# Community Water Center Drinking Water Tool
# 2024 Well Impact Analysis Update

## Summary

Two well impact analyses were performed to update the Community Water Center's (CWC) Drinking Water Tool with potential domestic well impacts in California's Central Valley under recent groundwater elevation and Sustainable Groundwater Management Act (SGMA)-related conditions based on data available in January 2024. First, we used cleaned domestic well data to assess whether wells were predicted to be “fully dewatered” (i.e., the well has gone dry and can no longer draw water), “partially dewatered” (i.e., surrounding groundwater levels have lowered and reduced the well’s capacity to draw water), or “not impacted” by depth-to-groundwater levels for the Fall 2022 and Spring 2023 seasons. Second, we analyzed the number of domestic wells within California’s Central Valley that would be fully dewatered, partially dewatered, or unimpacted if groundwater levels were to reach the depth to Minimum Thresholds (MT) and Measurable Objectives (MO) set by Groundwater Sustainability Agencies (GSAs) in their Groundwater Sustainability Plans (GSPs). Below, we provide an overview of these analyses and final processing steps taken to aggregate the results to Public Land Survey System (PLSS) sections (approximately 1 square-mile sections). More detailed methodology documentation is available here.

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### 1. Methods for Cleaning and Processing Domestic Well Data for Analysis.

#### 1.1. Downloaded and cleaned domestic well dataset.

The Water Equity Science Shop (WESS) downloaded well locations from the Department of Water Resources’ (DWR’s) Online System for Well Completion Reports (OSWCR) via the California Open Data Portal webpage on January 27, 2024 (Department of Water Resources, 2024a). WESS selected domestic wells drilled on or after January 1, 1970 and removed duplicate well records.

#### 1.2. Determined depth of well and perforated interval (Figure 1).

Under the direction of CWC, EKI Environment and Water, Inc identified wells with reasonable values for the perforated interval, according to the following criteria.

**1.2.1.** Top of perforated interval was at least 20 ft below the ground surface (ft bgs).

**1.2.2.** Top of perforated interval was shallower than bottom of perforated interval.

**1.2.3.** Bottom of perforated interval was shallower than the total well depth.

**1.2.3.1.** If this condition was not met, value for bottom of perforated interval was flagged and later replaced with a value equal to 80% of total completed depth (DWR, Water Well Standards, 2024).

**1.2.4.** Bottom of perforated interval was at least 80% of total well depth.

**1.2.4.1.** If this condition was not met, value for bottom of perforated interval was flagged and later replaced with a value equal to 80% of total completed depth.

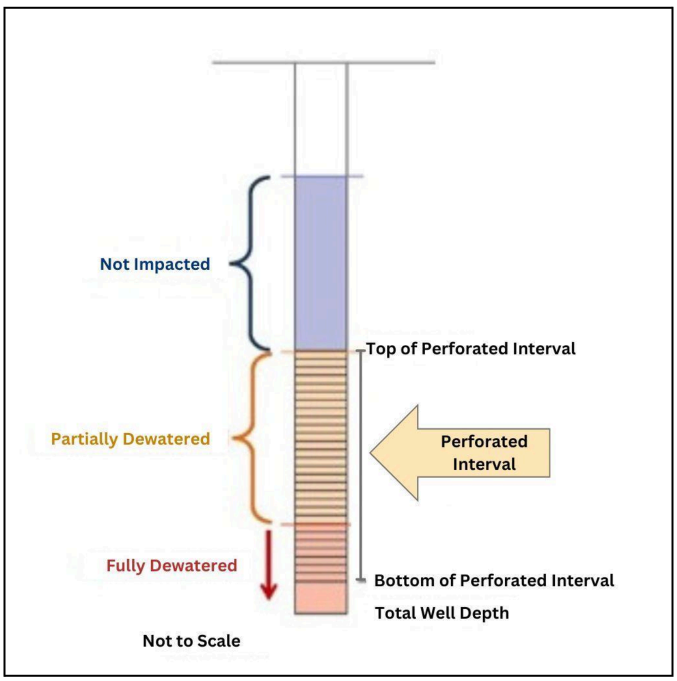


***Figure 1.*** *Perforated Interval and well impact definitions.*

**1.3. Selected study extent.**

EKI clipped the domestic well dataset to the Central Valley Basin (DWR, 2019).

