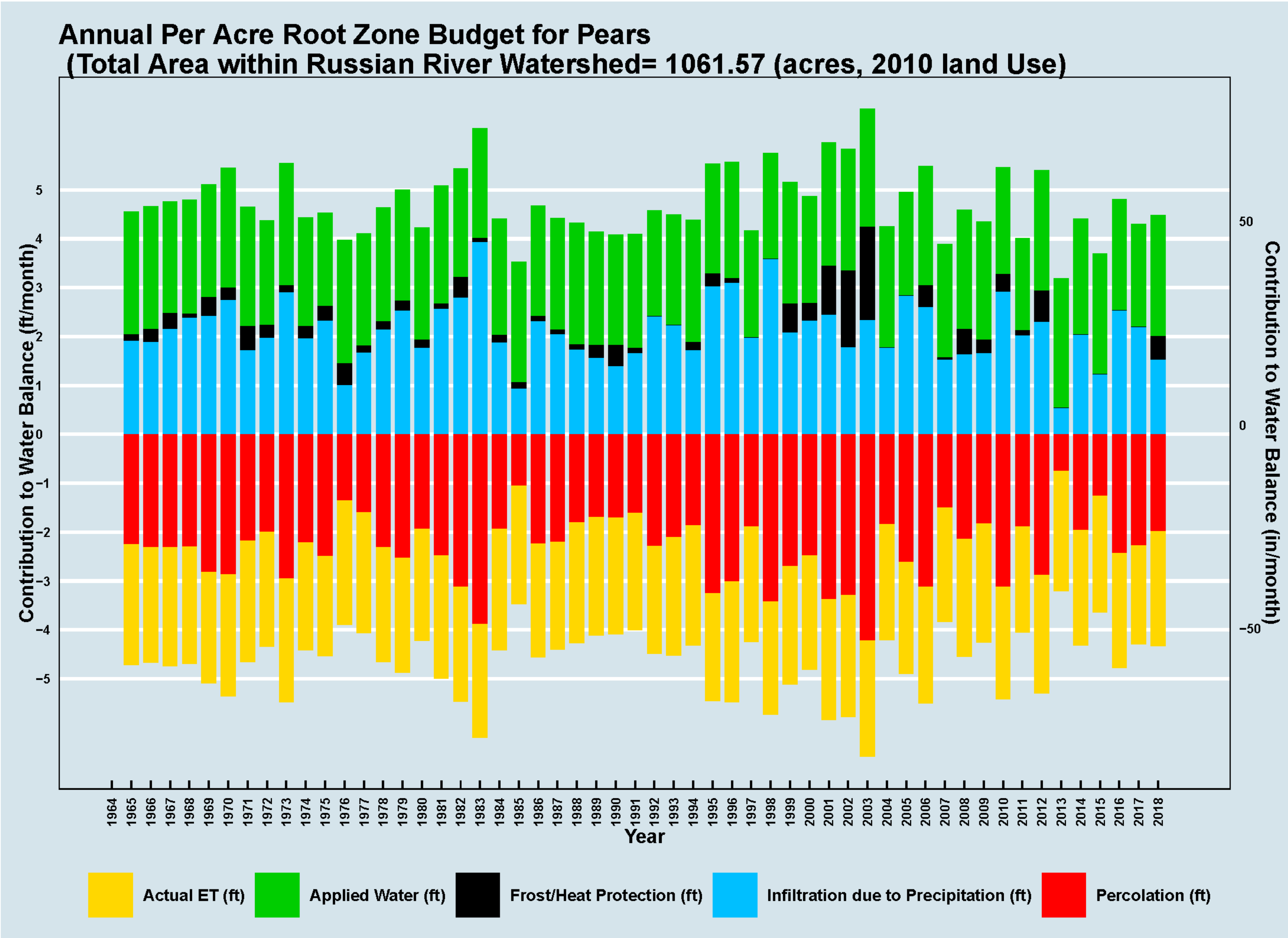


**Figure 7.17:** Annual historical Soil-zone water budegt for pear irrigation estimated by the UVIHM IDC.

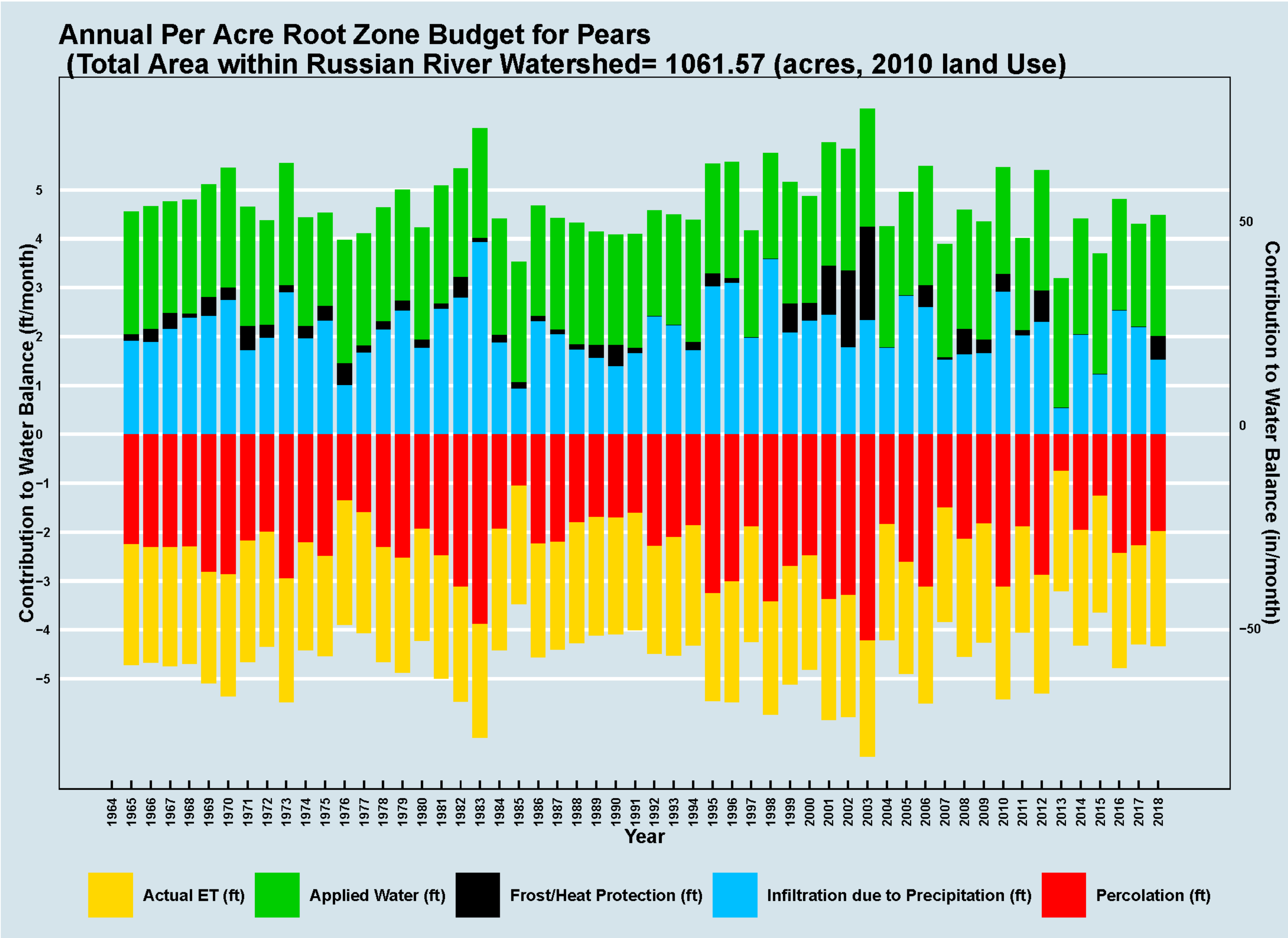


**Figure 7.18:** Annual historical Soil-zone water budegt for pasture irrigation estimated by the UVIHM IDC.

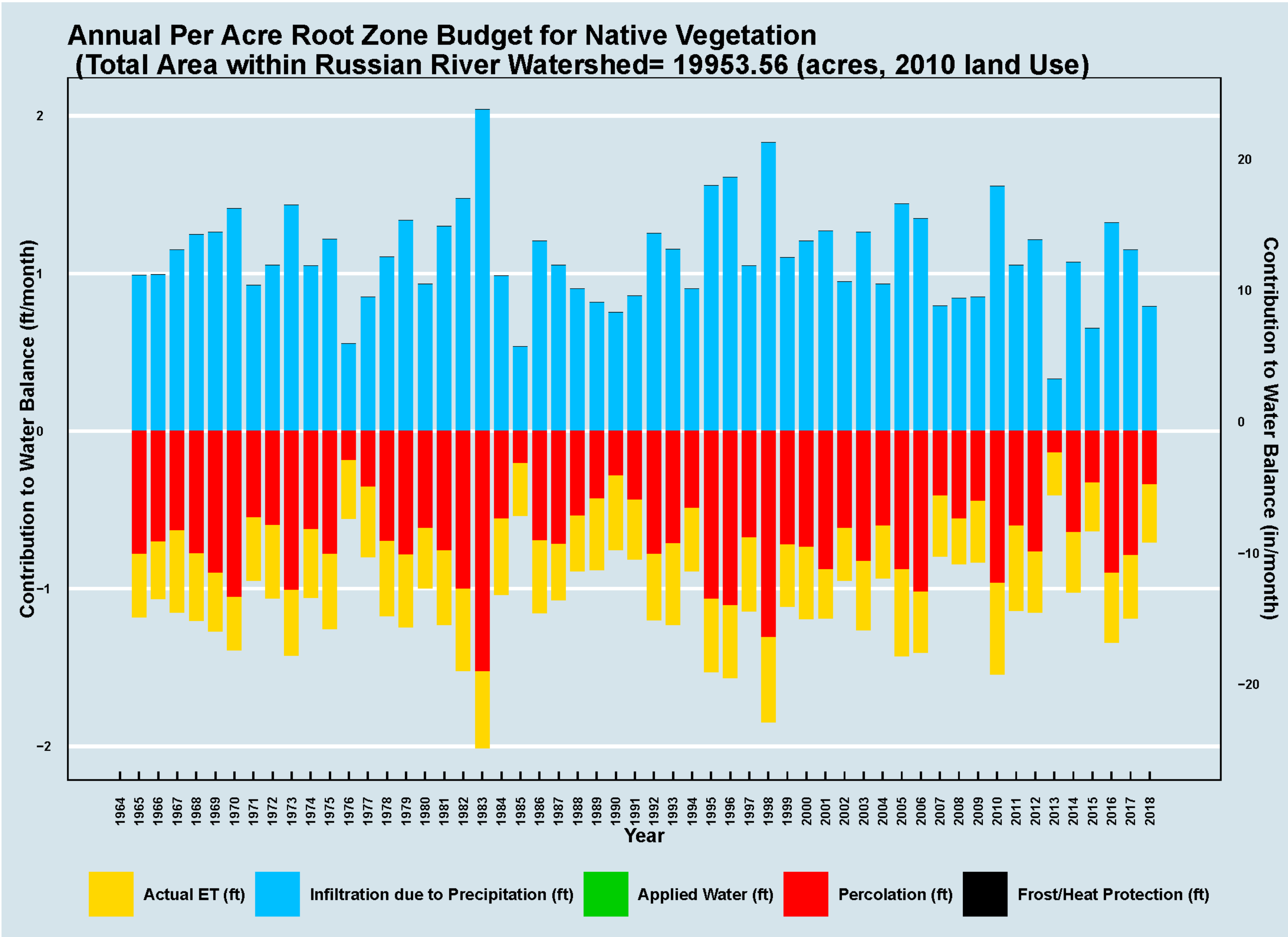


**Figure 7.19:** Annual historical Soil-zone water budegt for native vegetation estimated by the UVIHM IDC.

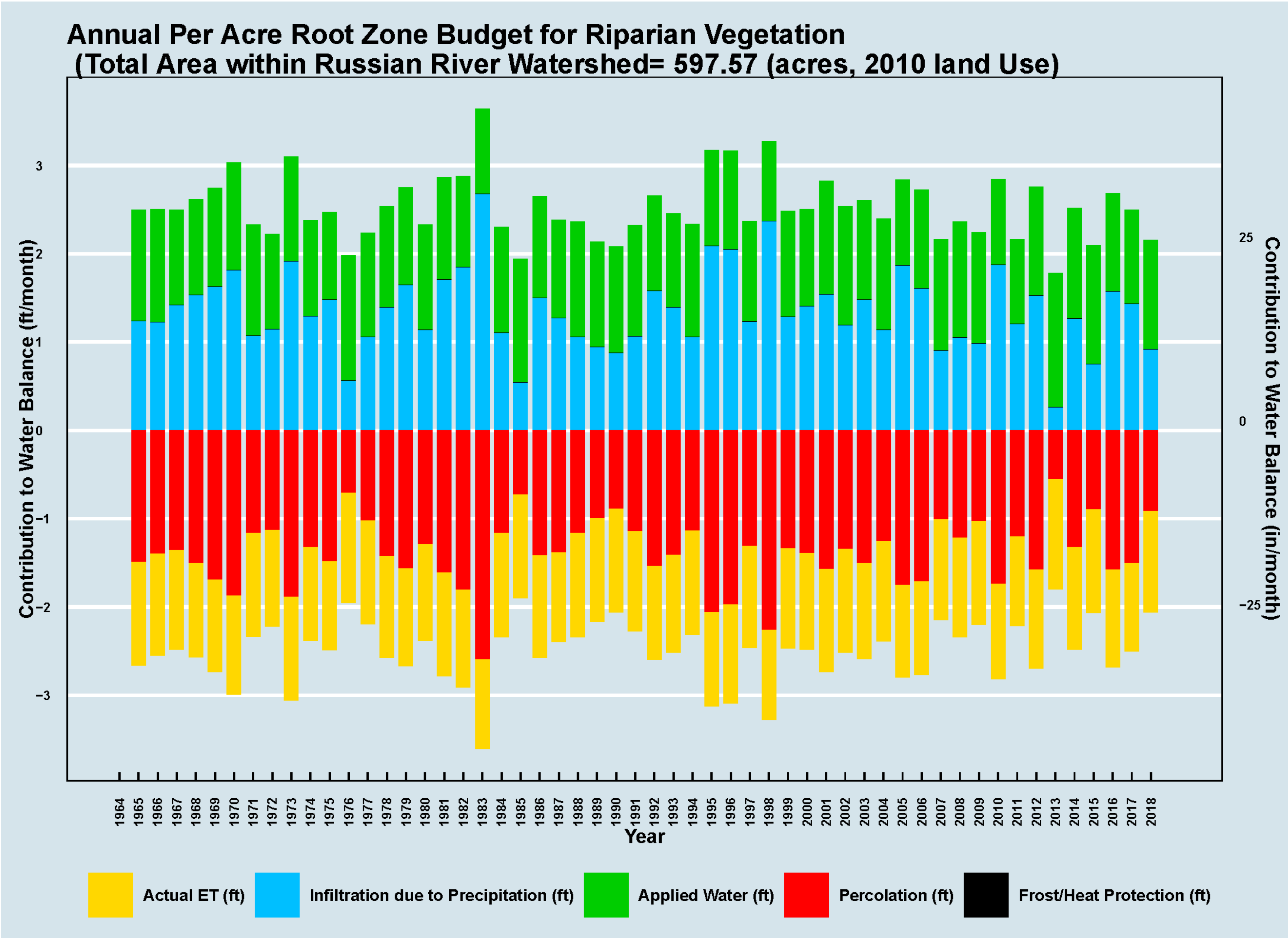


**Figure 7.20:** Annual historical Soil-zone water budegt for riparian vegetation estimated by the UVIHM IDC.

### 7.4.3 Groundwater Budget

Groundwater budget for the Basin is generated from the UVIHM and is shown below for the historical, current, and future baseline periods. Main inflows to the Basin include deep percolation or recharge from precipitation and agricultural irrigation, stream recharge, and inflow from upper watershed tributaries. All three of these inflows are directly dependent on precipitation. Recharge of the aquifers is therefore primarily the result of infiltrated precipitation that moves downward and reaches the principal aquifers. Streambed recharge is dependent on streamflows and the interaction of surface water bodies and groundwater aquifers. This interaction, although complex, is heavily impacted by direct runoff resulting from precipitation and managed reservoir releases that are determined by precipitation and streamflow. Main outflows from the Basin and groundwater budget are groundwater use and production, groundwater loss to the stream network, and water that flows out of the Basin through the Russian River stream channel. Groundwater outflow from Basin boundaries is considered negligible and outflow from the Basin primarily occurs through the Russian River surface and subsurface channel.

**Historical Water Budget**

**Figure 7.21** shows the annual water budget for the historical water budget by water years. Water budget shows that agricultural pumping has remained relatively constant throughout the years, and municipal pumping has decreased in recent years. The impact of precipitation and water year types can be observed from the annual water budget. **Figure 7.25** shows the monthly water budget averaged over each water year type during the historical period. It shows the change in the interaction of groundwater aquifers and streams during dry and wet seasons. A detailed annual summary water budget components are provided in **Table 7.2**.

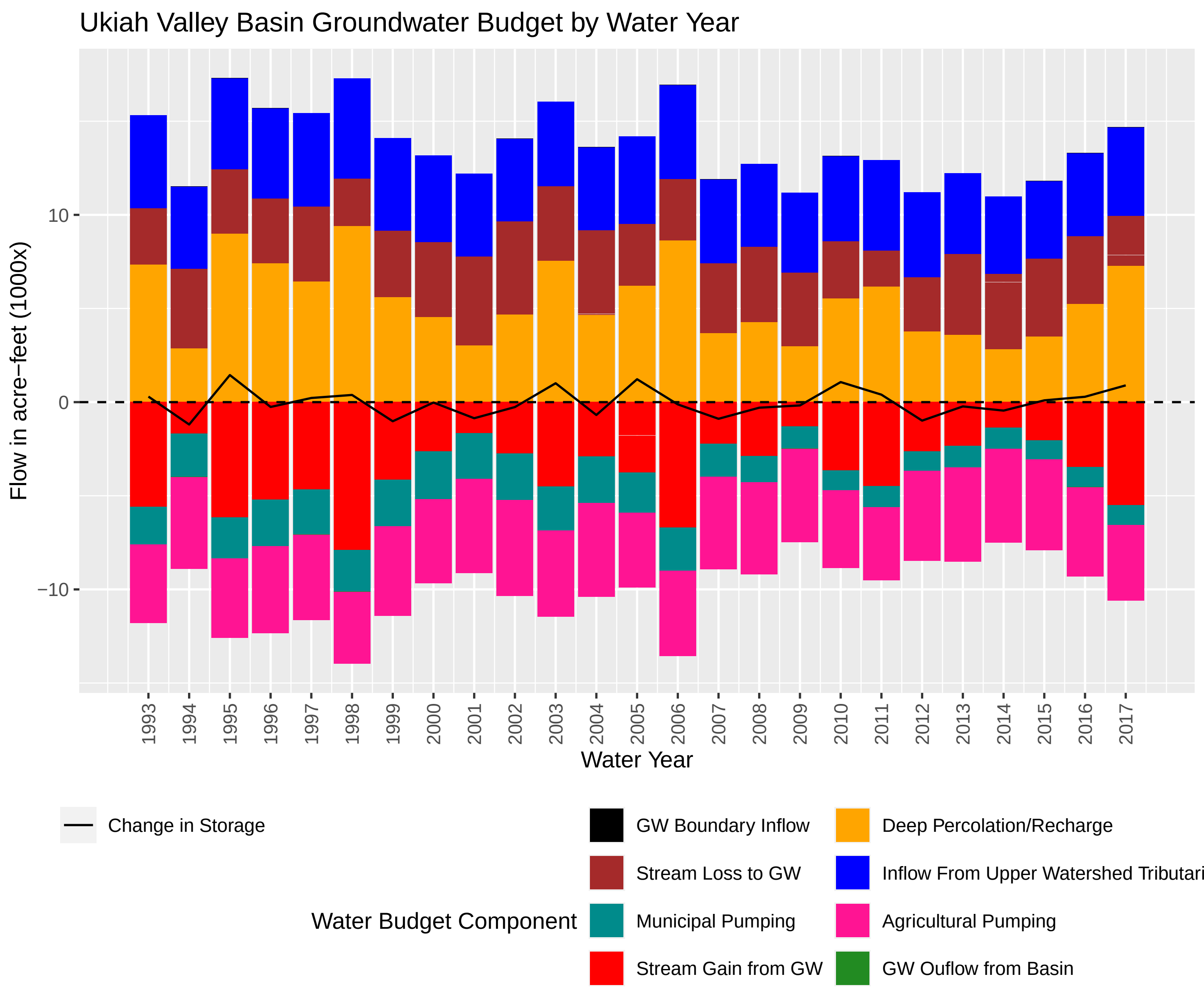


**Figure 7.21:** Estimated historical annual groundwater budget for the Basin averaged over 1992-2018.

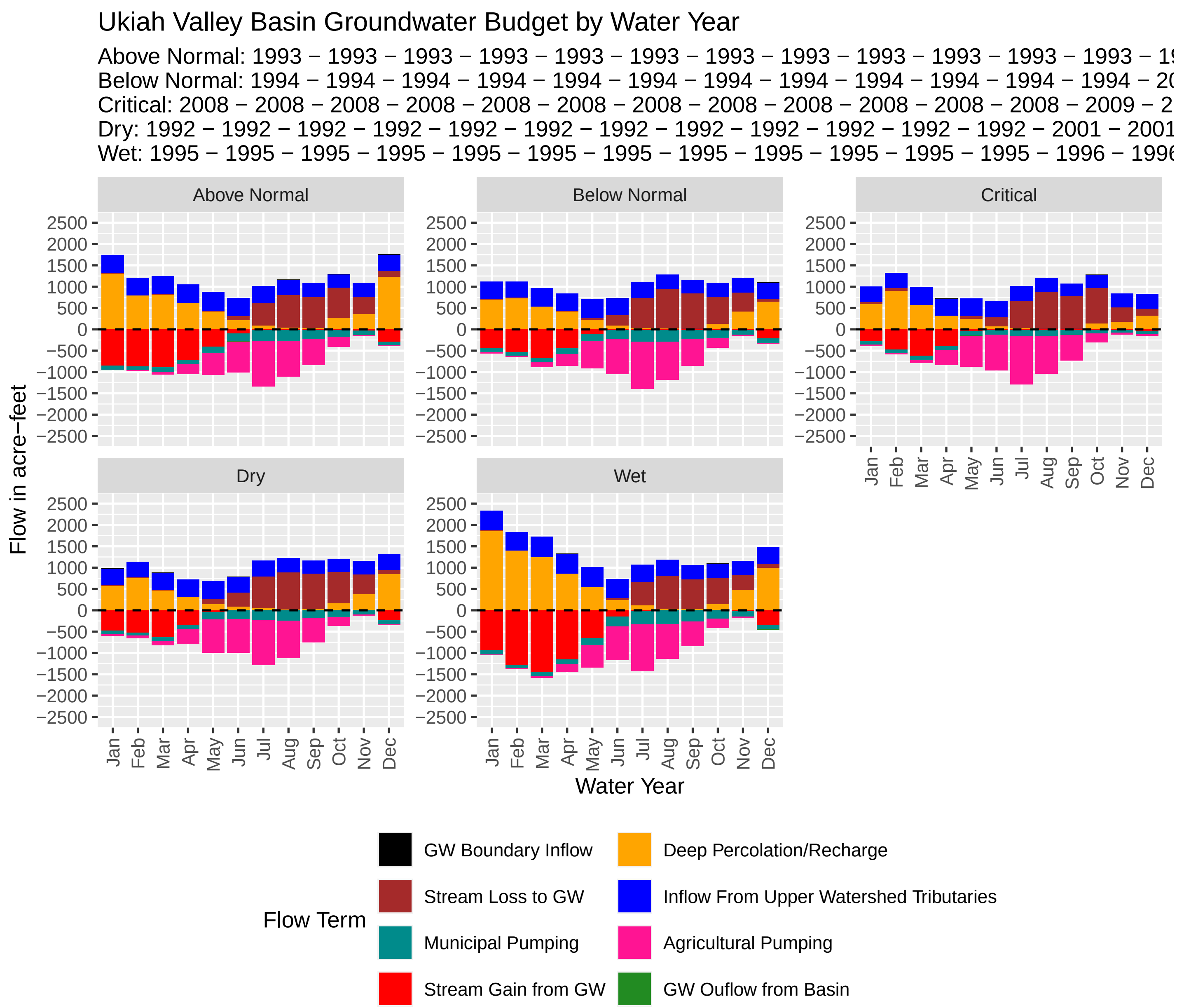


**Figure 7.22:** Estimated historical average monthly water budget for the groundwater Basin for each water year type. Water budget components are averaged over the same water year types in the 1992-2018 period.

**Table 7.2:** Ukiah Valley Groundwater Basin estimated historical annual water budget for the period of 1992-2018. Values are in acre-foot.

| Water Year | Water Year Type | Groundwater Boundary Inflow | Deep Percola-tion/Recharge | Stream Loss to Groundwater | Inflow From Upper Watershed | Municipal Pumping | Agricultural Pumping | Stream Gain from Groundwater | Groundwater Ouflow from Basin |
|---|---|---|---|---|---|---|---|---|---|
| 1992 | Dry | 5.3 | 5021.3 | 3781.5 | 4520.5 | 2218.4 | 4563.7 | 2849.7 | 1.0 |
| 1993 | Above Normal | 5.3 | 7326.6 | 3008.7 | 4981.6 | 2024.1 | 4208.8 | 5563.0 | 1.0 |
| 1994 | Below Normal | 5.3 | 2857.6 | 4243.2 | 4403.8 | 2331.7 | 4920.8 | 1651.6 | 1.0 |
| 1995 | Wet | 5.3 | 8984.2 | 3453.1 | 4853.4 | 2198.6 | 4240.9 | 6137.7 | 1.0 |
| 1996 | Wet | 5.3 | 7413.0 | 3441.5 | 4832.4 | 2491.9 | 4668.4 | 5180.9 | 1.0 |
| 1997 | Above Normal | 5.3 | 6437.1 | 3987.9 | 4998.9 | 2404.1 | 4573.7 | 4648.8 | 1.0 |
| 1998 | Wet | 5.3 | 9396.4 | 2526.3 | 5353.1 | 2224.6 | 3852.3 | 7881.7 | 1.1 |
| 1999 | Wet | 5.3 | 5595.5 | 3559.7 | 4940.4 | 2494.1 | 4793.7 | 4116.7 | 1.0 |
| 2000 | Below Normal | 5.3 | 4542.0 | 3996.2 | 4625.3 | 2565.2 | 4508.9 | 2602.1 | 1.0 |
| 2001 | Dry | 5.3 | 3013.5 | 4746.4 | 4429.7 | 2426.7 | 5048.6 | 1650.1 | 1.0 |
| 2002 | Below Normal | 5.3 | 4662.5 | 4978.4 | 4418.7 | 2496.2 | 5139.4 | 2715.0 | 1.0 |
| 2003 | Above Normal | 5.3 | 7532.6 | 3973.7 | 4532.3 | 2346.5 | 4625.0 | 4495.4 | 1.0 |
| 2004 | Above Normal | 5.3 | 4640.7 | 4518.2 | 4445.6 | 2489.7 | 5027.2 | 2878.8 | 1.0 |
| 2005 | Above Normal | 5.3 | 6198.0 | 3316.3 | 4671.1 | 2160.8 | 3993.8 | 3733.6 | 1.0 |
| 2006 | Wet | 5.3 | 8613.8 | 3291.2 | 5026.9 | 2302.3 | 4561.2 | 6687.7 | 1.0 |
| 2007 | Below Normal | 5.3 | 3674.3 | 3723.4 | 4493.1 | 1752.5 | 4967.8 | 2210.0 | 1.0 |
| 2008 | Critical | 5.3 | 4254.0 | 4037.3 | 4418.0 | 1393.6 | 4936.2 | 2861.4 | 1.0 |
| 2009 | Critical | 5.3 | 2983.8 | 3920.3 | 4276.4 | 1193.3 | 5022.7 | 1272.0 | 1.0 |

**Table 7.2:** Ukiah Valley Groundwater Basin estimated historical annual water budget for the period of 1992-2018. Values are in acre-foot. *(continued)*

| Water Year | Water Year Type | Groundwater Boundary Inflow | Deep Percolation/Recharge | Stream Loss to Groundwater | Inflow From Upper Watershed | Municipal Pumping | Agricultural Pumping | Stream Gain from Groundwater | Groundwater Ouflow from Basin |
|---|---|---|---|---|---|---|---|---|---|
| 2010 | Above Normal | 5.3 | 5517.2 | 3078.8 | 4532.6 | 1063.8 | 4171.0 | 3629.3 | 1.0 |
| 2011 | Above Normal | 5.3 | 6170.2 | 1911.4 | 4839.7 | 1141.3 | 3915.3 | 4454.7 | 1.0 |
| 2012 | Below Normal | 5.3 | 3757.0 | 2895.9 | 4547.9 | 1047.3 | 4823.9 | 2613.1 | 1.0 |
| 2013 | Dry | 5.3 | 3589.0 | 4313.9 | 4310.5 | 1166.8 | 5046.4 | 2308.4 | 1.0 |
| 2014 | Critical | 5.4 | 2819.1 | 4020.2 | 4139.0 | 1114.2 | 5041.9 | 1352.6 | 1.0 |
| 2015 | Dry | 5.4 | 3484.1 | 4179.7 | 4137.7 | 1034.1 | 4870.4 | 2014.5 | 1.0 |
| 2016 | Above Normal | 5.3 | 5235.3 | 3606.2 | 4453.1 | 1070.5 | 4796.3 | 3452.3 | 1.0 |
| 2017 | Wet | 5.3 | 7273.2 | 2668.5 | 4723.0 | 1068.5 | 4061.7 | 5475.2 | 1.0 |
| 2018 | Above Normal | 5.3 | 3135.9 | 3329.6 | 4234.4 | 1068.5 | 4988.8 | 1809.2 | 1.0 |

## Current Water Budget

The current water budget is a subset of the historical water budget and includes the water years 2015 through 2018. Annual water budget estimations are shown in **Figure 7.23**. Monthly average estimations of each water budget component for the current period are provided in **Table 7.3**.

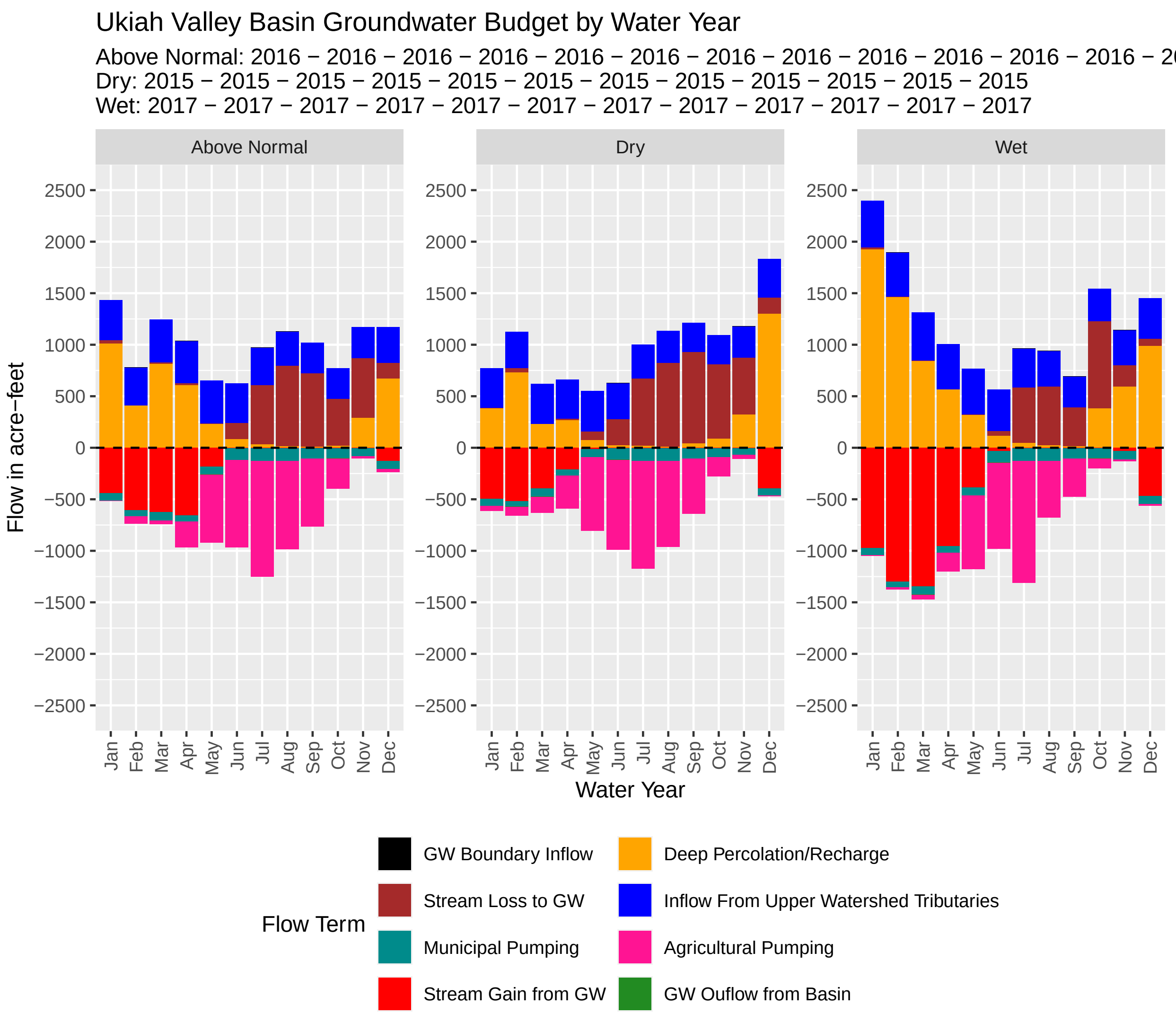


**Figure 7.23:** Estimated current annual groundwater budget for the Basin averaged over 2015-2018.

**Table 7.3:** Estimated Ukiah Valley Groundwater Basin monthly water budget averaged over 2015-2018 for current conditions. Values are in acre-foot.

| Water Budget Component | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater Boundary Inflow | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | 0.4 | 0.5 |
| Deep Percolation/Recharge | 1602.4 | 1016.4 | 1031.1 | 507.5 | 271.1 | 103.5 | 40.3 | 18.8 | 13.0 | 193.4 | 372.2 | 1084.6 |
| Stream Loss to Groundwater | 11.3 | 0.0 | 7.1 | 0.0 | 1.2 | 88.1 | 528.2 | 655.0 | 535.0 | 695.2 | 435.1 | 181.1 |
| Inflow From Upper Watershed | 434.2 | 413.8 | 455.1 | 431.5 | 433.5 | 400.1 | 377.1 | 341.9 | 302.4 | 308.4 | 319.2 | 370.8 |
| Municipal Pumping | 69.7 | 55.8 | 81.7 | 61.2 | 76.0 | 114.0 | 125.2 | 126.0 | 103.1 | 100.1 | 79.7 | 77.0 |
| Agricultural Pumping | 4.7 | 40.7 | 39.9 | 249.1 | 659.3 | 816.7 | 1143.0 | 704.3 | 526.0 | 206.9 | 24.6 | 13.7 |
| Stream Gain from Groundwater | 808.9 | 1050.9 | 1112.5 | 836.6 | 297.4 | 16.3 | 0.0 | 0.0 | 0.0 | 0.0 | 15.9 | 325.3 |
| Groundwater Ouflow from Basin | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

### Projected Water budget

The projected water budget is estimated using the UVIHM simulation of the future baseline. As mentioned above, climatic and gaged data for the future baseline period mirrors the historical period starting from WY 1969. This is also the case for CVD releases from Lake Mendocino. However, all other input data, including but not limited to water use, land use, soil type, and irrigation practices, are assumed to be constant and represent the most recent conditions on record. It is worth noting that no PMAs, including the Recycled Water Project, is considered in the simulation of future baseline and estimating the projected water budget.

**Figure 7.24** shows the projected annual water budget estimation for the future baseline. The projected water budget shows similar patterns to the historical water budget. However, an overall decrease in stream losses to groundwater and an overall increase in stream gain from groundwater is observed. There is no continuous decline in groundwater storage, and storage change generally follows water year types and precipitation patterns. The same impacts can be observed from monthly average water budget estimations shown in **Figure ??**. A detailed annual summary of water budget components are provided in **Table 7.2**.

