FORMATION ENVIRONMENTAL

TECHNICAL MEMORANDUM

APPROACH FOR SCREENING WELL CONSTRUCTION PERMIT APPLICATIONS UNDER SECTION 9B OF EXECUTIVE ORDER N-7-22

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1. INTRODUCTION AND OBJECTIVES

In view of an ongoing state of drought emergency across the State of California in 2022, on March 28, 2022, Governor Newsom issued Executive Order N-7-22 specifying a number of emergency regulations related to water management. Among other things, Section 9.b. of the Executive Order specifies the following:

> 9. *To protect health, safety, and the environment during this drought emergency, a county, city, or other public agency shall not:*
>
>   b. *Issue a permit for a new groundwater well or for alteration of an existing well without first determining that extraction of groundwater from the proposed well is (1) not likely to interfere with the production and functioning of existing nearby wells, and (2) not likely to cause subsidence that would adversely impact or damage nearby infrastructure.*
>
> *This paragraph shall not apply to permits for wells that will provide less than two acre-feet per year of groundwater for individual domestic users, or that will exclusively provide groundwater to public water supply systems as defined in section 116275 of the Health and Safety Code.*

To comply with this requirement, Formation Environmental, LLC has been requested by the Stanislaus County Department of Environmental Resources (DER) to develop a screening procedure that identifies new wells or well modifications that are not likely to interfere with the production and functioning of existing nearby wells (significant well interference) or to cause subsidence that would adversely impact or damage nearby infrastructure (significant subsidence). The intent of the procedure is to identify well construction permit applications whose issuance is unlikely to result in significant well interference or subsidence, and that may be processed by DER staff in accordance with the County's normal well permitting guidelines and procedures. For the remaining well construction permit applications, the applicant would be required to provide substantial evidence that operation of the wells would not result in significant well interference or subsidence. For these applications, the County would exercise discretionary authority to issue the permits only if operation of the wells is found by DER to be in compliance with the Executive Order. If so, the permit would be issued following the appropriate level of review under the California Environmental Quality Act (CEQA).

The remainder of this memorandum presents information regarding the screening procedure for identifying which well construction permit applications comply with the Executive Order which potentially do not.

2. BACKGROUND

Stanislaus County adopted a Groundwater Ordinance in November 2014 (Chapter 9.37 of the County Code) that codifies requirements, prohibitions, and exemptions intended to help promote sustainable groundwater extraction in unincorporated areas of the County (the Ordinance). Subsequent to Ordinance adoption, Stanislaus County implemented a Discretionary Well Permitting and Management Program that included, among other things, procedures to determine if operation of a well would potentially result in significant well interference or subsidence. Implementation of this program was evaluated in a Program Environmental Impact Report (PEIR) that was certified by the County on June 26, 2018 (JJ&A 2018).

2.1. Well Interference

Groundwater extraction from a well results in the formation of a "cone of depression" in groundwater levels around the well. Groundwater drawdown is greatest at the well and decreases in the surrounding area. The cone of depression will continue to grow and get deeper until the well intercepts recharge sources that are of an equivalent volume as the water being extracted. The rate of growth of the depression cone slows exponentially over time, reaching a state of quasi-equilibrium even if no recharge occurs. When a cone of depression reaches another well, the depth that well must pump water from increases. This is called interference drawdown, and can lead to decreased well productivity, increased pumping costs, or in severe cases, a well going dry. If water levels drop below the top of a well's screen interval, the rate of bacterial growth and encrustation of the well screen can increase, increasing the need for well maintenance. When a well is no longer able to support existing land uses or land uses for which permits have been granted, well interference impacts would be considered significant.

The PEIR adopted a threshold of significance for interference drawdown to domestic wells of 5 feet, or 10 percent of the available drawdown if the well extends more than 50 feet below standing water levels (JJ&A 2018). Drawdowns less than this amount over a period of 20 years of well operation (the assumed service life of a typical well) are assumed to be less than significant. The drawdown threshold of 5 feet was adopted because domestic wells are generally shallower than higher capacity production wells and are more vulnerable to effects from interference drawdown. A reasonable minimum completion depth of domestic wells below the water table is generally about 50 feet in Stanislaus County and decreasing the available drawdown of a well by 10 percent is not likely to significantly decrease well yield or result in other adverse effects. This threshold has been used to assess interference drawdown for numerous groundwater resources impact assessments across the state under CEQA.

For interference drawdown to existing municipal, industrial, or irrigation wells, the PEIR adopted a threshold of significance of 20 feet over a 20 year well lifetime. Larger production wells generally will have a greater completion depth than domestic wells, and in most cases in the county extend at least about 200 feet below the water table. An increased drawdown of 20 feet for these wells is not likely to significantly decrease well yield or result in other adverse effects. This threshold has been adopted as a threshold of significance in other groundwater resource impact assessments under CEQA across the state, based on local conditions.

2.2. Subsidence

Land subsidence can occur when compressible clays are depressurized from groundwater extraction, triggering water to flow from the clays into the surrounding aquifer, and ultimately consolidation of the clay under pressure from the overlying sediments. Aquifers with strongly confined conditions, such as those below the Corcoran Clay, experience greater head loss from groundwater extraction than unconfined aquifers and typically occur in basinal settings where potentially compressible clays are more abundant. For these reasons, they are considered more susceptible to subsidence. In general, most subsidence occurs when an aquifer is initially depressurized, but can continue for months, or even years, as clays slowly dewater and adjust to the new pressure regime. If groundwater levels subsequently recover, subsidence generally does not resume (or does not progress as rapidly), until groundwater levels fall below historical low levels.

Subsidence within Stanislaus County has been limited and has not resulted in reported infrastructure damage. Nevertheless, the Department of Water Resources (DWR) has designated the groundwater basins within the County as having a moderate to high potential for future subsidence. Most of the subsidence in the county is believed to have occurred as a result of groundwater extraction from confined aquifers underlying the Corcoran Clay (JJ&A 2018). Subsidence could also occur when groundwater is withdrawn from unconfined or semi-confined aquifers overlying the Corcoran Clay, or outside the Corcoran Clay subcrop area, but it is far less likely.

In some locations, groundwater levels declined to historical lows during the recent December 2011 to October 2016 drought and drawdowns ranging from 5 to over 50 feet were recorded in some wells in the County during that time (JJ&A 2018). Starting with the 2016 rainy season, water levels in these wells generally recovered, at least to some degree. From 2011 to 2015, the Modesto and Turlock Subbasins were identified as having 50 percent or more of wells monitored under the California Statewide Groundwater Elevation Monitoring (CASGEM) program at or below the historical spring low groundwater levels, and Eastern San Joaquin and Delta-Mendota Subbasins were identified as having 30 to 50 percent of wells at or below historical spring low water levels. Subsequently, with the end of the drought in 2016, groundwater levels generally recovered or stabilized.

United States Geological Survey (USGS) operates five subsidence monitoring stations in Stanislaus County. GPS Station P259, located near the intersection of Highway 33 and Bell Road, recorded approximately 50 millimeters (roughly 2 inches) of subsidence during between 2005 and 2015. From 2016 to 2020, no additional non-recoverable subsidence was recorded. Additional detail regarding this extensometer is available on the University NAVSTAR Consortium (UNAVCO) website funded by the National Science Foundation and the National Atmospheric and Space Administration (UNAVCO 2022). The remaining subsidence monitoring stations in Stanislaus County show do not show any non-recoverable subsidence. DWR and Bureau of Reclamation have undertaken a joint subsidence monitoring program in support of the San Joaquin River Restoration Program that includes a geodetic control network of monitoring stations that extends northward to near Patterson (SJRRP 2022). The rate of subsidence recorded in Stanislaus County by this network for the period from 2011 to 2021 is between 0 and 0.15 feet/year. Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA Inc., under contract with DWR and reported on DWR's SGMA Data Viewer website (DWR 2022a), indicates that the maximum total subsidence in Stanislaus County between 2015 and 2020 is generally less than 0.1 foot.

These above data indicate that despite the groundwater level declines recorded during the 2011 to 2016 drought, significant subsidence has not been observed in Stanislaus County. Figure 1 shows the Special Groundwater Management Areas (SMAs) established based on local geologic and soil conditions for implementation of the County's well permitting guidelines. Reported subsidence in Stanislaus County has been limited to areas underlain by the Corcoran Clay in SMA1, where clay basinal and lacustrine deposits are thickest, and groundwater extraction from more highly confined aquifers resulted in the dewatering of the compressible clay deposits. The aquifers overlying the Corcoran Clay are not confined, so wells completed in these deposits are at substantially less risk of inducing subsidence, although it remains possible. The alluvial fan deposits east and west of the Corcoran Clay subcrop area comprise SMA2. In these areas, most groundwater production is from semiconfined alluvial aquifers that tend to contain more limited compressible clay deposits and a greater proportion of coarser grained and consolidated deposits that are much less susceptible to subsidence. On this basis, the potential for subsidence in SMA2 was judged to be is less than significant in the PEIR (JJ&A 2018).

