



**2017 Annual Performance Report:
Model Criteria for Groundwater Monitoring in Areas of
Oil and Gas Well Stimulation**

Reporting Period: January 1, 2017 through December 31, 2017

STATE WATER RESOURCES CONTROL BOARD

March 27, 2018

Intentionally Left Blank

TABLE OF CONTENTS

GLOSSARY	III
ABBREVIATIONS AND ACRONYMS	V
EXECUTIVE SUMMARY	1
1.0 INTRODUCTION	5
1.1 BACKGROUND.....	5
2.0 AREA-SPECIFIC GROUNDWATER MONITORING	6
2.1 REQUESTS FOR GROUNDWATER MONITORING.....	7
2.1.1 <i>Summary of Groundwater Monitoring Plans Submitted for Review</i>	7
2.1.2 <i>Process and Timeline for Reviewing Groundwater Monitoring Plans</i>	11
2.2 GROUNDWATER MONITORING PLANS SUBMITTED THAT PROPOSE ALTERNATIVE METHODS	11
2.3 REQUESTS FOR EXCLUSION FROM GROUNDWATER MONITORING	11
2.3.1 <i>Summary of Requests for Exclusion from Groundwater Monitoring Submitted for Review</i>	12
2.3.2 <i>Process and Timeline for Reviewing Requests for Exclusion</i>	19
2.4 PRELIMINARY RESULTS	19
3.0 PROPERTY-OWNER NOTIFICATIONS AND REQUESTED WATER SAMPLING	23
4.0 REGIONAL MONITORING PROGRAM	24
4.1 OVERVIEW OF COMPLETED PHASES (2015 TO 2016).....	26
4.2 WORK CONDUCTED IN 2017	27
4.3 PRELIMINARY RESULTS	28
4.4 UPCOMING WORK IN 2018	29
5.0 PERFORMANCE MEASURES	30
5.1 GOAL #1: TRANSPARENCY AND AVAILABILITY OF ONLINE INFORMATION AND DOCUMENTATION	30
5.2 GOAL #2: PROVIDE CLEAR MILESTONES AND TIMELY DELIVERABLES	33
5.3 GOAL #3: UNDERSTAND AND MITIGATE THE IMPACTS OF WELL STIMULATION ON WATER QUALITY AND PUBLIC HEALTH	36
5.4 GOAL #4: PROVIDE REGION-SPECIFIC OR LOCALIZED FLEXIBILITY.....	40
5.5 GOAL #5: ASSESS IMPLEMENTATION COSTS.....	40
6.0 LESSONS LEARNED AND PLANNED ACTIONS FOR 2018	41
APPENDIX A PROCESS FLOW CHARTS	1
FLOW CHART A-1. PROCESS FLOW CHART FOR UPLOADING AND REVIEWING AREA-SPECIFIC GROUNDWATER MONITORING PLANS (NEW OR ADDENDUM)	2
FLOW CHART A-2. PROCESS FLOW CHART FOR REVIEWING REQUEST FOR EXCLUSION FROM GROUNDWATER MONITORING.....	3
FLOW CHART A-3. PROCESS FLOW CHART FOR REVIEWING WELL STIMULATION PERMIT APPLICATIONS.....	4

LIST OF CHARTS

2017 Annual Model Criteria Performance Report

CHART 2-1. GROUNDWATER MONITORING PLANS (NEW AND ADDENDUM) REQUESTS SUBMITTED IN 2017	7
CHART 2-2. REQUESTS FOR EXCLUSION FROM GROUNDWATER MONITORING SUBMITTED IN 2017	12
CHART 2-3. REQUESTS TO ADD WST WELLS FOR STIMULATED TREATMENT TO EXISTING EXCLUSIONS SUBMITTED IN 2017	15

LIST OF FIGURES

FIGURE 2-1. GROUNDWATER MONITORING PLANS AND WELLS FOR STIMULATED TREATMENT SUBMITTED (JANUARY 1, 2017 - DECEMBER 31, 2017).....	10
FIGURE 2-2. ...REQUESTS FOR EXCLUSION FROM GROUNDWATER MONITORING AND WELLS FOR STIMULATED TREATMENT SUBMITTED (JANUARY 1, 2017- DECEMBER 31, 2017)	14

LIST OF TABLES

TABLE 2-1. GROUNDWATER MONITORING PLANS REVIEWED (JANUARY 1, 2017 - DECEMBER 31, 2017)	9
TABLE 2-2. REQUESTS FOR EXCLUSION REVIEWED (JANUARY 1, 2017 - DECEMBER 31, 2017)	13
TABLE 2-3. ...REQUESTS TO ADD WST WELLS TO EXISTING APPROVED AREAS OF EXCLUSIONS (JANUARY 1, 2017 - DECEMBER 31, 2017)	17
TABLE 2-4. SUMMARY OF SAMPLING EVENTS FOR THE AREA-SPECIFIC GROUNDWATER MONITORING PROGRAM.....	21
TABLE 3-1. NUMBER OF NEIGHBOR NOTIFICATIONS SENT BY OPERATORS	23
TABLE 5-1. AVERAGE DAYS TO COMPLETE REVIEW PROCESS BY THE WATER BOARDS	35
TABLE 5-2. ...REGIONAL MONITORING PROGRAM INTERACTION WITH OPERATORS IN ADVANCE OF SAMPLING	38
TABLE 5-3. CIPA AND WSPA ESTIMATED OPERATOR COSTS	41
TABLE 6-1. MODEL CRITERIA - LESSONS LEARNED AND PLANNED ACTIONS FOR 2018	42

GLOSSARY

Axial Dimension Stimulation Area (ADSA) - The estimated maximum length, width, height, and azimuth of the area(s) affected by a well stimulation treatment (State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources [DOGGR] Well Stimulation Treatment Regulations, July 1, 2015). DOGGR approves or denies the ADSA as part of the well stimulation permitting process. A well stimulation permit with an approved ADSA may be issued to an operator; however, stimulation cannot occur until the State Water Board has approved either a groundwater monitoring plan or request for exclusion from groundwater monitoring associated with the permitted well(s).

Exempted aquifer – As defined in 40 Code of Federal Regulations (CFR) part 146.4, an aquifer or a portion thereof meets the criteria of underground source of drinking water that 1) does not currently serve as a source of drinking water, and 2) it cannot now and will not in the future serve as a source of drinking water. Refer to 40 CFR part 146.4 for regulation specifics.

Groundwater Monitoring – Monitoring of protected water in a specific area to assess potential effects from well stimulation treatment activities (i.e., well sampling, well gauging of water levels) in a specific area.

Groundwater Monitoring Plan (GWMP) – A plan submitted by the oilfield operator that describes the methods and procedures to characterize baseline water quality, conditions, and detect potential impacts to protected water from well stimulation treatments in a specific area. The GWMP will be designed to sufficiently monitor protected water. The GWMP will describe any assessments of area-specific groundwater, sampling, analytical testing, and a groundwater monitoring design. An Operator may propose additional wells to stimulate in an area that has already been approved by the Water Boards for an area-specific GWMP. This document is known as an GWMP addendum. Specific submission requirements for a GWMP and an GWMP addendum are provided in the *Model Criteria for Groundwater Monitoring in Areas of Well Stimulation*.

Interim Groundwater Monitoring Plans (Interim GWMPs) - GWMPs approved during interim period (January 1, 2014 - July 6, 2015), prior to the State Water Resources Control Board's (State Water Board) adoption of the Model Criteria.

Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation (Model Criteria) – Outlines the methods to be used for assessment, sampling, analytical testing, and reporting of water quality associated with oil and gas well stimulation activities.

Performance Measures – The product of collecting, analyzing, and/or reporting information regarding the performance of the Model Criteria. Five (5) goals were developed as the product of meetings with stakeholder groups. Performance measures are included in the *Model Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation* (March 1, 2016).

Project Sites - Locations of area-specific groundwater monitoring plans or requests for exclusions from groundwater monitoring.

Protected Water - Water with less than 10,000 milligrams per liter (mg/L) of total dissolved solids, and outside an exempt aquifer (meeting the criteria of 40 CRF part 146.).

Regional Groundwater Monitoring Program (RMP) – As required by Senate Bill 4 (Statutes of 2013), and detailed in the Model Criteria, State Water Board is to implement an oil and gas RMP in order to protect all waters designated for any beneficial use, while prioritizing the monitoring of groundwater that is or has the potential to be a source of drinking water. Factors considered for the RMP include well stimulation treatments, among other events or activities that have the potential to contaminate groundwater, such as an oil and gas well failure or breach. Fluids produced or introduced in the well stimulation process such as produced water ponds and Underground Injection Control (UIC) wells are included. The US Geological Survey is the technical lead.

Request for Exclusion from Area-Specific Groundwater Monitoring (Request for Exclusion) – A document submitted by the oilfield operator to request exclusion from groundwater monitoring before proceeding with well stimulation activities. Water Boards must provide a written concurrence for the exclusion from groundwater monitoring. Specific submission requirements are provided in the Model Criteria.

Well stimulation treatment (WST) – Treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. Well stimulation treatments include, but are not limited to, hydraulic fracturing treatments and acid well stimulation treatments. Well stimulation treatments do not include steam flooding, water flooding, or cyclic steaming and do not include routine well cleanout work, routine well maintenance, routine removal of formation damage due to drilling, bottom hole pressure surveys, or routine activities that do not affect the integrity of the well or the formation.

ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
bbbl	barrel(s) of oil
Central Valley Water Board	Central Valley Regional Water Quality Control Board
CIPA	California Independent Petroleum Association
COGG	United States Geological Survey California Oil, Gas, and Groundwater Program
DOGGR	State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources
GeoTracker	State Water Board's GeoTracker Information System
GeoTracker GAMA	Groundwater Ambient Monitoring and Assessment Information System
GWMP	Area-specific Groundwater Monitoring Plan
mg/L	milligrams per liter
MCL	maximum contaminant level
Model Criteria	Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation
Notifications	DOGGR Well Stimulation Treatment Neighbor Notification Form
Operator	oil and gas field operator
RMP	Regional Monitoring Program
Regional Water Board	Regional Water Quality Control Board
Reporting period	January 1, 2017 - December 31, 2017
State Water Board	State Water Resources Control Board
TDS	total dissolved solids
USGS	United States Geological Survey
USDW	underground source of drinking water, equivalent to less than 10,000 mg/L TDS
Water Boards	California State Water Resources Control Board and Regional Water Quality Control Board
WSPA	Western States Petroleum Association

Intentionally Left Blank

EXECUTIVE SUMMARY

This Annual Model Criteria Performance Report fulfills the requirements identified in the [Model Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation](#) (Performance Measures). This report summarizes work performed from January 1, 2017 through December 31, 2017 (reporting period) by the State Water Resources Control Board (State Water Board) and associated agencies regarding implementation of the [Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation](#) (Model Criteria). The Model Criteria was adopted by the State Water Board on July 7, 2015 (Resolution No. 2015-0047).

The Model Criteria was developed to assess potential effects of well stimulation treatment (WST) activities on California's groundwater resources. It outlines groundwater monitoring requirements for area-specific groundwater monitoring conducted by oil and gas operators (Operators), as well as the approach the State Water Board will take to conduct a Regional Monitoring Program.

A WST cannot be performed until State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) approves the WST permit and the California State Water Board and the Regional Water Quality Control Board (Water Boards) have:

- 1) approved an Operator-submitted groundwater monitoring plan (GWMP), or
- 2) issued a letter to the Operator that groundwater monitoring is not required (Exclusion).

Additionally, approval of a GWMP or GWMP addendum cannot occur until the Axial Dimension Stimulation Area (ADSA) has been approved by DOGGR and reviewed by the Water Boards.

The requirement for area-specific groundwater monitoring is limited to areas where "protected water" is present. "Protected water" is defined as:

- Water with less than 10,000 milligrams per liter (mg/L) of total dissolved solids (TDS), and
- Water located outside of an exempt aquifer (meeting the criteria of 40 Code of Federal (CFR) part 146.4).

Efforts performed by the Water Boards for the Model Criteria during the reporting period are presented in six sections in this report, as follows, 1) introduction and background of the Model Criteria, 2) area-specific groundwater monitoring, 3) property owner's requests for water quality testing, 4) Regional Monitoring Program (RMP), 5) performance measures, and 6) lessons learned.

Area-Specific Groundwater Monitoring. Area-specific groundwater monitoring is required unless an Operator has clearly demonstrated that the wells to be stimulated do not penetrate protected water and has requested an exclusion from groundwater monitoring requirements (Request for Exclusion). Operators must submit a GWMP addendum or an exclusion from

groundwater monitoring when additional WST wells are proposed for stimulation in the areas previously granted.

In 2017, the number of GWMPs (new and addendums), Requests for Exclusions, or added WST wells submitted by the Operators and their status (i.e., approved, denied, or review in progress) by the State Water Board is summarized in the table below.

Area-Specific Groundwater Monitoring Summary (January 1, 2017 – December 31, 2017)	Approved	Denied	Review in Progress	Total	No. of WST Wells
GWMPs (New)	5	2	1	8	46
GWMP Addendums	4	0	0	4	11
Requests for Exclusions	2	3	0	5	140

Property-Owner Notifications and Requested Water Sampling. Operators are required to hire an independent third party to notify property owners, or tenants of a property, located within 1,500 feet of the well to be stimulated or within 500 feet of the surface representation of the horizontal path of the area of stimulation. A property owner that has received a notification can access a list of designated contractors on the State Water Board website. Designated contractors are required to notify the State Water Board staff prior to sampling and upload the results to GeoTracker after sampling. In 2017, the majority of the notifications (138 out of 140) were sent by Aera Energy, LLC, which corresponds to their activity at North and South Belridge. The State Water Board has not been notified of any designated contractors performing water quality testing in 2017.

Regional Monitoring Program. The goal of the RMP is to evaluate potential impacts from oilfield operations and characterize the risk to subsurface water designated for any beneficial use (e.g., drinking water), while prioritizing the highest areas of risks to be monitored. In 2017, the United States Geological Survey (USGS) as technical lead of the RMP continued their salinity mapping work, performed airborne electromagnetic surveys, collected well depth and water chemistry data, and met with program stakeholders. The USGS refers to the work performed under the RMP as the California Oil, Gas, and Groundwater (COGG) Program. Preliminary results and other information are included in Section 4.0.

Performance Measures. The State Water Board directed staff to collaborate with stakeholders to develop performance measures for the evaluation of the Model Criteria. These performance measures were presented to the State Water Board on March 1, 2016 and included goals, strategies, and plans for implementing the Model Criteria. A summary of the five performance measures and actions completed during this reporting period is provided below.

2017 Annual Model Criteria Performance Report

Performance Measures	Water Boards Staff Actions During the Reporting Period
<p>1. Provide transparent and availability of online information and documentation</p>	<p>Developed new tools in GeoTracker to facilitate data and information sharing with DOGGR and Operators.</p> <p>Continued to consolidate existing oil and gas data and information into GeoTracker.</p> <p>Completed periodic updates to the State Water Board’s Oil and Gas Monitoring Program webpage.</p> <p>Water Boards and DOGGR staff use a secure file sharing to easily share documents.</p> <p>Water Boards and DOGGR staff meet at least monthly to coordinate on data sharing, process flow, and training.</p> <p>DOGGR provided training on the process of performing ADSA reviews.</p>
<p>2. Provide clear milestones and timely deliverables</p>	<p>Posted updated process flowcharts for “Uploading and Reviewing Area-Specific Groundwater Monitoring Plans” and “Reviewing Request for Exclusion from Groundwater Monitoring” on the Oil and Gas Monitoring webpage.</p> <p>Posted the first “Annual Model Criteria Performance Report” (dated May 5, 2017) on the State Water Boards Oil and Gas Monitoring webpage.</p> <p>Water Boards staff time for review of GWMPs and Request for Exclusions improved from 2016 to 2017.</p>
<p>3. Understand and mitigate impacts of well stimulation on water quality and public health</p>	<p>The USGS provided technical briefings at stakeholder meetings.</p> <p>The USGS established the COGG Program website (https://ca.water.usgs.gov/projects/oil-gas-groundwater/) to provide an overview of the objectives and technical approaches for the RMP to the public.</p> <p>The State Water Board maintained and updated the Oil and Gas Monitoring Program website (https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/) to provide stakeholders with updated information on area-specific groundwater monitoring, RMP, property owner sampling, and performance measures.</p> <p>The State Water Board and the USGS have provided Operators with a summary of the scope and goals of the sampling program and the rationale for selected sampling points prior to RMP sampling efforts.</p> <p>Area-specific groundwater monitoring results reviewed by Water Boards staff as of the end of this reporting period did not indicate any analytes that would require further investigation, with the exception of elevated benzene and TDS concentrations in groundwater at two oilfields.</p>
<p>4. Provide region-specific or localized flexibility</p>	<p>The Model Criteria allows for alternative plans but none were submitted.</p>
<p>5. Assess implementation costs</p>	<p>Operators have spent approximately \$3 million on implementing groundwater monitoring as part of requirements in GWMPs. During the same time period, Operators have spent an estimated total of \$76,000 on submittals for Requests for Exclusion from groundwater monitoring.</p>

Lessons Learned and Planned Actions for 2018. Based on the efforts performed during the reporting period and lessons learned documented in this report, the following State Water Board actions are planned for 2018.

