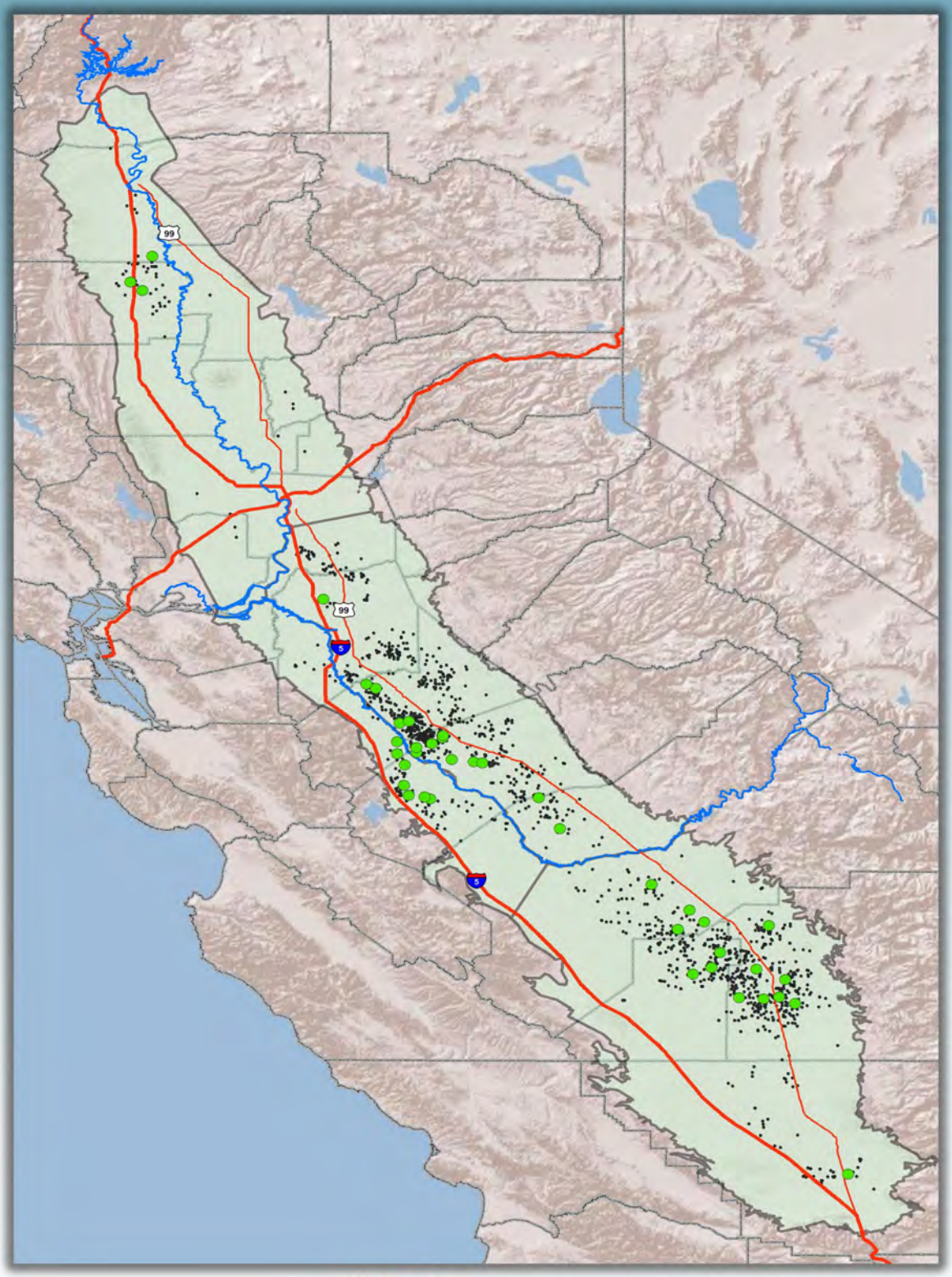
Central Valley Dairy Representative Monitoring Program Evaluation of Representativeness



Part I of II

May 15, 2013

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Signature Page

We certify under penalty of law that we have personally examined and are familiar with the information submitted in this document and all attachments and that, based on our inquiry of those individuals immediately responsible for obtaining the information, we believe that the information is true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

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- Central Area | West Side: ANT, COR, FG2, GOD, MAC and NUN, MOO, TON
- North Area: BRE, CRE, MTS
- South Area: AUK, DLF, ELK, ZZI, HOL, HYN, JAD, LON, ADO, MAL, MAP and ZON, RIC, SIE, SO2, SOJ

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Attachment A – Supporting Documents---------- *separately bound in Part II*

Attachment A1. USDA NRCS SSURGO Soil Data Reports (incl. data descriptions) for Phase 2 Dairies

EXECUTIVE SUMMARY

This report was prepared on behalf of the Central Valley Dairy Representative Monitoring Program (CVDRMP), a non-profit group of dairy owners and operators organized in 2010 to conduct representative groundwater monitoring on behalf of member dairies. The Representative Monitoring Program (RMP) was developed in response to *Waste Discharge Requirements General Order No. R5-2007-0035 for Existing Milk Cow Dairies* (General Order), adopted by the Central Valley Regional Water Quality Control Board (RB5) on May 3, 2007. Specifically, the RMP aims to satisfy the General Order's Monitoring and Reporting Program (MRP) requirements, as revised in February 2011. This particular report was prepared to satisfy the specific requirement of RB5's August 27, 2012 conditional approval letter for a report that assesses the representativeness of the current RMP.

The current network of dedicated RMP monitoring wells (i.e., monitoring wells intended, designed, and constructed for the sole purpose of monitoring groundwater conditions) was installed in two phases. Phase 1 RMP groundwater monitoring activities commenced in January 2012 on 18 dairy farms in Stanislaus and Merced Counties, with 234 dedicated monitoring wells at 126 well sites. Phase 2 expanded the network in fall 2012; and as of January 2013, the total current RMP monitors 42 dairy farms covering the Central Valley floor from Tehama County in the north to Kern County in the south with 439 dedicated monitoring wells at 275 well sites. This report assesses the representativeness of the total current RMP.

Per the MRP, the RMP examines conditions in first encountered groundwater. This examination is coupled with examinations of site conditions and dairy farming practices to facilitate the evaluation of cause-and-effect relationships between subsurface loading of nutrients and salts and groundwater conditions. The process for the selection and assembly of a group of dairy farms that is representative of typical site conditions and management practices on Central Valley dairies was first detailed in the Phase 1 RMP Workplan (LSCE, 2012a). The process emphasizes physical parameters that control subsurface loading, and it differentiates static physical parameters (i.e., site conditions) and dynamic physical parameters (i.e., dairy farming practices). For example, key static physical parameters that were taken into consideration were soil type and annual precipitation depth. Key dynamic physical parameters that were taken into consideration pertain to (i) crops and crop rotations, (ii) irrigation systems and water sources, (iii) nutrient sources and application, (iv) design and operation of corrals, and (v) design and operation of liquid manure storage ponds.

For the selection of dairy farms and the overall design of the monitoring well network, CVDRMP relied on input from two external advisory committees of experts from government, academia and the private sector, the Groundwater Technical Advisory Committee (GTAC) and the Multidisciplinary Advisory Committee (MAC). Based on the assessment provided in this report and due consideration of the input received on the representativeness of the current RMP from the advisory committees, we have determined that the current network of monitored dairies and dedicated monitoring wells are representative of typical site conditions and dairy farming practices on Central Valley dairies. This determination is based on current information and does not preclude the selective addition of monitoring wells in the future should additional information and data gathered through this program determine a need to do so.

The process of refinement, as detailed in the Phase 1 RMP Workplan (LSCE, 2012a), describes a process which provides for continuous assessment and dynamic modifications to the program in response to RMP findings. This includes activities CVDRMP deems necessary to attain the RMP's goals, and goes beyond groundwater monitoring. As part of this process, CVDRMP is launching a comprehensive 3-year effort in 2013 for the direct evaluation of storage pond performance and the systematic assessment and improvement of nutrient management on a whole-farm scale.

1 INTRODUCTION

This report was prepared for the Central Valley Dairy Representative Monitoring Program (CVDRMP). CVDRMP is the administrative body managing the Representative Monitoring Program (RMP) and was formed in response to *Waste Discharge Requirements General Order No. R5-2007-0035 for Existing Milk Cow Dairies* (General Order), adopted by the Central Valley Regional Water Quality Control Board (RB5) on May 3, 2007 (RB5, 2007).

The purpose of this report is to satisfy a particular requirement of RB5's August 27, 2012 conditional approval letter which states:

> By May 15, 2013, submit a report describing how the monitored dairies (Phase 1 and Phase 2) are representative of dairies covered by this program. In addition, the report must describe any gaps in the monitoring program that could impair the ability to identify whether the combination of management practices and site conditions are protective of groundwater quality (i.e., do additional representative dairies need to be added to the program). If data gaps are identified and monitoring at additional representative dairies is needed, this report must contain a workplan that addresses deficiencies in the program.

Background

Legal and Regulatory Background

Division 7 of the Water Code contains California's Porter-Cologne Water Quality Control Act (Porter-Cologne). The Legislature enacted Porter-Cologne in 1969, providing "activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made to those waters and total values involved, beneficial and detrimental, economic and social, tangible and intangible." (Wat. Code, § 13000, emphasis added.) The Legislature designated the State Water Resources Control Board (State Board) and nine Regional Water Quality Control Boards (Regional Boards) as the agencies responsible for regulation of water quality under Porter-Cologne. (Id., § 13001.) Each Regional Board is responsible for water quality protection, permitting, inspection, and enforcement within its region. (Id., § 13225(a).)

Porter-Cologne provides two primary tools to Regional Boards to regulate the discharge of waste into waters of the state. The Regional Boards may: (1) issue Waste Discharge Requirements (WDRs) proscribing conditions under which a person may discharge waste (Wat. Code, § 13263), or (2) adopt a waiver of WDRs (Wat. Code, § 13269). As with WDRs, a Regional Board may proscribe conditions for waivers of WDRs. (Id., § 13269.) Porter-Cologne's permitting requirements apply to any "person discharging waste, or proposing to discharge waste, within any region that could affect the quality of the waters of the state, other than into a community sewer system." (Id., § 13260(a)(1).)

Sometimes WDRs are issued to an individual discharger who has filed a "report of waste discharge" and requested the permit. (Wat. Code, § 13260.) Other times, a Regional Board may issue general WDRs for a category of dischargers if the Regional Board determines that (i) the discharges are produced by the same or similar operations; (ii) the discharges involve the same or similar types of waste; (iii) the discharges require the same or similar treatment standards; and, (iv) the discharges are more appropriately regulated under general discharge requirements than under individual discharge requirements. (Id., § 13263(i).) The General Order here falls into this category. When issuing WDRs, a Regional Board is required to consider a number of factors, including those specified in Water Code section 13241, which includes economic consideration. (Wat. Code, §§ 13263(a), 13241(d).)

Porter-Cologne further authorizes Regional Boards to conduct investigations and inspections to verify compliance with the act and with the terms of WDRs and waivers. (Wat. Code, § 13267(e).) A Regional

Board may also require discharges to furnish technical or monitoring reports. (Id., § 13267(b).) The Year 1 Report, as discussed further below, responds to a monitoring and reporting requirement issued by the RB5 on February 23, 2011.

Besides requiring Regional Boards to issue WDRs, Porter-Cologne also requires each Regional Board to adopt "water quality control plans" or "Basin Plans" for areas within each region. (Wat. Code, § 13240.) Basin Plans are required to conform to the policies set forth in Chapter 1 of Porter-Cologne, including the legislative mandate that activities affecting water quality be regulated to the highest quality that is reasonable considering all of the demands being made and to be made upon the waters. (Id. §§ 13000, 13240.) Further, Basin Plans identify and designate the "beneficial uses" for each water body in the region. (Id., § 13050(j).) Examples of "beneficial uses" for groundwater include municipal supply, agricultural supply, and industrial supply. Basin Plans also establish Water Quality Objectives (WQOs), which are defined to mean, "the limits or levels of water quality constituent or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." (Wat. Code, § 13050(h).) WQOs may be numeric or narrative standards. Further, Basin Plans are to include a program of implementation to achieve the adopted WQOs. (Id., § 13242.)

When a Regional Board issues WDRs or conditional waivers, it must do so consistent with applicable Basin Plans. (Wat. Code, §§ 13263(a), 13269(a)(1).) However, instantaneous compliance with WQOs is logically not required by Porter-Cologne. (Ibid. as to both cites) Rather, the Regional Board is given discretion to achieve this consistency, including setting of time schedules. (Id., § 13263(c).) RB5 adopted two Basin Plans under Porter-Cologne in 1975. They include the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Sacramento-San Joaquin Basin Plan) and the Water Quality Control Plan for the Tulare Lake Basin (Tulare Lake Basin Plan). Both Basin Plans have been amended several times over the years and are subject to regular review approximately every three years.

Currently, various stakeholders in the Central Valley (including dairy industry representatives) are leading an initiative to develop a Central Valley-wide salt and nitrate management plan. The initiative is referred to as the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), and one of its primary objectives is to provide the basis for amendments to the Sacramento-San Joaquin and Tulare Lake Basin Plans to address ongoing salinity and nutrient concerns in the Central Valley Region. The information developed and gathered through this effort will be helpful in developing Basin Plan amendments with respect to nutrient concerns, and the development of long-term plans for addressing such concerns.

Procedural and Chronological Background

The General Order defines an existing milk cow dairy as a dairy that (i) was operating as of October 17, 2005, (ii) filed a complete Report of Waste Discharge in response to the RB5's August 8, 2005 Report of Waste Discharge Request Letter, and (iii) has not expanded since October 17, 2005 (i.e., its herd size has not increased by more than 15%). The General Order regulates waste discharges to land at the majority of 1,429 existing dairies[1] of all sizes and imposes significantly more stringent requirements than in the past.

Relative to groundwater monitoring, the General Order and its accompanying Monitoring and Reporting Program (MRP) specify two requirements: (1) monitoring of domestic and agricultural supply wells at dairies, and (2) additional groundwater monitoring. The latter requirement is presently implemented by the Executive Officer by ordering individual dairies to install monitoring wells ("site-by-site approach"). However, the General Order also authorizes the Executive Officer to approve alternative monitoring methods. The Information Sheet (page IS-8) states:

[1] As of January 2010 (personal communication with J.P. Cativiela, Dairy Cares, April 2, 2010).

> "In the future, the Executive Officer or Central Valley Water Board may determine that a proposed alternative method of environmental monitoring is appropriate to determine if groundwater protection is being achieved. One suggested alternative has been to allow regional groundwater monitoring as a substitute for groundwater monitoring at individual dairies. Any proposed alternative will require sufficient details for consideration by either the Executive Officer or Central Valley Water Board. The Executive Officer or the Central Valley Water Board must issue a monitoring and reporting program order for any alternative environmental monitoring."

To further the development of an alternative environmental monitoring method, Dairy Cares (www.dairycares.com) submitted a proposal on October 5, 2009 (Dairy Cares, 2009) to the RB5 Executive Officer for the development of a collaborative plan that would allow a representative groundwater monitoring approach to satisfy the additional groundwater monitoring requirements in lieu of the site-by-site approach of the General Order MRP.

RB5 held a February 4, 2010 stakeholder meeting in Rancho Cordova where Luhdorff and Scalmanini, Consulting Engineers (LSCE) presented an initial outline of the representative groundwater monitoring approach, which was developed based on over a decade of dairy specific and groundwater-related research in the Central Valley and a regional monitoring approach proposed by Dr. Thomas Harter of the University of California Cooperative Extension (UCCE) in September 2008 (Harter, 2008). The monitoring approach was discussed in greater detail at the meeting of RB5's Groundwater Advisory Workgroup in Rancho Cordova on March 9, 2010.

Concurrently, LSCE evaluated dairy farm characteristics along with environmental parameters to determine an area in the Central Valley that is most sensitive to dairy management practices in the *Report of Results* (LSCE, 2010). This area was identified to be in Stanislaus and Merced Counties between the San Joaquin River and Highway 99, and was selected for initiating the RMP based on delineation of those areas in the Central Valley where high groundwater nitrogen and salt concentrations are thought to be substantially attributable to dairy operations and where changes in water quality are most likely to be detected quickly due to adoption of management practices required by the General Order. The analysis included comparison of key information such as:

- Relative dairy farm/milk cow densities and other historical livestock operations data
- Historical average depths to groundwater
- Soil permeability
- Historical recharge to groundwater
- Observed historical groundwater nitrate and total dissolved solids (TDS) concentrations
- Whole farm nitrogen balances submitted to the RB5 in response to the General Order

This work effort recommended that the representative groundwater monitoring be initiated in Stanislaus and Merced Counties (i.e., from the Stanislaus River in the north and the Chowchilla River in the south) between the San Joaquin River and Highway 99 (this area is referred to as the high priority area). Results of this work effort were presented at the April 5, 2010 stakeholder meeting held at the RB5's offices in Rancho Cordova.

Subsequently, two concurrent work efforts ensued. One was the formation of an administrative body to manage the RMP. This occurred on May 17, 2010 with the founding of the CVDRMP. The other effort concerned the modification of the MRP to provide regulatory support for the RMP. The revised General Order MRP was issued by the Central Valley Executive Officer on February 23, 2011 (RB5, 2011a).

Phase 1

On June 16, 2011, CVDRMP submitted the *Public Review Draft Monitoring and Reporting Workplan and Monitoring Well Installation and Sampling Plan Phase 1: Initiation of Representative Groundwater Monitoring Network Design & Monitoring Program, Existing Milk Cow Dairies – Stanislaus and Merced Counties, California* (finalized without changes January 11, 2012 [LSCE, 2012a]), which was followed by a 30-day public review period and subsequent conditional approval on September 9, 2011 (RB5, 2011b). The

Phase 1 well installation campaign commenced without delay and was concluded with the installation of 216 nested monitoring wells at 108 well locations in November 2011. The Phase 1 RMP well network also includes 18 pre-existing monitoring wells. The results of this work effort were described in the *Monitoring Well Installation Completion Report Phase 1 Representative Monitoring Program, Existing Milk Cow Dairies – Stanislaus and Merced Counties, California* (LSCE, 2012b).

Groundwater data collection in the Phase 1 network of wells commenced in January 2012. Concurrently, CVDRMP assembled two independent technical advisory committees with members from private industry, the University of California including its Cooperative Extension, and the public sector. The purpose of the Groundwater Technical Advisory Committee (GTAC) is to ensure adequacy of the RMP groundwater data collection effort, soundness of analytical tools, and interpretations.

The purpose of the Multidisciplinary Advisory Committee (MAC) is to provide support in the following areas:

- Identification of existing dairy management practices, which will affect both the extrapolation of RMP findings to non-monitored facilities and the ultimate extent of the RMP;
- Provide insights on innovative methodologies, approaches, and analytical tools (e.g., whole farm nitrogen use efficiency modeling, modeling of nitrogen and salt movement in the root zone, and groundwater modeling) to support the RMP;
- Review and evaluation of results from implemented methodologies, approaches, and analytical tools;
- Identification of potential research needs; and
- Identification of potential solutions in response to findings of the RMP.

Phase 2

On June 6, 2012, CVDRMP submitted the *Public Review Draft Monitoring and Reporting Workplan and Monitoring Well Installation and Sampling Plan, Phase 2: Representative Groundwater Monitoring Network Design & Monitoring Program, Existing Milk Cow Dairies – Central Valley, California* (LSCE, 2012d), which was followed by a 30-day public review period and the *Addendum Monitoring and Reporting Workplan and Monitoring Well Installation and Sampling Plan, Phase 2: Representative Groundwater Monitoring Network Design & Monitoring Program, Existing Milk Cow Dairies – Central Valley, California* (LSCE, 2012e). The RB5 approved the Phase 2 program with the subsequent conditional approval on August 27, 2012. The Phase 2 well installation campaign commenced without delay and was concluded with the installation of 55 nested monitoring wells at 30 well locations in October 2012. The Phase 2 RMP well network also includes 118 pre-existing monitoring well sites.

Collaboration with Advisory Committees

CVDRMP is collaborating with two external advisory committees, the Groundwater Technical Advisory Committee (GTAC) and the Multidisciplinary Advisory Committee (MAC). These committees are comprised of hydrologists, geologists, geochemists, agronomists, statisticians, agricultural engineers, irrigation and soils experts, dairy producers, and service providers to the dairy community. Committee members span the private, public, non-profit, and academic sectors including (i) consultants, (ii) staff from RB5, California Department of Food and Agriculture, Natural Resources Conservation Service, (iii) research staff from the U.S. Geological Survey, Lawrence Livermore National Laboratory, and UC Davis including its Cooperative Extension Service.

CVDRMP held meetings with the GTAC and the MAC in 2012 and, most recently in spring 2013. The recent meetings were held to obtain input from outside experts on the representativeness of the current RMP. The evaluations provided in this report give due consideration to input received from the advisory committees.

Year 1 RMP Annual Report

In accordance with the General Order, the *Central Valley Dairy Representative Monitoring Program Year 1 Annual Report (2012), Phase 1* (LSCE, 2013) was submitted to the RB5 on April 1, 2013. This report pertains to the first year of monitoring activities (i.e., 2012) in the Phase 1 network of dairies.

Total Current RMP

The total current RMP (Phases 1 and 2) encompasses 42 dairies (**Figure 1**), 275 dedicated monitoring well sites, and 439 wells (**Table 1**, **Map Series**). Groundwater data collection was expanded to include the Phase 2 network of wells in January 2013.

Report Outline

This report is organized to address the Regional Board's requirements to (i) demonstrate that the RMP satisfies the inclusion of Central Valley dairy farms representative of a range of site conditions and management practices, and (ii) describe future work to address data gaps.

In *Section 3*, this report discusses static physical parameters (i.e., site conditions), dynamic physical parameters (i.e., management practices), and additional dairy farm features, as introduced in the Phase 1 RMP Workplan (LSCE, 2012a), and their consideration in the selection of dairy farms.

In *Section 4*, key findings of the Year 1 RMP Annual Report (LSCE 2013) that identify additional data needs are discussed together with the resulting scoping of future work to address these needs. *Section 5* summarizes conclusions.

2 EVALUATION OF REPRESENTATIVENESS

The goal of the RMP is to identify dairy farm practices specific to liquid manure holding ponds, corrals, and land application areas (i.e., the fields where pond liquor and/or solid manure are used to fertilize crops), that are protective of groundwater quality. This necessitates the evaluation of cause-and-effect relationships between farming practices on the ground surface and groundwater chemical characteristics, and begins with those practices that are currently employed in response to the General Order.

The RMP is a data collection and analysis effort designed to develop a knowledge base from a subset of Central Valley dairy farms that will support conclusions with respect to practices and their ability to protect groundwater quality that are applicable to non-monitored dairy farms under the General Order. For this purpose, the selection of dairy farms was based on two types of data:

- Physical parameters that control subsurface loading
- Additional dairy farm features

The concept of subsurface loading was introduced in the Phase 1 Workplan and recognizes the most fundamental similarities between Central Valley dairy farms. Therefore, it is integral to the application of the RMP's conclusions to non-monitored dairy farms. The subsurface loading rate is determined by the product of its two components: the rate of deep percolation (i.e., the amount of infiltrated water reaching first encountered groundwater) and the constituent concentration of the infiltrate. It is a chemical flux that describes a particular management unit's performance. The subsurface loading rate is controlled by key physical parameters. Therefore, they directly support the analysis and interpretation of groundwater quality data. Physical parameters essentially serve as explanatory variables for groundwater chemical characteristics beneath specific management units. Static physical parameters refer to site conditions. Dynamic physical parameters refer to dairy farm practices, i.e., they are subject to change.

Static Physical Parameters (Site Conditions)

Static physical parameters that were considered in the design of a representative network of monitored dairy farms are soil texture and annual precipitation depth. Although the depth to groundwater and the age of a management unit do not control subsurface loading rates, they are discussed in this section because these parameters are taken into consideration in the evaluation of groundwater chemical characteristics.

Soil Texture

Soil texture, and particularly its clay content, relates to the soil's hydraulic properties, including the water holding capacity, permeability, the infiltration rate and its rate of change during individual and consecutive irrigation and precipitation events. For example, soil properties in conjunction with the rate of irrigation application (e.g., in a furrow irrigated system) relate to the spatial variability of deep percolation losses along the furrow profile. Farmers employ irrigation types (e.g., furrow, border, or sprinkler) and practices (e.g., rate of irrigation application, timing and duration of irrigation events) to complement their particular soil type. Similarly, the frequency and rate of fertilizer applications to satisfy a particular crop's demand depend, in part, on the soil.

Soil types in the current RMP range from coarse-textured, highly permeable dune sand over a variety of different loams to fine-textured, clay soils of low permeability (**Table 2**). These are all highly mineralized soils typical of soils beneath dairies in the Central Valley. CVDRMP is not aware of Central Valley dairies that are situated on soil types, such as peat, weathered limestone (Karst), fractured rock, or gravel beds, that would indicate fundamentally different hydraulic behavior or chemical processes in the subsurface.

Therefore, the current RMP is considered representative of the range of soil types encountered on Central Valley dairies.

Annual Precipitation Depth

Precipitation, while typically not a major contributor to deep percolation beneath crop fields in the Central Valley, poses a complicating variable to the farmer, as it can affect decisions relating to the timing of sowing, planting, harvest, irrigation, and manure/fertilizer applications. In addition, it can potentially cause unwanted flushing of the root zone. Since the long-term sustainability of irrigated agriculture depends on the flushing of excess salts below the root zone (to prevent a detrimental accumulation of salts), the interaction between the soil, irrigation and precipitation, and manure/fertilizer application is key to the interpretation of groundwater quality beneath cropped manure application fields.

The Central Valley is characterized by semi-arid climate with dry, hot summers and mild, typically snow-free winters with the great majority of precipitation falling from November to March. Aridity generally increases from north to south and from east to west (**Figure 2**).

The RMP accounts for the geographic distribution of precipitation in the Central Valley by including some of the northernmost and southernmost dairies regulated under the General Order (i.e., from Tehama to Kern counties), and it captures the range of annual precipitation depths from less than 8 to slightly over 22 inches. Therefore, the current RMP is considered sufficiently representative of the range of precipitation under which dairies regulated by the General Order operate.

Depth to Groundwater and Age of a Management Unit

The depth to groundwater does not control subsurface loading rates. Therefore, it was not considered for the representativeness of the program. However, the thickness of the unsaturated zone (i.e., the zone that separates the groundwater table from the ground surface) affects constituent travel time and reactive transport. Therefore, the depth to groundwater is a consideration when groundwater chemical characteristics are evaluated. Importantly, the RMP focuses on the evaluation of subsurface loading and not on reactive transport. In addition, the shorter the response time between management practices at the ground surface and effects on groundwater quality, the sooner conclusions can be drawn from the data, and the higher the confidence in the identified linkage between management practices and groundwater quality trends. Therefore, the RMP favors dairies situated on relatively shallow groundwater.

Similar to the depth to groundwater, the age of a management unit does not control subsurface loading rates. Therefore, it was not considered for the representativeness of the program. However, the age of a unit may be a consideration when interpreting groundwater quality, as it relates to the lag time between management practices at the ground surface and groundwater quality. For example, subsurface loading emanating from a new corral or newly constructed pond may not be detectable in groundwater for many years, and a 'no-impact' conclusion based on groundwater quality data without consideration of lag time may be drawn prematurely. Therefore, the RMP places emphasis on older management units (i.e., 10 years and up to 30 and more years in operation) such as to favor those with a history of nitrogen and salt loading.

Dynamic Physical Parameters (Dairy Farming Practices)

Crop Fields

Dynamic physical parameters that were considered for the selection of a representative group of monitored fields include:

- Crops and crop rotations

- Irrigation systems
- Irrigation water sources
- Irrigation practices
- Nutrient sources for crop fertilization
- Nutrient applications

Crops and Crop Rotations

Dairy farms in the Central Valley grow much of the feed for the cows on the farm. The climate allows for double cropping which refers to the harvest of a summer crop and a winter crop on the same field in one year. The summer crop is commonly corn and the winter crop is a cereal grain, most typically oats and wheat (**Table 3**). Oats are more popular in the northern San Joaquin Valley, and wheat is more popular in the southern San Joaquin Valley. This sequence constitutes the most typical crop rotation. Many dairy farmers keep a portion of their land out of the summer corn-winter grain rotation to grow perennial alfalfa, which is harvested several times a year. This is done on a multi-year rotation from one field to the next as alfalfa yields decline below desired levels. The homogeneity of cropping patterns throughout the dairy industry is advantageous for the RMP. There are less common winter crops grown on Central Valley dairy farms, such as sudan, triticale, and sorghum. However, these comprise a very small portion of the overall feed production, and they typically do not replace the more popular winter crops (oats and wheat) on any one dairy farm. Rather, they are used in a supplemental form. The only significant exception to the above are the few pasture dairies, where cows spend a large portion of their life on pasture, where they graze and fertigate the soil with their excretions.

The current RMP captures the three major crops grown on Central Valley dairies (i.e., corn, oats, and wheat). It also includes a variety of less common winter grains such as sudan, triticale, and sorghum, and a pasture dairy. Therefore, the RMP is considered representative of the range of forage crops typically encountered on Central Valley dairies.

Irrigation Systems

Dairy farms in the Central Valley irrigate their forage crops most typically using either a furrow or border system. Furrow irrigation is used for summer corn and border irrigation is used for the winter crop. In areas of non-cohesive (e.g., sandy) soil that cannot support furrows, the border system is also used in the summer. A very small subset of dairy farms uses center pivot irrigation systems (i.e., overhead sprinklers).

The current RMP captures the above irrigation systems, including the furrow/border rotation, border only, and center pivot (i.e., overhead) sprinklers (see **Table 3**). It is, therefore, considered representative of typical irrigation systems encountered on Central Valley dairies.

Irrigation Water Sources

Dairy farmers irrigate their crops with surface water delivered by local water purveyors (i.e., irrigation or water districts), groundwater from their own irrigation wells, or a combination thereof (pond liquor is discussed under *Nutrient Sources for Crop Fertilization*). Groundwater is typically of higher mineral content than surface water. The reliability of surface water to the farms can vary substantially from year to year and depends greatly on the surface water rights held by the purveyor. For example, CCID holds very senior water rights and can deliver nearly 100% of allocations often even in drought years. In other districts, some farmers may only receive 20% or less of their allocation in normal water years.

The current RMP captures the spectrum of dairy fields that are irrigated exclusively with surface water, those that are irrigated exclusively with groundwater, and those that are irrigated with variable proportions of these

sources (see **Table 3**). It is, therefore, considered representative of irrigation water source conditions under which Central Valley dairy farmers operate.

Irrigation Practices

Irrigation practices pertain to the farmer's choice of the field's run length (i.e., the length of the field that irrigation water travels between the head ditch and the tail end); whether fields are operated with or without tailwater runoff; and when, at what rate, and how long to irrigate. The run length is clearly identifiable and ranges from less than an eighth of a mile to almost half a mile among the monitored fields. This is an important parameter because high levels of irrigation uniformity are difficult to attain with longer run lengths.

Other irrigation practices are less defined and vary according to farmers' preferences and estimations. However, they are also strongly influenced by the resources available to the individual farmer, especially with regard to the irrigation water source(s) and systems they work with, the crops they grow, and soil properties. For example, farmers decide when to irrigate based on their field observations and agronomic experience, but the exact timing of irrigations may also be influenced by the water district's ability to deliver the water.

Importantly, the many combinations of irrigation practices have the potential to greatly affect irrigation water application uniformity and water use efficiency. Relatively subtle modifications may translate into significant reductions of water and mineral losses to deep percolation. Therefore, the RMP does not attempt to select a group of fields based on the many individual choices that are available to farmers and pertain to their exact irrigation water use and management. Rather, the RMP focuses on readily quantifiable differences (i.e., the run length, tailwater management, and irrigation durations).

Based on the range of run lengths, and indirectly based on the range of captured irrigation water sources and systems, crops, and soil properties, the current RMP is considered sufficiently representative of irrigation practices employed on Central Valley dairy farms.

Nutrient Sources for Crop Fertilization

Dairy farmers fertilize their crops with manure, synthetic fertilizers, or varying proportional combinations thereof. Manure may be applied in liquid form (i.e., pond liquor) or solid form. Similarly, synthetic fertilizers are applied in both liquid and solid forms.

The current RMP captures the spectrum of dairy fields that are fertilized with manure, synthetic fertilizers, or a combination thereof. Therefore, it is considered representative of nutrient sources relied upon by dairy farmers in the Central Valley.

Nutrient Application Practices

Nutrient applications pertain to the farmer's choice regarding the total application, the application rate, and its timing. Field-scale mass balance calculations can help evaluate the efficiency of nutrient management. Field-scale nitrogen mass ratios for fields investigated in 2012 alone (i.e., Phase 1 dairies) exhibited order of magnitude ranges for summer crops and also for winter crops.

Based on the above, the current RMP is considered representative of presently attained levels of nutrient management on a field scale.

Corrals

The RMP monitors corrals that are used by cows year-round and those where cows can be removed during the rainy season. This is independent of whether a dairy operates as a flush or scrape dairy, and cow occupancy may be the most prominent distinguishing factor for corrals as it relates to the manure excretion rate. Year-round cow occupancy also affects slope maintenance and the rate of manure removal during the rainy season, because wet soil conditions can make it challenging to maintain an adequate slope for drainage and can make it difficult to keep up with manure removal. Fundamentally, the assessment of corral conditions is largely non-quantitative and subjective. Also, regardless of the level of effort to remove manure solids, soils in the corrals are always rich in organic matter.

Based on the above, the current RMP is considered representative of corrals in operation by dairy farmers in the Central Valley.

Liquid Manure Holding Ponds

The RMP monitors liquid manure holding ponds ranging from earthen pits without construction information, to clay-lined ponds with varying construction details, and clay-lined and plastic-lined ponds with QA/QC documentation (**Table 4**). Typical management practices include solids separation via settling basins and/or mechanical separators; agitation and pump-out, dilution and pump-out, pump-out from varying depths; removal of solids with minimal waste level fluctuation; and purposeful drawdown of the waste level prior to solids removal. Nutrient and salt concentrations vary widely in the monitored ponds. All monitored dairies use a holding pond for storage, including one dairy which is identified as a scrape dairy.

Based on the above, the current RMP is considered representative of liquid manure holding ponds that are in operation on dairy farms in the Central Valley.

Additional Dairy Farm Features

There is a notion that large dairy farms have resources available to them (including advantages due to economies of scale) that are not available to small dairy farms, and that this could manifest itself in categorically advanced nutrient management. To address this, the RMP included dairies ranging in size from less than 200 to approximately 5,500 mature milk cows, with various amounts of support livestock (i.e., mainly calves, heifers, and dry cows).

