The following is an excerpt from the Groundwater Quality Improvement Monitoring Method [MM-06]

SGM Grant Program Requirements for Post-Performance Monitoring and Reporting

Groundwater Quality Improvement Monitoring Method

Project / Action Type	Groundwater Quality Improvement projects that use aquifer remediation or clean-up to improve accessibility to groundwater resources for different beneficial uses.
Similar / Related Project Types	Groundwater Recharge projects that help improve water quality by recharging high quality surface water and diluting existing groundwater constituents of concern.
Metric	Site specific; contaminant concentration (inorganic chemicals, organic chemicals, disinfectants and by-products, microorganisms, radionuclides), general water quality parameters (pH, salinity, turbidity, hardness, temperature, oxidation reduction potential). Applicable water quality constituents (situationally). Groundwater Dependent Ecosystems (situationally).
Measurement Unit	Concentration or measurement of applicable groundwater quality constituents (typically mg/L), may include, inorganic chemicals, organic chemicals, disinfectants and by-products, microorganisms, radionuclides, pH, salinity, turbidity, hardness, temperature, oxidation reduction potential or any other applicable constituent of concern.
Beneficial User	Municipal and domestic water supply (MUN) Industrial service supply (IND) Industrial process supply (PROC) Agricultural water supply (AGR) Freshwater replenishment to surface waters (FRSH) (situationally)

Approach to Implementing Groundwater Quality Improvement Monitoring Method

If a project is being considered in an aquifer with existing contamination, planning and evaluation is needed to ensure that undesired results do not occur. It may be possible to design a project or action to provide groundwater quality improvements. Understanding hydrogeologic and geochemical conditions is critical to anticipating whether the project may improve groundwater quality or potentially create impacts to previously uncontaminated portions of the aquifer. The potential to reinject treated water into the aquifer instead of discharging back to a stream or other surface water body, should be carefully considered and monitored.

Justification

A monitoring network is needed for water quality improvement projects that are capable of tracking compliance with regulatory thresholds. Where groundwater impacts are known to exist, networks may have already been established under the direction of other agencies. In some cases, Groundwater Sustainability Agencies or other project proponents may have to install additional monitor wells to supplement existing monitoring networks, to better track the effects of the remedial action in a portion of the aquifer.

A Step-by-Step Guide to Applying Groundwater Quality Improvements Monitoring Method

Implementation of an effective monitoring method to assess project benefits or impacts includes the following:

1. **Determine oversight agency for known groundwater impacts or existing remedial operations:** California Water Code guidelines designate the SWRCB and RWQCB as the principal state agencies with responsibility for the coordination and control of water quality for groundwater. However, depending on the source and nature of the water quality impacts, other federal, state, and local agencies may have jurisdiction over clean-up efforts.
   - If a significant groundwater quality issue is managed under the regulatory oversight of the SWRCB or RWQCB, the project proponent should confer with that agency and seek to confirm a reasonable plan to address the groundwater quality issue. Other agencies with regulatory responsibility for groundwater quality may include the United States Environmental Protection Agency, and different state agencies, including the California Department of Pesticide Regulation, Department of Conservation's Division of Oil, Gas, and Geothermal Resources, and Department of Toxic Substances Control. Counties and cities also may have regulatory authority over some issues pertaining to local groundwater quality.
   - If a significant groundwater quality issue has been identified and is not clearly under the purview of another agency, the project proponent should confer with SWRCB, RWQCB, or other appropriate staff, and affected parties, to determine a reasonable plan to address the issue.
1. **Develop a conceptual site model for the impacted site:** A site-specific conceptual site model may be developed based on the available hydrogeologic and geochemical data. The conceptual site model provides a basis for decision-making that evolves as investigations progress.
2. **Safety plan:** All projects with fieldwork related activities should produce a Safety Plan. Planning for fieldwork and availability of access to the site, such as monitoring wells, is necessary to maintain project safety. Groundwater quality improvement projects may require a Safety Plan to address these and other potential safety concerns.
3. **Design a monitoring well network consistent with guidelines and Groundwater Sustainability Plan Regulations specified in the Department of Water Resources (DWR) Best Management Practice (BMP) 2 Monitoring Networks and Identification of Data Gaps (DWR, 2016):** A water quality monitoring network should be capable of capturing data on a sufficient temporal frequency and spatial distribution to demonstrate short-term, seasonal, and long-term trends in basin conditions for relevant constituents of concern. A monitoring network can be designed and implemented to sufficiently track compliance with water quality standards, as well as provide enough detail to track project implementation and be able to assess potential impacts on beneficial users. The location of the

monitoring network should be easily accessible such that gaining access to the site does not inhibit gathering and downloading data (refer to Step 1).

