NORTHERN &
CENTRAL
DELTA-
MENDOTA

Final Draft
Groundwater Sustainability Plan

For the Northern and Central Delta-Mendota Regions

November 2019

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

PROP 1
GOVERNOR EDMUND G. BROWN, JR.
WATER BOND 2014
RELIABILITY | RESTORATION | RESILIENCE

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Appendix F
Quality Assurance Program Plan

Appendix F

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QUALITY ASSURANCE PROGRAM PLAN

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2175 N California Blvd | Suite 315
Walnut Creek California 94596
925.627.4100

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San Luis & Delta-Mendota Water Authority
August 2019

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Quality Assurance Program Plan

For

Northern & Central Delta-Mendota Region Groundwater Sustainability Plan Monitoring Protocol

In Coordination with the

Central Valley Groundwater Monitoring Collaborative CVGMC QAPP

August 2019

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FIGURES

List of Acronyms

COC	Chain of Custody
CRM	certified reference material
CVGMC	Central Valley Groundwater Monitoring Collaborative
CVRWQCB	Central Valley Regional Water Quality Control Board
DDW	California State Water Resources Control Board Division of Drinking Water
DMS	data management system
DQI	Data Quality Indicator
DQO	Data Quality Objective
E	environmental sample
EC	electrical conductivity
FD	field duplicate
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MQO	measurement quality objective
MS	matrix spike
MSD	matrix spike duplicate
PR	percent recovery
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Program Plan
RPD	relative percent difference
SGMA	Sustainable Groundwater Management Act of 2014
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
WDR	Waste Discharge Requirements

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1. INTRODUCTION

In compliance with the Sustainable Groundwater Management Act of 2014 (SGMA) and the associated Groundwater Sustainability Plan (GSP) Emergency Regulations, each GSP must include a monitoring network designed to collect the data necessary to demonstrate progress towards achieving the measurable objectives contained within the GSP, monitor impacts on beneficial uses or users of groundwater, monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds, and quantify annual changes in water budget components (California Water Code [CWC] Section 10733.2). Furthermore, each GSP must include monitoring protocols describing technical standards, data collection methods, and other procedures or protocols pursuant to CWC Section 10727.2(f) for monitoring sites or other collection facilities to ensure that the monitoring network utilizes comparable data and methodologies. To this end, Section 7.2 *Monitoring* (*Sustainability Implementation* chapter) of the Northern & Central Delta-Mendota (N-C DM) Region GSP contains the required monitoring protocols. This document augments this section of the GSP by providing additional details necessary to ensure consistent and comprehensive data collection methodologies.

As the N-C DM Region's data collection efforts are designed to complement and coordinate with other existing monitoring programs (including the California Statewide Groundwater Elevation Monitoring [CASGEM] and Irrigated Lands Regulatory Real Time Trend Monitoring programs), this document has been designed to reflect the Central Valley Groundwater Monitoring Collaborative (CVGMC) Quality Assurance Program Plan (QAPP) (LSCE, 2018) under which each of the participating CVGMC agricultural coalitions must meet their own groundwater monitoring requirements as outlined in their individual General Orders. The role of this document (and that developed by the CVGMC) is to establish common monitoring and reporting structure as it applies to the individual groundwater monitoring requirements outlined in the N-C DM Region GSP for each Groundwater Sustainability Agency (GSA). The GSAs will participate in a regional effort to collect and share groundwater monitoring data to be used for a broad geographical characterization of the potential effects of projects and management actions on groundwater sustainability in the N-C DM Region and for regulatory compliance and decision making throughout the entire Delta-Mendota Subbasin.

This QAPP establishes the quality assurance and quality control standards and requirements for useable data for individual projects contributing to this regional collaboration. It also establishes the structure and requirements for a regional data management system through which all useable data generated as part of the N-C DM Region GSP can be stored and accessed. In addition to the programmatic requirements addressed in this QAPP, the GSA Lead for data collection for each GSA conducting monitoring required by the N-C DM Region GSP Monitoring Protocol (GSP Monitoring Protocol) will adhere to the project-specific requirements established in this QAPP.

2. DISTRIBUTION LIST

Table 1: GSA Representatives

Title	Name	Organizational Affiliation	Contact Information (Telephone number, fax number, email address)
GSA Lead for Data Collection:			
Central Delta-Mendota GSA			
City of Patterson GSA			
DM-II GSA			
Northwestern Delta-Mendota GSA			
Oro Loma Water District GSA			
Patterson Irrigation District GSA			
West Stanislaus Irrigation District GSA			
Widren Water District GSA			
N-C DM Region GSP Quality Assurance (QA) Officer			
N-C DM Region GSP Representative/Monitoring Field Lead			
Contract Laboratory Project Manager			
Contract Laboratory QA Officer			

3. PROJECT ROLES AND RESPONSIBILITIES

3.1 GSA Lead for Data Collection

Each GSA member agency is responsible for coordinating with their co-GSA members to implement required GSP monitoring and data collection within their GSA's service area. The GSA member agencies are responsible for sharing data with the GSA Lead, where the GSA Lead will identify any errors or outliers and asks member agencies to collect additional information, if needed.

The GSA Lead is the person within each individual GSA responsible for overseeing the required GSP data collection and compilation within his/her GSA jurisdictional area, ensuring that the data are collected by each member agency (if applicable) and shared in a timely manner in coordination with this QAPP and for coordination with the N-C DM Region GSP Representative.

3.2 GSP Representative Role

The GSP Representative (known as the N-C DM Region GSP Monitoring Field Lead) facilitates the implementation of the GSP Monitoring Protocol, including the coordination of water level measurements, well sampling, laboratory analysis, and data collection analysis and reporting. The N-C DM Region GSP Monitoring Field Lead will work with the GSA Leads, analytical laboratory(ies), and N-C DM Region GSP Quality Assurance (QA) Officers to resolve analytical issues and maintain communication between all parties in regard to laboratory and/or sampling changes.

3.3 Project Quality Assurance (QA) Officer Role

The Project QA Officer (known as the N-C DM Region GSP QA Officer) is responsible for establishing quality assurance/quality control (QA/QC) guidelines for field sampling and analytical procedures conducted as part of the GSP Monitoring Protocol and for coordinating with GSA Leads to ensure that these protocols are implemented. The Project QA Officer will also, in coordination with the GSP Representative, compile GSA data into standardized forms and perform general quality control checks.

3.4 Persons Responsible for the Update and Maintenance of QAPP

The Project QA Officer, in coordination with the GSP Representative, will be responsible for creating, maintaining, and updating the QAPP template, including all forms required for data collection and reporting. The Project QA Officer will be responsible for making changes and submitting the final version to the GSAs for implementation.

3.5 Contract Laboratory Project Manager and QA Officer

The Contract Laboratory Project Manager and QA Officer are employees of the contracted State-certified analytical laboratory utilized for sample analysis. These entities will coordinate with the N-C DM Region GSP Monitoring Field Lead and Project QA Officer to resolve any issues relating to accuracy, completeness, and precision for samples collected as part of the GSP Monitoring Protocol.

4. PROBLEM DEFINITION/BACKGROUND

The Delta-Mendota Subbasin (Subbasin) is designated by the California Department of Water Resources (DWR) as a high-priority critically-overdrafted groundwater subbasin of the San Joaquin Valley Groundwater Basin, with local communities heavily, and sometimes solely, dependent on groundwater as a water supply. Currently known groundwater issues within the Subbasin include subsidence in the northern and southern ends of the Subbasin and varying water quality issues throughout. Groundwater levels in the Subbasin have, at times in the past, been declining due to over pumping resulting from limited surface water deliveries via the Central Valley Project and State Water Project. Agencies created to oversee and implement groundwater management practices, known as GSAs, overlie the Delta-Mendota Subbasin and are required to comply with SGMA. These entities have prepared six GSPs that, together, cover the entire Subbasin and which, when implemented, will achieve long-term groundwater sustainability. As part of GSP development, GSAs in the Northern and Central Delta-Mendota Regions have developed a monitoring protocol to characterize groundwater and related surface water conditions and to track changes in groundwater levels, groundwater storage, groundwater quality, subsidence, and interconnected surface water, including short-term, seasonal, and long-term trends. The fundamental goal of the N-C DM Region GSP is to ensure the long-term sustainability of the Northern and Central Delta-Mendota Regions. Development, and ultimately implementation, of a sound GSP, including a clear monitoring protocol, will help to improve groundwater management in the Region as well as help the Subbasin achieve and maintain SGMA compliance.

This QAPP supports the N-C DM Region GSP Monitoring Protocol (Section 7.2 *Monitoring* of the N-C DM Region GSP). This QAPP includes project-specific information pertaining to the monitoring to be performed by the GSAs within the Northern and Central Delta-Mendota Regions as described in the N-C DM Region GSP.

5. PROJECT DESCRIPTION

5.1 Geographical Setting

The Delta-Mendota Subbasin (DWR Basin 5-022.07) is located in the San Joaquin Valley Groundwater Basin and adjoins the following nine subbasins of the San Joaquin Valley Groundwater Basin: Tracy, Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Kings, and Westside. The Delta-Mendota Subbasin is bounded on the west by the Tertiary and older marine sediments of the Coast Ranges and on the north by San Joaquin-Stanislaus County line, except where Del Puerto Water District and West Stanislaus Irrigation District service areas extend into San Joaquin County. The eastern boundary is generally described by the San Joaquin River, Fresno Slough, James Bypass, and Mendota Pool and the following water purveyor service areas: Aliso Water District, Farmers Water District, Mid-Valley Water District, Reclamation District 1606, James Irrigation District, Tranquillity Irrigation District, and Fresno Slough Water District (except to include the entirety of the Columbia Canal Company). Tranquillity Irrigation District and Westlands Water District boundaries, as well as the San Luis Water District service area until reaching the Coastal Range, comprise the southern subbasin boundary. The N-C DM Region extends into five counties: San Joaquin, Stanislaus, Merced, Fresno, and San Benito. The N-C DM Region is generally defined as the area of the Delta-Mendota Subbasin in San Joaquin and Stanislaus Counties, with the exception of the City of Newman area and east of Crows Landing; following the western boundary of the Delta-Mendota Subbasin to the west and south of the Delta-Mendota Canal within Merced, San Benito and Fresno Counties; and the Tranquillity area at the southeastern tip of Delta-Mendota Subbasin in Fresno County.

The GSAs within the N-C DM Region have developed their own network of wells for groundwater level and quality trend monitoring, as well as land subsidence and interconnected surface water monitoring points, as described in the N-C DM Region GSP. These networks include sites spatially distributed across the Region as required to characterize each principal aquifer (referred to as the Upper and Lower Aquifers), as well as to evaluate impacts relating to interconnected surface waters and land subsidence. Data from these monitoring networks will be evaluated and incorporated with similar data from other Delta-Mendota Subbasin GSP monitoring networks for Subbasin-level analysis and reporting. Selected monitoring sites included in the N-C DM Region GSP monitoring network will be used to monitor groundwater levels, change in groundwater storage, and groundwater quality in the Upper and Lower Aquifer. Separate monitoring networks have been developed for monitoring for land subsidence and impacts to interconnected surface water. See Figure 1 through Figure 6 for established monitoring networks for groundwater levels and groundwater quality (Upper Aquifer and Lower Aquifer) as well as land subsidence and interconnected surface water. The established groundwater level monitoring network will also be used for monitoring change in groundwater storage in both principal aquifers