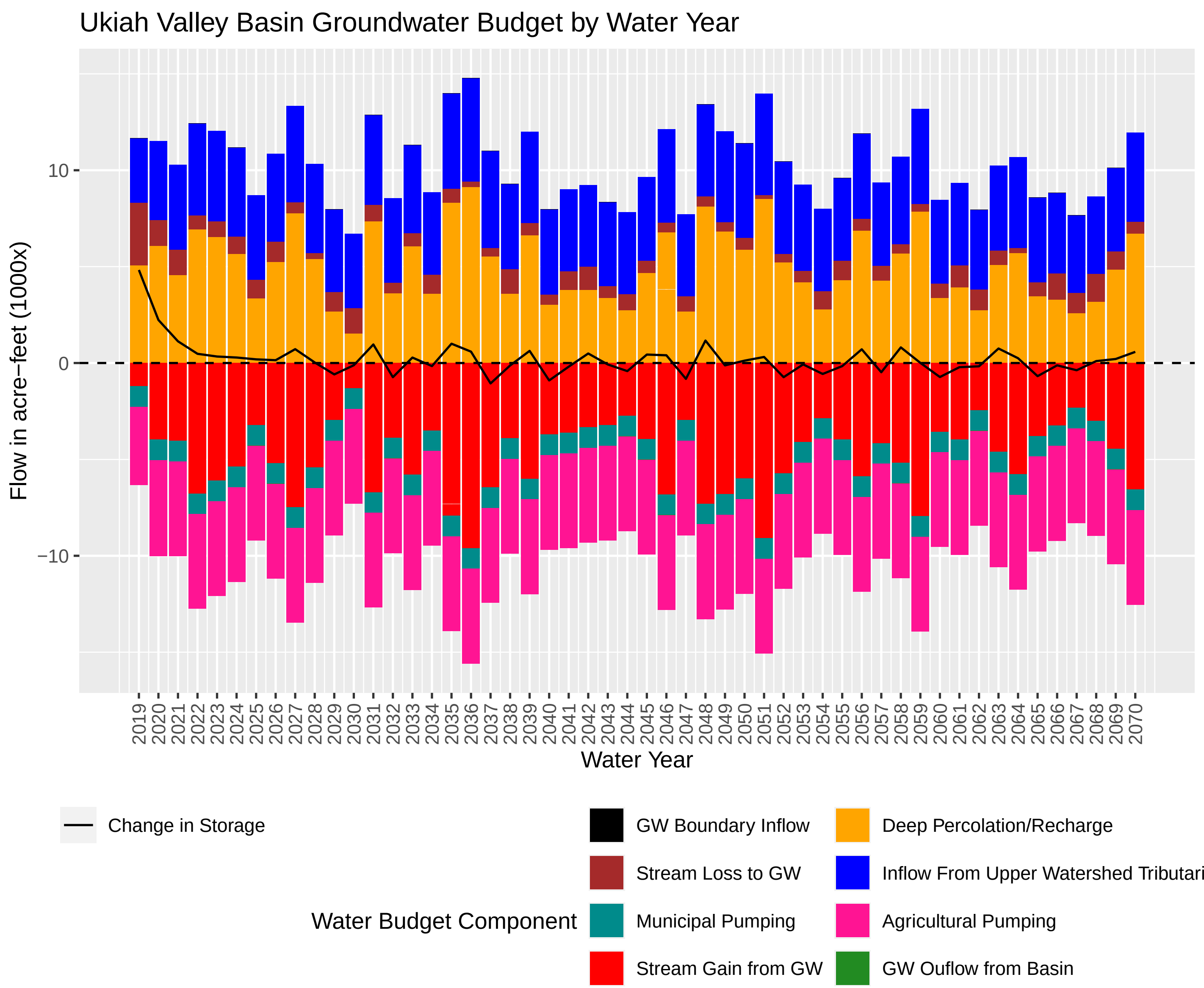


**Figure 7.24:** Estimated future annual groundwater budget for the Basin averaged over 2019-2070.

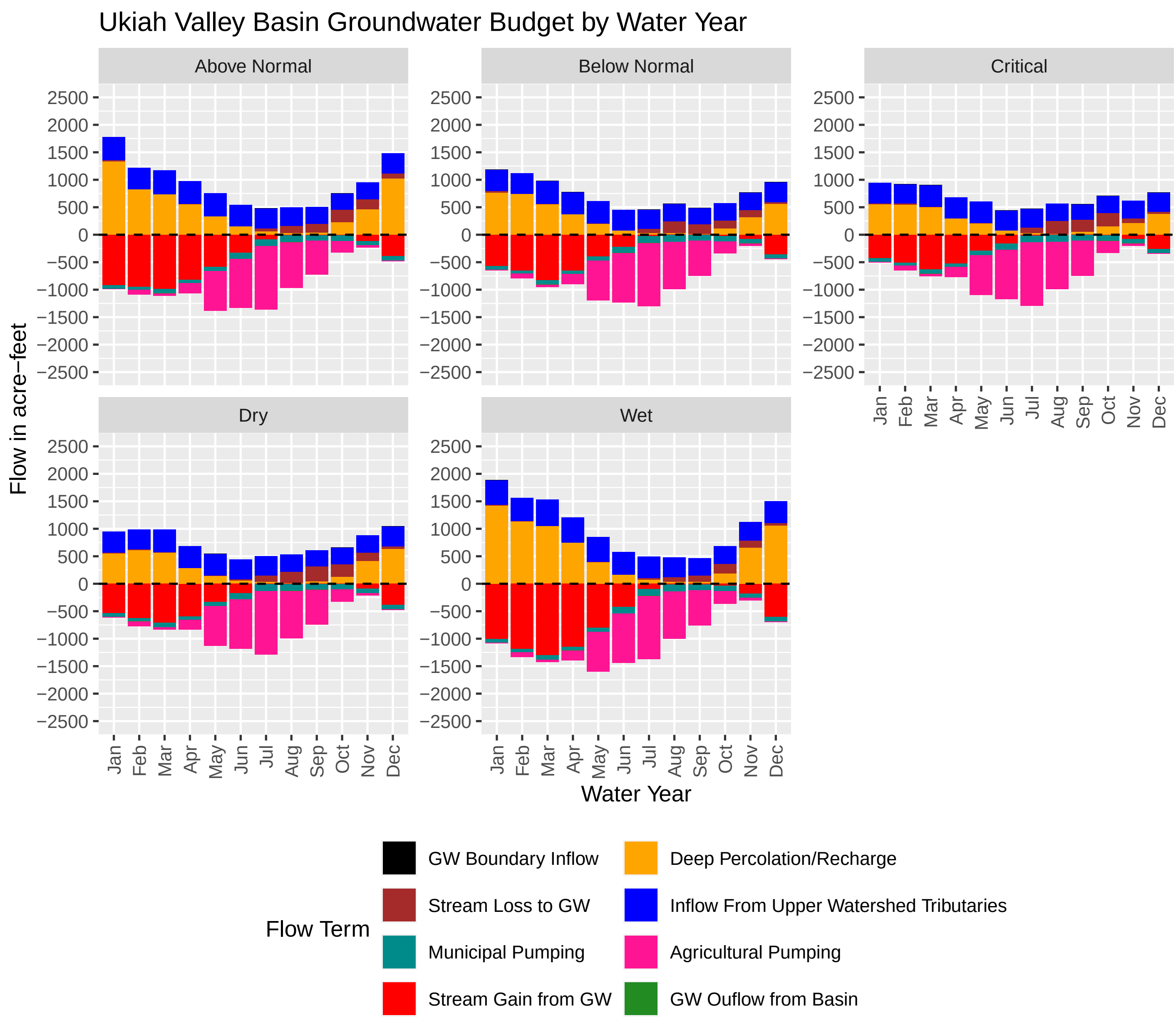


**Figure 7.25:** Projected average monthly water budget for the groundwater Basin for each water year type. Water budget components are averaged over the same water year types in the 2019-2070 period.

**Table 7.4:** Ukiah Valley Groundwater Basin estimated projected annual water budget for the period of 2019-2070 Values are in acre-foot.

| Water Year | Water Year Type | Groundwater Boundary Inflow | Deep Percolation/Recharge | Stream Loss to Groundwater | Inflow From Upper Watershed | Municipal Pumping | Agricultural Pumping | Stream Gain from Groundwater | Groundwater Ouflow from Basin |
|---|---|---|---|---|---|---|---|---|---|
| 2019 | Above Normal | 5.3 | 5059.2 | 3247.9 | 3343.4 | 1068.5 | 4061.7 | 1194.2 | 1.0 |
| 2020 | Wet | 5.3 | 6073.2 | 1325.7 | 4104.1 | 1068.5 | 4988.8 | 3961.0 | 1.0 |
| 2021 | Below Normal | 5.3 | 4540.3 | 1336.8 | 4406.0 | 1070.5 | 4934.6 | 4026.2 | 1.0 |
| 2022 | Wet | 5.3 | 6915.3 | 734.9 | 4772.6 | 1068.5 | 4931.2 | 6752.7 | 1.0 |
| 2023 | Wet | 5.3 | 6527.2 | 805.4 | 4702.0 | 1068.5 | 4931.2 | 6087.8 | 1.0 |
| 2024 | Wet | 5.3 | 5658.8 | 900.4 | 4604.2 | 1068.5 | 4931.2 | 5356.6 | 1.0 |
| 2025 | Critical | 5.3 | 3337.0 | 983.3 | 4373.2 | 1070.5 | 4934.6 | 3199.4 | 1.0 |
| 2026 | Above Normal | 5.3 | 5240.0 | 1059.8 | 4547.2 | 1068.5 | 4931.2 | 5177.4 | 1.0 |
| 2027 | Wet | 5.2 | 7750.9 | 574.1 | 5009.0 | 1068.5 | 4931.2 | 7470.8 | 1.0 |
| 2028 | Wet | 5.3 | 5381.7 | 307.6 | 4630.9 | 1068.5 | 4931.2 | 5398.4 | 1.0 |
| 2029 | Critical | 5.3 | 2656.0 | 1005.8 | 4296.7 | 1070.5 | 4934.6 | 2950.8 | 1.0 |
| 2030 | Critical | 5.3 | 1527.0 | 1304.7 | 3871.0 | 1068.5 | 4931.2 | 1304.1 | 1.0 |
| 2031 | Above Normal | 5.3 | 7338.2 | 845.3 | 4671.5 | 1068.5 | 4931.2 | 6688.1 | 1.0 |
| 2032 | Below Normal | 5.3 | 3611.7 | 548.1 | 4385.0 | 1068.5 | 4931.2 | 3859.1 | 1.0 |
| 2033 | Above Normal | 5.3 | 6048.7 | 670.3 | 4581.2 | 1070.5 | 4934.6 | 5777.8 | 1.0 |
| 2034 | Dry | 5.3 | 3584.5 | 996.5 | 4271.6 | 1068.5 | 4931.2 | 3483.4 | 1.0 |
| 2035 | Wet | 5.2 | 8299.6 | 721.8 | 4961.4 | 1068.5 | 4931.2 | 7904.6 | 1.1 |
| 2036 | Wet | 5.2 | 9115.2 | 286.3 | 5366.6 | 1068.5 | 4931.2 | 9589.4 | 1.1 |
| 2037 | Wet | 5.3 | 5523.2 | 427.9 | 5046.2 | 1070.5 | 4934.6 | 6430.6 | 1.0 |
| 2038 | Dry | 5.3 | 3579.1 | 1270.5 | 4426.5 | 1068.5 | 4931.2 | 3895.3 | 1.0 |

**Table 7.4:** Ukiah Valley Groundwater Basin estimated projected annual water budget for the period of 2019-2070 Values are in acre-foot. *(continued)*

| Water Year | Water Year Type | Groundwater Boundary Inflow | Deep Percolation/Recharge | Stream Loss to Groundwater | Inflow From Upper Watershed | Municipal Pumping | Agricultural Pumping | Stream Gain from Groundwater | Groundwater Ouflow from Basin |
|---|---|---|---|---|---|---|---|---|---|
| 2039 | Wet | 5.3 | 6610.1 | 652.1 | 4731.7 | 1068.5 | 4931.2 | 5987.3 | 1.0 |
| 2040 | Dry | 5.3 | 3001.9 | 530.8 | 4424.9 | 1068.5 | 4931.2 | 3691.9 | 1.0 |
| 2041 | Critical | 5.3 | 3784.7 | 964.7 | 4260.5 | 1070.5 | 4934.6 | 3604.3 | 1.0 |
| 2042 | Dry | 5.3 | 3774.7 | 1221.6 | 4228.0 | 1068.5 | 4931.2 | 3320.9 | 1.0 |
| 2043 | Critical | 5.3 | 3357.9 | 624.5 | 4354.1 | 1068.5 | 4931.2 | 3203.9 | 1.0 |
| 2044 | Critical | 5.3 | 2723.9 | 829.9 | 4261.9 | 1068.5 | 4931.2 | 2717.2 | 1.0 |
| 2045 | Dry | 5.3 | 4650.3 | 637.6 | 4350.1 | 1070.5 | 4934.6 | 3923.9 | 1.0 |
| 2046 | Above Normal | 5.2 | 6768.6 | 491.4 | 4865.9 | 1068.5 | 4931.2 | 6802.0 | 1.0 |
| 2047 | Below Normal | 5.3 | 2658.4 | 798.2 | 4254.0 | 1068.5 | 4931.2 | 2949.3 | 1.0 |
| 2048 | Wet | 5.3 | 8107.3 | 528.5 | 4770.2 | 1068.5 | 4931.2 | 7282.7 | 1.0 |
| 2049 | Wet | 5.3 | 6814.2 | 471.3 | 4730.3 | 1070.5 | 4934.6 | 6783.1 | 1.0 |
| 2050 | Above Normal | 5.3 | 5862.0 | 628.6 | 4898.9 | 1068.5 | 4931.2 | 5974.8 | 1.0 |
| 2051 | Wet | 5.2 | 8508.9 | 179.4 | 5276.2 | 1068.5 | 4931.2 | 9065.5 | 1.1 |
| 2052 | Wet | 5.3 | 5199.4 | 441.5 | 4806.6 | 1068.5 | 4931.2 | 5710.3 | 1.0 |
| 2053 | Below Normal | 5.3 | 4184.3 | 573.3 | 4485.1 | 1070.5 | 4934.6 | 4092.3 | 1.0 |
| 2054 | Dry | 5.3 | 2764.2 | 942.8 | 4287.9 | 1068.5 | 4931.2 | 2847.2 | 1.0 |
| 2055 | Below Normal | 5.3 | 4273.0 | 1026.5 | 4284.3 | 1068.5 | 4931.2 | 3956.2 | 1.0 |
| 2056 | Above Normal | 5.3 | 6856.3 | 605.7 | 4429.4 | 1068.5 | 4931.2 | 5870.1 | 1.0 |
| 2057 | Above Normal | 5.3 | 4272.2 | 770.4 | 4311.8 | 1070.5 | 4934.6 | 4140.8 | 1.0 |

**Table 7.4:** Ukiah Valley Groundwater Basin estimated projected annual water budget for the period of 2019-2070 Values are in acre-foot. *(continued)*

| Water Year | Water Year Type | Groundwater Boundary Inflow | Deep Percola-tion/Recharge | Stream Loss to Groundwater | Inflow From Upper Watershed | Municipal Pumping | Agricultural Pumping | Stream Gain from Groundwater | Groundwater Ouflow from Basin |
|---|---|---|---|---|---|---|---|---|---|
| 2058 | Above Normal | 5.3 | 5676.4 | 475.7 | 4543.3 | 1068.5 | 4931.2 | 5154.0 | 1.0 |
| 2059 | Wet | 5.2 | 7835.2 | 397.6 | 4942.9 | 1068.5 | 4931.2 | 7924.1 | 1.0 |
| 2060 | Below Normal | 5.3 | 3370.0 | 737.1 | 4350.9 | 1068.5 | 4931.2 | 3547.2 | 1.0 |
| 2061 | Critical | 5.3 | 3904.4 | 1143.2 | 4292.3 | 1070.5 | 4934.6 | 3948.8 | 1.0 |
| 2062 | Critical | 5.3 | 2734.6 | 1071.6 | 4135.9 | 1068.5 | 4931.2 | 2432.1 | 1.0 |
| 2063 | Above Normal | 5.3 | 5079.8 | 751.3 | 4402.5 | 1068.5 | 4931.2 | 4591.4 | 1.0 |
| 2064 | Above Normal | 5.3 | 5684.4 | 270.0 | 4718.0 | 1068.5 | 4931.2 | 5761.4 | 1.0 |
| 2065 | Below Normal | 5.3 | 3458.5 | 721.0 | 4401.1 | 1070.5 | 4934.6 | 3766.2 | 1.0 |
| 2066 | Dry | 5.3 | 3272.4 | 1368.7 | 4181.6 | 1068.5 | 4931.2 | 3222.2 | 1.0 |
| 2067 | Critical | 5.3 | 2578.0 | 1050.9 | 4023.6 | 1068.5 | 4931.2 | 2309.7 | 1.0 |
| 2068 | Dry | 5.3 | 3168.1 | 1455.5 | 4012.5 | 1068.5 | 4931.2 | 2975.0 | 1.0 |
| 2069 | Above Normal | 5.3 | 4826.2 | 949.6 | 4334.8 | 1070.5 | 4934.6 | 4429.1 | 1.0 |

## 7.5 Climate Change Scenarios

Climate change scenarios were generated using the two central tendency scenarios suggested by the DWR to assess climate change impacts on Basin's sustainability. The climate-influenced variables Precipitation (as rain), and Potential ET were altered to represent the following two DWR designed climate change scenarios:

- a. Near-future climate, representing conditions in the year 2030 (held over the entire projection timeline); and,
- b. Far-future climate, representing central tendency of projected conditions in the year 2070 (held over the entire 50-year projection)

The climate record for the projected timeline was constructed from model inputs for the same timeline multiplied by climate change factors provided by DWR for each scenario. These change factors are only provided up to 2011. Therefore, 2012-2018 multipliers were selected based on the similarity of water year types and precipitation amounts, with the preference of selecting the most recent similar years.

Under their SGMA climate change guidance, DWR provided a dataset of change factors that each GSA can use to convert local historical weather data into four different climate change scenarios (DWR 2018). Change factors are geographically and temporally explicit. Geographically, a grid of 1/16-degree resolution cells covers the extent of California; for each of these cells, one change factor applies to each month, 1911-2011.

The change factor concept is intended to convert all past years to a single near or far future year; for example, imagining that in a hypothetical grid cell, the 2030 (Near) scenario change factor for reference ET in March 2001 was 5%. This would imply that under the local results of the global climate change scenario used to inform this guidance, if March 2001 had occurred in the year 2030, there would be 5% more ET in that grid cell than historically observed.

Climate change scenarios include the Recycled Water Project since it started in 2019. Recycled water project delivers water to agricultural users along the mainstem Russian River in central and southern Ukiah Valley and provides an opportunity for conjunctive use. This helps reduce surface water diversion and groundwater pumping during the irrigation period. For climate change scenarios, it was assumed that recycled water users mainly use surface water, and the amount of recycled water delivered to them was subtracted from their most recent historical surface water diversion.

In addition, CVD releases from Lake Mendocino were not altered due to climate change. While this assumption is not scientifically accurate and climate change will impact managed water releases from the CVD and storage in Lake Mendocino, the accurate estimation of CVD releases for DWR scenarios was determined to be infeasible within the timeline available for GSP development. Therefore, acknowledging the uncertainty imposed by this assumption, the GSA found it the best feasible approach to consider climate change impacts during GSP development in its analysis and decision-making process. The GSA has outlined a PMA in **Chapter 4** of the GSP and developed a framework for the generation of future climate change scenarios and enhancement to the UVIHM. This framework is explained in more detail below.

**Table 7.5** shows annual groundwater budgets for all timelines and scenarios averaged over their entire respective periods. Comparison of historical, current, and future baseline periods indicates that less recharge and stream loss to groundwater on average is expected in the future, reducing the amount of inflow to the Basin. Groundwater discharge to the stream system will also be increased compared to historical and current conditions adding to the increasing difference between inflows and outflows. Similarly, Near and Far climate change scenarios show a decline in aquifer recharge and stream loss to aquifers. Although this seems to constrain the Basin in the future in average conditions, no significant trend in cumulative storage change could be established from the future baseline conditions or climate change scenarios. In addition, the uncertainty and unpredictability of climate conditions need to be considered to interpret future baseline and climate change results cautiously since an exact repeat of the historical period may not be likely.

**Table 7.5:** Ukiah Valley Groundwater Basin estimated historical, current, and future water budgets. Future budgets include future baseline, 2030, and 2070 Climate Change Scenarios. Values are in acre-foot.

| Water Budget Component | Historical: 1992-2018 | Current: 2015-2018 | Future Baseline: 2019-2070 | Climate Change 2030 Scenario | Climate Change 2070 Scenario |
|---|---|---|---|---|---|
| Groundwater Boundary Inflow | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 |
| Deep Percolation/Recharge | 5422.8 | 6254.2 | 5123.1 | 1949.4 | 4100.1 |
| Stream Loss to Groundwater | 3660.7 | 3137.3 | 818.8 | 1363.7 | 1031.8 |
| Inflow From Upper Watershed | 4611.7 | 4588.0 | 4512.2 | 4404.4 | 4183.0 |
| Municipal Pumping | 1854.7 | 1069.5 | 1069.0 | 1069.0 | 1069.0 |
| Agricultural Pumping | 4630.0 | 4429.0 | 4914.0 | 4914.0 | 4914.0 |
| Stream Gain from Groundwater | 3632.2 | 4463.7 | 4889.5 | 2152.0 | 3758.9 |
| Groundwater Ouflow from Basin | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

## 7.6 Framework to conduct watershed-wide climate change simulations using th UVIHM

To better simulate the impacts of climate change on the Basin and the Upper Russian River Watershed, the UVIHM needs to be enhanced and re-calibrated using additional data and information collected during GSP implementation. GSA has sought to coordinate with local and regional stakeholders in generating and conducting climate change scenarios to include the largest spectrum of expected changes possible. Through these coordinations, the GSA has developed a framework in communication with Sonoma Water[2] to conduct watershed-wide consistent climate change simulations for the Basin. This will help the GSA include the changes to reservoir operations and surface water availability in the Basin through the releases from the PVP and CVD. Surface water availability can have significant impacts on the Basin and need to be incorporated into future scenarios. Sonoma Water has implemented climate change scenarios based on downscaled General Circulation Models (GCM) data for the groundwater basins that it manages. Following its approach will help the GSA address climate change impacts as a watershed-wide and regional effort.

Two approaches can be pursued to include PVP and CVD reservoir operations into the UVIHM for future climate change simulation. The first approach is to ensure that the hydrological models used by Sonoma Water in tandem with the CVD and PVP reservoir operation models are using the same climate data and producing sufficiently similar streamflow results as the UVIHM. This will adequately justify the use of reservoir operation models' outputs despite no dynamic linking with the UVIHM. This approach would require significant resources from Sonoma Water and the GSA to harmonize the respective hydrological models.

The second approach is to link reservoir operation models with the UVIHM offline or dynamically for an iterative solution. This would ensure that impacts of the changes to reservoir releases are transferred to the UVIHM. In turn, changes in streamflow are transferred into the reservoir operation models. This approach is scientifically preferable due to the iterative solution that it provides. However, it would be a more complicated undertaking than the first approach and would require continuous coordination between Sonoma Water and the GSA and significant resources from both entities.

Conducting either of the two approaches will require major enhancements to the UVIHM and significant cooperation from Sonoma Water. They are extensive studies that could not be reasonably fit within the GSP development timeline. Therefore, the GSA decided to consider uncertainties imposed by the simplifying assumption of not changing historical CVD releases due to climate change impacts. The GSA determined that it would be more beneficial to the management of the Basin to consider this simplified simulation than not considering climate change impacts at all. However, GSA plans to move forward with its proposed framework to further analyze the impacts of climate change in the Basin. This framework and a comparison between what is required under SGMA, what was conducted during GSP development, and what is planned to be conducted contingent upon availability of funding and resources are shown in **Table 7.6**. The GSA proposed a PMA in **Chapter 4** to pursue funding and needed resources to implement this framework.

[2] Sonoma Water has developed two different HEC-ResSim models for PVP operations and Russian River Watershed reservoir operations that include CVD and Lake Mendocino. These models are generally referred to here as Sonoma Water ResSim models.

**Table 7.6:** The framework developed by the GSA for future scenario generation and simulation, including climate change scenarios, upon the availability of funding and resources.

| Future Scenario | SGMA Requirement | Approach Undertaken During the GSP Development | Proposed Improvements |
|---|---|---|---|
| Future Baseline | A 50-year representation | 50-year repeat of historical baseline | Coordinate with Sonoma Water to use similar water years, and a similar setup as the USGS integrated hydrological model in production for a watershed-wide consistent simulation. |
| Climate Change | Capture impacts of climate change using best available science and knowledge | Two DWR central tendency climate period analyses, 2030 and 2070, with the assumption of no changes to historical releases from the CVD | Transient simulation of 50-year period using the same GCM/RCP/Downscaling scenarios used by Sonoma Water to have a watershed-wide consistent simulation and climate change impact assessment. |
| CVD Releases | Best available science and information: forecast appropriate releases for each scenario | Historical and future baseline releases are based on measured streamflow at USGS gages/ Future changes due to climate changes are not simulated | Using either 1) compatible Sonoma ResSim model with matching climate data and diversions as the UVIHM GSFLOW 2) Offline or dynamically linked Sonoma ResSim Model with UVIHM GSFLOW |

**Table 7.6:** The framework developed by the GSA for future scenario generation and simulation, including climate change scenarios, upon the availability of funding and resources. *(continued)*

| Future Scenario | SGMA Requirement | Approach Undertaken During the GSP Development | Proposed Improvements |
|---|---|---|---|
| PVP | PVP outputs based on reasonable possibilities to assist with setting SMCs and developing management actions | Historical and future baseline releases are based on measured streamflow at USGS gages/ Future changes due to climate changes are not simulated. For future scenarios of PVP changes, PVP releases are taken directly from Sonoma Water ResSim outputs neglecting differences in hydrological and climatic conditions | Using either 1) compatible Sonoma ResSim model with matching climate data and diversions as the UVIHM GSFLOW 2) Offline or dynamically linked Sonoma ResSim Model with UVIHM GSFLOW |
| Overall for other informational future scenarios | Best available science and accurate representation of basin and possibilities to develop SMCs and MAs | Historical inputs and Sonoma Water ResSim models' outputs were used for combination of exploratory scenarios assuming no major discrepancies between their flow and diversion calculations and our model | Rerun impactful scenarios or additional scenarios with updated ResSim outputs, enhanced UVIHM, and compare their results with the USGS model, if available. |

# Chapter 8

# Recommendations and Future Work

Data gaps and sources of uncertainty are discussed in detail in **Appendix 2-E**. Although the UVIHM was developed using the best available data and science, it needs further enhancement and calibration to be reliably used in the decision-making process of the GSA. The following list of recommendations is provided for the GSA to consider for implementation as resources become available and the needs arise:

- Update and re-calibrate the UVIHM upon availability of additional data and information prior to the first 5-year review. Additional data and information needed include, but may not be limited to, groundwater elevation measurement, water use data, streamflow measurements, streambed data and stream profile information, aquifer properties and spatial extent, and land use and crop maps. Enhancement of aquifer and stream interaction simulation and tributary streamflow should be particularly noted.
- Improve reservoir operation representation in the UVIHM using approaches described in the framework outlined in **Section 7.6*.
- Compare UVIHM results with other regional models, including Sonoma Water hydrologic models, to resolve differences and improve the models.
- Improve cannabis water use estimation in the UVIHM
- Migrate the UVIHM from IDC to AG Package for dynamic calculation of agricultural use.
- Improve representation and water use estimation of native and riparian vegetation through better mapping, additional data regarding vegetation types and evapotranspiration needs, and harmonizing the UVIHM PRMS with IDC or AG Package.
- Simulate additional climate change scenarios such as DWR extreme scenarios or other GCM/RCP/Downsclaed scenario combinations.
- Coordinate with the USGS to harmonize the UVIHM with the USGS Model and transfer data and results.

These actions are not in the order of priority or importance. Their implementation will be at the decision of the GSA, considering the needs and availability of resources.

# Chapter 9

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# Appendix 2-E Data Gaps Report

# Table of Contents

# Chapter 1

# Introduction

During the process of developing the groundwater sustainability plan (GSP) for the Ukiah Valley Basin (Basin), multiple datasets were utilized to characterize current and historical Basin conditions. Monitoring networks were designed to support the evaluation of Basin conditions throughout GSP implementation, particularly with respect to five sustainability indicators. The representative monitoring points (RMPs) in these monitoring networks are sites at which quantitative values for minimum or maximum thresholds, measurable objectives, and interim milestones are defined. New RMPs will be considered for the 5-year GSP update based on the suggested expanded monitoring network as part of the project and management actions (PMAs) presented in Chapter 4. Data gaps that were identified throughout the GSP development process can be categorized into:

I. Data gaps in information used to characterize current and historical basin conditions. This can include data and information gap with respect to the development of the Ukiah Valley Integrated Hydrological Model (UVIHM).
II. Data gaps in monitoring networks developed to evaluate future Basin conditions which will be used in reporting and tracking Basin sustainability.

These data gaps were identified based on spatial coverage of data, the period for which data is available, frequency of data collection, and representation of Basin conditions. An overview of data gaps in the first category is provided in Chapter 2, as part of the characterization of past and current Basin setting and conditions, and the data gaps in the second category are in Chapter 3 as part of descriptions of the monitoring networks. This appendix details the identification of data gaps and uncertainties in each of the categories and the associated strategies for addressing them. The process of data gap identification and development of strategies to fill data gaps is illustrated in **Figure 1.1** below, sourced from the Monitoring Networks and Identification of Data Gaps Best Management Practice (BMP), provided by DWR (2016).

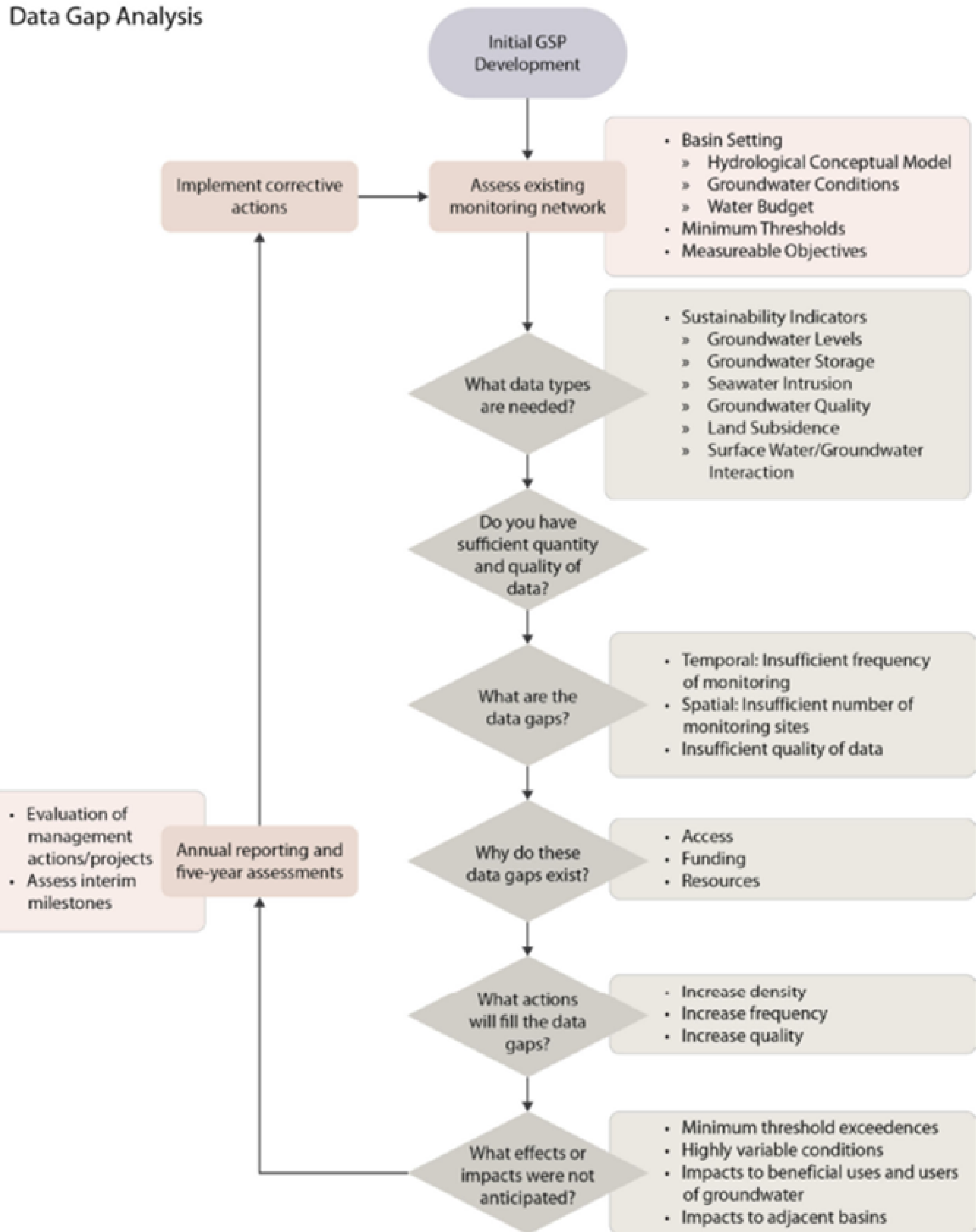


**Figure 1.1:** Data Gap Analysis Flowchart.

# Chapter 2

# Data Gaps in Existing Information Used for Basin Characterization

An accurate assessment of the physical setting and processes that control groundwater conditions in the Basin is foundational to the development of the sustainable management criteria and monitoring networks in Chapter 3 and the identification of projects and management actions in Chapter 4. The Basin Setting and the hydrogeological conceptual model (HCM) included in Chapter 2 of the GSP are essential to understanding and effectively characterizing historical and current groundwater conditions. Identification of data gaps and uncertainty within the HCM is a requirement per 23 CCR 354.14 (b)(5) and is an important element of the GSP as it informs the targeted development of additional monitoring, both in terms of monitoring type and location, to address relevant and impactful gaps and uncertainties. A summary of data gaps is included in Section 2.2.1.7 of the GSP to address this requirement. HCM data gaps along with additional data gaps identified in Chapter 2 of the GSP are discussed in more detail below.

## 2.1 Climate

Precipitation and temperature datasets are available from the National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center Climate Data Online portal and the California Data Exchange Center (CDEC). Daily solar radiation records were also available from the CDEC. A list of the climatic gages used for GSP development is shown in **Table 2.1**. Although precipitation records provided good coverage for the Basin, periods of record did not align and data gaps such as missing or flagged days were present across many time series. This was more pronounced for solar radiation data that only covered a brief recent history. The GSA cannot reasonably cover these data gaps and does not plan to install additional climate stations in or around the Basin. These data gaps were therefore considered as a source of uncertainty in the development of the UVIHM and in decision-making.

The closest California Irrigation Management Information System (CIMIS) weather station (Sanel Valley #106) is located approximately five miles to the south of the Ukiah Valley near the town of Hopland. CIMIS stations are valuable as they use defensible methods to monitor reference evapotranspiration, a key component of the method to estimate consumptive use. Stations are located on irrigated pastures, sites are properly maintained, and sensors are calibrated to ensure accurate estimates of reference ET. An additional CIMIS station that provides better spatial coverage for the Basin can benefit future evaluation and GSP updates. The GSA does not plan to install such a station but will coordinate this request to DWR and responsible agencies.

