$$\frac{DC_{Gaged}}{DC_{Gaged} + FK}\ x\ Pixley_{Total\ Basin\ Rech} = DC_{Basin\ Rech}$$

Where:

DC_{Gaged}	=	Gaged flow through Trenton Weir (acre-ft).
FK	=	Imported water delivered to the Pixley Irrigation District from the Friant-Kern Canal (acre-ft).
$Pixley_{Total\ Basin\ Rech}$	=	Total Pixley Irrigation District basin recharge from annual water use summaries (acre-ft).
$DC_{Basin\ Rech}$	=	Basin recharge in Pixley Irrigation District attributed to native Deer Creek water (acre-ft).

Managed recharge of diverted Deer Creek water is not included in the Sustainable Yield of the overall Tule Subbasin.

Managed Recharge of Imported Water

Managed recharge of imported water is accomplished via multiple recharge facilities within the Porterville Irrigation District, LTRID, Pixley Irrigation District, Tea Pot Dome Water District and DEID. Managed recharge attributed to imported water in the LTRID is estimated as follows:

$$\frac{FK}{TR_{Gaged} + FK}\ x\ LTRID_{Total\ Basin\ Rech} = LTRID_{Imp\ Basin\ Rech}$$

Where:

TR_{Gaged}	=	Sum of gaged flow at Below Oettle Bridge, Woods Central Diversion, Poplar Irrigation Company flow reaching LTRID, and Porter Slough at 192 (acre-ft).
FK	=	Imported water delivered to the LTRID from the Friant Kern Canal (acre-ft).
$LTRID_{Total\ Basin\ Rech}$	=	Total LTRID basin recharge from annual water use summaries (acre-ft).
$LTRID_{Imp\ Basin\ Rech}$	=	Basin recharge in LTRID attributed to imported water (acre-ft).

Managed recharge of imported water in the Pixley Irrigation District is estimated as follows:

$$\frac{FK}{DC_{Gaged} + FK}\ x\ Pixley_{Total\ Basin\ Rech} = Pixley_{Imp\ Basin\ Rech}$$

Where:

DC_{Gaged}	=	Gaged flow through Trenton Weir (acre-ft).
FK	=	Imported water delivered to the Pixley Irrigation District from the Friant Kern Canal (acre-ft).
$Pixley_{Total\ Basin\ Rech}$	=	Total Pixley Irrigation District basin recharge from annual water use summaries (acre-ft).
$Pixley_{Imp\ Basin\ Rech}$	=	Basin recharge in Pixley Irrigation District attributed to imported water (acre-ft).

Imported water delivered to recharge in basins for DEID, Porterville Irrigation District and Tea Pot Dome Water District will be provided by each district.

Managed recharge of imported water is not included in the Sustainable Yield of the overall Tule Subbasin.

Recharge of Recycled Water in Basins

Most of the recycled water generated by the City of Porterville is used for agricultural irrigation. From time to time, some of the recycled water is delivered to basins in the Old Deer Creek Channel where it infiltrates into the subsurface to become groundwater recharge. Basin recharge of recycled water will be based on data provided by the City of Porterville. Managed recharge of recycled water in basins is not included in the Sustainable Yield of the overall Tule Subbasin.

3.7.2.2.5 *Deep Percolation of Applied Water*

Deep Percolation of Applied Tule River Diversions

Deep percolation of applied Tule River water for irrigating agriculture will be applied to the various land uses in the Tule Subbasin according to the irrigation method (e.g. drip irrigation, flood irrigation, micro sprinkler, etc.) for each land use type reported in DWR on-line land use maps. Irrigation efficiencies will be applied to the different irrigation methods based on tables reported in California Energy Commission (2006)[3].

Tule River water is diverted for agricultural irrigation by the Pioneer Water Company, Porter Slough Headgate, Porter Slough Ditch Company, Campbell and Moreland Ditch Company, Vandalia Water District, Hubbs and Miner Ditch Company, Poplar Irrigation Co., Woods Central Ditch Company, Porter Slough Below 192, and Below Oettle Bridge. Application of the appropriate deep percolation rate will depend on the crop types receiving native Tule River water and the associated irrigation methods. In the LTGSA, estimation of the volume of applied water attributed to native Tule River water is based on the following:

[3] California Energy Commission, 2006. PIER Project Report: Estimating Irrigation Water Use for California Agriculture: 1950s to Present. May 2006.

$$\frac{TR_{Gaged}}{TR_{Gaged} + FK} \; x \; LTRID_{Total\ Deliveries} = TR_{App\ Water}$$

Where:

TR_{Gaged}	=	Sum of gaged flow at Below Oettle Bridge, Woods Central Diversion, Poplar Irrigation Company flow reaching LTRID, and Porter Slough at 192 (acre-ft).
FK	=	Imported water delivered to the LTRID from the Friant Kern Canal (acre-ft).
$LTRID_{Total\ Deliveries}$	=	Total LTRID deliveries (i.e. “Sales”) from annual water use summaries (acre-ft).
$TR_{App\ Water}$	=	Volume of applied native Tule River water in the LTRID (acre-ft).