3. SCREENING METHODOLOGY

3.1. Well Interference

3.1.1. Approach

To develop a screening approach for well construction and modification permit applications that identifies those proposed wells that are unlikely to cause significant adverse well interference and those that require additional evaluation, a drawdown analysis was conducted for each major aquifer area and used to develop lookup curves ("nomographs") for minimum setback distances from existing wells. Based on the drawdown thresholds established in the PEIR (5 feet or 10% of the available drawdown for domestic wells (maximum of 20 feet), and 20 feet for other production wells), lookup nomographs were developed for a range of well completion intervals (pumped aquifer thicknesses) and pumping rates for each aquifer area and depth in the County. The following approach was used.

- Upper and Lower Aquifer Zones were identified in the Corcoran Clay Subcrop area (SMA1), the alluvial fan area on the west side of the valley (Western SMA2) and the alluvial fan area on the east side of the valley (Eastern SMA2).

- Aquifer parameters, including hydraulic conductivity (K) and Storativity (S) were defined for the upper and lower aquifers in each aquifer area using the following approach:

  - K for the Upper and Lower Aquifer Zone in each SMA was derived from Layers 1 and 2, respectively of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) model developed by DWR (DWR 2021).

    - K values were contoured within the County using the values for each node in Layer 1 and Layer 2 of the model. Contouring was performed using an inverse-distance squared algorithm.

    - The contoured K values for Layers 1 and 2 were extracted to a regularly spaced orthogonal grid with a node spacing of approximately ½ mile to eliminate spatial bias associated with node spacing in the model, which is closer near the rivers.

    - The K values for Layers 1 and 2 in each aquifer area in the County (i.e., SMA1, Eastern SMA2 and Western SMA2) were statistically analyzed. The 25th percentile K value was calculated for each aquifer area for Layers 1 and 2, to represent the Upper and Lower Aquifer Zone. Use of the 25th percentile K value provides a conservatively low value of hydraulic conductivity suitable for screening use throughout the County.

  - S for the Upper and Lower Aquifer Zone in each of the aquifer areas was derived from Layers 1 and 2 of the C2VSim model using the following approach:

    - At each model node, Specific Storage was multiplied by the layer thickness to calculate S.

    - The S values were contoured within the County using the calculated values for each node in Layer 1 and Layer 2 of the model. Contouring was performed using an inverse-distance squared algorithm.

    - The contoured S values for Layers 1 and 2 were extracted to a regularly spaced orthogonal grid with a node spacing of approximately ½ mile to eliminate spatial bias associated with node spacing in the model, which is closer near the rivers.

- The geometric mean S value was calculated for Layers 1 and 2 in each aquifer area in the County (i.e., SMA1, Eastern SMA2 and Western SMA2) interval to serve as a value that would be applicable throughout the zone.

Distance-drawdown analysis was performed, and graphs were developed for each aquifer zone and aquifer area in the County showing the distance to 5-feet and 20-feet of drawdown associated with a range of well completion intervals (i.e., pumped aquifer thicknesses) and annual pumping rates. A total of 12 graphs were developed, each with a family of curves showing the predicted distance to the target drawdown after 20 years of pumping at annual extraction rates ranging from 50 to 1,000 acre-feet/year (AFY). The spreadsheet was developed to estimate the drawdown from a single pumping well in an aquifer under conditions satisfying the Theis solution, consistent with spreadsheet models developed by the State of Utah Division or Water Rights, the USGS Nevada Water Science Center and others (Utah DWR 2010; USGS Nevada Water Science Center 2005, Driscoll 1986). The spreadsheet model can estimate the distance to a specified drawdown interval based on inputs of transmissivity (K times aquifer thickness), Storativity, pumping rate and pumping duration. The model includes the following assumptions:

- The pumped aquifer is homogeneous and isotropic. This is a common simplifying assumption.
- The simulated aquifer is uniform in thickness and infinite in areal extent. This is a reasonable assumption in the absence of nearby flow impediments.
- The aquifer receives no recharge, and all flow from the pumping well comes from aquifer storage. This simplifying assumption tends to produce a conservative result that over-predicts drawdown.
- The well receives water from the full thickness of the aquifer, water is released form storage instantaneously, and vertical groundwater flow is not significant compared to lateral flow. These are common and reasonable simplifying assumptions when evaluating drawdown associated with a single pumping well.
- The well pumping rate is constant. This is a reasonable assumption for a non-seasonal water supply project, especially when examining drawdown effects at distance from the pumping well.

3.1.2. Results

Graphs showing a family of distance-drawdown curves for each aquifer area (SMA1, Eastern SMA2 and Western SMA2) and aquifer zone (Upper Zone and Lower Zone) after 20 years of pumping are included in Attachment A. For each aquifer area and zone, separate graphs are presented showing the distance to 5 feet of drawdown and 20 feet of drawdown for pumped aquifer thicknesses ranging from 50 feet to 250 feet for the Upper Zone, and 50 feet to 500 feet for the Lower Zone. Curves are presented for annualized pumping rates ranging from 50 to 1,000 AFY, and for distances between 100 and 10,000 feet from the pumping well. In many cases, pumping at the lower rates under the evaluated conditions did not produce the target drawdown, even at the lowest aquifer thickness evaluated. In such cases, a note was added presenting the value of the lowest pumping rate that resulted in the target drawdown. In other cases, evaluated pumping rates produced the target drawdown at distances exceeding 10,000 feet, even at the greatest aquifer thickness evaluated. In those cases, the upper limit of pumping rates that produced distances less than 10,000 feet was noted.

3.1.3. Application

The appropriate family of curves for the aquifer zone and area in which a proposed well is located will be used to establish a Minimum Setback Screening Distance (MSSD) between a proposed well and existing nearby wells, outside of which the proposed well is not likely to interfere with the production and functioning of existing nearby wells, as required in the Executive Order. The following stepwise approach will be used:

1. The Applicant shall provide a scaled plot plan that shows the boundaries of the parcel on which the well will be located, nearby streets and other geographic landmarks, and the location all existing wells within 500 feet of the parcel boundary. Houses visible in aerial imagery outside the service territories of municipal water service agencies or public water supply systems shall be assumed to be served by domestic wells. A table of well completion data, use and available drawdown keyed to well locations on the plot plan shall be provided, when known.

2. The long-term pumping rate for the well that is proposed to be installed or modified shall be determined and documented by the applicant as follows:

    a. For irrigation wells, the crop acreage served shall be documented and the associated annual water demand being served shall be calculated. Average historical surface water deliveries shall be documented and subtracted to calculate long-term average annual water demand of the well.

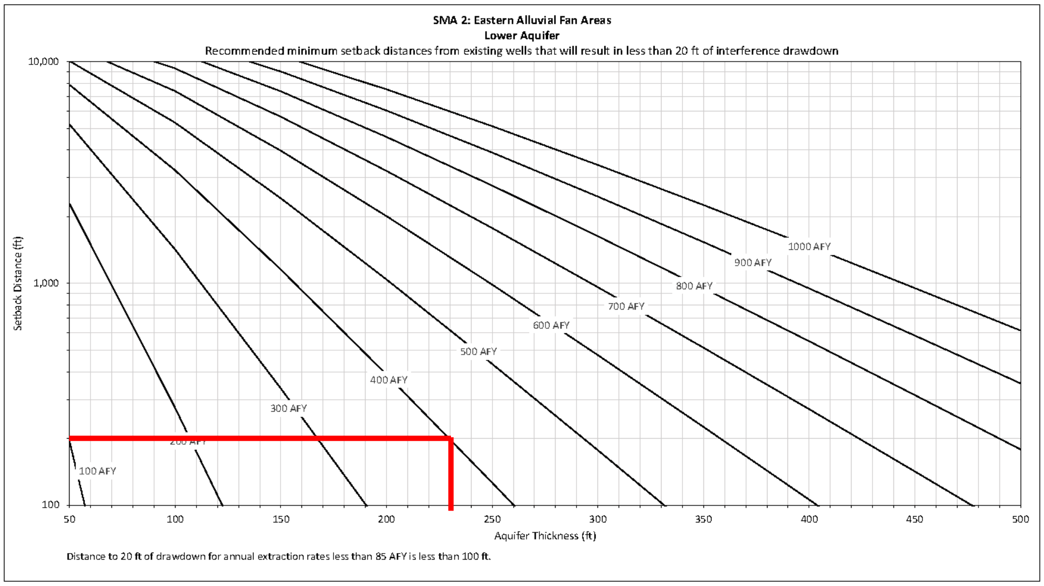
    b. For other water supply wells that are not exempt from the Executive Order (e.g., industrial wells), the average annual water demand shall be estimated by other appropriate means.

3. The proposed well completion depth and screen interval shall be used to estimate the aquifer thickness from which the well will pump. This shall be assumed to be the difference between the top of the uppermost screen interval to the bottom of the lowermost screen interval, plus 50 feet to account for vertical groundwater capture.