Also, there is a notion that the overall performance of a flush dairy farm with respect to groundwater quality may be different than that of a scrape dairy (i.e., open lot dairy). Scrape dairy farms are rare in the Central Valley, and while the RMP includes two scape dairies (HOL and HYN), it is important to note that on flush dairies, animal housing occurs under roofed areas (freestalls), but typically also on open lots where manure is scraped. These features and dairy farm information pertaining to select physical parameters are summarized on **Table 5**.

3 REFINEMENT AND FUTURE WORK

The Phase 1 RMP Workplan (LSCE, 2012a) describes a process of program refinement which provides for continuous assessment and dynamic modifications to the program in response to RMP findings. This includes activities CVDRMP deems necessary to attain the RMP's goals, and goes beyond groundwater monitoring. The Phase 1 RMP Workplan notes the "identification of innovative methodologies, approaches, and analytical tools" as a part of the process of refinement.

The Year 1 RMP Annual Report (LSCE, 2013) documents widespread occurrence of elevated nitrate concentrations beneath dairies, and the approximate nature of field-scale nutrient and salt mass accounting. The initial findings show nutrient and salt management will be critical in addressing groundwater quality in first encountered groundwater beneath dairies. Concurrently, improving the accuracy of nutrient accounting and confidence in application/harvest removal ratios will increase the effectiveness of expanded comparisons and sensitivity of comparative analyses.

In response to these findings, CVDRMP has already started to devise a comprehensive scope of work for nutrient management improvement over a three-year period on a subset of dairy farms that includes close cooperation with dairy farmers, extensive field work, improved data collection efforts, performance evaluation of modified practices, and vetting of improved practices via on-farm testing. CVDRMP is approaching this task in a collaborative manner and is partnering with dairy industry leaders, dairy farmers, agronomists, consultants, and academia. This project is slated to start in fall 2013, with a comprehensive report and a technical field manual due in summer 2016.

With regard to ponds, the Year 1 RMP Annual Report (LSCE, 2013) indicates that groundwater monitoring alone is not sufficient in all cases to determine whether a pond seeps or not. In addition, groundwater monitoring data are not suitable to determine a pond's seepage rate, which is needed to estimate its subsurface mass loading rate of nitrogen and minerals.

In response to these findings, CVDRMP has already started to devise a comprehensive scope of work for the measurement of pond seepage using the water balance method described in *Protocols for Measuring Dairy Lagoon Seepage Using the Water Balance Method, Technical Field Guide* (LSCE, 2012c). This effort will assess the 18 monitored ponds on the Phase 1 RMP dairy farms as to their suitability to be candidates for seepage measurements and is slated to carry out actual measurements starting in winter 2013/2014 on 12 to 15 ponds, with a technical report due in 2014. Following the initial phase of this work effort, the scope of work also provides for the evaluation of improved management practices to address nutrient storage on dairy farms, with a technical report due in 2016.

These projects will occur in parallel, and they include ongoing publicity, outreach, and stakeholder meetings throughout the project period to disseminate information and results of the activities. Outreach will be conducted through a variety of media, including newsletters, emails, websites, meetings, and field calls.

4 CONCLUSION

Based on the assessment provided in this report and due consideration of the input received on the representativeness of the current RMP from the Groundwater Technical Advisory Committee and the Multidisciplinary Advisory Committee, it is determined that the network of monitored dairies and dedicated monitoring wells at their current level are substantially representative of typical site conditions and dairy farming practices on Central Valley dairies. This determination does not preclude the selective addition of monitoring wells at a future date. The process of refinement will continue.

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Tables and Figures

Table 1
Well Inventory by Dairy Farm – Central Valley Dairy Representative Monitoring Program

CVDRMP Area	Dairy	No. of MW Locations (1)			No. of Individual MWs			Assigned to (4)		
		Single	Nested	Total	at Nested Locations	Total (2)	for GWQ Sampling (3)	Pond	Corral	Field
Central Area – East Side	MEN	0	7	**7**	14	14	**7**	2	3	2
	ANC	4	3	**7**	6	10	**7**	4	3	0
	BET	0	8	**8**	16	16	**8**	1	3	4
	DIE	4	0	**4**	0	4	**4**	2	1	1
	DUR	8	1	**9**	2	10	**9**	4	1	4
	FG1	0	9	**9**	18	18	**9**	1	2	6
	BEA	0	4	**4**	8	8	**4**	1	3	0
	COT	10	4	**14**	8	18	**14**	2	3	9
	SAN	0	8	**8**	16	16	**8**	1	3	4
	GEN	10	2	**12**	4	14	**12**	3	4	5
	TRO	3	0	**3**	0	3	**3**	0	1	2
	PLS	0	7	**7**	14	14	**7**	2	3	2
	CAE	0	6	**6**	12	12	**6**	1	2	3
	ROB	0	8	**8**	16	16	**8**	2	3	3
	WOO	3	0	**3**	0	3	**3**	0	0	3
Central Area West Side	ANT	0	6	**6**	12	12	**6**	1	3	2
	COR	0	5	**5**	10	10	**5**	1	4	0
	FG2	0	5	**5**	10	10	**5**	1	1	3
	GOD	0	7	**7**	14	14	**7**	1	2	4
	MAC	0	5	**5**	10	10	**5**	2	0	3
	NUN	0	4	**4**	8	8	**4**	1	2	1
	MOO	4	4	**8**	8	12	**8**	2	3	3
	TON	0	8	**8**	16	16	**8**	2	3	3
North Area	BRE	2	2	**4**	4	6	**3**	0	0	4
	CRE	0	3	**3**	6	6	**3**	0	0	3
	MTS	1	2	**3**	4	5	**3**	0	0	3
South Area	AUK	3	0	**3**	0	3	**3**	1	1	1
	DLF	6	3	**9**	7	13	**6**	3	1	5
	ELK	6	0	**6**	0	6	**4**	2	3	1
	ZZI	9	6	**15**	18	27	**7**	7	4	4
	HOL	3	0	**3**	0	3	**3**	2	1	0
	HYN	3	0	**3**	0	3	**3**	1	0	2
	JAD	3	4	**7**	8	11	**7**	0	2	5
	LON	7	7	**14**	16	23	**7**	6	2	6
	ADO	0	2	**2**	4	4	**2**	2	0	0
	MAL	6	2	**8**	4	10	**8**	3	1	4
	MAP	3	0	**3**	0	3	**3**	1	1	1
	RIC	6	3	**9**	6	12	**6**	2	4	3
	SIE	4	0	**4**	0	4	**4**	1	1	2
	SO2	4	4	**8**	8	12	**8**	2	2	4
	SOJ	4	2	**6**	4	8	**6**	3	2	1
	ZON	4	4	**8**	8	12	**6**	3	1	4
SUM Central		46	111	**157**	-	268	**157**	37	53	67
SUM North		3	7	**10**	-	17	**9**	0	0	10
SUM South		71	37	**108**	-	154	**83**	39	26	43
TOTAL		120	155	**275**	-	439	**249**	76	79	120

(1) Monitoring well location refers to a borehole in which a well or wells were constructed. A nested MW location is a location where more than one well was constructed in the borehole. (2) The total number of MWs is the sum of single completion MWs and individual wells constructed as nested wells. The total number of MWs equals the number of data collection points for monthly depth-to-water readings.

(3) In most cases, the number of MWs in which groundwater quality (gwq) samples are collected equals the total number of MW locations. Exceptions are dairies that have well clusters (i.e., two or more adjacent wells of different depth).

(4) The assignment indicates the management unit targeted for groundwater quality assessment. All wells are used for hydraulic control.

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Chemical Soil Properties: Cation Exchange Capacity (meq/100g)	pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Restrictive Layer Depth to Top (in)	Restrictive Layer Thickness (in)	Land Form	Parent Material
MEN [Eastern Stanislaus Area, California (CA644)]																					***CVDRMP Central Area – East Side***
Dinuba Sandy Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	DwA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.07-0.11	5.4	3.8-9.6	7.4-9.0	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Waukena Sandy Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	WdA	100	95-100	69-81	33-43	10-18	0.0-3.0	0.06-0.20	0.10-0.12	6.6	7.2-17	6.6-8.4	4.0-8.0	0-5	0	0-20	- - data not available - -			Basin-floor remnents	Alluvium derived from granite
ANC [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Loamy Sand, 0 to 3 percent slopes	DdA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.8	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dinuba Sandy Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	DrA	100	95-100	70-85	35-60	7-18	0.0-1.0	0.06-0.20	0.10-0.13	7.2	5.0-10	7.9-8.4	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Hilmar Loamy Sand, Slightly Saline-Alkali, 0 to 3 percent slopes	HhA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Waukena Fine Sandy Loam, Strongly Saline-Alkali, 0 to 1 percent slopes	WcA	100	95-100	50-90	30-50	8-30	0.0-1.0	0.06-0.20	0.06-0.15	6.1	5.0-20	7.8-9.6	4.0-30.0	0-5	0	5-20	- - data not available - -			Basin-floor remnents	Alluvium derived from granite
BET [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Sand, 0 to 3 percent slopes	DfA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Sand, Silty Substratum, 0 to 3 percent slopes	DgA	100	100	40-80	5-50	0-15	0.0-1.0	1.98-5.95	0.05-0.15	6.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial plains, valleys	Wind modified sandy alluvium derived from granite
Dello Sand, 0 to 1 percent slopes	DkA	100	100	50-70	5-20	0-7	0.0-1.0	5.95-19.98	0.06-0.08	4.2	1.0-5.0	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions	Alluvium derived from granite
Dello Sand, Slightly Saline-Alkali, 0 to 1 percent slopes	DoA	100	100	50-70	5-20	0-7	0.0-1.0	5.95-19.98	0.06-0.08	4.2	1.0-5.0	6.6-8.4	4.0-8.0	0	0	0-5	- - data not available - -			Depressions	Alluvium derived from granite
Dune Land, 0 to 3 percent slopes	DuA	100	100	50-80	0-25	0-1	0.0-0.1	5.95-19.98	0.03-0.05	2.5	-	-	0	0	0	0	- - data not available - -			Alluvial fans	Eolian deposits
Dune Land, 3 to 8 percent slopes	DuB	100	100	50-80	0-25	0-1	0.0-0.1	5.95-19.98	0.03-0.05	2.5	-	-	0	0	0	0	- - data not available - -			Alluvial fans	Eolian deposits
Hilmar Sand, 0 to 3 percent slopes	HoA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
DIE [Madera County, California (CA651)]																					***CVDRMP Central Area – East Side***
Chino Clay Loam, Moderately Saline-Alkali, 0-1 percent slopes	CebA	100	100	85-100	60-85	18-35	0.5-3.0	0.20-0.57	0.11-0.15	7.8	15-25	7.4-8.4	8.0-16.0	0-10	0	5-10	- - data not available - -			basin floors	Alluvium derived from granite
Chino Clay Loam, Slightly Saline-Alkali, 0-1 percent slopes	CeaA	100	100	85-100	60-85	18-35	0.5-3.0	0.20-0.57	0.15-0.20	10.3	15-25	6.6-8.4	4.0-8.0	0-10	0	0-5	- - data not available - -			Basin floors	Alluvium derived from granite
Chino Loam, Slightly Saline-Alkali, 0-1 percent slopes	CgaA	100	100	85-100	60-85	18-35	0.5-3.0	0.20-0.57	0.15-0.19	10.2	15-20	6.6-8.4	4.0-8.0	0-10	0	0-5	- - data not available - -			Basin flooers	Alluvium derived from granite
Fresno and El Peco Fine Sandy Loams, Slightly Saline-Alkali, 0-1 percent slopes - El Peco	FeaA	100	95-100	70-95	35-60	7-25	0.0-1.0	0.00-0.00	0.00-0.10	1.8	5.0-15	7.8-9.6	4.0-8.0	0-5	0	0-5	Duripan	24-30	0-3	Fan remnants	Alluvium derived from granite
- Fresno		100	95-100	60-95	35-65	10-35	0.0-1.0	0.00-0.00	0.00-0.12	1.9	5.0-20	7.8-9.6	4.0-8.0	1-10	0	0-20	Duripan	18-24	0-3		
Fresno and El Peco Fine Sandy Loams, Moderately Saline-Alkali, 0-1 percent slopes - El Peco	FebA	100	95-100	70-95	35-60	7-25	0.0-1.0	0.00-0.00	0.00-0.10	1.8	5.0-15	7.8-9.6	8.0-16.0	0-5	0	0-10	Duripan	24-30	0-3	Fan remnants	Alluvium derived from granite
- Fresno		100	95-100	60-95	35-65	10-35	0.0-1.0	0.00-0.00	0.00-0.12	1.9	5.0-20	7.8-9.6	8.0-16.0	1-10	0	0-20	Duripan	18-24	0-3		
Fresno and El Peco Loams, Moderately Saline-Alkali, 0-1 percent slopes - El Peco	FfbA	100	95-100	70-95	35-60	7-25	0.0-1.0	0.00-0.00	0.00-0.12	2.0	5.0-20	7.8-9.6	8.0-16.0	0-5	0	0-10	Duripan	24-30	0-3	Fan remnants	Alluvium derived from granite
- Fresno		100	95-100	60-95	35-65	10-35	0.0-1.0	0.00-0.00	0.00-0.12	2.1	5.0-20	7.8-9.6	4.0-16.0	1-10	0	0-20	Duripan	18-24	0-3		

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	Chemical Soil Properties: pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
DIE [Madera County, California (CA651)] - Continued																					***CVDRMP Central Area – East Side***
Fresno and El Peco Loams, Slightly Saline-Alkali, 0-1 percent slopes - El Peco	FfaA	100	95-100	70-95	35-60	7-25	0.0-1.0	0.00-0.00	0.00-0.12	2.0	5.0-20	7.8-9.6	4.0-16.0	0-5	0	0-5	Duripan	24-30	0-3	Fan remnants	Alluvium derived from granite
- Fresno		100	95-100	60-95	35-65	10-35	0.0-1.0	0.00-0.00	0.00-0.12	2.1	5.0-20	7.8-9.6	4.0-16.0	1-10	0	0-20	Duripan	18-24	0-3		
Fresno and El Peco Loams, Strongly Saline-Alkali, 0-1 percent slopes - El Peco	FfcA	100	95-100	70-95	35-60	7-25	0.0-1.0	0.00-0.00	0.00-0.12	2.0	5.0-20	7.8-9.6	8.0-30.0	0-5	0	0-15	Duripan	24-30	0-3	Fan remnants	Alluvium derived from granite
- Fresno		100	95-100	60-95	35-65	10-35	0.0-1.0	0.00-0.00	0.00-0.12	2.1	5.0-20	7.8-9.6	4.0-30.0	1-10	0	0-20	Duripan	18-24	0-3		
Grangeville Fine Sandy Loam, over Traver Soils, Slightly Saline-Alkali, 0-1 percent slopes	Gda	100	95-100	60-95	25-60	8-25	0.0-6.0	0.20-0.57	0.07-0.16	7.2	5.0-15	7.4-8.4	4.0-8.0	0-1	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
DUR [Eastern Stanislaus Area, California (CA644)]																					***CVDRMP Central Area – East Side***
Dinuba Fine Sandy Loam, Slightly Saline-Alkali, 0-1 percent slopes	DpA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.07-0.11	5.4	3.8-9.6	7.4-9.0	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Dinuba Sandy Loam, Moderately Saline-Alkali, 0-1 percent slopes	DxA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.07-0.11	5.4	3.8-9.6	7.4-9.0	8.0-16.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Fresno Fine Sandy Loam, Moderately Saline-Alkali, 0-1 percent slopes	FrA	100	95-100	75-100	34-85	10-35	0.0-1.0	0.00-0.00	0.00-0.12	3.7	7.6-27	7.8-9.6	4.0-16.0	0-5	0	0-20	Duripan	38-40	0-3	Fan remnants	Alluvium derived from granite
Hanford Sandy Loam, 0-3 percent slopes	HdA	95-100	86-100	61-82	28-44	7-18	0.0-1.0	1.98-5.95	0.11-0.15	8.1	5.5-15	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from igneous rock
Waukena Fine Sandy Loam, Moderately Saline-Alkali, 0-1 percent slopes	WbA	100	95-100	69-97	33-44	10-18	0.0-3.0	0.06-0.20	0.08-0.10	5.4	7.2-17	7.8-9.0	8.0-18.0	0-5	0	0-20	- - data not available - -			Basin-floor remnants	Alluvium derived from granite
FG1 [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Sand, 0 to 3 percent slopes	DfA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Sand, 3 to 8 percent slopes	DfB	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dinuba Sandy Loam, 0 to 1 percent slopes	DpA	100	95-100	70-85	35-60	7-18	0.0-1.0	0.06-0.20	0.10-0.13	7.2	5.0-10	6.6-8.4	0.0-4.0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
Grangeville Loam, 0 to 1 percent slopes	GbA	100	95-100	60-100	35-80	8-20	0.0-6.0	0.57-1.98	0.12-0.17	8.6	5.0-15	6.1-8.4	0.0-2.0	0-2	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
Grangeville Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	GcA	100	95-100	60-100	35-80	8-20	0.0-6.0	0.57-1.98	0.12-0.17	8.6	5.0-15	6.6-8.4	4.0-8.0	0-2	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Hanford Fine Sandy Loam, Channeled, 0 to 8 percent slopes	HcB	100	95-100	60-90	30-50	8-18	0.0-1.0	1.98-5.95	0.08-0.12	6.3	5.0-10	6.6-7.3	0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
- Columbia	HcB	100	95-100	60-90	30-50	8-18	0.0-2.0	1.98-5.95	0.08-0.12	6.3	5.0-10	6.1-7.8	0	0	0	0	- - data not available - -			Flood plains	coarse-loamy alluvium derived from igneous, metamorphic, and sedimentary rock
Hanford Fine Sandy Loam, Moderately Deep and Deep Over Sand, 0 to 1 percent slopes	HbA	85-100	75-100	40-75	5-50	0-18	0.0-1.0	1.98-5.95	0.04-0.15	6.2	5.0-10	6.6-7.3	0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from igneous rock
Riverwash	Rf	80-100	75-100	30-70	0-20	0-5	0.0-0.1	5.95-19.98	0.03-0.06	2.9	- - -	- - -	0	0	0	0	- - data not available - -			Basin floors	Gravelly alluvium

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	Chemical Soil Properties: pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Restrictive Layer Depth to Top (in)	Restrictive Layer Thickness (in)	Land Form	Parent Material
BEA [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Sand, 3 to 8 percent slopes	DfB	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Loamy Sand, 0 to 3 percent slopes	DdA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.8	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dello Sand, Slightly Saline-Alkali, 0 to 1 percent slopes	DoA	100	100	50-70	5-20	0-7	0.0-1.0	5.95-19.98	0.06-0.08	4.2	1.0-5.0	6.6-8.4	4.0-8.0	0	0	0-5	- - data not available - -			Depressions	Alluvium derived from granite
Hilmar Loamy Sand, Slightly Saline-Alkali, 0 to 3 percent slopes	HhA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Loamy Sand, Poorly Drained, Slightly Saline-Alkali, 0 to 1 percent slopes	HfA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	1.8	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Sand, Slightly Saline-Alkali, 0 to 3 percent slopes	HpA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
COT [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Sand, 0 to 3 percent slopes	DfA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Sand, 3 to 8 percent slopes	DfB	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dello Sand, 0 to 1 percent slopes	DkA	100	100	50-70	5-20	0-7	0.0-1.0	5.95-19.98	0.06-0.08	4.2	1.0-5.0	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions	Alluvium derived from granite
Dello Sand, Slightly Saline-Alkali, 0 to 1 percent slopes	DoA	100	100	50-70	5-20	0-7	0.0-1.0	5.95-19.98	0.06-0.08	4.2	1.0-5.0	6.6-8.4	4.0-8.0	0	0	0-5	- - data not available - -			Depressions	Alluvium derived from granite
Dune Land, 3 to 8 percent slopes	DuB	100	100	50-80	0-25	0-1	0.0-0.1	5.95-19.98	0.03-0.05	2.5	-	-	0	0	0	0	- - data not available - -			Alluvial fans	Eolian deposits
Fresno Loam, Poorly Drained Variant, Strongly Saline-Alkali, 0 to 1 percent slopes	FoA	100	95-100	60-95	35-65	10-35	0.0-1.0	0	0.00-0.12	2.3	5.0-20	7.8-9.6	4.0-30.0	0-5	0	0-20	- - data not available - -			Flood plains	Alluvium derived from granite
Hilmar Sand, 0 to 3 percent slopes	HoA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Sand, Poorly Drained, 0 to 1 percent slopes	HkA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Sand, Poorly Drained, Moderately Saline-Alkali, 0 to 1 percent slopes	HmA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	8.0-16.0	0-5	0	0-10	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Loamy Sand, 0 to 3 percent slopes	HgA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Loamy Sand, Poorly Drained, Slightly Saline-Alkali, 0 to 1 percent slopes	HfA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	1.8	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
SAN [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Atwater Loamy Sand, 0 to 3 percent slopes	AfA	100	100	50-75	15-50	2-18	0.0-1.0	1.98-5.95	0.07-0.13	5.8	1.0-10	6.1-7.3	0	0	0	0	- - data not available - -			Dunes, dunes	Sandy alluvium derived from granite
Delhi Loamy Fine Sand, 0 to 3 percent slopes	DbA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.8	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Loamy Sand, 0 to 3 percent slopes	DdA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.8	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite

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Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	Chemical Soil Properties: pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
SAN [Merced Area, California (CA648)] - Continued																					***CVDRMP Central Area – East Side***
Fresno Loam, Strongly Saline-Alkali, 0 to 1 percent slopes	FsA	100	95-100	60-95	35-65	10-35	0.0-1.0	0	0.00-0.12	2.3	5.0-20	7.8-9.6	4.0-30.0	0-5	0	0-20	- - data not available - -			Fan remnents	Alluvium derived from granite
Fresno Loam, Moderately Saline-Alkali, 0 to 1 percent slopes	FrA	100	95-100	60-95	35-65	10-35	0.0-1.0	0	0.00-0.12	2.3	5.0-20	7.8-9.6	4.0-16.0	0-5	0	0-20	- - data not available - -			Fan remnents	Alluvium derived from granite
Fresno Loam, Poorly Drained Variant, Moderately Saline-Alkali, 0 to 1 percent slopes	FnA	100	95-100	60-95	35-65	10-35	0.0-1.0	0	0.00-0.12	2.3	5.0-20	7.8-9.6	4.0-16.0	0-5	0	0-20	- - data not available - -			Flood plains	Alluvium derived from granite
Hilmar Sand, 0 to 3 percent slopes	HoA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Loamy Sand, 0 to 3 percent slopes	HgA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Loamy Sand, Slightly Saline-Alkali, 0 to 3 percent slopes	HhA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Landlow Silty Clay Loam, 0 to 1 percent slopes	LeA	100	95-100	90-100	80-95	30-60	0.0-2.0	0.00-0.06	0.13-0.17	9.1	25-50	6.6-8.4	0.0-4.0	0-5	0	0	- - data not available - -			Basin Floors	Alluvium derived from igneous, metamorphic and sedimentary rock
Landlow Silty Clay Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	LfA	100	95-100	95-100	80-95	30-60	0.0-2.0	0.00-0.06	0.09-0.17	7.5	25-50	7.4-9.0	4.0-8.0	0-5	0	0-5	- - data not available - -			Basin Floors	Alluvium derived from igneous, metamorphic and sedimentary rock
Lewis Silty Clay Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	LoA	100	95-100	60-100	50-95	15-60	0.0-1.0	0	0.00-0.18	3.1	10-50	7.9-9.6	0.0-16.0	1-5	0	0-20	- - data not available - -			Fan remnents	Alluvium derived from igneous, metamorphic and sedimentary rock
Snelling Sandy Loam, 0 to 3 percent slopes	SnA	90-100	75-100	50-90	25-50	5-30	0.0-1.0	0.20-0.57	0.08-0.18	8.4	5.0-20	6.1-8.4	0.0-2.0	0	0	0	- - data not available - -			Fan remnents	Alluvium derived from granite
Snelling Sandy Loam, 3 to 8 percent slopes	SnB	90-100	75-100	40-90	25-50	5-30	0.0-1.0	0.20-0.57	0.08-0.18	8.4	5.0-20	6.1-8.4	0.0-2.0	0	0	0	- - data not available - -			Basin-floor remnents	Alluvium derived from granite
GEN [Eastern Stanislaus Area, California (CA644)]																					***CVDRMP Central Area – East Side***
Chualar Sandy Loam, 0-3 percent slopes	CaA	84-100	63-100	46-90	22-51	10-25	0.0-2.0	0.20-0.57	0.10-0.15	7.9	7.6-20	6.1-7.8	0	0	0	0	- - data not available - -			Fan remnants	Alluvium derived from igneous, metamorphic and sedimentary rock
Delhi Loamy Sand, Moderately Deep over Clay, 0-3 percent slopes	DfA	100	100	76-100	26-91	0-60	0.0-1.0	0.06-0.20	0.06-0.16	6.2	0.1-35	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Sand, 0-3 percent slopes	DhA	100	100	76-81	26-31	0-5	0.0-1.0	5.95-19.98	0.06-0.10	4.8	0.1-4.2	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Sand, 3-8 percent slopes	DhB	100	100	76-81	26-31	0-5	0.0-1.0	5.95-19.98	0.06-0.10	4.8	0.1-4.2	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dinuba Fine Sandy Loam, 0-1 percent slopes	DmA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.10-0.13	7.2	3.8-9.6	6.6-8.4	0.0-4.0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
Dinuba Sandy Loam, 0-1 percent slopes	DrA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.10-0.13	7.2	3.8-9.6	6.6-8.4	0.0-4.0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
Dinuba Sandy Loam, Slightly Saline-Alkali, 0-1 percent slopes	DwA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.07-0.11	5.4	3.8-9.6	7.4-9.0	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Hanford Sandy Loam, 0-3 percent slopes	HdA	95-100	86-100	61-82	28-44	7-18	0.0-1.0	1.98-5.95	0.11-0.15	8.1	5.5-15	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from igneous rock
Hanford Sandy Loam, Moderately Deep over Silt, 0-1 percent slopes	HdpA	87-100	66-100	47-100	22-89	7-30	0.0-1.0	0.20-0.57	0.11-0.18	8.9	5.5-23	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from igneous rock
Oakdale Sandy Loam, 0-3 percent slopes	OaA	95-100	81-100	61-86	17-45	5-18	0.0-2.0	1.98-5.95	0.08-0.15	7.3	2.6-9.6	6.1-7.3	0	0	0	0	- - data not available - -			Fan remnants	Alluvium derived from granite

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Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Chemical Soil Properties: Cation Exchange Capacity (meq/100g)	pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Restrictive Layer Depth to Top (in)	Restrictive Layer Thickness (in)	Land Form	Parent Material
GEN [Eastern Stanislaus Area, California (CA644)] - Continued																					***CVDRMP Central Area – East Side***
Tujunga Loamy Sand, 0-3 percent slopes	TuA	91-100	71-100	53-81	18-31	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	0.1-4.2	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Sandy alluvium derived from granite
TRO [Madera Area, California (CA651)]																					***CVDRMP Central Area – East Side***
Grangeville Fine Sandy Loam, over Traver Soils, 0-1 percent slopes	GcA	100	95-100	60-95	25-60	8-26	0.0-6.0	0.20-0.57	0.07-0.16	7.2	5.0-15	6.6-8.4	0.0-4.0	0-1	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Grangeville Fine Sandy Loam, Slightly Saline-Alkali, 0-1 percent slopes	GbA	100	95-100	60-95	25-50	8-18	0.0-6.0	1.98-5.95	0.08-0.15	6.3	5.0-15	6.6-8.4	4.0-8.0	0-1	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Traver Loam, Moderately Saline-Alkali, 0-1 percent slopes	TnA	100	95-100	65-90	35-60	10-25	0.0-1.0	0.57-1.98	0.08-0.13	6.6	5.0-15	7.4-9.6	8.0-16.0	1-5	0	5-20	- - data not available - -			Fan remnants	Alluvium derived from granite
Traver Loam, Slightly Saline-Alkali, 0-1 percent slopes	TmA	100	95-100	65-90	35-60	10-25	0.0-1.0	0.57-1.98	0.08-0.13	6.6	5.0-15	7.4-9.6	4.0-8.0	1-5	0	0-20	- - data not available - -			Fan remnants	Alluvium derived from granite
Traver Loam, Strongly Saline-Alkali, 0-1 percent slopes	ToA	100	95-100	65-90	35-60	10-25	0.0-1.0	0.57-1.98	0.08-0.10	5.4	5.0-15	7.4-9.6	16.0-30.0	1-5	0	5-20	- - data not available - -			Fan remnants	Alluvium derived from granite
Tujunga Loamy Sand, 0-3 percent slopes	TwA	60-100	50-95	20-70	0-25	0-5	0.0-1.0	5.95-19.98	0.04-0.10	3.9	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Sandy alluvium derived from granite
Visalia Sandy Loam, 0-3 percent slopes	VdA	80-100	75-100	50-70	35-50	8-18	0.0-4.0	1.98-5.95	0.10-0.16	7.9	5.0-15	6.5-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
Wunjey Very Fine Sandy Loam, Slightly Saline-Alkali, 0-1 percent slopes	WuA	100	100	95-100	60-95	8-18	0.0-1.0	0.57-1.98	0.10-0.14	7.2	5.0-10	7.8-9.6	4.0-8.0	0	0	0	- - data not available - -			Flood plains	Alluvium derived from granite
PLS [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Sand, 0 to 3 percent slopes	DfA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dinuba Sandy Loam, 0 to 1 percent slopes	DpA	100	95-100	70-85	35-60	7-18	0.0-1.0	0.06-0.20	0.10-0.13	7.2	5.0-10	6.6-8.4	0.0-4.0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from granite
Dinuba Sandy Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	DrA	100	95-100	70-85	35-60	7-18	0.0-1.0	0.06-0.20	0.10-0.13	7.2	5.0-10	7.9-8.4	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Hilmar Sand, 0 to 3 percent slopes	HoA	100	100	40-100	5-85	0-15	0.0-1.0	0.06-0.20	0.05-0.17	7.3	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
Hilmar Loamy Sand, 0 to 3 percent slopes	HgA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	2.0-4.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
CAE [Merced Area, California (CA648)]																					***CVDRMP Central Area – East Side***
Delhi Sand, 0 to 3 percent slopes	DfA	100	100	40-80	5-35	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.3	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Delhi Loamy Sand, Silty Substratum, 0 to 3 percent slopes	DeA	100	100	40-80	5-50	0-15	0.0-1.0	1.98-5.95	0.05-0.15	6.4	1.0-5.0	6.1-7.8	0	0	0	0	- - data not available - -			Sand sheets	Wind modified sandy alluvium derived from granite
Dune Land, 0 to 3 percent slopes	DuA	100	100	50-80	0-25	0-1	0.0-0.1	5.95-19.98	0.03-0.05	2.5	-	-	0	0	0	0	- - data not available - -				
Dello Sand, 0 to 1 percent slopes	DkA	100	100	50-70	5-20	0-7	0.0-1.0	5.95-19.98	0.06-0.08	4.2	1.0-5.0	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions	Alluvium derived from granite
Hilmar Loamy Sand, Slightly Saline-Alkali, 0 to 3 percent slopes	HhA	100	100	50-100	15-85	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.7	1.0-5.0	7.3-9.6	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Percent Passing Sieve Number 4 4.76 mm	10 1.68 mm	40 0.42 mm	200 0.074 mm	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
		Physical Soil Properties									Chemical Soil Properties						Soil Features				
ROB [Eastern Stanislaus Area, California (CA644)]																					***CVDRMP Central Area – East Side***
Dinuba Sandy Loam, Slightly Saline-Alkali, 0 to 1 percent slopes	DwA	100	95-100	69-100	33-85	7-18	0.0-1.0	0.06-0.20	0.07-0.11	5.4	3.8-9.6	7.4-9.0	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans	Alluvium derived from granite
Hilmar Sandy Loam, 0 to 1 percent slopes	HfA	100	100	72-95	5-77	0-15	0.0-1.0	0.06-0.20	0.06-0.17	7.2	0.1-7.6	7.3-9.6	0.0-8.0	0-5	0	0	- - data not available - -			Fan skirts	Wind modified sandy alluvium derived from granite over silty alluvium derived from granite
WOO [San Joaquin County, California (CA077)]																					***CVDRMP Central Area – East Side***
Acampo Sandy Loam, 0-2 percent slopes	101	0-100	0-100	0-80	0-50	7-18	0.0-3.0	0.00-0.00	0.00-0.14	5.6	15-20	6.1-8.4	0.0-2.0	0	0	0	Duripan	40-60	0-20	Fan terraces	Alluvium derived from granite
DeVries Sandy Loam, Drained, 0-2 percent slopes	149	0-100	0-100	0-85	0-50	7-18	0.0-3.0	0.00-0.00	0.00-0.14	3.5	5.0-15	6.6-8.4	0.0-2.0	0-3	0	0	Duripan	20-40	4-17	Rims on basin floors	Alluvium derived from mixed rock sources
Tokay Fine Sandy Loam, 0-2 percent slopes	256	100	95-100	50-85	25-50	8-18	0.0-3.0	1.98-5.95	0.10-0.15	7.8	8.0-14	6.1-8.4	0.0-2.0	0	0	0	- - data not available - -			Fan skirts	Alluvium derived from granitic rock sources
ANT [Stanislaus County, California, Western Part (CA642)]																					***CVDRMP Central Area – West Side***
Pedcat Clay Loam, 0 to 2 percent slopes	331	100	100	75-100	50-95	27-50	0.0-1.0	0.01-0.06	0.09-0.16	6.7	10-37	6.6-9.0	0.0-16.0	1-15	0	0-50	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
Vernalis Loam, 0 to 2 percent slopes	122	100	95-100	80-100	55-80	18-30	0.5-2.0	0.60-2.00	0.14-0.18	9.6	15-24	6.6-8.4	0.0-2.0	0-5	0	0-5	- - data not available - -			Alluvial fans	Alluvium from mixed rock
Vernalis-Zacharias Complex, 0 to 2 percent slopes, Rarely Flooded	126	100	95-100	80-100	55-85	18-35	0.5-2.0	0.20-0.60	0.14-0.18	10	15-28	6.6-8.4	0.0-2.0	0-5	0	0-5	- - data not available - -			Alluvial fans	Alluvium from mixed rock
- Zacharias	126	85-100	75-100	60-90	50-80	25-35	0.0-2.0	0.20-0.60	0.13-0.19	9.7	17-27	6.1-7.8	0	1-2	0	0	- - data not available - -			Alluvial fans	Alluvium from mixed rock
COR [Merced County, California, Western Part (CA647)]																					***CVDRMP Central Area – West Side***
Chinvar Loam	153	40-100	35-100	25-95	15-75	10-30	0.0-3.0	0.57-1.98	0.07-0.16	7.4	5.0-20	7.4-8.4	0.0-8.0	0-3	0	5-13	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
Pedcat Loam, 0 to 2 percent slopes	234	100	100	75-100	50-95	18-50	0.0-1.0	0.00-0.06	0.09-0.14	6.6	10-30	6.1-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
Pedcat Clay, 0 to 2 percent slopes, Severely Eroded	237	100	100	75-100	50-95	30-50	0.0-1.0	0.06-0.20	0.09-0.13	6.6	15-30	7.9-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Drainageways	alluvium derived from sedimentary rock
Pedcat Clay Loam, Leveled, 0 to 2 percent slope	236	100	100	75-100	50-95	27-50	0.0-1.0	0.00-0.06	0.09-0.16	6.7	15-30	6.6-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
FG2 [Merced County, California, Western Part (CA647)]																					***CVDRMP Central Area – West Side***
Dos Amigos Clay Loam, Partially Drained	168	100	95-100	85-100	50-95	30-50	0.0-2.0	0.00-0.06	0.09-0.20	8.6	5.0-30	7.9-8.4	0.0-16.0	20-35	0-10	0	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
Dos Amigos Clay, Partially Drained	169	100	95-100	85-100	50-95	30-50	0.0-2.0	0.00-0.06	0.09-0.17	8.3	5.0-30	7.9-8.4	0.0-16.0	20-35	0-10	0	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
Pedcat Clay Loam, Leveled, 0 to 2 percent slopes	236	100	100	75-100	50-95	27-50	0.0-1.0	0.00-0.06	0.09-0.16	6.7	15-30	6.6-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
GOD [Merced County, California, Western Part (CA647)]																					***CVDRMP Central Area – West Side***
Henmel Clay Loam, Partially Drained	192	100	100	60-100	35-95	15-45	0.0-3.0	0.06-0.20	0.10-0.19	9.3	10-25	7.9-9.0	0.0-2.0	0-5	0	0-10	- - data not available - -			Fan aprons	alluvium derived from sedimentary rock
Pedcat Clay Loam, Leveled, 0 to 2 percent slopes	236	100	100	75-100	50-95	27-50	0.0-1.0	0.00-0.06	0.09-0.16	6.7	15-30	6.6-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
Woo Loam, 0 to 2 percent slopes	274	80-100	75-100	65-95	50-75	18-35	0.5-2.0	0.20-0.57	0.14-0.19	10	10-15	6.6-8.4	0.0-2.0	1-10	0	0	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
MAC and NUN [Merced County, California, Western Part (CA647)]																					***CVDRMP Central Area – West Side***
Trulae Silty Clay, Partially Drained	258	90-100	90-100	80-100	65-95	30-65	0.0-2.0	0.00-0.06	0.12-0.16	8.2	20-50	7.9-8.4	4.0-8.0	0-10	0	0-50	- - data not available - -			Basin floors	alluvium derived from sedimentary rock
Woo Clay Loam, Wet, 0 to 2 percent slopes	279	100	95-100	75-100	50-90	18-45	0.0-2.0	0.06-0.20	0.14-0.19	10.2	10-25	6.6-8.4	0.0-4.0	1-10	0	0	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock

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Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Percent Passing Sieve Number 4 4.76 mm	10 1.68 mm	40 0.42 mm	200 0.074 mm	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
		Physical Soil Properties									Chemical Soil Properties						Soil Features				
MOO [Stanislaus County, California, Western Part (CA642)]																					***CVDRMP Central Area – West Side***
Bolfar-Columbia Complex, 0 to 2 percent slopes, Rarely Flooded	245	100	100	60-100	35-80	18-35	0.0-2.0	0.20-0.60	0.12-0.17	8.5	5.0-28	7.4-8.4	0.0-4.0	0-2	0	0	- - data not available - -			Flood plains	Alluvium derived from granite
- Columbia	245	100	95-100	40-95	5-50	0-18	0.0-2.0	0.60-2.00	0.05-0.15	7.1	0.0-16	6.1-8.4	0	0	0	0	- - data not available - -			Flood plains	Alluvium derived from granite
Columbia Fine Sandy Loam, Channeled, Partially Drained, 0 to 2 percent slopes, Frequently Flooded	153	100	100	80-95	35-50	8-18	0.0-2.0	2.00-6.00	0.10-0.12	6.6	5.0-16	6.1-7.8	0	0	0	0	- - data not available - -			Flood plains	Alluvium from mixed rock
Dos Palos-Bolfar Complex, 0 to 2 percent slopes, Occasionally Flooded	170	100	100	80-100	50-95	30-60	0.0-3.0	0.06-0.20	0.09-0.15	7.4	5.2-52	7.4-8.4	0.0-4.0	1-15	0	0	- - data not available - -			Flood plains	Alluvium derived from granite
- Bolfar	170	100	100	80-100	35-80	18-35	0.0-2.0	0.20-0.60	0.12-0.17	8.8	5.0-28	7.4-8.4	0.0-4.0	0-2	0	0	- - data not available - -			Flood plains	Alluvium derived from granite
Elsalado Loam, 0 to 2 percent slopes	274	95-100	90-100	75-90	35-65	8-18	0.0-1.0	0.60-2.00	0.14-0.16	9	6.2-15	7.4-8.4	0.0-2.0	1-15	0	1-5	- - data not available - -			Alluvial fans	Alluvium derived from sandstone-shale
Pedcat Clay Loam, 0 to 2 percent slopes, Rarely Flooded	330	100	100	75-100	50-95	27-50	0.0-1.0	0.01-0.06	0.09-0.16	6.7	10-37	6.6-9.0	0.0-16.0	1-15	0	0-50	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
Vernalis Loam, 0 to 2 percent slopes	122	100	95-100	80-100	55-80	18-30	0.5-2.0	0.60-2.00	0.14-0.18	9.6	15-24	6.6-8.4	0.0-2.0	0-5	0	0-5	- - data not available - -			Alluvial fans	Alluvium from mixed rock
Vernalis Clay Loam, 0 to 2 percent slopes	125	100	95-100	80-100	55-85	18-35	0.5-2.0	0.20-0.60	0.14-0.18	10	15-28	6.6-8.4	0.0-2.0	0-5	0	0-5	- - data not available - -			Alluvial fans	Alluvium from mixed rock
TON [Merced County, California, Western Part (CA647)]																					***CVDRMP Central Area – West Side***
Deldota Clay, Partially Drained	167	100	95-100	90-100	75-95	30-50	0.0-3.0	0.06-0.20	0.15-0.18	9.9	2.0-7.0	7.4-8.4	0.0-2.0	20-40	1-20	0	- - data not available - -			Terraces	Residuum weathered from sedimentary rock
Dos Amigos Clay Loam, Partially Drained	168	100	95-100	85-100	50-95	30-50	0.0-2.0	0.00-0.06	0.09-0.20	8.6	5.0-30	7.9-8.4	0.0-16.0	20-35	0-10	0	- - data not available - -			Alluvial fans	alluvium derived from sedimentary rock
Pedcat Loam, 0 to 2 percent slopes	234	100	100	75-100	50-95	18-50	0.0-1.0	0.00-0.06	0.09-0.12	6.6	10-30	6.1-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
Pedcat Clay Loam, Leveled, 0 to 2 percent slopes	236	100	100	75-100	50-95	27-50	0.0-1.0	0.00-0.06	0.09-0.16	6.7	15-30	6.6-9.0	8.0-16.0	0-3	0	13-60	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
Volta Clay Loam	265	100	100	90-100	70-95	27-50	0.0-1.0	0	0.00-0.17	6	15-25	7.4-9.0	0.0-8.0	1-10	0	0-30	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
Volta Clay Loam, Partially Drained	266	100	100	90-100	70-95	30-50	0.0-1.0	0	0.00-0.17	6.2	15-25	7.4-9.0	0.0-8.0	1-10	0	0-30	- - data not available - -			Fan Aprons	alluvium derived from sedimentary rock
BRE [Tehama County, California (CA645)]																					***CVDRMP North Area***
Altamont Clay, Terrace, 0-3 percent slopes	AcA	100	95-100	80-100	70-95	35-60	0.5-3.0	0.06-0.20	0.14-0.18	7.9	25-50	6.1-8.4	0.0-2.0	0-10	0	0	- - data not available - -			Hills	Residuum weathered from sedimentary rock
Arbuckle Gravelly Loam, 0-3 percent slopes	AvA	35-80	30-75	15-65	10-50	12-30	0.0-1.0	0.20-0.57	0.04-0.15	7.6	5.0-20	5.6-7.3	0	0	0	0	- - data not available - -			Terraces	Alluvium derived from metamorphic and sedimentary rock
Arbuckle Gravelly Loam, Clayey Substratum, Channeled - Arbucle	Ay	55-100	50-100	45-95	35-90	12-60	0.0-1.0	0.06-0.20	0.10-0.16	7.9	5.0-30	5.6-7.3	0	0	0	0	- - data not available - -			Terraces	Alluvium derived from metamorphic and sedimentary rock
Riverwash		10-55	10-50	5-30	0-5	0-1	0.0-0.1		0.01-0.03							0					
Corning Gravelly Loam, 3-8 percent slopes	CwB	60-90	50-75	35-75	25-60	10-55	0.0-1.0	0.00-0.06	0.04-0.14	2.5	5.0-35	5.1-7.3	0	0	0	0	Abrupt textural change	21-36	-	Terraces	Alluvium derived from metamorphic and sedimentary rock
Hilgate Loam, 0-3 percent slopes	HgA	80-100	75-100	70-100	55-95	10-45	0.0-1.0	0.00-0.06	0.05-0.18	2.9	10-35	5.6-7.8	0	0	0	0	Abrupt textural change	17	22	Terraces	alluvium derived from sedimentary rock
Kimball Gravelly Loam, 0-3 percent slopes	KoA	65-80	60-75	50-70	35-65	15-60	0.0-3.0	0.00-0.06	0.08-0.17	1.7	10-35	5.6-6.6	0	0	0	0	Abrupt textural change	11	49	Terraces	Alluvium derived from sedimentary rock

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	Chemical Soil Properties: pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
CRE [Glenn County, California (CA021)]																					***CVDRMP North Area***
Arbuckle Gravelly Loam, Clayey Substratum, 0-2 percent slopes	Ar	55-100	50-100	45-95	35-90	12-60	0.0-2.0	0.06-0.20	0.10-0.16	7.6	5.0-20	5.6-7.3	0	0	0	0	Strongly contrasting textural stratification	60	-	Terraces	Alluvium derived from conglomerate
Cortina Very Gravelly Sandy Loam	Czr	30-60	25-55	15-50	0-15	0-25	0.0-1.0	1.98-5.95	0.03-0.11	2.8	1.0-10	5.6-7.3	0	0	0	0	Strongly contrasting textural stratification	-	-	Alluvial fans	Gravelly alluvium
Hillgate Clay Loam, 0-3 percent slopes	HI	95-100	90-100	80-100	60-95	27-45	0.0-1.0	0.00-0.06	0.05-0.19	2.7	15-35	5.1-7.3	0	0	0	0	Abrupt textural change	-	-	Terraces	Alluvium derived from sedimentary rock
Hillgate Loam, 0-2 percent slopes	HgA	80-100	75-100	70-100	55-95	10-45	0.0-1.0	0.00-0.06	0.05-0.18	2.5	10-35	5.1-7.3	0	0	0	0	Abrupt textural change	-	-	Terraces	Alluvium derived from sedimentary rock
Myers Clay, 0-3 percent slopes	MzrA	100	100	90-100	80-95	40-60	0.5-2.0	0.06-0.20	0.14-0.16	9.0	30-50	6.1-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from sedimentary rock
Tehama Silt Loam, Water Table, 0-2 percent slopes	Tn	90-100	85-100	80-100	60-95	15-35	0.0-2.0	0.06-0.20	0.14-0.19	10.6	10-25	5.6-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Terraces	Alluvium derived from metamorphic and sedimentary rock
MTS [Glenn County, California (CA021)]																					***CVDRMP North Area***
Arbuckle Gravelly Sandy Loam, 0-2 percent slopes	As	35-80	30-75	15-65	10-50	10-30	0.0-2.0	0.20-0.57	0.04-0.15	5.4	5.0-20	5.6-7.3	0	0	0	0	- - data not available - -			Terraces	Alluvium derived from conglomerate
Hilgate Loam, 0-2 percent slopes	HgA	80-100	75-100	70-100	55-95	10-45	0.0-1.0	0.00-0.06	0.05-0.18	2.5	10-35	5.1-7.3	0	0	0	0	Abrupt textural change	-	-	Terraces	Alluvium derived from sedimentary rock
Tehama Loam, Deep to Gravel, 0-3 percent slopes	Tb	30-100	25-100	15-100	0-95	0-35	0.0-2.0	0.20-0.57	0.02-0.19	7.9	1.0-25	5.6-8.4	0.0-2.0	0-5	0	0	Strongly contrasting textural stratification	-	-	Terraces	Alluvium derived from metamorphic and sedimentary rock
Tehama Silt Loam, 0-3 percent slopes	Tm	90-100	85-100	80-100	60-95	15-35	0.0-2.0	0.06-0.20	0.14-0.19	10.6	10-25	5.6-8.4	0	0-5	0	0	- - data not available - -			Terraces	Alluvium derived from metamorphic and sedimentary rock
AUK [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Biggriz-Biggriz, Saline-Sodic, Complex, 0-2 percent slopes - Biggriz	104	100	95-100	75-95	40-80	18-33	0.3-1.0	0.20-0.60	0.12-0.17	9.3	10-20	7.4-9.6	0.0-4.0	1-10	0-1	1-13	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
- Biggriz, saline-sodic		100	95-100	75-95	40-80	18-33	0.3-1.0	0.20-0.60	0.10-0.13	7.2	10-20	7.9-9.6	4.0-8.0	1-10	0-1	13-200					
Colpien Loam, 0-2 percent slopes	108	100	100	50-90	40-80	10-31	0.2-3.0	0.20-0.60	0.10-0.21	10.7	10-20	6.6-8.4	0.5-4.0	0-5	0	1-12	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
DLF [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Akers-Akers, Saline-Sodic, Complex, 0-2 percent slopes - Akers	101	100	95-100	70-90	40-70	8-18	0.1-1.0	0.60-2.00	0.13-0.21	9.7	5.0-15	7.4-8.4	0.0-4.0	1-10	0-2	1-12	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
- Akers, Saline Sodic		100	95-100	70-90	40-70	8-18	0.1-1.0		0.12-0.20		5.0-15	7.4-9.0	2.0-8.0	1-10	0-2	1-30					
Colpien Loam, 0-2 percent slopes	108	100	100	50-90	40-80	10-31	0.2-3.0	0.20-0.60	0.10-0.21	10.7	10-20	6.6-8.4	0.5-4.0	0-5	0	1-12	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
Crosscreek-Kai Association, 0-2 percent slopes - Crosscreek	109	60-100	50-100	35-90	20-70	18-35	0.1-1.0	0.01-0.06	0.06-0.18	7.8	5.0-10	6.6-9.9	1.0-12.0	1-10	1-5	1-13	Duripan	40-60	-	Fan remnants	Formed by the chemical and mechanical alteration of the kai series which orignally formed in alluvium derived from granitic rock
- Kai		100	100	60-100	35-90	0-35	0.1-0.8	0.01-0.06	0.10-0.21	0.9	5.0-20	6.6-11.0	0.0-16.0	0-10	0	4-80	Natric	4-12	-		
- Kai																	Duripan	20-40	-		
Flamen Loam, 0-2 percent slopes	116	85-100	75-100	65-90	40-80	18-30	1.0-3.0	0.06-0.20	0.10-0.19	6.6	10-20	6.1-8.4	0.0-2.0	0-2	0	1-12	Duripan	40-60	-	Fan remnants	Alluvium derived from granitic rock sources
Nord Fine Sandy Loam, 0-2 percent slopes	130	100	100	25-95	20-70	2-18	0.1-2.0	0.60-2.00	0.05-0.15	7.2	5.0-15	6.6-8.4	0.0-2.0	0-4	0	2-10	- - data not available - -			Flood plains, alluvial fans	Alluvium derived from mixed

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		Physical Soil Properties									Chemical Soil Properties						Soil Features				
ELK [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Calgro-Calgro, Saline-Sodic, Complex, 0-2 percent slopes - Calgro	105	65-100	55-100	25-80	10-50	2-18	0.0-1.0	0.01-0.20	0.04-0.18	3.6	5.0-15	7.4-8.4	0.0-4.0	0-2	0	1-12	Duripan	20-40	-	Fan remnants	Alluvium derived from granitic rock sources
- Calgro, Saline-sodic		65-100	55-100	25-80	10-50	2-18	0.0-1.0	0.01-0.20	0.02-0.16	3.0	5.0-15	7.9-11.0	2.0-16.0	1-4	0	13-100	Duripan	20-40	-		
Crosscreek-Kai Association, 0-2 percent slopes - Crosscreek	109	60-100	50-100	35-90	20-70	18-35	0.1-1.0	0.01-0.06	0.06-0.18	7.8	5.0-10	6.6-9.9	1.0-12.0	1-10	1-5	1-13	Duripan	40-60	-	Fan remnants	Formed by the chemical and mechanical alteration of the kai series which orignally formed in alluvium derived from granitic rock
- Kai		100	100	60-100	35-90	0-35	0.1-0.8	0.01-0.06	0.10-0.21	0.9	5.0-20	6.6-11.0	0.0-16.0	0-10	0	4-80	Natric	4-12	-		
- Kai																	Duripan	20-40	-		
Quonal-Lewis Association, 0-2 percent slopes - Quonal	132	60-100	50-100	45-100	40-100	18-50	0.1-1.0	0.01-0.06	0.08-0.17	5.4	15-40	7.4-9.6	0.0-8.0	1-10	1-5	0-50	Duripan	40-60	-	Fan remnants	Formed by the chemical and mechanical alteration of the kai series which orignally formed in alluvium derived from granitic rock
- Lewis		100	95-100	60-100	50-95	15-60	0.1-1.0	0.01-0.06	0.06-0.18	0.9	10-20	7.9-9.6	4.0-40.0	1-8	0	13-100	Natric	2-6	-		
- Lewis																	Duripan	20-40	-		
ZZI [Kings County, California (CA031)]																					***CVDRMP South Area***
Kimberlina Fine Sandy Loam, Saline-Alkali	130	80-100	75-100	40-70	25-50	6-18	0.5-1.0	0.20-0.57	0.02-0.08	3.0	5.0-10	7.9-8.4	4.0-8.0	0-5	0	15-25	- - data not available - -			Alluvial fans	Alluvium derived from igneous and sedimentary rock
Lakeside Clay Loam, Drained	135	80-100	75-100	60-95	50-80	10-35	0.5-2.0	0.20-0.57	0.08-0.15	7.0	10-20	6.6-9.0	4.0-16.0	1-5	0	2-35	- - data not available - -			Rims on basin floors	Alluvium derived from igneous and sedimentary rock
HOL [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Biggriz-Biggriz, Saline-Sodic, Complex, 0-2 percent slopes - Biggriz	104	100	95-100	75-95	40-80	18-33	0.3-1.0	0.20-0.60	0.12-0.17	9.3	10-20	7.4-9.6	0.0-4.0	1-10	0-1	1-13	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
Biggriz, saline-sodic		100	95-100	75-95	40-80	18-33	0.3-1.0	0.20-0.60	0.10-0.13	7.2	10-20	7.9-9.6	4.0-8.0	1-10	0-1	13-200					
Colpien Loam, 0-2 percent slopes	108	100	100	50-90	40-80	10-31	0.2-3.0	0.20-0.60	0.10-0.21	10.7	10-20	6.6-8.4	0.5-4.0	0-5	0	1-12	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
Gambogy-Biggriz, Saline-Sodic, Association, Drained, 0-2 percent slopes - Gambogy	118	95-100	90-100	55-100	30-80	8-35	0.5-3.0	0.20-0.60	0.10-0.17	8.3	5.0-20	7.4-8.4	0.0-4.0	0-3	0-1	1-12	- - data not available - -			Flood plains, alluvial fans	Alluvium derived from granitic rock sources
- Biggriz		100	95-100	75-95	40-80	18-33	0.3-1.0	0.20-0.60	0.10-0.13	7.2	10-20	7.9-9.6	4.0-8.0	1-10	0-1	13-200					
HYN [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Nord Fine Sandy Loam, 0-2 percent slopes	130	100	100	25-95	20-70	2-18	0.1-2.0	0.60-2.00	0.05-0.15	7.2	5.0-15	6.6-8.4	0.0-2.0	0-4	0	2-10	- - data not available - -			Flood plains, alluvial fans	Alluvium derived from mixed
Tagus Loam, 0-2 percent slopes	137	100	100	60-90	35-65	10-18	0.1-2.0	0.60-2.00	0.12-0.15	8.4	5.0-15	7.4-9.0	0.0-2.0	0-10	0	0-12	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
JAD [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Colpien Loam, 0-2 percent slopes	108	100	100	50-90	40-80	10-31	0.2-3.0	0.20-0.60	0.10-0.21	10.7	10-20	6.6-8.4	0.5-4.0	0-5	0	1-12	- - data not available - -			Fan remnants	Alluvium derived from granitic rock sources
Crosscreek-Kai Association, 0-2 percent slopes - Crosscreek	109	60-100	50-100	35-90	20-70	18-35	0.1-1.0	0.01-0.06	0.06-0.18	7.8	5.0-10	6.6-9.9	1.0-12.0	1-10	1-5	1-13	Duripan	40-60	-	Fan remnants	Formed by the chemical and mechanical alteration of the kai series which orignally formed in alluvium derived from granitic rock
- Kai		100	100	60-100	35-90	0-35	0.1-0.8	0.01-0.06	0.10-0.21	0.9	5.0-20	6.6-11.0	0.0-16.0	0-10	0	4-80	Natric	4-12	-		
- Kai																	Duripan	20-40	-		

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		Physical Soil Properties									Chemical Soil Properties						Soil Features				
LON [Kings County, California (CA031)]																					***CVDRMP South Area***
Cajon Sandy Loam	104	90-100	85-100	40-70	5-35	0-18	0.5-1.0	1.98-5.95	0.06-0.12	5.1	1.0-15	7.4-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans	Alluvium derived from igneous and sedimentary rock
Excelsior Sandy Loam	112	100	100	50-90	30-70	5-18	0.5-1.0	0.06-0.20	0.05-0.12	6.0	5.0-10	7.9-9.6	0.0-16.0	0-5	0	0-80	- - data not available - -			Alluvial fans	Alluvium derived from igneous and sedimentary rock
Kimberlina Fine Sandy Loam, Saline-Alkali	130	80-100	75-100	40-70	25-50	6-18	0.5-1.0	0.20-0.57	0.02-0.08	3.0	5.0-10	7.9-8.4	4.0-8.0	0-5	0	15-25	- - data not available - -			Alluvial fans	Alluvium derived from igneous and sedimentary rock
Wasco Sandy Loam, 0-5 percent slopes	174	80-100	75-100	45-80	25-50	8-18	0.5-1.0	1.98-5.95	0.08-0.13	6.4	5.0-10	6.1-8.4	0.0-2.0	1-5	0	0	- - data not available - -			Alluvial fans	Alluvium derived from sandstone
ADO [Eastern Fresno Area, California (CA654)]																					***CVDRMP South Area***
Hanford Sandy Loam	Hc	100	95-100	50-75	30-40	7-18	0.0-1.0	1.98-5.95	0.10-0.15	7.8	5.0-10	6.1-7.3	0	0	0	0	- - data not available - -			Alluvial fans, flood plains	Granitic alluvium
Hesperia Fine Sandy Loam	Hsr	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	7.8	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			-	Granitic alluvium
Hesperia Fine Sandy Loam, Moderately Deep	Hst	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	8.5	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Alluvial fans, fan skirts	Granitic alluvium
Hesperia Fine Sandy Loam, Moderately Deep, Saline-Alkali	Hsy	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.08-0.15	6.9	5.0-15	7.9-9.0	4.0-8.0	0-5	0	0-5	- - data not available - -			Alluvial fans, fan skirts	Granitic alluvium
Hesperia Sandy Loam, Moderately Deep, Saline-Alkali	Hsn	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.08-0.15	6.9	5.0-15	7.9-9.0	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts, abandoned channels on alluvial fans	Granitic alluvium
MAL [Kings County, California (CA031)]																					***CVDRMP South Area***
Kimberlina Fine Sandy Loam, Saline-Alkali	130	80-100	75-100	40-70	25-50	6-18	0.5-1.0	0.20-0.57	0.02-0.08	3.0	5.0-10	7.9-8.4	4.0-8.0	0-5	0	15-25	- - data not available - -			Alluvial fans	Alluvium derived from igneous and sedimentary rock
Kimberline Saline-Alkali-Garces Complex - Kimberlina	132	80-100	75-100	40-70	25-50	6-18	0.5-1.0	0.20-0.57	0.02-0.08	3.0	5.0-10	7.9-8.4	4.0-8.0	0-5	0	15-25	- - data not available - -			Alluvial fans	Alluvium derived from igneous and sedimentary rock
- Garces		100	100	60-100	35-85	10-35	0.5-1.0	0-00-0.06	0.05-0.16	1.3	5.0-20	7.4-9.6	2.0-16.0	0-5	0	10-30	Natric	-	-		
Nord Fine Sandy Loam	147	100	100	60-95	35-70	10-18	0.5-2.0	0.57-1.98	0.10-0.15	7.6	5.0-15	6.6-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Flood plains	Alluvium derived from igneous rock; alluvium derived from sedimentary rock
MAP [Eastern Fresno Area, California (CA654)]																					***CVDRMP South Area***
Calhi Loamy Sand, 0-3 percent slopes	CfA	100	100	50-90	5-35	0-8	0.0-1.0	5.95-19.98	0.05-0.08	4.1	1.0-5.0	7.4-9.0	0.0-4.0	1-5	0	0	- - data not available - -			Dunes on Fan skirt	Eolian deposits derived from granitic alluvium
Dello Sandy Loam	Dn	100	100	50-80	5-50	0-18	0.0-1.0	1.98-5.95	0.04-0.13	4.5	1.0-10	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions on flood plains, depressions on alluvial fans	
Grangeville Fine Sandy Loam	Gf	100	95-100	60-95	35-60	8-18	0.5-6.0	1.98-5.95	0.12-0.15	8.3	5.0-15	6.1-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Grangeville Fine Sandy Loam, Hard Substratum	Gn	100	95-100	50-75	35-50	8-18	0.5-6.0	0.01-0.14	0.00-0.15	5.2	5.0-15	6.6-8.4	0.0-2.0	0	0	0	Duripan	24-60	4-17	Alluvial fans, flood plains	Recent granitic alluvium
Grangeville Fine Sandy Loam, Hard Substratum, Saline-Alkali	Go	100	95-100	50-75	35-50	8-18	0.5-6.0	0.01-0.14	0.00-0.13	4.0	5.0-15	7.4-8.4	4.0-16.0	0	0	0-5	Duripan	24-60	4-17	Valleys	Recent granitic alluvium
Grangeville Fine Sandy Loam, Saline-Alkali	Gg	100	95-100	60-95	35-60	8-18	0.5-6.0	0.57-1.98	0.12-0.15	8.3	5.0-15	7.4-9.0	4.0-8.0	0	0	0.5	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Grangeville Fine Sandy Loam, Sandy Substratum	Gm	85-100	75-100	40-75	5-50	0-18	0.0-6.0	1.98-5.95	0.04-0.15	6.2	1.0-15	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Traver Fine Sandy Loam	Tt	100	95-100	65-90	35-50	8-25	0.0-1.0	0.06-0.20	0.06-0.13	5.3	5.0-15	7.4-9.6	4.0-16.0	1-5	0	0-20	- - data not available - -			Fan skirts	Granitic alluvium
Traver Sandy Loam	Tr	100	100	65-90	35-50	8-25	0.0-1.0	0.06-0.20	0.06-0.13	5.3	5.0-15	7.4-9.6	0.0-16.0	1-5	0	0-20	- - data not available - -			Fan skirts	Granitic alluvium
Tujunga Loamy Sand, 0-3 percent slopes	TzbA	90-100	75-95	40-70	5-25	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.2	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Flood plains, alluvial fans	Granitic alluvium

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Percent Passing Sieve Number 4 4.76 mm	10 1.68 mm	40 0.42 mm	200 0.074 mm	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
		Physical Soil Properties									Chemical Soil Properties						Soil Features				
RIC [Kern County, California, Southwest Part (CA691)]																					
Bakersfield Fine Sandy Loam, Drained, 0-1 percent slopes	101	100	95-100	64-100	17-93	2-27	0.1-3.0	0.57-1.98	0.05-0.22	9.9	1.8-22	6.1-8.4	0.5-5.0	0-3	0	2-12	- - data not available - -			Flood plains	Alluvium derived from granitoid
Bakersfield Sandy Loam, Partially Drained, 0-1 percent slopes	102	100	95-100	64-100	17-93	2-27	0.1-3.0	0.57-1.98	0.05-0.22	9.9	1.8-22	6.1-8.4	1.0-10.0	0-3	0	5-80	- - data not available - -			Flood plains	Alluvium derived from granitoid
Granoso Sandy Loam, 0-2 percent slopes, Overwash	123	85-100	85-100	61-86	8-42	4-12	0.1-0.9	1.98-5.95	0.04-0.15	4.9	2.8-9.1	7.4-8.4	0.1-2.0	0-3	0	1-4	- - data not available - -			Alluvial fans, flood plains	Alluvium derived from mixed
Old River Loam, Partially Drained, Sodic, 0-1 percent slopes	251	100	91-100	52-100	27-98	6-50	0.1-4.0	0.01-1.98	0.06-0.22	7.9	5.0-39	7.4-9.0	2.0-15.0	0-4	0-5	2-30	- - data not available - -			Flood plains	Alluvium derived from granitoid rock
SIE [Tulare County, Western Part, California (CA659)]																					***CVDRMP South Area***
Hanford Sandy Loam, 0-2 percent slopes	124	85-100	75-100	40-75	15-50	5-18	0.1-1.0	2.00-6.00	0.07-0.15	6.6	5.0-15	5.6-7.8	0.0-2.0	0-2	0	0-7	- - data not available - -			Flood plains, alluvial fans	Alluvium derived from granitic rock sources
Nord Fine Sandy Loam, 0-2 percent slopes	130	100	100	25-95	20-70	2-18	0.1-2.0	0.60-2.00	0.05-0.15	7.2	5.0-15	6.6-8.4	0.0-2.0	0-4	0	2-10	- - data not available - -			Flood plains, alluvial fans	Alluvium derived from mixed
Tujunga Loamy Sand, 0-2 percent slopes	138	90-100	75-95	35-50	10-25	0-5	0.1-0.8	6.00-20.00	0.02-0.08	3.1	0.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Flood plains	Alluvium derived from granite
SO2 [Eastern Fresno Area, California (CA654)]																					***CVDRMP South Area***
Delhi Loamy Sand, 0-3 percent slopes	DhA	100	100	50-80	20-30	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.8	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Dunes on fan remnants	Eolian deposits derived from granitic alluvium
El Peco Fine Sandy Loam	Ed	100	100	70-95	35-85	7-25	0.0-1.0	0.00-0.01	0.00-0.10	1.8	5.0-15	7.8-9.6	8.0-16.0	0-5	0	0-5	Duripan	20-40	0-3	Fan skirts	Granitic alluvium
El Peco Sandy Loam	Ec	100	100	70-95	35-85	7-25	0.0-1.0	0.00-0.01	0.00-0.10	1.8	5.0-15	7.8-9.6	8.0-16.0	0-5	0	0-5	Duripan	20-40	0-3	Fan skirts	Granitic alluvium
Greenfield Sandy Loam, 0-3 percent slopes	GtA	95-100	90-100	50-75	30-50	7-18	0.00-1.0	1.98-5.95	0.10-0.16	8.0	5.0-15	6.1-7.8	0	0	0	0	- - data not available - -			Alluvial fans	Granitic alluvium
Hesperia Fine Sandy Loam, Moderately Deep	Hst	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	8.5	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Alluvial fans, fan skirts	Granitic alluvium
Hesperia Sandy Loam	Hsd	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	7.8	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Alluvial fans	Granitic alluvium
Hesperia Sandy Loam, Moderately Deep	Hsm	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	8.5	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Alluvial fans	Granitic alluvium
Hesperia Sandy Loam, Moderately Deep, Saline-Alkali	Hsn	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.08-0.15	6.9	5.0-15	7.9-9.0	4.0-8.0	0-5	0	0-5	- - data not available - -			Fan skirts, abandoned channels on alluvial fans	Granitic alluvium
SOJ [Eastern Fresno Area, California (CA654)]																					***CVDRMP South Area***
Delhi Loamy Sand, 0-3 percent slopes	DhA	100	100	50-80	20-30	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.8	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Dunes on fan remnants	Eolian deposits derived from granitic alluvium
Delhi Sand, 0-3 percent slopes	DeA	100	100	40-80	5-10	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.7	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Dunes on fan remnants	Eolian deposits derived from granitic alluvium
Dello Loamy Sand	Dm	100	100	50-80	5-35	0-10	0.0-1.0	5.95-19.98	0.04-0.10	4.1	1.0-5.0	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions on flood plains, depressions on alluvial fans	Granitic alluvium
Hesperia Sandy Loam	Hsd	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	7.8	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			Alluvial fans	Granitic alluvium
Hesperia Fine Sandy Loam	HsR	100	95-100	50-100	35-90	5-30	0.0-1.0	0.06-0.20	0.10-0.18	7.8	5.0-15	6.1-8.4	0.0-2.0	0-5	0	0	- - data not available - -			-	Granitic alluvium

Table 2
Soil Properties at Monitored Dairies – Central Valley Dairy Representative Monitoring Program

Dairy and Soil Survey Map Unit Name	Map Unit Symbol	Physical Soil Properties: Percent Passing Sieve Number 4 (4.76 mm)	10 (1.68 mm)	40 (0.42 mm)	200 (0.074 mm)	Clay (%)	Organic Matter (%)	$K_{sat(min)}$ (in/hr)	Available Water Capacity (in/in)	60 inch profile (in)	Cation Exchange Capacity (meq/100g)	Chemical Soil Properties: pH (pH-units)	Salinity (mS/cm)	$CaCO_3$ (%)	$CaSO_4$ $2H_2O$ (%)	SAR -	Soil Features: Restrictive Layer Kind -	Depth to Top (in)	Thickness (in)	Land Form	Parent Material
ZON [Eastern Fresno Area, California (CA654)]																					***CVDRMP South Area***
Calhi Loamy Sand, 0-3 percent slopes	CfA	100	100	50-90	5-35	0-8	0.0-1.0	5.95-19.98	0.05-0.08	4.1	1.0-5.0	7.4-9.0	0.0-4.0	1-5	0	0	- - data not available - -			Dunes on Fan skirt	Eolian deposits derived from granitic alluvium
Delhi Sand, 0-3 percent slopes	DeA	100	100	40-80	5-10	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.7	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Dunes on fan remnants	Eolian deposits derived from granitic alluvium
Dello Loamy Sand	Dm	100	100	50-80	5-35	0-10	0.0-1.0	5.95-19.98	0.04-0.10	4.1	1.0-5.0	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions on flood plains, depressions on alluvial fans	Granitic alluvium
Dello Sandy Loam	Dn	100	100	50-80	5-50	0-18	0.0-1.0	1.98-5.95	0.04-0.13	4.5	1.0-10	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Depressions on flood plains, depressions on alluvial fans	Granitic alluvium
Grangeville Fine Sandy Loam	Gf	100	95-100	60-95	35-60	8-18	0.5-6.0	1.98-5.95	0.12-0.15	8.3	5.0-15	6.1-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Grangeville Fine Sandy Loam, Hard Substratum, Saline-Alkali	Go	100	95-100	50-75	35-50	8-18	0.5-6.0	0.01-0.14	0.00-0.13	4.0	5.0-15	7.4-8.4	4.0-16.0	0	0	0-5	Duripan	24-60	4-17	Valleys	Recent granitic alluvium
Grangeville Fine Sandy Loam, Sandy Substratum	Gm	85-100	75-100	40-75	5-50	0-18	0.0-6.0	1.98-5.95	0.04-0.15	6.2	1.0-15	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Grangeville Sandy Loam, Saline-Alkali	Gd	100	95-100	60-95	35-60	8-18	0.5-6.0	0.57-1.98	0.10-0.13	7.2	5.0-15	7.4-9.0	4.0-8.0	0	0	0-5	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Grangeville Sandy Loam, Sandy Substratum	Ge	85-100	75-100	40-75	5-50	0-18	0.0-6.0	1.98-5.95	0.04-0.15	6.2	1.0-15	6.6-8.4	0.0-2.0	0	0	0	- - data not available - -			Alluvial fans, flood plains	Recent granitic alluvium
Traver Fine Sandy Loam	Tt	100	95-100	65-90	35-50	8-25	0.0-1.0	0.06-0.20	0.06-0.13	5.3	5.0-15	7.4-9.6	4.0-16.0	1-5	0	0-20	- - data not available - -			Fan skirts	Granitic alluvium
Tujunga Loamy Sand, 0-3 percent slopes	TzbA	90-100	75-95	40-70	5-25	0-5	0.0-1.0	5.95-19.98	0.05-0.10	4.2	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Flood plains, alluvial fans	Granitic alluvium
Tujunga Sand, 0-3 percent slopes	TzaA	90-100	75-95	40-70	5-25	0-5	0.0-1.0	5.95-19.98	0.05-0.08	4.2	1.0-5.0	6.1-7.3	0	0	0	0	- - data not available - -			Flood plains, alluvial fans	Granitic alluvium

Data Source: USDA NRCS Soil Survey Geographic Database (SSURGO)
With the exception of Ksat(min), numerical values and ranges pertain to a 60-inch soil profile and may integrate properties of multiple soil horizons.
Detailed parameter descriptions for Phase 2 dairies are provided in **Attachment A** (for Phase 1 dairies, see CVDRMP Year 1 Annual Report).

