.

The Liveoak soil is in the Land Capability class I, irrigated or dryland.
Photo 9. Liveoak sandy clay loam, 0 to 2 percent slopes soil map unit. (Photo taken February 1, 2011.)
**Still sandy clay, 0 to 2 percent slopes.** This very deep, well drained, moderately slow to slowly permeable soil is on stream terraces. It is formed in material weathered from siliceous sandstone of the Santa Margarita Formation and young alluvium. The mapped area was irregular in shape and approximately 0.85 acres.

The existing vegetation consists of wild oats (*Avena fatua*), filaree (*Erodium cicutarium*), blue-eyed grass (*Sisyrinchium bellum*), coast live oak (*Quercus agrifolia*), valley oak (*Quercus lobata*), purple vetch (*Vicia villosa*), coyote brush (*Baccharis pilularis*), poison oak (*Rhus toxicodendron*), California poppy (*Eschscholzia californica*), matilija poppy (*Romneya coulteri*), deer grass (*Muhlenbergia rigens*), giant red Indian paintbrush (*Castilleja miniata*), California sagebrush (*Artemesia californica*), black sage (*Salvia mellifera*), and hummingbird sage (*Salvia spathacea*). Elevation ranges from approximately 293 to 294 meters (963 to 966 ft.). The mean annual precipitation is 60 cm (23.5 in.) and the mean annual air temperature is 15°C (59°F). Annual frost free season is approximately 200 to 300 days per year.

This soil has been used as rangeland for sheep and as wildlife habitat. Typically the surface is very dark grayish brown (10YR 3/2) sandy clay about 43 cm (17 in.) deep. This is underlain by layers of dark grayish brown (10YR 4/2) clay loam to a depth of 76 cm (30 in.), grayish brown (10YR 5/2) clay loam to a depth of 152 cm (60 in.). The profile is slightly acid to neutral at the surface and becomes slightly alkaline as the depth increases. Hydraulic conductivity of the soil is low at the surface and the available water holding capacity is high. Surface runoff is negligible to moderate, and the hazard of water erosion is low. The effective rooting depth is generally greater than 200 cm (80 in.), or very deep.

Gophers have modified conditions in some areas with burrows in the upper horizons of the soil profile.

These soils have level to gentle slopes. They are suited for irrigated and dry-farmed vineyards, tree crops, and vegetable crops. Proper tillage and residue incorporation help to maintain soil structure, fertility, and hydraulic conductivity. These soils are also used for wildlife habitat and rangeland. If the area were considered for dwellings without basements, the moderate rating should be noted. Design for dwellings without basements should consider the moderate shrink-swell rating. If the area were considered for dwellings with basements, the moderate rating should be noted. Design for dwellings with basements should consider the moderate shrink-swell rating. If the area were considered for local roads and streets, the moderate rating should be noted. Design for local roads and streets should consider the moderate shrink-swell rating. If the area were considered for camp areas, the moderate rating should be noted. Design for camp areas should consider the moderate dusty and small stones rating.

The Still soil is in the Land Capability Class II, irrigated or dryland.
Photo 10. Still sandy clay, 0 to 2 percent slopes soil map unit. (Photo taken February 1, 2011.)
Management Recommendations
Rootstock Selection

The use of rootstocks in grapevines has been an important tool since the 1800’s when *Phylloxera* spp. was introduced to Europe from North American plant material. *Phylloxera* is estimated to have destroyed between two-thirds to three-fourths of all European vineyards, with the biggest impact in France. *Phylloxera* was eventually managed in Europe with the introduction of Eastern U.S. grapevine species as rootstock, as it is resistant to *Phylloxera*. In California, *Phylloxera* has only been an issue on own-rooted vines in clayey soils. In the San-Joaquin Valley, where sandy soils are dominant, *Phylloxera* has not been an issue even on own-rooted vines of *Vitis vinifera* parentage. All North American native grapevine species are resistant to *Phylloxera*. Rootstock selection today involves several more factors to consider besides disease-resistance when developing a vineyard. As the link between the scion and the soil, the rootstock influences plant nutrient uptake, vigor, and tolerance of soil conditions. The rootstock choice directly influences the quality of wine in the finished product, as it has an effect on budbreak date, vegetative growth, vine stress (water uptake), hormones, crop maturity, and crop yield.

Rootstock selection directly affects many other vineyard design factors including plant spacing, plant density, trellis system, pruning practices, irrigation and fertility management. Many rootstocks have preferences for soil types, with some rootstocks tolerating a wide variety of soil conditions. Rootstocks adaptation to specific soil conditions greatly influences nutrient uptake of the vines, as some rootstocks favor increased uptake of some nutrients and decreased uptake of other nutrients. Rootstock selection is a culmination of all the growth factors to consider; selecting for disease-resistance, drought tolerance, slope, aspect, soil type, soil acidity, tolerances to certain nutrients, increased uptake of other nutrients, ability to withstand a variety of soil conditions (wet feet, salt, lime, etc.), and desired wine quality. Own rooted vines have been shown to increase overall vigor of the vines, and claims by some winemakers as producing overall higher quality fruit, though fruit quality is more dependent on climate and farming practices (Patterson, 2008).

Several important factors need to be considered at the Saucelito Canyon Vineyards site to be developed. Slope, effective rooting depth, depth to seasonally high water table, drainage, soil acidity, soil texture, disease-resistance, lime tolerance, and influence on budbreak date and crop maturity all need to be considered when selecting for a rootstock. The most important factors to consider at this site would be the soil texture, which determines the available water holding capacity (AWHC). The AWHC has the greatest influence on potential vigor of the site, and can be used to determine the potential vigor of the grapevines. The AWHC of the soils found at Saucelito Canyon Vineyards range from low (Calhi) to high (Still, Botella, Chualar, Liveoak). The AWHC directly influences the potential vigor of the soils at the site to range from low to high. For the soils with low vigor potential, such as Calhi, a rootstock with a high vigor rating would be appropriate whereas a soil such as the Botella with a high potential vigor should be planted on a rootstock with a low vigor rating. Own-rooted vines should take note of clay percentage, as *Phylloxera* is commonly found in soils with higher percentages of clay. Sandy soils usually don’t have issues with *Phylloxera*.

Depth to the water table is a very important plant limiting growth factor in wet years, since some of the soils at the lower elevations have high water tables during the wet months of the year. This could lead to the development of *Phytophthora*, or oak root rot fungus, when temperatures
are warm enough to promote the development of the fungus. Grapevines can also cease root respiration and die in low oxygen/waterlogged environments during active growth. These seasonally wet soils can also delay budbreak date and rootstocks are selected to tolerate waterlogged soils. Depth to seasonally high water tables affects all of the soils in wet years, though the wetness subsides quickly. Although high water tables were not found in any of the soil pits at this site, during periods of heavy rainfall there could be some issues with high water tables in certain parts of the site.

Several rootstock recommendations were made for each soil type to give a diverse range of options for the grower. All of the rootstock selections have high to moderate resistance to a range of diseases and pests including *Phylloxera* and nematodes. All or any of the rootstock choices would be suitable for the soil types found at the site except for the Calhi series. Since the Calhi soil has a low potential vigor, the Saint George and 110 Richter were chosen as appropriate rootstocks. The Saint George and 110 R, as it’s commonly referred to, would also be suitable for the other soils in a dry-farmed site, as those rootstocks have a high drought tolerance. One must be careful selecting for a rootstock with a high vigor potential matched to a site with a high vigor potential as vine growth might be overly vigorous and increase vineyard maintenance and costs during the growing season for practices such as shoot thinning (Patterson, 2008). All of the other rootstock choices would be appropriate for this site, with the 5BB Kober being an especially well-paired choice with alkaline soil conditions present at this site, though one must be careful in regard to Rugose Wood Complex viruses with the Kober rootstock.

The use of own-rooted vines is a slight risk due to the threat of diseases such as *Phylloxera*, however, that hasn’t been an issue in the adjacent vineyard planting in its 130-year history. Disease-free wood and cuttings should be used if use of own-rooted vines were to commence, as *Eutypa* is present throughout adjacent vineyard, and is present in cuttings. Much debate has surfaced with own-rooted vines, from winemakers claiming increased overall vine health, vigor, and wine quality to some vineyard managers claiming poor growth and disease susceptibility are not worth the risk. The adjacent vineyard has shown the use of own-rooted vines as successful in a dry-farming situation, which is an indicator that own-rooted vines might work at this site. Possibly the biggest drawback to not using a rootstock is the inability to graft a separate varietal at a later date as the market demand changes for different wines and grapes.

**Scion Recommendations**

Many different scion varietals would be appropriate for the site. Zinfandel, Cabernet Sauvignon, Cabernet Franc, Grenache, Malbec, Mourvedre, Syrah and other Rhone red varietals would be excellent choices for this site. Rhone whites such as Roussanne, Marsanne, Grenache Blanc and Picpoul Blanc would also perform well in these conditions. Many other varietals would be great choices as well for this site. Scion (the fruiting part of the vine) choices are a combination of climate, market demand, availability, and winemaker preference more than anything.
Table 3. Rootstock attributes and soil type suitability.