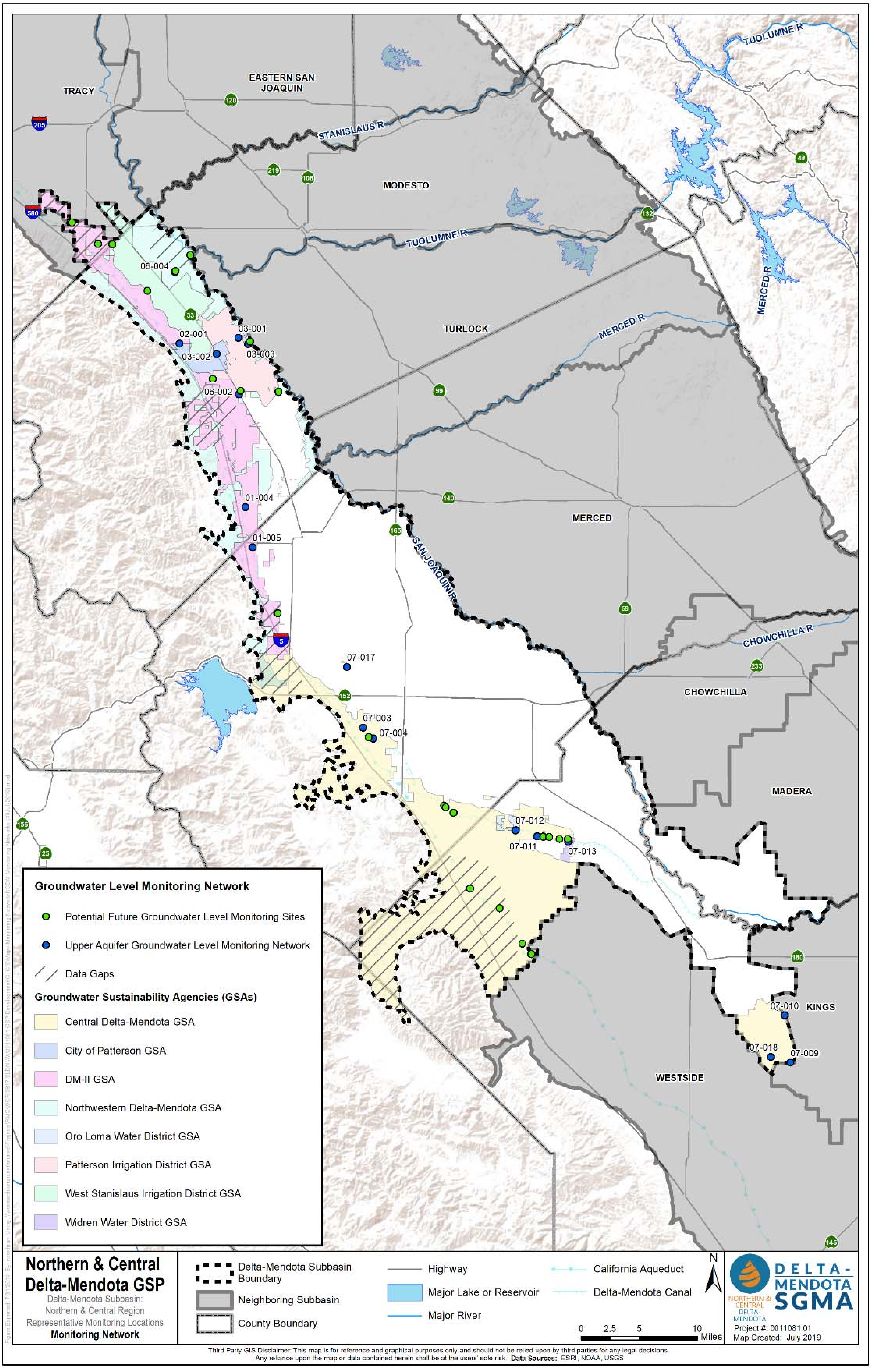

Figure 1: Upper Aquifer Groundwater Levels Monitoring Network, Northern & Central Delta-Mendota Region GSP

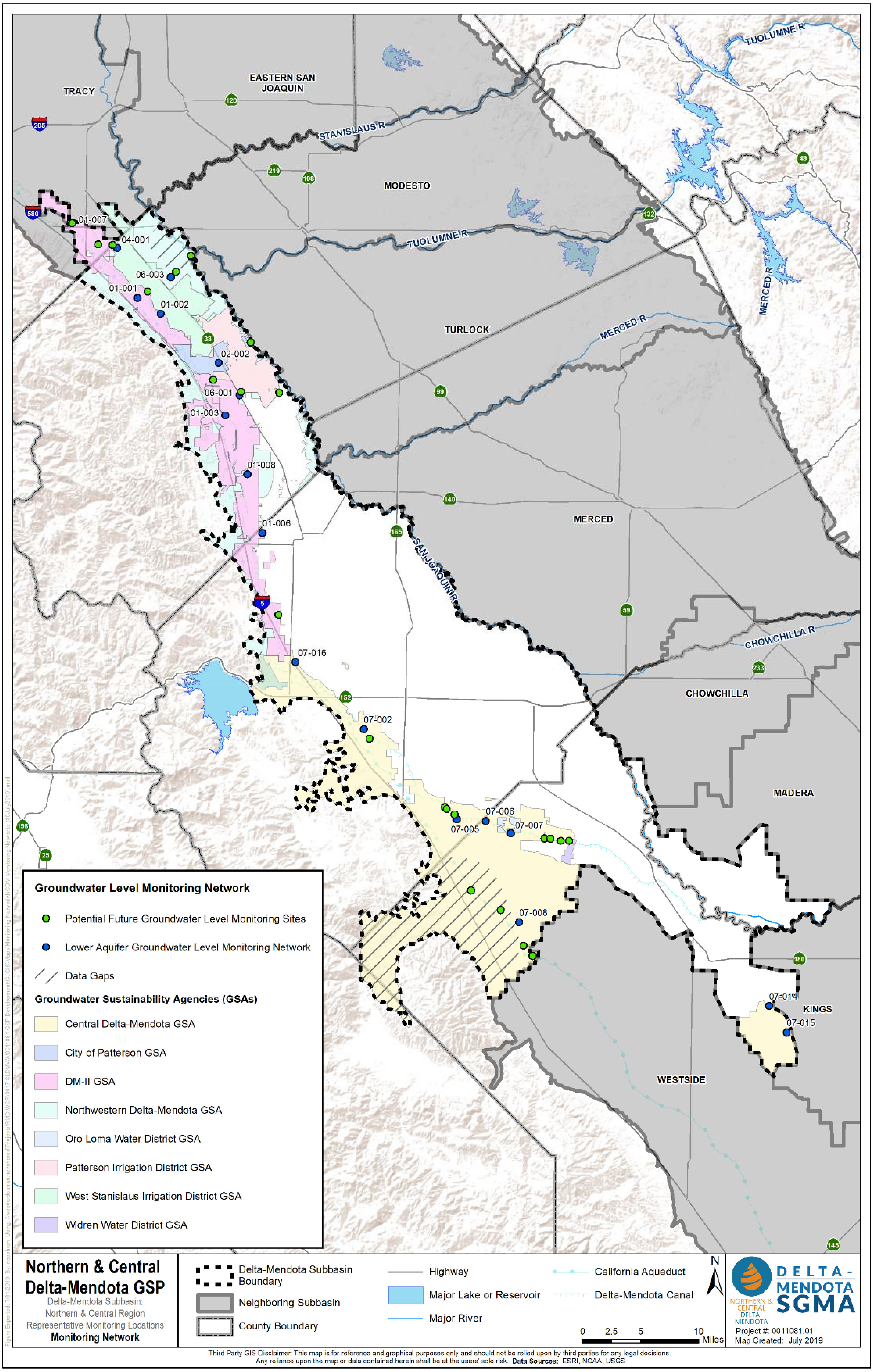

Figure 2: Lower Aquifer Groundwater Levels Monitoring Network, Northern & Central Delta-Mendota Region GSP

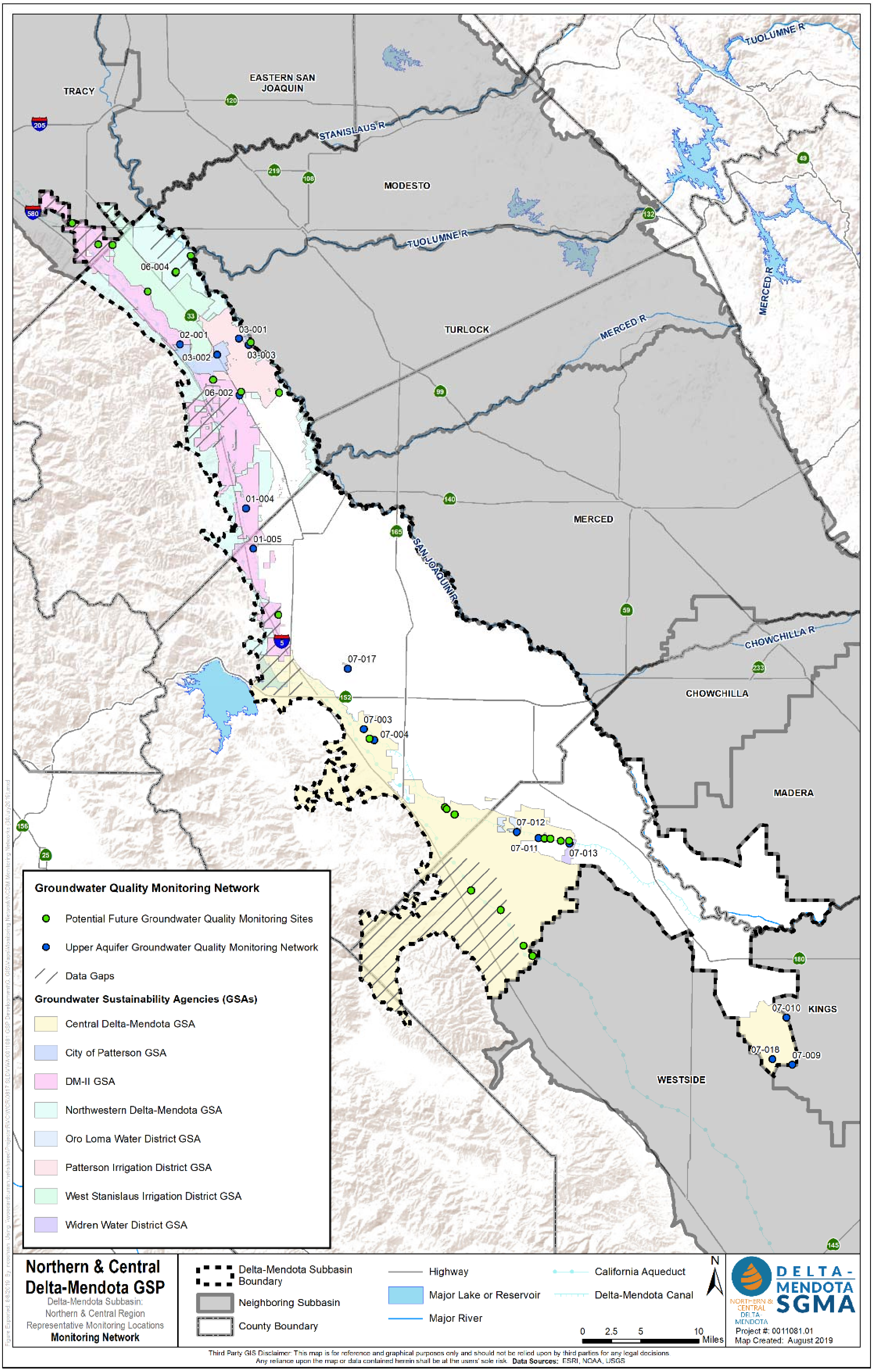

Figure 3: Upper Aquifer Groundwater Quality Monitoring Network, Northern & Central Delta-Mendota Region GSP

