

Appendix D

Groundwater Monitoring Plan

Groundwater Monitoring Plan

Submitted to:
Tuolumne and Stanislaus River
Groundwater Basin Association

Date: October 4, 2004
Project No: 040190

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1 Introduction

This Groundwater Monitoring Plan (GMP), prepared for the Stanislaus and Tuolumne Rivers Groundwater Basin Association (Association), provides guidance for the selection of wells for the monitoring network as well as groundwater monitoring and sampling procedures to reduce uncertainties in the monitoring data. This GMP is a starting point for the Association to modify as additional information becomes available to supplement the existing network. The Association's groundwater monitoring network and data acquisition will provide basic information needed to manage the groundwater resources of the Modesto groundwater subbasin.

1.1 Background

Groundwater is present in the consolidated and unconsolidated sediments. There are two principal aquifers, separated by the Corcoran clay, in the western portions of the study area and one aquifer east of the Corcoran clay. Figures 1 through 3 show the location of the aquifer in both plan and profile. The aquifers are defined as:

- The shallow aquifer, generally west of Highway 99, above the Corcoran clay. High groundwater levels sometimes cause problems for plants and may be related to a shallow aquitard (clay or hardpan).
- The deep aquifer, also located west of Highway 99, below the Corcoran clay and below the shallow aquifer.
- The forebay aquifers, east of the Corcoran clay. They merge with the shallow and confined aquifers west of Highway 99. Most of the Oakdale Irrigation District overlies the forebay aquifers.
- The confined Mehrten aquifers, which underlie all of these aquifers, are exposed on the ground surface in the eastern portion of the area and dip westward beneath the subbasin.

Each of the aquifers has water quality problems, as summarized below:

- Shallow aquifer – localized total dissolved solids (TDS), nitrate, dibromochloropropane (DBCP) and volatile organic compounds (VOCs) (western part near Modesto subasin)
- Deep aquifer – localized TDS and VOCs (City of Modesto area)

- Forebay aquifers – localized TDS, DBCP, and uranium (western part near the City of Modesto and Empire)
- Mehrten confined aquifer - potentially sodium, chloride, and TDS.

For the most part, these problems are localized and affect only portions of the subbasin. In general, the water north of the Modesto subbasin, around the City of Oakdale and Riverbank, is of good quality. The City of Modesto has abandoned some of its wells because of water quality issues. High groundwater levels with high levels of TDS are present in the western portion of the subbasin.

Iron and manganese are present in all four aquifers but are typically related to reduced, oxidized soils. At this time, arsenic does not appear to be a water quality issue, based on testing of the municipal supply wells.

Groundwater levels in the Modesto subbasin have been measured in about 230 wells by the Department of Water Resources (DWR) and its cooperatives. The wells used for monitoring may be in different aquifers and at times have long screen intervals that make an interpretation of groundwater flow directions and water quality difficult. Appendix A contains a list of these wells. Some member agencies may be reporting data to DWR and are included in this list.

The U.S. Geological Survey (USGS) has monitored 17 wells in the area for the National Water Quality Assessment Program. It has also constructed or plans to construct additional monitoring wells in the City of Modesto to define hydraulic characteristics, water levels, and water quality in the shallow and confined aquifers. Appendix A contains a list of these wells.

The University of California-Davis (UC-Davis) with grant funding has constructed several monitoring wells to assess nitrates and nutrient management near dairies.

The Association's members, to some varying extents, monitor groundwater production, levels, and quality. Table 1 summarizes the current level of monitoring through the member agencies.

Other groundwater monitoring conducted in the basin assesses releases of hazardous materials to the environment. These wells are typically near metropolitan areas and the resulting data are provided to the Regional Water Quality Control Board (RWQCB). These wells are extremely useful because they typically monitor the first water encountered, which can be correlated with surface water gaging stations to evaluate the aquifer connectedness.

1.2 Goals and Objectives

The goals of this GMP are to develop a plan to track and assess the potential effects from the implementation of basin management objectives (BMOs) and to manage the groundwater in

the basin to protect the quantity and quality of the groundwater within the subbasin. The GMP goals are to:

- Track groundwater levels to identify natural recharge areas, flow directions that govern the movement of contaminants, and potential areas where subsidence may occur.
- Develop a better understanding of the spatial variability (both horizontal and vertical) of groundwater quality to control degradation of water quality.
- Track groundwater production to develop a water balance.
- Monitor changes in water quality over time that indicate impacts to the aquifers.
- Obtain consistent and high quality data.
- Disseminate the information to the Association members.

The objectives of this GMP are to develop a groundwater monitoring network capable of collecting hydraulic measurements that will be used to characterize groundwater occurrence, flow direction, water quality, and recharge areas. Data on groundwater levels, flow directions, and water quality must be gathered from each of the identified aquifers.

This GMP describes a preliminary groundwater monitoring network and an approach to assess, justify, and select additional monitoring wells to provide information to address specific issues and BMOs within the subbasin.

This plan also designates a responsible party/agency (an Association member) that will coordinate activities and archive, compile, disseminate, and analyze the data. Personnel from member agencies will implement the plan.

2 Monitoring Network

The following sections describe the rationale for the selection of monitoring points to be included in the monitoring network. Because surface water and groundwater may interact, the monitoring network consists of both groundwater and surface water monitoring through activities of the Association members and other governmental agencies.

2.1 Rationale

The Association's goals are to manage groundwater resources for the long-term sustainability of the resource. Key issues in the subbasin are:

- High groundwater in western portion of the subbasin
- Groundwater quality
- Groundwater recharge and discharge areas
- Changes in groundwater levels that affect groundwater in storage

The following sections describe the rationale for selecting the monitoring network well sites.

2.1.1 Surface Water

The aquifers beneath the subbasin may seasonally discharge to or receive recharge from the Toulumne, Stanislaus and San Joaquin Rivers. Data regarding the stage height of water in these rivers should be obtained from gaging stations and compared to groundwater levels to assess the recharge-discharge relationships. Water quality data should also be obtained to assess the quality of water that may be entering the aquifers in recharge areas. Sources of data include the USGS and DWR websites. The gaging data may also be used to assess the amount of water gained or lost to aquifers by discharge to or recharge by the rivers.

2.1.2 Groundwater

Groundwater monitoring wells should be selected to provide regional coverage that can be economically accomplished yet provide high quality, reliable data.

These selections will be based on the purpose for which the well will be used and the issues to be defined. The location and spacing of the wells varies, dependent upon the issue.

- Groundwater levels and flow directions were selected when they have a rough triangular spacing. The triangular spacing allows the projection of a planar surface,

thus allowing the development of groundwater contours and their orientation. The contours show recharge areas, discharge areas, and the groundwater flow path.

- Groundwater quality monitoring well locations were generally selected with one up-gradient well (to assess the quality of water coming into the area) and a minimum of three down-gradient wells (to detect the horizontal extent of the contaminant). Additional wells are needed to assess the vertical extent (when contaminants may move into different aquifers).
- Groundwater discharge or recharge areas were selected, again with a rough triangular spacing, to project the plane into the discharge area. The elevation of the water surface elevation in the discharge or recharge area also provides confirming evidence of the connection of the groundwater surface to the surface water. At least some of these monitoring wells need to be located near the gaging station.
- Wells selected to detect groundwater movement between aquifers are typically closely spaced, but screened at different depths.
- Wells selected to detect changes in groundwater storage may be screened in multiple aquifers and scattered throughout the basin. These wells are used to account for the major portion of groundwater that is extracted from within the basin.
- Wells selected to detect groundwater inflow from outside of the basin generally consist of multiple clusters of three wells with a triangular spacing in the adjacent subbasins, just outside the Modesto groundwater subbasin boundaries.

After defining the purpose for monitoring and general areas, a detailed evaluation of potential wells needs to be conducted. Wells selected for monitoring should have:

- A well log that describes the well construction details and a description of the sediments encountered
- A detailed description of the well's location
- A relatively short screen interval in only one aquifer
- A sanitary seal to prevent surface water from entering the well

Although the most desirable wells to be included in the monitoring network are wells with short screen intervals completed within a specified aquifer, some wells with longer screen intervals may need to be initially included in the network when there are no wells with short screen intervals to complete the regional interpretation and tracking of groundwater level and water quality. Wells with long screen intervals may also be designated for monitoring because their long historic records provide valuable trending information about the general status of the aquifers. Data obtained from the longer screen wells usually represent an

aggregate of water quality from two or more aquifers. These wells with longer screen intervals should be replaced with wells with shorter screen intervals if warranted, based on a review and interpretation of the monitoring data.

For purposes of this monitoring plan, the following definitions of the well to be used by aquifers are:

- High groundwater monitoring wells – wells that are screened to or near the ground surface and overlie the Corcoran clay.
- Shallow aquifer monitoring wells – wells that are screened between 30 to 150 feet below ground surface (bgs) in the area where the Corcoran clay is present.
- Deep aquifer monitoring wells – wells that are screened 250 feet or more bgs in the area where the Corcoran clay is present.
- Forebay aquifer monitoring wells – wells that may be screened as shallow as 30 feet but toward the west, increase in depth to as deep as 400 feet bgs.
- Confined Mehrten aquifer monitoring wells- wells that may be screened from as shallow as 30 feet up to 800 feet bgs and will generally increase in depth toward the west.

Upon selection of a well to be potentially included in the monitoring network, a site visit will be necessary to assess the field conditions. The conditions necessary for a well to be used in the network include:

- A well owner who will allow access for monitoring
- All-weather access
- Access through the pump or well casing for water level sounders
- An assessment to determine if lubrication oil from a turbine pump has accumulated in the well or if there are obstructions in the well that would prevent obtaining repeat and reliable measurements
- A pump and electrical service, if the well is to be used for water quality monitoring

During the site visit, the investigator should sketch the location and access to the well and the location for measuring water levels and record any special contact information to perform the monitoring. This will ensure consistent monitoring even though monitoring staff may change. Figure 3 shows a typical well sounding location detail.

Not all wells have to be monitored by the Association members to be included in the network. Potential sources of other monitoring data may include:

- DWR monitoring records for about 230 wells (including cooperators) in the Modesto subbasin and an undetermined number in adjacent subbasins. Appendix A lists the wells reported by DWR. Some may be monitored by member agencies.
- The USGS monitoring wells near the City of Modesto.
- The 15 wells included in the USGS National Water Quality Assessment Program.
- UC-Davis and its farm advisory special studies for nitrate and nutrient management near dairies.
- Reports submitted to the Regional Water Quality Control Board for releases of hazardous materials to the environment that are affecting groundwater and shallow groundwater levels.

These sources have not been assessed for inclusion of additional monitoring wells into this GMP. The Association should assess these potential sources and select wells that would improve this GMP by filling in gaps in the spacing of the network or wells that can provide specific localized information.

2.2 Monitoring Network

The proposed groundwater monitoring network consists of gaging stations and wells owned by Association members, private parties, and other governmental bodies. Combined, the network will provide the necessary data to assess groundwater conditions beneath the subbasin. Monitoring will not be performed by any one group, but the data will be collected and analyzed by the Association. The monitoring network described below should not be considered as a final network but will provide initial representation of the groundwater conditions within the subbasin. The wells included in this preliminary network were those wells owned or monitored by Association members. An evaluation of wells monitored by other parties has not been included. Additional wells, selected using the rationale presented above, should be added to monitor specific issues.

Table 2 identifies groundwater wells that were selected to assess high groundwater conditions (possibly water that is perched on a shallow clay layer) in the western portion of the subbasin. These wells have screen intervals that extend to or near the ground surface. The table also provides well construction details. Figure 4 shows their locations.

Table 3 identifies the wells that were selected to assess groundwater levels and water quality in the shallow aquifer, above the Corcoran clay. Data from these wells will also assist in the

evaluation of the groundwater discharges to the rivers that must be maintained to prevent salt accumulations in the basin. Figure 4 shows their locations.

