Appendix 3-B. Monitoring Protocols

Contents

Monitoring Protocols

This Appendix provides the monitoring protocols for the monitoring networks described in Chapter 3.

Groundwater Levels

Groundwater level data collection may be conducted remotely via telemetry equipment or with an in-person field crew. The following section provides the monitoring protocols for groundwater level data collection. Establishment of these protocols will ensure that data collected for groundwater levels are accurate, representative, reproducible, and contain all required information. All groundwater level data collection in support of this GSP is required to follow these established protocols for consistency throughout the Basin and over time. These monitoring protocols will be updated as necessary and will be re-evaluated every five years. The reference for the following text is the groundwater level monitoring protocols in the Santa Cruz Mid-County Sustainability Plan (MGA 2020), with modifications.

All groundwater elevation measurements are referenced to a consistent elevation datum, known as the Reference Point (RP), surveyed to the National Geodetic Vertical Datum of 1988 (NGVD 88). For monitoring wells, the RP consists of a mark on the top of the well casing while most production wells have the RP at the top of the well's concrete pedestal. State requirements for surveying the RP is a measurement within 0.1 ft (3 cm) horizontally and 0.01 ft (0.3 cm) vertically. Groundwater level measurements are taken to the nearest 0.01 ft (0.3 cm) relative to the RP.

Groundwater elevation is measured by subtracting the depth to water from the reference point:

GWE = RPE - DTW,

where:

- GWE = groundwater elevation
- RPE = reference point elevation
- DTW = depth to water

Sample Collection:

- Equipment must be operated and maintained in accordance with manufacturer's instructions.
- Water level measurements must use units of feet, tenths of feet, and hundredths of feet.
- Measurements must include a record of the date, well name/identifier, time (in 24-hour military format), RPE, DTW, and GWE.
- Comments must be included regarding factors which may influence the recorded measurement such as nearby production wells pumping, weather, flooding, or well condition (including oil and other foreign bodies floating on the water surface).

Manual Groundwater Level Measurement

Groundwater level data collected by an in-person field crew will follow the following general protocols:

- Prior to sample collection, all sampling equipment and the sampling port must be cleaned.
- Manual groundwater level measurements are made with electronic sounders or steel tape. Electronic sounders consist of a long, graduated wire equipped with a weighted electric sensor. When the sensor is lowered into water, a circuit is completed and an audible beep is produced, at which point the sampler will record the depth to water. Some production wells may have lubricating oil floating on the top of the water column, in which case electric sounders will be ineffective. In this circumstance, steel tape may be used. Steel tape instruments consist of simple graduated lines where the end of the line is chalked to indicate depth to water without interference from floating oil.
- All equipment is used following manufacturer specifications for procedure and maintenance.
- Measurements must be taken in wells that have not been subject to recent pumping. At least two hours of recovery must be allowed before a hand sounding is taken.
- For each well, multiple measurements are collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.
- Equipment is sanitized between well locations to prevent contamination and maintain the accuracy of concurrent groundwater quality sampling.

Data Logger Groundwater Level Measurement

Telemetry equipment and data loggers can be installed at individual wells to record continuous water level data, which is then remotely collected via satellite to a central database and accessed on the Water Level Portal in a web browser.

Installation and use of data loggers must abide by the following protocols:

- Prior to installation the sampler uses an electronic sounder or steel tape to measure and calculate the current groundwater level in order to properly install and calibrate the transducer. This is done following the protocols listed above.
- All data logger installations must follow manufacturer specifications for installation, calibration, data logging intervals, battery life, and anticipated life expectancy.
- Data loggers are set to record only measured groundwater level to conserve data capacity; groundwater elevation is calculated after data are downloaded.
- In any log or recorded datasheet, the well ID, transducer ID, transducer range, transducer accuracy, and cable serial number are recorded.
- The sampler notes whether the pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are used, data are properly corrected for natural barometric pressure changes.
- All data logger cables are secured to the well head with a well dock or another reliable method. This cable is marked at the elevation of the reference point to allow estimates of future cable slippage.
- Data logger data are periodically checked against hand-measured groundwater levels to monitor electronic drift, highlight cable movement, and ensure the data logger is operating correctly. This check occurs at least annually, typically during routine site visits.

For wells not connected to a supervisory control and data acquisition (SCADA) system, transducer data are downloaded as necessary to ensure no data are overwritten or lost. Data are entered into the data management system as soon as possible after download. After the transducer data are

successfully downloaded and stored, the data are deleted or overwritten to ensure adequate data logger memory.

Groundwater Quality

Sample collection will follow the USGS National Field Manual for the Collection of Water Quality Data (Wilde 2008; USGS 2015) and Standard Methods for the Examination of Water and Wastewater (Rice, Bridgewater, and Association 2012), as applicable, in addition to the general sampling protocols listed below.

The following section provides a brief summary of monitoring protocols for sample collection and testing for groundwater quality. Establishment of these protocols will ensure that data collected for groundwater quality are accurate, representative, reproducible, and contain all required information. All sample collection and testing for water quality in support of this GSP are required to follow the established protocols for consistency throughout the Basin and over time. All testing of groundwater quality samples will be conducted by laboratories with certification under the California Environmental Laboratory Accreditation Program (ELAP). These monitoring protocols will be updated as necessary and will be re-evaluated every five years.