Deep percolation is calculated as the applied water ($TR_{App\ Water}$) multiplied by the appropriate percent deep percolation depending on the crop type receiving the water and the associated irrigation method.

Deep percolation of applied native Tule River water is not included in the Sustainable Yield of the overall Tule Subbasin.

Deep Percolation of Applied Deer Creek Diversions

The portion of native Deer Creek water delivered for agricultural use within the PIXID GSA is estimated using the following equation:

$$\frac{DC_{Gaged}}{DC_{Gaged} + FK} \; x \; Pixley_{Total\ Deliveries} = DC_{App\ Water}$$

Where:

DC_{Gaged}	=	Gaged flow through Trenton Weir (acre-ft).
FK	=	Imported water delivered to the Pixley Irrigation District from the Friant Kern Canal (acre-ft).
$Pixley_{Total\ Deliveries}$	=	Total Pixley Irrigation District deliveries (i.e. “Sales”) from annual water use summaries (acre-ft).
$DC_{App\ Water}$	=	Applied water in Pixley Irrigation District from native Deer Creek River water (acre-ft).

Deep percolation is estimated as the applied water ($DC_{App\ Water}$) multiplied by the appropriate percent deep percolation depending on the crop type receiving the water.

Deep percolation of applied native Deer Creek water is not included in the Sustainable Yield of the overall Tule Subbasin.

Deep Percolation of Applied Imported Water

Deep percolation of imported water delivered and applied to crops within the LTGSA is based on the following equation:

$$\frac{FK}{TR_{Gaged} + FK}\ x\ LTRID_{Total\ Deliveries} x\ DP_{Factor} = DP_{LTRID\ FK}$$

Where:

TR_{Gaged}	=	Sum of gaged flow at Below Oettle Bridge, Woods Central Diversion, Poplar Irrigation Company flow reaching LTRID, and Porter Slough at 192 (acre-ft).
FK	=	Imported water delivered to the LTRID from the Friant Kern Canal (acre-ft).
$LTRID_{Total\ Deliveries}$	=	Total LTRID deliveries (i.e. "Sales") from annual water use summaries (acre-ft).
DP_{Factor}	=	Deep percolation factor that varies from 0.06 to 0.33 depending on the type of crop receiving the imported water (see Section 3.7.1.1.2.3.4) (unitless).
$DP_{LTRID\ FK}$	=	Deep percolation of imported water applied to crops in the LTRID (acre-ft).

Deep percolation of imported water delivered and applied to crops within the PIXID GSA is based on the following equation:

$$\frac{FK}{DC_{Gaged} + FK}\ x\ Pixley\ ID_{Total\ Deliveries} x\ DP_{Factor} = DP_{Pixley\ ID\ FK}$$

Where:

DC_{Gaged}	=	Deer Creek at Trenton Weir (acre-ft).
FK	=	Imported water delivered to the Pixley ID from the Friant Kern Canal (acre-ft).
$Pixley\ ID_{Total\ Deliveries}$	=	Total Pixley ID deliveries (i.e. "Sales") from annual water use summaries (acre-ft).
DP_{Factor}	=	Deep percolation factor that varies from 0.06 to 0.33 depending on the type of crop receiving the imported water (see Section 3.7.1.1.2.3.4) (unitless).
$DP_{Pixley\ ID\ FK}$	=	Deep percolation of imported water applied to crops in Pixley Irrigation District (acre-ft).

Deep percolation of imported water delivered and applied to crops in DEID, Porterville Irrigation District, Saucelito Irrigation District, Tea Pot Dome Water District, Alpaugh Irrigation District, Angiola Water District, and Atwell Island Water District shall be estimated as the delivered water, minus water delivered to basins, multiplied by the appropriate percent deep percolation factor.

Deep percolation of applied imported water is not included in the Sustainable Yield of the overall Tule Subbasin.

