Shaping the Future

Upper Llagas Creek Flood Protection Project

Site Characterization Report

June 2012

Prepared For

Santa Clara Valley Water District

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Executive Summary

This Site Characterization Report provides a summary of the findings that resulted from implementing the Soil Description and Sampling Plan (Sampling Plan or Plan) (Cardno ENTRIX 2011). The Sampling Plan and the corresponding soil investigations support the development and evaluation of vegetation mitigation opportunities for the Upper Llagas Creek Flood Protection Project. This technical report evaluates soil samples from thirty six (36) different locations in the project area. The soil description and sampling locations were identified in the Plan to provide a representation of the diversity of soil types and conditions from potentially suitable mitigation sites, capable of supporting self-sustaining riparian restoration. This report analyzes and interprets the soil data and recommends areas eligible for either in-kind or out-of-kind riparian mitigation. A list of potential mitigation sites and their associated acreages has been assembled for each proposed vegetation community type. This report also provides information and guidance to the civil design team regarding preferable cut and fill locations, suitable soil borrow sites and areas with poor soil conditions that may require over-excavation or soil amendments in order to be considered suitable for revegetation.

One of the key elements of this report is to specify why certain soil qualities and tests were performed and how the chosen methods and materials were specifically tailored and applied to gather meaningful information that will support the decision making process regarding the project's mitigation requirements. The physical, chemical, and hydrologic attributes that support the findings, opportunities, and limitations for successful mitigation are discussed.

The main findings regarding the native soil characteristics are:

- For significant sections of the project area, two (2) types of substratum were encountered, paralithic fanglomerates and massive densic materials. Both types of substratum can impose substantial limitations to establishing root systems of plants.
- The majority of the soil samples were nitrogen, phosphorus, and potassium deficient.
- The majority of the soil samples have low organic matter content and low soil water holding capacity.
- Massive soils and high volumes of coarse fragments limit the capacity for root penetration, extraction of nutrients, and transmission of water.
- Micro-nutrient and trace element deficiencies and/or excesses were widespread; particularly magnesium (very high), boron and sulfur (both very low)..
- Limited availability of accessible and reliable sources of water represent a substantial limitation to establishing vegetation, regardless of the lack soil structure and existing nutrient limitations.
- Reach 6, which has perennial flow up to the Church Avenue percolation facility from releases at Chesbro Reservoir, provides the best mitigation opportunity.

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Chapter 1

Introduction

1.1 Background

This Site Characterization Report summarizes the surface and sub surface soil sampling of the Llagas Creek Flood Protection Project area. Previous environmental investigations for the Upper Llagas Creek Flood Protection Project site by Questa Engineering (Santa Clara Valley Water District, unknown date) have indicated the presence of coarse grained textured surface soils, dense subsurface bodies called fanglomerate and man-made fill. These soils related features have been confirmed to influence considerable sections of Reaches 4, 5, 6 and 7b. In addition, the Llagas Creek watershed has undergone significant urban development along the project reach that flows through the cities of Morgan Hill and Gilroy. Llagas Creek has also experienced suburban development in San Martin along with the noteworthy presence of commercial agriculture being intermittently practiced throughout the entire project area.

This Site Characterization Report provides the results developed from implementing the Sampling Plan which was prepared in December 2011 after consultation with the SCVWD (Cardno ENTRIX 2011). The Sampling Plan details the soil sample locations and the rationale for selecting the sampling sites, sampling methods, descriptive soil characteristics to be collected on-site, and the laboratory analyses to be performed. The Sampling Plan identified a minimum of 25 soil sample sites; a total of 36 samples were collected and analyzed. This report describes the soils, provides analyses of the samples, and identifies and assesses the appropriate soil parameters that will support successful establishment of riparian vegetation along Llagas Creek. This information will be used to determine and demarcate appropriate areas for mitigation.

1.2 Project History

In 1999, the United States Congress authorized the United States Army Corps of Engineers (USACE) to assume the Llagas Creek Flood Protection Project from the Natural Resources Conservation Services (NRCS). The NRCS initiated project construction in 1973 and has completed about half of the originally authorized project (Lower Llagas Creek). Due to funding restrictions imposed on the NRCS, Congress transferred project authorization to the USACE in order to complete the remaining portions of the Llagas Creek Flood Protection Project (Upper Llagas Creek).

The Llagas Creek Flood Protection Project was separated into 14 reaches. The NRCS has completed about half of the originally authorized project, the lower portion below Buena Vista Avenue, consisting of Reaches 1, 2, 3, 9, 10, 11, 12 and 13. The current Upper Llagas Creek Flood Protection Project, consists of the remaining reaches, located above Buena Vista Avenue, Reaches 4, 5, 6, 7, 8 and 14, as shown in Figure 1-1 Upper Llagas Creek Flood Protection Project - Soil Description and Sampling Location Map. The NRCS had developed preliminary designs for these reaches however; changes in the environmental habitat within these reaches, overall watershed used and Federal and State laws necessitated a re-evaluation of these designs to prepare acceptable flood protection features.

The NRCS hydraulic design for the Upper Llagas Creek was complete in 1995. The design proposed various channel improvement work, including some widening of the existing channel, installation of several grade control structures, and channel stability features.

Once the NRCS channel designs were completed, a lack of available funding delayed the construction of the project. Additionally, the increased concerns over environmental impacts associated with the proposed NRCS project delayed construction also. A field review in November 1999 indicated that the conditions in Reach 6 had dramatically changed since 1995, increasing the concern of the environmental impacts the NRCS design would have on the existing creek system.

A primary change was the establishment of dense riparian vegetation in the channel due to conservation recharge releases from Chesbro Reservoir. The near perennial low flow channel created by the re-operation of Chesbro Reservoir provides favorable conditions for the persistent vegetation within the channel. Furthermore, designation of new endangered species also occurred within the project limits.

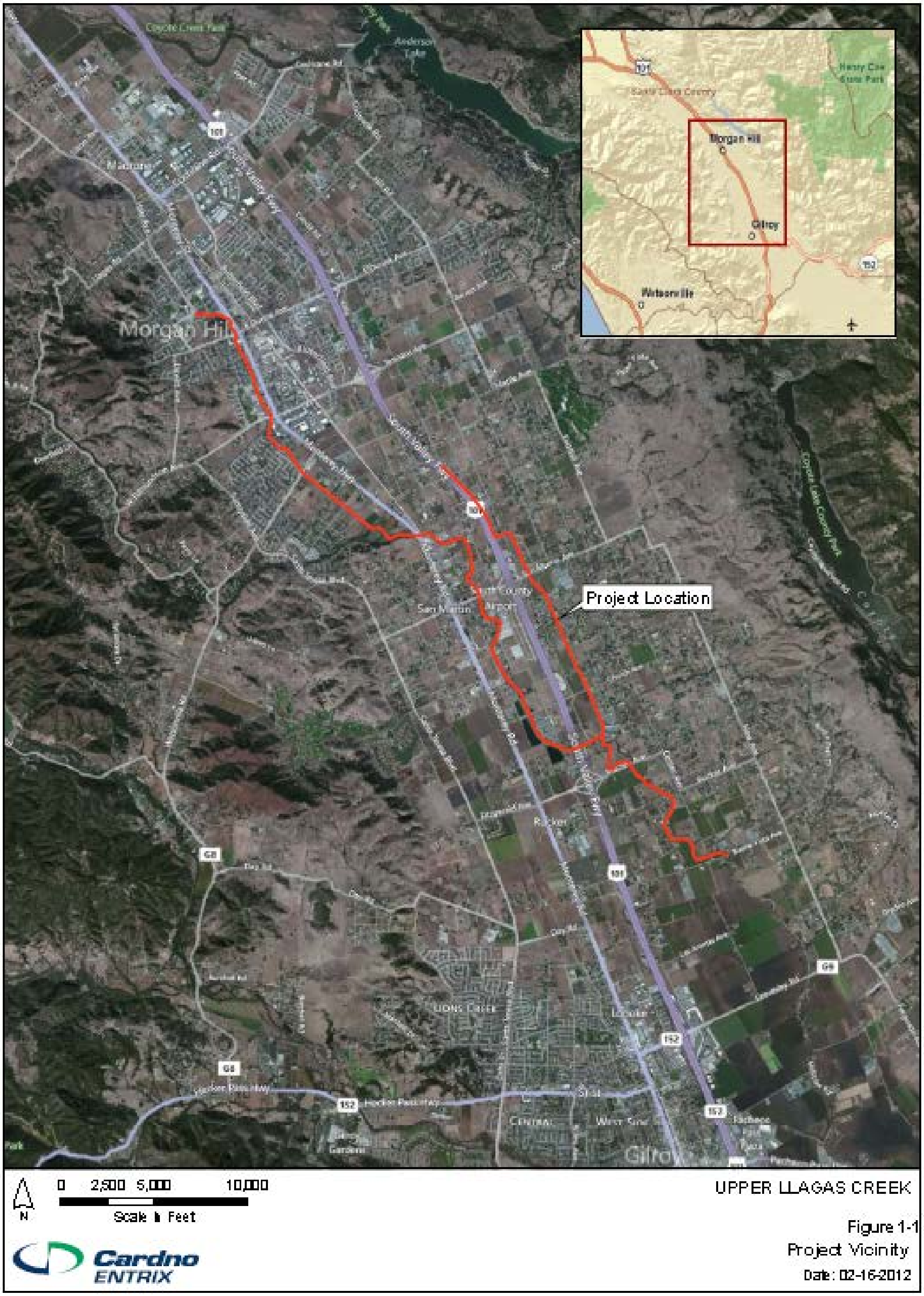
This is a USACE led project. The project was transferred from the NRCS to the USACE to complete the remaining reaches of the project in accordance with the watershed plan while taking into consideration the new growth of vegetation in the creek. The project currently consists of updated hydrology and hydraulic channel design. This includes the removal of grade control structures, a diversion channel, a meandering effective discharge channel, low flow fish barriers, and minimizing the impacts to the channel to the extent possible, while also achieving 100-year level of flood protection to the affected urban areas of Morgan Hill and San Martin (Reaches 7 and 8), 10-year level of flood protection to Reach 14, and maintaining the existing level of flood protection and prevent induced flooding to intervening agricultural areas in the other project reaches.

The Santa Clara Valley Water District is the local sponsor responsible for land rights acquisition, utility and structure relocations, the design and construction of box culverts and channel design dimensions and configuration.

1.3 Purpose and Objective of the Report

The Site Characterization Report examines the soils of the Upper Llagas Creek Project area, describes their relevant physical, chemical, and hydrologic properties, and identifies their suitability for mitigation plantings. Soils deemed suitable for mitigation must have, or could have, the appropriate physical and chemical qualities and hydrologic conditions necessary for restoring self-sustaining riparian communities. The report also defines feasible mitigation opportunities (including in-kind or out-of-kind mitigation), and the species recommended for planting. The findings presented in this report are also intended to assist and guide the civil design team to identify preferable cut and fill locations, appropriate areas for topsoil salvage and borrow sites, and to identify areas with poor soils that could benefit from treatments to improve the lateral migration of surface water, fertility, and other soil characteristics to support mitigation plantings. Recommendations to improve soil characteristics based on their identified limitations are not presented as prescriptive requirements, rather they are provided only to give guidance and examples of potential treatments to improve revegetation opportunities. The decision to undertake any soils reclamation activities is outside the boundaries of this report since a myriad of other engineering and resource issues must also be addressed.

Figure 1-1 Upper Llagas Creek Flood Protection Project Area



Chapter 2

Field Investigation

2.1 Project Study Area

The project area originates in the north section of Morgan Hill (see Figure 1-1). The northern limit of the project is located just north of Wright Avenue. The project area then parallels the west shoulder of Hale Avenue south as it follows the alignment of West Little Llagas Creek. The project area (channel) then migrates its way through the downtown, traversing underneath First through Fifth Streets. The channel remains west of Monterey Road until it crosses east in the area southeast of Lake Silveira, approximately one mile south of Middle Avenue. The channel then maintains its course south again through San Martin and past the Church Avenue percolation facilities. The southern boundary of the project area terminates at Buena Vista Avenue, north of Gilroy. Reach 8, which is the urbanized section of Morgan Hill extending from the Hillwood Lane to West Dunne Avenue, is not included in the soil study area, as determined in the Sampling Plan.

The soil sampling locations are provided in the set of three maps, Figures 2-1a, 2-1b, and 2-1c. These figures also identify the project reaches and the NRCS soil sample type along the stream corridor

2.1.1 Assessment of the Soil and Site Suitability

Soil is fundamental to all plant growth. This assessment was designed to answer the question, “Are the soils in the project area capable of providing a medium that would support self-sustaining riparian vegetation communities for mitigation?” From a soil quality and site productivity assessment point-of-view, the soils of Upper Llagas Creek project area were evaluated for their suitability based on the following parameters and diagnostic criteria.

2.1.2 Soil Suitability Parameters and Diagnostic Test Criteria

1. The soil allows for adequate root penetration so that the plants can exploit water and nutrients. Diagnostic Criteria: Soil Strength and Descriptive Soil Morphology

2. The soil allows water and air to move freely. Diagnostic Criteria: Texture, Percent Coarse Fragments and Porosity

3. The soil provides adequate storage of water so that the plants can access what they need between rainfall events or irrigations. Diagnostic Criteria: Percent Organic Matter, Hydraulic Conductivity (Ksat), Hydrophobic Index and Estimated Water Holding Capacity, Plant Available Water

4. The soil provides for both the storage and availability of nutrients so that the plants can take up what they need to grow. Diagnostic Criteria: pH, Cation Exchange Capacity and Percent Clay

5. The soil cannot have excessive amounts of salts like magnesium or sodium; or toxic elements like copper, zinc and boron. Diagnostic Criteria: Micronutrient Analysis, pH and Buffering Index.

6. The soil surface can be easily worked to allow for out planting or nursery stock and uniform germination and emergence of seeds. Diagnostic Criteria: Texture, Percent Organic Matter and Percent Coarse Fragments

Unless a majority of the factors listed above are deemed satisfactory, sustained productivity will not be feasible without soil remediation and further capital investment. Soils vary widely in their appearance and their physical and chemical properties. These differences can affect plant growth and soil behavior in profoundly different ways. The methodical description and analysis of soil can highlight their potential for various uses and can usually pinpoint problems that must be addressed before further project management decisions are made (e.g. environmental alternatives analysis).

2.2 Field Methods and Tests

The following soil tests were performed in the field during November and December 2011. These tests were part of the Soil Sampling Plan and are described below.

2.2.1 Applied Field Method 1: Use of the Static Cone Penetrometer

The Static Cone Penetrometer was used to evaluate the strength or resistance of the soil. This apparatus was used to assess the level of compaction and the load bearing capacity of the soil at ten (10) to twenty (20) inches below ground surface under very dry moisture conditions. A Static Cone Penetrometer with 60° cone with an area of 1.5 cm^2 was used because it was specifically developed for use in sandy soils. Any soil horizon or substrata with a soil strength exceeding 3,000 kPa (510 psi) is considered a physical barrier to root penetration.(Greacen and Gerard 1981, Sands et al 1979, Taylor 1971, Skinner and Bowen 1974 and Frolich 1973, 1978.) High resistance readings also indicate an impaired capacity to infiltrate, transmit and store water. Roots may not be completely excluded because joints and fissures in the rock fabric, or gaps between ped aggregates and soil macropores will allow root growth to greater depths. However, the efficiency of water and nutrient extraction necessary to support sustained plant growth diminishes with increased soil densities.

2.2.2 Augmenting the Penetrometer Readings by Describing the Subsurface Diagnostic Features

Densic materials are described in Soil Taxonomy (NRCS 1999) as non-cemented and thus differ from paralithic materials which are cemented. Both of these subsurface diagnostic features are defined as being root restrictive contacts, except the contact boundary may have cracks that would allow roots to penetrate but they must be at least 10 centimeters apart.

In this study, a gravelly, moderately cemented paralithic materials (i.e. Cmd horizon) and a finely textured densic material resulting from a paleo lacustrine or deltaic deposit were observed. However, a third massive subsurface condition was also detected. A subsoil horizon (i.e. Cm horizon) with massive structure was described, but this condition was more root retarding than root excluding (e.g. similar to the distinction between an aquatard and aquaclude). This soil condition was created through in situ pedogenic processes and not through paleo-geogenic processes; as the first two were. Massive structure is easy to observe and describe in the field when it's dry. The soil is generally too hard to crush between the fingers and it has a massive, structure-less appearance. In addition, root sizes were significantly smaller, root distribution more uneven, and the numbers of roots were fewer. The mechanics of soil compaction in forest soils differs significantly from that in agriculture because of differences in the weight, size and longevity of the crop (e.g. corn stalk vs. oak tree). Long living tree roots compact surrounding soils as they grow and increase in size. However, trees also transmit compacting forces to the surrounding soils from resisting the forces applied to them by the wind. As a consequence, the natural evolution of a forest soils structure often results in some damage, often manifested as compaction. When soil is compacted, soil strength is increased and total porosity is reduced through the collapse of the larger interstitial void spaces that are present between soil particles. When any of these three massive subsurface units are encountered at shallow depths they impose a strong influence on the soil quality and mitigation suitability.

Figure 2-1a Soil Sample Locations (Map 1 of 3)

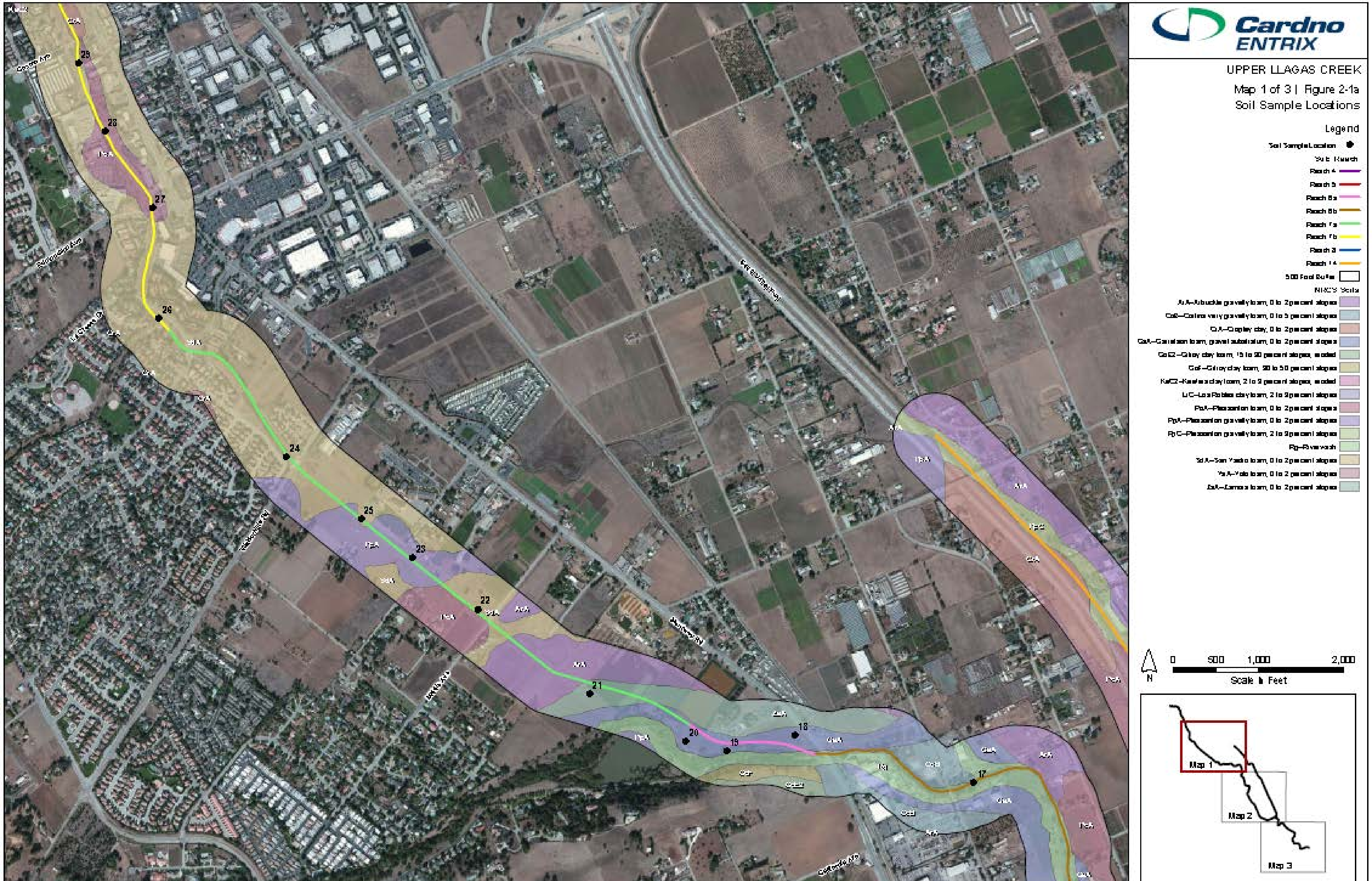


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Figure 2-1b Soil Sample Locations (Map 2 of 3)

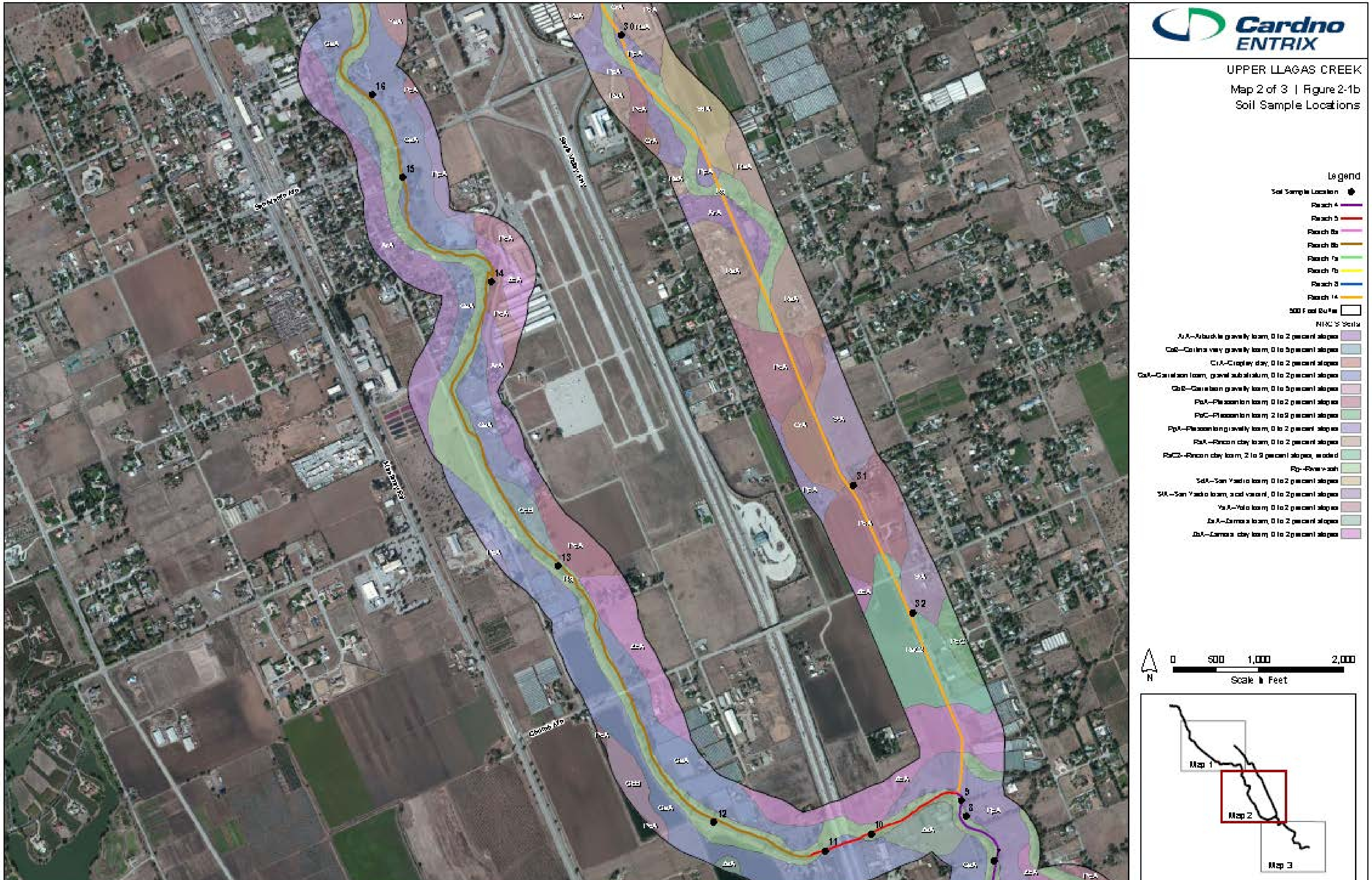

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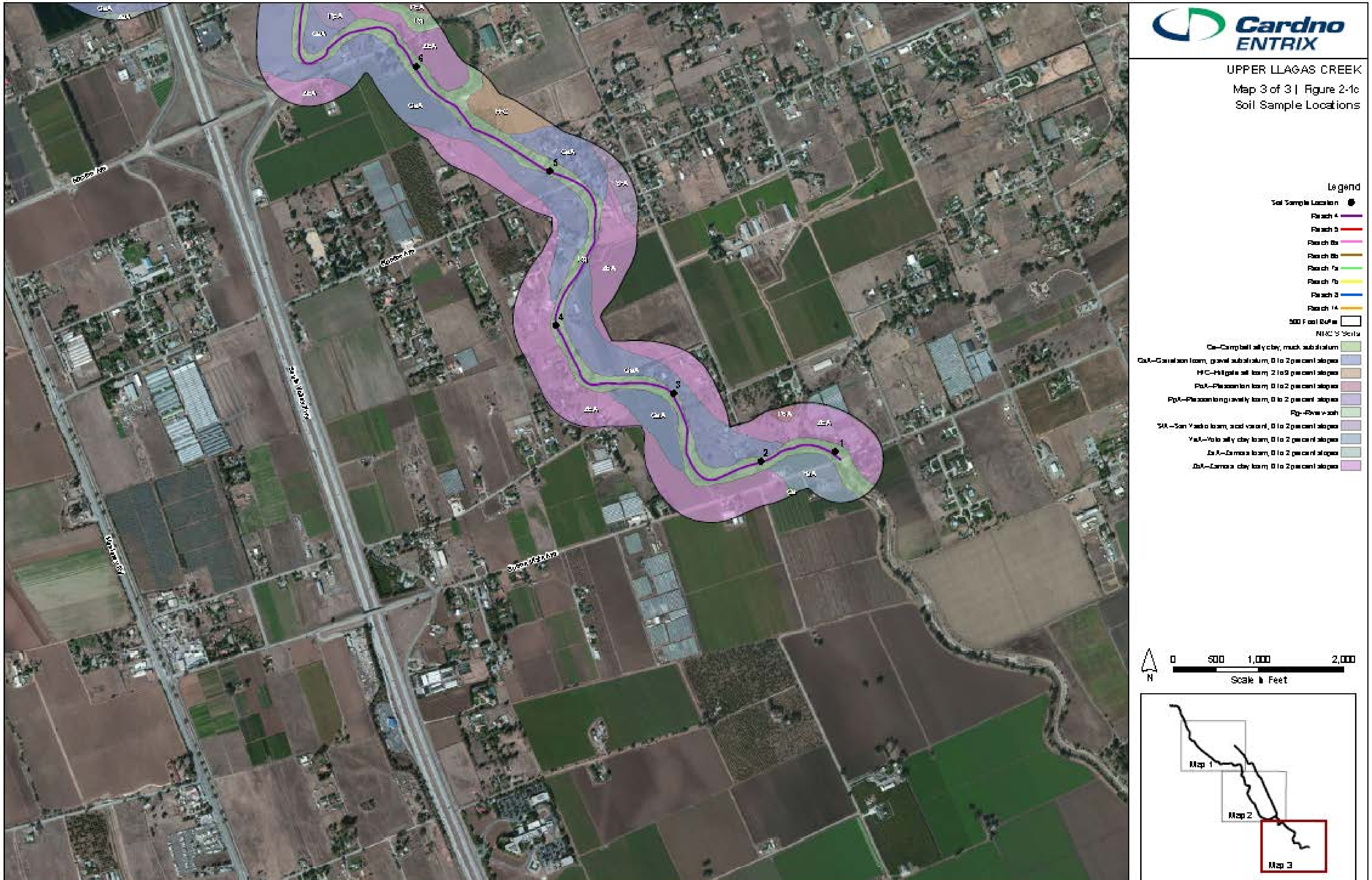
Figure 2-1c Soil Sample Locations (Map 3 of 3)



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Massive subsoil structure often restricts root development by imposing a mechanical barrier to their downward growth. Roots are often confined to congregating above the contact boundary that defines the ceiling of a massive subsoil horizon or substratum. These types of dense soil conditions reduce the ability of most roots to explore the majority of the soil column. Massive subsoil structure also reduces the capacity of the soil to transmit water and store plant available moisture. However, subsoil whose matrix consistence and structure was described as hard and firm; yet massive, do not impose absolute restrictions but relative (albeit significant) limitations on root establishment and growth. This means you can have massive subsoil structure but there can be mitigating characteristics of the subsoil so that it's not a 100 percent limitation on root proliferation. This interpretation suggests there is a continuum, or a range, from impenetrable to penetrable.