**Table 2.1:** Precipitation gage summary as incorporated into the UVIHM.

| Station Name | Source of Data | Measured Data | Start Date as Implemented in UVIHM | End Date as Implemented in UVIHM | Latitude | Longtitude | Gage Elevation |
|---|---|---|---|---|---|---|---|
| CDW | CDEC | Evaporation | 2010-02-08 | 2018-12-31 | 39.2031 | -123.1853 | 670 |
| CIMIS 106 | CIMIS | Evaporation | 1965-01-01 | 2018-12-31 | 38.9826 | -123.0893 | 525 |
| CDW | CDEC | Precipitation | 2010-02-08 | 2018-12-31 | 39.2031 | -123.1853 | 670 |
| LYO | CDEC | Precipitation | 2010-12-23 | 2017-04-09 | 39.1250 | -123.0710 | 3200 |
| POTTER VALLEY POWERHOUSE, CA US | NOAA | Precipitation | 1965-01-01 | 2018-12-31 | 39.3619 | -123.1286 | 1018 |
| UKIAH 4 WSW, CA US | NOAA | Precipitation | 1965-01-01 | 2018-11-30 | 39.1266 | -123.2719 | 1328 |
| UKIAH MUNICIPAL AIRPORT, CA US | NOAA | Precipitation | 2001-01-01 | 2018-12-31 | 39.1258 | -123.2008 | 601 |
| UKIAH, CA US | NOAA | Precipitation | 1965-01-01 | 2013-05-24 | 39.1466 | -123.2102 | 636 |
| WIL | CDEC | Precipitation | 1991-01-01 | 2018-12-31 | 39.3506 | -123.3217 | 1925 |
| WILLITS 1 NE, CA US | NOAA | Precipitation | 1965-01-01 | 2012-09-27 | 39.4194 | -123.3425 | 1353 |
| CDW | CDEC | Solar Radiation | 2010-12-23 | 2018-12-31 | 39.2031 | -123.1853 | 670 |
| LYO | CDEC | Solar Radiation | 2010-12-23 | 2014-04-26 | 39.1250 | -123.0710 | 3200 |
| BOONVILLE CALIFORNIA, CA US | NOAA | Temperature | 1991-01-01 | 2018-12-31 | 38.9875 | -123.3486 | 644 |
| CDW | CDEC | Temperature | 2010-02-08 | 2018-12-31 | 39.2031 | -123.1853 | 670 |
| HOPLAND CALIFORNIA, CA US | NOAA | Temperature | 2001-10-04 | 2018-12-31 | 39.0308 | -123.0806 | 2682 |
| LYO | CDEC | Temperature | 1991-06-01 | 2018-12-31 | 39.1250 | -123.0710 | 3200 |
| POTTER VALLEY POWERHOUSE, CA US | NOAA | Temperature | 1965-01-01 | 2018-12-31 | 39.3619 | -123.1286 | 1018 |
| Q03 | CDEC | Temperature | 2014-01-10 | 2016-03-21 | 39.3771 | -123.3280 | 1447 |
| UKIAH MUNICIPAL AIRPORT, CA US | NOAA | Temperature | 2001-01-01 | 2018-12-31 | 39.1258 | -123.2008 | 601 |
| UKIAH, CA US | NOAA | Temperature | 1965-01-01 | 2013-05-24 | 39.1466 | -123.2102 | 636 |
| WIL | CDEC | Temperature | 2009-10-27 | 2013-06-12 | 39.3506 | -123.3217 | 1925 |
| WILLITS 1 NE, CA US | NOAA | Temperature | 1965-01-01 | 2012-09-27 | 39.4194 | -123.3425 | 1353 |

## 2.2 Geology

GSP Chapter 2 characterizes the geology of the Basin using data from an array of sources including public agencies, available literature, publicly available geologic data from DWR, and well-completion reports (WCRs). The GSA processed a subset of WCRs and developed a lithologic dataset to develop geological cross-sections. However, due to the limitations of the WCR data, there is uncertainty in the extent of geologic formations and the definition of aquifers defined. This uncertainty extends to specific aspects of geologic conditions, including knowledge of fold formations, the impact of the Maacama Fault on groundwater flow and its vertical displacement, and estimates of aquifer lithology. As more lithologic data is collected through well construction, GSP implementation, and regional studies, this data will be used to refine the cross-sections and the HCM further, as necessary.

DWR is currently conducting Airborne Electromagnetic (AEM) surveys in all high and medium priority basins. The AEM survey for the Ukiah Valley Groundwater basin is scheduled to be conducted in November 2021. Data provided by the survey can significantly improve the understanding of the Basin and its hydrogeology. Datasets derived from the survey will be available during the GSP implementation phase to support model refinements, identify potential managed aquifer recharge and injection sites, and update the HCM for the 5-year review.

Preliminary geophysical analysis conducted during the GSP development process indicated the presence of conductive soils in the Basin that could contribute toward groundwater recharge from surface water sources. Geophysical studies will be further explored as part of the possible supply augmentation and managed aquifer recharge projects and management actions (PMAs) outlined in Chapter 4. Using geophysical techniques such as electrical resistivity and electromagnetic conductivity surveying, the hydrogeologic properties of the Basin can be better characterized.

## 2.3 Aquifer Characteristics

Aquifer characteristics were estimated based on past literature, GSA's textural analysis, and the available pumping test data. Data used to define Principal Aquifer I hydrogeological properties was limited to six wells with pumping test data, accurate location data, and evidence of being screened. Principal Aquifer II properties were determined with 35 wells. Existing and interpreted lithologic data was used to support aquifer classification as applicable. The resulting transmissivity and hydraulic conductivity results are less than ideal due to the lack of monitoring wells during pumping tests and uncertainty about the test method. As additional data becomes available, the HCM and groundwater models will be updated to more effectively reflect observed conditions throughout the Basin. As part of the monitoring activities PMA outlined in Chapter 4, GSA may elect to conduct additional pumping tests or obtain other hydrogeologic information to cover high priority data gaps during GSP implementation.

Movement of groundwater flow in the Basin, specifically the interaction of principal aquifers with streams and their vertical flow, needs to be further investigated. As the UVIHM is enhanced and re-calibrated using the additional data collected during GSP implementation, the model can help improve the understanding of groundwater flow in the Basin and aquifer/stream interactions. Moreover, as part of the Chapter 4 monitoring activities PMA, the GSA may consider developing and carrying out an isotope study. This study can help evaluate water movement throughout the Basin, estimate inflows to the Basin, and better represent and characterize wells' sources of water.

## 2.4 Stream Network and Hydrololgic Data

The GSA has identified two categories of data gaps concerning stream network and hydrological data in the Basin:

- Stream cross-sections and characteristics, and
- Streamflow data and measurements.

As discussed in Appendix 2D, the entrenchment of the Russian River mainstem can have considerable impacts on groundwater elevations and interaction of surface water and groundwater. Moreover, to properly understand and simulate the interactions of surface water and groundwater in the Basin, a detailed characterization of stream profiles is needed. The GSA used the best available data and science to estimate river profiles, as explained in Appendix 2D. However, better estimates of river profiles, their depth, streambed soil type, and conductivity would significantly improve model simulations. As part of the monitoring activities PMA in Chapter 4, the GSA may elect to conduct studies and activities to address this key data gap and element of uncertainty in the hydrologic understanding of the Basin, including a bathymetric study or topographic and stream cross-sectional surveys of the mainstem Russian River.

In addition to stream characteristics, streamflow in Russian River tributaries and their contribution to the Russian River flow and groundwater recharge is a significant component of the Basin's water budget and an important factor in understanding groundwater and surface water interactions. Installing streamflow gages is generally difficult in the Basin due to a myriad of factors including but not limited to, access, landowner permits, maintenance considerations. The GSA has installed two additional streamflow gages during the GSP development process to cover prioritized data gaps in the Basin, as shown in **Figure 2.1**. The first streamflow gage was installed on Forsythe Creek, a major tributary to the Russian River in the Redwood Valley area. The second gage was installed on the mainstem Russian River in the Redwood Valley area to account for natural flows entering the Basin. While it is impractical to consider installing streamflow gages on all tributaries in the Basin, the GSA will re-evaluate data needs and prioritize tributaries to be considered for gage installation during the GSP implementation. This is included in monitoring activities PMA in Chapter 4. Orrs Creek, Gibson Creek, Doolin Creek, McClure Creek, Mill Creek, and Robinson Creek are the tributaries that have been discussed as priorities to be considered.

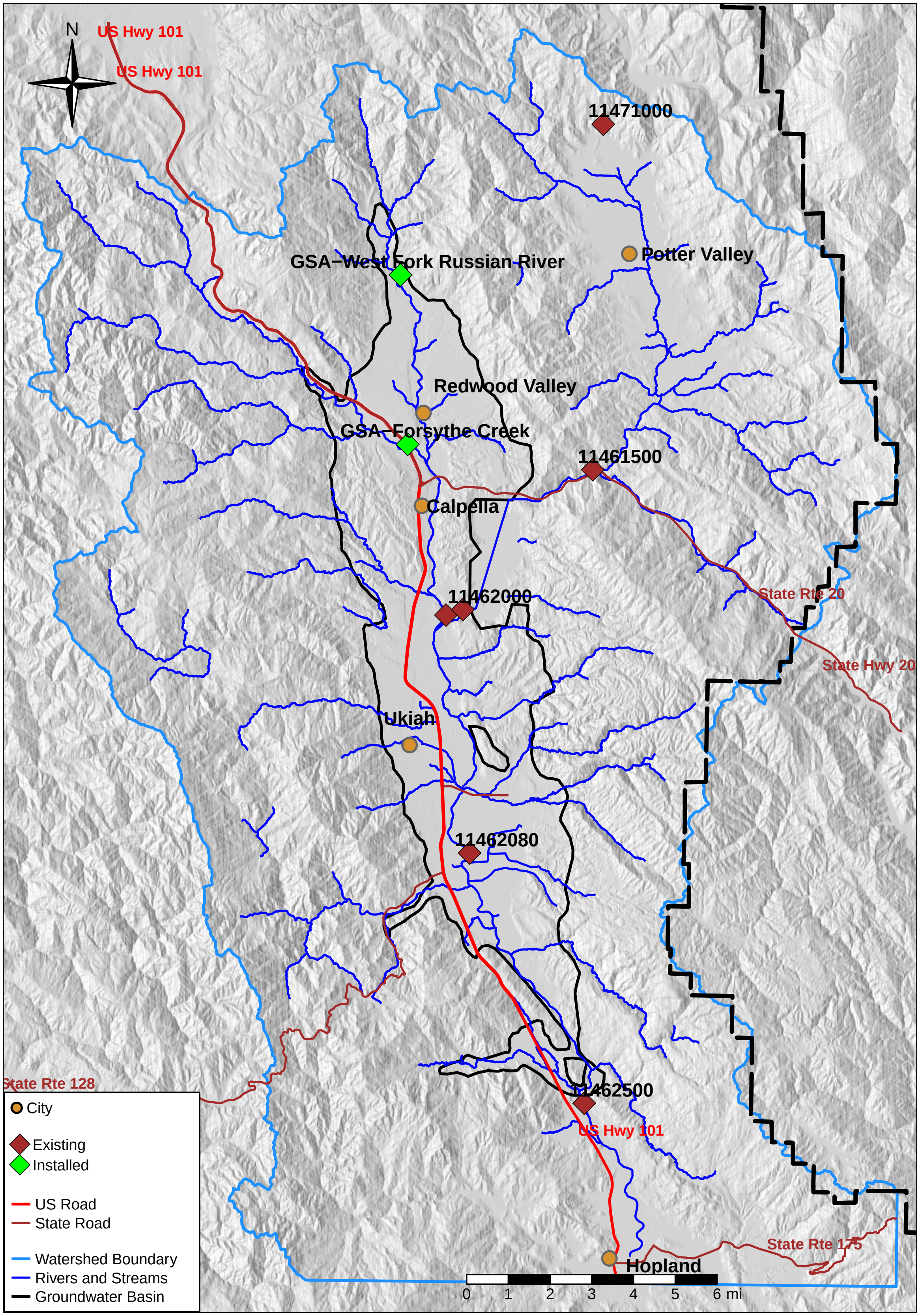


**Figure 2.1:** Existing and GSA installed streamflow gages in the Basin.

## 2.5 Groundwater Wells' Construction Information and Well Inventory

The GSA assessed the vulnerability of domestic wells to groundwater decline in Appendix 3A - Shallow Well Protection Memorandum. This analysis used public well construction data available from DWR. Well-construction information normally extracted from well completion reports (WCRs) is essential for Appendix 3A analysis, as it generally is in any groundwater assessment and planning. The WCR dataset made clear that a considerable number of groundwater wells in the Basin, including California Statewide Groundwater Elevation Monitoring Program (CASGEM) monitoring wells and other wells in the GSP monitoring network, had varying levels of missing construction information. The missing construction information includes well depth, screen information, location and coordinates, and surface and reference point elevations.

Well construction information is required to be reported for wells included in the monitoring networks. The GSA plans to survey or video log its monitoring wells during implementation to fill in missing construction information. In addition, the GSA has developed a well inventory PMA in chapter 4 that would provide a complete inventory of wells in the Basin, including their available construction information. This inventory would be helpful to update the Domestic Well Protection Memorandum and critical to the planning ad design of other PMAs.

## 2.6 Groundwater Elevation

Groundwater elevation data was sourced primarily from the CASGEM and DWR, supplemented with information from the SWRCB GeoTracker database. Historical groundwater elevation data in the Basin prior to 2014 is limited to four DWR wells with biannual data, three of them dating back to the 1960s. The limited temporal and spatial coverage of groundwater elevations in the Basin makes it difficult to produce reliable groundwater elevation contours for the historical period and assess groundwater conditions. It also restricts the calibration of the UVIHM. The groundwater elevation data gap is more pronounced and impactful in Aquifer I.

As of 2020, the CASGEM database contains biannual data for 45 wells within the Basin. The GSA has instrumented a few existing wells with continuous measurement devices and uses DWR TSS funds to drill new wells to monitor groundwater elevations. Although this high-frequency data was not available during the GSP development process, it will be available during GSP implementation as part of the GSP monitoring network to better characterize the groundwater elevation and address data gaps.

**Figure** 2.2 shows potential groundwater monitoring data gap areas within the Basin. The GSA does not foresee the need to monitor and/or drill a well at each area as some gaps are not productive aquifer areas and/or are not crucial to the understanding of the Basin. The GSA will prioritize these areas and try to cover any gaps identified as funding becomes available.

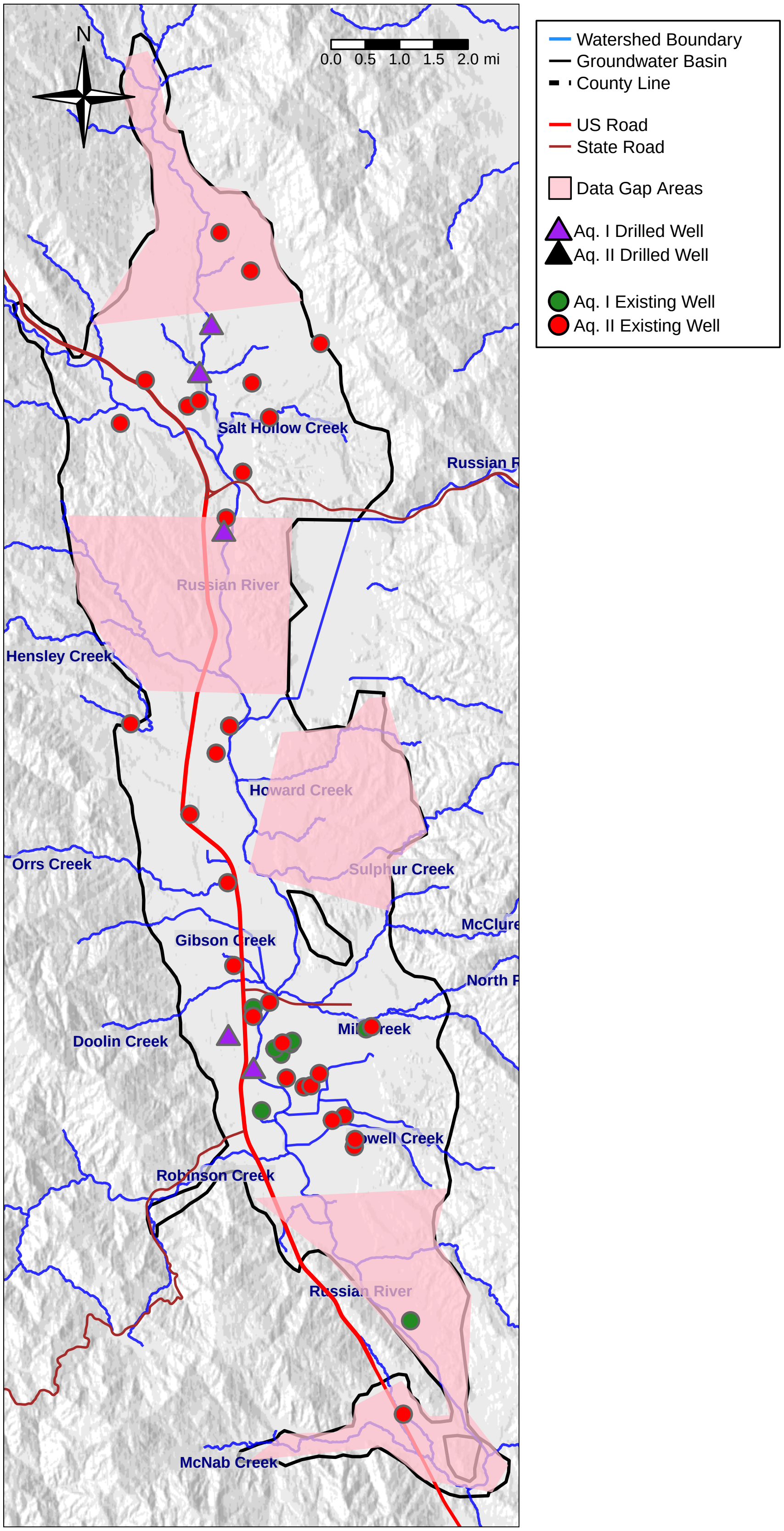


**Figure 2.2:** Groundwater elevation gap areas and newly drilled wells by the GSA.

## 2.7 Identification of Interconnected Surface Water Systems

The characterization of interconnected surface waters (ISWs) in the Basin was primarily conducted by comparing assumed streambed elevations and depth to groundwater maps during different seasons. ISW identification was limited by existing data gaps in groundwater elevations, streambed elevations, tributaries, and mainstem streamflow. These data gaps are discussed in Sections 2.4 and 2.6.

## 2.8 Identification of Groundwater Dependent Ecosystems

The primary resource used to establish the spatial extent of mapped GDEs is the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset. This NCCAG information was combined with geospatial data such as land use, land cover, and crop maps to create a refined mapped representation of mapped potential GDEs. The inherent uncertainty and accuracy in these resources is a data gap for this GSP. The GSA intends to ground-truth these coverage maps during GSP implementation and as better public data becomes available.

In order to evaluate the accessibility of mapped potential GDEs to groundwater, vegetation rooting zone depths were compared to representations of depth to groundwater. The methodology required assuming a representative rooting zone depth for mapped potential GDEs based on descriptions of vegetation or communities from the NCCAG or land use datasets and introduce a key element of uncertainty in the GDE analysis. Mapped representations of depth to groundwater were calculated as the difference between land surface elevation and interpolated groundwater elevation above mean sea level. They can also be a source of uncertainty due to data gaps in spatial and temporal groundwater elevation measurements, as discussed in Section 2.6.

Mapped potential GDEs were identified as “likely connected GDEs” if their assumed rooting zone depths were deeper than the depth to groundwater during all spring seasons. In order to consider the sources of uncertainty mentioned above in the determination of GDEs, the GSA assigned all mapped potential GDEs that are connected in one or more springs, but not all, as “potential GDEs.” The GSA will re-evaluate these GDEs upon collecting more data and the availability of better information.

The approach developed and carried out to identify and evaluate GDEs within the Basin represents a conservative application of best available science through the formulation of reasonable assumptions. A physical determination of GDEs must show that roots are connected to groundwater, which would require an infeasible subsurface geophysical survey across the Basin. In the first five years of GSP development, more data will be collected and used to refine the characterization of GDEs throughout the Basin. Through the monitoring activities PMA in Chapter 4 PMA, GSA may use satellite images to improve the evaluation of the status of GDEs.

## 2.9 Estimated Groundwater Storage

The UVIHM was used to estimate the change in storage in the Basin for water years 1992-2018. HCM includes storage of principal aquifers according to existing literature and past studies. In order to improve the estimation of storage changes in the Basin, the UVIHM needs to be enhanced by providing additional data and covering data gaps with regards to groundwater elevation, stream network and hydrology, geology and lithology, and water use data. Therefore, the GSA acknowledged the uncertainty in its storage change estimation through UVIHM and limited the storage change to the entire Basin rather than providing storage changes for each principal aquifer. This will be covered upon collecting additional data in the categories mentioned above for the UVIHM re-calibration and attaining a better understanding of principal aquifers' extents, depths, and properties.

## 2.10 Water Quality

Groundwater quality data was obtained from several sources, including the California Groundwater Ambient Monitoring and Assessment (GAMA) Program Database, augmented with data supplied by the Department of Health Services (DHS) and data submitted to the California Integrated Water Quality System (CIWQS) by permittees. As detailed in Appendix 2-F presenting water quality assessment, available water quality data was compared to regulatory standards and mapped. Constituents of concern were identified through visual analysis of the generated maps' recent data (within the past 30 years).

While the general water quality of the Basin is good, limited water quality data is available for Aquifer I in the Redwood Valley region and can be identified as a potential data gap. The GSA has installed monitoring wells in that area during GSP development to cover this data gap by implementing its monitoring networks. A more comprehensive discussion regarding efforts to address these data gaps is discussed under the groundwater quality monitoring network associated with Chapter 3, below.

## 2.11 Land Subsidence

Land subsidence data is entirely sourced from the TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) dataset which provides estimates of vertical displacement from June 2015 to September 2019. The GSA did not identify major data gaps for this section and considers the publicly avalaible data sufficient for assessing the conditions of the Basin.

## 2.12 Water Budget

The GSA used the UVIHM to develop its historical, current, and future baseline water budgets. A complete discussion of the water budget is provided in Section 2.2.3 of the GSP. Moreover, additional discussion regarding model development and the Basin water budget, including a detailed discussion of data gaps and possible improvements, are provided in Appendix 2D.

Sources of uncertainty and data gaps in water budget development in this GSP can be categorized into:

- Data gaps and uncertainty in water use estimates and water demands,
- Data gaps and uncertainty regarding climate change impacts, and,

- Other data gaps and simplifying assumptions that contribute to UVIHM simulation uncertainty.

These data gaps and sources of uncertainty are discussed in more detail below.

### 2.12.1 Water Use Estimates and Water Demands

Water use in the Basin is discussed in detail in Appendix 2D. Surface water and groundwater have been the primary supply sources in the Basin, historically. In recent years, recycled water has been added to the Basin's water supply portfolio made available from the City of Ukiah's (City) Wastewater Treatment Plan (UWWTP) through the Purple Pipe project.

Water use in the Basin in this GSP is divided into four categories:

1. Domestic Non-Municipal Use,
2. Municipal use (City of Ukiah)
3. Agricultural use, and,
4. De-minimis water users using less than two acre-feet per year of groundwater for domestic use.

For the first category, water use estimates were generated using the data supplied by water agencies. These agencies include the Russian River Flood Control and Water Conservation Improvement District (RRFC), Calpella County Water District (CWD), Millview CWD, Redwood Valley CWD, Rogina Water Company Inc, and Willow CWD. However, the data at hand does not extend past 2015 requiring an assumption that water consumption in the following years was consistent with what was observed in 2015. Moreover, water use data for the Yoakayo tribe and the City of 10,000 Buddhas was not obtained and is considered a data gap. Millvew CWD and Rogina Water Company's recharge amounts are data gaps and not considered in the water budget. Rogina Water company's groundwater use data was not available and is considered a data gap, as well. The GSA will coordinate with respective water agencies to extend its data and cover the data gaps for this category.

For the municipal use from the City, data for surface water and groundwater was shared up to 2015 and used in the UVIHM and the GSP. Data for the UWWTP was obtained from the California Integrated Water Quality System Project (CIWQS). The GSA will coordinate with the City to extend its municipal water use data and cover the existing data gaps.

Agricultural use, including surface water and groundwater used for irrigation, is a significant data gap. Measured agricultural pumping was not made available to the GSA during the GSP development process. Groundwater in the Basin is not generally metered. Surface water use can be determined through post-processing the eWRIMS database. However, this was considered an undertaking outside the scope and timeline of the GSA development.

In order to cover the agricultural water use data gap, agricultural water demands were derived using the Integrated Water Flow Model Demand Calculator (IDC) model with published crop coefficients. As recommended in Appendix 2-D, the IDC can be replaced with GSFLOW Ag Package in the future since it is integrated with GSFLOW and can dynamically estimate water use.

Improved estimates of actual evapotranspiration can also be used to refine agricultural, native, and riparian water requirements. During the development of the UVIHM, no measured evapotranspiration data was available to calibrate IDC estimations. IDC estimations were generally approved by soliciting input from stakeholders and the agricultural community. Data from the newly released, OpenET platform can be used to cost-effectively validate and refine model inputs, as necessary. This has been included as a recommended action for improvements to the UVIHM.

Additionally, cannabis cultivation has significantly increased in the past couple of years in the County and the Basin. Cannabis cultivation practices can vary, creating different demands. Improving the knowledge of where cannabis is being grown and under what cultivation practice is the first step to understanding cannabis' impact on groundwater management. Secondly, studies on cannabis water demands are not yet widely available, and deciding on a representative crop coefficient is challenging. Platforms such as OpenET can be used as a first iteration of understanding cannabis crop water requirements.

The GSA intends to continue its outreach and coordination with the agricultural community to refine its water estimates and improve its understanding of agricultural water use in the Basin during the implementation. Upon availability of new data such as land use maps and crop maps, the GSA will update its UVIHM and water use estimates accordingly.

Additionally, for the upcoming 5-year review of the GSP, the GSA will consider if using the eWRIMS dataset to summarize surface water diversions is beneficial and feasible to improve UVIHM and water use estimates. The GSA will also consider utilizing platforms such as OpenET to calibrate its IDC simulations. Finally, the GSA will also consider upgrading the UVIHM with implementing Ag Package and migrating IDC estimations.

As discussed in Appendix 2D, de-minimus water users are not included at this stage in estimating water use and the development of the UVIHM. The GSA could not obtain a reliable estimate of the population and location of this user base. The GSA hopes that implementing the well inventory PMA will help provide a reliable image of where such use is happening. Combining this information with parcel maps and land use maps can lead to a reliable estimate of use that could be included in the water budget and the UVIHM. This estimation will be considered for the upcoming review of the GSP in 5 years if the well inventory PMA is successfully implemented.

### 2.12.2 Potential Impacts of Climate Change

As discussed in detail in Appendix 2D, climate change simulations conducted during GSP development followed DWR methodology and central tendency scenarios. To better assess the impacts of climate change in the future concerning water budgets and conditions of the Basin, the UVIHM needs to be enhanced and re-calibrated using additional data. Furthermore, reservoir releases from Coyote Valley Dam and Potter Valley Projects need to be simulated and included in the UVIHM in these climate change scenarios. Appendix 2D discusses the GSA's steps and the recommendations for future work with respect to climate change and UVIHM development. The GSA will consider these steps to cover data gaps with respect to climate change impact assessments. While these steps may enhance the GSA's understanding of the impacts of climate change, they cannot eliminate the uncertainty imposed by it. Therefore, climate change uncertainty needs to be considered throughout the GSP implementation in planning and decision making.

### 2.12.3 Additional UVIHM Data Gaps

Additional data gaps and sources of uncertainty in water budget calculations and the UVIHM include key sources of uncertainty outlined in the rest of this appendix, such as stream network and hydrology data gaps, groundwater elevation measurements, geologic and hydrogeologic information, etc. All these data gaps limit the ability of the UVIHM to effectively simulate observed and actual surface water and groundwater conditions of the Basin. While the GSA takes steps to cover these data gaps, it will also include additional data and information into the UVIHM to improve its simulations.

Moreover, leakage to and from the river can be better understood using the recently installed groundwater elevation monitoring transects using the DWR Technical Support Services (TSS) funds and existing and installed streamflow gages. The GSA may consider conducting a seepage study to better quantify this leakage in the future.

Finally, a major source of uncertainty in producing future simulations is the assumptions that need to be made regarding demand projections, land use changes, population changes, political and regulatory landscape changes, and water system status. In most cases, the best available forecast or judgment is used, or current conditions are assumed to remain in place. These are the sources of uncertainty that the GSA may not be able to improve upon unless special studies are conducted by other responsible agencies or in coordination with the GSA. These uncertainties need to be considered in the decision-making throughout the implementation as well.

# Chapter 3

# Data gaps in Monitoring Networks

## 3.1 Requirements

Multiple data gap requirements are relevant to the design of monitoring networks for sustainability indicators. Per 23 CCR 354.38 ("Assessment and Improvement of Monitoring Network"):

A. Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.
B. Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
C. If the monitoring network contains data gaps, the plan shall include a description of the following:
    a. The location and reason for data gaps in the monitoring network
    b. Local issues and circumstances that prevent monitoring
D. Each Agency shall describe steps that will be taken to fill the data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

The following discussion summarizes the identified data gaps, description, and strategy to fill the identified data gaps.

## 3.2 Groundwater Level and Storage Monitoring Network

As elaborated in Section 2.6, observed groundwater elevation data in the Basin is limited in its spatial coverage. They also cover a short recent history, mostly starting from 2014. Two principal aquifers are defined for the Basin. Each aquifer needs to have its specific monitoring network and sustainable management criteria. As shown in **Figure 2.2**, a data gap exists for the number of groundwater wells that specifically monitor Aquifer I. The limited number of available wells and the short history of groundwater elevation data have also limited GSA's ability to define RMPs. Both aquifers would benefit from additional RMPs to provide better coverage of the Basin.

The GSA has already installed wells in the Basin using DWR TSS grant to cover the above-mentioned data gaps. These wells will be added as RMPs to their respective aquifers upon collection of sufficient data and establishing an adequate baseline. In addition, a subset of CASGEM wells included in the groundwater elevation monitoring network have been selected to be instrumented with continuous measurement devices. The GSA has instrumented a few of these wells during GSP development and will continue to do so contingent upon available funding and well owner willingness.

Further implementation actions are proposed through the monitoring activities PMA in Chapter 4 to cover data gaps in the groundwater elevation monitoring networks, support the evaluation of storage changes, and refine model calibration. An assessment of the groundwater elevation monitoring network is planned for both spatial density and monitoring frequency adequacy within the first five years of GSP implementation. Further evaluations of the monitoring network will be conducted on a 5-year basis.

## 3.3 Groundwater Quality Monitoring Network

### 3.3.1 Requirements

According to 23 CCR 354.34 (c)(4): Degraded Water Quality, the groundwater quality monitoring netowrk is required to collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the GSA, to address known water quality issues.

### 3.3.2 Data Gaps

Existing wells used for monitoring groundwater quality in the Basin include public water supply wells, monitoring wells at the UWWTP, monitoring wells at known groundwater contamination sites, and TSS-funded wells drilled for GSP monitoring. These wells are used to monitor concentrations of the five constituents of interest specified in Chapter 2: boron, iron, manganese, nitrogen, and specific conductivity. While the current selection provides sufficient coverage to assess overall groundwater quality in the basin, there exist areas and localities where wells were not available to monitor one or both principal aquifers. The GSA will consider installing additional wells, as needed and possible, to cover these data gaps contingent upon funding. Within the first five years of implementation, an assessment of the monitoring results for both spatial density and monitoring frequency suitability based on the proposed monitoring network will be performed to determine the need for expansion of the network with additional wells.

In addition, as mentioned in Section 2.5, data gaps exist regarding well completion reports available for supply wells, as well as principal aquifers' depth at different well locations resulting from kriging analysis. Well construction information will be acquired through coordination with monitoring agencies and conducting video logs as necessary during the implementation. Geological data gaps with respect to aquifer depths will be covered as discussed in Section 2.2.

## 3.4 Depletion of Interconnected Surface Water Monitoring Network

### 3.4.1 Requirements

The requirements for the depletion of interconnected surface water monitoring network, as part of§ 354.34. Monitoring Network, are detailed below:

A. Flow conditions including surface water discharge, surface water head, and baseflow contribution.
B. Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
C. Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
D. Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.
E. Changes in gradient between river and groundwater system.

### 3.4.2 Data Gaps

The GSA has selected an adaptive design for the depletion of ISWs sustainable management criteria (SMC). For the first phase of implementation, depletion of ISWs monitoring network will be complementary to the groundwater elevation monitoring network because groundwater level is used as a proxy for ISW depletion.

Upon collecting additional data, the UVIHM will be used to calculate the depletion of ISWs due to groundwater pumping, and sustainable management criteria will be re-defined. This will be done once a more comprehensively calibrated model is obtained over the next five years. Monitoring is necessary for inputs and calibration of the UVIHM and to demonstrate sustainability through the SMC defined for ISWs. Therefore, all data gaps that are mentioned above concerning the UVIHM development apply to the depletion of ISWs, as well.

As discussed in Chapter 2 and Section 2.6, existing data provides insufficient high-frequency groundwater elevation measurements to enable the effective characterization of groundwater conditions within the Basin. Multiple actions are planned to address these data gaps under the monitoring activities PMA designed in Chapter 4. The proposed monitoring network is intended to address and improve the temporal and spatial distribution of data with regard to groundwater level measurements and streamflow measurements. This would entail pairing newly installed TSS-funded wells and privately owned existing CASGEM wells instrumented with continuous measurement devices with the existing and installed streamflow gages to form monitoring transects. Three transects have already been installed during GSP development and will provide critical information to fully understand the relationship between the river and the aquifer. Additional transects may be considered during the first five years of GSP implementation. Future efforts may also include discretionary monitoring activities such as installing additional streamflow gages on tributaries, conducting an isotope study to identify sources of water, and conducting one or more seepage runs in the summer/fall months to estimate leakage.

## Chapter 4

# Data Gap Prioritization

Filling data gaps can be achieved by increasing monitoring frequency, adding monitoring sites to increase spatial distribution and density of the monitoring network, or developing new monitoring programs or tools. In this section, identified data gaps are categorized into high, medium, and low priority ranking based on their value to better understand the basin setting and enhance the management of the Basin, as shown in **Table 4.1**.

High priority data gaps significantly limit the understanding of the basin setting, the ability to establish SMCs, or evaluate basin sustainability. Medium priority data gaps are those where information is available but can be improved. Covering these data gaps would either strengthen the monitoring network used to demonstrate basin sustainability or help refine SMCs by significantly improving the understanding of the Basin. Low priority data gaps are those where additional data collection would marginally improve the understanding of the basin setting, ability to establish SMCs, or evaluate basin sustainability.