Deep Percolation of Applied Recycled Water

Deep percolation of recycled water applied to crops will be estimated using the deep percolation factors described earlier in this section. Deep percolation of applied recycled water is not included in the Sustainable Yield of the overall Tule Subbasin.

Deep Percolation of Applied Native Groundwater for Agricultural Irrigation

The balance of agricultural irrigation demand not met by imported water or stream diversions is assumed to be met by groundwater pumping. Groundwater extraction will be calculated based on the methods described in Section 3.3. Deep percolation of applied water from groundwater pumping will be based on the types of crops on which the water is applied and will be calculated using the deep percolation factors discussed earlier in this section. Deep percolation of applied water from agricultural groundwater pumping is included in the Sustainable Yield of the overall Tule Subbasin.

Deep Percolation of Applied Native Groundwater for Municipal Irrigation

Deep percolation of applied water for landscape irrigation was estimated for the urbanized portions of the Tule Subbasin. All municipal water demand is met from groundwater pumping. For the City of Porterville, landscape irrigation was estimated to be 47 percent of the total water delivered to each home based on an analysis of the total groundwater production and influent flows to the wastewater treatment plant (City of Porterville draft Urban Water Management Plan 2010 Update, 2014). Of the water used for irrigation, 25 percent is assumed to become deep percolation and groundwater recharge. Deep percolation of applied water from municipal groundwater pumping is included in the Sustainable Yield of the overall Tule Subbasin.

For the other smaller communities in the Tule Subbasin, wastewater discharge is assumed to be through individual septic systems. For water discharged to septic systems, it is assumed that 100 percent of the discharge becomes deep percolation and groundwater recharge. As with the City of Porterville, 47 percent of total water use was assumed to be for landscape irrigation and 25 percent of the landscape irrigation is assumed to become deep percolation.

3.7.2.2.6 *Evapotranspiration*

Evapotranspiration of Precipitation from Crops and Native Vegetation

Evapotranspiration (ET) is the loss of water to the atmosphere from free-water evaporation, soil-moisture evaporation, and transpiration by plants. Evapotranspiration of precipitation is assumed to be the difference between total precipitation (Section 3.7.1.1.1.1) and areal recharge from precipitation (Section 3.7.1.1.2.1). This value includes evapotranspiration of precipitation from crops as well as native vegetation.

Evapotranspiration of Surface Water Within the Tule River Channel

Evapotranspiration of surface water within the Tule River channel is a function of the ET rate and wetted channel surface area. The ET rate was based on published data for riparian vegetation in an intermittent stream and applied to channel segments with similar average width based on aerial photographs (Google Earth). The ET rate was applied to the surface area of each reach to obtain an estimate of ET. The sum of reach by reach ET estimates between Lake Success and the western Tule Subbasin boundary represents the total Tule River ET.

Evapotranspiration of Surface Water Within the Deer Creek Channel

Evapotranspiration within the Deer Creek channel was estimated using the same methodology as described for the Tule River Channel.

Evapotranspiration of Surface Water Within the White River Channel

Evapotranspiration in the White River channel was estimated using the same methodology as described for the Tule River Channel.

Evapotranspiration of Recycled Water in Basins

Evapotranspiration of recycled water delivered to basins will be provided by the City of Porterville.

Agricultural Consumptive Use

Crop consumptive use may be estimated using one of the methods described in Section 3.3.1.

Municipal Consumptive Use

Consumptive use of landscaping associated with applied municipal groundwater pumping will be estimated based on the methods described in Section 3.5.1.2.2.

3.7.2.2.7 *Surface Water Flow Out of the Subbasin*

Tule River

Any residual stream flow in the Tule River that reaches the Turnbull Weir, located at the west (downstream) end of the Tule Subbasin, is assumed to flow out of the subbasin. Outflow through the Turnbull Weir is documented in the TRA annual reports. Exports of Tule River water to the Friant-Kern Canal will be the same as reported in TRA annual reports.

Deer Creek

During periods of above-normal precipitation, residual stream flow left in the Deer Creek after diversions has historically flowed into Homeland Canal, located at the west end of the Tule Subbasin. The data for this outflow is currently unavailable. As this data becomes available, it will be incorporated into the surface water budget.