Table 4 identifies the wells that were selected to assess groundwater levels and water quality in the deep aquifer, below the Corcoran clay. The list is short because all of the wells are screened in both the shallow and confined aquifers except for one well south of the Toulumne River (City of Modesto well #19). Replacement wells will need to be found for the long screened wells. Figure 4 shows their locations. These wells should be reevaluated upon the USGS's release of a report later this year that provides detailed stratigraphy in the subbasin. We understand the USGS plans to construct a new set of wells to monitor this aquifer and to assess vertical gradients. These wells should be added to this list.

Table 5 identifies those wells that were selected to assess groundwater levels and water quality in the forebay aquifers. Figure 4 shows their locations. Most of these wells have relatively long screen intervals. Some of the wells on this list have long screen intervals that cross both the forebay and confined Mehrten aquifers but are being used to provide regional coverage. As soon as practical, these wells should be replaced with wells that monitor only the forebay.

Table 6 identifies those wells in the eastern portion of the subbasin that monitor only the confined Mehrten aquifers. Figure 4 shows their locations. Groundwater in these wells may or may not be connected to the aquifers in the forebay. Some of the wells on this list have long screen intervals that cross both the forebay and confined Mehrten aquifers but are being used to provide regional coverage. As soon as practical, these wells should be replaced with wells that monitor only the confined aquifer.

Table 7 identifies the top ten producing wells in the Modesto Irrigation District service area that could affect the quality of water supplied to agricultural users and may cause problems under the Agriculture Waiver or various Total Maximum Daily Loads (TMDLs). Table 8 could potentially be used to identify those wells that could be used to better understand the aquifer-to-river interconnectedness. Wells for this task probably will be obtained from the RWQCB.

Additional tables may be created and attached to provide information regarding specific BMOs such as the extent of arsenic, nitrate, uranium, and DBCP.

In summary, the groundwater monitoring network will consist of 93 wells (a combination of Association and DWR monitoring wells) designated for groundwater level and quality monitoring. The number of wells by aquifer is summarized below:

- High groundwater aquifer (perched aquifer): 21 monitoring wells
- Shallow aquifer: 16 monitoring wells

- Deep aquifer: 6 monitoring wells
- Forebay aquifers: 39 monitoring wells

Monitoring wells specifically designated to track specific BMOs may add additional wells to this total.

All municipal and irrigation wells owned by the Association members are equipped with totalizing flowmeters or power meters and will be included in the monitoring network to measure groundwater production.

Six surface water gaging stations along the Toulumne and Stanislaus Rivers continuously monitor the height of water in the rivers. The spacing of the gaging stations on the San Joaquin River was not favorable to assist in evaluating discharge-recharge relationships. Table 9 lists the gaging stations to be included in the monitoring network. The URL for the USGS website is also shown on the table. Figure 4 shows the gaging station locations.



3 Monitoring and Reporting Frequency

The following sections describe the frequency for monitoring and reporting. Subsequent sections provide a description of the work to be accomplished during each of the designated monitoring periods. Table 10 lists the wells and monitoring types and frequencies.

3.1 Monthly Groundwater Production Monitoring

Groundwater production from all Association member wells will be measured monthly. The measurements should be made within with a two-week period, if possible.

3.2 Semiannual Groundwater Level Monitoring

Groundwater levels and electrical conductivity from all designated monitoring wells listed in Table 10 shall be measured in the spring and fall (semiannually). Spring is generally considered to be February through April, prior to the start of irrigation. Fall is generally considered to be October through November, after the irrigation season but prior to the start of the winter rains. If possible, Association member agency personnel should make groundwater level measurements within a two-week period and, if possible, coordinate groundwater level monitoring with DWR and its semiannual measurements. Monthly groundwater level measurements should be obtained for those wells to assess aquifer-to-surface water interaction, listed in Table 8.

Groundwater levels from the DWR-monitored wells listed in Table 10 (name given as a state well numbers) and river height data from the surface water gaging stations listed in Table 9 should be downloaded from the Internet semiannually and archived.

3.3 Annual Water Quality Monitoring

In addition to the monthly and semiannual monitoring requirements, water quality samples from all monitoring wells listed in Table 10 shall be collected each fall. This work can be accomplished concurrently with the work described in Section 3.2.

3.4 Annual Reporting

The Association will prepare an annual groundwater monitoring report to summarize the findings of the groundwater level, production, quality, and gaging station data. The report should include an interpretation of the data (including but not limited to groundwater flow directions and the relationship of pumping to water quality and water levels), a discussion of any significant changes from the last reporting period, and groundwater management

recommendations. Recommendations to improve the monitoring network should also be included.

Groundwater contours for each aquifer will be developed, using only those wells that are screened only within the aquifer. The contours can then be used to evaluate recharge and discharge areas, changes in groundwater storage, and the need for additional monitoring wells.



4 Project Organization and Responsibility

The Association will plan, organize, collect, and archive the groundwater monitoring and sampling data. The following is a summary of the monitoring, sampling, and reporting responsibilities under this GMP.

The Association is responsible for:

- Coordinating monitoring and sampling schedules with member agencies so that production data and groundwater level measurements occur within the same two-week periods
- Archiving sampling and monitoring results
- Overseeing quality assurance/quality control (QA/QC) sampling and monitoring methods and procedures
- Revising this GMP annually, as necessary
- Preparing an annual summary report for distribution to the Association's members for discussion and development of management options

Each member agency will be responsible for:

- Scheduling equipment and supplies needed for sampling and monitoring
- Measuring and recording groundwater levels
- Measuring and recording electric conductivity measurements
- Arranging with the laboratory for sample bottles and analysis
- Collecting representative groundwater samples
- Overseeing quality assurance/quality control (QA/QC) sampling and monitoring methods and procedures

The designated contact for making decisions regarding the Association's GMP is _____, _____ District (559-____ - _____).

State-certified laboratories selected by the Association members will be responsible for sample analysis quality control and assurance. The laboratory(s) shall notify the members

immediately if samples have been compromised during shipment or handling or if the requested analyses cannot be conducted within the designated holding times.



5 Monthly Monitoring

Groundwater production from all Association wells will be measured monthly. The measurements shall be made within the same week.

5.1 Preparation for Field Work

Field personnel shall prepare for field work by obtaining the following equipment:

- A copy of Table 11 or other in-house forms to record the field measurements
- Figure 5 showing the location of the wells
- Clipboard and ballpoint pen

5.2 Meter Reading

Some of the irrigation and municipal wells have been equipped with totalizing flowmeters. The totalizer reading shall be recorded onto Table 11 to provide consistency in the measurements. Field measurements should include all numbers displayed on the meter, including zeros, which provides a level of quality control that the meter was read correctly. Any issues associated with the meter, including ability to read the meter or suggested maintenance, shall also be documented.

5.3 PG&E Records

Groundwater production at some wells is estimated from PG&E billings that list the kilowatt-hours used by the pumps on the wells. To accurately estimate the production totals, a pump efficiency test should be performed annually. The billings from PG&E need to be archived monthly.

5.4 Quality Control

After recording the totalizer readings, the member agencies shall enter the data into an electronic accounting form that will automatically subtract the measurement from the previous month's reading. The agency managers should review the production data for accuracy within five days of obtaining the initial measurement. Should a measurement appear suspicious, a confirmation reading shall be obtained. Agency personnel should be prepared to maintain the flowmeters.

6 Semiannual Groundwater Level Monitoring

Groundwater levels and electrical conductivity at all designated monitoring wells shall be measured semiannually, typically in the spring and fall. If possible, groundwater level measurements should be taken within a two-week period. If possible, groundwater level monitoring should be coordinated with DWR. Groundwater level data from the DWR and gaging station data from the USGS should be downloaded from the Internet.

6.1 Preparation for Field Work

Prior to collecting semiannual field measurements and before going to the field, the sampling personnel will assemble the following equipment and supplies:

- Copy of Table 12, Semiannual Groundwater Level and Sampling Form
- Copy of Table 13, Purge Volume Calculations
- Copies of Figure 3, Well Sounding Location Details, and Figure 4, Groundwater Level and Quality Monitoring Network
- Portable electrical conductivity meter, calibration standards, and manufacturer's calibration instructions
- Electrical water level sounder
- Watch or stopwatch
- Ballpoint pen and clipboard
- Paper towels
- Bleach
- Spray bottles
- Distilled water

6.2 Calibration of Field Equipment

Prior to collecting semiannual field measurements and before going to the field, sampling personnel shall clean, maintain, and test the water level sounder and calibrate the electrical conductivity meter, using appropriate standards.

6.2.1 Electrical Conductivity Meter

The frequency and nature of the electrical conductivity meter calibration shall be consistent with the manufacturer's recommendations. At a minimum, the meter shall be calibrated every day and when significant changes in climatic conditions occur (e.g., when the air temperature changes by more than 30°F). The meter type, its manufacturer, model and identification numbers, and calibration information shall be documented in the member agencies' files.

6.2.2 Groundwater Level Sounder

During use of a water level sounder, it is possible for the cable to stretch or to shorten because of tangles and obstructions in wells. Annually, the water level sounder shall be laid out and compared with a steel tape and the results documented. When calibration measurements show that the measurements are greater than 0.10 feet off in 100 feet, the cable shall be replaced.

6.3 Monitoring Procedures

The following procedures shall be used to measure the depth to water and electrical conductivity at each designated monitoring well. Water levels and electrical conductivity measurements will be collected semiannually to assess the groundwater flow direction and quality and to detect trends that can lead to improved management of the groundwater resources.

6.3.1 Groundwater Level Measurements

Each well has been assigned a unique identification number and a common name. The numbers and names for each well are listed in Table 10. Table 11, Semiannual Groundwater Level and Sampling Form, should be used to record all groundwater level measurements during the semiannual monitoring.

Prior to obtaining the water level measurement at each well and between each well site, the electric sounder cable shall be rinsed in a solution of sodium hypochlorite (liquid bleach) and distilled water. The solution shall consist of bleach and distilled water in a one-tablespoon-to-one-quart ratio (a concentration of about 200 parts per million chlorine is desirable). The sounder shall then be rinsed thoroughly three times with distilled water and allowed to air-dry. Thorough cleaning of equipment is necessary to avoid any possibility of cross-contamination and the transport of bacteria between wells.

Prior to purging and sampling, the depth to static groundwater level will be obtained at each well, using an electric water level sounder with a cable graduated in increments of 0.01 foot. To obtain a depth to water measurement, the electric sounder cable will be lowered slowly into the well through the access port until the sounder indicates submergence by either a beeping sound or light, depending on the type of signal installed for that particular model. At

this point, the sampling personnel will note the depth to water (to the nearest 0.01 foot) from the reference point. The depth shall be confirmed by lifting the sounder above the water surface by about 2 to 3 feet and then remeasuring the depth to water. If the depth remains constant, the depth-to-water shall be recorded on Table 12, along with the time and date of the measurement. If the depth changes, the sampling personnel shall indicate that on the form, the variable nature of the measurement, and its possible cause (e.g., bouncing, recovering water levels).

6.3.2 Electrical Conductivity Measurement

A representative sample of the groundwater must be obtained from the well. For purposes of this monitoring plan, a “representative” sample can be collected after at least three well volumes have been pumped from the well. The purge volume and time will be calculated using data from Table 10 and the calculation sheet shown on Table 12. These calculations can be saved and entered into another table that provides approximate purge times. This new spreadsheet will be a quick guide for sampling personnel to use in lieu of having to recalculate the purge time each time the well is sampled.

Several different types of electrical conductivity meters may be used by the sampling personnel. Some have a sample cup built into the unit, while others have a probe that requires that the sample be collected in a separate container.