2.2.2.1 Describing the Coarse Fragment Content

Most of the soils in the project area have developed from an alluvial parent material and mixed mineralogy. The soil families mapped (NRCS, 1974) in the project area are described as having coarse fragments (by volume) that range from fifteen (15) to sixty-five (65) percent by volume (i.e. percent gravels, cobbles and stones). This range was corroborated by the soil sampling and that information is provided in the soil descriptions located in Appendix A Soils dominated by these larger particle sizes often have increased overall soil densities. Coarse fragments, if too abundant, can create substantive resistance and barriers to the root development and growth of planted stock or emerging seeds. Soils having greater proportions of these larger particle sizes are interpreted to be less workable (i.e. cultivation, tillage and precision grading).

2.2.2.2 Describing and Distinguishing the Different Types of Dense Subsoils

The Llagas Subbasin is bounded on the west by the Santa Cruz Mountains-Gabilan Range and on the east by the Diablo Range, and merges to the south with the Gilroy-Hollister Groundwater Subbasin. The Tertiary to Mesozoic age bedrock forming these mountain ranges is relatively impermeable and limits the extent of groundwater movement to the east and west and at depth. The regional aquifer systems are comprised of alluvial deposits over valley basin bedrock and include Pliocene to Holocene age continental deposits of unconsolidated to semi-consolidated gravel, sand, silt, and clay. These sedimentary deposits include older and younger alluvium from meandering stream systems, alluvial fans, floodplains, and lacustrine (lake bottom) and deltaic deposits from the ancestral Lake San Benito and Lake San Juan and the underlying Santa Clara Formation.

Thicknesses of the alluvial deposits above bedrock in the central part of the subbasin are cited as at least 450 feet (CVWQCB, 2005). The depositional history and paleo-drainage system of the Llagas Subbasin was mostly comprised of meandering stream channels that drained to the south-southeast and inter-channel areas between active stream systems. Subsurface stratigraphy is hypothesized to be composed of alternating permeable sand-gravel units and low permeability clay-silt units of variable thicknesses. The units split and merge but can be traced for considerable distances.

The older alluvium stream channel deposits are described as Pliocene to Holocene age alluvial deposits of unconsolidated (non cemented) to semi-consolidated (moderately cemented) gravel, sand, silt, and clay. It is postulated the streams drained into the ancestral Lake San Benito in the Holocene period at least 5,000 years ago. The lacustrine deposits of the ancestral Lake San

Benito (and Lake San Juan) are described as Holocene age clay and silt units that form a series of fairly continuous confining beds. The ancestral Lake San Benito deposits extend as far north as Middle Avenue and the ancestral Lake San Juan deposits extend as far north as Gilman Road and Dunlap Avenue. Lacustrine deltaic deposits are present where the meandering streams met the ancestral lakes. The lacustrine clays appear to be fairly continuous and form a series of confining beds south of Middle Avenue. The water bearing deposits are characterized as unconfined north of Middle Avenue. The Llagas Subbasin's northern boundary consists of a groundwater divide that is believed to coincide with the Coyote Creek alluvial fan topographic high as it emerges from the eastern foothills (CVWQCB, 2005).

As previously mentioned, a gravelly, moderately cemented substratum and a finely textured lacustrine-deltaic deposit were observed (See Appendix D - Figures 4 and 23).When encountered as shallow contacts, these two subjacent geological units impose a strong influence on soil quality and mitigation suitability.

The gravelly, moderately cemented substratum was interpreted to be a fanglomerate, which is a moderately indurated conglomerate rock that's been deposited through fluvial processes and cemented by dissolved silica (i.e. reprecipitated silicic acid). The fanglomerates observed in the project area are meta-sedimentary rocks consisting of moderately well sorted, subangular to subrounded clasts (i.e. gravels) embedded in a fine sandy-clay matrix. Fanglomerate can be differentiated from breccias, which is a sedimentary rock dominated by cemented angular clasts. Both conglomerates and breccias are dominated by clast sizes larger than sand (>2 mm).

Both types of substratum were observed in sections of Reaches 4, 6 and 7a. Both types of substratum were observed to directly prevent the downward growth of roots, causing them to bend at 90 degrees at the point of contact (See Appendix D - Figures 4 and 23).

The following table summarizes the locations, master horizon designations and depths bgs for the different types of root restricting materials encountered in the soil subsurface. The C horizon, by definition, is the section of the soil profile dominated by parent material, which is the underlying consolidated (e.g. weathered bedrock) or unconsolidated (e.g. fluvial deposit) geologic material. The master horizon suffix or subscript designates a subordinate morphologic or genetic distinction that refines the diagnostic interpretation. In this case, the master horizon suffix "Cd" means the C horizon also has a densic layer that is root restrictive, but it's not necessarily a cemented matrix. In contrast, the master horizon suffix "Cm" means the C horizon is massive, it has no structure and the parent material matrix is cemented. Therefore, the distinctions in the types of root restricting layers discussed above are represented in the soil profile descriptions by the two differing horizon designations Cd and Cmd.

Cross sections of specific stations within the project area will be developed to visually illustrate the subsurface information presented below. The cross sections will be located in Appendix E.

Table 2-1 Depth to Root Restrictive Contact (Subsurface Massive, Densic or Paralithic Materials)

Reach	Site 1.1	Densic Horizon Contact Depth	Relative Position of Soil Description Pit within Channel Cross Section
Reach 4	Site 1.1	Densic Horizon (Cd) @ ~36 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 4	Site 2.1	Densic Horizon (Cd) @ ~42 " bgs	Mid Terrace Flank (Left Bank)
Reach 4	Site 3.2	Densic Horizon (Cd) @ ~40 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 4	Site 4.2	Cemented Densic Horizon (Cmd) @ ~32 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 4	Site 5.1	Cemented Densic Horizon (IICmd) @ ~42 " bgs	Mid Terrace Flank (Left Bank)
Reach 4	Site 6.1	Densic Horizon (IICd) @ ~23 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 4	Site 7.1	Densic Horizon (Cd) @ ~24 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 4	Site 8.1	Cemented Densic Horizon (IICmd) @ ~41 " bgs	Mid Terrace Flank (Left Bank)
Reach 5	Site 10.1	Cemented Densic Horizon (IICmd) @ ~36 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 5	Site 11.1	Cemented Densic Horizon (IICmd) @ ~46 " bgs	Top of Bank - from terrace knickpoint down to channel (invert) substrate (Right Bank)
Reach 6	Site 14.1	Cemented Densic Horizon (IICmd) @ ~33 " bgs	Mid Terrace Flank (Left Bank)
Reach 6	Site 14.2	Cemented Densic Horizon (IICmd) @ ~31 " bgs	Mid Terrace Flank (Right Bank)
Reach 6	Site 15.1	Cemented Densic Horizon (IICmd) @ ~38 " bgs	Mid Terrace Flank (Left Bank)
Reach 6	Site 15.2	Cemented Densic Horizon (IICmd) @ ~36 " bgs	Mid Terrace Flank (Right Bank)
Reach 6	Site 16.1	Densic Horizon (IICd) @ ~40 " bgs	Mid Terrace Flank (Left Bank)
Reach 7a	Site 19.1	Cemented Densic Horizon (IICmd) @ ~36 " bgs	South Central Part of County "Bowtie" Parcel
Reach 7a	Site 23.1	Cemented Densic Horizon (IICmd) @ ~39 " bgs	SCVWD Easement - Agricultural Field North of Middle Avenue

2.2.3 Applied Field Method 2: The Water Repellence Test (Hydrophobic Index)

Water repellence (non-wetting or waxiness) is a condition observed mainly in sandy surface soils of Mediterranean climates. The condition is most pronounced in the summer and early autumn when there is an observably uneven infiltration and distribution of water at the soil surface or at some shallow depth just below the soil surface. Water will either sit prone or move around like beads of mercury on a smooth surface. This soil condition is caused by the deposition and accumulation of aliphatic hydrocarbons, a paraffin class of waxy materials that coat the soil grain that comprise the soil surface. The hydrophobic layer on the soil surface primarily results from two (2) simultaneous processes: 1) the long term seasonal deposition of a viscous waxy exudate emitted from the leaves and needles of certain plant species; and 2) the repeated oxidation (i.e. breakdown) of fallen xeric plant matter on the soil surface (e.g. pine needles and manzanita leaves). Although sandy soils are most affected, heavier clay dominated soils can become hydrophobic too.

Severe water repellence can represent a noteworthy site productivity problem. Hydrophobic soils are notorious for having poor surface infiltration, low soil moisture content and inconsistent seed germination. Reduced soil water availability means potentially more runoff and less water entering and being stored in the soil column.

A simple field method of assessing water repellence is the water absorption test. This field test was performed at all soil sampling sites. Drops of distilled deionized water are applied to a fresh soil ped surface retrieved from the just below the mineral and organic layer interface. The soil is considered non hydrophobic if the distilled and deionized (non repellent) water is absorbed in less than 60 seconds. If the water takes more than 60 seconds to be absorbed, then the time to water absorption is recorded and the severity of the hydrophobic effect is recorded. Most of the soils that were tested in the project area were shown to be moderately hydrophobic, except for the soils associated with Reach 14, which were severely hydrophobic.

2.2.4 Applied Field Method 3: Measuring Saturated Hydraulic Conductivity

Saturated Hydraulic Conductivity (Ksat) is a quantitative measure of a saturated soil's ability to transmit water when subjected to a hydraulic gradient. It can be thought of as the ease with which the pores of a saturated soil permit water movement (i.e. internal transmission). The Constant Head Permeameter (CHP) is a device that measures the in situ saturated hydraulic conductivity of a soil. The apparatus is designed to maintain a constant head of water in a shallow auger hole. The rate of water released from the apparatus necessary to maintain the constant head (once saturated soil conditions have been reached) is proportional to the saturated hydraulic conductivity (or permeability) of the soil.

2.2.4.1 The Constant Head Permeameter Test

The depth of the test hole should be indicative of the depth of the planned use of the soil being examined. The top twenty (20) inches of the soil profile was examined for planting suitability and retrievable topsoil. Therefore, the depth of CHP measurement was conducted between ten (10) and twenty (20) inches below ground surface (bgs). This vertical interval or position in the soil profile was chosen in order to acquire an approximate measure of the native soil's in situ hydraulic conductivity for the top twenty (20) inches.

2.2.4.2 Constant Head Permeameter Field Measurement

A borehole making tool was vertically hammered into the ground surface at about two inches per effort. Upon extracting the tool from the ground, we removed the soil from the core with a dowel sized piece of rebar. This process was repeated until the desired depth of ten (10) inches bgs was achieved. The loosened soil was then cleaned away from the rim of the hole and a spacer base plate was placed over the hole. Nails were used to fix the spacer base plate to the soil surface to help stabilize the apparatus. The CHP was filled with water and gently positioned into the hole through the spacer base plate. The slide compression is then locked down to make contact with the spacer base plate. The slide spacer is then gently lifted away from between the spacer base plate and the compression lock. The flow valve is then slowly opened and the water begins to make contact with the soil.

2.2.4.3 Reading the Constant Head Permeameter

Throughout the first fifteen minutes the flow meter is checked for consistency or aberration. At the end of this initial time period a reading is taken of the water level in the CHP and the time is recorded. After one minute another reading is taken and recorded. With slowly conductive soils, such as the soils of the project area, a longer time interval was necessary to achieve a reading. The time interval for reading the meter should be long enough to capture two or more intervals. The change in water level per minute was then calculated. The scale on the CHP is marked such that the change per minute equals the inches per hour (or Ksat of the soil).

Example Reading

Initial reading after 15 minutes is 125, the reading after 10 minutes 120.

(125 - 120) / 10 = 0.5 in/hr.

Table 2-2 summarizes the locations where the previously explained tests were performed. The Table below provides the quantitative results for each test and their applicable interpretations for assessing site suitability. The soil quality measurements and their corresponding rankings for compaction and internal water transmission should be viewed as indicating that all the settings described and sampled should be viewed as being moderately to significantly limited for providing a suitable planting medium in their current condition.

Table 2-2 Soil Strength, Hydraulic Conductivity and Hydrophobicity Index Data

Soil Sample Site Number	Project Reach	Soil Strength (kPa) (Increments of 500)	Soil Strength Interpretation and Compaction Rating	Hydraulic Conductivity (Ksat - in/hr)	Ksat Permeability Class	Hydrophobic Index
1.1	4	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
3.2	4	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
5.1	4	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
8.1	4	>5,000	Root Preventing	0.0015-0.02	Slow	Severe
10.1	5	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
13.1	6	>5,000	Root Preventing	0.0015-0.02	Slow	Severe
14.1	6	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
15.2	6	>5,000	Root Preventing	0.0015-0.02	Slow	Severe
17.1	6	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
18.1	Lower 7a	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
20.1	Lower 7a	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
23.1	Upper 7a	>5,000	Root Preventing	0.0015-0.02	Slow	Severe
26.1	7b	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
28.1	7b	~3,000	Moderately Severe	0.2-0.6	Moderately Slow	Moderate
30.1	14	~3,000	Moderately Severe	0.0015-0.02	Slow	Severe
32.1	14	~3,000	Moderately Severe	0.0015-0.02	Slow	Severe

2.2.5 Field Method 4: Describing the Morphology of the Soil Profile

Most soil profiles consist of layers called horizons or strata. The different horizons usually correspond to differences in physical and chemical properties or parent source of the material, so each horizon or strata must be carefully examined, sampled and described.

Soil profiles are best described as an exposed face in situ. This study relied on the hand excavation of thirty six (36) soil profile description pits. The soil pits were precisely positioned in pre-designated locations, as described in the Soil Sampling Plan, along the cross sectional perimeter of the creek. Two locations were chosen to achieve the most reliable and applicable information for assessing soil quality and planting suitability. The two locations that were described and sampled were: (1) the lower creek bank from the knick point down to the floor of the invert substrate and; (2) the mid slope position above the interior channel bank knick point, but below the proposed location for the maintenance road. The channel cross section provided in the Sampling Plan offers a visual orientation as to where these two positions are. The soil profile description pits were excavated to four (4) feet below ground surface, whenever feasible. This was done because plant roots are not confined to just the top twenty inches of the topsoil, and they frequently extend below this depth into the transitional subsoil horizons. Additionally, examining the soil profile to this depth provided a means to measure the depth of contact to the massive and/or cemented gravelly substratums and to determine if the water table was present either thru direct contact with saturated soil conditions or thru the presence of redoximorphic features. (See section 2.2.2.2).

For each horizon in the soil profile, the following was examined and described:

- Texture
- Structure (type, consistence)
- Percent Coarse Fragments (percent stones, cobbles and gravel)
- Color
- Roots (abundance, size and depth)
- Consistence
- Redoximorphic Features
- pH

2.2.6 Soil Sampling and Laboratory Analysis

The laboratory soil analyses conducted for this study were designed to diagnose the soil's chemical status and physical properties. This information was generated to evaluate the need for soil amendments and fertilizers to support revegetation, if warranted.

Soil nutrient and fertility analysis was compared to the nutrient requirements defined under the "General Crop" and "Riparian Plant" categories. These two soil-plant fertility tests were deemed the most appropriate and applicable as determined by discussion with the A and L laboratory agronomist.

These two interpretative categories have slightly different fertilizer recommendations. The "General Crop" recommendations provide information most applicable to annual crops and non agronomic plants such as forbs and grasses. The "Riparian Plant" recommendation provides information most applicable to perennial woody riparian plants.

The soil laboratory analyses that were performed for this study include:

1. Particle Size Analysis (fine earth fraction: mineral particles between 2 mm and 0.002 mm)
2. Total Nitrogen and Nitrate Nitrogen
3. Percent Organic Matter
4. Available Phosphorus and Potassium
5. pH
6. Electrical Conductivity (Soluble Salts)
7. Micro Nutrients and Elements
8. Chloride and Sulphate
9. Cation Exchange Capacity and Exchangeable Base Cations
10. Estimated Water Holding Capacity

Soil samples tested were formulated from a combination of bulked subsamples collected from similar soil types. The samples were retrieved from the soil profile face at ten (10) inches below ground surface (bgs). The following list identifies the bulked sample number and the corresponding sampling sites and reaches they were retrieved from.

- Bulked Soil Sample 1.A - represents Sites 1 through 4 in Reach 4
- Bulked Soil Sample 2.B - represents Sites 5 through 8 in Reach 4
- Bulked Soil Sample 3.C - represents Sites 9 through 12 in Reach 5 and 6
- Bulked Soil Sample 4.D - represents Sites 13 through 17 in Reach 6
- Bulked Soil Sample 5.E - represents Sites 18 through 21 in Upper and Lower Reach 7a
- Bulked Soil Sample 6.F - represents Sites 22 through 25 in Reach 7a
- Bulked Soil Sample 7.G - represents Sites 26 through 29 in Reach 7b
- Bulked Soil Sample 8.H - represents Sites 30 through 32 in Reach 14

2.2.7 Nutrient Analysis and Chemical Fertility

2.2.7.1 Terms for Interpreting the Soil Laboratory Analyses and Chemical Fertility Report

The Soil Analysis Report and Fertility Guidelines Report have been summarized in a spreadsheet table for quick viewing convenience. The laboratory analysis results were provided by A and L

Soil Testing Laboratory of Modesto, CA. A Chain of Custody was used to tract the integrity of the soil sample shipment from Cardno ENTRIX offices to the receiving laboratory. The original print-out of the results are located in Appendix B for closer examination. Throughout the document, technical information is being reported and discussed for interpretation. The following information provides a basic reference for understanding the units and terms found in the following report sections.

2.2.7.2 Parts per million (ppm)

Results for the major and minor elements are reported in parts per million (ppm) on an elemental basis. An acre of mineral soil is modeled to be calculated as a slice of land that is 6.66 inches deep, weighing approximately 2 million pounds. Therefore, to convert parts per million readings to pounds per acre, multiply by 2.

2.2.7.3 Meq/100g (milliequivalents per 100 grams)

Soil cations are the basic chemical elements used for describing and understanding soil nutrients and their relation to plant nutrition. Soil cations are expressed in terms of their relative ability to displace other cations. The unit of measure meq/100g serves this purpose. For example, one milliequivalent of potassium is able to displace exactly one milliequivalent of magnesium. The cation exchange capacities of a soil, as well as the total amounts of individual cations, are expressed by using these units.

2.2.7.4 milliSiemens or Millimhos/cm (mmhos/cm)

Electrical conductivity measurements are used to measure the amount of soluble salts in the soil. Conductivity is generally expressed in milliSiemens or mmhos/cm. The electrical conductivity readings increase with increasing soluble salts. The soil is considered saline when the electrical conductivity reading reaches 2 mmhos/cm. Salts in the soil water may inhibit plant growth for two reasons. First, the presence of salt in the soil solution reduces the ability of the plant to take up water, and this leads to reductions in the growth rate. This is referred to as the osmotic or water-deficit effect of salinity. Second, if excessive amounts of salt enter the plant in the transpiration stream there will be injury to cells in the transpiring leaves and this may cause further reductions in growth.

2.2.7.5 Interpretative Ratings

A and L Soil Testing Laboratory provided the soil test readings in the report. Their analysis provides test ratings of very low (VL), low (L), medium (M), high (H), or very high (VH). The purpose of these readings is to provide a relative guideline for both interpreting and determining the optimum soil nutrient levels for achieving successful plant growth.

2.2.8 Reporting Categories for Soil Laboratory Analyses

2.2.8.1 Total Nitrogen and Nitrate Nitrogen

Nitrate-nitrogen (NO3-N) which is water soluble and readily available to plants was tested. This test indicates nitrogen levels needed for optimum plant performance.

Nitrogen deficiency was determined to be a widespread nutrient problem throughout the project area. Naturally occurring nitrate-nitrogen values of 15 to 25 ppm are considered moderate to good in native soils. The soils of the project area are considered low for inherent nitrate-nitrogen, with average levels between 2 ppm and 11 ppm, with only soils samples 1A and 4D having adequate natural levels with 13 and 15 ppm respectively.

Most of the nitrogen that does occur in the soil is in the organic fraction and the percent organic matter readings for the project areas soils are also low. Nitrogen is only available to plants in the mineral (inorganic nitrate) form. Mineralization must occur for nitrogen to become plant available (i.e. converted from an organic to inorganic species by microbial activity). Mineralization is highly dependent on the hydrological and biological conditions within the soil. As indicated by the data in the attached nutrient analysis tables, maintaining adequate levels of plant available nitrogen in the soil during the early stages of revegetation and plant growth will be important for successful mitigation. Although virtually all the soils sampled from the project area were nitrogen deficient, it is the preparation and management of the soil rather than its inherent nutrient status which will determine the nitrogen availability at the time of replanting. Nitrogen levels are usually linked to the percent organic matter content of the topsoil. A target of three (3) to five (5) percent organic matter content in the top twenty (20) inches of the soil would be considered optimum at the time of replanting.

Recommended nitrogen levels are usually linked to the percent organic matter content of the topsoil and the target species planned for replanting. The total nitrogen and nitrate nitrogen tests provide good indications of the soils current nitrogen status, However, initial soil testing should only be used to establish whether there is a need for more detailed testing based on a plant tissue analysis. Plant tissue analysis is used to further refine the soil amendment and fertilizer recommendations in preparation for the actual time of planting.

2.2.8.2 Percent Organic Matter and Estimated Nitrogen Release

As well as influencing nitrogen supply, soil organic matter also holds and supplies other plant nutrients and moisture, and it plays a key role in stabilizing the soil structure. Percent organic matter is a measurement of the amount of plant and animal residue in the soil. The color of the soil is usually closely related to its organic matter content, with darker soils being higher in organic matter. The organic matter serves as a reserve for many essential nutrients, especially nitrogen. Bacterial activity, through the process of mineralization releases some of this reserve nitrogen, making it available to the plant. The Estimated Nitrogen Release (ENR) readings are an estimate of the amount of nitrogen that will be released over one season.

The organic carbon test (combustion loss upon ignition or LOI) provides a useful indicator of the topsoil organic matter content by weight. This value represents a reasonable approximation of the overall fertility and structural stability of the surface soil (i.e. top twenty inches). The percent organic matter (OM) by weight was assessed by laboratory analysis for all eight (8) bulked soil samples. All reaches but Reach 6 (2.9 % OM) reported the topsoil as being low or depauperate in organic matter with readings from 1.6 to 2.2 percent. As a benchmark, the average range of organic matter content in a relatively pristine and intact riparian soil would be between 4 and 7 percent.

2.2.8.3 Available Phosphorus and Potassium

Two types of phosphorus tests were conducted. The weak Bray test measures the phosphorus that is readily available to plants. The optimum level will vary with soil conditions, but for most plants, 20 to 30 ppm is adequate. The weak Bray extractions are for measuring plant available phosphorous in more acidic soils (pH of < 7.0).

The Bicarbonate P test (The Olsen Method NaHCO3-P, sodium bicarbonate test) measures the amount of plant available phosphorus in slightly basic to highly basic soils (pH of 7.0 to >7.3). In neutral to basic soils, phosphorus will exist mostly as an alkaline phosphate. The extraction by dilute sodium bicarbonate test correlates well with the phosphorous that is considered plant available when the soil is neutral to basic.

Like nitrogen, phosphorus is almost universally deficient in the project area topsoil. The weak Bray test results report a low of 4 ppm to an anemic high of 14 ppm.

Added phosphorus must attach to clay particles, organic matter and/or compounds of iron and aluminum. The project area topsoil is not abundant in any of those three constituents. The topsoil is slightly acid to neutral; therefore pH will not limit the capacity of the soil to supply phosphorus in plant available forms. Most of the project area soil texture is proportionally dominated by sand. Sandy loam and loamy sand soils are generally inert and prone to leaching nutrients, and therefore mitigation sites that are dominated by loamy coarse sand and coarse sandy loam soils that are low in organic matter may prove to be persistently phosphorus deficient.

Deficiencies of potassium in the soils of the project area were also noteworthy. The tests results seem slightly unusual because the parent rocks and sediments from which most of the soils are formed contain clay minerals that are naturally high in potassium. The deficiencies observed may be due to large amounts of potassium having been removed as a result of erosion and/or through the agricultural management practices of the surrounding vicinity. Optimum levels for light-colored, coarse textured soils may range from 100 to 150 ppm. Five (5) of the eight (8) soils tested were reported to be less than 100 ppm.

2.2.8.4 Soil pH

The soil pH is a measure of acidity or alkalinity. Soil pH is important in determining the degree and likelihood of acidification, which helps forecast possible nutrient deficiencies. Soils which are excessively acid or alkaline will cause reduced nutrient availability and lower plant productivity. Soil pH is critical to assessing the suitability of potential mitigation sites for replanting success.

Six (6) of the eight (8) soils tested from the project area were neither acid nor alkaline having a pH that is categorically defined as neutral. The method used for measuring pH was the calcium chloride solution test. This method takes account of any dissolved salts in the soil sample that may confound an accurate reading. The majority of native riparian plant species likely to be considered for mitigation prefer neutral soils.

Acidification is normally caused-by the over accumulation of organic matter (which produces surplus organic acids) or by the superfluous addition of nitrogen through inappropriately high applications of ammonium based fertilizer. Both of these practices could result in the production of nitrates, which are soluble and easily leached from sandy loams and loamy sands. In addition, the leaching nitrates will drag the base cations of calcium and magnesium with them during the leaching process, leaving concentrated acidic residues up in the rhizosphere (i.e. effective root zone) in the vicinity of the roots.

The susceptibility of a given soil to acidification is determined by its "Buffering Capacity or Index". This measurement represents the ability of the soil to resist pH change. Soils with higher clay content, cation exchange capacity and percent organic matter generally have higher buffering capacities. The Buffer Index is also a value used for determining the amount of lime to apply to acid soils with a pH of less than 6.6. The lower the buffer index, the higher the lime requirement. Only soil samples 4D and 6F, with slightly acid pH values of 6.1 and 6.2 respectively, were found to be modestly deficient in their Buffering Capacity.

2.2.8.5 Soil Salinity and Soluble Salts

Plant productivity decreases as salt levels increase in the soil. Depending on the salt tolerance of the individual species, death eventually occurs. Salinity affects root growth through direct toxic effects, and also by increasing the osmotic pressure in the soil solution to a point where plant roots can no longer absorb water. Excessive exchangeable (insoluble) sodium can have toxic effects on root systems. Soils with high proportions of exchangeable sodium relative to other cations are referred to as 'sodic'. Sodicity is measured as the proportion of exchangeable salts relative to the cation exchange capacity. If the level of salinity is less than 1.0 mmhos/cm the effect is negligible. Soluble salt readings that are greater than 1.0 mmhos/cm may negatively affect some plants. All of the soils of the project area were reported to be very low to low in sodium and soluble salts with readings that were under 0.4 mmhos/cm. Therefore, salinity and sodicity are not limitations to revegetation.

2.2.8.6 Micro Nutrients and Trace Elements

Micro nutrients and trace elements are required by plants for healthy growth. Generally speaking, excess or deficiency issues occur sporadically across the landscape and may be due to seasonal conditions or induced unavailability caused by additions of other soil inputs.

The project area soils were both in excess and in deficiency of specific micro nutrients and trace elements. The laboratory analysis detected the following:

a) Copper: A normal range is from 1 to 1.8 ppm. All of the project area soils reported moderate to mildly high levels except for two (2) samples. Sample 2.B represented the low with a reading of 0.8 ppm and sample 7.G represented the high with a reading of 3.6 ppm.

b) Magnesium: A normal range is from 50 to 70 parts per million. All the project area soils reported very high levels with readings in excess of 731 ppm.

c) Manganese: A normal range is from 20 to 30 ppm. All the project area soils reported moderate levels except for two (2) samples. Samples 2.B and 3.C reported as low with readings of 0.2 ppm respectively.

d) Iron: A normal range is from 20 to 30 ppm. The project area soils reported varying levels. Sample 7.G represented the high with 22 ppm and sample 2.B represented the low with 7 ppm.

e) Zinc: A normal range is from 3 to 6 ppm. The project area soils reported varying levels. Sample 7.G represented a high with 18.2 ppm and sample 5.E represented a low with 0.5 ppm.

f) Boron: A normal range is from 1 to 1.5 ppm. All the project area soils reported consistently low to very low levels. Samples 1.A and 4.D represented the high with 0.5 ppm and samples 5.E and 6.F represented the low with 0.2 ppm.

g) Sulfur: A normal range is from 15 to 20 ppm. All the project area soils reported consistently low levels. Sample 1.A represented the high with 8 ppm and sample 5.E represented the low with 1 ppm.

Soil tests for micro nutrients and trace elements should be used to establish the need for plant tissue analyses, which further refines the soil amendment and fertilizer recommendations in preparation for the actual time of planting.

2.2.8.7 Chloride and Sulphate

Chloride, together with sodium, is the principal component of most soluble salts in soil, so chloride concentrations generally parallel Electrical Conductivity readings. The project area soils were normal to low in their reported chloride levels. Sulphur occurs in both organic matter and as sulphate in the soil. Sulphur deficiencies are widespread across the soils of the project area. This is likely because the soils are predominantly sandy and low in organic matter. Low sulfur levels in the soil can contribute to plant chlorosis, which results in a yellowing of the leaf and an observable lack of vigor.

Gypsum is a very soft sulfate mineral composed of calcium sulfate dihydrate, (CaSO4·2H2O). Gypsum applications have been recommended in six (6) of the eight (8) bulked soil samples (i.e. project reaches) to compensate for this deficiency.