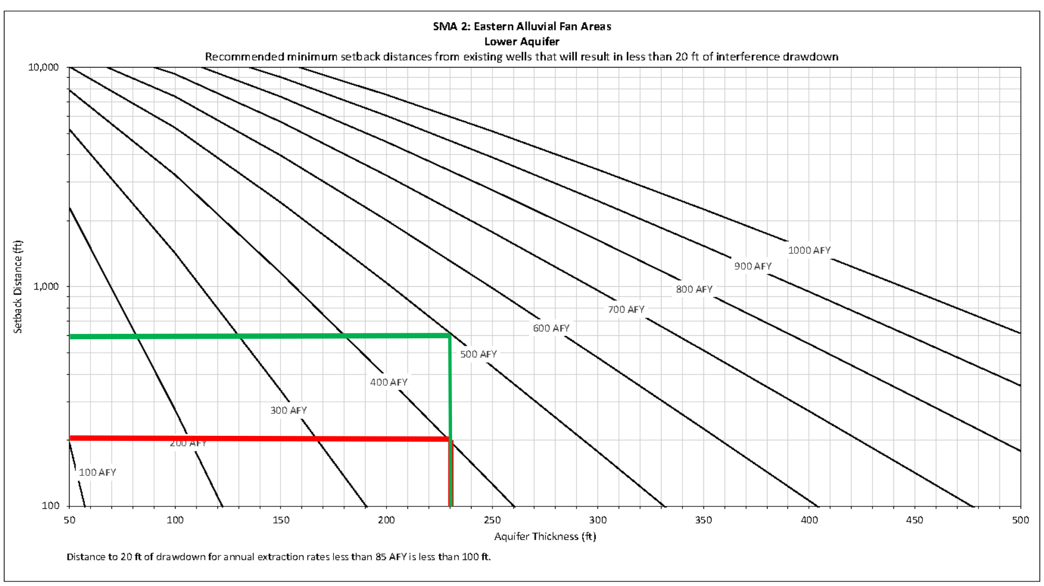
4. Select the appropriate pair of nomograph curves for evaluation of minimum setback screening values for the well based on the aquifer area in which the well is located (SMA1, Eastern SMA2 or Western SMA2), and the aquifer zone in which the well is completed (Upper Zone or Lower Zone).

5. Identify the closest irrigation, industrial supply or public supply well to the parcel and determine the minimum setback screening value from the 20-foot drawdown nomograph. Note that the closest well may be outside the 500-foot buffer on the plot plan provided by the applicant. Use the following approach:

a. Locate the aquifer thickness calculated in Step 3 above on the horizontal (aquifer thickness) axis of the graph and extend a line upwards. Select the curve that represents the long-term pumping rate of the well. From the point where the vertical line intersects this curve, draw a horizontal line left toward the vertical (minimum setback) axis to find the MSSD. For example, as illustrated below, for a in the Lower Aquifer of SMA2 pumping from an aquifer thickness of 230 feet at a long-term rate of 400 AFY, the MSSD is 200 feet.



b. If the long-term pumping rate is between two curves on the graph, follow the above procedure for both curves and interpolate linearly between setback values at the two intersection points to calculate the appropriate MSSD for the well. For example, as illustrated below, if the long-term average extraction rate of the proposed well is 460 AFY, first follow the procedure in 5.a., above for the 400 AFY and 500 AFY curves.



Next, calculate the MSSD as follows:

$$MSSD_{460AFY} = MSSD_{400AFY} + (MSSSD_{500AFY} - MSSD_{400AFY}) \times \frac{(460\ AFY - 400\ AFY)}{(500\ FY - 400\ AFY)}$$

$$= 200\ feet + \{(600\ feet - 200\ feet) \times 60\ /100\}$$

$$= 440\ feet$$

5. If the closest irrigation, industrial or public supply well is located outside of the MSSD determined under Step 4, the MSSD for domestic wells shall be evaluated using the following approach. The MSSD for a domestic well depends on its drawdown threshold, which can vary from 5 feet to 20 feet depending on how deep the well is relative to static groundwater levels and its available drawdown. As a result, several wells may need to be evaluated to verify they are located outside their respective MSSDs and unlikely to be adversely affected by interference drawdown. Generally, the shallowest domestic wells are most vulnerable to potential interference drawdown and should be evaluated first. Use the following approach:

   a. Determine the distance to nearby domestic wells and their available drawdown. This may include wells outside the search radius provided by the applicant. If the completion depth of a well is not known, or a well is assumed to exist at a nearby residences that is not served by a municipal water agency or other public water system, the well depth shall be assumed to be the minimum depth reported for the section in which the well is located in the DWR's Well Completion Report Map Application (DWR 2022b).

   b. Use the appropriate nomographs for the aquifer area and aquifer zone in which the proposed well is located to identify the most sensitive domestic well and verify whether it is located outside the MSSD. This may require determination of the MSSD for several wells.

      i. Use the approach discussed in Step 4 above to find the MSSD.

      ii. For domestic wells with interference drawdown thresholds of 5 feet or 20 feet, use the 5-foot and 20-foot nomographs, respectively, for the applicable aquifer area and aquifer zone.

      iii. If the drawdown threshold is between 5 feet and 20 feet, determine the theoretical MSSD for the well using both the 5-foot and 20-foot nomographs, then use linear interpolation between the theoretical values to determine the actual MSSD based on the well's interference drawdown threshold. For example, if the well is completed to a depth that is 125 feet below the static water levels reported in the area (i.e., its interference drawdown threshold is 12.5 feet), the MSSD for the well is halfway between the theoretical MSSDs determined using the 5-foot and 20-foot nomographs.

6. If the proposed well meets the minimum setback requirements from all existing wells not located on the applicant's property, the well is determined to be unlikely to interfere with the

production and functioning of existing nearby wells, and the permit will be processed following the DER's applicable guidelines and procedures.

7. If the well does not meet the minimum setback requirements, the likelihood the well may interfere with the production and functioning of existing nearby wells cannot be ruled out. In such cases, the applicant shall submit a supplemental evaluation and application that meets the requirements of the County's Discretionary Well Permitting Program (JJ&A 2018).

3.2. Subsidence

Based on the available information, significant subsidence has not been observed in Stanislaus County despite significant groundwater level declines experienced during the 2011 to 2016 drought. Although subsidence is possible in the basinal areas of the aquifer system where compressible clays are more widespread, based on the available information, it is judged to be unlikely in the unconfined to semi-confined alluvial fan aquifer systems in SMA2, and is unlikely in the unconfined to semi-confined Upper Aquifer in SMA1. Permit applications for the construction or modification of wells completed in the Lower Aquifer in SMA1 will be screened using the approach below to identify wells that are not likely to cause subsidence that would adversely impact or damage nearby infrastructure, as required in the Executive Order.

1. The Applicant shall provide a sketch or map that shows the location of all existing infrastructure that could be damaged by subsidence within the predicted 5-foot drawdown distance. This shall include canals, drainage ditches, streams, levees, storm drains and drainage basins.

2. If the identified infrastructure is closer than the minimum setback interpolated for 5-feet of drawdown from the appropriate nomograph in Attachment A, the applicant shall provide a letter from a qualified professional (Professional Engineer or Professional Geologist) with the following additional information:

    a. An analysis of hydrographs showing groundwater level trends for nearby wells and an assessment of historical low, long-term average and forecast trends, and an opinion whether operation of the well is likely to draw down groundwater levels more than 5 feet below historical lows.

    b. If data are available, an analysis of the hydrostratigraphy of the aquifer interval pumped by the well, whether it contains potentially compressible clays that are more than 50 feet in composite thickness, and an opinion whether or not the drawdown induced by the well is likely to lead to significant subsidence that could damage infrastructure.

3. If the well meets the minimum setback requirements from existing infrastructure that could be damaged by subsidence, or a letter from a qualified professional indicates that significant subsidence is not likely, the well is unlikely cause subsidence that would adversely impact or

damage nearby infrastructure, and the permit will be processed following the DER's normal guidelines and procedures.

4. If the well does not meet the minimum setback requirements and a letter from a qualified professional with the above findings is not provided, the likelihood the well may cause subsidence that would adversely impact or damage nearby infrastructure cannot be ruled out. In such cases, the applicant shall submit a supplemental evaluation and application that meets the requirements of the County's Discretionary Well Permitting Program (JJ&A 2018).

4. REFERENCES

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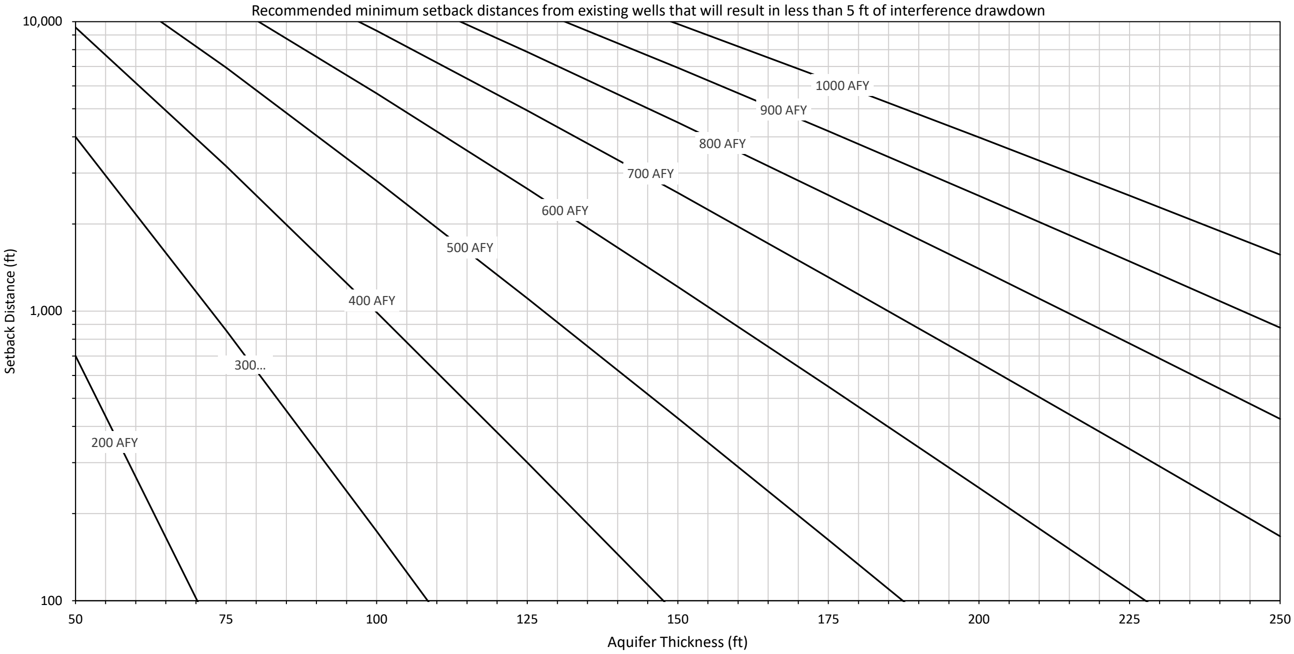
FIGURES