3.7.3 Groundwater Budget

The groundwater budget describes the sources and estimates the volumes of groundwater inflow and outflow within the Tule Subbasin. The difference between the sum of inflow terms and the sum of outflow terms is the change in groundwater storage (ΔS). A fundamental premise of the groundwater budget is the following relationship:

Inflow – Outflow = +/- ΔS

Sources of recharge (inflow terms) in the groundwater budget include:

1. Areal recharge from precipitation.
2. Recharge within stream and river channels.
3. Managed recharge in basins.
4. Canal infiltration.
5. Deep percolation of applied municipal and agricultural irrigation.
6. Release of water from compression of aquitards.
7. Subsurface inflow.
8. Mountain-Front Recharge.

It is noted that many of the groundwater inflow terms are surface water outflow terms. The groundwater budget includes the following sources of discharge (outflow terms):

1. Municipal groundwater pumping.
2. Agricultural groundwater pumping.
3. Groundwater pumping for export out of the subbasin.
4. Evapotranspiration.
5. Subsurface outflow.

3.7.3.1 *Sources of Recharge*

3.7.3.1.1 *Areal Recharge*

Groundwater recharge from precipitation falling on the valley floor in the Tule Subbasin will be estimated for each GSA as described in Section 3.7.1.1.2.1. Areal recharge of the groundwater system from precipitation is included in the Sustainable Yield of the overall Tule Subbasin.

3.7.3.1.2 *Tule River*

Groundwater recharge of native Tule River water occurs as streambed infiltration, infiltration of water in unlined canals, recharge in basins, and deep percolation of applied water.

The methods for estimating the volumes of Tule River water that become groundwater recharge are described in Section 3.7.1.1.2.

3.7.3.1.3 *Deer Creek*

Groundwater recharge of native Deer Creek water occurs as streambed infiltration, canal loss, recharge in basins, and deep percolation of applied water. The methods for estimating the volumes of Deer Creek water that become groundwater recharge are described in Section 3.7.1.1.2.

3.7.3.1.4 *White River*

Groundwater recharge of White River water occurs as streambed infiltration as described in Section 3.7.1.1.2.

3.7.3.1.5 *Imported Water Deliveries*

Groundwater recharge of imported water occurs as canal loss, recharge in basins, and deep percolation of applied water as described in Section 3.7.1.1.2.

3.7.3.1.6 *Recycled Water*

Groundwater recharge of recycled water occurs as artificial recharge and deep percolation of applied water as described in Section 3.7.1.1.2.

3.7.3.1.7 *Deep Percolation of Applied Water from Groundwater Pumping*

A portion of irrigated agriculture and municipal applied water from groundwater pumping becomes deep percolation and groundwater recharge as described in Sections 3.7.1.1.2.8.1 and 3.7.1.1.2.8.2.

3.7.3.1.8 *Release of Water from Compression of Aquitards*

As land subsidence due to groundwater withdrawal is considered an undesirable result, the ultimate goal of the Tule Subbasin TAC is to reduce it to de minimis levels. In the meantime, in order to produce a representative water balance, the volume of water released to the aquifer as a result of subsidence can be estimated using the methods described in Section 3.8.

3.7.3.1.9 *Subsurface Inflow*

The subsurface inflow and outflow along the southern, western and northern boundaries of the Tule Subbasin as well as the internal boundaries between each GSA will be evaluated as needed using either of the following methodologies:

Flow Net Analysis

A flow net analysis is applied to groundwater elevation contours developed for both the shallow and deep aquifers. The groundwater elevation contours will be based on measured groundwater levels at designated monitoring wells with perforations specific to each aquifer. After developing the groundwater contours, flow lines that are perpendicular to the groundwater elevation contours will be equally spaced along the boundary of the Subbasin or GSA.

For the shallow aquifer, which is conceptualized as being unconfined, subsurface inflow/outflow will be estimated using the Dupuit Equation, which is expressed as:

$$Q = 0.5K\left(\frac{(h_1 - h_2)^2}{L}\right)$$

Where:

Q	=	Subsurface flow, (acre-ft)
K	=	Hydraulic Conductivity, (ft/day)
h_1	=	Initial Hydraulic head, (ft amsl)
h_2	=	Ending Hydraulic head, (ft amsl)
L	=	Flow Length (ft)

For the deep aquifer, which is conceptualized as being semi-confined/confined, subsurface inflow/outflow will be estimated using the Darcy Equation, which is expressed as:

$$Q = KA\left(\frac{dh}{dl}\right)$$

Where:

Q	=	Subsurface flow, (acre-ft)
K	=	Hydraulic Conductivity, (ft/day)
A	=	Aquifer Cross-Sectional Area, (ft^2)
$\frac{dh}{dl}$	=	Hydraulic gradient

As the groundwater flow lines into and out of the subbasin/GSA may not occur at right angles to the subbasin/GSA boundary, it will be necessary to correct the subsurface flow by the angle (degrees) of the flow line relative to the basin boundary. This will be conducted by multiplying the subsurface inflow value by the sine of the angle of flow relative to the boundary.