Sampling personnel will collect water from as close to the well as possible and place the sample in the electrical conductivity meter sample cup or container. The sample shall be poured into the meter sample cup or container, then discharged and replaced three times before taking a measurement. The measurement shall be recorded on Table 12 and the sampling location noted (e.g., hose bib, end of discharge pipe, etc.).

After the measurement has been taken, the electrical conductivity meter sample cup or probe and container shall be rinsed at least three times with distilled water to maintain the equipment and to prevent false readings in subsequent wells.

6.4 Quality Control

After field personnel have completed their work, the member agencies shall enter the data into an electronic spreadsheet or database. The agencies’ managers shall review the groundwater level and electrical conductivity measurements for accuracy within five days of obtaining the measurements. Should a measurement appear suspicious, a confirmation reading shall be obtained.

6.5 Obtain DWR and USGS Records

Semiannually, Association personnel shall obtain river gaging data for the six surface water gaging stations listed on Table 9 from the Internet addresses also listed in Table 9. A hard

copy and an electronic copy of the files shall be made. Should the data be absent, either the USGS or the DWR should be contacted to determine the reason and this conversation documented. The hard copy and/or documentation shall be placed in the project files.

After the wells monitored by DWR have been evaluated and if they are selected to be included in the monitoring network, the water level measurements for these wells can be obtained from an Internet search.

7 Annual Groundwater Quality Monitoring

In the fall of each year, water quality samples will be collected from all wells listed on Table 10 and sent to a laboratory for a more extensive analysis of the water chemistry. These analyses will provide an indication of the source of the water, changes over time, and potential mixing between aquifers. The results will be used to assess the effects of groundwater management actions. The work described below will be performed concurrently with work described in Section 6, Semiannual Groundwater Level Monitoring.

7.1 Preparation for Field Work

Prior to water quality sampling, designated sampling personnel shall notify the laboratory when sampling is scheduled, list the sample analysis parameters, and request sample bottles. A copy of Table 14 and Section 8.0 should be faxed to the laboratory to confirm the analytical methods and analytical quality control and assurance requirements. The laboratory should also be provided with the number of wells to be sampled as identified in Table 10 so that they can provide the appropriate number of sample bottles. The laboratory should be requested to deliver these sample containers in clean ice chests to the location chosen by the sampling personnel at least two days before the sampling begins. Upon receipt of the sample bottles, sampling personnel shall inventory the bottles to ensure that an adequate number and proper types of bottles have been provided.

The sampling personnel will assemble the following field forms, sampling equipment, and supplies:

- Copy of Table 10
- Copy of Table 13, Purge Volumes Calculations
- Copy of Table 15, Example Chain-of-Custody, or obtain one from the laboratory
- Sample bottles and ice chest from the laboratory
- Ballpoint pen and waterproof marking pen
- Safety glasses or goggles
- Latex or nitrile gloves
- Paper towels
- Ice



7.2 Sample Containers

Sample containers will be prepared by the laboratory with both preservative and container type in accordance with the required analysis as presented in Table 14. The containers shall be laboratory-cleaned prior to use, based on the analytes of interest, in accordance with the latest edition of the U.S. Environmental Protection Agency (USEPA), *Standard Methods for Examination of Water and Wastewater*. Sample containers must be stored in a manner that prevents the accumulation of dust or other contaminants. Prior to shipment to the sampling personnel, the laboratory will be responsible for verifying the cleanliness and integrity of the sample containers, pursuant to its sample container quality assurance and quality control procedures.

Each container will have a preprinted identification label that clearly shows the constituent(s) to be analyzed. A laboratory sample number will be assigned by the laboratory upon delivery of the sample(s) to the laboratory for proper identification and tracking.

7.3 Well Purging and Discharge

The water quality samples shall be collected after purging the well as described in Section 6.0. The well purge volumes shall be calculated as shown on Table 13 to exchange three well volumes before collecting the sample.

7.4 Sample Identification and Labeling

Each well has been assigned a unique identification number as listed in Table 10. This number shall be marked on each sample bottle.

All sample containers will be pre-labeled, to the extent possible, prior to each sampling event. Sample containers provided by laboratory will contain waterproof labels that will show the analyte and laboratory identification number. To the extent possible, the designated sampling personnel will inscribe on the label the sample identification, sampler's name or initials, and date, under dry conditions, using a waterproof marker pen during purging of each well. Immediately before collecting the water sample, sampling personnel will inscribe on the sample bottle label the time the sample was collected.

7.5 Sample Collection

Groundwater samples shall be collected from the well discharge water as close to the pump as possible. The sampling location should be the same as that used to collect the electrical conductivity measurements. Sampling personnel will be trained in the use of and exercise care during the handling of acid-preserved sample containers to minimize spillage, damage, and/or injury to the sampler(s) or the field equipment. In addition to latex or nitrile sampling gloves, the designated sampling personnel should wear safety glasses or goggles to minimize potential eye injury.

Designated sampling personnel will use “clean sampling techniques” to minimize potential contamination of water samples. Prior to the collection of samples, sampling personnel will rinse their hands and don sterilized latex or nitrile gloves. Sample containers and lids will not touch the ground, the sampling personnel’s clothing, or any other potential sources of contamination. Sample container lids will not be removed from a particular container until that container is to be filled. Sample containers shall be rinsed three times with the sample prior to collection unless the container contains a preservative. The sample container shall be filled to the top of the rim to minimize air space between the liquid level and the lid. The lid shall be tightened securely to the container immediately after sample collection is completed.

7.6 Sample Preservation and Storage

Chemical preservatives and refrigeration shall be used to maintain sample integrity prior to analysis. Immediately after the sample has been collected, it shall be placed in a clean ice chest containing commercially prepared ice packs to maintain the temperature in the ice chest between 2°C and 6°C until the samples have been delivered to the laboratory. The ice packs will be double-bagged to prevent ice-melt water from touching the sample containers. Samples must be returned to the laboratory within 22 hours of sampling to meet analytical holding time requirements.

7.7 Record Keeping and Chain of Custody

Sampling personnel will maintain Table 13 field forms showing the dates and times of sample collections. A chain-of-custody form indicating the sampling site, sampler’s name, date and time sampled, and any special observations shall be filled out by sampling personnel and placed in a sealable plastic bag with the sample(s) in the ice chest. The samples shall remain in the control and custody of a designated sampling team member at all times. A chain-of-custody form is presented in Table 15. When sampling personnel deliver the samples to the laboratory, the laboratory will sign for custody of the samples and provide a copy of the completed chain-of-custody form to the sampling personnel.

7.8 Quality Control Samples

This sampling plan does not require collection of any field quality control samples because the parameters being collected are stable and no volatile samples are being collected.

7.9 Quality Control

Within one day after field personnel have completed their work, the member agencies’ managers shall review Tables 13 and 15 to assess if all of the necessary field information has been documented and that adequate purge times were allowed before collecting the samples. Upon receipt of the laboratory analyses, the managers shall compare the results to historic data and identify any anomalous results, and if present, notify the laboratory to confirm the measurement.

8 Laboratory Procedures and Reporting of Results

The laboratory will select the appropriate sampling containers for the chemical constituents to be analyzed (Table 14) and will meet its internal quality control requirements for duplicate and spike analyses.

8.1 Record Keeping

The laboratory will keep appropriate records to indicate the following for each sample:

- Date, location, and time of sampling
- Name(s) of individuals who performed the water sampling
- Date and time that samples were received by the laboratory
- Temperature of the ice chest interior upon receipt by the laboratory
- Date(s) that the analyses were made
- Analytical testing methods used and detection limits
- Analytical results

8.2 Quality Assurance

The laboratory will adhere to a quality assurance program that follows accepted USEPA protocols. It must maintain state certification for drinking water analyses and perform routine analyses including known, commercially available standards. These QA/QC procedures are to be described in the laboratory's Quality Assurance and Quality Control Manual. The laboratory shall submit to the agencies a report that describes the quality assurance results, spike recovery, any problems discovered or identified for the analytical period covered at the laboratory, and any subcontract laboratories used.

All analysts must be certified or approved to perform the required analyses or have the necessary training. A copy of the certification and training records shall be available to the agencies upon request.

8.3 Analytical Methods

The laboratory (including any subcontractor laboratory it may use) must use accepted laboratory analytical methods as specified in Table 14 where appropriate. USEPA limits on holding times must also be observed.

The laboratory (and any subcontractor laboratory it may use) must be certified by the State of California for the analytical methods used. Written test procedures including quality control practices shall be followed for each analytical method used to measure the parameters listed in Table 14.

Detection limits must be equal to or less than the detection limits for reporting purposes or State Action Levels for drinking water set forth by the California Department of Health Services. Table 14 lists the detection limits for each monitoring parameter.

8.4 Laboratory Reporting of Results

The laboratory will use a standard reporting form for all water sources listing date(s) of analysis, name(s) of person who analyzed the samples, analytical method(s) used, name of parameter analyzed, detection limit, units of measurement, and results of the analysis. Any analytical result of less than detectable shall be reported as less than the method detection limit. All inorganic constituents analyzed shall be designated as the ion or as calcium carbonate.

The laboratory shall submit to the agencies paper and electronic copies of laboratory results and written reports within 30 calendar days of receipt of the samples. Unusual spikes, questionable results, or detection of chemicals not on the list of required constituents will be promptly reported to the designated sampling personnel. The laboratory will maintain records that show the calibration of equipment used in the various analyses for at least three years from the date the analytical reports were submitted to the designated sampling personnel.



9 Recommendations

A shallow clay layer may be present in the western portion of the subbasin but it is not well defined. This clay layer may be causing high groundwater conditions and may also be limiting river and aquifer interaction. A profile of the sediments needs to be developed to define the geologic controlling conditions as they relate to the high groundwater. The database developed by the USGS should be queried to define the presence and extent of this clay layer.

The currently designated monitoring well network for groundwater level, quality, and production was limited to readily available data supplied to us by Modesto Irrigation District, Oakdale Irrigation District, the City of Oakdale, the City of Modesto, and the City of Riverbank. Further development of the monitoring network should be performed by reviewing well logs from DWR, USGS, and UC-Davis and applying the criteria given in Section 2.1.2 to select valid wells.

Special interest areas will need focused monitoring. Issues such as DBCP, nitrate, arsenic, and reservoir underflow may need specially designated monitoring wells. It is recommended that a special interest area be considered to evaluate groundwater recharge and discharge areas to the rivers. The current understanding is based on wells with screens starting about 100 feet bgs. Shallow monitoring wells with screens starting where water is first encountered may show different conditions. This detail of information is probably best evaluated through RWQCB records. If proven to be of value, these wells should be incorporated into the monitoring network and funding obtained for additional wells.

Elevations at each of the monitoring wells listed in Table 10 should be surveyed to the nearest 0.01 foot to allow conversions of depth to water to elevations. These elevations can be used to detect subtle differences in groundwater heads between aquifers. The heads will demonstrate whether the different aquifers are connected and will also allow an assessment of the vertical movement of groundwater in the area. Groundwater contours showing the horizontal flow direction of the groundwater can also be developed using the elevations.

Additional testing of the agricultural water supply wells and drainage wells should be performed to fully assess the distribution and concentrations of arsenic, uranium, and DBCP in the area.

Upon completion of the first water quality sampling, the data should be evaluated and the list of annual groundwater sampling wells revised.