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Vigor</th>
<th>Phylloxera Resistance</th>
<th>Nematode X. Index</th>
<th>M. incognita Resistance (Root-knot)</th>
<th>Preffered Soil</th>
<th>Drought Tolerance</th>
<th>Wet Feet</th>
<th>Lime Tolerance</th>
<th>Maturity Influence</th>
<th>Mg uptake</th>
<th>Acid Soil Tolerance</th>
<th>SCV Soil Type Suitability</th>
</tr>
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<tbody>
<tr>
<td>Saint George</td>
<td>High</td>
<td>High</td>
<td>Low/Mod.</td>
<td>Mod.</td>
<td>Deep/Fert. Loam</td>
<td>High</td>
<td>Low</td>
<td>14%</td>
<td>Late</td>
<td></td>
<td></td>
<td>All</td>
</tr>
<tr>
<td>Schwarzmann</td>
<td>Mod.</td>
<td>High</td>
<td>High</td>
<td>Mod.</td>
<td>Deep/Fert. Heavy Clay</td>
<td>Low/Mod.</td>
<td>Mod.</td>
<td>6-9%</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>All*</td>
</tr>
<tr>
<td>101-14</td>
<td>Mod.</td>
<td>High</td>
<td>High</td>
<td>Mod.</td>
<td>Deep/Fert. Clay loams</td>
<td>Low/Mod.</td>
<td>High</td>
<td>9&amp;</td>
<td>Early</td>
<td>Poor</td>
<td>Poor</td>
<td>All*</td>
</tr>
<tr>
<td>5BB Kober</td>
<td>Mod.</td>
<td>High</td>
<td>Mod.</td>
<td>Mod.</td>
<td>Deep/Well drained Clay loams</td>
<td>Low</td>
<td>Low</td>
<td>20%</td>
<td>Mid</td>
<td>Poor</td>
<td>Poor</td>
<td>All*</td>
</tr>
<tr>
<td>3309</td>
<td>Mod.</td>
<td>High</td>
<td>Poor</td>
<td>Poor</td>
<td></td>
<td>Low</td>
<td>High</td>
<td>11%</td>
<td>Mid</td>
<td>Good</td>
<td>Poor</td>
<td>All*</td>
</tr>
<tr>
<td>1616</td>
<td>Low</td>
<td>High</td>
<td>Mod.</td>
<td>High</td>
<td>Deep/Fert. Clay loams</td>
<td>Low</td>
<td>High</td>
<td>11%</td>
<td>Early</td>
<td></td>
<td></td>
<td>All*</td>
</tr>
<tr>
<td>420A</td>
<td>Low</td>
<td>Mod.</td>
<td>Mod.</td>
<td>Mod.</td>
<td>Deep/Fert. Clay loams</td>
<td>Low</td>
<td>20%</td>
<td></td>
<td>Late</td>
<td></td>
<td></td>
<td>All*</td>
</tr>
<tr>
<td>110 Richter</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Mod. Fert</td>
<td></td>
<td>High</td>
<td>Low</td>
<td>17%</td>
<td>Late</td>
<td>Poor</td>
<td>Mod.</td>
<td>All</td>
</tr>
<tr>
<td>Own-rooted</td>
<td>Varies</td>
<td>Very low</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>All</td>
</tr>
</tbody>
</table>

* Denotes all soils except for Calhi series
Table 4. Soil properties influencing rootstock compatibility.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Texture</th>
<th>Slope (%)</th>
<th>AWHC$_1$</th>
<th>Soil Depth Class</th>
<th>Depth to Seasonally High Water Table</th>
<th>Drainage Class</th>
<th>Acidity$_1$</th>
<th>Potential Vigor$_2$</th>
<th>Limiting Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botella</td>
<td>Sandy Clay</td>
<td>0-2</td>
<td>High</td>
<td>Very Deep</td>
<td>Low</td>
<td>Well Drained</td>
<td>Slightly/ Mod. Alkaline</td>
<td>High</td>
<td>Alkalinity</td>
</tr>
<tr>
<td></td>
<td>Loamy Sand</td>
<td>0-2</td>
<td>Low</td>
<td>Very Deep</td>
<td>Low</td>
<td>Well Drained</td>
<td>Mod. Alkaline</td>
<td>Low</td>
<td>Low vigor, alkalinity</td>
</tr>
<tr>
<td>Calhi</td>
<td>Sandy Clay</td>
<td>0-2</td>
<td>High</td>
<td>Very Deep</td>
<td>Low</td>
<td>Well Drained</td>
<td>Neutral/ Mod. Alkaline</td>
<td>High</td>
<td>Alkalinity</td>
</tr>
<tr>
<td>Chualar</td>
<td>Sandy Clay Loam</td>
<td>0-2</td>
<td>High</td>
<td>Very Deep</td>
<td>Low</td>
<td>Well Drained</td>
<td>Slightly/ Mod. Alkaline</td>
<td>High</td>
<td>Alkalinity</td>
</tr>
<tr>
<td>Liveoak</td>
<td>Sandy Clay Loam</td>
<td>0-2</td>
<td>High</td>
<td>Very Deep</td>
<td>Low</td>
<td>Well Drained</td>
<td>Slightly Alkaline</td>
<td>High</td>
<td>Alkalinity</td>
</tr>
<tr>
<td>Still</td>
<td>Sandy Clay</td>
<td>0-2</td>
<td>High</td>
<td>Very Deep</td>
<td>Low</td>
<td>Well Drained</td>
<td>Slightly Acid/ Alkaline</td>
<td>High</td>
<td>Alkalinity</td>
</tr>
</tbody>
</table>

Footnote$_1$: See Glossary

Footnote$_2$: See Rootstock Selection Narrative
Nutrient Management

From a nutrient management standpoint, the Saucelito Canyon Vineyard proposed vineyard site topsoils are relatively similar. Most soils are sandy lays or sandy clay loams, with pHs in the top 100 cm ranging from 8.4 to 6.8.

Soil pH is a major factor controlling plant essential nutrient availability. Most plant essential nutrients have the greatest plant availability at pH about 6.5. At pH values less than 6.5 the basic cations (Ca, Mg, K, Na) are usually present in relatively low concentrations. At pH values above 6.5, the metal micronutrients (Fe, Mn, Cu, Zn) become less available due to precipitation as carbonates. Phosphorus becomes less available at pH values less than 6.0 due to precipitation with iron, aluminum oxides and hydroxides, and at pH values between 7.5 and 8.5 due to precipitation with calcium.

The cation exchange capacity (CEC) of a soil is the primary measure of the potential fertility of a soil, the higher pH values as in the survey will yield a higher CEC value. It measures the ability of the negatively charged clay and humus particles in the soil to hold onto positively charged cations (Smith, 2009). Generally, coarser textured soils have low CEC values, ranging from 2 to 8 meq/100g soil. Finer textured soils typically have higher CEC values, ranging from 10 to 30 meq/100g soil (WFH, 2002). Sandy loam soils typically range from 8 to 12 meq/100g soil. The soils sampled from the proposed vineyard site contained CEC values ranging from 16.3 to 26.6 meq/100g soil in the topsoil, and 12.3 to 20.4 meq/100g soil in the top 100 cm, indicating relatively high nutrient holding capacities in regards to the soil texture. Topsoils have higher CEC due to increased levels of organic matter.

Soil organic matter plays a large role in soil fertility and productivity. Soil organic matter improves soil tilth and structure, improves aeration and water infiltration, increases water-holding capacity, adds to CEC, and provides sources of plant nutrients. Organic matter has many positive benefits for plant growth (WFH, 2002).

When selecting fertilizers for the proposed vineyard site, pH and soil texture should be considered. For acid soils, neutralization can be promoted by properly selecting fertilizers. Improper selection of fertilizers however may exaggerate existing pH issues. Sandy soils present an increased concern for fertilizer-induced changes when compared to clayey soils due to their lower buffering capacities, including their ability to resist changes in pH (Grant, 2002).

Nitrogen (N), Phosphorous (P), and Potassium (K)

According to the soil analysis reports from A & L Laboratories (dated 29 April 2010) Nitrate-N (NO3-N) levels are low, indicating a need for nitrogen additions in a fertilizer program. Low nitrogen levels in the soil are desirable, as it allows the grower to control the amount of nitrogen available to the vines. Soil phosphorus levels are medium throughout. Potassium levels are medium to high throughout.

Calcium (Ca), Magnesium (Mg), and Sulfur (S)

Throughout the Saucelito Canyon Vineyard proposed vineyard site all the calcium levels are high to very high with medium magnesium levels are generally optimal for vine growth. The optimal calcium to magnesium ratio (Ca:Mg ratio) for grapevines is between 5:1 and 10:1. Magnesium levels are generally moderate to low, while calcium levels are generally moderate to high. All but one of the soils within the proposed vineyard site have a Ca:Mg ratio between 6.64:1 and 8.64:1. All
soils surveyed had relatively low levels of sulfur. Sulfur dust could be used in an Integrated Pest Management (IPM) program, and would likely remedy this deficiency.

**Iron (Fe), Zinc (Zn), Manganese (Mn), Copper (Cu), and Boron (B)**

The availability of metal micronutrients (Fe, Zn, Mn, Cu, B) is dependent on soil pH. Soil pH values below 7.0 allow metal micronutrients to mobilize, increasing their availability to plants. Conversely, soil pH values above 7.0 cause metal micronutrients to precipitate out of solution, decreasing their availability to plants. At the Saucelito Canyon Vineyard proposed vineyard site all soils are deficient throughout the soil profile in zinc, copper, and boron due to their absence in the soil parent materials. Additionally, iron and manganese levels are also low throughout the vineyard site. Iron levels are low in all other soils. Manganese levels are medium throughout.