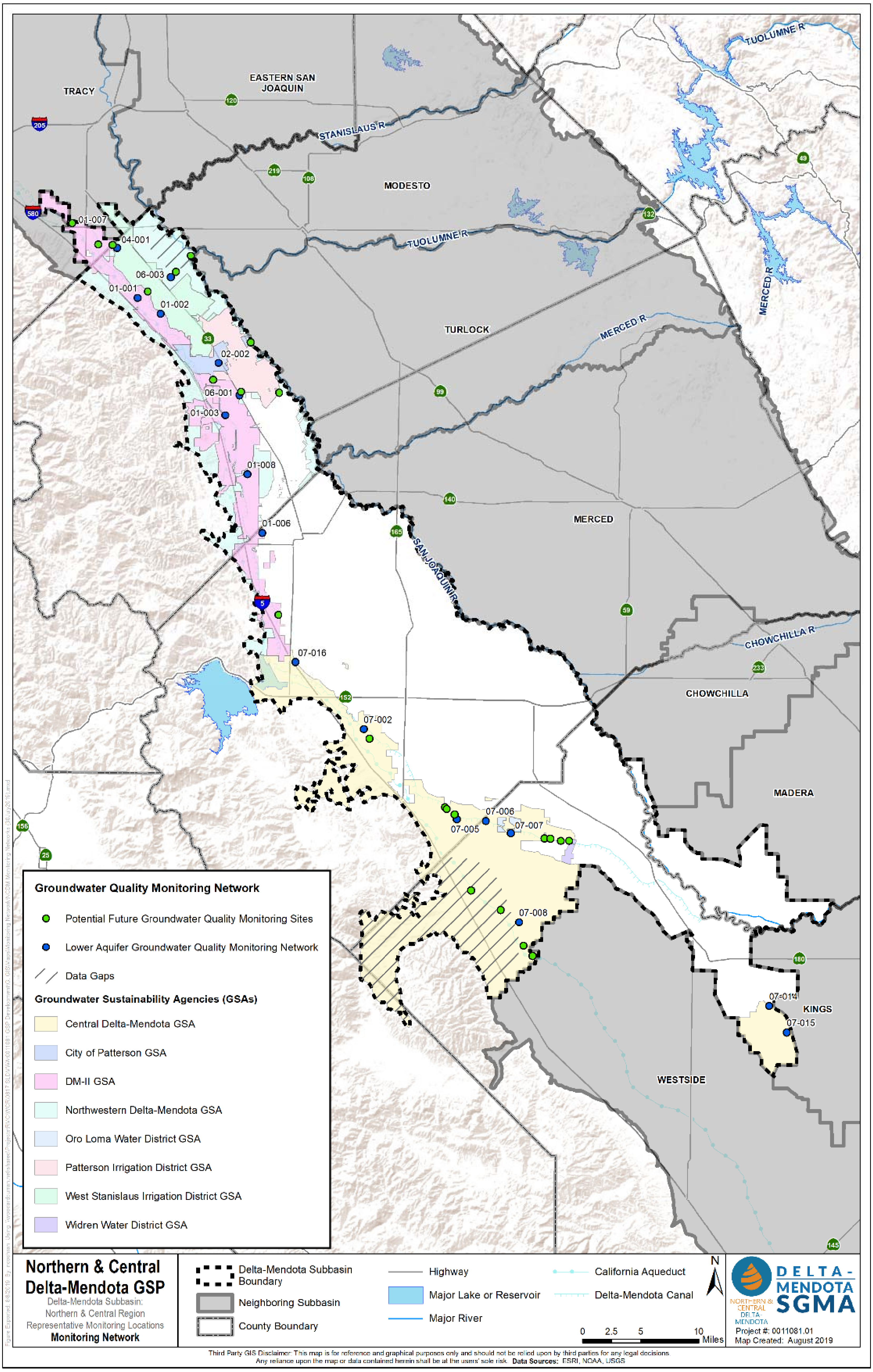

Figure 4: Lower Aquifer Groundwater Quality Monitoring Network, Northern & Central Delta-Mendota Region GSP

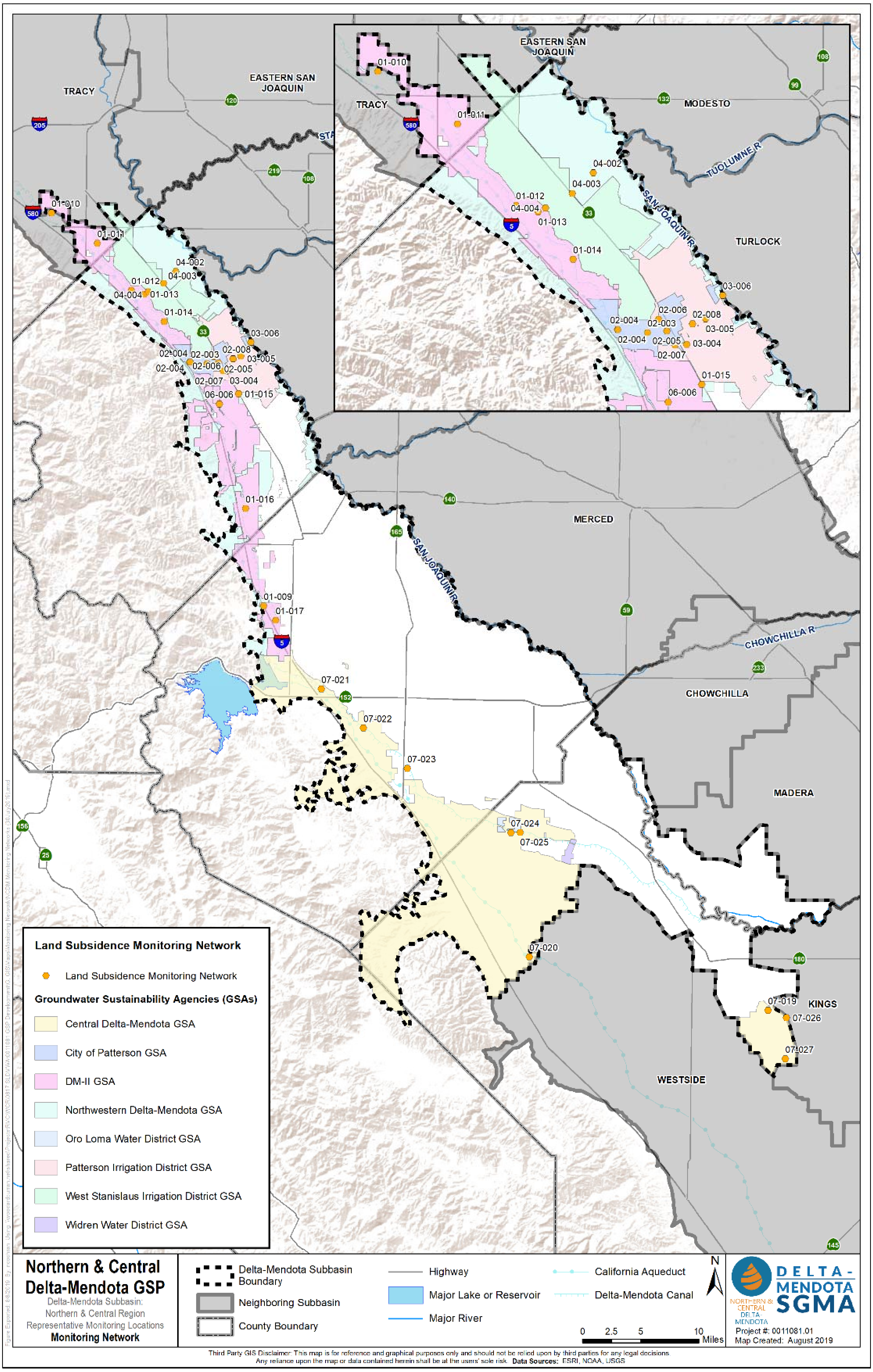

Figure 5: Land Subsidence Monitoring Network, Northern & Central Delta-Mendota Region GSP

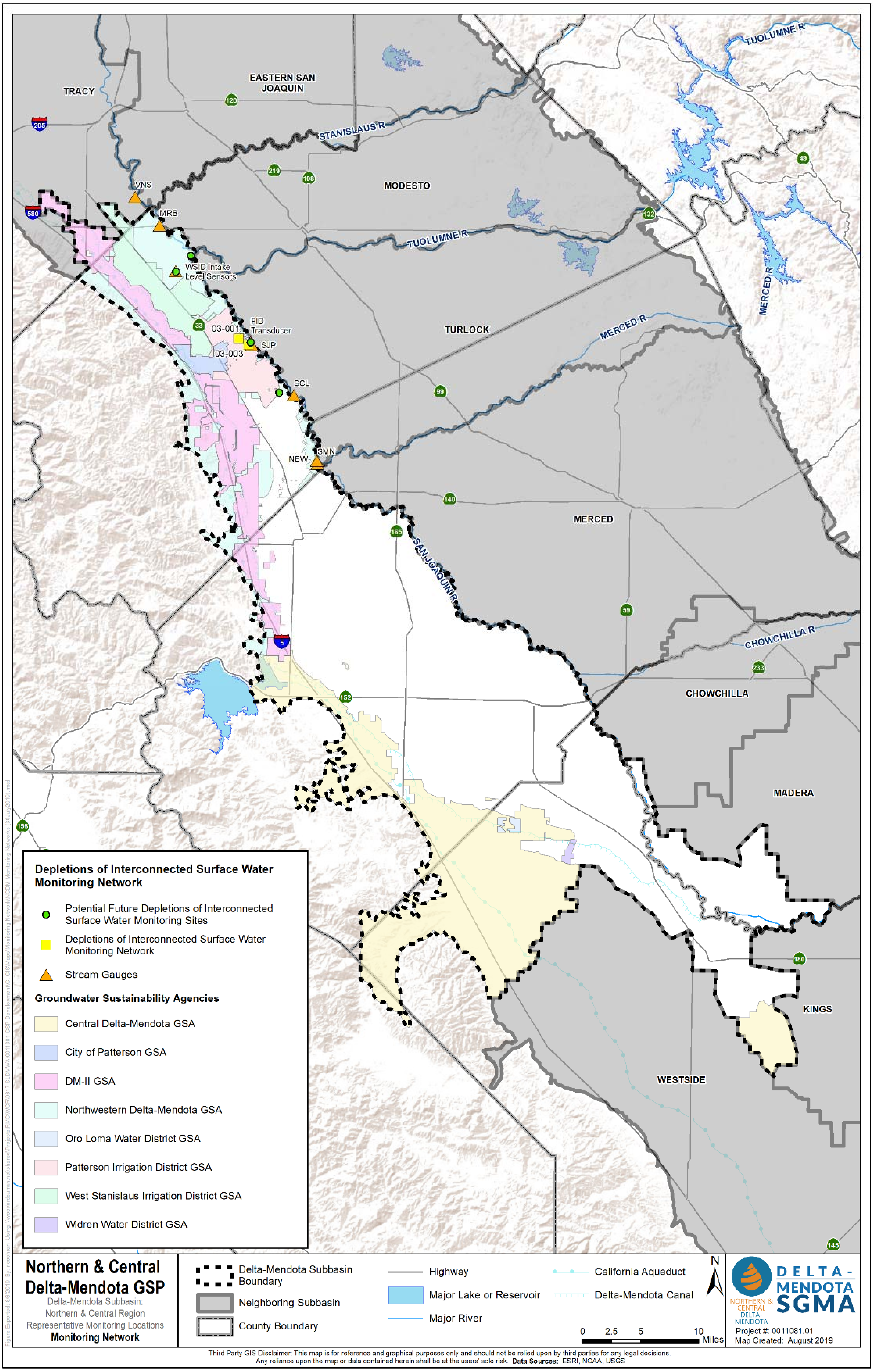

Figure 6: Interconnected Surface Water Monitoring Network, Northern & Central Delta-Mendota Region GSP

6. PROJECT QUALITY OBJECTIVES

6.1 Data Quality Indicators

The minimum requirements for Data Quality Indicators (DQIs) (precision, accuracy, comparability, completeness, representativeness, and sensitivity) are addressed herein. Project-specific measurement quality objectives (MQOs) are included in Section 13 *Quality Control* and are established to ensure that the Designated Monitoring Entities are meeting the minimum requirements as outlined in this QAPP.

7. SPECIAL TRAINING/CERTIFICATION

7.1 Specialized Training or Certifications

The GSA Lead for data collection is responsible for ensuring that all field crews receive proper training and certifications as required herein. The Contract Laboratory Project Manager is responsible for ensuring that all laboratory staff maintain current training in all relevant aspects of their role in the sample processing and data generation. Training records must be maintained and available upon request.

8. PROJECT DOCUMENTATION

Copies of this QAPP will be distributed to all personnel and/parties involved in the monitoring program as outlined in the distribution list. If the GSP Monitoring Protocol and associated QAPP requires the analysis of a constituent not already included in the QAPP, a method not already identified, or proposes different Data Quality Objectives (DQOs) that are less stringent than those listed, an amendment form must be submitted to the Program QA Officer for review once the GSP is approved. The GSP does not require an amendment to this QAPP.

This QAPP includes project-specific information for the following sections: 9. Sampling Process and Design, 10. Sampling Methods, 11. Sample Handling and Custody, 12. Analytical Methods, 13. Quality Control, 14. Instrument/Equipment Testing, Inspection and Maintenance, 15. Instrument/Equipment Calibration and Frequency, and 16. Inspection/Acceptance of Supplies and Consumables.

