STAGE 1 ABATEMENT PLAN
CREEKSIDE DAIRY DP-913
EDDY COUNTY, NEW MEXICO

Prepared for:

Creekside Dairy
7785 Roswell Highway
Artesia, New Mexico

Prepared by:

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LIST OF ABBREVIATIONS

ac-ft – acre-feet
ags – above ground surface
amsl – above mean sea level
AP – Abatement Plan
bgs – below ground surface
Cl – chloride
DP – Discharge Permit
DQO – Data Quality Objectives
CSM – conceptual site model
EPA – United States Environmental Protection Agency
ft – foot or feet
ft^2 – square feet
GGI – Glorieta Geoscience, Inc.
GWQB – Ground Water Quality Bureau
gpd – gallons per day
HASP – health and safety plan
in – inch(es)
k – hydraulic conductivity
LAA – land application area
mg/kg – milligram(s) per kilogram (equivalent to ppm)
mg/L – milligram(s) per liter
N - nitrogen
NMAC – New Mexico Administrative Code
NMED – New Mexico Environment Department
NMOSE – New Mexico Office of the State Engineer
NMWQCC - New Mexico Water Quality Control Commission
NO_3 – nitrate
NRCS – Natural Resource Conservation Service
PQL – practical quantification limit
ppm – parts per million
PVC – polyvinyl chloride
QA/QC – Quality Assurance/Quality Control
QAPP – Quality Assurance Project Plan
S – storage
SA – Settlement Agreement
SAP – Sampling and Analysis Plan
SO_4 – sulfate
T – transmissivity
TDS – total dissolved solids
TKN – total Kjeldahl nitrogen
USGS – United States Geological Survey

1.0 INTRODUCTION

Glorieta Geoscience, Inc. (GGI) submits this Stage 1 Abatement Plan (AP) Proposal on behalf of Creekside Dairy, DP-913 ("Dairy"), to satisfy requirements with the New Mexico Environment Department (NMED) as required under Title 20 New Mexico Administrative Code (NMAC) 20.6.2 §4106 through §4110 regarding impacts to groundwater quality at the Dairy. This Stage 1 AP Proposal is submitted in response to the AP required under the Settlement Agreement (SA) between the Dairy and the NMED, approved by the Water Quality Control Commission on August 13, 2019. This AP includes components of a Field Investigation, Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), a site-specific Health and Safety Plan (HASP) and satisfies Stage 1 AP requirements cited in NMAC 20.6.2 §4106 through §4110. GGI has researched historical data available at the time this document was produced. Some historical data was collected by consultants and individuals not affiliated with GGI. GGI reserves the right to modify information within this AP as new or more accurate information is discovered or made available.

1.1 GENERAL PROJECT BACKGROUND

Creekside Dairy is located at 7785 Roswell Highway, north of Artesia, New Mexico, within Eddy County and the following PLSS coordinates – Section 1, 2, 11 and 12 in Township 16S Range 25 E (Figure 1). The Dairy is situated within the greater Pecos River Valley in an agricultural area where irrigated farmland and dairies predominate. Irrigated farmland is located immediately adjacent to the dairy to the west, east, north, south and southeast of the Dairy. Numerous septic tanks are in use within a one-mile radius of the Dairy.

The August 13, 2019 SA specified that the Dairy submit a complete Stage 1 Abatement Plan proposal, stating in part:

> "Dairy Stage 1 Abatement Plans: Rockhill, Creekside, Dexter, Starry Night and Orchard Park shall each prepare and submit a Stage 1 Abatement Plan to NMED by the deadlines in this Section 4. Dexter and Starry Night will submit a joint Stage I Abatement Plan based on NMED's request that the two facilities apply for a joint permit, and once combined, both dairies will share NMED Discharge Permit DP-606. In consideration of the limited resources of the Dairies' contractors to prepare and submit the Stage I Abatement Plans, and NMED personnel to review and administer the Stage 1 Abatement Plans, the following deadlines shall apply:
>
> b. Creekside shall file a Stage 1 Abatement Plan no later than 180 days after the Effective Date of this Settlement Agreement.
>
> (SA, pages 3 and 4)

The intent of this AP is to investigate the extent of any contamination originating from the Dairy caused by past discharges related to the facility and to provide the data necessary to select and design an effective abatement option. It was during the time of SA negotiations that GGI began providing environmental consulting services to Creekside Dairy.

The Dairy is permitted under Groundwater Discharge Permit (DP), DP-913 issued December 31, 2018. The Dairy is permitted to discharge up to 56,000 gallons per day (gpd) of dairy greenwater. Greenwater is stored within a clay-lined lagoon constructed in 2001 with a capacity of 20.4 acre-feet (6.647 million gallons). Two stormwater impoundments (SW-1 and SW-2) that have capacities of 5 acre-feet each (1.63 million gallons each, or 3.26 million gallons total) also built in 2001 convey stormwater to the lagoon prior to land application. The greenwater is land applied to six (6) Land Application Area (LAA) fields totaling 385 acres. Groundwater quality at the Dairy is monitored quarterly, as required by the DP. The Dairy's irrigation and monitoring wells will be included within Creekside Dairy's Abatement monitoring program. There are currently seven (7) monitoring wells specifically designated as the Dairy monitoring wells (Figure 2). However, MW-2A was damaged in 2014 and can no longer be sampled. In addition, the 2018 DP requires the Dairy to install up to seven additional monitoring wells (includes 2 replacement wells, if needed) to monitor potential sources (LLAs, lagoons, etc.). No other monitoring wells at other locations in the immediate area of the Dairy are reasonably close to provide meaningful data for the purposes of this AP.

The Dairy has seven (7) monitoring wells which are sampled quarterly for nitrate (NO_3), total Kjeldahl nitrogen (TKN), chloride (Cl), sulfate (SO_4) and total dissolved solids (TDS). A summary of analytical data is presented in Table 1. Nitrate is above the NMWQCC standard of 10 mg/L in six of seven wells, including all upgradient wells at the facility. Chloride is below standard of 250 mg/L in all wells except one. TDS is above the standard of 1000 mg/L in all wells ranging from approximately 2000 to 4200 mg/L. Additional information on groundwater quality is provide in Section 3.7 below.

A requirement of the discharge permit issued December 31, 2018 was for the permittee to provide a Monitoring Well Location Proposal for NMED approval and subsequent to that approval for the installation of a number of monitoring wells at NMED approved location. The Monitoring Well Location Proposal will be submitted per the DP requirement and it will be incorporated into the Abatement Plan.

1.2 SUSPECTED CHEMICALS OF CONCERN

Constituents described within NMED abatement requirements and associated with the Dairy include those listed within the Discharge Permit: nitrogen as NO_3, Cl, TDS and SO_4. All constituents (NO_3, Cl, SO_4, and TDS) have been found to exceed NMWQCC limits for groundwater. Elevated TDS, Cl and SO_4 in groundwater are not generally considered to be threats to human health. Extremely high levels of NO_3 in drinking water have been seen to be a health risk to humans. High SO_4 and NO_3 in drinking water can be a health risk to livestock.

2.0 SITE SETTING

The following subsections provide the general setting for the Dairy including geology, hydrogeology, and potential receptors as related to this Stage 1 AP proposal.

2.1 TOPOGRAPHY

Topographical information was obtained from review of topographic maps. Figure 1 shows that the property is located at approximately 3,434 feet (ft) above mean sea level (msl). The land surface slopes very gently (approximately 20 ft/mile) generally to the east. Cottonwood Creek runs through the property just south of the Dairy production area (corrals, stormwater impoundments, and greenwater lagoon.). The close proximity of Cottonwood Creek appears to influence the water levels in adjacent wells, such as MW-3A.

2.2 GEOLOGIC AND HYDROLOGIC SETTING

The Dairy property is located within the Roswell Artesian Basin. The aquifers beneath the Dairy include an unconfined alluvial aquifer that ranges from 10 to 300 ft in thickness, commonly referred to as the "shallow" aquifer and a confined artesian aquifer. The shallow alluvial aquifer overlies the San Andres confined or artesian aquifer. The San Andres artesian aquifer can be up to 1,200 ft thick. The artesian system is recharged from snow melt and rainfall in the Sacramento Mountains to the west. Shallow groundwater has historically been recharged from an upward leaking artesian aquifer (Welder, 1983), however due to heavy artesian aquifer pumping, upward recharge of the shallow aquifer may not be as significant and widespread as it once was in the area. The largest use of groundwater in the basin, both shallow and artesian, is irrigation.

The hydrology beneath the Dairy and throughout the general area is complex. Several of the monitoring wells located within just over one-mile of the dairy, and possibly at the dairy itself, are completed in what is considered to be a perched saturated zone, and not the true shallow aquifer. A potentiometric surface map is included within this Proposal (Figure 3). Data thus far suggests that the perched saturated zone originates from irrigation return flow, and is not part of the original, natural shallow aquifer system in the region.

Recent water level measurements indicate that shallow groundwater at the Dairy currently ranges from approximately 18 ft at MW-3A to 110 ft at MW-9, below ground surface (bgs), with the regional groundwater flow direction to the east-southeast. However, based on water level measurements it appears two monitoring wells, MW-3A and MW-10 are completed in a perched aquifer zone. Water levels in these two wells is approximately 20 to 45 ft bgs, while the remaining five wells have water levels from 83 to 100 ft bgs. Groundwater flow in the shallow aquifer at Creekside Dairy is generally moving to the east-southeast (Figure 3). Water levels in the shallow aquifer under the Dairy have tended to be steady in recent years. Hydrographs will be prepared as part of Stage 1 reporting.

Geologic Units

A general geologic map based on the state geologic map is provided in Figure 4. This map shows that the Creekside property is underlain by units *Qa* and *Qp* which are Quaternary age (Holocene to Upper Pleistocene) alluvial and piedmont alluvial deposits, respectively. Lithologic unit *Qa* is alluvium (stream deposits). Lithologic unit *Qp* includes deposits of higher gradient tributaries bordering major stream valleys, alluvial veneers of the piedmont slope, and alluvial fans; and may locally include uppermost Pliocene deposits. Lithologic unit *Qoa*, to the west of the property, is older alluvium deposits of the middle to lower Pleistocene (Scholle, 2003).

Also to the west of the property are lithologic unit *Qep*, eolian and piedmont deposits, and the San Andres Formation (*Psa*) which is limestone and dolomite with minor shale (Scholle, 2003). To the east of the property is the Artesia Group (*Pat*) and the Santa Rose Formation (*Trs*). The Artesia Group is marine shelf facies forming broad south-southeast trending outcrops from Glorieta to Artesia area. The Group includes the Tansill, Yates, Seven Rivers, Queen and Grayburg Formations (sandstone, siltstone, limestone, dolomite, anhydrite, gypsum, and red mudstone, respectively). The Santa Rosa Formation is a sandstone that includes the Moenkopi Formation in this location of the state (Scholle, 2003). The Salado Formation (*Psl*) is an evaporate sequence that is predominantly halite, and the Rustler Formation (*Pr*) is an interbedded siltstone, gypsum, sandstone and dolomite. Both crop out to the southeast of the Dairy property (Figure 3).

The Dairy property lies within a distal end of the alluvial slope east of the Sacramento Mountains and west of the Pecos River. This corridor is underlain by a shallow alluvial aquifer consisting of unconsolidated sand and gravel derived from eroding slopes of limestone and sandstone. This aquifer is generally less than 250 feet thick (Barroll and Shomaker, 2003).

The shallow alluvial aquifer is separated from the deeper artesian aquifer by the low permeability beds of mudstone and evaporites in the Artesia Group in this area. The San Andres artesian aquifer is 300 to 500 feet thick and extends under the Pecos River where the top of the aquifer is reached at a depth of approximately 1,100 feet.

There are several northeast trending faults and fracture zones, part of the Pecos Buckles, through the San Andres Formation, west of the property. There are no mapped faults through the Dairy property.

The nearest surface waters are the dry Cottonwood Creek, that bisects the Dairy property and flows only during heavy precipitation events, and the Pecos River, located approximately 5 miles to the east of the Dairy.

2.3 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) was compiled to assist in the design of the sampling activities to be performed at the Dairy. This CSM will be refined as more data become available from the on-going site investigation. These data will include investigation derived, site-specific hydrogeologic parameters, and additional groundwater and soil data to better define vertical and horizontal extents of any soil and/or groundwater contamination at the Dairy.

Potential Contaminant Sources

Greenwater and stormwater lagoons, chemical fertilizer and manure-based fertilizer applied to the LAAs, are the primary potential contaminant sources for NO_3 impacts to groundwater. These are the principal sources that are being reviewed in this Stage 1 AP. Table 4 provides a summary of site-specific potential sources and the assessment efforts to determine the probability that the sources are contributing to the groundwater contamination. TDS (between 2000 and 3000 mg/L) and SO_4 (800 and 1800 mg/L) are found in samples collected from the Dairy's most upgradient wells, MW-4 and MW-6, at levels exceeding NMWQCC limits and can be presumed to be due to existing or background concentrations in area shallow aquifer groundwater. Sources of these constituents are geologic units within water bearing geology, soils and shallow aquifer recharge from irrigation with groundwater naturally high in those constituents. Chloride does not follow this trend and over that same period of 2012 to the present, and has generally been between 30 and 100 mg/L. NO_3 during that same period has been between 10 and 20 mg/L for MW-6 while MW-4 started <10 mg/L in 2012 but has had several large exceedances of between 50 and 70 mg/L. These large and relatively long-term exceedances at these upgradient wells need to be factored into the development of the abatement plan. MW-4 is an upgradient well monitoring contamination moving onto the Dairy. MW-4 is downgradient of multiple adjacent off-site irrigated fields and sets the baseline standard for contamination at the facility. As of fourth quarter 2019, MW-4 had recorded NO_3 values of 45 mg/kg, well above NMWQCC standards. MW-4 has the highest NO_3 concentrations of all the shallow aquifer wells at Creekside. The excess NO_3 measured entering the Dairy suggests that Creekside's management practices are not contributing additional contamination to the groundwater, and are in fact likely mitigating the NO_3 plume.

Release Mechanisms

Regulated constituents in manure or greenwater may be released to groundwater by two principal means: primary release mechanisms and secondary release mechanisms.

Primary release mechanisms at the Dairy include:

- Stormwater run-off that discharged to unlined stormwater lagoons;
- Infiltration of stormwater or greenwater from lagoons; and
- Infiltration of stormwater or greenwater from spill(s) or breaching of lagoons and piping.

Secondary release mechanisms include:

• Soil leachate migrating vertically to groundwater from the LAAs.

Transport of NO_3, Ci, SO_4 and TDS once released, is by infiltration (e.g., leaching to groundwater), and groundwater transport. Potential pathways include soil leaching to groundwater and, in turn, migration to wells by natural gradient transport and localized pumping effects.

2.1 Potential Source Assessment

As part of the Stage 1 Abatement investigation, historical documents will be reviewed for assessment of potential sources of contamination at the Dairy. Sources of information included interviews with Dairy personnel, review of NMED case files, and GGI case files. The following potential sources were considered during this S1 AP. The locations of these potential sources are shown in Figure 2.

- **Greenwater Lagoons:** The lagoon was constructed in 2001 and has a storage capacity of 20.4 ac-ft. The location of the lagoon is south of corrals and of the stormwater impoundment, SW-1. The location of the lagoon is consistent with historical information found in the various sources. The lagoon is clay-lined and is used to store both greenwater and stormwater prior to land application. From the period of the dairy's opening in 1993, a former lagoon was also operated on the property and used to store wastewater. The former lagoon was located east of the corrals along the north property boundary (current commodity storage area) with a capacity of 13.8 ac-ft. The lagoon was taken out of service sometime between 2014 and 2016.

- **Storm Water Runoff Ponds:** Two storm water retention structures (SW-1 and SW-2) are located along on the south side of the corrals and adjacent to (north) of the greenwater lagoon in the production area. The stormwater is pumped to the 20.4 acre-foot clay line greenwater lagoon. The water is mixed and then pumped from a sump in the middle of the lagoon and out onto the LAAs.

- **Land Application Areas (LAAs):** The Dairy currently uses six (6) LAAs for irrigation with greenwater from the lagoon system. The fields consist of 120, 120, 70, 30 and 30 acres for center pivot irrigation and one flood irrigated field of 15 acres for delivery of the greenwater blend. Historic aerial imagery indicates that prior to 1997, flood irrigation was used on each of these fields. By 2005, Fields 3, 4 and 6 had been transformed to pivot irrigation. In 2015, Fields 2A and 2B were also converted to pivot irrigation. Currently, only Field 1 is still using flood irrigation.

  LAA Field 1 is located to the southeast of the production area along the boundary of Cottonwood Creek. Field 1 is the only LAA at the facility which utilizes flood irrigation. Flood irrigation can accelerate the rate of infiltration of NO_3 from the shallow subsurface to the water table.

  LAA Fields 2A and 2B are 30-acre pivot fields located south and west of the corrals and production area. These fields are due east of the property boundary. Locally, groundwater flow in the region is to the east-southeast towards the Pecos River, therefore the closest monitoring well to monitor NO_3 concentrations from Fields 2A and 2B is MW-9. MW-6 is upgradient of these fields and provides a record of contamination coming onto the Dairy from off-site sources. The 2018 DP requires installation of a MW downgradient of these fields, but installation has not occurred to date.

LAA Field 3 is an approximately 120-acre field located at the Dairy's southwest property boundary. The closest monitoring well is MW-10, east of Field 4. Groundwater elevation data suggests the presence of a perched aquifer and a flow direction which cannot be determined within the discontinuous zone. The production well located on the western edge of Field 3 could potentially provide a data point for contamination moving on-site from adjacent sources through annual irrigation sampling. The 2018 DP requires installation of a MW downgradient of this field, but installation has not occurred to date.

LAA Field 4 is an approximately 120-acre center pivot irrigation field on the eastern edge of the property. Directly northwest of the field is MW-9, which monitors NO_3 sources reaching the field from the northwest, where the commodities storage, lagoon and stormwater impoundments and production area are located. Due to the irregular shape of the facility, there are no dairy sources due west of the field, as the area is not owned by the Dairy, however further west is Field 3 which could contribute to NO_3 concentrations at MW-9.

LAA Field 6 is a 70-acre half pivot located at the southeast edge of the property. The 2018 DP requires installation of a MW downgradient of this field, but installation has not occurred to date.

Monitoring wells MW-9 and MW-10 are currently located down gradient of land application fields with the possible exception of LAA-Field 3 and LAA-Field 6. The Dairy is prepared to install monitoring well(s) down gradient of the LAAs as part of the DP-913 requirements.

- **Pipelines:** Underground pipelines provide for the transfer of greenwater in the Dairy's operation. A pipeline transfers greenwater from the separate milking parlor sumps to the screen separator on the east side of greenwater lagoon. From the lagoon, pipelines transfer greenwater to the five center pivot LAAs.

- **Other surface sources with hydraulic heads:** Other potential sources were assessed including the milking parlor sumps, and locations in the production area with the potential for ponding such as the area between the corrals and lagoon. Other sources to be considered are up-gradient land uses that include agricultural operations.

- **Off-site sources:** When evaluating potential sources of contamination at the Dairy, it is important to look at potential off-site sources which may be contributing contamination to the Dairy, particularly when the facility's upgradient wells show contamination above NMWQCC standards. This is the case for MW-1A (12 mg/kg), MW-4 (38 mg/kg) MW-5 (14 mg/kg) and MW-6 (11 mg/kg) all of which are upgradient of the Dairy production area and downgradient of adjacent irrigated fields. The regional flow direction is consistently east-southeast, with local fluctuations due south (see Figure 3), this places the upgradient wells at Creekside directly in the path of any potential NO_3 plume that has developed in the subsurface from other facilities. For fourth quarter 2019, MW-4, the closest proximity well to adjacent farm fields of other ownership, measured NO_3 concentrations of 45 mg/kg. The constituent measurement fell to 38 mg/kg for second quarter 2020, but was still well above standard. This measurement provides a baseline of NO_3 coming onto the facility from off-site and should become the standard with which to evaluate contamination at the facility. Again, this is consistent with soil sample results which do not indicate overapplication to the degree that would dictate such high NO_3 in the groundwater.

Potential sources of NO_3 are the LAAs and residual N-containing soils in the area of the lagoon structures. Results from soil samples collected in Fall, 2019 show that the NO_3 concentrations in soils beneath the LAAs area are <15 mg/kg at a depth of 3 ft. As such, LAA are not a source of NO_3 in groundwater.

Of the pipelines identified, the pipeline segments from the greenwater lagoon to the LAA center pivots have the potential for providing an additional source of contamination if there is a leak in the structure. There is no historical evidence of pipe failure associated with the greenwater process system.

The two sumps and the runoff pond areas were not considered potential sources for contamination based on the available information. There were no visual indications of release from either of the two sumps that would suggest a significant potential source. The sumps are constructed of concrete with no visible signs of fractures or separation at corners. Additional pipelines for fresh water supplies in the corral areas are located near alleys. There was no evidence of excessive ponding or pipe failure associated with this water supply system. Based on interviews with Dairy personnel, any incidences of pipe leakage or failure in water level control in water troughs were addressed immediately due to the potential to excessively drain the surface water storage tanks used for the milking parlor operations.

Existing "low spots" or ponding areas have been identified in the production areas. The production areas are periodically graded for the removal of manure solids and to maintain surface drainage towards the appropriate storm water pond.

3.0 EXISTING DATA SUMMARY AND HISTORICAL OPERATIONS

Existing historical operations of the Dairy and monitoring data have been compiled and summarized, below. Additional information relevant to Dairy operations will be compiled during ongoing research of the facility and will be included within the Stage 1 Abatement Report.

3.1 OPERATIONAL HISTORY

Creekside Dairy is an animal feeding operation (AFO) with approximately 2766 milking cows and an additional 454 dry cows and 3000 heifers. The Dairy is currently permitted for a discharge of 56,000 gallons per day, according to DP-913 issued by NMED on December 31, 2018. Current discharge volumes from the Dairy have been higher.

The Dairy has a single milking barn which discharges greenwater through a flush alley system and ultimately to a sump located southwest of the milking barn (see Figure 2 and historical aerial photos and Site Maps in Appendix B). The greenwater is pumped from the sump to a single clay-lined lagoon on the south side of the corrals. A screen separator for manure solids is the subject of a DP condition (Table B5(b)) which states:

> "b) Complete construction of a manure solids separator associated with the existing wastewater disposal system, in accordance with approved construction plans and specifications and supporting design within 120 days of the effective date of this Discharge Permit (by **April 29, 2018**)."

An open lot corral system is used in the Dairy operation. The main corrals used for the milking cows, are oriented north and south and generally surround the milking parlor, which is oriented north/south. Dry cows and heifers are housed in corrals located east of the milking cow corrals. There is a commodity/hay storage area and green silage storage along the east side of the facility.

Stormwater runoff from the corrals and the production area drain primarily to the south and to the southeast and have surface flow toward two runoff ponds to the south and southeast of the corrals. Both stormwater impoundments, SW-1 and SW-2, are described in the current Discharge Permit. Stormwater is pumped from the permitted impoundments to the greenwater lagoon prior to land application.

The Dairy currently uses six (6) LAAs for irrigation with greenwater from the lagoon system; five are large center pivot irrigated fields of 120, 120, 70, 30 and 30 acres, and one is a flood irrigated fields of 15 acres located east of the Dairy toward U.S. Highway 285. These fields began accepting greenwater blend between 2004 (Fields 2A, 2B and 3), 2008 (Field 6) and 2010 (Fields 1 and 4). The current groundwater Discharge Permit for the Dairy lists a total of 385 acres of pivot irrigated and flood field lands used for land application of greenwater from the Dairy. As part of Stage 1 AP activities, a complete history of the LAA will be compiled and reported within the Stage 1 Report.

Based on the most recent groundwater analytical results of June 2020, samples collected from all but one of the monitoring wells (MW-1A) were shown to contain NO_3 concentrations in excess of the WQCC standard of 10 milligrams per liter (mg/L), including the upgradient monitoring wells, MW-4, MW-5 and MW-6. Monitoring well MW-4, the upgradient well northwest of the corrals, had NO_3 concentrations of <10 mg/L between 2012 and 2015, but has increased since then with several large exceedances between 40 and 70 mg/L. These upgradient wells presently range between 11 and 38 mg/L, respectively. The sample collected from wells MW-9 and MW-10, which are located on the eastern edge of the dairy property and are the most down gradient, were shown to contain 10 and 36 mg/L of NO_3, respectively.

To define existing plume boundaries for NO_3, Ci, SO_4 and TDS, GGI will construct isoconcentration maps for submittal with the Stage 1 AP Report, using the most recent four quarters of analytical data collected at the Dairy. The construction of these maps, along with direction of groundwater flow and gradient determinations, provides the basis for additional abatement decisions for the Dairy.

3.2 LINER UPGRADES

The greenwater lagoon system at the Dairy is clay-lined while the two separate stormwater impoundments that feed into the lagoon are unlined. The 2018 DP does not require upgrades to the lagoon or to the impoundments, but the DP does require concrete lining of any ditches that deliver stormwater to the impoundments and to the flood irrigation field (Field 1).

3.3 LAND APPLICATION AREAS

The Dairy currently uses six (6) LAAs for irrigation with greenwater from the lagoon system. The fields consist of 120, 120, 70, 30 and 30 acres for center pivot irrigation and one flood irrigated fields of 15 acres for delivery of the greenwater blend. Monitoring wells MW-3A is located downgradient of stormwater impoundment (SW-2) and MW-9 and MW-10 are currently located down gradient of all land application fields with the possible exception of LAA-Field 3 and LAA-Field 6. It should be noted that a monitoring well location plan is required under DP-913. As such, GGI will reevaluate potential well locations based on new information (the presence of a discrete perched zone) and submit a proposal to NMED within 45 days of the abatement plan approval.

3.4 POTENTIAL FLUID ACCUMULATION AND INFILTRATION AREAS

The Dairy production area is graded to drain rainfall toward the runoff impoundments (Figure 2). The corrals and sections of the property boundary are bermed to prevent runoff from leaving the property. Manure is not stored on-site except for short periods of time prior to land application of the solids. The Dairy is contracted with manure haulers and solids are used on-site at selected fields or is taken off-site on bi-weekly to monthly basis. The sump located at the milking parlor is the only sump that has been used at the Dairy. The sump has had minor overflows during periods of intense precipitation, however clean-up and pumping of the over-flow was quickly accomplished. Most overflows would have drained to the stormwater impoundment located south of the sump. There are no records or recollection of significant/prolonged over-flows at any water troughs at the Dairy. Pumps used to fill water troughs are a considerable source of electrical usage at the Dairy, and therefore a significant operations cost. Leaks and malfunctions at watering troughs are remedied as soon as they are discovered. Green silage is stored along the northern side of the Dairy, but is not considered to be a significant potential source of contamination. Cow pens are graded on an almost daily basis, so any low spot within the pens are eliminated on that same timeframe.

3.5 SOURCE CONTROLS

The greenwater lagoon is clay lined, while stormwater impoundments are unlined. As per NMED regulations, stormwater impoundments are not required to be lined under the condition that water is not allowed to remain in the holding ponds for a period longer than 14 days. The Dairy regularly pumps water from the stormwater ponds into the clay lined lagoon to ensure this requirement is met. Additional measures the Dairy intends to implement to provide source control include to improve drainage patterns and runoff control and to permanently close depressions that regularly collect runoff. A summary of proposed abatement actions for the Dairy is provided in Table 2.

The dairy is currently permitted under the 2018 DP-913 for disposal of 56,000 gpd but regularly has exceeded that flow. Initial observations at the Dairy indicate that the flows from the dairy parlor's floor flushing system to wash out accumulated manure may be excessive. Additional study of the automated system and switching that system to one operated manually are in order and were underway in December 2019. Measuring the extent of change in flow following any structural or operational change to the flushing system are needed to confirm progress in reducing parlor greenwater flow. Additional oversight and control of the hose lines in the parlor are also necessary.

The Dairy manages surface runoff in accordance with its Discharge Permit and does not have any recorded incidents of spills. The lagoon and impoundments are, and will continue to be, cleaned and maintained on a regular basis. Manure solids are, and will continue to be used on-site or hauled off-site, with only temporary, minor stockpiling on-site. Abatement efforts will be focused on source control and source identification.