Planned State Water Board Staff Actions for 2018
<p>Goal #1: Transparency and Availability of Online Information and Documentation</p> <ul style="list-style-type: none"> • Communicate with the Operators the importance of the RMP and when lack of access to oilfields for RMP sampling or lack of digital records is impeding the process. • Provide a summary of site characteristics and site selection criteria as part of the notification to Operators prior to RMP sampling. USGS will Request input from Operators' technical experts to be evaluated for use in design of the sampling program. • Continue to work with the Operators as efficiently as possible during the area-specific groundwater monitoring review process and proactively communicate any of the Water Boards' concerns since hydrogeologic and geologic conditions at oilfields can be very complex, such that, longer reviews may be necessary. • Request input from the Operators on user experience with Water Boards information portals (i.e., GeoTracker, State Water Board's Oil and Gas Monitoring Program website). • Discuss with DOGGR data sharing between GeoTracker and the newly created DOGGR's Well State Tracking and Reporting (WellSTAR) system to assess the interaction with these systems and the objectives of meeting the Model Criteria data needs. • Perform periodic review and updates of procedures and checklists based on lessons learned to streamline reviews and avoid duplicative efforts amongst Water Boards staff and DOGGR staff. • Provide GeoTracker map function to show boundaries of approved GWMPs or Exclusions to the public.
<p>Goal #2: Provide Clear Milestones and Timely Deliverables</p> <ul style="list-style-type: none"> • Prepare the 2018 Model Criteria Performance Report – Final publication anticipated March 2019. • Perform a completeness review of an Operator's submittal within 14 working days of receipt in GeoTracker to communicate any deficiencies in the submittal to the Operator as an effort to make the review more efficient for the Operator and Water Boards staff.
<p>Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health</p> <ul style="list-style-type: none"> • Continue to schedule technical briefings with the stakeholders to present RMP results. • Request input regarding Operator's experiences with respect to the implementation of the area-specific groundwater monitoring, and feedback for suggested modifications to the Model Criteria. • Continue to work with the USGS and other state agencies to better understand which compounds used in WST fluids are the most appropriate tracer and/or indicator compounds. • Request a list of possible indicator and/or tracer compounds in the Operator's submittal for a GWMP (new or addendum) so that State Water Board staff can start the evaluation process. • Request groundwater analytical results for TDS to confirm Operator's interpretations of geophysical logs as part of the Operator's evidence of protected water in a GWMP (new or addendum) or lack thereof, in a request for Exclusion.
<p>Goal #4: Provide Region-Specific or Localized Flexibility - None planned.</p>
<p>Goal #5: Assess Implementation Costs - None planned.</p>

1.0 INTRODUCTION

The State Water Resources Control Board (State Water Board) [Model Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation](#)¹ (Performance Measures) specifies that the State Water Board prepare and make publicly available an “Annual Model Criteria Performance Report.” This report summarizes work conducted from January 1, 2017 through December 31, 2017 (reporting period) associated with the State Water Board’s [Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation](#)² (Model Criteria). Well stimulation permits are issued to Operators by the State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) and required prior to performing well stimulation activities. The number and status of well stimulation permits can be found on DOGGR’s website at: <http://www.conservation.ca.gov/dog/Pages/WST.aspx> - “WST Permit Website” icon.

This report is organized into six sections. This section, Section 1.0, provides a description of the establishment of the Model Criteria and Performance Measures. Section 2.0 describes the process of the area-specific groundwater monitoring program and results for 2017. Section 3.0 summarizes the procedures and the number of the property owner notifications sent prior to WST activities in 2017. Section 4.0 describes the Regional Monitoring Program (RMP) since inception in 2014 along with a summary of completed activities in 2017, preliminary results, and a listing of the planned activities for the RMP in 2018. Performance Measures, described in Section 5.0, provides strategies and actions taken in 2017 for each of the five performance goals. Lastly, Section 6.0 summarizes the efforts in this report as a list of lessons learned and planned actions for 2018.

1.1 Background

California Water Code section 10783 (Senate Bill 4, Pavley, statutes of 2013) requires the State Water Board to establish and implement a comprehensive regulatory groundwater monitoring and oversight program for well stimulation treatment (WST) activities (including hydraulic fracturing) in areas of oil and gas operations. The Legislature also required the State Water Board to develop Model Criteria for groundwater monitoring in order to assess potential effects of WST on California’s groundwater resources. The Model Criteria was adopted by the State Water Board on July 7, 2015 (Resolution No. 2015-0047). It outlines groundwater monitoring requirements for area-specific groundwater monitoring conducted by Operators, as well as the approach the State Water Board will take to conduct a regional monitoring program.

Upon the passage of Senate Bill 4, the State Water Board and DOGGR developed Emergency Interim Regulations³ which included interim groundwater monitoring requirements. Effective January 1, 2014 through June 30, 2015, well operators were required to submit either an approved groundwater monitoring plan (Interim GWMP) or a letter from the State Water Board

¹ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/performance_measures/index.shtml

² https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/well_stimulation/index.shtml

³ <http://www.conservation.ca.gov/dog/Pages/WSTInterimProgram.aspx>

staff concurring that there is no protected water to monitor for their WST well permit. If WST activities were planned after June 30, 2015, the Operator was required to submit a new GWMP but allowed to follow the interim GWMP after July 1, 2015 if no WST activities were planned. Therefore, there are a number of Interim and Model Criteria GWMPs active during this reporting period. Data from both Interim and Model Criteria GWMPs are uploaded to GeoTracker.

The State Water Board directed staff to collaborate with stakeholders to develop performance measures for the evaluation of the Model Criteria. These performance measures were presented to the State Water Board on March 1, 2016 and included goals, strategies, and plans for implementing the Model Criteria.

Five performance measures were identified, as provided below:

1. Provide transparent and availability of online information and documentation,
2. Provide clear milestones and timely deliverables,
3. Understand and mitigate impacts of well stimulation on water quality and public health,
4. Provide region-specific or localized flexibility, where possible, and
5. Assess implementation costs.

More information regarding the status of these Performance Measure goals is provided in Section 5.0 of this report.

2.0 AREA-SPECIFIC GROUNDWATER MONITORING

This section provides a summary of the area-specific GWMPs submitted by Operators to the State Water Board and Regional Water Quality Control Boards (collectively Water Boards) during the reporting period. All GWMPs submitted during the reporting period were within the jurisdiction of the Central Valley Regional Water Quality Control Board (Central Valley Water Board).

A WST cannot be performed until DOGGR approves the WST permit and the Water Boards have:

- approved an Operator-submitted GWMP, or
- issued a letter to the Operator that groundwater monitoring is not required (i.e., an exclusion from groundwater monitoring).

The requirement for area-specific groundwater monitoring is limited to areas where “protected water” is present. “Protected water” is defined as:

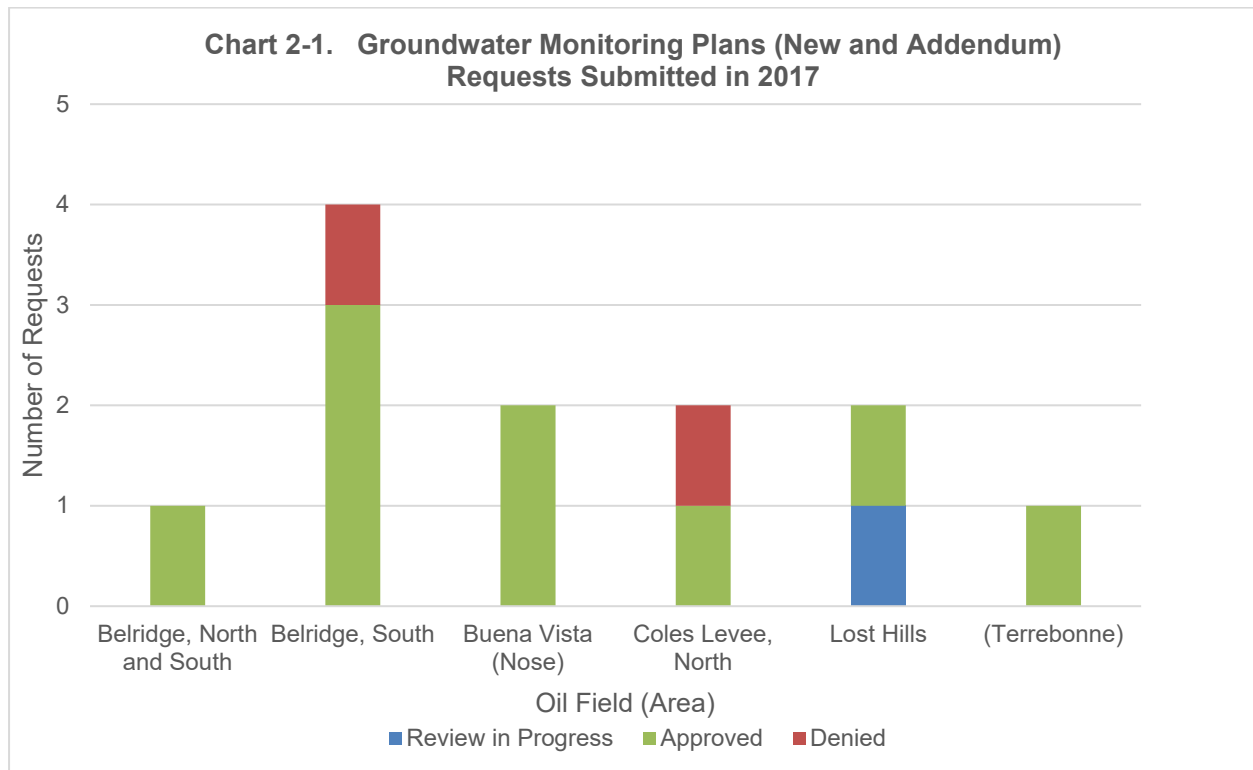
- water with less than 10,000 milligrams per liter (mg/L) of total dissolved solids (TDS), and
- located outside an exempt aquifer (meeting the criteria of 40 CFR part 146.4).

2.1 Requests for Groundwater Monitoring

This section provides a summary of the number, status, and location of GWMP requests (new and addendums) submitted in 2017 and the Water Board’s review process and timeline. An GWMP addendum is required if the Operator proposes to stimulate additional wells in an area of an already approved GWMP. This section also provides the number, status, and location of requests to add WST wells for GWMP addendums in 2017.

2.1.1 Summary of Groundwater Monitoring Plans Submitted for Review

During the reporting period, a total of 12 proposed new or GWMP addendums were uploaded by Operators to the publicly-accessible State Water Board’s GeoTracker information system ([GeoTracker](#)) for Water Board’s staff review. All GWMPs are located in Kern County, covering four oilfields and two areas (Buena Vista Nose and Terrebonne) outside of an oilfield administrative boundary as highlighted in Chart 2-1.



2017 Annual Model Criteria Performance Report

Nine GWMPs were approved (5-new and 4- addendum), two GWMP submittals (South Belridge and North Coles Levee) did not meet the Model Criteria requirements (denied), and one GWMP is in review during the reporting period (Chart 2-1). Of the 12 GWMPs submitted, eight were new GWMPs and the remaining four were GWMP addendums (Table 2-1). The five approved GWMPs included a total of 46 WST wells. The four requests for GWMP addendums included a total of 11 WST wells to be added (Table 2-1). Requests to add WST wells were located in two oilfields: South Belridge (six WST wells approved) and Buena Vista Nose (five WST wells approved). All of these requests for GWMP addendums have been approved. Location and status of the project sites and wells stimulated in 2017 are shown on Figure 2-1.

Note: The location of stimulated wells shown on Figure 2-1 and Figure 2-2 was obtained from the DOGGR WST Disclosure webpage⁴. This webpage populates data from the WST Disclosure Form completed and uploaded by the Operators after a WST has been completed. Data available on this website may not reflect all of the wells stimulated in 2017. The stimulated wells shown on figures in this report reflect data that was last uploaded as of March 1, 2018.

⁴ <http://www.conservation.ca.gov/dog/Pages/WSTDisclosureSearchDisclaimer.aspx>

**Table 2-1. Groundwater Monitoring Plans Reviewed
(January 1, 2017 - December 31, 2017)**

GeoTracker Global Identification	Oil Field or (Area)	Township (T), Range (R), Section (S) ¹	Operator	GWMP Date Received	New or Addendum GWMP	Interim Actions (GeoTracker Submittal Date(s))	Status/Determination ²	Number of WST Wells Approved	Status/Determination Date	Days to Complete Process ²	Comments
GAOG10010818	Belridge, North & South	T28S, R20E, S12	Breitburn Operating, LP	8/1/2017	New	Operator revised GWMP (10/11/17)	Approved	5	10/24/2017	13	Area of GWMP is known as the Dow Chanslor Lease.
GAOG10009277	Belridge, South	T28S, R20E, S12, S13, S18	Aera Energy, LLC	8/18/2016	New	Operator revised GWMP (1/2/2017 and 3/28/2017)	Approved	27	4/11/2017	14	Site was monitored under an Interim GWMP.
				5/30/2017	Addendum	--	Approved	1	7/10/2017	41	
				11/8/2017	Addendum	--	Approved	5	12/21/2017	43	
GAOG10009958		T28S, R21E, S19	Linn Operating, Inc	11/30/2016	New	--	Denied	--	6/22/2017	204	Water Boards staff worked with the Operator several months to develop an approach to assess the infiltrated produced water in the subsurface and its relevance to the Model Criteria. The GWMP was denied because it did not meet many of the Model Criteria requirements, namely, inadequate monitoring network and supporting documentation.
GAOG10009209	Buena Vista (Nose)	T31S R24E S36, T31S R25E S31, T32S R25E S3-11, 14-17, & T32S, R24E, S1	California Resources Corporation	11/2/2017	Addendum	--	Approved	3	1/4/2018	63	Site was monitored under an Interim GWMP. Original GWMP approved on March 24, 2016.
				12/6/2017	Addendum	--	Approved	2	1/19/2018	44	Site was monitored under an Interim GWMP. Original GWMP approved on March 24, 2016.
GAOG10010467	Coles Levee, North	T30S, R25E, S30	California Resources Corporation	6/6/2017	New	Operator revised GWMP (10/2/2017)	Approved	1	10/24/2017	22	Site was monitored under an Interim GWMP.
GAOG10011004		T30S, R25E, S28		9/25/2017	New		Denied	--	2/26/2018	155	The GWMP was denied because it did not meet many of the Model Criteria requirements, namely, inadequate monitoring network and lack of sentry wells to protect existing drinking water supply.
GAOG10009406	Lost Hills	T27S, R21E, S4, S5	Aera Energy, LLC	9/20/2016	New	Review on hold late 2016 to late 2017	Review in Progress	--	--	--	December 2016 to October 2017 – Review on hold - 1) DOGGR's determination whether Tulare Formation is considered exempt (or not) in this area. 2) Operator indicated to State Water Board that GWMP may not be moving forward. October 2017 - Operator requested State Water Board to move forward on GWMP review. October 23, 2017 – State Water Board letter denied GWMP. December 2017 - Operator communicated to State Water Board that revisions to GWMP in progress. Site was monitored under Interim GWMP. Number of WST wells in GWMP = 8.
GAOG10010391	Lost Hills	T26S, R21E, S29, S32, S33 & T27S, R21E, S5	Chevron USA, Inc	8/19/2016	New	Operator revised GWMP (5/12/2017, 8/11/2017)	Approved	12	9/20/2017	40	Original GWMP submitted into GeoTracker on 8/19/16. Site was monitored under an Interim GWMP.
GAOG10011238	(Terrebonne)	T28S, R23E, S22	California Resources Corporation	8/8/2017	New		Approved	1	11/17/2017	101	Original GWMP submitted into GeoTracker on October 12, 2016. Last revision was submitted into GeoTracker on January 16, 2018 (Review by State Water Board was performed with an earlier emailed copy of GWMP from Operator).