8.1 Field Sheets

The GSP Monitoring Protocol's field sheets are included in Figure 7, Figure 8 and Figure 9. At a minimum, field sheets (and associated field notes) must include the following:

- Project name
- Site name
- Site code
- Physical address of property on which the monitoring site is located
- State well number (if available and applicable)
- Sampling personnel
- GPS coordinates taken with each sampling event
- Sample type
- QC sample type
- Date and time of sample collection
- Results of field measurements
- Depth to standing water (static water level)
- Sampling conditions
- Constituents sampled
- Sample container
- Sample preservation
- Benchmark associated with subsidence monitoring site
- Measured subsidence monitoring site elevation

8.2 Chain of Custody

Chain of Custody (COC) forms will be used to document water quality sample collection, shipping, and handling. The GSP Monitoring Protocol's COC form is included in Figure 10. At a minimum COC forms must include the following:

- Collection agency name and contact information
- Receipt agency name and contact information
- Sample Identification
- Date and time of sample collection
- Analyses requested
- Sample container type
- Number of sample containers
- Preservation
- Relinquished by name(s)
- Relinquished by date(s)
- Relinquished by signature(s)
- Received by name(s)
- Received by date(s)
- Received by signature(s)

GROUNDWATER LEVEL DATA FORM
MANUAL MEASUREMENTS

WELL ID NUMBER	WELL NAME	STATE WELL NUMBER	COUNTY	B-118 BASIN OR SUBBASIN	MEASURING AGENCY	LAND SURFACE DATUM (LSD) ELEV.	RP TO LAND SURFACE DATUM (LSD), IN FT	REFERENCE POINT (RP) ELEV.

NO MEASUREMENT (NM)
0. Measurement discontinued
1. Pumping
2. Pump house locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well has been destroyed
7. Special
8. Casing leaky or wet
9. Temporarily inaccessible

QUESTIONABLE MEASUREMENT (QM)
0. Caved or deepened
1. Pumping
2. Nearby pump operating
3. Casing leaky or wet
4. Pumped recently
5. Air or pressure gauge measurement
6. Other
7. Recharge operation at or nearby well
8. Oil in casing

MEASUREMENT METHOD (MM)
0. Steel tape
1. Electric sounding tape
2. Other

DATE	TIME	N M	Q M	MM	TAPE at RP	TAPE at WS	RP to WS	LSD to WS	OBS	COMMENTS

[For explanation of terms, see figure 1.]

DWR Form 1213 (modified 6/28/2010) (data for Water Data Library)

Figure 7: Northern & Central Delta-Mendota Region GSP Monitoring Protocol – Groundwater Elevation Field Sheet

Northern & Central Delta-Mendota GSP Monitoring Protocol - Well Purge Field Sheet

Well ID ______________________ Date ______________ Arrival Time ________________

Field Staff ______________________________________ Time Since Well Last Pumped (hrs) __________

Notes: ____

____

____

____

____

Water Level Ref. Point ____

TOTAL WELL DEPTH (ft)		SWL (ft)	STICKUP (ft)	CASING DIAMETER (in)		PVC/Steel
STANDING WATER COLUMN (ft)	x	0.16 (for 2" casing); 0.37 (for 3" casing); 0.65 (for 4" casing); 1.0 (for 5" casing); 1.47 (for 6" casing); 2.61 (for 8" casing); 4.08 (for 10" casing); 5.88 (for 12" casing); 10.45 (for 16" casing); 16.32 (for 20" casing)		=	WET CASING VOL. Ve (gal)	3 Ve (gal)

Stability is achieved when pH varies by 1 SU or less, EC by 5% or less, and Turbidity is below 10 NTU

Clock Time	Pumping Time (min)	Flow Rate (gpm)	Cumulative Flow (gals)	Water Level (ft)	pH	EC (µs/cm)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	Observations (color, odor, etc.)

Average Flow Rate (Q in gals/min):		4-Hour Extrapolated Drawdown (s in ft):		Specific Yield (Sc = Q/s):		% Change Since Last Test (100 x (ScCurrent-ScLast)/ScLast):	

Note: Field measurements for turbidity, ORP and DO are optional.

Figure 8: Northern & Central Delta-Mendota Region GSP Monitoring Protocol - Well Purge Field Sheet

Northern & Central Delta-Mendota GSP Monitoring Protocol - Well Sampling Field Sheet

Well ID ____________ Site Name ____________ Site Address ____________

SWN ____________ Date ____________ Event Type (GQTM 1-yr) (GQTM 5-yr) Other ____________

Field Staff ____________ Latitude (Decimal Deg. NAD 83) ____________ Longitude (Decimal Deg. NAD 83) ____________

Current Weather Conditions (cloudy/sunny) (dry/raining) (hot/warm/cold) Site Photos Take (#) ____________ Tap Photos Take (#) ____________

Sample tap location if different from recommended sample tap (describe the tap and its location and why the recommended tap was not used).

____

Condition of Sample Tap ____________ Wellhead ____________ Well Sea/Pad ____________

Note of Any Adjacent Contaminant Sources ____________

Time Since Well Last Pumped (hours) ____________ Static Water Level ____________ Water Level Ref. Point ____________

Pump Start Time ____________ Approx. Flow (GPM) ____________ Field Purge Form: YES NO Sample Collection Time ____________

pH ____________ EC (µs/cm) ____________ Water Temp (°C) ____________ DO (mg/L) ____________ ORP (mV) ____________ Turbidity (NTU) ____________

Field Probe Make and Model ____________ Field Probe Last Calibration/Maintenance Date ____________

#	Sample ID	Size (mL)	Bottle Type (Amber glass, opaque plastic, or translucent plastic), Preservative	Analyte(s)	Sample Type (sample, blank, duplicate)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Comments: ____________

Note: Field measurements for turbidity, ORP and DO are optional.

Figure 9: Northern & Central Delta-Mendota Region GSP Monitoring Protocol – Well Sampling Field Sheet

Northern & Central Delta-Mendota GSP Monitoring Protocol	Well ID	Project #	P.O. #	Page 1 of

Collecting Agency or Company (receives data)		Other Agency to Receive Data		Chain-of-Custody Record and Analysis Request		
Contact		Contact		Analysis Request	TAT	Special Instructions
Phone	Email	Phone	Email		☐ 12 hr ☐ 24 hr ☐ 48hr ☐ 72 hr ☐ 1 wk	Email Preliminary Results to:
Address		Address				
Sampler Signature		EDF Deliverable To (Email Address)				

Sample Designation	Sampling: Date	Sampling: Time	Container Type							Preservative: HCl	Preservative: HNO_3	Preservative: Sulfuric Acid	Preservative: ICE		Matrix: Water	Matrix: Soil	Matrix: Air	Analysis Request											TAT	Notes:

Relinquished by: (Sign/Print)	Date	Time	Received by: (Sign/Print)
Relinquished by: (Sign/Print)	Date	Time	Received by: (Sign/Print)
Relinquished by: (Sign/Print)	Date	Time	Received by: (Sign/Print)

Remarks:

Bill to:

For Lab Use Only: Sample Receipt				
Temp °C	Initials	Coolant Present	Time	Therm. ID #
		Yes / No		

Figure 10: Northern & Central Delta-Mendota Region GSP Monitoring Protocol - Chain of Custody Form

DATA GENERATION AND ACQUISITION

9. SAMPLING DESIGN

9.1 Groundwater Level Monitoring

The GSA Lead responsible for data collection will measure the depth to groundwater in each well in the N-C DM Region GSP representative monitoring network twice per year - during seasonal high and seasonal low conditions. Seasonal high is defined as February through April and seasonal low is defined as September through October. These data will be used to establish groundwater elevation and change in storage trends, as well as to evaluate vertical gradients between principal aquifers. These data will be combined with publicly-available stream gauge data, including river discharge and river stage, to establish changes to interconnected surface waters. See Table 2 for more details on wells included in this monitoring network.

9.2 Groundwater Quality Monitoring

For purposes of characterizing ambient water quality in the principal aquifers of the Subbasin, groundwater samples will be collected separately from both the Upper Aquifer and Lower Aquifer of the groundwater system. Wells selected for monitoring will be sampled and tested in a State-certified analytical laboratory on an annual frequency (between May and August each year) for water quality parameters including nitrate as nitrogen (as N), electrical conductivity at 25 °C (EC), pH, Total Dissolved Solids (TDS), boron, and temperature. Electrical conductivity, pH, and temperature will be measured in the field whereas nitrate, TDS, and boron concentrations will be analyzed by a certified analytical laboratory.

All water samples must be sampled and preserved according to established protocols in correct containers. Each sample of well water must be sampled and analyzed at the expense of the GSA. See Table 2 for more details regarding wells included in this monitoring network.

9.3 Land Subsidence Monitoring

Inelastic land subsidence will be monitored at different frequencies based on the established management areas and remaining GSP area at designated representative monitoring locations as shown in Figure 5. Within the West Stanislaus Irrigation District-Patterson Irrigation District (WSID-PID) Management Area (MA), a baseline measurement (or elevation) will be taken as a reference within calendar year 2019. Two additional elevation surveys will be performed within the WSID-PID MA over the next five years, where the first will be performed by the end of calendar year 2020 (in preparation for the 2021 Annual Report) and the second will be performed by the end of calendar year 2023 (in preparation for the first 5-Year GSP Update due January 31, 2025). In the Tranquillity Irrigation District (TRID) MA, land surveys will be performed on an annual basis. Within the remaining N-C DM Region GSP area, land surveys will be performed every other year during even years. All surveys will be conducted by a California licensed land surveyor and will tie into established benchmarks. See Table 3 for more details regarding the subsidence monitoring network.

9.4 Interconnected Surface Water Monitoring

Groundwater levels will be used as proxy to monitor trends in interconnected surface water, where groundwater levels will be monitored at the frequency identified in Section 9.1 of this QAPP. Publicly-available stream gauge data will be collected to evaluate changes to identified interconnected streams. See Table 2 for more information regarding wells included in this representative monitoring network.

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Table 2: Well Information for Groundwater Level, Groundwater Quality, and Interconnected Surface Water Monitoring Networks

Data Management System (DMS) ID	State Well Number	CASGEM ID	Local ID	Status	Well Use	Agency	Program	Latitude	Longitude	County	Aquifer Designation	Depth (ft)	Screen Intervals (ft)	GSA/Agency
02-001	05S07E15N002M	374934N1211934W001	MP037.32L	Active	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	37.4934	-121.1934	Stanislaus	Upper	360	150-360	City of Patterson
06-004			MP031.31L1-L2Well1				DMC Pump-in Program	37.582983	-121.202425	Stanislaus	Upper		140-160; 200-240	Northwestern GSA, Unincorporated Stanislaus County
03-001 [1]		375015N1211011W001	MW-2	Active	Monitoring	Patterson ID	Patterson ID, CASGEM (Mandatory)	37.501461	-121.101125	Stanislaus	Upper	250	220 - 250	Patterson ID
03-002			MW-3		Monitoring	Patterson ID	Patterson ID	37.48156	-121.135034	Stanislaus	Upper	260	220 - 250	City of Patterson, belongs to Patterson ID
03-003 [1]	05S/08E-16R		WSJ003		Irrigation		Western San Joaquin GQTMP	37.494	-121.0862	Stanislaus	Upper	255	130 - 250	Patterson ID
06-002	06S08E09E003M	374316N1210994W003	P259#3	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	37.43139	-121.0994	Stanislaus	Upper	115	95 - 115	Northwestern GSA, Unincorporated Stanislaus County
01-004	07S08E28R002M	372907N1210875W002	MC10#2	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	37.2907	-121.0875	Stanislaus	Upper	135	115 - 135	Del Puerto WD
01-005	08S08E15G001M	372424N1210754W001	MP058.28L	Active	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	37.240656	-121.075193	Merced	Upper	170	120 - 150	Del Puerto WD
07-017			Well 1		Public Supply	Volta CSD	Volta Community Services District	37.092944	-120.925805	Merced	Upper		170-253	Volta CSD
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	37.0173	-120.8999	Merced	Upper	160	150 - 160	San Luis WD
07-004	11S10E04L001M		MP081.08R				DMC Pump-in Program	37.003859	-120.883295	Merced	Upper		140-200 ft (assumed)	San Luis WD
07-011		368835N1206270W001	MP099.24L	Inactive	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Voluntary)	36.8835	-120.627	Fresno	Upper	405	300-390	Mercy Springs WD
07-012	12S/12E-16B		GDA003		Irrigation		Grassland Drainage Area GQTMP	36.891	-120.6609	Fresno	Upper	410	270 - 390	Oro Loma WD
07-013			MP102.04R	Active	Irrigation	SLDMWA, Widren WD	DMC Pump-in Program	36.877419	-120.578801	Fresno	Upper	600	220-240; 280-340	Widren WD
07-009		366000N1202300W001	KRCDTID03	Active	Irrigation		CASGEM (Mandatory)	36.60276	-120.23201	Fresno	Upper	543	434-510	Tranquillity ID
07-010		366500N1202500W001	KRCDTID02	Active	Irrigation		CASGEM (Mandatory)	36.66167	-120.241	Fresno	Upper	540	295-535	Central Delta-Mendota Multi-Agency GSA, Unincorporated Fresno County
07-018	15S/16E-20		WSJ001		Domestic		Western San Joaquin GQTMP	36.6098	-120.262639	Fresno	Upper	205	165 - 205	Tranquillity ID
01-007			MP021.12L				DMC Pump-in Program	37.642858	-121.365121	San Joaquin	Lower		400-570 ft (assumed)	Del Puerto WD
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Inactive	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	37.550862	-121.260919	Stanislaus	Lower	475	230 - 475	Del Puerto WD
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Inactive	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	37.53138	-121.22431	Stanislaus	Lower	510	235 - 475	Del Puerto WD
06-003		375774N1212096W001	WSID 3	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	37.5774	-121.20957	Stanislaus	Lower	400	280 - 380	Northwestern GSA, Unincorporated Stanislaus County
02-002			WELL 02 - NORTH 5TH STREET		Public Supply	City of Patterson	City of Patterson	37.471196	-121.132831	Stanislaus	Lower	360	170-356	City of Patterson