3.6 SOIL DATA

Analytical data for soil samples collected within LAAs was not found within NMED files for DP-913. GGI is attempting to locate historical soil sampling results for the Dairy. NMED files will be researched again, along with Dairy files, former and currently involved consultants to the dairy and soil sampling contractors known to have provided soil sampling services to the Dairy. Historical and current soil sampling results will be tabulated and included within the Stage 1 AP Report.

Soil sampling was conducted in September 2019 at four of the six LAAs. Samples were not collected from Field 1 and Field 2A. Soil data is important because it provides the first indicator of NO_3 contamination at the surface before infiltration to the water table. Soil sample results are attached in Appendix 3 and Figure 5. A review of soil results from the Dairy indicate minimal NO_3 concentrations in the subsurface and a decreasing trend with depth. Field 3 was the only field with high NO_3 concentration in the 0-12" sample depth at 64 mg/kg and decreased with depth to <20 mg/kg in the 24-36" depth. The remaining three fields (2B, 4, and 6) had NO_3 concentrations below 35 mg/kg for all sample depths with a decreasing trend with depth.

The limited soil data cannot be used to determine potential past practices impacts on groundwater. As stated above, additional research will be performed to try and obtain additional data. In addition, future soil sampling data will be obtained and evaluated. This information will be included in the Stage 1 Abatement Report.

3.7 MONITORING WELL DATA

Historical water level measurements

GGI reviewed historical water levels measurements dating back to May 2012. Based on the data, there appears to be a perched aquifer(s) beneath the Dairy where water levels are approximately 40 to 50 ft higher than monitoring wells completed in the shallow aquifer. To date two perched aquifer zones have been identified. One is associated with the Cottonwood Creek arroyo (MW-3A) and a second zone in the southeast area of the Dairy associated with MW-10. Based on MW-9 which is completed in the shallow aquifer and situated between MW-3A and MW-10, the perched aquifer appears to be isolated and discontinuous beneath the Dairy.

The greatest water level decline over the period of record has occurred in MW-1A, with greater than seven feet of decline measured since 2012. This is consistent with the other on-site monitoring wells which have experienced declining water levels (ranging from less than one foot to as much as seven feet). However, water levels at MW-3A have risen more than 12 feet since 2012, most of which has occurred within the last year. A large rainfall occurred in the Roswell area in October 2019 which may be responsible for the significant recharge to the perched aquifer associated with MW-3A. Given the amount of time required for groundwater to percolate through the subsurface to the water table, it is likely the effects of this recharge event are still impacting water levels and it will take time before water levels equilibrate.

As noted in Table 1 water levels in MW-3A were lowest in 2012 and are currently abnormally high. MW-3A is also more likely to be affected by recharge due to its close proximity to Cottonweed Creek (see site map, Figure 1).

Historical water level measurements and analytical laboratory data for the Dairy are summarized in Table 1. Data presented within this proposal is considered reliable as it was submitted to NMED as part of DP requirements, however, GGI did not collect all data reported within Table 1 and cannot validate its accuracy.

Contaminant Concentrations

Reviewing contaminant concentrations presented in Table 1 trends begin to emerge. First, the highest concentrations for each constituent of concern (NO_3, Cl, SO_4, TDS) are centered around MW-3A and MW-10, both completed into a perched aquifer. It is important to note, these monitoring wells have the highest groundwater elevations at the facility. As discussed previously, MW-3A water levels are likely related to Cottonwood Creek, however MW-10 does not appear directly linked to a body of water which could contribute to recharge. MW-3A and MW-10 were completed into the perched aquifer while the rest of the wells at the facility were completed into the shallow alluvial aquifer.

<u>Nitrate Data</u>

Reported NO_3 concentrations from the groundwater sampling events conducted between 2012 and 2019 show samples collected from all wells, except MW-2A (no longer in service), showing exceedances above the NMWQCC standard of 10 mg/L. It should be noted that MW-9 had one exceedance at approximately 75 mg/L NO_3 which appears to be an anomaly given the consistent pattern of results at this well and the more recent compliant results.

The perched zone(s), represented by MW-3A and MW-10, show significantly higher NO_3 contamination than all of the shallow aquifer wells except for the upgradient well, MW-4. MW-3A showed a decreasing concentration trend from early 2014 (53 mg/L) through late 2018 (33 mg/L) before increasing to 41 mg/L in fourth quarter 2019. MW-10 has increased from <20 mg/L between 2012 and 2014, before increasing to 33 mg/L in fourth quarter 2019. Note, there are no sampling results for this well between mid-2015 and mid-2018.

Within the shallow aquifer, the highest concentrations over the 2012 to 2019 period were recorded in MW-4, one of three upgradient wells at the site. NO_3 concentrations in MW-4 were <10 mg/kg between 2012 and third quarter 2015. Since then, concentrations have increased and fluctuated significantly, exceeding 45 mg/L NO_3 during 5 events with highs of >70 mg/L. MW-1A and MW-6, both upgradient wells, have opposing trend with MW-1, rising slightly over the 2014 to 2019 period (currently at 12 mg/L), and MW-6 declining from a high of 19 mg/L to a current concentration of 13 mg/L. Two downgradient wells, MW-5 and MW-9, have generally remained relatively stable (<10 mg/L) over the 2012 to 2018 period, being slightly above 10 mg/L since 2018.

The samples collected from wells MW-1A, MW-4, MW-6 are located on the upgradient side of the dairy property. All exceed the NO_3 standard (although MW-1A and MW-6 only slightly). This would indicate that upgradient off-site sources of NO_3 are contributing to the elevated levels of NO_3 in groundwater and that downgradient of the Dairy the levels remain essentially the same or are often lower in concentration, as shown in Figure 4.

Chloride Data

For the 2012 to 2019 sampling period, Cl concentrations were below the NMWQCC standard for all wells except for MW-10, a perched zone well. MW-10 has been consistently above the standard and was above the standard at the beginning of this sampling period, ranging from approximately 250 mg/L in 2013 to over 400 mg/L at present. Although not exceeding NMWQCC standards, MW-3A, has the second highest Cl concentrations ranging between 200 to 250 mg/L. All of the shallow aquifer wells are generally >100 mg/L.

Sulfate Data

For the 2014 to 2019 sampling period that was conducted for SO_4 analysis, SO_4 was found consistently above the NMWQCC standard at all wells. The SO_4 concentrations in upgradient wells MW-1A, MW-4, and MW-6 were found at concentrations >1000 mg/L. This would indicate that natural background sources of SO_4 are contributing to the elevated levels.

TDS Data

Analytical results from 2012 to 2019 sampling events show TDS concentrations consistently in exceedance of the NMWQCC standard at all monitoring wells. All wells during this period began with result for TDS above the standard (>1000 mg/L) including the upgradient wells MW-1A, MW-4, and MW-6. This would indicate that natural background sources of TDS are contributing to the elevated levels. The highest TDS concentrations are found in the perched zone, MW-3A and MW-10, at between approximately 3500 to 4500 mg/L.

GGI will use groundwater flow direction data and the most recent groundwater analytical data from each of the Dairy monitoring wells to construct four quarters of Creekside Dairy focused isoconcentration maps for NO_3, Cl, SO_4 and TDS data.

3.8 HISTORICAL GROUNDWATER GRADIENT AND FLOW DIRECTION

Historical data from quarterly monitoring reports show groundwater flow direction at the Dairy is generally toward the east-southeast, which mirrors regional flow toward the Pecos River. However, in the southeast corner of the Dairy, near MW-10, there is a localized reverse gradient where groundwater moves to the northwest. The reverse gradient does not appear to correlate pumping effects, as the two production wells on-site are located upgradient (west) of the main production area and most of the monitoring wells, including MW-10. Historical groundwater levels and monitoring well survey information for the Dairy monitoring wells were used to create potentiometric surface maps included within this proposal. Sampling data from the previous year conducted by GGI and historical data obtained from Atkins Engineering estimate groundwater flow direction to the east-southeast. Using MW-4 and MW-9 a groundwater gradient was determined to be 0.002933 ft/ft.

Water level data will be further examined and findings presented as part of the Stage 1 AP report to evaluate seasonal trends and impacts from irrigation. The direction of groundwater flow at Creekside Dairy is crucial to proper monitoring well placement planned under Discharge Permit renewal activities.

3.9 EXISTING MONITORING WELL AND PRODUCTION WELL LITHOLOGIC LOGS

There are seven (7) existing groundwater monitoring wells installed at the Dairy. Well completion logs for MW-1A, MW-2A (no longer in service), MW-3A, MW-4, MW-5, MW-6, MW-9 and MW-10 are included within Appendix A. The logs are also provided for MW-1, MW-2 and MW-3 which have now been plugged and abandoned. The Dairy is provided fresh water by three on-site dairy production/irrigation wells. Completion information for the production wells will be researched as part of the Stage 1 AP activities.

The monitoring wells are completed into valley fill alluvial deposits, primarily clayey sands and clayey gravels with some sand and gravel. The well logs show total depth and water levels are from most recent sampling:

Monitoring Well	Total depth (feet, bgs)	Screen Interval	Water level (feet, bgs)
MW-1A	99	74-94	87.31
MW-3A	53	28-48	18.10*
MW-4	94	69-89	87.06
MW-5	102	82-102	100.14
MW-6	95	70-90	84.21
MW-9	123	98-118	110.90
MW-10	68	43-63	45.25

*Water level measurement from 4^{th} quarter 2019.

None of the monitoring wells are equipped with permanent pumps.

3.10 SUBSURFACE CROSS SECTION

Figures 6a and 6b depict the geologic cross sections beneath the Dairy based on the limited wells available. Additional geologic/alluvium cross-sections will be completed as part of the Stage 1 AP Report as additional monitoring wells are installed. A focused effort will be made on the wells situated within and around the arroyo. At least one North-South and at least one East-West cross section will be completed for the area, including wells located on the Dairy property.

4.0 SAMPLING AND ANALYSIS PLAN

The following sections discuss the purpose of the investigation (Section 4.1), the associated sampling design (Section 4.2), the supporting sampling procedures to be implemented (Section 4.3), and the evaluation of site subsurface hydrology (Section 4.4).

4.1 PURPOSE OF THE INVESTIGATION

The purpose for this investigation is to satisfy the requirements set forth in NMAC 20.6.2 4106 C, Stage 1 AP, and will assist in providing the data necessary to select and design an effective and appropriate abatement option for Creekside Dairy. The groundwater abatement investigation will have two objectives; 1) for the perched zone aquifer; and 2) for the shallow regional aquifer.

The current conceptual model for the perched zone is that there are at least two isolated aquifers of limited extent beneath the Dairy. They are identified at the locations of MW-3A and MW-10 which have significantly shallower depth to water than the other site monitoring wells (see cross-sections in Figures 6a and 6b). The limited extent of the perched zone is based on the fact that MW-9 is located between the two perched zone monitoring wells and a perched aquifer was not identified during the installation of the well. Also, a perched zone was not encountered at MW-2A which is located approximately 1000 ft north of MW-3A. The two perched zone wells did not encounter a confining stratum during their installation, but it is assumed that they are perched on carbonate cemented bedrock that is observed as physical outcrops along the Cottonwood Creek arroyo. These outcrops are limited in areal extent and occur at varying depths throughout the alluvium. Recharge to MW-3A appears to come from periodic flows of Cottonwood Creek based on a review of the DTW for this well that shows spikes occurring in the fall months associated with the monsoon season.

In addition, data will be collected for the purpose of: (1) examining the vertical and horizontal extent of soil contamination at the Dairy sources, (2) performing the hydrogeologic characterization of the abatement plan area, (3) completing contaminant plume delineation, (4) defining the rate and direction of contaminant migration, and (5) researching and identifying area activities that may have impacted groundwater quality at Creekside Dairy.

4.2 SAMPLING DESIGN

The following sections outline the rationale and goals for data collection. All existing monitoring wells (MW-1A, MW-3A, MW-4, MW-5, MW-6, MW-9 and MW-10) and the two production/irrigation wells for the production area and the LAAs will be sampled for the listed contaminants of concern. Potential receptors of contaminants will be assessed to identify relevant off-site wells, if any, to be sampled during the Stage 1 abatement investigation, provided landowners grant permission to access and sample the identified wells.

4.2.1 Delineation of Vertical and Horizontal Extent of Soil Contamination

Soil sampling is conducted within the LAAs on an annual basis as part of the DP requirements for the Dairy. Fifteen soil samples per field is collected at depths of 0-12 inches and will be combined into one composite sample for analysis for NO_3 and TKN. Six soil cores per field will be collected at depths of 12-24 inches and from 24-36 inches and each depth will be combined into one composite sample for analysis for NO_3 and TKN. Soil data from historical and future sampling events will be used to determine if deep soil sampling is necessary for any LAA fields or other potential sources based on an exceedance of 50 mg/kg from the 24-36inch sample. If deep sampling is required, composite soil samples will be collected at depth of 6, 8 and 10 ft bgs from up to six locations per LAA.

4.2.2 Hydrogeologic Characterization

The hydrogeologic characterization will use the previously described seven monitoring wells and two production wells on the Dairy property, and any wells from the adjacent sites, if appropriate in terms of depth and location from the Dairy and if approval for access is available. Well logs of nearby off-site wells will be researched for hydrogeologic information pertinent to delineating the sources of NO_3, TDS, SO_4 and Cl impacting the Dairy.

The lateral extent and identification of additional perched aquifer zones will be evaluated during the installation of source monitoring wells required under the 2018 DP-913. It is anticipated that up to five monitoring wells will be needed to meet the DP requirements. In addition, GGI will complete short duration pump tests on the existing perched monitoring wells to estimate aquifer characteristics and quantity of water held in the perched zones. The tests would be completed after sampling of wells during a future quarterly sampling event.

Currently, the only shallow aquifer well that shows significant NO_3 contamination above NMWQCC standards is the most upgradient well, MW-6, located northwest of LAA Field 2B, immediately east of the Dairy's western property boundary. As such, no abatement investigation on this aquifer is required at this time as it appears contamination originates from an off-site source. Abatement investigation activities for the shallow regional aquifer, if required, will be based on future sampling results (a minimum of four quarters) obtained from the planned source monitoring wells to be installed at the Dairy.

In addition, the following subsections describe the activities necessary to complete the hydrogeologic characterization, including site-specific stratigraphy and ascertaining basic aquifer properties, verifying groundwater flow direction, determining up-gradient and down-gradient water quality, and performing plume delineation.

4.2.2.1 Site Stratigraphy

Boring/well construction logs from monitoring well borings will be utilized to determine the site-specific subsurface stratigraphy and generate hydrogeologic cross-sections across the facility. These logs will be correlated with information from logs for on-site domestic and production wells, as applicable.

4.2.2.2 Direction of Shallow Groundwater Flow

Data that can be used to develop potentiometric surface maps focused on the Dairy will be completed for at least the past five years or to the extent that sufficient data allows. If data shows a focus on the Dairy to be different from the regional groundwater flow, a separate regional map will be prepared. Based on the fourth quarter 2019 data, shallow groundwater at the site ranges from approximately 18 feet bgs in MW-3A to 123 feet bgs in MW-9. The groundwater flow direction at the Dairy appears to be to the east-southeast.

4.2.2.3 Production Well Information

An in-depth study of potential receptors in and around the Dairy will conducted by GGI as part of the State 1 Abatement activities. Permitted wells within a 1-mile radius of the Dairy will be identified using the New Mexico Office of State Engineer (NMOSE) WATERS on-line database records to identify the permitted points of diversions. Once the OSE District II office (Roswell) reopens from the COIVD-19 closure, a paper file review will also be conducted. Location of the points of diversion will be plotted on a map and will information and logs and provided as an appendix included with the Stage 1 Abatement report. Upon completion of the monitoring well survey and construction of potentiometric surface maps, GGI will identify potential down-gradient receptors and will then propose sampling of relevant receptors. For the Stage 1 AP investigation, only wells completed within the shallow aquifer and situated down-gradient of the Dairy will be considered as possible receptors of elevated levels of contaminants of concern impacting the Dairy.

In addition, NMED files will be researched for well water quality data collected within the vicinity of the Dairy. NMED has conducted sampling activities of groundwater wells within the Artesia area. GGI will attempt to identify any data collected by NMED within relevant proximity to the Dairy. Once those records are compiled, wells potentially suitable for sampling as off-site receptors will be determined and well owners will be contacted to discuss whether they are using their domestic well for drinking water. It is not likely that homes within the down-gradient area of the Dairy derive their potable water from the shallow aquifer.

4.2.2.4 Groundwater Quality and Plume Delineation

The seven (7) existing monitoring wells at the Dairy will be inspected and will form a monitoring well network utilized for plume delineation (Figure 2).

Groundwater samples will be collected from existing monitoring wells in accordance with Table 3. The concentrations for NO_3, Cl, TKN, SO_4 and TDS will be plotted on site maps in isoconcentration contours based on the direction of groundwater flow. Isoconcentration maps will be produced for the most recent four quarters of groundwater data. The groundwater sample results and locations of contamination will be used to define the rate and direction of contaminant migration.

4.2.2.5 Plugging and Abandonment

After completion of the hydrogeologic characterization described in the sections above, it will be determined if any existing monitoring wells need to be plugged and abandoned according to NMED guidelines.

4.3 FIELD ACTIVITIES AND SAMPLING PROCEDURES

The following sections outline field activities and sampling procedures that will be conducted to fulfill the goals of the investigation.

4.3.1 Obtain Access Agreements for Private Well Sampling and Monitoring Well Installation

Preliminary research has not identified any off-site domestic wells that are at risk from NO_3, TDS, SO_4 or Cl plumes associated with the Dairy. If, upon determination of the localized gradient at the Dairy and completion of the Point of Diversion record search of NMOSE files/database, it is determined that a domestic well is in need of sampling, an access agreement will be pursued at that time.

4.3.2 Health and Safety Plan and Utility Locations

As part of any drilling or sampling activities, a site-specific Health and Safety Plan (HASP) will be developed and maintained for the investigation tasks at the Dairy. The HASP will contain all the elements described in Occupational Safety and Health Administration (OSHA) Code of Federal Regulations (CFR) Title 29 Part 1910.120(b)(4)(ii). The HASP will be reviewed by the designated Health and Safety Coordinator and Project Manager to ensure the work plan for the field activities conform to the tasks in the HASP, to address any changes in chemicals or physical hazards that were not part of the original risk assessment, and to allow for proper training of field personnel to perform assigned tasks.

For subsurface portion of the investigations, New Mexico One-Call and local utility services will be contacted to identify buried utilities to ensure that drilling locations are cleared and that activities will not interfere with services provided in the area.

4.3.3 Hollow Stem Auger Drilling and Soil Sampling

Drilling for boring and monitoring well installation will be performed using hollow stem auger drilling methods. A minimum 6 ¾ -inch diameter auger will be used. Split spoon or continuous core samples will be collected every five feet. Drilling and sampling equipment (split spoons) will be decontaminated prior to use and between samples using a laboratory-grade detergent and deionized water rinse.

All soil borings will be logged by the on-site geologist. Soils will be described based on grain size, sorting, lithology and color (using a Munsell color chart) using visual manual procedures. Additional properties including estimates of percent gravel, percent sand, percent silt, percent clay, and effervescence in hydrochloric acid (10% HCl) will be noted as is applicable.

Protective equipment will be worn as specified in the HASP. Management of drill cuttings is addressed in the investigation-derived wastes section (4.3.10) of this plan.

4.3.4 Monitoring Well Construction

All information, including the abandonment plan and the abandonment record, will be filed with NMOSE by a licensed driller, as required by 19 NMAC 27.4.30.B(3).

<u>Monitoring Well Construction</u>
Monitoring wells proposed for the Stage 1 AP will be constructed in accordance with NMED guidelines and NMOSE rules (19 NMAC 27.4.29 and 19 NMAC 27.4.30) and according to the following specification. Wells will be constructed as nominal 2-inch or 4-inch diameter wells.

1. Well bores will be drilled by hollow stem auger with a minimum 6 ¾-inch diameter auger.

2. Well materials will consist of Schedule 40 polyvinyl chloride (PVC) flush-thread jointed screen and blank casing.

3. To accommodate long-term water level declines at the site, screen will consist of 20 feet of 0.020-inch machine slotted screen. The screen will be submerged 15 feet and extend five feet above water table.

4. Filter pack will consist of 10-20 mesh silica sand placed from total depth to two feet above the top of screen.

5. A minimum two-foot thick hydrated bentonite pellet seal will be placed above the filter pack.

6. The remainder of the annulus between blank casing and surface will be grouted with a cement bentonite grout containing 95% cement and 5% bentonite.

7. Surface completion shall consist of above grade steel locking shroud with a minimum two-foot stick up. Monitor well shroud shall be painted yellow for visibility. Shrouds shall be set in concrete well pads (two feet by two feet by four-inch thick) sloped towards the outside edges in order to drain.

8. In trafficked areas or locations susceptible to farm machinery, three bollards (4-inch diameter posts of steel) set in two-foot deep post holes, secured and filled with concrete, and painted yellow will be installed around the well head to protect the monitoring well.

Monitoring well construction information will be documented on Boring/Monitoring Well Construction Logs. Well records will be filed with the NMOSE by the licensed driller according to 19 NMAC 27.4.29 K.

After installation, the wells will be surveyed by a licensed surveyor to a permanent benchmark common to the wells already surveyed (Section 4.3.9).

4.3.5 Monitoring Well Development

No earlier than 24 hours after the wells are completed, they will be developed. Development will be conducted by bailing and/or air lifting using the auger rig. Wells will be surged and bailed to the extent practicable until the well yields clear water. A minimum of 10 casing volumes will be removed during development. Development shall be under the direct supervision of the site geologist who will document the development activities.

4.3.6 New Mexico Office of State Engineer

All information, including the well installation and abandonment plan and the abandonment record, will be filed with NMOSE by a licensed driller, as required by 19 NMAC 27.4.30.B(3).

4.3.7 Water Level Measurements

An electronic water level indicator will be used to measure the depth to water in the well during each scheduled sampling event. This measurement will serve several purposes: to calculate a potentiometric surface, assess water level fluctuations, and to calculate the column of standing water in the well for purging prior to sampling. The depth to groundwater will be measured from a marked measuring point on the top of casing. The depth to groundwater measurement will be made to the precision of one hundredth of a foot. The water level indicator will be decontaminated between wells. Decontamination shall consist of washing the indicator probe and measuring tape that was submerged with non-phosphate detergent (e.g., Alconox™) and rinsing with distilled or DI water.

The total depth of the well will be measured using the same reference point used for the water level measurement. The distance to the bottom of the well will be measured annually to one hundredth of a foot, to determine if silting has taken place. A water level meter or weighted tape measure may be used for total depth gauging.

4.3.8 Groundwater Sampling

Groundwater sampling will be performed to establish whether or not impacts to groundwater are observed.

4.3.8.1 Monitoring Well Sampling

The following monitoring well sampling procedure will be followed:

1. Measure Water Level. Measure the depth to water to the precision of one hundredth of a foot in the well from the marked measuring point on the PVC well casing (same point from where the well casing was surveyed). Decontaminate the electronic tape after each well gauging in Alconox™ solution and then rinse with distilled or DI water.

2**.** *Calculate Purge Volume.* GGI personnel will follow the procedure outlined below, excerpted from GGI's Standard Operating Procedure (SOP) on monitoring well sampling:

> The accepted volume for successful purging of the well prior to sampling is a minimum of three (3) well bore volumes. There are 0.163 gallons per vertical foot of water in a 2-inch (ID) well casing and 0.653 gallons per vertical foot of water in a 4-inch (ID) well casing. If the monitoring well casing has an inner diameter other than the standard 2 or 4 inches, you will need to make a calculation of the volume per foot for that particular well ID based on the following equation for the column of a one-foot tall cylinder:
>
> Volume of a cylinder = $\pi \times r^2 \times h$
> Where r = inner radius of the casing in feet (½ x ID ÷ 12 (inches per ft)), h = height of 1 ft, π = 3.1416
>
> Equation Becomes:
>
> V (gallons per ft) = $(3.1416 \times (D \div 24)^2) \times 7.48$
> Where D = well casing inner ID in inches, and there are 7.48 gallons in 1 ft^3
>
> To calculate the purge volume, first multiply the height (h) of the water column [total depth of well – depth to water in feet] by 0.163 (for a 2-inch well) to get the total volume of water in the well casing. Then multiply this calculation by three to get the required three well bore volumes for purging.
>
> Use the following formulas:
>
> Height of water column
> (**h**)= total depth of well – depth to water
>
> One Well Bore Volume
> (**BV**)= (**h**) x 0.163 (gal/ft) = Gallons (for 2-inch ID well casing)
>
> Minimum purge amount:
> **BV** x 3 = 3 **BV**
>
> Complete a table similar to the following example:

Monitoring Well ID	Total depth of well (in ft) **A**	Depth to water (in ft) **B**	Water column height (in ft) **h = (A-B)**	One well bore volume (in gal) **BV = (h x gal/ft)**	Total purge volume (in gal) **3 x BV**	Actual volume purged (in gal) or Purge Time	Sample Time or Pump Depth
MW 1							
MW 2							

Calculate the required purge volume for each well prior to pumping. You will need to pump out three times the volume of water calculated to be in the casing.

Well Purging Procedures

a. *Purging with a bailer*: On shallow, small-diameter wells, or if equipment failure does not permit pump use, a single-use (disposable) bailer can be used. Attach a single-use bailer to an unused, clean rope or strong string (white nylon braided mason's twine or equivalent) with an appropriate length to reach below the static water level and capable of suspending the full bailer's weight. A weighted bailer is preferred for purging. A recommended step is to wind the rope on a reel used for lawn hoses or extension cords. Make sure that the bailer rope is attached to the reel or some other surface feature prior to bailing. Try to keep the bailer rope from becoming contaminated by surface debris or other materials that could impact the sample.

b. *Purging with a pump*: Place pump in well casing and lower to the water column. Placement of the pump below the middle of the screen and above the bottom of the well casing is critical for proper purging. The purge pump may be placed near the very bottom of the well if the observed conditions require this position (e.g. small water column, a history of poor recharge). Start the purging and monitor the pumping time and measure flow (gallons per minute) with a five-gallon bucket or other known volume container. Adjust the flow of the purge pump as needed to ensure a steady rate of flow.

Divide required purge volume (gallons) by flow (gallons per minute) to figure time needed to pump three well bore volumes. Pump well until the required amount has been purged. Purging more than three well bore volumes is acceptable, but will not necessarily improve the quality of the sample.

c. *Purging of domestic or production (irrigation) wells:* Domestic or irrigation wells usually have their own dedicated pump either submersed in the well or attached to the top of the well with piping and drive shaft extending down below the groundwater (turbine-shaft pump). The turbine shaft pumps are used in large production applications such as irrigation wells and municipal wells.

Arrange for access to the well and obtain a water level if possible following the procedures used in a monitoring well. Document the measuring point and other information regarding elevation of the measuring point and well conditions.

Purging times of domestic wells will vary based on pump size, depth to water, and the associated domestic pipe system. As a general rule, a minimum of 20 minutes of active pumping and discharging of domestic wells is sufficient to purge the original well volume and additional bore volumes. Individual assessment of domestic wells may be required to determine if a sufficient purge volume has been completed.

Purging times of the larger wells will depend on schedules for irrigation or for production for storage in surface containers (tanks, lagoons, etc.). Contact the well operator (e.g. property owner, dairy manager, water system technician) and determine an appropriate time for sampling that conforms to the pumping schedule. These pumps may operate over significant periods and the ability to obtain a static water level may not be possible at the time of sampling.

Do not attempt to operate any pump or sample without a property owner or designated representative present.

Safety Note: Be careful regarding sampling operations around turbine wells. The motors for this type of well run with high voltage and high revolutions. If there is a concern for personal safety or equipment safety, do not sample and arrange for another day for sampling. This is especially true in the vicinity of lightning storms during summer months.

4. Temperature, pH, and electrical conductivity will be measured in the field during each groundwater sampling event.

5. Sample Well. After three casing volumes have been purged/developed, the well is ready to sample. Fill sample containers according to Table 4. The analysis, time of collection, date, and monitoring well number shall be recorded on sample bottle label and in the sampler’s field notebook. The sample containers will be placed in a cooler on ice as soon as they are filled and labeled.