After planting, leaf and petiole samples will be required to monitor plant nutrient levels. Routine soil tests are also recommended in order to maintain sustainable fertilizer practices.
Fertilizer Recommendations

The soils at the site have very similar nutrient levels. Most of the soils need some fertilizer and soil amendment additions to achieve optimal vineyard soil fertility. The soils range in pH from 6.8 to 8.4 with most soils in pH range 7 to 8. There are no serious nutrient availability issues in the pH range 7 to 8, however soil nutrient availability for metal micronutrients typically decreases for pH values greater than 7 (Fig. 5). Some metal micronutrients (Fe, Mn, Zn) are less available outside this pH range.

![Soil pH and Nutrient Availability](image)

**Figure 5.** Soil pH and Nutrient Availability (NCCE)

The soils are low in nitrogen and the metal micronutrients except for iron. Low nitrogen levels in grapes can lead to stuck fermentations, as the yeast need nitrogen containing amino acids such as arginine and proline as a source of energy. Excess nitrogen can increase the production of ethyl carbamate, a carcinogenic compound, in the finished wine. To increase soil nitrogen levels, N-fertilizer such as a slow-release (sulfur-coated) urea (46-0-0), could be used. Nitrate-N fertilizers are not recommended because of their leaching potential, especially in these sandy loam soils. The nitrogen should be plant-available early in the growing season when plants are growing vegetatively. High nitrogen levels later in the growing season can reduce fruit set and delay grape cluster maturity. N-fertilizer additions are recommended for the first year prior to planting, until a cover crop can be established. A leguminous cover crop including clovers, vetch, lupines or beans can add significant amounts of N (200-300 lbs. N/acre per year) to the soil if incorporated (Havlin et al., 2005). The addition of leguminous cover crops reduces the need for N-fertilizer additions.

In addition to nitrogen, all the soils are relatively low in potassium. Potassium sulfate (0-0-39; 18% S) is recommended for these soils. Potassium can be added by surface broadcasting or dissolving in the irrigation water. Care should be taken not to over-apply potassium since an
excess of potassium will result in grape cluster pH exceeding 4.0, which can lead to wine fermentation and storage problems.

Phosphorus levels adequate in the soils throughout the site, however phosphorus should be monitored nevertheless. Phosphorus deficiencies can lead to reduced bud fruitfulness, reduced yield, and restricted foliage growth. Triple superphosphate (0-45-0) can be added to the fertilizer mix to mitigate phosphorus deficiencies, should they arise. Low soil phosphorus levels can decrease bloom. Incorporating phosphorus into the subsoil can increase fertilizer effectiveness.

Magnesium levels are moderate to low in the soils. Care should be taken when adding magnesium in regard to the Ca:Mg ratio to maintain the optimum 5:1 to 10:1 ratio. K-Mag (0-0-22; 11% Mg, 22% S) can be added to the fertilizer mix to increase soil levels of potassium, magnesium, and sulfur. Magnesium deficiencies can lead to yellowing of the leaf edges and between the veins.

Metal micronutrients are deficient in these soils as well. These nutrients can be added post-bloom as foliar applications in chelates or sulfates, including ZnSO₄, MnSO₄, FeSO₄ and CuSO₄. Zinc deficiencies can lead to poor fruit set, shot berries, and uneven ripening of the clusters (Waschkies et al., 1993). Of particular importance to vineyards are sulfur nutrient levels in the soil. Sulfate-S levels are low in all the soils. Sulfur compounds such as elemental sulfur are commonly sprayed in vineyards to manage fungal infections such as powdery mildew, and also is a valuable source of sulfur for the vines. Metal micronutrients are commonly added to the mix during this time. Since the absorption rate is high in foliar applications, low rate applications of the metal micronutrients would be sufficient.

Additionally, boron levels are low in the soils. Boron can be added as a foliar application, but it is less costly to add a boronated N-fertilizer to the soil. Care should be taken not to over-apply boron as a toxicity level can be reached at relatively low concentrations.
Irrigation Recommendations

The permeability rating was determined based on soil texture and structure using the least permeable horizon (Rice, 2005). Available water holding capacity was determined based on soil texture, depth, and percent rock fragments (Table 5).

Slopes on this vineyard range from 0 to 2 percent. Drip irrigation is the preferred method of irrigation, if irrigation is chosen. Drip irrigation minimizes erosion caused by runoff and can also be utilized with fertilization methods. Drip irrigation is better utilized than other irrigation methods to control the rooting zone growth and stress on the plant to ensure high quality grapes. Water is applied to the areas just above the effective rooting zone and is not wasted on inter-row areas where weeds could grow.

Due to the topography and layout of the site, it is recommended that one or more holding tanks be installed at an elevation above the site. Flow emitters with preset flow rates can be used to distribute irrigation water to the vines as needed. Irrigation amounts can be determined based on the soil properties of each map unit, including surface texture, slope phase, permeability, and water holding capacity (Table 5).

Irrigation rates should be adjusted throughout the year in accordance with annual precipitation, average wind speeds, average temperature, and the evapo-transpiration rates available from the California Irrigation Management Information Systems (CIMIS) website. Climatic data from 1947 to 1995 can be found in Tables 1 and 2. Special considerations should be made for drip irrigation on steep slopes or where irrigation water could run off a steep slope. On these sites vegetation must be established, and measures taken to offset sediment loss due to erosion.

Due to the topography of the site, and the soil properties (especially soil depth), dry-farming the proposed vineyard site could be utilized. Most of the precipitation in the area flows by gravity from the surrounding mountains into the canyon, with ample groundwater for a well at a depth of less than 30 feet (grapevine roots can grow to that depth given no severely root-limiting layers). Irrigation is recommended to establish the vines during the first year of growth, although a complete drip system need not be installed if cost prohibitive.
Table 5. Soil physical properties relative to irrigation for Saucelito Canyon Vineyard soils.

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>Surface Texture</th>
<th>Slope Phase (%)</th>
<th>Rooting Depth (cm)</th>
<th>Permeability Class</th>
<th>AWHC(^1) (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botella</td>
<td>sandy clay</td>
<td>0-2</td>
<td>&gt;200</td>
<td>Moderate</td>
<td>30.0</td>
</tr>
<tr>
<td>Calhi</td>
<td>loamy sand</td>
<td>0-2</td>
<td>&gt;200</td>
<td>Moderately Rapid</td>
<td>10.2</td>
</tr>
<tr>
<td>Chualar</td>
<td>sandy clay loam</td>
<td>0-2</td>
<td>&gt;200</td>
<td>Moderately Rapid</td>
<td>26.5</td>
</tr>
<tr>
<td>Liveoak</td>
<td>sandy clay loam</td>
<td>0-2</td>
<td>&gt;200</td>
<td>Moderate</td>
<td>30.0</td>
</tr>
<tr>
<td>Still</td>
<td>sandy clay</td>
<td>0-2</td>
<td>&gt;200</td>
<td>Moderately Slow</td>
<td>30.0</td>
</tr>
</tbody>
</table>

Footnote\(^1\): Available Water Holding Capacity (AWHC)

*Orange indicates low AWHC, blue indicates high AWHC.

Figure 6. Available water holding capacity (AWHC) (cm), by soil series.
References


Pouget and Delas handout. 1989. Written communication from Dr. Patterson FRSC 211, 2009.


APPENDIX A: Glossary
Alluvial fan. Fan-shaped alluvium deposited at the mouth of a canyon or ravine where debris-laden water fan out, slow down, and deposit their burden.

Alluvium. Material such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference in the amount of soil water at field moisture capacity and the amount at permanent wilting point, and expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

\[
\text{Centimeters } H_2O
\]

Very low........................... 0 to <7.5
Low............................... 7.5 to <15
Moderate.......................... 15 to <22.5
High........................................ ≥ 22.5

Backslope. The profile position of a hillslope situated between the shoulder and the footslope.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous. Composed of, containing, or characteristic of calcium carbonate, calcium, or limestone. Calcareous parent material is composed of sedimentary rock that contains calcium carbonate (CaCO\(_3\)). Examples are calcite, limestone, chalk, or aragonite. Calcium carbonate is alkaline with a pH of 10.0-12.0.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Coarse fragments. Mineral or rock particles up to 3 inches in diameter.

Colluvium. Soil parent material consisting of soil material, rock fragments, or both moved by creep, slide, or local outwash and deposited at the bases of steep slopes.

Compaction. Reduction in bulk volume or thickness of fine-grained sediments, owing to increasing weight of overlying material that is continually being deposited, or to pressures resulting from earth movements.
**Consistence.** Cohesion, adhesion, and/or resistance to rupture deformation of soil material.

<table>
<thead>
<tr>
<th>Dry</th>
<th>Moist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose (L)</td>
<td>Loose (L)</td>
</tr>
<tr>
<td>Soft (S)</td>
<td>Very Friable (VFR)</td>
</tr>
<tr>
<td>Slightly Hard (SH)</td>
<td>Friable (FR)</td>
</tr>
<tr>
<td>Mod. Hard (MH)</td>
<td>Firm (FI)</td>
</tr>
<tr>
<td>Hard (HA)</td>
<td>Very Firm (VFI)</td>
</tr>
<tr>
<td>Very Hard (VH)</td>
<td>Extremely Firm (EF)</td>
</tr>
<tr>
<td>Extremely Hard (EH)</td>
<td>Slightly Rigid (SR)</td>
</tr>
<tr>
<td>Rigid (R)</td>
<td>Rigid (R)</td>
</tr>
<tr>
<td>Very Rigid (VR)</td>
<td>Very Rigid (VR)</td>
</tr>
</tbody>
</table>

**Depth class (soil).** Refers to the depth of the soil to the root limiting layer.

- Shallow: <50 cm
- Moderately deep: 50-100 cm
- Deep: 100-150 cm
- Very deep: >150 cm

**Dolomite.** (1) A common rock forming mineral, CaMg(CO$_3$)$_2$. Part of the Mg may be replaced by ferrous iron. Dolomite is white to light-colored and has perfect rhombohedral cleavage. Cf: calcite. (2) A sedimentary rock, of which more than 50% by weight consist of the mineral dolomite; specif. a rock containing more than 90% mineral dolomite and less than 10% calcite. Most dolomite is associated and often interbedded with limestone.