ATTACHMENT A

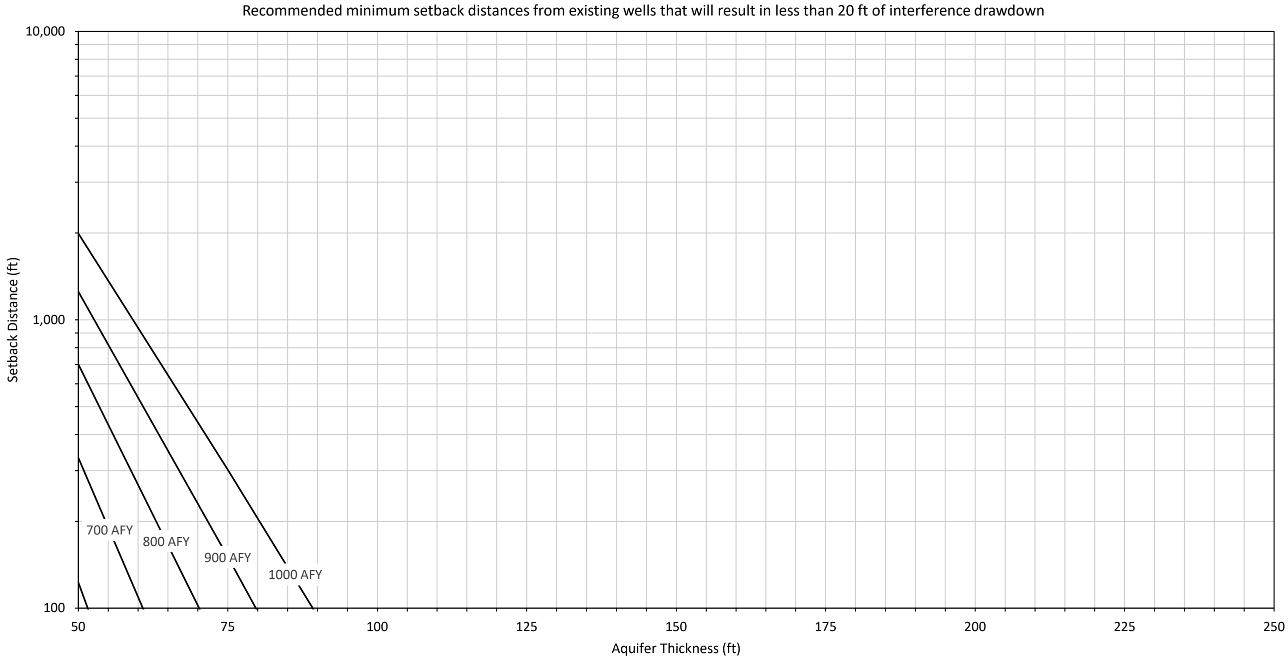
Interference Drawdown Nomographs for Special Management Areas and Aquifer Zones of Groundwater Basins in Stanislaus County

SMA 1: Area Underlain by the Corcoran Clay
Upper Aquifer
Recommended minimum setback distances from existing wells that will result in less than 5 ft of interference drawdown



Distance to 5 ft of drawdown for annual extraction rates less than 145 AFY is less than 100 ft.
Setbacks for annual extraction rates over 1,550 AFY are greater than 10,000 ft.

SMA 1: Area Underlain by the Corcoran Clay
Upper Aquifer
Recommended minimum setback distances from existing wells that will result in less than 20 ft of interference drawdown



Distance to 20 ft of drawdown for annual extraction rates less than 580 AFY is less than 100 ft.

Instructions: Aquifer thickness is determined based on the vertical distance between the top of the uppermost screen interval to the base of the lowermost screen interval, plus 50 feet. The annual extraction rate is determined based on the long-term average annual demand (in acre-feet/year [AFY]) met by groundwater extraction from the well as explained in the text. Results for actual long-term extraction rates may be interpolated between the curves shown. For allowable interference drawdown values between 5 feet and 20 feet, the results for 5 feet and 20 should be determined and multiplied by a proportional scaling factor as described in the text.

Stanislaus County
Striving to be the Best

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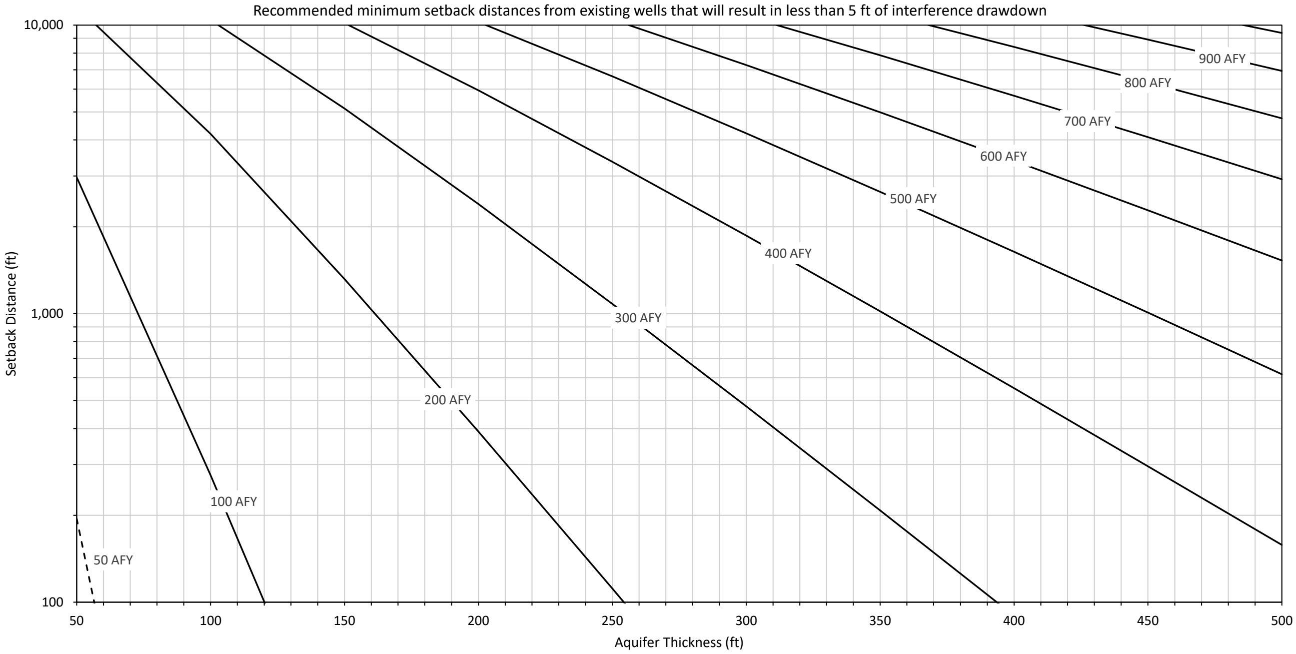
WELL PERMITTING
FIGURE 1
SMA 1: CORCORAN CLAY
UPPER AQUIFER
WELL INTERFERENCE NOMOGRAPHS
DATE: MAY 2022
BY: CFJ | FOR: MT/RK
FORMATION ENVIRONMENTAL