Notes and Acronyms:

-- = not applicable

ADSA = Axial Dimension Stimulation Area

DOGGR = Division of Oil, Gas, and Geothermal - Department of Conservation

GWMP = Groundwater Monitoring Plan

1. All located in Kern County.

2. Available options are Approved, Review in Progress, and Denied. Denied indicates that the GWMP did not meet the minimum requirements in the Model Criteria.

3. Days to complete the process equates to the elapsed time between the "GWMP Date Received" to "Status/Determination Date". For GWMPs (new and addendums) with multiple revisions, days to complete the process equates to the sum of days to review the original submittal and the days to review each of the revisions. This time includes communications with the Operator, Regional Water Board staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence. Refer to **Flow Chart A-1 - Process Flow Chart for Uploading and Reviewing Area-Specific Groundwater Monitoring Plans (New or Addendum) in Appendix A** for the detailed flowchart of the GWMP review process.

	Approved	No. of WST Wells
GWMPs (New)	5	46
GWMP Addendums	4	11

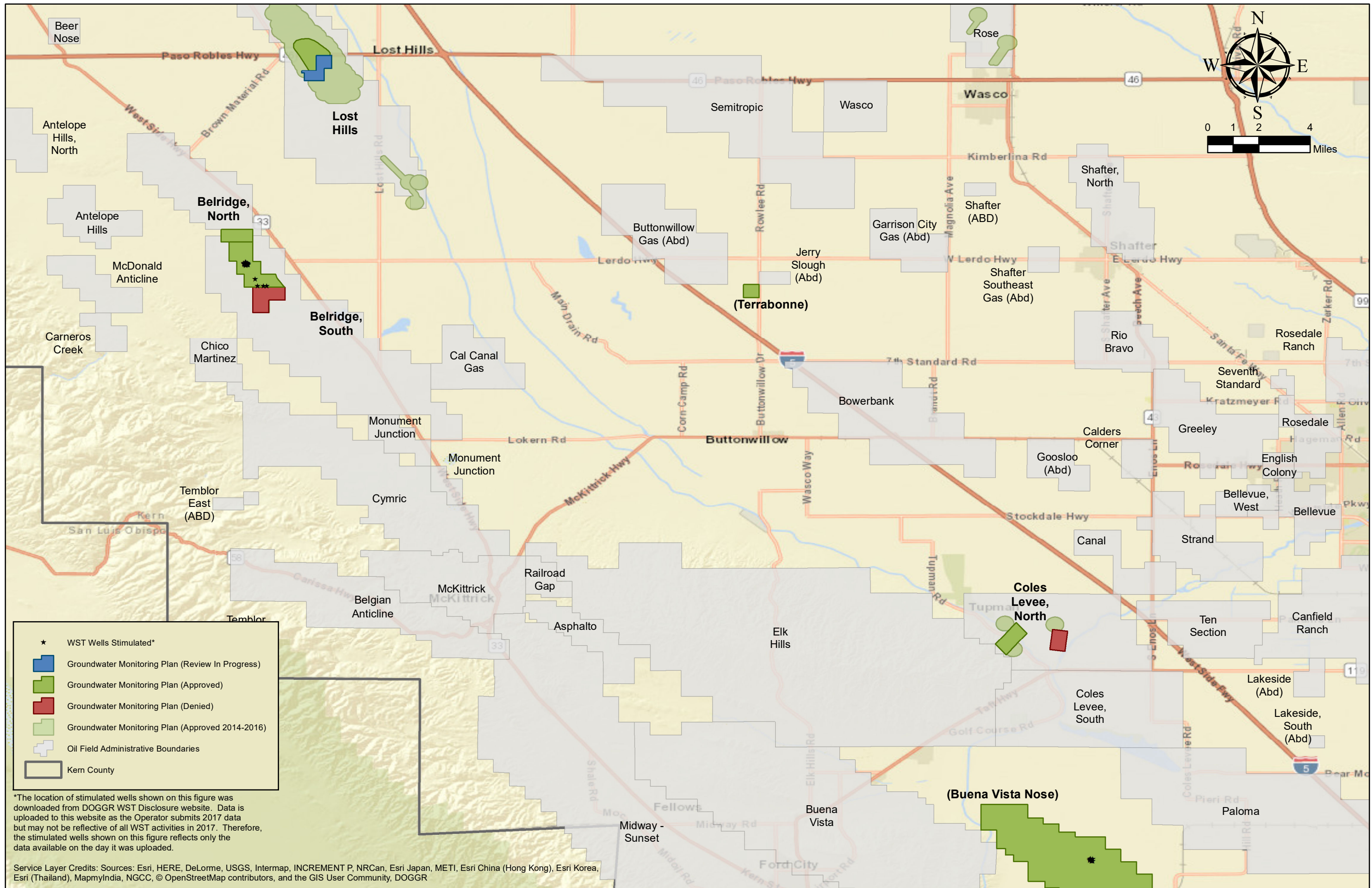


Figure 2-1. Groundwater Monitoring Plans and Wells Stimulated (January 1, 2017 - December 31, 2017)



2.1.2 Process and Timeline for Reviewing Groundwater Monitoring Plans

The process flow chart for reviewing GWMPs is shown on Figure A-1 in Appendix A. Water Boards staff review begins after a GWMP or GWMP addendum has been uploaded to GeoTracker and has been accepted by State Water Boards staff. It is the State Water Boards' staff intention to respond to the Operator with review comments within 45 calendar days from acceptance of the submittal. After review completion, additional information may be requested, the GWMP may be denied, or the GWMP may be approved. A revised GWMP addressing Water Boards staff comments is required to be submitted to GeoTracker. Approval of a GWMP or GWMP addendum cannot occur until the Axial Dimension Stimulation Area (ADSA) has been approved by DOGGR and reviewed by the Water Boards.

As noted in Table 2-1, in some cases, the data to review the GWMP did not meet the Model Criteria requirements and the GWMP was denied or a revision to a GWMP was requested. Upon receipt of a revised GWMP, additional time for the Water Boards' staff review is incurred.

In 2017, the average time for Water Boards staff to complete the review process was 49 days for an GWMP addendum. It took Water Board staff on average 78 days to review a new GWMP. In 2016, these average review times were not estimated. The process flow chart for reviewing a WST permit application for a GWMP addendum is shown on Figure A-3 in Appendix A.

2.2 Groundwater Monitoring Plans Submitted that Propose Alternative Methods

The Model Criteria allows Water Boards staff to consider proposed alternatives and modifications to the methods for area-specific groundwater monitoring based on factors such as site-specific conditions (e.g., terrain, geology, access), number and depth of aquifers containing protected water, potential pathways, and risk to receptors (e.g., groundwater resources). The Water Boards shall provide at least fifteen days public notice and an opportunity for comments on the proposal prior to approving a proposed alternative or modification.

Water Boards have not received any requests for consideration of alternative methods during the reporting period.

2.3 Requests for Exclusion from Groundwater Monitoring

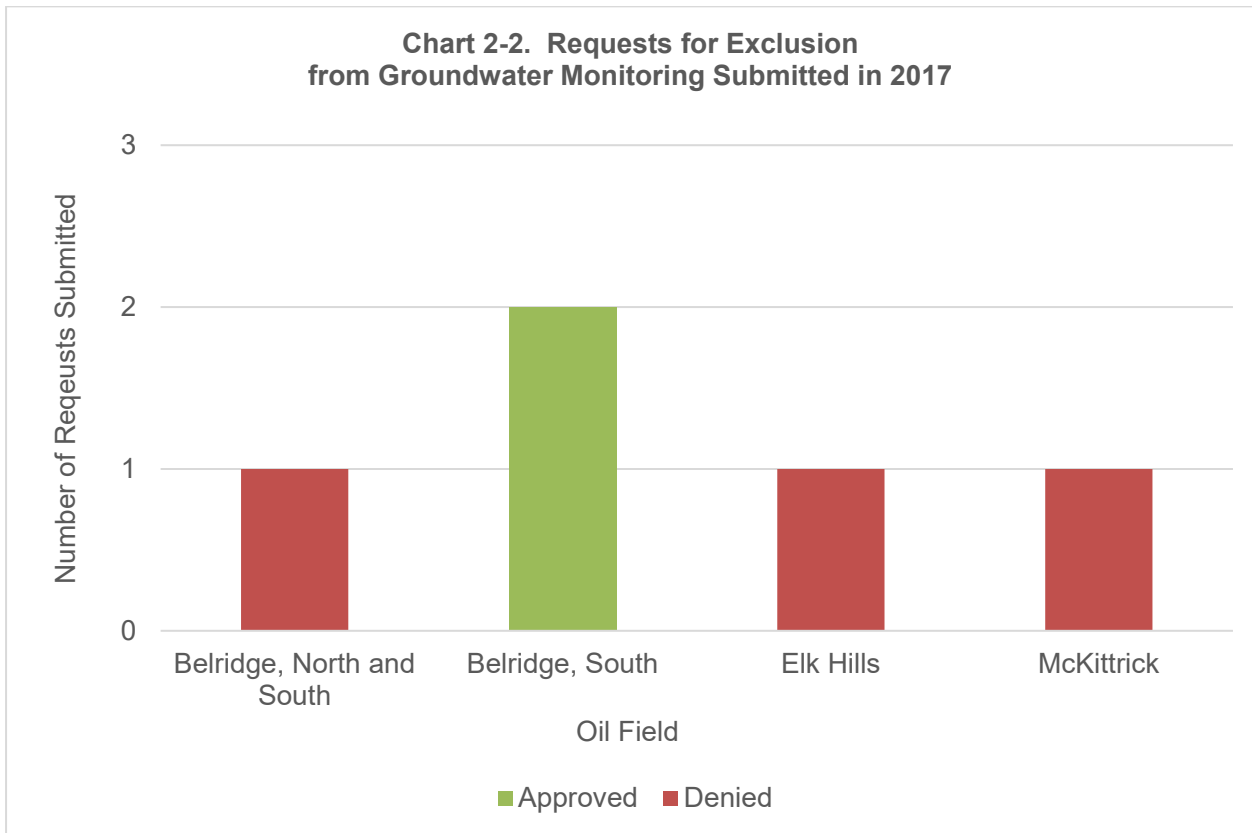
Area-specific groundwater monitoring is required unless an Operator can clearly demonstrate that the wells to be stimulated do not penetrate protected water. If the Water Boards staff concurs, an exclusion from groundwater monitoring requirements is granted to the Operator. Operators must also obtain approval for additional WST wells to be stimulated in areas previously granted an exclusion.

This section provides a summary of the 2017 Requests for Exclusion (i.e., number, status, and location) submitted to the Water Boards and the process and timeline involved in reviewing a

Request for Exclusion from groundwater monitoring. This section also summarizes the number of WST wells added to already approved Requests for Exclusion during the reporting period.

2.3.1 Summary of Requests for Exclusion from Groundwater Monitoring Submitted for Review

Five new Requests for Exclusion from groundwater monitoring were uploaded by Operators to GeoTracker for Water Boards staff review during the reporting period. These submittals are publicly available in GeoTracker. All of the requests were located at four oilfields, as highlighted in **Chart 2-2**.



As shown in Chart 2-2, two of the five Requests for Exclusion were approved; the other three Requests for Exclusion did not meet the Model Criteria requirements. There were no Requests for Exclusion in review at the end of the reporting period (Table 2-2). Detailed information about the status of Requests for Exclusion submitted during the reporting period is provided in Table 2-2.

**Table 2-2. Requests for Exclusion
Reviewed (January 1, 2017 -
December 31, 2017)**

GeoTracker Global Identification	Oil Field	Township (T), Range (R), Section (S)	County	Operator	Request for Exclusion Received Date	Interim Actions (GeoTracker Submittal Date(s))	Status/Determination	Status/Determination Date	Days to Complete Review Process ¹	Comments
GAOG10009243	Belridge, North and South	T28S, R20E, S1	Kern	Breitburn Operating, LP	8/8/2016	Operator revised Exclusion (1/6/17)	Denied	3/22/2017	75	The Request for Exclusion was denied since water samples collected from a nearby monitoring well had results less than 10,000 µg/L TDS (protected water).
GAOG10009592	Belridge, South	T29S, R21E, S3	Kern	Aera Energy, LLC	10/31/2016	Operator revised Exclusion (12/21/16)	Approved	3/9/2017	78	
GAOG10009914	Belridge, South	T28S, R21E, S20	Kern	Aera Energy, LLC	11/23/2016	Operator revised Exclusion (12/21/16)	Approved	3/9/2017	78	
GAOG10010505	Elk Hills	T30S, R24E, S33	Kern	California Resources Corporation	6/27/2017	--	Denied	10/4/2017	99	The Request for Exclusion was denied since the submittal did not clearly indicate the absence of protected water.
GAOG10010268	McKittrick	T30S, R22E, S7,8,9,16,17,18	Kern	Chevron USA, Inc	3/28/2017	--	Denied	6/22/2017	86	The Request for Exclusion was denied since the package was missing information, inconsistent site conceptual model for the Tulare Formation, lacked supporting data for the absence of protected water in the alluvium.

Notes and Acronyms:

-- = not applicable

WST = well stimulation treatment

5	Total Number of Reviews of Requests for Exclusion in 2017
---	---

1. Days to complete the process equates to the elapsed time between the "Request for Exclusion Received Date" to "Status/Determination Date". For Requests for Exclusion with multiple revisions, days to complete the process equates to the sum of days to review the original submittal and the days to review each of the revisions. This time includes communications with the Operator, Regional Water Board staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence. Refer to **Flow Chart A-2. Process Flow Chart for Reviewing Requests for Exclusion from Groundwater Monitoring in Appendix A** for the detailed flowchart of the Exclusions from Groundwater Monitoring review process.