**Drainage class (natural).** Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

- *Excessively drained.* Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
- *Somewhat excessively drained.* Water is removed from the soil rapidly. Many
somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

*Well drained.* Water is removed from the soil readily, but not rapidly. It is available to the plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are typically medium textured. They are mostly free of mottling.

*Moderately well drained.* Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic plants are affected. They commonly have a slowly pervious layer within or directly below the slum, or periodically receive high rainfall, or both.

*Somewhat poorly drained.* Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic plants unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

*Poorly drained.* Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface long enough during the growing season that many mesophytic crops cannot be grown unless artificial drainage is provided. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

*Very poorly drained.* Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in “hillpeats” and “climatic moors.”

**Effervescence.** The gaseous response (seen as bubbles) of soil to applied hydrochloric acid, hydrogen peroxide, or other chemicals. Effervescence refers only to the matrix.

**Erosion.** The wearing away of the land surface by running water, wind, ice or other geologic agents and by such processes as gravitational creep.

*Erosion* (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.
**Erosion** (eolian). The wearing away of the land surface by wind.

**Erosion** (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

**Footslope.** The lower bend of a slope or grade.

**Gravel.** Rounded or angular fragments of rock from 2 mm to 7.5 cm in diameter. An individual piece is a pebble.

**Gravelly soil material.** Material from 15 to 50 percent, by volume, rounded or angular fragments of rock, not prominently flattened, up to 3 inches in diameter.

**Hydraulic Conductivity.** The current standard for measuring a soil’s ability to transmit water.

**Horizon.** Surface soil horizons are mainly influenced by the addition of organic matter.

- **O-horizon.** Composed of organic matter and are mainly found in forest soils where the yearly addition of leaves builds up a layer of undecomposed leaves. The O horizon contains very little mineral soil.

- **A-horizon.** A mineral horizon that is dark in color due to the incorporation of decomposed organic matter, which coats the mineral soil particles with colloidal-sized particles.

- **E-horizon.** Develops when materials are eluviated out of a zone in the soil. The effect of this is to remove the organic matter and iron out of this zone, which causes it to be lighter in color than the horizons above or below it.

- **B-horizon.** Horizon below the E or A horizons that is a zone of illuviation or accumulation.

- **C-horizon.** Horizon outside the zone of "pedogenesis" (soil development). C horizons are little altered by the soil forming processes. C horizons are referred to as the parent material of the soil.

- **R-horizon.** Hard bedrock.

**Humus.** The organic matter that is added to a soil will first be undecomposed. Gradually organisms in the soil will begin to decompose this litter until it is no longer recognizable as leaves. Eventually this organic matter is decomposed so much it becomes colloidal in size and coats the mineral particles of the soil.

**Illuviation.** Material carried down from overlying horizons which has been precipitated from solution or deposited from suspension. Characterized by a layer of accumulation.

**Infiltration.** The downward entry of water into the immediate soil surface or other material, as contrasted with percolation, which is movement of water through soil layers or material.
**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied to the surface.

**Krotovina.** Filled faunal burrows.

**Leaching.** The removal of soluble material from soil by percolating water.

**Liquid limit.** The minimum mass water content at which a small sample of soil will barely flow under a standard treatment. Synonymous with “upper plastic limit.”

**Lithic.** Unaltered material (rock) that is continuous, coherent, and indurated. Plant and tree roots cannot enter except in cracks.

**Mineral soil.** Soil that is mainly inorganic material and low in organic material. Its bulk density is greater than that of organic soil.

**Miocene.** A period of time that extends from about 23.03 to 5.332 million years before the present. An epoch of the early Tertiary period, after the Oligocene and before the Pliocene; refers to the corresponding series of rocks.

**Morphology, soil.** The physical makeup of the soil including structure, texture, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

**Mudstone.** An indurated mud, similar to shale, but lacking its fissility and having approximately equal portions of clay and silt.

**Munsell notation.** A designation of color by degrees of the three variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

**Paralithic.** Relatively unaltered material that has an extremely weakly cemented to moderately cemented rupture-resistance class. Cementation or bulk density is such that plant and tree roots cannot enter except in cracks.

**Parent material.** The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

**Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.

**Pedon.** The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons.

**Percolation.** The downward movement of water through a soil.

**Permeability.** The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Permeability is described by the following terms:
Very slow-less than 0.15 cm
Slow-0.06 to 0.51 cm
Moderately slow-0.51 to 1.5 cm
Moderate-1.5 to 5.1 cm
Moderately rapid-5.1 to 15.2 cm
Rapid-15.2 to 50.8 cm
Very rapid-more than 50.8 cm

Petrocalcic. Illuvial horizon in which secondary calcium carbonates or other carbonates have accumulated to the extent that the horizon is cemented or indurated.

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences on the soil that affect its management. A soil series, for example, may be divided in phases based on differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. A numerical designation of acidity and alkalinity in soil. The negative log of hydrogen ion activity on a scale from 0 to 14. Soil less than 7 is considered acidic, soil more than 7 is basic or alkaline, and 7 is considered neutral.

Plastic limit. The minimum water mass content at which a small sample of soil material can be deformed without rupture. Synonymous with “lower plastic limit.”

Plasticity. The degree to which “puddled” or reworked soil can be permanently deformed without rupturing.

<table>
<thead>
<tr>
<th>Class</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-plastic</td>
<td>0</td>
</tr>
<tr>
<td>Slightly plastic</td>
<td>1</td>
</tr>
<tr>
<td>Moderately plastic</td>
<td>2</td>
</tr>
<tr>
<td>Very plastic</td>
<td>3</td>
</tr>
</tbody>
</table>
Pliocene. The period in the geologic timescale that extends from 5.332 million to 1.806 million years before present. The Pliocene is the second epoch of the Neogene period in the Cenozoic era. The Pliocene follows the Miocene epoch and is followed by the Pleistocene epoch; refers to the corresponding series of rocks.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed as pH units. A soil that tests 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

\[
pH
\]

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<tr>
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<tr>
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</tr>
<tr>
<td>Very strongly alkaline</td>
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</tr>
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</table>

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rootstock. A plant onto which another is grafted as a new top.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called groundwater runoff or seepage flow from groundwater.

Sandstone. A sedimentary rock formed by compacted or cemented weathering products (grain size between 2 and 0.062 mm). Grains are composed of quartz (and chert), feldspar, and lithic fragments.
Secondary carbonates. Translocated lime precipitated in place from the soil solution rather than inherited from a soil parent material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Series, soil. A group of soils formed from a particular parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shoulder. The profile position of a hillslope situated between the summit and the backslope.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Siliceous. Containing, resembling, relating to, or consisting of silica. Siliceous parent material is composed of sedimentary rock that contains silica (SiO$_2$). Examples are chert, diatomite, and quartz. Silica is slightly acidic with a pH of 5.5-7.0.

Slickensides. Stress surfaces that are polished and striated and are produced by one soil mass sliding past another.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, and then multiplied by 100.

Slope class. Division of slopes according to slope gradient limits.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stickiness. The capacity of soil to adhere to other objects.

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<td>2</td>
</tr>
<tr>
<td>Very Sticky</td>
<td>3</td>
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</tbody>
</table>
**Structure, soil.** The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are:

- *Platy* (laminated)
- *Prismatic* (vertical axis of aggregates longer than horizontal)
- *Columnar* (prisms with rounded tops)
- *Blocky* (angular or subangular)
- *Granular* (polyhedrals with curved or irregular faces)

**Structureless soils.** Either single grained (each grain by itself), or massive (the particles adhering without any regular cleavage, as in many hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below the plow depth.

**Summit.** Profile position of a hillslope situated at the top of the hill above the shoulder.

**Surface soil.** The soil normally moved in tillage, or equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 cm).

**Tertiary.** The first period of the Cenozoic era (after the Cretaceous of the Mesozoic era and before the Quaternary), thought to have covered the span of time between 65 million and 2 million years ago; also, the corresponding system of rocks. It is divided into five epochs: the Paleocene, Eocene, Oligocene, Miocene, and Pliocene.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

**Toeslope.** Profile position of a hillslope situated at the bottom of the hill.

**Water table.** The upper limit of the soil or underlying rock material that is completely saturated with water.

**Weathering.** All physical and chemical changes produced in rocks or other sediments at or near the earth’s surface by atmospheric agents. These changes result in disintegration and decomposition of the material.
APPENDIX B: Representative Pedon Chemical Attributes
Figure 7. Soil Series and horizon pH values.
Figure 8. Percent organic matter by soil series and horizon.
Figure 9. Potassium (K) and sodium (Na) cation saturation (%) by soil series and horizon.
Figure 10. Calcium (Ca) and magnesium (Mg) cation saturation (%) by soil series and horizon.
Figure 11. Calcium (Ca) to Magnesium (Mg) ratios by soil series and horizon.
Figure 12. Cation Exchange Capacity (CEC) (cmol/kg) by soil series and horizon.
Figure 13. Metal micronutrient concentration (ppm) by soil series and horizon.
Figure 14. Iron (Fe) concentration (ppm) by soil series and horizon.
Figure 15. Nitrate-N levels (ppm) by soil series and horizon.
Figure 16. Sulfate-S levels (ppm) by soil series and horizon.
Figure 17. Phosphorus (P) (ppm) levels by soil series and horizon.
Figure 18. Potassium (K) (ppm) levels by soil series and horizon.
Figure 19. Boron (B) (ppm) levels by soil series and horizon.
APPENDIX C: Roles and Deficiency Symptoms of Plant Essential Nutrients
Nitrogen