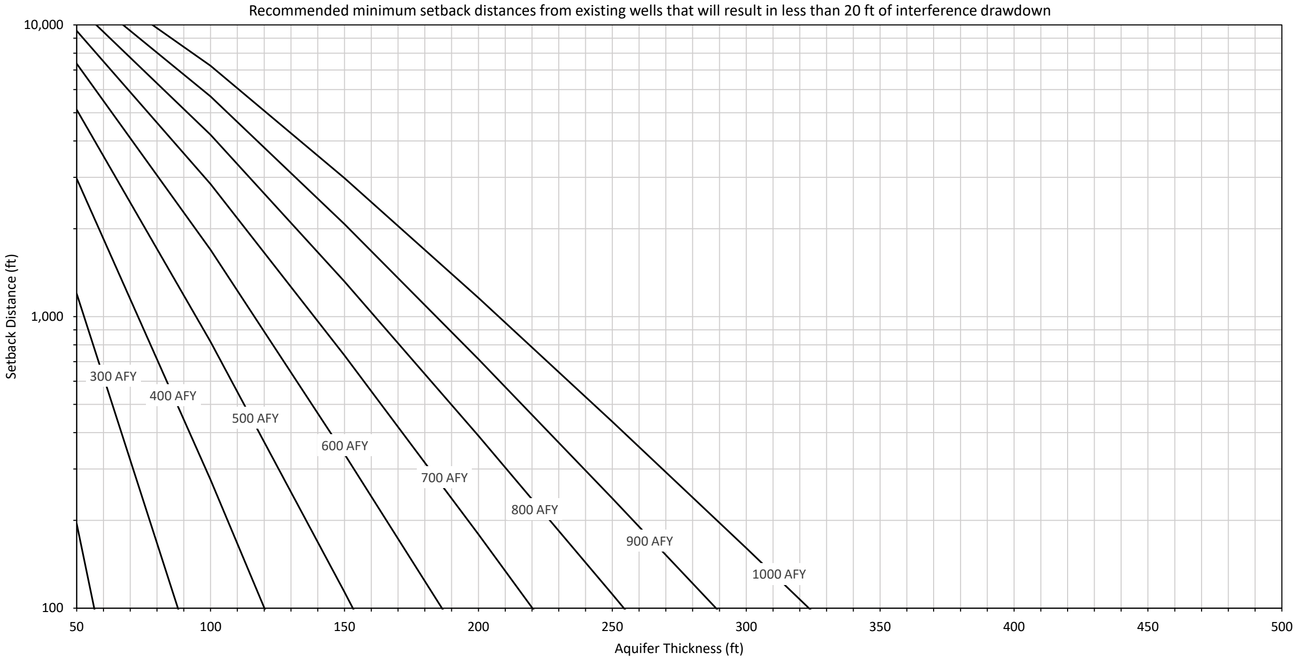
slaus County\Tasks\Environmental Resources\Executive Order Compliance\DrawdownCalc\theis_drawdown_calculation.xlsx

SMA 1: Area Underlain by the Corcoran Clay
Lower Aquifer
Recommended minimum setback distances from existing wells that will result in less than 5 ft of interference drawdown



Distance to 5 ft of drawdown for annual extraction rates less than 45 AFY is less than 100 ft.
Setbacks for annual extraction rates over 1,020 AFY are greater than 10,000 ft.

SMA 1: Area Underlain by the Corcoran Clay
Lower Aquifer
Recommended minimum setback distances from existing wells that will result in less than 20 ft of interference drawdown

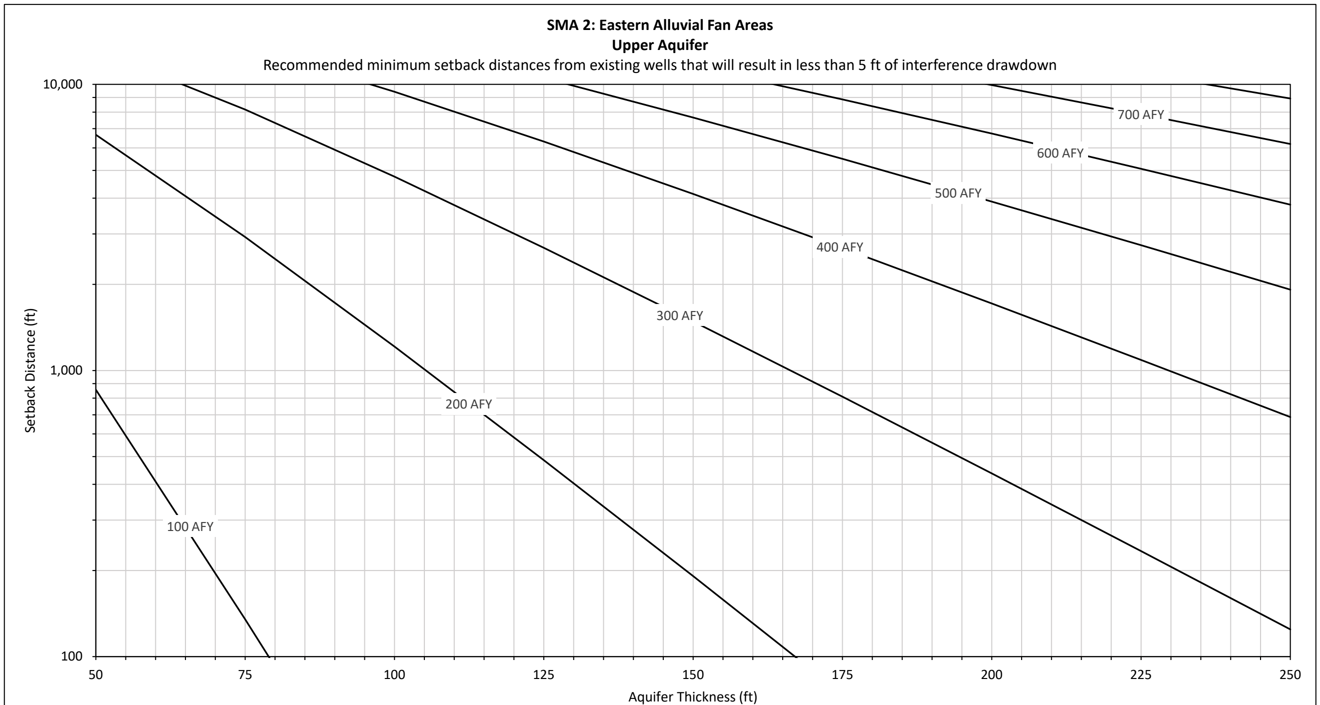


Distance to 20 ft of drawdown for annual extraction rates less than 175 AFY is less than 100 ft.

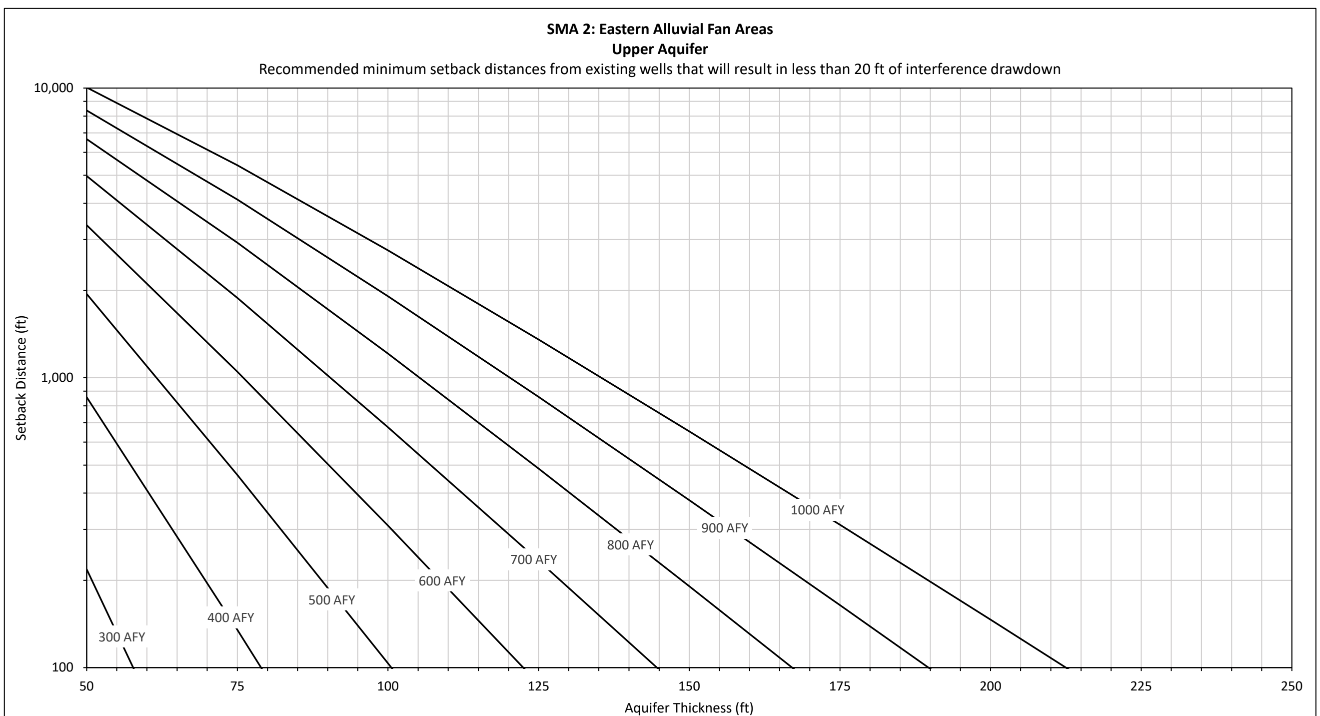
Instructions: Aquifer thickness is determined based on the vertical distance between the top of the uppermost screen interval to the base of the lowermost screen interval, plus 50 feet. The annual extraction rate is determined based on the long-term average annual demand (in acre-feet/year [AFY]) met by groundwater extraction from the well as explained in the text. Results for actual long-term extraction rates may be interpolated between the curves shown. For allowable interference drawdown values between 5 feet and 20 feet, the results for 5 feet and 20 should be determined and multiplied by a proportional scaling factor as described in the text.