2.2.8.8 Cation Exchange Capacity and Exchangeable Base Cations

The soil samples retrieved for laboratory analysis were collected from 10 inches below ground surface (bgs). The samples were sieved to only include the fine earth fraction, which is the mineral fraction of the soil that only includes the particle sizes that qualify as sand (2.0 mm) to clay (0.002 mm). Therefore, the soil samples did not include any gravels, which are considered coarse fragments. Clay micelles are secondary mineral colloid particles that are < 1 - 2 µm in size. Soil colloids can take a number of forms, such as: crystalline silicate clay, non-crystalline silicate clay, iron and aluminum oxide or organic humus. However, the clay species found in the project area are mostly aluminum or magnesium crystalline complexes arranged around phyllosilicate sheets. Clays can typically have surface areas in the range of 10-800 m^2·g-1. Clay micelle surfaces have significant electrostatic properties with internal and external layers having electronegative or electropositive charges. Each clay micelle surface is capable of adsorbing thousands of hydrated Al^{3+}, Ca^{2+} , H^+, K^+, Mg^{2+} and Na^+ ions (hydrated means enclosed within several H_2O molecules). Cation exchange occurs when ions break away (desorb) from the micelle surface into the surrounding soil solution and are then replaced by other ions (adsorb). Some highly active clay species have ionic double layers with strong negatively charged surfaces that become surrounded by swarms of aqueous cations.

Cation Exchange Capacity or CEC simply means to what degree a clay micelle can adsorb, desorb and exchange cations that are critical to plant growth and health. CEC has mostly to do with availability and proportions of specific cations in the soil solution as they relate to each other. High levels of one cation may influence the uptake of another (i.e. chemical antagonism). The relative concentrations of cations in the soil solution also determine the rates and degrees of cation adsorption and desorption on the micelle surface (e.g. isomorphic substitution). Cation site occupation, release and availability are not equal for all cations on the clay surface. And not all secondary mineralogy's (i.e. clay species) are equal in their CEC (e.g. montmorillonite vs. illite vs. kaolinite). In addition, there is also a fixed order among the different cations regarding their adsorption and desorption rates. Nutrient availability (i.e. Ca, Mg and K) does generally increase with a higher percent Base Saturation but a percent Base Saturation below 100% may also indicate that hydrogen and aluminum ions are occupying the remainder of colloid surface sites that should be occupied by plant nutrient cations.

The cation exchange capacity is defined simply as the sum total of the exchangeable cations that a soil can adsorb. The higher the CEC of soil the more cations it can retain. The project area soils have the capacity to be more fertile than they currently are. They do have the physical capacity (clay content and mineralogy) to retain plant nutrients and provide a more fertile growth media. However, the existing biogeochemical cycle of the soils along Upper Llagas Creek (the current water, soil and plant cycling regime) are not optimal for sustaining plant growth and maintaining soil fertility in a dynamically steady state. Consequently, the actual occupation of the available exchange sites with plant nutrient cations is low, meaning the soils are generally depauperate in the available nutrient cations required for plant growth and health

The CEC of a soil is dependent upon the amounts and types of clay minerals and the quality of the organic matter present (e.g. humic and fulvic acids). Humic acids are complex organic molecules that are formed by the microbial digestion of dead plant and animal matter (i.e. lignin, cellulose). Colloidal humin has the greatest CEC and contributes a positive effect on the water holding capacity of the soil. Humic acids positively influence soil fertility through increasing the microbial populations (e.g. actinomycetes) and the permeability of the root membranes to cation uptake. The common measurement for CEC is milliequivalents per 100 grams (meq/100g) of soil. A normal range for most soils will vary from 2 to 35 meq/100g.

Cation exchange capacities of more than 15 indicate high potential for soil fertility; values of less than 5 indicate very low potential for achieving and maintaining fertility. The project area soils ranged from a low of 14.7 (sample 6.F Reach 7a) to a high of 24.1 (sample 3.C Reach 5/6).

The proportions of the certain cations on the exchange complex are also important. Excessive exchangeable sodium, as well as causing structural problems, also affects plant growth due to the low tolerance of many species to high sodium. However, as previously cited, all of the soils of the project area were reported to be very low to low in sodium and soluble salts.

2.2.8.9 Percent Base Saturation

Percent base saturation refers to the proportion of the CEC occupied by specific cations referred to as bases (i.e. sodium, calcium, magnesium and potassium). To calculate the percent base saturation, divide the sum of the K, Mg, Ca, and Na (the bases) in meq/100g soil by the CEC.

For optimum plant performance the percentage saturation for each of the cations will usually be within the following ranges:

- Potassium: 1 to 5 percent
- Magnesium: 10 to 40 percent
- Calcium: 60 to 80 percent

The proportionate distribution and levels of Base Cations for the soils sampled were good as implied by the satisfactory CEC findings cited above.

2.2.9 Physical and Hydrological Soils Analysis

Soil physical properties and processes are notoriously heterogeneous, with their values depending greatly on the spatial scale of interest. Specifically, the scale-dependency of soil properties and their relation to the processes of lateral groundwater flow and internal water transport are difficult to extrapolate and apply across a linear project area like Upper Llagas Creek.

The exact nature of the functional differences for both soil water retention and saturated hydraulic conductivity differs significantly among soil types with different particle size compositions, organic matter content, pore size geometry and minerology. Despite their heterogeneous nature, the project area soils were analyzed and examined in homogeneous sub-groups in an effort to make cogent interpretations at an applicable spatial scale.

One of the important objectives of this report was to coalesce a set of functional soil parameters from multiple soil samples and integrate them to describe the suitability of a reach or sub-area as a whole for vegetation mitigation. This approach requires using professional judgment to interpret the measured physical and hydraulic properties gathered from site-specific sampling and appropriately incorporate them with other described morphologic properties to represent reasoned assessments relating mitigation site suitability.

2.2.9.1 Particle Size Analysis - Texture

This test determined the proportion of sand, silt and clay sized particles, which make up the mineral or fine earth fraction of the soil being sampled. The proportional distribution of particle sizes dictates the soil texture. The size range categories are:

- Sand: 2.0 - 0.02 mm
- Silt: 0.02 - 0.002 mm
- Clay: < 0.002 mm

The proportion of particle sizes in a given soil will influence the amount of water that it can store, its rate of internal water movement and gas exchange, its nutrient supply, the ease of root growth, its workability and its inherent resistance to erosion. Sand and silt sized particles are generally inert, but clay particles, by virtue of their layered crystalline structure and electrostatic charge, control the retention and release of water and nutrients.

Soil texture was assessed in the field at each sampling site by standard assessment protocols which include sieving to remove organic matter and particle sizes larger that 2mm. The soil was then moistened and massaged into a ball and pressed into a ribbon. The soil is slowly moistened while kneading to achieve the correct moisture content so that the ball "just fails" to stick to the fingers. Kneading continues for a minute longer to ensure that the fine clay aggregates are completely broken down. The soil ball is then pressed out between the thumb and forefinger to form a ribbon. The feel (grittiness) of the soil ball and the length of the ribbon indicate the texture of the soil.

The soil samples were also sent to the laboratory for a mechanical wet-sieving procedure to ascertain the most accurate characterization of the particle size distribution and texture. This additional analysis was done as a correlation exercise and quality control check of the textures that were derived in the field using the previously cited protocol.

2.2.9.2 Soil Water Holding Capacity and Plant Available Water

One of the main functions of soil is to store moisture and supply it to plants. Evaporation from the soil surface, transpiration by plants, microbial consumption and deep percolation all combine to reduce the moisture content of the soil between water inputs (e.g. rain events). If the water content for a control section of the soil column that represents eighty (80) percent of the root mass becomes too low, the plants begin to desiccate and stress. The storing of available moisture in a soil provides a critical buffer which can strongly influence a plant's capacity to establish and withstand dry periods, particularly in a Mediterranean climate. A and L Soil Testing Laboratory provided the soil test readings in the report. Their analysis provides test ratings of very low (VL), low (L), medium (M), high (H), or very high (VH). The purpose of these readings is to provide a relative guideline that is calibrated for the soils of the region. This rating assists in both interpreting and determining the optimum soil nutrient levels for achieving successful plant growth.

The soil water holding capacity of all the soils tested was significantly low with values ranging from 1 inch to 1.4 inches of available water per foot of topsoil. The data from A and L laboratory indicates that the available water holding capacity or plant available water varies considerably across the project area. The available water holding capacity of the soil, will in general, be less than one inch per foot in sandy loams and loamy sands; but up to two inches in the sandy clay loams and clay loam. Therefore, if there are any plans developed for irrigation, they would need to accommodate the available water holding capacity specifications of the reclaimed and amended topsoil accordingly.

2.2.9.3 Soil Water Storage

Water is held in soil in various ways and not all of it is available to plants. Chemical water is an integral part of the molecular structure of soil minerals. Hygroscopic water is held tightly by electrostatic forces to the surfaces of clay micelles and other primary minerals. Both of these forms of soil water are unavailable to plants.

The rest of the water in the soil is held in pores, which is the interstitial void space between the mineral soil particles. The amount of moisture that a soil can store and the amount it can supply to plants depend on the number, size and diversity and geometry of its pore spaces.

Gravimetric water is soil water that is temporarily held in large soil pores and rapidly drains out under the action of gravity soon after input. Plants can make little use of gravimetric water.

Capillary water is soil water that is held in the pores that are small enough to hold water against gravity, but not so tightly that roots cannot absorb it. This soil water occurs as a film around particles, thereby occupying the pore spaces between them. Therefore, it is the particle size distribution or textural class of the soil that is the main source of plant available moisture. As soil water is withdrawn, the larger pores drain first. The finer and more torturous the path of connectivity between pores, the more resistant they are to the removal of water. As water is withdrawn, the film of water becomes thinner, and more plant energy is needed to absorb it. This capillary water can move upwards through soil as well as all directions in response to differences in soil atmospheres and internal suction.

When a soil is considered saturated, all the pores are interpreted to be full of water. After 24 hours, all gravimetric (i.e. gravitational) water drains out, leaving the soil at field capacity. Plants then draw water out of the capillary pores, readily at first, and then with greater difficulty until no more can be extracted and the only water are located in the micro-pores. The soil is then at wilting point and without additional water; a plant will desiccate and die. The amount of water available to a plant is therefore determined by the capillary porosity, which is determined by the difference in percent moisture content as calculated for field capacity and the wilting point for a specific fraction of the soil column that represents eighty (80) percent or more of the root mass. This calculation is represented as the total available water storage or estimated water holding capacity for that particular control section of the soil. The portion of the total available moisture stored, which can be extracted by plants without stress, is termed plant available moisture. Revegetation specialists for this project must have knowledge of the plant available moisture and the estimated water holding capacity of the soils so that water can be adequately supplied, if necessary.

Table 2-3 summarizes the locations where the previously explained tests were performed. The Table below provides the quantitative results for each test. Soil quality measurements and their corresponding rankings for texture and water holding capacity should be viewed as indicating that all the settings described and sampled should be viewed as being moderately to significantly limited for providing a suitable planting medium in their current condition.

Table 2-3 Estimated Available Water and Particle Size Distribution Data

Soil Sample Number	Estimated Water Holding Capacity (%)	Estimated Available Water (inches/foot)	Particle Size Analysis			
			Sand %	Silt %	Clay %	Texture
1.A	43.3	1.3	60	16	23	Sandy Clay Loam
2.B	39.3	1.2	64	12	23	Sandy Clay Loam
3.C	34.8	1	68	16	15	Sandy Loam
4.D	38.1	1.1	72	10	17	Sandy Loam
5.E	32.2	1	72	8	19	Sandy Loam
6.F	37.7	1.1	34	36	29	Clay Loam
7.G	47.5	1.4	48	18	34	Sandy Loam
8.G	41.5	1.2	70	6	23	Sandy Clay Loam

2.2.9.4 Soil Surface Workability

Soil workability refers to the ease with which soil can be cultivated, prepared for planting or precisely graded. Workability is affected by four main soil qualities:

- The structure of the surface soil
- The plasticity and stickiness of the soil when moist
- The amount coarse fragments in the upper 20 inches
- The average percent slope

Soil surface workability is an assessment designed to evaluate the potential for creating a favorable environment for successful out-planting establishment and seedling emergence. Achieving highly uniform and successful rates of out-plantings and emergent seed depends on a well structured surface soil. Good surface structure provides for adequate nutrition and satisfactory seed-soil contact. Poor soil surface structure can be a significant cause for patchy plant performance. Poorly structured surface soils are hard and massive, resulting in one or both of the following symptoms:

- A surface texture dominated by high proportions of sand or clay;
- Topsoil organic matter content that is less than 2 percent by weight.

Poorly structured soils tend to seal-over and become severely hydrophobic if they dry out. The presence of a sealed soil surface may also create a notable problem for emerging seedlings and establishing rooted planting stock. The only real challenge or impediment to surface workability associated with the project area soils is their coarse fragment content, which can be as high as 45 percent by volume, as described in the soil surface horizons for Reaches 6 and 14.

2.2.9.5 Surface Soil Structure

Hard, massive surface soils are difficult to work while they are dry because they break up and shatter into clod like units. This scenario would represent a degraded condition for soil structure, surface infiltration and hydraulic conductivity. Because of the clay fraction in many of the soils in the project area, there will be a narrower moisture range for effective and safe working. However, this may be a more difficult situation to manage for certain areas such as Reach 7a which has the heaviest average texture reported with twenty-nine (29) percent clay (Soil Sample 6.F). Soft and loose soils with granular to subangular structure are more readily worked, but can nevertheless be de degraded by inattentive reclamation, stockpiling and grading practices.

2.2.9.6 Consistence

Soil consistency defined as the strength with which soil materials are held together or the resistance of soils to deformation and rupture. Soil consistency as measured for dry moist and wet soils. Consistency is expressed by measures of firmness, friability, stickiness and plasticity. Soil consistency may be estimated in the field using a simple test. Stickiness is determined by the ability of soil materials to adhere to other objects. Plasticity represents the water content in a soil where the soil transitions between brittle and plastic behavior. A thread of soil is plastic when it fails to crumble when rolled out to a diameter of approximately five (5) millimeters. Soils prone to becoming sticky and plastic can present a problem for replanting.

Most of the topsoil in the project area was described as slightly sticky and slightly plastic. Non-sticky is defined when no soil sticks to your fingers and slightly sticky is defined when the soil begins to stick to your fingers but comes off one or the other cleanly but it does not stretch when the fingers are opened. Non-plastic is defined when a rolled soil wire cannot be formed and slightly plastic is defined when a rolled soil wire can be formed but it can be easily broken and returned to its former state. As alluded to in the previous section, if conditions are too wet, some of soils in the project area would be quite susceptible to significant compaction and severe damage if worked by heavy machinery.

2.2.9.7 Gravels and Cobbles

The effects of gravels and cobbles are obvious with regards to their effect on soil friability, soil density and the difficulty they can represent to precision grading, soil preparation and plant cultivation. In extreme cases, the land can reasonably be interpreted as being non-arable. There are some challenging soils in the project area; these soils are mostly located in Reaches 4, 5, 6, 7b and 14. The soils in these reaches have appreciably high amounts of coarse fragments. There can be substantial costs associated with treating and working with these very gravelly and cobbly soils.

2.2.9.8 Percent Slope

Access of mechanical machinery is a potential problem on sloping ground and in extreme cases, safety is an issue too. Slopes that are generally steeper than twenty (20) percent cannot safely be worked on the contour and slopes that are much steeper than thirty (30) percent are generally considered unsafe for machinery. The increased erosion potential as well as the added costs associated with the time, effort and materials necessary to work steeper settings, are major factors to consider when rating site suitability. Percent slope was cited as a standard measurement at all description and sampling locations and the percent slope has been provided in the upper right header of the soil description narratives in Appendix A.

2.3 Interpretation of Soil Descriptions and Laboratory Analyses

The soil properties outlined on the both the preceding and following pages all have a bearing on the productivity and performance of soils being evaluated for their mitigation suitability. The following provide s as basic summary of what was observed in the thirty six (36) pedons described for this report. A pedon is a three-dimensional sample of a soil just large enough to show the characteristics of all its horizons.

2.3.1 Soil Horizons and Descriptive Morphology

An A horizon is the uppermost, darkest zone that is richest in organic matter. The upper section of the A horizon usually contains humus along with plant and animal matter in varying stages of decay. The development and depth of A horizons depends on landscape position, density and type of vegetation, internal drainage, parent material and time. The B Horizon is immediately below the A-horizon and it contains deposits of organic matter and clay leached from the A horizon. The C horizon is the layer in the soil profile below the B horizon and immediately above weathered bedrock; it consists chiefly of weathered partially decomposed rock.

Moderately well to well developed A horizons were found in all the pedons examined in the study. The A horizons ranged from the shallowest average of six (6) inches associated with Reach 14 to the thickest average of sixteen (16) inches associated with Reach 7b. The A horizons contained weak to moderate granular and subangular blocky structure. The mean A horizon depth for all thirty six (36) pedons examined was twelve (12) inches. Overall color was contrastingly darker and root density was highest in the A horizons.

Of the thirty six (36) pedons that were sampled during this field examination twelve (12) exhibited A-C horizonation; eighteen (18) pedons had A-AC-C horizonation; and six (6) pedons showed an A-B-C horizonation. AC horizons were characterized by weak subangular blocky structure and common very fine and fine roots. The C horizons were massive or densic in all of the pedons described. These compacted layers were identified by being very hard and firm in place, and very restrictive to rooting. C horizons designated as having densic materials were found within forty (40) inches of the ground surface in sixteen (16) out of the thirty six (36) pedons. Plant roots were completely limited by all of these compacted layers due to the lack of structural planes of weakness. Densic layers were described when the horizon was of very firm consistence, obviously compacted and massive in all visible faces of the pit. Densic materials were defined as being root limiting for this study.

2.3.2 Redoximorphic Features and Groundwater Elevation

Saturated soil biogeochemistry can produce complex color patterns in soil horizons referred to as Redoximorphic Features. Redoximorphic Features are relied on in descriptive morphology for identifying the groundwater or hyporheic contact zone that occurs adjacent to the creek channel. These soil features are relied on for interpreting periods of soil saturation or seasonal high groundwater levels over long periods of time.

In saturated soils bacterial decomposition of soil organic matter (roots insects) consumes oxygen dissolved in soil water. When all of the dissolved oxygen is consumed the soil water is said to be reduced. If bacterial decomposition continues beyond this point, organic chemicals are produced that reduce Fe (Iron) and Mn (Manganese) oxide minerals. If the decomposing organic matter is roots, then reduction of Fe and Mn occurs mostly in the soil adjacent to the root. However, if there are enough organic compounds dissolved in the soil water (dissolved carbon) then entire horizons can become reduced. Redoximorphic features are formed in seasonally and perennially saturated soils by the processes of reduction, translocation, and oxidation of Fe and Mn. Soil reduction is defined when an ion gains an electron; transforming $Fe3^+$ to $Fe2^+$ and $Mn3^+$ to $Mn2^+$ (i.e. 2^+ is the reduced state). Oxidation occurs when an ion loses an electron; thereby transforming $Fe2^+$ back to $Fe3^+$ and $Mn2^+$ back to $Mn3^+$ (3^+ is the oxidized state).

In the oxidized (3^+) state Fe will color portions of soils red, brown, yellow, and/or orange, where as Mn in the oxidized (3^+) state produces black colors. Fe and Mn oxide minerals coat the surfaces of sand, silt, and clay particles imparting the color of the oxide mineral coating and a variegated appearance to the soil profile.

A previous study (Soil and Groundwater Characterization Report for the Upper Llagas Creek Flood Protection Project, Reaches 4, 5 and 6), observed that in the strip of land immediately adjacent to the channel, the groundwater table is located one to three feet below the channel thalweg, (Peters, et al. 2003). This statement indicates a losing stream or lateral phreatic profile that corroborates the lack of identifiable redoximorphic features in the adjacent channel soils. Only two of the channel bank soils that were described at the thalweg-invert elevation exhibited any redoximorphic features, suggesting that there is little appreciable lateral infiltration or hyporheic zone of contact between the in-channel surface water and groundwater levels in the adjacent channel soils.

2.3.3 Physical Barriers to Root Growth - Densic Material and Paralithic Contacts

Densic materials are relatively unaltered materials and do not meet the requirements for any other named diagnostic horizons or any other diagnostic soil characteristic. Densic materials by definition (Soil Survey Staff, 1999) have a non-cemented rupture-resistance class. Paralithic materials, by contrasting definition, require the soil fabric or matrix to be at least moderately well cemented (Soil Survey Staff, 1999). The bulk density or fabric of these massive layers is such that roots cannot enter, except through cracks and fissures, of which very few were observed. Non-cemented agglomerate rocks can be densic if they are imbedded in a dense matrix or they are so tightly packed that they prevent roots from entering, except through cracks.

Densic materials are non-cemented root restrictive horizons by taxonomic definition and thus differ from paralithic materials and massive indurated soil materials which are cemented root restrictive horizons. Densic materials have, at their upper boundary, a densic contact if they have no cracks or if the spacing between rooted cracks is four (4) inches or more. These diagnostic features can be used to differentiate soil series and families if the materials are within the particle size control section. The particle size class of the soil is determined by the textural materials in the particle size control section (10 to 40 in. bgs). For the purposes of this study, densic materials were often not included in the analyses of the ten (10) to forty (40) inch control section. The particle size control section for Entisols and Inceptisols was chosen because ninety percent (90) of the soils described in the project area are classified as typic xerorthents and xerofluvents, which are Entisols. Entisols are defined as soils that do not show any appreciable profile development other than an A horizon. An Entisol has no diagnostic subsurface horizons, and most of these soils exhibit little genetic alteration from their parent material, which in this setting are unconsolidated alluvial sediments.

Table 2-4 is a summary of the soil attributes that correlate the depth of the soil solum and topsoil horizon development and with the downward proliferation of roots and contact to densic substratum.

Table 2-4 Average Interpretative Depths by Bulked Soil Sample Group and Project Area Reach

Bulked Soil Sample Number and Corresponding Reach	Average Depth in Inches to the Bottom of the "A" Horizon	Average Depth in Inches to the Bottom of the "A/C" Horizon	Average Depth in Inches to the Bottom of the Soil Solum	Average Depth in Inches to the Bottom of the Root System	Average Depth in Inches to the Top of the "Cd" Horizon
1A - Sites 1 to 4 (Reach 4)	15	(0 of 6 samples) none present	22	32	(2 of 6 samples) 37
2B - Sites 5 to 8 (Reach 4)	15	(2 of 4 samples) 19	22	30	(4 of 4 samples) 33
3C - Sites 9 to 12 (Reach 5/6)	11	(3 of 4 samples) 19	19	35	(2 of 4 samples) 41
4D - Sites 13 to 17 (Reach 6)	13	(3 of 7 samples) 17	17	30	(5 of 7 samples) 34
5E - Sites 18 to 21 (Reach 7a)	10	(3 of 4 samples) 14	24	30	(1of 4 samples) 36
6F - Sites 22 to 25 (Reach 7a)	11	(1 of 4 samples) 14	24	35	(2 of 4 samples) 37
7G - Sites 26 to 29 (Reach 7b)	16	(3 of 4 samples) 22	22	30	(0 of 4 samples) none present
8H - Sites 30 to 32 (Reach 14)	6	(3 of 3 samples) 12	12	32	(0 of 3 samples) none present

Chapter 3

Discussion and Recommendations

3.1 Evaluation of Mitigation Site Suitability by Reach

Identifying a potential riparian mitigation site entails surveying the soil landscape within the project vicinity looking for areas of soil that (1) are large or expansive enough to meet permit mandated area requirements, (2) allow appropriate access for construction equipment, monitoring, and potentially for irrigation where appropriate, (3) meet the previously cited parameters for physical, hydrologic and chemical soil quality. And lastly, (4) the candidate sites preferably should also be capable of being restored to a similar hydrogeomorphic type (Brinson, 1996). The soils of each project reach are evaluated for their inherent attributes and capacity to be repaired to a level that would support the restoration of an in-kind or similar riparian community type; one that will successfully establish and persist with minimal or no intervention. This last criterion for creating self sustaining vegetative communities is often the most difficult one to satisfy.

The following is a summary by project reach that considers both the soil qualities and the issues associated with developing a potential mitigation site. The reaches are ranked by suitability for mitigation, with the lowest number being the highest suitability.

3.1.1 Lower Reach 4

Mitigation Site Ranking:	7th of 8
Soil Suitably Rating:	Moderately Good
Surface Water Hydrology:	Unfavorable
Mitigation Site Recommendation:	Not a Suitable Candidate Mitigation Area

Lower Reach 4 is the downstream part of Reach 4 and extends from Buena Vista Avenue north to Foothill Avenue. The soils description is based on data collected from sampling sites: 1.1, 2.1, 3.1, 3.2, 4.1 and 4 .2

The soils in the downstream section of Reach 4 are moderately suitable for revegetation. Most of the sampling sites had good topsoil depth, and the area was not dominated by the presence of a shallow gravelly substratum that would be considered an insurmountable challenge to successful riparian planting. The majority of the soil profiles characterized in this reach had an average of 15 to 25 percent gravels by volume and a light sandy clay loam texture in the top 20 inches. The inherent resistance or soil strength of the native topsoil was generally less than what is considered deleterious to root growth but still far from optimum. In general, the soils are firm yet friable when dry and have been classed as workable. These soils are naturally dense, with low organic matter content. Thus, they would be likely to re-compact upon reapplication and re-grading, if left un-amended.

The solum consists of the surface and subsoil layers that have undergone the same soil forming conditions. The base of the solum is the relatively un-weathered parent material, termed the C horizon or substratum. There was a fair abundance of roots observed in the soil solum but they were predominantly very fine and fine sizes suggesting that the existing soil densities did impose some relative difficulty for downward root proliferation. The hydraulic conductivity of the topsoil is moderately permeable, and this implies that these soils are disposed to being naturally dense pedons. The relatively shallow depth at which the two reported densic layers were described, in combination with the observed fill and debris reported in the soil description taken at sampling location 3.1 suggests that these moderately favorable topsoil conditions may not consistently persist through Reach 4 and soil conditions could change abruptly over a short distance or following excavation.

The majority of the described soil solum (i.e. A and Bt Horizons) associated with the Sampling Sites 1.1 through 4.1 had an average of fifteen (15) to twenty five (25) percent gravels by volume with a light sandy clay loam texture in the top twenty (20) inches. In general, the soils are firm yet friable when dry and not prone to becoming too sticky or too plastic when deformed and moist. These collective attributes together give the soils a workable interpretation.

The estimated plant available water in the top twenty (20) inches of topsoil is inadequate for successful riparian planting. This condition could be improved by the addition of organic matter to increase its percent by weight from 2.1 percent to four (4) or even five (5) percent. Plant hydration during initial establishment is more critical and limiting a factor than soil quality. There is no water present in the channel during the late summer through autumn in this lower section of the project area and this is a practical constraint against recommending site suitability. The final configurative design for the new channel has yet to be determined but if the channel is widened then it will be less confined and more of the substrate surface area will be available for water infiltration. Assuming that the summer release schedule from Chesbro Reservoir is kept the same, then this lower part of Reach 4 would continue to be dry, and it would be a difficult to recommend this section as an eligible candidate for successful riparian mitigation, regardless of soil quality.

If the southern part of Reach 4 is selected as a riparian mitigation site, it would be recommended to amend the topsoil before reuse. For issues of engineering and grading, it might be necessary to screen the soil to achieve the needed degree of material consistency before reapplying the topsoil. Adding organic matter to lighten the stockpiled topsoil mix and make it more favorable to plant growth would have to be balanced with the requirements of precision grading and slope stability and geotechnical reasons. As indicated in the soil fertility report, the soil in this reach would also require the addition of organic matter, gypsum, nitrogen, phosphorus and potassium to adequately support riparian plantings. The favorable ratings assigned to this group of soils for Cation Exchange Capacity and pH, combined with a texture collectively described as light sandy clay loam imply that these topsoil's would be investment worthy, if the hydration issue was effectively addressed. The reclaimed topsoil should then be reapplied in lifts to achieve the necessary balance between engineering parameters and friable topsoil conditions with targeted gravimetric bulk densities of less than 1.6 gm/cc (in situ and corrected for percent gravels) for the top twenty (20) inches.

Adequate water during initial establishment of plantings is more critical and limiting a factor than soil quality. There is no water present in the channel during the late summer through autumn in this section of Reach 4 and this is a practical constraint limiting mitigation potential. If the design for the new channel includes widening, then the channel will be less confined and more of the channel bed surface area will be available for water infiltration. Assuming that the summer release schedule from Chesbro Reservoir is unchanged, this lower part of Reach 4 would continue to be dry, even without a widened channel.

In summary, there are substantive challenges to achieving suitable topsoil conditions that will successfully support riparian mitigation in this lower section of Reach 4, and it is unlikely that hydrologic conditions would support self-sustaining riparian vegetation. This section is not recommended as a candidate for riparian mitigation.

3.1.2 Upper Reach 4

Mitigation Site Ranking:	5th of 8
Soil Suitably Rating:	Moderately Poor
Surface Water Hydrology:	Unfavorable
Mitigation Site Recommendation:	Not a Suitable Candidate Mitigation Area

Upper Reach 4 is the upstream portion of Reach 4 and extends from Foothill Avenue north to the confluence with Reaches 5 and 14. The soils description is based on data collected from sampling sites 5.1, 6.1, 7.1 and 8.1

The soils in the northern section of Reach 4 are moderately poor and are less suitable for revegetation than the soils in the southern section of Reach 4, although the topsoil depth average that is the same. All of the soil profiles characterized in this upper section of Reach 4 had densic materials at an average depth of 33 inches below ground surface. The majority of the soil profiles characterized in this reach had an average of 20 to 35 percent gravels by volume and a light sandy clay loam texture in the top 20 inches. In general, the topsoil consistence is hard when dry but becomes friable when moist. This topsoil has been classed as workable.