- Determine the number of wells to evaluate and document the contaminant types, contaminant concentrations, and lateral and vertical distribution of contaminants. The number and location of wells will depend on site-specific factors, including groundwater flow direction and gradient, hydrostratigraphy, and the identified water-bearing zones. The number of contaminant sources on a site, the properties of contaminants, and the extent of groundwater contamination also will affect decisions regarding the number of wells needed and how the wells are spaced.
- At a minimum, a monitoring network should include wells in the following locations in relation to the site and contaminant plume:
    - Upgradient to provide background water quality
    - Within a plume to identify the distribution of contaminant concentrations
    - At either side of the plume to define the lateral extent of contamination
    - At the downgradient edge of the plume to monitor its migration
    - Clusters installed at different depths in a contaminated, water-bearing zone to identify the vertical extent of contamination
    - In underlying water-bearing zones to identify the presence or absence of contamination
    - Drinking water supply wells (domestic, public supply, and small water system wells) that may be impacted by contamination
- Monitoring network wells should ideally be dedicated groundwater monitoring wells with known construction information. The selection of wells can be aquifer-specific and wells that are screened across more than one aquifer should be avoided where possible. If existing wells are used, the screened intervals should be known to interpret and utilize the water level or water quality data collected from those wells. Monitoring wells should be drilled and installed in accordance with DWR Bulletin 74-81 and 74-90.

4. **Implement groundwater monitoring program:** Protocols for monitoring groundwater levels and groundwater quality are addressed in DWR's BMP 1 Monitoring Protocols Standards and Sites (DWR, 2016). Selected notable considerations for implementation of a groundwater monitoring program include the following:
    - All monitoring should be conducted in such a manner to produce reliable, consistent, high-quality, and defendable data.
    - A Quality Assurance Program Plan, Sampling and Analysis Plan, and/or Quality Assurance Project Plan can be developed, where applicable, to establish data quality objectives for data measurement, sampling procedures, sample and document custody procedures, laboratory analytical methods, data validation protocol, and reporting procedures.
    - To assess the potential effects a project may have on water quality, monitoring should be conducted prior to the start of project operations to establish baseline conditions. While baseline monitoring should be conducted at a minimum prior to commencement of recharge projects, collecting baseline monitoring for at least one year before recharge operations would provide a more robust dataset to compare to project implementation data should groundwater quality impacts occur.
    - The frequency of groundwater quality monitoring may be based on the hydrogeologic conditions of the project area. For new monitoring wells, it is recommended that sampling be conducted at least quarterly for a minimum of one (1) year to establish water quality trends and track seasonal variations. Semi-annual or annual monitoring may be sufficient once water quality trends have been established.

Data and Protocols - Fundamentals

The effectiveness of a groundwater quality remedy and resulting groundwater quality improvement can be assessed using wells installed specifically for monitoring. Table 1 provides an example list of monitoring parameters that can be used in reporting and understanding the effects of a project in a quantifiable way over time. The primary monitoring requirements and tools include the following:

- Groundwater levels are measured to evaluate groundwater flow directions and gradients; primary monitoring points are monitoring wells. Primary tools for measuring groundwater levels include electrical sounders and pressure transducers installed in the monitoring wells and piezometers as outlined in DWR's BMP 1 Monitoring Protocols Standards and Sites (DWR, 2016); the use of dataloggers in association with pressure transducers allows automated collection of water level measurements at frequent intervals.
- Groundwater sampling is conducted to evaluate groundwater quality and monitor mobilization of chemical constituents. Primary tools for sampling groundwater include dedicated or temporary pumps installed in the monitoring wells to purge and obtain representative groundwater samples for laboratory analyses, as indicated in DWR's BMP 1 Monitoring Protocols Standards and Sites (DWR, 2016).

Table 1. **Example Data Monitoring Report (Generally Annually)**

Monitoring Reporting	
Total Groundwater Treated	XXX AF
Total Contaminants Removed	XXX tons
Average Groundwater Quality Constituent Change (list all identified, Recharge Area / Background)	+/- XXX mg/L / +/- XXX mg/L
Incurred Costs	$XXX

Data Analysis and Reporting

1. **Analyze monitoring data:** Results of the groundwater monitoring program should be used to evaluate potential water quality impacts or benefits, from project implementation.
2. **Prepare reports and manage data:** Results of groundwater quality monitoring BMP be reported in accordance with regulatory order requirements and/or grant requirements and provided to DWR for review. Data reporting and management procedures are addressed in the Data Management and Monitoring Method (MM-12).
3. **Expand or refine monitoring network adaptively**, as needed.

Data Standards

- Groundwater monitoring should be conducted in accordance with standard sampling and analytical protocols and documentation requirements to ensure groundwater monitoring data are collected, reviewed, and analyzed in a consistent manner and results are repeatable and defensible.
- Data collected should be machine readable, with pre-established fields of entry, to better allow data analytics.
- Concentration data should be compared to current regulatory standards. A variety of standards exist depending on toxicology and related policy. Common regulatory standards for comparing groundwater concentrations are the SWRCB primary and secondary maximum contaminant levels and notification levels, though some emerging contaminants are regulated under different entities such as the United State Environmental Protection Agency.

Key Protocols

The key protocols for groundwater quality monitoring can be found in the following:

- **DWR's BMP 1 Monitoring Protocols Standards and Sites (DWR, 2016) -** Describes protocols for measurement of groundwater levels and collection of groundwater samples for analysis to establish consistent data collection procedures.
- **DWR's BMP 2 Monitoring Networks and Identification of Data Gaps (DWR, 2016) -** Provides guidelines for establishing monitoring networks capable of providing sustainable indicator data of sufficient accuracy and quantity to demonstrate sustainable management in the basin and provides information on how to identify and resolve data gaps to reduce uncertainty.
- **California Department of Toxic Substances (2012): Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites -** Presents a recommended approach to planning and conducting groundwater investigations, when planning and conducting site characterization activities.