In grapevines, nitrogen (N) is a key component of vigor management. Nitrogen makes up roughly 1 to 2% of a plant’s dry weight, or roughly 1-2 kg N per ton of grapes. Adequate nitrogen is needed for inflorescence initiation and flower differentiation. It is a primary component of proteins, with structural and catalytic functions, and similarly is important in energy transfer in chlorophyll (Patterson, 2008). Plants absorb nitrogen in the forms of nitrate, or ammonium. Nitrate ions are absorbed quickly by roots, but leach easily. Ammonium ions are attracted to soil particles and move slowly through the soil to plant roots (Smith, 2009). Vines deficient in nitrogen exhibit reduced vigor, smaller leaf size, and reduced shoot length. Leaves turn yellow from reduced chlorophyll, and leaf petioles become red. Excess nitrogen produces excess vegetative growth with dark green foliage that results in lower quality fruit. Fall cane lignification is also reduced by excess nitrogen (Patterson, 2008). Grapes require an estimated 75 lbs N/ac for stem, leaf, and fruit growth and bud fertility (Christensen, 1990; Coombe, 1992). Following bloom, the nutrient demand in the fruit greatly increases and the emphasis in fertilizer nutrients shifts slightly from nitrogen to potassium (Grant, 2002). Nitrogen should be monitored by petiole testing semi-annually for the first 2 to 3 years following planting to establish a nutrient budget assessing all forms of N input such as organic matter, fertilizers, and N in the water supply.

Phosphorus

All plants require phosphorus during periods of rapid growth. Phosphorus (P) improves the ability of plants to absorb water and other nutrients (CFA, 2009). Roughly 0.1 to 0.3% of plant dry weight, or about 0.3 to 0.6 kg/ton of grapes, is comprised of P. It is a vital component of ATP, which is responsible for energy transfer and storage in photosynthesis, and genetic material, as well as being a component of the fatty acids portion of the cell membrane (Patterson, 2008). Most soils contain 0.02 to 0.10% available P, which is supplied by weathered minerals, fertilizers, and organic matter (Tisdale et al. 1985). Low P levels eventually leads to low levels of photosynthates, and thus reduced shoot growth, sometimes without severe leaf symptoms. A P deficiency can result in yellowing leaves in white varietals; reddening leaves in red/black varietals, basal leaf yellowing or turning pale and red dots may form near edges of mid or terminal lobes of basal leaves which later coalesce forming red bars at right angles to the vein (Coombe, 1992; Patterson, 2008). Severe deficiencies result in poor fruit set and yield. P levels should be monitored by annual petiole testing and should also be monitored in the soil.

Potassium

Potassium (K) plays a vital role in vacuolar transport as the most important cation balancing organic and inorganic anions. K is a key nutrient in relation to fruit quality, as it encourages root growth and fruit production as well as enhancing vines’ disease resistance. It is involved in translocation of carbohydrates and opening and closing of the stomata (Patterson, 2008). Only .1 to 2% of K in the soil is readily available to plants, while 1 to 10% is fixed and will become available only slowly over time (Smith, 2009). Grapevines require approximately 65 tons of soluble potassium each season to produce 5 tons of fruit (CFA, 1995). K makes up 50 to 70% of the cations found in grape must and therefore has a major influence on pH. Too much K in the must results in high pH wine, a highly unfavorable situation. During ripening K migrates into the fruit from leaves and canes; a dense canopy often results in grapes with an increased pH. Potassium deficiency shows first in older basal leaves and progresses to younger leaves. Symptoms of mild deficiency may not become apparent until just before harvest. In white grape varieties, yellowing near the margin extending inwards towards the center of the leaf can end up in marginal burning of the leaves. The same occurs in red varieties except with reddening instead of yellowing (Coombe, 1992). Prolonged, severe deficiency will result in fewer and smaller tight clusters with unevenly colored berries. A
high water table during spring may induce a K deficiency (Patterson, 2008). Care must be taken when diagnosing K deficiency as moisture stress and leaf-roll virus both mimic K deficiency symptoms. Annual monitoring of leaf petioles is advised.

**Magnesium**

Magnesium (Mg) is a component of chlorophyll and an enzyme activator. Deficiency is uncommon in California vineyards, but can occur in sandy soils, and soils with high calcium carbonate or sodium. Levels of magnesium should be considered in relation to calcium, a Ca:Mg ratio of approximately 5:1 is optimal. Young vines are more susceptible to magnesium deficiency, usually due to low Mg content in the topsoil. As vines age and their roots dig deeper, the problem usually disappears. Advanced magnesium deficiency symptoms can be quite aesthetic, displaying broad interveinal chlorosis, with scorching/necrosis along leaf margins. This symptom can be easily confused with symptoms of Pierce’s Disease, as well as zinc and iron deficiencies. Magnesium uptake is antagonized by K and Ca. Coastal soils with serpentine parent material commonly have problems with excess Mg (Patterson, 2008).

**Calcium**

Calcium (Ca) deficiencies are rare in California. High sodium soils are improved by addition of calcium (as gypsum). A direct vine response has been demonstrated only in soils with very high Mg concentrations. Calcium is essential for stability of cell walls. Deficiency results in restricted root and shoot growth while excess can reduce K and Mg uptake. High K can limit Ca uptake. A correlation has been found between sufficient Ca content in plants and an increased resistance to fungal pathogens (Patterson, 2008). Deficiency symptoms include leaf discoloration, fruit disorders, and the premature abscission of buds and blossoms.

**Sulfur**

Sulfur (S) is required in about the same amount as phosphorus. Sulfur is available to plants in two forms: sulfate ions, and sulfur dioxide gas (Smith, 2009). Plants rarely suffer from sulfur deficiencies due to the high amount present in the air and precipitation. Vineyard deficiencies are rarer still, due to the use of gypsum (calcium sulfate) as a soil amendment; and the use of sulfur dust to control powdery mildew. Deficiency symptoms include retarded plant growth, delayed maturity, and the discoloration of younger leaves (Ruehr, 1995). Most central coast vineyards use sulfur dust for Integrated Pest Management (IPM) so a sulfur deficiency is highly unlikely.

**Iron**

Iron (Fe) deficiencies are rare in California vineyards with the exception of soils that have high manganese levels, greater than 5% calcium carbonate, or poor aeration (Winkler et al., 1974). Primary minerals and rocks such as olivine and pyrite supply iron to the soil (Tisdale et al., 1985). Iron is a micronutrient involved in chlorophyll formation and energy trapping and transfer in photosynthesis. Deficiency symptoms are pale yellow color of young shoot growth, a.k.a. lime induced chlorosis (American *vitis* spp. are more susceptible to this than Vinifera, except V. Berlandieri). Iron uptake is inhibited by bicarbonate ions, especially under anaerobic conditions. Deficiency can be remedied with addition of iron chelate (Patterson, 2008).
Manganese

Manganese (Mn) deficiencies appear to a "mild degree" in Californian vineyards (Winkler et al., 1974). Manganese is involved in chlorophyll synthesis and nitrogen metabolism while also serving as an enzyme activator. Deficiency symptoms first occur in older leaves, which exhibit yellowing in between the main veins. Manganese deficiency mimics zinc deficiency; and Mn toxicity can occur in acid soils (Patterson, 2008).

Zinc

Zinc (Zn) deficiency is the most commonly deficient micronutrient. Sandy soils have the lowest Zn content. Zinc levels are highest in topsoil; and become less available in soils with a pH above 6.0. Soils high in Mg are often low in available Zn. Low levels are commonly found in soils containing high P concentrations, low organic matter, poor aeration, or high pH (Tisdale et al., 1985). Grapevines grafted on nematode resistant rootstock are also susceptible to Zn deficiencies (Winkler et al., 1974). Zinc is needed for auxin production, elongation of internodes, and in the formation of chloroplasts and starch. Zinc is essential for normal leaf development, shoot elongation, pollen development, and the setting of fully developed berries. Deficiency symptoms vary with grape variety and with degree of deficiency. Mottled foliar symptoms usually appear in early summer on lateral shoots. These leaves are typically smaller in size on both primary shoot and lateral shoots. Veins of these leaves are usually darker than the rest of the leaf. Certain varieties will have stunted leaves with an open petiolar sinus. Zinc deficiency can seriously affect the set and development of berries, leading to reduced yields and decreased quality (Patterson, 2008).

Copper

Copper (Cu) is an enzyme activator and is essential to vitamin A and protein production in plants (CFA, 1995). It is found in organic matter, and in rocks and minerals such as chalocopyrite, oxides, and carbonates (Tisdale et al., 1985). Copper deficiency has been seen in Gingin, Western Australia (Coombe, 1992). Vines were found to be unthrifty, had short canes with shortened internodes, leaves were small, had only slight indentations and were pale in color (Coombe, 1992). The excessive use of Cu fungicides can be toxic to plants. Toxicity symptoms include reduced shoot vigor, chlorosis, and poorly developed roots (Tisdale et al., 1985).