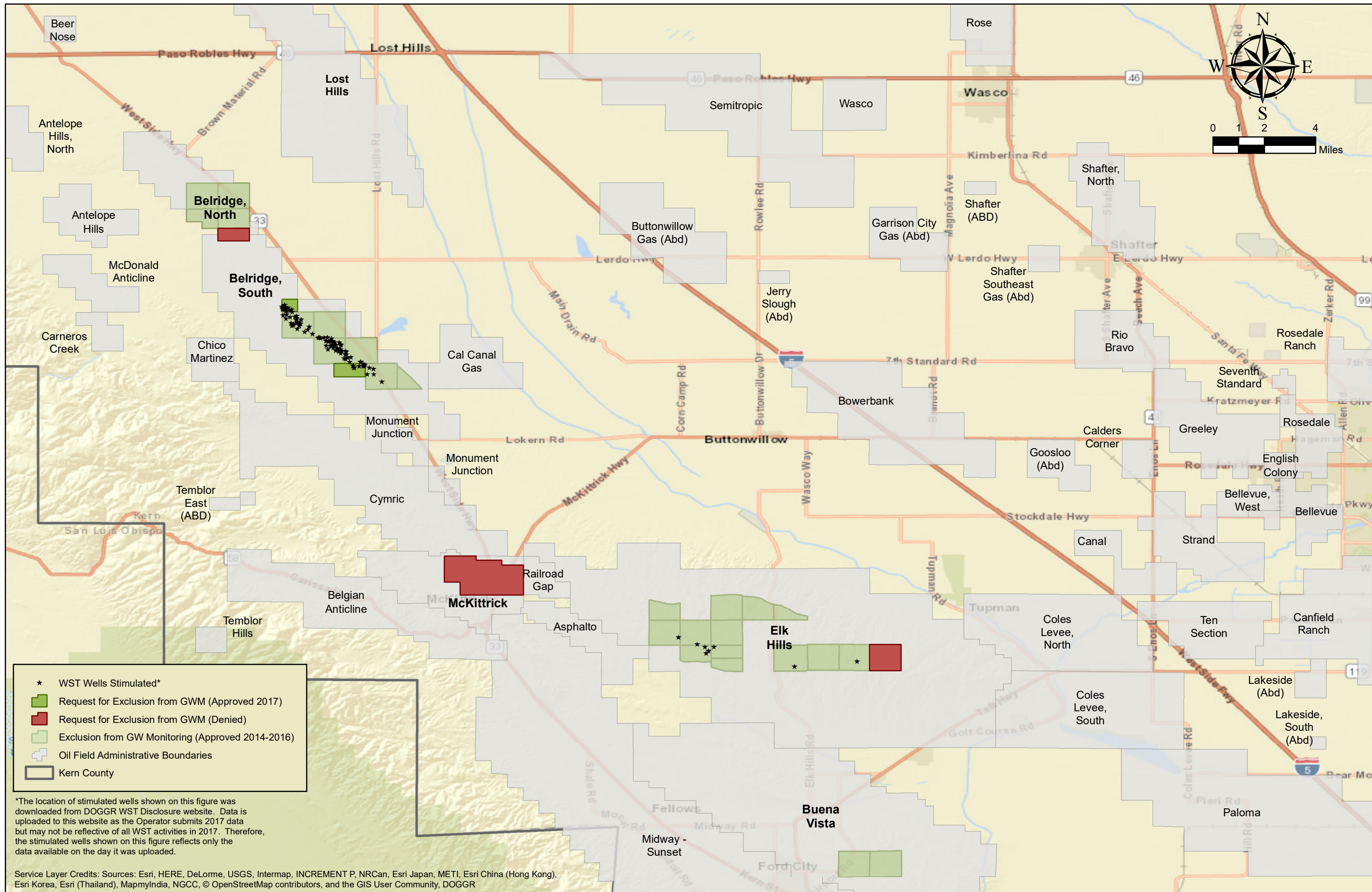
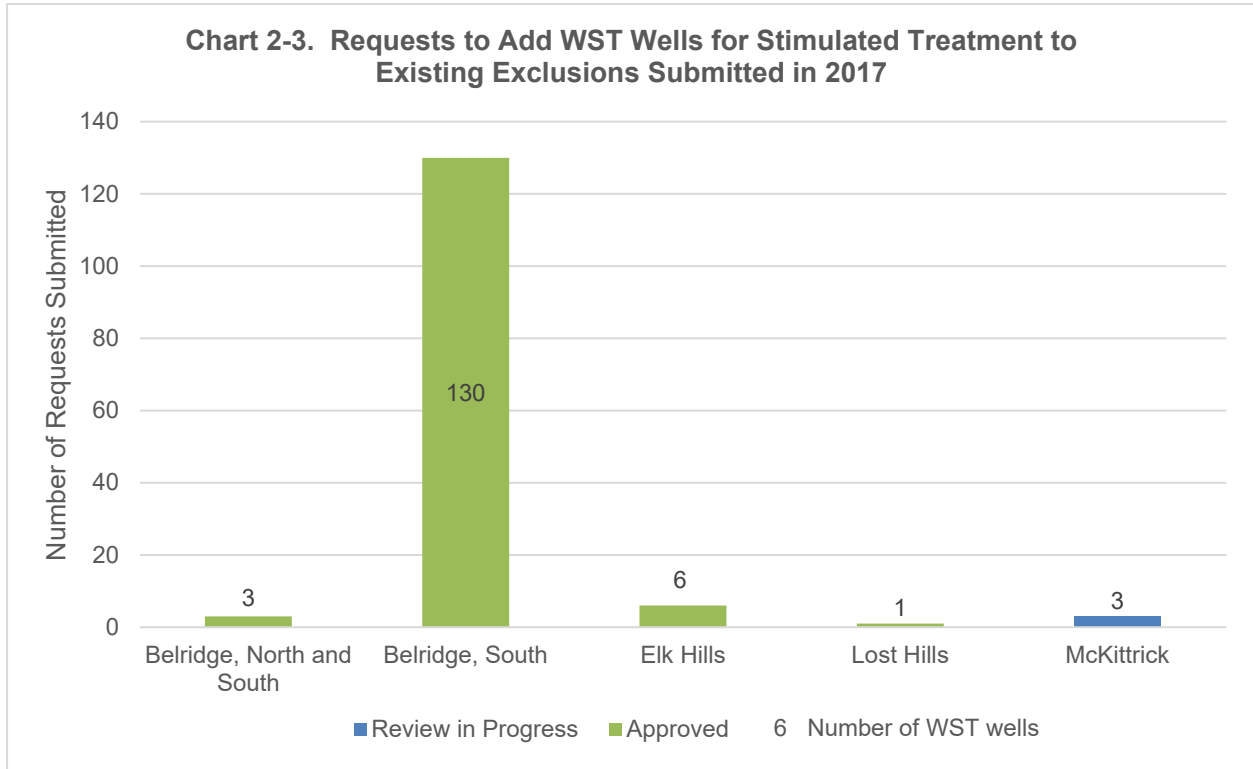


Figure 2-2. Requests for Exclusion from Groundwater Monitoring and Wells Stimulated (January 1, 2017 - December 31, 2017)



Requests for approval of 143 WST wells were submitted during the reporting period. One hundred and thirty (140) WST wells were verified by Water Boards staff to be located in an area of exclusion previously approved, the remaining 3 WST wells are in review (Table 2-3).



Majority of the 130 approved WST well requests were located in the South Belridge Oil Field (Chart 2-3). Detailed information about the status of the other WST wells is provided in Table 2-3. Locations of wells stimulated in 2017 are shown on Figure 2-2. The process flow chart for reviewing a WST permit application for a GWMP addendum is shown on Figure A-3 in Appendix A.

Intentionally Left Blank

Table 2-3. Requests to Add WST Wells to Existing Approved Areas of Exclusions (January 1, 2017 - December 31, 2017)

GeoTracker Global Identification	Oil Field	Township (T), Range (R), Section (S)	County	Operator	Date Received for Request of Additional WST Wells	Number of WST Wells Added to Approved Exclusions	Status/ Determination	Status/ Determination Date	Days to Complete Review Process ¹
GAOG10011106	Belridge, North	T28S, R20E, S2	Kern	Aera Energy, LLC	12/4/2017	1	Approved	12/22/2017	18
GAOG10011109	Belridge, North	T28S, R20E, S2	Kern	Aera Energy, LLC	12/4/2017	1	Approved	12/22/2017	18
GAOG10011109	Belridge, North	T28S, R20E, S2	Kern	Aera Energy, LLC	12/22/2017	1	Approved	1/11/2018	20
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	4/20/2017	5	Approved	5/11/2017	21
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	6/2/2017	17	Approved	6/30/2017	28
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	7/11/2017	7	Approved	8/3/2017	23
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	8/1/2017	1	Approved	8/21/2017	20
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	9/25/2017	6	Approved	9/29/2017	4
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	10/17/2017	2	Approved	11/13/2017	27
GAOG10008913	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	6/2/2017	3	Approved	6/21/2017	19
GAOG10008913	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	7/7/2017	1	Approved	7/28/2017	21
GAOG10008913	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	9/25/2017	1	Approved	9/29/2017	4
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	4/24/2017	1	Approved	5/11/2017	17
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	6/19/2017	2	Approved	6/29/2017	10
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	7/7/2017	1	Approved	7/31/2017	24
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	7/11/2017	4	Approved	7/31/2017	20
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	9/25/2017	2	Approved	9/29/2017	4
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	10/17/2017	1	Approved	11/6/2017	20
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	1/24/2017	2	Approved	2/17/2017	24
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	2/7/2017	1	Approved	3/30/2017	51
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	2/8/2017	1	Approved	3/30/2017	50
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	4/20/2017	2	Approved	5/4/2017	14
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	5/9/2017	1	Approved	5/19/2017	10
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	6/2/2017	3	Approved	6/30/2017	28
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	7/7/2017	4	Approved	7/28/2017	21
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	7/11/2017	2	Approved	7/28/2017	17
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	7/31/2017	3	Approved	8/8/2017	8
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	9/25/2017	1	Approved	9/29/2017	4
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	10/17/2017	15	Approved	11/6/2017	20
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	12/4/2017	5	Approved	12/22/2017	18
GAOG10009914	Belridge, South	T28S, R21E, S20	Kern	Aera Energy, LLC	6/2/2017	3	Approved	7/31/2017	59

...continued on next page

Table 2-3. Requests to Add Wells for Stimulated Treatment to Existing Exclusions During Reporting Period (January 1, 2017 - December 31, 2017) (cont'd)

GeoTracker Global Identification	Oil Field	Township (T), Range (R), Section (S)	County	Operator	Date Received for Request of Additional WST Wells	Number of WST Wells added to Approved Exclusions	Status/ Determination	Status/ Determination Date	Days to Complete Review Process ¹
GAOG10009914	Belridge, South	T28S, R21E, S20	Kern	Aera Energy, LLC	7/31/2017	1	Approved	8/4/2017	4
GAOG10009914	Belridge, South	T28S, R21E, S20	Kern	Aera Energy, LLC	10/17/2017	2	Approved	12/22/2017	66
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	7/31/2017	13	Approved	8/8/2017	8
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	8/1/2017	5	Approved	8/21/2017	20
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	10/16/2017	3	Approved	11/3/2017	18
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	12/14/2017	9	Approved	2/2/2018	50
GAOG10010419	Elk Hills	T30S, R23E, S8	Kern	California Resources Corporation	5/4/2017	1	Approved	6/7/2017	34
GAOG10010420	Elk Hills	T30S, R23E, S34	Kern	California Resources Corporation	5/25/2017	1	Approved	6/7/2017	13
GAOG10010422	Elk Hills	T30S, R23E, S33R	Kern	California Resources Corporation	5/24/2017	3	Approved	6/7/2017	14
GAOG10011093	Elk Hills	T30S, R23E, S29R	Kern	California Resources Corporation	11/15/2017	1	Approved	12/12/2017	27
GAOG10008916	Lost Hills	T26S, R20E, S13 and T26S, R21E, S18, S19	Kern	Aera Energy, LLC	5/9/2017	1	Approved	6/6/2017	28
GAOG10011060	McKittrick	T30S, R22E, S7, S17, S8	Kern	Chevron USA, Inc	10/30/2017	3	Review in Progress	--	--
						143 wells			

Notes and Acronyms:

-- = not applicable

WST = well stimulation treatment

- Days to complete the process equates to the elapsed time between the "Date Received for Request of Additional WST Wells " to "Status/Determination Date". This time includes communications with the Operator, Regional Water Board staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence.

43	Number of Requests to Add WST Wells to Approved Exclusions
140	Total number of Approved WST Wells to be Added to Approved Exclusions in 2017
143	Total number of WST Wells Requested to be Added to Approved Exclusions in 2017

2.3.2 Process and Timeline for Reviewing Requests for Exclusion

The process flow chart for reviewing Requests for Exclusion is shown on Figure A-2 in Appendix A. Water Boards staff begin their review after a Request for Exclusion has been uploaded to GeoTracker and has been accepted as complete. Water Boards' staff goal is to respond to the Operator with review comments within 45 calendar days from acceptance of the submittal. After Water Boards staff has completed their review, additional information may be requested, the Request for Exclusion may be denied, or the Request for Exclusion may be approved. A revised request that addresses Water Boards staff comments needs to be submitted to GeoTracker. Approval of a Request for Exclusion is not dependent on an approved ADSA by DOGGR but is based solely on whether sufficient technical information has been submitted to indicate the absence of protected water.

In 2017, the average review time for Water Boards staff to complete the process for a Request for Exclusion (which may have included multiple iterations and requests for additional information from the Operator) was between 78 days (approved) and 87 days (denied). In 2016, the average was 112 days.

On average, the review time for Water Boards staff was 22 days in 2017 to verify proposed WST wells submitted by an Operator were located in an approved area of exclusion. In 2016, an average of 18 days was needed.

2.4 Preliminary Results

Analytical groundwater monitoring data uploaded to GeoTracker from wells sampled and collected as part of Interim GWMPs and Model Criteria GWMPs was reviewed by Water Boards staff. A total of 94 sampling events were submitted into GeoTracker by the end of this reporting period (Table 2-4). A sampling event consists of one or multiple wells sampled during a discrete period of time (i.e. one to multiple days of sampling depending on the number of wells). Each sample is then tested at an analytical laboratory for a suite of analytes per the water quality testing standards, protocols, and procedures in the Emergency Interim Regulations for an Interim GWMP or in the Model Criteria for a post-Model Criteria GWMP.

State Water Board staff used California maximum contaminant levels (MCL) for drinking water⁵ as the comparison criteria for the review. If the test result of an analyte exceeded its respective MCL, further review was performed to assess the magnitude of the exceedance. The objective of this review was to report our findings to the Regional Water Boards for further investigation, where warranted.

A number of analytes exceeded their respective MCLs. However, these analytes are commonly found in groundwater or indicative of poor water quality. TDS is primarily composed of inorganic salts. Common inorganic salts that can be found in groundwater include calcium, magnesium, potassium, and sodium, which are all cations, and carbonates, nitrates, bicarbonates, chlorides,

⁵ https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.shtml

and sulfates, which are all anions. Therefore, elevated concentrations of TDS⁶ may also correlate to elevated concentrations of cations and anions. Other analytes above their respective MCLs were arsenic⁷, barium, strontium, boron, selenium, radium-226, or radium-228⁸, which occur naturally in groundwater from leaching from rock and soil.

Oilfield produced water is a by-product during oil extraction from an oilfield reservoir. The chemistry of produced water, can contain dissolved gases, and similar organic constituents and dissolved solids. The composition of produced water is most commonly influenced by the depositional environment of the oil-field reservoir host rock. If the source rock originated in the sea, then produced water will be saline. Therefore, produced water can contain elevated levels of TDS and other inorganic salts and metals, if the source of the oil is in a marine formation.

State Water Board staff preliminary review did not indicate any analytes of concern except for benzene and TDS at two locations. Analytical data showed elevated concentrations of benzene in shallow groundwater at Lost Hills Oil Field and high concentrations in shallow groundwater of TDS at Buena Vista nose area. The Central Valley Water Board is currently investigating these data and will follow-up with the respective Operators.

⁶ https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_salinity.pdf

⁷ https://www.waterboards.ca.gov/gama/docs/coc_arsenic.pdf

⁸ https://www.waterboards.ca.gov/gama/docs/coc_radionuclides.pdf

Table 2-4. Summary of Sampling Events for the Area-Specific Groundwater Monitoring Program