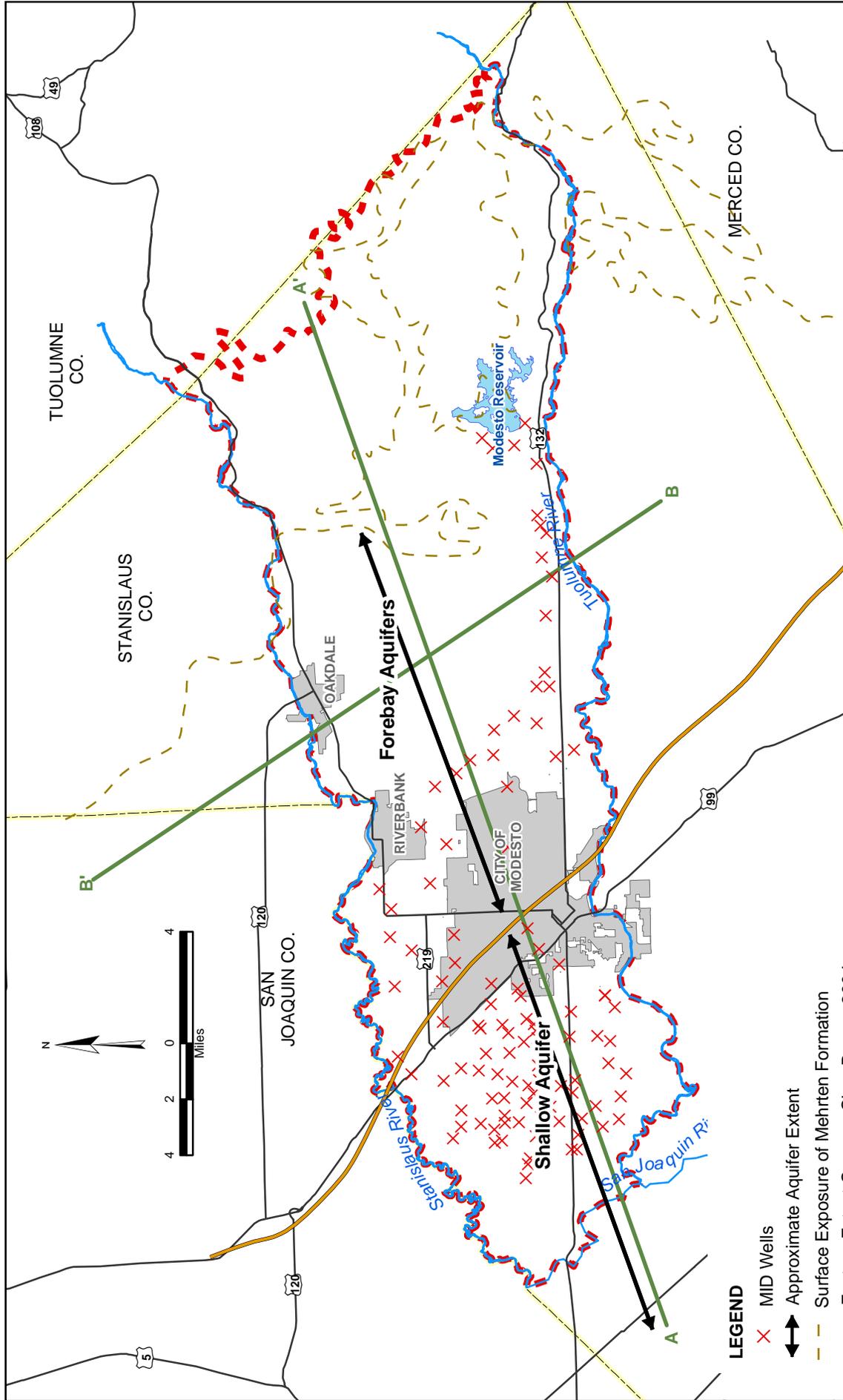
The member agencies have limited data on historic groundwater level, water quality, production, and surface water level. With the implementation of this GMP, data will

accumulate quickly and must be easily retrievable. A data management system should be instituted to archive groundwater level, water quality, groundwater production, and river gage data. Available historic data should be entered to initially populate the database. The database should be capable of producing standard tables and graphics that can aid in the interpretation and presentation of trends in both groundwater level and quality.

The development of this GMP should evolve and change as new information and wells become available. As the program evolves, additional wells may be added and other wells may be removed. Preferably all monitoring wells should have well construction details. The figures, tables, and text in this GMP should be updated annually to reflect the changes implemented through the member agencies' groundwater management actions.

Figures





LEGEND

- X MID Wells
- ↔ Approximate Aquifer Extent
- - - Surface Exposure of Mehrten Formation
- - - Eastern Extent of Cocoran Clay, Burrow 2004
- ▭ Modesto Groundwater Subbasin
- ▭ Cities

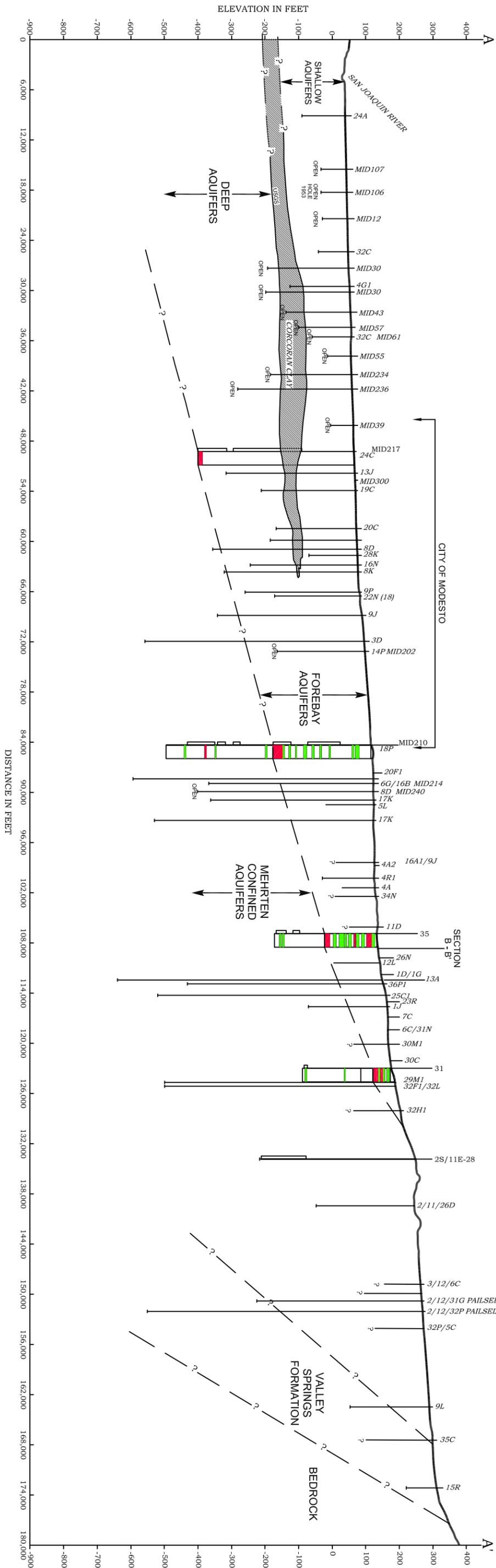
SOURCES: City of Modesto, City of Oakdale, City of Riverbank, CA Dept of Water Resources Groundwater Basins, 2002, California Spatial Library.



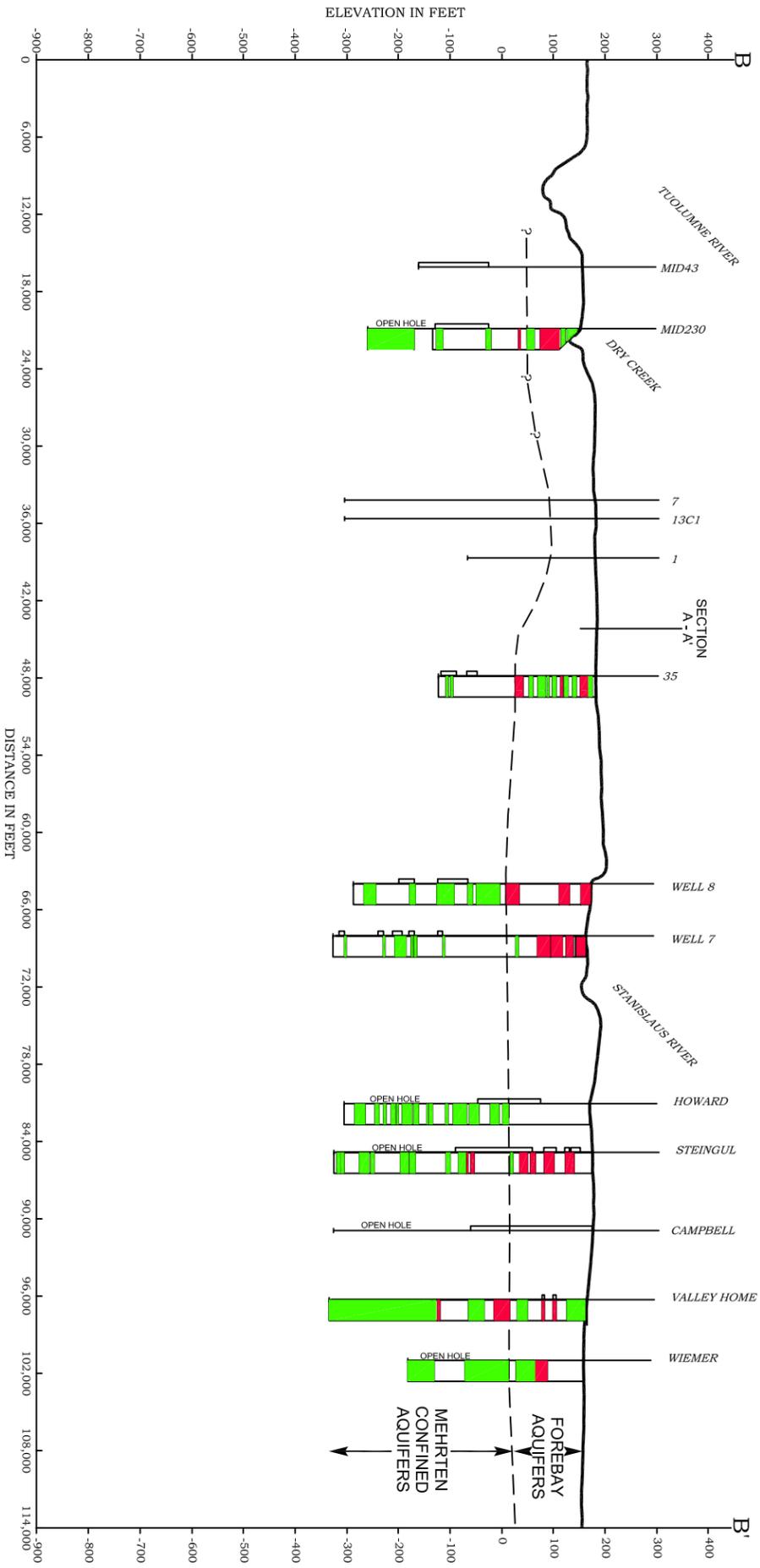
INTEGRATED REGIONAL GROUNDWATER
MANAGEMENT PLAN FOR
THE MODESTO BASIN
General Location of Aquifers

APRIL 2005

FIGURE 1

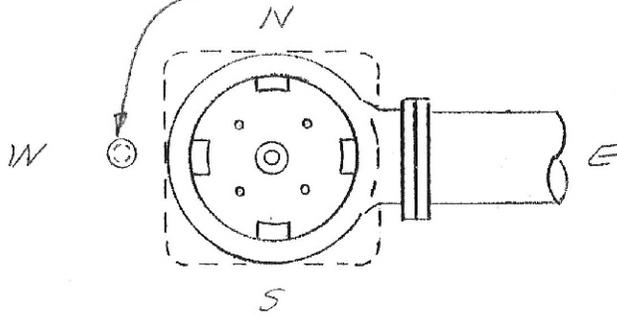


MODESTO GROUNDWATER SUBBASIN		 Bookman-Edmonston A Division of GEI Consultants	GEOLOGIC SECTION A - A'	
MODESTO, CALIFORNIA			042190.1000	SEPTEMBER 2004