Boron

There is a very narrow range (1 to 3 ppm) between Boron deficiency and toxicity. Boron is involved in regulation of growth by hormones, and plays a role in pollen germination by being required for the elongation of pollen tubes. Deficiency more commonly occurs in acid soils or irrigated sandy soils and, in severe cases, can result in reduced fruit set, parthenocarpy (seedless berries), shoot tip death, striped tendrils, and even cracked or split canes. Boron deficiency can be confused with other disorders. Accurate diagnosis depends on severity and time of year. In early spring, symptoms of stunted, distorted shoot growth following budbreak and short internodes growing in a zig-zag pattern can be temporary, i.e. they can be fixed. If symptoms don’t appear until early to mid-summer berry set and development can be affected. In this scenario, shoot growth oftentimes will appear normal (Patterson, 2008). Grapes are sensitive to a concentration of 0.5 to 0.75 ppm of B in overhead irrigation water (Tisdale et al., 1985). Boron levels should be monitored by annual leaf blade analysis.
Sodium

Most plants do not require sodium (Na) for growth and avoid absorbing it (Ruehr, 1995). It is supplied to the soil through irrigation water, silicate minerals, and sodic plagioclases, such as albite (Tisdale et al., 1985). Its presence in soils concerns vineyard managers due its harmful effects (Winkler et al., 1974). High Na concentrations in the soil solution disperse organic and clay particles, which destroys soil structure and permeability. It can also cause leaf burn and stunt vine growth (also common symptoms of a K deficiency). Five to ten meq/L Na in irrigation water can cause injury to grapes (CFA, 1995). In many cases, gypsum (CaSO4 \cdot 2H2O) additions and leaching with good quality irrigation water are used to correct Na problems in agricultural soils (Tisdale et al., 1995).
APPENDIX D: A & L Laboratory Data
A & L WESTERN AGRICULTURAL LABORATORIES

REPORT NUMBER: 11-104-038

CLIENT NO: 99999

SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

SUBMITTED BY: THOMAS

GROWER: SAUCELITO CANYON VYD

REPORT DATE: 04/19/11

LAB NO: 57334

SAMPLE ID: Botella-A1 Horizon

PAGE: 1

**Graphical Soil Analysis Report**

**DATE OF REPORT:** 04/19/11

**ANALYTE**

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<tr>
<th>Nitrates-N</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Calcium</th>
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**Results**

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**Percent Cation Saturation (computed)**

**Potassium**

**Magnesium**

**Calcium**

**Sodium**

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**Soil Fertility Guidelines**

**CROP:** VINEYARD

**RATE:** lb/acre

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<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
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<th>Elemental Sulfur</th>
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</table>

**NOTES:**

- **METHOD OF SAMPLING:** Results reflect status of only the soil submitted. If a portion of the topsoil is excluded or if insufficient depths/sites are sampled, results may be misleading.
- **COMMENTS:** YOU MAY want to download our submittal forms from www.al-labs-west.com (under Analytical Services) and submit with future samples. This will help avoid processing errors in the lab. Thanks.
- **NITROGEN:** Use local conditions and experience with variety to determine rates and timing. Allow for nitrate levels in your water source also (ppm NO<sub>3</sub> X 0.61 = lb N/ac-ft water). Monitor plant-N.
- **FERTILIZATION:** Light frequent applications of fertilizer through the irrigation water will provide the most efficient uptake of nutrients. Limit applications to active growth periods.

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Graphical Soil Analysis Report

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Soil Fertility Guidelines

Dolomite
Lime
Gypsum
Elemental
Sulfur
Nitrogen
Phosphate
P2O5
Potash
K2O
Magnesium
Mg
Sulfur
SO42-
Zinc
Mn
Manganese
Iron
Fe
Copper
Cu
Boron
B

1200
40
180
10
10
10
10
2.0

C SULFATE-SULFUR: Low soil levels may cause yellowing and lack of vigor. Maintain above 15 to 20 ppm to guard against deficiencies. Although, sulfates may have leached below sampling depth.

Z ZINC: Maintain soil levels above 1.0 ppm to ensure an adequate zinc supply. A tissue analysis at the appropriate time will determine more accurately, availability to the plant.

M MANGANESE: Soil levels below 2 ppm may respond to applications of manganese. But, first check on tissue levels to confirm any likely deficiencies. Follow label instructions if required.

T IRON: Soil with levels below 5 ppm may respond to applications of iron. Follow label instructions if yellowing symptoms occur, and also lower the soil pH if practical.

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1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 11-104-038

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672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405

GROWER: SAUCELITO CANYON VYD

SUBMITTED BY: THOMAS

DATE OF REPORT: 04/19/11

LAB NO: 57336
SAMPLE ID: Botella-Ab Horizon

Graphical Soil Analysis Report

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<tr>
<td>Copper ppm</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron ppm</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride ppm</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percent Cation Saturation (computed)

- Potassium K%: 1.6
- Magnesium Mg%: 1.1
- Calcium Ca%: 87.0
- Sodium Na%: 0.2

Graph showing cation saturation levels.

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Soil Fertility Guidelines

CROP: VINEYARD

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dolomite (70)</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>Lime (70)</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Gypsum</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nitrogen N</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Phosphate P2O5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Potash K2O</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Magnesium Mg</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Sulfur SO4-S</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Zinc Zn</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Manganese Mn</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Iron Fe</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Copper Cu</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Boron B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COPPER: Soil levels below 0.3 ppm may respond to applications of copper. Follow label instructions or confirm level of availability by tissue analysis.

BORON: Aim for soil levels above 0.5 ppm to avoid a deficiency. A tissue analysis at the appropriate time will determine more accurately, plant availability. ADD BORON WITH CAUTION.

ACIDIFICATION of high pH soils could improve soil environment. Compare different sources of acidifying materials, but be aware that sulfate-sulfur (as shown on report) has NO acidifying power.

PLEASE note that the previous comments where applicable, apply to the entire report. Thank you.

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REPORT NUMBER: 11-104-038
CLIENT NO: 99999

SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

GROWER: SAUCELITO CANYON VYD

SUBMITTED BY: THOMAS

DATE OF REPORT: 04/19/11
LAB NO: 57337
SAMPLE ID: Botella-Bt2 Horizon

Graphical Soil Analysis Report

Cation Saturation (computed)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Organic Matter</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Calcium</th>
<th>Sodium</th>
<th>Sulfur</th>
<th>Zinc</th>
<th>Manganese</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>NO₃-N ppm</td>
<td>Weak Bray</td>
<td>Mg ppm</td>
<td>ppm</td>
<td>SO₄-S</td>
<td>ppm</td>
<td>ppm</td>
</tr>
<tr>
<td>Very High</td>
<td>2912</td>
<td>10</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>238</td>
<td>10</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
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<tr>
<td>Medium</td>
<td>97</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>31</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>54</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results: 1.0

ECe
0.2

INCREASING SALINITY

ECe

CEC

16.8

INCREASING NEED FOR LIME

Ex. Lime

8.0

pH

Buffer pH:

Potassium

Magnesium

Calcium

Sodium

1.5

11.7

86.6

0.3

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Soil Fertility Guidelines

CROP: VINEYARD

RATE: lb/acre

NOTES:

COMMENTS:

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Graphical Soil Analysis Report

DATE OF REPORT: 04/19/11
LAB NO: 57338
SAMPLE ID: Calhi-C Horizon
PAGE: 1

Percent
Cation Saturation (computed)

Potassium
Mg
Calcium
Na
K

Results

Low
AVERAGE
High
0.2
1
20
10
48
75
1329
12
3
0.1
1
1
0.1
0.1

0.2
7.4
8.4

ECe

7.4

CEC

8.4

INCREASING SALINITY

INCREASING NEED FOR LIME

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Acidification of high pH soils could improve soil environment. Compare different sources of acidifying materials, but be aware that sulfate-sulfur (as shown on report) has NO acidifying power.

NITROGEN: Use local conditions and experience with variety to determine rates and timing. Allow for nitrate levels in your water source also (ppm NO3 x 0.61 = lb N/ac-ft water). Monitor plant-N.

FERTILIZATION: Light frequent applications of fertilizer through the irrigation water will provide the most efficient uptake of nutrients. Limit applications to active growth periods.

MICRONUTRIENTS: Where levels are low, apply according to label instructions, or refer to a tissue analysis to determine necessity. Maintain organic matter and pH at a satisfactory level.

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REPORT NUMBER: 11-104-039
CLIENT NO: 99999

SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

GROWER: SAUCELITO CANYON VYD

SUBMITTED BY: THOMAS

Soil Fertility Guidelines

CROP: VINEYARD
RATE: lb/acre
NOTES:

<table>
<thead>
<tr>
<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P2O5</th>
<th>Potash K2O</th>
<th>Magnesium Mg</th>
<th>Sulfur SO4-S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
<th>Iron Fe</th>
<th>Copper Cu</th>
<th>Boron B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>40</td>
<td>240</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 11-104-040
SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405

GROWER: SAUCELITO CANYON VYD

Graphical Soil Analysis Report

DATE OF REPORT: 04/19/11
LAB NO: 57339
SAMPLE ID: Chualar-A1 Horizon

Cation Saturation (computed)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Organic Matter</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Magnesium</th>
<th>Calcium</th>
<th>Sodium</th>
<th>Sulfur</th>
<th>Zinc</th>
<th>Manganese</th>
<th>Iron</th>
<th>Copper</th>
<th>Boron</th>
<th>Chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>1.7</td>
<td>1</td>
<td>33</td>
<td>20</td>
<td>151</td>
<td>201</td>
<td>2857</td>
<td>10</td>
<td>0.2</td>
<td>1</td>
<td>4</td>
<td>0.1</td>
<td>0.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

RESULTS

ECe

Increasing Salinity

Increasing Need for Lime

pH

Buffer pH:

Soil Fertility Guidelines

CROP: VINEYARD
RATE: lb/acre
NOTES:

<table>
<thead>
<tr>
<th>Dolomite</th>
<th>Lime</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen</th>
<th>Phosphate</th>
<th>Potash K2O</th>
<th>Magnesium</th>
<th>Sulfur</th>
<th>Zinc</th>
<th>Manganese</th>
<th>Iron</th>
<th>Copper</th>
<th>Boron</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>150</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DEPTH OF SAMPLING: "Topssoil" fertility may be significantly altered by taking a sample from more than one foot depth (backhoeing, slip-plowing, augering, etc.). Interpret guidelines accordingly.