GeoTracker Global Identification	Oil Field or (Area)	Interim GWMP or GWMP	Township (T), Range (R), Section (S)	County	Operator	Number of Groundwater Monitoring Wells	Sampling Events					Comments
							2014	2015	2016	2017	Total	
GAOG10010818	Belridge, North and South	GWMP	T28S, R20E, S12	Kern	Breitburn Operating, LP	5	NA	NA	NA	0	0	GWMP approved by State Water Board on 10/24/17. No wells stimulated.
GAGW10007878	Belridge, South	Interim GWMP	T28S, R21E, S19	Kern	Linn Operating, Inc.	5	NA	2	1	2	5	Interim GWMP received on 6/29/2015.
GAOG10009277	Belridge, South	GWMP	T28S, R20E, S12, S13, S18	Kern	Aera Energy, LLC	5	NA	4	4	2	10	GWMP approved by State Water Board on 4/11/2017. Sampling data includes interim sampling events since 2015. Stimulation occurred from 1/2/2014 through 11/29/2017.
GAGW10000050	Brea-Olinda	Interim GWMP	T3S, R9W, S6	Orange	Linn Operating, Inc	2	0	2	1	1	4	Interim GWMP received on 4/3/2014. Pre-stimulation groundwater sampling occurred on 9/3/2015. Stimulation occurred on 9/23/2015 to 9/24/2015.
GAGW10000035	Buena Vista (Nose)	Interim GWMP	T32S, R25E, S8	Kern	California Resources Corporation	9	2	2	1	1	6	Interim GWMP received on 2/18/2014. Stimulation occurred on 10/27/2014.
GAOG10009209	Buena Vista (Nose)	GWMP	T31S R24E S36, T31S R25E S31, T32S R25E S3-11, 14-17, & T32S, R24E, S1	Kern	California Resources Corporation	13	NA	NA	NA	2	2	GWMP approved by State Water Board on 11/18/2016. Stimulation occurred on 10/27/2014.
GAGW10000018	Coles Levee, North	Interim GWMP	T30S, R25E, S29, 30	Kern	California Resources Corporation	4	2	2	2	1	7	Interim GWMP received on 8/19/2014. Stimulation occurred on 10/24/2014 to 10/26/2014 and 11/7/2014 to 11/9/2014.
GAGW10007872	Coles Levee, North	Interim GWMP	T30S, S25E, S31	Kern	California Resources Corporation	1	0	3	2	2	7	Interim GWMP received on 9/19/2014. Stimulation occurred on 6/19/2015 to 6/20/2015.
GAOG10010467	Coles Levee, North	GWMP	T30S, R25E, S30	Kern	California Resources Corporation	3	NA	NA	NA	0	0	GWMP approved by State Water Board on 10/24/17. No wells stimulated.
GAGW10000042	Hopper Canyon	Interim GWMP	T4N, R18W, S13	Ventura	DCOR, LLC	2	1	0	0	0	1	Interim GWMP received on 5/22/2014. Pre-stimulation/baseline sampling only conducted in 2014. No wells stimulated.
GAGW10000040	Kettleman Middle Dome	Interim GWMP	T23S, R19E, S19	Kings	California Resources Corporation	1	1	3	0	2	6	Interim GWMP received on 6/11/2014. Stimulation occurred on 11/23/2014 to 11/28/2014 and 2/16/2015 to 3/13/2015. Post stimulation sampling was not performed in 2016.
GAGW10000038	Lost Hills	Interim GWMP	T27S, R21E, S4 and S5	Kern	Aera Energy, LLC	7	3	5	3	1	12	Interim GWMP received on 2/2/2014. Stimulation occurred from 6/4/2014 through 8/7/2017.
GAGW10000039	Lost Hills	Interim GWMP	T27S, R21E, S36	Kern	Seneca Resources Corporation	1	2	2	2	2	8	Interim GWMP received on 3/10/2014. Stimulation occurred on 10/13/2014 and 10/20/2014.
GAOG10010391	Lost Hills	GWMP	T26S, R21E, S29, S32, S33 & T27S, R21E, S5	Kern	Chevron USA, Inc	8	1	3	2	1	7	GWMP approved by State Water Board on 9/20/2017. Sampling data includes interim sampling events since 2014. Stimulation occurred from 3/17/2014 through 9/27/2015.
GAGW10000032	Rose	Interim GWMP	T26S, R24E, S36	Kern	California Resources Corporation	1	1	2	2	2	7	Interim GWMP received on 5/5/2014. Stimulation occurred on 9/16/2014 to 9/22/2014. Pre-stimulation (baseline) sampling event was not performed.
GAGW10000031	Rose	Interim GWMP	T26S, R24E, S26	Kern	California Resources Corporation	2	3	3	2	2	10	Interim GWMP received on 2/18/2014. Stimulation occurred on 10/7/2014 to 10/8/2014.
GAGW10000041	Stockdale	Interim GWMP	T30S, R27E, S22	Kern	Crimson Resources	1	2	0	0	0	1	Interim GWMP received on 7/15/2014. Stimulation occurred on 11/17/2014 – 11/21/2014. Approved Interim GWMP proposed a baseline sampling event and one post-stimulation sampling event.
							18	33	22	21	94	

Notes:

NA = not applicable

Interim GWMPs were approved by DOGGR. Sampling events are required pre-well stimulation and post well stimulation. Events may be zero because well stimulation was not performed, sampling was not performed, or sampling reports have not been uploaded to GeoTracker.

Intentionally Left Blank

3.0 PROPERTY-OWNER NOTIFICATIONS AND REQUESTED WATER SAMPLING

Operators are required to use a third party to notify property owners, or tenants of a property, located within 1,500 feet of the well to be stimulated or within 500 feet of the surface representation of the horizontal path of the area of stimulation. DOGGR is responsible for maintaining records regarding the third-party notification process. The third party sends the property owners or tenants a Well Stimulation Treatment Neighbor Notification Form⁹ (notifications), which includes information such as the earliest date the well may be stimulated and how the property owner may request water quality testing on an existing water well or surface water suitable for drinking. The number of notifications sent by Operators during 2014, 2015, 2016, and 2017 are summarized in Table 3-1.

In 2017, the majority of the notifications (138 out of 140) were sent by Aera Energy, LLC, which corresponds to their activity at North and South Belridge Oil Fields.

Notifications have dropped off from about 1,200 in 2014-15, to just 73 in 2016, and 140 in 2017. Oil prices declined during this same time period resulting in less well stimulation activities.

Table 3-1. Number of Neighbor Notifications Sent by Operators

Operator	2014	2015	2016	2017
Aera Energy, LLC	818	960	29	138
Breitburn Energy Co., LLC	18	-	-	-
Central Resources, Inc	19	-	-	-
Chevron USA, Inc	35	6	-	-
Crimson Resource Management	194	-	-	-
DCOR, LLC	11	-	-	-
Occidental of Elk Hills, Inc	57	36	-	-
Seneca Resources Corporation	19	4	-	-
Vintage Production California, LLC	108	-	-	-
California Resources Elk Hills, LLC	-	5	42	2
Linn Operating, Inc	-	273	-	-
Salt Creek Oil, LLC	-	-	2	-
Total	1,279	1,284	73	140

Source: State Water Board staff communication with Will Flores, Associate Oil & Gas Engineer, DOGGR, Well Stimulation Program. January 10, 2018.

State Water Board staff is required to designate qualified independent third-party contractors (designated contractor) to perform property owner requested water quality sampling. A property owner that has received a notification can access a list of designated contractors on the State

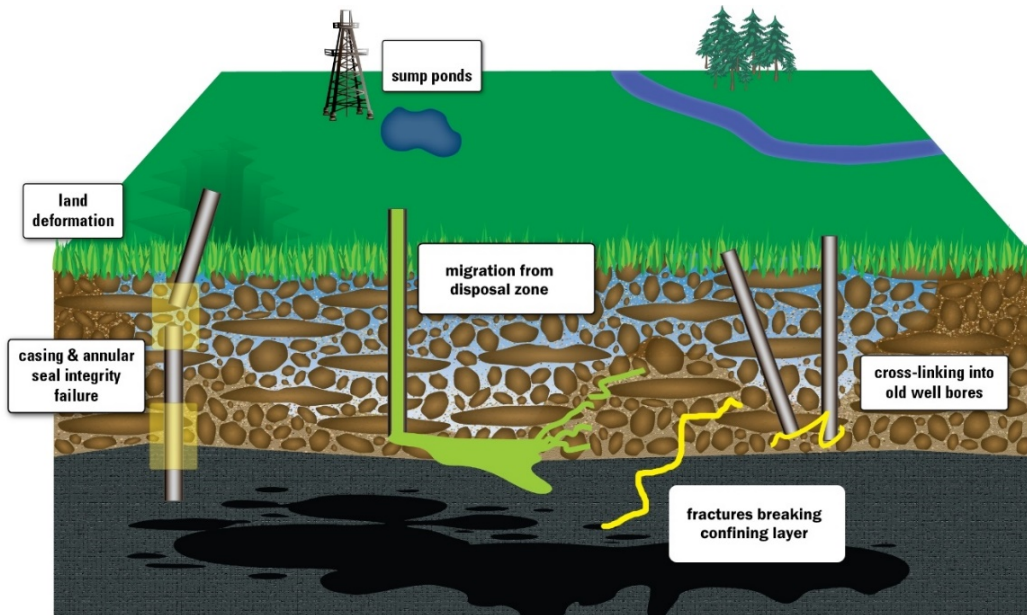
⁹ <ftp://ftp.consrv.ca.gov/pub/oil/forms/Oil%26Gas/WST/WST%20Neighbor%20Notification%20Form.pdf>

Water Board website¹⁰. The designated contractor is to sample in accordance with the standards and protocols outlined in the Model Criteria. Designated contractors are required to notify the State Water Board staff prior to sampling and upload the results to GeoTracker after sampling. During 2017, State Water Board staff did not receive any notifications of water sampling performed by a designated contractor.

The State Water Board staff performed a review of the location of public water system wells in the State Water Board's GeoTracker Groundwater Ambient Monitoring and Assessment Program (GAMA) information system with the locations of wells stimulated in 2017 (as presented on Figures 2-1 and 2-2). According to information in GeoTracker GAMA, there were no water supply wells within 1,500 feet of a stimulated well or within 500 feet of the surface representation of the horizontal path of the bottom of that stimulated well.

4.0 REGIONAL MONITORING PROGRAM

The goal of the RMP is to evaluate potential impacts from oilfield operations and characterize the risk to subsurface water designated for any beneficial use (e.g., drinking water), while prioritizing the highest areas of risks to be monitored. The RMP is evaluating pathways (see illustration below) by which well stimulation treatments and other oil and gas development practices have the potential to contaminate groundwater, such as the injection of water and/or steam during enhanced oil recovery practices, underground oilfield waste injection, or leakage along improperly constructed and/or compromised wells.



Potential Pathways between Oil & Gas Activities and Protected Groundwater
 (Source: USGS, <https://ca.water.usgs.gov/projects/oil-gas-groundwater/science/pathways/>)

¹⁰ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/sampling_contractor/index.shtml

The RMP is designed to answer the following questions:

- Where are protected groundwater resources?
- How close are oil and gas operations and protected groundwater, and what geologic materials (i.e., features and properties) separate them?
- Where is there evidence of fluids from oil and gas sources in protected groundwater? Where does evidence indicate no connections?
- When fluids from oil and gas sources are present in protected groundwater, what pathways or processes are responsible for observed transport?
- Have oil and gas operations as a whole contributed to water-quality changes in groundwater basins?

The approaches being used to answer those questions include: 1) mapping protected groundwater, 2) characterizing and monitoring groundwater in wells near oilfields, and 3) characterizing oilfield fluids. Together, with robust, site-specific information about the local geology, hydrology, and historic disposal areas, these three components will help to systematically and comprehensively collect and interpret information that will support management and protection of waters designated for any beneficial use. Technical lead of the RMP is the United States Geological Survey (USGS). The USGS refers to the work performed under the RMP as the California Oil, Gas, and Groundwater (COGG) Program.

The RMP is being conducted in a phased approach that allows for findings to be assessed which allow for refinements of future work. A “phase” depicts the compilation, review, synthesis, collection, and interpretation of data. Generally, the phases are as follows:

Phase 1 - Prioritizing areas for regional monitoring and collecting groundwater and produced water quality data for high priority oilfields. This phase began in 2015.

Phase 2 – Divided into four primary tasks for each oilfield study area: 1) salinity mapping, 2) groundwater sampling, 3) oilfield fluid sampling, and 4) interpretative analysis of the collected data from tasks 1 through 3. Types of data used in this phase include, historical water sample data, newly sampled water supply and produced water sample data, borehole geophysical logs, well construction, and surface and airborne electromagnetics methods. This phase includes determining gaps in the data, location and installation of monitoring well networks to fill-in those data gaps. This phase also includes a groundwater risk zone analysis. This phase began in 2015.

Phase 3 – If results from Phase 2 indicates there is a high risk to protected groundwater from oil production activities, a data sampling plan will be developed that could include the installation of groundwater monitoring wells.

4.1 Overview of Completed Phases (2015 to 2016)

An overview of completed work by phases is provided below for 2015 through 2016.

Phase 1 – Initiated in 2014, Phase 1 focused on prioritizing areas for regional groundwater monitoring and collecting data from about 100 high priority oilfields. Data obtained from the underground injection control activities and aquifer exemption proposals were used in the prioritization process. Oilfields with the presence of protected groundwater and active oil production were given the highest priority. Work also included exploratory groundwater sampling to verify that chemical constituents used in similar studies elsewhere would also be relevant in California. Analyses of the exploratory data are summarized in the USGS Open-File Report 2016-1100:

“Preliminary results from exploratory sampling of wells for the California Oil, Gas, and Groundwater Program, 2014-15.”

This report is publicly available on the State Water Board Oil and Gas Monitoring website at:

http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/regional_monitoring/index.shtml

Additional published reports completed during this phase include:

Davis, T.A., Kulongoski, J.T., and McMahon, P.B., 2016, *Produced water chemistry data for samples from four petroleum wells, Southern San Joaquin Valley, California*, 2014: U.S. Geological Survey data release.

<https://www.sciencebase.gov/catalog/item/57a50c48e4b0ebae89b6d87f>

Dillon, D.B., Davis, T.A., Landon, M.K., Land, M.T., Wright, M.T., and Kulongoski, J.T., 2016, *Data from exploratory sampling of groundwater in selected oil and gas areas of coastal Los Angeles County and Kern and Kings Counties in southern San Joaquin Valley, 2014–15: California Oil, Gas, and Groundwater Project*, U.S. Geological Survey Open-File Report 2016–1181, 24 p. <https://pubs.er.usgs.gov/publication/ofr20161181>

Phase 2 - In 2016, efforts were focused on salinity mapping in 30 oilfields in Kern County. Well depth and water chemistry data were compiled into numerical databases for use in the regional analyses. Compilations were completed for the Fruitvale Oil Field and are nearing completion for several other oilfields in Kern County.

Using results from the prioritization report (Davis and others, to be published in 2018 – refer to Section 4.4 of this report for full citation), the USGS and the State Water Board collaboratively selected fields for study each year from the high priority list. The first oilfields identified during this process were: Fruitvale, Lost Hills, South Belridge, and North Belridge. Work then began on the four major tasks 1) salinity mapping, 2) groundwater sampling, 3) oilfield fluid sampling,

and 4) interpretative analysis of the collected data from tasks 1 thru 3 in each of these selected fields. The USGS identified suitable locations of groundwater wells and oil wells/injectate sites within these study areas that would meet well and oil fluid sample criteria for the RMP. Once the well locations were determined, the USGS worked with well owners to get permission to collect the samples. In 2016, the USGS sampled 14 water supply wells and eight oil wells/injectate sites in the Fruitvale Oil Field, and 14 water supply or monitoring wells and nine oil wells in the Lost Hills and South Belridge Oil Fields.

4.2 Work Conducted in 2017

A public website (<https://ca.water.usgs.gov/projects/oil-gas-groundwater/>) was developed in 2017 by the USGS that is organized as a Conceptual Study Plan. This website combines information from the public briefings, scientific approaches, and answers questions about the RMP. This website contains a repository of publicly available documents published by the USGS regarding this program and is updated with any new publication.

In 2017, the USGS continued their salinity mapping work, performed airborne electromagnetic surveys, collected well depth and water chemistry data, and met with stakeholders. This work performed in 2017 is summarized below:

- Oil well construction data was extracted and compiled from scanned or paper records include oil well perforation depth and drill date (~40,000 wells), types and depths of geophysical logs collected (~23,000 wells), water well construction information (~25,000 wells), and water chemistry/salinity data combined with well depth (~12,000 wells). Oil-field injection records since 1977 extracted from digital files available from DOGGR are being analyzed. Records of pre-1977 injection, well integrity observations, and formation contact depths are being compiled in selected areas.
- Well depth and water chemistry data was compiled from many sources into numerical databases for use in the regional analyses; depth and chemistry data have been compiled for about 11,000 wells in 470 oilfield areas.
- Salinity mapping continues near high priority oilfields to evaluate groundwater quality by using water sample data, oil well borehole geophysical logs, and collecting airborne and surface geophysical surveys.
- Airborne (helicopter-mounted) electromagnetic survey was performed in areas adjacent to the Elk Hills, North Coles Levee, and South Coles Levee Oil Fields.
- Regional scale salinity mapping was performed on the west side of the San Joaquin Valley using ground-based electromagnetic survey.
- Seventy-four water supply and monitoring wells, as well as eight (8) oil wells and pond sites were sampled in the North Belridge, Cymric, Buena Vista, and Midway-Sunset Oil Fields.
- Analysis of water chemistry data continues for the Fruitvale and Lost Hills/South Belridge/North Belridge study areas. Groundwater and noble gas casing sample data in

Fruitvale and the noble gas casing sample data for the Lost Hills oil wells were sent to well owners.

- Oilfields were prioritized with the USGS for the next sampling events. The following oilfields were identified: Oxnard, Orcutt, Elk Hills, North Coles Levee, and Montebello.
- Updated stakeholders on RMP activities, as summarized in Section 5.3, Strategy #1.

4.3 Preliminary Results

A focus of RMP efforts in 2017 was the compilation, review, analysis, and interpretation of salinity and water sample analysis data obtained at the Fruitvale Oil Field. Preliminary interpretations have been completed, as summarized below, with the finalized results to be published by the USGS in 2018.

Salinity Mapping. The spatial distribution of available water sample salinity data does not provide adequate coverage to clearly define the distribution of protected water near many oilfields. These spatial gaps can be filled in using models of salinity calculated from resistivity, porosity, and temperature data from oil well borehole geophysical logs and calibrated to available water sample data. For example, a salinity model of the Fruitvale-Rosedale Ranch Oil Field area suggests the base of protected water slopes from a depth of about 3,200 feet in the northwest to about 4,200 feet in the southeast. Spatial changes in salinity are related to depth, proximity to groundwater recharge areas, geologic formations, and faulting.

