



550 West Locust Avenue  
Fresno CA 93650  
P 559.497.2880  
F 559.497.2886  
www.bskassociates.com



TRANSMITTED VIA EMAIL

[commentletters@waterboards.ca.gov](mailto:commentletters@waterboards.ca.gov)

May 29, 2015

Ms. Jeanine Townsend, Clerk to the Board  
State Water Resources Control Board  
1001 I Street, 24<sup>th</sup> Floor  
Sacramento, California 95814

SUBJECT: Comment Letter  
Model Criteria for Groundwater Monitoring  
Areas of Oil and Gas Well Stimulation

Dear Ms. Townsend:

BSK Associates is providing the following comments regarding the April 29, 2015 *Draft Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation* (Draft Model Criteria) prepared by the State Water Resources Control Board (Water Board). BSK is an environmental engineering consulting firm and we also operate an environmental analytical laboratory. Over the past year, BSK has prepared and implemented several Groundwater Monitoring Plans (GMPs) for petroleum producers conducting well stimulation treatment (WST) operations throughout California's southern San Joaquin Valley. In addition, we provide engineering services on a variety of other projects overseen by the Water Board. The following comments are based on BSK's experience with the preparation of GMPs and implementation of the associated groundwater monitoring programs.

General comments pertaining to the overall approach proposed in the Draft Model Criteria are presented first, then followed by section-specific comments. The portion of the Draft Model Criteria addressed below is provided in bold font, with BSK's comment immediately following in regular font. Other sections that BSK's comment applies to throughout Draft Model Criteria are listed following the initial comment in regular font.

#### GENERAL COMMENTS

The listed purpose of the Draft Model Criteria is "early detection of potential impacts to protected water from well stimulation activities." The proposed methodology of monitoring well installation and groundwater sampling will not effectively accomplish the stated goal. The early installation of

monitoring wells is effective for evaluating potential impacts from point sources, but would be of limited use for evaluating impacts from well stimulation activities. As most well stimulation activities are completed within 2 to 3 days and 98% of the fluids injected consist of water and sand, the long term migration of other constituents would be limited. In addition, a better method to protect water above the injection zones is to monitor pressure during well stimulation. A significant loss in pressure should then result in cessation of well stimulation activities, and investigation to assess the extent of those losses can occur at that time.

### SECTION-SPECIFIC COMMENTS

Section 2.1, third paragraph, last sentence (p.4), states that "For additional stimulated well permits to be issued in these areas, previous groundwater monitoring plans must be resubmitted consistent with these Model Criteria."

This new requirement, in conjunction with the new requirements for the number, locations, and construction of monitoring wells, is unnecessary. The addition of a single WST well to an area that has been covered under an approved area-specific GMP would require that new monitoring wells be installed under the Draft Model Criteria, invalidating the use of the existing monitoring wells. Monitoring conditions under the formerly approved area-specific GMPs would provide the necessary data to evaluate existing WST wells and future WST wells.

Section 2.1.1, Establishing Baseline Water Quality Conditions, second paragraph (p.5), indicates that to identify evidence of changes in chemical constituent concentrations in groundwater, that "A recommended method is the prediction limit in United States Environmental Protection Agency (U.S. EPA) (2009) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance, U.S. EPA 530/R-09-007."

This document was prepared for evaluation of RCRA sites, and is primarily oriented towards the groundwater monitoring statistical analysis provisions of 40 CFR Parts 264.90 to 264.100. These regulations govern the detection, characterization and response to releases from regulated units into the uppermost aquifer, not necessarily deep groundwater and confined conditions. Therefore, this document would not be applicable for use as a guideline to assess changes in chemical constituent concentrations in deep groundwater and confined conditions associated with well stimulation treatment activities.

In addition, statistical analysis of groundwater quality requires that at least 8 to 10 sampling events occur to establish background concentrations. It would be unreasonable to expect that this data could be collected prior to well stimulation.

Section 2.1.1, Number and Locations of Monitoring Wells, first paragraph, last sentence (p.5), states "The number and locations of proposed monitoring wells in the monitoring plan shall consider the following:"

This statement is unclear in regards to the use of the word, "consider." As used in the sentence, the "numbers and locations of proposed monitoring wells" are encouraged to "consider" the six items listed after the sentence. The statement appears to indicate that the "numbers and locations" of the proposed monitoring wells are required to consider the six listed items; however, including the items as part of the monitoring plan would not be required as long as they have been considered.