The presence of moderately deep to deep densic materials are a moderate constraint to successfully riparian planting. The inherent resistance or soil strength of the native topsoil when dry was just less than 3,000 kPa, as measured at Sampling Site 5.1. However, the soil strength measured at ten (10) inches bgs at Sampling Site 8.1 was greater than 5,000 kPa, a value that represents significant compaction or soil density. Soil strength, in terms of relative compaction, is an important assessment because strength is a measure of the resistance that the soil offers to further compaction or, in this case, one that will resist successful root growth or even earth worm penetration.

The soils in the northern section of Reach 4 are low in organic matter similar to the lower part of Reach 4. This suggests that these soils would be inclined to re-compact upon reapplication and re-grading, if left un-amended. There were abundant roots observed in the soil solum but they trended to mostly very fine and fine sizes below twenty five (25) inches. This observation suggests that the existing soil densities do impose some relative resistance for downward root proliferation. The hydraulic conductivity of the topsoil, as measured at ten (10) inches bgs at Sampling Site 5.1 is moderately slow but the hydraulic conductivity measured at Sampling Site 8.1 was slow. The relatively shallow depths at which the densic layers were found suggests that the topsoil conditions may not consistently persist across this upper section of Reach 4 and could abruptly change over short distances.

The majority of the described soil solums (i.e. A and A/C Horizons) associated with the Sampling Sites 5.1 through 8.1 had an average of twenty (20) to thirty five (35) percent gravels by volume with a light sandy clay loam texture in the top twenty (20) inches. In general, the soils are firm yet friable when dry and not prone to becoming too sticky or too plastic when deformed and moist. These collective attributes together give the soils a workable rating. As stated previously, any amount of organic matter that may be recommended to improve the topsoil friability, structure, nitrogen availability and water holding capacity will have to be balanced with the requirements of precision grading, soil cohesiveness and density that are important for slope stability and geotechnical reasons.

The estimated plant available water for the top twenty (20) inches of soil is currently considered inadequate at 2.1 inches. However, this current condition could be improved by adding organic matter to increase the soils from two (2) percent to four (4) or perhaps even five (5) percent by weight.

If the northern part of Reach 4 is selected as a riparian mitigation site, it would be necessary to amend the topsoil before reuse. Adding organic matter to lighten the stockpiled topsoil mix and make it more favorable to plant growth would have to be balanced with the requirements of precision grading and slope stability. The soil in this reach would also require the addition of gypsum, nitrogen, phosphorus, potassium, zinc, manganese and boron in order to prepare it for successful planting.

The ratings assigned to this group of soils for Cation Exchange Capacity and pH is better than those reported for Sampling Sites 1.1 through 4.1. These qualities, combined with a texture that was collectively described as a light sandy clay loam suggests that the topsoil's associated with Sample Sites 5.1 through 8.1 may be investment worthy, particularly if the plant hydration issue could be effectively addressed through portable irrigation. The reclaimed topsoil should then be reapplied in lifts to achieve the necessary balance between engineering parameters and friable topsoil conditions with targeted gravimetric bulk densities of less than 1.6 gm/cc (in situ and corrected for percent gravels) for the top twenty (20) inches.

There is no water present in the channel of this northern section Reach 4 during the late summer through autumn. This is a significant practical constraint for successful revegetation. Assuming that the summer release schedule from Chesbro Reservoir is unchanged after this project is implemented, this upper part of Reach 4 would continue to be dry. In that situation, this section would not be recommended as a candidate for successful riparian mitigation, regardless of soil quality.

In summary, there are substantive challenges for achieving suitable topsoil conditions that will successfully support riparian mitigation in this upper section of Reach 4, and it is unlikely that hydrologic conditions that would support self-sustaining riparian vegetation are achievable.

3.1.3 Reach 5 and Lower Reach 6

Mitigation Site Ranking:	2nd of 8
Soil Suitably Rating:	Moderately Poor
Surface Water Hydrology:	Somewhat Favorable
Mitigation Site Recommendation:	Not a Suitable Candidate Area

Reach 5 extends from the confluence with Reaches 4 and 14 east of US 101 to the west side of US 101, where Llagas Creek bends to the north. Lower Reach 6 extends from the north end of Reach 5 to Church Avenue. The soils description is based on data collected from sampling sites 9.1, 10.1, 11.1 and 12.1

The soils in Reach 5 and the southern part of Reach 6 are moderately poor or not suitable for revegetation. The topsoil depth average was rated as the third lowest of those in the study area. Only two of the four soil profiles characterized in this reach had densic materials and the average depth of contact to the dense layers was 35 inches below ground surface. The topsoils in these reaches averaged of 35 percent gravels by volume and were predominantly comprised of heavier sandy loams.

The inherent resistance or soil strength of the native topsoil when dry was less than 3,000 kPa, as measured at Sampling Site 10.1. The percolation facility embankment soils located along the northwestern section of Reach 5, north through the Church Avenue underpass to the southern part of Section 6 were not measured for soil strength because they were very dense and presumably engineered to exacting specifications for achieving a level of compaction necessary to control seepage. These settings would not be appropriate for riparian mitigation or consistent with levee management practices.

The soils of Reach 5 and 6 are observably denser than those in Reach 4, possibly because this area has had an active history of private property development, contemporary commercial agriculture and levee embankment engineering. There were roots observed in the soil solum but they trended quickly to very fine and fine sizes below twenty (20) inches. The soils along the northwestern part of Reach 5 were mostly modified during the installation of the Church Avenue percolation facilities. Nevertheless, these soils tied for the second highest percent organic matter content of the project reaches with a reported reading of 2.2 percent by weight. The hydraulic conductivity of the more native topsoil, as measured at ten (10) inches bgs at Sampling Site 10.1 was moderately permeable.

The estimated water in the topsoil that is currently available to plants (1.6 inches) is inadequate for establishing riparian plants and the topsoil at the sampling sites in this reach have thirty five percent gravels by volume. This condition could be improved by adding organic matter to the soils, but that adjustment cannot be recommended for the engineered embankment fill of the Church Avenue percolation facilities. The topsoil is predominantly comprised of heavier sandy loams. The clay content is approximately 15 percent by weight. The ratings assigned to this group of soils for Cation Exchange Capacity and pH is the best of those being reported.

Adding organic matter to lighten the stockpiled topsoil mix is recommended to improve the topsoil friability, structure, nitrogen availability and water holding capacity will have to be balanced with the requirements of precision grading, soil cohesiveness and density that are critical to slope stability. Improving the balance of the soil would also require the addition of substantial amounts of gypsum, phosphorus and potassium, as well as zinc and manganese.

There are persistently ponded sections of surface water present in Reach 5 during the late summer and autumn. These ponded areas are intermittently present downstream to the confluence with Reach 14 and Reach 4. If the new channel is significantly widened to provide added flood stage conveyance, then the channel will be constructed to be less confined than it is presently. This change in hydraulic radius will result in more of the channel bed surface area being available for infiltration and groundwater recharge. If the summer release schedule from Chesbro Reservoir is unchanged after this project is implemented, then there is some concern that the summer release flows may not migrate far enough south in the lower part of Reach 6 and all of Reach 5 to create the ponded sections of surface water that presently exist. This section may present some risk for becoming increasingly dry and unsuitable for riparian mitigation.

In summary, there are substantive challenges this area has due to soil quality. However, if the existing water conditions in the channel can be relied on to continue as they are now under post project conditions, then Lower Reach 6 and Reach 5 would rank as the second best mitigation candidate due to the assumed continued presence of late season water.

3.1.4 Upper Reach 6

Mitigation Site Ranking:	1st of 8
Soil Suitably Rating:	Moderately Good (with substantial logistical and management considerations)
Surface Water Hydrology:	Favorable
Mitigation Site Recommendation:	Suitable Candidate Mitigation Area

Upper Reach 6 extends from Church Avenue north to Monterey Road. The soils description is based on data collected from sampling sites 13.1, 14.1, 14.2, 15.1, 15.2, 16.1 and 17.1

The soils in the northern section of Reach 6 are moderately good but less than fully suitable in their current condition. This reach had an average topsoil depth of 17 inches that was the second shallowest recorded for all of the soils examined, but the average topsoil colors in this area were the second darkest amongst all soils. Five of the seven sample sites in this upper section of Reach 6 had densic materials at an average depth of 34 inches bgs. The presence of moderately deep densic materials is a partial constraint to successful riparian planting, because there is reliable late season release water present. The majority of the soil samples had an average of 20 to 35 percent gravels by volume and a sandy loam texture in the top 20 inches. In general, the soils are soft and loose when dry and are classed as workable. As with other reaches, these topsoil conditions may not consistently persist across this area, and conditions could change abruptly over a short distance or following excavation.

Although two of the soil profiles characterized had conditions suggesting compaction the topsoil in the central section of Reach 6 is generally less dense, having the highest organic matter content reported for any of the soils in the study area averaging 2.9 percent by weight. Consequently, the pH was slightly acid, and this is the only reach where the soil amendment recommendation is for liming instead of gypsum applications. Despite the higher percent organic matter present in these soils, the estimated water in the topsoil that is currently available to plants is considered inadequate (1.8 inches for the top 20 inches). However, this condition could be improved by adding more organic matter to increase the content in the soils from 2.9 percent to four (4) or even five (5) percent by weight. The ratings assigned to this group of soils for Cation Exchange Capacity were the second highest reported. Adding organic matter to lighten the stockpiled topsoil mix and make it more favorable to plant growth would have to be balanced with the requirements of precision grading and slope stability. Improving the soil would also require the addition of lime, nitrogen, phosphorus and potassium. Soil amendments should also include sulfur, as a pH correcting measure.

Existing soil density imposes some resistance to root growth as the soil column makes the transitional contact with the massive subsoil horizon or strata of densic materials. The hydraulic conductivity of the topsoil, as measured at ten (10) inches bgs at Sampling Sites 13.1 and 15.2 were low, which indicates that these moderately deep soils are somewhat limited in their moisture holding capacity. The hydraulic conductivity measured at Sampling Sites 14.1 and 17.1 was moderately slow.

Most of the soil profile sites for this reach were located on a lower terrace and flanking benches adjacent to the channel. These geomorphic features are currently vegetated with thickets of Himalayan blackberry (Rubus discolor) and arroyo willow (Salix lasiolepis), with the occasional sycamore (Platanus sp.) or pine (Pinus sp.). The topographic position of the soil profiles taken along the west bank terrace was less than two feet above the surface water elevation in the channel. Even though the soil pits extended below the water surface elevation in the channel, the soils of the neighboring terrace were dry and absent of any redoximorphic features. The soil profile and lack of redoximorphic features indicate that Upper Llagas Creek is a losing stream system with a steeply descending lateral hyporeic profile. Regardless, as described in the following paragraphs, the soils that are present in much of Reach 6 could be made suitable for riparian mitigation due to their access to late season sub-irrigation water if the reconstructed topsoil could be made more infiltrating to lateral flow migration.

Although the soils in this reach are very gravelly and only shallow to moderately deep, the other soil conditions, in conjunction with the available water, make this reach most suitable for riparian mitigation plantings. If Reach 6 is selected for riparian mitigation, then the topsoil should be reclaimed, stockpiled, amended and reused to the greatest extent practicable. However, the topsoil has a significant noxious weed problem (both seeds and rhizomes) that would have to be adequately addressed (e.g. sterilization) before this soil could be reapplied and used for mitigation planting. This requirement may be cost prohibitive.

In summary, there are challenges to achieving topsoil reclamation, amendment and regrading in Reach 6. However, this area ranks as the best on-site mitigation site opportunity because of the persistent presence of water in the creek channel late into the autumn.

3.1.5 Lower Reach 7a

Mitigation Site Ranking:	3rd of 8
Soil Suitably Rating:	Moderately Good
Surface Water Hydrology:	Favorable
Mitigation Site Recommendation:	Suitable Candidate Mitigation Area

Lower Reach 7a extends from Monterey Road to the southern end of Upper Reach 7a. Lower Reach 7a would start just west of the Monterey Road overpass, where the new channel would depart to the northwest and be cut and formed through the adjacent riparian and agricultural floodplain. The soils description is based on data collected from sampling sites 18.1, 19.1, 20.1 and 21.1.

The soil sample locations for Lower Reach 7a are located from southeast to northwest across the county Bowtie parcel (APN 779-06-030), located just northeast of Lake Silveira. These soils are considered good, but less than fully suitable, in their current condition. The sample sites had an average topsoil depth of 24 inches, which was tied as the deepest recorded for all of the soils examined in the study area. The average topsoil colors were the third darkest which suggests there is adequate organic matter present. Only one of the four soil profiles characterized for Reach 7a had densic materials present in the subsurface. The one subsurface horizon was 36 inches bgs. The lack of dense layers and the generally deeper soil support this as a suitable onsite mitigation area for a xeric type of riparian community.

The one significant constraint with Lower Reach 7a is that this area would not have access to reliable late season water for irrigation. The proposed channel orientation for Lower Reach 7a starts just west of the Monterey Road overpass where it would depart to the northwest and be cut and formed through the adjacent riparian and agricultural floodplain.

The inherent resistance or soil strength of the native topsoil when dry was deemed acceptable with measurements of less than 3,000 kPa, being recorded at Sampling Sites 18.1 and 20.1. The hydraulic conductivity of the topsoil, as measured at ten (10) inches bgs at Sampling Sites 18.1 and 20.1 were moderately low with readings close to 0.6 inches per hour. The topsoil in Lower Reach 7a are generally less dense than the soils found immediately flanking the channels because there was some evidence in the soil profile of a history of prior disking and cultivation. The majority of the soil profiles characterized in this reach had an average of 20 percent gravels by volume and a heavy sandy loam texture in the top 20 inches. In general, the soils are hard when dry and friable when moist and are classed as workable.

The estimated water in the topsoil that is currently available to plants is inadequate at 1.6 inches for in the top 20 inches. However, this condition could be improved by adding more organic matter from 1.9 percent to four (4) or even five (5) percent by weight. Adding organic matter to lighten the stockpiled topsoil mix and make it more favorable to plant growth would have to be balanced with the requirements of precision grading and slope stability. These soils have the second lowest organic matter content reported with an average reading of 1.9 percent by weight. The ratings assigned to this group of soils for Cation Exchange Capacity The pH was neutral. Improving the soil would also require the addition of gypsum, nitrogen, phosphorus, potassium, zinc, and boron in order to prepare it for successful riparian planting.

Although the soils in this reach are gravelly and moderately deep, other soil conditions were acceptable. These soils will respond to appropriate site preparation techniques such as de-compaction tilling and the appropriate application of fertilizer and soil amendments. This area will have access to reliable late season water present in the channel. Although riparian mitigation may be appropriate on the channel banks, the feasibility of that proposal has yet to be determined because the level of backwater or inundation into this reach from the Chesbro Reservoir releases is unknown. Therefore, most of the mitigation opportunity for this reach is outside of the future channel on what will be the adjacent floodplain where the potential to expand the boundaries of the adjacent riparian forest would be possible.

If Lower Reach 7a is selected for riparian mitigation, then the topsoil should be reclaimed during the initial stages of channel excavation and stockpiled, amended and reused as inset material for forming low elevation benches in the new channel. The remainder of the adjacent floodplain associated with the county Bowtie parcel should be used for riparian oak woodland restoration. However, the topsoil does apparently have some noxious weeds and potential seed bank problems that would have to be thoroughly addressed (e.g. sterilization) before this soil could be reapplied and used for proving in-channel mitigation.

In summary, Lower Reach 7a is not considered a prime candidate for riparian mitigation due to the likely lack of water in the channel late into the summer season. However, when considering soil quality alone, this reach could rank as the one of the best on-site mitigation site opportunities, but only if irrigation is supplied as a medium term maintenance commitment. This area does afford some acknowledgement though, because of its larger area, good soil qualities and plausible access to irrigation water.

3.1.6 Upper Reach 7a

Mitigation Site Ranking:	4th of 8
Soil Suitably Rating:	Moderately Good
Surface Water Hydrology:	Uncertain
Mitigation Site Recommendation:	Potentially Suitable Candidate Mitigation Area

Upper Reach 7a would be a new channel, originating at the northern end of Lower Reach 7a where the newly constructed channel would extend north through land that is immediately adjacent to land currently used for commercial agriculture. The soils description is based on data collected from sampling sites 22.1, 23.1, 24.1 and 25.1

The soil sample locations for Upper Reach 7a are located between Middle Avenue and Watsonville Road, north of the county Bowtie parcel. These soils are good, but are less than fully suitable in their current condition. The average topsoil depth was 24 inches, which tied with Lower Reach 7a as the deepest recorded in the study area.

Only two of the four soil descriptions in Upper Reach 7a had densic materials present, at an average depth of 36 inches bgs. The topsoils in Upper Reach 7a are probably less dense that soils in other reaches because there was some evidence in the soil profile of a history of prior disking and cultivation. The soils in this reach had an average of 15 to 20 percent gravels by volume and a heavy sandy loam texture in the upper 20 inches. The one anomaly was Soil Description Site

25.1, which is located near the isolated stormwater detention basin located southeast of Watsonville Road. In general, the soils are firm and friable and are classed as workable.

These soils have the third highest organic matter content in the project reaches averaging 2.2 percent by weight and were slightly acid. Despite this organic matter content, the estimated water in the topsoil that is currently available to plants is inadequate in the top 20 inches of topsoil. This condition could be improved by adding more organic matter. These agronomic soils will respond to appropriate site preparation techniques such as de-compaction tilling and the appropriate application of fertilizer and soil amendments. Improving the soil would require the addition of organic matter, lime, nitrogen, phosphorus and potassium, zinc, and boron. This group mixture of soils was one of only two subsamples from the study area for which additional sulfur, a pH correcting measure, was recommended. Adding organic matter to lighten the stockpiled topsoil mix and make it more favorable to plant growth would have to be balanced with the requirements of precision grading and slope stability.

The described soil solums (i.e. A, B and A/C Horizons) associated with Soil Description Sites 22.1 through 25.1 had an average of fifteen (15) to twenty (20) percent gravels by volume with a heavy sandy loam texture in the top twenty (20) inches. The one anomaly was the Soil Description Site 25.1 located near the isolated stormwater detention basin located southeast of Watsonville Road. This location had topsoil with upwards of 40 percent gravels by volume in the control section. In general, the soils are firm and friable yet not too sticky or too plastic when deformed and moist. These collective attributes together give these soils a workable rating. The estimated plant available water is currently considered inadequate at 1.8 inches for the top twenty (20) inches of topsoil. However, this current condition could be improved by adding some more organic matter to increase the soils from 2.9 percent to perhaps four (4) or even five (5) percent by weight.

If Upper Reach 7a is selected as a suitable site for riparian mitigation then the topsoil should be reclaimed during the initial stages of channel excavation and then stockpiled, amended and reused as inset material for forming low elevation insets in the new channel. The remainder of the adjacent floodplain terrace should be restored as a stringer or narrow gallery of xeric riparian oak woodland. However, the topsoil apparently has some noxious weeds and potential seed bank problems that would have to be thoroughly addressed before this soil could be reapplied and used as the in-channel bench forming material.

In summary, there are fewer substantive challenges for achieving successful riparian mitigation in Upper Reach 7a than on some of the other reaches. This area ranks as the fourth best on-site mitigation site opportunity available, because of its larger area, ease of access and good soil qualities. However, despite the relatively favorable soil conditions, there is little potential for establishing on-site riparian mitigation along Upper Reach 7a if surface water is not going to be present in the channel late into the autumn.

3.1.7 Reach 7b

Mitigation Site Ranking:	6th of 8
Soil Suitably Rating:	Moderately Good
Surface Water Hydrology:	Uncertain
Mitigation Site Recommendation:	Unlikely Candidate Mitigation Area, (Urban Encroachment and Land Use)

The soil description and sampling sites for Reach 7b are positioned along the West Little Llagas Creek flood protection channel located west of downtown Morgan Hill between Watsonville Road and Cosmos Avenue. Reach 7b originates at the northern end of Upper Reach 7a. This area is located where West Little Llagas Creek and the new constructed channel will connect, just north of the Watsonville Road overpass. This reach of the channel was previously reengineered and upgraded to provide improved flood protection for downtown Morgan Hill. The soils description is based on data collected from sampling sites 26.1, 27.1, 28.1 and 29.1

Soils in this reach are good, but are less than fully suitable in their current condition. Sample sites in this reach had an average topsoil depth of 22 inches, which was tied for being the second deepest in the study area. None of the four soil profiles characterized in Reach 7b had densic materials present in the subsurface.

The soil strength of the native topsoil when dry was deemed acceptable with measurements of less than 3,000 kPa. The hydraulic conductivity of the topsoil, as measured at ten (10) inches bgs was moderately slow with readings close to 0.6 inches per hour. The topsoil in Reach 7b is somewhat denser than downstream topsoils, because they were re-graded when this section of West Little Llagas Creek became urbanized. These soils have an average organic matter reading of 1.8 percent by weight, and the pH was neutral.

The estimated water in the topsoil that is currently available to plants is inadequate in the upper 20 inches of topsoil. However, this condition could be improved by adding more organic matter. Improving the soil would also require the addition of organic matter, gypsum, nitrogen, phosphorus, potassium, and boron in order to prepare it for successful riparian planting.

The soil solum (i.e. A, B and A/C Horizons) associated with Sample Sites 26.1 through 29.1 had an average of fifteen to twenty percent gravels by volume with a heavy sandy loam to loamy sand texture in the top twenty inches.

The estimated plant available water is currently considered inadequate at 2.3 inches for the top twenty inches of topsoil. However, this condition could be improved by adding some more organic matter to increase the soils from 1.8 percent to perhaps 4 or even 5 percent by weight. Given their current function as engineered embankments and urban parkland, the soils in this area would not be recommended for techniques such as de-compaction tilling. Adding organic matter to lighten the stockpiled topsoil mix and make it more favorable to plant growth would have to be balanced with the requirements of precision grading and slope stability.

Although the soils in this reach are gravelly, moderately dense, and modified by human activities, they can be improved at a reasonable cost. The topsoil apparently has some invasive weeds and potential seed bank problems that would have to be addressed before they could be reapplied and used to form the inset material necessary for providing mesic riparian mitigation.

The mitigation opportunities associated with Upper Reach 7a are located both inside and just outside of the channel on top of the narrow floodplain terrace. However, the potential for establishing on-site riparian mitigation is highly contingent on surface water being reliably persistent in this reach of the channel late into the autumn.

In summary, there are significant and substantive challenges for achieving successful riparian mitigation in Reach 7b. This reach would rank as the sixth best on-site mitigation opportunity available in the project area. Reach 7b also has good existing access along the entirety of its length.

3.1.8 Reach 14

Mitigation Site Ranking:	8th of 8
Soil Suitably Rating:	Poor
Surface Water Hydrology:	Uncertain, Most Likely Improbable
Mitigation Site Recommendation:	Not a Suitable Candidate Mitigation Area

The soil sampling sites for Reach 14 are positioned along the East Little Llagas Creek flood protection channel located east of Highway 101 from just north of San Martin Avenue to just south of Church Avenue. The soils description is based on data collected from sampling sites 30.1, 31.1 and 32.1

These soils are coarse and droughty and are not suitable for riparian mitigation in their current condition. The average topsoil depth of only 12 inches, which was the thinnest, recorded in the project area.

The estimated water in the topsoil that is currently available to plants is inadequate at 1.2 inches for the top twelve (12) inches of topsoil. None of the three soil descriptions performed in Reach 14 had densic materials present in the subsurface. Improving the soil would require the addition of gypsum, nitrogen, phosphorus and potassium, with no corrective adjustments necessary for micronutrients or trace elements. These soils would require the lowest overall additions. Given their current role as engineered invert embankments, the soils in this area would not be recommended for techniques such as de-compaction tilling.

In summary, Reach 14 has the most substantive challenges for achieving successful riparian mitigation of all the project reaches, and this area would rank as the least suitable for on-site mitigation. Although it would be possible to amend the soil adequately to provide good soil conditions, the absence of available water in the summer and fall would result in a high risk for failure.

3.1.9 Simplified Fertilizer Application Scenario

The following assumptions and calculations provide the soil amendment needs and approximate costs and benefits associated with selecting certain mitigation sites. The example remediation needs provided in Table 3-1 were chosen as worst case scenarios in order to depict the costs associated with treating project reaches that have highest nitrogen and phosphorus requirements. The remediations presented here are not prescriptive requirements, they are only intended to provide a possible approach to improving soil conditions and successful mitigation planting.

Table 3-1 Soil Fertility Recommendations and Guidelines Table

Sample ID	Lab Number	Plant Type	Soil Amendments				Potash K2O	Sulfur SO4-S	Zinc Zn	Manganese Mn	Boron B
			Lime	Gypsum	Nitrogen N	Phosphate P2O5					
1.A	633	GENERAL		2400	110	100	180				
1A	55633	RIPARIAN		2400	50	100	180				
2.B	634	GENERAL		2100	120	200	180		5	10	0.5
2.B	55634	RIPARIAN		2100	60	200	180			5	0.5
3.C	635	GENERAL		1900	120	80	180		10	10	0.5
3.C	55635	RIPARIAN		1900	60	70	180			5	0.5
4.D	636	GENERAL	4000		100	100	180	25			
4.D	55636	RIPARIAN	4000		40	100	180	15			
5.E	637	GENERAL		1900	130	160	180		10		1
5.E	55637	RIPARIAN		1900	70	160	180		5		1
6.F	638	GENERAL	2000		120	80	180	30	10		1
6.F	55638	RIPARIAN	2000		60	70	180	20	5		1
7.G	639	GENERAL		2300	130	80	180				0.5
7.G	55639	RIPARIAN		2300	70	70	180				0.5
8.H	640	GENERAL		1500	120	80	150				0.5
8.H	55640	RIPARIAN		1500	60	40	150				0.5

Note: All values represent pounds per acre and plant type prescription was designated as General.

3.1.9.1 Fertilizer Specification and Application Computation

Assumption: Biosol is a organic fertilizer considered appropriate for use in wildland riparian soils. The nutrient specifications are: *Organic Matter > 85 percent, Carbon/Nitrogen ratio 5:1, Total Nitrogen >7 percent, Nitrogen (water soluble) <0.5 percent, Phosphorus (P_20_5) 4 percent and Potassium (K_20) 1 percent, at pH levels of 6.5 to 7.5.* The nutrient content (N-P-K) of Biosol is 7-4-1.

Biosol is comprised of ninety three (93) percent fungal biomass, four (4) percent water and three (3) percent potassium-magnesia. A fungal biomass (dry mycelium) is obtained during the manufacture of penicillin by fermenting materials such as soybean meal, cottonseed meal, sucrose, lactose, trace elements and vitamins under constant sterile conditions. The fungus strain used is *Penicillium chrysogenum*. After the penicillin is removed, the remaining biomass is dried at 130° C for 4 hours. During this process the residual antibiotic is eliminated and the moisture is reduced by less than 6 percent. Biosol is a sterilized and weed free fertilizer that comes in a granulated form packed in fifty (50) pound bags.

Example 1:

Nitrogen Application for Bulked Sample 5.E: GENERAL

130 lb. Nitrogen per 43,560 sq. ft.
-------------------------------------- = 1,857 pounds / 43,560 sq. ft. for Nitrogen
7 % Nitrogen in 7-4-1 fertilizer

Biosol costs approximately $40.00 per 50 lb. bag. Following the guidelines provided in the Soil Fertility Report, it could cost up to $1,485 per acre to achieve the recommended nitrogen applications for Sites 18.1 through 21.1 (Reaches 7a and the lower part of Upper Reach 7a). NOTE: Bulked Sample 5.E had 1.9 percent organic matter by weight, which translates into 68 lbs of estimated nitrogen mineralized and available to plants per annual growing season. If moderately composted organic matter was added as an amendment to increase and maintain the percent by weight of the organic matter content in the soil to between 3.6 to 4 percent, no additional nitrogen would be required.

Example 2:

Phosphorous Application for Bulked Sample 2.B: GENERAL

200 lb. Phosphorous per 43,560 sq. ft.
-------------------------------------- = 5,000 pounds / 43,560 sq. ft. for Phosphorous
4 % Phosphorous in 7-4-1 fertilizer

Biosol costs approximately $40.00 per 50 lb. bag. If one follows the guidelines provided in the Soil Fertility Report, it could cost up to $ 4,000 per acre to achieve the recommended phosphorous applications for Sites 5.1 through 8.1 (Upper Reach 4).

3.2 Feasible Mitigation Types

This section of the report addresses feasible mitigation types for on-site mitigation in the project reaches. No matter how well the on-site soils are modified, chemically or physically, the greatest factor limiting revegetation options on the Project reaches is the availability of water. Options for improving vegetation access to water in the Project reaches are also limited. On-site mitigation may not meet the full mitigation needs for the project, but off-site mitigation is not addressed in this report.

Feasible mitigation types for each reach of the project are limited by soil, hydrology and design constraints. Soil and hydrological constraints and potential revegetation opportunities are summarized by reach in Table 3-2.