Water Sample Analysis. The analysis of the 14 water supply wells and eight oil wells/injectate sites along with historical data from the Fruitvale Oil Field area show little evidence of fluids from oil development sources in overlying groundwater. Two of the 14 groundwater wells sampled had enriched carbon isotopic values that could be consistent with mixtures of less than 9 percent produced water. One of these wells had a trace detection of methane in 2015 with isotopic values consistent with a petroleum source.

The groundwater quality in the Kern River formation aquifer that overlies the Fruitvale Oil Field is good. The aquifer has high groundwater recharge, young groundwater, and rapid flushing of the aquifer system due to proximity to the Kern River. The wells available for sampling were perforated in the upper 800 feet of the aquifer. Monitoring these relatively shallow aquifer zones does not address processes that may be occurring deeper in protected waters overlying the oilfield production zones. Deeper monitoring would require installing deep monitoring wells. Ongoing monitoring in some existing groundwater wells with trace detections and in proximity to potential risk factors may be warranted.

Based on data collected at the Fruitvale Oil Field, preliminary interpretations suggest that the overall groundwater quality in the aquifer overlying this oilfield is good even though there have been many decades of oil production in this area. The protected water, located in the shallow aquifer overlying the oil production zones has high groundwater recharge and rapid flushing due to the close proximity to the Kern River.

4.4 Upcoming Work in 2018

The following work is planned for the 2018 RMP:

- Sampling groundwater and produced water in the following oilfields: Buena Vista, Midway-Sunset, and Kern River (Kern County), Placerita (Los Angeles County), San Ardo (Monterey County), and Santa Maria Valley (Santa Barbara County).
- Sampling groundwater and produced water in the following oilfields: Elk Hills (Kern County), Montebello (Los Angeles County), Oxnard (Ventura County), and Orcutt (Santa Barbara County).
- State Water Board staff in collaboration with the USGS staff will generate a new list of oilfields based on the prioritization report (Phase 1) for 2018. Sampling data from 2017 may be used to modify the priority of oilfields. Suitable locations of supply water wells and/or oil wells/injectate sites within these oilfields will be identified. Once the well locations are determined, the USGS will work with the landowner (usually the Operator) to get permission to collect the samples.
- Drilling and installation of up to three monitoring well sites for monitoring fluid pressure and water quality at different depths in groundwater systems near selected oilfields, including Lost Hills and South Belridge. The monitoring well sites have been selected to fill-in priority gaps in existing data required for an initial interpretive analysis.
- Publish results from the salinity mapping, groundwater quality, produced water chemistry results, and data collection efforts at the Fruitvale and Lost Hills/South Belridge/North Belridge study areas.
- Data will be sent to well owners in the Lost Hills/South Belridge and Fruitvale/Lost Hills/South Belridge/North Belridge Oil Fields.
- Continue to update stakeholders on RMP activities via technical meetings and other face to face meetings.
- In advance of sampling activities, the USGS will perform the following:
 - Provide written summaries to the Operators of sampling objectives, a general history of major fluid flows (e.g., water disposal, water flood, steam enhanced oil recovery, surface disposal), and proposed areas for monitoring wells.
 - Request review and input from the Operators' technical experts to identify sampling locations, to further document fluid flows, and specific conditions and characteristics of the site to be sampled.
 - Review the information provided by the Operators as input to finalizing the sampling plan and interpretation of the data.

Reports expected to be published in 2018:

Davis, T.A., Landon, M.K., and Bennett, G.L., in press, *Prioritization of California oil and gas fields for regional groundwater monitoring based on a preliminary assessment of petroleum resource development and proximity to groundwater resources*: U.S. Geological Survey Scientific Investigations Report.

Bennett, G.L., and Davis, T.A., *Total well depths for water wells in and near oil and gas fields in California*, compiled 2014-2015, in press, USGS Tabular Digital Data Report.

Metzger, L.F., and Landon, M.K., in press, *Preliminary groundwater salinity mapping near selected oil fields using existing water sample data, Central and Southern California*, U.S. Geological Survey Scientific Investigations Report.

5.0 PERFORMANCE MEASURES

The performance measures for this report were developed during stakeholder meetings held on November 10, 2015 and January 8, 2016. Stakeholders included staff from the DOGGR, Clean Water Action, Environmental Working Group, Chevron USA, California Resources Corporation, Western States Petroleum Association (WSPA), California Independent Petroleum Association (CIPA), and the State Water Board. It is anticipated that these draft performance measures will be periodically re-evaluated and updated through a stakeholder process.

These performance measures are a means to evaluate the effectiveness and efficiency of the Model Criteria. The following section provides an overview of the five performance measures (goals), each corresponding strategy, and actions performed in 2017 to meet each goal. During the review of these performance measures, some actions were identified for 2018 and mentioned below in ***italicized bolded*** text.

5.1 Goal #1: Transparency and Availability of Online Information and Documentation

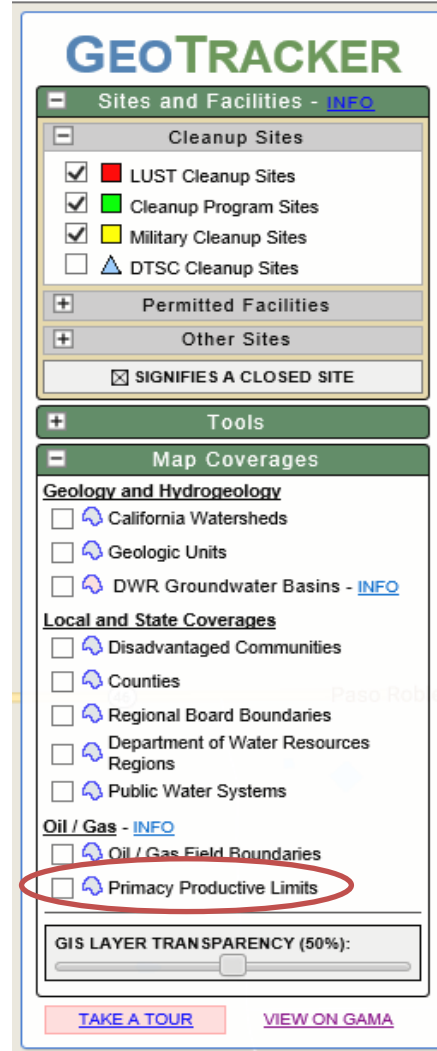
The overall objective of this goal is to provide transparent, effective, and efficient access for the public and state agencies to online information and documentation on the permitting and approval process of well stimulation activities in California. GeoTracker provides public online access to Operator-submitted plans, requests, data, reports, and State agency correspondence. These data and information are publicly available for export and analysis. GeoTracker provides capabilities and guides for Operators to upload information.

Strategies and actions to meet this goal in 2017 include the following:

Strategy #1: Improve and expand upon available data sets and the ability to analyze and manipulate that data.

Action #1: Develop New Tools in GeoTracker. Water Boards staff developed new tools in GeoTracker to facilitate data and information sharing with DOGGR and Operators, as summarized below. Accessibility to tools within GeoTracker may be different on the public website from the regulator website. Therefore, the pertinent website for each tool will also be provided below.

- Added DOGGR “Primacy Production Limits” map layer to the Map Coverages Tools on the left sidebar (see snapshot to the right) (*GeoTracker - Public and Regulator portal*).
- Created fields for Water Boards staff to better manage sites. These tools (under password protection) “Manage My Projects” under “Regulatory Tools” were added so that data can be queried by the public in a more efficient manner (*GeoTracker Regulator portal*).
- The Electronic Submittal of Information (ESI) in GeoTracker has an added field point class of “POILW” for Production Oil Well as a valid value within the “Geo_XY” electronic data deliverable (*GeoTracker - Public and Regulator portal*).
- Expanded the ability to search for WST wells using an American Petroleum Institute (API) number, DOGGR permit number, and Well Number (*Regulator GeoTracker portal*).
- Added a column, titled “Status” within the Proposed Well Stimulation Location Data sub-table, located within each GWMP or GWMP Exclusion webpage. The purpose of this table is to list the WST wells associated with a GWMP or Exclusion. Other columns in this table are: DOGGR Permit number, API number, Operator well number, latitude and longitude of the WST well (top and bottom hole), total measured depth of the WST well, and total vertical depth of the WST well. The possible options for the “Status” column is: Under Review, Approved ADSA, DOGGR Approved, 72-Hour Notice, and Final. The State Water Board changes the status of each WST well when the permit is received from DOGGR (Under Review), ADSA is received from DOGGR



(Approved ADSA), WST permit is approved by DOGGR (DOGGR Approved), upon receipt of the 72-hour notice from the Operator (72-Hour notice), and when DOGGR updates the WST Disclosure website

(<http://www.conservation.ca.gov/dog/Pages/WSTDisclosureSearchDisclaimer.aspx>)

showing the completed WST activity at that well (Final) (*GeoTracker Regulator portal*).

- Updated the Map function to show the boundaries of approved GWMPs or Exclusions under Oil/Gas Sites in the left sidebar (*Regulator GeoTracker portal*). ***This function is planned to appear on the GeoTracker Public portal in 2018.***

Action #2: Consolidate existing oil and gas data into GeoTracker. Water Boards staff is continuing to consolidate existing oil and gas data and information and is transferring that information into GeoTracker (e.g. produced water pond geolocations and associated monitoring data). Continued efforts were made to enter the locations of produced water ponds into GeoTracker. ***This effort will continue into 2018.***

Strategy #2: Improve online user experience with simplified and clear messaging to make data easier to access.

Action #1: Model Criteria Webpage Updates: Periodic updates are made to the State Water Board's Oil and Gas Monitoring Program webpage¹¹. In 2017, updates consisted of uploading the 2016 Annual Performance Report for the Model Criteria and process flowcharts for "Uploading and Reviewing Area-Specific Groundwater Monitoring Plans" and "Reviewing Request for Exclusion from Groundwater Monitoring". Additionally, the USGS updates their COGG Program website¹² periodically. This webpage provides information on the most recent published studies performed to assess the impacts from oil and gas well stimulation activities on a regional groundwater basis in California.

Action #2: Feedback from the Operators. State Water Board staff will seek input from the Operators on using information portals (i.e., GeoTracker, State Water Board's Oil and Gas Monitoring Program website).

Strategy #3: Create data communication/ sharing strategy to optimize data and information sharing between the State Water Board, Regional Water Boards, DOGGR, and other agencies, as appropriate.

Action #1: Sharing data. The State Water Board continues to implement the "Oil and Gas Data Communication and Data Sharing Plan for the State Water Resources Control Board and Division of Oil, Gas and Geothermal Resources" (Data Sharing Plan, June 1, 2016¹³). The Data Sharing Plan was developed by the Water Boards, in collaboration with DOGGR, with the objective of outlining current Water Boards and DOGGR oil and gas data systems, existing communication and data sharing processes, and strategies

¹¹ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/

¹² <https://ca.water.usgs.gov/projects/oil-gas-groundwater/>

¹³ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/docs/data_sharing_plan_06012016.pdf

for future data sharing between the agencies. Effective sharing of oilfield related data and information will help streamline regulatory efforts, avoid duplicity of collection and submittal requirements, facilitate data submittal processes for Operators, and help provide the public easy access to the information. For example, the Water Boards and DOGGR have created a secure file sharing and online storage “drop box” to easily share documents.

Action #2: Coordinated Meetings/Conference Calls. Currently, the Water Boards and DOGGR meet at least monthly in person or via conference calls but not always with the focused intent of assessing ways to improve data systems and data sharing. ***Water Boards and DOGGR staff plan to discuss data sharing between GeoTracker and DOGGR’s Well State Tracking and Reporting (WellSTAR) system once it’s released.***

Action #3: Process Sharing. Process flow charts and tracking tables are shared between agencies to help ensure logical flow and consistency between data and information sharing. In 2017, DOGGR provided a training session on the process of performing ADSA reviews to the Water Boards. DOGGR and the Water Boards also developed guidelines to clarify responsibilities of each agency in reviewing WST well permit applications and ADSA analyses. The objective is intended to streamline reviews and avoid duplicative efforts between agencies. ***Periodic review and updates of procedures and checklists will be conducted based on lessons learned.***

5.2 Goal #2: Provide Clear Milestones and Timely Deliverables

The objective of this goal is to 1) report on the completion of the milestones and deliverables included within the Model Criteria and Senate Bill 4 and to 2) provide timely deliverables (i.e., staff letters) during the review of GWMPs, Requests for Exclusion, and requests to add WST wells to already approved groundwater exclusions.

Strategies and actions to meet this goal in 2017 include the following:

Strategy #1: Make milestones and deliverables outlined in the Model Criteria and Senate Bill 4 (Chapter 313, Statutes of 2013, including Water Code section 10783), publicly available.

Action #1: Availability of Milestone Schedule. Milestone schedule¹⁴ and status of Senate Bill 4 deliverables are provided on the State Water Board website. All of the milestones included on this schedule have been completed except for 1) the review and evaluation of the threshold values for acid matrix stimulation treatments, and 2) review of the criteria for exclusion from groundwater monitoring (i.e., whether groundwater containing more than 10,000 mg/L TDS and whether exempt aquifers pursuant to 40 CFR 146.4 should be subject to groundwater monitoring). The deadlines for these milestones are planned for January 1, 2020.

¹⁴ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/docs/sb4_deliverable_schedule.pdf

Strategy #2: Prepare review processes, flowcharts, and timelines for reviewing groundwater monitoring plans and requests for exclusion from groundwater monitoring, including interagency collaboration and program efficiencies.

Action #1: Updated Process Flowcharts. State Water Board staff reviewed, updated, and posted process flowcharts for “Uploading and Reviewing Area-Specific Groundwater Monitoring Plans” and “Reviewing Request for Exclusion from Groundwater Monitoring” on the Oil and Gas Monitoring webpage¹⁵. These flowcharts provide the Operator’s process for uploading GWMPs or Exclusions from Groundwater Monitoring into GeoTracker and the Water Board’s process for review. Estimated timelines for responding to the Operator is provided in these process flow charts.

Action #2: Preparation of Annual Model Criteria Performance Report. State Water Board staff prepared and made publicly available the first “Annual Model Criteria Performance Report” (dated May 5, 2017) for the reporting period from July 7, 2015 through December 31, 2017. This report is posted on the Oil and Gas webpage under Performance Measures¹⁶. This 2017 Annual Model Criteria Performance Report will be available on the website in March 2018. **The next Annual Model Criteria Performance Report documenting for the 2018 calendar year will be drafted. Final publication is anticipated for March 2019.**

Action #3: Evaluate State Water Board’s Timeliness of Review. An evaluation of the time to review deliverables by Water Boards staff was performed for this report. As mentioned in Action #1 above, estimated timelines of the State Water Board’s response are provided in the “Area-Specific Groundwater Monitoring” and “Requests for Exclusion from Groundwater Monitoring” process flowcharts. The goal of review times for both processes is:

- State Water Board responds to the Operator within 45 calendar days from acceptance of the GWMP into GeoTracker.
- Regional Water Board provides review comments to State Water Board within 30 calendar days.

Time spent to review GWMPs, Requests for Exclusion, and requests to add WST wells to existing GWMPs (GWMP addendums) or exclusions is summarized below for 2016 and 2017 (Table 5-1). On average, time spent during the review process was close to the goal of 45 days for new GWMPs, GWMP addendums, and Requests for Exclusion in 2017. New GWMPs were reviewed in an average of 78 days, GWMP addendums were reviewed in an average of 49 days, and Requests for Exclusion were reviewed in 78 to 87 days. Average time spent reviewing any request to add WST wells to an approved exclusion were reviewed in 21 days.

¹⁵ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/area_specific_monitoring/index.shtml

¹⁶ https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/performance_measures/index.shtml

Table 5-1. Average Days to Complete Review Process by the Water Boards

Item to Review	Calendar Days		
	Goal	2016	2017
New GWMP	45	not estimated	78
GWMP Addendums	45		49
Request for Exclusion	45	112	78 (approved) to 87 (denied)
Request to Add WST Wells to Existing Exclusion	not established	18	22

Note:

Days to complete the process equates to the elapsed time between the Date Received in GeoTracker to the date of the Approval or Denial Letter from the State Water Board. For GWMPs or Requests for Exclusion with multiple revisions, days to complete the process equates to the days to review the last submittal. Review time includes communications with the Operator, Water Boards staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence.