Section 2.1.1, Number and Locations of Monitoring Wells, Point No. 1 (p.5), states "At a minimum, one upgradient and two downgradient monitoring wells will be required for each protected aquifer that is penetrated by the stimulated well, or group of stimulated wells. Upgradient and downgradient groundwater monitoring wells shall be located within 0.5 mile of the surface projection of the zone(s) of stimulation."

and

Section 2.1.1, Number and Locations of Monitoring Wells, Point No. 2 (p.5), states "When multiple protected aquifers are present, each protected aquifer shall be monitored separately. At a minimum, one monitoring well is required for each protected aquifer within 0.5 mile of the surface projection of the zone(s) of stimulation. Wells are to be screened at discrete depths in separate aquifers. Various well construction options may be proposed for State Water Board staff approval."

When requesting a landowner's approval to sample their water well, the producer has no control over the screened interval over which the water well is constructed. If no property owner's within 0.5 mile of the oil well allow their water well to be monitored, then a monitoring well would be required to be installed to the depth of protected water, which would generally be a depth of approximately 2,400 feet. Assuming that the Water Board is referring to number of aquifers containing protected water, and not "protected aquifers," then even the minimal number of separate aquifers (based on the USGS' designation of the depths/thicknesses of regional clay layers (i.e., the A Clay, C Clay, and Corcoran Clay), would require that six to nine monitoring wells be installed (assuming three nested monitoring wells per location) for each WST well-specific monitoring plan, or area-specific monitoring plan. The cost per installed nested monitoring well, assuming that a water-well drill rig could install a nested well to a depth of approximately 2,400 feet, would range between approximately \$250,000 and \$300,000 (approximate total of \$750,000 to \$900,000 for the installation of three nested monitoring wells).

In regards to the requirement for the monitoring wells being within 0.5 mile of the WST well, the locations of the monitoring wells are typically not in the control of the producer. The producer must request that a land owner allow the water well to be sampled, or the land owner must approve the producer to install a monitoring well on their property. Should the land owners within 0.5 mile of the WST well not allow the producer to either sample his water wells, or install a monitoring well on his property, then this requirement could not be met.

Section 2.1.1, Number and Locations of Monitoring Wells, Point No. 3 (p.5), states "All groundwater monitoring wells shall be completed with limited screen lengths; preferably less than 50 feet."

Limiting the length of the screened interval of a monitoring well would increase the possibility of a potential constituent associated with the well stimulation operations potentially migrating past a monitoring well without detection. Heterogeneous sedimentary conditions over the vertical distance from the fracture zone to the depth at which groundwater is being monitored would result in anisotropic flow, which would increase the opportunity for a constituent to migrate at a depth either below or above the limited 50-foot well screen interval.

Section 2.1.1, Number and Locations of Monitoring Wells, Point No. 4 (p.5), states "Monitoring wells shall be completed so the screened interval is located in a portion of the aquifer(s) that will best detect any impacts from well stimulation."

As previously indicated, limiting the length of the screened interval of a monitoring well would increase the possibility of a potential constituent associated with the well stimulation operations migrating past a monitoring well without detection. Since the geologic information available within the areas to be monitored decreases with depth, the selection of the optimal depth to place the well screen would be limited to review of geophysical log data from the monitoring well drilling operations.

Section 2.1.1, Number and Locations of Monitoring Wells, Point No. 5 (p.5), states "For any water-supply well located within one mile and downgradient of the surface projection of the zone(s) of stimulation, a sentry monitoring well shall be located between the stimulated well(s) and the water supply well."

As previously indicated, the locations of the monitoring wells are typically not in the control of the producer. The producer must request that a land owner allow the owner's water well to be sampled, or the land owner must approve the producer to install a monitoring well on his property. Should the land owners within 0.5 mile of the WST well not allow the producer to

either sample his water wells, or install a monitoring well on his property, then this requirement could not be met.

Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 1.e (p.6), indicates that area-specific GMPs shall include a map of the oil field that depicts "Active or inactive produced water ponds."