Table 3
Forage Crops, Irrigation Systems, and Water Sources
Central Valley Dairy Representative Monitoring Program

CVDRMP Area	Dairy	Corn	Oats	Wheat	Alfalfa	Sudan	Triticale	Pasture	Sorghum	Irrigation System	Water Source
Central Area – East Side	MEN	✓	✓		✓	✓	✓			b/b	sw
	ANC (1)	-	-	-	-	-	-	-	-	-	-
	BET	✓	✓							b/b	sw/gw
	DIE	✓		✓					✓	b/b	gw
	DUR	✓	✓		✓					b/b	sw
	FG1	✓	✓							f/b	sw
	BEA (1)	-	-	-	-	-	-	-	-	-	-
	COT	✓	✓	✓				✓		b/b	gw
	SAN	✓	✓		✓			✓		b/b	gw
	GEN	✓	✓	✓			✓			b/b	sw
	TRO	✓		✓	✓					b/b	gw
	PLS	✓	✓		✓	✓				b/b	sw/gw
	CAE	✓	✓			✓				b/b	sw
	ROB	✓	✓	✓	✓	✓				b/b	sw/gw
	WOO	✓	✓		✓		✓			f/b	gw
Central Area West Side	ANT	✓	✓							f/b	sw
	COR (1)	-	-	-	-	-	-	-	-	-	-
	FG2	✓	✓		✓	✓				f/b	sw
	GOD	✓	✓		✓	✓				f/b	sw
	MAC	✓	✓							f/b	sw
	NUN	✓	✓		✓	✓				f/b	sw
	MOO	✓		✓	✓		✓		✓	f/b	sw/gw
	TON	✓	✓		✓					f/b	sw/gw
North Area	BRE (2)	✓								cp	gw
	CRE							✓		flood	sw
	MTS	✓		✓	✓		✓			b/b	gw
South Area	AUK	✓		✓						b/b	sw/gw
	DLF	✓		✓	✓			✓		b/b	sw/gw
	ELK	✓		✓	✓					f/b	sw/**gw**
	ZZI	✓		✓	✓		✓			b/b	sw/gw
	HOL (1)	-	-	-	-	-	-	-	-	-	-
	HYN	✓		✓	✓					f/b	sw/gw
	JAD	✓		✓						f/b	sw/gw
	LON	✓		✓	✓					f/b	sw/**gw**
	ADO (1)	-	-	-	-	-	-	-	-	-	-
	MAL	✓			✓		✓		✓	f/b	sw/gw
	MAP	✓		✓						f/b	sw/**gw**
	RIC	✓	✓	✓	✓					cp	sw/gw
	SIE	✓		✓	✓					f/b	sw/**gw**
	SO2	✓		✓	✓	✓	✓		✓	f/b	sw/gw
	SOJ	✓		✓						f/b	gw
	ZON	✓		✓						f/b	sw/**gw**

(1) Fields are not monitored at this dairy farm.
(2) Winter crop is rye.
Irrigation Systems: summer crop/winter crop, b=border, f=furrow, cp=center pivot
Water Sources: sw=surface water, gw=groundwater (bold indicates main water source)

Table 4
Monitored Liquid Manure Holding Ponds
Central Valley Dairy Representative Monitoring Program

Dairy	Liquid Manure Pond Information	Soil (3)
MEN	1970s and 1990s, no records	sandy loam 7-18
ANC	1993 (1)	loamy sand 0-15
BET	2000 (1)	sand 0-15
DIE	1997, 2001, clay-lined (2)	loams 7-35
DUR	1970s, no records	sandy loams 7-35
FG1	1979, no records	loam 8-20
BEA	2001 (2)	sand & loamy sand 0-15
COT	2003 (2)	sand 0-5, loamy sand 0-15
SAN	2001 (2)	loam 10-35
GEN	1950s (?), no records	sandy loam 7-18
PLS	1960s, no records	sandy loam 7-18
CAE	1998 (1)	dune land 0-1
ROB	1975 (no records), 2003 (1)	sandy loam 7-18, loamy sand 0-15
ANT	1980s and 2000s (2)	loam 18-30
COR	2001, no records	loam 18-50, clay 30-50
FG2	2002, no records	clay loam 27-50
GOD	2005 (1)	loam 18-35
MAC	1979, no records	clay loam 18-45, silty clay 30-65
NUN	1981, no records	silty clay 30-65
MOO	2003, 10/10 design standard; pond soil report (The Twining Laboratories, 2003)	loam 18-30
TON	1972, no records	clay loams 27-50
AUK	1999, earthen-lined (2)	Biggriz-Biggriz 18-33
DLF	2001, engineered clay liner (2)	sandy loam 2-18
ELK	2000, earthen-lined (2)	Quonal-Lewis Association 18-50
ZZI	1970s/2000s, earthen-lined (2)	sandy loam 6-18
HOL	2000, earthen-lined (2)	Gambogy-Biggriz 8-35
HYN	1998, clay-lined (2)	sandy loam 2-18
LON	earthen lined lagoons (1970s), no records; one Tier 2 lagoon with 60-mil HDPE liner (Lagoon # 3) installed in 2010; CQA documentation (Ausenco Vector, 2010)	sandy loam 6-18
ADO	one lagoon with Tier 2 single 60-mil HDPE liner installed in 2006 adjacent to earthen lagoon; approved CQA Report (Provost and Pritchard, 2006)	sandy loam 5-30
MAL	two lagoons with 40-mil HDPE liners installed in 2005; construction report (Striatus Engineering, 2005)	Kimberlina-Garces 6-18
MAP	no records (2)	sandy loams 0-18, loamy sand 0-8
RIC	lagoons constructed in 1999 with partial clay liners to cover sandy areas (10/10 design standard); lagoon soil report (Soils Engineering Inc., 1999)	sandy loam 2-27
SIE	1950s (?), no records	sandy loam 5-18
SO2	one lagoon with 1-2' thick engineered clay liner (imported material) installed in 1988 (?); construction report (True Engineering, 1989)	sandy loam 5-30
SOJ	one lagoon with engineered clay liner (10/10 design standard) installed in 1994 (?); lagoon soil testing rpt by Soil Conservation Service (1994)	loamy sand 0-5
ZON	east lagoon with engineered clay-liner (1-ft thick) constructed in 1990 according to 10/10 design standard; soil report (Anderson, 1990); rpt. states that west lagoon will be rebuilt in 1991; these lagoons are now combined to one single lagoon; adjacent to settling basin	sandy loam 8-18, loamy sand 0-5

Ponds are not monitored at TRO, WOO, BRE, CRE, MTS, and JAD.
(1) It was recently indicated that records are available.
(2) Construction information may be available.
(3) Numerical values give range of clay content in percent by weight.

Table 5
Summary of Dairy Farm Information – Central Valley Dairy Representative Monitoring Program

CVDRMP Area	Dairy	Mature Milk Cows (head)				Animal Housing			Soils (1)			Annual Precipitation (inches)			Depth to First Encountered Groundwater (feet)			Crops and Crop Rotations					Irrigation Systems				Irrigation Water Sources		Pond Construction		
		<500	500-999	1,000-2,000	>2,000	Freestall	Open Lot	Combination	Sandy	Loamy	Clayey	<10	10-16	>16	<50	50-100	>100	Corn/Oats	Corn/Wheat	Other Winter Crops (2)	Alfalfa	Pasture	Furrow/ Border	Border/ Border	Center Pivot	Flood	Surface Water	Ground-Water (4)	Plastic Lined	Fully Clay Lined	Less than Fully Clay Lined (3)
Central Area – East Side	MEN			✓				✓	✓	✓			✓		✓			✓		✓	✓			✓			✓				✓
	ANC				✓			✓	✓	✓			✓		✓			na	na	na	na	na	na	na	na	na	na	na			✓
	BET			✓				✓	✓				✓		✓			✓						✓			✓	✓			✓
	DIE				✓			✓		✓	✓		✓			✓	✓		✓	✓				✓				✓			✓
	DUR		✓					✓	✓	✓			✓		✓			✓			✓			✓			✓				✓
	FG1			✓				✓	✓	✓			✓		✓			✓					✓				✓				✓
	BEA				✓			✓	✓				✓		✓			na	na	na	na	na	na	na	na	na	na	na			✓
	COT				✓		✓		✓	✓			✓		✓			✓	✓			✓		✓				✓			✓
	SAN				✓		✓		✓	✓	✓		✓		✓			✓			✓	✓		✓				✓			✓
	GEN			✓				✓	✓	✓			✓		✓			✓	✓	✓				✓			✓				✓
	TRO				✓			✓	✓	✓			✓		✓	✓			✓		✓			✓				✓	na	na	na
	PLS	✓					✓		✓	✓			✓		✓			✓		✓	✓			✓			✓	✓			✓
	CAE		✓					✓	✓				✓		✓			✓		✓				✓			✓				✓
	ROB			✓				✓	✓	✓			✓		✓			✓	✓	✓	✓			✓			✓	✓			✓
	WOO	✓						✓	✓	✓			✓	✓	✓			✓		✓	✓		✓					✓	na	na	na
Central Area West Side	ANT		✓					✓		✓	✓		✓		✓			✓					✓				✓				✓
	COR		✓					✓		✓	✓		✓		✓			na	na	na	na	na	na	na	na	na	na	na			✓
	FG2				✓			✓		✓	✓		✓		✓			✓		✓	✓		✓				✓				✓
	GOD			✓				✓		✓	✓		✓		✓			✓		✓	✓		✓				✓				✓
	MAC		✓					✓		✓	✓		✓		✓			✓					✓				✓				✓
	NUN			✓				✓		✓	✓		✓		✓			✓		✓	✓		✓				✓				✓
	MOO			✓				✓		✓	✓		✓		✓				✓	✓	✓		✓				✓	✓			✓
	TON				✓			✓		✓	✓		✓		✓			✓			✓		✓				✓	✓			✓
North Area	BRE			✓				✓		✓				✓	✓	✓									✓			✓	na	na	na
	CRE		✓					✓	✓	✓	✓			✓	✓							✓				✓	✓		na	na	na
	MTS		✓					✓	✓	✓				✓	✓	✓			✓	✓	✓			✓				✓	na	na	na
South Area	AUK				✓			✓		✓	✓	✓				✓			✓					✓			✓	✓			✓
	DLF				✓	✓			✓	✓		✓				✓	✓		✓		✓	✓		✓			✓	✓			
	ELK				✓			✓		✓	✓		✓		✓				✓		✓		✓				✓	✓✓			✓
	ZZI		✓			tbd	tbd	tbd	✓	✓		✓			✓				✓	✓	✓			✓			✓	✓			✓
	HOL				✓	✓				✓	✓	✓					✓	na	na	na	na	na	na	na	na	na	na	na			✓
	HYN			✓			✓		✓	✓		✓					✓		✓		✓		✓				✓	✓			✓
	JAD			✓			✓			✓		✓				✓			✓				✓				✓	✓	na	na	na
	LON			✓				✓	✓	✓		✓				✓	✓		✓		✓		✓				✓	✓✓	✓		✓
	ADO			✓		tbd	tbd	tbd	✓	✓			✓			✓		na	na	na	na	na	na	na	na	na	na	na	✓		
	MAL				✓			✓	✓	✓		✓			✓					✓	✓		✓				✓	✓	✓		
	MAP			✓				✓	✓	✓		✓				✓			✓				✓				✓	✓✓			✓
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	SOJ		✓					✓	✓	✓			✓			✓			✓				✓					✓			✓
	ZON				✓		✓		✓	✓		✓				✓	✓		✓				✓				✓	✓✓		✓	

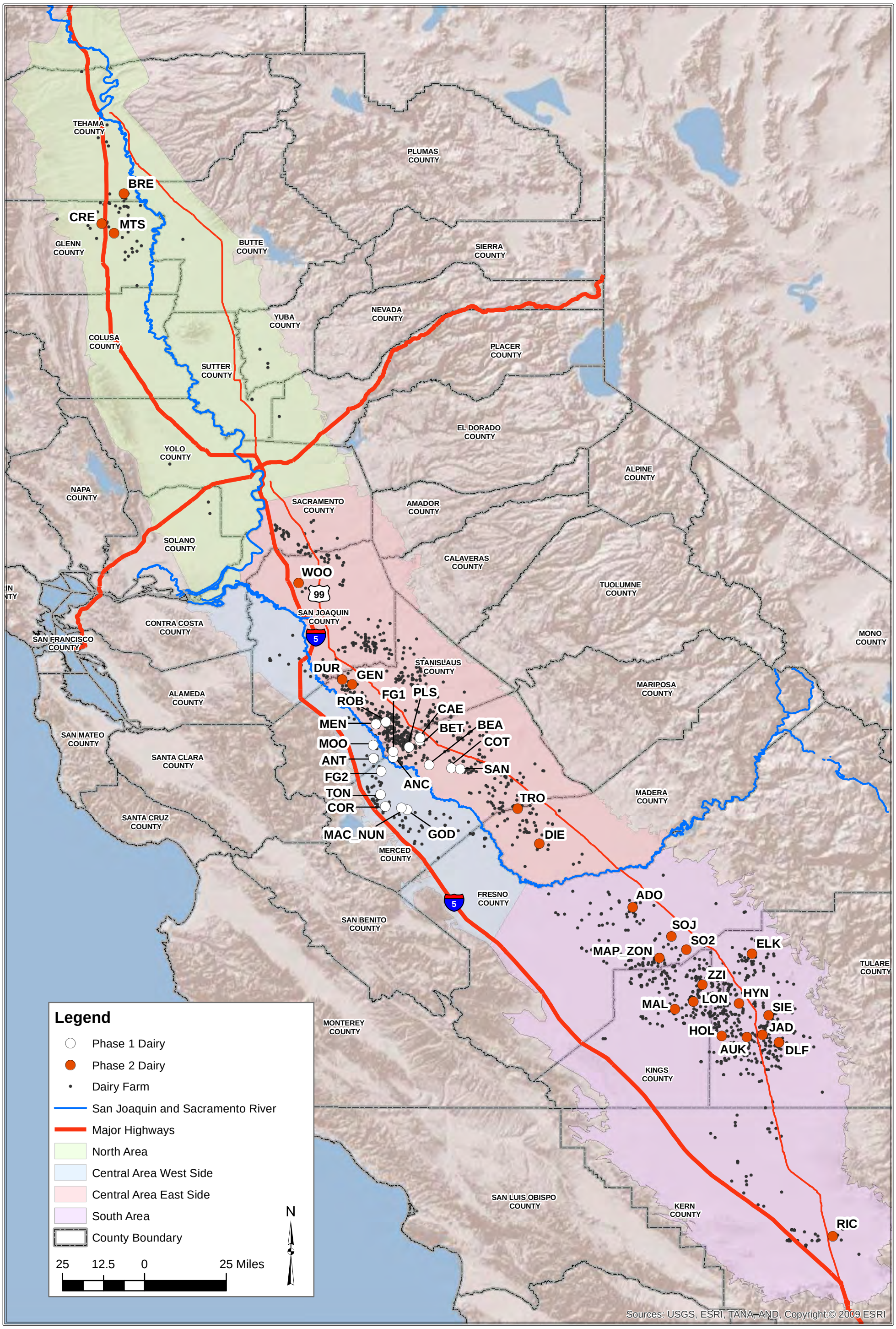
tbd (to be determined), na (not applicable, i.e., pertinent managagement unit is not monitored)

(1) Soil categories are intended to broadly group predominantly sandy soils of high permeability, predominantly clayey soils of low permeability, and intermediate soils. Loams may occur in all categories.

(2) Sudan, triticale, sorghum, milo, barley, rye.

(3) Includes (a) ponds constructed in compliance with CCR, Title 27, which proscribes ponds to be lined with or underlain by soils that contain at least 10% clay and not more than 10% gravel, including ponds with partial clay liners and ponds without constructed clay liners, and (b) ponds constructed as earthen pits without consideration of soil texture.

(4) Two check marks indicate chief water source.



Clerical\2012\12-019\Data\GIS\Jeanette\Figure 1 Location Map of Monitored RMP Dairies CVDRMP20130503.mxd

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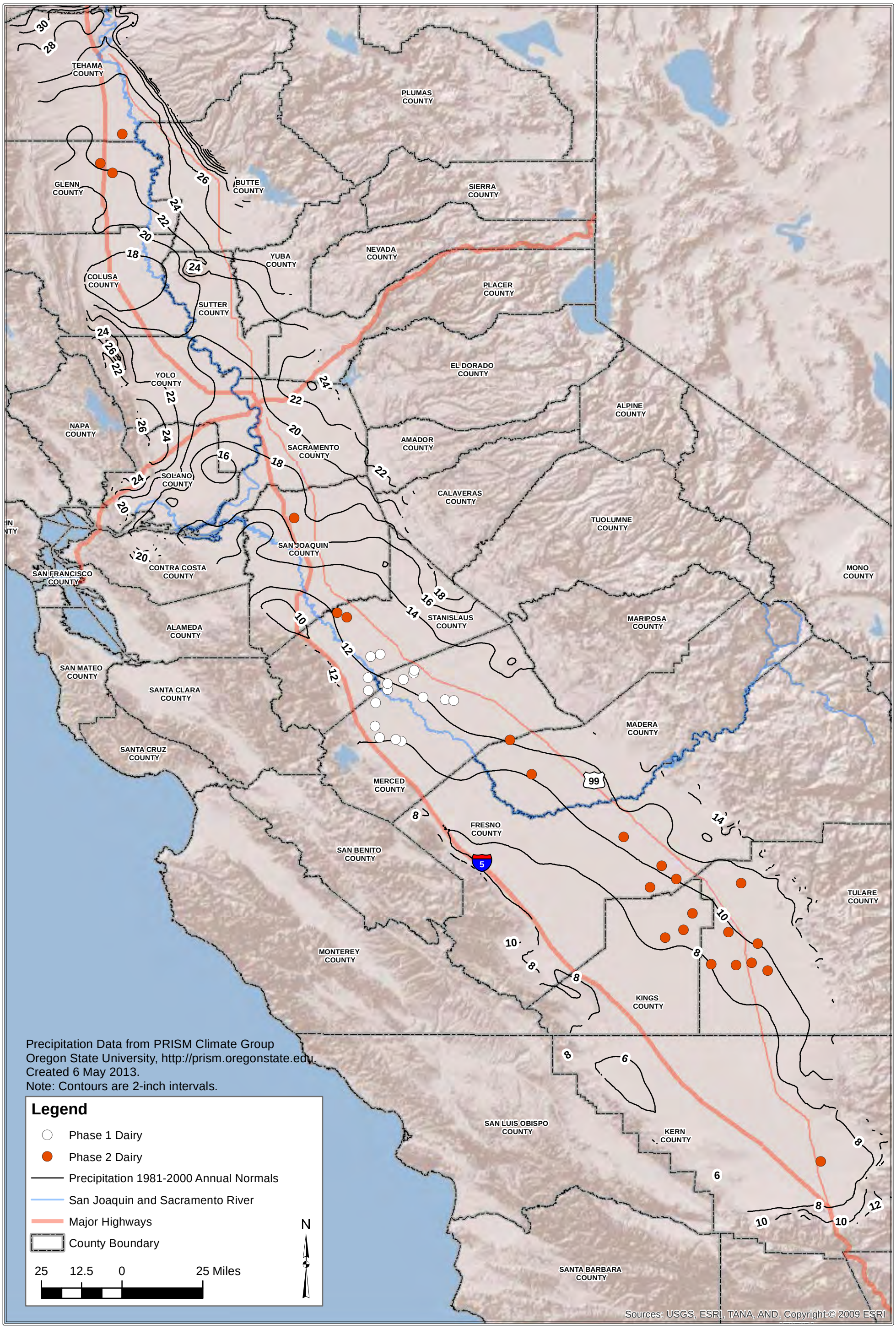
Figure 1
Location Map of Monitored RMP Dairies
Central Valley Dairy Representative Monitoring Program



Clerical\2012\12-019\Data\GIS\Jeanette\Figure 2 Isohyetal Contour Map20130506.mxd

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Figure 2
Isohyetal Contour Map for California's Central Valley
Central Valley Dairy Representative Monitoring Program

Map Series

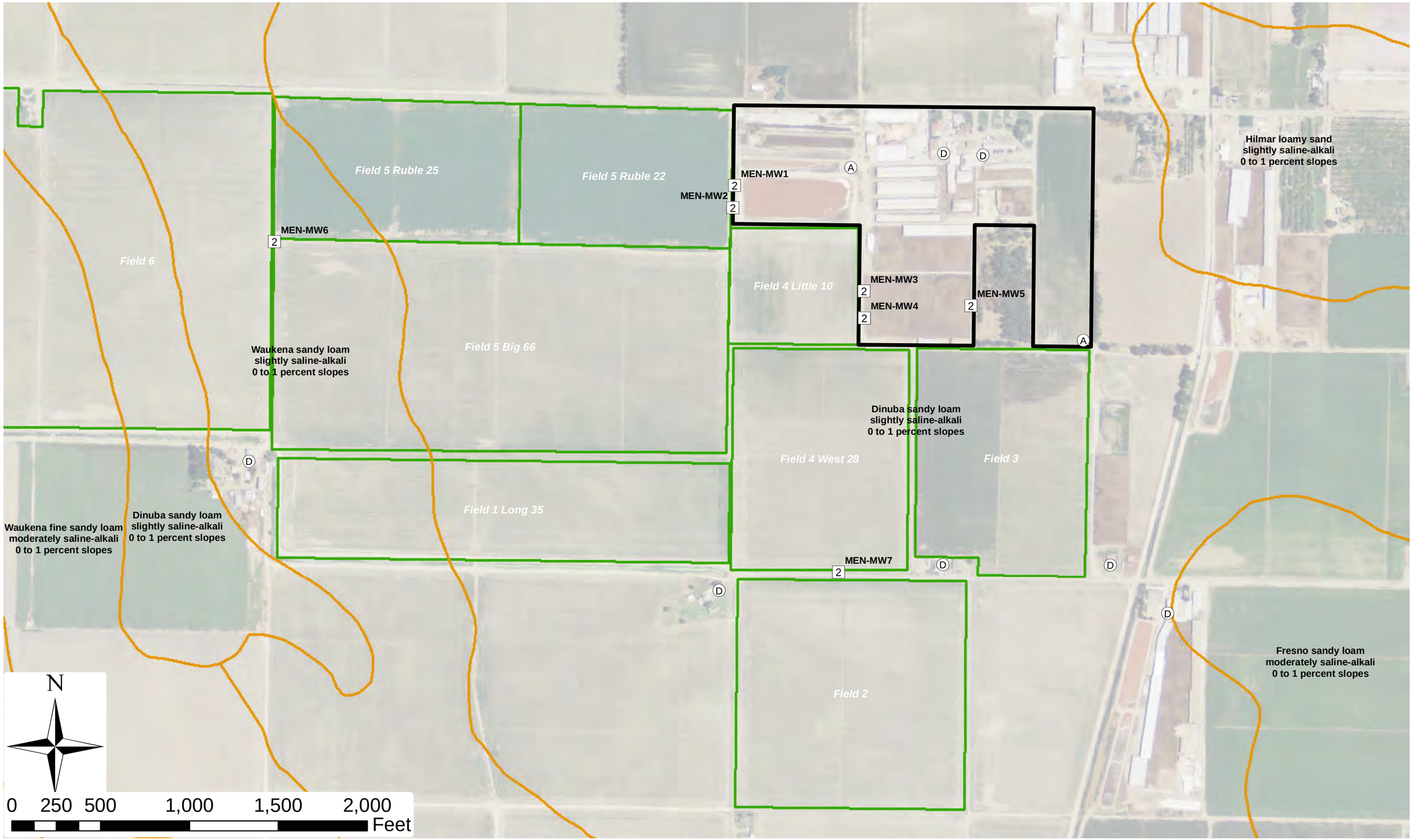
Dairy Production Area, Fields, Wells, and Soil Characteristics (NRCS – SSURGO)

- Central Area | East Side: MEN, ANC, BET, DIE, DUR, FG1, BEA, COT, SAN, GEN, TRO, PLS, CAE, ROB, WOO
- Central Area | West Side: ANT, COR, FG2, GOD, MAC and NUN, MOO, TON
- North Area: BRE, CRE, MTS
- South Area: AUK, DLF, ELK, ZZI, HOL, HYN, JAD, LON, ADO, MAL, MAP and ZON, RIC, SIE, SO2, SOJ

Legend

- Installed 1-Pipe Monitoring Well
- Installed 2-Pipe Monitoring Well
- Pre-Existing 1-Pipe Monitoring Well
- Pre-Existing 2-Pipe Monitoring Well
- Pre-Existing 3-Pipe Monitoring Well
- Ag Well
- Domestic Well
- Unknown Type Well
- Dairy Production Area
- Soil Characteristic Units
- Box, Irrigation Control
- Box, Mixing
- Capped
- Drain
- Drop Box
- Flow Meter
- Flush Return Inlet Pipe
- Mechanical Separator
- Microjet Irrigation Filter & Pump
- Pump
- Pump, Floating
- Pump, Portable
- Pump, Tailwater
- Pump, Tile Drain
- Pump, Wastewater
- Stand Pipe
- TID Inlet
- Tank, Flush
- Tank, Water Storage
- Valve
- Berms/Levees
- Canal, Concrete
- Canal, Earthen
- Culvert
- Ditch, Concrete
- Ditch, Concrete - Community
- Ditch, Earthen
- Ditch, Earthen - Community
- Flow Direction, Irrigation Flow
- Flow Direction, Surface Drainage
- Flow Direction, Tailwater Flow
- Pipeline, Freshwater
- Pipeline, Irrigation
- Pipeline, Tailwater
- Pipeline, Tailwater/Tile Drain
- Pipeline, Tile Drain
- Pipeline, Wastewater
- Setback/Physical Barrier
- Animal Housing/Shade
- Calf Barn
- Calf Hutches
- Milk Barn
- Corral
- Hay Barn
- Commodity Barn
- Shed/Shop
- Other Structure
- Feed Storage (Roofed)
- Feed Storage (on Concrete)
- Feed Storage (on Earth)
- Field
- Field, Tiled
- Earthen Tailwater Pond
- Dry Scrape Alley
- Manure Stacking Area (on Concrete)
- Manure Stacking Area (on Earth)
- Solids Settling Basin
- Flush Lane
- Liquid Manure Storage
- Earthen Stacking Area
- Equipment Storage
- Concrete Processing Pit
- Concrete Sand Trap
- Digester
- Weir Box
- Waterbody

Central Area | East Side



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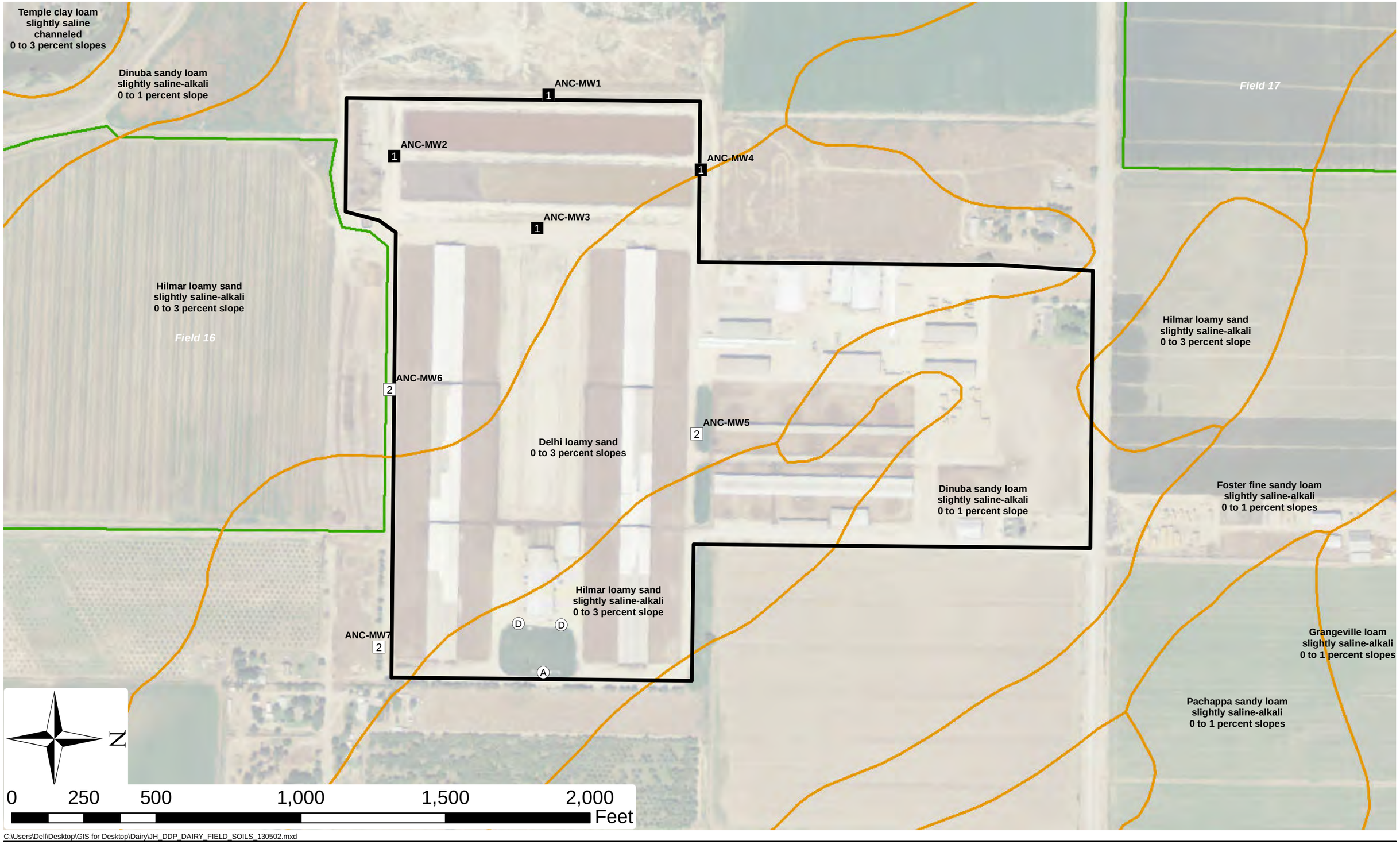
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
MEN
Central Valley Dairy Representative Monitoring Program