Overall, the review process times improved from 2016 to 2017 (Table 5-1). Factors that contributed to longer review times than goal in 2017 were: 1) training new staff on procedures and standards, and 2) hydrogeologic and geologic conditions that exist at these oilfields can be very complex; thereby, more time for the review process between Water Boards staff and the Operator is needed.

Days to complete a review are dependent on the completeness of the submittal from the Operator because the data provided does not meet the minimum standards of the Model Criteria. During these cases, Water Boards staff requests the Operator to revise the GWMP or exclusion, sometimes more than once. Because of these revisions, the review time may lengthen by several months. In an extreme case, the review time was lengthy due to complications of the applicability of the produced water ponds to the Model Criteria (i.e., over 200 days for a GWMP at South Belridge – Linn Operating, Inc – GeoTracker ID#: GAOG10009958). ***Moving forward, Water Boards staff will perform a completeness review of an Operator’s submittal within 14 working days of receipt into GeoTracker to communicate any deficiencies to the Operator.***

5.3 Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health

The objective of this goal is to assess groundwater monitoring data as required in the approved GWMPs. There have been a total of 94 groundwater sampling events uploaded into GeoTracker for GWMPs and Interim GWMPs for sampling events through 2017. A breakdown of sampling events by year is provided in the table to the right. Strategies and actions to meet this goal in 2017 include the following:

	2014	2015	2016	2017
Total Number of Sampling Events Uploaded into GeoTracker by Year	18	33	22	21
Total Number of Sampling Events				94

Strategy #1: Provide regular assessments of monitoring data, including pilot study results and identification of any chemicals of concern.

The Model Criteria was developed to assess the potential impact of well stimulation treatments on groundwater resources and consists of two groundwater monitoring activities: area-specific groundwater monitoring conducted by Operators and the RMP. Water quality information collected as part of the approach defined in the Model Criteria will help evaluate groundwater and hydrogeological conditions, including establishing a baseline of water quality that will be used to assess future potential impacts. Due to the large scale associated with this monitoring program, it will take a considerable amount of time before an appropriate level of data is collected, the density of the groundwater monitoring well network is fully established, and a baseline of water quality is determined. State Water Board staff will consider the USGS and Operator recommendations when assessing if information being collected is effective in understanding potential impacts to groundwater resources from well stimulation activities.

Action #1: Technical Briefings of Regional Monitoring Program. In 2017, the USGS provided technical briefings on the following subjects to the Stakeholders.

- May 15, 2017 - *Update on Oil and Gas Regional Groundwater Monitoring and Analysis Activities, June 2016-April 2017.*
- Past publications are located on the USGS' California Oil, Gas, and Groundwater (COGG) Program website at <https://ca.water.usgs.gov/projects/oil-gas-groundwater/>.

Other Stakeholder meetings were held in 2017 with WSPA, CIPA, and the State Water Board staff and were conducted, as follows:

- March 8, 2017 - Review of Produced Water Sampling/ RMP efforts
- June 7, 2017 - Review of Produced Water Sampling/ RMP efforts
- November 9, 2017 –Current RMP Program efforts

- December 13, 2017 – Discussion of questions raised by WSPA and CIPA regarding the RMP Program Implementation

Additional technical briefings will be scheduled in 2018 to review area-specific groundwater monitoring or RMP results.

Action #2: Provide stakeholders with information on the overarching objectives and ongoing activities for the RMP. In 2017, the USGS and the State Water Board has created new websites and updated existing websites to enhance transparency and share information pertaining to the RMP as follows:

- In 2017, the USGS established the COGG Program website (<https://ca.water.usgs.gov/projects/oil-gas-groundwater/>). This website provides an overview of the objectives for the RMP as well as an explanation of the technical approaches currently being used for salinity mapping, construction of the geologic framework, regional sampling design, evaluation of potential pathways, and geochemical end-member mixing analyses.
- The State Water Board has maintained and updated the Oil and Gas Monitoring Program website to provide stakeholders with updated information on area-specific groundwater monitoring, RMP, property owner sampling, and performance measures (https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/).

Action #3: Provide information to Operators in advance of RMP sampling to promote transparency. Prior to conducting sampling in areas of oil and gas operations, the State Water Board and the USGS have held “kick-off” meetings with Operators and have provided Operators with a summary of the scope and goals of the sampling program and the rationale for selected sampling points. Additional meetings and iterative discussions were held prior to sampling efforts to request feedback from Operators on the proposed sampling programs. A summary of interactions with Operators prior to sampling efforts is provided in Table 5-2. ***The USGS will provide summaries of site characteristics and site selection criteria to Operators in advance of sampling in areas of oil and gas operations. Input will be requested from Operators’ technical experts and this information will be evaluated for use in design of the RMP sampling program for that oilfield.***

Action #4: Provide an analysis of preliminary data of the most significant results. A summary of the results of the data collected to date is provided in Section 2.4 for the Area-Specific Groundwater Monitoring Program and in Section 4.3 for the Regional Monitoring Program of this report.

During this analysis and the process of reviewing GWMPs and WST permit applications, the State Water Board recognizes that the indicator compounds and/or tracer compounds proposed by the Operators may or may not be discernible, recognizable, or traceable in groundwater. The presence or absence of the appropriate compounds is critical in understanding if WST fluids have migrated beyond containment included in the

GWMP. State Water Board staff will work with the USGS and other state agencies to better understand which WST fluid chemical constituents are the most appropriate indicators. The State Water Board will be requesting from the Operator as part of the GWMP (new or addendum) submittal process a list of possible indicator and/or tracer compounds so that State Water Board staff can start the evaluation process.

The Operators use TDS data as evidence to support areas of protected water in a GWMP (new or addendum) or the lack thereof, for a Request for Exclusion. Therefore, TDS data is a critical and the best available data should be used. In addition to the Operators' interpretation of TDS on geophysical logs, **Water Boards staff will also request submittal of groundwater analytical results for TDS to confirm the Operator's TDS interpretations.**

Table 5-2. Regional Monitoring Program Interaction with Operators in Advance of Sampling

Steps/Actions	Elements of each Action	Timeline
Email notification to Operator	High level overview of the Regional Monitoring Program (RMP).	60 days in advance of mobilization
	Scope of the sampling program/summary of samples to be collected ("the what").	
	Rationale for selecting sampling points ("the why").	
	Overarching goals of the sampling program ("why we're looking for the data").	
	Logistics for sampling.	
	Points of contact.	
	<i>New step - The USGS will provide written summaries of sampling objectives, a general history of fluid flow, and proposed areas and depth zones for sampling.</i>	
	<i>New step - The USGS will request review and input from Operators' technical experts to identify sampling locations, further document fluid flows, and specific conditions and site characteristics of the sites to be sampled.</i>	
	<i>New step - The USGS will evaluate information received from the Operators for use in finalizing the sampling plan and to consider in interpretation of the data collected.</i>	
Kickoff meeting	PowerPoint presentation of the proposed field program.	30 days in advance of mobilization
	Dialogue between SWRCB/USGS and Operator regarding the proposed field program.	
Follow-up	Operators provide input and feedback on the proposed sampling program.	14 days in advance of mobilization
	Iterative discussions between SWRCB/USGS and Operator regarding sampling program plans and logistics.	

Strategy #2: Mitigate problems as they occur and share mitigation efforts with stakeholders.

Action #1. Develop Work Plan. If data demonstrates a potential water quality or public health concern, the Water Boards staff will develop a work plan to address the concerns and information will be made available to the public. Data available thus far has not indicated any significant water quality concerns.

Action #2: Actions by Regional Water Boards. Based on the review of groundwater sampling results from wells sampled according to approved GWMPs, there are two efforts in progress by the Central Valley Water Board to further understand potential water quality concerns, as summarized in Section 2.4 of this report.

Strategy #3: Develop a plan to re-evaluate the effectiveness of monitoring. Modify the scope of work and approach based on evaluation of the data collected and evaluated.

Action #1: Re-evaluate Model Criteria. The State Water Board staff reviews the Model Criteria periodically to determine if an update is necessary. At this time, there are no current plans to update or modify the Model Criteria.

The use of the United States Environmental Protection Agency's definition of an Underground Source of Drinking Water (USDW) as containing less than 10,000 mg/L TDS in groundwater (40 CFR part 144.3) and whether exempt aquifers pursuant to 40 CFR part 146.4 shall be subject to groundwater monitoring shall be reviewed by the state board through a public process on or before January 1, 2020.

Action #2: Evaluate Monitoring Programs. The proposed scope to evaluate each of the monitoring programs is summarized below:

Area-specific Groundwater Monitoring: Monitoring data collected for the area-specific groundwater monitoring program is uploaded into GeoTracker. These data will be analyzed to help establish a baseline of water quality conditions that will be used to assess future potential impacts. These data will also be evaluated to assess if the required list of analytes provided in the Model Criteria should be modified to include fewer analytes or additional analytes.

In the 2017 Annual Model Criteria Performance Report Conducting, a survey was planned with the purpose of asking the Operators to provide information on how the area-specific groundwater monitoring is working for them, lessons learned, and any additional feedback for suggested modifications to the Model Criteria requirements. Feedback has been gathered informally during project meetings since the adoption of the Model Criteria. However, a formalized survey was not sent to the Operators in 2017. **Since the adoption of the Model Criteria will be 3 years old on July 7, 2018, State Water Board staff will request formal responses from the Operators in 2018.**

Regional Monitoring: The USGS is tasked to report on analysis of regional monitoring data after three years of interpretive data collection. The USGS will include information collected as part of the area-specific groundwater monitoring. The results of these analyses will be used to evaluate, if any potential revision(s) to the Model Criteria are necessary.

Strategy #4: Coordinate with other agencies to identify risk.

Action #1. Gather, Consolidate, and Publish Lessons Learned. The State Water Board staff requested a list of lessons learned from the staff at the Regional Water Boards, USGS, and DOGGR. The accumulated lessons learned during this reporting period are provided in Section 6.0 of this report.

Action #2: Gather, Consolidate, and Publish Significant Findings. Significant findings from the RMP to date are provided in Section 4.3 of this report and a list of current publications is provided in Section 4.0 of this report.

5.4 Goal #4: Provide Region-Specific or Localized Flexibility

The objective of this goal is to consider localized conditions (i.e., geologic, hydrogeologic, land use restrictions, access restrictions, monitoring frequency) when reviewing GWMPs or Requests for Exclusion. The strategies for this goal include:

- 1) Coordinate with other agencies to identify risks.
- 2) Clearly communicate why region- specific activities are occurring.
- 3) Use consistent flexibility criteria for monitoring.

The Model Criteria allows for alternative plans. However, none have been submitted. Additionally, the RMP is geared towards evaluating any regional geological trends that may provide further guidance in the review of those plans. As these region-specific situations are identified (see Section 4.0 of this report), they are included in this report.

5.5 Goal #5: Assess Implementation Costs

State Water Board staff, in cooperation with Operators and representatives from CIPA and WSPA, developed a list of information needed to assess Operator costs. CIPA, in collaboration with WSPA, used a third-party aggregator to collect and report Operator costs associated with the implementation of the Model Criteria.

Estimated Operator costs for the periods of 2014 through 2016 and for 2017 is summarized in Table 5-3. According to this information, between 2014 and 2017 approximately \$10.6 million was spent by Operators on implementing groundwater monitoring as part of requirements in GWMPs. There was a decrease from 176 well stimulation treatments from 2014 through 2016 to 34 well stimulation treatments in 2017 associated with GWMPs. Approximately 451,000 barrels of oil was produced from these 34 wells in 2017, which is approximately a 67 percent reduction

in production. Overall, an estimated 1.8 million barrels (bbl) of oil has been produced from a total of 210 stimulated wells since 2014.

Since 2014, an estimated total of \$150,000 has been spent by the Operator on submittals for Requests for Exclusion, and a total of 1,211 wells have underwent stimulation treatments producing an estimated total of 9.7 million bbl of oil.

Fourteen Water Boards staff positions have been identified to work on implementing the Model Criteria, with an approximate expenditure of \$1.96 million per year. The USGS is under a contract agreement with the Water Boards to implement the RMP at less than \$7.25 million per year funded through the Oil, Gas and Geothermal Administrative Fund.

Table 5-3. CIPA and WSPA Estimated Operator Costs

		2014 through 2016 (1)	2017
Groundwater Monitoring Plans	Number of Groundwater Monitoring Plans Developed	19	7
	Total Cost	\$517,250	\$207,843
Monitoring Well Installation	Number of Wells Installed	19	12
	Total Cost	\$5,806,232	\$2,000,673
Sampling and Reporting	Number of Samples Collected	105	85
	Number of Reports Submitted	28	12
	Total Cost	\$990,000	\$418,702
Laboratory Testing	Number of Samples Analyzed	86	80
	Total Cost	\$172,500	\$188,490
Other Subcontractor and Consultant Fees		\$111,969	\$150,000
<i>Total Cost (Capital + Opex)</i>		<i>\$7,597,951</i>	<i>\$2,965,708</i>
Number of Well Stimulation Treatments Performed		176	34
Oil Production from Stimulated Wells (bbl)		1,362,969	451,478
Numbers of Requests for Exclusion		11	7
<i>Total Cost</i>		<i>\$73,710</i>	<i>\$76,075</i>
Number of Well Stimulation Treatments Performed		1,089	122
Oil Production from Stimulated wells (bbl)		9,438,976	296,336
<i>Estimated Total Operators Cost</i>		<i>\$15,000</i>	<i>\$18,000</i>
Oil Produced subject to Model Criteria Requirements (bbl)		10,801,945	451,478
Estimated Groundwater Monitoring Cost per Sample		\$72,361	\$34,891
Groundwater Monitoring Cost per bbl of Oil		\$5.57	\$6.57
Average Cost of Compliance per Monitoring Well		\$43,170	\$87,227

Note: (1) Reporting period equal to 2.5 years.

6.0 LESSONS LEARNED AND PLANNED ACTIONS FOR 2018

This section provides lessons learned gathered from the State Water Board, DOGGR, Central Valley Water Board, and the USGS resulting this past year of implementing the Model Criteria, including the Regional Monitoring Program. All of the GWMPs and Requests for Exclusion reviewed this year were located in the Central Valley Water Board.

Table 6-1 organizes the lessons learned into six (6) major program categories: site access, data complexity, data gathering, data analysis, program development, and external feedback. This table describes the lesson, the relative impact to the Model Criteria program, and the next steps or actions planned to 2018 for each lesson.

Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2018

Performance Measure Goal	Lesson	Next Steps/Actions for 2018
<p>Goal #1: Transparency and Availability of Online Information and Documentation</p>	<p>Lack of access to oilfields (or portions thereof) for sampling impedes the implementation of the Regional Monitoring Program (RMP).</p>	<p>Water Boards staff will continue to communicate with the Operators the importance of the RMP and the many benefits. Example ways to engage with the Operators using fact sheets, stakeholder meetings, and at project meetings.</p>
	<p>Hydrogeologic and geologic conditions that exist at these oilfields can be very complex; thereby, review time may exceed goal.</p>	<p>Water Boards staff will continue to work with the Operators as efficiently as possible during the review process and proactively communicate any of the Water Boards' concerns.</p>
	<p>Greater access to digital records held by Operators would improve the efficiency of the regional monitoring program. Extracting and compiling information from paper records is very time consuming.</p>	<p>USGS will continue to reach out to the Operators and state agencies during the initial planning process to ask for digital records.</p>
	<p>The Operators have valuable site-specific data and knowledge that should be considered by the USGS in the design of the RMP sampling program.</p>	<p>The USGS will provide a summary of site characteristics and site selection criteria as part of the notification to Operators prior to RMP sampling. The USGS will request input from Operators' technical experts to be evaluated for use in design of the sampling program.</p>
	<p>User experience from the Operator's perspective with information portals should be evaluated.</p>	<p>State Water Board staff will request input from the Operators on user experience with information portals (i.e., GeoTracker GAMA, State Water Board's Oil and Gas Monitoring Program website).</p>
	<p>GeoTracker and the newly released WellSTAR website provide Operators online access to their data. Any unnecessary overlaps or data gaps in these systems should be evaluated focusing on the Model Criteria.</p>	<p>State Water Board will perform semi-annual meetings with DOGGR focused on data sharing between GeoTracker and DOGGR's WellSTAR to leverage existing capabilities and reduce redundancies between agencies, and meet the Model Criteria data needs.</p>

...continued on next page

Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2018 (cont'd)

Performance Measure Goal	Lesson	Next Steps/Actions for 2018
Goal #1: Transparency and Availability of Online Information and Documentation (cont'd)	The development of standard procedures, checklists, and staff training are critical for statewide consistency and efficient program implementation.	Internal Water Boards staff training has been developed and will be evaluated for potential improvement. Periodic review and updates of procedures and checklists will be conducted based on lessons learned.
	GeoTracker updates to the public are periodically needed.	Provide GeoTracker map function to show boundaries of approved GWMPs or Exclusions to the public.
Goal #2: Provide Clear Milestones and Timely Deliverables	Annual performance evaluation is a necessary step for continuous improvement of the program.	State Water Board staff will prepare the 2018 Model Criteria Performance Report – Final publication anticipated March 2019.
	Incomplete and poor quality of the Operator's submittal affects the review.	Water Boards staff will perform a completeness review of an Operator's submittal within 14 days of receipt in GeoTracker to communicate any deficiencies to the Operator.
Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health	Transparency of the data results is essential for program success and to get Operator's feedback.	State Water Board staff will schedule technical briefings with stakeholders to communicate results from the RMP.
	Implementability of the Model Criteria from the Operator's perspective has not been evaluated.	State Water Board staff will request input from the Operators with respect to the implementation of the area-specific groundwater monitoring, and request feedback for suggested modifications to the Model Criteria.
	Better understanding of tracer and/or indicator compounds is needed to determine the persistence of WST fluids.	State Water Board staff will continue to work with the USGS and other state agencies to better understand which compounds used in WST fluids are the most appropriate tracer and/or indicator compounds.
		State Water Board staff will work with the Operators to provide a list of possible indicator and/or tracer compounds in the submittal for a GWMP (new or addendum).