**Table 4.1:** Data Gap Prioritization.

| Priority | Data Gap Classification | Data Gap Summary | Strategy to Fill Data Gap |
| --- | --- | --- | --- |
| High | Groundwater Wells' Construction Information and Well Inventory | Determine well depths, screen depths, and assign wells to appropriate aquifers | Obtain well completion reports and conduct video log and well surveys |
| High | Groundwater Wells' Construction Information and Well Inventory | Develop a better understanding of wells in the basin, specifically domestic wells, and their depths and locations | Establish a well inventory that includes approximate locations and construction information of wells |
| High | Groundwater Elevation | Include additional wells into the monitoring network for both aquifers in gap areas | Instrument existing wells or drill new wells in gap areas |
| High | Groundwater Elevation | Obtain high-frequency groundwater elevation measurements | Instrument wells with continuous measurement devices |
| High | Water budget | Extend municipal and domestic non-municipal water use estimates | Obtain appropriate water use data from municipal and non-municipal domestic users |
| High | Groundwater Level and Storage Monitoring Network | Increase RMPs in the network | Add recently installed wells to the monitoring network upon establishing sufficient baseline |
| High | Depletions of interconnected surface water monitoring network | Establish better understanding of depletion volumes and revise sustainable management criteria | Collect additional data and re-calibrate and enhance the UVIHM to run scenarios |
| Medium/High | Stream Network and Hydrologic Data | Improve understanding on streamflow and aquifer interaction, tributaries connections, and the contribution of tributaries to the water budget | Install additional streamflow gages on tributaries |
| Medium | Geology | Refine cross sections and produce a better representation of aquifer extents | Use well completion reports and well drillers logs along with geophysical studies such as AEM surveys |
| Medium | Stream Network and Hydrologic Data | Develop a better understanding of the river profiles, entrenchment, and streambed properties | Conduct river surveys and bathymetric studies |

**Table 4.1:** Data Gap Prioritization. *(continued)*

| Priority | Data Gap Classification | Data Gap Summary | Strategy to Fill Data Gap |
|---|---|---|---|
| Medium | Water budget | Develop reliable estimate of de-minimum water use | Conduct well inventory and use land use and parcel maps |
| Medium | Water budget | Improve understanding of cannabis water use impact | Coordinate with responsible agencies to find better land use data and irrigation practice information to improve IDC simulations |
| Medium | Water budget | Improve understanding of climate change impacts | Conduct additional climate change simulations as discussed in Appendix 2D |
| Medium | Geology | Determine the impact of Maacama fault on groundwater flow and its geological displacement | Use groundwater monitoring wells and AEM and geophysical surveys |
| Medium | Aquifer Characteristics | Understand interaction of aquifers with rivers | Use groundwater wells near the river and conduct isotope studies |
| Medium | Water Quality | Improve localized water quality measurements in aquifer I | Install new wells or use existing wells in gap areas to monitor water quality constituents |
| Medium | Water budget | Improve agricultural water use estimates | Use public ET data and local water use data to calibrate IDC results |
| Medium | Additional UVIHM Data Gaps | Improve estimations of leakage between aquifer and streams | Conduct seepage runs along the mainstem Russian River |
| Medium | Aquifer Characteristics | Determine aquifer properties | Use additional pumping tests and lithological data |
| Low | Identification of Groundwater Dependent Ecosystems | Improve understanding of GDE coverage | Conduct satellite imagery analysis |

## Chapter 5

# References

DWR. (2016). *Monitoring Networks and Identification of Data Gaps Best Management Practice* (p. 34). Sacramento, CA: California Department of Water Resources. Retrieved from https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-and-Identification-of-Data-Gaps_ay_19.pdf

# Appendix 2-F Water Quality

# Contents

# Regulatory Background

*Federal and State Regulations*

The overarching federal law concerning water quality is the Clean Water Act, passed in 1972, and is applicable to surface waters and wetlands. In contrast, the federal Safe Drinking Water Act (SDWA) applies to both surface and groundwater, providing protection to drinking water supplies. Under the SDWA, federal standards were established through the United States Environmental Protection Agency (USEPA), in the form of maximum contaminant levels (MCLs). Secondary maximum contaminant levels (SMCLs) have also been established at the federal level; these address esthetics of drinking water sources and are not enforceable. The state of California has its own Safe Drinking Water Act that includes MCLs and SMCLs which are, for select constituents, stricter than those set at the federal level. The California MCLs and SMCLs are codified in Title 22 of the California Code of Regulations (CCR). The standards established under the federal and state Safe Drinking Water Acts are enforced through the State Water Resource Control Board's (SWRCB's) Division of Drinking Water (DDW).

The California Porter-Cologne Water Quality Act, contained in California Water Code Division 7, applies to groundwater and surface waters, designating responsibility for water quality and safe drinking water to the SWRCB and the nine Regional Water Quality Control Boards (RWQCB) in California. The Act requires RWQCBs to develop water quality control plans to manage the quality of surface water and groundwater in specific hydrologic regions; the plans contain defined water quality objectives for each region. These water quality objectives protect the quality of surface waters, groundwaters, and associated beneficial uses. The water quality control plan must be approved by both the SWRCB and the USEPA. The Ukiah Valley Basin is in the North Coast Region and is regulated under the North Coast Regional Water Quality Control Board (Regional Water Board), with water quality objectives detailed in the Water Quality Control Plan for the North Coast Region (Basin Plan).[1]

The SWRCB's Policy for Water Quality Control For Recycled Water (Recycled Water Policy),[2] most recently amended in 2018, includes additional requirements to address salt and nutrients. Under this policy, Regional Water Boards are required to assess basins or subbasins within the region where water quality is threatened by salt and nutrients, and where management is required. In basins or subbasins where salt and nutrients are identified as a threat, a salt and nutrient management plan (SNMP) or equivalent management plan is required; this plan can address other constituents in addition to salt and nutrients.

*Water Quality Control Plan for the North Coast Region*

The Water Quality Control Plan for the North Coast Region (Basin Plan) is a regulatory tool used by the North Coast Regional Water Quality Control Board (Regional Water Board) to protect water quality within the North Coast Region. The Basin Plan is adopted by the NCRWQCB and approved by the State Water Resources Control Board; the water quality standards are approved by the United States Environmental Protection Agency (USEPA). Within the Basin Plan, beneficial uses of water, water quality objectives, including an antidegradation policy and plans for implementing

[1] {North Coast Regional Water Quality Control Board. 2018. "Water Quality Control Plan for the North Coast Region." Available: https://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/}

[2] {SWRCB Resolution No. 2018-0057 and "Amendment to the Policy for Water Quality Control For Recycled Water." Available: https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2018/121118_7_final_amendment_oal.pdf}

protections are included. Table 2-1 of the Basin Plan designates the following beneficial uses for all groundwater (Basin Plan):

- Municipal and Domestic Supply (MUN)
- Agricultural Supply (AGR)
- Industrial Service Supply (IND)
- Native American Culture (CUL)

Potential beneficial uses of groundwater include:

- Industrial Process Supply (PRO)
- Aquaculture (AQUA)

For chemical constituents in waters with MUN beneficial uses, the Basin Plan specifies that no waters are to exceed the MCL in Title 22 of the California Code of Regulations (CCR). The Basin Plan also includes numeric water quality objectives, specifically for groundwaters in the Ukiah Valley hydrologic area.

A complete list of constituents, comparison concentrations and sources are listed in Table 2.

# Water Quality Assessment

## Data Sources

Water quality data was obtained from several databases and supplemented with data provided by local organizations and community members. The majority of the water quality data used in the assessment was sourced from the SWRCB's Groundwater Ambient Monitoring and Assessment Program (GAMA), a database containing datasets from agencies including the Department of Pesticide Regulation (DPR), Department of Water Resources (DWR), the State Water Board, Lawrence Livermore National Laboratory (LLNL) and the United States Geological Survey (USGS). Additional data in the Ukiah Valley Wildlife Area was directly provided by the California Department of Fish and Wildlife.

The datasets in GAMA with information in Ukiah Valley Groundwater Basin are:

- **The Public Water System Wells** dataset includes wells regulated by the State Water Board's Division of Drinking Water (DDW). This dataset includes information for active and inactive drinking water sources with 15 or more connections or more than 25 people per day.

- **National Water Information System (NWIS)**, a dataset provided by USGS with samples from water supply wells and reported quarterly to the State Water Board's data management system, GeoTracker.

- **Monitoring wells** regulated by the State Water Board includes wells under different regulatory programs, with data available for download through GeoTracker. There are monitoring wells in Ukiah Valley Basin for the following programs:

- Leaking Underground Storage Tank (LUST) Cleanup sites
- Cleanup Program Sites
- Land Disposal Sites

- **GAMA's Priority Basin Project**, a State Water Board, USGS and LLNL initiative to assess groundwater quality statewide. Data primarily collected from public water system wells but private domestic, monitoring and irrigation wells are also sampled.
- **DWR's Water Data Library**, a dataset including groundwater quality and depth data with samples from multiple well types including irrigation, stock, domestic and public supply.
- **Department of Pesticide Regulation's Groundwater Protection program**, a compilation of information from DPR and other public agencies from domestic, public supply and irrigation wells.

## Selection of Numeric Thresholds

Numeric thresholds are used with well data to evaluate groundwater quality. These numeric standards are selected to satisfy all relevant groundwater quality standards and objectives; the general selection approach used is consistent with recommendations by the State Water Board for determination of assessment thresholds for groundwater [Reference]. More than one water quality objective or standard may apply to a constituent and a prioritization process is used to select the numeric threshold value. Where available, the strictest value, of the federal and state regulated water quality standards, and water quality objectives specified in the Basin Plan, is used.

The following sources were used in establishing the numeric thresholds:

i) Basin Plan numeric water quality objectives

Specific groundwater quality objectives are defined in the Basin Plan for specific conductance, pH, hardness and boron. These limits are listed in Table 1 below.

ii) State and Federal Maximum Contaminant Levels (MCLs)

MCL-CA: State of California MCLs

MCL-US: Federal MCLs

Per the Basin Plan, groundwaters in the Ukiah Valley hydrologic area have a designated beneficial use as domestic or municipal water supply (MUN) beneficial use and must not exceed the maximum contaminant levels (MCLs) and secondary maximum contaminant levels (SMCLs) defined in Title 22 of the California Code of Regulations (CCR). The strictest value of the state and federal MCLs and SMCLs is used.

The complete list of constituents and corresponding sources and values for comparison concentrations used in the water quality analysis can be found in Table 2.

Table 1: Basin Plan Specific Water Quality Objectives for Groundwaters in the Ukiah Valley Hydrologic Area (upstream)

| Constituent | Limit Type | Value |
|---|---|---|
| Specific Conductance (mmhos) at 77 degrees F | 90% Upper Limit | 320 |
| Specific Conductance (mmhos) at 77 degrees F | 50% Upper Limit | 250 |
| pH | Maximum | 8.5 |
| pH | Minimum | 6.5 |

[a] 90% upper and lower limits represent the 90 percentile values for a calendar year. 90% or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit

[b] 50% upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment.

| Full Name | MCL | Units | Source |
|---|---|---|---|
| 1,1 Dichloroethane (1,1 DCA) | 5 | ug/L | Title 22 Table 64444-A |
| 1,1 Dichloroethylene (1,1 DCE) | 6 | ug/L | Title 22 Table 64444-A |
| 1,1,1 Trichloroethane | 200 | ug/L | Title 22 Table 64444-A |
| 1,1,2 Trichloro-1,2,2-Trifluoroethane (Freon 113) | 1.2 | mg/L | Title 22 Table 64444-A |
| 1,1,2 Trichloroethane | 5 | ug/L | Title 22 Table 64444-A |
| 1,1,2,2 Tetrachloroethane (PCA) | 1 | ug/L | Title 22 Table 64444-A |
| 1,2 Dibromo-3-chloropropane (DBCP) | 0.2 | ug/L | Title 22 Table 64444-A |
| 1,2 Dibromoethane (EDB) | 0.05 | ug/L | Title 22 Table 64444-A |
| 1,2 Dichlorobenzene (1,2-DCB) | 600 | ug/L | Title 22 Table 64444-A |
| 1,2 Dichloroethane (1,2 DCA) | 0.5 | ug/L | Title 22 Table 64444-A |
| 1,2 Dichloropropane (1,2 DCP) | 5 | ug/L | Title 22 Table 64444-A |
| 1,2,3 Trichloropropane (1,2,3 TCP) | 0.005 | ug/L | Title 22 Table 64444-A |
| 1,2,4 Trichlorobenzene (1,2,4 TCB) | 5 | ug/L | Title 22 Table 64444-A |
| 1,2,4 Trimethylbenzene | 330 | ug/L | NL |
| 1,3 Dichlorobenzene | 600 | ug/L | US-HAL |
| 1,3 Dichloropropene | 0.5 | ug/L | Title 22 Table 64444-A |
| 1,3,5 Trimethylbenzene | 330 | ug/L | NL |
| 1,4 Dichlorobenzene (p-DCB) | 5 | ug/L | Title 22 Table 64444-A |
| 1,4 Dioxane | 1 | ug/L | HBSL |
| 2 Chlorotoluene | 140 | ug/L | US-HAL |
| 2,3,7,8 TCDD | 0.00003 | ug/L | MCL-US |
| 2,4 Dichlorophenoxyacetic acid (2,4 D) | 70 | ug/L | Title 22 Table 64444-A |
| 2,4,5 TP (Silvex) | 50 | ug/L | Title 22 Table 64444-A |
| 2,4,6 Trinitrotoluene (TNT) | 1 | ug/L | US-HAL |
| 4 Chlorotoluene | 140 | ug/L | HBSL |
| 4,4’ DDD | 0.1 | ug/L | CA-CPF |
| 4,4’ DDE | 0.1 | ug/L | CA-CPF |
| 4,4’ DDT | 0.1 | ug/L | CA-CPF |
| Acetone | 6300 | ug/L | RfD |
| Alachlor | 2 | ug/L | Title 22 Table 64444-A |
| Aldicarb | 7 | ug/L | HBSL |
| Aldicarb Sulfone | 7 | ug/L | HBSL |
| Aldicarb sulfoxide | 7 | ug/L | HBSL |
| Alpha-Benzene Hexachloride (Alpha-BHC) | 0.15 | ug/L | CA-Prop65 |
| Aluminum | 200 | ug/L | Title 22 Table 64449-A |
| Ammonia | 30 | mg/L | US-HAL |
| Antimony | 6 | ug/L | Title 22 Table 64431-A |
| Arsenic | 10 | ug/L | Title 22 Table 64431-A |
| Asbestos | 7 | MFL | Title 22 Table 64431-A |

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment. *(continued)*

| Full Name | MCL | Units | Source |
|---|---|---|---|
| Atrazine | 1 | ug/L | Title 22 Table 64444-A |
| Azinphos Ethyl | 10 | ug/L | HBSL |
| Barium | 1 | mg/L | Title 22 Table 64431-A |
| Bensulfuron Methyl | 1000 | ug/L | HBSL |
| Bentazon | 18 | ug/L | Title 22 Table 64444-A |
| Benzene | 1 | ug/L | Title 22 Table 64444-A |
| Benzo(a)pyrene | 0.2 | ug/L | Title 22 Table 64444-A |
| Beryllium | 4 | ug/L | Title 22 Table 64431-A |
| Beta-Benzene Hexachloride (Beta-BHC) | 0.25 | ug/L | CA-Prop65 |
| Boron | 1 | mg/L | NL |
| Bromacil | 70 | ug/L | US-HAL |
| Bromate | 10 | ug/L | MCL-US |
| Bromodichloromethane (THM) | 80 | ug/L | MCL |
| Bromoform (THM) | 80 | ug/L | MCL |
| Cadmium | 5 | ug/L | Title 22 Table 64431-A |
| Carbaryl (1-naphthyl methylcarbamate) | 40 | ug/L | HBSL |
| Carbofuran | 18 | ug/L | Title 22 Table 64444-A |
| Carbon Disulfide | 160 | ug/L | HBSL |
| Carbon Tetrachloride | 0.5 | ug/L | Title 22 Table 64444-A |
| Chlorate | 800 | ug/L | NAS-HAL |
| Chlordane | 0.1 | ug/L | Title 22 Table 64444-A |
| Chloride | 500 | mg/L | Title 22 Table 64449-B |
| Chlorite | 1 | mg/L | MCL-US |
| Chlorobenzene | 70 | ug/L | Title 22 Table 64444-A |
| Chloroform (THM) | 80 | ug/L | MCL |
| Chloropicrin | 12 | ug/L | NAS-HAL |
| Chromium | 50 | ug/L | Title 22 Table 64431-A |
| Chromium, Hexavalent (Cr6) | 20 | ug/L | HBSL |
| cis-1,2 Dichloroethylene | 6 | ug/L | Title 22 Table 64444-A |
| Copper | 1 | mg/L | Title 22 Table 64449-A |
| Cyanazine | 0.3 | ug/L | HBSL |
| Cyanide (CN) | 150 | ug/L | Title 22 Table 64431-A |
| Cypermethrin | 40 | ug/L | HBSL |
| Dacthal | 70 | ug/L | HBSL |
| Dalapon | 200 | ug/L | Title 22 Table 64444-A |
| Deethylatrazine | 50 | ug/L | CA-Prop65 |
| Di(2-ethylhexyl)adipate | 0.4 | mg/L | Title 22 Table 64444-A |
| Di(2-ethylhexyl)phthalate (DEHP) | 4 | ug/L | Title 22 Table 64444-A |
| Diazinon | 1.2 | ug/L | HBSL |
| Dibromochloromethane (THM) | 80 | ug/L | MCL |
| Dicamba | 210 | ug/L | RfD |

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment. *(continued)*

| Full Name | MCL | Units | Source |
|---|---|---|---|
| Dichlorodifluoromethane | 1 | mg/L | HBSL |
| Dichloromethane (Methylene Chloride) | 5 | ug/L | Title 22 Table 64444-A |
| Dichlorprop | 300 | ug/L | HBSL |
| Dichlorvos (DDVP) | 0.4 | ug/L | HBSL |
| Dieldrin | 0.002 | ug/L | HBSL |
| Diesel | 100 | ug/L | US-HAL |
| Dimethoate | 2 | ug/L | HBSL |
| Dinoseb | 7 | ug/L | Title 22 Table 64444-A |
| Diquat | 20 | ug/L | Title 22 Table 64444-A |
| Diuron | 2 | ug/L | HBSL |
| Endosulfan I | 42 | ug/L | RfD |
| Endosulfan II | 42 | ug/L | RfD |
| Endosulfan Sulfate | 42 | ug/L | RfD |
| Endothall | 100 | ug/L | Title 22 Table 64444-A |
| Endrin | 2 | ug/L | Title 22 Table 64444-A |
| EPTC | 200 | ug/L | HBSL |
| Ethylbenzene | 300 | ug/L | Title 22 Table 64444-A |
| Ethylene glycol | 14 | mg/L | US-HAL |
| Fecal Coliform (bacteria) | 0.99 | Count | MCL |
| Fenamiphos | 0.7 | ug/L | HBSL |
| Fluoride | 2 | mg/L | Title 22 Table 64431-A |
| Foaming Agents (MBAS) | 0.5 | mg/L | Title 22 Table 64449-A |
| Fonofos | 10 | ug/L | HBSL |
| Formaldehyde | 100 | ug/L | US-HAL |
| Gasoline | 5 | ug/L | US-HAL |
| Glyphosate (Round-up) | 700 | ug/L | MCL-US |
| Gross Alpha radioactivity | 15 | pCi/L | Title 22 Table 64442 |
| Gross beta | 50 | pCi/L | MCL-US |
| Guthion (Azinphos Methyl) | 10 | ug/L | HBSL |
| Heptachlor | 0.01 | ug/L | Title 22 Table 64444-A |
| Heptachlor Epoxide | 0.01 | ug/L | Title 22 Table 64444-A |
| Hexachlorobenzene (HCB) | 1 | ug/L | MCL-US |
| Hexachlorobutadiene | 0.9 | ug/L | HBSL |
| Hexachlorocyclopentadiene | 50 | ug/L | Title 22 Table 64444-A |
| Hexazinone | 400 | ug/L | HBSL |
| Iodide | 1190 | ug/L | NAS-HAL |
| Iprodione | 0.8 | ug/L | HBSL |
| Iron | 300 | ug/L | Title 22 Table 64449-A |
| Isopropylbenzene ( Cumene) | 770 | ug/L | HBSL |
| Kerosene | 100 | ug/L | US-HAL |

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment. *(continued)*

| Full Name | MCL | Units | Source |
|---|---|---|---|
| Lead | 15 | ug/L | AL |
| Lindane (Gamma-BHC) | 0.2 | ug/L | Title 22 Table 64444-A |
| Linuron | 5 | ug/L | HBSL |
| Malathion | 500 | ug/L | HBSL |
| Manganese | 50 | ug/L | Title 22 Table 64449-A |
| Mercury | 2 | ug/L | Title 22 Table 64431-A |
| Metalaxyl | 500 | ug/L | HBSL |
| Methomyl | 200 | ug/L | HBSL |
| Methoxychlor | 30 | ug/L | Title 22 Table 64444-A |
| Methyl Bromide (Bromomethane) | 10 | ug/L | US-HAL |
| Methyl Isobutyl Ketone (MIBK) | 120 | ug/L | NL |
| Metolachlor | 700 | ug/L | HBSL |
| Metribuzin | 90 | ug/L | HBSL |
| Molinate | 20 | ug/L | Title 22 Table 64444-A |
| Molybdenum | 40 | ug/L | US-HAL |
| MTBE (Methyl-tert-butyl ether) | 5 | ug/L | Title 22 Table 64449-A |
| Naled | 10 | ug/L | HBSL |
| Naphthalene | 17 | ug/L | HBSL |
| Napropamide | 800 | ug/L | HBSL |
| n-Butylbenzene | 260 | ug/L | NL |
| Nickel | 100 | ug/L | Title 22 Table 64431-A |
| Nitrate as N | 10 | mg/L | Title 22 Table 64431-A |
| Nitrate+Nitrite | 10 | mg/L | Title 22 Table 64431-A |
| Nitrite as N | 1 | mg/L | Title 22 Table 64431-A |
| N-Nitrosodiethylamine (NDEA) | 0.01 | ug/L | CA-CPF |
| N-Nitrosodimethylamine (NDMA) | 0.01 | ug/L | CA-CPF |
| N-Nitrosodi-N-Propylamine (NDPA) | 0.01 | ug/L | CA-CPF |
| Norflurazon | 10 | ug/L | HBSL |
| n-Propylbenzene (Isocumene) | 260 | ug/L | NL |
| Octogen (HMX) | 0.35 | mg/L | US-HAL |
| Oxamyl | 50 | ug/L | Title 22 Table 64444-A |
| Oxyfluorfen | 20 | ug/L | HBSL |
| Parathion | 0.02 | ug/L | HBSL |
| PCNB | 21 | ug/L | RfD |
| Pentachlorophenol (PCP) | 1 | ug/L | MCL-US |
| Perchlorate | 6 | ug/L | Title 22 Table 64431-A |
| Perfluorooctanoic acid | 5.1 | ng/L | US-HAL |
| Perfluorooctanoic sulfonate | 6.5 | ng/L | NL |
| Permethrin | 4 | ug/L | HBSL |
| pH | 6.5-8.5 | -log[H+] | Basin Plan Table 3-1 |

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment. *(continued)*

| Full Name | MCL | Units | Source |
|---|---|---|---|
| Phorate | 4 | ug/L | HBSL |
| Picloram | 0.5 | mg/L | Title 22 Table 64444-A |
| Polychlorinated Biphenyls (PCBs) | 0.5 | ug/L | MCL-US |
| Prometon | 400 | ug/L | HBSL |
| Prometryn | 300 | ug/L | HBSL |
| Propachlor (2-Chloro-N-isopropylacetanilide) | 90 | ug/L | HBSL |
| Propanil | 6 | ug/L | HBSL |
| Propargite | 1 | ug/L | HBSL |
| Radium 226 | 5 | pCi/L | Title 22 Table 64442 |
| Radium 228 | 5 | pCi/L | Title 22 Table 64442 |
| Radon 222 | 4000 | pCi/L | MCL-US |
| RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) | 0.3 | mg/L | US-HAL |
| sec-Butylbenzene | 260 | ug/L | NL |
| Selenium | 50 | ug/L | Title 22 Table 64431-A |
| Silver | 100 | ug/L | Title 22 Table 64449-A |
| Simazine | 4 | ug/L | Title 22 Table 64444-A |
| Sodium | 50 | mg/L | AL |
| Specific Conductivity | 250 (50% UL) - 320 (90% UL) | umhos | Basin Plan Table 3-1 |
| Strontium | 4000 | ug/L | US-HAL |
| Strontium 90 | 8 | pCi/L | Title 22 Table 64443 |
| Styrene | 100 | ug/L | Title 22 Table 64444-A |
| Sulfate | 500 | mg/L | Title 22 Table 64449-B |
| tebuthiuron | 1000 | ug/L | HBSL |
| tert-Butyl alcohol (TBA) | 12 | ug/L | NL |
| tert-Butylbenzene | 260 | ug/L | NL |
| Tetrachloroethene (PCE) | 5 | ug/L | Title 22 Table 64444-A |
| Thallium | 2 | ug/L | Title 22 Table 64431-A |
| Thiabendazole | 231 | ug/L | HHBP |
| Thiobencarb | 1 | ug/L | Title 22 Table 64449-A |
| Toluene | 150 | ug/L | Title 22 Table 64444-A |
| Total Coliform Bacteria | 0.99 | Count | MCL |
| Total Dissolved Solids | 1000 | mg/L | Title 22 Table 64449-B |
| Total Trihalomethanes | 80 | ug/L | MCL-US |
| Toxaphene | 3 | ug/L | Title 22 Table 64444-A |
| trans-1,2, Dichloroethylene | 10 | ug/L | Title 22 Table 64444-A |
| Trichlopyr | 400 | ug/L | HBSL |
| Trichloroethene (TCE) | 5 | ug/L | Title 22 Table 64444-A |

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment. *(continued)*

| Full Name | MCL | Units | Source |
|---|---|---|---|
| Trichlorofluoromethane (Freon 11) | 150 | ug/L | Title 22 Table 64444-A |
| Trifluralin | 20 | ug/L | HBSL |
| Tritium | 20000 | pCi/L | Title 22 Table 64443 |
| Uranium | 20 | pCi/L | Title 22 Table 64442 |
| Vanadium | 50 | ug/L | RfD |
| Vinyl Chloride | 0.5 | ug/L | Title 22 Table 64444-A |
| Warfarin | 2 | ug/L | HBSL |
| Xylene, Isomers m & p | 1750 | ug/L | Title 22 Table 64444-A |
| Xylenes (total) | 1750 | ug/L | Title 22 Table 64444-A |
| Zinc | 5 | mg/L | Title 22 Table 64449-A |

Table 3: Comparison Concentration Rank and Descriptions (modified from table used in GAMA).

| Rank | Comparison Concentration | Description |
|---|---|---|
| 1 | Basin Plan / Title 22 | Basin Plan Groundwater Requirements in Table 3-1 and specific Title 22 tables |
| 2 | MCL-CA | California drinking water maximum contaminant level |
| 3 | MCL-US | Federal drinking water maximum contaminant level |
| 4 | AL-US | Federal Action Level |
| 5 | HBSL | Cancer or non-cancer Health Based Screening Level |
| 6 | HHBP | Chronic non-cancer Human Health Benchmark for Pesticides |
| 7 | US-HAL | Federal Health Advisory Level |
| 8 | RfD | Reference Dose as a drinking water level |
| 9 | NAS-HAL | National Academy of Science Health Advisory Level |
| 10 | CA-CPF | California Cancer Potency Factor |
| 11 | CA-Prop. 65 | California Proposition 65 Safe Harbor Levels as a drinking water level |
| 12 | SMCL | Secondary MCL |
| 13 | NL | Notification Level |

## Calculations

Specific water quality objectives for the Ukiah Valley hydrologic area groundwaters, as defined in the Basin Plan, have specific limits and calculation requirements associated with specific conductance, hardness and boron. Per the Basin Plan, the 50% upper limit and 90% upper limit are defined as follows:

- 50% upper limits represent “the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater”

- 90% upper limits represent “the 90 percentile values for a calendar year. 90% or more of the values must be equal to an upper limit and greater than or equal to a lower limit.”

The monthly means of specific conductance and boron measurements were compared to the 50% and 90% upper limits.

## Filtering Process

To analyze groundwater quality, several filters were applied for relevance and quality. Though groundwater quality data for the Basin is available from 1952, data was limited to only include information collected in the past 30 years. Restricting the timespan from which data was collected increases confidence in data collection methods and quality of the data and focuses on information that is reflective of current groundwater quality conditions.

Groundwater quality for each constituent was analyzed by comparing the well data to the corresponding comparison concentration. Maps showing the location of wells where samples were collected were generated for each constituent. The maximum concentration sampled at each well is displayed on the map as one of the following groups:

a) Not detected
b) Detected but below half of the comparison concentration
c) Detected and above half of the comparison concentration
d) Above the comparison concentration

The number of samples in each category is displayed in the map's legend. Two iterations of map generation were conducted with the following scenarios:

1. Data is limited to those collected in the past 30 years only (1990-2020)
2. Data is limited to wells that have more than one data point in the past 30 years (1990-2020)

For the second scenario, where data is limited to wells that have more than one data point in the past 30 years, timeseries are generated for each constituent and well to identify changes over time in groundwater quality at a location.

## Constituents of Interest (COIs)

Constituents of Interest (COIs) were identified based on visual identification of potential groundwater quality issues using the maps generated in this assessment, identification of common constituents of interest, and discussion with stakeholders. Resulting from this analysis and discussion with stakeholders, the full list of COIs were:

1. Nitrate as N
2. Specific Conductivity
3. Iron
4. Manganese
5. Boron

A series of maps for each COI, with water quality data from the past 30 years (1990-2020), shows the location of tested wells and whether the maximum concentration ever recorded in that well has violated the MCL. The maps and associated timeseries for water quality data of COIs in the Basin over the past 30 years are included in **Section 2.2.2.4** of the GSP.

# Appendix 2-G Groundwater Dependent Ecosystems Assessment Tables

**Table 2-G-1: NCCAG Wetland Dataset "Original_C" Field Descriptions.**

| Class | Classification Description |
|---|---|
| PEM1C | Palustrine, Emergent, Persistent, Seasonally Flooded |
| PFOC | Palustrine, Forested, Seasonally Flooded |
| PSSC | Palustrine, Scrub-Shrub, Seasonally Flooded |
| R2UBH | Riverine, Lower Perennial, Unconsolidated Bottom, Permanently Flooded |
| R2USC | Riverine, Lower Perennial, Unconsolidated Shore, Seasonally Flooded |
| R5UBF | Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded |
| R3UBH | Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded |
| R3USC | Riverine, Upper Perennial, Unconsolidated Shore, Seasonally Flooded |
| 45800 | Seep or Spring |

**Table 2-G-2: 2010 California Department of Water Resources (DWR) Land Use and Land Cover Field Descriptions for Mendocino County.**

| Land Use/Land Cover Class | Description |
|---|---|
| C6 | Olives |
| C6-U | Olives |
| C6-Y | Olives |
| D1 | Apples |
| D10 | Miscellaneous Deciduous |
| D11 | Mixed Deciduous |
| D13 | Walnuts |
| D14 | Pistachios |
| D6 | Pears |
| D6-U | Pears |
| D6-X | Pears Partially Irrigated |
| D6-Y | Pears Young Crops |
| D-F | Tree Fallow |
| D-Y | Miscellaneous Tree |
| F6 | Corn |
| F-F | Field-Fallow |
| G | Grains |
| I1 | Land Not Cropped |
| I2 | New Land Being Prepared for Crops |
| NB1 | Dry Stream Channel |
| NR3 | Riparian |
| NV | Native |
| NW | Water Surface |
| NW6 | Wastewater Pond |
| P1 | Alfalfa & Alfalfa Mixtures |
| P3 | Mixed Pasture |
| P3-X | Mixed Pasture Partially Irrigated |
| P4 | Native Pasture |
| P4-X | Native Pasture Partially Irrigated |
| S1 | Farmsteads (Includes a Farm Residence) |
| S1-U | Farmsteads (Includes a Farm Residence) |
| S5 | Farmsteads (Without a Farm Residence) |
| S6 | Miscellaneous Semi-Ag (Small Roads, Ditches, Non-Planted Areas of Cropped Fields) |
| T16 | Flowers, Nursery, and Christmas Tree Farms |
| T17 | Mixed (Four or More) |
| T20 | Strawberries |
| T-F | Truck and Nursery Crops Fallow |

| Land Use/Land Cover Class | Description |
|---|---|
| U | Urban |
| UC | Urban Commercial |
| UC1 | Offices, Retailer, etc. |
| UC6 | Schools |
| UC7 | Municipal Auditoriums, Theaters, Churches, Buildings and Stands Associated with Race Tracks, Football Stadiums, Baseball Parks, Rodeo Arenas, Amusement Parks, etc. |
| UC-R | Urban Commercial Recreational |
| UI | Urban Industrial |
| UI1 | Manufacturing, Assembling, and General Processing |
| UI11 | Fruit and Vegetable Canneries and General Food Processing |
| UI12 | Miscellaneous High Water Use |
| UI13 | Sewage Treatment Plant Including Ponds |
| UI14 | Waste Accumulation Sites |
| UI2 | Extractive Industries |
| UI3 | Storage and Distribution |
| UI6 | Saw Mills |
| UL1 | Lawn Area – Irrigated |
| UL2 | Golf Course – Irrigated |
| UL4 | Cemeteries – Irrigated |
| UR | Urban Residential |
| UR1 | Single-Family Dwellings with Lot Sizes Great Than 1 Acre up to 5 Acres |
| UR2 | Single-Family Dwellings with a Density of 1 Unit/Acre up to 8+ Units/Acre |
| UR4 | Trailer Courts |
| UV1 | Urban Vacant |
| UV3 | Railroad Right of Way |
| UV4 | Paved Areas |
| UV4-K | Freeways |
| UV6 | Airport Runways |
| V | Vineyards |
| V-A | Vineyards Abandoned |
| V-F | Vineyards Fallow |
| V-U | Vineyards |
| V-X | Vineyards – Partially Irrigated |
| V-Y | vineyard |

**Table 2-G -3: 2014 California Department of Water Resources (DWR) Land Use and Land Cover Field Descriptions for Mendocino County.**

| Land Use/Land Cover Class | Description |
|---|---|
| D10 | Miscellaneous Deciduous |
| X | Unclassified |
| T18 | Miscellaneous Truck Crops |
| P3 | Mixed Pasture |
| P6 | Miscellaneous Grasses |
| D6 | Pears |
| T16 | Flowers, Nursery and Christmas Tree Farms |
| U | Urban |
| Y | Young Perennials |
| G6 | Miscellaneous Grain and Hay |
| D10 | Miscellaneous Deciduous |

**Table 2-G -4: 2016 California Department of Water Resources (DWR) Land Use and Land Cover Field Descriptions for Mendocino County.**

| Land Use/Land Cover Class | Description |
|---|---|
| D6 | Pears |
| V | Grapes |
| X | Unclassified |
| T16 | Flowers, Nursery and Christmas Tree Farms |
| P3 | Mixed Pasture |
| C6 | Olives |
| P6 | Miscellaneous Grasses |
| T18 | Miscellaneous Truck Crops |
| D13 | Walnuts |
| D10 | Miscellaneous Deciduous |
| U | Urban |
| G6 | Miscellaneous Grain and Hay |