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
ANC
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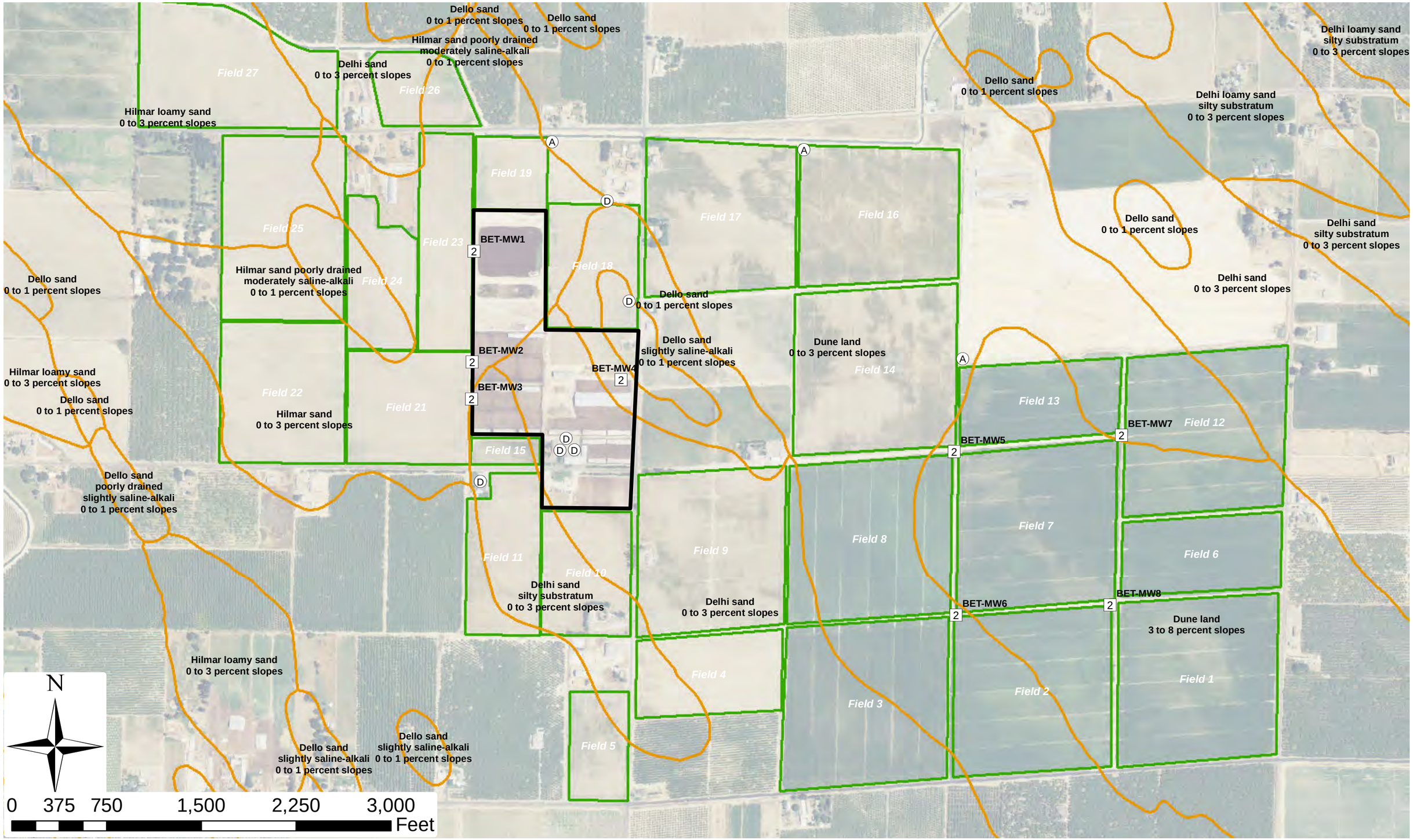

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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
BET
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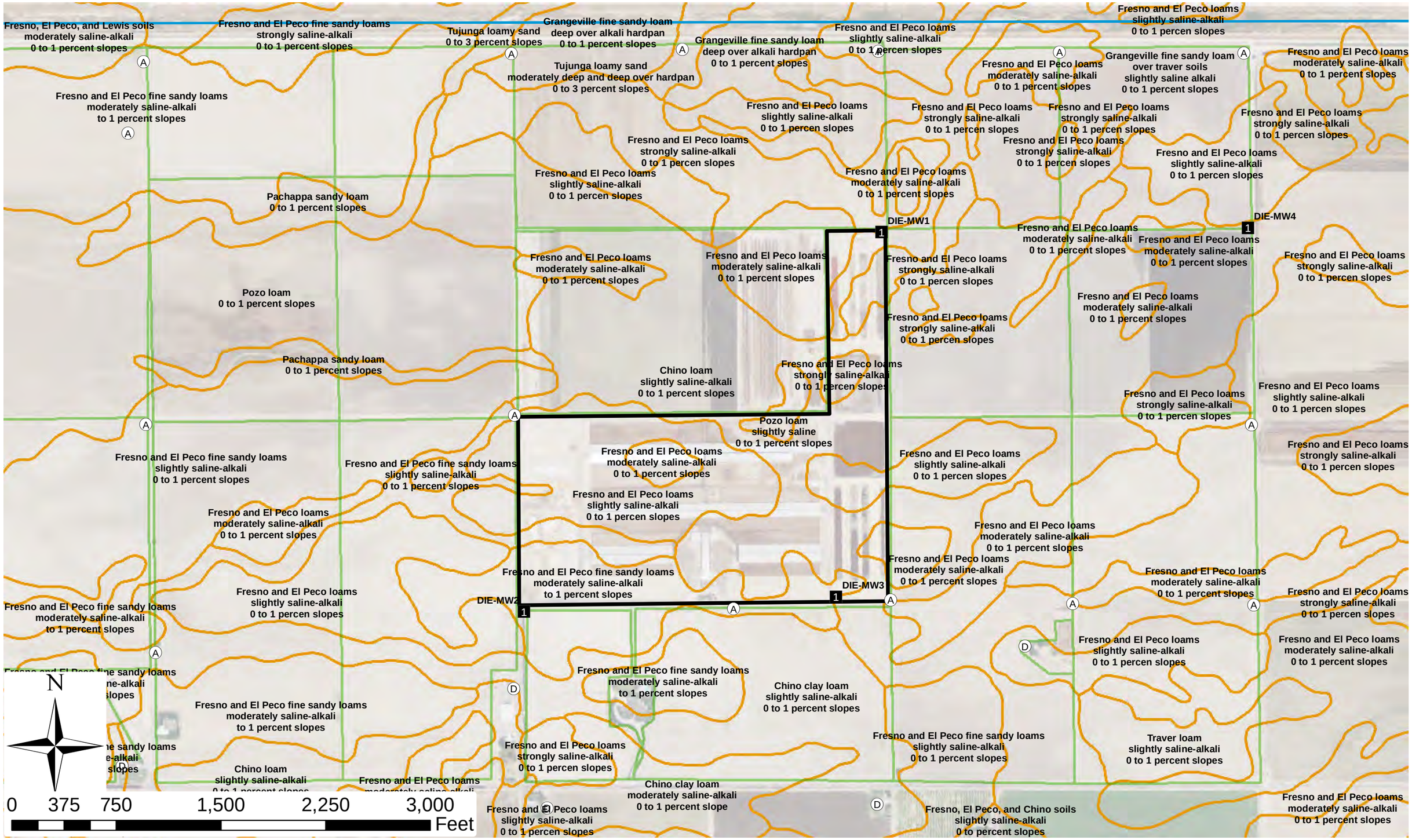

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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
DIE
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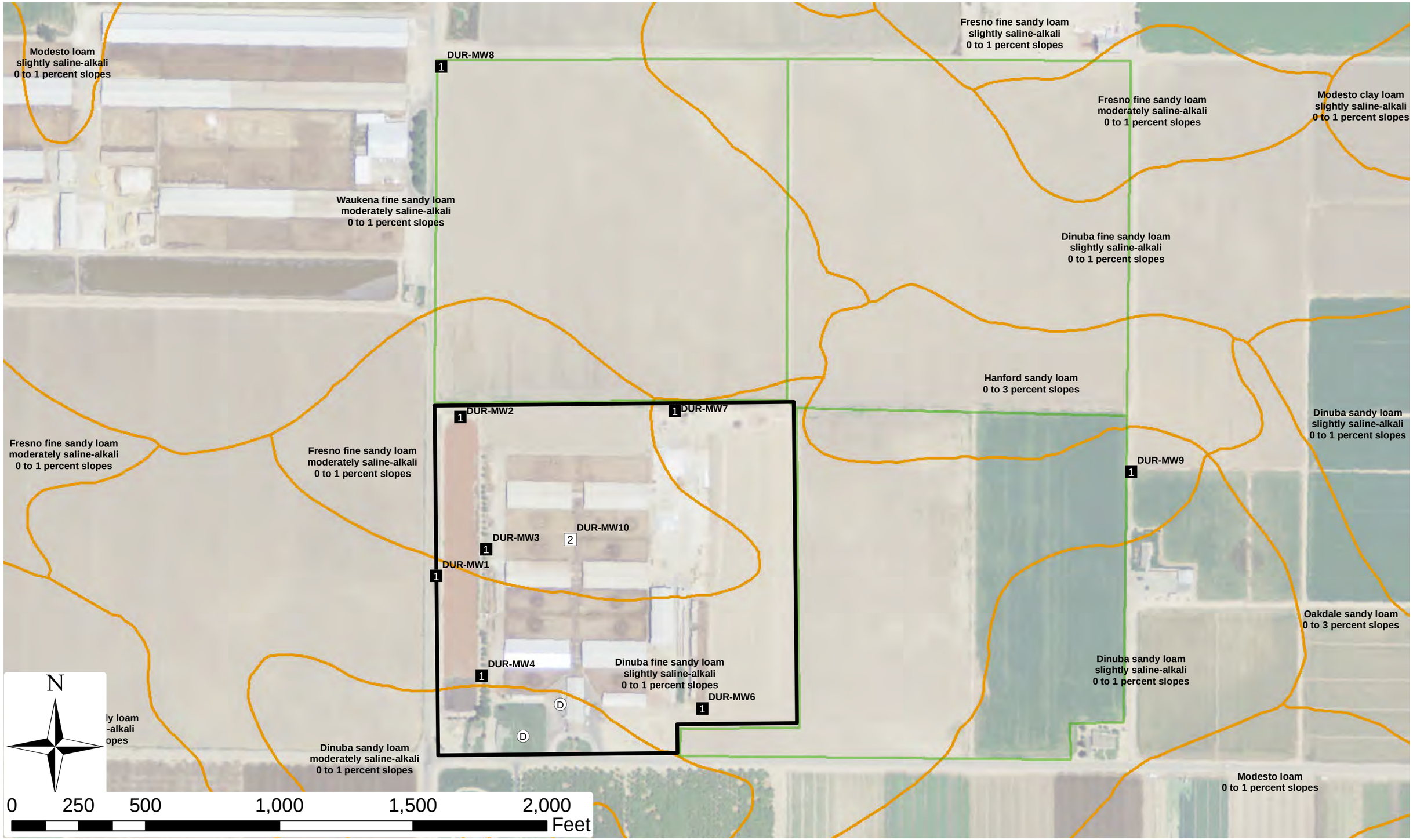

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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
DUR
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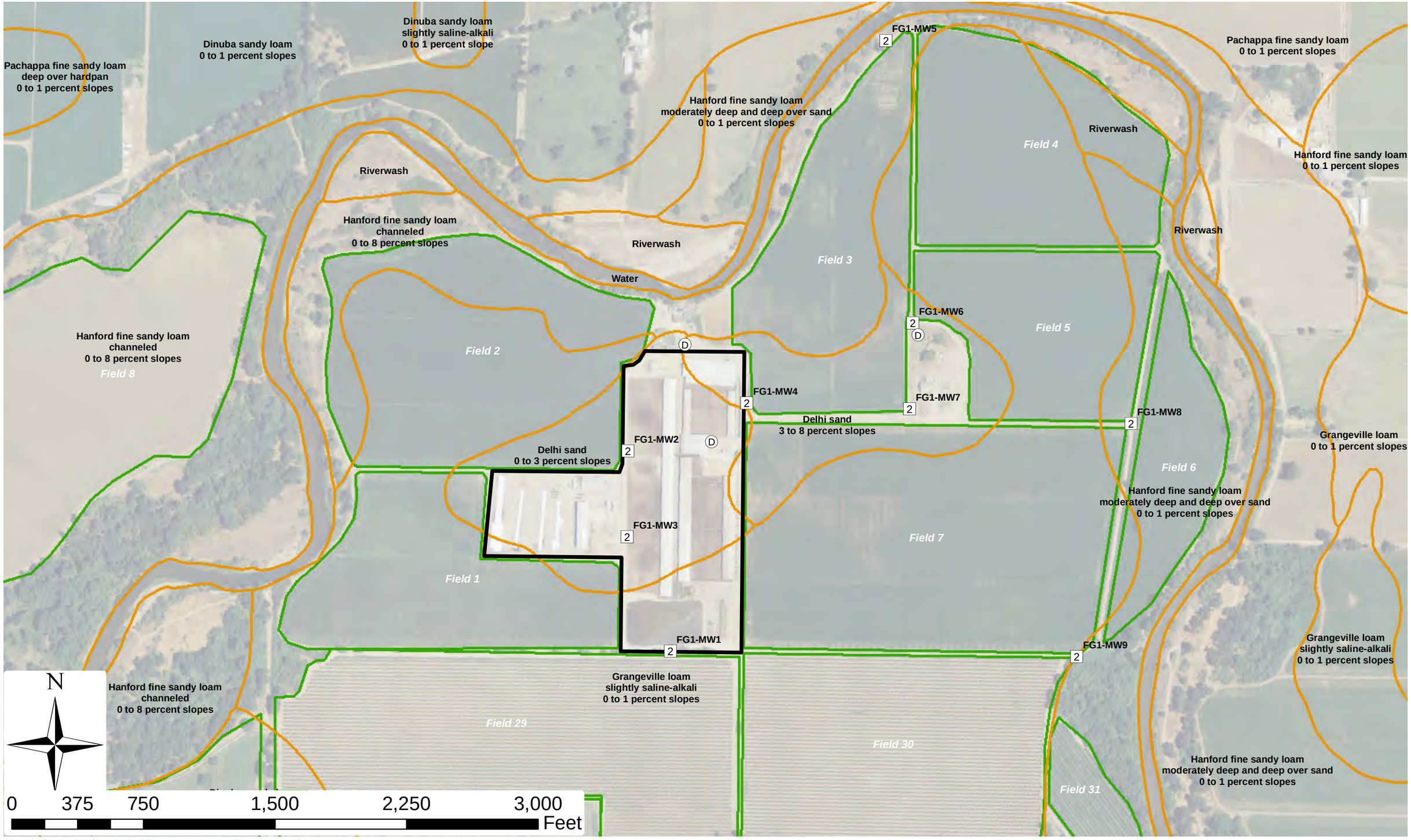

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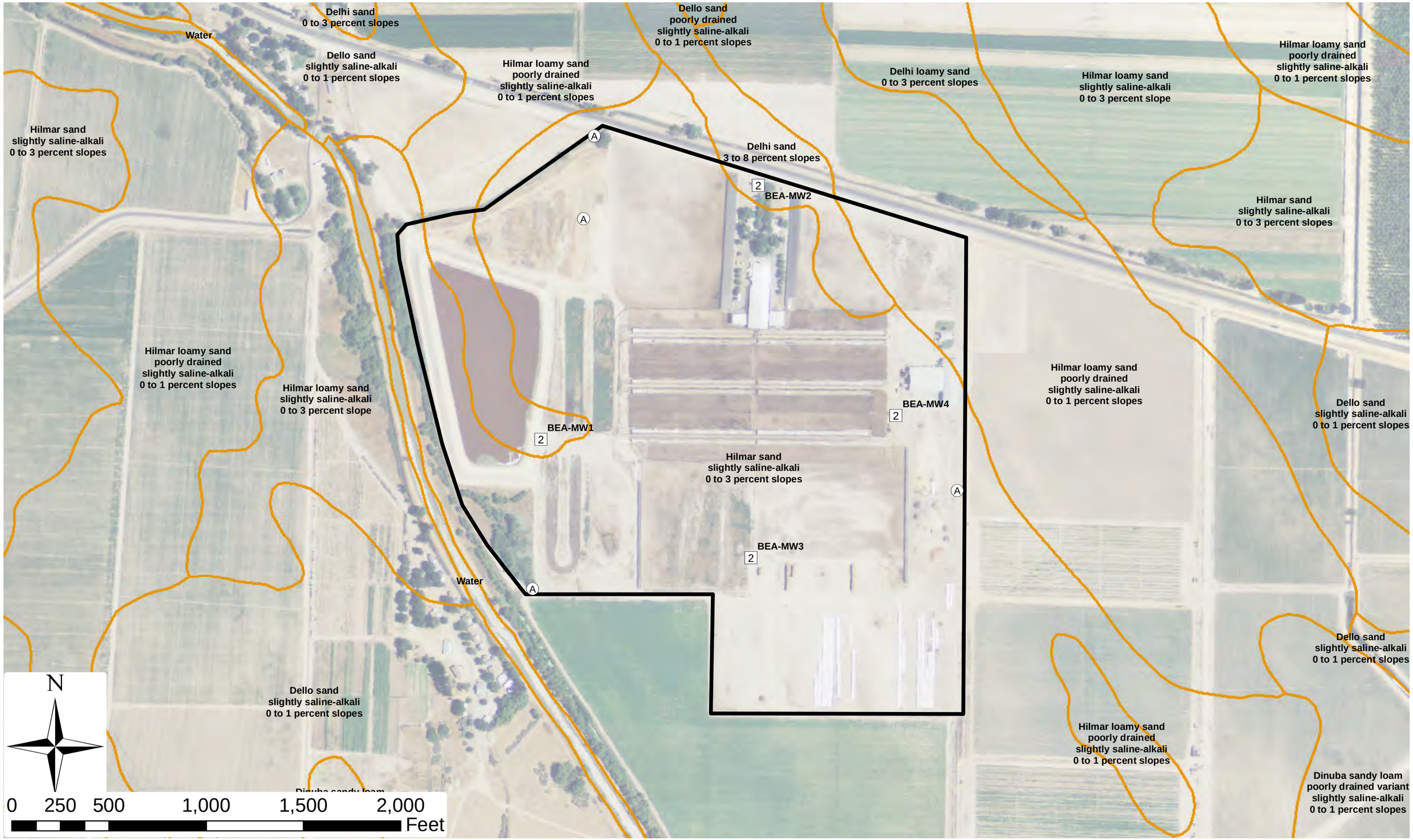
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
FG1
Central Valley Dairy Representative Monitoring Program



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
BEA
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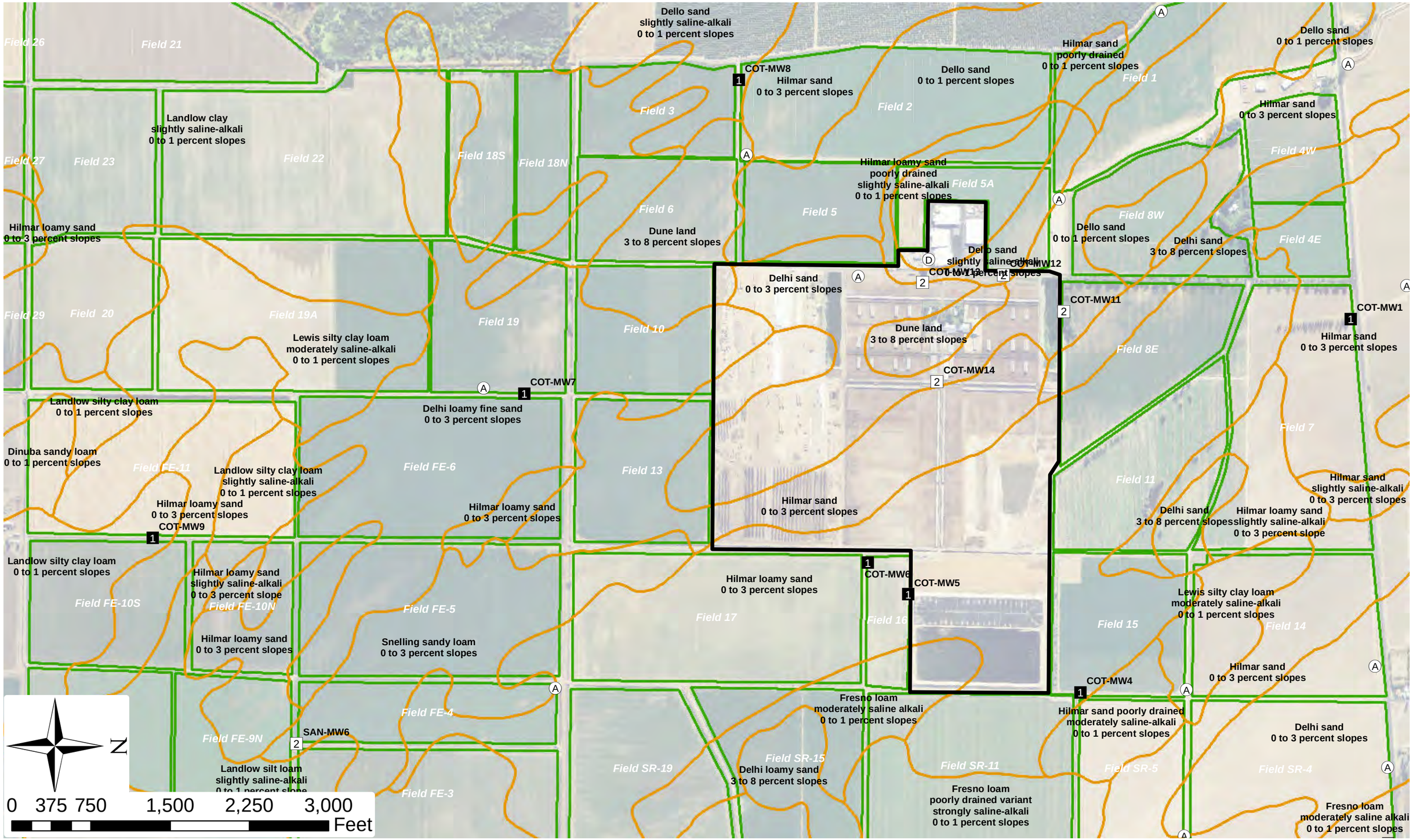

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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
COT
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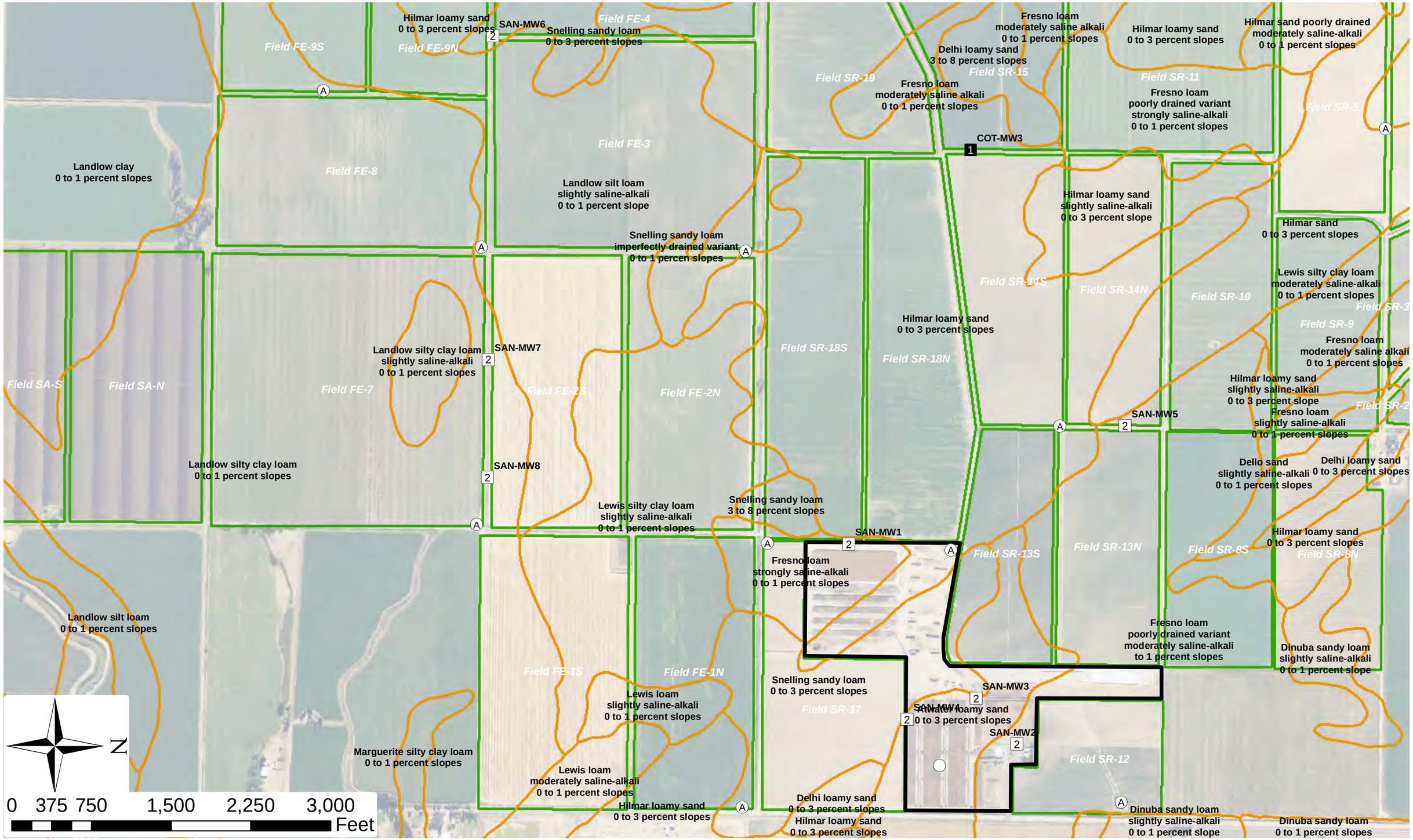

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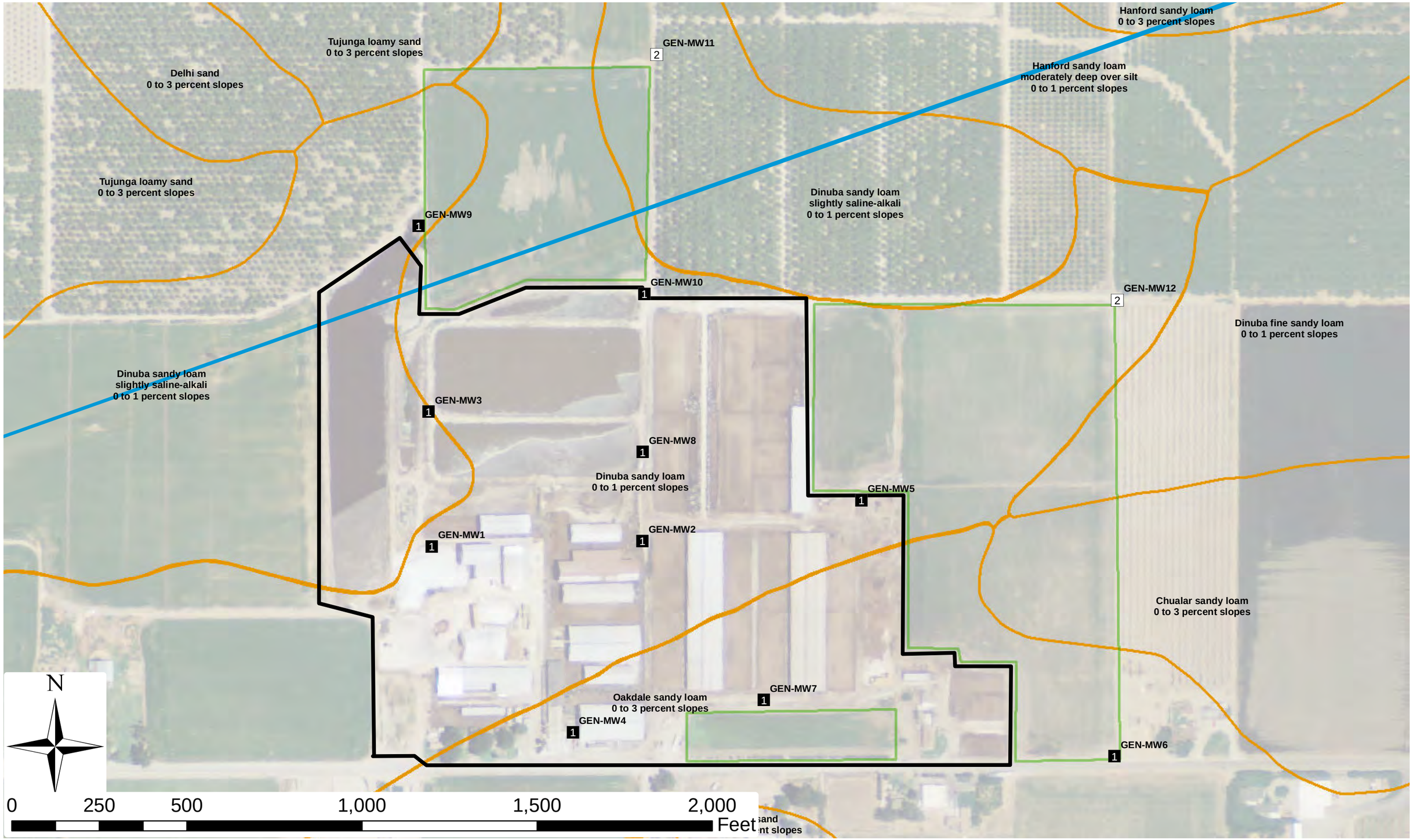
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
SAN
Central Valley Dairy Representative Monitoring Program



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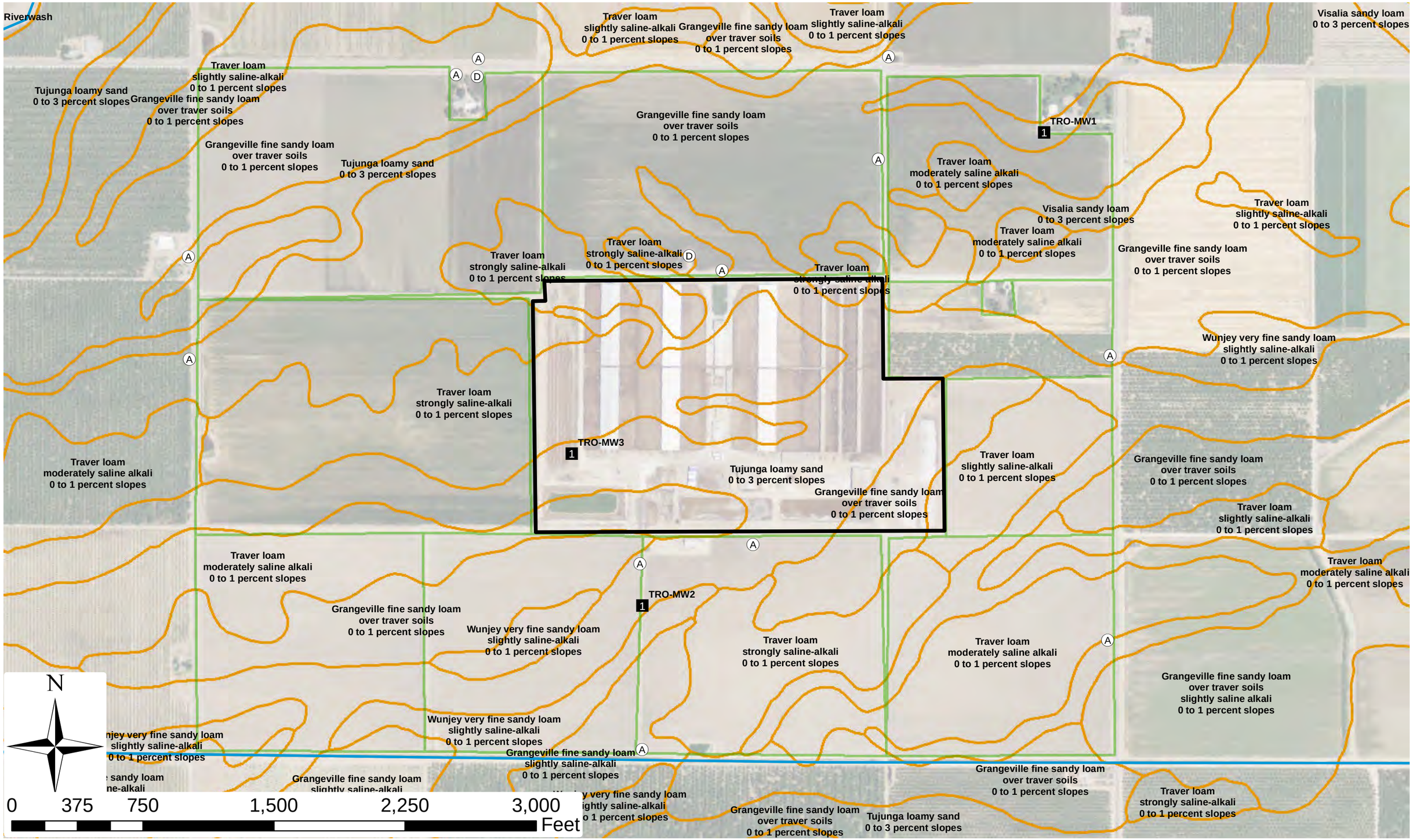
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
GEN
Central Valley Dairy Representative Monitoring Program



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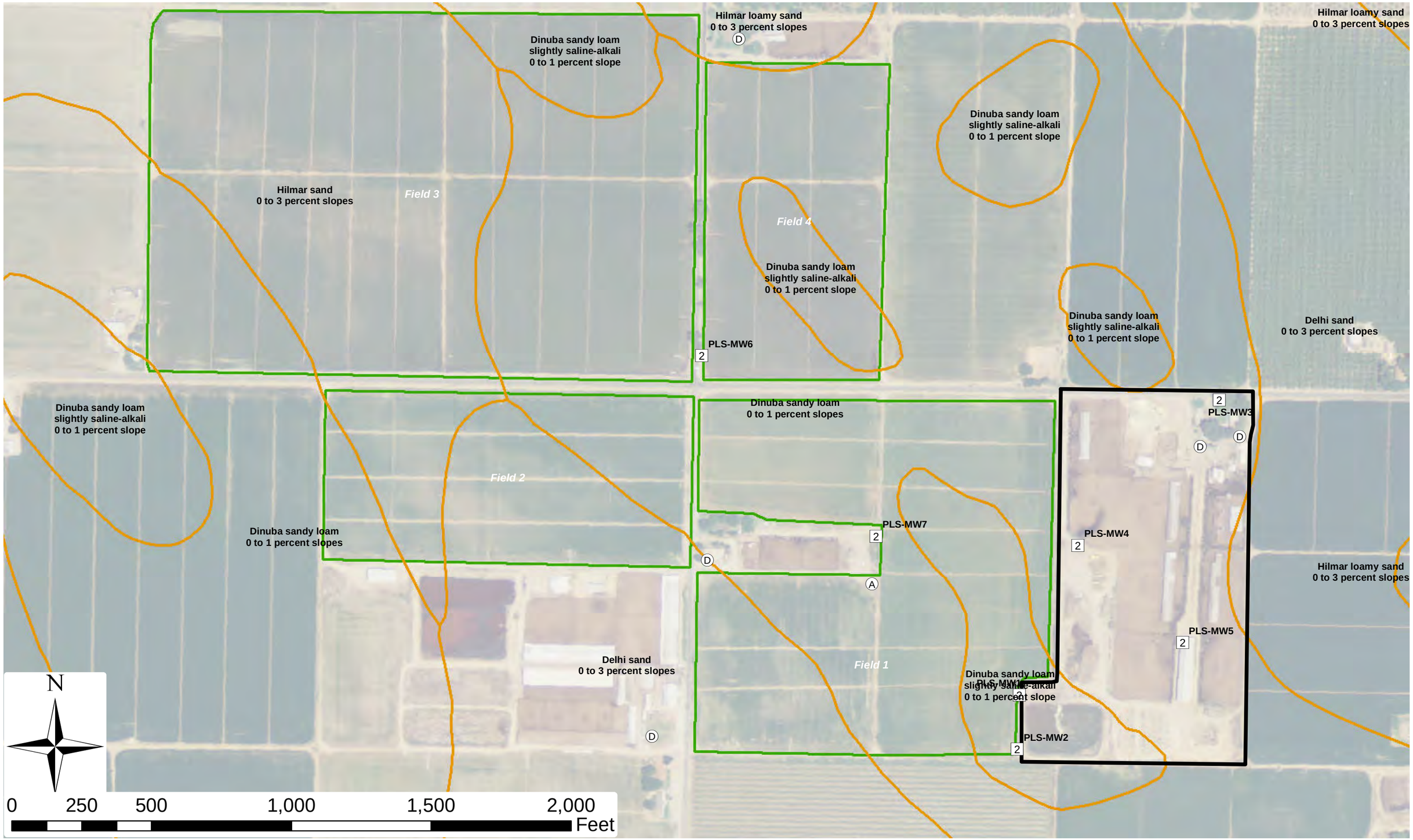
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
TRO
Central Valley Dairy Representative Monitoring Program