4.3.8.2 Domestic/Production Well Sampling

The location and identification of the off-site domestic or production wells will be determined as a part of the Stage 1 AP. The same general procedures for groundwater samples will be applied to domestic and production well samples. A sample location will be selected that does not include either one of the following problems:

- *A sample location that may be at the end of a significant distance of piping*. Find a sample location that is close to the pump source. This reduces the potential for stagnant water to be included in the sample.
- *On irrigation wells, a sample location downstream of lines and systems that add fertilizers to pipe systems.* Many irrigation wells combine greenwater and/or chemical fertilizers as part of the delivery system such as a center pivot. Again, the closer to the pump source, the less likely for contamination from sources outside the well.

When the minimum time for purging has been completed, the water sample will be collected, and the field technician will complete the same labeling and chain of custody procedures as a groundwater sample. Documentation will include a description of the sample location and any other pertinent information about the sample.

4.3.9 Surveying

New and existing monitoring wells will be surveyed by a licensed surveyor. The survey will be done in New Mexico State Plane Coordinates, Central Zone, NAD 27 and will include northing and easting to a tenth of a foot accuracy. Elevations of top of casing elevations for wells will be surveyed to the nearest hundredth of a foot.

4.3.10 Investigation-Derived Waste Management

The implementation of the activities outlined in this Stage 1 AP will generate cuttings from drilling of boreholes, water from wells purging for development and prior to sampling, and personal protective equipment (PPE) used by field personnel.

The cuttings generated during drilling boreholes using HSA equipment will be spread in the vicinity of the borehole, directly on the ground.

Purge water from well development and sampling will be ground discharged. Purging from sampling of new wells will generate a limited quantity of water which will be released to the ground, a practice consistent with compliance monitoring routine procedures. Water generated during short-term, low-volume pumping tests will also be discharged to the ground surface.

PPE generated during this investigation includes protective gloves, paper towels, and general solid waste. None of this waste will require special handling and will be disposed as solid waste.

4.4 SURFACE HYDROLOGY EVALUATION

The interaction between groundwater and surface water will be evaluated based on information gathered from published sources. The NMOSE has conducted extensive hydrogeologic studies in the Pecos Valley that can be used to determine if groundwater contamination at the Dairy has the potential to reach any nearby surface water. NM Department of Game and Fish conducts surveys of fish, invertebrates and wildlife populations and health in the Pecos Valley. Public reports from this state agency can be used to evaluate impacts from the dairy.

5.0 QUALITY ASSURANCE PROJECT PLAN

This section of the SAP includes the Quality Assurance Project Plan (QAPP) for executing the sampling described in Section 4.0. This QAPP includes elements of the Guidance Quality Assurance Project Plans (QA/G-5) (EPA 2002) and Guidance on Systematic Planning using the Data Quality Objectives Process (QA/G-4) (EPA 2006b).

5.1 DATA QUALITY OBJECTIVES

In summary, the overall data quality objectives (DQOs) for this project are shown in Table 3 and include: defining the potential contaminant sources, performing the hydrogeologic characterization of the area according to the requirements of 20 NMAC 6.2.4106.C, and to gain knowledge about the Creekside Dairy property groundwater quality conditions including plume delineation. The data decisions defined herein are applicable to the Stage 1 Abatement Plan.

5.2 PROJECT MANAGEMENT

Project organization, roles and responsibilities, training, record keeping, and documentation are discussed in the subsections that follow.

5.2.1 Project Organization

- Steve Jetter – Technical Lead, Quality Assurance/Quality Control (QA/QC) Manager
- Marques Hatfield – Project Manager and Field Operations Manager
- Paul Drakos – Health and Safety Coordinator
- Jeremiah Starr and Doug Idsinga – Environmental Field Technicians

5.2.2 Responsibilities

Technical Lead, QA/QC Manager – Project oversight, communication with clients and NMED personnel, evaluate employee experience and certify they are qualified to work at the site, technical review of report(s), which will include QA/QC of technical data and verification of data usability.

Project Manager – Liaison between client and NMED, abatement plan preparation, assignment of personnel to appropriate positions, report(s) preparation—including initial evaluation of data usability and data quality, communication with laboratory, coordination of sampling. Duties may include: securing utility locations, notifications, site supervisor, and health and safety.

Health and Safety Coordinator – Responsible for Health and Safety Plan (HASP) review and approval.

Field Sampling Crew – Responsible for field sampling and measurement activities in accordance with approved SAP and implementing proper sampling and sample handling procedures.

5.2.3 Training Requirements

This section outlines the training and certification required to complete the activities described in this SAP. The following sections describe the requirements for personnel working on site.

Health and Safety Training

The Dairy has been identified to conduct voluntary corrective actions that include site investigation and sampling of contaminated groundwater. Field personnel who are conducting investigative or sampling work at the Dairy do not qualify under one of the five activities detailed in OSHA's 29 CFR Part 1910.120(a)(i) *Scope* and are exempt from the requirements for training under 29 CFR 1910.120(e).

The basis of this exclusion is the assessment of the "hazardous waste" and hazardous substances listed as the contaminants of concern for the field activities under this work plan. NO_3, Cl, TDS, and related animal waste products are not classifiable as a hazardous substance and are not found in the various defined lists in the Comprehensive Environmental Response, Compensation, and Liability Act (40 CFR 302.4), the Clean Water Act (40 CFR 110, 116.4, 117, 122, and toxic pollutants listed under Section 307(a)), the Resource Conservation and Recovery Act (40 CFR 261 through 262), the Clean Air Act (40 CFR 68) or the Toxic Substance Control Act (40 CFR 760.120). However, the health safety of field personnel is still a primary goal and requires the sufficient training and monitoring to maintain a safe work environment.

Therefore, to ensure adequate monitoring of health and safety issues at the Dairy, the staff geologist or environmental scientist who supervises field personnel for field activities will be qualified under 29 CFR 1910.120(e)(4). Additionally, the staff geologist/environmental scientist will also have completed the additional eight hours of specialized supervisor training. The supervisor training covers health and safety program requirements, training requirements, PPE requirements, spill containment program, and health-hazard monitoring procedures and techniques. Before work begins at the Dairy, field personnel will be required to complete reviews of the following topics:

- Names of personnel and alternates responsible for health and safety at the site;
- Health and safety hazards present on site;
- Selection of the appropriate personal protection levels;
- Correct use of PPE;
- Work practices to minimize risks from hazards; and
- Contents of the site-specific health and safety plan (HASP).

Field personnel are not authorized to participate or supervise any activities that are considered to be emergency responses to spills or release of a hazardous substance. The work plan and associated HASP will be periodically reviewed for changes in operation or contaminants of concern to that may change the training requirements to satisfy 29 CFR 1910.120.

5.2.4 Documentation and Records

Documentation is critical for evaluating the success of any environmental data collection activity.
The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. Section 6 describes reports that will be submitted as a result of this project.

<u>Field Documentation</u>
Field personnel will compile field boring logs as described above and will document field activities in bound field notebooks with numbered pages. Field notebooks are maintained according to GGI's field notebook SOP as follows:

Standard Operating Procedure (SOP)
for
FIELD NOTEBOOK MAINTENANCE

Author: J. Riesterer
Reviewed by: J. Lazarus, P. Drakos
Date: 2/9/09

<u>Purpose and Scope</u>
The purpose of this SOP is to instruct field personnel in proper field notebook maintenance and to provide an overview of information that should be recorded in the field notebook for all projects, regardless of the type of work being conducted.

<u>General Notebook Guidelines</u>
All field notebooks should include the following information:

- Owner information inside front cover, including owner's name, GGI name, address, and telephone number

- Index of projects included in the field notebook. If a notebook does not have pre-numbered pages, page numbers should be added manually and used to create the index
- Write the start date and end date for each notebook on the field notebook binder (a sharpie works well for this)

Guidelines for Field Data Entries

The following guidelines apply to all field notebook entries, regardless of project type. Information that should be recorded for every project include:

- Date at the top of each page
- Project name at the top of each page
- Location information (where the field work is being conducted)
- Field team members
- Weather conditions
- New projects should be started on a fresh page
- New days, even for a continuing project, should be started on a fresh page
- All data should be entered using black or blue ink
- Corrections should be made by drawing a single line through the error and then entering the corrected information
- Document phone calls to a project manager for a change in scope or procedure not in the original project (note time; person contacted; subject matter; final resolution)
- Review the field notes for clarity and legibility at the end of the field day
- Make sure field notes are legible
- Review field notes at the end of each day for completeness/legibility

Guidelines for Collection of GPS Points

- Under most circumstances, GPS coordinates should be collected using UTM coordinates, NAD 1927. The coordinate system (UTM) and datum (NAD 1927) should be recorded in the field notebook. If a different coordinate system is used, the pertinent information must be recorded.
- All GPS points collected should be recorded in the field notebook, even if they are added as waypoints to a GPS

Guidelines for Field Sketches

- Where possible, sketches should be drawn to scale, with the scale indicated on the drawing
- If it is not possible to make a scale drawing, it should be noted that the drawing is not to scale
- All sketches should include a directional reference (i.e. north arrow if it is a plan view sketch, direction labels at ends if the drawing is a cross-section)
- All drawings should include a text description of the location of the drawing, ideally including GPS coordinates
- If photographs are taken of the sketched location, this should be indicated in the field notes, including the number and orientation of the photos (for example: one photo taken looking east at sketch location, two photos taken looking north at sketch location)

Post-Field Control of Field Data

- Upon return from the field, all notes are to be photocopied, scanned into the appropriate project folder on the server, and provided to the project manager for filing.
- If photographs were taken during the field work, the photographs should be downloaded from the camera to an appropriate directory on the server and assigned descriptive names as soon as possible to avoid confusion in the future about the photos' subjects.

5.3 DATA ACQUISITION

This section describes the requirements for the following:

- Sample Design (Section 5.3.1)
- Sampling Method Requirements (Section 5.3.2)
- Sample Handling and Custody (Section 5.3.3)
- Analytical Methods (Section 5.3.4)
- Quality Control Sampling (Section 5.3.5)
- Instrument / Equipment Testing, Inspection, and Maintenance (Section 5.3.6)
- Instrument Calibration Procedures (Section 5.3.7)
- Inspection and Acceptance Requirements for Supplies and Consumables (Section 5.3.8)
- Management of Stage 1 AP Deviations (Section 5.3.9)

5.3.1 Sample Design

The sampling design for the general investigation is described in detail in Section 4.2. The final sample design will reflect the information acquired in the inventory of domestic wells.

5.3.2 Sampling Method Requirements

Sample method requirements for the project are specified in Table 4. The current sampling methods are consistent with the suite defined in the Discharge Permit.

5.3.3 Sample Handling and Custody Requirements

The following subsections describe sample handling procedures, including sample identification and labeling, documentation, COC, and shipping.

<u>Sample Identification</u>
Each sample collected during site assessment activities will be identified using a unique sample identification (ID) number. The description of the sample type and the monitoring well name, as well as depth of the sample collection point, will be recorded on the COC forms, as well as in the field notebook.

Sample IDs will be listed on the sample labels and the COC forms submitted to the laboratory, and will be cross-referenced to the point name in field notebook.

<u>Sample Labels</u>
A sample label will be affixed to each sample container. The label will be completed with the following information written in indelible ink:

- Project name and location
- Sample identification number
- Date and time of sample collection
- Preservative used
- Sample collector's initials
- Each sample will be refrigerated or placed in a cooler containing ice.

<u>Sample Documentation</u>
Documentation during sampling is essential to promote proper sample identification. Field personnel will

adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent black or blue ink.
- All entries will be legible.
- Errors will be corrected by crossing out the entry with a single line and then dating and initialing the lineout.

Chain of Custody

Field personnel will use standard sample chain of custody (COC) procedures to maintain and document sample integrity during collection, transportation, storage, and analysis.

A sample will be considered to be in custody if one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal in such a way that the sample cannot be reached without breaking the seal.

COC procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The COC form will be used to document all samples collected and the analyses requested.

Information that the field personnel will record on the COC form includes:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of sample (laboratory name)
- Sample ID
- Date and time of collection
- Number and type of containers filled
- Analyses requested
- Preservatives used
- Filtering (if applicable)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Air bill number (if applicable) or courier information
- Project contact and phone number

Signed air bills will serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the COC form and the air bill will be retained and filed by field personnel before the containers are shipped.

The laboratory sample custodian will receive all incoming samples, sign the accompanying COC forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample IDs, and any unique laboratory identification numbers for the samples. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will ensure that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, will be properly stored and maintained prior to analysis.

5.3.4 Analytical Methods

Analytical methods for the project are specified in Table 4. This table also specifies the sample quantities, sample container, holding times, and preservatives.

5.3.5 Quality Control Sampling

The subsections below specify QC protocols for field samples and laboratory samples. Two types of field samples are proposed.

<u>Duplicate Sample</u>
Duplicate samples will be obtained as part of the sampling plan. One duplicate sample will be obtained either for every ten (10) water samples collected at the combined Dairies or, at a minimum, from one sample location for Dairies with less than a total of ten sample locations. The duplicate sample will be collected at location to be determined later. The sample will be submitted for analyses for NO_3, TKN, TDS, and Cl. The results will be included in the data validation review of the quarterly reports.

<u>Equipment Rinsate Sample</u>
A single equipment rinsate sample will be obtained from the submersible pump after the sampling is completed at the Dairy. The sample will be submitted for analyses for NO_3, TKN, TDS, and Cl. The results will be included in the data validation review of the quarterly reports.

No additional quality control samples such as trip blanks, field blanks, spike samples, or surrogate samples will be performed. The contract laboratory will be required to provide internal QA/QC samples with protocols and results.

5.3.6 Instrument/Equipment Testing, Inspection and Maintenance

All equipment used during the site assessment will be properly tested, inspected, maintained, and calibrated. Samples collected during this investigation will be analyzed only by laboratory equipment.

The laboratory's QA plan and written operating procedures describing specific testing, inspection, maintenance, and calibration procedures for equipment will be followed.

5.3.7 Instrument Calibration Procedures

The equipment utilized for this project is a water quality multi-meter. The calibration of this instrument will be performed according to the manufacturer's Operation Manual.

5.3.8 Inspection and Acceptance Requirements for Supplies and Consumables

The project manager has the primary responsibility for identifying the types and quantities of supplies and consumables needed to complete the project and is responsible for identifying acceptance criteria for these items.

Supplies and consumables can be received either at GGI's office or at a work site. When supplies are received at an office, the project manager or field personnel will sort them according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before they are accepted for use on a project. If an item does not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order and the item will then be returned to the vendor for replacement or repair.

Procedures for receiving supplies and consumables in the field are similar. When supplies are received, the project manager or field personnel will inspect all items against the acceptance criteria. Any deficiencies or problems will be noted in the field logbook, and deficient items will be returned for immediate replacement.

Analytical laboratories are required to provide certified clean containers for all analyses. These containers must meet EPA standards described in *Specifications and Guidance for Obtaining Contaminant-Free Sampling Containers* (EPA, 1992). The analytical laboratory will be contracted to provide the appropriate chemical preservation in the specified container type based on the required analysis. The analytical laboratory will label the prepared container to ensure that the field technician is aware of the content.

5.3.9 Management of Stage 1 AP Deviations

Minor deviations, including field instrument malfunction (pH meter, etc.) will be addressed by field crew and the project manager and professional judgment will be utilized. Any deviation from the SAP will be detailed in the field notebook and included in the final report to NMED. Any deviation considered significant will be addressed by the field crew, project manager and NMED Project Managers. A consensus on correcting the deviation will be achieved prior to executing any work plan changes, if at all possible. It is expected that the NMED GWQB Project Manager or other agency representative will be available for communication during fieldwork. If a situation arises that requires work plan deviation, every attempt will be made to reach an NMED-GWQB representative. If attempts are unsuccessful and a deviation from the work plan must be made in a timely manner, the project manager will use professional judgment to adjust work plan specifications as needed.

5.4 DATA VALIDATION AND USABILITY

This section describes the procedures that are planned to review and evaluate field and laboratory data. This section also discusses procedures for verifying that the data are sufficient to meet DQOs for the project.

5.4.1 Data Review, Validation and Verification Requirements

For this project GGI will perform data review on 100 percent of the laboratory results. No validation will be performed. Data will be reviewed for holding times, handling and preservation procedures, chain of custody, acceptance within control limits, and to ensure data meet method control limits for project goals.

5.4.2 Laboratory Data Evaluation and Usability

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any non-conformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation will be clearly identified in the case narrative section of the analytical data package.

All laboratory data will be reviewed to ensure usability. The data evaluation strategy will not be a full data validation process, but will determine if the analytical results are within the QC limits set for the project. In this process, the data usability will be assessed. Specifically, sample handling requirements, holding times, duplicate results, and QC control limits will be reviewed.

5.4.3 Reconciliation with DQOs

After environmental data have been reviewed and evaluated in accordance with the procedures described above, the data must be further evaluated to assess whether DQOs have been met.

To the extent possible, EPA's data quality assessment (DQA) process will be followed to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's *Data Quality Assessment, A Reviewer's Guide* (EPA, 2006a). The DQA process includes five steps: (1) review the DQOs and sampling design; (2) conduct a preliminary data review; (3) select a statistical test; (4) verify the assumptions of the statistical test; and (5) draw conclusions from the data. In the case of this project, no statistical analysis is planned.

When the five-step DQA process is not completely followed because the DQOs are qualitative, data quality and data usability will be systematically assessed. This assessment will include:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives;
- A review of project-specific data quality indicators and project reporting limits to evaluate whether acceptance criteria have been met;
- A review of project-specific DQOs to assess whether they have been achieved by the data collected; and
- An evaluation of any limitations associated with the decisions to be made based on the data collected.

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

5.5 DATA MANAGEMENT

Field data will be recorded in field notebooks or field forms and will be included in the appendices of the Site Investigation report. Analytical data will be received in electronic form and will be summarized, tabulated, analyzed, and provided in the body of the report. The original laboratory data will also be provided in the appendices, or electronically on CD. As appropriate, some data will be presented graphically. GGI will oversee collection of environmental data using the appropriate assessment and audit activities.

Any problems encountered during an assessment of field investigation or laboratory activities will require appropriate corrective action to ensure that the problems are resolved. Any problems and the associated corrective action will be noted in the annual summary report.

5.6 PLANNED DATA EVALUATION

This section discusses procedures for verifying that the data are sufficient to meet DQOs for the project. NO_3, Cl, SO_4 and TDS in groundwater will be evaluated against the WQCC Standards as well as against up-gradient (background) concentrations, if necessary. TKN will be evaluated as an indicator of recent groundwater or soil contamination. Practical quantification limits for these compounds will be sufficiently low that a comparison to the standards will be possible (see Table 4).

6.0 REPORTING

The outcome of this Stage 1 AP will be documented in a Stage 1 AP Site Investigation Report (§4106.C.6.). This report will include a description of field operations, any deviations from the Stage 1 AP, the raw and processed analytical data, as well as graphical representations of all spatial data including cross section(s) and a potentiometric surface map.

Supporting information such as an evaluation of analytical data from other facilities operating under discharge permits will be included. The report will include a section on data gaps, if any are identified, and recommendations for subsequent data collection.

7.0 MONITORING PLAN

All Stage 1 AP monitoring wells installed under this plan, once deemed necessary, will be sampled on a quarterly basis during the first two years (8 quarters) to establish baseline conditions. The AP wells will be sampled along with sampling existing monitoring wells so that water level and chemistry data is contemporaneous. Any off-site wells sampled during this investigation that show elevated levels of the contaminants of concern will also be sampled on a quarterly basis, pending permission of well owners. After the initial 8 quarters of monitoring, the frequency of monitoring well sampling may be changed following NMED approval.

If for any reason sample analyses indicate that any well sampling should cease, a formal request documenting the reason for the change should be submitted to NMED. The abatement plan wells will be sampled in accordance with procedures outlined in this Stage 1 AP. Sampling results and water level data will be provided to NMED as a letter report on a quarterly basis. A formal abatement monitoring report will be submitted on an annual basis. The report will include an analysis of soil and groundwater analytical results, potentiometric surface maps for all four sampling events, contaminant isoconcentration maps, cumulative data for the analytical results and recommendations.

8.0 IMPLEMENTATION SCHEDULE

The schedule for the implementation of this Stage 1 AP, as per requirements of 20 NMAC 20.6.2.4106.C.6, is presented below. The quarterly monitoring reports shown in this schedule will follow the sampling performed for the Investigation Report and will continue until other monitoring requirements will be established in collaboration with NMED. Summary quarterly progress reports will be submitted during periods of active field investigations outside of groundwater monitoring events. This schedule is predicated on NMED review cycle.

Days	**Task**	**20.6.2 NMAC**
	PHASE I	
0	Submit Stage 1 Abatement Plan Proposal	§4106.C
30	Public Notice Requirements (NMED News Release)	§4108.A
60	Stage 1 Abatement Plan Proposal Approval by NMED	§4109.A
120	Site Investigation Activities Begin	§4110
150	Quarterly Progress Report 1 – Estimated date; TBD based on approval of NMED approval of Proposal Plan elements.	§4106.C.6
180	Site Investigation Activities Completed	-

Days	Task	20.6.2 NMAC
240	Quarterly Progress Report 2 – Estimated date; TBD based on approval of NMED approval of Proposal Plan elements.	§4106.C.6
270	Site Investigation Report Submittal for NMED approval	§4106.C.6
300	Meeting with NMED to discuss comments on Site Investigation Report and any additional investigation work required.	-
330	Quarterly Progress Report 3 – Estimated date; TBD based on approval of NMED approval of Proposal Plan elements	§4106.C.6
330	Submit revision to Site Investigation Report (Final), if necessary.	
	PHASE II	
0	NMED Comments on Final Stage I Abatement Report	§4109.A
30	Updates to Final Site Investigation	§4106.C.6
40	Meeting about Stage 2 Plan and Monitoring requirements (If required)	§4106.D
90	Summary Quarterly Progress Report 3 – Estimated date; TBD based on approval of NMED approval of Proposal Plan elements.	§4106.C.6
TBD	Begin Stage 2 Abatement activities or implement long-term monitoring	§4106.E
180	Summary Quarterly Progress Report 4 – Estimated date; TBD based on approval of NMED approval of Proposal Plan elements.	§4106.C.6

9.0 REFERENCES

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FIGURES

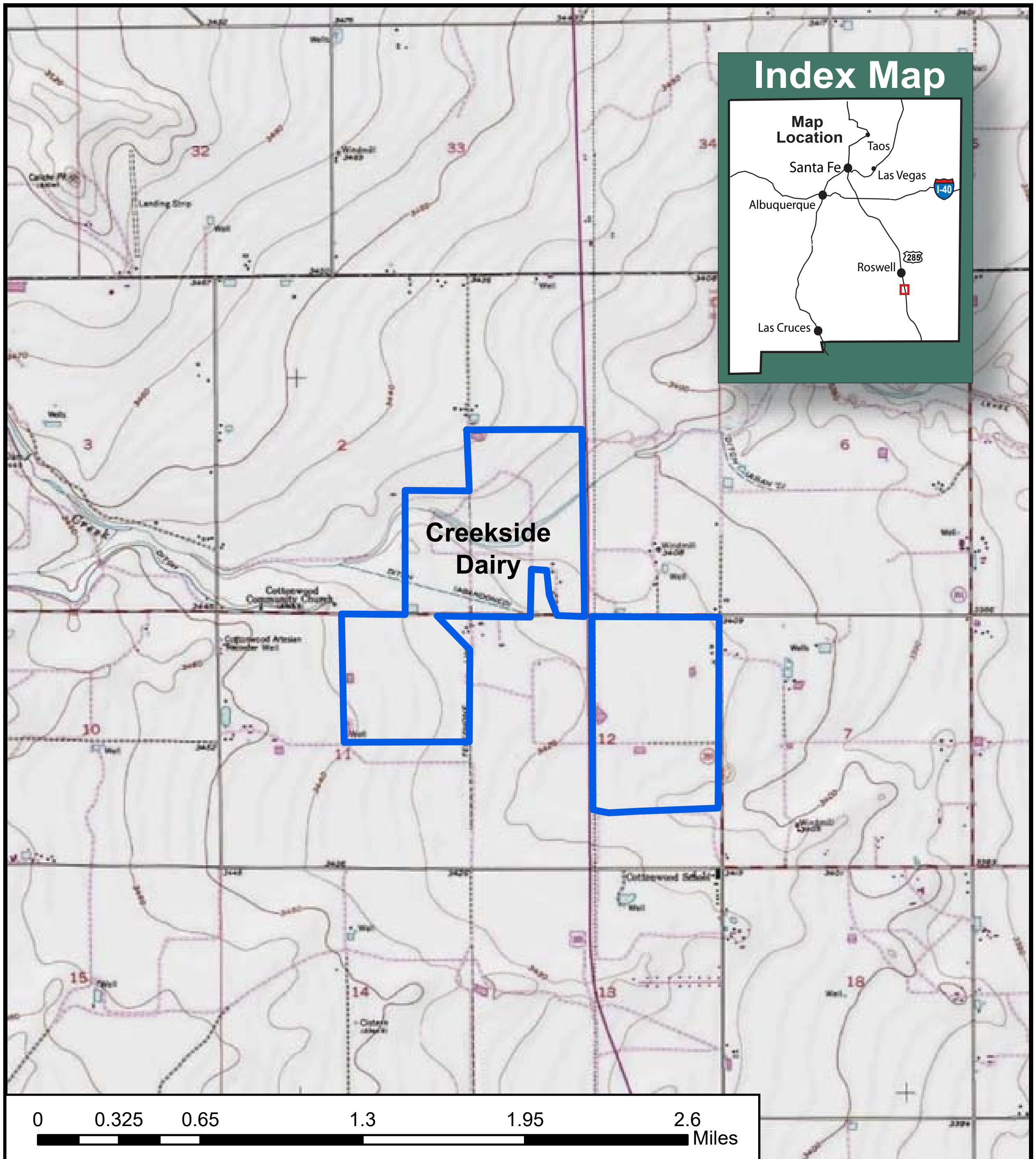

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Figure 1. Creekside Dairy: Site Location Map

DP-913, Permitted Discharge of 56,000 gpd

GLORIETA GEOSCIENCE, INC.