Groundwater Flow Model

TH&Co has prepared a calibrated groundwater flow model of the Tule Subbasin. The model is capable of calculating the subsurface inflow and outflow to/from the subbasin boundaries and/or each GSA boundary. In order to develop updated subsurface inflow/outflow values for the water budget, the model will be updated annually with groundwater extractions, recharge values, and groundwater levels. The model calibration will be validated with the measured data and adjusted periodically. Once the updated model is validated, it can be used to estimate the subsurface inflow/outflow at each subbasin boundary and each GSA boundary.

3.7.3.1.10 *Mountain-Front Recharge*

Mountain-front recharge represents the infiltration of precipitation into the fractures in the bedrock east of the Tule Subbasin, which eventually flows into the alluvial aquifer system in the subsurface where the fractured rock aquifer system is in hydrologic communication with the alluvial aquifer system. Estimates of mountain-block recharge will be developed using the calibrated groundwater flow model.

3.7.3.2 Sources of Discharge

3.7.3.2.1 *Municipal Groundwater Pumping*

Groundwater pumping data for municipal supply is metered and will be provided by the individual cities within the Tule Subbasin, as described in Section 3.7.1.1.1.5

3.7.3.2.2 *Agricultural Groundwater Pumping*

Agricultural groundwater production will be estimated as described in Section 3.3.

3.7.3.2.3 *Groundwater Pumping for Export Out of the Tule Subbasin*

The volume of groundwater that is pumped and exported out of the subbasin on a quarterly basis will be provided by Angiola Water District and the Boswell/Creighton Ranch.

3.7.3.2.4 *Subsurface Outflow*

The subsurface outflow at the Tule Subbasin boundaries and/or GSA boundaries will be estimated using one of the methods described in Section 3.7.1.2.1.9.

3.7.4 Quality Assurance and Control

The water budget will be completed and updated by each GSA using professionals working under the direct supervision of a California Registered Professional Civil Engineer, Professional Geologist, or Certified Hydrogeologist. All GSA water budgets will be subject to review by the Tule Subbasin TAC's technical consultant.

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IV. Sustainable Management Criteria (§357.4(b)(3)(C))

Pursuant to 23 Cal. Code Regs. §357.4(b)(3)(C), the coordination agreement shall describe how the GSAs have used the same data and methodologies for estimating sustainable yield for the basin. The description shall be supported by a description of undesirable results for the basin, and an explanation of how the minimum thresholds and measurable objectives defined by each Plan relate to those undesirable results, based on information described in the basin setting.

4.1 Introduction (Reg. § 354.22)

Pursuant to 23 Cal. Code Regs. §354.22, this Chapter describes criteria that constitute sustainable groundwater criteria for the Tule Subbasin[4], including its sustainability goal and the characterization and definition of undesirable results for each applicable sustainability indicator.

4.2 Sustainability Goal (§ 354.24)

Pursuant to 23 Cal. Code Regs. §354.24, the Sustainability Goal of the Tule Subbasin is defined as the absence of undesirable results, accomplished by 2040 and achieved through a collaborative, Subbasin-wide program of sustainable groundwater management by the various Tule Subbasin GSAs.

Achievement of this goal will be accomplished through the coordinated effort of the Tule Subbasin GSAs in cooperation with their many stakeholders. It is further the goal of the Tule Subbasin GSAs that coordinated implementation of their respective GSPs will achieve sustainability in a manner that facilitates the highest degree of collective economic, societal, environmental, cultural, and communal welfare and provides all beneficial uses and users the ability to manage the groundwater resource at least cost. Moreover, this coordinated implementation is anticipated to ensure that the sustainability goal, once achieved, is also maintained through the remainder of the 50-year planning and implementation horizon, and well thereafter.

In achieving the Sustainability Goal, these GSPs are intended to balance average annual inflows and outflows of water by 2040 so that long term negative change in storage does not occur after 2040, with the ultimate goal being avoidance of undesirable results caused by groundwater conditions throughout the Subbasin. The stabilization of change in storage should also drive stable groundwater elevations, which, in turn, works to inhibit water quality degradation and arrest land subsidence.

4.2.1 Sustainable Yield

Chapter 2.3.2.6 of the *Tule Subbasin Setting* estimates the projected Sustainable Yield for the Tule Subbasin to be approximately 130,000 acre-ft/yr (see ***Table 2-4,*** *Tule Subbasin Setting*).