...continued on next page

Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2018 (cont'd)

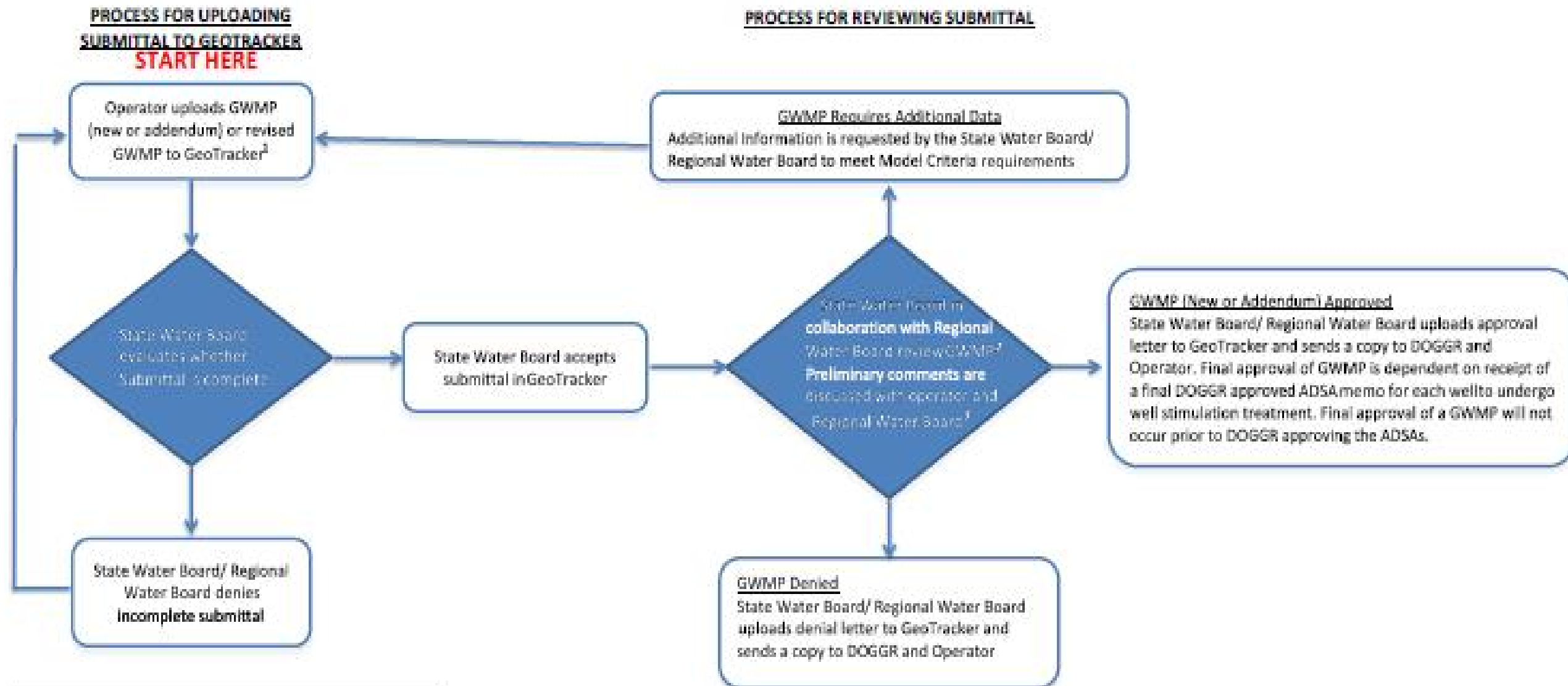
Performance Measure Goal	Lesson	Next Steps/Actions for 2018
Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health (cont'd)	Laboratory water sample analysis for TDS is an important tool to use in confirming TDS interpretations obtained from geophysical logs.	Water Boards staff will request submittal of groundwater analytical results for TDS as part of the Operator's evidence of protected water in a GWMP (new or addendum) and in a Request for Exclusion.
Goal #4: Provide Region-Specific or Localized Flexibility	None identified.	
Goal #5: Assess Implementation Costs	None identified.	

APPENDIX A PROCESS FLOW CHARTS

APPENDIX A: LIST OF FLOW CHARTS

Flow Chart A-1	Process Flow Chart for Uploading and Reviewing Area-Specific Groundwater Monitoring Plans (New or Addendum)
Flow Chart A-2	Process Flow Chart for Reviewing Request for Exclusion from Groundwater Monitoring
Flow Chart A-3	Process Flow Chart for Reviewing Well Stimulation Permit Applications

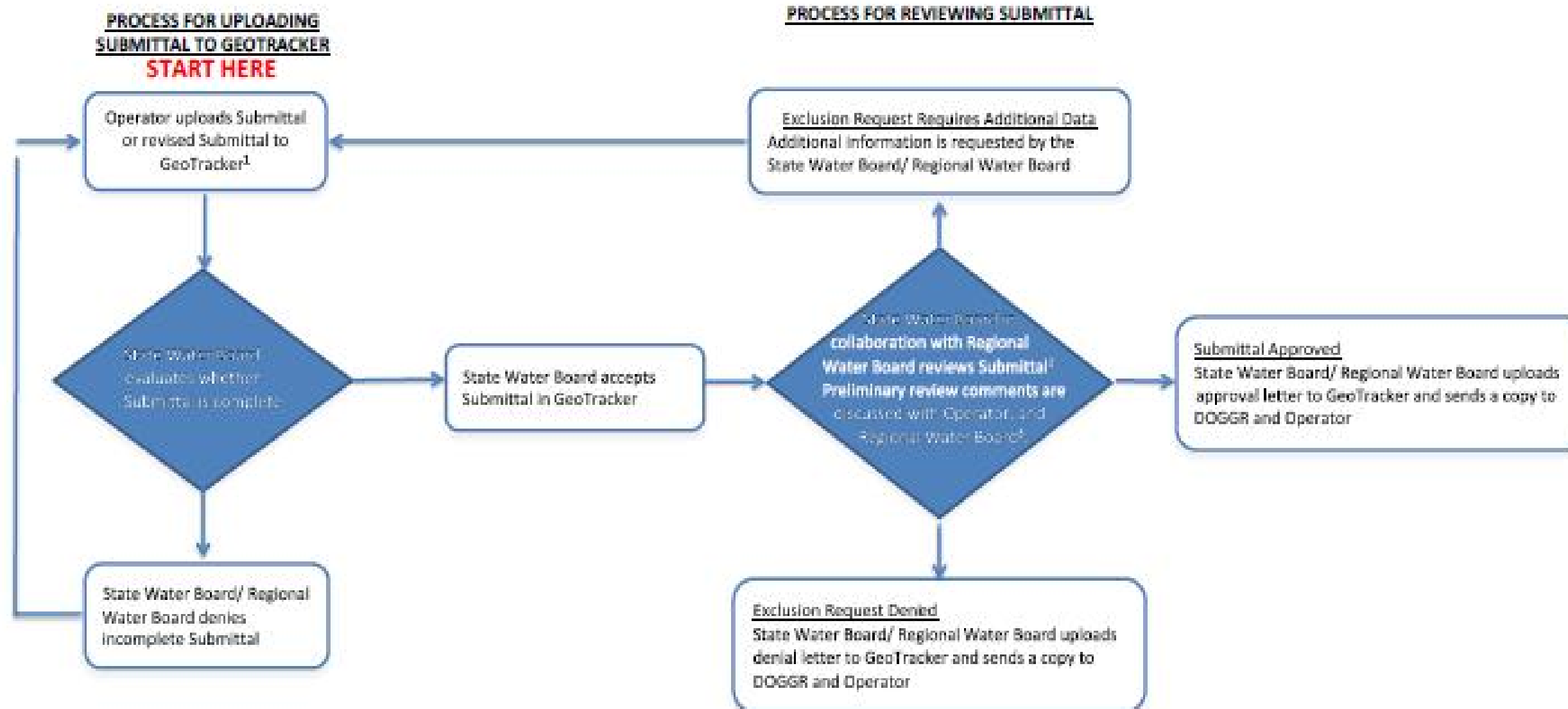
Flow Chart A-1. Process Flow Chart For Uploading and Reviewing Area-Specific Groundwater Monitoring Plans (New or Addendum)
State Water Resources Control Board
Oil and Gas Monitoring Unit



DEFINITIONS
 ADSA = Axial Dimensional Stimulation Area
 DOGGR = Division of Oil, Gas, and Geothermal Resources
 GWMP = Groundwater Monitoring Plan
 Regional Water Board = Regional Water Quality Control Board
 State Water Board = State Water Resources Control Board

FOOTNOTES
 1. New monitoring plans, or addendums to existing monitoring plans, submitted after July 7, 2015 must follow the requirements outlined in the [Model Criteria for Groundwater Monitoring in areas of Oil and Gas Well Stimulation \(Model Criteria\)](#).
 2. Regional Water Board provides review comments to State Water Board within 30 calendar days.
 3. State Water Board staff will respond to the Operator in 45 calendar days from acceptance of a complete GWMP.

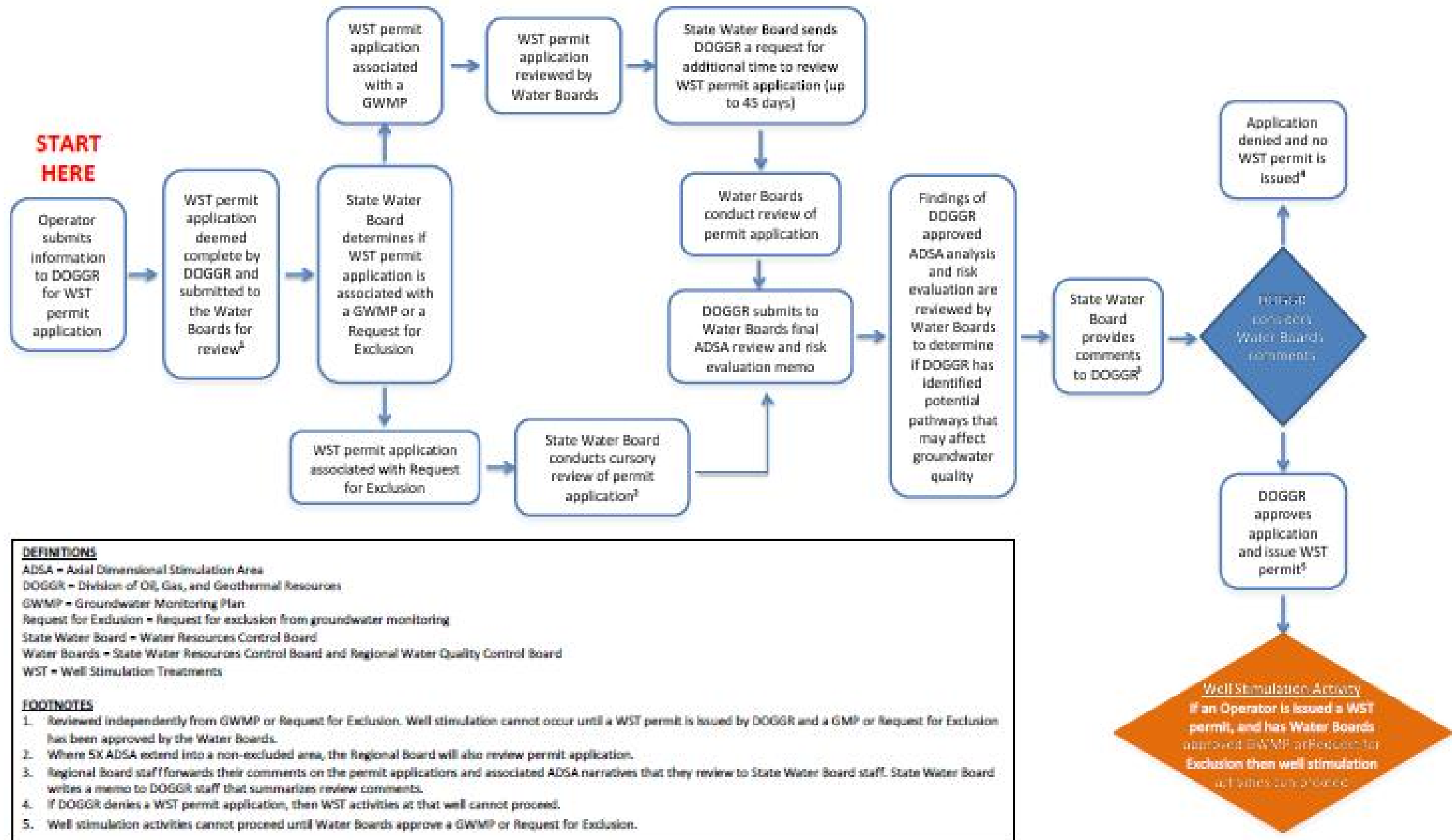
Flow Chart A-2. Process Flow Chart For Reviewing Request For Exclusion From Groundwater Monitoring State Water Resources Control Board Oil and Gas Monitoring



DEFINITIONS
 DOGGR = Division of Oil, Gas, and Geothermal Resources
 Regional Water Board = Regional Water Quality Control Board
 Submittal = Request for Exclusion from Groundwater Monitoring
 State Water Board = State Water Resources Control Board

FOOTNOTES
 1. Requests for exclusion from groundwater monitoring submitted after July 7, 2015 must follow the requirements outlined in the [Model Criteria for Groundwater Monitoring in areas of Oil and Gas Well Stimulation \(Model Criteria\)](#). If future information indicates the potential presence of protected water in an area granted exclusion from groundwater monitoring, the State Water Board/ Regional Water Board will re-evaluate its determination.
 2. Regional Water Board provides review comments to State Water Board within 30 calendar days.
 3. State Water Board staff will respond to the Operator in 45 calendar days from acceptance of complete submittal.

Flow Chart A-3. Process Flow Chart For Reviewing Well Stimulation Permit Applications
State Water Resources Control Board
Oil and Gas Monitoring Unit



DEFINITIONS
 ADSA = Axial Dimensional Stimulation Area
 DOGGR = Division of Oil, Gas, and Geothermal Resources
 GWMP = Groundwater Monitoring Plan
 Request for Exclusion = Request for exclusion from groundwater monitoring
 State Water Board = Water Resources Control Board
 Water Boards = State Water Resources Control Board and Regional Water Quality Control Board
 WST = Well Stimulation Treatments

FOOTNOTES
 1. Reviewed independently from GWMP or Request for Exclusion. Well stimulation cannot occur until a WST permit is issued by DOGGR and a GMP or Request for Exclusion has been approved by the Water Boards.
 2. Where SX ADSA extend into a non-excluded area, the Regional Board will also review permit application.
 3. Regional Board staff forwards their comments on the permit applications and associated ADSA narratives that they review to State Water Board staff. State Water Board writes a memo to DOGGR staff that summarizes review comments.
 4. If DOGGR denies a WST permit application, then WST activities at that well cannot proceed.
 5. Well stimulation activities cannot proceed until Water Boards approve a GWMP or Request for Exclusion.