**1.4. Designated aquifer for each well.**

EKI used USGS spatial datasets for Corcoran Clay thickness and depth (USGS, 2024) and assigned depth and thickness to each domestic well location. The Corcoran Clay layer separates the “upper aquifer” (above the clay) from the “lower aquifer” (below the clay), which is useful for understanding drought vulnerability. Based on the location of the well’s perforated interval relative to the Corcoran Clay layer (above, intersecting, or below), wells were assigned to an aquifer using the following guidelines (**figure 2**). Only wells located in the upper aquifer were retained for the first drought analysis based on SGMA related conditions from Fall 2022 and Spring 2023.

**1.4.1.** Wells were identified as “upper aquifer” in the following circumstances:

**1.4.1.1.** Both Corcoran Clay depth and Corcoran Clay thickness values were available and the perforated interval was above the Corcoran Clay depth and Corcoran Clay thickness.

**1.4.1.2.** OR, both Corcoran Clay depth and Corcoran Clay thickness values were missing for wells (in this case the wells were assumed to be outside of the extent of the Corcoran Clay and therefore in the upper aquifer).

**1.4.2.** Wells were identified as “lower aquifer” when both Corcoran Clay depth and Corcoran Clay thickness values were available and the well’s perforated interval was below the Corcoran Clay depth and Corcoran Clay thickness.

**1.4.3.** Wells were classified as “composite” when the perforated interval intersected with the Corcoran Clay depth or thickness.

**1.4.4.** Wells were classified as “lower or composite” when they received a value for Corcoran Clay depth that was above the bottom of the well’s perforated interval, but were missing a value for Corcoran Clay thickness.

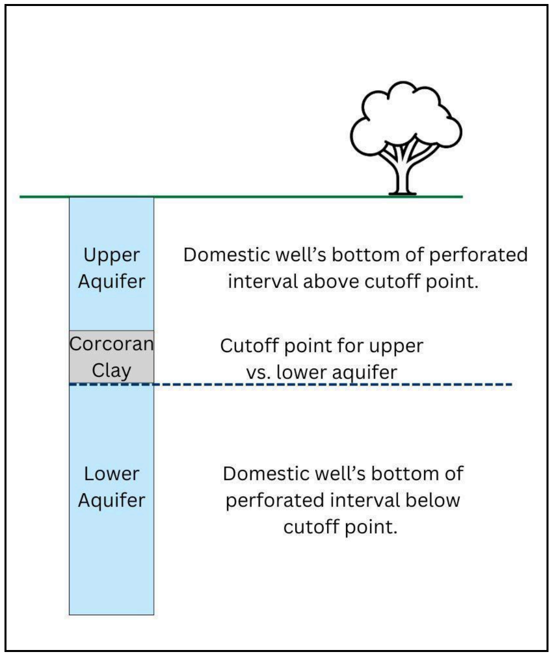


***Figure 2.*** *Domestic wells in the upper vs. lower aquifer.*

**Table 1. SUMMARY TABLE**

| **Data Source** | **Well Type** | **Number of Records** |
|---|---|---|
| Cleaned Well Completion Report dataset from CWC | Total Wells in Dataset | N = 162,591 |
| | Central Valley Domestic Wells | N = 46,187 |
| | *By well perforation information:* | |
| | *Wells with missing/erroneous top of perforation values* | *N = 1,353* |
| | *Wells with bottom of perforation values replaced with 80% of total well depth* | *N = 2,902* |
| | *Wells with retained top and bottom of perforation values* | *N = 42,411* |
| | *By aquifer designations:* | |
| | *Upper Aquifer Wells (included in analysis)* | *N = 42,171* |
| | *Lower Aquifer Wells* | *N = 3,281* |
| | *Composite Wells* | *N = 367* |
| | *Lower Aquifer or Composite Wells* | *N = 368* |