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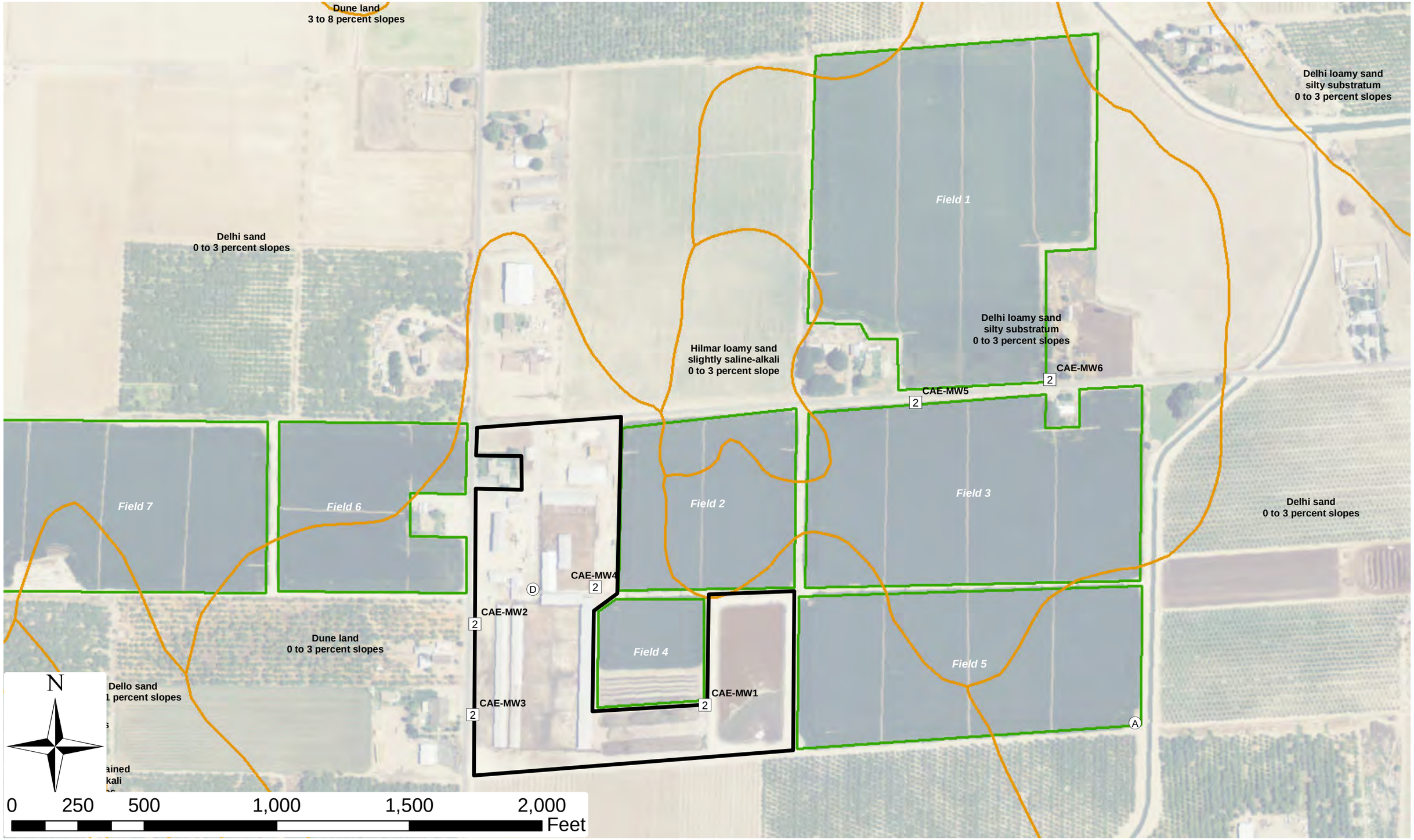
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
PLS
Central Valley Dairy Representative Monitoring Program



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
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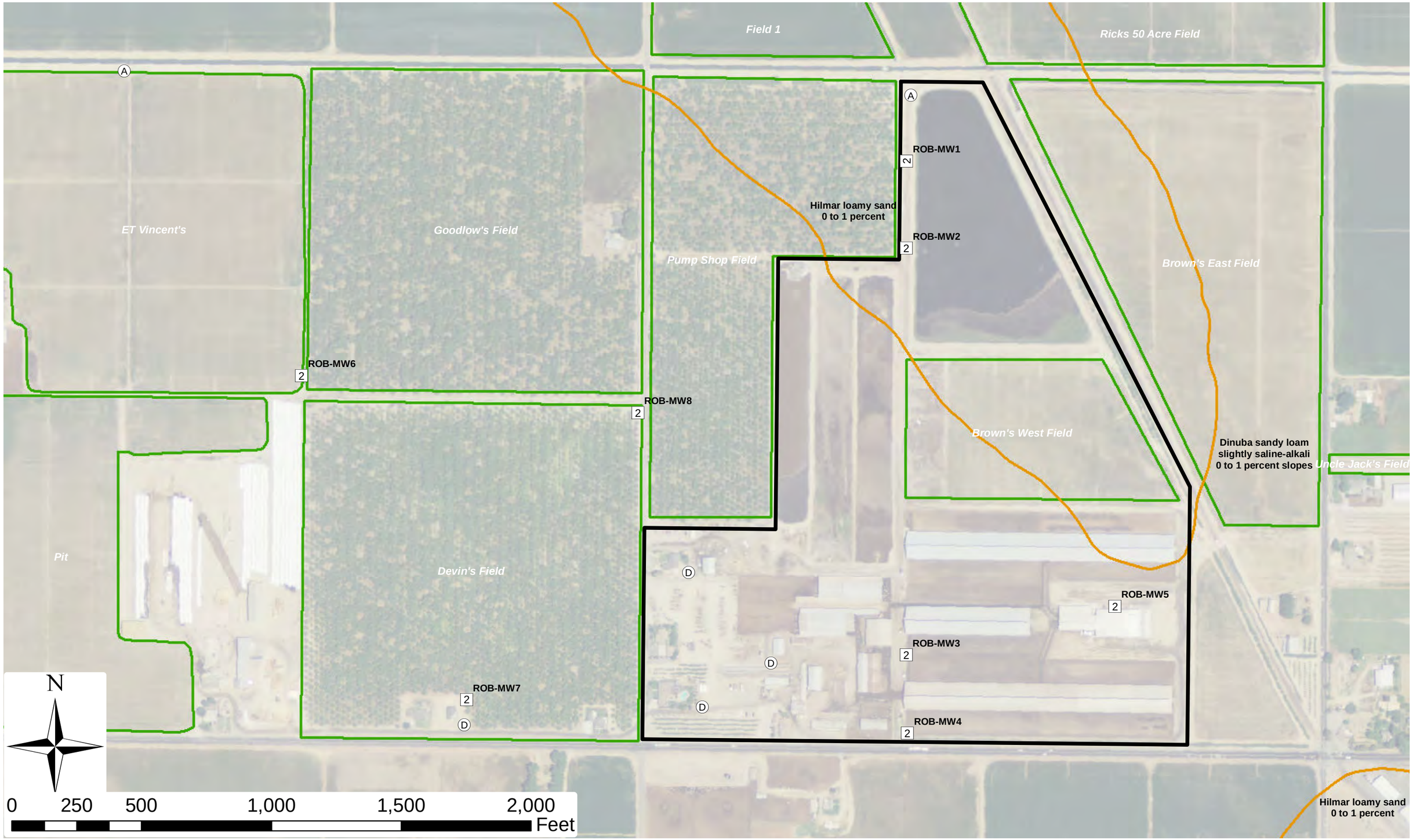
Central Valley Dairy Representative Monitoring Program



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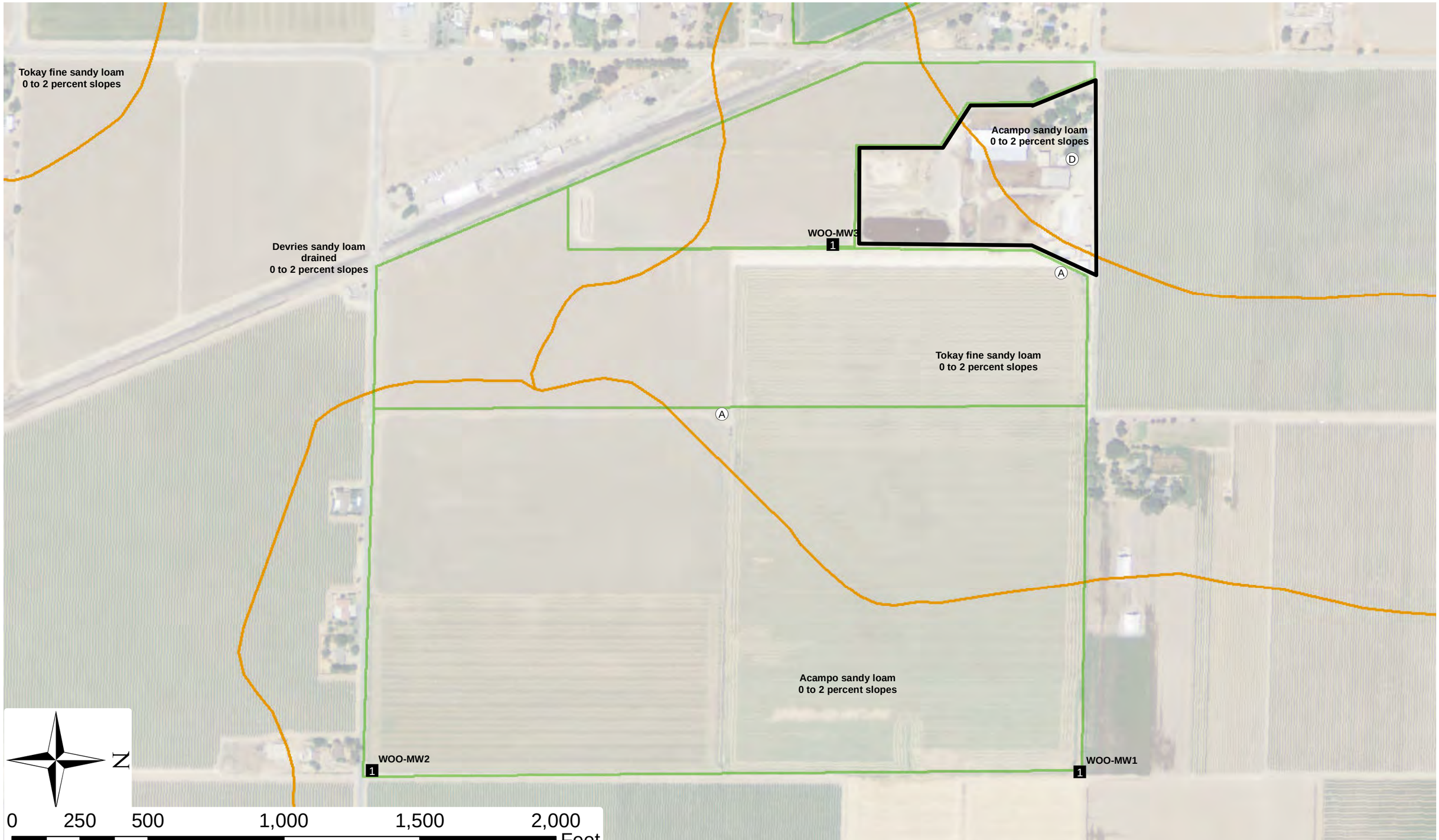
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
ROB
Central Valley Dairy Representative Monitoring Program



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
WOO
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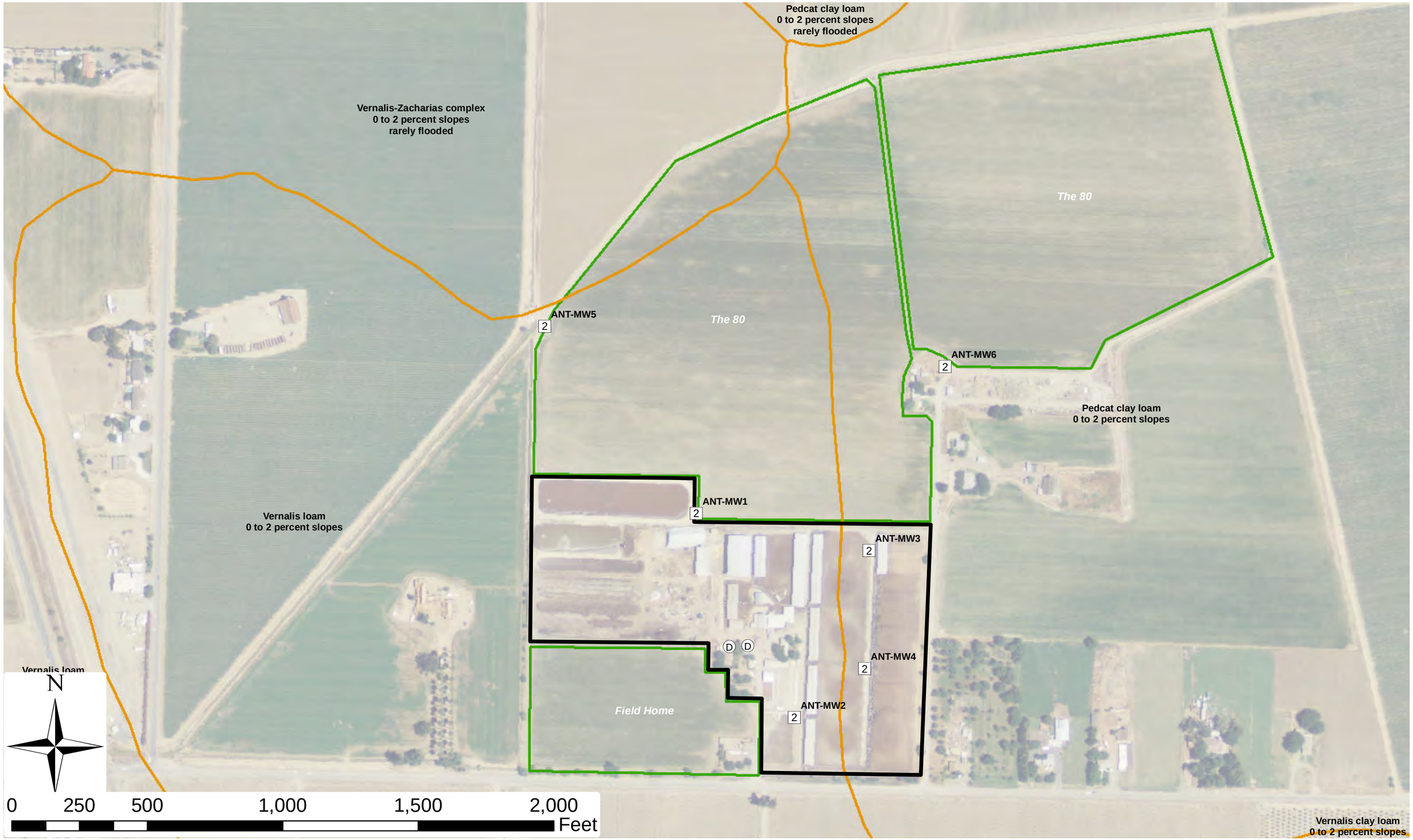
Central Area | West Side



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
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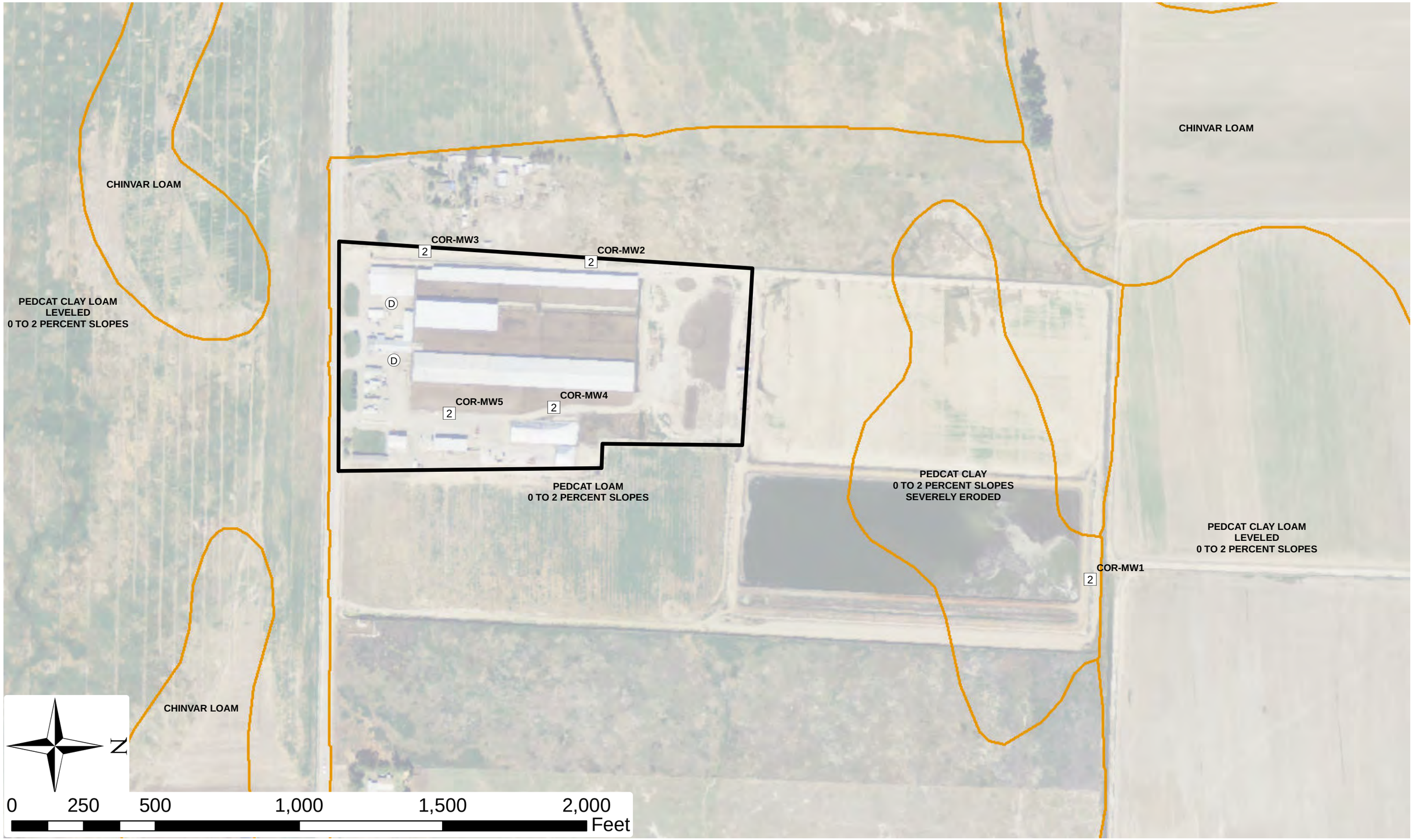

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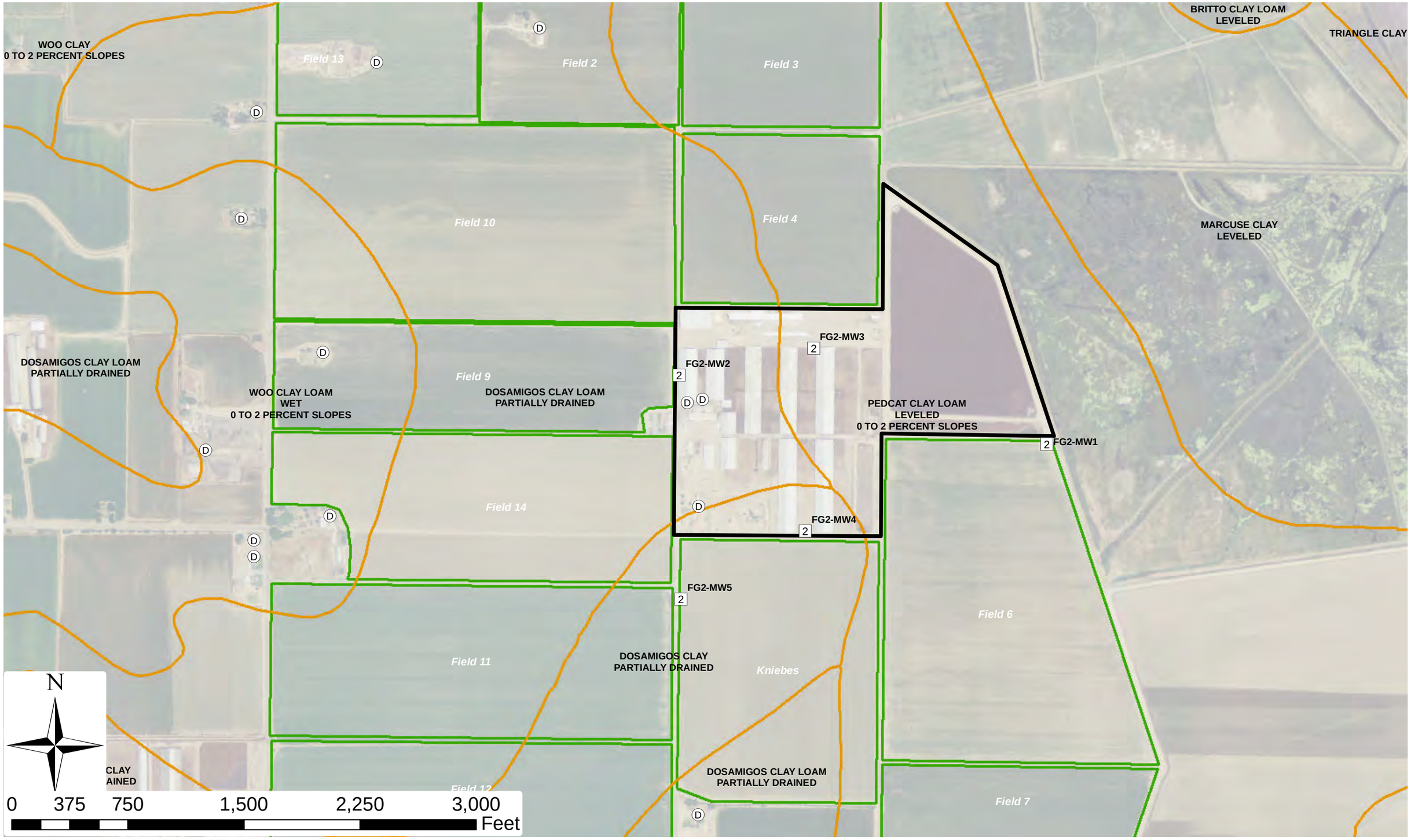
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
COR
Central Valley Dairy Representative Monitoring Program



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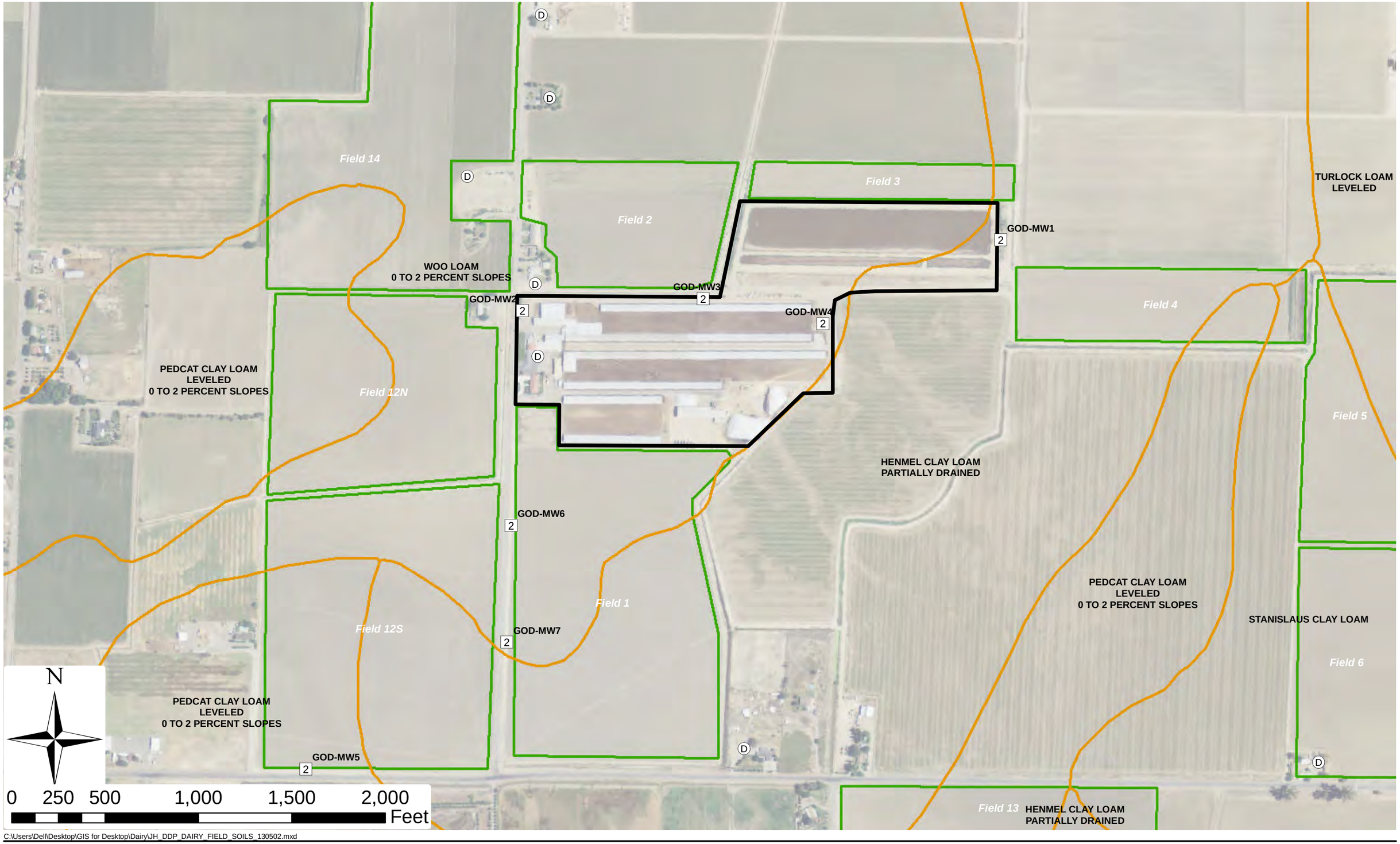
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
FG2
Central Valley Dairy Representative Monitoring Program



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
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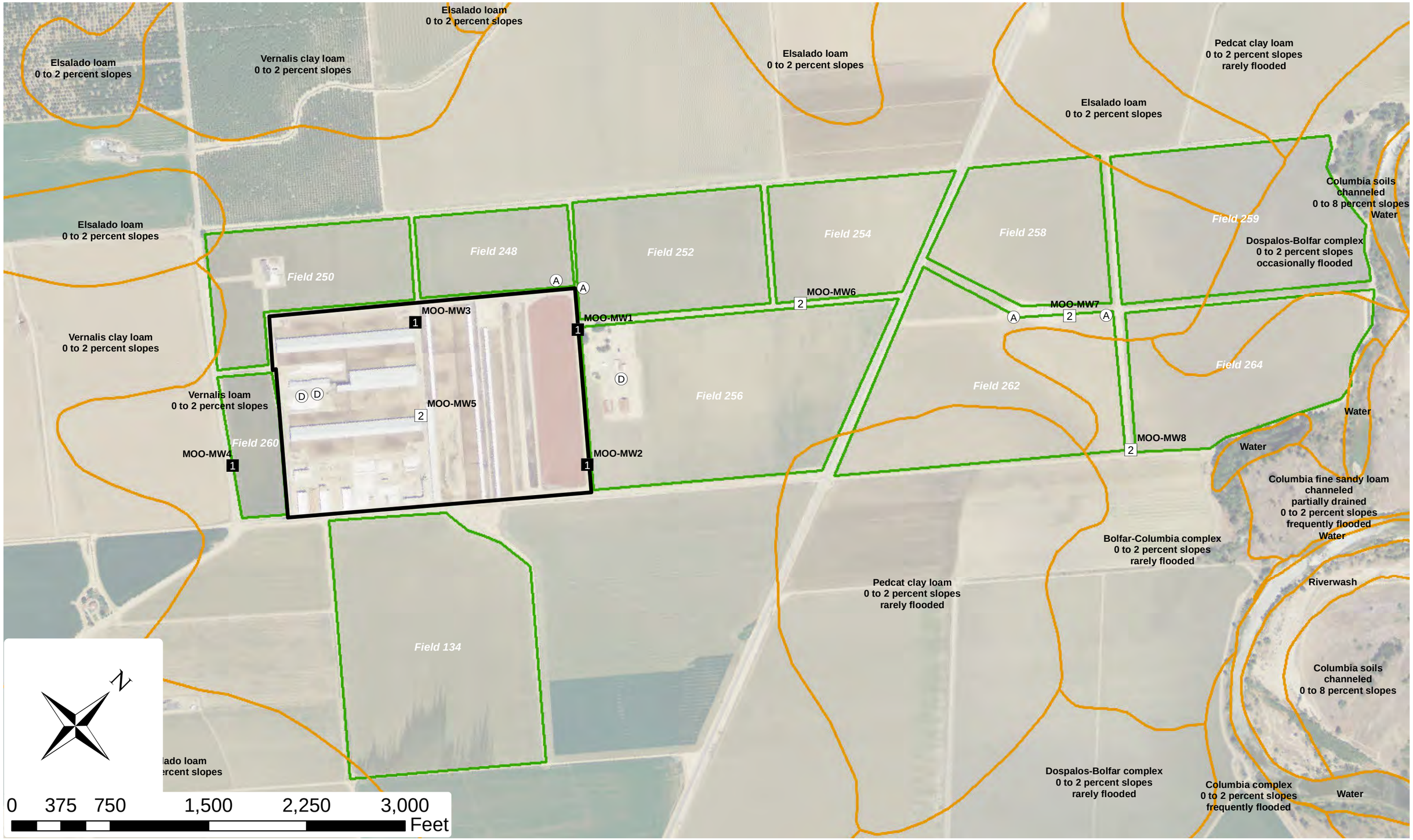
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
MAC/NUN
Central Valley Dairy Representative Monitoring Program



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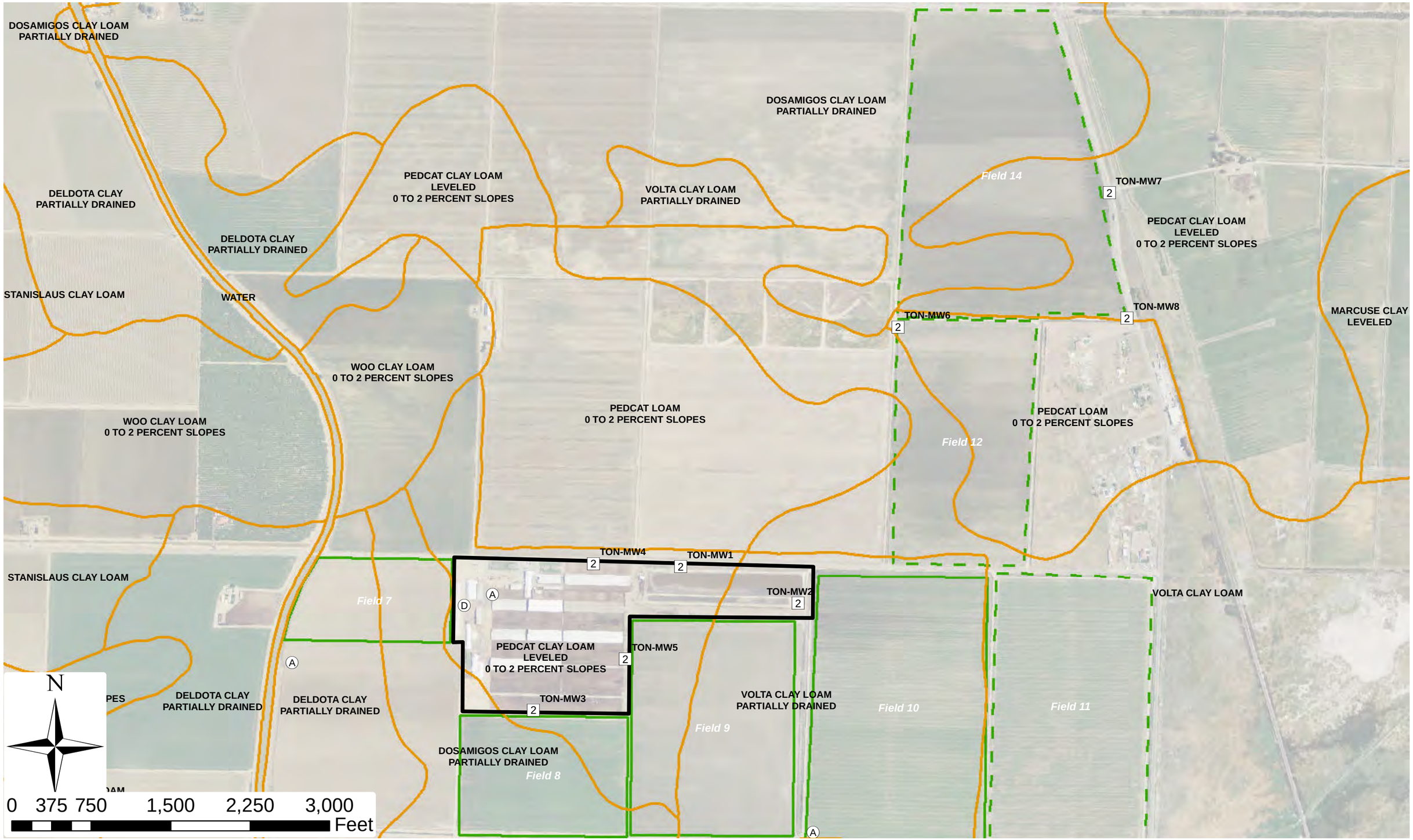
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
MOO
Central Valley Dairy Representative Monitoring Program