7785 Roswell Highway
Artesia, New Mexico
Chaves County

Property Boundary

Sections 1, 2, 11 and 12
Township 16S, Range 25E

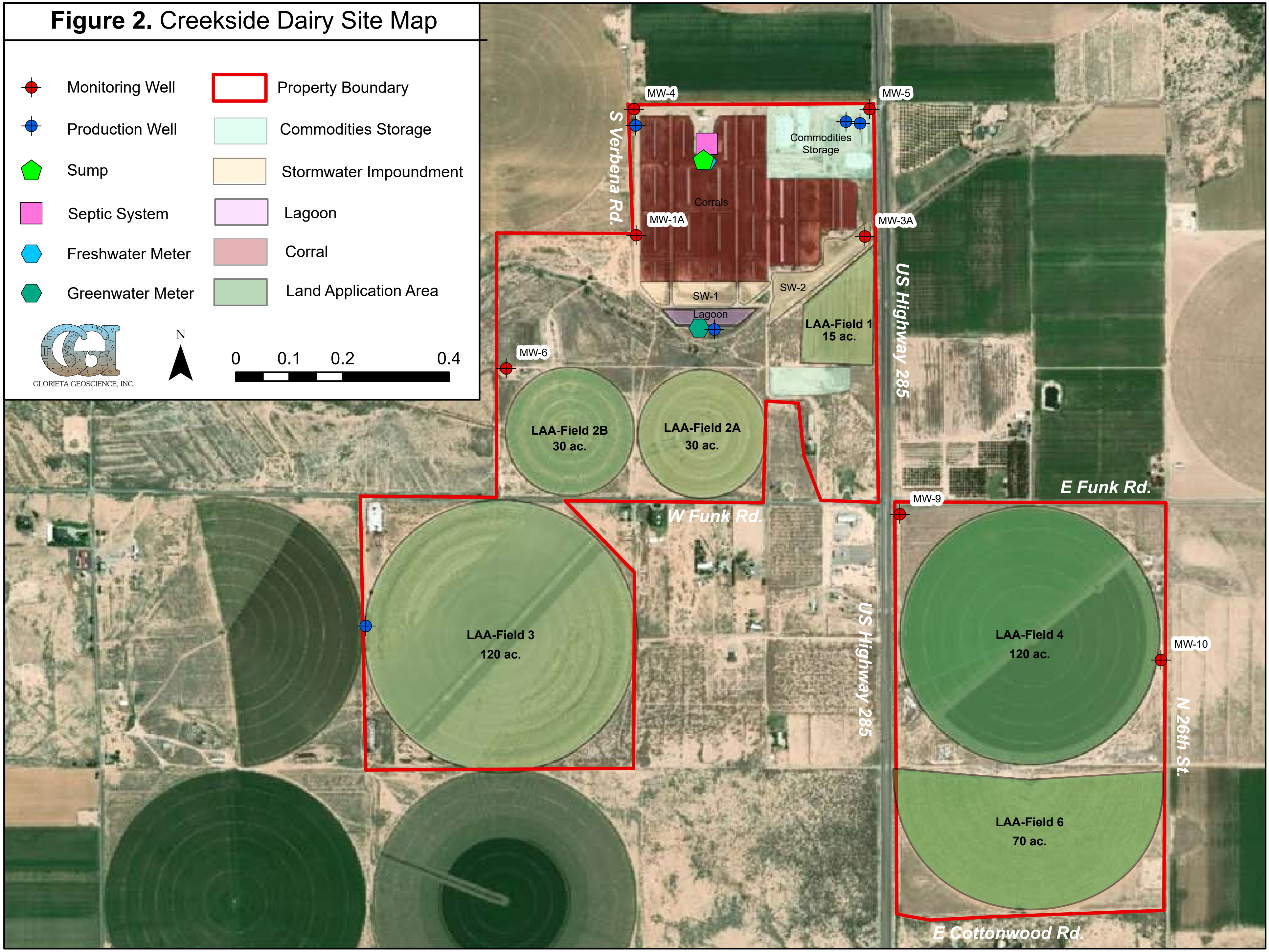


Figure 2. Creekside Dairy Site Map
Monitoring Well
Production Well
Sump
Septic System
Freshwater Meter
Greenwater Meter
Property Boundary
Commodities Storage
Stormwater Impoundment
Lagoon
Corral
Land Application Area
GLORIETA GEOSCIENCE, INC.
N
0
0.1
0.2
0.4
MW-4
MW-5
MW-1A
MW-3A
MW-6
MW-9
MW-10
S Verbena Rd.
Commodities Storage
Corrals
SW-1
SW-2
Lagoon
LAA-Field 1
15 ac.
US Highway 285
LAA-Field 2B
30 ac.
LAA-Field 2A
30 ac.
E Funk Rd.
W Funk Rd.
LAA-Field 3
120 ac.
US Highway 285
LAA-Field 4
120 ac.
N 26th St.
LAA-Field 6
70 ac.
E Cottonwood Rd.

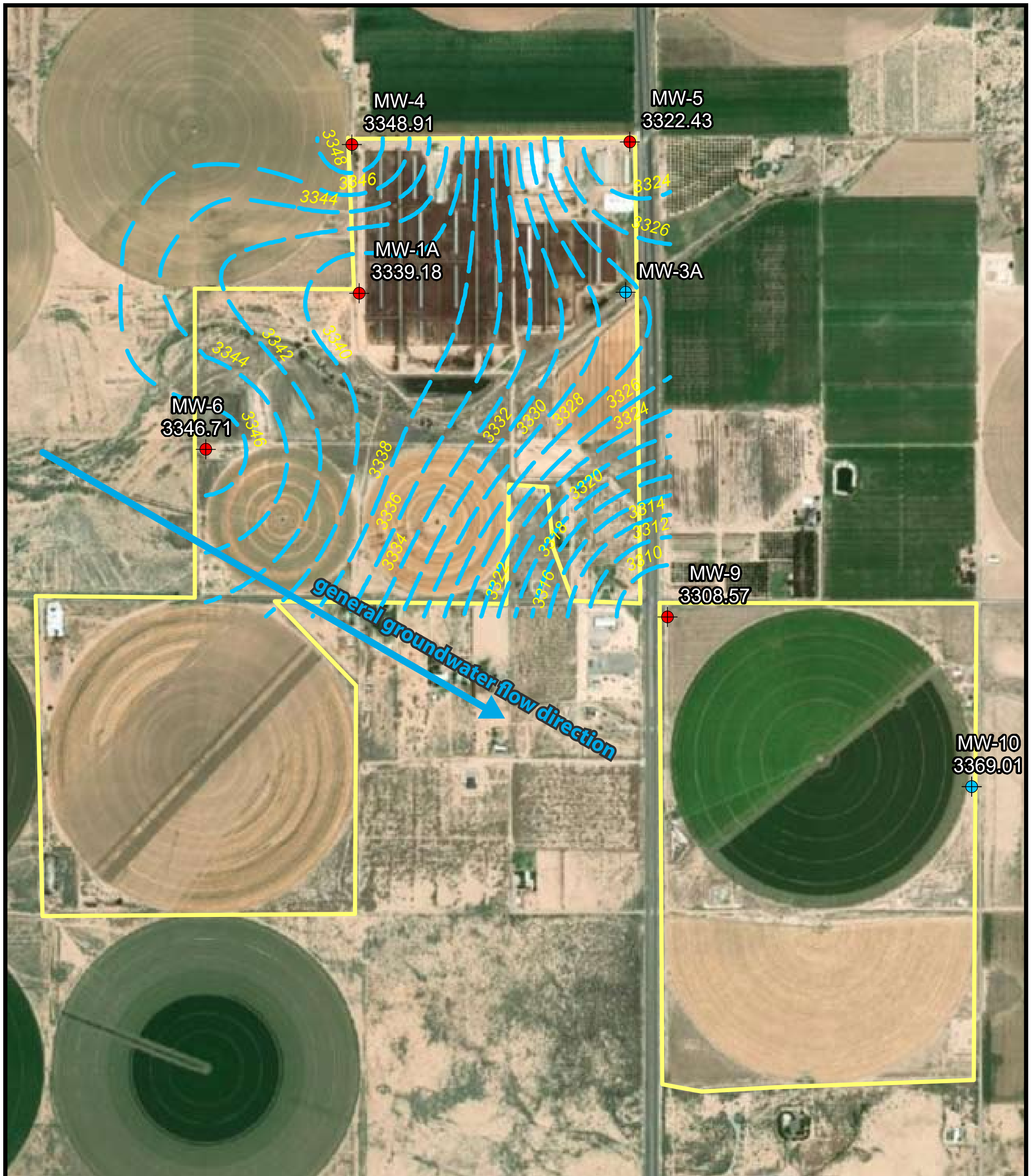


Figure 3. Creekside Dairy: Groundwater Elevation Map, 2nd Quarter 2020

**MW-3A and MW-10 are located in the perched zone -- data was not used in contouring*

Shallow Monitoring Well
Perched Monitoring Well
GWE Contour

N

0 0.075 0.15 0.3 0.45 0.6 Miles

GLORIETA GEOSCIENCE, INC.

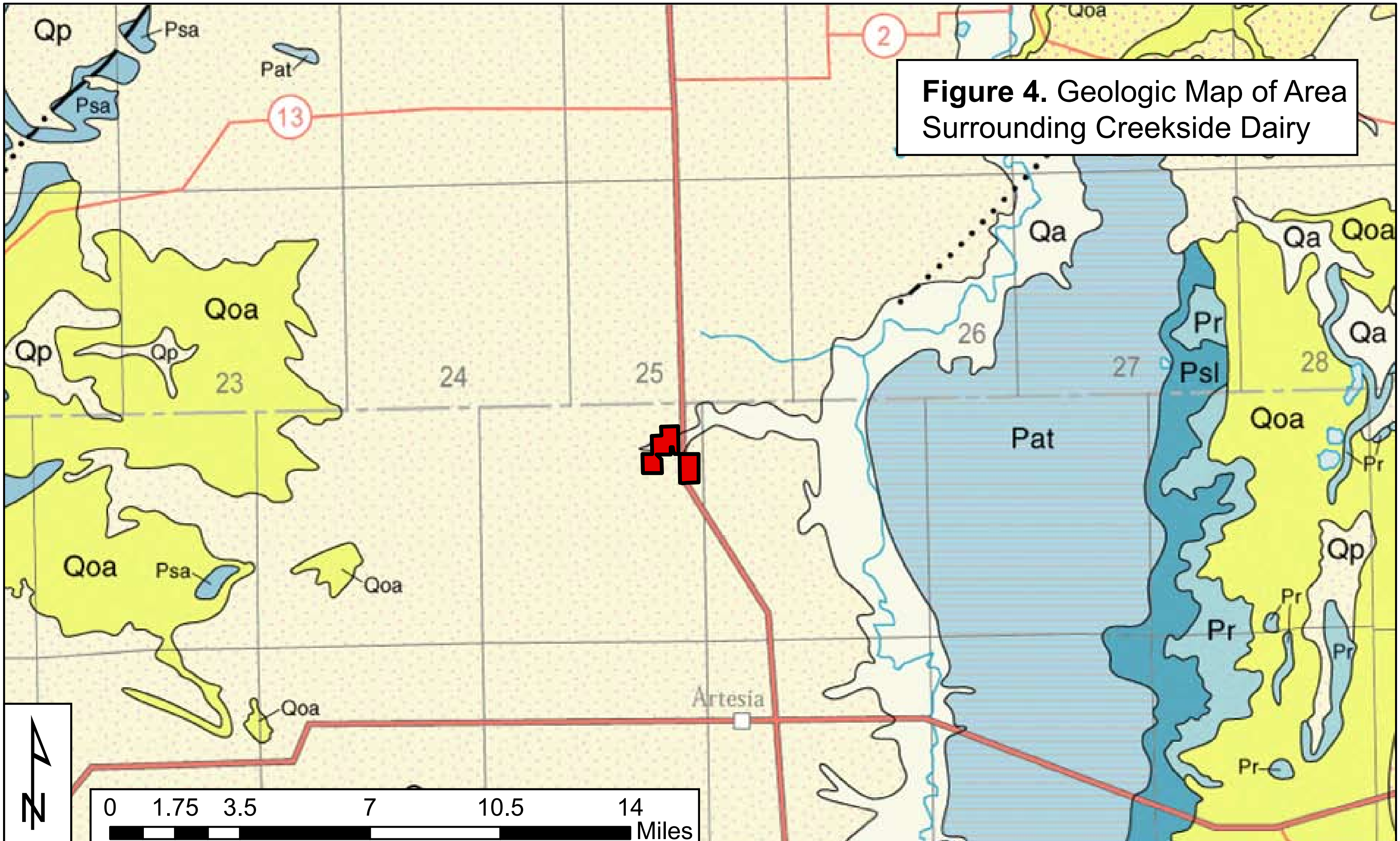


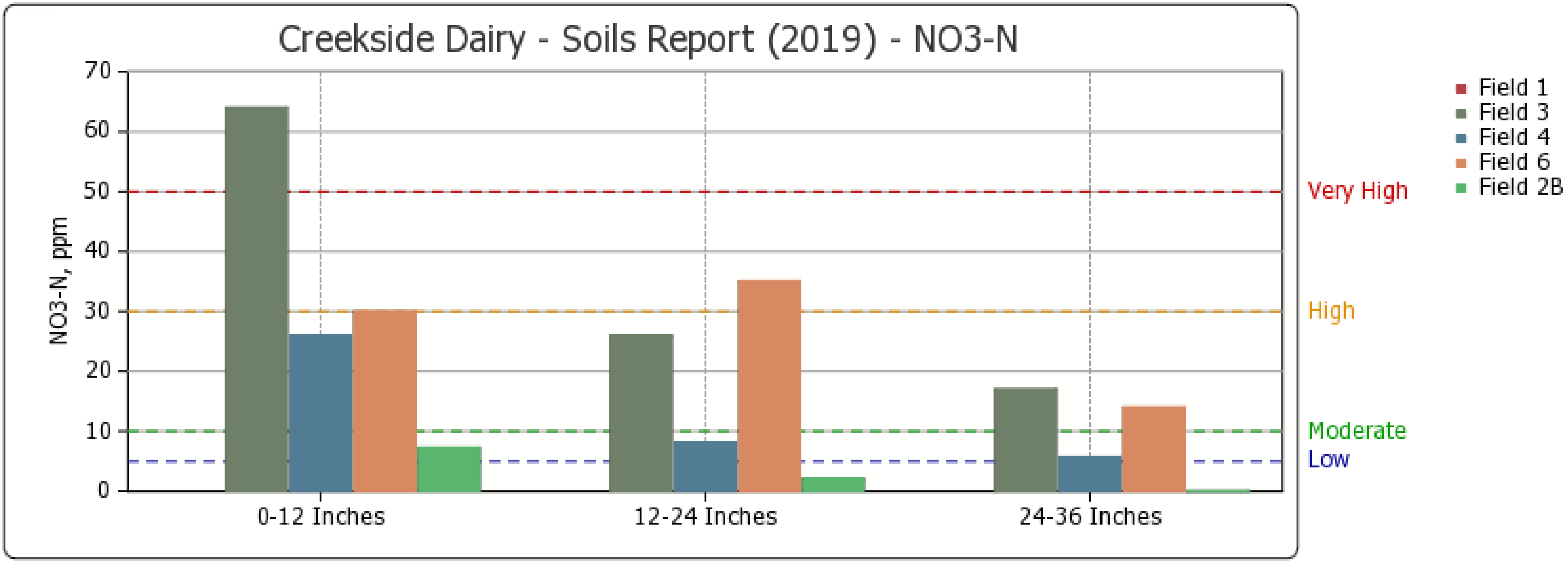
Figure 4. Geologic Map of Area Surrounding Creekside Dairy

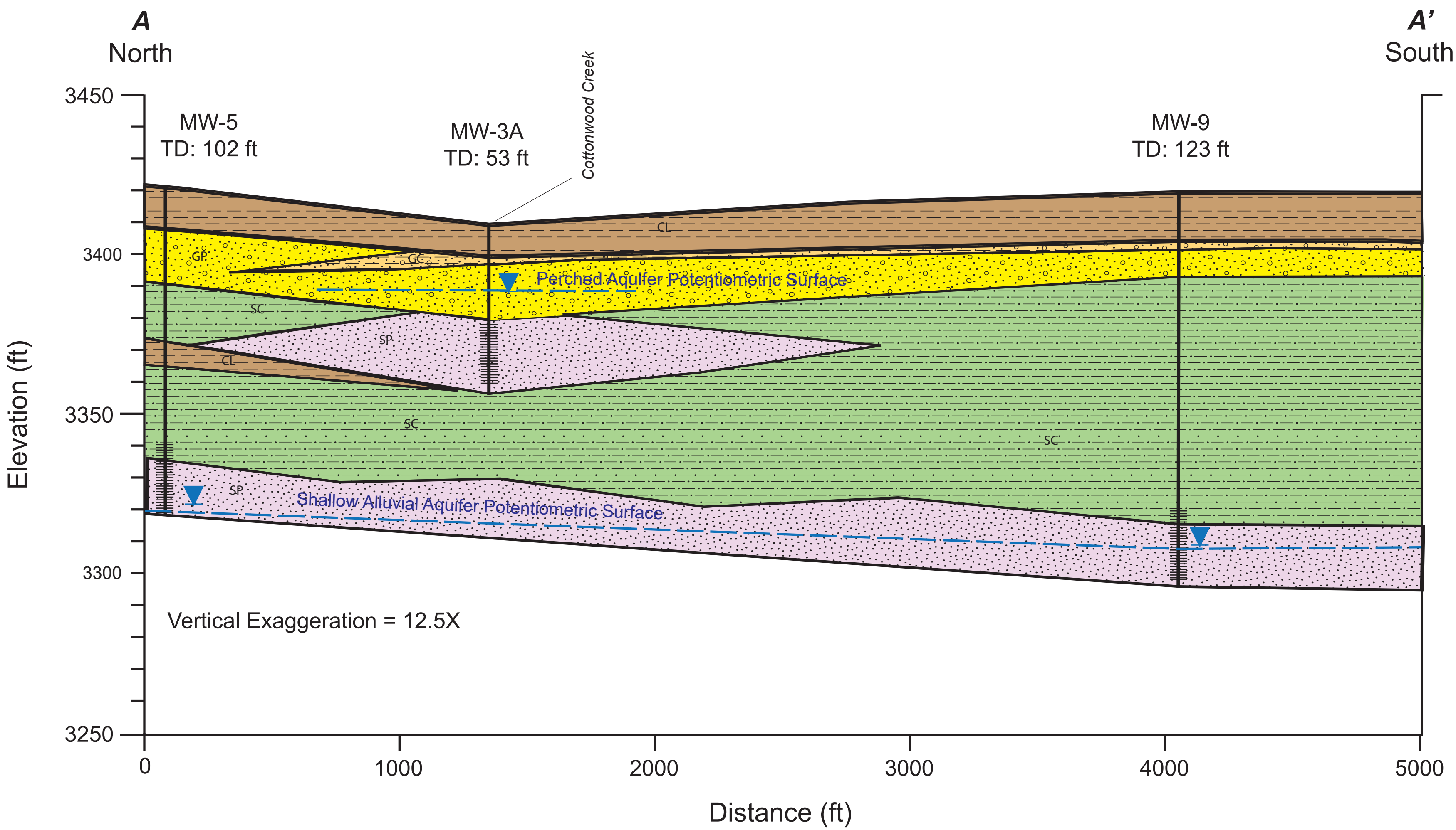
Explanation

(red)	Property Boundary	Qep	Eolian and Piedmont Deposits	Psl	Salado Fm.
Qa	Alluvium	Qoa	Older Alluvial Deposits	Pat	Artesia Group
Qp	Piedmont Alluvial Deposits	Pr	Rustler Fm.	Psa	San Andreas Fm.

GLORIETA GEOSCIENCE, INC.

Figure 5. Creekside Dairy Soil NO3 Concentrations by Land Application Area





EXPLANATION

Monitoring Well Location *(with well number and total depth in feet below ground surface)*

Approximate position of screen interval

Elevation in feet (ft) above mean sea level (AMSL); surface elevations from Atkins Engineering survey.

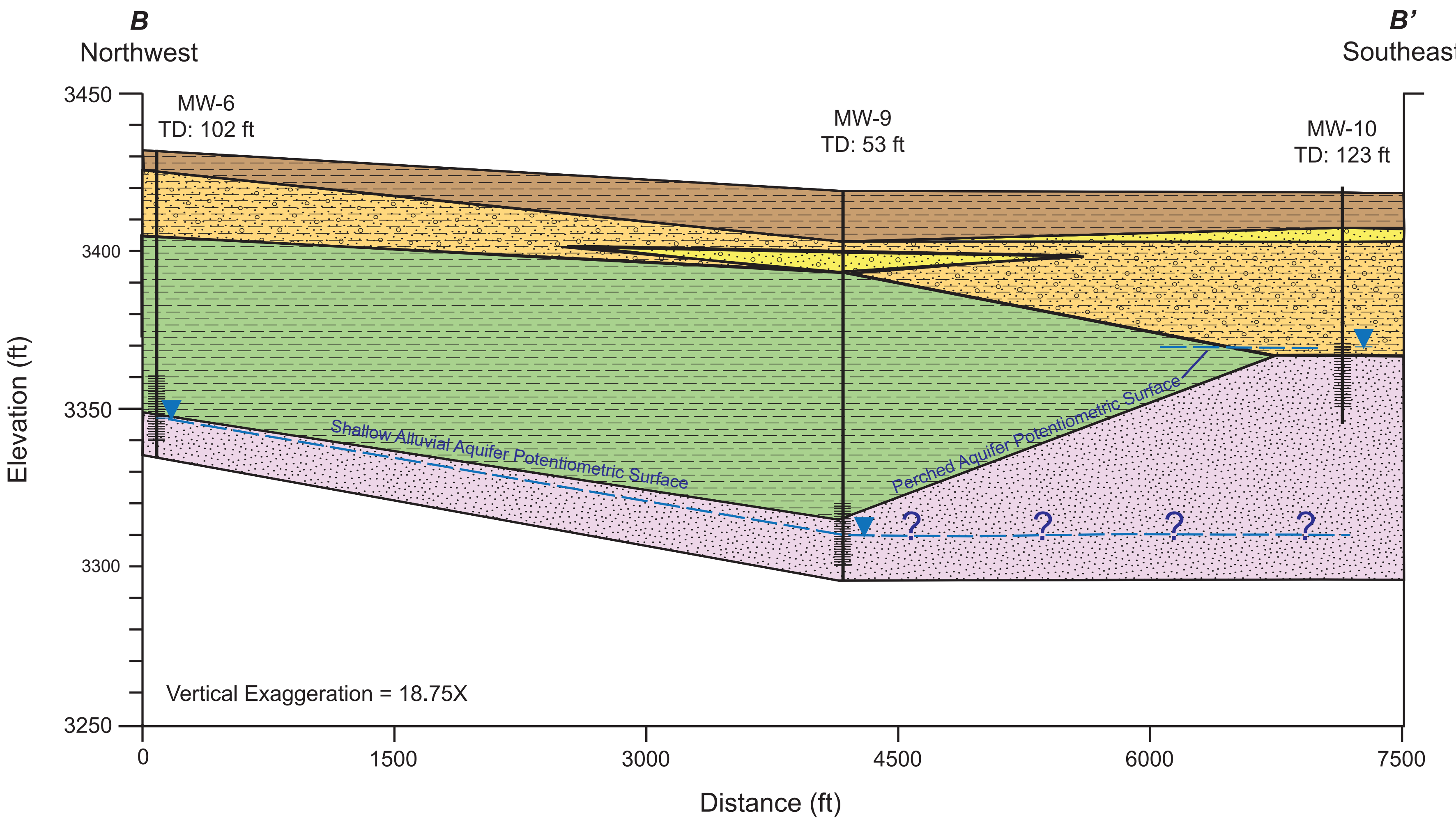
Water level measurements for October 23, 2019 sample event; measurement point Top-of-Casing.

Lithologic Unit Descriptions

- Clay
- Poorly graded gravel
- Clayey gravel
- Clayey sand
- Poorly graded sand

FIGURE 6a. Geologic Cross-Section Based on Monitoring Well Logs - Creekside Dairy

GLORIETA GEOSCIENCE, INC.



EXPLANATION

Monitoring Well Location *(with well number and total depth in feet below ground surface)*

Approximate position of screen interval

Elevation in feet (ft) above mean sea level (AMSL); surface elevations from Atkins Engineering survey.

Water level measurements for October 23, 2019 sample event; measurement point Top-of-Casing.

Lithologic Unit Descriptions

- Clay
- Poorly graded gravel
- Clayey gravel
- Clayey sand
- Poorly graded sand

FIGURE 6b. Geologic Cross-Section Based on Monitoring Well Logs - Creekside Dairy

GLORIETA GEOSCIENCE, INC.

TABLES

Table 1. Summary of Groundwater Quality Data

NMWQCC MCL							250	600	10	1000	--
Well ID	**Date**	**TOC (ft)**	**DTW (ft)**	**TD (ft)**	**Water Column (ft)**	**Groundwater Elevation (ft)**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
MW 1A	5/15/2012	NA	80.24	97.5	17.26	NA	26	NA	9.2	3310	< 1.0
MW 1A	8/8/2012	NA	83.13	97.43	14.3	NA	25	NA	8.5	3280	< 5.0
MW 1A	11/20/2012	NA	84.47	97.1	12.63	NA	25	NA	7.6	2780	< 1.0
MW 1A	3/20/2013	NA	81.35	97.21	15.86	NA	20	NA	7	3100	< 1.0
MW 1A	6/19/2013	NA	81.64	97.28	15.64	NA	19	NA	7.3	2860	< 1.0
MW 1A	9/19/2013	NA	84.56	97.13	12.57	NA	21	NA	6.7	2920	< 1.0
MW 1A	12/23/2013	NA	85.03	97.1	12.07	NA	20	NA	6.3	2920	< 1.0
MW 1A	3/27/2014	NA	84.83	97.5	12.67	NA	20	NA	7.4	2840	< 2.0
MW 1A	6/30/2014	NA	85.57	96.77	11.2	NA	19	NA	6.3	3140	< 1.0
MW 1A	9/30/2014	NA	86.6	96.76	10.16	NA	21	NA	6.1	2750	< 5.0
MW 1A	12/22/2014	NA	85.4	96.61	11.21	NA	21	1700	5.9	2960	< 5.0
MW 1A	3/17/2015	NA	84.8	96.55	11.75	NA	21	1800	6.6	2630	< 5.0
MW 1A	6/15/2015	NA	84.78	96.23	11.45	NA	20	1600	6.7	3070	< 1.0
MW 1A	9/15/2015	NA	85.78	96.25	10.47	NA	21	1800	6.7	2750	< 2.0
MW 1A	12/22/2015	NA	84.4	96.2	11.8	NA	21	1900	6.6	2770	< 2.0
MW 1A	3/17/2016	NA	81.24	94.53	13.29	NA	21	NA	6.5	3740	< 5.0
MW 1A	6/21/2016	NA	83.63	96.28	12.65	NA	19	1600	6.3	2840	< 2.0
MW 1A	9/19/2016	NA	84.09	96.2	12.11	NA	20	1600	7	2980	< 5.0
MW 1A	12/21/2016	NA	82.4	95.98	13.58	NA	21	1600	7	2750	< 2.0
MW 1A	3/21/2017	NA	81.75	96.11	14.36	NA	24	1800	8.1	2900	< 1.0
MW 1A	6/19/2017	NA	82.65	96.1	13.45	NA	25	1700	8.5	3100	< 2.0
MW 1A	9/12/2017	NA	84.26	97.9	13.64	NA	26	1600	8.7	2980	< 2.0
MW 1A	12/21/2017	NA	82.65	96	13.35	NA	28	1800	9.5	2790	< 2.0
MW 1A	3/1/2018	3426.49	84.37	95.7	11.33	3342.12	28	NA	8.9	2650	< 5.0
MW 1A	5/31/2018	3426.49	85.33	95.7	10.37	3341.16	29	1400	9	2510	< 5.0
MW 1A	9/25/2018	3426.49	87.4	95.75	8.35	3339.09	31	1500	9.8	2780	5.6
MW 1A	12/18/2018	3426.49	87.45	95.75	8.3	3339.04	32	1700	10	2800	< 2.0
MW 1A	3/5/2019	3426.49	87.05	96.67	9.62	3339.44	33	1500	11	2600	2.2
MW 1A	9/17/19	3426.49	88.28	95.68	7.4	3338.21	32	1400	10	2690	< 2.0
MW 1A	10/23/19	3426.49	87.65	95.68	8.03	3338.84	40	1600	12	2740	<2.0
MW 1A	6/16/20	3426.49	87.31	95.68	8.37	3339.18	37	1600	12	3090	<2.0

NMWQCC MCL							250	600	10	1000	--
Well ID	**Date**	**TOC (ft)**	**DTW (ft)**	**TD (ft)**	**Water Column (ft)**	**Groundwater Elevation (ft)**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
MW 2A	5/15/2012	NA	92.82	105.85	13.03	NA	41	NA	7.5	3020	< 5.0
MW 2A	8/8/2012	NA	93.51	105.85	12.34	NA	41	NA	7.3	3330	< 1.0
MW 2A	11/20/2012	NA	95.8	105.7	9.9	NA	41	NA	5.5	2330	< 1.0
MW 2A	3/20/2013	NA	93.6	105.63	12.03	NA	41	NA	7	2800	< 1.0
MW 2A	6/19/2013	NA	96.78	106.3	9.52	NA	39	NA	6.2	2620	< 1.0
MW 2A	9/19/2013	NA	96.98	106.09	9.11	NA	39	NA	5.4	2520	< 1.0
MW 2A	12/23/2013	NA	95.57	107.79	12.22	NA	43	NA	5.5	2730	< 1.0
MW 2A	3/27/2014	NA	96.09	108.93	12.84	NA	37	NA	5	2460	< 1.0
MW 2A	6/30/2014	NA	Dry	108.59	NA	NA	36	NA	4.8	2470	< 1.0
MW 2A	9/30/2014	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	12/22/2014	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	3/17/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	6/15/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	9/15/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	12/22/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	3/17/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	6/21/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	9/19/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	12/21/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	3/21/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	6/19/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	9/12/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	12/21/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	3/1/2018	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	5/31/2018	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	9/25/2018	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	12/18/2018	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	3/5/2019	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	9/17/19	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	10/23/19	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 2A	6/16/20	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA

NMWQCC MCL							250	600	10	1000	--
Well ID	**Date**	**TOC (ft)**	**DTW (ft)**	**TD (ft)**	**Water Column (ft)**	**Groundwater Elevation (ft)**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
MW 3A	5/15/2012	NA	30.51	55.75	25.24	NA	250	NA	47	4020	< 5.0
MW 3A	8/8/2012	NA	29.43	55.85	26.42	NA	250	NA	41	3740	< 5.0
MW 3A	11/20/2012	NA	28.6	55.9	27.3	NA	260	NA	41	3680	< 5.0
MW 3A	3/20/2013	NA	27.7	55.8	28.1	NA	240	NA	45	3540	< 5.0
MW 3A	6/19/2013	NA	28	55.9	27.9	NA	220	NA	47	3700	< 5.0
MW 3A	9/19/2013	NA	25.87	55.84	29.97	NA	220	NA	52	3740	< 5.0
MW 3A	12/23/2013	NA	28.03	55.79	27.76	NA	200	NA	48	3590	< 5.0
MW 3A	3/27/2014	NA	27.96	55.84	27.88	NA	220	NA	53	3670	< 5.0
MW 3A	6/30/2014	NA	28.74	55.83	27.09	NA	180	NA	49	3780	< 5.0
MW 3A	9/30/2014	NA	21.2	56.25	35.05	NA	200	NA	49	3530	< 5.0
MW 3A	12/22/2014	NA	27.31	55.85	28.54	NA	220	1800	47	3620	< 5.0
MW 3A	3/17/2015	NA	27.77	55.87	28.1	NA	240	1900	49	3420	< 5.0
MW 3A	6/15/2015	NA	28.04	55.82	27.78	NA	230	1600	45	3510	< 5.0
MW 3A	9/15/2015	NA	27.62	58.9	31.28	NA	230	1600	44	3700	< 5.0
MW 3A	12/22/2015	NA	27.5	55.85	28.35	NA	250	1900	38	3570	< 5.0
MW 3A	3/17/2016	NA	25.1	53.31	28.21	NA	250	NA	42	3650	< 5.0
MW 3A	6/21/2016	NA	27.96	55.95	27.99	NA	210	1600	41	3570	< 5.0
MW 3A	9/19/2016	NA	23.69	55.83	32.14	NA	210	1600	39	3650	5.6
MW 3A	12/21/2016	NA	26.66	55.85	29.19	NA	220	1700	41	3540	< 5.0
MW 3A	3/21/2017	NA	27.54	55.82	28.28	NA	200	1500	39	3420	< 5.0
MW 3A	6/19/2017	NA	27.81	55.81	28	NA	250	1800	41	3640	< 5.0
MW 3A	9/12/2017	NA	26.77	55.87	29.1	NA	210	1600	36	3540	< 5.0
MW 3A	12/21/2017	NA	25.31	46.54	21.23	NA	200	1900	45	3560	< 5.0
MW 3A	3/1/2018	3410.25	28.16	55.82	27.66	3382.09	220	NA	36	3750	< 5.0
MW 3A	5/31/2018	3410.25	28.22	55.83	27.61	3382.03	240	1500	33	3410	< 5.0
MW 3A	9/25/2018	3410.25	27.77	55.8	28.03	3382.48	230	1500	32	3580	< 5.0
MW 3A	12/18/2018	3410.25	23.94	54.55	30.61	3386.31	240	1700	34	3380	< 5.0
MW 3A	3/5/2019	3410.25	27.8	56.7	28.9	3382.45	230	1600	35	3700	< 5.0
MW 3A	9/17/19	3410.25	27.02	55.79	28.77	3383.23	230	1700	36	3610	< 5.0
MW 3A	10/23/19	3410.25	18.1	55.79	37.69	3392.15	240	1800	41	3540	< 5.0
MW 3A	6/16/20	3410.25	NA	NA	NA	NA	NA	NA	NA	NA	NA

NMWQCC MCL							250	600	10	1000	--
Well ID	**Date**	**TOC (ft)**	**DTW (ft)**	**TD (ft)**	**Water Column (ft)**	**Groundwater Elevation (ft)**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
MW 4	5/15/2012	NA	85.45	94.95	9.5	NA	31	NA	3.8	1560	< 1.0
MW 4	8/8/2012	NA	86.14	95	8.86	NA	34	NA	0.7	2220	67
MW 4	11/20/2012	NA	85.45	96.04	10.59	NA	31	NA	4.3	1570	< 1.0
MW 4	3/20/2013	NA	85	96	11	NA	47	NA	11	2670	< 1.0
MW 4	6/19/2013	NA	86.02	96	9.98	NA	35	NA	7.7	1920	< 1.0
MW 4	9/19/2013	NA	86.88	96.05	9.17	NA	31	NA	4.5	1550	< 1.0
MW 4	12/23/2013	NA	85.94	96.07	10.13	NA	35	NA	6.1	1760	< 1.0
MW 4	3/27/2014	NA	85.93	96.03	10.1	NA	31	NA	4.9	1700	< 2.0
MW 4	6/30/2014	NA	86.56	96.02	9.46	NA	28	NA	3.5	1920	7
MW 4	9/29/2014	NA	87.8	96.1	8.3	NA	26	NA	2.5	1200	< 1.0
MW 4	12/22/2014	NA	85.6	96.09	10.49	NA	31	850	5	1760	< 1.0
MW 4	3/17/2015	NA	83.54	96.05	12.51	NA	44	1700	7.3	3050	< 2.0
MW 4	6/15/2015	NA	85.855	96.09	10.235	NA	39	1400	6.2	2400	< 1.0
MW 4	9/15/2015	NA	86.87	96.05	9.18	NA	36	1200	5.3	1850	< 1.0
MW 4	12/22/2015	NA	83.45	96.1	12.65	NA	64	1700	25	2700	< 5.0
MW 4	3/17/2016	NA	80.97	93.85	12.88	NA	57	NA	20	3280	< 5.0
MW 4	6/21/2016	NA	85.62	96.23	10.61	NA	42	1600	13	2960	< 2.0
MW 4	9/19/2016	NA	83.4	96.09	12.69	NA	45	1700	18	3120	< 2.0
MW 4	12/21/2016	NA	82.62	96.09	13.47	NA	93	1700	51	3390	< 5.0
MW 4	3/21/2017	NA	83.15	96.85	13.7	NA	110	1600	73	3340	< 5.0
MW 4	6/19/2017	NA	85.7	96.09	10.39	NA	91	1400	51	2940	< 5.0
MW 4	9/12/2017	NA	83.66	96.17	12.51	NA	23	1800	7.6	3070	< 1.0
MW 4	12/21/2017	NA	84.08	97.55	13.47	NA	75	1800	48	2940	< 5.0
MW 4	3/1/2018	3435.97	85.73	96.9	11.17	3350.24	37	NA	17	3290	< 5.0
MW 4	5/31/2018	3435.97	87.79	96.09	8.3	3348.18	66	1100	7.9	2220	< 1.0
MW 4	9/25/2018	3435.97	87.34	96.08	8.74	3348.63	61	1200	33	3080	< 5.0
MW 4	12/18/2018	3435.97	83.8	96.2	12.4	3352.17	110	1700	71	3160	< 5.0
MW 4	3/5/2019	3435.97	87.96	96.26	8.3	3348.01	86	1500	52	3310	< 5.0
MW 4	9/17/19	3435.97	89.48	96.08	6.6	3346.49	47	740	26	1560	< 5.0
MW 4	10/23/19	3435.97	85.85	96.08	10.23	3350.12	76	1600	45	2860	< 5.0
MW 4	6/16/20	3435.97	87.06	96.08	9.02	3348.91	66	1400	38	2770	< 5.0

NMWQCC MCL							250	600	10	1000	--
Well ID	Date	TOC (ft)	DTW (ft)	TD (ft)	Water Column (ft)	Groundwater Elevation (ft)	Chlorides (mg/L)	Sulfate (mg/L)	Nitrates (mg/L)	TDS (mg/L)	TKN (mg/L)
MW 5	5/15/2012	NA	93.23	105.05	11.82	NA	56	NA	8.2	2970	< 5.0
MW 5	8/8/2012	NA	95.43	105	9.57	NA	54	NA	8.4	2930	< 1.0
MW 5	11/20/2012	NA	98.6	105	6.4	NA	62	NA	9.2	2620	< 1.0
MW 5	3/20/2013	NA	96.2	105	8.8	NA	59	NA	9.8	2850	< 1.0
MW 5	6/19/2013	NA	98	105	7	NA	52	NA	8.3	2990	< 1.0
MW 5	9/19/2013	NA	99	105.3	6.3	NA	54	NA	8.3	2830	< 1.0
MW 5	12/23/2013	NA	96.3	104.99	8.69	NA	58	NA	8.8	2620	< 1.0
MW 5	3/27/2014	NA	98.7	107.7	9	NA	53	NA	38.3	2720	< 2.0
MW 5	6/30/2014	NA	100.15	104.84	4.69	NA	53	NA	8.43	2970	< 1.0
MW 5	9/29/2014	NA	Damaged	105.6	NA	NA	56	NA	9.2	2740	< 1.0
MW 5	12/22/2014	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	3/17/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	6/15/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	9/15/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	12/22/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	3/17/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	6/21/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	9/19/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	12/21/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	3/21/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	6/19/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	9/12/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	12/21/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	3/1/2018	3422.57	Well repaired	NA	NA	NA	NA	NA	NA	NA	NA
MW 5	5/31/2018	3422.57	98.29	104.95	6.66	3324.28	57	1500	11	2680	< 5.0
MW 5	9/25/2018	3422.57	100.93	104.83	3.9	3321.64	57	1500	13	3030	3.9
MW 5	12/18/2018	3422.57	98.36	105.22	6.86	3324.21	58	1700	13	2790	< 2.0
MW 5	3/5/2019	3422.57	97.9	106.6	8.7	3324.67	60	1600	12	3240	< 2.0
MW 5	9/17/19	3422.57	102.21	105.0	2.79	3320.36	60	1600	13	3000	< 2.0
MW 5	10/23/19	3422.57	100.6	105.1	4.5	3321.97	64	1700	14	2930	< 2.0
MW 5	6/16/20	3422.57	100.14	105.0	4.86	3322.43	62	1600	19	3210	5.0

NMWQCC MCL							250	600	10	1000	--
Well ID	Date	TOC (ft)	DTW (ft)	TD (ft)	Water Column (ft)	Groundwater Elevation (ft)	Chlorides (mg/L)	Sulfate (mg/L)	Nitrates (mg/L)	TDS (mg/L)	TKN (mg/L)
MW 6	5/15/2012	NA	80.93	108.1	27.17	NA	34	NA	8.1	2560	< 5.0
MW 6	8/8/2012	NA	81.5	100.9	19.4	NA	31	NA	7.8	3720	< 1.0
MW 6	11/20/2012	NA	82.55	100.7	18.15	NA	33	NA	8.5	2410	< 1.0
MW 6	3/20/2013	NA	82.27	100.63	18.36	NA	33	NA	9.1	2820	< 5.0
MW 6	6/19/2013	NA	81.76	100.67	18.91	NA	29	NA	9.1	2820	< 1.0
MW 6	9/19/2013	NA	82.74	100.64	17.9	NA	30	NA	9.8	2820	< 1.0
MW 6	12/23/2013	NA	83.4	100.66	17.26	NA	29	NA	11	2830	< 2.0
MW 6	3/27/2014	NA	83.64	100.41	16.77	NA	29	NA	11	2900	< 2.0
MW 6	6/30/2014	NA	83.96	100.33	16.37	NA	28	NA	11	2990	< 2.0
MW 6	9/30/2014	NA	83.2	100.41	17.21	NA	29	NA	11	2700	< 2.0
MW 6	12/22/2014	NA	82.78	100.35	17.57	NA	28	1700	10	2940	< 2.0
MW 6	3/17/2015	NA	83.38	100.36	16.98	NA	30	1900	10	2630	< 2.0
MW 6	6/15/2015	NA	83.52	100.08	16.56	NA	28	1700	9.8	2890	< 1.0
MW 6	9/15/2015	NA	83.88	99.96	16.08	NA	30	1700	10	2730	< 2.0
MW 6	12/22/2015	NA	83.72	100.5	16.78	NA	30	1800	10	2870	< 2.0
MW 6	3/17/2016	NA	74.8	98.23	23.43	NA	30	NA	9.6	2870	< 2.0
MW 6	6/21/2016	NA	83.05	100.08	17.03	NA	27	1600	9.5	2860	< 2.0
MW 6	9/19/2016	NA	83.09	99.9	16.81	NA	27	1600	10	3000	< 2.0
MW 6	12/21/2016	NA	82.49	99.99	17.5	NA	27	1700	11	2690	< 2.0
MW 6	3/21/2017	NA	81.82	100.95	19.13	NA	26	1600	16	2620	< 2.0
MW 6	6/19/2017	NA	81.8	99.9	18.1	NA	26	1500	17	2580	< 2.0
MW 6	9/12/2017	NA	82.23	99.85	17.62	NA	23	1200	19	2220	< 2.0
MW 6	12/21/2017	NA	82.35	101.55	19.2	NA	24	950	16	2260	< 2.0
MW 6	3/1/2018	3430.92	82.49	99.89	17.4	3348.43	26	NA	18	1850	< 5.0
MW 6	5/31/2018	3430.92	82.76	99.53	16.77	3348.16	29	990	16	2100	< 2.0
MW 6	9/25/2018	3430.92	83.62	99.45	15.83	3347.3	29	1100	16	1960	< 2.0
MW 6	12/18/2018	3430.92	84.1	99.45	15.35	3346.82	32	1300	15	2230	< 2.0
MW 6	3/5/2019	3430.92	82.2	100.4	18.2	3346.72	31	1200	14	2310	< 2.0
MW 6	9/17/19	3430.92	84.78	99.0	14.22	3346.14	30	1200	13	2250	< 2.0
MW 6	10/23/19	3430.92	83.13	99.0	15.87	3347.79	32	1300	13	2250	< 2.0
MW 6	6/16/20	3430.92	84.21	99.0	14.79	3346.71	32	1200	11	2330	< 2.0

NMWQCC MCL							250	600	10	1000	--
Well ID	**Date**	**TOC (ft)**	**DTW (ft)**	**TD (ft)**	**Water Column (ft)**	**Groundwater Elevation (ft)**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
MW 9	5/15/2012	NA	111.43	125.3	13.87	NA	64	NA	8	3000	< 1.0
MW 9	8/8/2012	NA	112.22	125.3	13.08	NA	53	NA	8.3	2480	< 1.0
MW 9	11/20/2012	NA	109.84	125.3	15.46	NA	75	NA	7.7	2130	< 1.0
MW 9	3/20/2013	NA	111.6	125.4	13.8	NA	67	NA	8.1	2260	< 1.0
MW 9	6/19/2013	NA	112.68	125.2	12.52	NA	51	NA	8.2	2470	< 1.0
MW 9	9/19/2013	NA	112.35	125.11	12.76	NA	57	NA	8.3	2490	< 1.0
MW 9	12/23/2013	NA	110.53	125.17	14.64	NA	67	NA	7.9	2300	< 1.0
MW 9	3/27/2014	NA	111.72	125.14	13.42	NA	68	NA	8	2310	< 1.0
MW 9	6/30/2014	NA	113.56	125.07	11.51	NA	57	NA	7.8	2520	< 1.0
MW 9	9/29/2014	NA	114.34	126.69	12.35	NA	62	NA	8.2	2330	< 1.0
MW 9	12/22/2014	NA	110.95	125.13	14.18	NA	72	1200	7.8	2480	< 2.0
MW 9	3/17/2015	NA	109.93	125.04	15.11	NA	82	1300	8.3	2000	< 2.0
MW 9	6/15/2015	NA	113.43	124.93	11.5	NA	69	1300	8.3	2390	< 1.0
MW 9	9/15/2015	NA	114	124.7	10.7	NA	69	1300	9.6	2320	< 1.0
MW 9	12/22/2015	NA	110.1	124.8	14.7	NA	76	1400	9.3	2290	< 1.0
MW 9	3/17/2016	NA	106.74	122.74	16	NA	99	NA	7.9	2160	< 5.0
MW 9	6/21/2016	NA	106.74	122.74	16	NA	64	1200	8.1	2420	< 1.0
MW 9	9/19/2016	NA	111.31	124.55	13.24	NA	64	1200	8.2	2420	< 1.0
MW 9	12/21/2016	NA	109.2	124.6	15.4	NA	74	1200	7.9	2160	< 1.0
MW 9	3/21/2017	NA	108.51	126.08	17.57	NA	88	1000	7.5	2110	< 1.0
MW 9	6/19/2017	NA	111.95	124.57	12.62	NA	73	1300	8.7	2280	< 1.0
MW 9	9/12/2017	NA	112.3	124.6	12.3	NA	68	1200	8.1	2250	< 1.0
MW 9	12/21/2017	NA	108.02	127.75	19.73	NA	71	1100	7.5	2340	< 1.0
MW 9	3/1/2018	3419.47	107.37	125.52	18.15	3312.1	81	NA	73.5	2140	< 5.0
MW 9	5/31/2018	3419.47	111.03	124.35	13.32	3308.44	66	1100	7.9	2300	< 1.0
MW 9	9/25/2018	3419.47	112.35	124.3	11.95	3307.12	64	1200	8.8	2580	< 1.0
MW 9	12/18/2018	3419.47	109.05	123.4	14.35	3310.42	100	1100	7.7	2110	< 1.0
MW 9	3/5/2019	3419.47	108.24	124.4	16.16	3311.23	83	1100	8.1	2150	< 1.0
MW 9	9/17/19	3419.47	112.51	123.95	11.44	3306.96	67	1200	9.1	2340	< 1.0
MW 9	10/23/19	3419.47	110.57	123.95	13.38	3308.9	71	1400	11	2440	< 2.0
MW 9	6/16/20	3419.47	110.9	123.95	13.05	3308.57	66	1300	10	2490	< 2.0

NMWQCC MCL							250	600	10	1000	--
Well ID	**Date**	**TOC (ft)**	**DTW (ft)**	**TD (ft)**	**Water Column (ft)**	**Groundwater Elevation (ft)**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
MW 10	5/15/2012	NA	44.2	67.1	22.9	NA	280	NA	18	4590	< 2.0
MW 10	8/8/2012	NA	44.86	67.1	22.24	NA	270	NA	17	4270	< 2.0
MW 10	11/20/2012	NA	45.1	66.8	21.7	NA	250	NA	18	4040	< 2.0
MW 10	3/20/2013	NA	44.6	66.5	21.9	NA	300	NA	18	4200	< 2.0
MW 10	6/19/2013	NA	44.7	66.6	21.9	NA	300	NA	18	4360	< 2.0
MW 10	9/19/2013	NA	44.51	66.58	22.07	NA	310	NA	18	4400	< 2.0
MW 10	12/23/2013	NA	43.83	66.37	22.54	NA	310	NA	18	4660	< 2.0
MW 10	3/27/2014	NA	43.83	66.21	22.38	NA	310	NA	18	4300	< 2.0
MW 10	6/30/2014	NA	44.42	65.93	21.51	NA	280	NA	18	4340	< 2.0
MW 10	9/29/2014	NA	44.6	65.85	21.25	NA	360	NA	21	4360	< 5.0
MW 10	12/22/2014	NA	44.93	65.51	20.58	NA	330	2300	20	4450	< 5.0
MW 10	3/17/2015	NA	45.06	65.55	20.49	NA	400	2600	23	4080	< 5.0
MW 10	6/15/2015	NA	45.15	65.35	20.2	NA	380	2400	23	4810	< 5.0
MW 10	9/15/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	12/22/2015	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	3/17/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	6/21/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	9/19/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	12/21/2016	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	12/21/2017	NA	Damaged	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	3/1/2018	3414.25	Well repaired	NA	NA	NA	NA	NA	NA	NA	NA
MW 10	5/31/2018	3414.25	45.4	64.43	19.03	3368.85	410	2100	26	4200	7
MW 10	9/25/2018	3414.25	45.74	64.2	18.46	3368.51	400	2100	27	4110	< 5.0
MW 10	12/18/2018	3414.25	44.7	64	19.3	3369.55	450	2500	28	4280	< 5.0
MW 10	3/5/2019	3414.25	44.25	64.28	20.03	3370	380	2100	26	4460	< 5.0
MW 10	9/17/19	3414.25	44.91	63.65	18.74	3369.34	390	2100	28	4390	< 5.0
MW 10	10/23/19	3414.25	44.99	63.65	18.66	3369.26	420	2300	32	4290	< 5.0
MW 10	6/16/20	3414.25	45.24	63.65	18.41	3369.01	470	2200	36	4440	< 5.0

NMWQCC MCL		250	600	10	1000	--
Well ID	**Date**	**Chlorides (mg/L)**	**Sulfate (mg/L)**	**Nitrates (mg/L)**	**TDS (mg/L)**	**TKN (mg/L)**
Lagoon	5/15/2012	230	NA	1.2	5560	270
Lagoon	8/8/2012	NA	NA	NA	NA	NA
Lagoon	11/20/2012	NA	NA	NA	NA	NA
Lagoon	3/20/2013	NA	NA	NA	NA	NA
Lagoon	6/19/2013	210	NA	1.4	4670	260
Lagoon	9/19/2013	14	NA	< 0.5	730	6.2
Lagoon	12/23/2013	250	NA	1.1	4350	240
Lagoon	3/27/2014	250	NA	1.1	3850	250
Lagoon	6/30/2014	260	NA	< 1.0	4280	220
Lagoon	9/29/2014	380	NA	< 1.0	3610	140
Lagoon	12/22/2014	300	570	< 1.0	4410	250
Lagoon	3/17/2015	300	400	< 1.0	3720	220
Lagoon	6/15/2015	260	110	< 1.0	3630	210
Lagoon	9/15/2015	350	NA	< 1.0	3590	140
Lagoon	12/22/2015	280	890	< 1.0	3450	220
Lagoon	3/17/2016	250	NA	< 1.0	3960	320
Lagoon	6/21/2016	250	160	< 1.0	3220	240
Lagoon	9/19/2016	330	80	< 1.0	3630	200
Lagoon	12/21/2016	210	870	< 1.0	3350	260
Lagoon	3/21/2017	160	560	< 1.0	3410	160
Lagoon	6/19/2017	140	410	< 1.0	2970	170
Lagoon	9/12/2017	200	730	< 1.0	3030	130
Lagoon	12/21/2017	130	1100	< 1.0	3420	160
Lagoon	3/1/2018	130	3430	< 1.0	NA	160
Lagoon	5/31/2018	120	94	< 1.0	2700	140
Lagoon	9/25/2018	130	800	< 1.0	3370	100
Lagoon	12/18/2018	170	1100	< 1.0	3230	490
Lagoon	3/5/2019	140	560	< 1.0	3130	260
Lagoon	9/17/19	140	610	< 1.0	2980	130
Lagoon	10/23/19	140	930	< 1.0	3030	100
Lagoon	6/16/20	NA	NA	NA	NA	NA

CREEKSIDE DAIRY

Table 2. Summary of NMED List of Potential Source Areas and Assessment Status

NMED Potential Source	Status	History	Research to be Conducted	Comments on Potential Source	Additional Research/Investigation of Source Proposed
Clay-Lined Green Water Lagoon System,	One Cell, Clay-Lined.	One Cell System online in 2001.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files.	The closest downgradient monitoring well is MW-9 located over 2500ft from the lagoon. NO_3 and Cl are below standards.	Localized groundwater flow direction is to the east-southeast. A localized perched zone may exist at this location based on proximity to Cottonwood Creek. An additional monitoring well is likely needed and will be proposed under the DP requirements. The MW would also serve to monitor stormwater pond SW-1
Closed Lagoon	Clay Lined, closed in 2014 to 2016.	Used from 1993-1994 to 2014/2016.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files.	MW-2A (damaged) and MW-5 were used to monitor this potential source. MW-3A may be substituted for the damaged well.	Localized groundwater flow direction is to the east-southeast. No action proposed for this closed source.
Stormwater Impoundments SW-1 and SW-2	Unlined, in use.	Used from 2001 to present.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	These ponds are located south of corrals. Water is held for limited periods of time before transfer to the greenwater lagoon.	Facility re-grade will improve runoff collection and management within these ponds. MW-3A is located downgradient of SW-2

Table 2. Summary of NMED List of Potential Source Areas and Assessment Status

NMED Potential Source	Status	History	Research to be Conducted	Comments on Potential Source	Additional Research/Investigation of Source Proposed
LAA Field 1 (15-acre flood field)	Accepts green water from lagoon system, flood field irrigation system	Installed in approx. 2010.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	MW-3A is slightly up/cross gradient of this potential source and exceeded limits for NO_3, SO_4 and TDS.	Soil sampling has not been completed at this LAA based on available data. An additional monitoring well is likely needed and will be proposed under the DP requirements. The MW may also serve to monitor stormwater pond SW-2.
LAA Field 2A (30-acre center pivot field)	Accepts green water from lagoon system, center pivot sprinkler irrigation/ application	Installed in approx. 2014.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	The closest downgradient well is MW-9 located ~1500ft from this potential source. NO_3 and Cl are below standards. MW-1A and MW-6 are upgradient of the field and both have exceedance of NO_3.	Soil sampling was conducted in 2019 with very low NO_3 concentrations. An additional monitoring well is likely needed and will be proposed under the DP requirements. The MW may also serve to monitor stormwater pond LAA Field 2B.
LAA Field 2B (30-acre center pivot field)	Accepts green water from lagoon system, center pivot sprinkler irrigation/ application	Installed in approx. 2014	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	The closest downgradient well is MW-9 located over 2500ft from this potential source. NO_3 and Cl are below standards. MW-6 is upgradient of the field and exceeds standard NO_3.	Soil sampling was conducted in 2019 with very low NO3 concentrations. An additional monitoring well is likely needed and will be proposed under the DP requirements.

Table 2. Summary of NMED List of Potential Source Areas and Assessment Status

NMED Potential Source	Status	History	Research to be Conducted	Comments on Potential Source	Additional Research/Investigation of Source Proposed
LAA Field 3 (120-acre center pivot)	Accepts green water from lagoon system, center pivot sprinkler irrigation/ application	Installed in approx. 2004.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	There are no MWs located downgradient of this field.	Soil sampling was conducted in 2019 with low NO_3 concentrations found below 12 inches. An additional monitoring well is likely needed and will be proposed under the DP requirements.
LAA Field 4 (120-acre center pivot field)	Accepts green water from lagoon system, center pivot sprinkler irrigation/ application	Installed in approx. 2010.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	MW-10 is downgradient of this potential source and exceeds standards for NO_3, Cl, SO4 and TDS. MW-10 is completed in a perched zone.	Soil sampling was conducted in 2019 with very low NO_3 concentrations. No MW is needed at this source.
LAA Field 6 (70-acre half-pivot field)	Accepts green water from lagoon system, half-pivot sprinkler irrigation/ application	Installed in approx. 2008.	Dairy Personnel Interviews, Aerial Photos, Historical Maps and NMED files	There are no MWs located downgradient of this field.	Soil sampling was conducted in 2019 with very low NO_3 concentrations. An additional monitoring well is likely needed and will be proposed under the DP requirements.

Table 2. Summary of NMED List of Potential Source Areas and Assessment Status

NMED Potential Source	Status	History	Research to be Conducted	Comments on Potential Source	Additional Research/Investigation of Source Proposed
Chemical Fertilizer Application	Not applied at Dairy	None to LAA fields since approximately 2006	Dairy Personnel Interviews, NMED files	None at this time	NMED file review, Additional dairy record review.
Manure Storage	Short-term storage only (two-weeks to one-month maximum), contracted with manure hauler	Has contract with manure hauler and long-term storage has not been practiced on-site	Dairy Personnel Interviews, Aerial Photos	Not considered a likely source. New separator is required under the DP.	None needed at this time.
Manure Application in LAA	None		Dairy Personnel Interviews	Not considered a potential source.	None needed at this time.
Green Silage Storage	Storage on northeast corner of production area.	Has been stored on-site since what appears to be dairy's beginning.	Dairy Personnel Interviews, Aerial Photos	Not considered a potential source. Adequately monitored by MW-3A and MW-5.	None needed at this time.