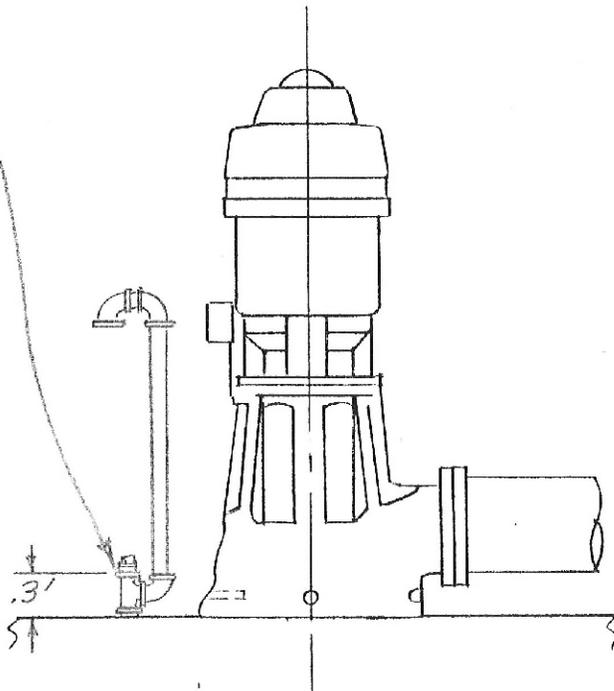
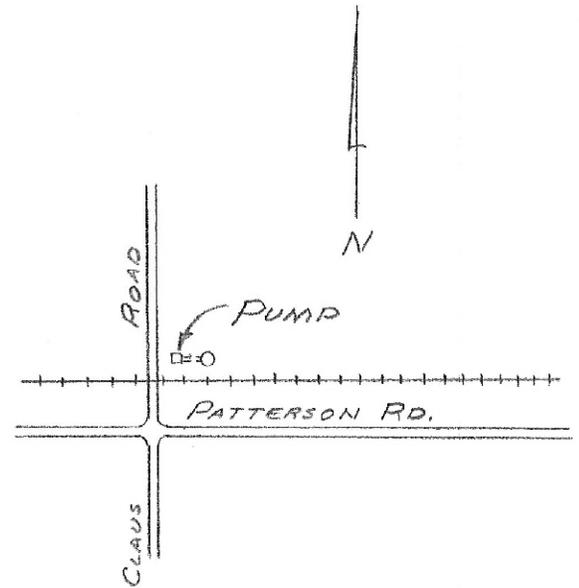


MODESTO GROUNDWATER SUBBASIN		 Bookman-Edmonston A Division of GEI Consultants	GEOLOGIC SECTION B - B'	
MODESTO, CALIFORNIA			042190.1000	SEPTEMBER 2004

REMOVE PIPE PLUG
TO SOUND WELL



MEASURE FROM TOP OF TEG
SUBTRACT 0.30' FROM READING
TO DETERMINE DISTANCE
FROM FLOOR TO WATER



DRAWN BY: _____

DATE: _____

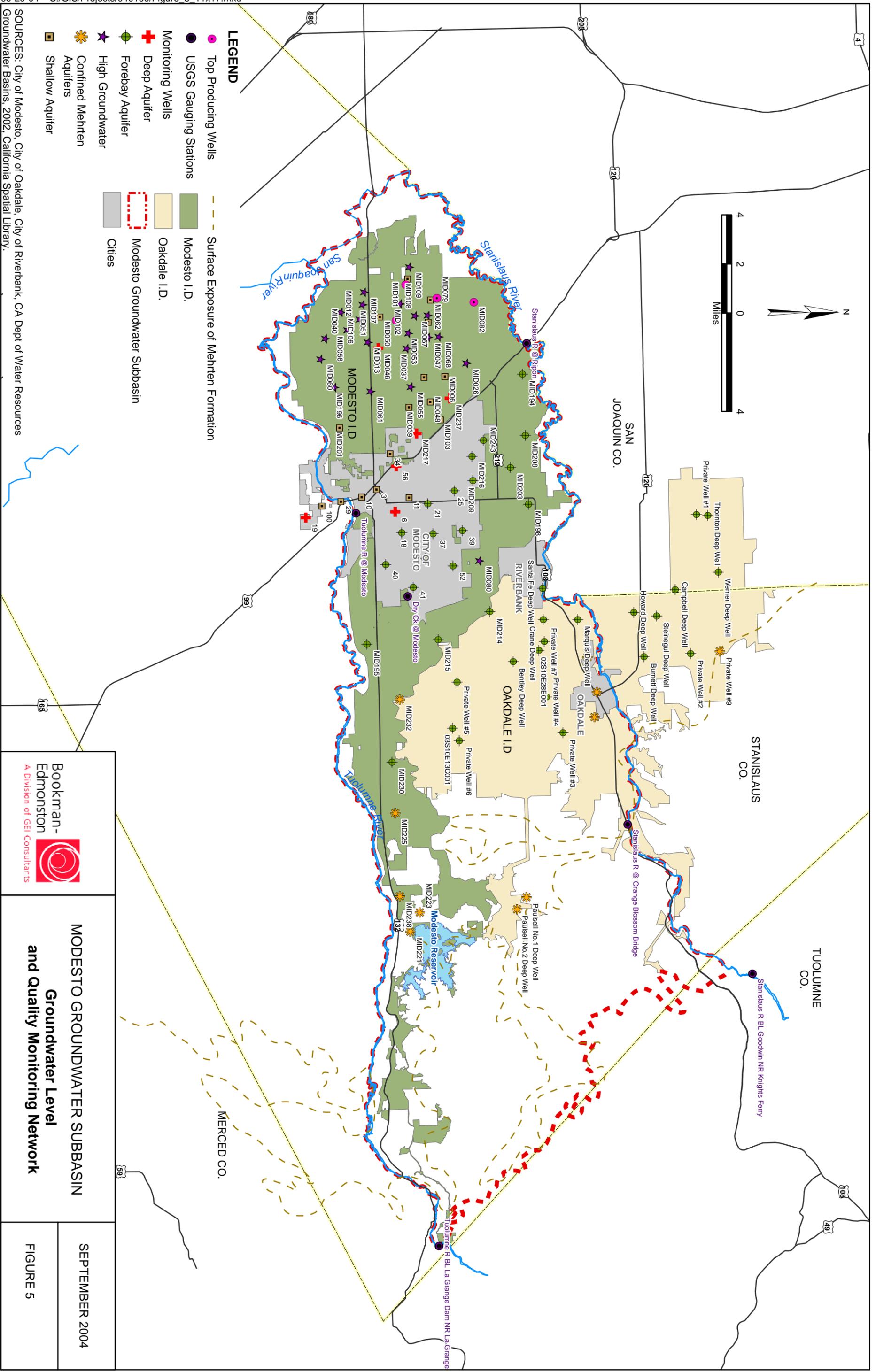
06-11-04 S:/GIS/Projects/040190/Core/SoundingDetail.cdr



TYPICAL WELL SOUNDING LOCATION DETAIL
Claus Road Well

SEPTEMBER 2004

FIGURE 4



- LEGEND**
- Top Producing Wells
 - USGS Gauging Stations
 - Monitoring Wells
 - Deep Aquifer
 - Forebay Aquifer
 - High Groundwater
 - Confined Mehtren Aquifers
 - Shallow Aquifer
 - Surface Exposure of Mehtren Formation
 - Modesto I.D.
 - Oakdale I.D.
 - Modesto Groundwater Subbasin
 - Cities

SOURCES: City of Modesto, City of Oakdale, City of Riverbank, CA Dept of Water Resources
 Groundwater Basins, 2002, California Spatial Library.



**MODESTO GROUNDWATER SUBBASIN
 Groundwater Level
 and Quality Monitoring Network**

SEPTEMBER 2004
 FIGURE 5

Tables



**TABLE 1
CURRENT LEVEL OF MONITORING EFFORTS**

Member Agency	Total Number of Wells	Pumping Totals Monthly	Number of Wells Where Groundwater Levels Are Measured			Number of Wells Where Groundwater Samples Are Analyzed for Water Quality			Water Quality Analyses Performed
			Monthly	Semiannual	Annual	Quarterly	Semiannual	Annual	
MID	104	104		96			15		General Mineral, Boron
OID	17	17		17				104	EC + pH
City of Modesto	62	86				14 (VOCs)			Per Title 22 and DHS
Ceres	4	4							Per Title 22 and DHS
Walnut Manor	1	1							Per Title 22 and DHS
Salida	7	7							Per Title 22 and DHS
Del Rio	3	3				1			Per Title 22 and DHS
Waterford	7	7							Per Title 22 and DHS
Hickman	2	2				1			Per Title 22 and DHS
City of Oakdale	7	7							Per Title 22 and DHS
City of Riverbank	7	7							Per Title 22 and DHS
Total	221	245	0	113	0	16	15	104	

Source: CCR from City of Modesto; MID e-mail communication, 2004; OID well location map; Oakdale Water Master Plan, Riverbank production totals

Member Agency	Total Number of Wells	Pumping Totals Monthly	Number of Wells Where Groundwater Levels Are Measured			Number of Wells Where Groundwater Samples Are Analyzed for Water Quality			Water Quality Analyses Performed
			Monthly	Semiannual	Annual	Monthly to Every Three Years	Monthly to Every Three Years		
DWR (including Cooperators)	230			230					
OID	15						15		Drinking Water Parameters
Department of Health Services (Including Cooperators)							209		Per Title 22 and DHS
Total	245			230			224		Per Title 22 and DHS

Source: DWR, 2004, Bulletin 118

**TABLE 2
HIGH GROUNDWATER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID012	1927	76	0	34	14" Casing	Perforated	Unknown
			34	76	Open Hole 12" dia	Open	
MID013	1927	86	0	40	No. 14 Gauge, 16" dia.	Perforated	Unknown
			40	86	Open Hole 14" dia.	Open	
MID026	1927	85	0	73	16" Casing	Perforated	Unknown
			73	85	Open Hole 14" dia.	Open	
MID036	1927	77	0	40	16" Casing	Perforated	Unknown
			40	77	Open Hole 14" dia.	Open	
MID037	1926	74	0	46	16" Casing	Perforated	Unknown
			46	74	Open Hole 14" dia.	Open	
MID040	1972	106	0	6	1/4" thick, 24" dia. Casin	Blank	No
			0	92	No. 8 Gauge 16" dia.	Perforated	
			92	106	Open Hole 24" dia	Open	
MID047	1927	85	0	43	16" Casing	Perforated	Unknown
			43	85	Open Hole 14" dia.	Open	
MID051	1969	152	0	104	No. 8 Gauge 14" dia.	Perforated	No
			104	117	No. 8 Gauge 14" dia.	Blank	
			117	152	Open Hole 14" dia.	Open	
MID053	1929	110	0	110	16" Casing	Perforated	Unknown
MID055	1930	72	0	48	No. 14 Gauge, 16" dia.	Perforated	Unknown
			48	72	Open Hole 14" dia.	Open	
MID056	1930	94	0	30	No. 14 Gauge, 16" dia.	Perforated	Unknown
			30	60	No. 14 Gauge, 14" dia.	Perforated	
			60	94	Open Hole 12" dia	Open	

