Appendix C

Data Collection Protocols

STANISLAUS & TUOLUMNE RIVERS GROUNDWATER BASIN ASSOCIATION

GROUNDWATER MONITORING PROTOCOL FOR MEASURING STATIC GROUNDWATER LEVELS

GENERAL

The Stanislaus & Tuolumne Rivers Groundwater Basin Association is comprised of the County of Stanislaus, the Cities of Oakdale, Riverbank, and Modesto, and the Oakdale and Modesto Irrigation Districts. The Association's jurisdiction is defined by the *Memorandum of Understanding Relating to the Formation and Operation of the Stanislaus and Tuolumne Rivers Groundwater Basin Association* (1994, 2002). As recommended by the Groundwater Association Board (See Board Minutes, January 15, 1998), monitoring of spring and fall water levels is to be coordinated among association member agencies and other participating entities within the groundwater basin to (1) facilitate regional mapping of groundwater levels, (2) ensure consistency of data collection, and (3) to channel ongoing work in a cost effective manner.

Monitoring spring and fall static water level measurements represents the groundwater association's first step toward implementation of local groundwater management plans that were developed under Assembly Bill 3030 (1992). The purpose of this work is to (1) preserve and protect the quantity and quality of groundwater for local agencies' constituents and (2) to ensure local control of groundwater as a valuable resource by showing that prudent groundwater management practices are being implemented within the local groundwater basin.

The development of a groundwater monitoring protocol will continue to be an evolving program as information regarding wells within the basin is developed. Well information, including total depths and screened intervals, location, access, and measuring point elevation, will provide a basis for the development of criteria to select wells best suited for monitoring static water levels. Ultimately, wells selected for the monitoring program must also be accurately surveyed according to a common coordinate system to establish the horizontal and vertical well location.

This document as well as its attachments represent procedures for acquiring, recording, and exchanging groundwater level data. To the extent practical, groundwater association members, as well as other participating entities, will strive to collect and record spring and fall groundwater level data consistent with the following protocol.

MAPPING

The purpose of collecting spring and fall static water level measurements is to develop water level contour maps that display the relationship between hydrologic resources and the cultural resources of the groundwater basin. This mapping tool can then be used by local agencies to better understand the spatial relationships between groundwater recharge and discharge areas, flow

directions, pumping patterns, and land use impacts on groundwater quantity and quality. When water level maps are referenced in time, water level measurements can reveal changes in groundwater flow regimes brought about by natural or human influences.

Regional mapping of groundwater levels requires the monitoring of uniformly distributed monitoring wells that capture the vertical extent of the aquifer of interest. This objective is not only technically difficult to accomplish, but also is not economically feasible. A proposed alternative is to utilize production wells currently being monitored by various agencies as representative of average head conditions for that well site. Currently, monitoring of groundwater levels are performed by many agencies and private entities within the basin. Table 1 below shows the agencies and number of wells currently being monitored.

Table 1: Summary of Wells Currently Monitored by Local Agencies for Static Groundwater Levels

	City of Modesto	*City of Riverbank*	*City of Oakdale*	*Oakdale Irrigation District*	*Modesto Irrigation District*	*Stanislaus County*	*Total*
Number of Agency Wells in Basin:							
Irrigation	0	0	0	14	48	0	62
Drainage	0	0	0	0	53	0	53
Public Water Supply	141	7	8	5	0	0	161
							276

As the groundwater monitoring program is further developed, well sites that are better suited to monitoring will be identified and located. Production and monitoring wells not currently in the program will be evaluated based on the monitoring program's needs, with the ultimate objective of developing a uniform grid of well monitoring sites across the basin. Mapping of groundwater levels will be coordinated with the ongoing local geographic information system.

GROUNDWATER MONITORING

The acquisition and interpretation of water level data are essential parts of a groundwater monitoring program. Prior to developing these data, a monitoring program must include standard procedures for the acquisition of water level data. This will ensure that groundwater level data is not only consistent between sampling events, but that the data being collected is comparable between different field personnel. Without this, water level data collected during varying months and methods may not be comparable and, if used in a water-level flow analysis, could lead to erroneous conclusions.

The following text outlines a proposed water level measurement protocol that will ensure data consistency between the various agencies' field operations. It is understood that participating Association's member agencies, as well as other entities, currently have groundwater monitoring programs underway. In recognition of these ongoing programs, the intent of this protocol is not to create additional field work, but to coordinate ongoing monitoring programs to ensure that field data collection efforts share common monitoring program techniques that will best represent depth

to water measured from the ground surface. Once this has been accomplished, depth to groundwater below ground surface can be converted to an elevation referenced to feet above or below mean sea level.

Please see Attachments - C and - D, and - E (Figure 1) for the definition of terms, documentation of well-site field notes, and the diagram of a wellhead as they will be referred to through the remainder of this document.

General Preparation

Prior to the measurement of static water levels, an inspection of the required equipment is necessary. Electric sounders should be checked for proper battery operation and all cables, regardless of type, should be calibrated quarterly using a graduated steel tape. Transducers also periodically require calibration.

Most importantly, all wells, especially public or community supply wells, require standard procedures for field equipment decontamination to guard against the transfer of bacteria, oil lubricants and its by-products, and possible other trace organics, etc. to other wells. While no national standard exists for decontaminating well sampling field equipment, a reasonable guideline to follow would be to immerse or rinse the equipment thoroughly in a mixture of detergent (Alconox) and water or liquid chlorine bleach and water. A final rinse of the equipment with potable water is always required.