The term "Sustainable Yield" for the purposes of SGMA and GSPs developed under SGMA is defined by Water Code §10721(w) as: "*the maximum quantity of water, calculated over*

[4] The Tule Subbasin is designated by the California Department of Water Resources as Basin No. 5-22.13 and is also abbreviated herein as the "Subbasin".

a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result."

Within the Tule Subbasin, the Sustainable Yield includes the natural channel losses in the natural streams, precipitation, subsurface inflow and subsurface outflow, mountain front subsurface inflow, and return flow of applied water not subject to recapture (by virtue of a Water Right). The components not included in the estimate of the Tule Subbasin's Sustainable Yield are described below from the Tule Subbasin Setting:

"It is noted that sources of groundwater recharge in the subbasin that are associated with pre-existing water rights and/or imported water deliveries are not included in the Sustainable Yield estimate. These recharge sources include:

Diverted Tule River water canal losses, recharge in basins, and deep percolation of applied water, Diverted Deer Creek water canal losses, recharge in basins, and deep percolation of applied water, Imported water canal losses, recharge in basins, and deep percolation of applied water, and Recycled water deep percolation of applied water and recharge in basins." (Tule Subbasin Setting)

The sources of groundwater recharge that are not included in the Subbasin Sustainable Yield calculations are intended to be accounted for by each GSA.

As noted above, for purposes of establishing the water budget pursuant to 23 Cal. Code Regs. §354.18, the GSAs in the Tule Subbasin have agreed that the Sustainable Yield for the Subbasin shall be divided amongst the GSAs for purposes of development of their GSPs as described in the attached water budget (**Attachment 2**). The basin-wide portion of the Sustainable Yield identified in the water budget was divided amongst each GSA by multiplying that GSA's proportionate areal coverage of the Tule Subbasin times the total Subbasin Sustainable Yield.

The water budget, as divided amongst the GSAs, is not an allocation or final determination of any water rights (including without limitation any claimed appropriative or prescriptive rights). This understanding is consistent with §10720.5(b) of SGMA, which provides that nothing in SGMA or in a plan adopted under SGMA determines or alters surface or groundwater rights under common law or any provision of law that determines or grants water rights. Rather, for practical reasons and in keeping with SGMA limitations with respect to determining water rights and the statutory deadlines for GSP submittal, the use of the proportional acreage basis for dividing up the water budget—among the Tule Subbasin GSAs—was used because it represents the most readily-available and implementable manner of accounting for the water budget for GSA-specific GSP preparation purposes at this time.

The GSAs will be collecting additional data during the GSP implementation period and will consider refining or changing the method of dividing Sustainable Yield for water budget purposes in future GSP updates. The division of Sustainable Yield among the GSAs under this Coordination Agreement does not constitute any determination that groundwater extractions within a GSA in excess of a budgeted amount would cause an undesirable result or that extractions less than a budgeted amount would not cause an undesirable result. The water budget division also does not require any GSA to implement particular projects or management actions.

4.3 Undesirable Results (Reg. § 354.26)

Pursuant to 23 Cal. Code Regs. §357.26, the GSAs agree on the following processes and criteria to define undesirable results applicable to the Subbasin. Undesirable Results are caused by groundwater conditions occurring throughout the basin that, for any sustainability indicator, are considered significant and unreasonable. These conditions, or sustainability indicators, include:

- Chronic lowering of groundwater levels indicating a depletion of supply if continued over the planning and implementation horizon;
- Reduction of groundwater storage;
- Seawater intrusion;
- Degraded water quality, including the migration of contaminant plumes that impair water supplies;
- Land subsidence that substantially interferes with surface land uses; and
- Depletions of interconnected surface water that have adverse impacts on beneficial uses.

The process to identify the conditions that constitute significant and unreasonable conditions in the Tule Subbasin was informed through:

- Research and documentation of the hydrogeological conceptual model of the subbasin (see Attachment 1);
- Development of a calibrated numerical groundwater flow model of the subbasin for use in estimating sustainable yield and analyzing the effects of projects and management actions on future groundwater levels and land subsidence (see Attachment 3);
- Analysis of potential future groundwater levels, land subsidence, and groundwater quality throughout the subbasin for use in assessing significant and unreasonable groundwater conditions and identifying sustainable management criteria (see Attachments 4, 5, and 6).