STANISLAUS COUNTY
WELL PERMITTING
FIGURE 2
SMA 1: CORCORAN CLAY
LOWER AQUIFER
WELL INTERFERENCE NOMOGRAPHS
DATE: MAY 2022
BY: CFJ | FOR: MT/RK
FORMATION ENVIRONMENTAL

laus County\Tasks\Environmental Resources\Executive Order Compliance\DrawdownCalc\theis_drawdown_calculation.xlsx



Distance to 5 ft of drawdown for annual extraction rates less than 65 AFY is less than 100 ft.
Setbacks for annual extraction rates over 835 AFY are greater than 10,000 ft.

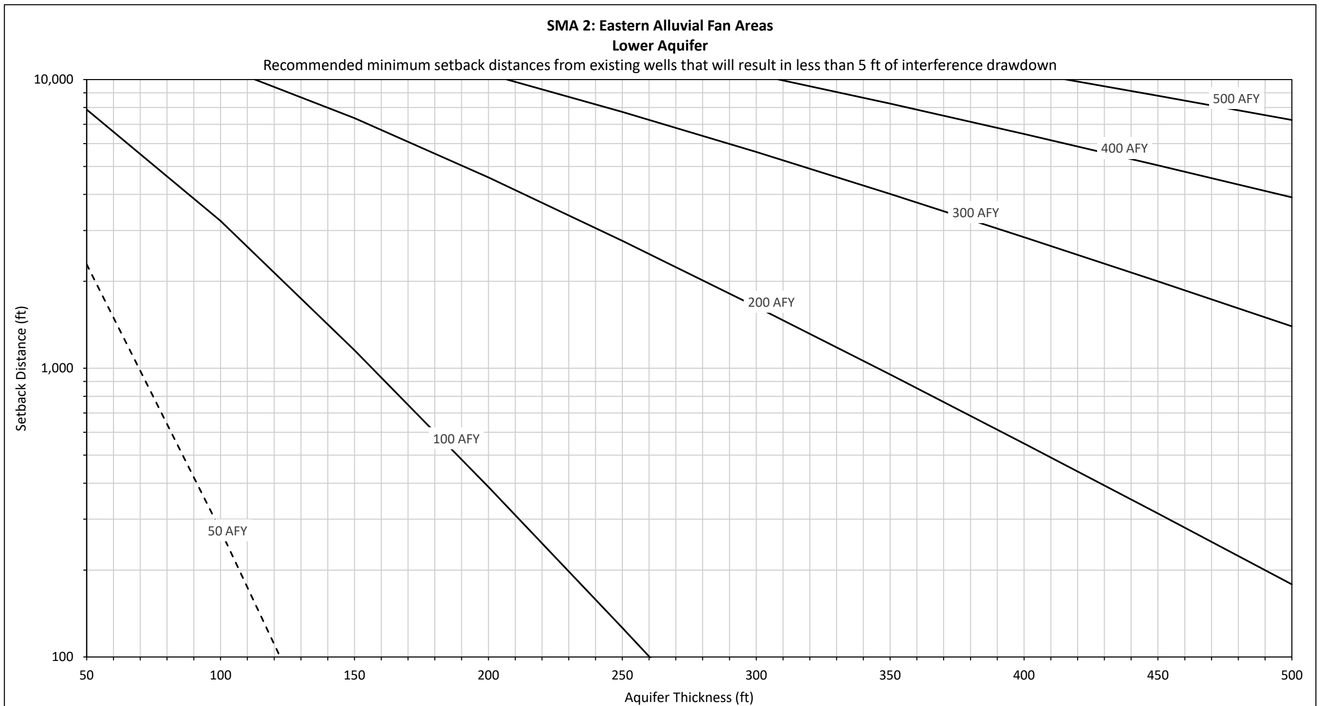


Distance to 20 ft of drawdown for annual extraction rates less than 260 AFY is less than 100 ft.

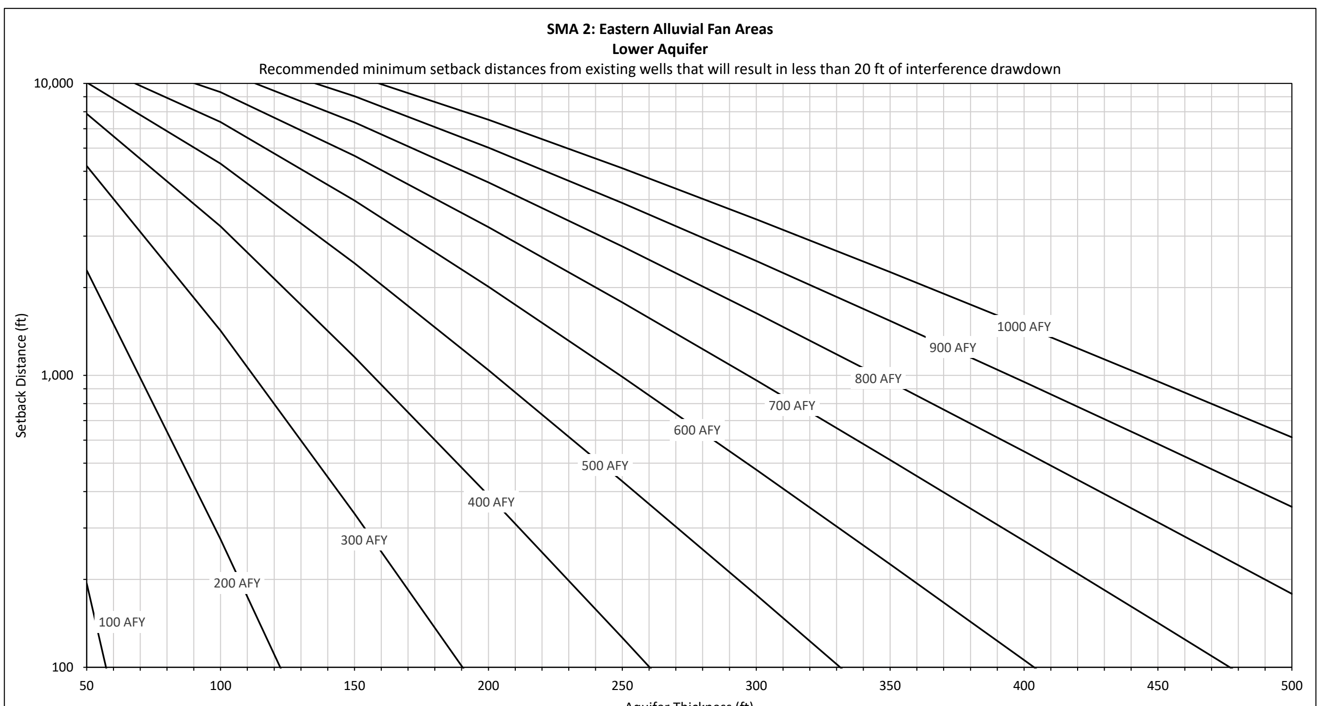
Instructions: Aquifer thickness is determined based on the vertical distance between the top of the uppermost screen interval to the base of the lowermost screen interval, plus 50 feet. The annual extraction rate is determined based on the long-term average annual demand (in acre-feet/year [AFY]) met by groundwater extraction from the well as explained in the text. Results for actual long-term extraction rates may be interpolated between the curves shown. For allowable interference drawdown values between 5 feet and 20 feet, the results for 5 feet and 20 should be determined and multiplied by a proportional scaling factor as described in the text.

STANISLAUS COUNTY
WELL PERMITTING
FIGURE 3
SMA 2: EASTERN ALLUVIAL FANS UPPER AQUIFER WELL INTERFERENCE NOMOGRAPHS
DATE: MAY 2022
BY: CFJ FOR: MT/RK
FORMATION ENVIRONMENTAL

laus County\Tasks\Environmental Resources\Executive Order Compliance\DrawdownCalc\theis_drawdown_calculation.xlsx



Distance to 5 ft of drawdown for annual extraction rates less than 20 AFY is less than 100 ft.
Setbacks for annual extraction rates over 575 AFY are greater than 10,000 ft.



Distance to 20 ft of drawdown for annual extraction rates less than 85 AFY is less than 100 ft.