Wells used for sampling are required to have a distinct identifier, which must be located on the well housing or casing. This identifier will be included on the sample label to ensure traceability.

Event Preparation:

- Before the sampling event, coordination with any laboratory that will be used to test the samples is required. Coordination must include scheduling laboratory time for sample testing and reviewing the applicable sample holding times and preservation requirements that must be conducted before the sampling event.
- Sample labels must include the sample ID, well ID, sample date and time, personnel responsible for sample collection, any preservative, analyte, and analytical method. Sample containers may be labelled before or during the sampling event.

Sample Collection and Analysis:

- Collection of a raw sample must occur at, or close to, the wellhead for wells with dedicated pumps and may not be collected after any treatment, from tanks, or after the water has travelled through long pipes. Prior to sample collection, all sampling equipment and the sampling port must be cleaned. The sample equipment must also be cleaned between use at each new sample location or well.
- Sample collection in wells with low-flow or passive sampling equipment must follow protocols outlined in EPA's Low-flow (minimal drawdown) ground-water sampling procedures (Puls, Barcelona, and Agency 1996) and USGS Fact Sheet 088-00 (USGS 2000), respectively. Prior to sample collection in wells without low-flow or passive sampling equipment, at least three well casing volumes should be purged prior to sample collection to make sure ambient water is tested. The sample collector should use best professional judgement to ensure that the sample is representative of ambient groundwater. If a well goes dry, this should be noted, and the well should be allowed to return to at least 90% of the original level before a sample is collected.

- Sample collection should be completed under laminar flow conditions, which is defined as follows: the pump rate during sampling should produce a smooth, constant (laminar) flow rate, and should not produce turbulence during the filling of bottles.
- Samples must be collected in accordance with appropriate guidance and standards and should meet specifications for the specific constituent analyzed and associated data quality objectives.
- In addition to sample collection for the target analytes, field parameters, including temperature, pH and specific conductivity, must be collected at every site during well purging. Field parameters should stabilize before being recorded and before samples are collected. Field instruments must be calibrated daily and checked for drift throughout the day.
- Samples should be chilled and maintained at a temperature of 4 C degrees and maintained at this temperature during transport to the laboratory responsible for analysis.
- Chain of custody forms are required for all sample collection and must be delivered to the laboratory responsible for analysis of the samples to ensure that samples are tested within applicable holding limits.
- Laboratories must use reporting limits that are equivalent to, or less than, applicable data quality objectives.
- Quality control samples will be taken to confirm accuracy, replication, confidence, and robustness of the testing protocols procedures. Quality control samples will be collected during each monitoring event based on a schedule dependent on monitoring frequency. Quality control samples may include field blanks, field duplicates, lab duplicates or matrix spike/matrix spike duplicates. Field-generated quality control samples (field duplicates and field blanks) will be submitted “blind” to the laboratory, with an identifier different from the sampled sites. Issues with quality control samples that are flagged either by the laboratory or GSP QA/QC Officer will be used to correct any issues with the monitoring or lab testing protocol.

Subsidence

The subsidence monitoring network currently depends on data provided by DWR through the TRE ALTAMIRA InSAR Subsidence Dataset. The following describes the data collection and monitoring completed by DWR contractors to develop the dataset. The GSA will monitor all subsidence data annually. If any additional data become available, they will be evaluated and incorporated into the GSP implementation. If the annual subsidence rate is greater than minimum threshold, further study will be needed.

The statewide InSAR subsidence dataset was acquired by DWR to provide important SGMA relevant data to GSAs for GSP development and implementation. TRE ALTAMIRA processed InSAR data collected by the European Space Agency (ESA) Sentinel-1A satellite. Statewide data was collected between January 1, 2015 and September 19, 2019 and calibrated to data from 232 stations in the regional network of Continuous Global Positioning System (CGPS) stations. TRE ALTAMIRA compiled time series data of vertical displacement values for point locations on a grid with 100 m spacing, with values representing averages of vertical displacement measurements within the immediate 100 by 100 m square areas of each point. Gaps in the spatial coverage of the point data are areas with insufficient data quality. TRE ALTAMIRA also created two sets of GIS rasters: annual vertical displacement and total vertical displacement relative to the common start date of June 13, 2015, both in monthly time steps. An inverse distance weighted (IDW) method with a maximum search radius of 500 meter was used to interpolate the rasters from the point data.

Under contract with DWR, Towill Inc. conducted an independent study to ground truth and verify the accuracy of the InSAR dataset. In the study, variation in vertical displacement of California's ground surface over time, as measured from interferometric synthetic aperture radar (InSAR) satellites, was statistically compared to available ground-based continuous global positioning systems (CGPS) data. The study compared the InSAR-based vertical displacement point time series data to data from 160 CGPS stations that were not used for calibrating the InSAR data, as well as 21 CGPS stations that were used for calibrating InSAR data in Northern California. For the statewide dataset, the study provides statistical evidence that InSAR data accurately measured vertical displacement in California's ground surface to within 16 mm for the period January 1, 2015 through September 19, 2019. The statement of accuracy may vary for regional or localized area subsets (CDWR 2020).

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