**Table 2. ATTRIBUTE TABLE**

| *domestic_wells_cleaned_prj.shp* | | | |
|---|---|---|---|
| **Field Heading** | **Field Type** | **Field Description** | **Source** |
| FID | Long | FID | ESRI generated |
| WCRNUMBER | String | Well identification code (WCR) | OSWCR |
| DATE_WRK_ENDED | Long | Date of well construction completion | OSWCR |
| TOTALCOMPLETEDDEPTH | Long | Total completed depth (ft bgs) | OSWCR |
| TOPOFPERFORATEDINTERVAL | Long | Depth to well's top of perforated interval (ft bgs) | OSWCR |
| BOTTOMOFPERFORATEDINTERVAL | Long | Depth to well's bottom of perforated interval (ft bgs) | OSWCR |
| CASINGDIAMETER | Long | Casing diameter with "0" values recorded as "-9999" | OSWCR |
| PLANNEDUSEFORMERUSE | String | Well's intended use, or past use (if retired) | OSWCR |
| DECIMALLATITUDE | Double | Latitude of well location | OSWCR |
| DECIMALLONGITUDE | Double | Longitude of well location | OSWCR |
| WELLLOCATION | String | Street address of well | OSWCR |
| CITY | String | City of well location | OSWCR |
| RECORDTYPE | String | Well entry type in OSWCR dataset | OSWCR |
| LLACCURACY | String | Accuracy of longitude and latitude coordinates | OSWCR |
| TOTALDRILLDEPTH | String | Total well depth (ft bgs) | OSWCR |
| TOTALDRILL | Long | Total well depth, with "NA" in place of missing values | OSWCR |
| TOP_20 | String | "Error" if top of perforated interval was less than 20 ft bgs or negative. Equal to "TOPOFPERFORATEDINTERVAL" if greater than 20 ft bgs. | Calculated |

| *domestic_wells_cleaned_prj.shp* | | | |
|---|---|---|---|
| **Field Heading** | **Field Type** | **Field Description** | **Source** |
| ORIGINAL_BOTTOM | String | "Yes" if original bottom of perforated interval was greater than 80% of the total well depth. "No" otherwise. | Calculated |
| BOTTOM_80_OR_REPLACED | Long | Equal to BOTTOMOFPERFORATEDINTERVAL if ORIGINAL_BOTTOM was "Yes". Equal to 0.8*TOTALCOMPLETED DEPTH otherwise. | Calculated |
| CC_THICK | Double | Extracted Corcoran Clay Thickness value in ft | USGS |
| CC_BOT_DEPTH | Double | Extracted depth to bottom of Corcoran clay in ft bgs | USGS |
| DESGINATION | String | Well designation calculated based on method specified above | Calculated |

2. **Method for comparing each well's perforated interval to groundwater depth.**

   EKI evaluated groundwater levels for each well at two points in time: Fall 2022 and Spring 2023 using seasonal groundwater measurements maintained in the DWR Enterprise Water Management database. Then each well was predicted as "not impacted", "partially dewatered", or "fully dewatered" based on conditions in Fall 2022 and Spring 2023 for each time point (**figure 3**).