**TABLE 2
HIGH GROUNDWATER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID060	1931	95	0	9	No. 14 Gauge, 18" dia. □	Blank	Unknown
			9	42	No. 14 Gauge, 18" dia. □	Perforated	
			45	70	No. 14 Gauge, 14" dia. □	Perforated	
			70	95	Open Hole 12" dia	Open	
MID061	1931	115	0	15	No. 14 Gauge, 18" dia. □	Blank	Unknown
			15	68	No. 14 Gauge, 18" dia. □	Perforated	
			45	90	No. 14 Gauge, 14" dia. □	Perforated	
			90	115	Open Hole 12" dia	Open	
MID067	1933	58	0	21	18" Casing	Perforated	Unknown
			21	45	18" Casing	Blank	
			45	58	16" Casing	Perforated	
MID068	1933	105	0	20	18" Casing	Perforated	Unknown
			20	48	18" Casing	Blank	
			48	72	12" Casing	Perforated	
			72	105	Open Hole 10" dia.	Open	
MID080	1938	155	0	45	18" Casing	Perforated	Unknown
			42	82	16" Casing	Perforated	
			76	81	14" Casing	Blank	
			81	141	14" Casing	Perforated	
			141	155	Open Hole 12" dia	Open	
MID102	1949	154	0	4	16" Casing	Blank	Unknown
			4	25	16" Casing	Perforated	
			25	40	16" Casing	Blank	
			82	85	14" Casing	Blank	
			85	117	Open Hole 12" dia	Perforated	
			117	154	12" Hole, caved in.	Open	

**TABLE 3
SHALLOW AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID006	1924	41	0	32	14" Casing	Blank	Unknown
			31	41	Open Hole 12" dia	Open	
MID014	1923	93	0	56	16" Casing	Blank	Unknown
			56	93	Open Hole 14" dia. Perforated		
MID034	1973	94	0	80	No. 8 Gauge 14" di	Blank	Unknown
			80	94	Open Hole 14" dia. Open		
MID039	1924	74	0	41	16" Casing	Blank	Unknown
			41	74	Open Hole 14" dia. Open		
MID048	1924	100	0	10	Sump & Drain	Blank	Unknown
			10	28	18" Casing	Blank	
			28	62	12" Casing	Blank	
			62	100	Open Hole 10" dia. Open		
MID050	1949	67	0	40.5	No. 12 Gauge, 16" Open Hole 14" dia.	Blank	Unknown
			40.5	67			
MID062	1931	75	0	21	No. 14 Gauge, 16" Open Hole 14" dia.	Blank	Unknown
			21	56	No. 14 Gauge, 16" Perforated		
			56	75	Open Hole 14" dia. Open		
MID103	1949	130	0	54	16" Casing	Blank	Unknown
			53	81	12" Casing	Perforated	
			81	120	Open Hole 10" dia. Open		
			120	130	10" Hole, caved in.		
MID108	1955	90	0	70	No. 12 Gauge, 14" Open Hole 14" dia.	Blank	None
			70	90			
MID201	1949	88	0	36	No. 12 Gauge, 18" Open Hole 16" dia	Blank	Unknown
			36	48	Open Hole 16" dia	Open	
			48	58	No. 12 Gauge, 16" Blank		
			58	74	No. 12 Gauge, 16" Perforated		
			74	78	No. 12 Gauge, 16" Blank		
			78	88	Open Hole 12" dia	Open	

**TABLE 3
SHALLOW AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
City of Mod. Well #3	1956	138	0	92	14" dia. Steel Open Hole	Blank Open	Unknown
City of Mod. Well #10	1939	110	0	?	24 inch dia. Steel 20 inch dia. Steel 10 inch dia. Steel	Blank Blank Blank	Unknown
City of Mod. Well #11	1936	125	0	?	24" dia. Steel 20" dia. Steel 14" dia. Steel Open Hole	Blank Blank Blank Open	Unknown
City of Mod. Well #29	1964	144	0	138 144	14" dia. Steel Open Hole	Blank Open	Unknown
City of Mod. Well #34	1967	112	0	100 112	16" dia. Casing Open Hole	Blank Open	Unknown
City of Mod. Well #100	1958	127	0	?	14" dia. Steel 12" dia. Steel Open Hole	Blank Blank Open	Unknown

**TABLE 4
DEEP AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID046	1925	240	0	151	12" Casing	Blank	Unknown
			151	240	Open Hole 10" dia.	Open	
MID217	1961	467	0	120	No. 10 Gauge 18" dia.	Blank	Unknown
			116	124	No. 8 Gauge 16" dia.	Blank	
			124	152	No. 8 Gauge 14" dia.	Blank	
			152	364	No. 8 Gauge 14" dia.	Perforated	
			364	368	No. 8 Gauge 14" dia.	Blank	
			368	467	UNKNOWN		
MID237	1991	297	0	32	No. 10 Gauge 24" dia.	Blank	0-32'
			0	164	No. 8 Gauge 18" dia.	Blank	
			155	159	No. 10 Gauge 16" dia.	Blank	
			159	251	No. 10 Gauge 16" dia.	Perforated	
			251	255	No. 10 Gauge 16" dia.	Blank	
			255	297	Open Borehole	Open	
City of Mod. Well #6	1921	234	0	175	18" dia. Steel	Blank	Unknown
			175	234	Open Borehole	Open	
City of Mod. Well #19	1957	240	0	240	18" dia. Steel	Blank	Unknown
City of Mod. Well #56	Unknown	255	180	180	16" dia. Steel	Blank	Unknown
			180	255	Open Borehole	Open	

Note: Currently only one well is screened solely beneath the Corcoran clay. The other wells should be replaced with wells that are screened solely below the Corcoran clay. Until then, monitor these wells to provide a general indication of the conditions.

**TABLE 5
FOREBAY AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID194	1948	302	0	106	18" Casing	Blank	Unknown
			100	150	16" Casing	Blank	
			148	182	3/16" thick, 12" dia.	Perforated	
			182	211	3/16" thick, 12" dia.	Blank	
			211	302	Open Hole 10" dia.	Open	
MID195	1948	260	0	136.5	No. 12 Gauge, 18" dia.	Blank	Unknown
			127	140.5	16" Casing	Blank	
			140.5	149.5	16" Casing	Perforated	
			149.5	152.5	16" Casing	Blank	
			152.5	164.5	16" Casing	Perforated	
			164.5	169	16" Casing	Blank	
			170	185	14" Casing	Blank	
			185	210	14" Casing	Perforated	
			210	233	14" Casing	Blank	
			233	260	Open Hole 11" dia.	Open	
			MID198	1980	258	0	
105	109	No. 10 Gauge, 14" dia.				Blank	
109	209	No. 10 Gauge, 14" dia.				Perforated	
209	213	No. 10 Gauge, 14" dia.				Blank	
MID 202	1949	255	0	78	No. 12 Gauge, 18" dia. Do	Blank	Unknown
			76	92	No. 12 Gauge, 16" dia. Do	Perforated	
			92	152	No. 12 Gauge, 16" dia. Do	Blank	
			131	204	3/16" thick, 14" dia.	Perforated	
			204	222	3/16" thick, 14" dia.	Blank	
			222	255	Open Hole 12" dia	Open	
MID203	1949	384	0	136	No. 12 Gauge, 18" dia. Do	Blank	Unknown
			135	151	No. 12 Gauge, 16" dia. Do	Blank	
			175	175	No. 12 Gauge, 16" dia. Do	Perforated	
			166	187	No. 12 Gauge, 14" dia.	Blank	
			175	180	No. 12 Gauge, 16" dia. Do	Blank	
			187	229	No. 12 Gauge, 14" dia.	Perforated	
			229	250	No. 12 Gauge, 14" dia.	Blank	
			250	259	Open Hole 14" dia.	Open	
			259	277	3/16" thick, 12" dia.	Blank	
			277	313	3/16" thick, 12" dia.	Perforated	
			313	331	3/16" thick, 12" dia.	Blank	
331	384	Open Hole 10" dia.	Open				

**TABLE 5
FOREBAY AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID208	1950	320	0	98	No. 12 Gauge, 18" dia. Dr	Blank	Unknown
			79	119	No. 10 Gauge 16" dia.	Perforated	
			119	139	No. 10 Gauge 16" dia.	Blank	
			128	203	No. 12 Gauge, 14" dia.	Perforated	
			196	272	No. 12 Gauge, 12" dia.	Perforated	
			272	276	No. 12 Gauge, 12" dia.	Blank	
			276	320	Open Hole 10" dia.	Open	
MID209	1949	424	0	90	No. 12 Gauge, 18" dia. Dr	Blank	Unknown
			78	108	No. 10 Gauge 16" dia.	Perforated	
			108	128	No. 10 Gauge 16" dia.	Blank	
			128	148	No. 10 Gauge 16" dia.	Perforated	
			148	168	No. 10 Gauge 16" dia.	Blank	
			158	230	No. 12 Gauge, 14" dia.	Perforated	
			230	248	No. 12 Gauge, 14" dia.	Blank	
			248	284	Open Hole 14" dia.	Open	
			284	365	No. 12 Gauge, 12" dia.	Perforated	
			365	384	No. 12 Gauge, 12" dia.	Blank	
		384	424	Open Hole 10" dia.	Open		
MID214	1959	480	0	116	No. 10 Gauge 18" dia. Dr	Blank	0-116'
			107	275	No. 8 Gauge 14" dia.	Perforated	
			275	362	Open Hole 11" dia.	Open	
			362	480	Exploratory Borehole 6" dia	Open	
MID215	1959	476	0	106	No. 10 Gauge 18" dia.	Blank	Unknown
			106	116	Open Hole 18" dia.	Open	
			116	216	No. 12 Gauge, 16" dia.	Perforated	
			198	310	No. 12 Gauge, 14" dia.	Perforated	
			306	400	No. 12 Gauge, 12" dia.	Perforated	
			400	476	Open Hole 10" dia.	Open	
MID216	1960	382	0	114	No. 12 Gauge, 18" dia. Dr	Blank	Unknown
			110	128	No. 8 Gauge 14" dia.	Blank	
			128	380	No. 8 Gauge 14" dia.	Perforated	
MID230	1989	412	0	28	No. 8 Gauge 24" dia.	Blank	0-30'
			0	192	No. 8 Gauge 18" dia.	Blank	
			175	179	No. 10 Gauge 16" dia.	Blank	
			179	283	No. 10 Gauge 16" dia.	Perforated	
			283	287	No. 10 Gauge 16" dia.	Blank	
		287	412	Open Borehole	Open		

**TABLE 5
FOREBAY AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID243	1996	346	0	20	No. 10 Gauge 24" dia.	Blank	0-20'
			0	148	No. 8 Gauge 18" dia.	Blank	
			141	251	No. 10 Gauge 16" dia.	Perforated	
			251	346	Open Borehole	Open	
OID-Bentley							
OID-Burnett							
OID-Campbell	1948	502	0	118	118 18" dia Casing	Perforated	
					240 14" dia Casing	Perforated	
OID-Crane							
OID-Howard	Unknown	475	0	?	18" dia. Casing	Blank	Unknown
			?	102	18" dia Casing	Perforated	
			98	232	14" dia Casing	Perforated	
			232	475	Open Borehole	Open	
OID-Marquis							
OID Santa Fe							
OID-Steinegul	1943	500	0	43	43 18" dia. Casing	Blank	Unknown
			43	53	53 18" dia Casing	Perforated	
			53	69	69 18" dia Casing	Blank	
			69	93	93 18" dia Casing	Perforated	
			93	115	115 14" dia Casing	Blank	
			115	265	265 14" dia Casing	Perforated	
			265	362	362 Open Borehole	Open	
OID-Thornton							
OID-Wemer							
OID-Private well #1							
OID-Private well #2							
OID-Private well #3							