Data Management System (DMS) ID	State Well Number	CASGEM ID	Local ID	Status	Well Use	Agency	Program	Latitude	Longitude	County	Aquifer Designation	Depth (ft)	Screen Intervals (ft)	GSA/Agency
06-001	06S08E09E001M	374316N1210994W001	P259-1	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	37.43139	-121.0994	Stanislaus	Lower	430	390 - 410	Northwestern GSA, Unincorporated Stanislaus County
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Inactive	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	37.406198	-121.121273	Stanislaus	Lower	721	218 - 242; 290 - 346; 353 - 358; 418 - 480; 490 - 538; 562 - 550; 600 - 595; 658 - 610	Del Puerto WD
04-001		376129N1212942W001	121	Active	Irrigation	SLDMWA	CASGEM (Mandatory)	37.6129	-121.2942	Stanislaus	Lower	600	400 - 570	West Stanislaus ID
01-008			MP051.66L				DMC Pump-in Program	37.332953	-121.085714	Stanislaus	Lower		290-470 ft (assumed)	Del Puerto WD
01-006		372604N1210611W001	91	Active	Irrigation	SLDMWA	CASGEM (Mandatory)	37.26042	-121.0611	Merced	Lower	260	120 - 210	Del Puerto WD
07-016			Well 01		Public Supply		Santa Nella County WD	37.100426	-121.007245	Merced	Lower		185-225	Santa Nella Co WD
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	37.0173	-120.8999	Merced	Lower	355	335 - 355	San Luis WD
07-005	12S11E03Q001M	369097N1207554W001	MP091.68R	Inactive	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	36.906261	-120.754538	Merced	Lower	615	425 - 455; 495 - 615	Pacheco WD
07-006	12S12E07E001M	369044N1207092W001	MP094.26L	Inactive	Irrigation	SLDMWA	DMC Pump-in Program, CASGEM (Mandatory)	36.904331	-120.709129	Fresno	Lower	840	440 - 600; 640 - 720	Eagle Field WD
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Active	Monitoring	SLDMWA	CASGEM (Mandatory)	36.8896	-120.6702	Fresno	Lower	550	530 - 550	Panoche WD
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Active	Irrigation	SLDMWA	CASGEM (Mandatory)	36.778586	-120.656111	Fresno	Lower	1,002	542 - 982	Panoche WD
07-014			TW-4		Nested Monitoring	Tranquillity ID	DWR Local Groundwater Assistance Grant	36.6757861	-120.267836	Fresno	Lower	690	650-690	Fresno Slough WD
07-015			TW-5		Monitoring	Tranquillity ID	DWR Local Groundwater Assistance Grant	36.643	-120.240372	Fresno	Lower	630	630-670	Tranquillity ID

[1] Bolding indicates that the well is also selected for the Interconnected Surface Water Monitoring Network

Table 3: Monitoring Site Information for Land Subsidence Monitoring Network

DMS ID	Local ID	Agency	Latitude	Longitude	County	Management Area
02-003	Floragold Well	City of Patterson	37.469845	-121.15038	Stanislaus	N/A
02-004	Subsidence Monitoring Point #6	City of Patterson	37.471722	-121.17744	Stanislaus	N/A
02-008	Well 11	City of Patterson	37.4765	-121.1099	Stanislaus	N/A
02-005	Well 2	City of Patterson	37.471196	-121.13283	Stanislaus	N/A
02-006	Well 4	City of Patterson	37.479451	-121.14055	Stanislaus	N/A
02-007	Well 6	City of Patterson	37.461222	-121.12526	Stanislaus	N/A
03-004	Locust Avenue Well	Patterson ID	37.461617	-121.11488	Stanislaus	WSID-PID
03-005	Pumping Plant No. 2	Patterson ID	37.480123	-121.09787	Stanislaus	WSID-PID
03-006	River Station	Patterson ID	37.497175	-121.08259	Stanislaus	WSID-PID
01-010	Subsidence Monitoring Point #1	SLDMWA	37.654889	-121.39772	Stanislaus	N/A
01-011	Subsidence Monitoring Point #2	SLDMWA	37.617972	-121.32504	Stanislaus	N/A
01-012	Subsidence Monitoring Point #3	SLDMWA	37.560037	-121.27075	Stanislaus	N/A
01-013	Subsidence Monitoring Point #4	SLDMWA	37.555484	-121.25076	Stanislaus	N/A
01-014	Subsidence Monitoring Point #5	SLDMWA	37.521817	-121.21845	Stanislaus	N/A
02-004	Subsidence Monitoring Point #6	SLDMWA	37.471694	-121.1774	Stanislaus	N/A
04-002	WSID 1	West Stanislaus ID	37.584133	-121.20136	Stanislaus	WSID-PID
04-003	WSID 11	West Stanislaus ID	37.569203	-121.21998	Stanislaus	WSID-PID
04-004	WSID 21	West Stanislaus ID	37.558389	-121.24414	Stanislaus	WSID-PID
01-015	Subsidence Monitoring Point #7	SLDMWA	37.43295	-121.10056	Stanislaus	N/A
06-006	Subsidence Monitoring Point #8	SLDMWA	37.420163	-121.13078	Stanislaus	N/A
01-016	Subsidence Monitoring Point #9	SLDMWA	37.290455	-121.0878	Stanislaus	N/A
01-017	Subsidence Monitoring Point #10	SLDMWA	37.151795	-121.03902	Merced	N/A
07-021	Subsidence Monitoring Point #11	SLDMWA	37.066733	-120.96664	Merced	N/A
01-009	P252	UNAVCO	37.1696	-121.0577	Merced	N/A
07-022	Subsidence Monitoring Point #12	SLDMWA	37.018728	-120.90058	Merced	N/A
07-023	Subsidence Monitoring Point #13	SLDMWA	36.968956	-120.83173	Merced	N/A
07-020	104.20-R	San Luis WD	36.735837	-120.639565	Fresno	N/A
07-024	Subsidence Monitoring Point #14	SLDMWA	36.889859	-120.66982	Fresno	N/A

DMS ID	Local ID	Agency	Latitude	Longitude	County	Management Area
07-025	Subsidence Monitoring Point #15	SLDMWA	36.890329	-120.6552	Fresno	N/A
07-019	AG-24	Tranquillity ID	36.670464	-120.26962	Fresno	TRID
07-026	TID A	Tranquillity ID	36.661582	-120.24111	Fresno	TRID
07-027	TID B	Tranquillity ID	36.610114	-120.24237	Fresno	TRID

10. SAMPLING METHODS

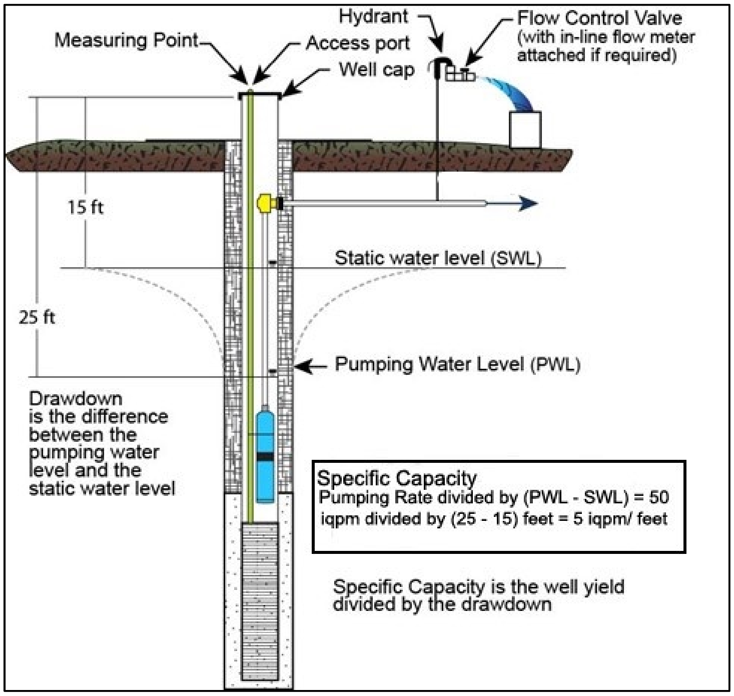
10.1 Groundwater Levels

The following procedures shall be used to measure the depth to water at each designated monitoring well.

10.1.1 Establishing Groundwater Level Monitoring Well Location(s)

Prior to collecting groundwater level data, several steps must be taken to prepare for the collection event, regardless of the method used to measure groundwater levels. These steps are performed once, prior to the first data collection event, and repeated only when changes in the well require revisiting the information. The steps are generally as follows:

1. Establish a data file for each monitoring well location – Identify any name or names of the well, along with any identifying numbers such as a State Well Number and/or County well permit number, and landowner agreements. Identify the well's location (longitude and latitude GPS coordinates) and representative monitoring point elevation (ground surface and/or measuring point elevation in feet above mean sea level), and include the method(s) used to determine this information (e.g. land survey).
2. Establish a data file providing details for each monitoring well – Collect any available records on well construction (e.g. State well construction report), local hydrogeology (e.g. boring logs prepared during well construction or well video reports), testing conducted on the well (such as slug or aquifer pumping test records), and any groundwater quality data from the well.
3. Perform a site visit to the well – Take photographs for documentation of the well and surrounding location. At a minimum, three photographs should be taken showing the access point used to measure depth to groundwater or groundwater elevation. It is recommended that at least two photographs be taken of the access point from the side and at least one photograph of the access point be taken from above. All photographs should show the top of casing with the measuring reference point (RP), and at least one photograph must show the totalizing flow meter (if applicable). Such photographs help confirm the well location for others in the future. Document the best way of accessing the well, including a map showing the proper ingress and egress routes (i.e., Do you need to unlock a gate to access the well? Are there other issues that may impeded your ability to monitor the well? Does the well have a dedicated sounding tube?). Observe the surrounding environment and make notes for the well file.
4. Prepare the site for monitoring – Identify how you will be accessing groundwater. Unlike dedicated monitoring wells which have accessible caps, wells used for domestic and agricultural water production have wellheads that can make access to the well casing difficult. Typical methods of accessing the casing to measure groundwater levels include access ports (holes) in the wellhead and sounding tubes. Lower the sounder or a weighted tape to ensure that you can reach the groundwater surface without getting wrapped around a pump column or any other subsurface obstacle. Identification and consistent use of the method of accessing groundwater will help ensure consistent measurements.
5. Establish a measuring point – Once you have established how to get the electric sounder or tape into the well, select a specific reference point for consistent measurements of the depth to groundwater (see below) if one does not currently exist and is documented in the well records (see #3, above). Make a permanent indication of the established measuring point on the well and document in files – a notch in the PVC casing, an etched arrow on a metal casing, etc. – so that you can recognize that point in the future.