The locations of active/inactive produced water ponds may be obtained for oil field operations associated with the producer for which the GMP is being prepared; however, information concerning produced water ponds (either active or inactive) is not obtainable through public resources. Therefore, it is unreasonable to attempt to locate all active or inactive produced water ponds on a map at the scale required to depict an entire oil field or the area proposed for area-specific groundwater monitoring. In addition, the depiction of produced water ponds on an oil field map or area-specific map does not provide information beneficial to the SB4 monitoring program.

This comment also applies to the following sections:

- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 2.c (page 6)
- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 3.c (page 7)
- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 5.e (page 8)
- Section 2.1.4, Reporting Requirements, Point No. 1 (page 13)

Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 2.g (p.6), indicates that area-specific GMPs shall include a map of the area proposed for area-specific groundwater monitoring that depicts "Active, inactive, or abandoned Underground Injection Control (UIC) wells."

The locations of plugged or inactive wells (whether former oil production or UIC) are currently depicted on GMP map(s) if they are located within 1,500 feet of the oil well proposed to undergo WST, or within 500 feet of the surface projection of the horizontal component of the WST wellbore. Locating all active, inactive, or abandoned UIC wells within the area proposed for area-specific groundwater monitoring (unless within the vicinity of the proposed WST wells) is extraneous, and does not provide information beneficial to the SB4 monitoring program.

This comment also applies to the following sections:

- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 3.g (page 7)
- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 4.k (page 7)
- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 5.h (page 8)

- Section 2.1.2, Addendum to an Approved Groundwater Monitoring Plan, Point No. 1.g (page 10)
- Section 2.1.4, Reporting Requirements, Point No. 1 (page 13)

Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 3.i (p.7), indicates that area-specific GMPs shall include, "Contours showing the potentiometric surface for each protected aquifer, showing arrows indicating groundwater flow direction. The operator shall document whether the water levels were measured during pumping or non-pumping conditions."

With the exception of unconfined aquifer contours available through the California Department of Water Resources (DWR) and/or some of the local irrigation districts, this information, on the scale that the Water Board is requesting, is not available. Neither the Water Board, the DWR, or local irrigations districts provide potentiometric contour maps for discrete aquifers that indicate whether measurements were collected during pumping or non-pumping conditions.

This comment also applies to the following sections:

- Section 2.1.2, Addendum to an Approved Groundwater Monitoring Plan, Point No. 1.i (page 10)
- Section 2.1.4, Reporting Requirements, Point No. 3 (page 13)

Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 4.e (p.7), indicates that area-specific GMPs shall include, "The distribution of groundwater salinity, and gas presence and composition, in aquifers along the stratigraphic section between the water table and target formations."

This information, on the scale that the Water Board is requesting, is not readily available, or is sporadic. Neither the Water Board, the DWR, or local irrigations districts provide detailed information regarding salinity distribution at depth, or gas presence and composition in aquifers.

This comment also applies to the following sections:

- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 5.c (page 8)

Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 5.j (p.7), indicates that area-specific GMPs shall include, "For each protected aquifer, indicate any available hydraulic conductivity data (in meters per second) and the source of the data (e.g., hydraulic test)."

This information, on the scale that the Water Board is requesting, is not readily available. Neither the Water Board, the DWR, or local irrigations districts provide detailed information regarding hydraulic conductivity in aquifers.

Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 7 (p.9), indicates that area-specific GMPs shall include, "...well completion reports for existing wells."

For existing water wells that are operated by private property owners, and used as monitoring wells by producers, completion reports have not been included in previous GMPs due to confidentiality requirements at the request of the Water Board. This information can only be provided if the private well owner agrees to make the information available to the public.

This comment also applies to the following sections:

- Section 2.1.2, Groundwater Monitoring Plan Requirements, Point No. 12 (page 9)
- Section 2.1.4, Reporting Requirements, Point No. 6 (page 13)

Section 2.1.3, Sampling and Testing Requirements, Point No. 5.h, j, l, m, n, and o (p.12)

The constituents hydrogen sulfide, dissolved organic carbon (DOC), gasoline range hydrocarbons, oxygen and hydrogen stable isotopes in water, and guar gum sugars have not been required to be analyzed for during the previous monitoring events. These constituents are not typically associated with WST operations and would not provide an indication of a release associated with WST activities.