Based on analysis of the hydrogeological conceptual model, four sustainability indicators were identified with potential to cause significant and unreasonable effects within the Tule Subbasin. These indicators are:

- Chronic lowering of groundwater levels indicating a depletion of supply if continued over the planning and implementation horizon;
- Reduction of groundwater storage;
- Degraded water quality, including the migration of contaminant plumes that impair groundwater supplies; and
- Land subsidence that substantially impacts critical infrastructure.

The definitions of undesirable results for each of these sustainability indicators are provided in the following subsections along with the criteria used to define them.

Based on groundwater level and land subsidence projections from the Tule Subbasin groundwater flow model and analysis of potential impacts of the additional groundwater level decline and land subsidence projected for the transition period from 2020 to 2040 (see Attachments 4 and 6), each GSA developed Sustainable Management Criteria for each of the sustainability indicators to avoid undesirable results in consideration of the beneficial uses of groundwater and the beneficial users of these supplies and facilities:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Supply
- Critical Infrastructure, including the Friant-Kern Canal (FKC)

The Sustainable Management Criteria identified to avoid undesirable results were vetted through a public process that included multiple stakeholder workshops, meetings, and document review. While the sustainable management criteria are protective of undesirable results for most beneficial uses and users, during the transition period between 2020 and 2040, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

Each individual GSA may further refine the Sustainable Management Criteria in its GSP based on GSA-specific information and considerations as long as it includes the above-described beneficial uses/users and undesirable results and provides explanations in support of its minimum thresholds and other criteria in a manner meeting SGMA requirements.

4.3.1 Chronic Lowering of Groundwater Levels

4.3.1.1 *Causes of Groundwater Conditions That Could Lead to Undesirable Results (§354.26(b)(1))*

Groundwater levels in the Tule Subbasin have shown a general chronic lowering since approximately 1987. Without management actions to arrest this trend, the groundwater resource in the subbasin is not sustainable, which is an undesirable result. The primary cause of groundwater conditions that have led to chronic lowering of groundwater levels is groundwater production in excess of natural and artificial recharge over a multi-year period that includes both wetter than average and drier than average conditions. This condition has been exacerbated during natural drought-cycles when access to imported water supplies is restricted and groundwater production increases. Restricted access to imported surface water can occur due to a variety of factors, including but not limited to, increased requirements in the Delta, which may increase the likelihood imported supplies from Millerton Lake will be delivered outside the Tule Subbasin. Climate change may also affect the availability and rate upon which natural and artificial recharge is available.

4.3.1.2 *Criteria to Define Undesirable Results (§354.26(b)(2))*

The GSA's have determined that continued chronic lowering of groundwater levels below those needed to accommodate continued pumping during the transitional period of temporary overdraft is an undesirable result, as that condition is considered unsustainable. Further, lack of access to water supplies for all beneficial uses and users due to lowered groundwater levels is considered significant and unreasonable and, therefore, an undesirable result.

These significant and unreasonable conditions in the subbasin were informed through:

- Development of a detailed hydrogeologic conceptual model of the subbasin (see

Attachment 1)

- Development of a calibrated numerical groundwater flow model of the subbasin (see Attachment 3)
- Analysis of potential future groundwater levels using the model and incorporating each GSA's planned projects and management actions, and
- Comparison of model-forecasted groundwater levels with the best available information on well depths in the subbasin (see Attachment 4).

Each GSA has followed a public process through stakeholder workshops, Technical Advisory Committee meetings, and meetings of individual GSA Board of Directors to communicate potential undesirable results and receive feedback from the various beneficial uses and users of groundwater within its jurisdictional area. Based on the best available data collected to date and groundwater model analysis, each GSA identified groundwater level conditions designed to reasonably protect access to groundwater for the majority of beneficial users. For those uses such as shallow domestic well owners where impacts to groundwater access may occur, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

Aside from mitigation provisions for impacted beneficial uses, the quantitative definition of undesirable results for chronic lowering of groundwater levels indicating continued overdraft conditions is the lowering of the groundwater elevation below the minimum threshold at an RMS in any given GSA for the area and beneficial uses and users associated with that RMS. This condition would indicate that more aggressive management actions were needed by the GSA to mitigate the overdraft.