**Table 2-G-5: Master Vegetation Lookup, Assumed Rooting Depth, and Possible Action Summary.**

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| | 45800 | | | UR | _45800_ _ _UR | 9.6 | Remove Urban Paved |
| | 45800 | | | NV | _45800_ _ _NV | 9.6 | Retain Natural |
| | 45800 | | | UC | _45800_ _ _UC | 9.6 | Remove Urban Paved |
| | 45800 | U | Urban | UR2 | _45800_U_Urban UR2 | 9.6 | Remove Urban Paved |
| | 45800 | U | Urban | NV | _45800_U_Urban NV | 9.6 | Retain Natural |
| | 45800 | U | Urban | UV3 | _45800_U_Urban UV3 | 9.6 | Remove Urban Paved |
| | PEM1C | | | NV | _PEM1C_ _ _NV | 4.8 | Retain Natural |
| | PFOC | | | | _PFOC_ _ _ | 30 | Retain Natural |
| | PFOC | | | NR3 | _PFOC_ _ _NR3 | 30 | Retain Natural |
| | PFOC | | | NB1 | _PFOC_ _ _NB1 | 13.1 | Retain Natural |
| | PFOC | | | NW | _PFOC_ _ _NW | 30 | Retain Natural |
| | PFOC | | | NV | _PFOC_ _ _NV | 30 | Retain Natural |
| | PFOC | | | S6 | _PFOC_ _ _S6 | 30 | Retain Check |
| | PFOC | | | V | _PFOC_ _ _V | 30 | Remove Ag. |
| | PFOC | | | UV4 | _PFOC_ _ _UV4 | 30 | Remove Urban Paved |
| | PFOC | | | D6 | _PFOC_ _ _D6 | 30 | Remove Ag. |
| | PFOC | | | UR | _PFOC_ _ _UR | 30 | Remove Urban Paved |
| | PFOC | | | S5 | _PFOC_ _ _S5 | 30 | Retain Check |
| | PFOC | X | | NV | _PFOC_X_ _NV | 30 | Retain Natural |
| | PFOC | X | Idle | NV | _PFOC_X_Idle_NV | 30 | Retain Natural |
| | PFOC | V | Grapes | NV | _PFOC_V_Grapes_NV | 30 | Retain Natural |
| | PFOC | V | Grapes | V | _PFOC_V_Grapes_V | 30 | Remove Ag. |
| | PFOC | V | Grapes | U | _PFOC_V_Grapes_U | 30 | Remove Urban Paved |
| | PFOC | U | Urban | V | _PFOC_U_Urban V | 30 | Remove Ag. |
| | PFOC | U | Urban | U | _PFOC_U_Urban U | 30 | Remove Urban Paved |
| | PFOC | U | Urban | UR2 | _PFOC_U_Urban UR2 | 30 | Remove Urban Paved |
| | PFOC | U | Urban | UV4 | _PFOC_U_Urban UV4 | 30 | Remove Urban Paved |
| | PFOC | V | | V | _PFOC_V_ _V | 30 | Remove Ag. |
| | PFOC | U | Urban | NV | _PFOC_U_Urban NV | 30 | Retain Natural |
| | PSSC | | | V | _PSSC_ _ _V | 13.1 | Remove Ag. |
| | PSSC | | | NV | _PSSC_ _ _NV | 13.1 | Retain Natural |
| | PSSC | | | UV4 | _PSSC_ _ _UV4 | 13.1 | Remove Urban Paved |
| | PSSC | | | S1 | _PSSC_ _ _S1 | 13.1 | Retain Check |
| | PSSC | | | S6 | _PSSC_ _ _S6 | 13.1 | Retain Check |
| | PSSC | | | S5 | _PSSC_ _ _S5 | 13.1 | Retain Check |
| | PSSC | | | UR | _PSSC_ _ _UR | 13.1 | Remove Urban Paved |
| | PSSC | | | NR3 | _PSSC_ _ _NR3 | 30 | Retain Natural |
| | PSSC | | | NW | _PSSC_ _ _NW | 13.1 | Retain Natural |
| | PSSC | | Grapes | V | _PSSC_ _Grapes_V | 13.1 | Remove Ag. |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| | PSSC | | Grapes | NV | _PSSC__Grapes_NV | 13.1 | Retain Natural |
| | PSSC | V | Grapes | V | _PSSC_V_Grapes_V | 13.1 | Remove Ag. |
| | PSSC | V | Grapes | S1 | _PSSC_V_Grapes_S1 | 13.1 | Retain Check |
| | PSSC | V | Grapes | S6 | _PSSC_V_Grapes_S6 | 13.1 | Retain Check |
| | PSSC | V | | V | _PSSC_V__V | 13.1 | Remove Ag. |
| | PSSC | V | | NV | _PSSC_V__NV | 13.1 | Retain Natural |
| | PSSC | U | Urban | NR3 | _PSSC_U_Urban NR3 | 30 | Retain Natural |
| | PSSC | U | Urban | NV | _PSSC_U_Urban NV | 13.1 | Retain Natural |
| | PSSC | U | Urban | UI6 | _PSSC_U_Urban UI6 | 13.1 | Remove Urban Paved |
| | PSSC | U | Urban | UV4 | _PSSC_U_Urban UV4 | 13.1 | Remove Urban Paved |
| | PSSC | U | Urban | UV4-K | _PSSC_U_Urban UV4-K | 13.1 | Remove Urban Paved |
| | R2UBH | | | | _R2UBH___ | 4.8 | Retain Natural |
| | R2UBH | | | UL1 | _R2UBH___UL1 | 4.8 | Retain Check |
| | R2UBH | | | NV | _R2UBH___NV | 4.8 | Retain Natural |
| | R2UBH | | | NB1 | _R2UBH___NB1 | 13.1 | Retain Natural |
| | R2UBH | | | NR3 | _R2UBH___NR3 | 30 | Retain Natural |
| | R2UBH | | | UR1 | _R2UBH___UR1 | 4.8 | Remove Urban Paved |
| | R2UBH | | | V | _R2UBH___V | 4.8 | Remove Ag. |
| | R2UBH | | | S6 | _R2UBH___S6 | 4.8 | Retain Check |
| | R2UBH | | | NW | _R2UBH___NW | 4.8 | Retain Natural |
| | R2UBH | | | D6 | _R2UBH___D6 | 4.8 | Remove Ag. |
| | R2UBH | | | UV4-K | _R2UBH___UV4-K | 4.8 | Remove Urban Paved |
| | R2UBH | | | D6-U | _R2UBH___D6-U | 4.8 | Remove Ag. |
| | R2UBH | | | UI3 | _R2UBH___UI3 | 4.8 | Remove Urban Paved |
| | R2UBH | | | UR2 | _R2UBH___UR2 | 4.8 | Remove Urban Paved |
| | R2UBH | | | UI2 | _R2UBH___UI2 | 4.8 | Remove Urban Paved |
| | R2UBH | | | UV1 | _R2UBH___UV1 | 4.8 | Retain Check |
| | R2UBH | | | UV4 | _R2UBH___UV4 | 4.8 | Remove Urban Paved |
| | R2UBH | | | I1 | _R2UBH___I1 | 4.8 | Retain Check |
| | R2UBH | V | | V | _R2UBH_V__V | 4.8 | Remove Ag. |
| | R2UBH | V | | NV | _R2UBH_V__NV | 4.8 | Retain Natural |
| | R2UBH | V | | NR3 | _R2UBH_V__NR3 | 30 | Retain Natural |
| | R2UBH | V | Grapes | V | _R2UBH_V_Grapes_V | 4.8 | Remove Ag. |
| | R2UBH | V | Grapes | NV | _R2UBH_V_Grapes_NV | 4.8 | Retain Natural |
| | R2UBH | D6 | Pears | S6 | _R2UBH_D6_Pears_S6 | 4.8 | Retain Check |
| | R2UBH | D6 | Pears | D6-U | _R2UBH_D6_Pears_D6-U | 4.8 | Remove Ag. |
| | R2UBH | D6 | Pears | NR3 | _R2UBH_D6_Pears_NR3 | 30 | Retain Natural |
| | R2UBH | D6 | Pears | NV | _R2UBH_D6_Pears_NV | 4.8 | Retain Natural |
| | R2UBH | | Grapes | V | _R2UBH__Grapes_V | 4.8 | Remove Ag. |
| | R2UBH | V | Grapes | S6 | _R2UBH_V_Grapes_S6 | 4.8 | Retain Check |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| | R2UBH | U | Urban | UR2 | _R2UBH_U_Urban UR2 | 4.8 | Remove Urban Paved |
| | R2UBH | X | Idle | I1 | _R2UBH_X_Idle_I1 | 4.8 | Retain Check |
| | R2UBH | U | Urban | NW | _R2UBH_U_Urban NW | 4.8 | Retain Natural |
| | R2UBH | U | Urban | NR3 | _R2UBH_U_Urban NR3 | 30 | Retain Natural |
| | R2UBH | U | Urban | NV | _R2UBH_U_Urban NV | 4.8 | Retain Natural |
| | R2USC | | | NB1 | _R2USC___NB1 | 13.1 | Retain Natural |
| | R2USC | | | NV | _R2USC___NV | 30 | Retain Natural |
| | R2USC | | | NR3 | _R2USC___NR3 | 30 | Retain Natural |
| | R2USC | | | NW | _R2USC___NW | 30 | Retain Natural |
| | R2USC | | | V | _R2USC___V | 30 | Remove Ag. |
| | R2USC | | | UV4 | _R2USC___UV4 | 30 | Remove Urban Paved |
| | R2USC | | | UI2 | _R2USC___UI2 | 30 | Remove Urban Paved |
| | R2USC | V | | V | _R2USC_V__V | 30 | Remove Ag. |
| | R2USC | V | | NV | _R2USC_V__NV | 30 | Retain Natural |
| | R2USC | V | | NR3 | _R2USC_V__NR3 | 30 | Retain Natural |
| | R3UBH | | | | _R3UBH___ | 4.8 | Retain Natural |
| | R3UBH | | | V | _R3UBH___V | 4.8 | Remove Ag. |
| | R3UBH | | | C6 | _R3UBH___C6 | 4.8 | Remove Ag. |
| | R3UBH | | | NV | _R3UBH___NV | 4.8 | Retain Natural |
| | R3UBH | | | UV4 | _R3UBH___UV4 | 4.8 | Remove Urban Paved |
| | R3UBH | | | UI11 | _R3UBH___UI11 | 4.8 | Remove Urban Paved |
| | R3UBH | | | S6 | _R3UBH___S6 | 4.8 | Retain Check |
| | R3UBH | | | NB1 | _R3UBH___NB1 | 13.1 | Retain Natural |
| | R3UBH | | | NW | _R3UBH___NW | 4.8 | Retain Natural |
| | R3UBH | | | NR3 | _R3UBH___NR3 | 30 | Retain Natural |
| | R3UBH | | | UR | _R3UBH___UR | 4.8 | Remove Urban Paved |
| | R3UBH | | | UC | _R3UBH___UC | 4.8 | Remove Urban Paved |
| | R3UBH | | | UI6 | _R3UBH___UI6 | 4.8 | Remove Urban Paved |
| | R3UBH | V | Grapes | V | _R3UBH_V_Grapes_V | 4.8 | Remove Ag. |
| | R3UBH | U | Urban | UR | _R3UBH_U_Urban UR | 4.8 | Remove Urban Paved |
| | R3UBH | U | Urban | NV | _R3UBH_U_Urban NV | 4.8 | Retain Natural |
| | R3UBH | U | Urban | UV4 | _R3UBH_U_Urban UV4 | 4.8 | Remove Urban Paved |
| | R3UBH | U | Urban | UC | _R3UBH_U_Urban UC | 4.8 | Remove Urban Paved |
| | R3UBH | U | | NB1 | _R3UBH_U__NB1 | 13.1 | Retain Natural |
| | R3UBH | U | | NW | _R3UBH_U__NW | 4.8 | Retain Natural |
| | R3UBH | U | | NR3 | _R3UBH_U__NR3 | 30 | Retain Natural |
| | R3UBH | U | | NV | _R3UBH_U__NV | 4.8 | Retain Natural |
| | R3UBH | U | Urban | NB1 | _R3UBH_U_Urban NB1 | 13.1 | Retain Natural |
| | R3UBH | U | Urban | NR3 | _R3UBH_U_Urban NR3 | 30 | Retain Natural |
| | R3UBH | U | Urban | UI6 | _R3UBH_U_Urban UI6 | 4.8 | Remove Urban Paved |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| | R3USC | | | NB1 | _R3USC_ _ _NB1 | 13.1 | Retain Natural |
| | R3USC | | | NW | _R3USC_ _ _NW | 30 | Retain Natural |
| | R3USC | | | NV | _R3USC_ _ _NV | 30 | Retain Natural |
| | R3USC | U | | NR3 | _R3USC_U_ _NR3 | 30 | Retain Natural |
| | R3USC | U | | NV | _R3USC_U_ _NV | 30 | Retain Natural |
| | R3USC | U | | V | _R3USC_U_ _V | 30 | Remove Ag. |
| | R3USC | U | | S6 | _R3USC_U_ _S6 | 30 | Retain Check |
| | R3USC | U | Urban | NW | _R3USC_U_Urban NW | 30 | Retain Natural |
| | R3USC | U | Urban | UC1 | _R3USC_U_Urban UC1 | 30 | Remove Urban Paved |
| | R3USC | U | Urban | NR3 | _R3USC_U_Urban NR3 | 30 | Retain Natural |
| | R3USC | U | Urban | NV | _R3USC_U_Urban NV | 30 | Retain Natural |
| | R3USC | U | Urban | UV4-K | _R3USC_U_Urban UV4-K | 30 | Remove Urban Paved |
| | R3USC | U | Urban | UV4 | _R3USC_U_Urban UV4 | 30 | Remove Urban Paved |
| | R5UBF | | | | _R5UBF_ _ _ | 4.8 | Retain Natural |
| | R5UBF | | | NW | _R5UBF_ _ _NW | 4.8 | Retain Natural |
| | R5UBF | | | NR3 | _R5UBF_ _ _NR3 | 30 | Retain Natural |
| | R5UBF | | | NB1 | _R5UBF_ _ _NB1 | 13.1 | Retain Natural |
| | R5UBF | | | NV | _R5UBF_ _ _NV | 4.8 | Retain Natural |
| | R5UBF | | | S6 | _R5UBF_ _ _S6 | 4.8 | Retain Check |
| | R5UBF | | | I1 | _R5UBF_ _ _I1 | 4.8 | Retain Check |
| | R5UBF | | | V | _R5UBF_ _ _V | 4.8 | Remove Ag. |
| | R5UBF | | | S1 | _R5UBF_ _ _S1 | 4.8 | Retain Check |
| | R5UBF | | | D6 | _R5UBF_ _ _D6 | 4.8 | Remove Ag. |
| | R5UBF | | | V-Y | _R5UBF_ _ _V-Y | 4.8 | Remove Ag. |
| | R5UBF | | | UV4 | _R5UBF_ _ _UV4 | 4.8 | Remove Urban Paved |
| | R5UBF | | | UI2 | _R5UBF_ _ _UI2 | 4.8 | Remove Urban Paved |
| | R5UBF | | | UI3 | _R5UBF_ _ _UI3 | 4.8 | Remove Urban Paved |
| | R5UBF | | | S5 | _R5UBF_ _ _S5 | 4.8 | Retain Check |
| | R5UBF | X | | I1 | _R5UBF_X_ _I1 | 4.8 | Retain Check |
| | R5UBF | X | | NV | _R5UBF_X_ _NV | 4.8 | Retain Natural |
| | R5UBF | U | Urban | NR3 | _R5UBF_U_Urban NR3 | 30 | Retain Natural |
| | R5UBF | U | Urban | NW | _R5UBF_U_Urban NW | 4.8 | Retain Natural |
| | R5UBF | U | Urban | NB1 | _R5UBF_U_Urban NB1 | 13.1 | Retain Natural |
| | R5UBF | U | Urban | NV | _R5UBF_U_Urban NV | 4.8 | Retain Natural |
| Fremont Cottonwood | | | | | Fremont Cottonwood_ _ _ _ | 30 | Retain Natural |
| Fremont Cottonwood | | | | NV | Fremont Cottonwood_ _ _ _NV | 30 | Retain Natural |
| Fremont Cottonwood | | | | NW | Fremont Cottonwood_ _ _ _NW | 30 | Retain Natural |
| Fremont Cottonwood | | | | NR3 | Fremont Cottonwood_ _ _ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | | | | NB1 | Fremont Cottonwood_ _ _ _NB1 | 13.1 | Retain Natural |
| Fremont Cottonwood | | | | UV4 | Fremont Cottonwood_ _ _ _UV4 | 30 | Remove Urban Paved |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| Fremont Cottonwood | | | | S1 | Fremont Cottonwood_ _ _S1 | 30 | Retain Check |
| Fremont Cottonwood | | | | V | Fremont Cottonwood_ _ _V | 30 | Remove Ag. |
| Fremont Cottonwood | | | | S5 | Fremont Cottonwood_ _ _S5 | 30 | Retain Check |
| Fremont Cottonwood | | | | S6 | Fremont Cottonwood_ _ _S6 | 30 | Retain Check |
| Fremont Cottonwood | | | | D-Y | Fremont Cottonwood_ _ _D-Y | 30 | Remove Ag. |
| Fremont Cottonwood | | | | V-Y | Fremont Cottonwood_ _ _V-Y | 30 | Remove Ag. |
| Fremont Cottonwood | | | | I1 | Fremont Cottonwood_ _ _I1 | 30 | Retain Check |
| Fremont Cottonwood | | U | Urban | NV | Fremont Cottonwood_ _U_Urban NV | 30 | Retain Natural |
| Fremont Cottonwood | | U | Urban | NW | Fremont Cottonwood_ _U_Urban NW | 30 | Retain Natural |
| Fremont Cottonwood | | U | Urban | UR2 | Fremont Cottonwood_ _U_Urban UR2 | 30 | Remove Urban Paved |
| Fremont Cottonwood | | V | | V | Fremont Cottonwood_ _V_ _V | 30 | Remove Ag. |
| Fremont Cottonwood | | V | Grapes | V | Fremont Cottonwood_ _V_Grapes_V | 30 | Remove Ag. |
| Fremont Cottonwood | | V | Grapes | NV | Fremont Cottonwood_ _V_Grapes_NV | 30 | Retain Natural |
| Fremont Cottonwood | | V | Grapes | S6 | Fremont Cottonwood_ _V_Grapes_S6 | 30 | Retain Check |
| Fremont Cottonwood | | V | Grapes | NR3 | Fremont Cottonwood_ _V_Grapes_NR3 | 30 | Retain Natural |
| Fremont Cottonwood | | X | | V | Fremont Cottonwood_ _X_ _V | 30 | Remove Ag. |
| Fremont Cottonwood | | X | | NR3 | Fremont Cottonwood_ _X_ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | | X | Grapes | V | Fremont Cottonwood_ _X_Grapes_V | 30 | Remove Ag. |
| Fremont Cottonwood | | V | | V-Y | Fremont Cottonwood_ _V_ _V-Y | 30 | Remove Ag. |
| Fremont Cottonwood | | V | | NV | Fremont Cottonwood_ _V_ _NV | 30 | Retain Natural |
| Fremont Cottonwood | | V | Grapes | I1 | Fremont Cottonwood_ _V_Grapes_I1 | 30 | Retain Check |
| Fremont Cottonwood | PFOC | | | NB1 | Fremont Cottonwood_PFOC_ _ _NB1 | 13.1 | Retain Natural |
| Fremont Cottonwood | PFOC | | | V | Fremont Cottonwood_PFOC_ _ _V | 30 | Remove Ag. |
| Fremont Cottonwood | PFOC | | | NV | Fremont Cottonwood_PFOC_ _ _NV | 30 | Retain Natural |
| Fremont Cottonwood | PFOC | | | NR3 | Fremont Cottonwood_PFOC_ _ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | PFOC | | | NW | Fremont Cottonwood_PFOC_ _ _NW | 30 | Retain Natural |
| Fremont Cottonwood | PFOC | X | | V | Fremont Cottonwood_PFOC_X_ _V | 30 | Remove Ag. |
| Fremont Cottonwood | PFOC | X | | NR3 | Fremont Cottonwood_PFOC_X_ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | R2UBH | | | | Fremont Cottonwood_R2UBH_ _ _ | 30 | Retain Natural |
| Fremont Cottonwood | R2UBH | | | NR3 | Fremont Cottonwood_R2UBH_ _ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | R2UBH | | | NW | Fremont Cottonwood_R2UBH_ _ _NW | 30 | Retain Natural |
| Fremont Cottonwood | R2UBH | | | NB1 | Fremont Cottonwood_R2UBH_ _ _NB1 | 13.1 | Retain Natural |
| Fremont Cottonwood | R2UBH | | | NV | Fremont Cottonwood_R2UBH_ _ _NV | 30 | Retain Natural |
| Fremont Cottonwood | R2UBH | | | V | Fremont Cottonwood_R2UBH_ _ _V | 30 | Remove Ag. |
| Fremont Cottonwood | R2UBH | V | | NV | Fremont Cottonwood_R2UBH_V_ _NV | 30 | Retain Natural |
| Fremont Cottonwood | R2USC | | | NV | Fremont Cottonwood_R2USC_ _ _NV | 30 | Retain Natural |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| Fremont Cottonwood | R2USC | | | NR3 | Fremont Cottonwood_R2USC_ _ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | R2USC | | | NW | Fremont Cottonwood_R2USC_ _ _NW | 30 | Retain Natural |
| Fremont Cottonwood | R3UBH | | | NB1 | Fremont Cottonwood_R3UBH_ _ _NB1 | 13.1 | Retain Natural |
| Fremont Cottonwood | R3UBH | | | NR3 | Fremont Cottonwood_R3UBH_ _ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | R5UBF | | | NB1 | Fremont Cottonwood_R5UBF_ _ _NB1 | 13.1 | Retain Natural |
| Fremont Cottonwood | R5UBF | | | NR3 | Fremont Cottonwood_R5UBF_ _ _NR3 | 30 | Retain Natural |
| Fremont Cottonwood | R5UBF | | | NW | Fremont Cottonwood_R5UBF_ _ _NW | 30 | Retain Natural |
| Riparian Mixed Hardwood | | | | V | Riparian Mixed Hardwood_ _ _ _V | 30 | Remove Ag. |
| Riparian Mixed Hardwood | | | | NV | Riparian Mixed Hardwood_ _ _ _NV | 30 | Retain Natural |
| Riparian Mixed Hardwood | | | | S1 | Riparian Mixed Hardwood_ _ _ _S1 | 30 | Retain Check |
| Riparian Mixed Hardwood | | | | S5 | Riparian Mixed Hardwood_ _ _ _S5 | 30 | Retain Check |
| Riparian Mixed Hardwood | | | | NR3 | Riparian Mixed Hardwood_ _ _ _NR3 | 30 | Retain Natural |
| Riparian Mixed Hardwood | | V | | V | Riparian Mixed Hardwood_ _V_ _V | 30 | Remove Ag. |
| Riparian Mixed Hardwood | | V | | NV | Riparian Mixed Hardwood_ _V_ _NV | 30 | Retain Natural |
| Riparian Mixed Hardwood | | | Grapes | V | Riparian Mixed Hardwood_ _ _Grapes_V | 30 | Remove Ag. |
| Riparian Mixed Hardwood | | V | Grapes | V | Riparian Mixed Hardwood_ _V_Grapes_V | 30 | Remove Ag. |
| Riparian Mixed Hardwood | | V | Grapes | NV | Riparian Mixed Hardwood_ _V_Grapes_NV | 30 | Retain Natural |
| Riparian Mixed Hardwood | | V | Grapes | NR3 | Riparian Mixed Hardwood_ _V_Grapes_NR3 | 30 | Retain Natural |
| Riparian Mixed Hardwood | | V | Grapes | S1 | Riparian Mixed Hardwood_ _V_Grapes_S1 | 30 | Retain Check |
| Willow - Alder | | | | | Willow - Alder_ _ _ | 13.1 | Retain Natural |
| Willow - Alder | | | | NR3 | Willow - Alder_ _ _ _NR3 | 30 | Retain Natural |
| Willow - Alder | | | | NW | Willow - Alder_ _ _ _NW | 13.1 | Retain Natural |
| Willow - Alder | | | | NV | Willow - Alder_ _ _ _NV | 13.1 | Retain Natural |
| Willow - Alder | | | | NB1 | Willow - Alder_ _ _ _NB1 | 13.1 | Retain Natural |
| Willow - Alder | | | | D6-X | Willow - Alder_ _ _ _D6-X | 13.1 | Remove Ag. |
| Willow - Alder | | | | UI | Willow - Alder_ _ _ _UI | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | UV4 | Willow - Alder_ _ _ _UV4 | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | S1 | Willow - Alder_ _ _ _S1 | 13.1 | Retain Check |
| Willow - Alder | | | | V | Willow - Alder_ _ _ _V | 13.1 | Remove Ag. |
| Willow - Alder | | | | I1 | Willow - Alder_ _ _ _I1 | 13.1 | Retain Check |
| Willow - Alder | | | | UR | Willow - Alder_ _ _ _UR | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | UR2 | Willow - Alder_ _ _ _UR2 | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | UL1 | Willow - Alder_ _ _ _UL1 | 13.1 | Retain Check |
| Willow - Alder | | | | U | Willow - Alder_ _ _ _U | 13.1 | Remove Urban Paved |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| Willow - Alder | | | | UI3 | Willow - Alder___UI3 | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | UI2 | Willow - Alder___UI2 | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | nF-F | Willow - Alder___nF-F | 13.1 | Retain Natural |
| Willow - Alder | | | | UV3 | Willow - Alder___UV3 | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | S6 | Willow - Alder___S6 | 13.1 | Retain Check |
| Willow - Alder | | | | D6 | Willow - Alder___D6 | 13.1 | Remove Ag. |
| Willow - Alder | | | | V-U | Willow - Alder___V-U | 13.1 | Remove Ag. |
| Willow - Alder | | | | S5 | Willow - Alder___S5 | 13.1 | Retain Check |
| Willow - Alder | | | | V-F | Willow - Alder___V-F | 13.1 | Remove Ag. |
| Willow - Alder | | | | D-Y | Willow - Alder___D-Y | 13.1 | Remove Ag. |
| Willow - Alder | | | | UR1 | Willow - Alder___UR1 | 13.1 | Remove Urban Paved |
| Willow - Alder | | | | V-Y | Willow - Alder___V-Y | 13.1 | Remove Ag. |
| Willow - Alder | | V | Grapes | NV | Willow - Alder__V_Grapes_NV | 13.1 | Retain Natural |
| Willow - Alder | | U | Urban | UI | Willow - Alder__U_Urban UI | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | UL1 | Willow - Alder__U_Urban UL1 | 13.1 | Retain Check |
| Willow - Alder | | U | Urban | UV4 | Willow - Alder__U_Urban UV4 | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | NV | Willow - Alder__U_Urban NV | 13.1 | Retain Natural |
| Willow - Alder | | U | Urban | NR3 | Willow - Alder__U_Urban NR3 | 30 | Retain Natural |
| Willow - Alder | | X | | NV | Willow - Alder__X__NV | 13.1 | Retain Natural |
| Willow - Alder | | U | Urban | UR2 | Willow - Alder__U_Urban UR2 | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | NW | Willow - Alder__U_Urban NW | 13.1 | Retain Natural |
| Willow - Alder | | U | Urban | UR | Willow - Alder__U_Urban UR | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | NB1 | Willow - Alder__U_Urban NB1 | 13.1 | Retain Natural |
| Willow - Alder | | U | Urban | U | Willow - Alder__U_Urban U | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | UR4 | Willow - Alder__U_Urban UR4 | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | UC | Willow - Alder__U_Urban UC | 13.1 | Remove Urban Paved |
| Willow - Alder | | V | Grapes | V | Willow - Alder__V_Grapes_V | 13.1 | Remove Ag. |
| Willow - Alder | | | Urban | NV | Willow - Alder___Urban NV | 13.1 | Retain Natural |
| Willow - Alder | | | Urban | P3 | Willow - Alder___Urban P3 | 13.1 | Retain Check |
| Willow - Alder | | | Urban | S1 | Willow - Alder___Urban S1 | 13.1 | Retain Check |
| Willow - Alder | | | Urban | V | Willow - Alder___Urban V | 13.1 | Remove Ag. |
| Willow - Alder | | | Urban | NR3 | Willow - Alder___Urban NR3 | 30 | Retain Natural |
| Willow - Alder | | | Urban | UC | Willow - Alder___Urban UC | 13.1 | Remove Urban Paved |
| Willow - Alder | | | Urban | UV4 | Willow - Alder___Urban UV4 | 13.1 | Remove Urban Paved |
| Willow - Alder | | U | Urban | UV3 | Willow - Alder__U_Urban UV3 | 13.1 | Remove Urban Paved |
| Willow - Alder | | V | Grapes | S6 | Willow - Alder__V_Grapes_S6 | 13.1 | Retain Check |
| Willow - Alder | | V | Grapes | S1 | Willow - Alder__V_Grapes_S1 | 13.1 | Retain Check |
| Willow - Alder | | D6 | Pears | D6 | Willow - Alder__D6_Pears_D6 | 13.1 | Remove Ag. |
| Willow - Alder | | D6 | Pears | NV | Willow - Alder__D6_Pears_NV | 13.1 | Retain Natural |
| Willow - Alder | | X | Idle | V | Willow - Alder__X_Idle_V | 13.1 | Remove Ag. |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| Willow - Alder | | X | Idle | S6 | Willow - Alder__X_Idle_S6 | 13.1 | Retain Check |
| Willow - Alder | | P3 | | NV | Willow - Alder__P3__NV | 13.1 | Retain Natural |
| Willow - Alder | | D6 | Pears | S6 | Willow - Alder__D6_Pears_S6 | 13.1 | Retain Check |
| Willow - Alder | | V | | V-U | Willow - Alder__V__V-U | 13.1 | Remove Ag. |
| Willow - Alder | | V | | NV | Willow - Alder__V__NV | 13.1 | Retain Natural |
| Willow - Alder | | V | | V | Willow - Alder__V__V | 13.1 | Remove Ag. |
| Willow - Alder | | X | | S5 | Willow - Alder__X__S5 | 13.1 | Retain Check |
| Willow - Alder | | X | | V-F | Willow - Alder__X__V-F | 13.1 | Remove Ag. |
| Willow - Alder | | | Grapes | V | Willow - Alder___Grapes_V | 13.1 | Remove Ag. |
| Willow - Alder | | | Grapes | NV | Willow - Alder___Grapes_NV | 13.1 | Retain Natural |
| Willow - Alder | | V | Grapes | V-U | Willow - Alder__V_Grapes_V-U | 13.1 | Remove Ag. |
| Willow - Alder | | D10 | | D-Y | Willow - Alder__D10__D-Y | 13.1 | Remove Ag. |
| Willow - Alder | | D10 | | NV | Willow - Alder__D10__NV | 13.1 | Retain Natural |
| Willow - Alder | | | Miscellaneous Deciduous | D-Y | Willow - Alder___Miscellaneous Deciduous_D-Y | 13.1 | Remove Ag. |
| Willow - Alder | | | Miscellaneous Deciduous | NV | Willow - Alder___Miscellaneous Deciduous_NV | 13.1 | Retain Natural |
| Willow - Alder | | D10 | Miscellaneous Deciduous | D-Y | Willow - Alder__D10_Miscellaneous Deciduous_D-Y | 13.1 | Remove Ag. |
| Willow - Alder | | D10 | Miscellaneous Deciduous | NV | Willow - Alder__D10_Miscellaneous Deciduous_NV | 13.1 | Retain Natural |
| Willow - Alder | | V | Grapes | NR3 | Willow - Alder__V_Grapes_NR3 | 30 | Retain Natural |
| Willow - Alder | | V | | S6 | Willow - Alder__V__S6 | 13.1 | Retain Check |
| Willow - Alder | | D6 | Pears | NR3 | Willow - Alder__D6_Pears_NR3 | 30 | Retain Natural |
| Willow - Alder | PFOC | | | NR3 | Willow - Alder_PFOC___NR3 | 30 | Retain Natural |
| Willow - Alder | PFOC | | | NW | Willow - Alder_PFOC___NW | 13.1 | Retain Natural |
| Willow - Alder | PFOC | | | NV | Willow - Alder_PFOC___NV | 13.1 | Retain Natural |
| Willow - Alder | PFOC | | | D6 | Willow - Alder_PFOC___D6 | 13.1 | Remove Ag. |
| Willow - Alder | PFOC | | | S6 | Willow - Alder_PFOC___S6 | 13.1 | Retain Check |
| Willow - Alder | PFOC | | | NB1 | Willow - Alder_PFOC___NB1 | 13.1 | Retain Natural |
| Willow - Alder | PFOC | D6 | Pears | D6 | Willow - Alder_PFOC_D6_Pears_D6 | 13.1 | Remove Ag. |
| Willow - Alder | PFOC | D6 | Pears | S6 | Willow - Alder_PFOC_D6_Pears_S6 | 13.1 | Retain Check |
| Willow - Alder | R2UBH | | | NR3 | Willow - Alder_R2UBH___NR3 | 30 | Retain Natural |
| Willow - Alder | R2UBH | | | NW | Willow - Alder_R2UBH___NW | 13.1 | Retain Natural |
| Willow - Alder | R2UBH | | | NB1 | Willow - Alder_R2UBH___NB1 | 13.1 | Retain Natural |
| Willow - Alder | R2UBH | | | NV | Willow - Alder_R2UBH___NV | 13.1 | Retain Natural |
| Willow - Alder | R2UBH | | | I1 | Willow - Alder_R2UBH___I1 | 13.1 | Retain Check |
| Willow - Alder | R2UBH | | | V | Willow - Alder_R2UBH___V | 13.1 | Remove Ag. |
| Willow - Alder | R2UBH | | | D6 | Willow - Alder_R2UBH___D6 | 13.1 | Remove Ag. |
| Willow - Alder | R2UBH | | | S6 | Willow - Alder_R2UBH___S6 | 13.1 | Retain Check |
| Willow - Alder | R2UBH | U | Urban | NW | Willow - Alder_R2UBH_U_Urban NW | 13.1 | Retain Natural |

| VEGETATION | ORIGINAL_C | CROPTYP2_2016 | Crop2014 | LABEL_2010 | join_field[1] | Assumed Rooting Depth (ft.) | Possible Action |
|---|---|---|---|---|---|---|---|
| Willow - Alder | R2UBH | U | Urban | NR3 | Willow - Alder_R2UBH_U_Urban NR3 | 30 | Retain Natural |
| Willow - Alder | R2UBH | V | Grapes | NR3 | Willow - Alder_R2UBH_V_Grapes_NR3 | 30 | Retain Natural |
| Willow - Alder | R2USC | | | NR3 | Willow - Alder_R2USC_ _ _NR3 | 30 | Retain Natural |
| Willow - Alder | R2USC | | | NV | Willow - Alder_R2USC_ _ _NV | 13.1 | Retain Natural |
| Willow - Alder | R2USC | | | NW | Willow - Alder_R2USC_ _ _NW | 13.1 | Retain Natural |
| Willow - Alder | R2USC | | | NB1 | Willow - Alder_R2USC_ _ _NB1 | 13.1 | Retain Natural |
| Willow - Alder | R5UBF | | | NB1 | Willow - Alder_R5UBF_ _ _NB1 | 13.1 | Retain Natural |
| Willow - Alder | R5UBF | | | NW | Willow - Alder_R5UBF_ _ _NW | 13.1 | Retain Natural |
| Willow - Alder | R5UBF | | | NR3 | Willow - Alder_R5UBF_ _ _NR3 | 30 | Retain Natural |
| | | | | NB1 | _ _ _ _NB1 | 13.1 | Retain Natural |
| | | | | NR3 | _ _ _ _NR3 | 30 | Retain Natural |
| | | | | NW | _ _ _ _NW | 13.1 | Retain Natural |

[1]The order of the spatial join used to produce the "join_field" is 1) NC vegetation dataset, 2) NC wetlands dataset, 3) DWR 2016 land use/land cover, 4) DWR 2014 land use/land cover, and 5) DWR 2010 land use/land cover. Underscores ("_") represent fields without values.

# Appendix 3-A Shallow Well Protection Memorandum

# Vulnerable Well Impact Analysis in the Ukiah Valley Basin: Well Inventory, Historical Groundwater Trends, and Analysis to Inform Sustainable Management Criteria

Larry Walker Associates

2021-07-21

# Table of Contents

# 1. Executive Summary

Groundwater planning under the Sustainable Groundwater Management Act (SGMA) aims to curb the chronic lowering of groundwater levels, which may impact shallow, vulnerable wells and cause dewatering or failure. Domestic, agricultural, and public wells are beneficial uses of groundwater identified by stakeholders in the Ukiah Valley Basin (UVB) groundwater sustainability plan (GSP) working group. Out of these three beneficial user categories domestic wells have been identified as the most vulnerable group to lowering groundwater levels. In general, the depth of wells in UVB is relatively stable with a minimal amount of critically shallow wells identified. Wells that are identified as the shallowest are also the most likely to be in old age on near the retirement threshold. Residents and water users in the UVB that rely on drinking water obtained from private domestic wells are considered beneficial users of groundwater. The GSP aims to avoid chronic groundwater level decline that leads to significant and unreasonable impacts to vulnerable wells that hamper access to water for drinking, irrigation, and municipal use.

Although wells in the UVB provide beneficial uses of groundwater, the UVB lacks a comprehensive historical well census (i.e., inventory) and understanding of how sustainable management criteria (SMC) may impact vulnerable wells in the UVB. These knowledge gaps motivate this memorandum, which aims to provide a well inventory based on best available data, and well protection analysis to inform critical decision-making in support of unstainable groundwater management in the UVB.

Herein, we assess potential impacts to vulnerable wells that may result during the SGMA planning and implementation period (2022-2042). First, we take inventory of wells in the UVB using publicly available, digitized well completion reports to describe the location and depths of different types of wells (e.g., domestic, public, agricultural). Next, we analyze historical groundwater elevation trends in the UVB from Spring 2014 to Fall 2018, where the groundwater level data density is adequate for interpolation. Then, we combine well construction data and modeled groundwater levels to assess the count and location of impacted wells assuming different groundwater level scenarios (i.e., a return to the fall 2016 low, 10 ft below Fall 2016 levels, and 20 ft below Fall 2016 levels). Finally, we estimate costs to rehabilitate impacted wells and advance recommended sustainable management criteria that mitigate impacts to vulnerable wells.

Results suggest that the most common well types with direct beneficial uses are domestic (n = 644), agricultural (n = 79), and public (n = 16) wells[1], although the actual number of "active" wells today is likely less due to ageing and well retirement. Assuming 31-to-40-year retirement ages (based on Pauloo et al, 2020), and that wells with pumps above initial groundwater level conditions are inactive, the number of

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[1] At the time of writing, these are the well counts provided by the online well completion report database. Note that public wells are "municipal" wells, and domestic wells are private residential wells.

assumed active wells in the UVB is much lower: domestic (n = 282 - 343), agricultural (n = 15 - 19), and public (n = 6 - 10). An ongoing well "census" would supersede this data, but in its absence, this approach provides a reasonable approximation of the count and location of active wells.

During fall of 2016, groundwater levels were at a low level in the UVB after four consecutive years of drought and excess pumping to augment lost surface water supply. Data from the DWR and Cal OPR suggests that during this time, no wells in the UVB were reported dry, in contrast to more than two thousand wells reported dry across California (Pauloo et al, 2020)[2]. Thus, a return to Fall 2016 groundwater level lows is unlikely to result in catastrophic and widespread well impacts, which we confirm via modeling described in this memorandum.