Locating a Well

Well location is important to mapping static water levels. At the present time, over six hundred wells within the groundwater basin have been located for mapping purposes using a global positioning satellite (GPS) system. Because of the success of GPS in measuring well locations, future mapping of wells will likely be located using GPS. Developing a vertical benchmark for the well site measuring point requires additional work in terms of a survey grade GPS system or the use of a traditional survey team to develop a vertical benchmark. In terms of well location accuracy, the following well location criteria should be used:

(1) horizontal (+/-) 3 feet;
(2) vertical (+/-) 0.1 foot.

Well location coordinates should be mapped using a recognized coordinate system that allows conversion to other coordinate systems. The current coordinate system being used that facilitates sharing of data with the regional GIS system is:

(1) System:	United States State Plane 1983
(2) Zone:	California Zone 3 0403
(3) Datum:	North American Datum - 83 (NAD83 - Western U.S.)
(4) Coordinate Units:	Feet

(5) Altitude Reference: Mean Sea Level

In addition to developing coordinates for the well location site, each well site should have documentation or field notes that physically describe the well site as well as other detailed well information. Please refer to Attachment - D for a breakdown of documentation to be included in the well site's field notes.

Establishing a Permanent Measuring Point

A permanent measuring point (MP) is important to ensure consistency and comparability of measured static water level data over time. In addition, the height between the MP and the land surface datum should be accounted for prior to reporting depth to water below ground surface to the regional groundwater mapping entity. Attachment - C provides a detailed definition for establishing a MP at a wellhead site.

Static Water Level Measurement Considerations

Static water level is the level at which water stands in a well or unconfined aquifer when no water is being removed from the aquifer either by pumping or free flow. It is generally expressed as the distance from the ground surface (or from a measuring point near the ground surface) to the water level in a well. For example, when the static water level in a well is 25 ft, it means that water stands 25 ft below the ground surface or measuring point (datum reference dependent) when there is no pumping. For the Association's groundwater monitoring work, each participating agency is responsible for (1) developing a measuring point, (2) the distance between the MP and the land surface, if not the MP, and (3) reporting the water level measurement as the SWL.

For regional static water level monitoring there are a number of methods and instruments used to collect and record changes in groundwater levels. Several measurement techniques currently utilized by association members include electric sounding, air-line submergence method, and pressure transducers. Each technique requires different information necessary to collect water level data. Details regarding measurement techniques should be well understood by field personnel prior to use of the measurement equipment. Common to each technique, however, are several factors that must be observed in order to maximize the accuracy of the water level data.

These factors include:

- Ensure that the well being monitored for water level has not been in use for at least 24 hours prior to measuring event.
- Annotate nearby pumping wells and approximate distance.
- Ensure that the water level measurement is recorded to the tenth of a foot, and is repeatable.

- Account for any factors that may lead to measurement error, such as access port geometry, measuring point above or below ground surface, thick oil layers in oil lubricated wells, etc.

Water Level Measurement Precision and Intervals

Water level measurement accuracies vary between the different measurement methods. Despite the source of error associated with the different measurement devices, the objective is to measure water levels to the tenth of a foot. This level of accuracy will facilitate water level hydrograph analysis should specific needs arise.

Monitoring seasonal fluctuations of water levels in the local groundwater basin require that static water levels should be measured in early spring (late February to mid-March) and again in late fall (late October to mid-November), with emphasis in the spring measurement.

Reporting of Data

Water level data should be reported as depth to water below ground surface in feet, accurate to a one-tenth of a foot. Attachments - A, and - B are sample spreadsheets that comprise the necessary information required to analyze and interpret water level data collected by field staff.

The primary use of the association's groundwater monitoring program is to monitor water level changes over time. The usual procedure is to plot the location of the wells on a base map, convert the depth-to-water measurements to elevations, plot the water level elevations on the base map, and then construct a groundwater elevation contour map. The direction of groundwater flow can be estimated by drawing groundwater flow lines perpendicular to the groundwater elevation contours.

This relatively simple approach to estimating groundwater flow directions is suitable where wells are screened in the same zone and the flow of groundwater is predominantly horizontal. In terms of the associations groundwater monitoring program, these assumptions are generally consistent with regional flow within the basin. As detailed well construction information and geologic strata in which well screens are situated become available, these assumptions will be revised as needed.

Water Level Interpretation

Interpretation of water level data requires that information regarding the well construction specifications be made available for each well in the monitoring program. This information should be contained in the field notes for each well-site (Attachment - D), which should include:

- Production or Monitoring Well Installations

    1. Geologic sequence.

    2. Well construction features, especially total well depth, screen and gravel pack length, and geologic strata in which the screen is situated.

    3. Depth and elevation of the top and bottom of the screen, or multiple screens, and gravel pack, if used.

    4. Measuring point location and elevation (x, y, z).

- Water Level Data

    1. Date and time of measurement.

    2. Method used to obtain the measurement.

    3. Other conditions in the area which might be affecting the water level data such as river stage, well pumping, storm events, irrigation, etc.

Performing an analysis of the association's regional monitoring program entails the evaluation of a large data set. To facilitate this work, computer statistical analysis and contouring will be used to map water-level depths and elevations. Critical review of this approach will be done manually and will require the above individual well construction information.

Attachments:

A - Sample Well Construction Information Data Table
B - Sample Water-Level Data Table
C - Groundwater Monitoring Protocol Definitions
D - Well Facility Field Notes and Documentation
E - Figure of Well Facility