



SUSTAINABLE GROUNDWATER
MANAGEMENT (SGM)
GRANT PROGRAM



The following is an excerpt from the Groundwater Trading Monitoring Method [MM-14]

SGM Grant Program Requirements for Post-Performance Monitoring and Reporting

Groundwater Trading Monitoring Method

Project / Management Action Type	Groundwater trading is an evolving approach to sustainable groundwater management where willing groundwater users (usually growers) within a managed basin are allowed to sell all or part of their groundwater allocation to others in the basin willing to pay for it. Trading does not necessarily reduce the total amount of water pumped within a basin but rather allows growers and other users to redistribute the total pumping amount to help shift pumping away from areas of groundwater decline or other issues to areas with better groundwater conditions.
Similar / Related Project Types	Examples of water markets and groundwater allocations and trading can be found in adjudicated basins in California and in other western states, such as Arizona, Colorado, and Nebraska. Water trading has also been successfully used in the Murray-Darling Basin in Australia.
Primary Metrics	Gross and net (of recharge) volume traded and pumped by location and time. Monitoring of localized groundwater levels to identify potentially excess drawdown and impacts on other uses. Groundwater quality and other metrics may be applicable situationally and are addressed by other Monitoring Methods.
Measurement Units	Gross and net acre-feet traded and pumped. Feet of groundwater level change; concentrations of applicable water quality constituents of concern.
Primary Beneficial Users	Municipal and domestic water supply (MUN) Agricultural water supply (AGR)

Groundwater Trading Monitoring

In order to implement groundwater trading, adequate measurement of groundwater pumped by well or parcel is required. GSAs are approaching the monitoring of groundwater use in different ways. Some are relying on a water balance approach based on land use (e.g., standard crop consumptive use factors, irrigation efficiency and return flow estimates, and effective precipitation); others are augmenting the water balance with remote sensing estimates of consumptive use; and others are planning to implement well metering. For groundwater trading, accurate measurements are required for the traders to verify that the terms of trade are followed, and for both traders and the GSA to track use of allocations.

Monitoring the effects of a groundwater trading program will be needed to make sure that sustainable management criteria are not violated (i.e., undesirable results do not occur). At program initiation, the established GSP monitoring networks may be suitable to monitor the benefits and impacts for at least some of the sustainability indicators, if located in areas that may be directly impacted by trades. Monitoring of groundwater levels is expected in all cases, and depending on the GSA and its indicators, monitoring could also include water quality, subsidence, and seawater intrusion. If one or more indicators show an undesirable trend, additional monitoring (more sites or greater frequency) may become necessary.

All of the Sustainability Indicator Improvements Monitoring Methods (MM-07 to MM-10) may be applicable to track potential effects of groundwater trading. Monitoring of groundwater pumping and allocation accounting can be incorporated into the protocols of Data Management and Monitoring (MM-12).

Background and Context

Monitoring of Pumping and Trades

Monitoring and tracking the volume of water trading is crucial to ensure the overall water balance of the basin is not affected and local impacts can be managed. The volume of traded water must be monitored. It might be possible to measure pumped and traded water use without metering. For example, pumping might be calculated from electricity use and pump efficiency information or through remote sensing methods. Metering of wells that pump water for trades could be required.

Monitoring for Sustainability Indicators

Groundwater levels and groundwater quality monitoring should be conducted for groundwater trading programs. Monitoring groundwater levels and groundwater quality allows the project proponent to measure total progress toward sustainability and water quality goals. These measures are not an indicator for water trading alone as they are affected by all management actions as well as annual hydrology and economy-driven land use changes. However, analysis of the locations of impacts may suggest that trading has contributed to them. Groundwater level monitoring should include wells installed within the aquifer zone that is being pumped for the trading or transferring of groundwater to identify project benefits and impacts.

If trading appears to be causing or contributing to localized impacts, additional sites or more frequent measurements may be warranted. For example, a local concentration of trade-induced pumping groundwater may occur near a basin boundary or near a GDE, which may suggest additional groundwater level and quality monitoring be implemented. Prior to starting a groundwater trading program, groundwater levels and quality in the potential new pumping area should be assessed to provide a baseline for parameters that could be worsened by trading.