Working group input indicated significant and undesirable results to include 5% or more of impacted wells of any type (domestic, agricultural, public). Thus, well impact analysis under projected groundwater level conditions was evaluated to assess impacts assuming a return to historic Fall 2016 lows, and projected groundwater management and climate change scenarios.

Well protection analysis informed the creation of minimum thresholds (MTs) which avoid significant and unreasonable impacts to wells in the basin. Well rehabilitation costs for impacted wells over the implementation horizon, assuming all MTs are reached at all representative monitoring points (RMPs), were estimated at around $130,000 - $230,000 following the cost structure of Pauloo et al. (2021), EKI (2020), and Gailey (2019), but would likely be less, as significant and unreasonable impacts occur when one third of RMPs exceed MTs.

Possible well protection measures may include a combination of regional groundwater supply and demand management (e.g., managed aquifer recharge and pumping curtailments that increase or maintain groundwater levels); well protection funds to internalize well refurbishment and replacement costs, domestic supply management, (e.g., connecting rural households to more reliable municipal water systems); and proactive community-based monitoring that acts as an early warning system to anticipate impacts at the level of individual wells.

# 2. Introduction

Around 1.2 million Californians depend on private domestic wells for drinking water,16.6% of which live in Northern Coast Ranges (Johnson and Belitz 2015). Even fewer reside in the Ukiah Valley Basin (UVB), and these wells tend to be in mixed agricultural-residential land. Private domestic wells are more numerous than other types of wells (e.g., public or agricultural), and tend to be shallower and have smaller pumping

[2] Outage data analyzed by Pauloo et al (2020) was provided via an agreement between Cal OPR and the authors, but has since been released by the DWR at MyDryWaterSupply: https://mydrywatersupply.water.ca.gov/report/publicpage.

capacities, which makes them more vulnerable to groundwater level decline (Theis 1935; Theis 1940; Sophocleous 2020; Greene 2020; Perrone and Jasechko 2019). During previous droughts in California, increased demand for water has led to well drilling and groundwater pumping to replace lost surface water supplies (Hanak et al 2011; Medell n-Azuara et al 2016). Increased pumping lowers groundwater levels and may partially dewater wells or cause them to go dry (fail) altogether. However, zero dry wells were reported in the UVB, which suggests a combination of relatively stable groundwater levels and more favorable well construction properties (e.g., deeper wells and pump locations). Moreover, this observation implies that a return to 2016 low groundwater levels is unlikely to cause widespread and catastrophic well failure in the UVB.

Until recently, few solutions and data products existed that addressed the vulnerability of shallow wells to drought and unsustainable groundwater management (Mitchell et al. 2017; Feinstein et al. 2017). A lack of well failure research and modeling approaches can largely be attributed to the fact that well location and construction data (well completion reports, or WCRs) were only made public in 2017. Released digitized WCRs span over one hundred years in California drilling history and informed the first estimates of domestic well spatial distribution and count in the state (Johnson and Belitz 2015; Johnson and Belitz 2017). Since then, these WCRs, provided in the California Online State Well Completion Report Database (CA-DWR 2018), have been used to estimate failing well locations and counts (Perrone and Jasechko 2017), and domestic well water supply interruptions during the 2012–2016 drought due to over pumping and the costs to replenish lost domestic water well supplies (Gailey et al 2019). A regional aquifer scale domestic well failure model for the Ukiah Valley was developed by Pauloo et al (2020) that simulated the impact of drought and various groundwater management regimes on domestic well failure.

California's snowpack is forecasted to decline by as much as 79.3% by the year 2100 (Rhoades et al 2018). For California it is estimated that the risk of decadelong megadrought this century is at least 80%, and the risk of drought of up to 35 years in length is as much as 50% (Ullrich et al 2018). A drier and warmer climate (Diffenbaugh 2015; Cook 2015) with more frequent heat waves and extended droughts (Tebaldi et al 2006; Lobell et al 2011) will coincide with urban development and population growth, land use change, conjunctive use projects, and implementation of the Sustainable Groundwater Management Act (SGMA 2014), in which groundwater sustainability plans (GSPs) will specify groundwater level minimum thresholds (MTs) that among other outcomes, protect vulnerable wells.

In this technical memorandum, we analyze how projected hydrologic conditions, projects and management actions (PMA), and climate change may impact vulnerable wells in the UVB. In Section 3, the methodology is explained, followed by the results in Section 4, and a discussion of the results in terms of how they impact sustainable groundwater management in Section 5. This memorandum closes with a discussion of future actions and SGMA management recommendations.

## 3. Methods

Groundwater level analysis and interpolation and stakeholder input were used to evaluate the impact of historically observed groundwater conditions on well failure (i.e., domestic, agricultural, and public wells). Groundwater levels are measured twice a year for the majority of CASGEM wells including wells monitored by DWR. These measurements are normally taken during the Fall (October- November) and Spring seasons (April-May), corresponding to low and high groundwater levels, respectively. CASGEM data from the Spring 2014 to Fall 2018 period was analyzed at a seasonal level and used to define MTs and assess impacts. Wherever possible, the MT is set as the average of the three lowest (Fall season) historical measurements on record (or the lowest if a short historical record exists) for depth to groundwater taken during drought periods. A well specific margin, not exceeding the minimum of 10% or 10 ft, is further added to the MT to account for uncertainty in measuring annual low groundwater levels.

A map of the average groundwater depth below the land surface generated using monitoring well locations is presented in **Figure 1** below. The black points on the map represent the location of the monitoring points.

### 3.1 Groundwater level

The data suggest that the depth to groundwater in some locations is 300 feet or greater, but mostly the range falls within 50 feet from the land surface. A higher depth to groundwater is estimated at higher elevations where monitoring points are sparse. It should be noted that groundwater levels are better represented with higher certainty for the valley floor due to adequate spatial coverage with monitoring points. The map in **Figure 1** can be considered the best available representation until further data collection is conducted.

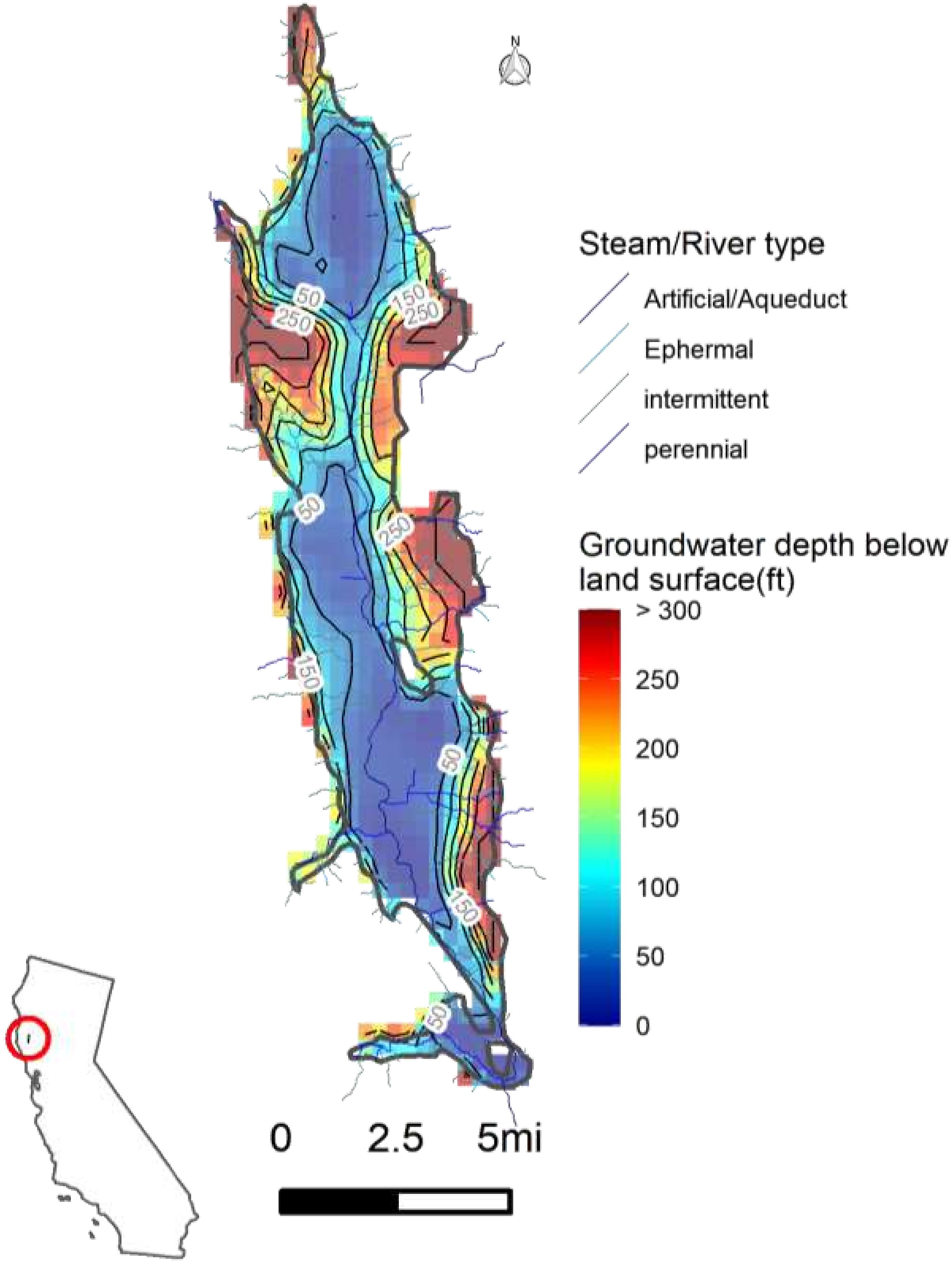


*Figure 1. Average groundwater depth below land surface, 2015-2019.*

The average groundwater depth below the land surface of 50 feet, which is the approximate depth to groundwater in the lowland regions, is compared to the representative well depths in the public, agricultural, and domestic wells in **Figure 2** below. The interquartile range of all well types safely fall outside of this zone, so we would expect that most wells would not fail based on long term average conditions.

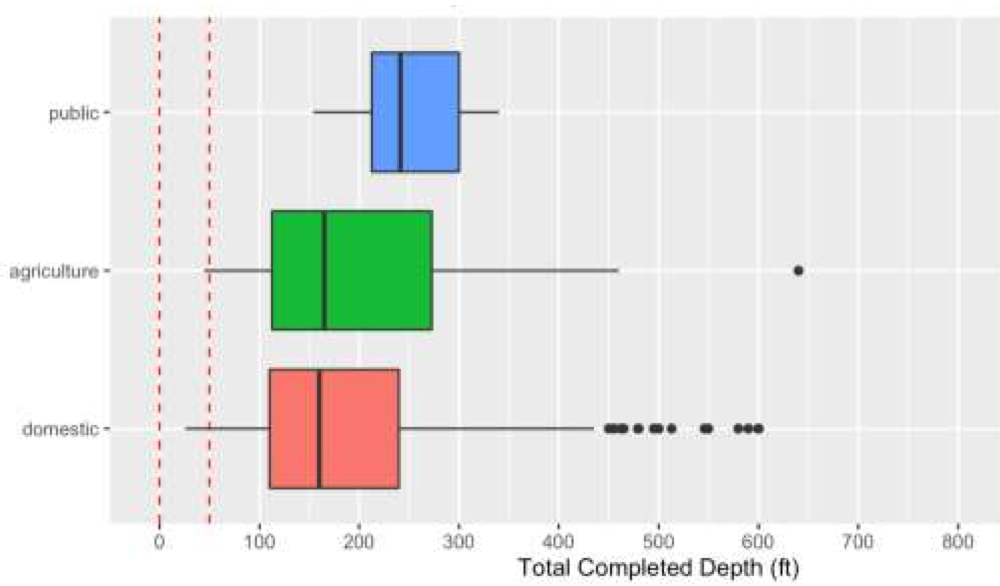


*Figure 2. Box plot representation of well depth (ft) for public (blue), agricultural (green), and domestic (red) well categories. The red dashed lines represent the approximate range of depth to groundwater in the lowland regions*

## 3.2 Well Completion Reports (WCRs)

Well Completion Reports (CA-DWR, 2020) in the Basin were analyzed alongside groundwater elevation data to estimate the number of active wells at present-day groundwater level initial conditions. Next, potential significant and unreasonable impacts to vulnerable wells were evaluated at the proposed MTs.

## 3.3 Groundwater Level Scenarios

Well impacts are characterized using three possible groundwater level scenarios:

- Return to Fall 2016 levels
- 10 ft below Fall 2016 levels
- 20 ft below Fall 2016 levels

Undesirable results occur when the percentage of impacted domestic, agricultural, or public wells exceeds 5%. These three scenarios were evaluated to quantify which wells fail, and if undesirable results occur.

## 3.4 Classification of failing wells and cost estimate

The initial set of wells to consider include all domestic, agricultural, and public wells in the CASGEM database. Wells are removed based on the year in which they were constructed[3], and their estimated pump location relative to the initial groundwater level condition prior to impact analysis. In other words, wells that are likely to be inactive, or already dry at the initial condition are not considered, and do not count towards the well impact count.

Next, we assign a “critical datum”[4] to each well, equal to 20 feet above the total completed depth, roughly 3 times the height of water column required to prevent decreased well function and cavitation as calculated by Pauloo et al 2020 using standard assumptions of pumping rate, net positive suction head, barometric pressure head, vapor pressure, and frictional losses (see Pauloo et al 2020, SI Appendix Section S2.3). If groundwater level scenarios imply a groundwater elevation below this critical datum, the well is considered “impacted” and may require pump lowering or well deepening to rehabilitate it (**Figure 3**).

In reality, wells dewater and experience reduced yield when the groundwater level approaches the level of the pump. However, for the purposes of this study, we assumed wells maintain the net positive suction head (Tullis 1989) required to provide uninterrupted flow until groundwater falls below the critical datum. At this point, we assume the well needs replacement (i.e., a well deepening event). Therefore, the well impact estimates provided in this study should be interpreted as a worse-case scenario wherein wells can no longer access reliable groundwater and are deepened. In most cases, pumps will be able to be lowered into the 20-foot operating margin prior to a deepening event – this is more affordable than a well deepening, so the cost estimate is conservative in this sense.

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[3] A retirement age of 31 years was accepted based on peer reviewed publication suggestions. To account for uncertainty in the well retirement age, we also consider another well retirement age of 40 years. Importantly, these numbers reflect mean retirement ages in the retirement age distribution. Although some wells in the population may be active for longer than 31 or 40 years, some will also retire before 31 or 40 years. Thus, results should be interpreted as an average estimate of well impacts.

[4] A standard approach for the choice of a critical datum is not well established. Other studies (e.g., Gailey et al, 2019; Pauloo et al, 2020; Bostic and Pauloo et al, 2020; Pauloo et al, 2021) estimate pump locations in different ways. Since considerable uncertainty exists in estimating pumps at a local scale, but WCR data for total completed depth is present and reliable for nearly all wells in the dataset, it is favored. An operating margin of 30 feet added to the bottom of each well’s total completed depth is a reasonable column of water necessary for the well to properly function, although wells with greater pumping capacities may require a longer water column. This number was reduced to 20 ft for the UVB due to existence of shallower wells.

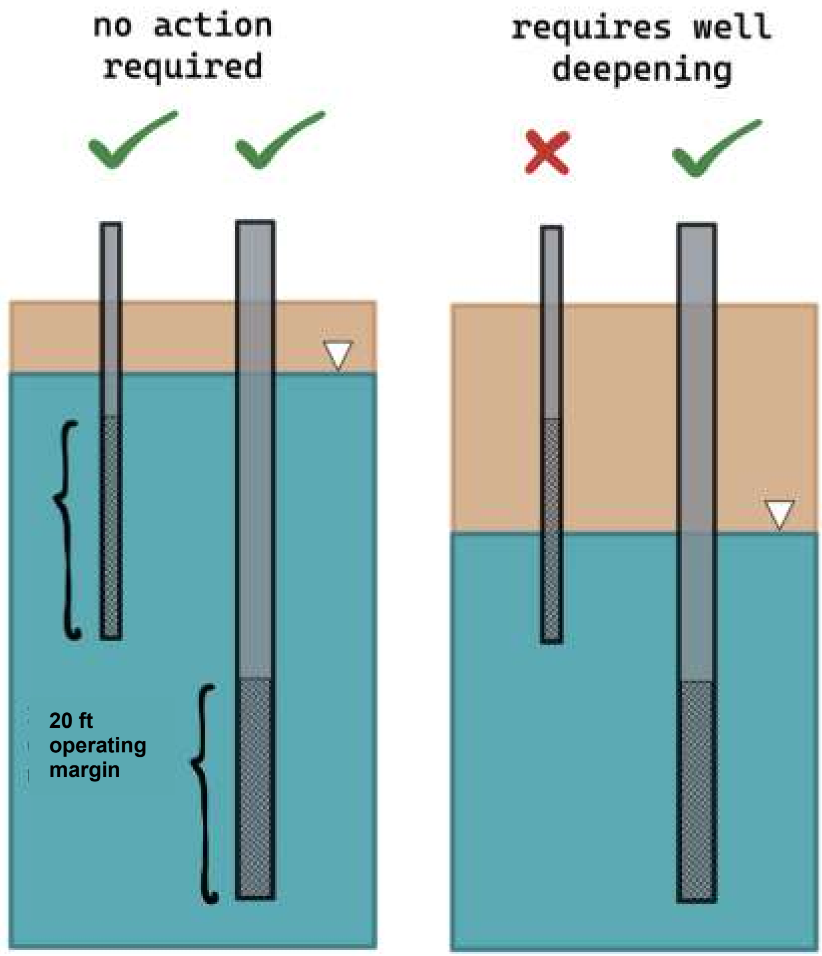


*Figure 3. Wells are assigned a 20-foot operating margin above the total competed depth. When groundwater levels are above this "critical datum" at a well, the well is active (left), and the well is impacted when the groundwater falls below the critical datum, which triggers a well deepening event. Note that, cones of depression form around active pumping wells, but are not shown in the figure above for simplicity.*

To compute rehabilitation costs, it is assumed that if the groundwater level falls below the total completed depth of the well plus an operating margin of 20 ft, a well deepening rehabilitation event is assumed to take place. Well deepening is estimated at $21,500 per domestic well, and $100,000 per agricultural and public well. We neglect costs associated with increased lift, as these constitute around 1% of total costs estimated by EKI, 2020. We also neglect costs associated with screen cleaning, as this action is unlikely to yield significant additional water when groundwater levels have fallen below the critical datum.

# 4. Results

## 4.1 Groundwater levels

Historic groundwater elevation data were analyzed using the available data California Department of Water Resources (DWR) Periodic Groundwater Level Database. Most groundwater level data is collected biannually in spring and fall and intended to capture seasonal variation – notably due to winter recharge and pumping and recharge during the dry growing season. Groundwater levels were assessed at biannual seasonal intervals during the period from 2015 to 2018 that partially includes the most recent data. “Spring” was defined as the months of March, April, and May and “fall” was defined as the months of August, September, and October.

At each monitoring location, the average groundwater level measured during spring and fall was computed by taking the grouped mean of observations in each spring and fall, respectively (if more than one measurement was taken). Next, ordinary kriging[5] (Journel A.G.  and Huijbregts, 1978) was applied to groundwater elevation measurements to generate groundwater level surfaces across the Basin at a 500-meter (0.31 mile) resolution. In order to minimize boundary effects, monitoring well data within a 20-kilometer (12.4 mile) buffer of the Basin were included. Results are shown in **Figure 4**.

[5] An exponential variogram model was used, and results did not appreciably differ from linear or spherical models. Data outliers were controlled by removing tails of the distribution above and below the 97.5th and 2.5th percentiles respectively. Groundwater elevations were approximately normal in distribution, thus log-transformation and exponentiation after kriging was not required.

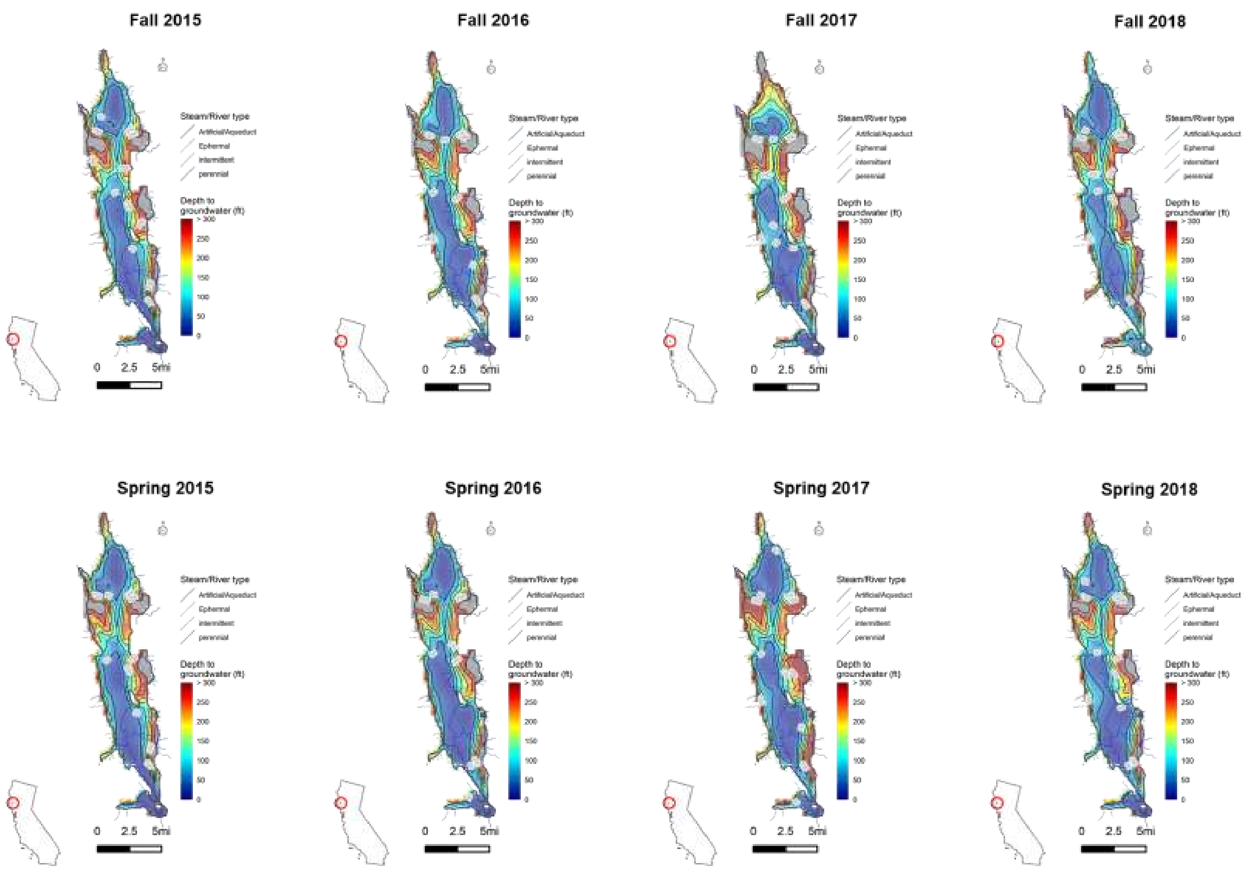


*Figure 4. Depth to groundwater in the Basin for spring (bottom) and fall (top) conditions for 2015-2018.*

## 4.2 Well inventory and characteristics

Results suggest that the most common well types (**Figure 5**) with direct beneficial uses are domestic (n = 644), agricultural (n = 79), and public (n = 16) wells, although the actual number of “active” wells today is likely less due to ageing and well retirement. Assuming 31-to-40-year retirement ages (**Figure 6**), and that wells with pumps above initial groundwater level conditions are inactive, the number of assumed active wells in the UVB is lower: domestic (n = 276 - 343), agricultural (n = 15 - 19), and public (n = 6 - 10). Domestic wells far outnumber agricultural and public wells.

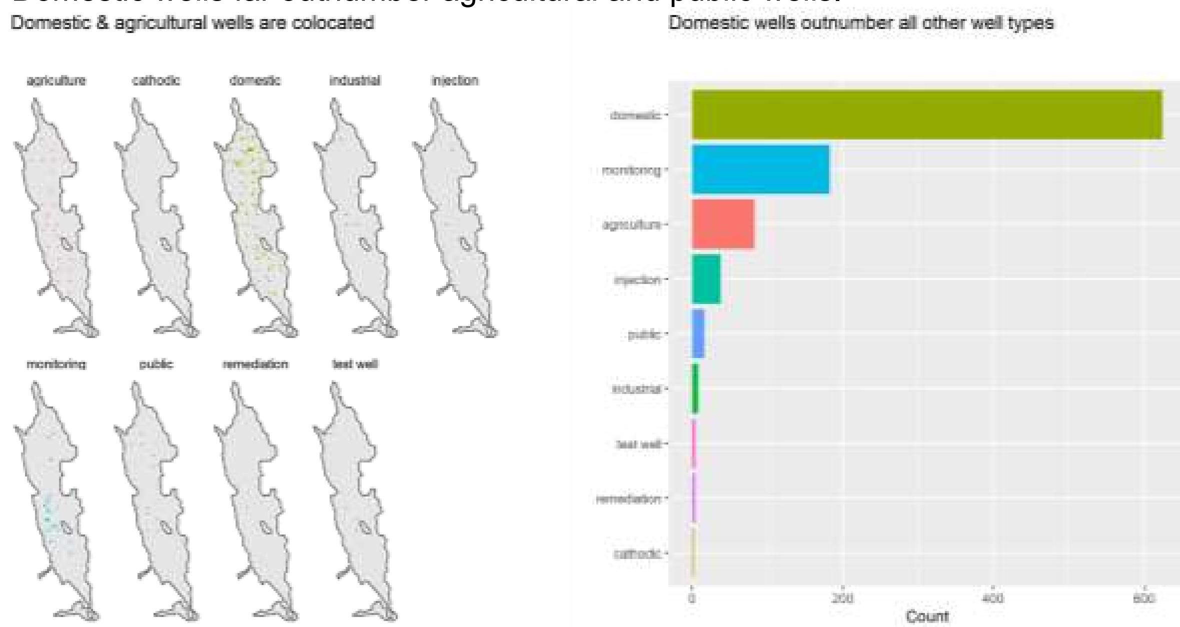


*Figure 5. Well inventory of the UVB. Locations and counts do not consider retirement age; thus, these wells do not reflect the location and count of active wells, but rather, all wells ever drilled for which records exist. Notice that agricultural, public, and domestic wells are collocated, and that domestic wells outnumber agricultural and public wells. Well locations appear in a grid like pattern because the accuracy of most wells is to the nearest PLSS section (1 square mile grid).*

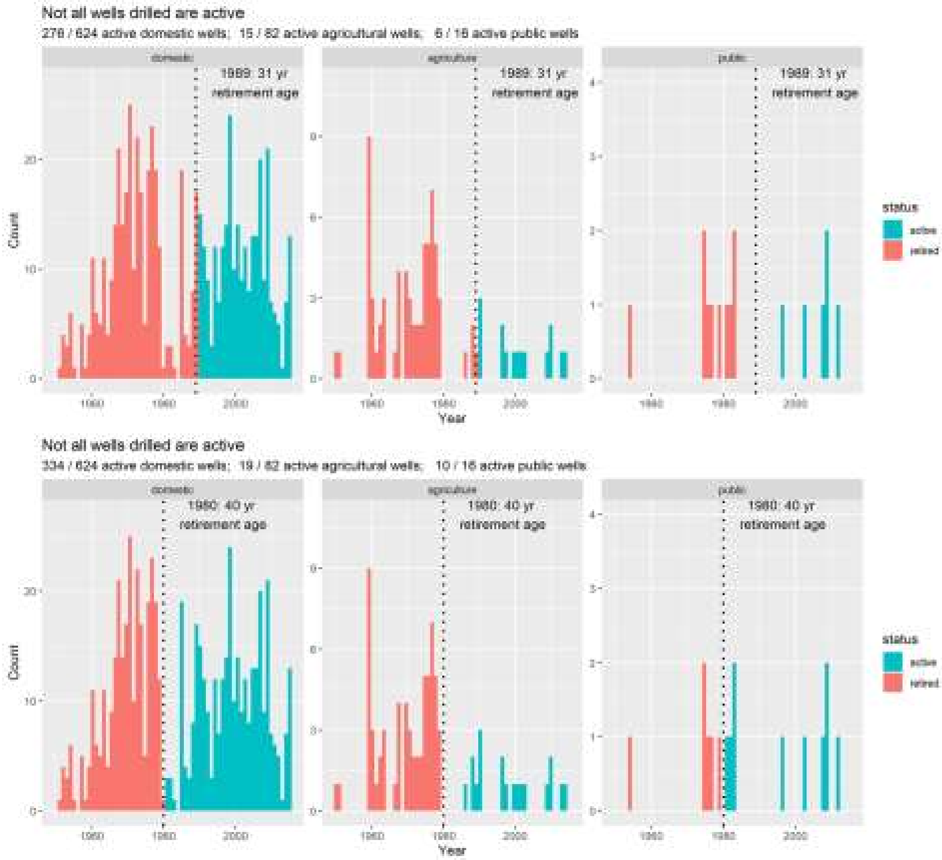


*Figure 6. Not all wells drilled are active. Assuming a 31-year (top) and 40-year (bottom) retirement age, different numbers of wells are active. For retired (red) and active (blue) wells*

Most wells are deeper than long-term average depths to groundwater in the UVB, which suggests a buffer against potential well impacts from declining groundwater levels, as seen in **Figure 2** in Section 3.1 above. Finally, wells tend to be drilled deeper over time (**Figure 7**), driven by improvements in drilling technology and the need for deeper groundwater unimpacted by surface contaminants and with sufficient transmissivity to support well yield targets. Since the 1950s, domestic and agricultural well depths in Ukiah Basin have increased while public well depths have remained relatively stable. Average domestic well depth has increased by around 2.2 times, while agricultural has increased by 4 times.

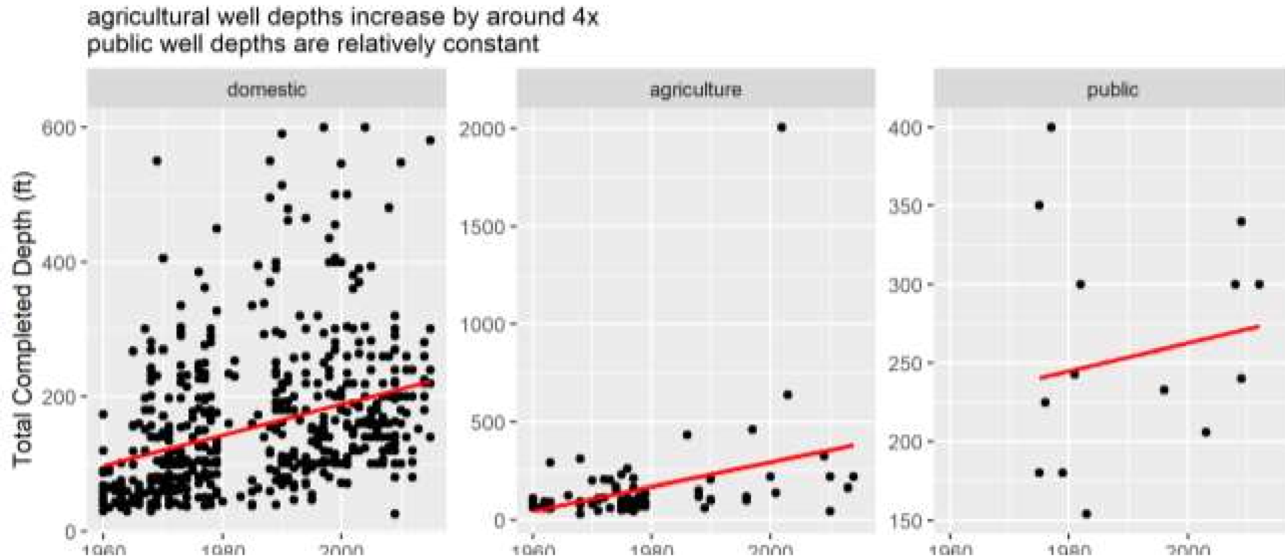


*Figure 7. Well depths over time (ft) for domestic (left), agriculture (middle), and public (right) wells.*

## 4.3 Well impacts: location, count, and cost

The results of the modeled groundwater scenarios listed in Section 3.3 suggest 6 domestic wells (2% of total wells assessed based on 31-year retirement age) would be impacted by a return to Fall 2016 levels. This number increases to 15 domestic wells and 1 agricultural well (5% of total wells) when groundwater levels in the basin are 10 ft lower than Fall 2016. Lowering Fall 2016 groundwater levels by 10 ft would be a worse scenario than the conditions proposed by MTs since the maximum difference in groundwater levels at RMPs and their respective MTs is 5 ft, and this difference is not basin wide. Increasing depth to groundwater by 20 ft from Fall 2016 levels would cause 25 domestic wells and 1 agricultural well (8% of total wells) to go dry.

*Table 1. Number of dry wells for each groundwater level scenario for 31-year retirement age.*

| Well Type | Total # of Wells | Return to Fall 2016 Levels Dry Wells | 10 ft Below Fall 2016 Levels Dry Wells | 20 ft Below Fall 2016 Levels Dry Wells |
|---|---|---|---|---|
| Domestic Wells | 276 | 6 | 15 | 25 |
| Agricultural Wells | 15 | 0 | 1 | 1 |
| Public Wells | 6 | 0 | 0 | 0 |
| Total # of Dry Wells | | 6 (2%) | 16 (5%) | 26 (8%) |

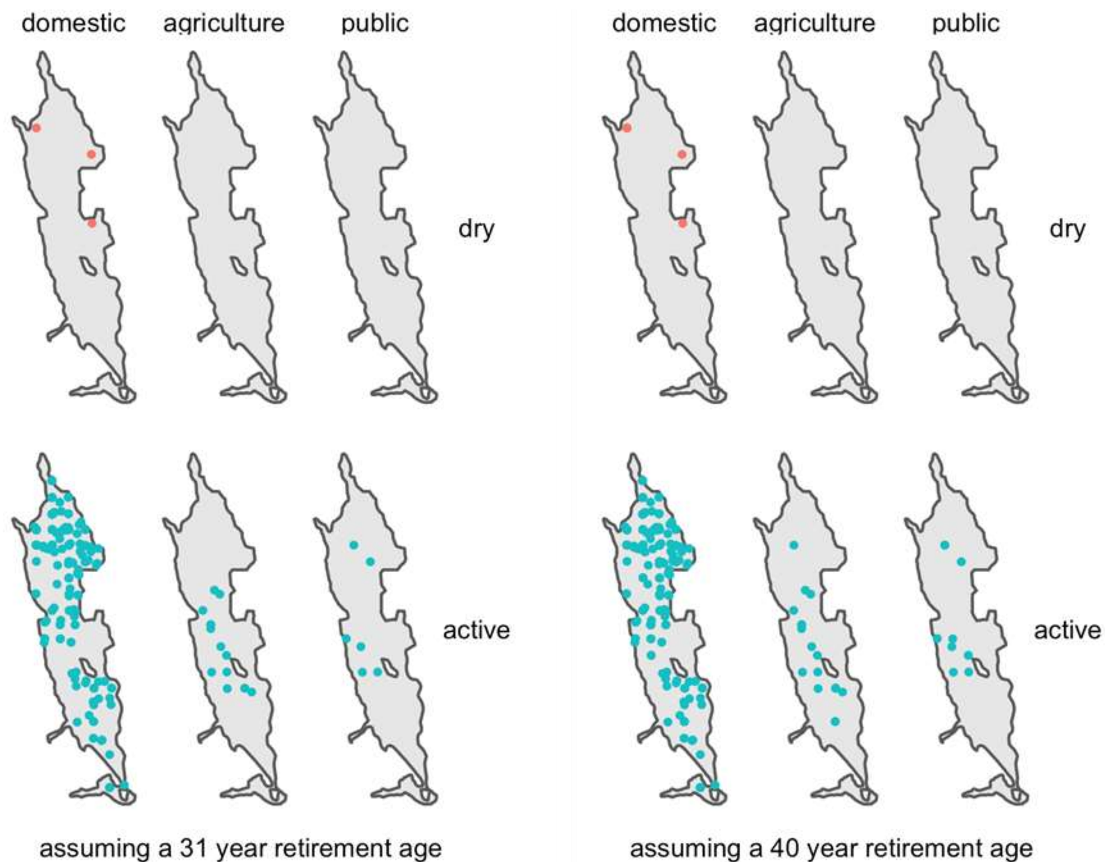


*Figure 8. Forecasted well failure under a return to fall 2016 levels.*

## 4.4 Estimated cost

Costs are estimated informed by the costs put forward by Gailey et al (2019), EKI (2020), and Pauloo et al (2021), which assume well deepening events occur in intervals of 100 feet. For simplicity, domestic wells were assumed to cost $21,500 USD per well replacement, and agricultural and public wells were assumed to cost $100,000 USD per well replacement.