Source: Agriculture and Agri-Food Canada as viewed at http://www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/water/wells-and-groundwater/water-wells/well-monitoring/?id=1371576110525

6. Survey your well – If adequate location or elevation information is not available, have a licensed professional land surveyor record the location and elevation of the well. For elevation, make sure to obtain the ground surface elevation in addition to the elevation of the established measuring point. The reference point elevation should be in feet above mean sea level relative to the North American Vertical Datum of 1988 (NAVD88).

10.1.2 Collecting Groundwater Level Data

The following steps are to be followed for collecting groundwater level data from designated monitoring locations.

Step 1: Groundwater level measurements will be conducted by experienced and trained personnel.

Step 2: Confirm well location by referring to maps within the well file and comparing the well site with a photograph, if available. If not available, take a picture of the well and submit to the GSA Lead responsible for data collection.

Step 3: Confirm well identify by checking the well ID number. If not labeled, inform the GSA Lead.

Step 4: Check the monitoring database for special notes and remarks on equipment required to gain access to the well and any notes or prior concerns.

Step 5: For accurate groundwater level measurements, confirm that the well is in static condition. Allowing 48 hours of non-operational recovery time for nearby pumping wells (within a 1-mile radius) and the well to be measured prior to groundwater level measurement is recommended.

Step 6: Open the well and allow time for adjustment to atmospheric pressure (only for sealed wells).

Step 7: Access the groundwater well. Remove any caps or covers on wellhead. If vault entry is required, exercise precautionary safety procedures associated with confined space entry.

Step 8: Refer to previous well groundwater level measurements or groundwater level measurements of nearby wells for an estimate of anticipated water depth. Make note of the screened interval depth.

Step 9: Identify the established measuring point, which typically corresponds to the top of the well casing.

Step 10: Take the water level measurements.

If a steel tape and chalk is used:

1. If the groundwater level was measured previously at the well, use the previous measurement(s) to estimate the length of tape that should be lowered into the well. Preferably, use measurements that were obtained during the same season of the year.
2. Chalk the lower few feet of the tape by pulling the tape across a piece of blue carpenter's chalk or sidewalk chalk (the wetted chalk mark identifies that part of the tape that was submerged). Slowly lower the tape into the well to avoid splashing when the bottom end of the tape reaches the water. Continue to lower the end of the tape into the well until the next graduation (a whole foot mark) is at the RP and record this number on Groundwater Level Data Form next to "Tape at RP". Rapidly bring the tape to the surface before the wetted chalk mark dries and becomes difficult to read.
3. Record the number to the nearest 0.1 foot in the column labeled as "Tape at WS" (0.01-foot accuracy is preferred). Subtract the "Tape at WS" number from the "Tape at RP" number and record the difference (to the nearest 0.1-foot) as "RP to WS". This reading is the depth to water below the RP.
4. Wipe and dry off the tape and re-chalk based on the first measurement.
5. Make a second measurement by repeating Steps 3 through 5, recording the time of the second measurement on the line below the first measurement. If the second measurement does not agree with the original measurement within 0.1 of a foot, make a third measurement, recording this measurement and time on the row below the second measurement with a new time.
6. Compare the measured depth to water with the well's screened interval to ensure that the measured water level is representative of the screened aquifer and is not standing water in the well's cellar (should one exist).

If an electronic sounder is used, calibrated indicators will also be required (in lieu of the tape and chalk) to ensure accuracy. The general procedure for collecting depth to water measurements is as follows:

1. Check the circuitry of the electric tape before lowering the probe into the well by dipping the probe into tap water and observing whether the indicator needle, light, and (or) beeper (collectively termed the "indicator" in this document) are functioning properly to indicate a closed circuit. If the tape has multiple indicators (sound and light, for instance), confirm that they are operating simultaneously. If they are not, determine the most accurate indicator. Check the last date of sounder calibration.
2. Make all readings using the same deflection point on the indicator scale, light intensity, or sound so that water levels will be consistent among measurements.
3. Before taking the measurement, ensure that the tape and electronic probe are clean and disinfected.
4. Lower the electrode probe slowly into the well until the indicator shows that the circuit is closed and contact with the water surface is made. Place the nail of the index finger on the insulated wire at the measuring point and read the depth to water.
5. Record the date and time of the measurement and the depth to water measurement(s).

6. Record the measuring point correction length in the field notebook (if one exists) and subtract it from the value recorded in Step 4 (above) to get the depth to water below or above the land surface datum (LSD). The measuring point correction is positive if the measuring point is above land surface and is negative if the measuring point is below land surface. Record the water level in the field notebook as the water level below the LSD. If the water level is above LSD (that is, the groundwater level in the well is above the ground surface), record the depth to water in feet above land surface as a negative number.
7. Pull the tape up and make a check measurement by repeating Steps 4 through 6. Record the subsequent check measurement in the field notebook while still at the well location. If the check measurement does not agree with the original measurement within 0.1 foot, continue to make measurements until the reason for lack of agreement is determined or the results are shown to be reliable. If more than two measurements are made, use best judgment to select the measurement most representative of field conditions.
8. After completing the water level measurements, disinfect and rinse that part of the tape that was submerged below the water surface to reduce the possibility of cross-contamination of other wells from the tape. Rinse the tape thoroughly with deionized or tap water to prevent tape damage. Dry the tape and rewind onto the tape reel.
9. Compare the measured depth to water with the well's screened interval to ensure that the measured water level is representative of the screened aquifer and is not standing water in the well's cellar (should one exist).

Step 11: For consistent documentation, record measurement results on a standardized field form. In addition to the depth to water measurement, the form should include information such as: well identification and location, date and time of measurement, and measurement qualifiers (i.e., static water status, well conditions, measurement method/device, etc.).

Step 12: If the groundwater level could not be measured due to pumping, contact the owner or agency and request a date and time the well will be static for at least 48 hours prior to returning for measurement.

Qualifiers should use standard DWR flags, as follows:

No Measurement Codes (NMC)

When it is not possible to measure the water level in a well, a code is entered in the NMC field to explain the reason for the missed measurement. The valid codes are shown in the following table. Sometimes an entry is made in the Remarks field supplement the no measurement code.

Code	Definition
0.	Discontinued
1.	Pumping
2.	Pumphouse locked
3.	Tape hung up
4.	Can't get tape in casing
5.	Unable to locate well
6.	Well destroyed
7.	Special
8.	Casing leaking or wet
9.	Temporarily inaccessible
D.	Dry well
F.	Flowing well

Questionable Measurement Codes (QMC)
When conditions at a well affect the quality of a measurement, a code is entered in the QMC field to explain the reason for the questionable measurement. The valid codes are shown in the following table. Sometimes an entry is made in the Remarks field to supplement the questionable measurement code.

Code	Definition
0.	Caved or deepened
1.	Pumping
2.	Nearby pump operating
3.	Casing leaking or wet
4.	Pumped recently
5.	Air or pressure gauge measurement
6.	Other
7.	Recharge operation at nearby well
8.	Oil in casing
9.	Acoustical sounder measurement (sonic)

10.2 Water Quality

Prior to sampling, the well will be purged following standards of practice for the industry which includes the option to forego purge under specific circumstances. In general, a minimum of three casing volumes of water should be purged from the well prior to sampling collection. Groundwater elevations in the well should be measured both before and after purging, and water levels should be allowed to recover prior to water quality sampling. Additionally, groundwater quality field parameters (temperature and EC) should be measured during purging and allowed to stabilize prior to groundwater sample collection.

Once groundwater elevations and quality parameters (temperature and EC) have stabilized, groundwater samples can be collected. Samples shall be collected directly from the discharge port of the tubing from the sampling pump, from a dedicated sampling port on the pump column, or via bailer if no pump is available. Whenever possible, dedicated sampling equipment should be used at each well. If not available, all sampling equipment should be cleaned and disinfected before use at the first well and between sampling at wells.

All field data will be recorded on the monitoring well sampling logs or in a field notebook. Samples will be collected in laboratory-supplied, pre-preserved containers (as applicable). Immediately upon collection, the containers will be sealed, labeled with an identification number, wrapped in bubble pack, and placed on ice in a cooler maintained at approximately 4°C pending shipment to the laboratory. Samples will be delivered to the laboratory the same day they are collected, if possible. If samples are to be held until the next day, they will be maintained at approximately 4º C in a controlled environment. Sample control will be maintained by a chain-of-custody (COC) form which accompanies the sample from the point of collection. The form documents the time, date and responsible person during each step of the transportation process.

All samples taken will be logged and identified with a naming system to include the year, month, and day collected, and a naming system specific to the sample location. The complete labeling of the containers will include the unique DMS number, date and time of collection, preservative used (if any) and sampler's name. The analytical laboratory will specify the sample volume, type of bottle, need for preservative, and special handling requirements.

10.3 Land Subsidence

The following procedures shall be used to measure ground surface elevation relative to established benchmarks for the purposes of monitoring changes in ground surface elevation or subsidence over time. These procedures have been established by the United States Department of Agriculture, National Resources Conservation Service and documented in their *Engineering Field Handbook* (October 2009).

Vertical surveys will be performed where the only requirement for the vertical component of the survey is that it must begin with a known elevation or benchmark. For surveys that are required to tie into an established vertical control, a known benchmark is located. A benchmark is a point of known or assumed permanent elevation. Such points may be marked with a brass pin or a cap set in concrete, cross or square mark cut on concrete, lone metal stake driven into the ground, specifically located point on a concrete bridge, culvert, or foundation, or similar objects that are not likely to be disturbed. Federal, State, and municipal agencies and private and public utility companies have established benchmarks. Such benchmarks should be used when convenient. Contact the appropriate entity to obtain maps and coordinate positions for benchmarks throughout the area.

10.3.1 Methods for Performing Vertical Survey

Elevation differences between any two or more points can be read directly with several different instruments or calculated from the measured vertical angle between any two points with several other instruments. Those that read elevation differences directly include hand levels, engineer's levels, and laser levels. Direct reading level instruments also make use of some type of measurement rod to take readings from.

Hand Levels

Hand levels are used for rough measurements of differences in elevation. The user stands erect and sights through the eyepiece, holding the tube in the hand, and moving the objective end up and down until the image of the spirit level bubble on the mirror is centered on the fixed cross wire. The point where the line of sight in the position strikes the rod or other object is then noted. The vertical distance from the ground to the surveyor's eye determines the height of instrument and other ground elevations. A rough line of levels may be carried with the land level for a distance of 400 to 500 feet provided the length of each sight is not over about 50 feet. These instruments used along with a level rod provide rough elevation differences between points.

Engineer's Level

The dumpy level was once the principal level in use because of its sturdiness, convenience, and stability of adjustment. These instruments are used along with a level rod provide very accurate elevation differences between points. For the most part, it has since been replaced by the self-leveling level.

The self-leveling level, which has no tubular spirit level, automatically levels its line of sight with great accuracy. Self-leveling levels are used with a level rod to provide accurate elevation differences between points. It levels itself by means of a compensator after the circular spirit level is centered approximately. Precise, simple, and quick, it can be used for any level survey.

Level Rods and Accessories

The Philadelphia level rod is a two-section rode equipped with clam screws. Its length is approximately 7 feet, extending to 13 feet. It may be equipped with a round or oval target that may be plain or include a Vernier scale.

The Frisco or California level rod is a three-section rod equipped with clamp screws. It is about 4 feet 6½ inches long, extending to 12 feet. This rod is not equipped for use with a target. These are rarely used anymore.

The Chicago or Detroit level rod is a three- or four-section rod with metal friction joints. Each section is about 4½ feet long, extending from 12½ to 16½ feet. It is generally equipped for use with a target. These are rarely used anymore.

Fiberglass telescoping level rods are usually round or oval, 16 or 25 feet in length, and in sections that will telescope down to a 5-foot barrel for transporting. It is equipped for use with a target or prism.