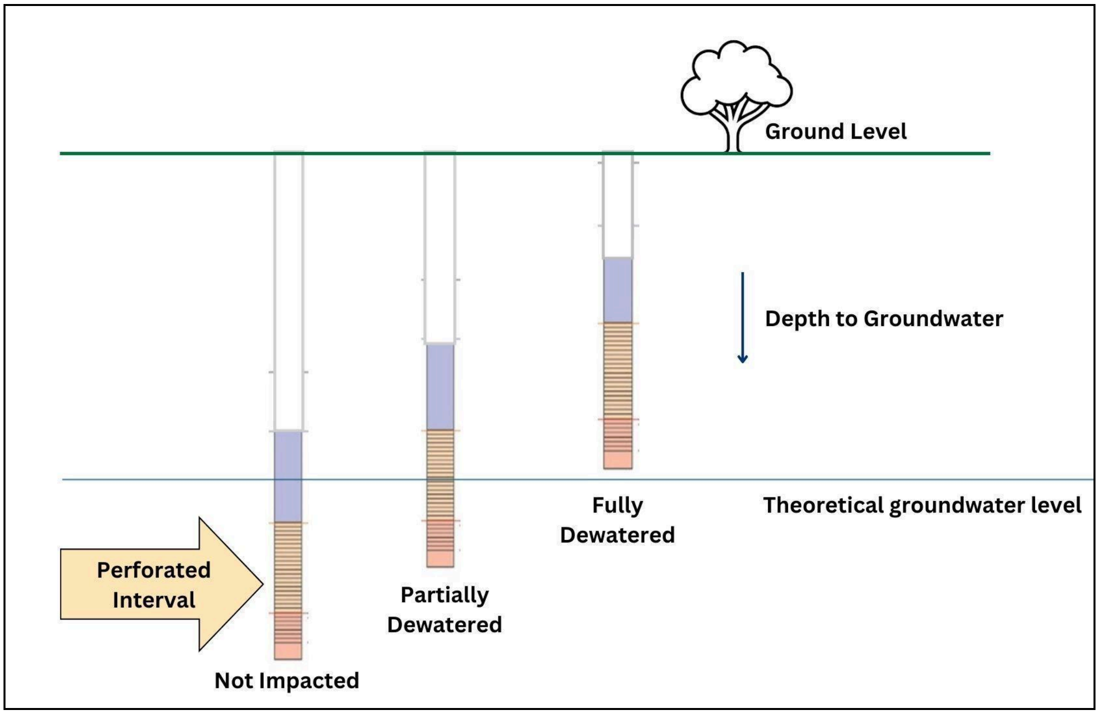


***Figure 3.*** *Example of well depth compared to theoretical depth to groundwater level.*

**Table 3. Fall 2022 Well Impact Analysis Results**

| Well Type | Number of Records |
|---|---|
| Upper Aquifer Wells | N = 42,171 |
| *Not Impacted* | *N = 31,986 (76%)* |
| *Partially Dewatered* | *N = 4,040 (10%)* |
| *Fully Dewatered* | *N = 5,029 (12%)* |
| *Unable to Determine* | *N = 1,010 (2%)* |
| *Not Included in the Analysis* | *N = 106 (0.3%)* |

**Table 4. Spring 2023 Well Impact Analysis Results**

| Well Type | Number of Records |
|---|---|
| Upper Aquifer Wells | N = 42,171 |
| *Not Impacted* | *N = 33,756 (80%)* |
| *Partially Dewatered* | *N = 3,534 (8%)* |

| | |
|---|---|
| *Fully Dewatered* | *N = 3,705 (9%)* |
| *Unable to Determine* | *N = 1,070 (3%)* |
| *Not Included in the Analysis* | *N = 106 (0.3%)* |

## 3. Method for evaluating impact of Sustainable Management Criteria (SMC) on domestic wells.

### 3.1. Sustainable Management Criteria for Representative Monitoring Wells.

EKI downloaded DWR's "Sustainable Management Criteria (SMC) (New – Under Development)" (CNRA, GSP Monitoring Data, 2024). This dataset includes information on Measurable Objectives (MOs) and Minimum Thresholds (MTs) for the Chronic Lowering of Groundwater Levels sustainability indicator for 3,139 Representative Monitoring Wells (RMWs), submitted by the respective Groundwater Sustainability Agencies (GSAs). The Measurable Objective (MO) represents a specific, quantifiable goal for maintaining or improving groundwater level conditions to achieve the overall sustainability goal and avoid undesirable results (defined as: significant and unreasonable declines in groundwater levels, reductions in groundwater storage, intrusion of seawater, degradation of water quality, subsidence of land, and depletions of interconnected surface waters). The Minimum Threshold (MT) represents the water level at which undesirable results are expected to occur. **Figure 4** displays theoretical values for achieving sustainable management over 20 years. Depth data is reported in units of feet above mean sea level (ft amsl).

***Note***: Some GSAs are revising their GSPs so the MTs and MOs may be out of date if amended after July 2022. Revised levels will be incorporated into future Drinking Water Tool updates.