Additional useful monitoring

A calibrated groundwater model can be used to estimate the total water budget with the changes in pumping schemes in the basin and also evaluate any potential effects on nearby beneficial users. This can be used to measure outcomes after a groundwater trading program is developed and implemented. Prior to implementation, it can also be linked to a calibrated economic model to support groundwater trading program development (e.g., evaluate likely volumes, location, and timing of trades under different program rules, and adjust those rules as needed).

In some cases, other sustainability indicators might benefit from groundwater trading programs. Monitoring for the depletion of interconnected surface water, subsidence and seawater intrusion sustainability indicators are discussed in other Monitoring Methods.

A Step-by-Step Guide to Applying the Groundwater Trading Monitoring Method

1. **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 reading meters and monitoring wells, is necessary to maintain project safety. Groundwater trading projects may require a Safety Plan to address these and other potential safety concerns.
2. **Area Identification:** Identify the footprint of the area that will be subject to groundwater pumping for the trading program and the specific lands and wells that will be used for the trades.
3. **Identify how water use on lands or wells involved in trading will be calculated:** Normally, pumping will already be metered to support enforcement of allocations.

If not, a water use measurement plan will be required that is sufficient for the types of trades allowed. If land idling is used to provide water for trade, then inspection of idled land may be sufficient and additional measurement at the source not required. Total water requirement by crop and irrigation type can be estimated, or pumping might be estimated from electricity use and pump efficiency, but potential accuracy of these measurement methods must be addressed.

4. **Monitoring Plan:** Develop a monitoring plan to establish a baseline for the footprint area
 - Identify existing monitoring wells that may be sufficient to use for this evaluation using GSP wells if applicable.
 - Identify monitoring protocols and follow GSP monitoring protocols if applicable.
5. **Data collection:** Collect background groundwater level and quality data prior to the start of the trading program. Collecting seasonal data for up to 1 year prior to project implementation is useful for establishing a baseline. Note: 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).
6. **Monitoring:**
 - Track the volume of water that is pumped and traded in the footprint area
 - Monitor groundwater levels at monitoring wells and conduct water quality testing where pumping is increased by trades.
7. **Assessment of Impacts:** Review all monitoring data at least annually for evaluation of undesirable results and to assess that the claimed quantities of water trading are not exceeded. Assess if groundwater trading in the basin helps stabilize water levels and does not affect water quality. If part of a GSA, the assessment will be included in its annual report.
8. **Assess if data gaps exist:** Determine if additional monitoring is necessary to better evaluate the groundwater trading effects on groundwater sustainability.
9. **Reporting:** Report amounts traded and pumped, by location and timing, to the GSA at a frequency sufficient to track pumping and use of allocation for basin management. Report other monitoring data to the basin's GSA(s) at least twice per year based on SGMA and GSP requirements.
 - Upload project-specific monitoring data to the DWR SGMA data portal on an annual basis. This step will need to be coordinated with and completed by the GSA(s). (See Data Management and Monitoring Method)
10. **Adaptive Management:**
 - Expand or refine monitoring network and frequency adaptively, as needed if trading outcomes indicate potential sustainability impacts.
 - Modify trading rules and restrictions as needed to mitigate or avoid impacts.

Data and Protocols - Fundamentals

A groundwater trading program needs to be based on:

- Accurate measurement of water use in areas with limiting water use allocations.
- Coordination with SGMA requirements and relevant GSAs.
- Good initial aquifer data and a solid GSP that includes basin information.
- An agreed upon water budget with water accounting.
- An understanding of potential impacts on local communities.

Groundwater trading monitoring typically consists of measuring pumping at participating traders' wells and tracking that against their allocations. Potential impacts of trading may involve changes in groundwater levels, groundwater quality impacts, and other sustainability indicators based on where and when trades are occurring. However, separating out the effect of one or more trades from the effects of other projects and actions (e.g., from natural hydrologic variability or from unrelated land use changes) may be challenging. Table 1 provides an example list of monitoring parameters that can be used in reporting and understanding the effects of a trading program in a quantifiable way over time. The fundamental monitoring methods for groundwater trading programs include the following:

- Volumes and flow rates of extracted water from any well participating in trading should be measured to an acceptable level of accuracy, typically achieved by using a flow meter installed at the wellhead. If other measurement is used, such as remote sensing, it should be developed at an acceptable level of accuracy as well.
- Aquifer groundwater level monitoring using wells or piezometers installed in the saturated zone for evaluating changes in groundwater levels and gradients. Groundwater levels are measured manually using electrical sounders and automatically using pressure transducers lowered into and/or installed in the monitoring wells and piezometers. Groundwater level monitoring protocols are provided in the Department of Water Resources (DWR) Best Management Practices (BMP) 1 Monitoring Protocols Standards and Sites (DWR, 2016). The use of dataloggers in association with pressure transducers allows automated collection and storage of water level measurements at frequent intervals.
- Water quality sampling of source water extracted water, and monitoring wells to evaluate water quality changes due to extraction cycles. Water samples can be collected directly from a tap at the wellhead during extraction and from this discharge location of the demand water. Groundwater quality monitoring in dedicated observation wells should follow protocols provided in DWR's BMP 1 Monitoring Protocols Standards and Sites (DWR, 2016).

Table 1. Example Data Monitoring Report (Generally Annually)

Monitoring Reporting	
Extraction Basin	XX Basin
Pumped/Extracted Basin-wide Groundwater Volume	XXX AF
Basin-wide Groundwater Volume of water traded	YYY AF
Well # and pumping (List all wells that pumped traded water)	+/- ZZZ ft / +/- ZZZ ft
Average Groundwater Level Change – average	Ft Change Q ft
Footprint Groundwater Level Change – average	Ft Change R ft
Maximum Impact of Trading on Basin Depletion	+YYY/XXX
Potential Impact of Trading in Footprint Area	+AAA/ZZZ
Incurred Monitoring Costs	\$XXX

Data Analysis and Reporting

1. **Analyze monitoring data:** Monitoring data should be used to track traded amounts relative to pumping allocations and to evaluate the effectiveness and performance of the trading program. The assessment should also include any possible concerns that may arise from trading, such as causing unreasonable harm to nearby land or beneficial water uses and if/how trading rules can be modified to avoid significant risks.
2. **Prepare reports and manage data:** Trades represent a change in location and timing of groundwater pumped within the framework of an established allocation. The GSA needs to track allocations and trades in order to manage the basin. It is unclear whether SGMA authorizes DWR to keep track of the same information about trading within a GSA or subbasin and therefore whether the GSA must report the full details of its own tracking information to DWR. The GSA's tracking needs to include the following information about each trade:
 - Buyer's and seller's annual allocation,
 - If seller's well is not metered, land and water use information needed to verify that sold amount was unused by the seller.
 - Status of allocation at time that trade is agreed to – amount used to date, amount carried over from previous year (if allowed),
 - Buyer's location (the wells/parcel whose allocation will be credited by the amount of the trade)
 - Seller's location (the wells/parcel whose allocation will be debited by the amount of the trade)
 - Details about the actual use (pumping) of the traded water – amount, location, timing
 - Status of buyer's and seller's allocation after the pumping of traded water.
3. Compliance with regulatory and grant requirements and providing data to DWR are addressed in the Data Management and Monitoring Method (MM-12). Data can be uploaded to the DWR system annually and progress on project implementation and monitoring can be provided in Annual Reports. If the project is associated with a GSP, the annual project summary should be provided in the Annual Reports, and a full project performance assessment should be provided in the 5-Year Assessment Report.

Data Standards

Groundwater and water quality monitoring data should conform to the technical and reporting standards of the California Water Code §352 et seq.

Groundwater levels - Groundwater elevation measurements should be recorded relative to a consistent vertical datum.

Groundwater quality - Concentrations of groundwater quality constituents of concern should be compared to maximum contaminant levels available from the SWRCB.

Key Protocols

The following protocols should be followed for required monitoring:

- DWR has not established installation, operation, maintenance, and accuracy standards or BMPs for wellhead meters for purposes of SGMA compliance (DWR, 2016). Some GSAs have established (or are developing) standards, and pumpers in adjudicated groundwater basins operate under rules set by the watermaster (see, for example, Chino Basin Watermaster, 2019).
- Standard groundwater level measurement and groundwater quality monitoring protocols are described in DWR's BMP 1 (DWR, 2016).
- Guidelines for establishing monitoring networks and resolving data gaps to reduce uncertainty are provided in DWR's BMP 2 Monitoring Networks and Identification of Data Gaps (DWR, 2016).
- Technical and reporting standards included in California Water Code (CWC) §352 *et seq.*