Table 3-2 Summary of Constraints and Opportunities by Reach

Reach	Ranking	Constraints	Opportunities
Lower Reach 4	7	No summer water Access more difficult than others	Limited to species that can persist without summer water.
Upper Reach 4	5	Moderately poor soils requiring greater investment for improvement No summer water	Limited to species that can persist without summer water.
Reach 5 and Lower Reach 6	6	Moderately poor soils Greater soil reclamation needs and costs Concern for loss of current ponded water late into summer season post project .	Limited to species that can persist without summer water. There will be reliable late season water in channel.
Upper Reach 6	2	Shallow densic and /or paralithic contact but moderately good topsoils, that will require some amendment to improve. Himalayan blackberry control required	Presence of water in summer and autumn should support mesic species
Lower Reach 7a	1	Good soils, still require amendment Weed treatment required. No summer water	Possibly establish native forest on a area that currently lacks woody vegetation
Upper Reach 7a	3	Good soils, still require amendment Weed treatment required No summer water	Can establish native forest on land that currently lacks woody vegetation.
Reach 7b	4	Good soils, still require amendment Adjacent land use in part of the reach may be incompatible No summer water	Possibly establish native forest on land that currently lacks woody vegetation – only part of reach with this potential
Reach 14	8	Soil unsuitable Embankment engineered and limits potential to improve soil No summer water	Primarily grassland Limited potential to establish woody species that can persist without summer water at the southernmost end.

The vegetation types in the project area include agricultural crops, annual grasslands, weedy areas, and strips in developed areas with horticultural trees and shrubs, in addition to stands of both native and non-native woody species in undeveloped areas along the existing channels. In addition, where there is permanent water in the channel or very near the surface, stands of freshwater marsh species occur.

Agricultural lands and weedy areas are expected to either return to agricultural use once the project is completed or to be included in the mitigation areas, either as grasslands or as upper riparian. The banks in the developed areas are expected to be planted with native species, but the channel design and maintenance needs may preclude planting woody species at some locations.

Stands of freshwater marsh species that are removed during project construction will require mitigation, but mitigation for freshwater marsh species is not addressed in this report. The stands are small and discontinuous, which reduces their habitat value. These species will establish where there is sufficient permanent water at or near the surface. If further evaluation as the channel design develops suggests that it is unlikely to support any freshwater marsh species, then off-site mitigation will be required.

Soil conditions combined with hydrologic conditions in the project area are not conducive to the development of mesic vegetation except in or near the stream channels. However, it is desirable to establish riparian mitigation plantings wherever it is feasible, in order to reduce the amount of off-site mitigation required. Further, resource agencies have indicated that canopy replacement is expected to the extent feasible, even if the existing canopy is of limited extent or is provided by non-native invasive species.

3.2.1 Mitigation Types

Recent vegetation mapping in the project area defines a larger variety of vegetation types than were identified in earlier mapping efforts. A preliminary correlation of the current mapped vegetation types with the mitigation types is provided in Table 3-3. This does not include agricultural or horticultural types, nor does it include unvegetated habitats or the freshwater marsh types. Generally, areas supporting horticultural vegetation would likely be classed as either Upper Riparian or Grassland.

Table 3-3 Mitigation Types and Corresponding Mapped Vegetation Types

Mitigation Type	Vegetation Types Mapped in the Project Area
Upper Riparian	▪ California Broadleaf Woodland ▪ Oak Woodland - Mixed Quercus pp. ▪ Eucalyptus Spp. ▪ Juglans hindsii Semi-Natural Stands ▪ Platanus racemosa ▪ Quercus agrifolia ▪ Quercus lobata ▪ Rubus armeniacus (= R. discolor)
Lower Riparian	▪ Arundo donax ▪ Riparian Herbaceous Cover ▪ Rubus armeniacus (= R. discolor) ▪ Populus fremontii ▪ Salix laevigata ▪ Salix lasiolepis ▪ Salix Spp. Canopy with Rubus armeniacus Understory ▪ SW N.A. Riparian Evergreen & Deciduous Woodlands ▪ SW N.A. Riparian/Wash Scrub ▪ Willow Scrub - Mixed Salix Spp.
Vegetated Inset	▪ Arundo donax ▪ Baccharis salicifolia ▪ Riparian Herbaceous Cover ▪ Salix exigua ▪ Salix laevigata ▪ Salix lasiolepis ▪ Salix Spp. Canopy with Rubus armeniacus Understory ▪ SW N.A. Riparian Evergreen & Deciduous Woodlands ▪ SW N.A. Riparian/Wash Scrub ▪ Willow Scrub - Mixed Salix Spp.
Grassland	▪ Baccharis pilularis ▪ Naturalized Annual & Perennial Grasslands ▪ Centaurea solstitialis ▪ Ruderal

3.2.2 Mitigation Opportunities

Based on the constraints identified and the recommendations in Section 3.1, Reach 4, Reach 5, Lower Reach 6, Upper Reach 7a, Lower Reach 7a, and Reach 7b can only be expected to support the Upper Riparian and Grassland mitigation types. Reach 14 can probably only support the Grassland mitigation type. Upper Reach 6 can probably support all four mitigation types. Upper Reach 7a and portions of Reach 7b could probably support all four vegetation types if they had sufficient summer/autumn water, but late season water is not expected to be available in these reaches.

Chapter 4

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Chapter 5

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Appendix A

Soil Description Data Sheets

Appendix A

Upper Llagas Creek Riverwash (Invert Substrate Materials)

The Upper Llagas Creek Riverwash map unit is “fluvial stringer” landscape complex that consists of poorly sorted sandy, gravelly and cobbly alluvial sediments deposited on the inset floodplain and along the active channel. The changing configuration and location of these sediments in the floodplains and active channels are affected by river hydraulics and channel entrenchment. This map unit is usually barren because of the frequent recurrence of disturbance, but some deposit areas do have some opportunistic vegetative growth. The Upper Llagas Creek Riverwash is an unstable sandy, silty, and gravelly bank of sediment that is seasonally inundated, washed, and reworked. The seasonally episodic deposition of fresh alluvium generally precludes in situ soil genesis and development. The coarse alluvial material deposited by water often contrasts abruptly with the underlying sediment and stratigraphy. This coarse deposited material is thick enough in some settings to influence management decisions regarding future channel design. There were occasionally adjacent deposits of flood event overwash encountered; however descriptive phases were not applied to these young alluvial sediment deposits because they expressed no genetic development.

Reach 4: Site 1.1

Profile Aspect: 21º
Slope: 80 percent (Creek Bank)
Date Described: 10/27/2011
Topsoil Quality: Moderately Good
Soil Profile Position: top of terrace down to creek invert, river right.
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Haploxeralf

A--0 to 11 inches; Olive brown (2.5Y 4/3) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; moderate coarse subangular blocky structure; hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common very fine pores; 15 percent subangular and subrounded gravels and cobblestones; slightly acid (pH 6.8); clear wavy boundary.

Bt--11 to 23 inches; Brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak, coarse subangular blocky structure; hard, firm, slightly sticky, slightly plastic; many fine and very fine roots; common very fine pores; few thin clay films on faces of peds and pore linings; 20 percent subangular and subrounded gravels and cobblestones; neutral (pH 6.8); gradual wavy boundary.

C-23 to 36 inches; Brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 4/3) moist; massive; very hard, friable, sticky, plastic; very few fine and very fine roots; common very fine pores; continuous moderately thick clay films on faces of peds and lining pores; 20 percent subangular and subrounded gravels and cobblestones; gradual wavy boundary.

Cd-36 to 48 inches; Yellowish brown (10YR 5/4) gravelly sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, friable, slightly sticky, slightly plastic; no roots; common very fine pores; few thin clay films line pores; 20 percent subangular and subrounded gravels and cobblestones; clear wavy boundary.

Reach 4: Site 2.1

Profile Aspect: 120º
Slope: 24 percent
Date Described: 10/26/2011
Topsoil Quality: Moderately Good
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Xerorthent

A--O to 10 inches; brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak to moderate, medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine and fine roots; many very fine interstitial and tubular pores; 15 percent subangular and subrounded gravels and cobbles; neutral (pH 6.8); gradual smooth boundary.

A2--10 to 24 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; moderate, medium subangular blocky structure; slightly hard, very friable, slightly sticky, nonplastic; many very fine roots; many very fine interstitial and tubular pores; 20 percent subangular and subrounded gravels and cobbles; neutral (pH 6.8); gradual smooth boundary.

C--24 to 42 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; few very fine roots; many very fine interstitial and tubular pores; 20 percent subangular and subrounded gravels and cobbles; gradual smooth boundary.

Cd--42 to 53 inches; brown (10YR 5/3) very gravelly sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky, nonplastic; very few fine roots; few very fine interstitial pores; 30 percent subangular and subrounded gravels and cobbles.

Reach 4: Site 3.1

Profile Aspect: 128º **Slope:** 22 percent
Date Described: 10/26/2011 **Topsoil Quality:** Poor
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent (Man Modified)

A--0 to 13 inches; grayish brown (2.5Y 5/2) gravelly sandy loam (disturbed), very dark grayish brown (2.5Y 3/2) moist; weak, medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots; common very fine interstitial pores; 30 percent subangular and subrounded gravels and cobbles; slightly acid (pH 6.2); clear smooth boundary.

C1--13 to 32 inches; light brownish gray (2.5Y 6/2) very gravelly sandy loam (disturbed), dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 35 percent subangular and subrounded gravels and cobbles; clear smooth boundary.

C2--32 to 48 inches; light gray and light brownish gray (2.5Y 6/2) very gravelly sandy loam (disturbed), light brownish gray (2.5Y 6/2) moist; massive; slightly hard, firm nonsticky and nonplastic; few very fine roots; very few fine interstitial pores; 40 percent subangular and subrounded gravels and cobbles.

Reach 4: Site 3.2

Profile Aspect: 44°
Slope: 82 percent (Creek Bank)
Date Described: 10/26/2011
Topsoil Quality: Moderately Good
Soil Profile Position: top of terrace down to creek invert, river right
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Haploxeralf

A--0 to 10 inches; Olive brown (2.5Y 4/4) gravelly sandy loam, very dark grayish brown (2.5Y 3/2) moist; moderate to weak coarse angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many fine and very fine roots; common very fine interstitial and tubular pores; 15 percent subangular and subrounded gravels and cobbles; slightly acid (pH 6.8); clear wavy boundary.

Bt--10 to 23 inches; Brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak to moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common fine and very fine roots; common very fine interstitial and tubular pores; common thin clay films on ped faces and pore linings; 15 percent subangular and subrounded gravels and cobbles; clear wavy boundary.

C-23 to 32 inches; Brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 4/3) moist; massive; hard, firm, slightly sticky, slightly plastic; few fine and very fine roots; common very fine pores; thin clay films on ped faces and pore linings; 15 percent subangular and subrounded gravels and cobbles; gradual wavy boundary.

Cd--32 to 48 inches; Yellowish brown (10YR 5/4) gravelly sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, firm, slightly sticky, slightly plastic; no roots; common very fine interstitial pores; few thin clay films line pores; 15 percent subangular and subrounded gravels and cobbles.

Reach 4: Site 4.1

Profile Aspect: 282º
Slope: 18 percent
Date Described: 10/26/2011
Topsoil Quality: Moderately Good
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent

A1--O to 11 inches; Brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots; many very fine interstitial and tubular pores; 15 percent subangular and subrounded gravels and cobblestones; neutral (pH 6.8); clear wavy boundary.

A2--11 to 19 inches; Yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; common very fine and fine roots; many very fine interstitial and common fine tubular pores; 15 percent subangular and subrounded gravels and cobbles; gradual smooth boundary.

C1--19 to 29 inches; Yellowish brown (10YR 5/4) very gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; massive; hard, firm, slightly sticky, slightly plastic; common very fine roots; many very fine interstitial and tubular pores; 35 percent subangular and subrounded gravels and cobbles; clear wavy boundary.

C2--29 to 48 inches; Brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 4/3) moist; massive; hard, firm, slightly sticky, nonplastic; few very fine roots; few very fine interstitial and tubular pores; 40 percent subangular and subrounded gravels and cobbles.

Reach 4: Site 4.2

Profile Aspect: 118º | Slope: 77 percent (Creek Bank)
Date Described: 10/26/2011 | Topsoil Quality: Moderately Good
Soil Profile Position: top of terrace down to creek invert, river right
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Haploxeralf

A--0 to 13 inches; Olive brown (2.5Y 4/4) gravelly sandy loam, very dark olive brown (2.5Y 3/2) moist; moderate to weak coarse subangular blocky structure; hard, friable, slightly sticky, slightly plastic; many very fine, fine and medium roots; common very fine and fine interstitial and tubular pores; 15 percent subangular and subrounded gravels and cobbles; slightly acid (pH 6.8); clear wavy boundary.

Bt--13 to 30 inches; Brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak coarse angular blocky structure trending to massive; hard, friable, slightly sticky, slightly plastic; common very fine, fine and medium roots; common very fine interstitial and tubular pores; common moderately thick clay films on ped faces and pore linings; 15 percent subangular and subrounded gravels and cobbles; clear wavy boundary.

C--30 to 40 inches; Brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 4/3) moist; massive; very hard, firm, slightly sticky, non plastic; few fine and medium roots; common very fine interstitial pores; common thin clay films on ped faces and pore linings; 15 percent subangular and subrounded gravels and cobbles; clear wavy boundary.

Cmd--40 to 48 inches; Yellowish brown (10YR 5/4) very gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, firm, non sticky, non plastic; no roots; common very fine interstitial pores; very few thin clay films in pore linings; 35 percent subangular and subrounded gravels and cobbles.

Reach 4: Site 5.1

Profile Aspect: 206º
Date Described: 10/26/2011
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Xerorthent

Slope: 34 percent
Topsoil Quality: Good

A1--O to 10 inches; Brown (10YR 5/3) gravelly coarse sandy loam, dark brown (10YR 3/3) moist; weak to moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; many very fine, fine and medium roots; many very fine tubular and interstitial pores; 25 percent subangular and subrounded gravels and cobbles; neutral (pH 6.8); clear smooth boundary.

A2--10 to 24 inches; Yellowish brown (10YR 5/4) gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; many very fine and fine roots and common medium roots; many very fine interstitial and common fine tubular and interstitial pores; 25 percent subangular and subrounded gravels and cobbles; clear smooth boundary.

C--29 to 42 inches; Yellowish brown (10YR 5/4) very gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; massive; hard, firm, non sticky, non plastic; few very fine and fine roots; many very fine interstitial pores; 35 percent subangular and subrounded gravels and cobbles; clear smooth boundary.

IICmd--42 to 53 inches; Grayish brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 4/3) moist; massive; very hard, firm, non sticky, non plastic; no roots; few very fine interstitial pores; 45 percent subangular and subrounded gravels and cobbles.

Reach 4: Site 6.1

Profile Aspect: 40º | Slope: 28 percent (Creek Bank)
Date Described: 10/25/2011 | Topsoil Quality: Moderately Good
Soil Profile Position: top of terrace down to creek invert, river right.
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Xerorthent

A--0 to 7 inches; Brown (10 YR 5/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots; many very fine and fine tubular and interstitial pores; 20 percent subangular and subrounded gravels; neutral (pH 6.8); clear wavy boundary.

AC--7 to 12; Pale brown (10YR 6/3) gravelly coarse sandy loam, brown (10YR 4/3) moist; massive; hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; many fine tubular and interstitial pores; 20 percent subangular and subrounded gravels; clear wavy boundary.

C--12 to 23 inches; Pale brown (10YR 6/3) gravelly coarse sandy loam, brown (10YR 4/3) moist massive, hard, friable; common very fine, and few fine roots; many very fine and fine interstitial and tubular pores; 25 percent subangular and subrounded gravels; abrupt smooth boundary.

IICmd--23 to 36 inches; Brown (10YR 5/3) very gravelly coarse loamy sand, brown (10YR 4/3) moist, massive; very hard, firm; no roots; common very fine interstitial and tubular pores; 45 percent subangular and subrounded gravels, stratified.

Reach 4: Site 7.1

Profile Aspect: 121º
Slope: 86 percent (Creek Bank)
Date Described: 10/25/2011
Topsoil Quality: Good
Soil Profile Position: top of terrace down to creek invert, river right
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Haploxeralf

A--0 to 5 inches; Light yellowish brown (1OYR 6/4) gravelly coarse sandy loam, brown (1OYR 4/3) moist; weak, moderate to coarse granular and subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine, fine and medium roots, many very fine and fine interstitial pores; 20 percent subangular and subrounded gravels; neutral (pH 6.8); clear smooth boundary.

A2--5 to 15 inches; Light yellowish brown (1OYR 6/4) gravelly sandy clay loam, brown (1OYR 4/3) moist; weak moderate to coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine, fine and medium roots; many very fine and fine interstitial pores; few thin clay films on ped faces and pore linings; 20 percent subangular and subrounded gravels; clear wavy boundary.

Bt--15 to 24 inches; Light yellowish brown (1OYR 6/4) gravelly coarse sandy clay loam; dark yellowish brown (1OYR 4/4) moist; weak coarse subangular blocky structure; hard, firm, slightly sticky, slightly plastic; common very fine and few fine roots; common very fine and fine interstitial and tubular pores; common thin clay films on ped faces and pore linings; 20 percent subangular and subrounded gravels; abrupt smooth boundary

Cd--24 to 32 inches; Light brownish gray (1OYR 6/2) very gravelly, coarse loamy sand, dark yellowish brown (1OYR 4/4) moist; massive; very hard, firm, nonsticky and nonplastic; common very fine interstitial pores; no roots; 50 percent subangular and subrounded gravels; gradual wavy boundary.

IICd--32 to 46 inches; Light brownish gray (1OYR 6/2) very gravelly, coarse loamy sand, dark yellowish brown (1OYR 4/4) moist; massive; very hard, firm, nonsticky and nonplastic; common very fine interstitial pores; no roots; 50 + percent subangular and subrounded gravels, stratified.

Reach 4: Site 8.1

Profile Aspect: 248º
Slope: 43 percent
Date Described: 10/25/2011
Topsoil Quality: Moderately Good
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent

A1--0 to 7 inches; Dark grayish brown (10 YR 4/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine and medium granular and coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores; 35 percent subangular and subrounded gravels and cobbles; neutral (pH 6.8); clear wavy boundary.

A2--7 to 12; Brown (10YR 5/3) very gravelly loamy sand; dark yellowish brown (10YR 4/4) moist; weak, medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots and common medium roots ; many very fine tubular and interstitial pores; 35 percent subangular and subrounded gravels; clear wavy boundary.

AC--12 to 26; Pale brown (10YR 6/3) very gravelly coarse loamy sand; dark yellowish brown (10YR 4/4) moist; massive; hard, firm, slightly sticky, slightly plastic; common very fine and fine roots; many very fine tubular and interstitial pores; 35 percent subangular and subrounded gravels; clear wavy boundary.

C--26 to 41 inches; Light brownish gray (10YR 6/2) very gravelly coarse loamy sand, brown (10YR 4/3) moist massive, hard, firm, non sticky, non plastic; few fine and common very fine roots; common very fine and fine interstitial and tubular pores; 50 percent subangular and subrounded gravels and cobbles; clear smooth boundary.

IICmd--41 to 48 inches; Light brownish gray (10YR 6/2) very gravelly loamy sand, brown (10YR 4/3) moist, massive; very hard, firm, non sticky, non plastic; no roots; common very fine interstitial pores; 50 percent subangular and subrounded gravels and cobbles, stratified.

Reach 4: Site 9.1

Profile Aspect: 132º
Slope: 40 percent
Date Described: 10/25/2011
Topsoil Quality: Moderately Good
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent

A--0 to 6 inches; Grayish brown (10 YR 5/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine, fine and medium roots; many very fine and fine interstitial and tubular pores; 25 percent subangular and subrounded gravels and cobbles; neutral (pH 6.8); clear wavy boundary.

A2--6 to 12; Grayish brown (10YR 5/2) gravelly coarse loamy sand, dark yellowish brown (10YR 4/4) moist; weak, medium and coarse subangular blocky structure trending to massive; hard, friable, slightly sticky, slightly plastic; common very fine, fine and medium roots; many very fine tubular and interstitial pores; 25 percent subangular and subrounded gravels; clear wavy boundary.

AC--12 to 20; Grayish brown (10YR 5/2) gravelly coarse loamy sand, dark yellowish brown (10YR 4/4) moist; weak, medium and coarse subangular blocky structure trending to massive; hard, firm, slightly sticky, slightly plastic; common very fine and fine roots and few medium roots; many very fine tubular and interstitial pores; 30 percent subangular and subrounded gravels; clear wavy boundary.

C1--20 to 42 inches; Light brownish gray (10YR 6/2) very gravelly loamy coarse sand, brown (10YR 4/3) moist; massive, very hard, firm, nonsticky and nonplastic; few very fine, fine and medium roots; many very fine and fine interstitial and tubular pores; Interior ped face has common, fine and medium, moderate, red-brown (7.5 YR 5/6) soft masses and coatings of oxidized iron in a reduced matrix (10 YR 5/1); 35 percent subangular and subrounded gravels and cobbles; clear smooth boundary.

C2--42 to 48 inches; Light brownish gray (10YR 6/2) very gravelly coarse sandy loam, brown (10YR 4/3) moist, coarse massive; very hard, firm, nonsticky and nonplastic; few very fine and fine roots; common very fine interstitial and tubular pores; Interior ped face has common, fine and medium, moderate, red-brown (7.5 YR 5/6) soft masses and coatings of oxidized iron in a reduced matrix (10 YR 5/1); 45 percent subangular and subrounded gravels and cobbles.

Reach 5: Site 10.1

Profile Aspect: 186º
Slope: 33 percent
Date Described: 10/24/2011
Topsoil Quality: Moderately Good
Soil Profile Position: top of terrace down to creek invert, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent

A--0 to 6 inches; Dark grayish brown (10YR 4/2) gravelly sandy loam, dark brown (10YR 3/3) moist; weak, fine and medium granular and coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine, fine and medium roots; many very fine and fine tubular and interstitial pores; 25 percent subangular and subrounded gravels; neutral (pH 6.8); clear wavy boundary.

AC--6 to 13; Dark grayish brown (10YR 4/2) very gravelly coarse sandy loam, dark brown (10YR 3/3) moist; weak, medium and coarse subangular blocky structure trending to massive; hard, friable, slightly sticky, non plastic; common very fine and fine roots; many very fine tubular and interstitial pores; 35 percent subangular and subrounded gravels; clear wavy boundary.

C--13 to 36 inches; Grayish brown (10YR 5/2) very gravelly coarse sandy loam, dark brown (10YR 3/3) moist; massive; very hard, firm, nonsticky, nonplastic; few very fine, fine roots; common very fine and fine interstitial and tubular pores; 45 percent subangular and subrounded gravels; clear smooth boundary.

IICd--36 to 48 inches; Gray (10YR 6/1) very gravelly coarse sandy loam, brown (10YR 4/3) moist; massive; very hard, firm, nonsticky, nonplastic; no roots; few very fine interstitial pores; 45 percent subangular and subrounded gravels.

Reach 5: Site 11.1

Profile Aspect: 175º | **Slope:** 29 percent
Date Described: 10/24/2011 | **Topsoil Quality:** Moderately Good
Soil Profile Position: top of terrace down to creek invert, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent

A1--0 to 7 inches; Brown (10YR 4/3) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine and medium granular and medium and coarse subangular blocky structure; hard, friable, slightly sticky, slightly plastic; many very fine, fine and medium roots; many very fine and fine tubular pores; 20 percent subangular and subrounded gravels and lesser cobbles; neutral (pH 6.8); clear wavy boundary.

A2--7 to 16; Brown (10YR 5/3) gravelly coarse sandy loam, brown (10YR 4/3) moist; weak, medium and coarse subangular blocky structure trending; slightly hard, friable, slightly sticky, slightly plastic; many very fine, fine and medium roots; many very fine tubular and interstitial pores; 20 percent subangular and subrounded gravels; clear wavy boundary.

AC--16 to 24 inches; brown (10YR 5/3) gravelly sandy clay loam, brown (10YR 4/3) moist medium and coarse subangular blocky structure trending to massive, hard, firm, nonsticky, nonplastic; common very fine and fine and few medium roots; many very fine and fine interstitial and tubular pores; 25 percent subangular and subrounded gravels; clear smooth boundary.

C1--24 to 35 inches; Pale Brown (10YR 6/3) gravelly sandy clay loam, brown (10YR 4/3) moist massive, hard, firm, nonsticky, nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; 30 percent subangular and subrounded gravels; clear smooth boundary.

C2--35 to 46 inches; Grayish brown (10YR 5/2) very gravelly sandy clay loam, dark brown (10YR 3/3) moist massive, very hard, firm, nonsticky, nonplastic; few very fine and fine roots; common trending to few very fine and fine interstitial pores; 35 percent subangular and subrounded gravels and cobbles; abrupt smooth boundary.

IICd--46 to 48 inches; Gray (10YR 5/1) very gravelly loamy coarse sand, dark brown (10YR 3/3) moist, coarse single grain; very hard, very firm, nonsticky, nonplastic; no roots; common very fine interstitial pores; 45 percent subangular and subrounded gravels, stratified.

Reach 6: Site 12.1

Profile Aspect: 26º | Slope: 29 percent
Date Described: 10/24/2011 | Topsoil Quality: Poor
Soil Profile Position: mid terrace flank, river right
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent, Man-Modified (Engineered Fill - Western Embankment Levee of the Church Avenue Flood Protection Basin)

A--0 to 10 inches; Dark grayish brown (10 YR 4/2); very gravelly sandy loam (fill); very dark grayish brown (10 YR 3/2) moist; weak, fine and medium granular and medium subangular blocky structure trending to massive; slightly hard, friable, nonsticky, nonplastic; common very fine roots; many very fine interstitial and tubular pores; 15 percent subangular and subrounded gravels; slightly acid (pH 6.6); clear smooth boundary.

C1--10 to 32 inches; Brown (10 YR 4/3) very gravelly sandy loam (fill), dark grayish brown (10 YR 4/2) moist; massive; hard, firm, nonsticky, nonplastic; very few very fine roots in the upper part, few very fine roots lower part; common very fine and fine interstitial pores; 20 percent subangular and subrounded gravels; clear smooth boundary.

C2--32 to 60 inches; Brown (10 YR 5/3) gravelly sandy clay loam (fill), dark grayish brown (10 YR 4/2) moist; massive; hard, firm, nonsticky, nonplastic; very few very fine roots in the upper part; few very fine interstitial pores; 20 percent subangular and subrounded gravels.

Reach 6: Site 13.1

Profile Aspect: 234º **Slope:** 26 percent
Date Described: 10/24/2011 **Topsoil Quality:** Poor
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent

A--0 to 8 inches; Dark grayish brown (2.5Y 4/2) very gravelly sandy loam, dark olive brown (2.5Y 3/3) moist; moderate, fine and medium granular and weak, medium subangular blocky structure; slightly hard, friable, nonsticky, nonplastic; common very fine and fine roots; many very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles (pH 6.6); clear smooth boundary.

AC--8 to 13 inches; Grayish brown (2.5Y 5/2) very gravelly sandy loam; olive brown (2.5Y 4/3) moist; moderate, fine and medium subangular blocky structure; slightly hard, friable, nonsticky, nonplastic; common very fine and fine roots; many fine and very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C--13 to 25 inches; Light brownish gray (2.5Y 6/2) very gravelly sandy loam; dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, nonsticky, nonplastic; common very fine and fine roots in the upper part trending to few very fine roots in the lower part; common very fine and fine interstitial pores; 45 percent subangular and subrounded gravels and lesser cobbles; abrupt smooth boundary.

IIC--25 to 48 inches; Gray (2.5Y 5/1) very gravelly sand; light brownish gray (2.5Y 6/2) moist; massive; very hard, firm, nonsticky and nonplastic; common trending to few very fine interstitial pores; few very fine roots trending down to none; 45 percent subangular and subrounded gravels and lesser cobbles, stratified.

Reach 6: Site 14.1

Profile Aspect: 260º | **Slope:** 12 percent
Date Described: 10/27/2011 | **Topsoil Quality:** Poor
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent

A1--0 to 10 inch; dark yellowish brown (10YR 3/4) gravelly loamy sand, dark brown (10YR 3/3) moist; weak medium granular and coarse subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; common very fine, fine and medium roots; common very fine interstitial and tubular pores; 25 percent subangular and subrounded gravels and lesser cobbles; slightly acid (pH 6.2); clear wavy boundary.

A2--10 to 15 inches dark yellowish brown (10YR 3/4) very gravelly loamy coarse sand, dark brown (10YR 3/3) moist; weak medium granular and coarse subangular blocky structure trending to massive; slightly hard, friable, non sticky and non plastic; common very fine, fine and medium roots; many very fine interstitial and tubular pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C--15 to 33 inches; grayish brown (10YR 5/2) very gravelly loamy coarse sand, dark grayish brown (10YR 4/3) moist, massive; hard, firm, non sticky, non plastic; few very fine and fine roots; common very fine interstitial pores; 40 percent subangular and subrounded gravels and lesser cobbles; abrupt smooth boundary.

IICmd--33 to 48 inches; dark yellowish brown (10YR 3/4) very gravelly loamy coarse sand; brown (10YR 5/3) moist; massive; very hard, firm, non sticky, non plastic; no roots; few very fine interstitial pores; 45 percent subangular and subrounded gravels and lesser cobbles.

Reach 6: Site 14.2

Profile Aspect: 260º
Slope: 12 percent
Date Described: 10/27/2011
Topsoil Quality: Poor
Soil Profile Position: mid terrace flank, river right
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent (Man Modified)

A1--0 to 6 inch; dark yellowish brown (10YR 3/4) gravelly loamy coarse sand, dark brown (10YR 3/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; many very fine, fine and medium roots; common very fine interstitial and tubular pores; 20 percent subangular and subrounded gravels and cobbles; slightly acid (pH 6.2); clear wavy boundary.