ORGANIC MATTER: Low levels may restrict beneficial microbial activity and lead to soil compaction and erosion. Consider raising levels if practical.

ACIDIFICATION of high pH soils could improve soil environment. Compare different sources of acidifying materials, but be aware that sulfate-sulfur (as shown on report) has NO acidifying power.

NITROGEN: Use local conditions and experience with variety to determine rates and timing. Allow for nitrate levels in your water source also (ppm NO3 X 0.61 = lb N/ac-ft water). Monitor plant-N.

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REPORT NUMBER: 11-104-040
CLIENT NO: 99999

SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

GROWER: SAUCELITO CANYON VYD

SUBMITTED BY: THOMAS

DATE OF REPORT: 04/19/11
LAB NO: 57340
SAMPLE ID: Chualar-A2 Horizon

Graphical Soil Analysis Report

Cation Saturation (computed)

<table>
<thead>
<tr>
<th>Percent</th>
<th>Cation Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Potassium K%</td>
</tr>
<tr>
<td>0.1</td>
<td>Magnesium Mg%</td>
</tr>
<tr>
<td>0.1</td>
<td>Calcium Ca%</td>
</tr>
<tr>
<td>0.1</td>
<td>Sodium Na%</td>
</tr>
</tbody>
</table>

| 1.9     | Potassium K%      |
| 11.2    | Magnesium Mg%     |
| 86.6    | Calcium Ca%       |
| 0.4     | Sodium Na%        |

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Soil Fertility Guidelines

CROP: VINEYARD
RATE: lb/acre

<table>
<thead>
<tr>
<th>Dolomite (ton)</th>
<th>Lime (ton)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P2O5</th>
<th>Potash K2O</th>
<th>Magnesium Mg</th>
<th>Sulfate SO42-S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
<th>Iron Fe</th>
<th>Copper Cu</th>
<th>Boron B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>40</td>
<td>180</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FERTIGATION: Light frequent applications of fertilizer through the irrigation water will provide the most efficient uptake of nutrients. Limit applications to active growth periods.

SULFATE-SULFUR: Low soil levels may cause yellowing and lack of vigor. Maintain above 15 to 20 ppm to guard against deficiencies. Although, sulfates may have leached below sampling depth.

ZINC: Maintain soil levels above 1.0 ppm to ensure an adequate zinc supply. A tissue analysis at the appropriate time will determine more accurately, availability to the plant.

MANGANESE: Soil levels below 2 ppm may respond to applications of manganese. But, first check on tissue levels to confirm any likely deficiencies. Follow label instructions if required.

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REPORT NUMBER: 11-104-040
CLIENT NO: 99999
SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-
GROWER: SAUCELITO CANYON VYD
SUBMITTED BY: THOMAS

Graphical Soil Analysis Report

| Date of Report: 04/19/11 | Lab No: 57341 | Sample ID: Chualar-Bt1 Horizon |

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Organic Matter %</th>
<th>Nitrogen NO₃-N ppm</th>
<th>Phosphorus Weak Bray ppm</th>
<th>Phosphorus NaHCO₃-P ppm</th>
<th>Potassium K ppm</th>
<th>Magnesium Mg ppm</th>
<th>Calcium Ca ppm</th>
<th>Sodium Na ppm</th>
<th>Sulfur SO₄-S ppm</th>
<th>Zinc Zn ppm</th>
<th>Manganese Mn ppm</th>
<th>Iron Fe ppm</th>
<th>Copper Cu ppm</th>
<th>Boron B ppm</th>
<th>Chloride Cl ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>1.2</td>
<td>1</td>
<td>22</td>
<td>35</td>
<td>101</td>
<td>200</td>
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<td>1</td>
<td>3</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cation Saturation (computed):

<table>
<thead>
<tr>
<th>Potassium K %</th>
<th>Magnesium Mg %</th>
<th>Calcium Ca %</th>
<th>Sodium Na %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7</td>
<td>10.7</td>
<td>87.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

ACIDIC BASIC

Increasing Salinity

ECₑ (dS/m)

Buffer pH:

Increasing Need for Lime

pH

0.2

LOW AVERAGE HIGH

15.3

LI Ex. Lime

7.8

Soil Fertility Guidelines

Crop: VINEYARD

<table>
<thead>
<tr>
<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P₂O₅</th>
<th>Potash K₂O</th>
<th>Magnesium Mg</th>
<th>Sulfur SO₄-S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
<th>Iron Fe</th>
<th>Copper Cu</th>
<th>Boron B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>40</td>
<td>180</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Iron: Soil with levels below 5 ppm may respond to applications of iron. Follow label instructions if yellowing symptoms occur, and also lower the soil pH if practical.

Copper: Soil levels below 0.3 ppm may respond to applications of copper. Follow label instructions or confirm level of availability by tissue analysis.

Boron: Aim for soil levels above 0.5 ppm to avoid a deficiency. A tissue analysis at the appropriate time will determine more accurately, plant availability. ADD BORON WITH CAUTION.

PLEASE note that the previous comments where applicable, apply to the entire report. Thank you.

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**Graphical Soil Analysis Report**

**DATE OF REPORT:** 04/19/11  
**LAB NO:** 57342  
**SAMPLE ID:** Chualar-Bt2 Horizon  
**PAGE:** 4

### Cation Saturation (computed)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Potassium</th>
<th>Magnesium</th>
<th>Calcium</th>
<th>Sodium</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
</tr>
<tr>
<td>2.0</td>
<td>11.2</td>
<td>85.4</td>
<td>1.4</td>
<td></td>
</tr>
</tbody>
</table>

### Results

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Organic Matter %</th>
<th>Nitrogen NO₃-N ppm</th>
<th>Phosphorus ppm</th>
<th>Potassium ppm</th>
<th>Magnesium ppm</th>
<th>Calcium ppm</th>
<th>Sodium ppm</th>
<th>Sulfur ppm</th>
<th>Zinc ppm</th>
<th>Manganese ppm</th>
<th>Iron ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
<th>Chloride Cl ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>0.7</td>
<td>1</td>
<td>55</td>
<td>34</td>
<td>125</td>
<td>216</td>
<td>2712</td>
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<td>0.1</td>
<td>1</td>
<td>3</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

**Weak Bray P unreliable at M or H excess lime or pH > 7.5**

### Soil Fertility Guidelines

<table>
<thead>
<tr>
<th>CROP</th>
<th>VINEYARD</th>
<th>RATE</th>
<th>lb/acre</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Comments

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**Mike Buttress, CPag**
**A & L WESTERN LABORATORIES, INC**
Graphical Soil Analysis Report

DATE OF REPORT: 04/19/11  LAB NO: 57329  SAMPLE ID: Liveoak-A1 Horizon  PAGE: 1

Analyte  Organic Matter %  Nitrogen NO\textsubscript{3}-N ppm  Phosphorus ppm  Potassium ppm  Magnesium ppm  Calcium ppm  Sodium ppm  Sulfur ppm  Zinc ppm  Manganese ppm  Iron ppm  Copper ppm  Boron ppm  Chloride ppm
Results  2.3  1  42  13  104  241  2807  10  5  0.2  1  3  0.1  0.1

\[
\begin{align*}
\text{ECe} &< 0.2 \\
\text{ECe} &< 1.0 \\
\text{ECe} &< 1.5 \\
\text{ECe} &< 2.0
\end{align*}
\]

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Soil Fertility Guidelines

CROP: VINEYARD  RATE: lb/acre  NOTES:

<table>
<thead>
<tr>
<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P\textsubscript{2}O\textsubscript{5}</th>
<th>Potash K\textsubscript{2}O</th>
<th>Magnesium Mg</th>
<th>Sulfur SO\textsubscript{4}-S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
<th>Iron Fe</th>
<th>Copper Cu</th>
<th>Boron B</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>30</td>
<td></td>
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<td>180</td>
<td>10</td>
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<td>10</td>
<td>10</td>
<td>10</td>
<td>2.0</td>
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</tr>
</tbody>
</table>

DEPTH OF SAMPLING: Soil fertility could differ greatly with depth. Concentrate on amending and fertilizing the topsoil zone only, but take note of trends down the profile that may need attention.

ACIDIFICATION of high pH soils could improve soil environment. Compare different sources of acidifying materials, but be aware that sulfate-sulfur (as shown on report) has NO acidifying power.

NITROGEN: Use local conditions and experience with variety to determine rates and timing. Allow for nitrate levels in your water source also (ppm NO\textsubscript{3} X 0.61 = lb N/ac-ft water). Monitor plant-N.

FERTILIZATION: Light frequent applications of fertilizer through the irrigation water will provide the most efficient uptake of nutrients. Limit applications to active growth periods.