The stadia rod is a two-, three-, or four-piece rod, 12 to 16 feet long, joined together with hinges and with a suitable locking devise to ensure stability. It has metal shoes on both ends. The face is about 3½ inches wide. Designed primarily for use in making topographic surveys, it is not equipped for use with a target. These are rarely used anymore.

The range pole is a one-, two-, or three-piece role generally used to establish a "line of sight." A standard metric range pole is 2.5 meters long and graduated in 0.5-meter segments painted red and white. The English range pole is from 6 to 10 feet long and is graduated in 1-foot segments.

Laser Levels

A laser level consists of a transmitter and receiver. Most transmitters are self-leveling units that emit a plane of light usable up to 1,000 feet in any direction. On some models, the plane of light may be adjusted from level to a grade usually up to 10 percent.

For measuring field elevations, a small laser receiver is mounted on a direct-reading survey rod. The user moves the receiver up or down the rod until a light or audible tone indicates the receiver is centered in the plane of laser light. The rod reading is then taken directly from the rod which allows the survey to be performed by one person.

10.3.2 Basic Surveying Measurements

The following steps will be taken to perform a vertical survey tied to an established benchmark:

Step 1: All surveys will be conducted by a California licensed land surveyor and will tie into established benchmarks.

Step 2: Confirm monitoring location by referring to maps and comparing the site with a photograph, if available. If not available, take a picture of the monitoring site and submit to the GSA Lead for data collection.

Step 3: Confirm monitoring location identify by checking the ID number. If not labeled, inform the GSA Lead.

Step 4: Check the monitoring database for special notes and remarks on equipment required to gain access to the monitoring site and any notes or prior concerns.

Step 5: Prior to taking the first measurement at a given monitoring location, determine the established benchmark the monitoring site will be tied to and obtain information from the appropriate entity prior to field work.

Step 6: Before attempting to set up the level, ensure that the tripod wing nuts have been tightened so that when held horizontally, each leg will barely fall under its own weight.

1. Holding two tripod legs, one in each hand, place the third leg on the ground. Using the third leg as a pivot, move the held legs until the footplate is nearly horizontal.
2. Lower the two legs to the ground without altering the horizontal position of the footplate.
3. Apply pressure to the legs to ensure a stable setup. Ensure that the tripod legs are spread at such an angle that the tripod is stable and that objects may be viewed through the telescope from a convenient posture.

For a level with four leveling screws:

4. For a level with four leveling screws, line up the telescope over one pair of leveling screws and center the bubble proximately. The process should be repeated with the telescope over the other pair. Continue this procedure until the bubble remains centered, or nearly so, for any position of the telescope. Final centering of the bubble is usually easier if only one screw is turned rather than trying to adjust two opposite screws at the same time. The leveling screws should be tightened only enough to secure a firm bearing.

For self-leveling levels with three leveling screws:

5. Turn the telescope until it is parallel with two of the screws and bring the bubble to the center using both the screws.
6. Then with the third screw, bring the bubble to the center of the circle. When you rotate the telescope, the bubble should remain centered in any position. If it does not, the bubble needs adjustment.
7. Before attempting to take sights, focus the crosshairs with the eyepiece. Point the telescope at some light surface such as a white building or the sky and turn the eyepiece slowly in or out until the most distinct appearance of the crosshairs is obtained. Focus the telescope (by means of the focusing screw) on a level rod, held at some point about 30 meters (100 ft) from the instrument. Then, move your eye slowly up and down to observe if the crosshair apparently moves over the face of the rod. If the crosshair does not appear to move, it is properly focused. If you detect movement, further adjustment is necessary. Once the eyepiece has been adjusted, no further adjustments are necessary so long as the same individual uses the instrument.

Step 7: After focusing on the rod, center the bubble exactly in the level vial before taking the rod reading. Be sure that the reading is taken with the rod in a vertical position and that no foreign material prevents clear contact between the rod and the point to be read. On benchmarks and for more precision, some surveyors ask the person holding the rod to move the rod back and forth over the center, using its base as a pivot. A rod level could also be used for this purpose. The minimum reading thus observed is the true vertical reading.

Step 8: Be sure not to lean on the instrument or step close to the tripod legs, because this may throw the instrument off level. It is good practice to check the bubble regularly to make sure no inadvertent movement has occurred. If this is the case, the entire circuit should be repeated. Adjustments to the level should never be made part way through a circuit.

Step 9: Take measurement with leveling instrument and record the following information in field notes:

1. Location of survey (written description and GPS coordinates)
2. Date and time of survey
3. Name(s) of surveyor(s) and company/organization
4. Instruments used, including serial numbers or other identifying numbers
5. Established benchmark tied to monitoring site
6. Monitoring site ID
7. Measured benchmark elevation (to 0.1-foot accuracy)
8. Measured elevation at monitoring site relative to established benchmark (to 0.1-foot accuracy)
9. Description of any modifications to the monitoring site, if necessary
10. Additional notes or comments

Step 10: All vertical elevation measurements will be collected relative to NAVD88.

10.4 Interconnected Surface Water

Groundwater levels will be used as a proxy for interconnected surface water monitoring. Coupled with publicly-available stream gauge data, groundwater levels and river discharge/river stage data will be evaluated to determine potential changes to identified interconnected streams. Refer to Section 10.1 of this QAPP regarding groundwater level sampling methods.

11. GROUNDWATER QUALITY SAMPLE HANDLING AND CUSTODY

All sample containers should be clearly labeled with DMS ID, sample ID, collection date and time, collector's name, and requested analyses. Custody of all samples is documented and traceable from collection time to submittal for analysis on a COC form. Chain of custody forms must be with samples during transport to the laboratory.

Samples are considered in custody if:

- They are in actual possession;
- They are in view after being in physical possession;
- They are placed in a secure area (accessible by or under the scrutiny of authorized personnel only after in possession).

All samples and accompanying COCs are signed by the sampler in charge and submitted to analyzing laboratories by the samplers, by private overnight courier, or by overnight common parcel service. Once the laboratory has received the samples and COCs, they are responsible for maintaining custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times. Sample size should be of sufficient quantity to permit more than one analyses in case samples need to be re-analyzed. The contract laboratories may recommend sample quantities as well as types of containers for sample collection; most laboratories offer containers for use in sample collection. All samples will meet the requirements for sampling containers, holding time, and sample custody outlined in Table 4 below. Holding times refer to the maximum time limit within which a laboratory must analyze a sample for the constituent listed.

12. ANALYTICAL METHODS

The Project QA Officer should be in communication with the Laboratory Project Manager to resolve analytical issues should they arise. It is the responsibility of the Project QA Officer to determine the most appropriate course of action to resolve any problems and/or accept data. All corrective actions should be reported in the annual reports.

Table 4: Sample Handling and Analytical Information

Constituent	Analytical Method	Matrix	Fraction	Sample Volume	Sample Container	Preparation	Preservative	Maximum Hold Time	Method Detection Limit	Reporting Limit (RL)	Reporting Unit
Dissolved Oxygen (DO)	SM4500-OG-2001	Groundwater	Unfiltered	NA	NA	None	None	NA	NA	0.01	mg/L
Electrical Conductivity (EC) at 25 °C	SM2510-B1997	Groundwater	Unfiltered	NA	NA	None	None	NA	NA	2.5	µS/cm
pH	SM4500-H+B-2000	Groundwater	Unfiltered	NA	NA	None	None	15 minutes	NA	0.1	pH units
Temperature	SM2550-B2000	Groundwater	Unfiltered	NA	NA	None	None	NA	NA	0.1	°C
Depth to standing water (static water level)	NA	Groundwater	Unfiltered	NA	NA	None	None	NA	NA	NA	ft
Oxidation-reduction potential (ORP)	NA	Groundwater	Unfiltered	NA	NA	None	None	NA	NA	NA	mV
Turbidity	EPA180.1	Groundwater	Unfiltered	NA	NA	None	None	NA	NA	1	NTU
Nitrate as N	EPA 300.0	Groundwater	NA	Lab Provide Bottle	Polyethylene	Lab Provided, Sealed, New	None	48 hours	0.004	0.05	mg/L
Carbonate	SM2330B	Groundwater	NA	Lab Provide Bottle	Polyethylene	Lab Provided, Sealed, New	None	14 days	2	2	mg/L
Chloride	EPA 300.0	Groundwater	NA	Lab Provide Bottle	Polyethylene	Lab Provided, Sealed, New	None	28 days	0.025	0.5	mg/L
Bicarbonate	SM2330B	Groundwater	NA	Lab Provide Bottle	Polyethylene	Lab Provided, Sealed, New	None	14 days	2	2	mg/L
Sulfate (SO4)	EPA 300.0	Groundwater	NA	Lab Provide Bottle	Polyethylene	Lab Provided, Sealed, New	None	28 days	0.06	0.5	mg/L
Boron	EPA 200.7	Groundwater	NA	Lab Provide Bottle	Polyethylene	Manufacturer Acidified	HNO3	6 months	0.008	0.05	mg/L
Calcium	EPA 200.7	Groundwater	NA	Lab Provide Bottle	Polyethylene	Manufacturer Acidified	HNO3	6 months	0.118	1	mg/L
Magnesium	EPA 200.7	Groundwater	NA	Lab Provide Bottle	Polyethylene	Manufacturer Acidified	HNO3	6 months	0.003	0.1	mg/L
Potassium	EPA 200.7	Groundwater	NA	Lab Provide Bottle	Polyethylene	Manufacturer Acidified	HNO3	6 months	0.13	1	mg/L
Sodium	EPA 200.7	Groundwater	NA	Lab Provide Bottle	Polyethylene	Manufacturer Acidified	HNO3	6 months	0.113	1	mg/L
Total Dissolved Solids (TDS)	SM2540C	Groundwater	NA	Lab Provide Bottle	Polyethylene	Lab Provided, Sealed, New	None	7 days	4.224	10	mg/L

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13. QUALITY CONTROL

13.1 Field Quality Control

Field quality control (QC) results must adhere to the limits of error and frequency requirements detailed in Table 5. Field QC frequencies are calculated to ensure that a minimum of 5% of all analyses are for QC purposes (both field duplicate and field blanks).

Table 5: Field Sampling QC

Sample Type	Frequency	Acceptable Limits	Corrective Action
Field Duplicate	5% annual total	Relative percent difference (RPD) ≤ 25%	Determine cause, take appropriate corrective action.
Field Blank	5% annual total	Detectable substance contamination <Reporting limit (RL) or < sample/5	Determine cause of problem, remove sources of contamination.

13.2 Analytical Quality Control

Analytical QC results must adhere to the minimum limits of error and frequency requirements detailed in

Table 6. All analytical QCs must be analyzed at a frequency of 1 every 20 samples, minimum of 1 per batch.

Precision will be assessed through a combination of field duplicate samples and laboratory duplicate samples. Precision of a pair of samples is measured as the relative percent difference (RPD) between a sample and its duplicate – a laboratory control sample (LCS) and its duplicate (LCSD), a matrix spike (MS) and matrix spike duplicate (MSD), an environmental sample (E) and field duplicate (FD), or an environmental sample and its associated lab duplicate. RPD is calculated as follows:

$$RPD\ (\%) = \left(\frac{2(V_{\mathrm{i}} - V_{\mathrm{D}})}{V_{\mathrm{i}} + V_{\mathrm{D}}}\right)100$$

V_i = the measured concentration of the initial sample

V_D = the measured concentration of the sample duplicate

Accuracy is assessed using either an LCS or MS. For an LCS, lab water is spiked with a known concentration of a target analyte and the percent recovery (PR) is reported. PR in an LCS is calculated as follows:

$$\%\ Recovery = \left(\frac{V_{\mathrm{LCS}}}{V_{\mathrm{Spike}}}\right)100$$

V_{LCS} = the measured concentration of the spiked control sample

V_{Spike} = the expected concentration

A MS can also be used to assess accuracy. For a MS, environmental water is spiked with a known concentration of a target analyte and the PR is reported. PR in a MS is calculated as follows:

$$\% \, Recovery = \left(\frac{V_{\mathrm{MS}} - V_{\mathrm{E}}}{V_{\mathrm{Spike}}}\right) 100$$

V_{MS} = the measured concentration of the spiked matrix sample

V_{Spike} = the concentration of the spike added

V_E = the concentration of the original (unspiked) matrix sample

The MS should not be used solely to assess accuracy due to the likelihood of matrix interference; however, if an LCS does not fall within acceptance criteria an MS may be used to validate a batch if the MS is within acceptance criteria. Some constituents are difficult to spike (e.g., Total Dissolved Solids); therefore, a laboratory may choose to analyze a certified reference material (CRM). A CRM analysis may be used in place of an LCS analysis.