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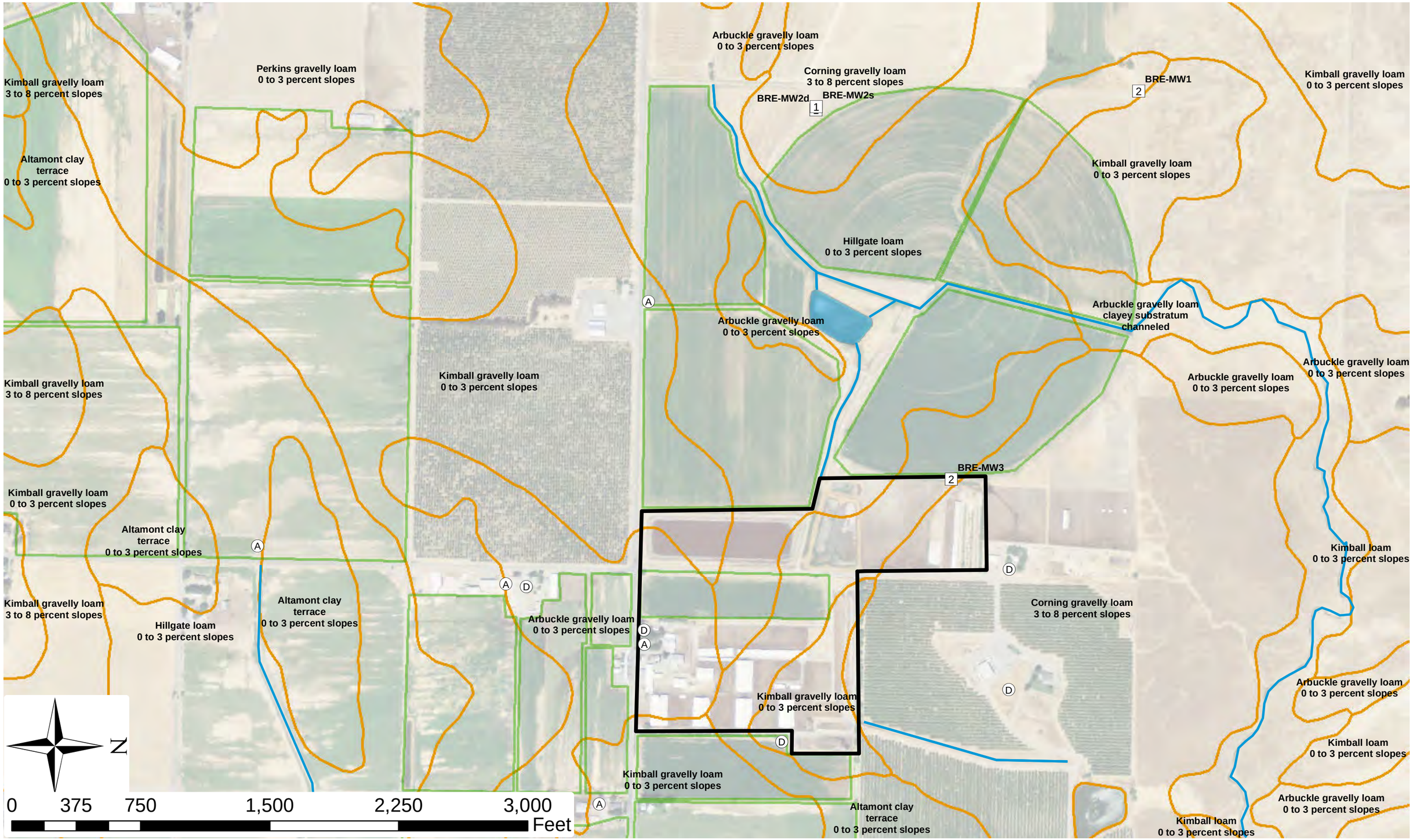
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
TON
Central Valley Dairy Representative Monitoring Program

North Area



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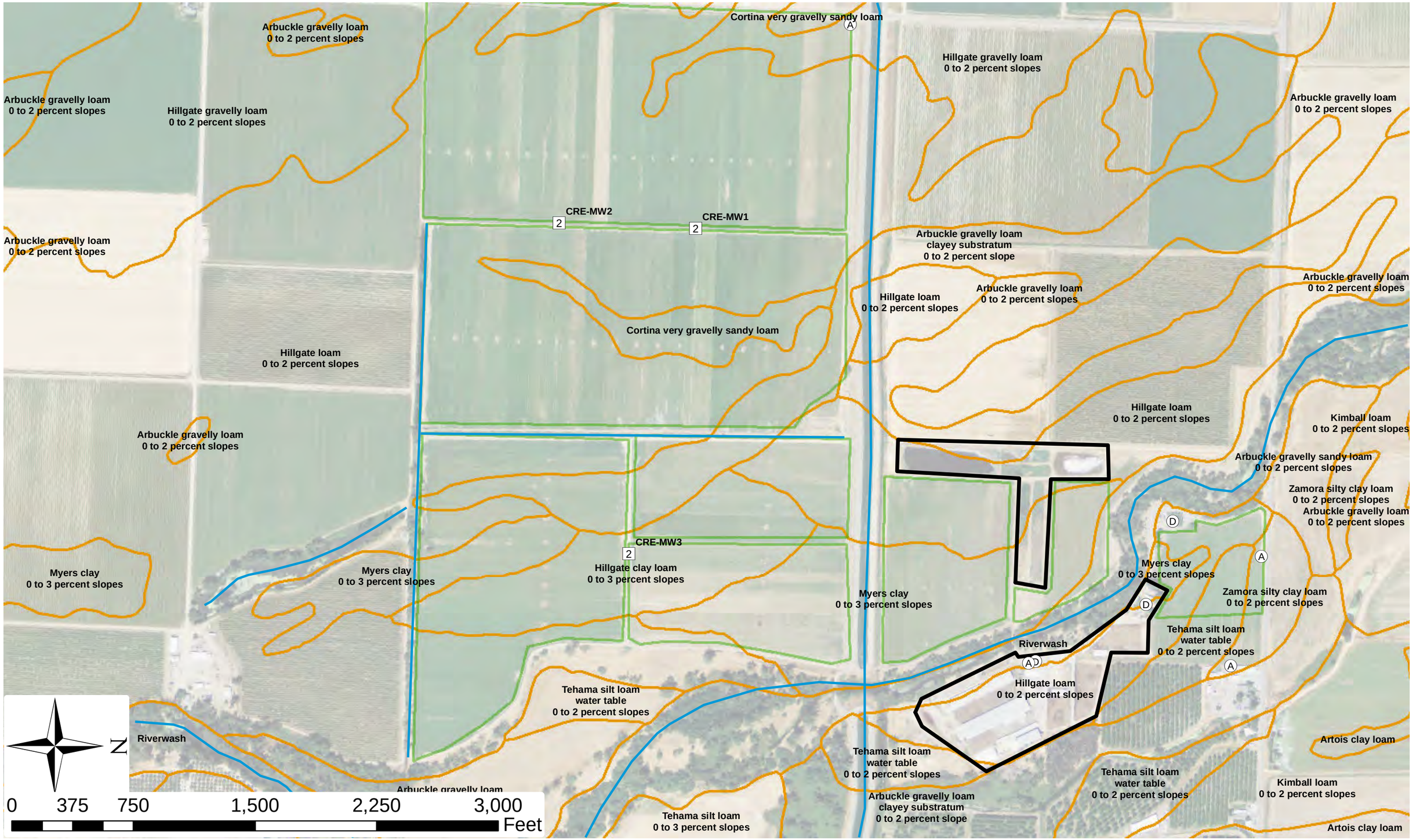
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
BRE
Central Valley Dairy Representative Monitoring Program



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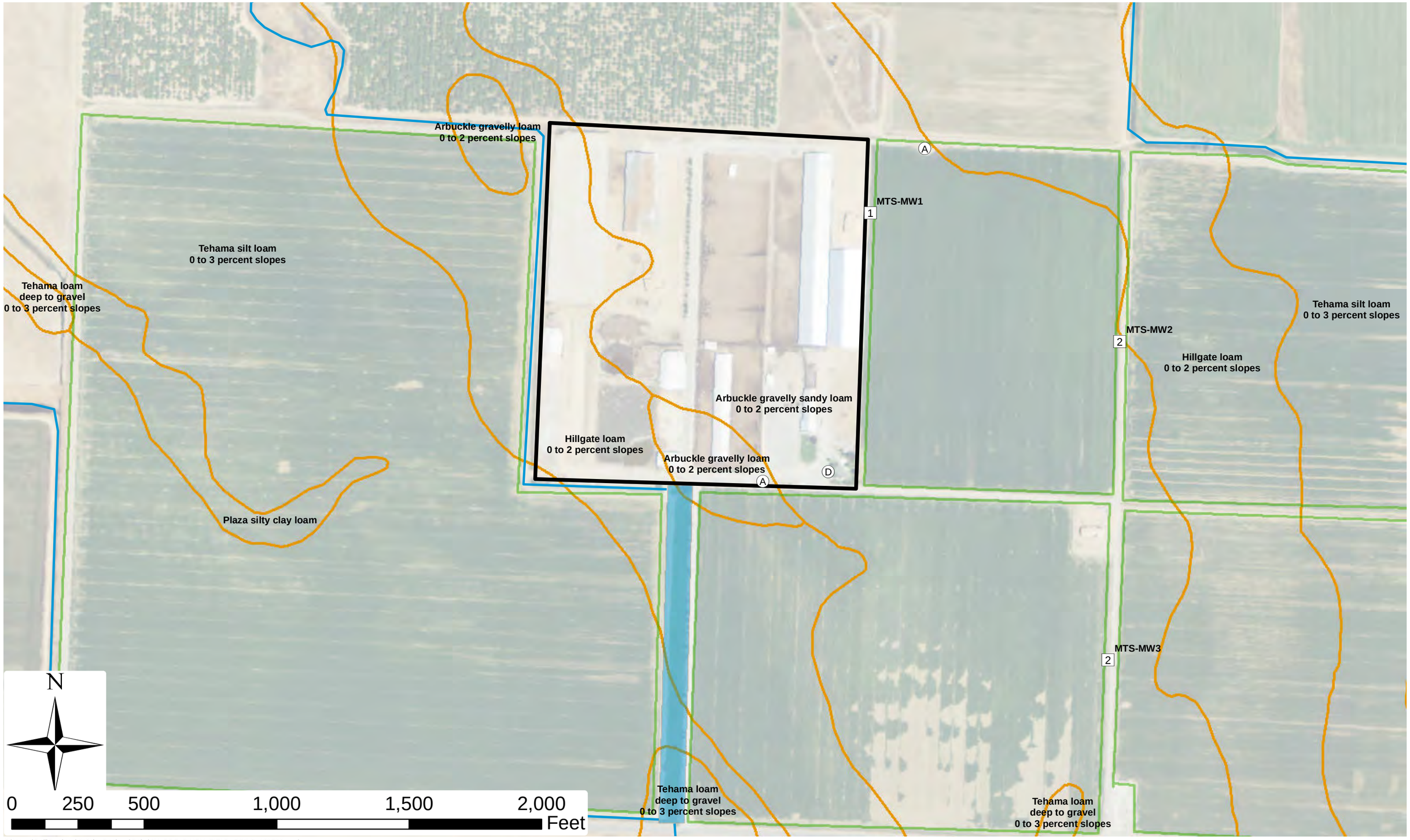
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
CRE
Central Valley Dairy Representative Monitoring Program



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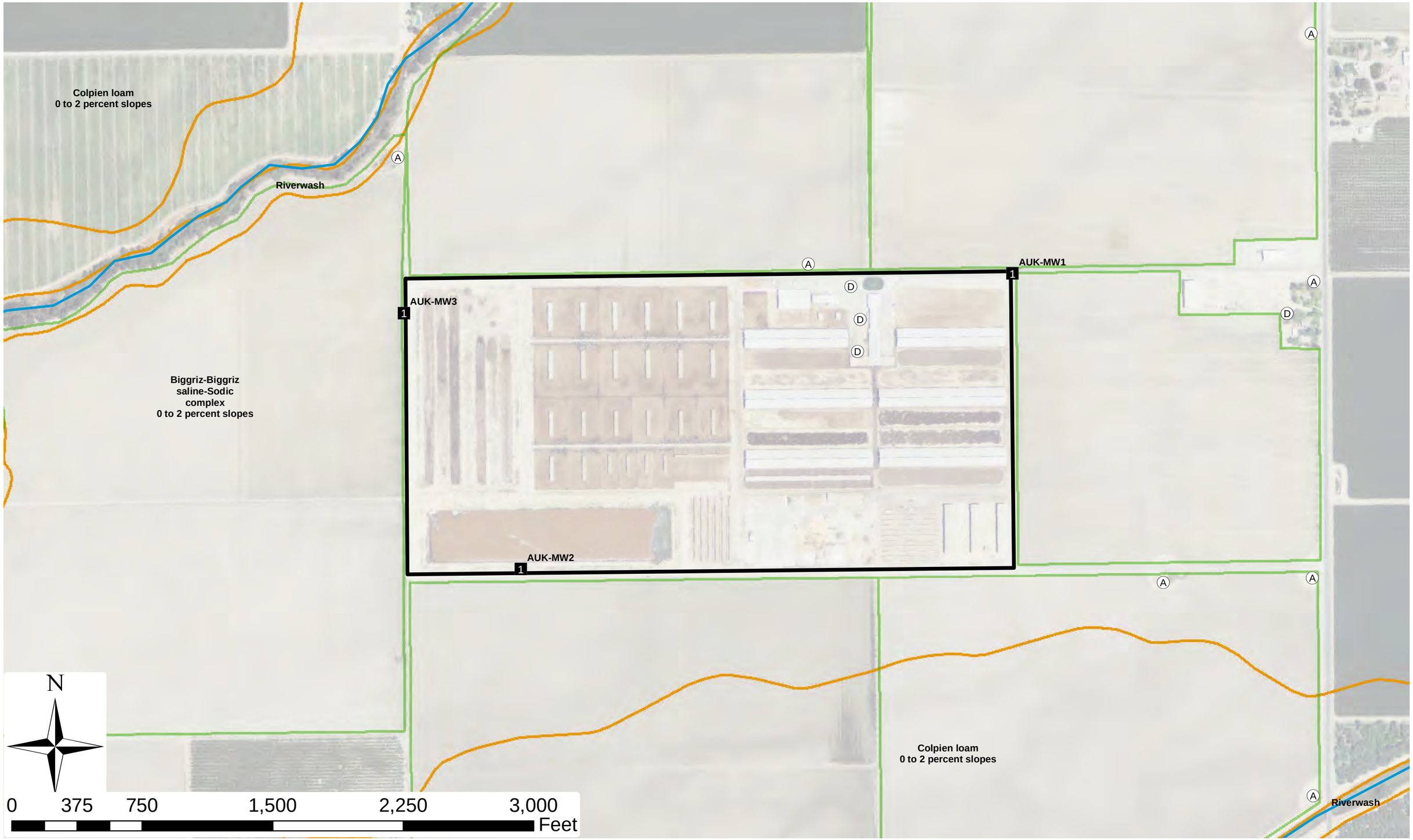
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
MTS
Central Valley Dairy Representative Monitoring Program

South Area



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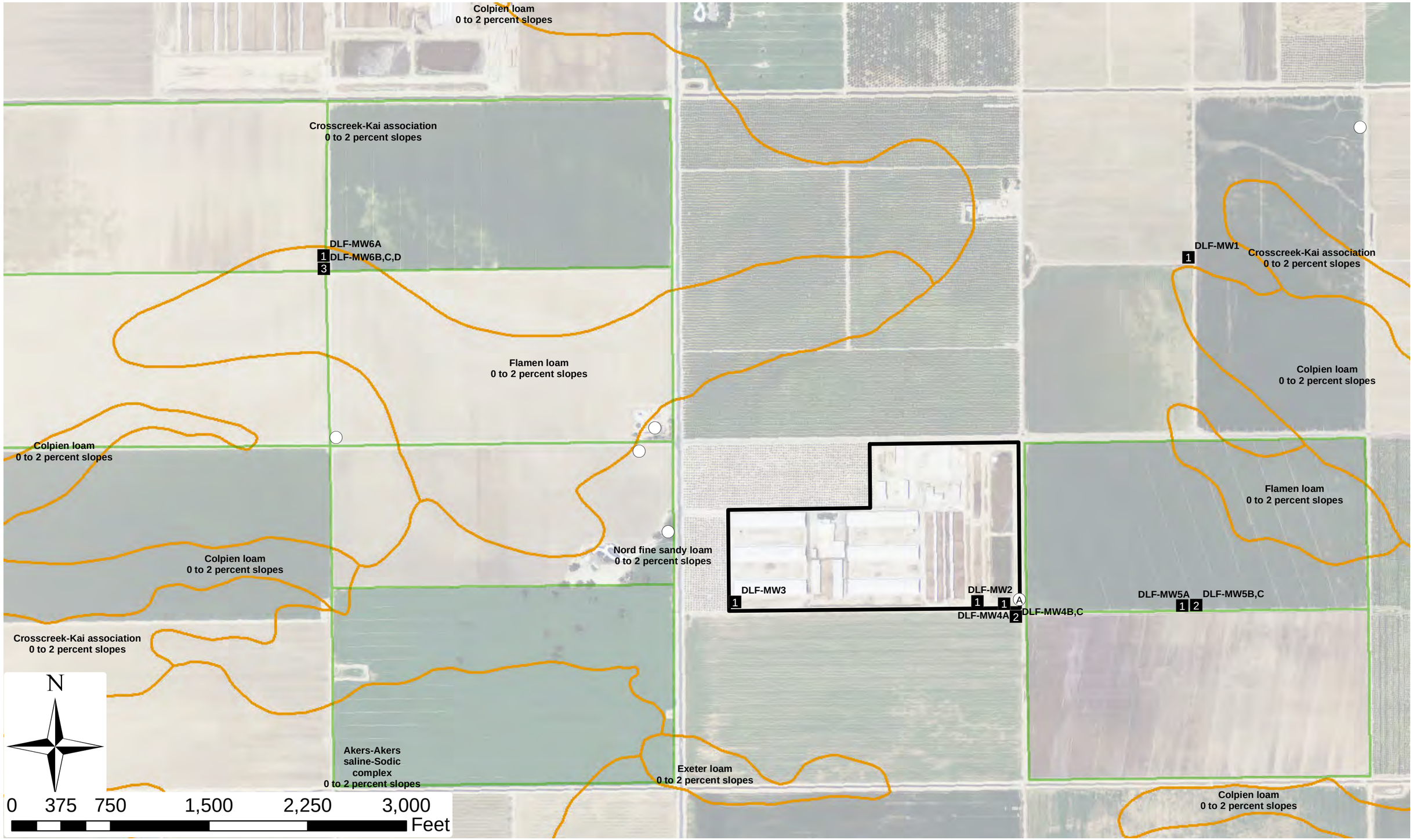
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
AUK
Central Valley Dairy Representative Monitoring Program



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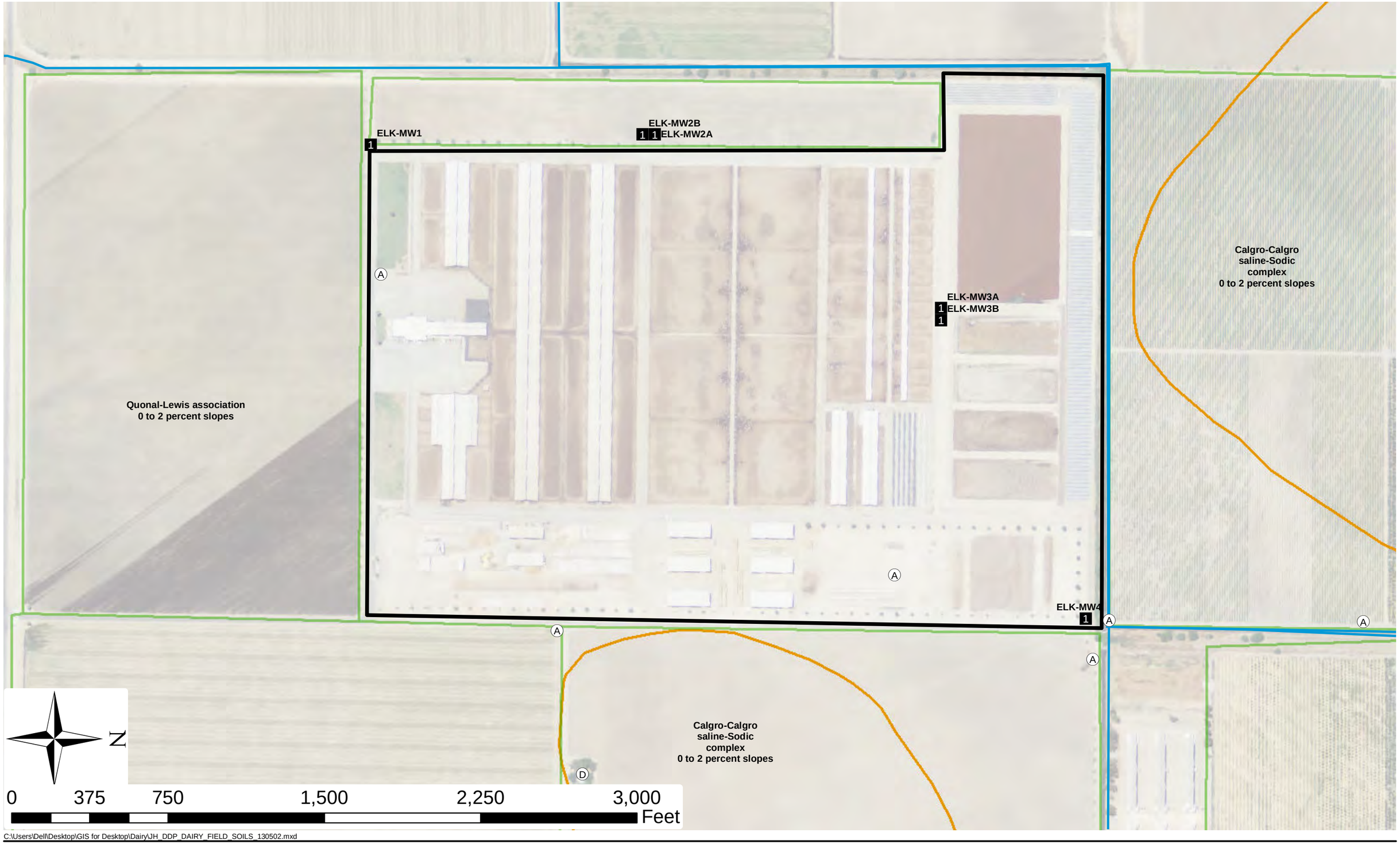
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
DLF
Central Valley Dairy Representative Monitoring Program



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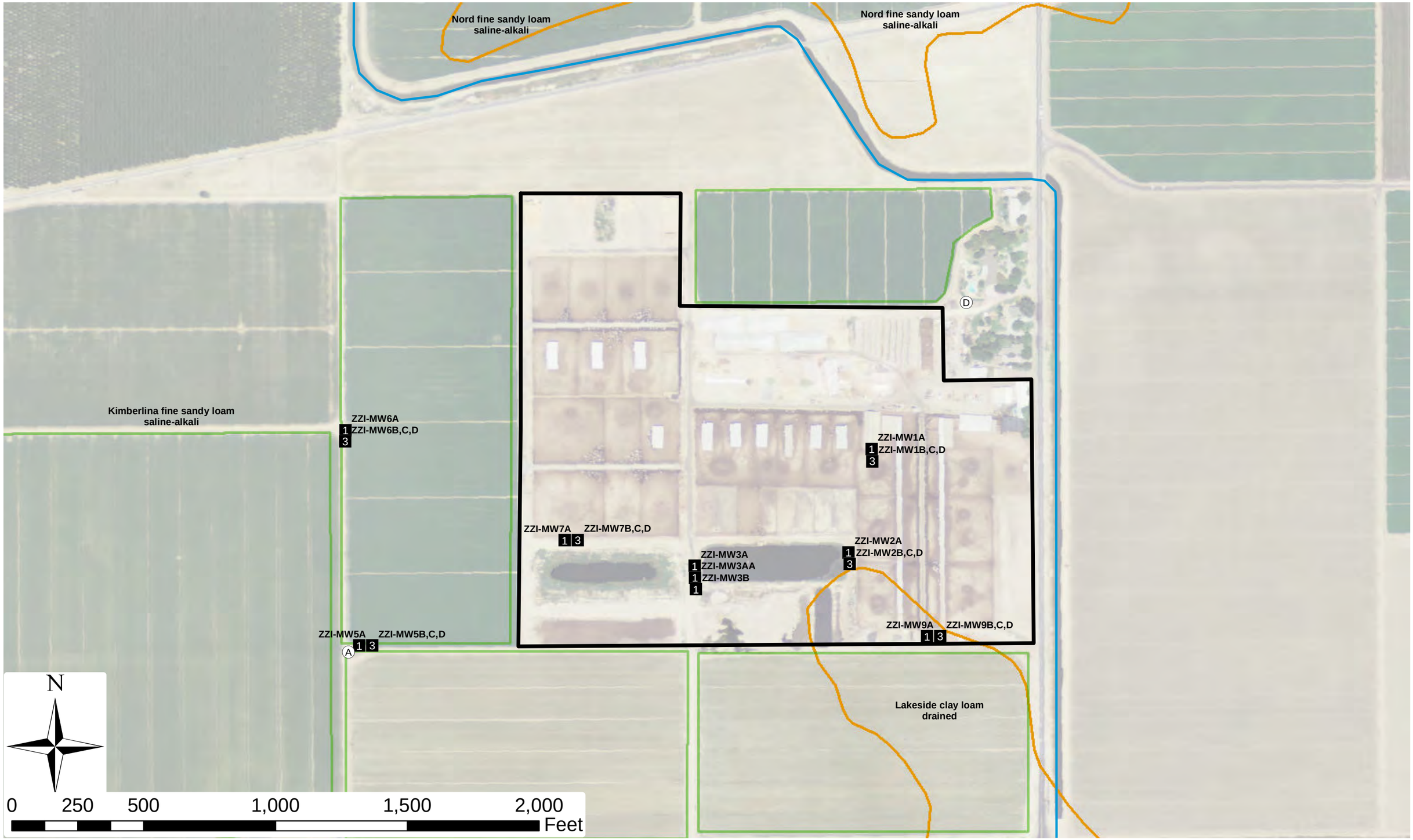
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
ELK
Central Valley Dairy Representative Monitoring Program



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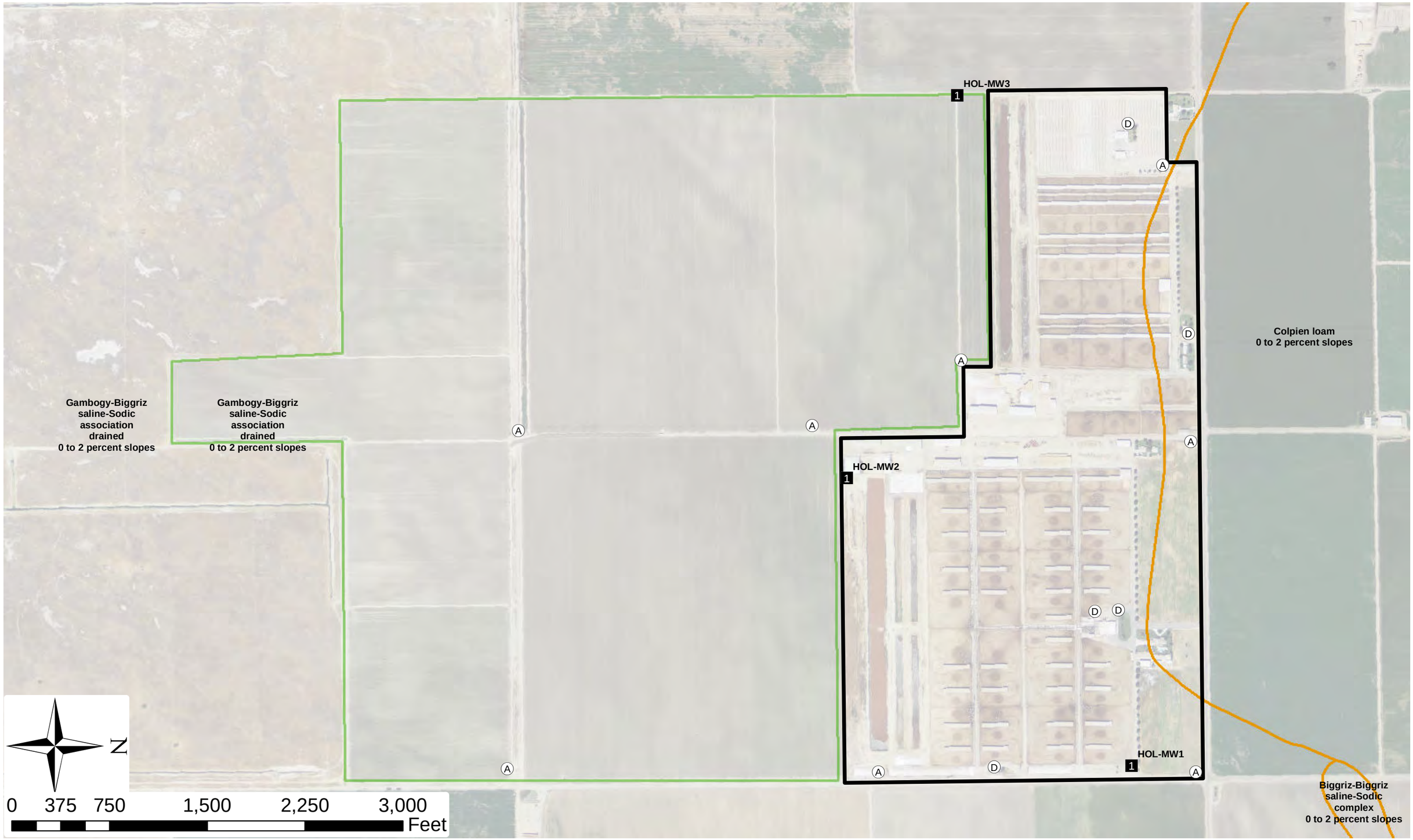
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
ZZI
Central Valley Dairy Representative Monitoring Program



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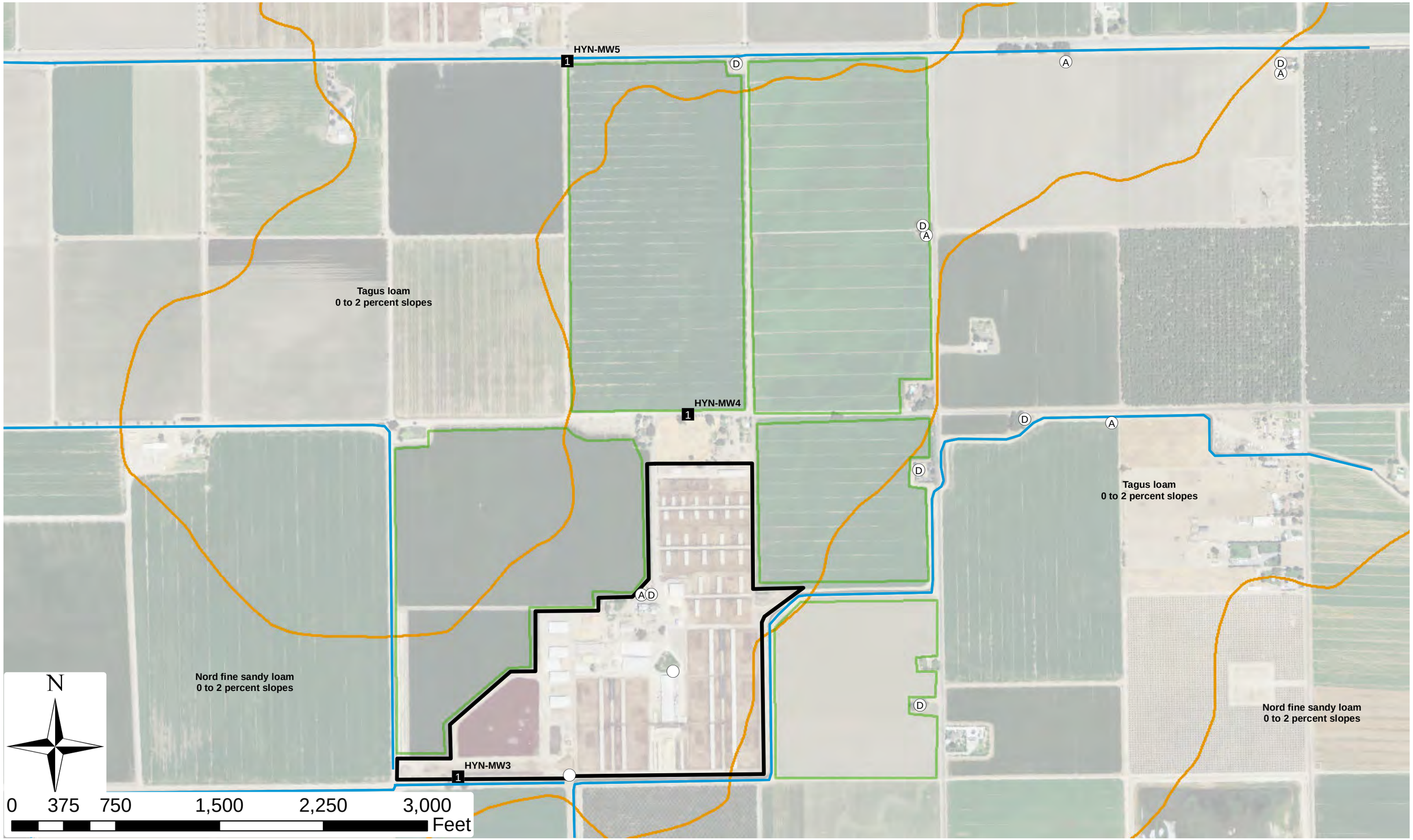
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
HOL
Central Valley Dairy Representative Monitoring Program