Results across all scenarios evaluated suggest a range of 6-26 wells would be impacted under 31-year retirement age, and accounting for uncertainty in projected management. An estimate for each groundwater lowering scenario (1) Return to Fall 2016 levels, (2) Conditions 10 ft below Fall 2016 levels, and (3) Conditions 20 ft below Fall 2016 levels, yield results that 2%, 5%, and 8% of wells would go dry respective to each scenario, within the Basin. The well impact percentages for scenarios (2) and (3) align with GSA-driven definitions of unreasonable results to vulnerable wells.

Further, unacceptable well impacts are defined as dewatering or lost access to groundwater at a well that requires well deepening. Well rehabilitation costs for impacted wells, assuming a return to the MT at all RMPs from fall 2016 levels and a 31-year retirement age, were estimated at around $130,000 - $230,000 following the cost structure of Pauloo et al. (2021), EKI (2020), and Gailey (2019), but would likely be less, as significant and unreasonable impacts occur when a third of RMPs exceed MTs, and less expensive rehabilitation costs such as pump lowering may be more appropriate in some situations (e.g., when operating margin exists).

# 5. Discussion

Vulnerable wells in the UVB tend to be privately owned and domestic wells with shallower depths. These wells are vulnerable when water levels decline due to drought or unsustainable management. With the passage of the Sustainable Groundwater Management Act, local groundwater sustainability agencies will develop sustainable management criteria including minimum thresholds and objectives, measured at monitoring networks that will chart progress towards, or deviance from, sustainability goals. Sustainable management criteria should identify vulnerable wells as beneficial users of groundwater, and hence, identify the quantitative thresholds at which they will be impacted by declining groundwater levels, and the percentages (or count) of impacts above which, local agencies deem significant and unreasonable. The GSP should then set groundwater level MTs according to these thresholds and manage groundwater levels above them to ensure that at MTs, significant and unreasonable impacts occur, and that at MOs, significant and unreasonable impacts are avoided.

Results suggest that a return to Fall 2016 groundwater level lows is unlikely to result in catastrophic and widespread impacts to wells. Moreover, additional declines anticipated under the scenarios of 10 ft below Fall 2016 levels and 20 ft below Fall 2016 levels result in significant and undesirable impacts to wells. The percentage of wells impacted in the worst-case scenario assuming groundwater levels 20 ft below Fall 2016 levels results include 25 domestic wells and 1 agricultural well to be impacted with a total of 8% of wells going dry. In the return to 2016 levels scenario well impacts for all well types remain below 5%. Under the scenarios of 10 ft below Fall 2016 levels 5% of wells go dry respectively and yield undesirable results.

Well protection analysis thus informs the creation of minimum thresholds (MTs) which avoid significant and unreasonable impacts to wells in the basin and allow the basin to achieve projected growth targets within a framework of regional conjunctive use and PMA.

# 6. Conclusion

Well completion reports, and historical groundwater levels for Ukiah Valley were analyzed to estimate groundwater thresholds at which different well use types in the UVB reach levels of impact deemed significant and unreasonable. Results suggest that projected groundwater return to Fall 2016 drought groundwater levels will not lead to widespread catastrophic well failure in the UVB, and thus groundwater level MTs should be designed considering more extreme scenarios of 10 ft below Fall 2016 levels, and 20 ft below Fall 2016 levels as well.

These groundwater level scenarios predicted that outages of 2%, 5%, and 8% of total domestic, agricultural, and supply wells would occur in the basin for the conditions of returning to Fall 2016 levels, 10 ft below Fall 2016 levels, and 20 ft below Fall 2016 levels, respectively. The conservative scenarios with greater groundwater level decline than Fall 2016 levels breach the significant and unreasonable 5% impact threshold.

Well impact analyses depend on reliable data to determine the set of active wells to consider, and their critical datum (the vertical elevation at which a well is estimated to be impacted by declining groundwater levels). Reasonable assumptions are made for modeling purposes but are not accurate to every well across the basin. Results are sensitive to well retirement age. A “well inventory” may improve understanding of well retirement and well vulnerability more generally. Such a census, if performed, should take place at the county level; results of the census may be attached to the parcel database used to better inform well protection and rates and fee schedules.

Top-down approaches like the analysis provided herein should be combined with bottom-up approaches. Localized, volunteer-based vulnerable well monitoring may empower point-of-use crowdsourced data and facilitate an early warning system to prioritize well rehabilitation measures before wells go dry. Truly, the best indication of well vulnerability will come from measurements at point-of-use wells. SGMA does not require this level of monitoring or provide guidance on how to achieve it, but GSAs may consider local monitoring programs outside of GSP RMP network to improve communication with well owners and take corrective actions as needed.

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# Appendix 5-A Annual Reporting Template

This appendix presents an example template for annual reporting. Use of this appendix is intended as an example only and is not intended to be specific to the Basin. Modification will be required based on specifics outlined in the Basin's Groundwater Sustainability Plan.

# SMC Tracker: A web dashboard to support GSP annual reporting with centralized monitoring, modeling, and data access

## Contents



## Introduction

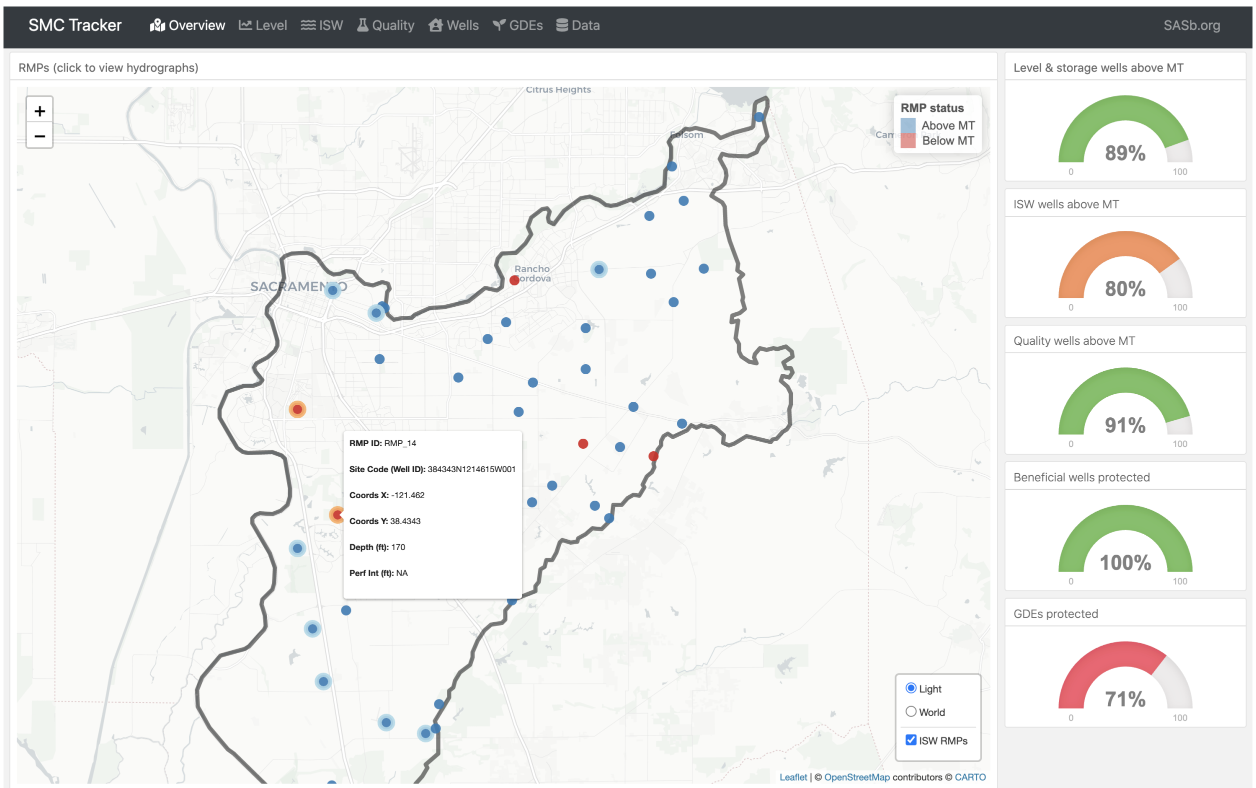
Annual reporting for SGMA requires monitoring at representative monitoring points (RMPs), analysis of potential impacts to beneficial users, evaluation of physical conditions in the basin to sustainable management criteria (SMC), and submission of data to the State. Data is collected different ways and at different sampling frequencies–often by multiple agencies and consulting firms–and the analysis, storage, reporting, and sharing of this information introduces friction into annual reporting, compliance assessment, and decision making. The need for streamlined annual reporting solutions is especially acute during severe drought where rapid access to information to guide critical decision making is paramount.

We propose a solution called **SMC Tracker**: a web-based data reporting and SMC tracking dashboard that integrates RMP monitoring data with assessments to beneficial users in automated interactive visualizations. This dashboard will summarize groundwater conditions in the basin, integrate data and models used in the annual report, and provide a central hub for tracking SMC in near-real time. Users will be able to visualize all RMPs at a glance, drill down into monitoring data collected at each RMP, and use summary panels to rapidly assess "basin vitals" that show if the basin has identified significant and unreasonable results for a given sustainability indicator and/or beneficial users of groundwater. And finally, users will be able to export data for analysis and in forms that directly comply with DWR submission criteria for a painless, drag-and-drop solution.

## Overview page

The SMC Tracker main page provides an overview of basin sustainability at a glance. All RMPs for groundwater level and storage are shown. Users can:

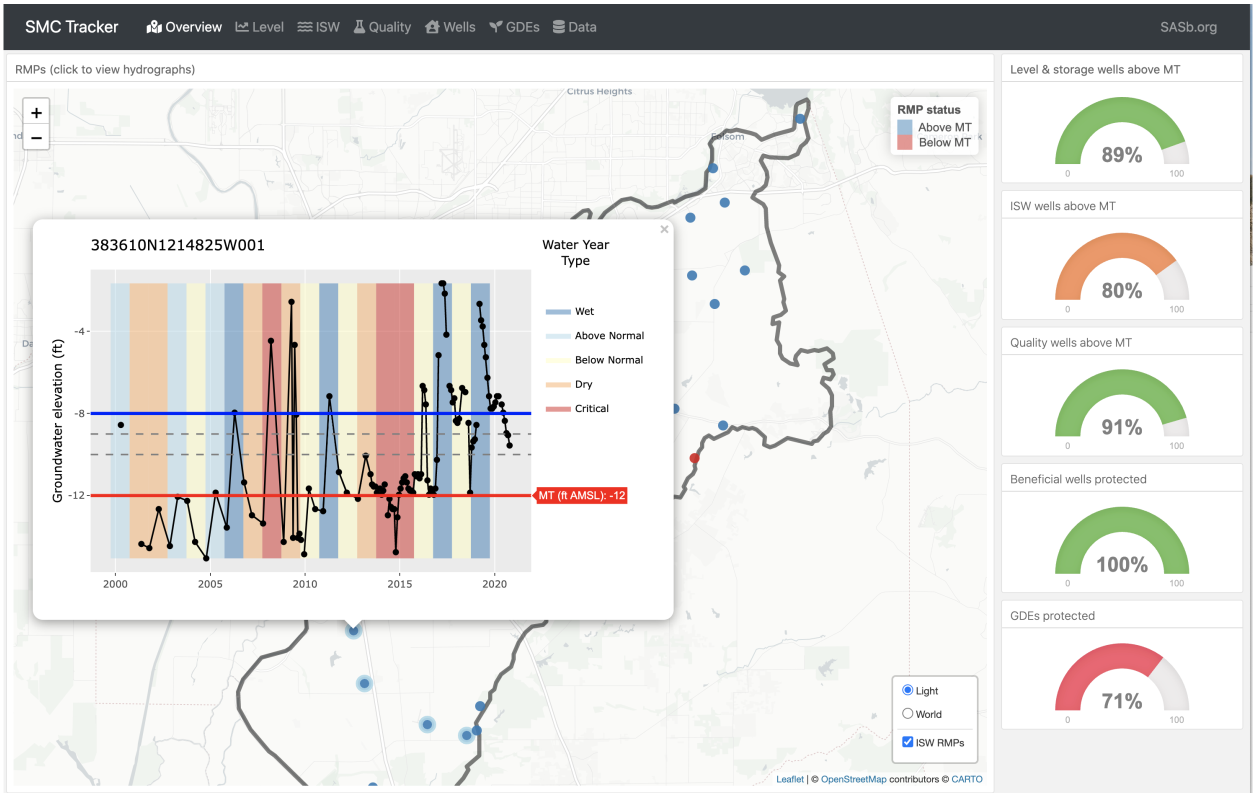
- hover over points to view site metadata
- use the legend to quickly identify RMPs that are above or below their MT
- use the legend to toggle between groundwater level, storage, and ISW monitoring points
- toggle basemaps to view satellite imagery
- click points to expand interactive timeseries plots that allow the user to zoom, pan, and export plots. Plots show:
  - water year type
  - historical data through the present day
  - SMC (minimum thresholds, measurable objectives, and interim milestones)




The lefthand sidebar shows "odometer" gauges which represent critical sustainability criteria, including:

- percentage of groundwater level and storage RMPs above the MT
- percentage of ISW RMPs above the MT
- percentage of water quality wells above the MT
- percentage of shallow wells protected at current groundwater levels
- percentage of GDEs protected

Colors of the gauges can be configured such that when the basin dips into "trigger" or "undesirable result" territory, the gauges show this.




## Groundwater level page

The "Groundwater level" pageis one example of many other pages where users can drill down into aggreagted data for a particular sustainability indicator. Whereas in the "Overview" page, users interact with RMPs spatially and click on individual RMPs to view groundwater levels, on the "Groundwater level" page, all groundwater levels are shown in a single interactive visualization.

This page will be configured to automatically incorporate data as is it collected in a standard form by agencies and consultants. In the event that data is collected via telemetry, this page can be configured to auto-update at a regular time interval (e.g., daily) so that users can always view the most up-to-date data. Features include:

- a right hand legend that can be clicked to toggle individual points on and off or highlight one timeseries line
- interactive zoom and pan to inspect small details in the timeseries data
- two tabs that render the data in terms of water surface elevation (ft AMSL) and depth to groundwater (ft below land surface)
- groundwater level data on hover including the site ID, the date, and the groundwater level
- a button to export the current state of the plot to a .png file which can be included in a presentation or a report


## Other pages

Just as the "Groundwater level" page allows the user to drill down into groundwater level data, users needs information on other Sustainability indicators that may include interconnected surface water (ISW), groundwater quality, land subsidence, and/or seawater intrusion. Moreover, key beneficial users may include shallow wells and GDEs, and the user may need information on impacts to these users suggested by the latest monitoring data and modeling. "Other" pages accomplish this, and are listed in the header from left to right. Here we include examples for ISW, groundwater quality, wells, and GDEs. Content on these pages will be developed to address basin-specific needs.

## Data access

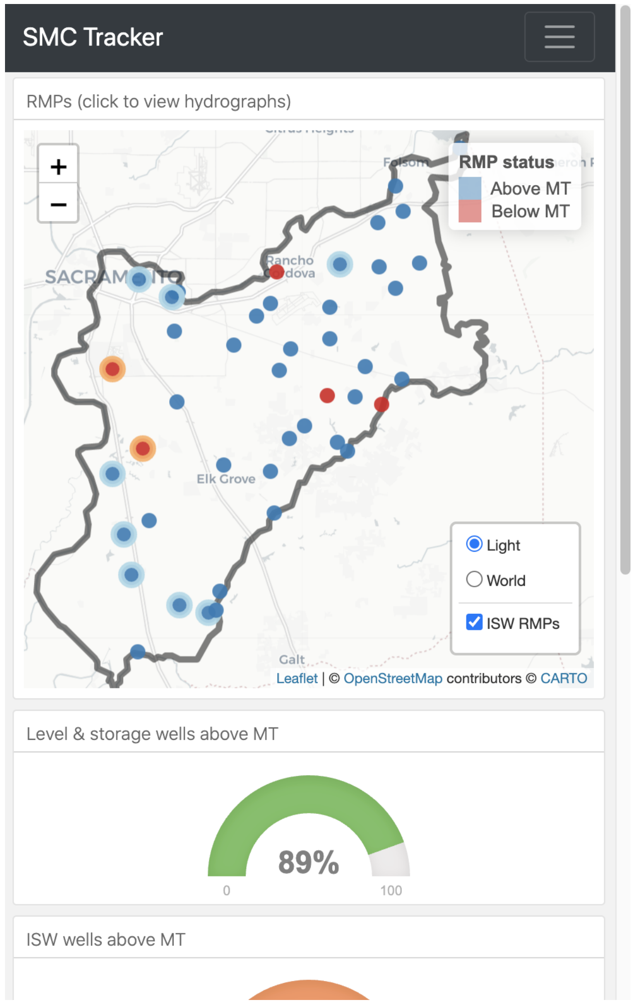
Agencies and consultants may require data from time to time, and as new data is made available, it must be centralized and distributed. SMC Tracker accomplishes this centralization and distribution on a "Data" page with links to the most up-to-date data. Also on this page are download links to data in DWR annual reporting templates for fast, painless, drag-and-drop solutions to annual reporting requirements.

## Additional features

Dashboards are highly customizable and additional features may be added on an ad-hoc basis.

### Mobile display

SMC Tracker is built with modern software optimized for mobile display. It looks great on smartphones and tablets.




### Near-real time monitoring

Custom data extraction for any continuous monitoring sites can be integrated into SMC Tracker so that GSAs can track groundwater levels and other sustainability indicators in near-real-time (e.g., following a recharge project, or during a severe drought). Receiving automated information quickly and in a visual format can help focus priorities for working groups, and allow consultant teams access to standardized data as soon as it is available so data-driven management actions can be rapidly planned and executed.

### Password protection and data privacy

Depending on GSA needs, dashboards can be made public or private. If dashboards are made private, they will sit behind password-protected walls for authorized users.

All data will be stored and protected on private servers configured by LWA.

## Conclusion

Once developed, SMC defined in GSPs must be monitored for the identification of significant and unreasonable results. Monitoring at RMPs occurs throughout the year and is reported to DWR annually. Data collection, analysis, reporting, and sharing all present friction in the annual reporting and compliance process. These challenges are obviated by centralizing all monitoring data in one place to visualize near-real-time groundwater conditions in the basin and how they measure up to SMC. The SMC Tracker tool will aid agencies and consultants by providing access to monitoring data, SMC tables, and standardized excel data export sheets that can be dragged and dropped into DWR's online reporting system.

# Appendix 5-B GSA Funding Technical Memorandum

# UKIAH VALLEY BASIN GROUNDWATER SUSTAINABILITY AGENCY

# FUNDING OPTIONS TECHNICAL MEMORANDUM

DECEMBER 2021

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# INTRODUCTION AND EXECUTIVE SUMMARY

## INTRODUCTION AND GOALS

The Ukiah Valley Basin Groundwater Sustainability Agency (UVBGSA or Agency) was created by a Joint Powers Agreement to serve as the official Groundwater Sustainability Agency (GSA) for the Ukiah Valley Basin, as required by the Sustainable Groundwater Management (SGMA) Act of 2014. The members of Joint Powers Agreement are the County of Mendocino, City of Ukiah, Russian River Flood Control and Water Conservation Improvement District and Upper Russian River Water Agency.

In the Winter of 2018, the Agency engaged a consultant team led by Larry Walker Associates (LWA Team) to develop the Phase 2 of the Ukiah Valley Basin Groundwater Sustainability Plan in compliance with the SGMA. The Agency directed the LWA Team to develop a plan with four functional work elements and eighteen total tasks. This Funding Options Technical Memorandum is the specified deliverable for Task 16 - Financial Evaluation.

The Ukiah Valley Basin Groundwater Sustainability Plan (GSP) includes goals and recommendations, as well as the associated costs, required for its implementation. Accordingly, the purpose of this technical memorandum is to describe a path forward to fund the GSP's implementation. It should be noted that SGMA, and its associated requirements and goals, are quite new, and there is not a clear, well-tested path forward to fund GSP implementations. Rather, the funding efforts for GSP implementation in the Ukiah Valley Basin need to be carefully crafted for the local conditions, preferences, and politics – as well as being flexible, creative, and reactive.

The Agency's Joint Powers Agreement indicates that the GSA is to initially be funded by a contribution from each of the initial Members, and subsequently funded by additional contributions, and as per the applicable sections in the California Water Code. The general direction from the GSA Board of Directors in regard to funding the GSP implementation can be summarized as:

- GSA expenses should be well-controlled
- Funding strategy needs to be locally viable and right-sized
- Metering of wells is not desired
- Revenue generated should be in relationship to water use

## EXECUTIVE SUMMARY

Following is a brief summary of the findings and recommendations contained within this Technical Memo, including a summary of the GSP implementation costs, potential funding mechanisms, and recommendations for funding of the implementation.

## REVENUE NEEDED FOR GROUNDWATER SUSTAINABILITY PLAN IMPLEMENTATION

The GSP makes numerous implementation recommendations, including annual operations and maintenance as well as capital projects. The associated costs for these tasks, including the low range and high range, are summarized in Table 1, below.

TABLE 1 – SUMMARY OF TOTAL ESTIMATED ANNUAL COSTS

| Summary | Preliminary Annual Budget | |
|---|---|---|
| | Low Range | High Range |
| Operations and Maintenance | $110,000 | $190,000 |
| Capital Projects | $25,000 | $45,000 |
| **Total** | **$135,000** | **$235,000** |

It is anticipated that capital projects will be primarily grant-funded. More detail is provided in Section II., below.

## FUNDING APPROACHES AND OPTIONS FOR GSP IMPLEMENTATION

There are a variety of funding approaches, each with pros and cons, and most likely a portfolio of various approaches will prove optimal. The likely most optimal funding mechanisms are listed below:

Best Options

- Existing Revenue Sources
- Grants and Loans
- Regulatory Fees

If additional revenue is needed:

- Property Related Fees – non-Balloted (*allocated to well owners*)
- Special Taxes – Balloted (allocated to all property owners within the basin)

Less optimal

- Property Related Fees – Balloted
- Benefit Assessments

Selection of the optimal approach or, more likely, portfolio of approaches, requires consideration of the key attributes of each.

Each funding mechanism and approach has key attributes - each of which should be considered to select the optimal funding portfolio, including:

- o Flexibility of Methodology (per acre, per acre-feet pumped, per well, etc.)

- o Costs of Implementation
- o Revenue Potential
- o Political Viability / Community Acceptance
- o Legal Rigor
- o Administration

### ALLOCATING IMPLEMENTATION COSTS TO WELL OWNERS VERSUS PROPERTY OWNERS

If funding beyond use of existing sources, grants and regulatory fees is needed, then one of the most important considerations for the UVBGSP is the allocation of the GSP implementation cost between the well owners and the larger group of all property owners within the Ukiah Valley Basin. Conventional wisdom suggests that the costs of the implementation of groundwater mitigation policies should be directly borne by the immediate users of the groundwater – the well owners. However, there are clear benefits to all properties and residents within a well-managed groundwater basin that provides additional, lower cost water resources. It can be argued that a community-wide funding mechanism in which all properties and/or residents pay their fair share is a more optimal approach. Both types of approaches are discussed in Section II of this technical memo.

### ROADMAP FORWARD AND RECOMMENDATIONS

A summary of this Technical Memo's major recommendations for implementation includes a step sequential roadmap as summarized below:

1. Conduct community outreach regarding the GSP and its implementation
2. Pursue use of existing revenue sources, grants, and regulatory fees to fund implementation

If additional revenue is needed:

3. Conduct a public opinion survey and focused community outreach
4. Implement a property related fee or special tax

The process of establishing long-term, sustainable, comprehensive funding for GSP implementation will likely take at least 18 months to complete. More detail is provided in Section III., below.

# I. DETAILED REVENUE NEEDS

## ANNUAL OPERATIONS AND MAINTENANCE COSTS

The GSP includes numerous recommendations for annual operations and maintenance in support of the long-term sustainability of the Ukiah Valley basin. The costs of these recommendations have been developed and bracketed with a low range of $110,000 per year and a high range of $190,000 per year, and are detailed in Table 2, below:

TABLE 2 – DETAILED SUMMARY OF ESTIMATED MAINTENANCE AND OPERATIONS COSTS

**Operations and Maintenance**

| | **Preliminary Annual Budget** | |
|---|---|---|
| | **Low Range** | **High Range** |
| General GSA Operations | $10,000 | $25,000 |
| Annual Reporting | $15,000 | $25,000 |
| Model Maintenance | $40,000 | $80,000 |
| Monitoring | $45,000 | $60,000 |
| Mediation Fund | TBD | TBD |
| **Total** | **$110,000** | **$190,000** |

Where:

General GSA Operations includes costs to operate the GSA including supporting and facilitating Board and committee meetings, disseminating information, satisfying existing grant administrative requirements, managing contracts for tasks listed below, maintaining the website, etc.

Annual Reporting: includes costs to draft and submit all required annual reports.

Model Maintenance: includes the annual installment costs to update the model every 5 years.

Monitoring includes:

a. Monitoring – Interconnected Surface Water: includes the periodic (likely semi-annual) inspection and maintenance at 3 sites - approximately 6 visits per year.

b. Monitoring - Water Level: includes the periodic (likely semi-annual) inspection of water level monitoring equipment at Includes CASGEM and DWR well sites and 10-15 additional well sites – approximately 40 visits per year.

c. Monitoring - Water Quality: includes the periodic sampling of water quality – approximately 10-15 samples per year.

Mediation Fund: is a placeholder for funds in support of mediation. For example, a grant program could be established for local well-owners to access capital to address compliance issues.

### ANNUAL CAPITAL COSTS

The GSP includes numerous recommendations for capital improvements in support of the long-term sustainability of the Ukiah Valley basin. Most likely, these capital improvements will be implemented if and only if significant grant funding is available. However, there are often associated costs with grants including grants writing and grants administration.

The costs of these recommendations have been developed and bracketed with a low range of $25,000 per year and a high range of $45,000 per year, and are detailed in Table 3, below:

TABLE 3 – DETAILED SUMMARY OF ESTIMATED MAINTENANCE AND OPERATIONS COSTS

| Capital Projects | Preliminary Annual Budget | |
|---|---|---|
| | **Low Range** | **High Range** |
| Grant Writing | $15,000 | $20,000 |
| Annual Grant Administration | $10,000 | $25,000 |
| Capital Projects Costs | Grant Funded | |
| **Total** | **$25,000** | **$45,000** |

Where:

Grant Writing: includes periodic grant writing primarily for capital projects.

Annual Grant Administration: includes costs satisfying annual grant administrative requirements including reporting and budget management.

### TOTAL ANNUAL IMPLEMENTATION COSTS

The total costs of these recommendations have been developed and bracketed with a low range of $135,000 per year and a high range of $235,000 per year, and are detailed in Table 4, below:

TABLE 4 –SUMMARY OF TOTAL ESTIMATED COSTS

| Summary | Preliminary Annual Budget | |
|---|---|---|
| | **Low Range** | **High Range** |
| Operations and Maintenance | $110,000 | $190,000 |
| Capital Projects | $25,000 | $45,000 |
| **Total** | **$135,000** | **$235,000** |

# II. EVALUATION OF POTENTIAL FUNDING MECHANISMS

## BACKGROUND OF FUNDING STRATEGIES FOR UVBGSA

Since the inception of the Agency, the leadership has discussed and considered the short term and long-term challenges associated with funding. In fact, from Page 12 of the Joint Powers Agreement April 5, 2017:

"Article 15 Budget and Expenses

15.2 Agency Funding and Contributions *In order to provide the needed capital to initially fund the Agency, the Agency shall be initially funded by a contribution for the initial Members in the amount establish in the bylaws, which contribution shall be set at an equal dollar amount for initial Members. In subsequent years, the Agency may be funded through additional voluntary contributions by all Member, and as otherwise provided in Chapter 8 of SGMA (commencing with Section 10730 of the Water Code.)"*

And the November 9, 2017 adopted Bylaws includes the same language.

The general direction from the GSA Board of Directors in regard to funding the GSP implementation can be summarized as:

- GSA expenses should be well-controlled
- Funding strategy needs to be locally viable and right-sized
- Metering of wells is not desired
- Revenue generated should be in relationship to water use

These basic principles were reinforced at the March 11, 2021, General Board meeting.

Hence, the GSA formation documents indicates a preference for the use of resources as contributions from member agencies initially and going forward, and also acknowledges the potential use of property-related fees on well owners as described in Section 10730 of the Water Code.

## INTRODUCTION TO AVAILABLE POTENTIAL FUNDING MECHANISMS OPTIONS IN CALIFORNIA

Existing California law provides a relatively finite number of mechanisms for local public agencies to reliably generate revenue to provide services. In many cases, a portfolio approach of several of these mechanisms will be optimal. Also, it is crucial to work closely with legal counsel on the implementation of all funding mechanisms to ensure legal compliance. This section provides a discussion of the mechanisms best suited to provide funding for groundwater management services recommended in the Agency GSP, including, but not limited to, the following:

Best Options

- Existing Revenue Sources
- Grants and Loans
- Regulatory Fees

If Additional Revenue is Needed

- Property Related Fees – non-Balloted (*allocated to well owners*)
- Special Taxes – Balloted (allocated to all property owners within the basin)

Less Optimal

- Property Related Fees – Balloted
- Benefit Assessments

Existing Revenue Sources and Grants Are Likely the Preferred Approach

Of course, it is recommended that the Agency rigorously explore all opportunities to fund the recommended groundwater management services through existing revenue sources and grants, eliminating the need for an additional allocation for well owners or all basin property owners. However, there are likely not sufficient available existing revenue sources to support GSP implementation, especially over the long term. See the discussion "Grants and Loans" below.

Regulatory Fee Should Be Imposed

Regulatory fees are an excellent source of reimbursement of actual costs for inspections, plan checks, etc., and should be imposed.

However, If Additional Revenue is Needed

If additional revenue is need beyond the amount that can be generated by existing revenue sources, there are two primary approaches:

| Revenue Generated from | Optimal Revenue Mechanism |
|---|---|
| Well Owners | Property Related Fee (non-balloted) |
| All Property Owners | Special Tax (balloting is required) |

Additional Funding from Well Owners or Community Property Owners

One unique challenge, and opportunity, associated with implementation of a funding mechanism for groundwater sustainability management is the decision regarding how costs will be allocated between well owners and the overall community of property owners. Generally speaking, the development of the Sustainable Groundwater Management Act was based upon the assumption that the allocation of costs would be primarily, perhaps exclusively, assigned to well owners, with some consideration of *de minimis* ground water users. However, there are clear benefits to all properties and residents within a basin with well managed groundwater resources. It can be argued that a community-wide funding mechanism in which all properties and/or residents pay their fair share is a more optimal approach.

Local political forces, often times concentrated with well owners, may dictate a preference for allocating the GSP implementation costs more broadly to all property owners within the basin, but it should be noted that California law requires that special taxes, which would be the mechanism required for an allocation on all basin property owners, requires a balloting. Balloted revenue mechanisms are arguably more legally rigorous, and legal challenges to voter-approved fees have rarely been successful. However, the balloting requirement significantly limits the total revenue that may be generated, as it is limited by the political "willingness to pay" of the local voters or property owners. Ballotings are also expensive and politically risky. For that reason, non-balloted approaches are typically preferable, and do not have the same apparent political limitation on the amount of revenue that can be generated, but political realities and influences are still significant.

As the Agency determines its funding strategy, it should take an in-depth look at many attributes, including flexibility of methodology (per acres, per water quantity, per well, per parcel, etc.), costs of implementation, revenue generation potential, political viability, legal rigor, administrative burden, etc., as described below.

## EXISTING REVENUE SOURCES

If the Agency can fund the groundwater management services with existing revenue sources, that is certainly optimal. However, even if this is possible in the short term, it is likely not possible very far into the future.

Again, the JPA and Bylaws associated the formation of the GSA state:

*"In order to provide the needed capital to initially fund the Agency, the Agency shall be initially funded by a contribution for the initial Members in the amount establish in the bylaws, which contribution shall be set at an equal dollar amount for initial Members. In subsequent years, the Agency may be funded through additional voluntary contributions by all Member, and as otherwise provided in Chapter 8 of SGMA (commencing with Section 10730 of the Water Code.)"*

The GSA is currently still funded by the initial "equal dollar amount" contribution from each of the initial members. In 2017, each of the four members contributed an initial $5,000 for a total of $20,000. This was augmented in 2020 with an additional contribution of $3,000 each for a total of an additional $12,000. The GSA's current fund balance (April 2021) is approximately $12,000 which does not include $1,000 to $2,000 expenses so far this year.

Mendocino County, as the administering agency, performs all the administrative tasks for the UVBGSA and charges back the GSA for major costs including basic salaries and benefits. However, there are significant additional miscellaneous costs including phone calls, correspondence, or internal conversations; as well as office space, office supplies, utilities that are not charged back to the GSA.

A brief summary of GSA spending is shown below.

**Non-Grant Expenses**

| FY | Admin Expenses |
|---|---|
| 2020/21 | $1,355.77 |
| 2019/20 | $7,597.77 |
| 2018/19 | $6,706.56 |
| 2017/18 | $4,308.53 |
| | $19,968.63 |

**Grant-Reimbursed Expenses**

| FY | Prop 1 Spending | Prop 68 Spending | |
|---|---|---|---|
| 2020/21 | $10,894.60 | $441,247.24 | (Q3 (1/1/21-3/30/21) not included) |
| 2019/20 | $483,362.21 | $110,556.25 | |
| 2018/19 | $266,840.54 | $0.00 | |
| | $761,097.35 | $551,803.49 | |
| | Total Grant Spending | $1,312,900.84 | |

### FUTURE ALLOCATIONS FROM MEMBER AGENCIES

Direct "volunteer" funding from each agency remains a very attractive a approach. However, the GSA should consider variations on this including varying the contribution from each agency based upon some other attribute(s) (ability to pay, % of revenue, % of total budget, etc.) in order to optimize the GSA budget.

## GRANTS AND LOANS

Grant funding is highly desirable, as it eliminates/lessens the need to generate revenue directly from well owners and/or the broader community of property owners. Grant funding is typically available for capital projects but can be available for other programmatic activities, including maintenance and operations. It is worth noting that grants often come with other funding requirements such as matching funds or requirements for post-project maintenance. For these reasons, an underlying revenue stream is very important to have access to leverage these opportunities.

California has a limited number of State grants and programs which provide funding opportunities for groundwater sustainability. The primary grants in support of SGMA are described below (*from https://water.ca.gov/Work-With-Us/Grants-And-Loans/Sustainable-Groundwater*):

"The SGMA Grant Program is funded by Proposition 68 and Proposition 1. To date, the California Department of Water resources (DWR) has awarded $139.5 million in three rounds of planning grants for development of Groundwater Sustainability Plans (GSPs) and related projects. All Proposition 1 funds have been awarded, with about $103 million now remaining to be awarded using Proposition 68 funds. Additional information can be found below.

### PROPOSITION 1, CHAPTER 10: GROUNDWATER SUSTAINABILITY

On November 4, 2014, California voters approved Proposition 1, which authorized $100 million be made available for competitive grants for projects that develop and implement groundwater plans and projects in accordance with groundwater planning requirements established under Division 6, commencing with §10000, Water Code §79775. DWR completed two grant solicitations for planning grants.

### PROPOSITION 68, CHAPTER 11.6: REGIONAL SUSTAINABILITY FOR DROUGHT AND GROUNDWATER, AND WATER RECYCLING

On June 5, 2018, California voters approved Proposition 68, which amended the Water Code to add, among other articles, §80146, authorizing the Legislature to appropriate funds for competitive grants for proposals that:

- Develop and implement groundwater plans and projects in accordance with groundwater planning requirements.
- Address drought and groundwater investments to achieve regional sustainability for investments in groundwater recharge with surface water, stormwater, recycled water, and other conjunctive use projects, and projects to prevent or cleanup contamination of groundwater that serves as a source of drinking water."