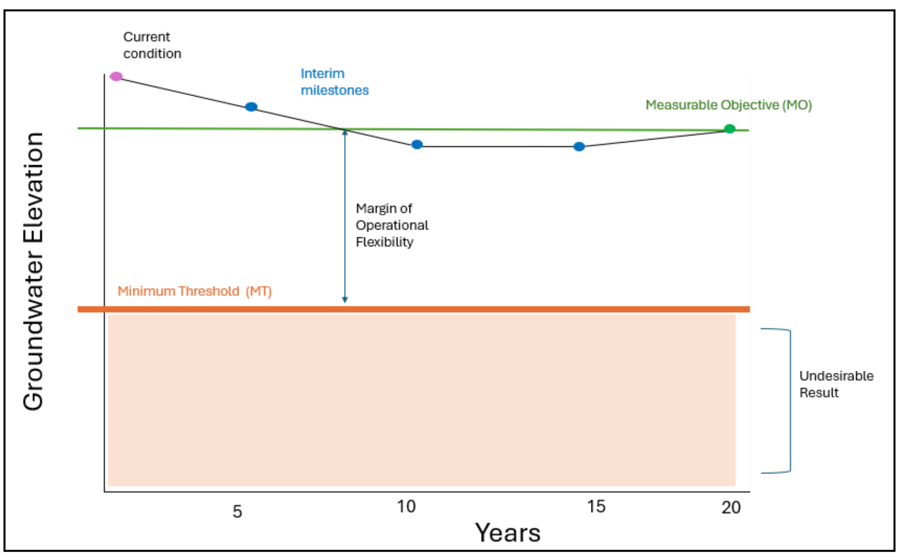

*Figure 4. Example of measurable objective, minimum threshold, and interim milestones for a representative monitoring well (RMW) in a theoretical groundwater sustainability plan.*

### 3.2. RMW Locations.

Spatial data (coordinates) for the RMW locations were downloaded from the DWR's "Groundwater Sustainability Plan (GSP) Monitoring Sites (New – Under Development)" dataset (CNRA, GSP, Monitoring Sites, 2024) (Number of records "N" = 6,194). This dataset was used to obtain spatial data for the RMWs in the SMC dataset.

### 3.3. Combined SMC data and RMW Location data.

The two datasets (SMC information and RMW Locations) were combined so that each RMW had both SMC and location data. Only wells with *both* SMC and location data were retained for the analysis (N = 2,614).

### 3.4. Designated aquifer for each RMW.

RMWs were then classified into Upper and Lower Aquifers based on depth of the monitoring well's perforated interval relative to the Corcoran Clay layer, following the same method outlined in section 1.4 (**figure 5**). Wells designated as "Lower Aquifer", "Lower Aquifer or Composite", or "Composite" were included in the Lower Aquifer Well Impact Analysis.

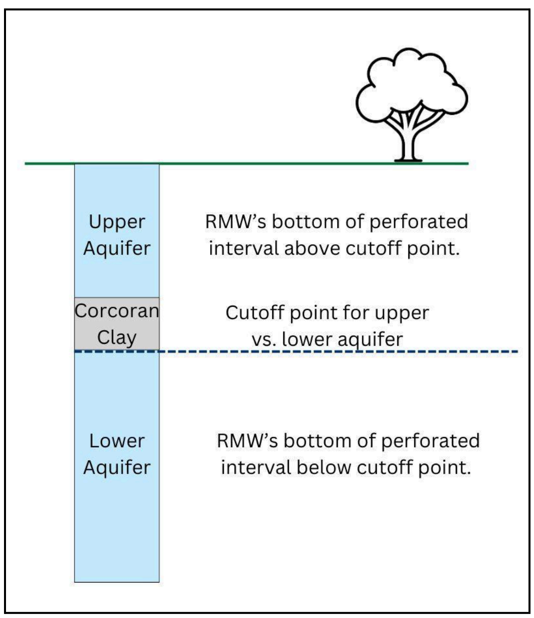


***Figure 5.*** *Representative monitoring wells (RMWs) in Upper vs. Lower aquifer.*

### 3.5. Estimated SMC values across aquifers.

SMC values (MO/MTs) for RMWs were used to estimate SMC values across each aquifer (upper and lower aquifer).

### 3.6. Method for comparing each domestic well's perforated interval to SMC values.

Domestic wells were assigned SMC values (MO/MTs) based on the well's designation as upper or lower aquifer (see step 1.4). The perforated intervals for domestic wells were compared to the MO/MTs to determine whether the well would be "not impacted", "partially dewatered", or "fully dewatered" (**figure 6**). Results are included in Tables 3-6.