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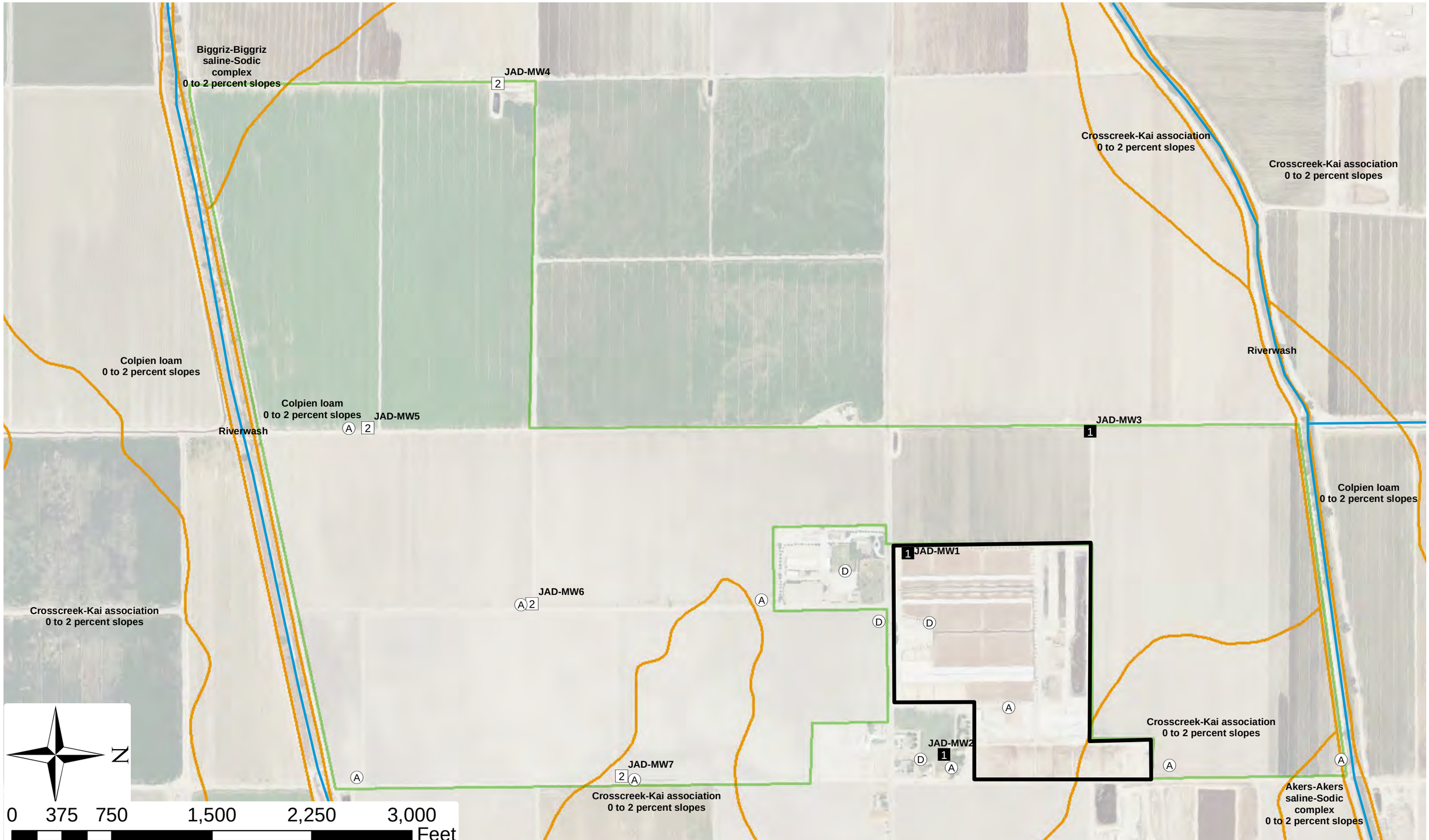
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
HYN
Central Valley Dairy Representative Monitoring Program



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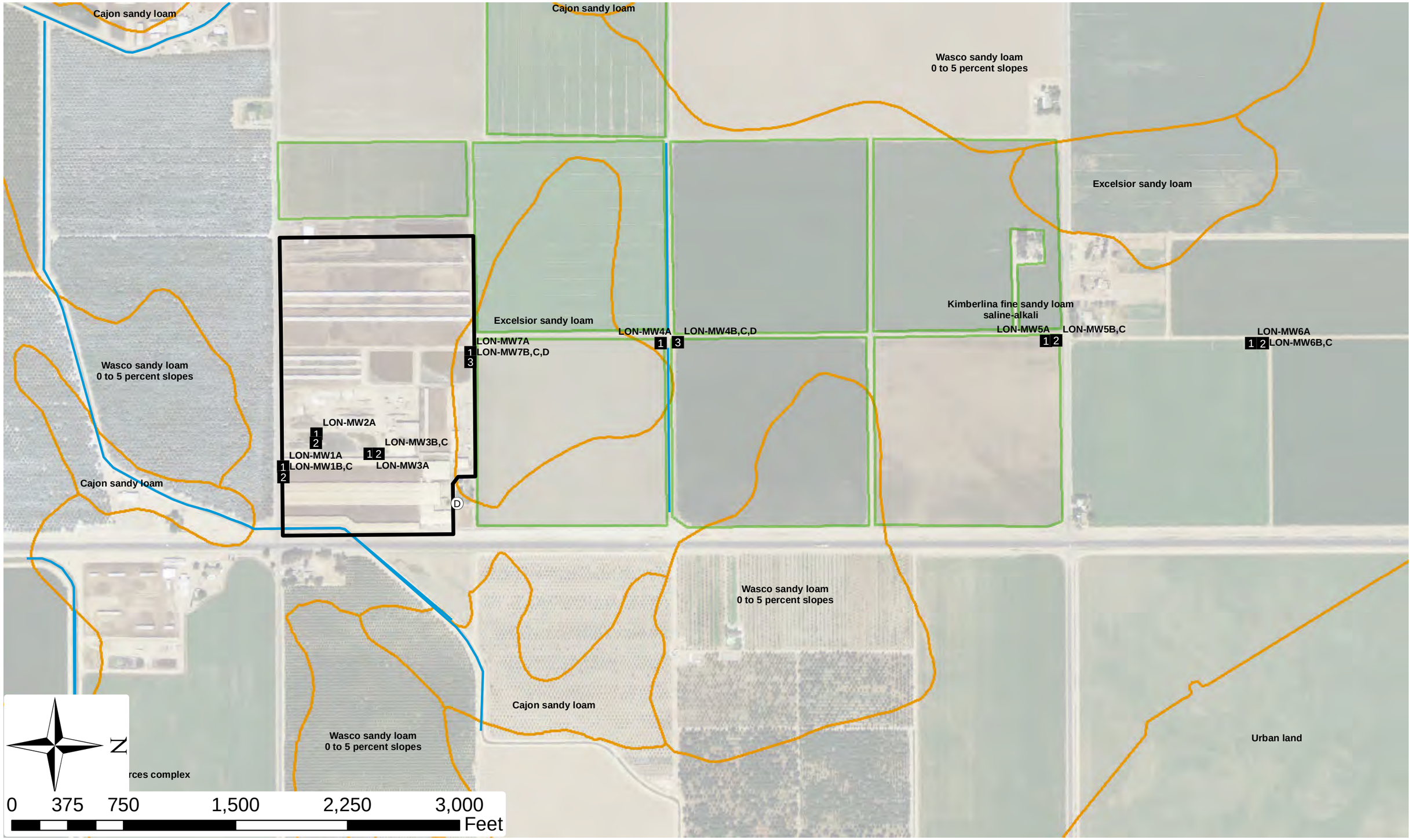
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
JAD
Central Valley Dairy Representative Monitoring Program



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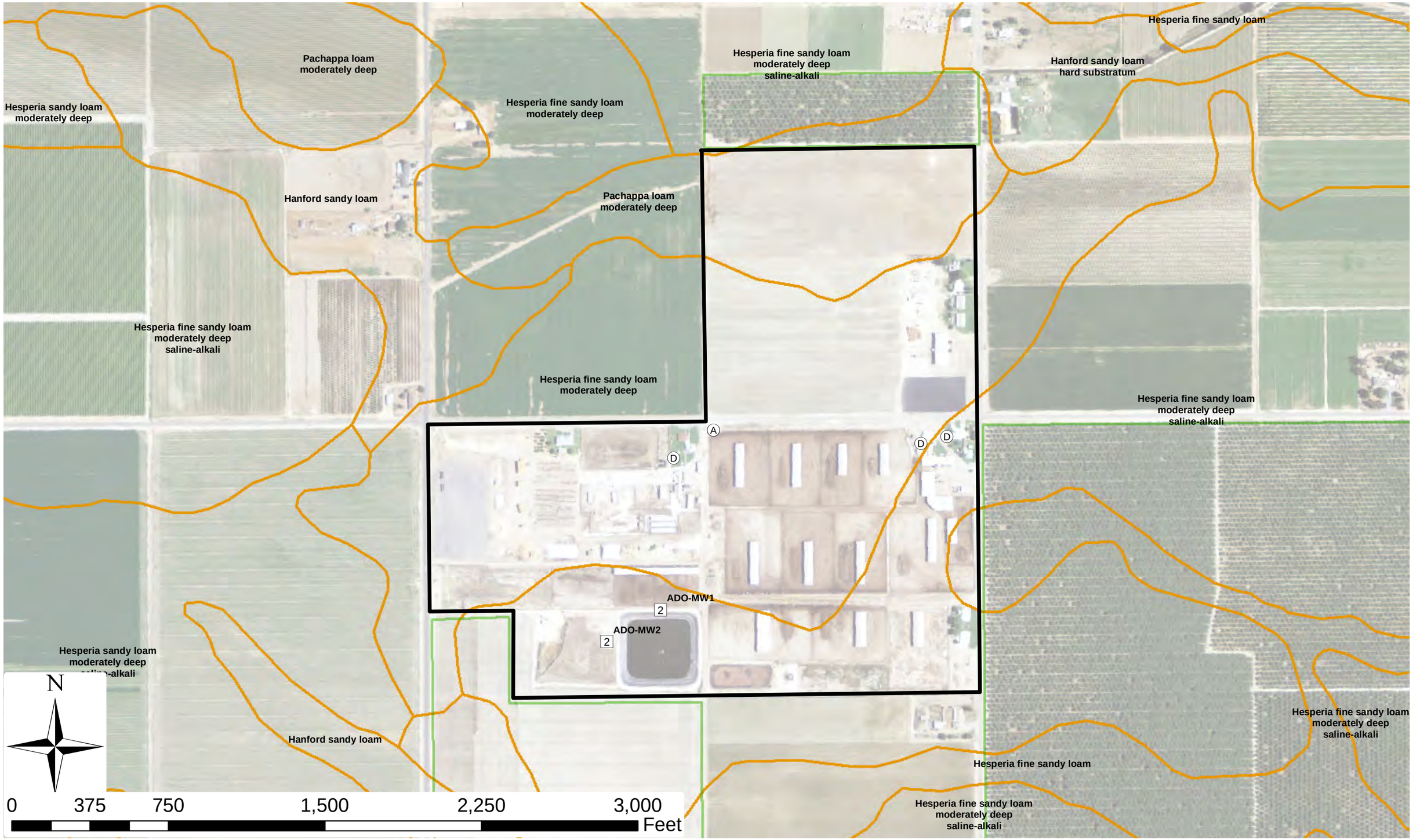
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
LON
Central Valley Dairy Representative Monitoring Program



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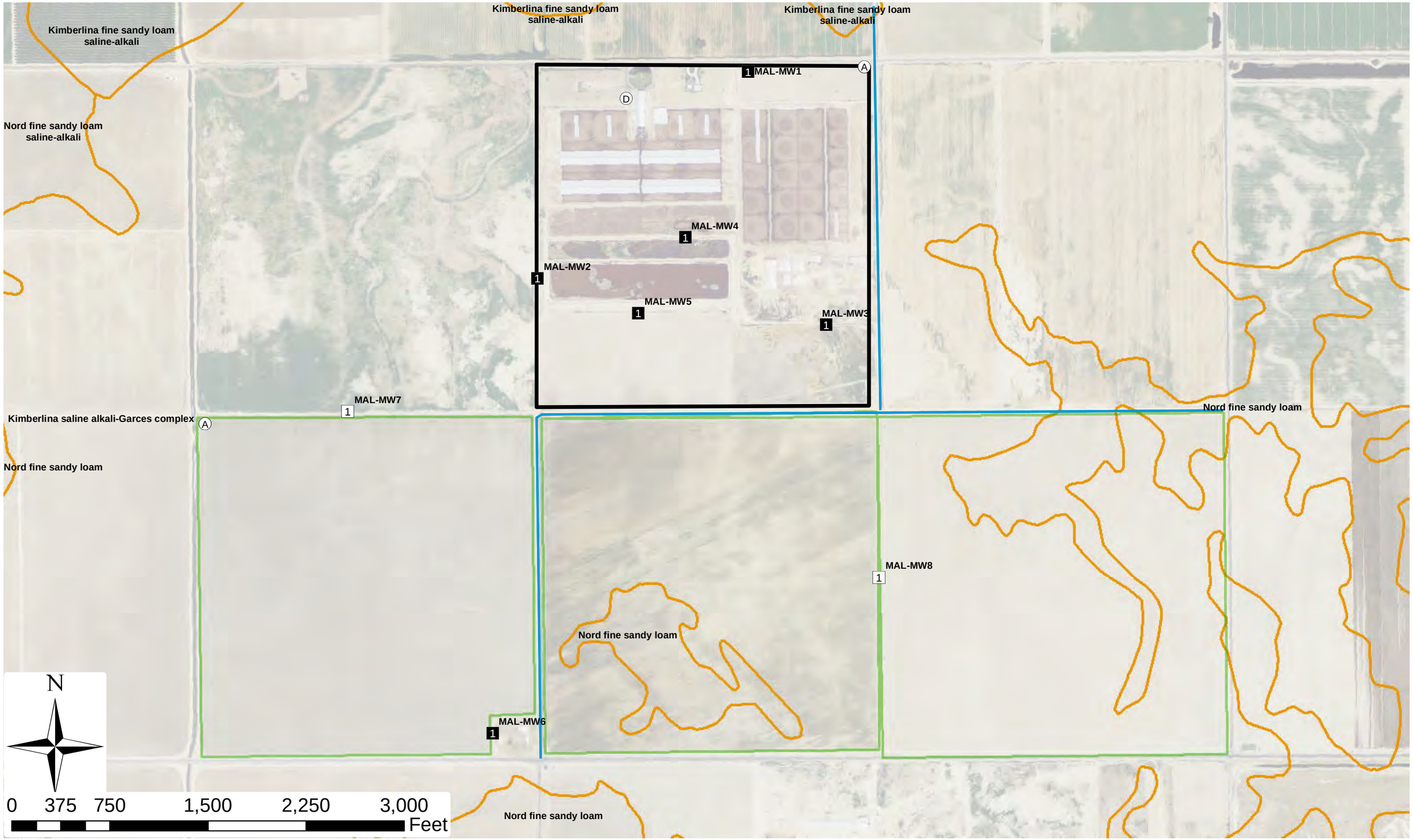
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
ADO
Central Valley Dairy Representative Monitoring Program



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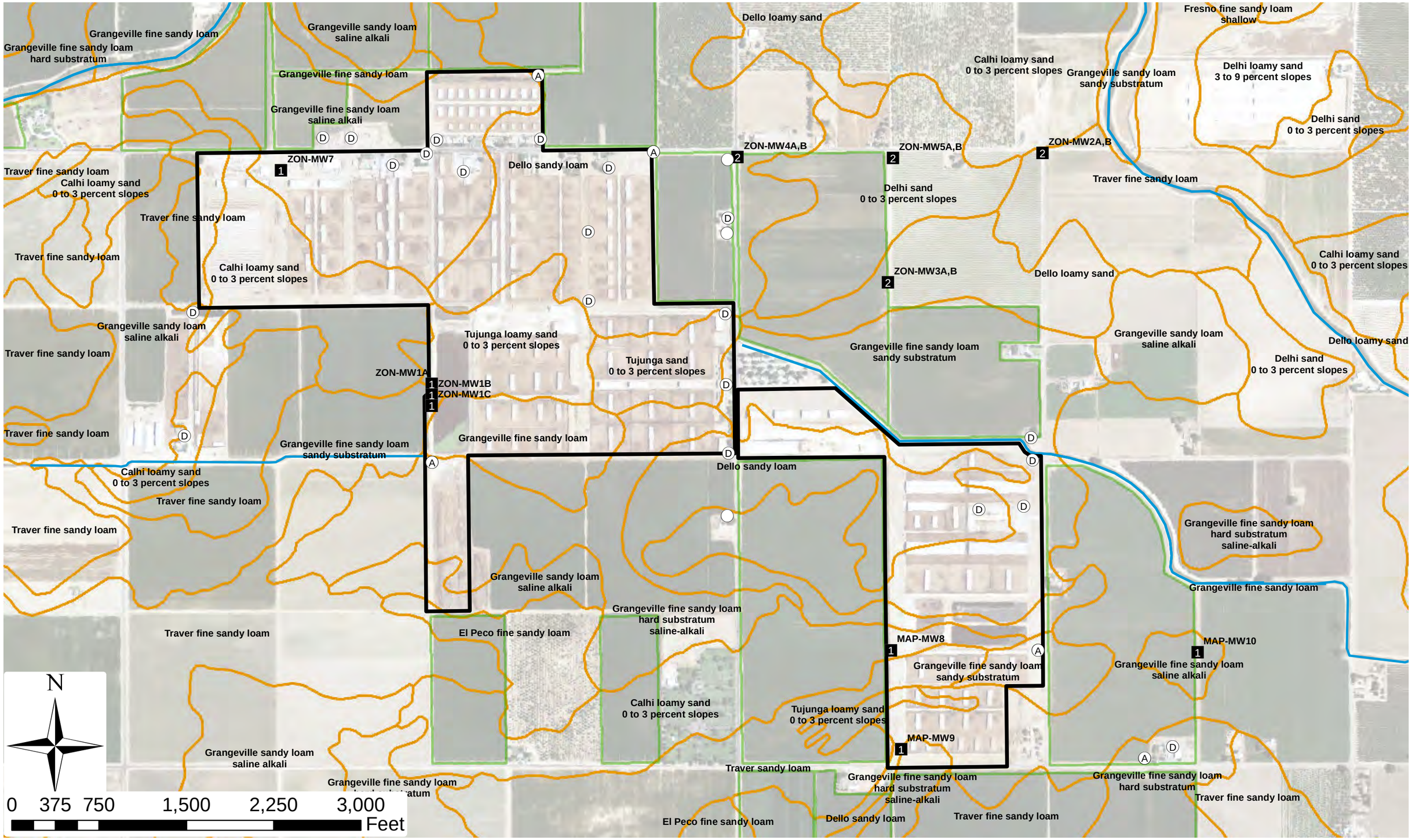
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
MAL
Central Valley Dairy Representative Monitoring Program



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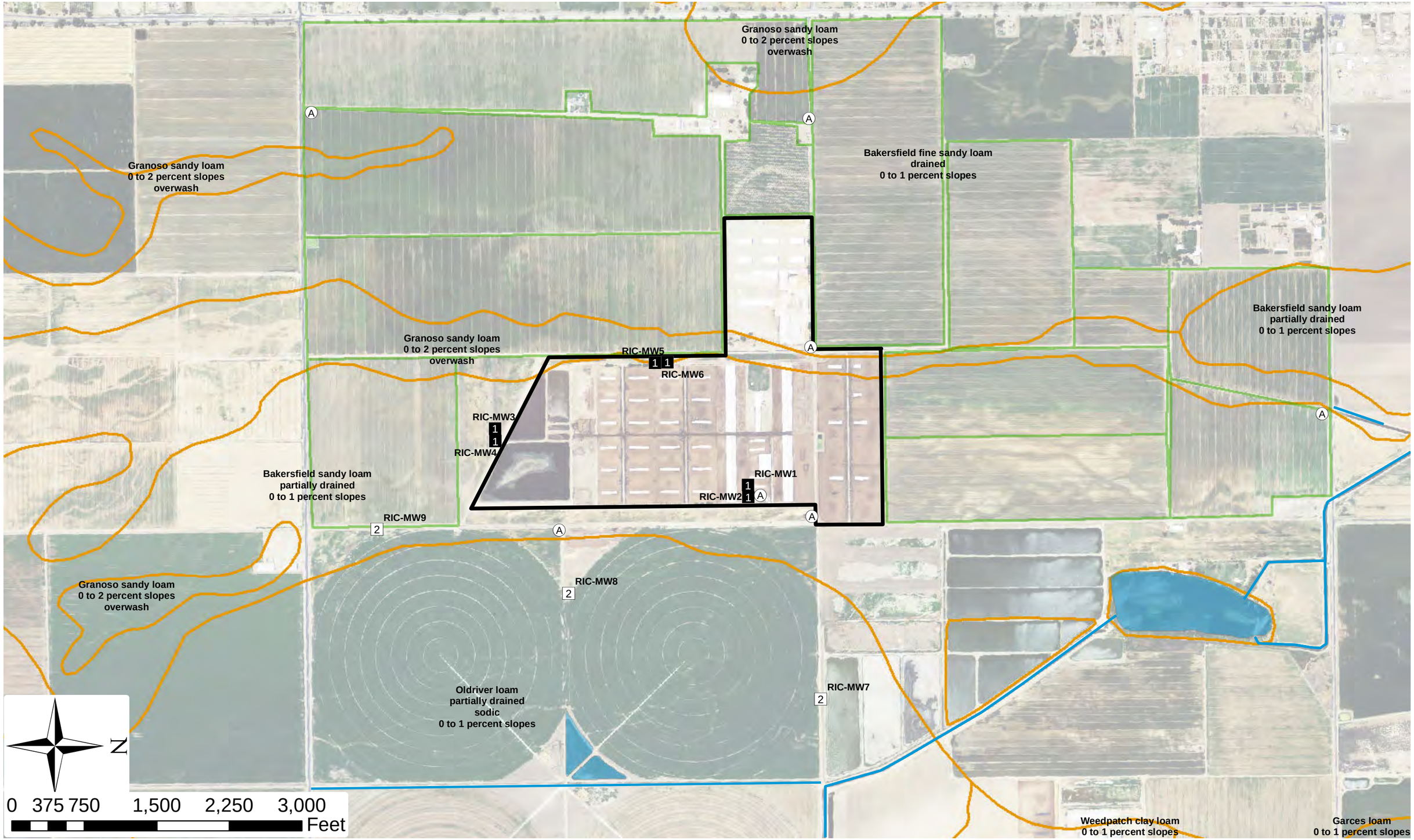
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
MAP/ZON
Central Valley Dairy Representative Monitoring Program



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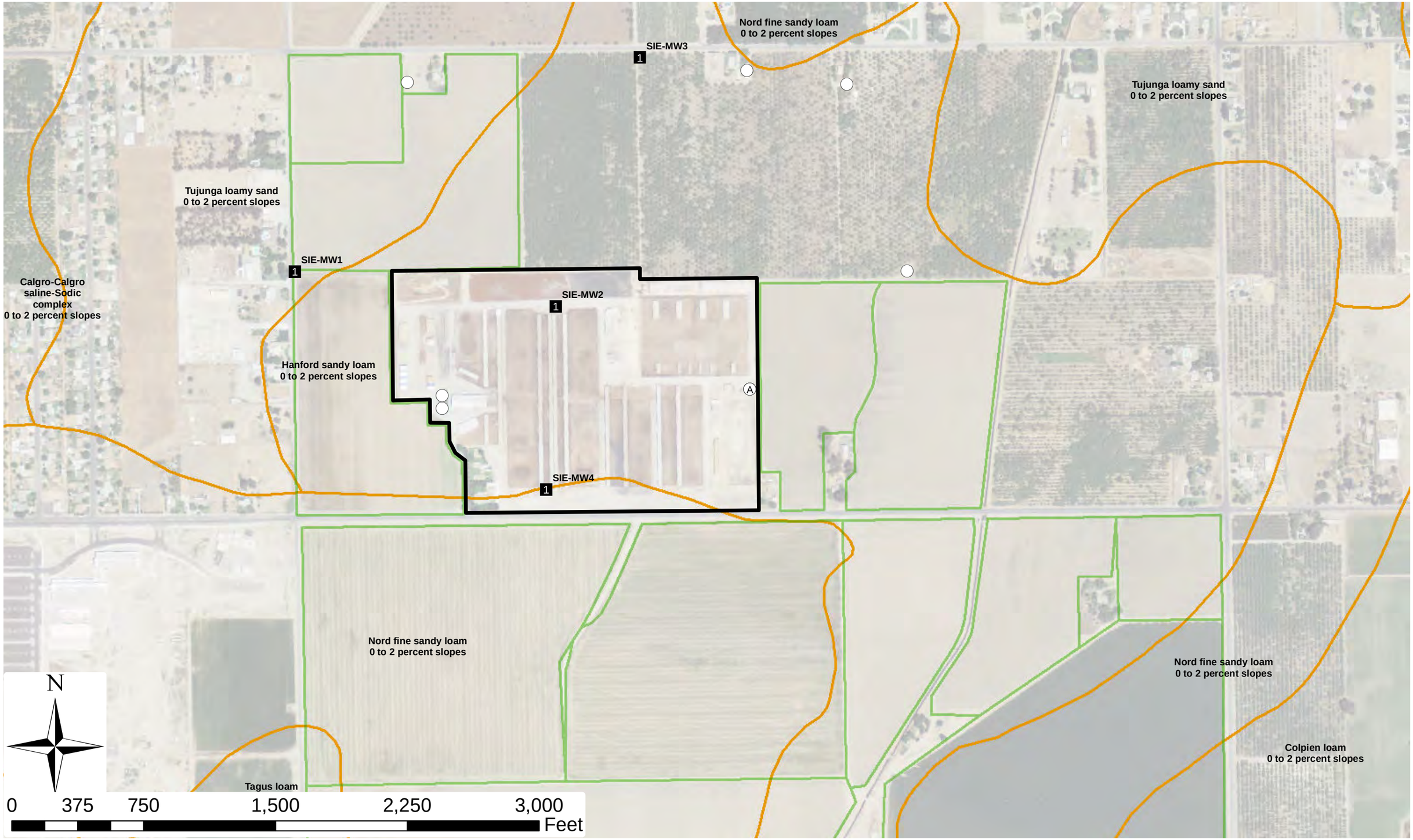
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
RIC
Central Valley Dairy Representative Monitoring Program



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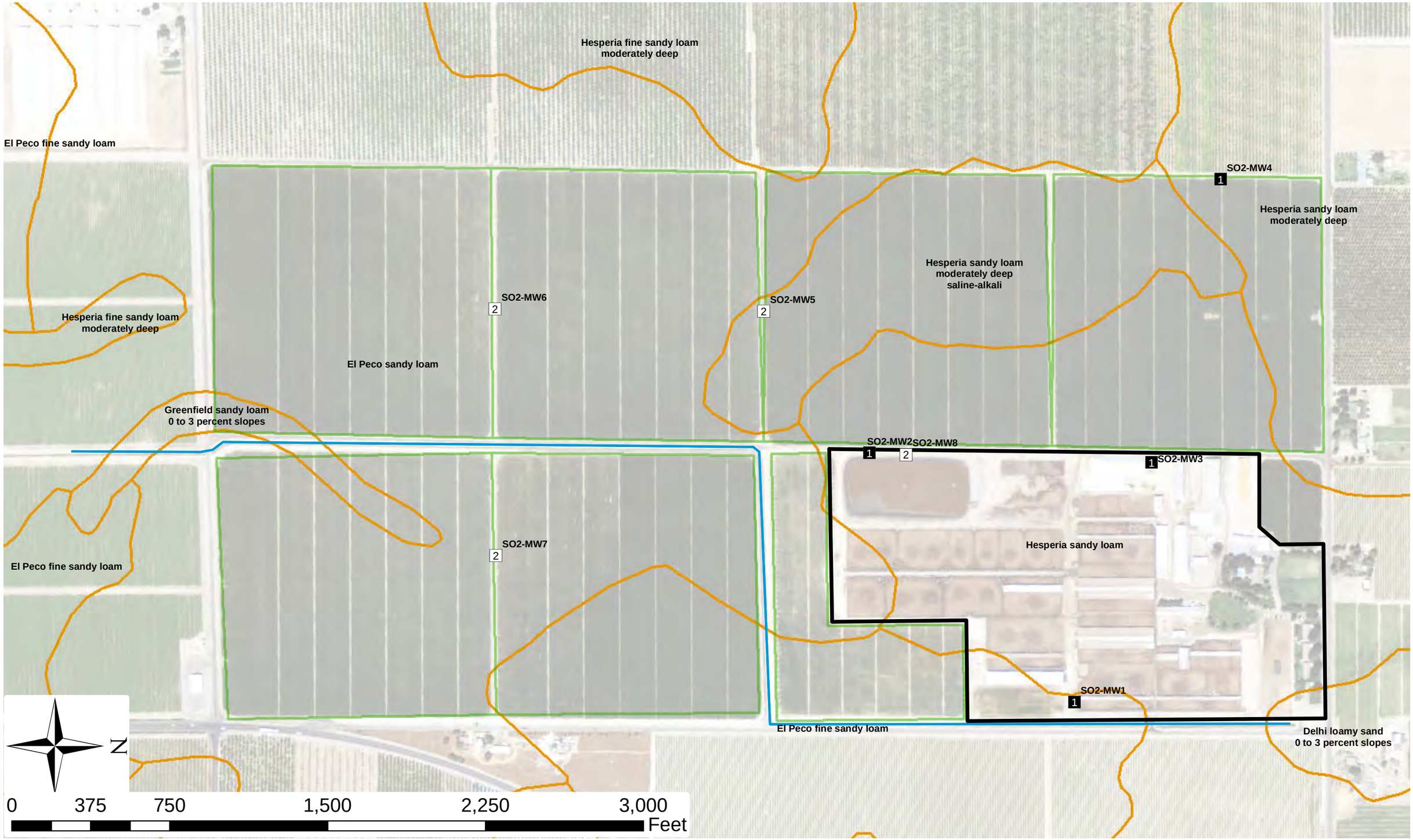
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
SIE
Central Valley Dairy Representative Monitoring Program



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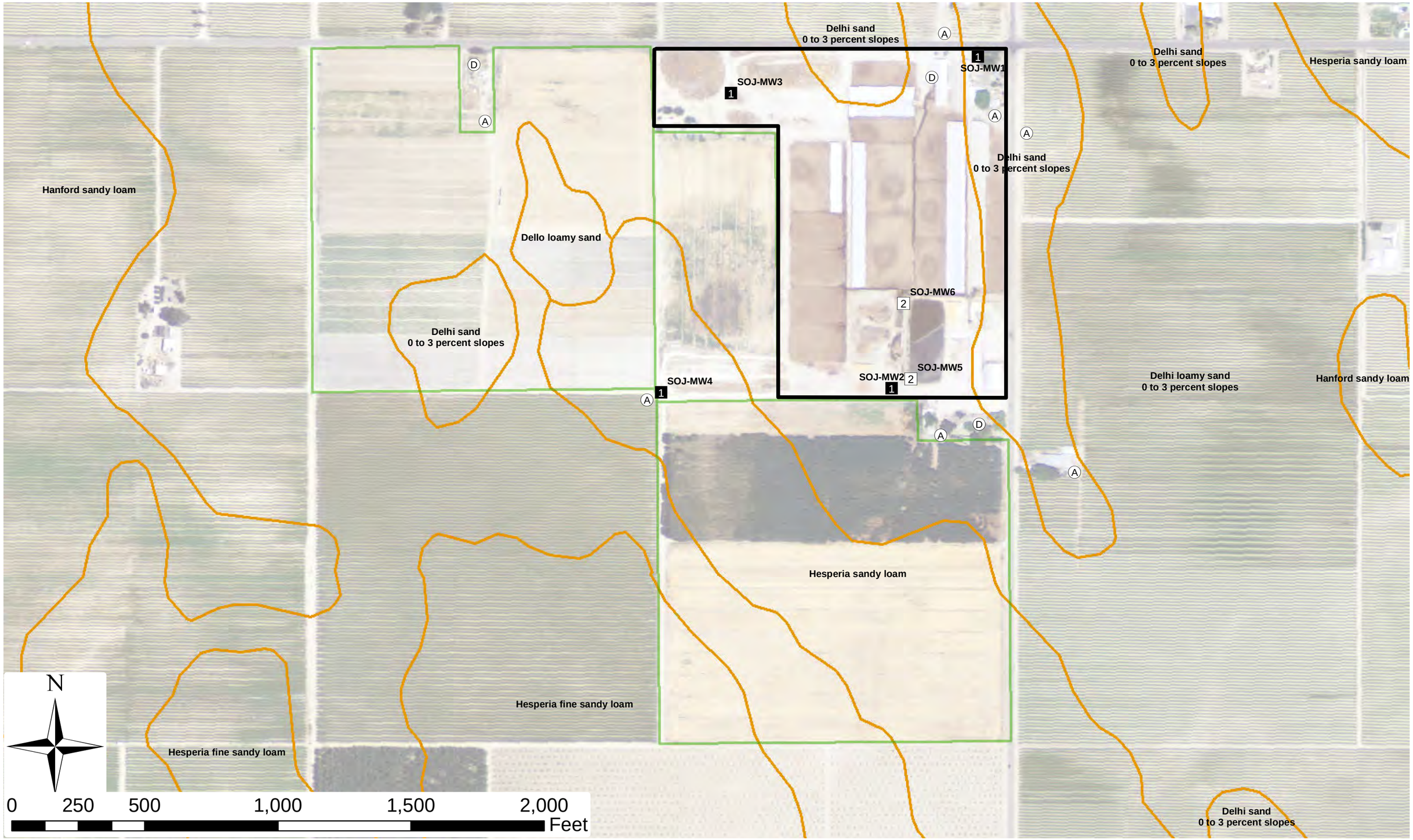
Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
SO2
Central Valley Dairy Representative Monitoring Program



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Soil Characteristics (NRCS - SSURGO) of Dairy Production Area and Associated Fields
SOJ
Central Valley Dairy Representative Monitoring Program