Table 6: Analytical Measurement Quality Objectives

Sample Type	Frequency	Acceptable Limits	Corrective Action
Nutrients			
Lab Blanks (method, reagent, instrument)	1 per 20 samples, minimum 1 per batch	Detectable substance contamination <RL	Determine cause of problem, remove sources of contamination, reanalyze suspect samples or flag all suspect data.
Lab Duplicate*	1 per 20 samples, minimum 1 per batch	RPD < 25%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Matrix Spike	1 per 20 samples, minimum 1 per batch	80-120%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Lab Control Spike	1 per 20 samples, minimum 1 per batch	90-110%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.

Sample Type	Frequency	Acceptable Limits	Corrective Action
Anions			
Lab Blanks (method, reagent, instrument)	1 per 20 samples, minimum 1 per batch	Detectable substance contamination <RL	Determine cause of problem, remove sources of contamination, reanalyze suspect samples or flag all suspect data.
Lab Duplicate*	1 per 20 samples, minimum 1 per batch	RPD < 25%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Lab Control Spike, CRM, or SRM	1 per 20 samples, minimum 1 per batch	75-125%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Cations			
Lab Blanks (method, reagent, instrument)	1 per 20 samples, minimum 1 per batch	Detectable substance contamination <RL	Determine cause of problem, remove sources of contamination, reanalyze suspect samples or flag all suspect data.
Lab Duplicate*	1 per 20 samples, minimum 1 per batch	RPD < 25%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Matrix Spike*	1 per 20 samples, minimum 1 per batch	75-125%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Lab Control Spike, CRM, or SRM	1 per 20 samples, minimum 1 per batch	75-125%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.

Sample Type	Frequency	Acceptable Limits	Corrective Action
Total Dissolved Solids			
Lab Blanks (method, reagent, instrument)	1 per 20 samples, minimum 1 per batch	Detectable substance contamination <RL	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Lab Duplicate*	1 per 20 samples, minimum 1 per batch	RPD < 25%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.
Lab Control Spike, CRM, or SRM	1 per 20 samples, minimum 1 per batch	80-120%	Determine cause, take appropriate corrective action. Recalibrate and reanalyze all suspect samples or flag all suspect data.

*For the purposes of this project it is acceptable for the matrix spike duplicate or the laboratory control duplicate to stand in for the lab duplicate as a measure of the precision of the analytical method.

13.3 Field and Laboratory Corrective Actions

Batches should be reanalyzed if a single QC sample did not meet an MQO due to an identifiable laboratory error and/or MQOs are not met for more than 50% of analytes analyzed in a QC sample. When batches are reanalyzed, the laboratory should provide both results to the third party. If DQOs fail, but neither of the above scenarios is applicable, the laboratory should follow the corrective actions prescribed in Table 5 and Table 6. Overall, all data failing to meet MQOs should be flagged and reanalysis may occur to confirm improvements in accuracy, precision, or contamination measures. The laboratory, GSA Lead for data collection and the Project QA Officer may further discuss additional corrective actions on a case by case basis.

Field crews and contract laboratories are responsible for responding to failures in their measurement systems. If sampling or analytical equipment fails, personnel must record the problem according to their documentation protocols.

14. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

14.1 Field Equipment

All field equipment must be inspected and repaired as necessary prior to each sampling event. Routine maintenance and repair of field equipment should follow manufacturer instructions and guidelines. Records of field equipment maintenance and repairs should be maintained for each instrument. These records will be available to Program Managers upon request.

14.2 Laboratory Equipment

Routine laboratory instrument testing, inspection, and maintenance should be carried out by a qualified technician. Laboratories are responsible for testing, inspecting, and maintaining all laboratory equipment according to manufacturer specifications. Frequency and procedures for maintenance of analytical equipment used by each laboratory are documented in the Quality Assurance Manual for each laboratory, which will be available to Program Managers from any contract laboratory on request.

15. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Field calibration procedures will follow manufacturer specifications for the equipment used and are outlined within the SOP titled Operators Manual for YSI 556 MPS, Operators Manual for Oakton T-100. Records of field equipment calibration should be maintained for each instrument. These records will be available to the Designated Monitoring Entities upon request. Calibration of laboratory instruments will be documented in the Quality Assurance Manual for each laboratory which will be available to the Designated Monitoring Entities upon request. See Table 7 and Table 8 for more detail.

Table 7: Instrument/Equipment Testing, Inspection, and Maintenance

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Frequency	Responsible Person
Probe (DO, pH, EC, Temp) YSI 556 MPS	Refer to operator's manual	Refer to operator's manual	Field Lead
Probe (Turbidity) Oakton T-100	Refer to operator's manual	Refer to operator's manual	Field Lead
ICP (EPA200.7)	Refer to SOP for EPA200.7	Refer to SOP for EPA200.7	Lab QA Officer
IC (EPA300.0)	Refer to SOP for EPA300.0	Refer to SOP for EPA300.0	Lab QA Officer
Probe (SM2330B)	Refer to SOP for SM2330B	Refer to SOP for SM2330B	Lab QA Officer
Furnace (SM2540C)	Refer to SOP for SM2540C	Refer to SOP for SM2540C	Lab QA Officer
Balance (SM2540C)	Refer to SOP for SM2540C	Refer to SOP for SM2540C	Lab QA Officer

Table 8: Instrument/Equipment Calibration and Frequency

Equipment / Instrument	Calibration Description and Criteria	Frequency of Calibration	Responsible Person
Probe (DO, pH, EC, Temp) YSI 556 MPS	Refer to operator's manual	Refer to operator's manual	Field Lead
Probe (Turbidity) Oakton T-100	Refer to operator's manual	Refer to operator's manual	Field Lead
ICP (EPA200.7)	Refer to SOP for EPA200.7	Refer to SOP for EPA200.7	Lab QA Officer
IC (EPA300.0)	Refer to SOP for EPA300.0	Refer to SOP for EPA300.0	Lab QA Officer
Probe (SM2330B)	Refer to SOP for SM2330B	Refer to SOP for SM2330B	Lab QA Officer
Furnace (SM2540C)	Refer to SOP for SM2540C	Refer to SOP for SM2540C	Lab QA Officer
Balance (SM2540C)	Refer to SOP for SM2540C	Refer to SOP for SM2540C	Lab QA Officer

16. NON-DIRECT MEASUREMENTS (EXISTING DATA)

Public supply wells may be included in some of the N-C DM Region GSP monitoring networks. Procedures described herein apply to these wells. Continued monitoring of these wells will also be performed by the water supply system operators in accordance with Division of Drinking Water (DDW) requirements. While the annual sampling of the N-C DM Region GSP monitoring network wells conducted by the GSA Leads will include collection of field parameters, monitoring of additional wells by other monitoring entities may not include testing of all the identified field parameters. Groundwater quality testing in additional wells monitored by others may not align exactly with the frequency of testing for all water quality parameters specified in the N-C DM Region GSP, although coordination efforts with cooperating monitoring entities will focus on establishing a testing program that is consistent and compatible with the monitoring objectives for all Delta-Mendota Subbasin GSPs. Data collected by other entities will undergo a general review to identify erroneous data. All preexisting data will be assembled within the established data management system (DMS) to facilitate organization, analysis, and display of the acquired data. Well construction information will also be obtained and stored within the database. Data collected by outside entities will be associated with their individual GSA area and clearly identified in any reports or analysis.

17. DATA MANAGEMENT

The N-C DM Region will use a coordinated data management system that will be centrally maintained for the purpose of implementing the N-C DM Region GSP. A coordinated DMS will be used to facilitate analyses and reporting of regional land surface, groundwater elevation and quality data across the GSP Plan area and submittal of required annual reports. The DMS is described in Chapter 8 *Plan Implementation* of the N-C DM Region GSP.

ASSESSMENT AND OVERSIGHT

18. ASSESSMENTS & RESPONSE ACTIONS

All reviews of QA data will be made by the Project QA Officer, including an assessment of precision, accuracy, and completeness. Reviews may include the Program QA Officer, if necessary. Contract laboratories are responsible for self-assessment and oversight of finalized data submitted in laboratory reports and GeoTracker files, although data are audited for compliance as part of the N-C DM Region GSP Monitoring Protocol's QA/QC program. The Project QA Officer is responsible for ensuring that all data that do not meet the established MQOs are flagged.

If a discrepancy is discovered during the review, the Project QA office will discuss the discrepancy with the personnel responsible for the activity. The discussion will include the accuracy of the information, potentials cause(s) leading to the deviation, how the deviation might impact data quality, and the corrective actions that might be considered. If discrepancies are observed, the details of the discrepancy and any corrective action will be reported in the final monitoring report. The Project QA Officer will be responsible for addressing all corrective actions.

19. REPORTS TO MANAGEMENT

Personnel involved in project tasks may encounter unforeseen issues/concerns at any time. It is important that staff report issues/concerns to managers when they are identified. Managers are responsible for project resolutions. If the resolution requires changes to approved documents, the N-C DM Region GSP Monitoring Field Lead will be contacted and the appropriate actions will be taken to have changes approved.

DATA VALIDATION AND USABILITY

20. DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

The Project QA Officer will review data collected as part of the N-C DM Region GSP Monitoring Protocol according to industry-standard DQOs and QA/QC practices. The decision to accept or reject the data will be based on an assessment of the impact of the data quality failure. Data collected by other monitoring agencies will go through a more general review as stated within Sections 16 and 0.

21. VERIFICATION AND VALIDATION METHODS

The Project QA Officer or a delegate of the QA Officer will do all reviews of 100% of the reports. Each contract laboratory's QA Officer will perform checks of all of its records at a frequency that the lab determines sufficient. General methods for conducting data validation and usability is shown below.

21.1 Data Review, Validation and Verification

Data sheets will be reviewed after each sampling event to determine if the data meet the QAPP objectives and to identify outliers, spurious results or omissions. Compliance with the data quality objectives will also be evaluated. Corrective actions will be suggested for implementation in subsequent monitoring trainings and data collection events. Problems with the data quality and corrective action will be reported in final reports.

21.2 Validation and Verification Methods

As part of the standard field protocols, any sample readings out of the expected range will be reported to the Project QA Officer and GSA Lead. A second sample will be taken as soon as possible to verify the condition. If data are invalid, then data will be noted and flagged on the data sheet. Further actions will be taken to trace the sources of error and to correct those problems.

21.3 Reconciliation with DQOs

If data quality indicators are not found to meet program specifications, data will not be entered into the data archiving system and will not be used in summarized annual reports. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration and maintenance procedures will be reassessed and improved. If the problem is found to be monitor error, the monitor will be retrained. If accuracy and precision goals are frequently not being met, a QC verification session will be scheduled for all monitors collecting data. If failure to meet program specifications is found to be unrelated to equipment, methods, or monitor error, specifications may be revised.

22. RECONCILIATION WITH USER REQUIREMENTS

Procedures to review, verify, and validate project data are described in the prior section. The Program Quality Objectives section describes the role of the DQO process and identifies the program's objectives. Reconciliation with the DQOs involves reviewing the data to determine whether the DQOs have been attained and that the data are adequate for their intended use. At the project level, reconciliation occurs during the data quality assessment.

Limitations in data use will be reported to the N-C DM Region GSP Monitoring Field Lead for discussion in the GSP Annual Reports and 5-Year GSP Updates.

23. REFERENCES

Luhdorff & Scalmanini Consulting Engineers (LSCE). 2018. *Quality Assurance Project Plan for Groundwater Monitoring By The Westside San Joaquin River Watershed Coalition In Compliance With The Central Valley Groundwater Monitoring Collaborative QAPrP*.

United States Department of Agriculture (USDA), National Resource Conservation Service (NRCS). October 2009. Part 650 Engineering Field Handbook, Chapter 1 Surveying. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=25276.wba. Accessed on July 25, 2019.

WOODARD
&CURRAN

woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS

Prepared by:

WOODARD & CURRAN

In association with:

PROVOST & PRITCHARD CONSULTING GROUP

1545 River Park Dr., Suite 425
Sacramento, CA 95815
916.999.8700