A2--6 to 15 inches dark yellowish brown (10YR 3/4) very gravelly loamy coarse sand, dark brown (10YR 3/3) moist; weak medium subangular blocky structure trending to massive; slightly hard, friable, non sticky, non plastic; common very fine, fine and medium roots; many fine and very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C--15 to 31 inches; grayish brown (10YR 5/2) very gravelly loamy coarse sand, dark grayish brown (10YR 4/3) moist, massive; hard, firm, non sticky, non plastic; few very fine and fine roots; common very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; abrupt smooth boundary.

IICmd--31 to 48 inches; dark yellowish brown (10YR 3/4) very gravelly loamy coarse sand; brown (10YR 5/3) moist; massive; very hard, very firm, non sticky and non plastic; no roots; few very fine interstitial pores; 40 percent subangular and subrounded gravels and lesser cobbles, stratified.

Reach 6: Site 15.1

Profile Aspect: 245° Slope: 9 percent
Date Described: 10/27/2011 Topsoil Quality: Poor
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent (Man- Modified)

A--0 to 13 inches; Brown (10YR 4/3) gravelly coarse loamy sand, dark brown (10YR 4/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, non sticky; non plastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 20 percent subangular and subrounded gravels and lesser cobbles; moderately acid (pH 6.2); clear wavy boundary.

AC--13 to 19 inches; Brown (10YR 5/3) gravelly coarse loamy sand, brown (10YR 4/3) moist single grain; hard, firm, non sticky; non plastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 25 percent subangular and subrounded gravels and lesser cobbles; clear wavy boundary.

C--19 to 38 inches; Yellowish brown (10YR 5/4) very gravelly coarse loamy sand; brown (10YR 4/3) moist; massive; hard, firm, non sticky, non plastic; few very fine and fine roots; common very fine and fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

IICmd--38 to 48 inches; Pale brown (10YR 6/3) very gravelly coarse loamy sand; brown (10YR 5/3) moist; massive; very hard, very firm, nonsticky, non plastic; no roots; common very fine interstitial pores; 45 percent subangular and subrounded gravels and lesser cobbles, stratified.

Reach 6: Site 15.2

Profile Aspect: 80º
Slope: 9 percent
Date Described: 10/28/2011
Topsoil Quality: Poor
Soil Profile Position: mid terrace flank, river right
Soil Taxonomic Class: Loamy-skeletal, mixed, Typic Xerofluvent

A1--0 to 8 inches; Brown (10YR 4/3) gravelly coarse loamy sand, dark brown (10YR 4/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, non sticky, non plastic; many very fine, fine and few medium roots; many very fine and fine interstitial pores; 25 percent subangular and subrounded gravels and lesser cobbles; moderately acid (pH 6.2); clear smooth boundary.

AC--8 to 18 inches; Brown (10YR 5/3) very gravelly coarse loamy sand, dark brown (10YR 4/3) moist; weak medium subangular blocky structure trending to massive; slightly hard, friable, non sticky, non plastic; common very fine and fine roots; many very fine and fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C--18 to 36 inches; Yellowish brown (10YR 5/4) very gravelly sandy loam, brown (10YR 4/3) moist; massive; hard, firm, non sticky; non plastic; few very fine and fine roots; common very fine interstitial pores; 40 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

IICmd--36 to 42 inches; Pale brown (10YR 6/3) extremely gravelly sandy loam; brown (10YR 5/3) moist; massive; very hard, very firm, nonsticky; non plastic; no roots; few very fine interstitial pores; 50 percent subangular and subrounded gravels and lesser cobbles.

Reach 6: Site 16.1

Profile Aspect: 202º **Slope:** 13 percent
Date Described: 10/28/2011 **Topsoil Quality:** Poor
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, Typic Xerofluvent (Man Modified)

A--0 to 9 inches; Brown (10YR 5/3) very gravelly coarse loamy sand; dark brown (10YR 4/3) moist; weak fine and medium granular structure; slightly hard, friable, non sticky, non plastic; common very fine, fine and medium roots; many very fine and fine interstitial pores; 40 percent subangular and subrounded gravels and lesser cobbles; moderately acid (pH 6.2); clear smooth boundary.

C--9 to 40 inches; Pale brown (10YR 6/3) very gravelly coarse loamy sand; brown (10YR 4/3) moist, massive; hard, firm, non sticky, non plastic; common very fine, fine and few medium roots; common very fine and fine interstitial pores; 50 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

IICd--40 to 48 inches; Light brownish gray (10YR 6/2) extremely gravelly coarse loamy sand; brown (10YR 5/3) moist; massive; very hard, very firm, nonsticky, non plastic; no roots; few very fine interstitial pores; 65 percent subangular and subrounded gravels and lesser cobbles, stratified.

Reach 6: Site 17.1

Profile Aspect: 163º
Date Described: 10/28/2011
Soil Profile Position: mid terrace flank, river left
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent
Slope: 48 percent
Topsoil Quality: Moderately Good

A1--O to 8 inches; Brown (10YR 4/3) gravelly coarse sandy loam, dark brown (10YR 3/3) moist; weak to moderate fine and medium granular and medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and common fine roots; many very fine and fine interstitial and tubular pores; 20 percent subangular and subrounded gravels and lesser cobbles; neutral (pH 6.7); clear smooth boundary.

A2--8 to 19 inches; Yellowish brown (10YR 5/4) gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; weak fine and medium subangular blocky structure trending to massive; slightly hard, very friable, slightly sticky, nonplastic; many very fine and common fine roots; many very fine interstitial and common fine tubular pores; 25 percent subangular and subrounded gravels and lesser cobbles; clear wavy boundary.

C1--19 to 33 inches; Yellowish brown (10YR 5/4) very gravelly loamy sand, dark yellowish brown (10YR 3/4) moist; massive; hard, very firm, non sticky, non plastic; few very fine and fine roots; many very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear wavy boundary.

C2--33 to 46 inches; Grayish brown (10YR 5/2) very gravelly loamy sand, dark brown (10YR 4/3) moist; massive; hard, firm, non sticky, non plastic; few very fine roots; few very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles.

Reach 7a: Site 18.1

Profile Aspect: 157º **Slope:** 2 percent
Date Described: 12/19/2011 **Topsoil Quality:** Moderately Good
Soil Profile Position: Eastern Part of the County Property (Bowtie Parcel)
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent (historically cultivated)

A1 (p)--0 to 5 inches; brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; many very fine and fine roots; many very fine interstitial pores; 25 percent subangular and subrounded gravels; neutral (pH 6.7); gradual smooth boundary.

A2--5 to 9 inches; Brown (10YR 5/3) gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; weak to moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; common very fine and fine roots; many very fine interstitial and tubular pores; 25 percent subangular and subrounded gravels; clear smooth boundary.

AC--9 to 23 inches; Yellowish brown (10YR 5/4); gravelly coarse loamy sand, dark yellowish brown (10YR 3/4) moist; weak to moderate medium subangular blocky structure trending to massive; hard, firm, nonsticky, nonplastic; few very fine roots; common very fine interstitial pores; 45 percent subangular and subrounded gravels and lesser cobbles; clear wavy boundary.

IIC--23 to 48 inches; Brown (10YR 5/3) very gravelly coarse loamy sand, dark brown (10YR 4/3) moist; massive; soft, loose, nonsticky; nonplastic; few very fine roots; few very fine tubular pores; 50 percent subangular and subrounded gravels and lesser cobbles.

Reach 7a: Site 19.1

Profile Aspect: 178º **Slope:** 2 percent
Date Described: 12/19/2011 **Topsoil Quality:** Moderately Good
Soil Profile Position: South Central Part of County Property (Bowtie Parcel)
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent (historically cultivated)

A1 (p)--O to 5 inches; Brown (10YR 4/3) gravelly coarse sandy loam, dark brown (10YR 3/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; many very fine and fine roots; many very fine interstitial pores; 20 percent subangular and subrounded gravels; neutral (pH 6.7); clear smooth boundary.

A2--5 to 10 inches; Yellowish brown (10YR 5/4) gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; weak and medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; common very fine and fine roots; many very fine interstitial pores; 20 percent subangular and subrounded gravels; clear smooth boundary.

AC--10 to 21 inches; Yellowish brown (10YR 5/4) gravelly loamy coarse sand, dark yellowish brown (10YR 3/4) moist; weak and medium subangular blocky structure trending to massive; hard, firm, nonsticky; nonplastic; common very fine and fine roots; many very fine interstitial pores; 25 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C--21 to 36 inches; Brown (10YR 5/3) very gravelly loamy coarse sand, dark brown (10YR 4/3) moist; massive; hard, firm, nonsticky and nonplastic; very few very fine roots; few very fine interstitial pores; 50 percent subangular and subrounded gravels and lesser cobbles; abrupt smooth boundary.

IICmd--36 to 48 inches; Brown (10YR 5/3) very gravelly loamy coarse sand, dark brown (10YR 4/3) moist; massive; very hard, very firm, nonsticky; nonplastic; no roots; few very fine interstitial pores; 60 percent subangular and subrounded gravels and lesser cobbles.

Reach 7a: Site 20.1

Profile Aspect: 182º
Slope: 2 percent
Date Described: 12/20/2011
Topsoil Quality: Moderately Good
Soil Profile Position: Northwestern Part of County Property (Bowtie Parcel)
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent (historically cultivated)

A1 (p)--O to 7 inches; Brown (10YR 4/3) gravelly coarse sandy loam; dark brown (10YR 3/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots; many very fine interstitial pores; 20 percent subangular and subrounded gravels; neutral (pH 6.7); clear smooth boundary.

A2--7 to 19 inches; Yellowish brown (10YR 5/4) very gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; medium subangular blocky structure trending to massive; slightly hard, friable, slightly sticky, nonplastic; common very fine and fine roots; many very fine interstitial and common fine tubular pores; 25 percent subangular and subrounded gravels; clear wavy boundary.

C--19 to 29 inches; Yellowish brown (10YR 5/4) very gravelly loamy coarse sand, dark yellowish brown (10YR 3/4) moist; massive; hard, firm, nonsticky; nonplastic; plastic; few very fine roots; common very fine interstitial pores; 45 percent subangular and subrounded gravels and lesser cobbles; abrupt smooth boundary.

IIC--29 to 48 inches; Brown (10YR 5/3) very gravelly loamy coarse sand, dark brown (10YR 4/3) moist; massive; very hard, very firm, nonsticky; nonplastic; no roots; few very fine interstitial pores; 50 percent subangular and subrounded gravels and cobbles, stratified.

Reach 7a: Site 21.1

Profile Aspect: 179º
Slope: 2 percent
Date Described: 12/20/2011
Topsoil Quality: Moderately Good
Soil Profile Position: North of County Property (Bowtie Parcel)
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent (historically cultivated)

A1 (p)--O to 8 inches; Brown (10YR 4/3) gravelly coarse sandy loam, dark brown (10YR 3/3) moist; weak fine and medium granular and medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and few fine roots; many very fine interstitial pores; 20 percent subangular and subrounded gravels; neutral (pH 6.7); clear wavy boundary.

A2--8 to 20 inches; Yellowish brown (10YR 5/4) very gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; many fine and very fine roots; many very fine interstitial pores; 35 percent subangular and subrounded gravels; clear smooth boundary.

AC--20 to 31 inches; yellowish brown (10YR 5/4) very gravelly loamy coarse sand, dark yellowish brown (10YR 3/4) moist; medium subangular blocky structure trending to massive; slightly hard, firm, nonsticky, nonplastic; common fine and very fine roots; common very fine and fine interstitial pores; 45 percent subangular and subrounded gravels; clear smooth boundary.

IIC--31 to 48 inches; Grayish Brown (10YR 5/2) very gravelly loamy coarse sand, dark brown (10YR 4/3) moist; massive; hard, firm, nonsticky, nonplastic; few very fine roots; few very fine interstitial pores; 50 percent subangular and subrounded gravels and lesser cobbles.

Reach 7a: Site 22.1

Profile Aspect: 179º
Slope: 2 percent
Date Described: 12/20/2011
Topsoil Quality: Moderately Good
Soil Profile Position: North of Middle Avenue
Soil Taxonomic Class: Fine-loamy, thermic Typic Haploxeralf (historically cultivated)

Ap--0 to 7 inches; grayish brown (10YR 5/2); gravelly fine sandy loam, dark brown (10YR 4/3) moist; weak to moderate fine to medium granular and weak fine to medium subangular structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; common very fine tubular and interstitial pores; 15 percent subangular and subrounded gravels; medium acid (pH 6.2); clear smooth boundary.

A2--7 to 15 inches; grayish brown (10YR 5/2); gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak medium granular and weak fine to medium subangular structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; common very fine interstitial pores; 15 percent subangular and subrounded gravels; medium acid (pH 6.0); clear smooth boundary.

Bt--15 to 23 inches; yellowish brown (10YR 5/4) gravelly sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular structure trending to massive, very hard, firm, slightly sticky, slightly plastic; few very fine and fine roots along ped faces; common very fine tubular and interstitial pores; common thin clay films on ped faces and pore linings; 15 percent subangular and subrounded gravels; abrupt wavy boundary.

IIC--23 to 40 inches; yellowish brown (10YR 5/4) very gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; massive; very hard, very firm, nonsticky, nonplastic; few very fine roots; common very fine interstitial pores; 50 percent subangular and subrounded gravels.

Reach 7a: Site 23.1

Profile Aspect: 167º **Slope:** 2 percent
Date Described: 12/21/2011 **Topsoil Quality:** Poor
Soil Profile Position: North of Middle Avenue
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerorthent

A--0 to 7 inches; Light olive brown (2.5Y 5/3) gravelly sandy loam; dark grayish brown (2.5Y 4/2) moist; weak medium granular and fine to medium subangular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 20 percent subangular and subrounded gravels; medium acid (pH 6.2); clear smooth boundary.

AC--7 to 14 inches; Light brownish gray (10YR 6/2); gravelly sandy loam; dark brown (10YR 3/3) moist; weak fine granular trending to massive; hard, friable, nonsticky, nonplastic; common very fine and fine roots; common very fine interstitial pores; 30 percent subangular and subrounded gravels; clear smooth boundary.

C--14 to 39 inches; Light brownish gray (10YR 6/2); very gravelly loamy coarse sand; dark grayish brown (10YR 4/2) moist; massive; hard, firm, nonsticky, nonplastic; few very fine roots; common very fine and fine interstitial pores; 55 percent subangular and subrounded gravels and lesser cobbles; abrupt wavy boundary.

IICmd--39 to 50 inches; Gray (10YR 6/1); extremely gravelly loamy coarse sand; light brownish gray (10YR 6/2) moist; massive; very hard, very firm, nonsticky and nonplastic; many very fine and fine interstitial pores; no roots; 65 percent subangular and subrounded gravels and lesser cobbles.

Reach 7a: Site 24.1

Profile Aspect: 68º
Slope: 52 percent
Date Described: 12/21/2011
Topsoil Quality: Moderate
Soil Profile Position: North of Watsonville Road, river right (man modified material that forms the road embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Fine-loamy, thermic Typic Haploxeralf, man-modified

A1--0 to 8 inches; Brown (10YR 4/3); gravelly fine sandy loam, dark brown; (10YR 4/3) moist; weak fine to medium granular and medium subangular structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots; common very fine tubular and interstitial pores; 15 percent subangular and subrounded gravels; medium acid (pH 6.2); clear wavy boundary.

A2--8 to 12 inches; Brown (10YR 5/3); gravelly sandy clay loam, dark brown; (10YR 3/3) moist; weak fine to medium subangular structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; common very fine tubular and interstitial pores; 20 percent subangular and subrounded gravels; clear wavy boundary.

Bt--12 to 28 inches; Brown (10YR 5/3); gravelly clay loam, dark yellowish brown; (10YR 4/4) moist; weak medium subangular trending to massive, hard, firm, slightly sticky, slightly plastic; common fine and very fine roots; common very fine tubular pores; common thin clay films on ped faces and pore linings; 25 percent subangular and subrounded gravels; clear wavy boundary.

C--28 to 44 inches; Yellowish brown (10YR 5/4); gravelly sandy clay loam; dark yellowish brown (10YR 4/4) moist; massive; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; few very fine tubular and interstitial pores; 25 percent subangular and subrounded gravels.

Reach 7a: Site 25.1

Profile Aspect: 164º
Slope: 2 percent
Date Described: 12/21/2011
Topsoil Quality: Poor
Soil Profile Position: North of Middle Avenue, isolated stormwater basin embankment
Soil Taxonomic Class: Sandy-skeletal, mixed, thermic Typic Xerofluvent, man-modified

A--0 to 9 inches; Light olive brown (2.5Y 5/2); very gravelly loamy coarse sand; dark grayish brown (2.5Y 4/2) moist; weak medium and coarse subangular blocky structure; slightly hard, friable, nonsticky, nonplastic; common very fine and few fine roots; common very fine interstitial pores; 35 percent subangular and subrounded gravels; medium acid (pH 6.2); clear smooth boundary.

C--9 to 34 inches; Light brownish gray (10YR 6/2); very gravelly loamy coarse sand; dark grayish brown (10YR 4/2) moist; massive; hard, firm, nonsticky, nonplastic; few very fine roots; many to common very fine and fine interstitial pores; 40 percent subangular and subrounded gravels and cobbles; clear wavy boundary

Cd--34 to 44 inches; Light brownish gray (10YR 6/2); extremely gravelly loamy coarse sand; dark grayish brown (10YR 4/2) moist; massive; very hard, firm, nonsticky, nonplastic; no roots; common to few very fine interstitial pores; 65 percent subangular and subrounded gravels.

Reach 7b: Site 26.1

Profile Aspect: 281º
Slope: 53 percent
Date Described: 12/21/2011
Topsoil Quality: Moderately Good
Soil Profile Position: La Crosse Drive, river left (man modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Coarse-loamy, thermic Typic Dystroxerept, man-modified

A1--0 to 5 inches; Brown (10YR 4/3) gravelly sandy loam, dark brown (10YR 4/3) moist; weak to moderate, medium subangular structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine and fine roots; common fine and very fine interstitial pores; 20 percent subangular and subrounded gravels; medium acid (pH 6.2); clear smooth boundary.

A2--5 to 16 inches; Brown (10YR 5/3) gravelly coarse sandy loam, brown (10YR 4/3) moist; moderate medium to coarse subangular structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; common fine and very fine interstitial pores; 20 percent subangular and subrounded gravels; clear smooth boundary.

BC--14 to 20 inches; Dark yellowish brown (10YR 4/4) gravelly loamy coarse sand, brown (10YR 4/3) moist; weak medium to coarse subangular structure trending to massive, hard, firm, slightly sticky, slightly plastic; common fine and very fine roots; common very fine tubular and interstitial pores; common thin clay films on ped faces and pore linings; 20 percent subangular and subrounded gravels; clear wavy boundary.

C--20 to 44 inches; pale brown (10YR 6/3) gravelly sandy clay loam; brown (10YR 4/3) moist; massive; very hard, firm, slightly sticky, slightly plastic; few very fine and fine roots; common very fine interstitial pores; 25 percent subangular and subrounded gravels.

Reach 7b: Site 27.1

Profile Aspect: 216º
Slope: 57 percent
Date Described: 12/22/2011
Topsoil Quality: Moderately Good
Soil Profile Position: North of Edmundson Avenue, river left (man modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Xerorthent, man-modified

A1--0 to 9 inches; Pale brown (10YR 6/3) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular structure; hard, friable, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores; 20 percent subangular and subrounded gravels; neutral (pH 7.0); clear smooth boundary.

A2--9 to 22 inches; Brown (10YR 5/3) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular structure trending to massive; hard, friable, nonsticky and nonplastic; common trending to few very fine and fine roots; common very fine interstitial pores; 20 percent subangular and subrounded gravels; clear wavy boundary.

C--22 to 44 inches; Light brownish gray (10YR 6/2) very gravelly loamy coarse sand; dark grayish brown (10YR 4/2) moist; massive; hard, firm nonsticky, nonplastic; very few very fine and fine roots; many very fine and fine interstitial pores; 35 percent subangular and subrounded gravels.

Reach 7b: Site 28.1

Profile Aspect: 242º | Slope: 55 percent
Date Described: 12/22/2011 | Topsoil Quality: Poor

Soil Profile Position: South of Eddes Street, river left (man-modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).

Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Xerorthent, man-modified

A1--0 to 6 inches; Dark gray brown (2.5Y 4/2) gravelly sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak fine to medium granular and medium subangular structure; slightly hard, friable, slightly sticky, nonplastic; many very fine and fine roots; many very fine interstitial pores; 15 percent subangular and subrounded gravels; neutral (pH 7.0); clear smooth boundary.

A2--6 to16 inches; Grayish brown (2.5Y 5/2) gravelly coarse sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular structure; hard, friable, slightly sticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 15 percent subangular and subrounded gravels; clear wavy boundary.

AC--16 to 30 inches; light brownish gray (10YR 6/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular structure trending to massive; hard, firm nonsticky, nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; 25 percent subangular and subrounded gravels; clear wavy boundary

C--30 to 44 inches; light brownish gray (10YR 6/2) very gravelly loamy coarse sand; dark grayish brown (10YR 4/2) moist; massive; very hard, firm, nonsticky, nonplastic; few very fine roots; common very fine interstitial pores; 35 percent subangular and subrounded gravels.

Reach 7b: Site 29.1

Profile Aspect: 258º
Slope: 44 percent
Date Described: 12/22/2011
Topsoil Quality: Moderately Good
Soil Profile Position: South of Cosmo Avenue, river left (man-modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Coarse-loamy, mixed, thermic Typic Xerorthent, man-modified

A1--0 to 7 inches; Dark grayish brown (10YR 4/2) gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular and medium and coarse subangular structure; slightly hard, friable, slightly sticky, nonplastic; many very fine, fine and medium roots; many very fine and fine interstitial pores; 15 percent subangular and subrounded gravels; neutral (pH 7.0); clear smooth boundary.

A2--7 to11 inches; Grayish brown (10YR 5/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; medium and coarse subangular structure; hard, friable, slightly sticky and nonplastic; common very fine, fine and medium roots; many fine and very fine interstitial pores; 15 percent subangular and subrounded gravels; clear smooth boundary.

AC--11 to 19 inches; light brownish gray (10YR 6/3) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) moist; medium and coarse subangular structure trending to massive; hard, firm, nonsticky, nonplastic; common very fine roots and few fine roots; many very fine and fine interstitial pores; 20 percent subangular and subrounded gravels; clear wavy boundary.

C1--19 to 31 inches; light brownish gray (10YR 6/2) very gravelly loamy coarse sand; dark grayish brown (10YR 4/2) moist; massive; very hard, firm, nonsticky, nonplastic; common very fine and few fine roots; common very fine and fine interstitial pores; 35 percent subangular and subrounded gravels.

C2--31 to 42 inches; Grayish brown (10YR 5/2) very gravelly loamy coarse sand; dark gray (10YR 4/1) moist; massive; loose, nonsticky and nonplastic; common very fine roots; common very fine and fine interstitial pores; 40 percent subangular and subrounded gravels.

Reach 14: Site 30.1

Profile Aspect: 253º
Slope: 20 percent
Date Described: 12/22/2011
Topsoil Quality: Poor
Soil Profile Position: North of San Martin Avenue, river left (man-modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent, man-modified

A--0 to 6 inches; Light olive brown (2.5Y 5/3) gravelly coarse sandy loam, dark grayish brown (2.5Y 4/2) moist; weak fine and medium granular; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 30 percent subangular and subrounded gravels; neutral (pH 6.7); clear smooth boundary.

AC--8 to 12 inches; Light olive brown (2.5Y 5/3) very gravelly coarse sandy clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium granular trending to packed single grain-massive; loose, nonsticky, nonplastic; common very fine and fine roots trending to few very fine roots; many very fine and fine interstitial pores; 35 percent subangular and subrounded gravels; clear smooth boundary.

C1--22 to 34 inches; Light brownish gray (2.5Y 6/2) very gravelly coarse loamy sand, light brownish gray (2.5Y 6/2) moist; packed single grain-massive; loose, nonsticky, nonplastic; many very fine and fine interstitial pores; few very fine roots; 45 percent subangular and subrounded gravels and lesser cobbles; clear wavy boundary.

C2--34 to 45 inches; Light brownish gray (2.5Y 6/2) very gravelly coarse loamy sand, light brownish gray (2.5Y 6/2) moist; packed single grain-massive; loose, nonsticky, nonplastic; common very fine and fine interstitial pores; few very fine roots; 45 percent subangular and subrounded gravels and lesser cobbles.

Reach 14: Site 31.1

Profile Aspect: 245° **Slope:** 20 percent
Date Described: 12/22/2011 **Topsoil Quality:** Poor
Soil Profile Position: North of Church Avenue, river left (man-modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent, man-modified

A--0 to 5 inches; Brown (10 YR 4/3); gravelly coarse sandy loam; dark grayish brown (10 YR 4/2) moist; weak fine and medium granular; slightly hard, friable, non sticky, nonplastic; common very fine and fine roots; many very fine interstitial pores; 25 percent subangular and subrounded gravels and lesser cobbles; neutral (pH 6.7); clear wavy boundary.

AC--5 to 13 inches; Brown (10 YR 5/3); very gravelly coarse sandy loam; grayish brown (10 YR 5/2) moist; massive; slightly hard, friable, non sticky, nonplastic; common very fine and fine roots; many very fine interstitial pores; 35 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C1--13 to 29 inches; Pale brown (10 YR 6/2) very gravelly coarse sandy clay loam, grayish brown (10 YR 5/2) moist; packed single grain-massive; slightly hard, friable, nonsticky, nonplastic; few very fine roots; common very fine and fine interstitial pores; 40 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C2--29 to 44 inches; Gray (10 YR 6/1) very gravelly coarse loamy sand, light brownish gray (10 YR 5/1) moist; packed single grain-massive; loose, nonsticky, nonplastic; common to few very fine and fine interstitial pores; no roots; 55 percent subangular and subrounded gravels and lesser cobbles.

Reach 14: Site 32.1

Profile Aspect: 248º | **Slope:** 20 percent
Date Described: 12/22/2011 | **Topsoil Quality:** Poor
Soil Profile Position: South of Church Avenue, river left (man-modified material that forms the terrace embankment, soil profile examined down to bottom of engineered channel invert).
Soil Taxonomic Class: Loamy-skeletal, mixed, thermic Typic Xerofluvent, man-modified

A--0 to 7 inches; Brown (10YR 5/3) gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine and fine roots; common very fine and fine interstitial pores; 25 percent subangular and subrounded gravels and lesser cobbles; neutral (pH 6.7); clear wavy boundary.

AC--7 to 12 inches; brown (10YR 5/3) very gravelly sandy loam, dark brown (10YR 3/3) moist; weak fine and medium granular trending to packed single grain-massive; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; 35 percent subangular and subrounded gravels and cobbles; clear wavy boundary.

C1--12 to 33 inches; yellowish brown (10YR 5/4) extremely gravelly coarse sandy loam, dark brown (10YR 4/3) moist; packed single grain-massive; loose, nonsticky, nonplastic; few very fine roots; few very fine and fine interstitial pores; 40 percent subangular and subrounded gravels and lesser cobbles; clear smooth boundary.

C2--33 to 44 inches; yellowish brown (10YR 5/4) extremely gravelly coarse loamy sand, dark brown (10YR 4/3) moist; packed single grain-massive; loose, nonsticky, nonplastic; no roots; few very fine interstitial pores; 55 percent subangular and subrounded gravels and lesser cobbles.

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Appendix B

Laboratory Analysis Results for Soil Samples

A & L WESTERN AGRICULTURAL LABORATORIES

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

REPORT NUMBER: 12-032-014 **CLIENT:** 9999-D

SUBMITTED BY:

SEND TO: CARDNO ENTRIX
PO BOX 1533
ZEPHYR COVE, NV 89448-

GROWER:

DATE OF REPORT: 04/27/12

SOIL FERTILITY GUIDELINES

RATE: lb/acre **PAGE:** 1

Sample ID	Lab Number	Crop	SOIL AMENDMENTS				Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
			Dolomite	Lime	Gypsum	Elemental Sulfur										
1.A	55633	RIPARIAN			2400		50	100	180							
2.B	55634	RIPARIAN			2100		60	200	180				5			0.5
3.C	55635	RIPARIAN			1900		60	70	180				5			0.5
4.D	55636	RIPARIAN		4000			40	100	180		15					
5.E	55637	RIPARIAN			1900		70	160	180			10				1.0

COMMENTS

PLEASE NOTE amended soil fertility guidelines. We apologize for any inconvenience. PLEASE DESTROY previous guidelines. The main difference is less nitrogen will be required.
REVEGETATION should preferably be conducted on soils with a pH above 6.5 but below 7.5 and more than 2% organic matter. A minimum of 30 lb N/acre (15 ppm NO3-N) should be available at planting.
PHOSPHATE and POTASH levels are in fact fairly low and therefore recommendations haven't been modified here. Decide on what degree of vigor you require in establishment and fertilize accordingly.
MAGNESIUM: If levels are very high, one may encounter drainage problems and potassium uptake may be hindered. Extra calcium may provide some benefit, but source should depend on soil pH.
CALCIUM: As a guideline, (CEC x 200 x 0.65) - ppm Ca on soil report = lb Ca required per 3 acre-inch

NOTES:

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REPORT NUMBER: 12-032-014 **CLIENT:** 9999-D

SUBMITTED BY:

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PO BOX 1533
ZEPHYR COVE, NV 89448-

GROWER:

DATE OF REPORT: 04/27/12

SOIL FERTILITY GUIDELINES

RATE: lb/acre **PAGE:** 2

Sample ID	Lab Number	Crop	SOIL AMENDMENTS				Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
			Dolomite	Lime	Gypsum	Elemental Sulfur										
6.F	55638	RIPARIAN		2000			60	70	180		20	5				1.0
7.G	55639	RIPARIAN			2300		70	70	180							0.5
8.H	55640	RIPARIAN			1500		60	40	150							

COMMENTS

soil depth to raise to 65% Ca. Gypsum contains about 400 lb/ton, and lime possibly 600 lb/ton.
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.
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.
WETLAND vegetation may not be harvested, and would therefore require very little amending or fertilizing. Reduce above requirements accordingly, but avoid high salts at establishment.
WETLAND VEGETATION may include willow, cottonwood, swamp privet, green ash, rushes and sedges. Many species of oak, maple, hickory and rose, may also withstand long wet periods in certain areas.
SOIL TEXTURE: "Available water capacity" (plant-available water) may vary between less than one inch

NOTES:

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GROWER:

DATE OF REPORT: 04/27/12

SOIL FERTILITY GUIDELINES

RATE:

Sample ID	Lab Number	Crop	SOIL AMENDMENTS				Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
			Dolomite	Lime	Gypsum	Elemental Sulfur										

COMMENTS

per foot of soil in sands/loamy sands to over two inches in clays. Apply water accordingly.