The Agency should plan to submit an application for the next round of Proposition 68 funding.

### FUTURE STATE GRANT OPPORTUNITIES

Since all of Proposition 1 funding has been awarded and the remaining portion of Proposition 68 funding (just over $100 million) will be awarded over the next several years, there will likely be a shortfall of grant funding for GSP implementation in the near future. Unfortunately, there are not any large statewide bond measures (with grant opportunities) on the political horizon, but the Agency should continue to track such efforts. Also, future bond measures will likely emphasize funding for multi-benefit projects and programs that cross traditional organizational structures, and the Agency should also consider coordinating with other affected local agencies to put forth larger and potentially more competitive grant applications.

The final Proposition 68 Implementation Proposal contains $103 million in available funding. DWR has released Round 1 draft funding recommendations, allocating $26 million to high priority basins.[1] Of the remaining $77 million, $15 million will be reserved for Underrepresented Communities, leaving $62 million available for general awards in Round 2 Implementation.[2]

Round 2 Grant Solicitation will open in spring of 2022, with final awards disbursed in fall of that year. Awards will be allocated to medium and high priority basins that have adopted a

[1] Proposition 68 SGM Grant Program's Implementation – Round 1 Draft Award List (ca.gov)

[2] https://www.grants.ca.gov/grants/sustainable-groundwater-management-sgm-grant-programs-proposition-68-implementation-round-2/

GSP that has been deemed complete by DWR. Grant amounts must be between $2 million and $5 million, with a 25% locally matched cost share requirement. A cost share waiver is available for eligible projects proportionate to the degree that they serve Underrepresented Communities. Any local cost share cannot have contributed to other grant awarded projects. Project expenses must be incurred after January 31, 2022, the due date for medium and high priority basin GSPs. The state encourages applicants to work with the stakeholders and other non-member agencies in their basin that have potential activities and tasks that are complimentary to the overall project. Eligible projects are defined by Proposition 68 Chapter 11.6 and include sustainability measures such as groundwater recharge and contamination prevention.[3]

#### OTHER TYPES OF GRANTS

The Agency should work to identify applicable Federal grants, if any, and compete, in coordination with other affected local agencies for funding. Also, the Agency should consider working with local elected officials to pursue provisions that direct approved funds to be spent on specific projects, often called earmarks.

Grants from non-profits, foundations, high-net-worth individuals, and other stakeholders should be considered, especially with an emphasis on environmental sustainability.

#### REQUIRED DOCUMENTS FOR GRANTS

- Grant applications meeting specific requirements.

#### FLEXIBILITY OF METHODOLOGY

Use of grant funding is well-specific in the specific grant.

#### REVENUE GENERATION POTENTIAL

Amount of grant funding is well-specific in the specific grant.

#### ADVANTAGES

- Does not require cost to be allocated to local well owners or property owners.
- Revenue generation can be sufficient to offset significant costs of certain key activities.
- Legally rigorous as long as grants are expended on eligible activities.

#### CHALLENGES

- Provides funding for a limited time period only – difficult for long term planning solution.
- Awarded through a highly competitive process.

[3] Sustainable Groundwater Management Grant Program Implementation Grants Proposal Solicitation Package (ca.gov)

- Often requires matching local funds, tends to be focused on capital expenses, and are often narrowly focused in terms of scope and services.

## REGULATORY FEES

Public agencies throughout California often reimburse themselves for the costs of site inspections, permits, plan checks, plan reviews, and associated administrative and enforcement activities using regulatory fees. These fees are often approved and published as part of a "Master Fee Schedule," and are often collected as part of review for approval process. This approach can assist in significantly reducing the GSA's financial burden.

Proposition 26, approved by California voters in 2010, tightened the definition of regulatory fees. It defined a special tax to be *"any levy, charge, or exaction of any kind imposed by a local government"* with certain exceptions. Pursuant to law, all special taxes must be approved by a two-thirds vote of the electorate.

Regulatory fees are thus defined through the cited exceptions. The pertinent exception is, "a charge imposed for the reasonable regulatory costs to a local government for issuing licenses and permits, performing investigations, inspections, and audits, enforcing agricultural marketing orders, and the administrative enforcement and adjudication thereof." The other pertinent exception is, "assessments and property-related fees imposed in accordance with the provisions of Article XIIID."

The Proposition goes on to state that, "the local government bears the burden of proving by a preponderance of the evidence that a levy, charge, or other exaction is not a tax, that the amount is no more than necessary to cover the reasonable costs of the governmental activity, and that the manner in which those costs are allocated to a payor bear a fair or reasonable relationship to the payor's burdens on, or benefits received from, the governmental activity."

Proposition 26 provides the primary guidance for the funding of the Agency's plan review and inspection fees as regulatory fees. Moreover, Section 10730 of the California Water Code, (which corresponds well with Proposition 26 guidance) stipulates that these fees can be used "to fund the costs of a groundwater sustainability program, including, but not limited to, preparation, adoption, and amendment of a groundwater sustainability plan, and investigations, inspections, compliance assistance, enforcement, and program administration, including a prudent reserve." Hence, it seems that the intent of this section is that the development of the plan can be financed through regulatory fees (and this has been widely agreed upon) as well as some, but not all, GSP implementation activities. In any case, Water Code Section 10730 includes several unique requirements that should be carefully followed when implementing regulatory fees for GSP implementation.

### REGULATORY FEE IMPLEMENTATION PROCESS

Regulatory fees are relatively easy and straightforward to implement. Neither a public noticing nor a balloting is required. Typically, a public agency will engage a specialized consultant to conduct a Fee Study. This Study will present findings to meet the procedural requirements of Proposition 26, which require analysis and support that:

1. The levy, charge, or other exaction is not a tax; and
2. The amount is not more than necessary to cover the reasonable cost of the governmental activity; and
3. The way those costs are allocated to a payor bears a fair or reasonable relationship to the payor's burden on, or benefits received from, the governmental activity.

Additionally, case law has provided further clarification of these substantive requirements, that:

1. The costs need not be "finely calibrated to the precise benefit each individual fee payor might derive."
2. The payor's burden or benefit from the program is not measured on an individual basis. Rather, it is measured collectively, considering all fee payors.
3. That the amount collected is no more than is necessary to cover the reasonable costs of the program is satisfied by estimating the approximate cost of the activity and demonstrating that this cost is equal to or greater than the fee revenue to be received. Reasonable costs associated with the creation of the regulatory program may be recovered by the regulatory fee.

REQUIRED DOCUMENTS FOR REGULATORY FEES

- A Fee Study, reviewed by legal counsel and adopted by the governing authority.

FLEXIBILITY OF METHODOLOGY

Legal requirements and industry practice limit these fees to recovery of costs associated with eligible activities (e.g., inspections, permits, etc.) The Agency is advised to work closely with legal counsel and review Proposition 26 and Water Code Section 10730 requirements.

<u>SGMA and Regulatory Fees</u>

Section 10730 of the California Water Code dictates that regulatory fees can be used to fund the costs of a groundwater sustainability program, including, but not limited to:

(1) Preparation, adoption, and amendment of a groundwater sustainability plan
(2) Investigations, inspections, compliance assistance, enforcement
(3) Program administration
(4) A prudent reserve

While the framers of SGMA seem to have intended that regulatory fees be used for program administration concurrently with the development of a GSP, Section 10730 of the Water Code does not dictate that this authority is lost once a GSP is submitted to the Department of Water Resources. There are examples of GSAs utilizing regulatory fees for general program administration both before and after GSP submittal. Although there are questions regarding whether the cost of items such as groundwater monitoring and groundwater model maintenance can be paid for by funds from regulatory fees, one can make the argument that they can be included in the cost of "program administration." It is imperative that legal counsel be consulted to ensure that the methodology and implementation of a regulatory fee aligns with California law.

In reference to regulatory fees, Section 10730 also specifies that "a groundwater sustainability agency may impose fees, including, but not limited to, permit fees and fees on groundwater extraction or other regulated activity."

Other ideas to consider include:

- Parcel-based Administration Fee,
- Water Company Service Fee
- Irrigated Acres Fee
- Remediation Fee for over-pumping.
- Augmentation Fee on over users to pay to import water.

### REVENUE GENERATION POTENTIAL

Traditionally, regulatory fees have been used to obtain full recovery of costs associated with eligible activities such as inspections and permits. Various other costs associated with GSP implementation, such as groundwater monitoring, annual reporting, and model maintenance are likely also eligible to be funded by regulatory fees. Table 5 below models rates and revenue generated using a hypothetical flat annual rate for each type of well.

Note: de minimis users are not charged in this model. (Number and types of wells is an approximate count for the Ukiah Valley Basin)

TABLE 5 — MODEL OF ESTIMATED USAGE RATE AND REVENUE FOR REGULATORY FEE ON WELLS

**Basin Wells**

| | Approx. Number | Low Range | | High Range | |
|---|---|---|---|---|---|
| | | Rate | Revenue | Rate | Revenue |
| Agricultural | 117 | $685.00 | $80,145 | $1,200.00 | $140,400 |
| Industrial | 11 | $685.00 | $7,535 | $1,200.00 | $13,200 |
| Municipal | 70 | $685.00 | $47,950 | $1,200.00 | $84,000 |
| Domestic | 1,058 | $0.00 | $0 | $0.00 | $0 |
| Other (Monitoring, injection,etc.) | 1,606 | $0.00 | $0 | $0.00 | $0 |
| **Total** | **2,862** | | **$135,630** | | **$237,600** |
| | Revenue Goals: | | $135,000 | | $235,000 |

Also, a regulatory fee could be established based upon water drawn out of the basin (which would require of measuring of flow), as modelled in Table 6, below.

Note: de minimis users are not charged in this model. (Acre feet based on estimates for The Ukiah Valley Basin)

TABLE 6 — MODEL OF USAGE RATE AND REVENUE FOR REGULATORY FEE ON ACRE-FEET

**Basin Wells**

| | Approx. Acre Feet | Low Range | | High Range | |
|---|---|---|---|---|---|
| | | Rate | Revenue | Rate | Revenue |
| Agricultural | 5,000 | $21.00 | $105,000 | $36.00 | $180,000 |
| Industrial | 500 | $21.00 | $10,500 | $36.00 | $18,000 |
| Municipal | 1,000 | $21.00 | $21,000 | $36.00 | $36,000 |
| Domestic | 500 | $0.00 | $0 | $0.00 | $0 |
| Other (Monitoring, injection,etc.) | 100 | $0.00 | $0 | $0.00 | $0 |
| **Total** | **7,100** | | **$136,500** | | **$234,000** |
| | Revenue Goals: | | $135,000 | | $235,000 |

ADVANTAGES

- Quick and inexpensive to implement. No noticing nor balloting is required.
- Revenue generation is sufficient to offset significant costs of certain key activities.
- Legally rigorous as long as fees are for eligible activities.
- Efficient administration.

CHALLENGES

- Potential for "push back" from affected well owners against fees.
- Potential legal scrutiny if fee covers non-eligible activities.
- Do not typically apply to infrastructure operations and capital costs.

## IF ADDITIONAL REVENUE IS NEEDED

To be clear, this technical memorandum is recommending that (if the costs of GSP implementation necessitate it) the Agency consider either a Non-balloted Property Related Fee on Well Owner parcels or a Special Tax on all property owners in the basin, but likely not both, unless the financial need is very significant.

## PROPERTY-RELATED FEE – (NON- BALLOTED) ON WELL OWNERS

Property-related fees were first described in 1996's Proposition 218, (which is manifested as Section 6 of Article XIII D of the California Constitution) and are commonly used today to fund water, sewer, solid waste and even storm drainage. They are most commonly referred to as a "water charge or a "sewer charge," etc., but are technically a property-related fee.

Proposition 218 imposes certain procedural requirements for imposing or increasing property related fees. There are two distinct steps: 1.) a mailed noticing of all affected property owners (well owners in this case) and 2.) a mailed balloting on all affected property owners requiring a 50% approval for adoption.

### A REALLY IMPORTANT EXEMPTION ELIMINATES THE BALLOTING REQUIREMENT

Proposition 218 goes on to exempt fees for water, sewer and refuse collection from the second step – the balloting. Hence, a property-related fee imposed on well owners' properties would be exempt from the balloting requirement. This is very significant because it reduces costs and political risk and lessens willingness-to-pay limitations.

California Water Code Provides Additional Clarity in 10730.2

California Water Code, Division 6., Part 2.74., Chapter 8. Financial Authority [10730 - 10731] provides considerable direction and authority to local governments tasked with groundwater sustainability regarding property-related fees.

In particular, Section 10730.2 (c) in the water code states:

*"Fees imposed pursuant to this section shall be adopted in accordance with subdivisions (a) and (b) of Section 6 of Article XIII D of the California Constitution."*

Section 6 of Article XIII of the California Constitution describes the specific requirements of the implementation of a property related fee, and most importantly, refers to subdivision (a) as the noticing requirement, (b) as the limitations on fees and services, and subdivision (c) as the balloting requirement. Hence, by omission of (c) in Section 10730.2, balloting is not required for property related fees for groundwater sustainability.

### PROPERTY RELATED FEE IMPLEMENTATION PROCESS

As described above, only the first step of the two-step process applies to property related fees in this context. That step is the noticed public hearing. Once the Agency has determined the fees they wish to impose, they must mail a written notice to each affected property owner at least 45 days prior to the public hearing. During that time, and up until the conclusion of the hearing, any affected property owner may file a written protest opposing the proposed fees. If the owners of a majority of the affected parcels file a written protest, the agency cannot impose the fee (known as a "majority protest"). If a majority protest is not formed, the agency may impose the fees.

Also, Section 10730.2 of the California Water Code includes several unique requirements that should be carefully followed when implementing property related fees for GSP implementation.

### REQUIRED DOCUMENTS FOR A PROPERTY RELATED FEE

- Mailed Notices of Rate Proposal/Opportunity to Protest/Public Hearing.
- Fee Report and Presentation for Public Hearing.
- Report to Governing Board (assumes < 50% protest).
- Ordinance or Resolution Adopting Fees (assumes >50% support).

### FLEXIBILITY OF METHODOLOGY

Long standing use of property related fees for water charges support relatively flexible use of this approach to fund a wide range of GSP implementation activities.

<u>SGMA and Property Related Fees</u>

Section 10730.2 (a) of the California Water Code dictates that once a GSA adopts a GSP, it "may impose fees on the extraction of groundwater from the basin to fund costs of groundwater management, including, but not limited to, the costs of the following:"

(1) Administration, operation, and maintenance, including a prudent reserve.
(2) Acquisition of lands or other property, facilities, and services.
(3) Supply, production, treatment, or distribution of water.
(4) Other activities necessary or convenient to implement the plan.

Section 10730.2 (c) states that "fees imposed pursuant to this section shall be adopted in accordance with subdivisions (a) and (b) of Section 6 of Article XIII D of the California Constitution," which refers to the legal framework for property related fees. This reference to property related fees, along with the stipulation that such fees be imposed after GSP submittal, would seem to indicate that that the framers of SGMA intended for property related fees to fund GSA costs after GSP submittal. Given the flexibility of their use, property related fees align well with near and long-term GSP implementation.

This section also specifies that "fees imposed pursuant to this section may include fixed fees and fees charged on a volumetric basis, including, but not limited to, fees that increase based on the quantity of groundwater produced annually, the year in which the production of groundwater commenced from a groundwater extraction facility, and impacts to the basin."

Other ideas to consider include:

- Parcel-based Administration Fee.
- Water Company Service Fee
- Irrigated Acres Fee
- Remediation Fee for over-pumping.
- Augmentation Fee on over users to pay to import water.

### REVENUE GENERATION POTENTIAL

Two potential revenue methodologies are modelled below based upon the use of a property related fee. Table 7 models rates meeting revenue goals generated using a hypothetical flat annual rate of between $685.00 and $825.00 per year per well for agricultural, industrial and municipal wells, and $0.00 to $27.50 per year for domestic and other wells. (Number and types of wells is approximate for the Ukiah Valley Basin)

TABLE 7 — MODEL OF ESTIMATED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON WELLS

**Basin Wells**

| | Approx. Number | Low Range | | High Range | |
|---|---|---|---|---|---|
| | | Rate | Revenue | Rate | Revenue |
| Agricultural | 117 | $685.00 | $80,145 | $825.00 | $96,525 |
| Industrial | 11 | $685.00 | $7,535 | $825.00 | $9,075 |
| Municipal | 70 | $685.00 | $47,950 | $825.00 | $57,750 |
| Domestic | 1,058 | $0.00 | $0 | $27.50 | $29,095 |
| Other (Monitoring, injection,etc.) | 1,606 | $0.00 | $0 | $27.50 | $44,165 |
| **Total** | **2,862** | | **$135,630** | | **$236,610** |
| | Revenue Goals: | | $135,000 | | $235,000 |

Also, a property related fee could be established meeting revenue goals based upon water drawn out of the basin (which would require of estimating or measuring of flow), ranging from $19.00 to $33.00 per acre foot per year, as modelled in Table 8, below:

TABLE 8 — MODEL OF USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON ACRE-FEET

Model of Usage Rate and Revenue for Property Related Fee on Acre-Feet

**Basin Wells**

| | Approx. Acre Feet | Low Range | | High Range | |
|---|---|---|---|---|---|
| | | Rate | Revenue | Rate | Revenue |
| Agricultural | 5,000 | $19.00 | $95,000 | $33.00 | $165,000 |
| Industrial | 500 | $19.00 | $9,500 | $33.00 | $16,500 |
| Municipal | 1,000 | $19.00 | $19,000 | $33.00 | $33,000 |
| Domestic | 500 | $19.00 | $9,500 | $33.00 | $16,500 |
| Other (Monitoring, injection,etc.) | 100 | $19.00 | $1,900 | $33.00 | $3,300 |
| **Total** | **7,100** | | **$134,900** | | **$234,300** |
| | Revenue Goals: | | $135,000 | | $235,000 |

ADVANTAGES

- Revenue generation is likely sufficient to fund all GSP implementation costs.
- Legally rigorous. Property related fees are the described in the Water Code for funding groundwater sustainability.
- Process is exempt from a balloting, and the likelihood of a 50% protest is not likely.

- Cost of implementation is relatively low and includes a fee study, a mailing and additional outreach.
- Efficient administration.

CHALLENGES

- Politically challenging. Many well owners within the Ukiah Valley Basin have made it clear that they prefer the costs be allocated to all properties within the basin and not just the well owners. Well owners exert significant political influence within the basin. Although a balloting is not required, well owners may be able to stop the process legislatively or possibly could attain a 50% protest, which would force a balloting.
- Unfamiliar Process. One potential criticism of the property-related fee is that property owners are generally unfamiliar with the process, and opponents can exploit this. However, with the recent dramatic increase in voting by mail in California, this is less of a major issue. Nonetheless, political opponents can exploit this unfamiliarity and focus the public's attention on the Proposition 218 process, and away from the proposed groundwater sustainability goals and messaging.

## A NOTE ON REGULATORY AND PROPERTY RELATED FEES

As noted in the sections above, regulatory fees and property related fees share some similarities as well as some important distinctions. Overall advantages and disadvantages of each are reviewed below for comparison:

Regulatory Fees

There are more limitations on what regulatory fees can be used to fund. Although many aspects of GSP implementation have not been legally tested under the laws surrounding regulatory fees, there are GSAs currently using them to fund general program administration. However, it is clear that regulatory fees *cannot* fund capital projects or grant writing, both of which may be crucial to GSP implementation. The need for alternative funding for such endeavors should be evaluated by the Agency.

Implementation of regulatory fees is somewhat faster, having no requirement of 45 days' notice or protest hearing. It should be noted, however, that the lack of a protest hearing lessens opportunity for community input. This may place more political pressure on the Agency. Additionally, the fee report for regulatory fees is slightly less comprehensive, requiring only that a fair and reasonable relationship to use be established.

Property Related Fees

Property related fees are far less limited in what they can pay for- virtually all aspects of GSP implementation would be eligible. There is ample case law supporting the use of property related fees for all activities related to groundwater management including operations, maintain and capital improvements.

Implementation of property related fees requires a 45-day notice and protest hearing, which adds more time to the process. It should be noted that the protest hearing provides more opportunity for community input, which also lends itself to political legitimacy. Additionally, property related fees require a more comprehensive fee report, one that establishes a nexus between the fee and its use.

## SPECIAL TAX ON ALL PROPERTY OWNERS IN THE BASIN

Special taxes are decided by registered voters and almost always require a two-thirds majority for approval. Traditionally, special taxes have been decided at polling places corresponding with general and special elections. Special taxes are well known to Californians but are not as common as property related fees for funding of water-related services and infrastructure activities.

As a reminder, this technical memorandum is recommending that (only if the costs of GSP implementation requires it) the Agency consider either a Non-balloted Property Related Fee on Well Owner parcels or a Special Tax (described below) on all property owners in the basin, but likely not both, unless the financial need is very significant.

### PARCEL BASED TAXES

Many special taxes are conducted on a parcel basis with a uniform “flat” rate across all parcels, or varied rates based upon property attributes such as use and/or size. Parcel taxes based upon the assessed value of a property are not allowed. Parcel based taxes (as opposed to sales taxes, etc.) are the most viable type of special tax for funding water-related activities. As such, most discussion of special taxes in this report will focus on parcel taxes.

### SPECIAL TAX IMPLEMENTATION PROCESS

Public agencies typically work with special consultants familiar with the administrative and political aspects of proposing a special tax to a community. Special tax elections held at polling places are conducted on the statutorily designated dates (typically in November for the general election and either March or June for the primary).

If the Agency ultimately decides to pursue a special tax, it is highly recommended that a special all-mail election be considered. Special all-mail ballot elections are often less expensive and allow for more optimization of the election date, as well as having the advantage of presenting a single issue to the voters.

### REQUIRED DOCUMENTS FOR A PARCEL BASED SPECIAL TAX

- Ordinance or Resolution stating: tax type, tax rates, collection method, election date and services provided
- Notice to the Registrar of Voters of measure submitted to voters
- Measure Text including:
    - Ballot question (75 words or less)
    - Full ballot text (300 words or less) including rate structure
    - Arguments in favor or against and independent analysis

- Tax Report

### FLEXIBILITY OF METHODOLOGY

There is considerable flexibility in tax methodology. The Agency could propose a flat tax rate in which all parcels are charged the same or a "tiered approach" where, for example larger, and/or commercial parcels may be taxed more than vacant lots. If a tiered approach is considered, the Agency should consider using existing Community Facilities District ("CFD") law and practice which better defends the use of a tiered structure.

### REVENUE GENERATION POTENTIAL

A detail breakdown of the parcel attributes including number of parcels, number of residential units (for multi-family parcels) and acres for agricultural parcels in the Ukiah Valley Basin is shown in Table 9, below:

TABLE 9 — PARCEL ATTRIBUTES WITHIN THE UKIAH VALLEY BASIN

| Use | Parcels | Residential Units | Acres |
|---|---|---|---|
| Single Family | 6,746 | 6,746 | 7,659 |
| Multi: 2 - 4 units | 233 | 466 | 120 |
| Mobile Home | 500 | 500 | 879 |
| Commercial/Industrial | 922 | NA | 1,929 |
| Vacant | 651 | NA | 1,379 |
| Parking & Storage | 85 | NA | 168 |
| Multi: 5+ units | 251 | 1,255 | 208 |
| Agricultural | 796 | NA | 16,864 |
| Timber & Pasture | 115 | NA | 3,252 |
| Mobile Home Park | 47 | NA | 174 |
| **Totals** | **10,346** | **8,967** | **32,632** |

Next, we have modelled hypothetical rates to generate the revenue goals in Table 10, below. This model shows that revenue goals could be met based upon taxes ranging from $9.50 to $17.50 per parcel per year for most parcel uses, and $1.75 to $4.00 per acres for agricultural and timber/pasture uses.

### TABLE 10 — MODEL OF TAX RATE AND REVENUES FOR SPECIAL TAX

| | Parcels | Residential Units | Acres | Low Range | | High Range | | Units |
|---|---|---|---|---|---|---|---|---|
| Single Family | 6,746 | 6,746 | 7,659 | $9.50 | $64,087 | $17.50 | $118,055 | *per residential unit* |
| Multi: 2 - 4 units | 233 | 466 | 120 | $9.50 | $4,427 | $17.50 | $8,155 | *per residential unit* |
| Mobile Home | 500 | 500 | 879 | $9.50 | $4,750 | $17.50 | $8,750 | *per residential unit* |
| Commercial/Industrial | 922 | NA | 1,929 | $9.50 | $8,759 | $17.50 | $16,135 | *per parcel* |
| Vacant | 651 | NA | 1,379 | $9.50 | $6,185 | $17.50 | $11,393 | *per parcel* |
| Parking & Storage | 85 | NA | 168 | $9.50 | $808 | $17.50 | $1,488 | *per parcel* |
| Multi: 5+ units | 251 | 1,255 | 208 | $9.50 | $11,923 | $17.50 | $4,393 | *per residential unit* |
| Agricultural | 796 | NA | 16,864 | $1.75 | $29,513 | $4.00 | $67,457 | *per acre* |
| Timber & Pasture | 115 | NA | 3,252 | $1.75 | $5,691 | $4.00 | $13,007 | *per acre* |
| Mobile Home Park | 47 | NA | 174 | $9.50 | $447 | $17.50 | $823 | *per parcel* |
| **Totals** | **10,346** | **8,967** | **32,632** | | **$136,587** | | **$249,655** | |
| | | | | Revenue Goals: | **$135,000** | | **$235,000** | |

### ADVANTAGES

- Revenue generation is likely sufficient to fund all GSP implementation costs if voter approved.
- Legally rigorous. Special taxes, if approved by two-thirds of the registered voters within a community, are very reliable and very rarely legally challenged successfully. Special tax revenue has not been subject to state level "take-aways" like ERAF.
- Well known. Most property owners are aware and comfortable with (but not necessarily supportive of) the special taxes and the special tax process.
- Efficient administration

### CHALLENGES

- Political support at required rate and revenue may be difficult. Generally speaking, the two-thirds majority threshold for approval is very politically challenging. Special taxes are subject to significant outside influence from media and opposition groups during voting and are more vulnerable to other measures and candidates that share the ballot. (However, a recent California Supreme Court decision called the "Upland Case" allows for certain types of special taxes to be approved with a more easily achievable 50% threshed. The Agency should evaluate the pros and cons of the effectiveness of an "Upland Tax.")

### GENERAL OBLIGATION BONDS SUPPORTED BY A SPECIAL TAX

In California, special taxes can be linked directly to the sale of general obligation bonds to finance the construction of infrastructure. In 2004, the City of Los Angeles successfully passed "Measure O" which provided funding for a variety of capital improvements related to water quality. Arguably, voters are more likely to support general obligation bond special taxes than parcel-based taxes at equivalent rates.

However, since special taxes for general obligations bonds can only be used for the financing of capital improvements, this mechanism could only be used to fund the CIP portion of the needs – not the operating costs of the groundwater management infrastructure.

In other words, the passage of a G.O. Bond would not satisfy the Agency's overall groundwater management funding goals, because this source could not fund ongoing operations and maintenance. However, it is possible that community priorities and a revised funding strategy could dictate that pursuit of a G.O. bond measure is optimal to fund any significant groundwater management capital projects. Results of the public opinion survey should help guide this decision.

## OTHER APPROACHES – LESS OPTIMAL

### BALLOTED PROPERTY-RELATED FEE OR BENEFIT ASSESSMENTS ON ALL PROPERTY OWNERS IN THE BASIN

If the Agency decides to pursue a revenue mechanism applied to well owners, a non-balloted property related fee is optimal, and if the Agency decides to pursue a revenue mechanism applied to all property owners in the basin, a special tax is most likely the best choice. However, there are two other approaches described in Proposition 218 worthy of discussion, especially if voter support is marginal: 1.) a balloted property related fee or 2.) a benefit assessment. Both of these are more expensive to implement and administer and are considerably less legally rigorous (especially with no current precedent) than a special tax. Nonetheless, both require only a 50% approval for implementation. Further research and evaluation would need to be pursued.

## OTHER CONSIDERATIONS

### CONDUCT A SURVEY IF CONSIDERING A PROPERTY-RELATED FEE OR SPECIAL TAX

See a full discussion in the next section.

### IMPLEMENT RIGOROUS COMMUNITY OUTREACH IF CONSIDERING A PROPERTY-RELATED FEE OR SPECIAL TAX

See a full discussion in the next section.

### TIMING AND SCHEDULE

The selection of the balloting date is one of the most important factors affecting the success of any measure. Potential competition with other measures, income and property tax due dates, seasons, and holidays, etc. should all be evaluated when choosing a balloting date.

### A COST ESCALATOR IS RECOMMENDED FOR BALLOTED MECHANISMS

Non-balloted funding mechanisms can be updated periodically using the noticed public hearing procedure described above. This is the typical method of keeping revenues aligned with costs through the years as in the case for retail water and sewer fees. Accordingly, the rates can be kept updated for inflationary forces and other cost increases on a five-year recurrence cycle.

However, for balloted mechanisms, any increase or change in rate structures requires a re-balloting unless the original balloting included a pre-determined formula for escalation – such as the Consumer Price Index (CPI). Infrastructure-intensive utilities are driven by many different forces than those that drive the CPI, including the need for capital investment programs, regulatory programs, and the economics of sustainability, conservation, and commodity constraints. Due, in part, to these other drivers, rates for utilities have not traditionally been tied to a straightforward CPI, but rather have been expressed as a specific rate amount for a given year based on actual projected costs. Nonetheless, costs do increase over time and a cost escalator is recommended to reimburse the Agency for this increase. The simplest to explain to property owners and to administer annually is a CPI, based upon a readily available index such as the U.S. Department of Labor, which would allow for annual rate increases without annual balloting. A CPI escalator is legally defensible with property related fees, regulatory fees, and special taxes.

However, a CPI approach may make it difficult to accommodate infrastructure-driven cost increases in coming years. An alternative approach would be to include a rate adjustment schedule that would include specific increases in future years that meet the UVBGAS's needs. (This approach, commonly used by water and sewer providers, often communicates to the property owner in table form with the proposed rate corresponding to each year for the next four or five years.)

At this point in the process, it is difficult to make a concise recommendation for the escalator mechanism. It would depend on the escalating costs and how they affect the proposed rates in the foreseeable future. It would also depend in part on the proposed rate structure itself, as some structures may be based on variables that intrinsically accommodate increasing groundwater management needs. Finally, it would depend on the political considerations that come with any ballot measure. Historically, the majority of survey data supports the fact that a CPI escalator introduces minimal decay in overall support.

### A SUNSET PROVISION IS NOT RECOMMENDED, BUT SHOULD BE CONSIDERED

A "Sunset Provision" is a mechanism used to increase political support by setting an expiration date for a measure, and can be used with a property related fee, regulatory fee, or tax. Sunset provisions typically range from five years to as much as 20 years in some rare cases. However, the political advantage may be slight and does not outweigh the negative aspect of the increased costs and political risk of having to re-ballot at the termination of the sunset period.

One variation is the "sundown" clause. This is the name given to a tax or fee that would reduce after a specific date – leaving a portion of the tax or fee to continue indefinitely. This tactic is useful for programs that have a one-time capital need and then would reduce to fund only operations and maintenance beyond that. If the one-time capital need is debt financed, the "sundown" period would need to be at least as long as the debt repayment period.

### A "DISCOUNT MECHANISM" SHOULD BE CONSIDERED, BUT MAY NOT BE COST-EFFECTIVE

Consistent with the efforts of obtaining higher quality groundwater, a discount or "rate reduction" program should be considered which rewards well owners implementing groundwater sustainability management measures on their properties with a lower fee, based on the reduced cost of providing groundwater service. Any such program would need to be coordinated with whatever rate structure the Agency decides on to ensure that it fits with the rationale and is compliant with Proposition 218.

The advantages of such a program include improved water quality, improved engagement by the community, as well as a rate more tailored to individual usage. Also, discount programs tend to be well received by the electorate, although most people do not participate. The downside of such a program is that the benefit may not justify the cost of administering this program, because the inspection of property-specific improvements is expensive and time consuming. Nonetheless, a couple of public agencies including the cities of Portland, Oregon, South Lake Tahoe, and Palo Alto have successfully implemented discount programs on their storm drainage fees. The community's interest level for a discount mechanism will be evaluated as part of the mail survey opinion research.

# III. RECOMMENDATIONS FOR IMPLEMENTATION OF FUNDING MECHANISMS

Following is a "Game Plan" outline of the recommended steps for implementation of funding for the UVBGAS' GSP implementation. Most of the steps have been discussed above – a discussion of community public opinion surveying and community outreach is included below.

## GAME PLAN

1. Conduct community outreach regarding the Plan and its implementation.
2. Pursue use of existing revenue sources to fund implementation.
3. Pursue Grants and Loan Opportunities to fund implementation.
4. Implement Regulatory Fees to offset eligible implementation costs.

If additional revenue is needed:

5. Conduct a survey and stakeholder outreach to better evaluate:
    a. Community priorities and associated messaging.
    b. Optimal rate.
    c. Preference of non-balloted property related fee versus special tax.
6. Use results of surveys, stakeholder input and other analyses to develop a community outreach plan.
7. Implement the community outreach.
8. Implement a property related fee or special tax balloting:
    a. Include a cost escalator schedule or mechanism.
    b. Include the use of rate zones or other distinguishing factors.
    c. Do not include a rate expiration date (also known as a "Sunset Clause").
    d. Include a Discount Program to encourage better groundwater management by well owners.

## CONSIDER A PUBLIC OPINION SURVEY

The primary purpose of the public opinion survey is to produce an unbiased, statistically reliable evaluation of voters' and property owners' interest in supporting a local revenue measure. Should the Agency decide to move forward with a revenue measure (property-related fee or special tax), the survey data provides guidance as to how to structure the measure so that it is consistent with the community's priorities and expressed needs. Agencies typically engage specialized survey firms to conduct surveys.

Specifically, the survey should:

- Gauge current, baseline support for a local revenue measure associated with specific dollar amounts. (How much are well owners/property owners willing to pay?)
- Identify the types of services and projects that voters and property owners are most interested in funding.
- Identify the issues voters and property owners are most responsive to (e.g., preventing subsidence, maintaining water availability, reducing pumping costs, protecting water quality, etc.).

- Expose respondents to arguments in favor of—and against—the proposed revenue measure to gauge how information affects support for the measure.
- Identify whether local residents prefer the measure as a property related fee or a special tax.

As the nation struggles with the COVID-19 pandemic, it is more important than ever to measure a community's position on all of these elements. What community leaders thought they knew about public opinion may no longer be accurate in a post-COVID world. And while a survey can provide the Agency with valuable information, it will also be an opportunity to begin getting the groundwater "brand" out into the community – a valuable early step in this process.

## COMMUNITY SUPPORT AND ENGAGEMENT

Clear, concise, and appropriate community outreach is one of the most important elements for successful implementation of a funding mechanism. The basic message components need to be simple, clear, and transparent, and need to be well supported with detailed and substantive information. Credibility is the most important factor in this outreach.

Agencies often, but not always, will engage specialized consultants to assist with community outreach in support of implementation of funding mechanisms. A community outreach plan should be developed and implemented. Three major steps are described blow.

### Develop Communication Infrastructure

The UVBGSA should carefully evaluate and develop potential communication infrastructure, ultimately coordinating with existing communication infrastructure, including stakeholder contacts, print media, website, social media, print publications, neighborhood groups, and newsletters, etc. Use of e-mail contacts (with HOA, neighborhood and stakeholder groups and leaders, and web-based platforms like nextdoor.com is encouraged). Develop a schedule of community stakeholder meetings, due dates for local group newsletters, etc.

In most cases, the most effective communication mechanisms for this type of infrastructure are small, local, and neighborhood-based, with personal communication or face-to-face (as appropriate in COVID-19 environment). This approach is not expensive, but it is a significant amount of work and is very effective when well-executed.

### Develop Communication Messaging

The development of the messaging and supporting information is an iterative process with staff, consultant, and community members. (If a community survey is conducted, it can be extremely helpful in developing the most effective messaging.) Throughout this process, the Agency and consultant will analyze and refine messaging associated with groundwater sustainability management benefits. In this task, the Agency should develop draft communications of various types, including Frequently Asked Questions documents, social media content, mailers and brochures, PowerPoint presentations, and e-mails, scripts, and other adaptable messages.

<u>Communications Rollout and Implementation</u>

Once the outreach plan is well-vetted, reviewed, and refined, the Agency should coordinate the plan's rollout and implementation.