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Graphical Soil Analysis Report

DATE OF REPORT: 04/19/11  
LAB NO: 57330  
SAMPLE ID: Liveoak-A2 Horizon  
PAGE: 2

Percent Cation Saturation (computed)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Organic Matter %</th>
<th>Nitrogen NO₃-N ppm</th>
<th>Phosphorus PO₄-P ppm</th>
<th>Potassium ppm</th>
<th>Magnesium ppm</th>
<th>Calcium ppm</th>
<th>Sodium ppm</th>
<th>Sulfur ppm</th>
<th>Zinc ppm</th>
<th>Manganese ppm</th>
<th>Iron ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
<th>Chloride ppm</th>
</tr>
</thead>
<tbody>
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<td>Results</td>
<td>1.2</td>
<td>1</td>
<td>35</td>
<td>12</td>
<td>93</td>
<td>276</td>
<td>3455</td>
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<td>5</td>
<td>0.1</td>
<td>1</td>
<td>2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Low  
Average  
High

0.2  
Increasing Salinity

19.8  
CEC meq/100g

H  
Ex. Lime

8.0  
pH

Buffer pH:
INCREASING NEED FOR LIME

Weak Bray P unreliable at M or H excess lime or pH > 7.5

Soil Fertility Guidelines

CROP: VINEYARD  
RATE: lb/acre

<table>
<thead>
<tr>
<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen</th>
<th>Phosphate</th>
<th>Potash K₂O</th>
<th>Magnesium</th>
<th>Sulfur</th>
<th>Zinc</th>
<th>Manganese</th>
<th>Iron</th>
<th>Copper</th>
<th>Boron</th>
</tr>
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</tr>
<tr>
<td>1200</td>
<td>40</td>
<td>180</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
</tr>
</tbody>
</table>

CO: Micronutrients: Where levels are low, apply according to label instructions, or refer to a tissue analysis to determine necessity. Maintain organic matter and pH at a satisfactory level.

M: Manganese: Soil levels below 2 ppm may respond to applications of manganese. But, first check on tissue levels to confirm any likely deficiencies. Follow label instructions if required.

Copper: Soil levels below 0.3 ppm may respond to applications of copper. Follow label instructions or confirm level of availability by tissue analysis.

Boron: Aim for soil levels above 0.5 ppm to avoid a deficiency. A tissue analysis at the appropriate time will determine more accurately, plant availability. ADD BORON WITH CAUTION.

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1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 11-104-037

CLIENT NO: 99999

SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

GROWER: SAUCELITO CANYON VYD

SUBMITTED BY: THOMAS

DATE OF REPORT: 04/19/11
LAB NO: 57331
SAMPLE ID: Still-A1 Horizon

Graphical Soil Analysis Report

Graphical representation of soil analysis results indicating

- Organic Matter
- Nitrogen
- Phosphorus
- Potassium
- Calcium
- Sodium
- Sulfur
- Zinc
- Manganese
- Iron
- Copper
- Boron
- Chloride

Results shown in ppm as follows:

- Organic Matter: 4.9
- Nitrogen: 1 ppm
- Phosphorus: 41 ppm
- Potassium: 164 ppm
- Calcium: 382 ppm
- Sodium: 4454 ppm
- Sulfur: 10 ppm
- Zinc: 5 ppm
- Manganese: 0.6 ppm
- Iron: 2 ppm
- Copper: 11 ppm
- Boron: 0.1 ppm
- Chloride: 0.2 ppm

Cation Saturation (computed):

- Potassium: 1.6
- Magnesium: 11.8
- Calcium: 83.5
- Sodium: 0.2

Percent

Soil Fertility Guidelines

CROP: VINEYARD
RATE: lb/acre
NOTES:

<table>
<thead>
<tr>
<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P₂O₅</th>
<th>Potash K₂O</th>
<th>Magnesium Mg</th>
<th>Sulfur S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
<th>Iron Fe</th>
<th>Copper Cu</th>
<th>Boron B</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>180</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>2.0</td>
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</tbody>
</table>

DEPTH OF SAMPLING: "Topsoil" fertility may be significantly altered by taking a sample from more than one foot depth (backhoeing, slip-plowing, augering, etc.). Interpret guidelines accordingly.

ORGANIC MATTER: Low levels may restrict beneficial microbial activity and lead to soil compaction and erosion. Consider raising levels if practical.

HIGH levels of organic matter should have a beneficial effect on growth and "soil" pH may not be as critical. However, watch carefully as amendments and extra nitrogen may still be necessary.

NITROGEN: Use local conditions and experience with variety to determine rates and timing. Allow for nitrate levels in your water source also (ppm NO₃ X 0.61 = lb N/ac-ft water). Monitor plant-N.

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**REPORT NUMBER:** 11-104-037

**SEND TO:** THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

**GROWER:** SAUCELITO CANYON VYD

**CLIENT NO:** 99999

**SUBMITTED BY:** THOMAS

---

**Graphical Soil Analysis Report**

**DATE OF REPORT:** 04/19/11  
**LAB NO:** 57332  
**SAMPLE ID:** Still-A2 Horizon  
**PAGE:** 2

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Organic Matter %</th>
<th>Nitrogen N ppm</th>
<th>Phosphorus Weak Bray ppm</th>
<th>Phosphorus NaHCO3-P ppm</th>
<th>Potassium K ppm</th>
<th>Magnesium Mg ppm</th>
<th>Calcium Ca ppm</th>
<th>Sodium Na ppm</th>
<th>Sulfur SO2-S ppm</th>
<th>Zinc Zn ppm</th>
<th>Manganese Mn ppm</th>
<th>Iron Fe ppm</th>
<th>Copper Cu ppm</th>
<th>Boron B ppm</th>
<th>Chloride Cl ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
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<td>305</td>
<td>344</td>
<td>3758</td>
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<td>0.1</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cation Saturation (computed)**

- **Potassium K %:** 3.5
- **Magnesium Mg %:** 12.6
- **Calcium Ca %:** 83.7
- **Sodium Na %:** 0.2

**ECe**  
**dS/m**  
**INCREASING SALINITY**

**CEC**  
**meq/100g**  
**INCREASING NEED FOR LIME**

- **Ex. Lime:** 7.3
- **pH:**

**Soil Fertility Guidelines**

**CROP:** VINEYARD

<table>
<thead>
<tr>
<th>Dolomite (70 score)</th>
<th>Lime (70 score)</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P2O5</th>
<th>Potash K2O</th>
<th>Magnesium Mg</th>
<th>Sulfur SO2-S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
<th>Iron Fe</th>
<th>Copper Cu</th>
<th>Boron B</th>
<th>Rate: lb/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
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<td></td>
<td></td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Notes:**

- **C** FERTIGATION: Light frequent applications of fertilizer through the irrigation water will provide the most efficient uptake of nutrients. Limit applications to active growth periods.
- **OM** SULFATE-SULFUR: Low soil levels may cause yellowing and lack of vigor. Maintain above 15 to 20 ppm to guard against deficiencies. Although, sulfates may have leached below sampling depth.
- **EM** ZINC: Maintain soil levels above 1.0 ppm to ensure an adequate zinc supply. A tissue analysis at the appropriate time will determine more accurately, availability to the plant.
- **M** MANGANESE: Soil levels below 2 ppm may respond to applications of manganese. But, first check on tissue levels to confirm any likely deficiencies. Follow label instructions if required.

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Mike Buttress, CPAg  
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1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 11-104-037
CLIENT NO: 99999

SEND TO: THOMAS RICHARDSON
672 SERRANO DR #10
SAN LUIS OBISPO, CA 93405-

GROWER: SAUCELITO CANYON VYD

SUBMITTED BY: THOMAS

DATE OF REPORT: 04/19/11
LAB NO: 57333
SAMPLE ID: Still-A3 Horizon

Graphical Soil Analysis Report

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Very High</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Very Low</th>
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<tbody>
<tr>
<td>Organic Matter %</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen N ppm</td>
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<td>Phosphorus ppm</td>
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<tr>
<td>Magnesium K ppm</td>
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<tr>
<td>Potassium Mg ppm</td>
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<td>Calcium Ca ppm</td>
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<td>Sodium Na ppm</td>
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<td>Sulfur ppm</td>
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<td>Zinc ppm</td>
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<td>Boron ppm</td>
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<td>Chloride ppm</td>
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Results

<table>
<thead>
<tr>
<th>Nitrogen N ppm</th>
<th>Phosphorus ppm</th>
<th>Magnesium K ppm</th>
<th>Potassium Mg ppm</th>
<th>Calcium Ca ppm</th>
<th>Sodium Na ppm</th>
<th>Sulfur ppm</th>
<th>Zinc ppm</th>
<th>Manganese ppm</th>
<th>Iron ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
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<td>12</td>
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<td>44</td>
<td>127</td>
<td>294</td>
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<td>0.1</td>
<td>1</td>
<td>3</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

ACIDIC          BASIC
PH: 7.5          INCREASING NEED FOR LIME

Buffer pH:

ECₑ (dS/m)
INCREASING SALINITY

CEC (mg/100g)
LOW AVERAGE HIGH

CROP: VINEYARD

<table>
<thead>
<tr>
<th>Dolomite</th>
<th>Lime</th>
<th>Gypsum</th>
<th>Elemental Sulfur</th>
<th>Nitrogen N</th>
<th>Phosphate P₂O₅</th>
<th>Potash K₂O</th>
<th>Magnesium Mg</th>
<th>Sulfur S</th>
<th>Zinc Zn</th>
<th>Manganese Mn</th>
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<th>Boron B</th>
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<tr>
<td>700</td>
<td>40</td>
<td>180</td>
<td>10</td>
<td>10</td>
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<td>2.0</td>
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NOTES:

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