NOTES:

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REPORT NUMBER: 12-032-014

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PO BOX 1533
ZEPHYR COVE, NV 89448-

GROWER:

DATE OF REPORT: 02/07/12

SOIL FERTILITY GUIDELINES

RATE: lb/acre

Sample ID	Lab Number	Crop	SOIL AMENDMENTS				Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
			Dolomite	Lime	Gypsum	Elemental Sulfur										
1.A	55633	GENERAL			2400		110	100	180							
2.B	55634	GENERAL			2100		120	200	180			5	10			0.5
3.C	55635	GENERAL			1900		120	80	180			10	10			
4.D	55636	GENERAL		4000			100	100	180		25					
5.E	55637	GENERAL			1900		130	160	180			10				1.0

COMMENTS

GENERAL guidelines may be improved upon if we are aware of the plant type or crop that is being grown, and any other relevant information. Please supply this information in future, if you can.
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.
MAGNESIUM: If levels are very high, one may encounter drainage problems and potassium uptake may be hindered. Extra calcium may provide some benefit, but source should depend on soil pH.
CALCIUM: As a guideline, (CEC x 200 x 0.65) - ppm Ca on soil report = lb Ca required per 3 acre-inch soil depth to raise to 65% Ca. Gypsum contains about 400 lb/ton, and lime possibly 600 lb/ton.
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.

NOTES:

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REPORT NUMBER: 12-032-014 **CLIENT:** 9999-D

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SEND TO: CARDNO ENTRIX
PO BOX 1533
ZEPHYR COVE, NV 89448-

GROWER:

DATE OF REPORT: 02/07/12

SOIL FERTILITY GUIDELINES

RATE: lb/acre **PAGE:** 2

Sample ID	Lab Number	Crop	SOIL AMENDMENTS				Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
			Dolomite	Lime	Gypsum	Elemental Sulfur										
6.F	55638	GENERAL		2000			120	80	180		30	10				1.0
7.G	55639	GENERAL			2300		130	80	180							0.5
8.H	55640	GENERAL			1500		120	80	150							

COMMENTS

ZINC: Maintain soil levels above 2.0 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.
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.
LIME REQUIREMENT: Liming may be necessary if buffer index is less than 6.9. Guidelines are based upon common agricultural lime (70-score) per six-inch depth to raise SOIL pH to about 6.5.

NOTES:

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CLIENT: 9999

SUBMITTED BY:

SEND TO: CARDNO ENTRIX
P. O. BOX 1533
ZEPHYR COVE, NV 89448

GROWER:

DATE OF REPORT: 02/06/12

SOIL ANALYSIS REPORT

Sample ID	Lab Number		Estimated Water Holding Capacity (%)	Estimated Available Water (inches/foot)				
1.A	55633		43.3	1.3				
2.B	55634		39.3	1.2				
3.C	55635		34.8	1.0				
4.D	55636		38.1	1.1				
5.E	55637		32.2	1.0				
6.F	55638		37.7	1.1				
7.G	55639		47.5	1.4				
8.G	55640		41.5	1.2				

NOTES: Estimated water holding capacity multiplied by 0.03 approximates the available water in inches per foot depth of soil.

Estimated available water capacity is that held between field capacity and wilting point in inches per foot depth of soil.

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REPORT NUMBER: 12-032-014

CLIENT NO: 9999-D

SEND TO: CARDNO ENTRIX
PO BOX 1533
ZEPHYR COVE, NV 89448-

SUBMITTED BY:

GROWER:

DATE OF REPORT: 02/07/12

SOIL ANALYSIS REPORT

PAGE: 1

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus $NaHCO_3$-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	PERCENT CATION SATURATION (COMPUTED) K %	Mg %	Ca %	H %	Na %
1.A	55633	2.1L	72	12L	6L	93L	917VH	1782L	55L	6.8		0.5	17.4	1.4	43.3	51.0	3.0	1.4
2.B	55634	2.0L	69	2VL	3VL	92L	981VH	1952L	62L	7.0		0.0	18.3	1.3	44.0	53.2	0.0	1.5
3.C	55635	2.2L	74	11L	8M	129L	1037VH	2754L	15VL	6.6		1.4	24.1	1.4	35.4	57.0	6.0	0.3
4.D	55636	2.9M	88	14L	7**	136L	889VH	2491L	16VL	6.1	6.6	3.3	23.4	1.5	31.2	53.0	14.0	0.3
5.E	55637	1.9L	68	4VL	4L	97L	892VH	2064L	12VL	6.7		0.8	18.8	1.3	39.1	54.8	4.5	0.3

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
1.A	13M	8L	3.1H	4M	11M	1.5H	0.5L	L	0.4L			60	16	23	SANDY CLAY LOAM
2.B	6L	5L	1.8M	2L	7L	0.8L	0.3VL	L	0.3L			64	12	23	SANDY CLAY LOAM
3.C	5L	3VL	1.0L	2L	9L	0.9M	0.4L	L	0.2VL			68	16	15	SANDY LOAM
4.D	15M	5L	3.7H	4M	14M	1.4H	0.5L	L	0.4L			72	10	17	SANDY LOAM
5.E	2VL	1VL	0.5VL	3M	8L	0.9M	0.2VL	L	0.2VL			72	8	19	SANDY LOAM

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

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REPORT NUMBER: 12-032-014

CLIENT NO: 9999-D

SEND TO: CARDNO ENTRIX
PO BOX 1533
ZEPHYR COVE, NV 89448-

SUBMITTED BY:

GROWER:

DATE OF REPORT: 02/07/12

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus $NaHCO_3$-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	PERCENT CATION SATURATION (COMPUTED) K %	Mg %	Ca %	H %	Na %
6.F	55638	2.2L	74	5VL	11L	92L	731VH	1299L	47L	6.2	6.8	1.8	14.7	1.6	40.9	44.1	12.0	1.4
7.G	55639	1.8L	66	7VL	10M	66L	953VH	1741L	43L	7.0		0.0	16.9	1.0	46.4	51.4	0.0	1.1
8.H	55640	1.6L	62	12L	14H	148M	793VH	2044L	14VL	6.7		0.8	18.0	2.1	36.3	56.8	4.5	0.3

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
6.F	6L	2VL	0.9L	7M	19H	1.3H	0.2VL	L	0.2VL			34	36	29	CLAY LOAM
7.G	4VL	6L	18.2VH	5M	22H	3.6VH	0.3VL	L	0.4L			48	18	34	SANDY CLAY LOAM
8.H	11L	5L	4.7H	4M	14M	1.5H	0.4L	L	0.5L			70	6	23	SANDY CLAY LOAM

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

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Appendix C

Soil Profile Photos

Figure 1: Soil Profile Description Location 1.1 in Reach 4 – A picture depicting the soil profile of a Coarse-loamy, mixed, thermic Typic Haploxeralf. The soil profile was located north of Buena Vista Avenue at the southern boundary of the Project Area.
(The soil profile was positioned to examine the material that forms the terrace embankment down to the bottom of the channel invert. The soil profile was located on the right side of the creek, looking downstream.)

Figure 2: Soil Profile Description Location 1.1 in Reach 4 - A picture depicting the use of a static cone penetrometer (and a hand-held geotester) to quantifiably assess the topsoil's strength and the depth to densic materials.

Figure 3: Soil Profile Description Location 1.1 in Reach 4 - A picture depicting the proportional soil textural separates and ped structure and color. The soil was sampled from the top 20 inches of a profile that forms the right terrace embankment.

Combinations of the following sieves were used to approximate the partitioning of soil textural separates in the field:

Mesh #5 – medium gravel (5 - 20 mm), Mesh #10 - fine gravel (2 - 5 mm), Mesh #35 - very coarse sand (1 - 2 mm), Mesh #60 - coarse sand (0.5 – 1.0 mm), Mesh #120 - medium sand (.25 – 0.5 mm), Mesh #230 - fine sand (0.1 - .25 mm) and the bottom pan captures the very fine sand, silt and clay fractions (0.0002 -0.1 mm).

Figure 4: Stratigraphic column portraying a gravelly, massive substratum between Soil Profile Description and Sampling Locations 1.1 and 2.1 in Reach 4. Notice the abrupt textural (color) change associated with the contact boundary between the different depositional units. The subjacent densic unit prevents downward root penetration.

(The stratigraphic column exposure is located on the right side of the creek channel, looking downstream)

Figure 5: Soil Description Location 2.1 in Reach 4. - A picture depicting the soil profile's location.
(The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream)

Figure 6: Soil Profile Description and Sampling Location 2.1 in Reach 4 - A picture depicting the proportional soil textural separates and ped structure.
(The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream)

Figure 7: Soil Profile Description Location 3.1 in Reach 4 - A picture depicting the soil profile's location.
(The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream)

Figure 8: Soil Profile Description Location 3.1 in Reach 4 - A picture depicting the soil profile being comprised of manmade fill and debris, This soil classified as a Loamy-skeletal, mixed, thermic Typic Xerofluvent (Man-Modified).
(The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream)

Figure 9: Soil Profile Description Location 3.2 in Reach 4 - A picture depicting the soil profile's location.
(The soil profile was positioned to examine the material that forms the terrace embankment down to the bottom of the channel invert. The soil profile was located on the right side of the creek, looking downstream)

Figure 10: Soil Profile and Sampling Description Location 3.2 - A picture depicting size, shape, and type of ped structure.
(The soil was sampled from the top 20 inches of a profile that forms the right terrace embankment)

Figure 11: Soil Profile Description Location 4.1 in Reach 4. - A picture depicting the soil profile's location.
(The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream)

Figure 12: Soil Profile Description Location 4.1 in Reach 4 - A picture depicting the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent.
(The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream)

Figure 13: Soil Profile Description and Sampling Location 4.1 in Reach 4 - A picture depicting the proportional soil textural separates and ped structure. The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 14: Soil Profile Description Location 4.2 in Reach 4 - A picture depicting the soil profile of a Coarse-loamy, mixed, thermic Typic Haploxeralf. The soil profile was positioned to examine the material that forms the terrace embankment down to the bottom of the channel invert. The profile was located on the right side of the creek, looking downstream.

Figure 15: Soil Description and Sampling Location 4.2 in Reach 4 - A picture depicting the proportional soil textural separates and ped structure. The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 16: Soil Profile Description Location 5.1 in Reach 4. - A picture depicting the soil profile's location.
(The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream)

Figure 17: Soil Profile Description and Sampling Location 5.1 in Reach 4 - A picture depicting the proportional soil textural separates.
(The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream)

Figure 18: Soil Profile Description Location 6.1 in Reach 4. - A picture depicting the soil profile of a Coarse-loamy, mixed, thermic Typic Xerorthent. The soil profile was positioned to examine the material that forms the terrace embankment down to the bottom of the channel invert. This soil profile was located on the right side of the creek, looking downstream.

Figure 19: Soil Profile Description and Sampling Location 6.1 in Reach 4 - A picture depicting the proportional soil textural separates.
(The soil was sampled from the top 20 inches of a profile that forms the right terrace embankment, looking downstream)

Figure 20: Soil Profile Description and Sampling Location 6.1 in Reach 4 - A picture depicting the medium to coarse subangular blocky structure and the interior ped face color. The soil was sampled from the top 20 inches of a profile that forms the right terrace embankment

Figure 21: Soil Profile Description Location 7.1 in Reach 4. - A picture depicting the soil profile's location.
The soil profile was positioned to examine the material that forms the terrace embankment down to the bottom of the channel invert. The soil profile was located on the right side of the creek, looking downstream.

Figure 22: Soil Profile Description Location 7.1 in Reach 4 - A picture depicting the proportional soil textural separates.
The soil was sampled from the top 20 inches of a profile that forms the right terrace embankment.

Figure 23: This is a picture depicting a stratigraphic column exposure located on the left side of the creek channel (looking downstream) between soil description and sampling sites 7 and 8 (the north end of Reach 4). Notice the abrupt change in particle size and the hydraulically related energetics (i.e. clast entrainment and sorting) represented at the contact boundary between the pedogenic unit and the weakly cemented subjacent fanglomerate.

Figure 24: Soil Profile Description Location 8.1 in Reach 4. - A picture depicting the soil profile's location.
The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 25: Soil Profile Description Location 8.1 in Reach 4 - A picture depicting the proportional soil textural separates.
The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 26: Soil Profile Description Location 9.1 in Reach 4. - A picture depicting the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent.
The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 27: Soil Profile Description and Sampling Location 9.1 in Reach 4 - A picture portraying the medium to coarse subangular blocky structure. Note the interior ped face color illustrating Fe^{++} reduced matrix and redoximorphic features. The soil sample was retrieved from 35 inches below the ground surface, which was one foot above the channel invert. The profile was located on left lower terrace flank of the creek, looking downstream.

Figure 28: Soil Profile and Sampling Description Location 9.1 in Reach 4 - A picture depicting the proportional soil textural separates associated with the AC horizon. The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 29: Soil Profile Description Location 10.1 in Reach 5 - A picture depicting the top soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 30: Soil Profile Description and Sampling Location 10.1 in Reach 5 - A picture depicting the proportional soil textural separates.
(The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream)

Figure 31: Soil Profile Description Location 11.1 in Reach 5 - A picture depicting the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned to examine the material that forms the terrace embankment down to the bottom of the channel invert. The soil profile was located on the left side of the creek, looking downstream.

Figure 32: Soil Profile Description Location 12.1 in Reach 6b - A picture depicting the soil profile's location.
(The soil profile was positioned on the right side of the creek on the western embankment of the flood control basin)

Figure 33: Soil Profile Description and Sampling Location 12.1 in Reach 6b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 34: Soil Profile Description Location 13.1 in Reach 6b - A picture depicting the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 35: Soil Profile Description and Sampling Location 13.1 - A picture depicting the proportional soil textural separates.
The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 36: Soil Profile Description Location 14.1 in Reach 6b – A picture depicting the soil profile's location.
The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 37: Soil Profile Description and Sampling Location 14.1 in Reach 6b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 38: Soil Profile Description Location 14.2 in Reach 6b - A picture depicting the soil profile's location. The soil profile was positioned on a mid-terrace flank located on the right side of the creek, looking downstream.

Figure 39: Soil Profile Description and Sampling Location 14.2 in reach 6b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of a profile located on the right mid-terrace flank of the creek, looking downstream.

Figure 40: Soil Profile Description Location 15.1 in Reach 6b - A picture depicting the soil profile's location. *The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.*

Figure 41: Soil Profile Description and Sampling Location 15.1 in Reach 6b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of a profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 42: Soil Profile Description Location 15.2 in Reach 6b - A picture depicting the soil profile's location. The soil profile was positioned on a mid-terrace flank located on the right side of the creek, looking downstream.

Figure 43: Soil Profile Description Location 15.2 in Reach 6b - A picture depicting the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on the right side of the creek, looking downstream.

Figure 44: Soil Profile Description and Sampling Location 15.2 in Reach 6b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of a profile located on the right mid-terrace flank of the creek, looking downstream.

Figure 45: Soil Profile Description Location 16.1 in Reach 6b - A picture depicting the upper part of the soil profile of a Loamy-skeletal, mixed, Typic Xerofluvent. The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 46: Soil Profile Description Location 16.1 in Reach 6b - A picture depicting the lower part of the soil profile of a Loamy-skeletal, mixed, Typic Xerofluvent. The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking.

Figure 47: Soil Profile Description Location 17.1 in Reach 6b - A picture depicting the location of the soil profile. *The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.*

Figure 48: Soil Profile Description Location 17.1 in Reach 6b - A picture depicting the upper part of the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 49: Soil Profile Description Location 17.1 in Reach 6b - A picture depicting the lower part of the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on a mid-terrace flank located on the left side of the creek, looking downstream.

Figure 50: Soil Profile Description and Sampling Location 17.1 in Reach 6b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile located on the left mid-terrace flank of the creek, looking downstream.

Figure 51: Soil Profile Description Location 18.1 in Reach 6a - A picture depicting the upper part of the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on the east side of the county parcel (County Bowtie Property).

Figure 52: Soil Description Location 18.1 in Reach 6a -A picture depicting the graduated series of soil sieves.

Figure 53: Location near Soil Profile Description Location 18.1 in Reach 6a - A picture depicting the geotechnical boring site positioned just south and east of Soil Profile Description Location 18.1. The picture is oriented looking toward the southeast side of the county parcel (aka the Bowtie property) in the direction of the Monterey Road overpass of Upper Llagas Creek.

Figure 54: Soil Profile Description Location 19.1 in Reach 6a - A picture depicting the location of the soil profile. *The soil profile was positioned on the south central part of the county parcel (aka the Bowtie property.*

Figure 55: Soil Profile Description Location 19.1 in Reach 6a - A picture depicting the upper soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on the south central part of the county parcel (aka the Bowtie property).

Figure 56: Soil Profile Description and Sampling Location 19.1 in Reach 6a - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 57: Soil Profile Description Location 20.1 in Reach 6a - A picture depicting the location of the soil profile. *The soil profile was positioned on western part of the county parcel (aka the Bowtie property).*

Figure 58: Soil Profile Description Location 20.1 in Reach 6a - A picture depicting the upper part of the soil profile of a Loamy-skeletal, mixed, thermic Typic Xerorthent. The soil profile was positioned on western part of the county parcel (aka the Bowtie property

Figure 59: Soil Profile Description and Sampling Location 20.1 in Reach 6a - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 60: Soil Profile Description Location 21.1 in Reach 7a - A picture depicting the location of the soil profile.
(The soil profile was positioned north the county's northwestern parcel boundary and just south of Middle Avenue.

Figure 61: Soil Profile Description Location 22.1 in Reach 7a - A picture depicting the location of the soil profile.
(The picture was oriented looking north toward Watsonville Road)

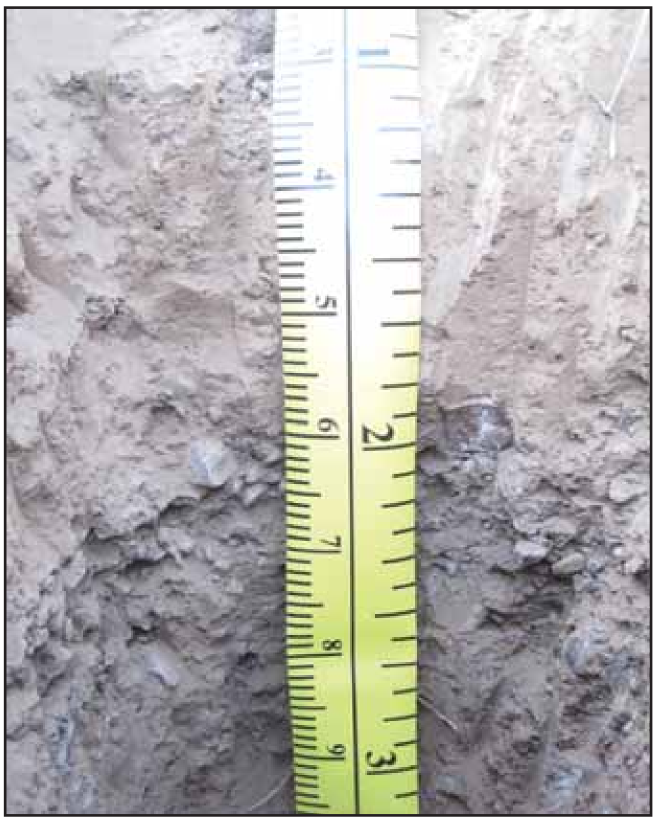

Figure 62: Soil Profile Description Location 22.1 in Reach 7a - A picture of the lower part of the soil profile depicting a Fine-loamy, mixed, thermic Typic Haploxeralf.

Figure 63: Soil Description Location 22.1 in Reach 7a - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 64: Soil Profile Description Location 23.1 in Reach 7a - A picture depicting the location of the soil profile.
(The picture was oriented looking northeast toward Watsonville Road)

Figure 65: Soil Profile Description Location 23.1 in Reach 7a - A picture depicting the lower part of the soil profile of a Loamy-skeletal, mixed, Typic Xerofluvent.

Figure 66: Soil Profile Description and Sampling Location 23.1 in Reach 7a - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 67: Soil Profile Description Location 24.1 in Reach 7a - A picture depicting the location of the soil profile.
(The soil profile was positioned on the right side of the engineered creek channel, looking south. The soil profile location was located just north of Watsonville Road.

Figure 68: Soil Profile Description Location 24.1 in Reach 7a - A picture depicting the soil profile of a Coarse-loamy, mixed, thermic Typic Haploxeralf.

Figure 69: Soil Description and Sampling Location 24.1 in Reach 7a - A picture depicting the proportional soil textural separates and massive “clod like” ped structure. The soil was sampled from the top 20 inches of the profile. The soil profile examined the man-modified soil material from the top of the road embankment down to the bottom of engineered channel invert.

Figure 70: Soil Profile Description Location 25.1 in Reach 7a - A picture depicting the location of the soil profile positioned near the isolated flood control basin south of Watsonville Road.

Figure 71: Soil Profile Description Location 25.1 in reach 7a - A picture depicting the massive, man modified fill that keys out as a Sandy-skeletal, mixed, Typic Xerofluvent (the closest taxonomic analog)

Figure 72: Soil Description and Sampling Location 25.1 in Reach 7a - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 73: Soil Profile Description Location 26.1 in Reach 7b - A picture depicting the location of the soil profile.
The soil profile was positioned on the left side of the engineered channel of West Little Llagas Creek (looking southwest and downstream) near the confluence with Edmundson Creek. The soil profile was located next to La Crosse Road.

Figure 74: Soil Profile Description Location 26.1 in Reach 7b - A picture depicting the massive man modified fill - soil profile that keys out as a Coarse-loamy, mixed, thermic Typic Haploxeralf. The soil profile examined the soil material from the middle of the road embankment down to the bottom of the engineered channel invert. The soil profile pit was positioned on the left side of the channel, looking southwest (downstream).

Figure 75: Soil Profile Description and Sampling Location 26.1 in Reach 7b - A picture depicting the massive “clod-like” soil peds. The soil was sampled from the top 20 inches of the profile.

Figure 76: Soil Profile Description Location 27.1 in Reach 7b - A picture depicting the location of the soil profile.
The soil profile was positioned on the left side of the engineered channel of West Little Llagas Creek (looking southwest). The soil profile location was located just north of Edmundsen Road. The soil profile examined the soil material from the top of the embankment down to the bottom of engineered channel invert on the left side of the channel.

Figure 77: Soil Profile Description Location 27.1 in Reach 7b - A picture depicting the massive embankment fill that keyed out as a man-modified Loamy-skeletal, mixed, thermic Typic Xerorthent.

Figure 78: Soil Profile Description and Sampling Location 27.1 in Reach 7b - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 79: Soil Profile Description Location 28.1 in Reach 7b - A picture depicting the location of the soil profile.
The soil profile examined the soil material from the top of the embankment down to the bottom of engineered channel invert on the right side of the West Little Llagas Creek channel (looking southwest). The soil Profile was located in middle of the channel section south of Cosmos Drive and north of Edmundsen Road.

Figure 80: Soil Profile Description Location 28.1 in Reach 7b - A picture depicting a embankment fill with an incipient A horizon that keys out as a man-modified Loamy-skeletal, mixed, thermic Typic Xerorthent.

Figure 81: Soil Profile Description and Sampling Location 28.1 in Reach 7b - A picture depicting the proportional soil textural separates and "clod-like" ped structure. The soil was sampled from the top 20 inches of the profile.

Figure 82: Soil Profile Description Location 29.1 in Reach 7b- A picture depicting the location of the soil profile.
The soil profile examined the soil material from the top of the embankment down to the bottom of engineered channel invert on the left side of the West Little Llagas Creek channel (looking southwest). The soil profile location was located just south of Cosmos Drive.

Figure 83: Soil Profile Description Location 29.1 in Reach 7b - A picture depicting the upper part of the soil profile that keys out as a man-modified Coarse-skeletal, mixed, thermic Typic Xerorthent.

Figure 84: Soil Profile Description and Sampling Location 29.1 in Reach 7b - A picture depicting the differing ped sizes, structure and color. The soil was sampled from the top 20 inches of the profile.

Figure 85: Soil Profile Description Location 30.1 in Reach 14 - A picture depicting the location of the soil profile.
The soil profile examined the soil material from the top of the embankment down to the bottom of engineered channel invert on the left side of East Little Llagas Creek channel (looking southwest). The soil profile location was located just north of San Martin Avenue.

Figure 86: Soil Description Location 30.1 in Reach 14 - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Figure 87: Soil Profile Description Location 31.1 in reach 14 - A picture depicting the location of the soil profile.
The soil profile examined the soil material from the top of the embankment down to the bottom of engineered channel invert on the left side of East Little Llagas Creek channel (looking southwest). The soil profile location was located south of Church Avenue.

Figure 88: Soil Profile Description Location 31.1 in Reach 14 - A picture depicting the soil profile that keyed out as a Loamy-skeletal, mixed, Typic Xerofluvent.

Figure 89: Soil Description Location 31.1 in Reach 14 - A picture depicting the proportional soil textural separates. The soil was sampled from the top 20 inches of the profile.