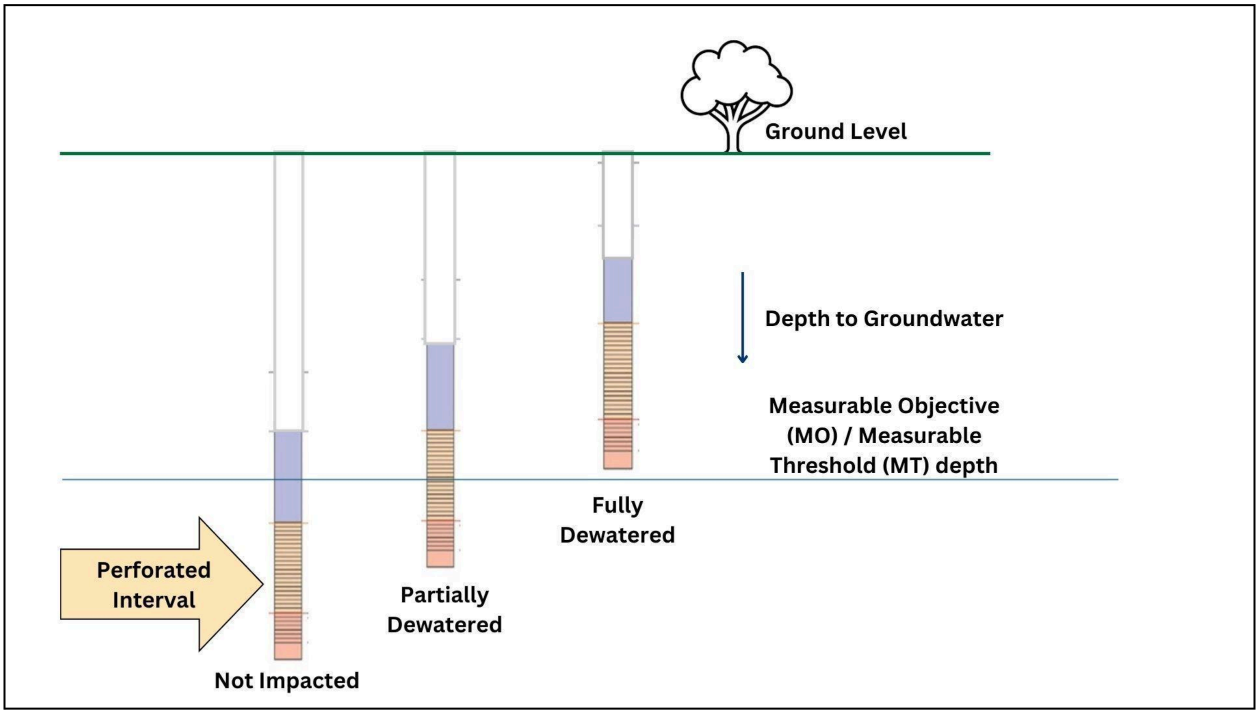


***Figure 6.*** *Example of well depth compared to Measurable Objective (MO) or Measurable Threshold (MT) depths.*

**Table 5. Upper Aquifer MO Well Impact Analysis Results**

| Well Type | Number of Records |
|---|---|
| Upper Aquifer Wells | N = 42,171 |
| *Not Impacted* | *N = 29,124 (69%)* |
| *Partially Dewatered* | *N = 3,808 (9%)* |
| *Fully Dewatered* | *N = 7,844 (19%)* |
| *Unable to Determine* | *N = 767 (2%)* |
| *Not Included in the Analysis* | *N = 628 (1%)* |

**Table 6. Upper Aquifer MT Well Impact Analysis Results**

| Well Type | Number of Records |
|---|---|
| Upper Aquifer Wells | N = 42,171 |
| *Not Impacted* | *N = 24,419 (58%)* |
| *Partially Dewatered* | *N = 4,492 (11%)* |
| *Fully Dewatered* | *N = 11,993 (28%)* |
| *Unable to Determine* | *N = 608 (1%)* |
| *Not Included in the Analysis* | *N = 659 (2%)* |