Section 2.1.3, Sampling and Testing Requirements, Point No. 5.p (p.12)

Analysis for two additional analytes at the producer's discretion would not provide additional information regarding a release associated with WST activities that is not already covered by the significant number of constituents that are already required under the current requirements.

Section 2.1.3, Sampling and Testing Requirements, Point No. 7 (p.13), states, "All purge water, soil cuttings, debris and other investigative derived materials are to be sealed and secured in clearly and properly labeled containers and shall be properly managed (removed, and/or disposed of) in accordance with all pertinent regulatory agency requirements, including permitting."

The requirement to contain, transfer, and dispose of materials derived from drilling and water sampling activities is required for investigative operations involving hazardous waste sites where contamination has been confirmed or is anticipated. However, there is no indication that there has been impact to soil or groundwater associated with WST operations. In addition, monitoring well installations typically involve the installation of the monitoring wells prior to the implementation of WST activities on properties that are a distance of up to ½ mile from the WST well. Therefore, the containment, transfer, and disposal of materials derived from drilling and water sampling activities is not warranted unless a release from the WST operations has been confirmed or suspected through monitoring activities.

Section 2.2.1, Exclusion Based on Absence of Protected Water, Point No. 3 (p.15), last sentence indicates that for submittal of an Exclusion Based on Absence of Protected Water that two cross-sections are required to be provided with, "at least 5 wells per cross-section."

Locations that have been selected for the installation of WST wells are frequently situated in areas where standard oil production operations are not conducted. The requirement for providing five well locations for each cross-section may not be reasonable based on the locations selected for WST well installation.

## CLOSING

The Draft Model Criteria appears to have been based on regulations established for point-source type investigations and monitoring. These methodologies are adequate and readily applicable to sites involving underground fuel storage tank (UST) releases, wastewater treatment facilities, landfills, and/or hazardous waste impacts, etc. However, the methodologies outlined in the Draft Model Criteria are not readily applicable to WST operations, which would involve monitoring protected water at depths that generally exceed 2,000 feet. In addition, the monitoring methods being required are typically associated with sites where impact to groundwater has already been confirmed, while at this time, there has not been any indication that WST operations in California have impacted groundwater.

Assuming the implementation of the Draft Model Criteria would be possible from a financial standpoint, the required acquisition of nearly non-existent data to prepare GMPs, and the installation and sampling of multiple monitoring wells within discrete aquifers to protected water depths would make WST operations infeasible from an applicability and scheduling standpoint.



BSK also has concerns regarding the Water Board's use of the term "protected aquifer" throughout the Draft Model Criteria document. This term has been observed recently in internet and newspaper articles, and its use by these media outlets is misleading to the public. Describing an aquifer in this manner would suggest that a governing agency has designated it as a "protected aquifer," similar to how the U.S. Environmental Protection Agency designates a "Sole Source Aquifer" under the Safe Drinking Water Act. However, the discrete aquifers addressed in the Draft Model Criteria are aquifers that contain protected water (groundwater with a total dissolved solids [TDS] concentration of 10,000 milligrams per liter [mg/l] or less), and have not been designated for protection due to unique attributes as determined by a governing agency. BSK understands that water containing less than 10,000 mg/l of TDS require protection of its potential beneficial uses, as indicated in the *Water Quality Control Plan for the Tulare Lake Basin*; however, to avoid further confusion, the use of the term "protected aquifer" to describe aquifers containing protected water should be discontinued.

It is BSK's conclusion that the Draft Model Criteria need to be re-evaluated, with greater consideration for the conditions involved with WST operations, and how monitoring of protected groundwater can be feasibly implemented so that WST operations can be conducted in a manner that protects groundwater and enables the collection of dependable data. The Water Board should request greater input from producers and engineering firms that are responsible for developing and implementing monitoring plans associated with well stimulation operations.

If you have questions concerning this letter or require additional services, please contact the undersigned at 559-497-2880.

Sincerely,  
**BSK Associates**



Matthew W. Hutson, P.G.  
Senior Geologist



Amer A. Hussain, P.E.  
Vice President of Engineering