**TABLE 5
FOREBAY AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
OID-Private well #4							
OID-Private well #5							
OID-Private well #6							
OID-Private well #7							
City of Mod. Well #18	1956	250	0	104	20" dia. Steel Casing	Blank	Unknown
			104	232	14" dia. Steel Casing	Perforated	
			232	250	Open Hole	Open	
City of Mod. Well #21	1959	320	0	144	20" dia. Steel casing	Blank	Unknown
			144	294	14" dia. Steel Casing	Perforated	
			294	320	12" dia. Open Hole	Open	
City of Mod. Well #25	1962	395	0	91	20" dia. Steel casing	Blank	Unknown
			91	366	16" dia. Steel Casing	Perforated	
			366	395	12" dia. Open Hole	Open	
City of Mod. Well #37	1970	228	0	102	20" dia. Steel casing	Blank	110
			102	214	18" dia. Well Screen	Perforated	
			214	218	18" dia. Steel casing	Blank	
			218	228	Unknown	Unknown	
City of Mod. Well #39	1972	292	0	116	24" dia. Steel casing	Blank	50
			116	216	18" dia. Well Screen	Perforated	
			216	220	18" dia. Steel casing	Blank	
			220	292	Open Hole	Open	
City of Mod. Well #40	1974	275	0	97	24" dia. Steel casing	Blank	52
			97	229	20" dia. Well Screen	Perforated	
			229	233	20" dia. Steel casing	Blank	
			233	275	18" dia. Open Hole	Open	
City of Mod. Well #41	1976	248	0	124	24" dia. Steel casing	Blank	52
			124	216	20" dia. Well Screen	Perforated	
			216	220	20" dia. Steel casing	Blank	
			220	248	18" dia. Open Hole	Open	

**TABLE 5
FOREBAY AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
City of Mod. Well # 52	1992	280	0	120	18" dia. Steel casing	Blank	100
			120	195	18" dia. Well Screen	Perforated	
			195	255	18" dia. Steel casing	Blank	
			255	270	18" dia. Well Screen	Perforated	
			270	280	18" dia. Steel casing	Blank	
2S/10E-28E1	Unknown	196	0	111	Unknown	Blank	Unknown
			111	196	Open Hole		
3S/10E-13C1	1952	108	0	95	7" dia Steel	Unknown	Unknown

Notes:

All wells without construction details listed in this table should be evaluated to confirm within the Forebay aquifers

These wells may be obtaining water from both the Mehrten Confined and Forebay aquifers. These wells should be replaced with wells that are screened solely within the Forebay aquifers. Until then, monitor these wells to provide a general indication of the conditions. Replacement wells may be found through DWR.

Conflicting data regarding well screen interval versus sanitary seal depths

**TABLE 6
MEHRTEN CONFINED AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID221	1994	510	0	320	1/4" thick, 16" dia. Casing	Blank	0-50'
			320	500	1/4" thick, 16" dia. Casing	Perforated	
			500	510	1/4" thick, 16" dia. Casing	Blank	
MID225	1960	235	0	104	No. 10 Gauge, 14" dia.	Blank	Unknown
			103	171	No. 12 Gauge, 12" dia.	Perforated	
			160	220	No. 12 Gauge, 10" dia.	Perforated	
			220	235	Open Hole 10" dia.	Open	
MID223	1959	380	0	116	No. 10 Gauge, 14" dia.	Blank	Unknown
			116	168	Open Hole 14" dia.	Open	
			168	208	No. 12 Gauge, 12" dia.	Perforated	
			208	380	Open Borehole	Open	
MID232	1989	460	0	16	No. 10 Gauge 24" dia.	Blank	0-20'
			0	216	No. 8 Gauge 18" dia.	Blank	
			192	196	No. 10 Gauge 16" dia.	Blank	
			196	288	No. 10 Gauge 16" dia.	Perforated	
			288	292	No. 10 Gauge 16" dia.	Blank	
			292	460	Open Borehole	Open	
MID238	1994	484	0	24	No. 8 Gauge 24" dia.	Blank	0-24'
			0	196	No. 8 Gauge 18" dia.	Blank	
			196	484	Open Hole 12" dia.	Open	
OID - private well #9							
Paulsell No. 1							
Paulsell No. 2	1945	830	0	54	No. 12 Gauge, 20" dia.	Blank	Unknown
			54	132	No. 12 Gauge, 18" dia.	Blank	
			132	159	16" dia.	Blank	
			159	830	Open Borehole	Open	

**TABLE 6
MEHRTEN CONFINED AQUIFER MONITORING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
City of Oakdale #2	1954	565	0	156	Casing	Blank	0-164'
			156	565	Perforated	Perforated	
City of Oakdale #7	1990	478	0	274	Casing	Blank	0-100'
			274	478	Perforated	Perforated	
City of Oakdale #8	1990	380	0	240	Casing	Blank	0-170'
			240	380	Perforated	Perforated	

Notes:

This well may be obtaining water from both the Mehrten Confined and Forebay aquifers. This well should be replaced with a well that is screened solely within the Forebay aquifers. Until then, monitor this well to provide a general indication of the conditions. Replacement wells may be found through DWR

**TABLE 7
MID TOP PRODUCING WELLS**

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
MID018	1965	136	0	24	No. 12 Gauge 24" dia.	Blank	No
			0	36	No. 8 Gauge 14" dia.	Blank	
			36	96	No. 8 Gauge 14" dia.	Perforated	
			96	100	No. 8 Gauge 14" dia.	Blank	
			100	136	Open Borehole	Perforated	
MID034	1973	94	0	80	No. 8 Gauge 14" dia.	Blank	Unknown
			80	94	Open Hole 14" dia.	Open	
MID062	1931	75	0	21	No. 14 Gauge, 16" dia.	Blank	Unknown
			21	56	No. 14 Gauge, 16" dia.	Perforated	
			56	75	Open Hole 14" dia.	Open	
MID079	1937	198	0	115.5	16" Casing	Perforated	Unknown
			115.5	198	Open Hole 14" dia.	Open	
MID082	1938	200	0	48	18" Casing	Blank	Unknown
			45	68	16" Casing	Perforated	
			60	79	PVC	Blank	
			79	94	14" Casing	Perforated	
			91	99	12" Casing	Perforated	
			99	120	PVC	Blank	
			120	200	Open Hole 10" dia.	Open	
MID101	1949	64	0	44	16" Casing	Blank	Unknown
			44	64	Open Hole 14" dia.	Open	
MID108	1955	90	0	70	No. 12 Gauge, 14" dia.	Blank	No
			70	90	Open Hole 14" dia.	Open	

Notes: Seven of the top ten are listed above. The remaining three wells have been incorporated into monitoring network.

Table 9
Surface Water Gaging Stations

Gaging Station Name	Gaging Station ID	Monitoring Agency	Elevation (feet above mean sea level)
Stanislaus River below Goodwin near Knights Ferry	SKF	USGS	253
Stanislaus River at Orange Blossom Bridge	OBB	DWR	117
Stanislaus River at Ripon	RIP	USGS	73
Tuolumne River below La Grange Dam	LGN	USGS	170
Dry Creek at Modesto	DCM	DWR	88
Tuolumne River at Modesto	MOD	DWR	90

Obtain USGS Information at <http://waterdata.usgs.gov/ca/nwis/rt>
Obtain DWR Information at <http://www.dpla.water.ca.gov/sjd/surfacewater/index.html>

**Table 10
Groundwater Monitoring Summary**

Well Name	Monthly Production ¹	Groundwater Level Monitoring				Groundwater Quality	
		Monthly	Quarterly	Semiannual	Annual	Semiannual	Annual
OID - Paulsell No. 1	X			X		X	X
OID - Paulsell No. 2	X			X		X	X
OID-Bentley	X			X		X	X
OID-Burnett	X			X		X	X
OID-Campbell	X			X		X	X
OID-Crane	X			X		X	X
OID-Howard	X			X		X	X
OID-Marquis	X			X		X	X
OID-Santa Fe	X			X		X	X
OID-Steinegul	X			X		X	X
OID-Thornton	X			X		X	X
OID-Wemer	X			X		X	X
OID-Private well #1	X			X		X	X
OID-Private well #2	X			X		X	X
OID-Private well #3	X			X		X	X
OID-Private well #4	X			X		X	X
OID-Private well #5	X			X		X	X
OID-Private well #6	X			X		X	X
OID-Private well #7	X			X		X	X
OID - private well #9	X			X		X	X
MID006	X			X		X	X
MID012	X			X		X	X
MID013	X			X		X	X
MID014	X			X		X	X
MID018	X			X		X	X
MID026	X			X		X	X
MID034	X			X		X	X
MID034	X			X		X	X
MID036	X			X		X	X
MID037	X			X		X	X
MID039	X			X		X	X
MID040	X			X		X	X
MID046	X			X		X	X
MID047	X			X		X	X
MID048	X			X		X	X
MID050	X			X		X	X
MID051	X			X		X	X
MID053	X			X		X	X
MID055	X			X		X	X
MID056	X			X		X	X
MID060	X			X		X	X
MID061	X			X		X	X
MID062	X			X		X	X
MID062	X			X		X	X
MID067	X			X		X	X
MID068	X			X		X	X
MID079	X			X		X	X
MID080	X			X		X	X
MID082	X			X		X	X
MID101	X			X		X	X
MID102	X			X		X	X
MID103	X			X		X	X
MID106	X			X		X	X
MID107	X			X		X	X
MID108	X			X		X	X
MID108	X			X		X	X
MID109	X			X		X	X

**Table 10
Groundwater Monitoring Summary**

Well Name	Monthly Production ¹	Groundwater Level Monitoring				Groundwater Quality	
		Monthly	Quarterly	Semiannual	Annual	Semiannual	Annual
MID194	X			X		X	X
MID195	X			X		X	X
MID196	X			X		X	X
MID198	X			X		X	X
MID201	X			X		X	X
MID202	X			X		X	X
MID203	X			X		X	X
MID208	X			X		X	X
MID209	X			X		X	X
MID214	X			X		X	X
MID215	X			X		X	X
MID216	X			X		X	X
MID217	X			X		X	X
MID221	X			X		X	X
MID223	X			X		X	X
MID225	X			X		X	X
MID230	X			X		X	X
MID232	X			X		X	X
MID237	X			X		X	X
MID238	X			X		X	X
MID243	X			X		X	X
City of Oakdale #8	X			X		X	X
City of Oakdale #7	X			X		X	X
City of Oakdale #2	X			X		X	X
City of Mod. Well #3	X			X		X	X
City of Mod. Well #6							
City of Mod. Well #11	X			X		X	X
City of Mod. Well #18	X			X		X	X
City of Mod. Well #19	X			X		X	X
City of Mod. Well #21	X			X		X	X
City of Mod. Well #25	X			X		X	X
City of Mod. Well #29	X			X		X	X
City of Mod. Well #34	X			X		X	X
City of Mod. Well #37	X			X		X	X
City of Mod. Well #39	X			X		X	X
City of Mod. Well #40	X			X		X	X
City of Mod. Well #41	X			X		X	X
City of Mod. Well #52	X			X		X	X
City of Mod. Well #56	X			X		X	X
City of Mod. Well #100	X			X		X	X
3S/10E-13C1 ²					X		
2S/10E-28E1 ²					X		

Notes:

1 = Monitor production in all wells including those on this list

2 = Obtain water level measurements from DWR website at <http://www.well.water.ca.gov/>