**Table 7. Lower Aquifer MO Well Impact Analysis Results**

| Well Type | Number of Records |
|---|---|
| Lower Aquifer Wells | N = 4,016 |
| *Not Impacted* | *N = 3,342 (83%)* |
| *Partially Dewatered* | *N = 340 (8%)* |
| *Fully Dewatered* | *N = 226 (6%)* |
| *Unable to Determine* | *N = 99 (3%)* |
| *Not Included in the Analysis* | *N = 9 (0.2%)* |

**Table 8. Lower Aquifer MT Well Impact Analysis Results**

| Well Type | Number of Records |
|---|---|
| Lower Aquifer Wells | N = 4,016 |
| *Not Impacted* | *N = 2,448 (61%)* |
| *Partially Dewatered* | *N = 516 (13%)* |
| *Fully Dewatered* | *N = 976 (24%)* |
| *Unable to Determine* | *N = 67 (2%)* |
| *Not Included in the Analysis* | *N = 9 (0.2%)* |

4. **Final processing steps for the Drinking Water Tool.**

**4.1.** WESS researchers aggregated the results from the SMC analysis to PLSS sections.

**4.2.** WESS researchers calculated the number of domestic wells (in both upper and lower aquifers) fully dewatered and partially dewatered under MT and MO conditions.

**Table 9. Spatial Reference**

| | | | |
|---|---|---|---|
| Geographic Coordinate System | NAD 1983 | Projected Coordinate System | NAD 1983 (Teale) Albers (Meters) |
| WKID | 4269 | Projection | 3310 |
| Authority | EPSG | Authority | EPSG |
| Angular Unit | Degree (0.0174532925199433) | Linear Unit | Meters (1.0) |
| Prime Meridian | Greenwich (0.0) | False Easting | 0.00 |
| Datum | D North American 1983 | False Northing | -4000000.0 |
| Spheroid | GRS 1980 | Central Meridian | -120.0 |
| Semimajor Axis | 6378137.0 | Standard Parallel 1 | 34.0 |
| Semiminor Axis | 6356752.314140356 | Standard Parallel 2 | 40.5 |
| Inverse Flattening | 298.257222101 | Latitude of Origin | 0.0 |

**Table 10. ATTRIBUTE TABLE**

| ***drought_analysis_plss_061224.shp*** | | | |
|---|---|---|---|
| **Field Heading** | **Field Type** | **Field Description** | **Source** |
| FID | Object ID | FID | ESRI generated |
| Shape | Geometry | Polygon | ESRI generated |
| MTRS | Text | Meridian, Township, Range, Section (MTRS); PLSS identifier | CA.gov |
| Up_well_n | Float | Number of domestic wells in the analysis located in the upper aquifer. | EKI |
| Low_well_n | Float | Number of domestic wells in the analysis located in the lower aquifer. | EKI |
| Up_MT_full | Float | Number of wells in the upper aquifer fully dewatered under MT conditions. | EKI |

| *drought_analysis_plss_061224.shp* | | | |
|---|---|---|---|
| **Field Heading** | **Field Type** | **Field Description** | **Source** |
| Low_MT_ful | Float | Number of wells in the lower aquifer fully dewatered under MT conditions. | EKI |
| Up_MT_part | Float | Number of wells in the upper aquifer partially dewatered under MT conditions. | EKI |
| Low_MT_par | Float | Number of wells in the lower aquifer partially dewatered under MT conditions. | EKI |
| Up_MO_full | Float | Number of wells in the upper aquifer fully dewatered under MO conditions. | EKI |
| Low_MO_ful | Float | Number of wells in the lower aquifer fully dewatered under MO conditions. | EKI |
| Up_MO_part | Float | Number of wells in the upper aquifer partially dewatered under MO conditions. | EKI |
| Low_MO_par | Float | Number of wells in the lower aquifer partially dewatered under MO conditions. | EKI |
| wells_n | Float | Total number of wells included in the analysis. | EKI |
| MT_fully | Float | Total number of wells fully dewatered under MT conditions. | EKI |
| MT_partial | Float | Total number of wells partially dewatered under MT conditions. | EKI |
| MO_fully | Float | Total number of wells fully dewatered under MO conditions. | EKI |
| MO_partial | Float | Total number of wells partially dewatered under MO conditions. | EKI |
| Shape_Leng | Double | GIS generated – length in meters | ESRI generated |
| Shape_Area | Double | GIS generated – area in square meters | ESRI generated |

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