Table 2. Summary of NMED List of Potential Source Areas and Assessment Status

NMED Potential Source	Status	History	Research to be Conducted	Comments on Potential Source	Additional Research/Investigation of Source Proposed
Milking Barn	Operational	Has always been in current location, any leaks in sprinklers or hoses are immediately fixed. Floor flush system under investigation to provide greater control of flow.	Dairy Personnel Interviews, Aerial Photos	Not considered a potential source. Adequately monitored by MW-3A and MW-5.	None needed at this time.
Corrals/ Production Areas	All in operation with livestock	Available data shows all existing corrals were part of original dairy.	Dairy Personnel Interviews, Aerial Photos	Not considered a likely source, corrals are graded and cleaned on a daily basis, low spots and high spots are eliminated. Adequately monitored by MW-3A and MW-5.	None needed at this time.
Water Troughs	Operational, not leaking	Operational, no significant leaks	Dairy Personnel Interviews, Aerial Photos	Not considered a potential source, leaks are fixed immediately. Adequately monitored by MW-3A and MW-5.	None needed at this time.

Table 2. Summary of NMED List of Potential Source Areas and Assessment Status

NMED Potential Source	Status	History	Research to be Conducted	Comments on Potential Source	Additional Research/Investigation of Source Proposed
Septic Systems	Identified, in downgradient direction, no sewer system extends to area of Dairy.	Not yet determined	Dairy Personnel Interviews, Aerial Photos	No sewer system extends to area of Dairy, all area homes expected to have septic systems.	None needed at this time.

Table 3. Data Quality Objectives, Creekside Dairy

Step 1: State the Problem
• Ground water samples collected from monitoring wells installed at the facility reported to contain concentrations of nitrate and/or TDS in excess of WQCC Standards (20 NMAC 6.2.3.3103). • Nature and extent of ground water and soil impacts must be established.
Step 2: Identify the Goals of the Stage 1 Abatement Plan
• What are the sources of contamination in the monitoring wells at the Dairy? • What are the hydrologic characteristics of the facility and what is their relation to the transport of contaminants? • What are the impacts, if any, to ground water wells and domestic well users in the vicinity of the facility related to current levels of contamination?
Step 3: Identify Inputs to the Decisions
• Inputs to the decision include identification of contaminant sources and management practices that have contributed to the potential contaminant sources. • Inputs to the decision are analysis of current and valid historical ground water sample results for nitrate, chloride, TDS, sulfate and TKN concentrations. • Inputs to the decision are soil analytical results and assessment of nitrate levels within soil profiles. • Inputs to the decision are the determination of ground water flow direction and aquifer hydrologic properties. • Inputs to the decision are stratigraphic and hydrologic information compiled into cross section(s) across the site. • Inputs to the decision are expanding current system of ground water monitoring to include additional on-site wells. • Inputs to the decision are determining background nitrate, TDS, chloride, sulfate and TKN levels and determining where Creekside Dairy concentrations range compared to background.
Step 4: Define Study Boundaries
• The horizontal study boundary is defined by the Dairy property boundaries, dairy supply wells and wells at current land application areas not owned by the Dairy, where practicable. Creekside Dairy has an extensive monitoring well network and data from that network will be evaluated with respect to Creekside Dairy. • The vertical extent of the study area extends from ground surface to the upper three feet of soil and into ground water (up to 120 feet bgs at present). • The temporal boundary extends through the period of performance for this project.
Step 5: Develop Decision Rules
• Evaluate potential receptors to determine if Stage 2 Abatement Plan is required. • Analyze trends of constituents of concern to determine if Stage 2 Abatement Plan is required. • Evaluate data for completeness to design an effective Stage 2 Abatement Plan, if required. If necessary, data gaps will be defined and further investigation will be required to complete the data gaps. • Utilize hydrogeologic data to evaluate potential threat to off-site receptors.

• Determine "background" concentrations for chemicals of concern within shallow aquifer up-gradient and down-gradient of Creekside Dairy.
Step 6: Specify Tolerable Limits on Decision Errors
• No statistical analyses are planned to be performed on the results of sample analyses. Data will be evaluated as outlined in the SAP.
Step 7: Optimize the Sampling Design
• Establish direction of ground water flow after four quarters of Creekside Dairy focused mapping are completed and evaluate ground water monitoring points for proper placement. • Additional monitoring points may be added if data gaps show them to be necessary.

TABLE 4. SUMMARY OF SAMPLE ANALYTICAL AND QUALITY CONTROL REQUIREMENTS, CREEKSIDE DAIRY

Target Analytes	Matrix	Analytical Method	WQCC Standard (mg/L)	PQL[1]	Sample Container	Preservative	Holding Time[2]
Nitrate as N	Water	EPA Method 300.0	10	0.1 mg/L	250 mL HDPE bottle	H_2SO_4 to pH <2, stored at <6°C	48 hours
Nitrate as N	Soil	EPA Method 300.0	NA	0.3 mg/Kg	Four ounce glass jar with Teflon-lined cap	Stored at <6°C	As soon as possible
TKN	Water	SM 4500-N_{org} C	No Standard	1.0 mg/L	500 mL HDPE bottle	H_2SO_4 to pH <2; stored at <6°C	28 days
TKN	Soil	SM 4500-N_{org} C	NA	25 mg/Kg	Four ounce glass jar with Teflon-lined cap	Stored at <6°C	As soon as possible
Chloride	Water	EPA Method 300.0	250	0.1 mg/L	250 mL HDPE bottle	Stored at <6°C	28 days
Chloride	Soil	EPA Method 300.0	NA	0.3 mg/Kg	Four ounce glass jar with Teflon-lined cap	Stored at <6°C	As soon as possible
TDS	Water	SM 2540 C	1,000	10 mg/L	250 mL HDPE bottle	Stored at <6°C	7 days
Physical Parameters	Soil	See Table 3 - Note A	NA	NA	One gallon plastic bag	None required	None specified
Agronomic Values	Soil	See Table 3 - Note B	NA	NA	One liter plastic-lined sample bag	Stored at <6°C	As soon as possible

PQL[1]: Practical Quantification Limit (based on no dilution of sample).
Holding Time[2]: Nitrate holding time is for unpreserved container; if holding time is exceeded for nitrate, then a combined nitrate/nitrite value is obtained within the 28-day holding time.
mg/Kg: milligram per kilogram; **mg/L:** milligram per liter; **mL**: milliliter; **HDPE**: high-density polyethylene; **NA:** not applicable

TABLE 3. SUMMARY OF SAMPLE ANALYTICAL AND QUALITY CONTROL REQUIREMENTS, CREEKSIDE DAIRY (Continued)

Table 3 Analytical Methods References:

Standard Methods (SM) are from *Standard Methods for the Examination of Water and Wastewater*, 21st Edition, 2005; American Public Health Association, *et.al.*

SM 2540 C: Total Dissolved Solids Dried at 180° C

SM 4500-N_{org} C: Semi-Micro-Kjeldahl Method

EPA Method is from United States Environmental Protection Agency *Methods for Chemical Analysis of Water and Wastes*, Revised; 600/4-79-020

Method 300.0: Determination of Inorganic Anions by Ion Chromatography, Revision 2.1, 1993

Table 3 -Note A: Soil Analytical Procedures For Physical Parameters:

The following American Standard for Testing and Materials (ASTM) methods are available for describing grain-size distribution for application in ground water modeling for soil samples obtained

ASTM Method D422 - 63 (2007) *Standard Test Method for Particle-Size Analysis of Soils*

ASTM Method D6836 - 02 (2008)e2 *Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge*

Table 3 - Note B: Soil Analytical Procedures For Agronomic Values:

The following soil components are analyzed using agronomy procedures for calculating the agronomic uptake for specific crops in land application areas. All of these methods are recognized by the National Resource Conservation Service, United States Department of Agriculture.

Soil NO_3-N: analyzed with a two-molar KCl extraction, as described in *Methods of Soil Analysis*: *Chemical Methods*, Part 3, Soil Science Society of America.

Soil TKN: analyzed by the Kjeldahl method as described in *Methods of Soil Analysis: Chemical Methods*, Part 3, Soil Science Society of America.

Soil Cl: analyzed by the mercury (II) thiocyanate method, as described in *Soil Testing: Sampling, Correlation, Calibration, and Interpretation,* SSSA Special Publication 21, Soil Science Society of America.

APPENDIX A

MONITORING WELL LOGS

ATKINS ENGINEERING ASSOCIATES, INC.
Professional Engineering / Land Surveying
Water Resources / Environmental Science

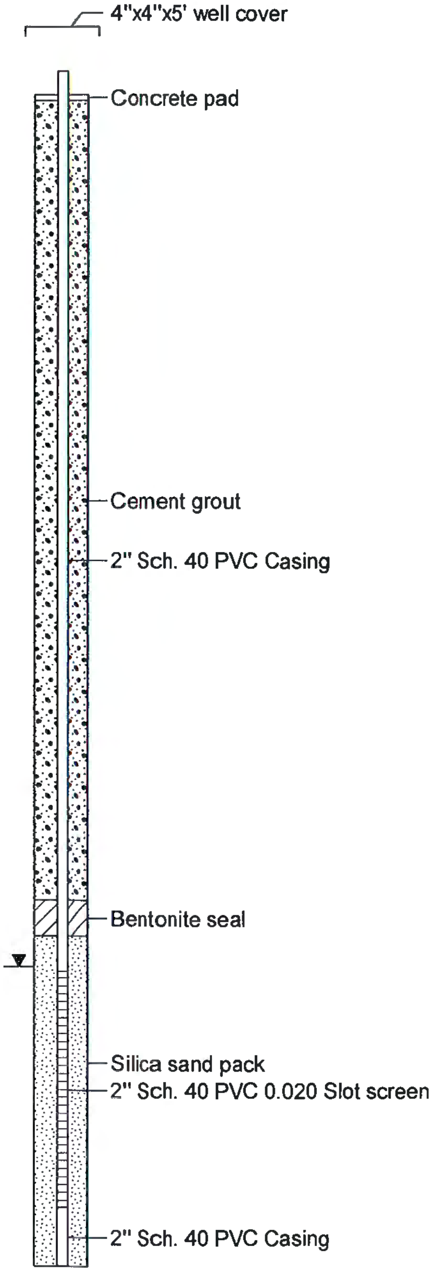
Log of Boring Monitor Well 1A

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico
Contact: Carlos Villalpando
Job#: CREEKSI.DAR.08

Drill Start	: 02-03-09 (09:30)
Drill End	: 02-03-09 (15:30)
Boring Location	: 32°57.102', -104°26.809'
Site Location	: Creekside Dairy
Auger Type	: 4¼ Hollow Stem
Logged By	: Mort Bates

Depth in Feet	USCS	Sample	DESCRIPTION
0–19	CL		Clay, brown, firm, dry
19–30	GC		Clayey gravel, tan, loose, dry
30–35	GP		Poorly graded gravel, tan, cemented, dry
35–72	SC		Clayey sand, tan, loose, damp
72–76	GP		Poorly graded gravel, tan, loose, moist
76–99	SP		Poorly graded sand, tan, soft, wet

Total Depth 99'
Water Level 75.57'



03-04-2009 E:\Creekside Dairy\Boring Logs\mw1a.bor

Atkins Engineering Associates, Inc.
Professional Engineering / Land Surveying
Water Resources / Environmental Science

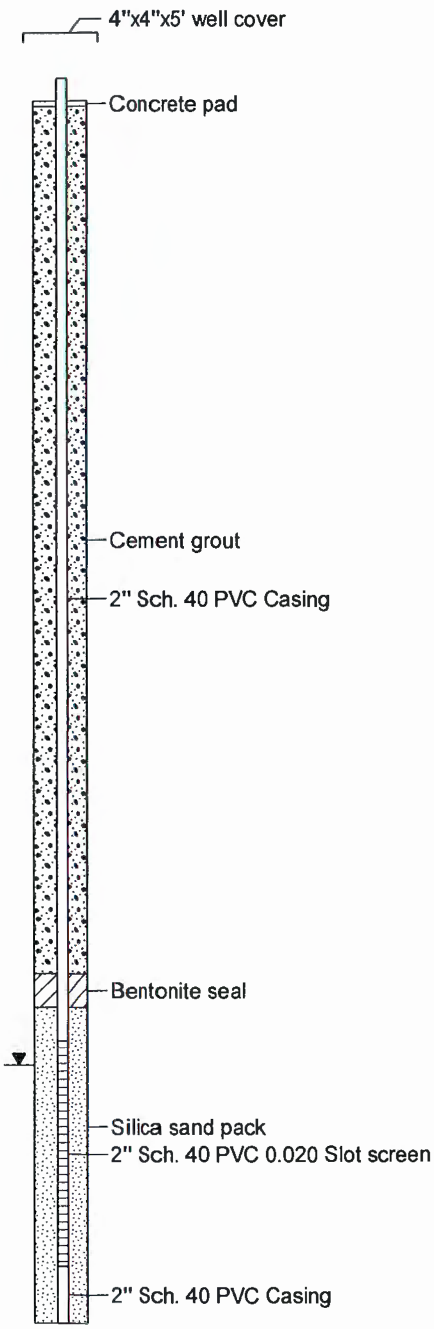
Log of Boring Monitor Well 2A

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico
Contact: Carlos Villalpando
Job#: CREEKSI.DAR.08

Drill Start	: 02-04-09 (11:00)	Logged By	: Mort Bates
Drill End	: 02-04-09 (16:30)		
Boring Location	: 32°57.247', -104°26.457'		
Site Location	: Creekside Dairy		
Auger Type	: 4¼ Hollow Stem		

Depth in Feet	USCS	Sample	DESCRIPTION
0–24	CL		Clay, brown, loose, dry
24–28	GP		Poorly graded gravel, tan, loose, dry
28–35	GP		Poorly graded, gravel, tan, cemented, dry
35–61	SC		Clayey sand, tan, loose, damp
61–90	SP		Poorly graded sand, tan, loose, moist
90–108	SP		Poorly graded sand, tan, soft, wet

Total depth 108'
Water level 87.12'



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Atkins Engineering Associates, Inc.
Professional Engineering / Land Surveying
Water Resources / Environmental Science

Log of Boring Monitor Well 3A

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

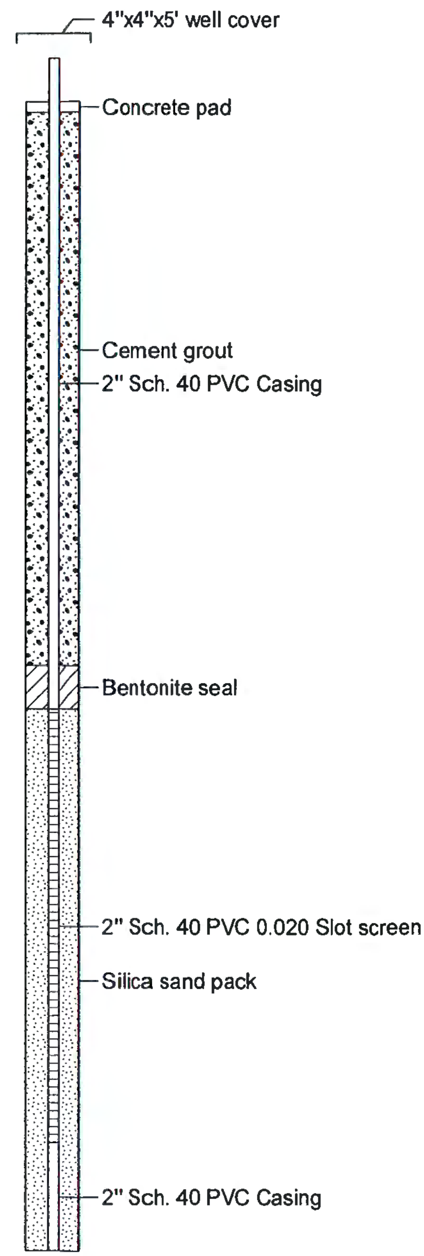
Contact: Carlos Villalpando

Job#: CREEKSI.DAR.08

Drill Start	: 02-04-09 (07:15)
Drill End	: 02-04-09 (10:30)
Boring Location	: 32°57.102', -104°26.366'
Site Location	: Creekside Dairy
Auger Type	: 4¼ Hollow Stem
Logged By	: Mort Bates

Depth in Feet	USCS	Sample	DESCRIPTION
0–10	CL		Clay, brown, loose, dry
10–15	GC		Clayey gravel, tan, loose, dry
15–20	GP		Poorly graded gravel, tan, cemented, dry
20–30	GP		Poorly graded gravel, tan, loose, damp
30–53	SP		Poorly graded sand, tan, soft, wet

Total depth 53'
Water level 30.68'



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ATKINS ENGINEERING ASSOCIATES, INC.
Professional Engineering / Land Surveying
Water Resources / Environmental Science

Log of Boring Monitor Well 4

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

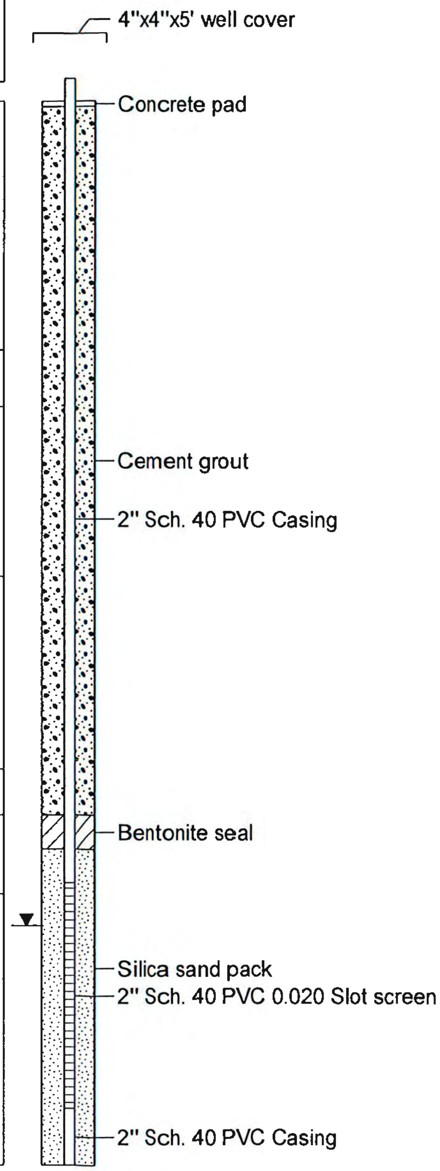
Contact: Carlos Villalpando

Job#: CREEKSI.DAR.08

Drill Start	: 02-02-09 (14:15)	Logged By	: Mort Bates
Drill End	: 02-03-09 (09:00)		
Boring Location	: 32°57.312', -104°26.814'		
Site Location	: Creekside Dairy		
Auger Type	: 4¼ Hollow Stem		

Depth in Feet	USCS	Sample	DESCRIPTION
0–22	CL		Clay, brown, firm, dry
22–27	SC		Clayey sand, tan, loose, damp
27–42	GC		Clayey gravel, tan, loose, dry
42–59	SC		Clayey sand, tan, loose, damp
59–63	SP		Poorly graded sand, tan, loose, damp
63–70	GP		Poorly graded cemented gravel, tan, firm, moist
70–94	SP		Poorly graded sand, tan, soft, wet

Total depth 94'
Water level 74.80'



ATKINS ENGINEERING ASSOCIATES, INC.
Professional Engineering / Land Surveying
Water Resources / Environmental Science

Log of Boring Monitor Well 5

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

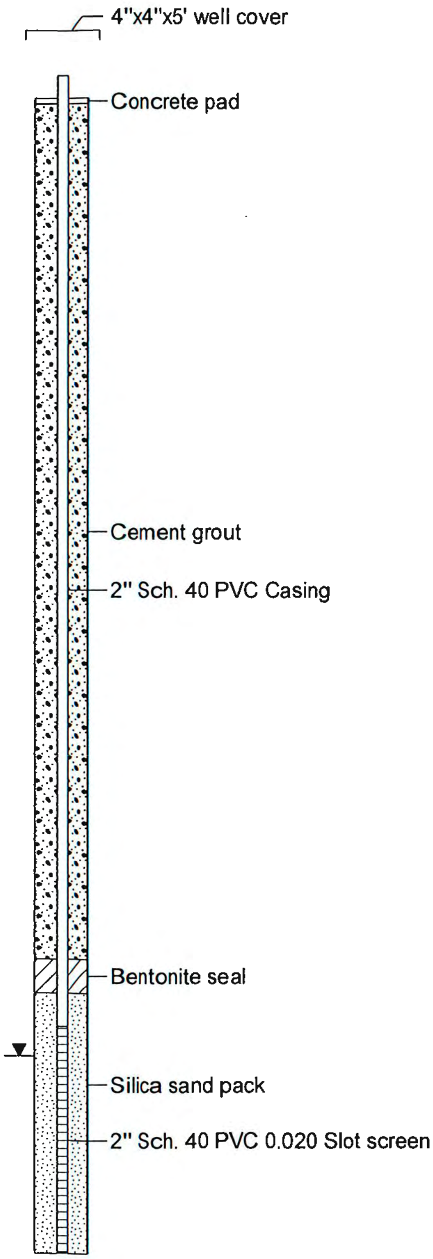
Contact: Carlos Villalpando

Job#: CREEKSI.DAR.08

Drill Start	: 02-02-09 (07:30)	Logged By	: Mort Bates
Drill End	: 02-02-09 (14:00)		
Boring Location	: 32°57.312', -104°26.359'		
Site Location	: Creekside Dairy		
Auger Type	: 4¼ Hollow Stem		

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0–14		CL		Clay, brown, loose, dry
14–22		GP		Poorly graded sandy gravel, tan, loose, dry
22–29		GP		Cemented gravel, tan, hard, dry
29–32		GP		Poorly graded gravel, tan, loose, dry
32–49		SC		Clayey sand, tan, loose, damp
49–56		CL		Clay, tan, stiff, moist
56–85		SC		Clayey sand, reddish tan, soft, moist
85–102		SP		Poorly graded sand, tan, soft, wet

Total depth 102'
Water level 86.60'



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Log of Boring Monitor Well 6

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

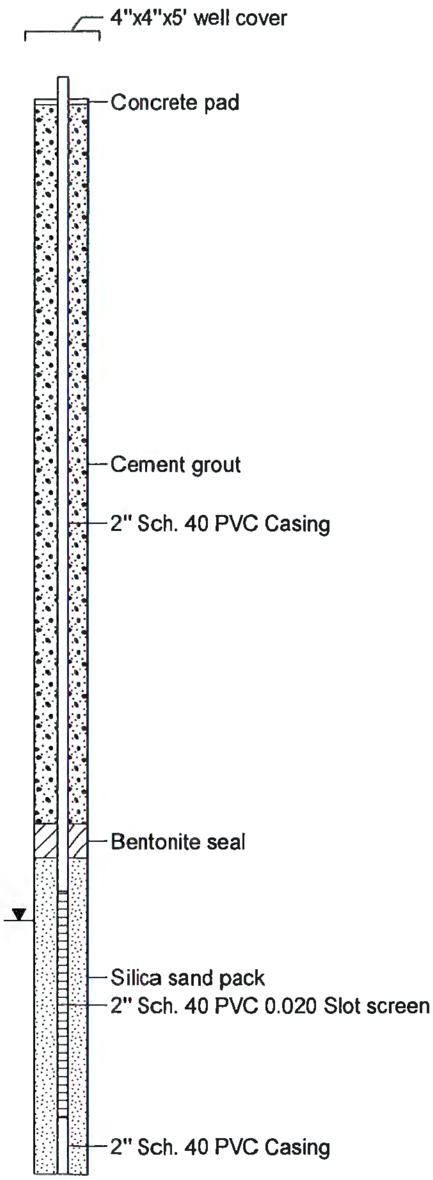
Contact: Carlos Villalpando

Job#: CREEKSI.DAR.08

Drill Start	: 02-05-09 (08:30)
Drill End	: 02-05-09 (16:30)
Boring Location	: 32°56.885', -104°27.066'
Site Location	: Creekside Dairy
Auger Type	: 4¼ Hollow Stem
Logged By	: Mort Bates

Depth in Feet	USCS	Sample	DESCRIPTION
0–4	CL		Clay, brown, loose, dry
4–26	GC		Clayey gravel, tan, firm, dry
26–59	SC		Clayey sand, tan, loose, dry
59–82	SC		Clayey sand, tan, loose, damp
82–95	SP		Poorly graded sand, tan, soft, wet

Total depth 95'
Water level 74.58'



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ATKINS ENGINEERING ASSOCIATES, INC.
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Water Resources / Environmental Science

Log of Boring Monitor Well 9

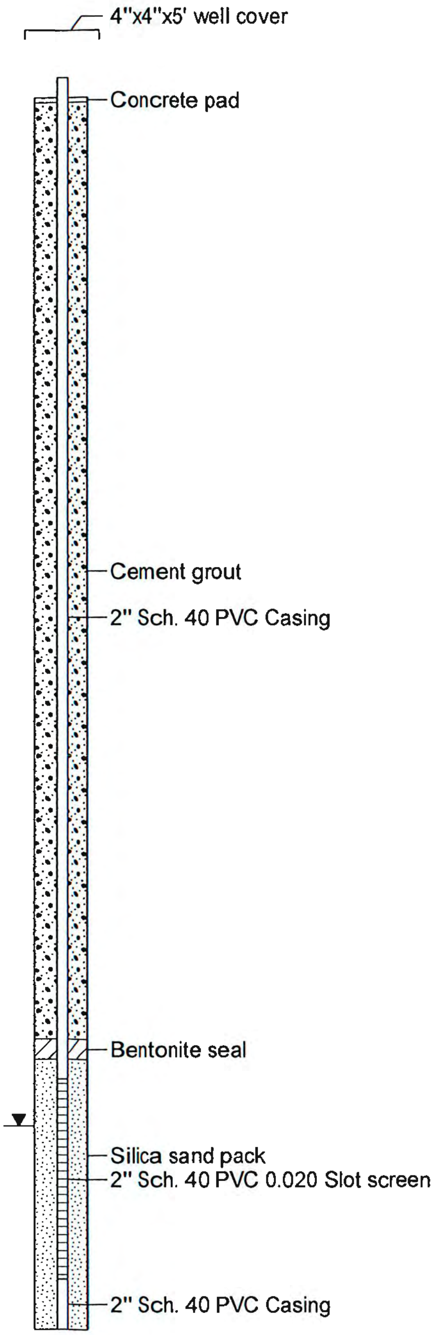
Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

Contact: Carlos Villalpando

Job#: CREEKSI.DAR.08

Drill Start	: 02-06-09 (08:00)	Logged By	: Mort Bates
Drill End	: 02-09-09 (07:30)		
Boring Location	: 32°56.646', -104°26.301'		
Site Location	: Creekside Dairy		
Auger Type	: 4¼ Hollow Stem		

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0 – 15		CL		Clay, brown, loose, dry
		GC		Clayey gravel, tan, loose, dry
20 – 25		GP		Poorly graded gravel, tan, loose, dry
30 – 40		SC		Clayey sand, tan, loose, damp
45 – 100		SC		Clayey sand, tan, loose, moist
105 – 120		SP		Poorly graded sand, tan, soft, wet
125 – 130				Total depth 123' Water level 104.70'



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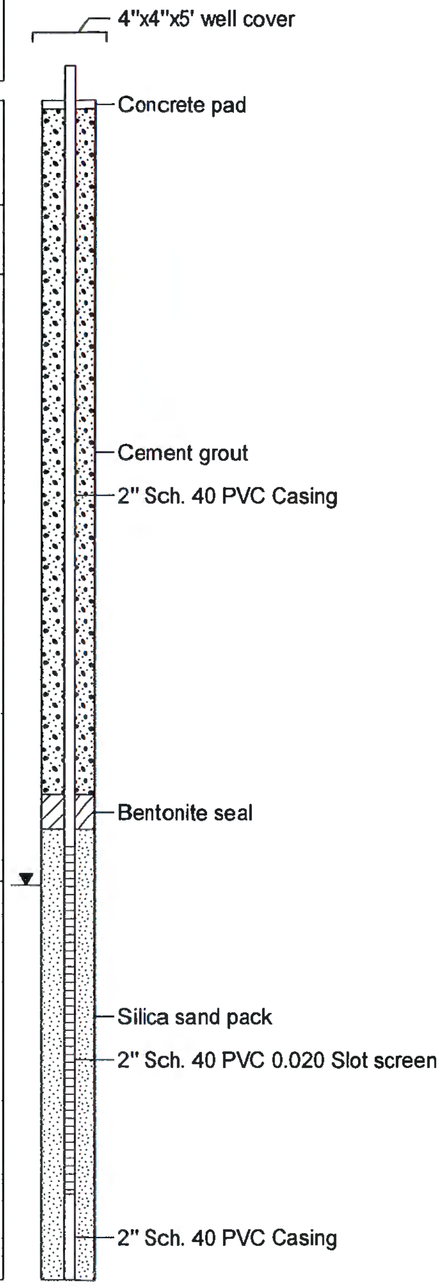
Log of Boring Monitor Well 10