Appendix D

Soil Field Cards

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 1.1 Right/ Left (Looking Downstream)

Geomorphic Position: terrace to invert **Aspect:** 21° **Percent Slope:** ~80% creekbank

Logged By: TH

Date: 10/27/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-11	grsl	2 co SBK	2.5Y 4/3	15	3f PTM	HA FI SS SP	NA	CW	
Bt	11-23	grscl	1 co SBK	10YR 5/3	20	3f T	HA FI SS SP	NA	GW	clay skins, few on ped faces and pore linings
C	23-36	grscl	MA	10YR 5/3	20	1f, vf T	VHA FI SS SP	NA	GW	Continuous moderately clayskins ped-linings
Cd	36-48	grscl	MA	10YR 5/4	20	None	VHA FI SS SP	NA	/	few thin clay skins

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 2,1 Right Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 120° **Percent Slope:** ~24%

Logged By: TH

Date: 10/26/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-10	gr fsl	1,2 M SBK	10YR 5/3	15	3vf,f TM	SHA VFI SS SP	NA	GS	
A2	10-24	gr sl	1 m f SBK	10YR 5/4	20	3vf T	SHA VFI SS SP	NA	GS	
C	24-42	gr sl	MA	10YR 5/4	20	1vf T	HA FI SS SP	NA	GS	
Cd	42-53	vgr sl	MA	10YR 5/3	30	None	HA FI SS NP	NA	GS	

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 3.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 128° **Percent Slope:** 22%

Logged By: TH

Date: 10/26/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-13	VGr SL	1 M SBK	2.5Y 5/2	30	2 f,vf TM	SHA FI NS NP	NA	CS	
C1	13-32	VGr SL	MA	2.5Y 6/2	35	2 f vf T	SHA FI NS NP	NA	CS	Man modified Fill and Human debris
C2	32-48	VGr SL	MA	2.5Y 6/2	40	1 vf T	SHA FI NS NP	NA	/	

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 3.2 Right / Left (Looking Downstream)

Geomorphic Position: terrace down to Invert **Aspect:** 44° **Percent Slope:** ≈82 (Creek Bank)

Logged By: TH

Date: 10/26/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-10	gr sl	1-2 Co SBK	2.5Y 4/4	15	3 vff MT	SHA FR SS SP	NA	CW	
Bt	10-23	gr SCL	1 Co SBK	10YR 5/3	15	2 vff T	SHA FR SS SP	NA	CW	
C	23-32	gr SCL	MA	10YR 5/3	15	1 vff T	HA FI SS SP	NA	GW	common clay skins around pore linings
Cd	32-48	gr SCL	MA	10YR 5/4	15	None	VHA FI SS SS	NA	/	few clay skins around pores - linings

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 4.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 282° **Percent Slope:** ~18%

Logged By: TH

Date: 10/26/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A_1	0-11	gr fsl	1 M SBK	10YR 5/3	15	3 vf f MT	SHA FR SS SP	NA	CW	
A_2	11-19	gr sl	1 M SBK	10YR 5/4	15	2 vf f (M) T	SHA FR SS SP	NA	GS	
C_1	19-29	vgr sl	M	10YR 5/4	35	2 vf T	HA FI SS SP	NA	CW	
C_2	29-48	vgr lcos	M	10YR 5/4	40	1 vf T	HA FI SS NP	NA	/	

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 4.2 Right Left (Looking Downstream)

Geomorphic Position: top of terrace down to invert **Aspect:** 118° **Percent Slope:** ~77% (Creek Bank)

Logged By: TH

Date: 10/26/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-13	gr sl	1,2 M GR SBK	2.5Y 4/4	15	3 vf, f, m M T	HA FR SS SP	NA	CW	
Bt	13-30	gr SCL	1 CO SBK	10YR 5/3	15	2 vf, f, m T	HA FR SS SP	NA	CW	Common mod. thick clay skins on ped faces/pore linings
C	30-40	gr SCL	M	10YR 5/3	20	1 f M T	VHA FI SS NP	NA	CW	Common thin clay films on ped faces/pore linings
Cmd	40-48	vgr SL	M	10YR 5/4	35	None	VHA FI NS NP	NA	—	Few thin clay films on pore linings

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 5.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 206° **Percent Slope:** ~34 %

Logged By: TH

Date: 10/26/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A_1	0-10	gr COSL	1,2 M GR-SBK	10YR 3/3	25	3vf,f,m M T	SHA FR SS NP	NA	CS	
A_2	10-24	gr COSL	1 M SBK	10YR 5/4	25	3vff 2m T	SHA FR SS NP	NA	CS	
C	29-42	vgr COSL	M	10YR 5/4	35	1vf,f T	HA FI NS NP	NA	CS	
IICd	42-50	vgr LCOS	M	10YR 5/2	45	none	VHA FI NS NP	NA		Densic material No live roots present moderately cemented sandy matrix

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 6.1 Right / Left (Looking Downstream)

Geomorphic Position: top of terrace down to inlet **Aspect:** 40° **Percent Slope:** 28% (Creek Bank)

Logged By: TH

Date: 10/25/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-7	gr COSL	1 m,co SBK	10YR 5/3	20	3 vf,f T	SHA FR SS SP	NA	CW	
AC	7-12	gr COSL	M	10YR 6/3	20	2 vf,f T	HA FR SS SP	NA	CS	
C	12-23	gr COSL	M	10YR 6/3	25	1 vf,f T	VHA FI NS NP	NA	AS	
IICmd	23-36	vgr LCOS	M	10YR 5/3	45	None	VHA FI NS NP	NA	/	Densic Materials No live Roots Present
										Seperate depositional unit moderately cemented
										Single grain - massive

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 7.1 Right / Left (Looking Downstream)

Geomorphic Position: top of terrace down to invert **Aspect:** 121° **Percent Slope:** ~86% (creek Bank)

Logged By: TH

Date: 10/25/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-5	gr COSL	1 m,co GR-SBK	10YR 6/4	20	3vf,f,m MT	SHA FR SS SP	NA	CS	
A2	5-15	gr SCL	1 m,co SBK	10YR 6/4	20	2vf,f,m T	SHA FR SS SP	NA	CW	few clay skins on ped faces and pore linings
Bt	15-24	gr COSCL	1 co SBK-M	10YR 6/3	20	2vf,1f T	HA FI SS SP	NA	AS	Common clay skins on Ped faces and pore linings
Cd	24-32	vgr / COS	M	10YR 6/2	50	None	VHA FI NS NP	NA	GW	
IICd	32-46	vgr LCOS	M	10YR 6/2	50+	None	VHA FI NS NP	NA	/	Densic Material No live Roots present
										moderately cemented separate depositional unit

Exhibit 1: Soil Profile Description Form

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Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 8.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 248° **Percent Slope:** ~43%

Logged By: TH

Date: 10/25/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-7	vgr SL	1f,m GR 1co SBK	10YR 4/2	35	3vf,f 2m MT	SHA FR SS SP	NA	CW	
A2	7-12	vgr LCOS	1co,m SBK	10YR 5/3	35	3vf,f 1m, T	SHA FR SS SP	NA	CW	
AC	12-26	vgr LCOS	M	10YR 6/3	35	2vf,f T	HA FI NP NS	NA	CW	
C	26-41	vgr LCOS	M	10YR 6/2	50	2vf,1f T	HA FI NP NS	NA	CS	
IICmd	41-48	vgr LCOS	M	10YR 6/2	50	None	VHA FI NP NS	NA	/	Dense Materials No live roots present
										moderately cemented seperate depositional unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 9.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 132° **Percent Slope:** ~40 %

Logged By: TH

Date: 10/25/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-6	gr COSL	1 co,m GR-SBK	10YR 4/2	25	3 vf,f,m M T	SHA FR SS SP	NA	CW	
A2	6-12	gr COSL	1 co,m SBK	10YR 5/2	25	2 vf,f,m T	SHA FR SS SP	NA	CW	
AC	12-20	gr COSL	1 co,m SBK	10YR 5/2	30	2 vf,f m T	HA FI SS SP	NA	CW	
C1	20-42	vgr LCOS	M	10YR 6/2	35	1 vf,f,m T	VHA FI NS NP	2 f,m Mod Fe mass	CS	7.5YR 5/6 RMF 10YR 5/1 matrix
C2	42-48	vgr LCOS	M	10YR 6/2	45	1 vf,f T	VHA FI NS NP	2 f,m Mod Fe mass	/	7.5YR 5/6 RMF 10YR 5/1 MATRIX

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 10.1 Right / Left (Looking Downstream)

Geomorphic Position: top of terrace down to invert **Aspect:** 186° **Percent Slope:** ~33%

Logged By: TH

Date: 10/24/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-6	gr SL	1 co, m GR-SBK	10YR 4/2	25	3 vf, f, m M, T	SHA FR SS SP	NA	cw	
AC	6-13	vgr coSL	1 co, m SBK	10YR 4/2	35	2 vf, f T	HA FR SS NP	NA	cw	
C	13-36	vgr coSL	M	10YR 5/2	45	1 vf, f T	VHA FI NS NP	NA	cs	
IICd	36-48	vgr coSL	M	10YR 5/2	45	None	VHA FI NS NP	NA	/	Denser Materials No Live Roots present moderately cemented separate depositional unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 11.1 Right / Left (Looking Downstream)

Geomorphic Position: top of terrace down to invert **Aspect:** 175° **Percent Slope:** ~29%

Logged By: TH

Date: 10/24/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-7	gr SL	1co, m GR-SBK	10YR 4/3	20	3vf, f, m M T	SHA FR SS SP	NA	CW	
A2	7-16	gr SL	1co, m GR-SBK	10YR 4/3	20	3vf, f, m T	SHA FR SS SP	NA	CW	
AC	16-24	gr SCL	1 co SBK	10YR 5/3	25	2vf, f 1m T	HA FI NS NP	NA	CS	
C1	24-35	gr SCL	M	10YR 6/3	30	2vf, f 1m T	HA FI NS NP	NA	CS	light sandy clay loam
C2	35-46	vgr SCL	M	10YR 6/3	35	1vf, f T	VHA FI NS NP	NA	AS	
IICd	46-48+	vgr LCOS	M	10YR 5/1	45	none	VHA VFI NS NP	NA	/	moderately cemented coarse matrix

Exhibit 1: Soil Profile Description Form

seperate depositional unit
dense materials
no live roots present

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 12.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 26° **Percent Slope:** ~29%

Man-Modified levee embankment

Logged By: TH

Date: 10/24/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-10	gr SL	2f GR 1 m SBK	10YR 4/2	15	2vf,f m T	SHH FR SS SP	NA	CS	
C	10-32	gr SL	M	10YR /3	20	1vf T	HA FI SS SP	NA	CS	
C	32-60	gr SCL	M	10YR 5/3	20	1vf T	HA FI SS SP	NA	/	light sandy clay loam

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 13,1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 234° **Percent Slope:** ~26%

Logged By: TH

Date: 10/24/2011

Excavation Method: Hand-Shovel Excavated Pit

Just North of Church Ave. Bridge

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-8	vgr COSL	2f,m GR 1 m SBK	2.5Y 4/2	35	2 vf f m T	SHA FR SS NP	NA	CS	
AC	8-13	vgr COSL	2f,m SBK	2.5Y 4/2	35	2 vf,f T	SHA FR SS NP	NA	CS	
C	13-25	vgr lCOS	M	2.5Y 6/2	40	2 vf 1f T	HA FI NS NP	NA	AS	
IIC	25-48	vgr SP	M SG	2.5Y 5/1	45	1 vf T	VHA FI NS NP	NA	/	Not Densic materials few live Roots Present weakly cemented seperate depositional Unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 14.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 260 **Percent Slope:** ~12%

Logged By: TH

Date: 10/27/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-10	gr LCOS	1co SBK	10YR 3/4	25	2 vf, f, m M T	SHA FR SS NP	NA	CW	
A2	10-15	vgr LCOS	1co M	10YR 4/3	35	2vf, f, m T	SHA FR NS NP	NA	CS	
C	15-33	vgr LCOS	M SG	10YR 5/2	40	1-vf, f T	HA FI NS NP	NA	AS	
IICm	33-48	vgr LCOS	M SG	10YR 4/1	45	none	VHA FI NS NP	NA	/	moderately cemented sandy matrix
										Densic Material No live Roots Present
										seperate depositional Unit single grain cementation massive structure.

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 14.2 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 260° **Percent Slope:** ~12%

Logged By: TH

Date: 10/27/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-6	gr LCOS	1f,mGR 1mSBK	10YR 3/4	20	3vf,f,m M T	SHA FR SS NP	NA	CW	
A2	6-15	vgr LCOS	1M SBK	10YR 3/4	25	2vf,f,m T	SHA FR NS NP	NA	CS	
C	15-31	vgr LCOS	M	10YR 5/2	35	2vf 1f T	HA FI NS NP	NA	AS	
II Cnd	31-48	vgr LCOS	M	10YR 5/1	40	None	VHA VFI NS NP	NA	/	moderately cemented Sandy matrix
										Densic materials No live Roots Present
										seperate depositional unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 15.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 245° **Percent Slope:** ~9%

Logged By: TH

Date: 10/27/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-13	gr LCOS	2 fim GR 1 M SBK	10YR 4/3	20	3 vf, f 1 M MT	SHA FR SS NP	NA	CW	
AC	13-19	gr LCOS	1 co SBK	10YR 5/3	25	2 vf, f 1 M T	HA FI NS NP	NA	CW	
C	19-38	vgr LCOS	SG M	10YR 5/4	35	1 vf, f T	HA FI NS NP	NA	CS	
II Cmd	38-48	vgr LCOS	M	10YR 6/3	45	None	VHA VFI NS NP	NA	/	moderately cemented sandy matrix
										Dense Materials No live Roots Present
										separate depositional Unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 15.2 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 80° **Percent Slope:** ~9%

Logged By: TH

Date: 10/28/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-8	vgr LCOS	2fmGR 1M<SBK	10YR 5/3	25	3vf f 1M MT	SHA FR SS NP	NA	CS	
AC	8-18	vgr LCOS	1COSBK M	10YR 5/3	35	2vf f T	SHA FR NS NP	NA	CW	
C	18-36	vgr LCOS	M	10YR 6/3	40	1vf f T	HA FI NS NP	NA	CS	
IICmd	36-42	xgr LCOS	M	10YR 5/2	50	None	VHA VFI NS NP	NA	/	moderately cemented sandy matrix
										single grain clast - massive No Live Roots Present
										Seperate Depositional Unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 16.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 202° **Percent Slope:** ~13%

Logged By: TH

Date: 10/28/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-9	vgr LCOS	1f,m GR	10YR 5/3	40	2vf,f,m T	SHA FR NS NP	NA	CS	
C	9-40	vgr LCOS	M	10YR 6/3	50	1vf,f T	HA FI NS NP	NA	CS	
IICd	40-48	xgr LCOS	M	10YR 6/2	65	None	VHA VFI NS NP	NA	/	moderately cemented sandy matrix, no live Roots present Densic Materials seperate depositional Unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 17.1 Right / Left (Looking Downstream)

Geomorphic Position: mid terrace flank **Aspect:** 163° **Percent Slope:** ~48%

Logged By: TH

Date: 10/28/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-8	gr COSL	1,2 f m GR 1 M SBK	10YR 5/3	20	3vf, 2f MT	SHA FR SS SP	NA	CS	
A2	8-19	gr COSL	1, m f SBK	10YR 5/4	25	3vf, 2f T	SHA FR NS NP	NA	CW	
C1	19-33	vgr COS	M	10YR 5/4	35	1 vf, f T	HA FI NS NP	NA	CW	
C2	33-46	vgr COS	M	10YR 5/2	35	1 vf T	HA FI NS NP	NA	/	

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 18.1 Right ~~/ Left~~ (Looking Downstream) Eastern part of County "Bartic" property

Geomorphic Position: Distal Floodplain **Aspect:** 157° **Percent Slope:** ~2% Former Agricultural field

Logged By: TH

Date: 12-19-2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A_1 (p)	0-5	gr SL	1 f, m GR 1 m-SBK	10YR 4/2	25	3 vf, f MT	SHA FR SS NP	NA	CS	
A_2	5-9	gr LCOS	1, 2 M SBK	10YR 5/4	30	2 vf, f T	SHA FR SS NP	NA	CS	
AC	9-23	gr LCOS	1 m SBK M	10YR 5/4	45	1 vf, f T	HA FI NS NP	NA	CW	
IIC	23-48	vgr LCOS	M	10YR 5/2	50	1 vf T	VHA FI NS NP	NA	/	densely packed but not truely cemented / live very fine roots present

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 19.1 Right ~~/ Left~~ (Looking Downstream) South central part of county "Bowtie" property

Geomorphic Position: High Distal Floodplain **Aspect:** 178° **Percent Slope:** ~2%

Close to margin of xeric Riparian woodland

Logged By: TH

Date: 12/19/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-5	gr COSL	1fm GR MSBK	10YR 4/3	20	3vf,f MT	SHA FR SS NP	NA	CS	
A2	5-10	gr COSL	1co,m SBK	10YR 5/4	20	2vf,f T	SHA FR SS NP	NA	CS	
AC	10-21	vgr LCOS	1co SBK-M	10YR 5/4	25	2vf,f T	HA FI NS NP	NA	CS	
C	21-36	vgr LCOS	M	10YR 5/3	50	1vf,f T	HA FI NS NP	NA	AS	seperate deposition unit
II Cmd	36-48	vgr LCOS	M	10YR 5/2	60	None	VHA FI NS NP	NA	/	weak to moderately well cemented matrix
										Dense materials No Live Roots Present

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 20.1 ~~Right / Left~~ (Looking Downstream) Northwestern part of County "Bastie" property

Geomorphic Position: Upland Valley flat **Aspect:** 182° **Percent Slope:** ~2%

Former agricultural field but still close to xeric riparian forest margin

Logged By: TH

Date: 12/20/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1 (p)	0-7	gr COSL	1f,m GR 1MSBK	10YR 4/3	20	3vf,f MT	SHA FR SS SP	NA	CS	
A2	7-19	gr COSL	1m SBK	10YR 5/4	25	2vf,f T	SHA FR SS NP	NA	CW	
C	19-29	vgr LCOS	M	10YR 5/2	45	1vf T	HA FI NS NP	NA	AS	
IICd	29-48	vgr LCOS	M	10YR 5/2	50	None	VHA VFI NS NP	NA	/	moderately cemented densic materials separate depositional unit No Live Roots Present

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 21.1 Right / ~~Left~~ (Looking Downstream) Southern terminus of Reach 7a just north of County property line Former agricultural field

Geomorphic Position: Upland Valley Flat **Aspect:** 179° **Percent Slope:** ~2%

Logged By: TH

Date: 12/20/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A_1(p)	0-8	gr COSL	1/2 fm GR M SBK	10YR 5/3	20	3 vf, f M T	SHA FR SS SP	NA	CW	
A_2	8-20	gr COSL	1 M SBK	10YR 5/4	25	3 vf, f T	SHA FR SS SP	NA	CS	
AC	20-31	vgr LCOS	M	10YR 5/4	45	2 vf, f T	HA FI NS NP	NA	CS	
IIC	31-48	vgr LCOS	M	10YR 5/2	50	1 vf T	HA FI NS NP	NA	/	Some roots not densic seperate depositional Unit weak cementation

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 22. Right / Left (Looking Downstream) North of Middle Avenue.

Geomorphic Position: Upland Valley Flat **Aspect:** 180° **Percent Slope:** ~2%

Logged By: TH

Former agricultural field

Date: 12/20/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1(p)	0-7	gr fsl	1fm GR-SBK	10YR 5/3	15	3vf,f mT	SHA FR S SP	NA	CW	
A2	7-15	gr fsl	1fm GR-SBK	10YR 5/3	15	2vf,f T	SHA FR SS SP	NA	CS	
Bt	15-23	gr scl	1f,m SBK-M	10YR 5/4	15	2vf,f T	HA FI S SP	NA	AW	common thin clay skins on ped faces and pore linings
IIC	23-40	vgr LCOS	M	10YR 5/2	50	1vf,f T	VHA VFI NS NP	NA	/	live roots not dense

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 23.1 ~~Right / Left~~ (Looking Downstream) North of Middle Avenue

Geomorphic Position: Upland Valley Flat **Aspect:** 167° **Percent Slope:** ~2%

Logged By: TH

Date: 12/21/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-7	gr SL	1f,m GR 2SBK	2.5Y 5/3	20	3vf,f M T	SHA FR SS SP	NA	CS	
AC	7-14	gr COSL	2SBK M	10YR 5/3	20	2vf,f T	HA FR SS NP	NA	CS	
C	14-39	vgr LCOS	M	10YR 6/2	55	1vf T	HA FI NS NP	NA	AW	
II Cmd	39-50	xgr LCOS	M	10YR 6/1	65	None	VHA VFI NS NP	NA	/	no live roots present densic materials moderately cemented seperate depositional unit

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 24.1 Right / Left (Looking Downstream) North of Watsonville Road

Geomorphic Position: mid flank down to invert **Aspect:** 68° **Percent Slope:** ~52%

Road Embankment man-modified but not engineered fill

Logged By: TH

Date: 12/21/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-8	gr fsl	2 f,M GR 1 M SBK	10YR 4/3	15	3 vf,f MT	SHA FR SS SP	NA	CW	
A2	8-12	gr SCL	1 f,m SBK	10YR 4/3	20	2 vf,f T	SHA FR SS SP	NA	CW	
Bt	12-28	gr SCL	1 M SBK-M	10YR 4/4	25	2 vf,f T	HA FI SS SP	NA	CW	Common thin clay skins on ped faces and pore linings
C	28-44	gr SCL	M	10YR 5/4	25	1 vf,f T	HA FI SS SP	NA	/	

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 25.1 ~~Right / Left~~ (Looking Downstream)

Geomorphic Position: Upland Valley Flat **Aspect:** 164° **Percent Slope:** ~2%

man modified soil influenced by earthwork of isolated flood storage basin
not engineered fill associated w/ levee

Logged By: TH

Date: 12/21/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-9	vgr LCOS	1co,m SBK	2.5Y 5/2	35	2vf, 1f T	SHA FR SS MP	NA	CS	
C	9-34	vgr LCOS	M	10YR 6/2	40	1vf T	HA FI NS NP	NA	CW	
Cmd	34-44	xgr LCOS	M	10YR 6/2	65	None	VHA FI NS NP	NA	/	man modified densic layer no live roots

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 26.1 Right / Left (Looking Downstream)

Geomorphic Position: Mid slope down to invert **Aspect:** 281° **Percent Slope:** ~53%

MAn modified embankment off LaCrosse Drive not engineered fill

Logged By: TH

Date: 12/21/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-5	gr SL	1,2 m SBK	10YR 4/3	20	3 vf, f MT	SHA FR SS SP	NA	CS	
A2	5-14	gr SL	2 m, co SBK	10YR 4/3	20	2 vf, f T	SHA FR SS SP	NA	CS	
BC	14-20	gr SCL	1 co SBK-M	10YR 4/4	20	2 vf, f T	HA FI SS SP	NA	CW	Common thin clay skins on ped faces,
C	20-44	gr SCL	M	10YR 6/3	25	1 vf, f T	VHA FI SS SP	NA	/	

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 27.1 Right / Left (Looking Downstream) North of Edmundson Avenue

Geomorphic Position: mid slope down to invert **Aspect:** 216° **Percent Slope:** ~57% Man modified embankment not engineered fill

Logged By: TH

Date: 12/22/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-9	gr SL	1 m SBK	10YR 4/3	20	2 vf,f M T	HA FI NS NP	NA	CS	
A2	9-22	gr COSL	1 m SBK-M	10YR 5/3	20	2,1 vf,f T	HA FI NS NP	NA	CW	
C	22-44	vgr LCOS	M	10YR 6/2	35	1 vf,f T	VHA FI NS NP	NA	/	not dense layer live roots present

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 28.1 Right / Left (Looking Downstream)

non-modified embankment not engineered fill South of Eddes St.

Geomorphic Position: midslope down to invert **Aspect:** 242° **Percent Slope:** ~46%

Logged By: TH

Date: 12/22/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A_1	0-6	gr SL	1,2 f,m GR 1 M SBK	2.5Y 5/4	15	3 vf, f MT	SHA FR SS NP	NA	CS	
A_2	6-16	gr COSL	1 M, M SBK	2.5Y 5/2	15	2 vf, f T	HA FR SS NP	NA	CW	
AC	16-30	gr COSL	1 CO SBK-M	10YR 6/2	25	2 vf T	HA FI NS NP	NA	CW	
C	30-44	VGR LCOS	M	10YR 6/2	35	1 vf T	VHA FI NS NP	NA	/	not dense live roots present very compacted.

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 29.1 Right / Left (Looking Downstream) South of Cosmos Avenue

Geomorphic Position: mid slope down to invert **Aspect:** 258° **Percent Slope:** ~44% non modified embankment not engineered fill

Logged By: TH

Date: 12/22/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A1	0-7	gr COSL	2 MGr 1co,m SBK	10YR 4/2	15	3vf,fm mT	SHA FR SS NP	NA	CS	
A2	7-11	gr COSL	1co,M SBK	10YR 4/3	15	2vf,fm T	HA FR SS NP	NA	CS	
AC	11-19	gr COSL	1co,M SBK-M	10YR 6/3	20	2vf, 1f T	HA FI NS NP	NA	CW	
C1	19-31	vgr LCOS	M	10YR 6/2	35	2vf 1f T	VHA FI NS NP	NA	CW	Not densic
C2	31-42	vgr LCOS	M	10YR 5/2	40	1vf T	VHA FI NS NP	NA	/	Live roots present very compacted

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 30.1 Right / Left (Looking Downstream)

North of San Martin Avenue
non modified embankment
not engineered fill

Geomorphic Position: top of terrace down to inlet **Aspect:** 253° **Percent Slope:** ≈ 20%

Logged By: TH

Date: 12/22/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-6	gr COSL	1 f,M GR	2.5Y 5/3	30	SHA FR NS NP	2vf T	NA	CS	
AC	8-12	vgr LCOS	1 M GR-M	2.5Y 5/3	35	LO NS NP	2vf T	NA	CS	
C_1	22-34	vgr LCOS	SG	2.5Y 6/2	45	LO NS NP	1vf T	NA	CW	
C_2	34-45	vgr LCOS	SG	2.5Y 6/2	45	LO NS NP	1vf T	NA	/	not dense live roots present

Exhibit 1: Soil Profile Description Form

Cardno ENTRIX

Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 31.1 Right / Left (Looking Downstream)

North of Church Avenue
Non-modified embankment
not engineered fill

Geomorphic Position: top of terrace down to invert **Aspect:** 245 **Percent Slope:** ~20%

Logged By: TH

Date: 12/22/2011

Excavation Method: Hand-Shovel Excavated Pit

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-5	gr COSL	1 f,m GR	2.5Y 5/3	30	2vf T	SHA FR NS NP	NA	CS	
AC	5-13	vgr LCOS	1 M GR	2.5Y 6/3	35	2vf T	SHA FR NS NP	NA	CS	
C1	13-29	vgr LCOS	SG	2.5Y 6/2	40	1vf T	LO NS NP	NA	CS	
C2	29-44	vgr LCOS	SG	2.5Y 6/1	55	1vf T	LO NS NP	NA	/	not densic layer live roots present

Exhibit 1: Soil Profile Description Form

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Soil Profile Description Form

Project Name and Number: Upper Llagas Creek Flood Control Project (Project # 30523030)

Soil Profile Description and Sampling Location Number: 32.1 Right / Left (Looking Downstream)

Geomorphic Position: top of terrace down to invert **Aspect:** 248° **Percent Slope:** ~20%

Logged By: TH

Date: 12/22/2011

Excavation Method: Hand-Shovel Excavated Pit

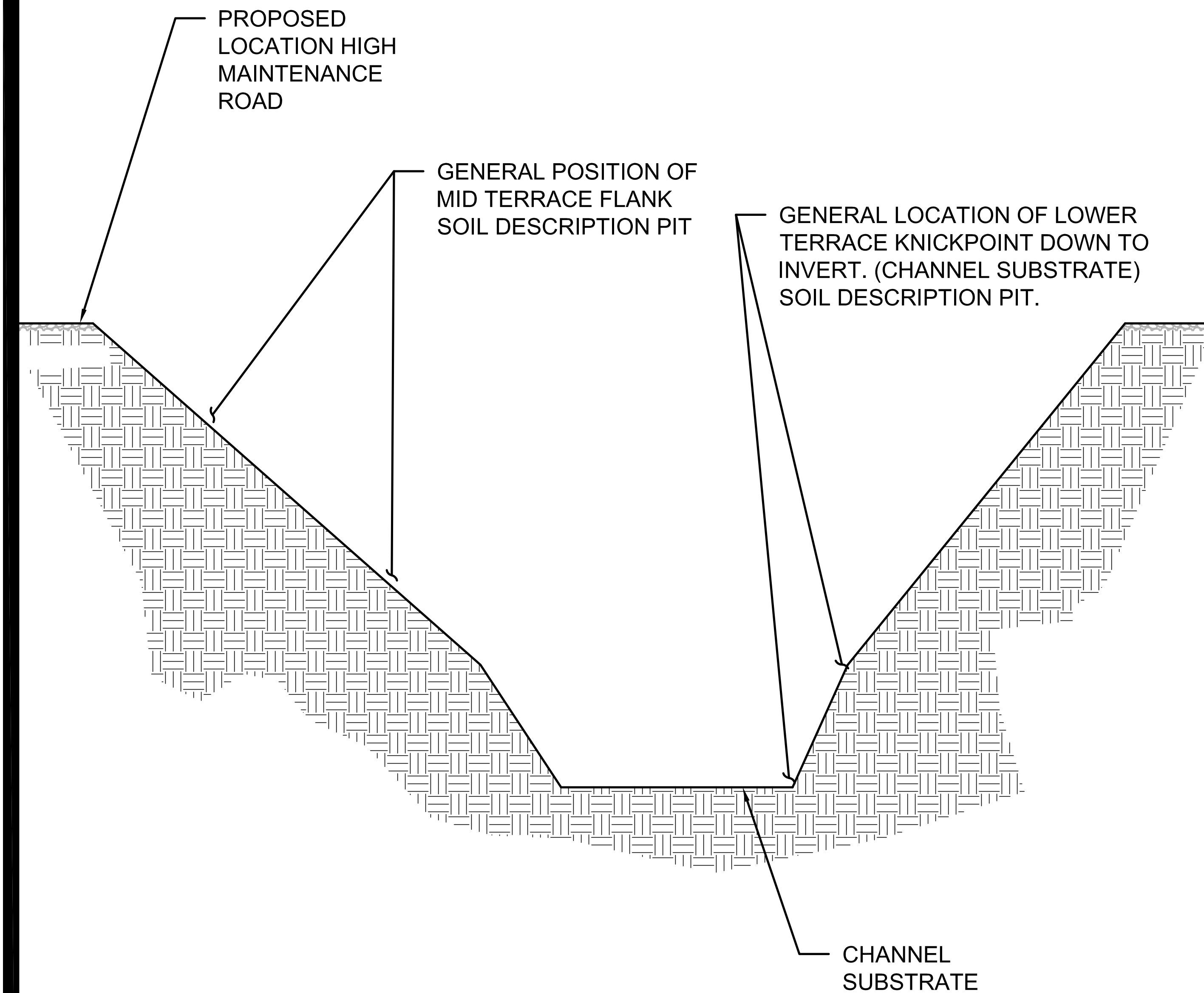
South of Church Avenue
Man-modified embankment
not engineered fill

Master Horizon	Depth (Thickness)	Texture	Structure	Color	% Coarse Fragments	Roots	Consistency	Redoximorphic Features	Boundary	Remarks
A	0-7	gr COSL	1,f,m GR	10YR 5/3	25	2vf,f T	SHA FR NS NP	NA	CW	
AC	7-12	vgr LCOS	1 m GR	10YR 5/3	35	2vf,f T	SHA FR NS NP	NA	CW	
C1	12-33	vgr LCOS	SG	10YR 5/2	40	1vf T	Lo NS NP	NA	CS	
C2	33-44	vgr LCOS	SG	10YR 5/2	55	none	Lo NS NP	NA	/	not dense layer live roots present
										Not seperate unit

Exhibit 1: Soil Profile Description Form

Appendix E

Channel Design Cross Sections and Subsurface Features



LLAGAS CREEK CHANNEL SECTION

NOT TO SCALE

SOIL DESCRIPTION
PIT LOCATION

SANTA CLARA COUNTY
FLOOD CONTROL DISTRICT

LLAGAS CREEK FLOOD CONTROL
CHANNEL PROJECT

CHANNEL SECTION

DATE:	PROJECT NO.:	BY:	FIGURE
09/2010	30523030.00	TH	1

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