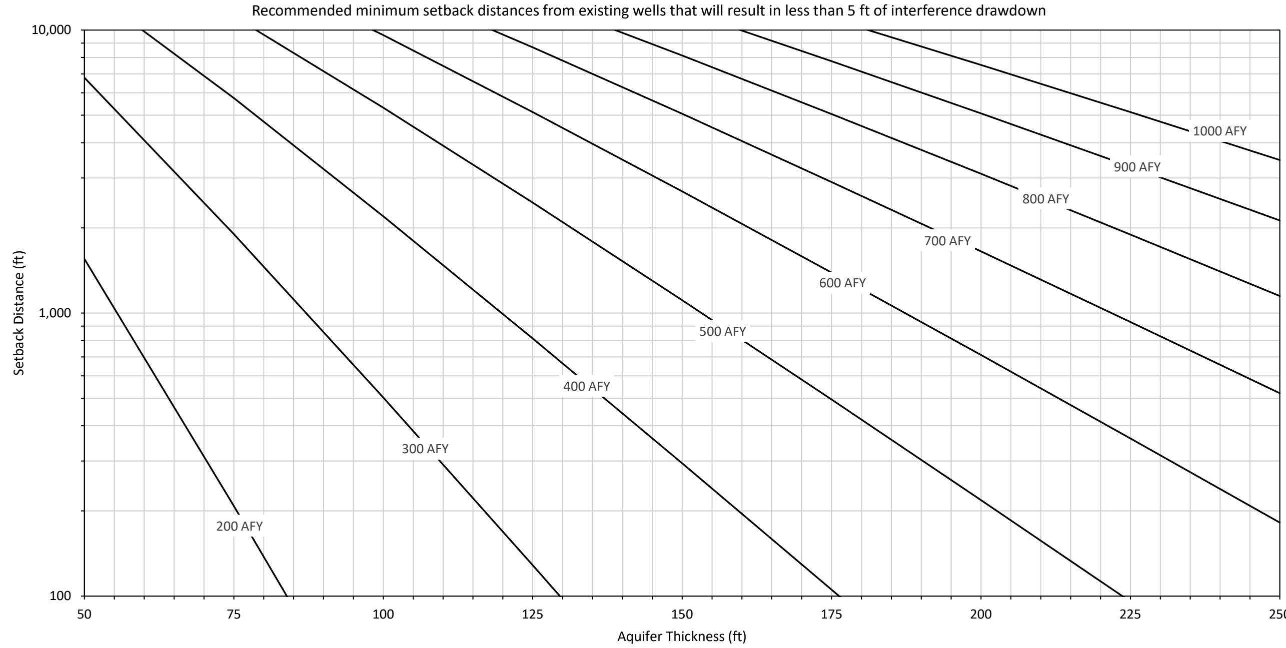
Instructions: Aquifer thickness is determined based on the vertical distance between the top of the uppermost screen interval to the base of the lowermost screen interval, plus 50 feet. The annual extraction rate is determined based on the long-term average annual demand (in acre-feet/year [AFY]) met by groundwater extraction from the well as explained in the text. Results for actual long-term extraction rates may be interpolated between the curves shown. For allowable interference drawdown values between 5 feet and 20 feet, the results for 5 feet and 20 should be determined and multiplied by a proportional scaling factor as described in the text.

Stanislaus County
Striving to be the Best

STANISLAUS COUNTY
WELL PERMITTING
FIGURE 4
SMA 2: EASTERN ALLUVIAL FANS
LOWER AQUIFER
WELL INTERFERENCE NOMOGRAPHS
DATE: MAY 2022
BY: CFJ FOR: MT/RK
FORMATION ENVIRONMENTAL

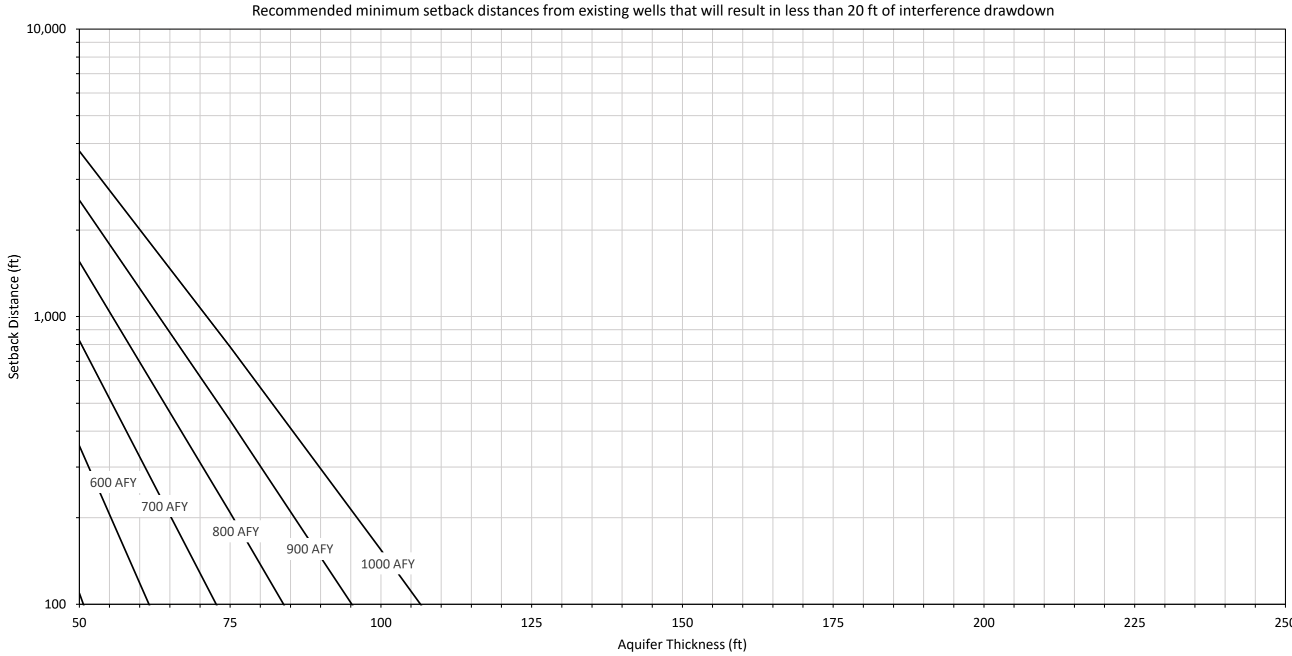
slaus County\Tasks\Environmental Resources\Executive Order Compliance\DrawdownCalc\theis_drawdown_calculation.xlsx

SMA 2: Western Alluvial Fan Areas
Upper Aquifer
Recommended minimum setback distances from existing wells that will result in less than 5 ft of interference drawdown



Distance to 5 ft of drawdown for annual extraction rates less than 120 AFY is less than 100 ft.
Setbacks for annual extraction rates over 1,300 AFY are greater than 10,000 ft.

SMA 2: Western Alluvial Fan Areas
Upper Aquifer
Recommended minimum setback distances from existing wells that will result in less than 20 ft of interference drawdown



Distance to 20 ft of drawdown for annual extraction rates less than 490 AFY is less than 100 ft.

Instructions: Aquifer thickness is determined based on the vertical distance between the top of the uppermost screen interval to the base of the lowermost screen interval, plus 50 feet. The annual extraction rate is determined based on the long-term average annual demand (in acre-feet/year [AFY]) met by groundwater extraction from the well as explained in the text. Results for actual long-term extraction rates may be interpolated between the curves shown. For allowable interference drawdown values between 5 feet and 20 feet, the results for 5 feet and 20 should be determined and multiplied by a proportional scaling factor as described in the text.

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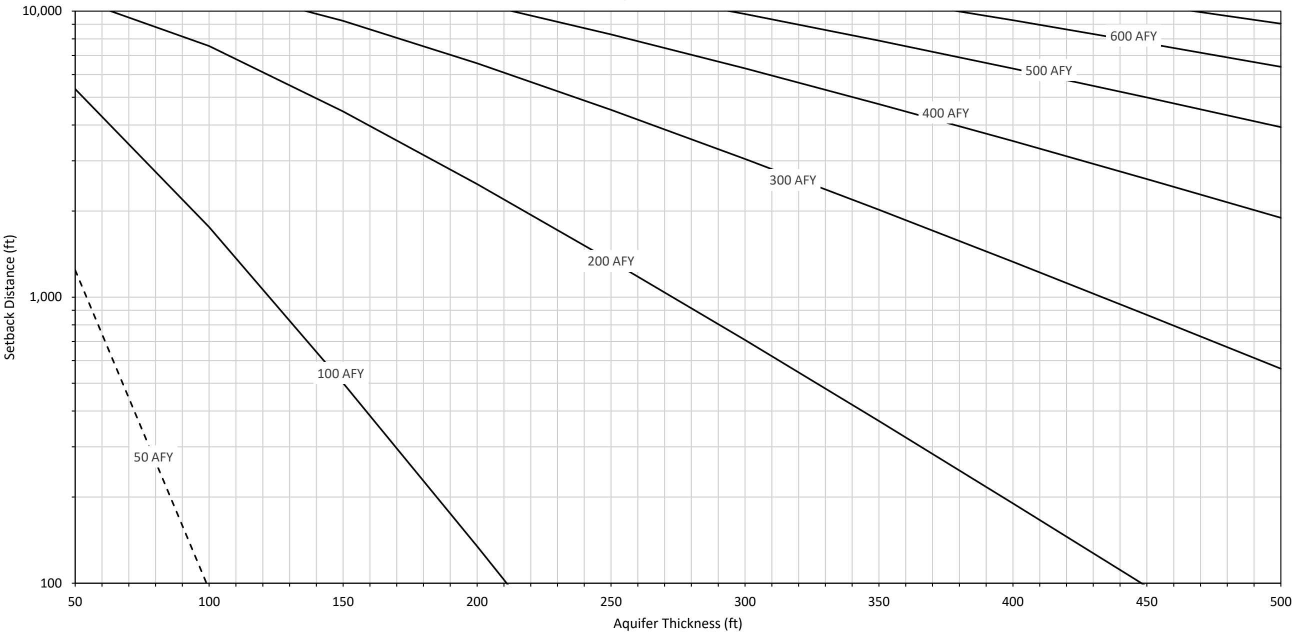
WELL PERMITTING
FIGURE 5
SMA 2: WESTERN ALLUVIAL FANS
UPPER AQUIFER
WELL INTERFERENCE NOMOGRAPHS