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico
Contact: Carlos Villalpando
Job#: CREEKSI.DAR.08

Drill Start	: 02-07-09 (07:45)	Logged By	: Mort Bates
Drill End	: 02-07-09 (12:15)		
Boring Location	: 32°56.402', -104°25.799'		
Site Location	: Creekside Dairy		
Auger Type	: 4¼ Hollow Stem		

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0–6		CL		Clay, brown, loose, dry
6–10		GP		Poorly graded gravel, tan, loose, dry
10–45		GC		Clayey gravel, tan, loose, damp
45–68		SP		Poorly graded sand, tan, soft, wet

Total depth 68'
Water level 47.25'



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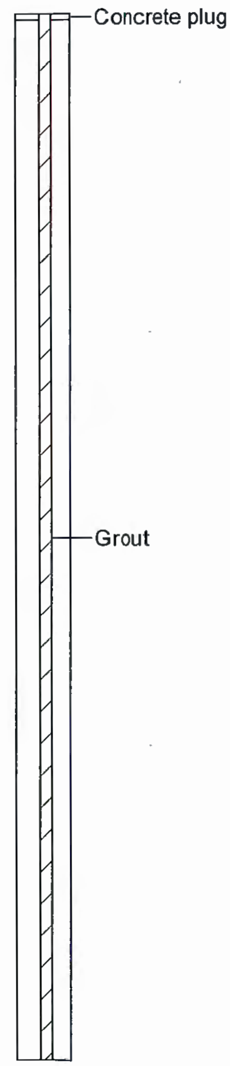
Professional Engineering / Land Surveying
Water Resources / Environmental Science

Log of Plugging Well #1

Creekside Dairy 7785 Roswell Highway Lake Arthur, New Mexico	Date : 03-05-09 Boring Location : 32°57.102, -104°26.809 Site Location : Creekside Dairy Logged By : Mort Bates
Contact: Abel Villalpando	
Job#: CREEKSI.DAR.08	

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0–88.09				Well was 88.09' with 2" PVC casing. Well volume was 15.5 gallons. 20± gallons of grout was injected into the casing at 16 to 16.5 pounds per gallon. The casing was cut off one foot below land surface and capped with a concrete plug.
				Total Depth 88.09'

Depth scale (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110



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Professional Engineering / Land Surveying
Water Resources / Environmental Science

Log of Plugging Well #2

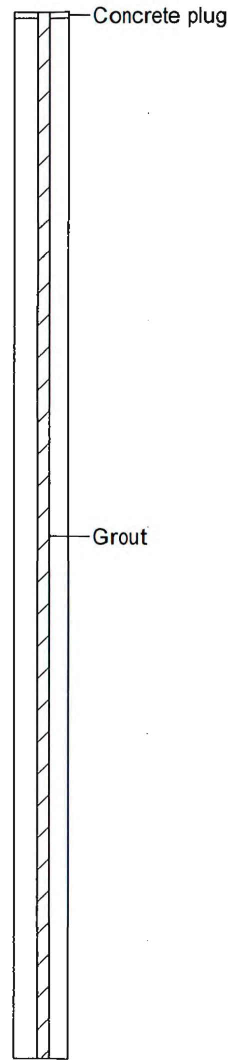
Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

Contact: Abel Villalpando

Job#: CREEKSI.DAR.08

Date	: 03-04-09
Boring Location	: 32°57.247, -104°26.457
Site Location	: Creekside Dairy
Logged By	: Mort Bates

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0				Well was 88.12' with 2" PVC casing. Well volume was 15.5 gallons. 20± gallons of grout was injected into the casing at 16 to 16.5 pounds per gallon. The casing was cut off one foot below land surface and capped with a concrete plug.
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				
60				
65				
70				
75				
80				
85				
90				Total Depth 88.12'
95				
100				
105				
110				



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ATKINS ENGINEERING ASSOCIATES, INC.
Professional Engineering / Land Surveying
Water Resources / Environmental Science

Log of Plugging Well #3

Creekside Dairy
7785 Roswell Highway
Lake Arthur, New Mexico

Contact: Abel Villalpando

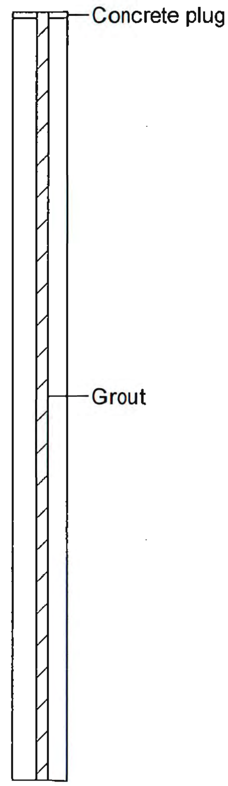
Job#: CREEKSI.DAR.08

Date	: 03-05-09
Boring Location	: 32°57.102, -104°26.364
Site Location	: Creekside Dairy
Logged By	: Mort Bates

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0–65				Well was 64.42' with 2" PVC casing. Well volume was 11.3 gallons. 19± gallons of grout was injected into the casing at 16.5 to 17 pounds per gallon. The casing was cut off one foot below land surface and capped with a concrete plug.

Total Depth 64.62

Depth in Feet: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110



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APPENDIX B

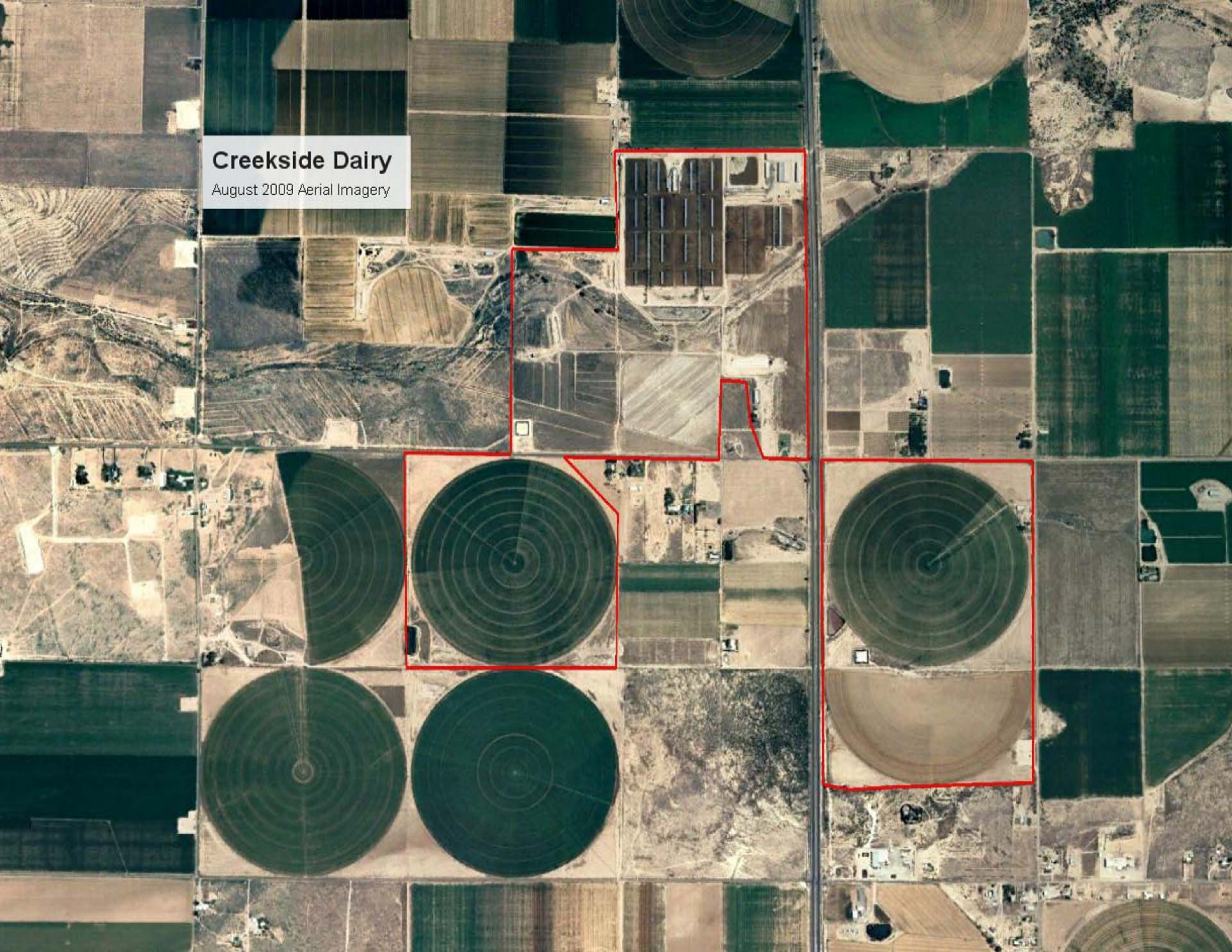
HISTORICAL AERIAL PHOTOS

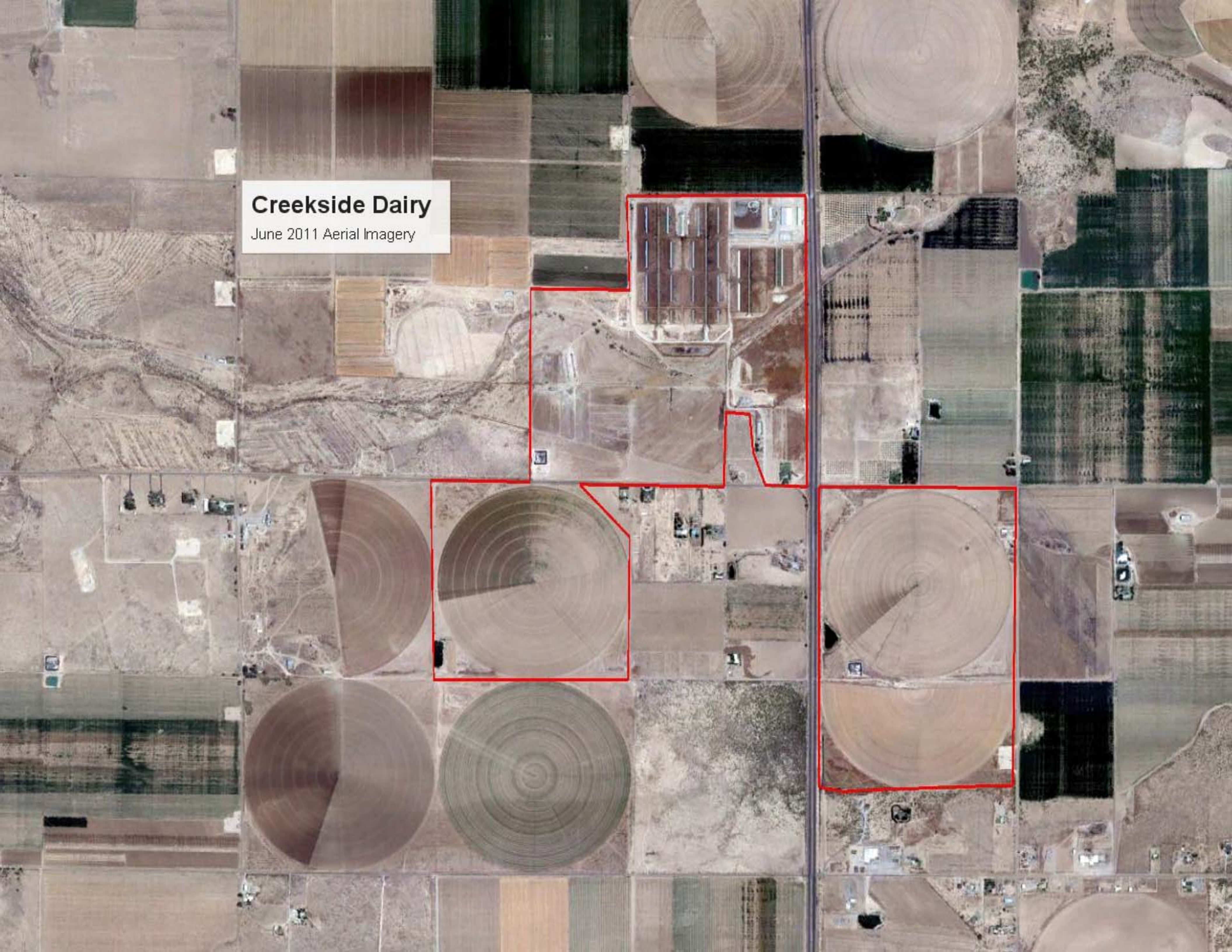

Creekside Dairy
October 1997 Aerial Imagery

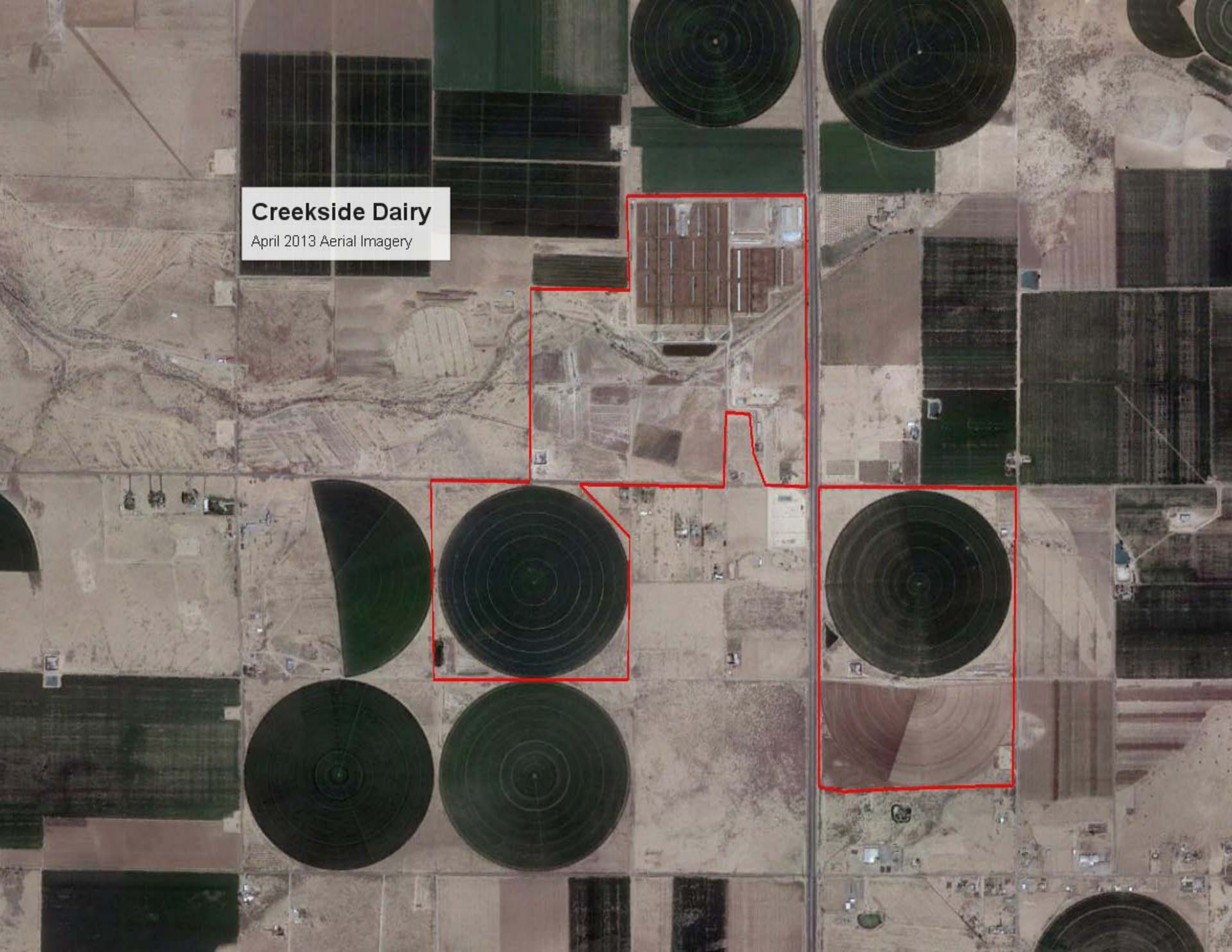

Creekside Dairy
January 2004 Aerial Imagery


Creekside Dairy
July 2005 Aerial Imagery


Creekside Dairy
September 2006 Aerial Imagery


Creekside Dairy
August 2009 Aerial Imagery


Creekside Dairy
June 2011 Aerial Imagery


Creekside Dairy
April 2013 Aerial Imagery


Creekside Dairy
May 2014 Aerial Imagery


Creekside Dairy
March 2016 Aerial Imagery


Creekside Dairy
June 2019 Aerial Imagery

APPENDIX C

SOIL LABORATORY ANALYTICAL RESULTS

ANALYTICAL CHEMISTS and BACTERIOLOGISTS Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-1/9
Project #/Name: None / Creekside
Sample ID: Field 3 0-12"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	9.0	10-50	Low
Nitrate (NO_3-N)	130	20-100	High
Total Available N	140	75-150	OK
Phosphorous(P_2O_5)	1100	100-300	High
Potassium (K_2O)	1300	2659-4432	Low
Calcium (Ca)	33000	22654-28317	High
Magnesium (Mg)	2300	2265-4530	OK
Sulfate (SO_4-S)	2400	100-200	High
Sodium (Na)	170	< 250	See SAR
Chloride (Cl)	90	1-100	OK
ECe (dS/m)	3.9	0.2-4	OK
Copper (Cu)	9.0	1 +	OK
Zinc (Zn)	10	3 +	OK
Iron (Fe)	8.6	8 +	OK
Manganese (Mn)	3.7	4 +	Low
Boron (B)	4.7	1-4	High
SAR	0.66	0-6	OK
CEC (meq/100gms)	94	10-20	OK
ESP (%)	0.40	0-10	OK
pHs Value	7.6	6.5-7.5	High
Organic Matter (%)	6.7		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

0	Nitrogen (N)
0	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
0.6 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	64	mg/Kg	KCl
NH_3-N	4.5	mg/Kg	KCl
P	240	mg/Kg	Olsen
SP	70	%	Sat
pHs	7.6	unit	Sat
ECe	3.9	dS/m	Sat
Ca	34	meq/L	Sat
Mg	22	meq/L	Sat
Na	3.5	meq/L	Sat
K	2.1	meq/L	Sat
Cl	1.8	meq/L	Sat
SO_4-S	52	meq/L	Sat
SAR	0.66	ratio	Calc
B	2.4	mg/Kg	CaCl2
Cu	4.5	mg/Kg	DTPA
Zn	5.2	mg/Kg	DTPA
Fe	4.3	mg/Kg	DTPA
Mn	1.9	mg/Kg	DTPA

Data:			Method
OrgMat	6.7	%	WalkBk
Org-C	3.9	%	WalkBk
SMP Bufffer pH	7.53	unit	SMP
GypReq	0.74	meq/100g	GypSol
Ca	17000	mg/Kg	NH_4OAc
Mg	1200	mg/Kg	NH_4OAc
Na	87	mg/Kg	NH_4OAc
K	540	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	94	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	87.9	% of CEC	Calc.
Mg	10.2	% of CEC	Calc.
Na	0.4	% of CEC	Calc.
K	1.5	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

ANALYTICAL CHEMISTS and BACTERIOLOGISTS
Approved by State of California
SOIL CONTROL LAB
42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-2/9
Project #/Name: None / Creekside
Sample ID: Field 3 12-24"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	8.6	10-50	Low
Nitrate (NO_3-N)	53	20-100	OK
Total Available N	61	75-150	Low
Phosphorous(P_2O_5)	220	100-300	OK
Potassium (K_2O)	1600	2033-3389	Low
Calcium (Ca)	24000	17321-21652	High
Magnesium (Mg)	2400	1732-3464	OK
Sulfate (SO_4-S)	2300	100-200	High
Sodium (Na)	230	< 250	See SAR
Chloride (Cl)	70	1-100	OK
ECe (dS/m)	4.3	0.2-4	High
Copper (Cu)	2.2	1 +	OK
Zinc (Zn)	2.3	3 +	Low
Iron (Fe)	12	8 +	OK
Manganese (Mn)	1.5	4 +	Low
Boron (B)	4.2	1-4	High
SAR	0.99	0-6	OK
CEC (meq/100gms)	72	10-20	OK
ESP (%)	0.69	0-10	OK
pHs Value	7.9	6.5-7.5	High
Organic Matter (%)	1.7		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

75	Nitrogen (N)
50	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
0.9 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	26	mg/Kg	KCl
NH_3-N	4.3	mg/Kg	KCl
P	51	mg/Kg	Olsen
SP	58	%	Sat
pHs	7.9	unit	Sat
ECe	4.3	dS/m	Sat
Ca	30	meq/L	Sat
Mg	27	meq/L	Sat
Na	5.3	meq/L	Sat
K	2.6	meq/L	Sat
Cl	1.7	meq/L	Sat
SO_4-S	61	meq/L	Sat
SAR	0.99	ratio	Calc
B	2.1	mg/Kg	CaCl2
Cu	1.1	mg/Kg	DTPA
Zn	1.2	mg/Kg	DTPA
Fe	5.9	mg/Kg	DTPA
Mn	0.74	mg/Kg	DTPA

Data:			Method
OrgMat	1.7	%	WalkBk
Org-C	0.98	%	WalkBk
SMP Bufffer pH	7.59	unit	SMP
GypReq	1.1	meq/100g	GypSol
Ca	12000	mg/Kg	NH_4OAc
Mg	1200	mg/Kg	NH_4OAc
Na	110	mg/Kg	NH_4OAc
K	680	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	72	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	83.0	% of CEC	Calc.
Mg	13.9	% of CEC	Calc.
Na	0.7	% of CEC	Calc.
K	2.4	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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42 HANGAR WAY
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TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-3/9
Project #/Name: None / Creekside
Sample ID: Field 3 24-36"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	5.3	10-50	Low
Nitrate (NO_3-N)	33	20-100	OK
Total Available N	39	75-150	Low
Phosphorous(P_2O_5)	120	100-300	OK
Potassium (K_2O)	1100	2792-4653	Low
Calcium (Ca)	34000	23785-29732	High
Magnesium (Mg)	2800	2378-4757	OK
Sulfate (SO_4-S)	2800	100-200	High
Sodium (Na)	300	< 250	See SAR
Chloride (Cl)	120	1-100	High
ECe (dS/m)	4.7	0.2-4	High
Copper (Cu)	1.6	1 +	OK
Zinc (Zn)	2.2	3 +	Low
Iron (Fe)	13	8 +	OK
Manganese (Mn)	1.3	4 +	Low
Boron (B)	3.5	1-4	OK
SAR	1.3	0-6	OK
CEC (meq/100gms)	99	10-20	OK
ESP (%)	0.66	0-10	OK
pHs Value	8.1	6.5-7.5	High
Organic Matter (%)	3.9		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

100	Nitrogen (N)
150	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.3 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	17	mg/Kg	KCl
NH_3-N	2.6	mg/Kg	KCl
P	26	mg/Kg	Olsen
SP	62	%	Sat
pHs	8.1	unit	Sat
ECe	4.7	dS/m	Sat
Ca	28	meq/L	Sat
Mg	35	meq/L	Sat
Na	7.2	meq/L	Sat
K	1.5	meq/L	Sat
Cl	2.8	meq/L	Sat
SO_4-S	70	meq/L	Sat
SAR	1.3	ratio	Calc
B	1.8	mg/Kg	CaCl2
Cu	0.81	mg/Kg	DTPA
Zn	1.1	mg/Kg	DTPA
Fe	6.5	mg/Kg	DTPA
Mn	0.65	mg/Kg	DTPA

Data:			Method
OrgMat	3.9	%	WalkBk
Org-C	2.2	%	WalkBk
SMP Bufffer pH	7.60	unit	SMP
GypReq	1.5	meq/100g	GypSol
Ca	17000	mg/Kg	NH_4OAc
Mg	1400	mg/Kg	NH_4OAc
Na	150	mg/Kg	NH_4OAc
K	450	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	99	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	86.6	% of CEC	Calc.
Mg	11.6	% of CEC	Calc.
Na	0.7	% of CEC	Calc.
K	1.2	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-4/9
Project #/Name: None / Creekside
Sample ID: Field 4 0-12"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	8.0	10-50	Low
Nitrate (NO_3-N)	53	20-100	OK
Total Available N	61	75-150	Low
Phosphorous(P_2O_5)	880	100-300	High
Potassium (K_2O)	640	3013-5022	Low
Calcium (Ca)	39000	25670-32087	High
Magnesium (Mg)	1800	2567-5134	Low
Sulfate (SO_4-S)	1900	100-200	High
Sodium (Na)	170	< 250	See SAR
Chloride (Cl)	110	1-100	High
ECe (dS/m)	4.0	0.2-4	OK
Copper (Cu)	5.7	1 +	OK
Zinc (Zn)	9.3	3 +	OK
Iron (Fe)	7.1	8 +	Low
Manganese (Mn)	3.0	4 +	Low
Boron (B)	3.3	1-4	OK
SAR	0.79	0-6	OK
CEC (meq/100gms)	110	10-20	High
ESP (%)	0.35	0-10	OK
pHs Value	7.8	6.5-7.5	High
Organic Matter (%)	4.7		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

75	Nitrogen (N)
0	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
0.3 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	26	mg/Kg	KCl
NH_3-N	4.0	mg/Kg	KCl
P	200	mg/Kg	Olsen
SP	56	%	Sat
pHs	7.8	unit	Sat
ECe	4.0	dS/m	Sat
Ca	36	meq/L	Sat
Mg	19	meq/L	Sat
Na	4.2	meq/L	Sat
K	0.71	meq/L	Sat
Cl	2.8	meq/L	Sat
SO_4-S	52	meq/L	Sat
SAR	0.79	ratio	Calc
B	1.6	mg/Kg	CaCl2
Cu	2.8	mg/Kg	DTPA
Zn	4.6	mg/Kg	DTPA
Fe	3.6	mg/Kg	DTPA
Mn	1.5	mg/Kg	DTPA

Data:			Method
OrgMat	4.7	%	WalkBk
Org-C	2.7	%	WalkBk
SMP Bufffer pH	7.57	unit	SMP
GypReq	0.39	meq/100g	GypSol
Ca	20000	mg/Kg	NH_4OAc
Mg	880	mg/Kg	NH_4OAc
Na	85	mg/Kg	NH_4OAc
K	270	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	110	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	92.1	% of CEC	Calc.
Mg	6.9	% of CEC	Calc.
Na	0.3	% of CEC	Calc.
K	0.6	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-5/9
Project #/Name: None / Creekside
Sample ID: Field 4 12-24"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	7.2	10-50	Low
Nitrate (NO_3-N)	16	20-100	Low
Total Available N	24	75-150	Low
Phosphorous(P_2O_5)	130	100-300	OK
Potassium (K_2O)	1200	2957-4929	Low
Calcium (Ca)	38000	25193-31491	High
Magnesium (Mg)	1900	2519-5038	Low
Sulfate (SO_4-S)	2000	100-200	High
Sodium (Na)	150	< 250	See SAR
Chloride (Cl)	130	1-100	High
ECe (dS/m)	4.0	0.2-4	OK
Copper (Cu)	1.5	1 +	OK
Zinc (Zn)	1.4	3 +	Low
Iron (Fe)	6.7	8 +	Low
Manganese (Mn)	1.2	4 +	Low
Boron (B)	2.9	1-4	OK
SAR	0.74	0-6	OK
CEC (meq/100gms)	100	10-20	OK
ESP (%)	0.31	0-10	OK
pHs Value	8.0	6.5-7.5	High
Organic Matter (%)	3.6		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