**TABLE 13
PURGE VOLUME ESTIMATION SHEET**

1. WELL SITE ID NO.: _____ TIME: _____

2. DATE: _____ FIELD TECH(S): _____

3. YEAR WELL CONSTRUCTED-INSTALLED: _____ WEATHER CONDITIONS: _____ (eg. hot, cold, clear, etc)

4. CASING MATERIAL: _____ REFERENCE POINT (R.P) _____ (ft)

5. WELL DIAMETER: _____ inches (in) DESCRIPTION: _____ (eg. top of casing)

6. WELL DEPTH: _____ feet (ft)

7. DEPTH TO WATER: _____ (ft)

8. COLUMN OF WATER (line 7 - line 6): _____ (ft)

PH METER (TYPE AND MODEL NO.) _____

CALIBRATED (yes/no) _____ DATE: _____

FIELD CALIBRATED (yes/no) _____ DATE: _____

EC METER (TYPE AND MODEL NO.) _____

CALIBRATED (yes/no) _____ DATE: _____

FIELD CALIBRATED (yes/no) _____ DATE: _____

WELL VOLUME CALCULATION

9. ONE WELL VOLUME (V) = Enter Line 5 (in) = _____ / 24 = (_____)² = _____ x 3.1416 = _____ x line 8 = _____ ft³

10. ONE WELL VOLUME (V in gallons) = $V_{(line\ 9)} \times 7.48 =$ _____ gal

11. THREE WELL VOLUMES (in gallons) = $V_{(line\ 10)} \times 3 =$ _____ gal

WELL PURGE TIME CALCULATION

12 WELL DISCHARGE RATE (Q) _____ gallons per minute (gpm) or _____ gpm from meter

13 WELL PURGE TIME (THREE WELL VOLUMES) = $V_{(line\ 11)} / Q_{(line\ 12)} =$ _____ min

ADDITIONAL FIELD NOTES

15 TIME PUMP TURNED "ON": _____

16 TIME PUMP TURNED "OFF": _____

17 ELAPSED PURGE TIME: _____ (min)

COMMENTS

TABLE 14
Analytical Parameters, Test Methods, Holding Times,
Sample Containers, Preservation and Approximate Detection Limits
For Groundwater Samples
Groundwater Monitoring Plan

Parameter	ANALYTICAL TESTING METHOD	MAXIMUM HOLDING TIME	SAMPLE CONTAINER		PRESERVATION	MINIMUM REPORTING LIMIT
			BOTTLE TYPE	SIZE/SET		
Calcium	SM 2340C or SM3500Ca-D	6 Months	Plastic	1 Liter	HNO ₃ , cool to 4 °C	1.0 mg/L
Magnesium	EPA 200.7 or SM3500Mg-E	6 Months	Plastic	1 Liter	HNO ₃ , cool to 4 °C	1.0 mg/L
Sodium	EPA 200.7 or SM3111B	6 Months	Plastic	1 Liter	HNO ₃ , cool to 4 °C	1.0 mg/L
Potassium	EPA 200.7	6 Months	Plastic	1 Liter	Cool to 4 °C	1.0 mg/L
Bicarbonate	SM 2320-B	14 Days	Plastic or Glass	250 mL	Cool to 4 °C	1.0 mg/L
Sulfate	EPA 300.0	28 Days	Plastic or Glass	250 mL	Cool to 4 °C	0.50 mg/L
Chloride	EPA 300.0	28 Days	Plastic or Glass	250 mL	Cool to 4 °C	1.0 mg/L
Nitrate, (Nitrate as NO ₃)	EPA 300.0	48 Hours	Plastic or Glass	250 mL	Cool to 4 °C	2.0 mg/L
pH	EPA 150.1	Immediate	Plastic	250 mL	None Required	None Required
Total Dissolved Solids (TDS)	SM 2450-C	7 Days	Plastic	250 mL	Cool to 4 °C	1.0 mg/L
Specific Conductance (EC)	SM 2510-B	28 Days	Plastic or Glass	250 mL	Cool to 4 °C	10 umhos/cm

Appendix A

Wells in the Modesto Subbasin Providing Water Quality Data



Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
01S07E01J001M							
01S07E02J001M							
01S07E03D001M							
01S07E05A001M							
01S07E06M002M							
01S07E08J002M							
01S07E09Q001M							
01S07E10A001M							
01S07E10A001M							
01S07E10A001M							
01S07E10A001M							
01S07E10A001M							
01S07E10A001M							
01S07E12H001M							
01S07E13J001M							
01S07E14M001M							
01S07E14P003M							
01S07E15F002M							
01S07E17N002M							
01S07E18L001M							
01S07E21G001M							
01S07E25E001M							
01S07E25R001M							
01S07E26G001M							
01S07E27K001M							
01S07E28D001M							
01S07E30R001M							
01S07E33H001M							
01S07E36D001M							
01S08E04R001M							
01S08E05A001M							
01S08E05R001M							
01S08E06D001M							
01S08E08J001M							
01S08E08J001M							
01S08E08J001M							
01S08E08J001M							
01S08E09Q001M							
01S08E11F001M							
01S08E14B001M							
01S08E15A001M							
01S08E15P001M							
01S08E25Q001M							
01S08E27A001M							
01S08E29K001M							
01S08E30C002M							
01S08E34Q001M							
01S08E35R002M							
01S09E02R001M							
01S09E05H002M							
01S09E07A001M							
01S09E07N001M							
01S09E11J001M							
01S09E11J002M							
01S09E13K001M							
01S09E14K001M							
01S09E14K001M							
01S09E14K001M							
01S09E14K001M							
01S09E14K001M							
01S09E15P001M							
01S09E16R001M							
01S09E18R003M							
01S09E19Q002M							
01S09E21J001M							
01S09E21J002M							
01S09E22L001M							
01S09E23A001M							
01S09E24R001M							
01S09E26A001M							
01S09E28M002M							
01S09E29M002M							

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
01S09E33J002M							
01S09E33P001M							
01S09E34A001M							
01S10E04C001M							
01S10E06Q001M							
01S10E08L001M							
01S10E16Q001M							
01S10E17L001M							
01S10E18M001M							
01S10E20G001M							
01S10E21A001M							
01S10E22Q001M							
01S10E23H001M							
01S10E23J001M							
01S10E26J001M							
01S10E27Q001M							
01S10E28J001M							
01S10E33J001M							
01S10E34R001M							
01S10E35F001M							
01S11E25N001M							
02S06E25J001M							
02S07E07D002M							
02S07E07Q001M							
02S07E08R001M							
02S07E09M001M							
02S07E10B002M							
02S07E11N002M							
02S07E12G001M							
02S07E12R001M							
02S07E12R001M							
02S07E12R001M							
02S07E12R001M							
02S07E12R001M							
02S07E12R001M							
02S07E12R002M							
02S07E12R002M							
02S07E12R002M							
02S07E12R002M							
02S07E12R002M							
02S07E12R002M							
02S07E12R002M							
02S07E19H001M							
02S07E20R002M							
02S07E22N002M							
02S07E24R002M							
02S07E26B001M							
02S07E31N001M							
02S08E04M001M							
02S08E06J001M							
02S08E07R001M							
02S08E08A001M							
02S08E08E001M							
02S08E09J001M							
02S08E12D001M							
02S08E14E001M							
02S08E17N002M							
02S09E03K001M							
02S09E05C001M							
02S09E07D001M							
02S09E09Q001M							
02S09E11K001M							
02S09E12R001M							
02S09E19B002M							
02S09E19B002M							
02S09E19B002M							
02S09E19B002M							
02S09E19B002M							
02S09E19B002M							
02S10E08H001M							
02S10E09E001M							
03S07E05J001M							
03S07E06Q001M							
02S10E01E001M							
02S10E02C001M							

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
02S10E02P001M							
02S10E10M002M							
02S10E22A001M							
02S10E22D001M							
02S10E23R001M							
02S10E24R001M							
02S10E25J001M							
02S10E26N001M							
02S10E27H001M							
02S10E28E001M	log available						
02S10E29B001M							
02S10E31C002M							
02S10E34M002M							
02S10E35M001M	no log available						
02S10E36A001M							
02S11E07J001M							
02S11E19K002M							
02S11E20N001M							
02S11E28J001M							
02S11E29M001M							
02S11E30C001M							
02S11E30M001M							
02S11E31N001M							
02S11E32H001M							
02S12E32P001M							
03S08E11K001M							
03S08E13C001M							
03S08E13J001M							
03S08E24K001M							
03S08E25J001M							
03S09E05J003M							
03S09E07C002M							
03S09E08K001M							
03S09E10E001M							
03S09E10M001M							
03S09E10P001M							
03S09E14G001M							
03S09E15L001M							
03S09E16D001M							
03S09E16N002M							
03S09E17D001M							
03S09E17P001M							
03S09E19C001M							
03S09E19E001M							
03S09E20C001M							
03S09E20J001M							
03S09E20K001M							
03S09E21H001M							
03S09E22F001M							
03S09E22N001M							
03S09E23E001M							
03S09E24F001M							
03S09E24M001M							
03S09E25D001M							
03S09E26K001M							
03S09E26M001M							
03S09E27D001M							
03S09E28C001M							
03S09E28J001M							
03S09E28K001M							
03S09E28M001M							
03S09E29B001M							
03S09E29D002M							
03S09E29G001M							
03S09E29P001M							
03S09E30E001M							
03S09E30Q001M							
03S09E31G001M							
03S09E32A001M							
03S09E32G001M							
03S09E33Q001M							
03S09E34A001M							
03S09E35A001M							
03S09E36C001M							

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
03S09E36C002M							
03S09E36D001M							
03S10E01J001M							
03S10E02D001M							
03S10E04A001M							
03S10E05L001M							
03S10E06B001M							
03S10E09J001M							
03S10E11D001M							
03S10E12L001M							
03S10E13C001M							
03S10E14A001M							
03S10E15A001M							
03S10E15Q001M							
03S10E16A001M							
03S10E19E001M							
03S10E20F001M							
03S10E20R001M							
03S10E22G001M							
03S10E26E001M							
03S10E30H001M							
03S10E30R002M							
03S10E31F001M							
03S10E31J001M							
03S10E31K001M							
03S10E34D002M							
03S11E06C001M							
03S11E07C001M							
03S11E18D001M							
03S11E19C001M							
03S11E27L001M							
03S11E28M001M							
03S11E31K001M							
03S11E34C003M							
03S11E34N001M							
03S12E05C002M							
04S08E01C002M							
03S12E33L001M							
04S08E13P001M							
04S08E22R001M							
04S08E27H001M							
04S08E35J001M							
04S08E36B002M							
04S09E03M001M							
04S09E04K001M							
04S09E04N002M							
04S09E05H001M							
04S09E05J001M							
04S09E09Q001M							
04S09E16D002M							
04S09E19A001M							
04S09E20A001M							
04S09E21A001M							
04S09E21J001M							
04S09E22C001M							
04S09E22L001M							
04S09E24G001M							
04S09E27H001M							
04S09E28J001M							
04S09E29M001M							
04S09E30Q001M							
04S09E31C001M							
04S09E32J001M							
04S09E33E001M							
04S09E36E002M							
04S10E02M001M							
04S10E08H001M							
04S10E11J001M							
04S10E12A001M							
04S10E18R001M							
04S10E21E001M							
04S10E21R002M							
04S10E24B001M							
04S10E29B001M							

Well #	Yr. Drilled	Drilled Depth (ft)	Top of Casing (ft)	Bottom of Casing (ft)	Casing Type	Blank or Perf ?	Sanitary Seal
04S10E31B001M							
04S10E32N002M							
04S11E03H001M							
04S11E08A001M							
04S11E11H001M							
04S11E14P001M							
04S11E15J001M							
04S11E17A001M							
04S11E21D001M							
04S11E24Q001M							
04S11E24Q001M							
04S11E28J001M							
04S11E28J001M							
04S11E31J001M							
04S11E32D002M							
04S11E32D002M							
04S11E33R001M							
04S11E33R001M							
04S11E35A001M							
04S11E36N001M							
04S12E03C001M							
04S12E03G001M							
04S12E06E001M							
04S12E06G001M							
04S12E07C001M							
04S12E07J001M							
04S12E08E001M							
04S12E08G001M							
04S12E09M001M							
04S12E16E001M							
04S12E17D001M							
04S12E17G001M							
04S12E18C001M							
04S12E19N001M							
04S12E21N001M							
04S12E27J001M							
04S12E30Q001M							
04S12E34F001M							
04S12E35C001M							
04S13E28B001M							
04S13E28K001M							
04S13E28Q001M							