DATE: MAY 2022		FORMATION ENVIRONMENTAL
BY: CFJ	FOR: MT/RK	

SMA 2: Western Alluvial Fan Areas
Lower Aquifer

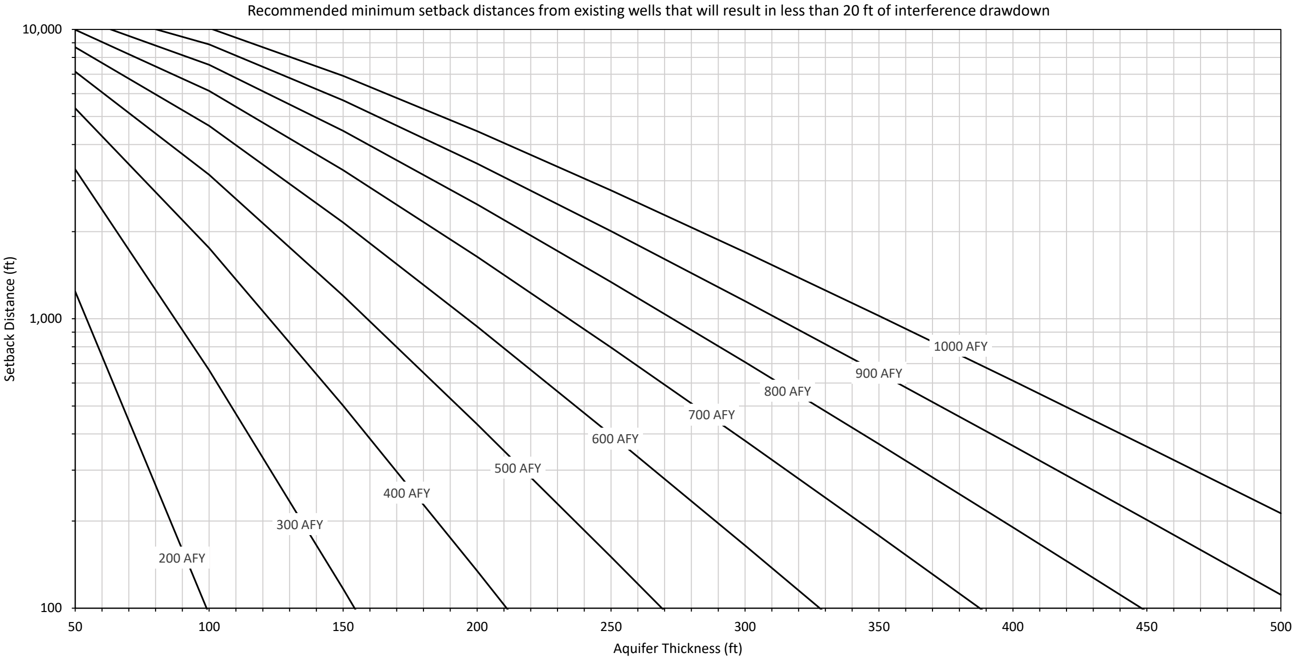
Recommended minimum setback distances from existing wells that will result in less than 5 ft of interference drawdown



Distance to 5 ft of drawdown for annual extraction rates less than 25 AFY is less than 100 ft.
Setbacks for annual extraction rates over 730 AFY are greater than 10,000 ft.

SMA 2: Western Alluvial Fan Areas
Lower Aquifer

Recommended minimum setback distances from existing wells that will result in less than 20 ft of interference drawdown



Distance to 20 ft of drawdown for annual extraction rates less than 105 AFY is less than 100 ft.

Instructions: Aquifer thickness is determined based on the vertical distance between the top of the uppermost screen interval to the base of the lowermost screen interval, plus 50 feet. The annual extraction rate is determined based on the long-term average annual demand (in acre-feet/year [AFY]) met by groundwater extraction from the well as explained in the text. Results for actual long-term extraction rates may be interpolated between the curves shown. For allowable interference drawdown values between 5 feet and 20 feet, the results for 5 feet and 20 should be determined and multiplied by a proportional scaling factor as described in the text.

Stanislaus County
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STANISLAUS COUNTY	
WELL PERMITTING	
FIGURE 6	
SMA 2: WESTERN ALLUVIAL FANS LOWER AQUIFER WELL INTERFERENCE NOMOGRAPHS	
DATE: MAY 2022	FORMATION ENVIRONMENTAL
BY: CFJ FOR: MT/RK	

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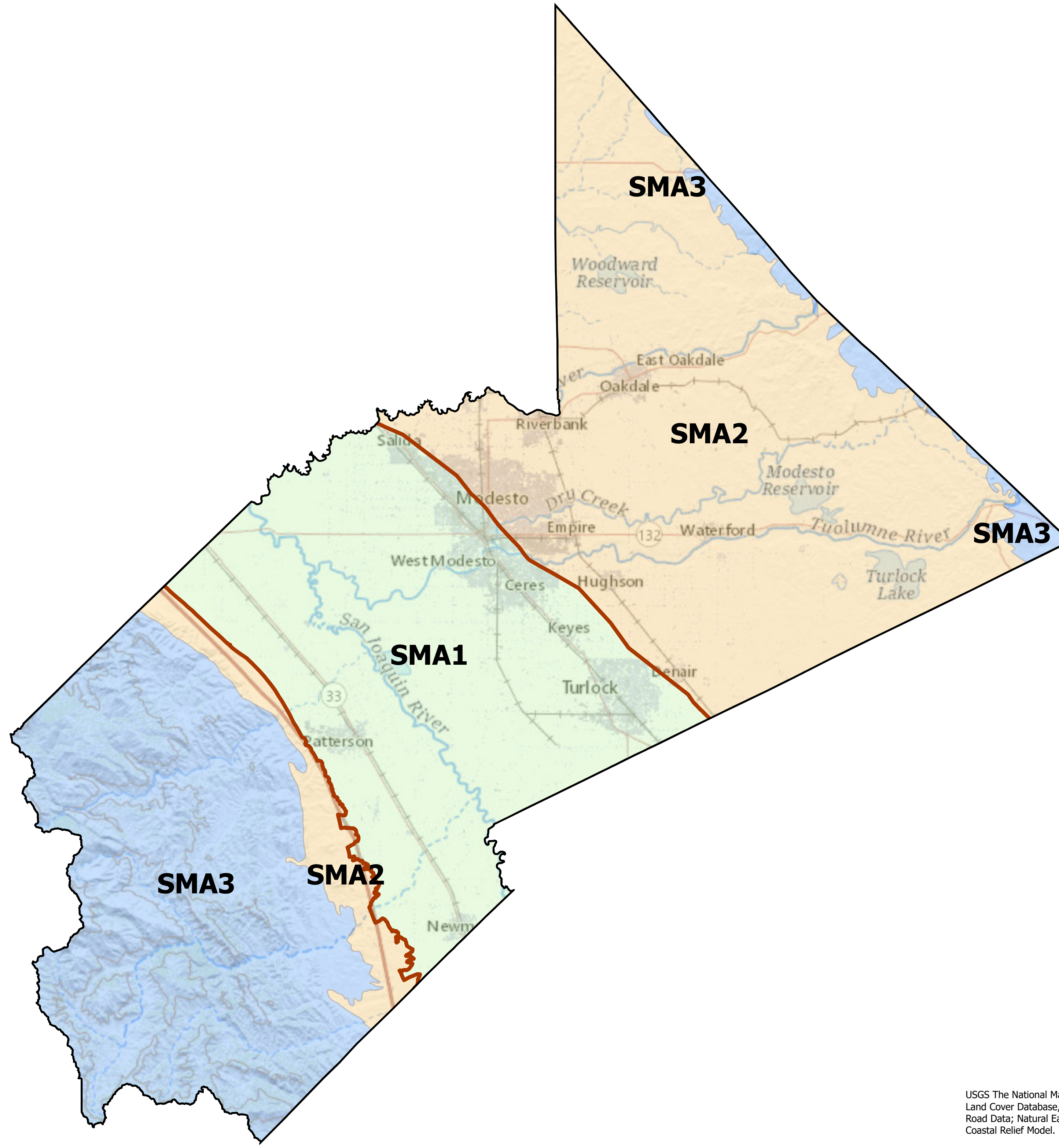

USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

FIGURE 1

LOCATIONS OF SPECIAL MANAGEMENT ZONES

Stanislaus County Groundwater Well Siting and Construction Guidelines

Legend

- Stanislaus County Boundary
- SMA1 – Area Underlain by the Corcoran Clay
- SMA2 – Alluvial Fan Areas
- SMA3 – Bedrock Areas of Coast Range and Sierra Nevada Foothills

DATE: MAR. 09, 2022

Scale for basemap

0 4 8

Miles

N

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