125	Nitrogen (N)
150	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
0.9 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	8.2	mg/Kg	KCl
NH_3-N	3.6	mg/Kg	KCl
P	29	mg/Kg	Olsen
SP	56	%	Sat
pHs	8.0	unit	Sat
ECe	4.0	dS/m	Sat
Ca	31	meq/L	Sat
Mg	22	meq/L	Sat
Na	3.8	meq/L	Sat
K	1.7	meq/L	Sat
Cl	3.2	meq/L	Sat
SO_4-S	54	meq/L	Sat
SAR	0.74	ratio	Calc
B	1.4	mg/Kg	CaCl2
Cu	0.74	mg/Kg	DTPA
Zn	0.72	mg/Kg	DTPA
Fe	3.4	mg/Kg	DTPA
Mn	0.61	mg/Kg	DTPA

Data:			Method
OrgMat	3.6	%	WalkBk
Org-C	2.1	%	WalkBk
SMP Bufffer pH	7.58	unit	SMP
GypReq	1.1	meq/100g	GypSol
Ca	19000	mg/Kg	NH_4OAc
Mg	940	mg/Kg	NH_4OAc
Na	76	mg/Kg	NH_4OAc
K	490	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	100	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	91.0	% of CEC	Calc.
Mg	7.5	% of CEC	Calc.
Na	0.3	% of CEC	Calc.
K	1.2	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-6/9
Project #/Name: None / Creekside
Sample ID: Field 4 24-36"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	6.2	10-50	Low
Nitrate (NO_3-N)	11	20-100	Low
Total Available N	18	75-150	Low
Phosphorous(P_2O_5)	120	100-300	OK
Potassium (K_2O)	1400	2747-4579	Low
Calcium (Ca)	35000	23406-29258	High
Magnesium (Mg)	2100	2340-4681	Low
Sulfate (SO_4-S)	2400	100-200	High
Sodium (Na)	180	< 250	See SAR
Chloride (Cl)	120	1-100	High
ECe (dS/m)	4.3	0.2-4	High
Copper (Cu)	1.6	1 +	OK
Zinc (Zn)	1.6	3 +	Low
Iron (Fe)	6.3	8 +	Low
Manganese (Mn)	1.4	4 +	Low
Boron (B)	3.4	1-4	OK
SAR	0.83	0-6	OK
CEC (meq/100gms)	98	10-20	OK
ESP (%)	0.39	0-10	OK
pHs Value	8.0	6.5-7.5	High
Organic Matter (%)	2.3		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

125	Nitrogen (N)
150	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs 0.0
pH 6.5 needs 0.0
pH 7.0 needs 0.0

Gypsum Requirement (needed for clay treatment)
0.9 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	5.7	mg/Kg	KCl
NH_3-N	3.1	mg/Kg	KCl
P	27	mg/Kg	Olsen
SP	60	%	Sat
pHs	8.0	unit	Sat
ECe	4.3	dS/m	Sat
Ca	30	meq/L	Sat
Mg	27	meq/L	Sat
Na	4.4	meq/L	Sat
K	2.6	meq/L	Sat
Cl	2.9	meq/L	Sat
SO_4-S	62	meq/L	Sat
SAR	0.83	ratio	Calc
B	1.7	mg/Kg	CaCl2
Cu	0.80	mg/Kg	DTPA
Zn	0.79	mg/Kg	DTPA
Fe	3.2	mg/Kg	DTPA
Mn	0.69	mg/Kg	DTPA

Data:			Method
OrgMat	2.3	%	WalkBk
Org-C	1.4	%	WalkBk
SMP Bufffer pH	7.61	unit	SMP
GypReq	1.1	meq/100g	GypSol
Ca	17000	mg/Kg	NH_4OAc
Mg	1100	mg/Kg	NH_4OAc
Na	88	mg/Kg	NH_4OAc
K	590	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	98	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	89.0	% of CEC	Calc.
Mg	9.1	% of CEC	Calc.
Na	0.4	% of CEC	Calc.
K	1.5	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-7/9
Project #/Name: None / Creekside
Sample ID: Field 6 0-12"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	7.0	10-50	Low
Nitrate (NO_3-N)	60	20-100	OK
Total Available N	67	75-150	Low
Phosphorous(P_2O_5)	680	100-300	High
Potassium (K_2O)	1700	2647-4413	Low
Calcium (Ca)	34000	22557-28196	High
Magnesium (Mg)	1900	2255-4511	Low
Sulfate (SO_4-S)	2100	100-200	High
Sodium (Na)	110	< 250	See SAR
Chloride (Cl)	53	1-100	OK
ECe (dS/m)	3.8	0.2-4	OK
Copper (Cu)	4.5	1 +	OK
Zinc (Zn)	5.3	3 +	OK
Iron (Fe)	7.2	8 +	Low
Manganese (Mn)	9.0	4 +	OK
Boron (B)	5.7	1-4	High
SAR	0.45	0-6	OK
CEC (meq/100gms)	94	10-20	OK
ESP (%)	0.26	0-10	OK
pHs Value	7.9	6.5-7.5	High
Organic Matter (%)	4.4		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

75	Nitrogen (N)
0	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep
needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
0.5 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	30	mg/Kg	KCl
NH_3-N	3.5	mg/Kg	KCl
P	150	mg/Kg	Olsen
SP	65	%	Sat
pHs	7.9	unit	Sat
ECe	3.8	dS/m	Sat
Ca	35	meq/L	Sat
Mg	16	meq/L	Sat
Na	2.3	meq/L	Sat
K	2.6	meq/L	Sat
Cl	1.2	meq/L	Sat
SO_4-S	51	meq/L	Sat
SAR	0.45	ratio	Calc
B	2.8	mg/Kg	CaCl2
Cu	2.3	mg/Kg	DTPA
Zn	2.6	mg/Kg	DTPA
Fe	3.6	mg/Kg	DTPA
Mn	4.5	mg/Kg	DTPA

Data:			Method
OrgMat	4.4	%	WalkBk
Org-C	2.6	%	WalkBk
SMP Bufffer pH	7.59	unit	SMP
GypReq	0.60	meq/100g	GypSol
Ca	17000	mg/Kg	NH_4OAc
Mg	960	mg/Kg	NH_4OAc
Na	57	mg/Kg	NH_4OAc
K	730	mg/Kg	NH_4OAc
Moisture	NA	%	Oven dry

Cation Exchange Capacity (CEC) and Base Saturation Percentages			
CEC	94	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	89.3	% of CEC	Calc.
Mg	8.5	% of CEC	Calc.
Na	0.3	% of CEC	Calc.
K	2.0	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-8/9
Project #/Name: None / Creekside
Sample ID: Field 6 12-24"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	13	10-50	OK
Nitrate (NO_3-N)	71	20-100	OK
Total Available N	84	75-150	OK
Phosphorous(P_2O_5)	780	100-300	High
Potassium (K_2O)	1600	2426-4043	Low
Calcium (Ca)	30000	20666-25833	High
Magnesium (Mg)	1900	2066-4133	Low
Sulfate (SO_4-S)	2100	100-200	High
Sodium (Na)	120	< 250	See SAR
Chloride (Cl)	59	1-100	OK
ECe (dS/m)	3.8	0.2-4	OK
Copper (Cu)	5.9	1 +	OK
Zinc (Zn)	5.7	3 +	OK
Iron (Fe)	6.8	8 +	Low
Manganese (Mn)	11	4 +	OK
Boron (B)	5.1	1-4	High
SAR	0.49	0-6	OK
CEC (meq/100gms)	86	10-20	OK
ESP (%)	0.31	0-10	OK
pHs Value	7.8	6.5-7.5	High
Organic Matter (%)	6.3		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

50	Nitrogen (N)
0	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
0.4 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	35	mg/Kg	KCl
NH_3-N	6.6	mg/Kg	KCl
P	180	mg/Kg	Olsen
SP	66	%	Sat
pHs	7.8	unit	Sat
ECe	3.8	dS/m	Sat
Ca	36	meq/L	Sat
Mg	17	meq/L	Sat
Na	2.5	meq/L	Sat
K	2.4	meq/L	Sat
Cl	1.3	meq/L	Sat
SO_4-S	50	meq/L	Sat
SAR	0.49	ratio	Calc
B	2.6	mg/Kg	CaCl2
Cu	3.0	mg/Kg	DTPA
Zn	2.8	mg/Kg	DTPA
Fe	3.4	mg/Kg	DTPA
Mn	5.6	mg/Kg	DTPA

Data:			Method
OrgMat	6.3	%	WalkBk
Org-C	3.7	%	WalkBk
SMP Bufffer pH	7.57	unit	SMP
GypReq	0.52	meq/100g	GypSol
Ca	15000	mg/Kg	NH_4OAc
Mg	960	mg/Kg	NH_4OAc
Na	61	mg/Kg	NH_4OAc
K	650	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	86	meq/100gm	Calc.
NH_3-N	0.1	% of CEC	Calc.
Ca	88.4	% of CEC	Calc.
Mg	9.3	% of CEC	Calc.
Na	0.3	% of CEC	Calc.
K	1.9	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

ANALYTICAL CHEMISTS
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42 HANGAR WAY
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TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 9090748
Account #: 9442
Date Received: Sep 25, 2019
Date Reported: Oct 1, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9090748-9/9
Project #/Name: None / Creekside
Sample ID: Field 6 24-36"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	9.0	10-50	Low
Nitrate (NO_3-N)	27	20-100	OK
Total Available N	36	75-150	Low
Phosphorous(P_2O_5)	290	100-300	OK
Potassium (K_2O)	1000	2623-4371	Low
Calcium (Ca)	32000	22344-27930	High
Magnesium (Mg)	2500	2234-4468	OK
Sulfate (SO_4-S)	2400	100-200	High
Sodium (Na)	260	< 250	See SAR
Chloride (Cl)	39	1-100	OK
ECe (dS/m)	4.1	0.2-4	High
Copper (Cu)	2.7	1 +	OK
Zinc (Zn)	1.8	3 +	Low
Iron (Fe)	7.0	8 +	Low
Manganese (Mn)	3.9	4 +	Low
Boron (B)	3.3	1-4	OK
SAR	1.0	0-6	OK
CEC (meq/100gms)	93	10-20	OK
ESP (%)	0.61	0-10	OK
pHs Value	8.0	6.5-7.5	High
Organic Matter (%)	3.4		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

100	Nitrogen (N)
0	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.0 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	14	mg/Kg	KCl
NH_3-N	4.5	mg/Kg	KCl
P	66	mg/Kg	Olsen
SP	62	%	Sat
pHs	8.0	unit	Sat
ECe	4.1	dS/m	Sat
Ca	31	meq/L	Sat
Mg	25	meq/L	Sat
Na	5.5	meq/L	Sat
K	1.1	meq/L	Sat
Cl	0.88	meq/L	Sat
SO_4-S	59	meq/L	Sat
SAR	1.0	ratio	Calc
B	1.6	mg/Kg	CaCl2
Cu	1.4	mg/Kg	DTPA
Zn	0.90	mg/Kg	DTPA
Fe	3.5	mg/Kg	DTPA
Mn	1.9	mg/Kg	DTPA

Data:			Method
OrgMat	3.4	%	WalkBk
Org-C	2.0	%	WalkBk
SMP Bufffer pH	7.61	unit	SMP
GypReq	1.1	meq/100g	GypSol
Ca	16000	mg/Kg	NH_4OAc
Mg	1200	mg/Kg	NH_4OAc
Na	130	mg/Kg	NH_4OAc
K	420	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	93	meq/100gm	Calc.
NH_3-N	0.0	% of CEC	Calc.
Ca	87.1	% of CEC	Calc.
Mg	11.1	% of CEC	Calc.
Na	0.6	% of CEC	Calc.
K	1.2	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 9110469
Account #: 9442
Date Received: Nov 18, 2019
Date Reported: Nov 27, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9110469-1/6
Project #/Name: None / Creekside
Sample ID: Field 2A 0-12"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	17	10-50	OK
Nitrate (NO_3-N)	18	20-100	Low
Total Available N	35	75-150	Low
Phosphorous(P_2O_5)	260	100-300	OK
Potassium (K_2O)	1200	1113-1855	OK
Calcium (Ca)	14000	9486-11857	High
Magnesium (Mg)	990	948-1897	OK
Sulfate (SO_4-S)	1500	100-200	High
Sodium (Na)	70	< 250	See SAR
Chloride (Cl)	30	1-100	OK
ECe (dS/m)	2.8	0.2-4	OK
Copper (Cu)	15	1 +	OK
Zinc (Zn)	3.9	3 +	OK
Iron (Fe)	8.1	8 +	OK
Manganese (Mn)	3.5	4 +	Low
Boron (B)	2.6	1-4	OK
SAR	0.38	0-6	OK
CEC (meq/100gms)	40	10-20	OK
ESP (%)	0.39	0-10	OK
pHs Value	7.7	6.5-7.5	High
Organic Matter (%)	2.6		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

100	Nitrogen (N)
0	Phosphorous (P_2O_5)
200	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep
needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.2 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	9.2	mg/Kg	KCl
NH_3-N	8.3	mg/Kg	KCl
P	58	mg/Kg	Olsen
SP	58	%	Sat
pHs	7.7	unit	Sat
ECe	2.8	dS/m	Sat
Ca	26	meq/L	Sat
Mg	11	meq/L	Sat
Na	1.6	meq/L	Sat
K	2.4	meq/L	Sat
Cl	0.72	meq/L	Sat
SO_4-S	40	meq/L	Sat
SAR	0.38	ratio	Calc
B	1.3	mg/Kg	CaCl2
Cu	7.5	mg/Kg	DTPA
Zn	2.0	mg/Kg	DTPA
Fe	4.1	mg/Kg	DTPA
Mn	1.8	mg/Kg	DTPA

Data:			Method
OrgMat	2.6	%	WalkBk
Org-C	1.5	%	WalkBk
SMP Bufffer pH	7.55	unit	SMP
GypReq	1.4	meq/100g	GypSol
Ca	6800	mg/Kg	NH_4OAc
Mg	500	mg/Kg	NH_4OAc
Na	35	mg/Kg	NH_4OAc
K	520	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	40	meq/100gm	Calc.
NH_3-N	0.2	% of CEC	Calc.
Ca	85.6	% of CEC	Calc.
Mg	10.5	% of CEC	Calc.
Na	0.4	% of CEC	Calc.
K	3.3	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9110469
Account #: 9442
Date Received: Nov 18, 2019
Date Reported: Nov 27, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9110469-2/6
Project #/Name: None / Creekside
Sample ID: Field 2A 12-24"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	12	10-50	OK
Nitrate (NO_3-N)	26	20-100	OK
Total Available N	38	75-150	Low
Phosphorous(P_2O_5)	94	100-300	Low
Potassium (K_2O)	970	2070-3450	Low
Calcium (Ca)	27000	17637-22046	High
Magnesium (Mg)	1200	1763-3527	Low
Sulfate (SO_4-S)	1600	100-200	High
Sodium (Na)	120	< 250	See SAR
Chloride (Cl)	58	1-100	OK
ECe (dS/m)	3.2	0.2-4	OK
Copper (Cu)	4.0	1 +	OK
Zinc (Zn)	1.5	3 +	Low
Iron (Fe)	7.4	8 +	Low
Manganese (Mn)	2.4	4 +	Low
Boron (B)	2.0	1-4	OK
SAR	0.68	0-6	OK
CEC (meq/100gms)	73	10-20	OK
ESP (%)	0.37	0-10	OK
pHs Value	7.7	6.5-7.5	High
Organic Matter (%)	1.9		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

100	Nitrogen (N)
200	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep
needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.0 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	13	mg/Kg	KCl
NH_3-N	6.0	mg/Kg	KCl
P	21	mg/Kg	Olsen
SP	52	%	Sat
pHs	7.7	unit	Sat
ECe	3.2	dS/m	Sat
Ca	27	meq/L	Sat
Mg	16	meq/L	Sat
Na	3.1	meq/L	Sat
K	1.7	meq/L	Sat
Cl	1.6	meq/L	Sat
SO_4-S	48	meq/L	Sat
SAR	0.68	ratio	Calc
B	1.0	mg/Kg	CaCl2
Cu	2.0	mg/Kg	DTPA
Zn	0.77	mg/Kg	DTPA
Fe	3.7	mg/Kg	DTPA
Mn	1.2	mg/Kg	DTPA

Data:			Method
OrgMat	1.9	%	WalkBk
Org-C	1.1	%	WalkBk
SMP Bufffer pH	7.58	unit	SMP
GypReq	1.2	meq/100g	GypSol
Ca	13000	mg/Kg	NH_4OAc
Mg	590	mg/Kg	NH_4OAc
Na	62	mg/Kg	NH_4OAc
K	400	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	73	meq/100gm	Calc.
NH_3-N	0.1	% of CEC	Calc.
Ca	91.5	% of CEC	Calc.
Mg	6.7	% of CEC	Calc.
Na	0.4	% of CEC	Calc.
K	1.4	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9110469
Account #: 9442
Date Received: Nov 18, 2019
Date Reported: Nov 27, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9110469-3/6
Project #/Name: None / Creekside
Sample ID: Field 2A 24-36"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	19	10-50	OK
Nitrate (NO_3-N)	13	20-100	Low
Total Available N	32	75-150	Low
Phosphorous(P_2O_5)	60	100-300	Low
Potassium (K_2O)	590	1995-3325	Low
Calcium (Ca)	26000	16998-21248	High
Magnesium (Mg)	1200	1699-3399	Low
Sulfate (SO_4-S)	1600	100-200	High
Sodium (Na)	270	< 250	See SAR
Chloride (Cl)	72	1-100	OK
ECe (dS/m)	3.7	0.2-4	OK
Copper (Cu)	1.8	1 +	OK
Zinc (Zn)	0.66	3 +	Low
Iron (Fe)	6.5	8 +	Low
Manganese (Mn)	1.7	4 +	Low
Boron (B)	1.5	1-4	OK
SAR	1.7	0-6	OK
CEC (meq/100gms)	71	10-20	OK
ESP (%)	0.84	0-10	OK
pHs Value	7.7	6.5-7.5	High
Organic Matter (%)	1.6		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

100	Nitrogen (N)
200	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep
needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.1 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	6.7	mg/Kg	KCl
NH_3-N	9.4	mg/Kg	KCl
P	14	mg/Kg	Olsen
SP	46	%	Sat
pHs	7.7	unit	Sat
ECe	3.7	dS/m	Sat
Ca	27	meq/L	Sat
Mg	19	meq/L	Sat
Na	8.0	meq/L	Sat
K	1.0	meq/L	Sat
Cl	2.2	meq/L	Sat
SO_4-S	55	meq/L	Sat
SAR	1.7	ratio	Calc
B	0.76	mg/Kg	CaCl2
Cu	0.91	mg/Kg	DTPA
Zn	0.33	mg/Kg	DTPA
Fe	3.3	mg/Kg	DTPA
Mn	0.87	mg/Kg	DTPA

Data:			Method
OrgMat	1.6	%	WalkBk
Org-C	0.93	%	WalkBk
SMP Bufffer pH	7.59	unit	SMP
GypReq	1.3	meq/100g	GypSol
Ca	13000	mg/Kg	NH_4OAc
Mg	590	mg/Kg	NH_4OAc
Na	140	mg/Kg	NH_4OAc
K	250	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	71	meq/100gm	Calc.
NH_3-N	0.1	% of CEC	Calc.
Ca	91.2	% of CEC	Calc.
Mg	6.9	% of CEC	Calc.
Na	0.8	% of CEC	Calc.
K	0.9	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Work Order #: 9110469
Account #: 9442
Date Received: Nov 18, 2019
Date Reported: Nov 27, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9110469-4/6
Project #/Name: None / Creekside
Sample ID: Field 2B 0-12"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	14	10-50	OK
Nitrate (NO_3-N)	15	20-100	Low
Total Available N	29	75-150	Low
Phosphorous(P_2O_5)	110	100-300	OK
Potassium (K_2O)	720	1293-2155	Low
Calcium (Ca)	16000	11015-13769	High
Magnesium (Mg)	1400	1101-2203	OK
Sulfate (SO_4-S)	1700	100-200	High
Sodium (Na)	110	< 250	See SAR
Chloride (Cl)	38	1-100	OK
ECe (dS/m)	3.3	0.2-4	OK
Copper (Cu)	8.0	1 +	OK
Zinc (Zn)	3.5	3 +	OK
Iron (Fe)	10	8 +	OK
Manganese (Mn)	3.4	4 +	Low
Boron (B)	2.5	1-4	OK
SAR	0.62	0-6	OK
CEC (meq/100gms)	46	10-20	OK
ESP (%)	0.53	0-10	OK
pHs Value	7.9	6.5-7.5	High
Organic Matter (%)	2.7		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

100	Nitrogen (N)
150	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
500	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.0 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	7.3	mg/Kg	KCl
NH_3-N	7.0	mg/Kg	KCl
P	26	mg/Kg	Olsen
SP	51	%	Sat
pHs	7.9	unit	Sat
ECe	3.3	dS/m	Sat
Ca	29	meq/L	Sat
Mg	19	meq/L	Sat
Na	3.0	meq/L	Sat
K	1.1	meq/L	Sat
Cl	1.0	meq/L	Sat
SO_4-S	51	meq/L	Sat
SAR	0.62	ratio	Calc
B	1.2	mg/Kg	CaCl2
Cu	4.0	mg/Kg	DTPA
Zn	1.8	mg/Kg	DTPA
Fe	5.1	mg/Kg	DTPA
Mn	1.7	mg/Kg	DTPA

Data:			Method
OrgMat	2.7	%	WalkBk
Org-C	1.6	%	WalkBk
SMP Bufffer pH	7.62	unit	SMP
GypReq	1.2	meq/100g	GypSol
Ca	7800	mg/Kg	NH_4OAc
Mg	680	mg/Kg	NH_4OAc
Na	56	mg/Kg	NH_4OAc
K	300	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	46	meq/100gm	Calc.
NH_3-N	0.1	% of CEC	Calc.
Ca	85.4	% of CEC	Calc.
Mg	12.3	% of CEC	Calc.
Na	0.5	% of CEC	Calc.
K	1.7	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

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Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9110469-5/6
Project #/Name: None / Creekside
Sample ID: Field 2B 12-24"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	13	10-50	OK
Nitrate (NO_3-N)	4.2	20-100	Low
Total Available N	17	75-150	Low
Phosphorous(P_2O_5)	56	100-300	Low
Potassium (K_2O)	440	1742-2903	Low
Calcium (Ca)	22000	14842-18552	High
Magnesium (Mg)	1400	1484-2968	Low
Sulfate (SO_4-S)	1500	100-200	High
Sodium (Na)	170	< 250	See SAR
Chloride (Cl)	120	1-100	High
ECe (dS/m)	3.5	0.2-4	OK
Copper (Cu)	1.8	1 +	OK
Zinc (Zn)	0.89	3 +	Low
Iron (Fe)	7.9	8 +	Low
Manganese (Mn)	1.6	4 +	Low
Boron (B)	1.5	1-4	OK
SAR	0.98	0-6	OK
CEC (meq/100gms)	62	10-20	OK
ESP (%)	0.61	0-10	OK
pHs Value	7.9	6.5-7.5	High
Organic Matter (%)	2.0		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

125	Nitrogen (N)
200	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep
needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.0 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	2.1	mg/Kg	KCl
NH_3-N	6.4	mg/Kg	KCl
P	13	mg/Kg	Olsen
SP	44	%	Sat
pHs	7.9	unit	Sat
ECe	3.5	dS/m	Sat
Ca	28	meq/L	Sat
Mg	20	meq/L	Sat
Na	4.8	meq/L	Sat
K	0.38	meq/L	Sat
Cl	3.9	meq/L	Sat
SO_4-S	51	meq/L	Sat
SAR	0.98	ratio	Calc
B	0.77	mg/Kg	CaCl2
Cu	0.88	mg/Kg	DTPA
Zn	0.45	mg/Kg	DTPA
Fe	3.9	mg/Kg	DTPA
Mn	0.80	mg/Kg	DTPA

Data:			Method
OrgMat	2.0	%	WalkBk
Org-C	1.2	%	WalkBk
SMP Bufffer pH	7.60	unit	SMP
GypReq	1.2	meq/100g	GypSol
Ca	11000	mg/Kg	NH_4OAc
Mg	700	mg/Kg	NH_4OAc
Na	86	mg/Kg	NH_4OAc
K	180	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	62	meq/100gm	Calc.
NH_3-N	0.1	% of CEC	Calc.
Ca	89.2	% of CEC	Calc.
Mg	9.4	% of CEC	Calc.
Na	0.6	% of CEC	Calc.
K	0.8	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 9110469
Account #: 9442
Date Received: Nov 18, 2019
Date Reported: Nov 27, 2019

Soil Report

Glorieta Geoscience, Inc.
P.O. Box 5727
Santa Fe, NM 87502
Attn: Dane Goble

Lab Number: 9110469-6/6
Project #/Name: None / Creekside
Sample ID: Field 2B 24-36"

	Your Values (lbs/acre 6" deep)	Suggested Values	
Ammonia (NH_3-N)	13	10-50	OK
Nitrate (NO_3-N)	< 4	20-100	Low
Total Available N	16	75-150	Low
Phosphorous(P_2O_5)	44	100-300	Low
Potassium (K_2O)	320	1549-2582	Low
Calcium (Ca)	20000	13199-16499	High
Magnesium (Mg)	1300	1319-2639	Low
Sulfate (SO_4-S)	1600	100-200	High
Sodium (Na)	130	< 250	See SAR
Chloride (Cl)	160	1-100	High
ECe (dS/m)	3.4	0.2-4	OK
Copper (Cu)	1.3	1 +	OK
Zinc (Zn)	0.75	3 +	Low
Iron (Fe)	8.5	8 +	OK
Manganese (Mn)	1.1	4 +	Low
Boron (B)	1.3	1-4	OK
SAR	0.72	0-6	OK
CEC (meq/100gms)	55	10-20	OK
ESP (%)	0.50	0-10	OK
pHs Value	7.8	6.5-7.5	High
Organic Matter (%)	1.8		

RECOMMENDATIONS
ALL VALUES lbs/acre 6" deep

125	Nitrogen (N)
250	Phosphorous (P_2O_5)
600	Potassium (K_2O)
0	Gypsum ($CaSO_4$)
0	Lime ($CaCO_3$)
0	Dolomite ($CaCO_3$ & $MgCO_3$)
0	Sulfur

*Gypsum adds Ca and doesn't affect pH; Lime adds Ca and raises pH; Dolomite adds Ca & Mg & raises pH.

Lime Requirement:
Tons of 100% $CaCO_3$ Lime per Acre 6" deep needed to raise pH of soil to:

pH 6.0 needs	0.0
pH 6.5 needs	0.0
pH 7.0 needs	0.0

Gypsum Requirement (needed for clay treatment)
1.0 tons per acre 6" deep
Gypsum helps the soil structure by "loosening" the soil

Data:			Method
NO_3-N	< 2	mg/Kg	KCl
NH_3-N	6.7	mg/Kg	KCl
P	9.9	mg/Kg	Olsen
SP	50	%	Sat
pHs	7.8	unit	Sat
ECe	3.4	dS/m	Sat
Ca	27	meq/L	Sat
Mg	20	meq/L	Sat
Na	3.5	meq/L	Sat
K	0.26	meq/L	Sat
Cl	4.5	meq/L	Sat
SO_4-S	51	meq/L	Sat
SAR	0.72	ratio	Calc
B	0.66	mg/Kg	CaCl2
Cu	0.66	mg/Kg	DTPA
Zn	0.38	mg/Kg	DTPA
Fe	4.2	mg/Kg	DTPA
Mn	0.57	mg/Kg	DTPA

Data:			Method
OrgMat	1.8	%	WalkBk
Org-C	1.1	%	WalkBk
SMP Bufffer pH	7.60	unit	SMP
GypReq	1.1	meq/100g	GypSol
Ca	9800	mg/Kg	NH_4OAc
Mg	670	mg/Kg	NH_4OAc
Na	63	mg/Kg	NH_4OAc
K	130	mg/Kg	NH_4OAc

Cation Exchange Capacity (CEC) and Base Saturation Percentages

CEC	55	meq/100gm	Calc.
NH_3-N	0.1	% of CEC	Calc.
Ca	88.7	% of CEC	Calc.
Mg	10.1	% of CEC	Calc.
Na	0.5	% of CEC	Calc.
K	0.6	% of CEC	Calc.
H	0.0	% of CEC	Calc.

Lab Analyst: Mike Galloway