4.3.1.3 *Potential Effects on Beneficial Uses and Users (§354.26(b)(3))*

Using the above-described criteria, the GSAs evaluated potential undesirable results to agricultural, domestic, industrial, and municipal beneficial uses. Overall, based on forecasting of future groundwater levels using a calibrated numerical groundwater flow model of the Tule Subbasin and the best available data, the projects and management actions to be implemented by each GSA are predicted to decelerate and arrest chronic lowering of groundwater levels by 2040. Potential impacts to wells associated with groundwater level declines in the transition period between 2020 and 2040 were evaluated through an analysis of well depths in the Tule Subbasin (see Attachment 4). Potential effects of lowered groundwater levels on the various beneficial uses of groundwater in the Tule Subbasin, in the context of the groundwater modeling and analysis of well depths, are as follows:

Agricultural

Potential effects to agricultural beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4).

Domestic

Some domestic uses and users of groundwater may be impacted by continued lowering of groundwater levels during the transition period from January 2020 to December 2040. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4). Lowering groundwater levels below the total depth of shallow domestic wells could lead to added costs to haul in water supplies, tie into other available supplies, consolidation with existing water service providers, or requiring other form of mitigation

Industrial

Potential effects to industrial beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4).

Municipal

Potential effects of lowered groundwater levels on municipal beneficial uses and users of groundwater include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4). All of the potentially impacted wells are in the City of Porterville. The City of Porterville has indicated that these potential effects can be mitigated through management actions by distributing pumping in such a way as to avoid the impacts.

To address potential effects on agricultural, domestic and industrial beneficial uses and ensure access to water until the Subbasin reaches a sustainable groundwater level condition, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

4.3.2 Reduction of Groundwater Storage

4.3.2.1 *Causes of Groundwater Conditions That Could Lead to Undesirable Results (§354.26(b)(1))*

The primary cause of groundwater conditions that have led to the reduction in groundwater in storage observed in the Subbasin since 1987 is groundwater production in excess of natural and artificial recharge over a multi-year period that includes both wetter than average and drier than average conditions. This condition, if allowed to continue indefinitely into the future, will not allow for the support of the beneficial uses and users of the Subbasin and is considered an undesirable result.

4.3.2.2 *Criteria to Define Undesirable Results (§354.26(b)(2))*

The GSA's have determined that continued chronic depletion of groundwater in storage below that which is needed to accommodate continued pumping during the transitional period of temporary overdraft is an undesirable result, as that condition is considered unsustainable. Further, lack of access to water supplies for all beneficial uses and users due to depletion of groundwater in storage is considered significant and unreasonable and, therefore, an undesirable result.

These significant and unreasonable conditions in the subbasin were informed through:

- Development of a detailed hydrogeologic conceptual model of the subbasin (see Attachment 1)
- Development of a calibrated numerical groundwater flow model of the subbasin (see Attachment 3)
- Analysis of potential future groundwater levels using the model and incorporating

each GSA's planned projects and management actions, and
- Comparison of model-forecasted groundwater levels with the best available information on well depths in the subbasin (see Attachment 4).

The groundwater level conditions established to protect access to groundwater for the majority of beneficial users form the basis for the conditions used to define an unreasonable depletion of groundwater in storage. Thus, the maximum theoretical amount of groundwater that can be removed from storage in the transition period from 2020 to 2040, including implementation of the proposed projects and management actions, is the volume of groundwater that would be removed if Upper Aquifer groundwater levels were lowered to the minimum thresholds across the Subbasin. For those uses such as shallow domestic well owners where depletion of groundwater in storage causes impacts, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

Each GSA has followed a public process through stakeholder workshops, Technical Advisory Committee meetings, and meetings of individual GSA Board of Directors to communicate potential undesirable results and receive feedback from the various beneficial uses and users of groundwater within its jurisdictional area.

4.3.2.3 *Potential Effects on Beneficial Uses and Users (§354.26(b)(3))*

Using the above-described criteria, the GSAs evaluated potential undesirable results to agricultural, domestic, industrial, and municipal beneficial uses. Overall, based on forecasting of future groundwater levels using a calibrated numerical groundwater flow model of the Tule Subbasin and the best available data, the projects and management actions to be implemented by each GSA are predicted to decelerate and arrest chronic depletion of groundwater in storage by 2040. Potential impacts to wells associated with groundwater storage declines in the transition period between 2020 and 2040 were evaluated through an analysis of well depths in the Tule Subbasin (see Attachment 4). Potential effects of lowered groundwater storage on the various beneficial uses of groundwater in the Tule Subbasin, in the context of the groundwater modeling and analysis of well depths, are as follows:

Agricultural

Potential effects to agricultural beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4). In extreme circumstances, agricultural well owners may be forced to share use of wells or facilities with other lands or landowners.

Domestic

Some domestic uses and users of groundwater may be impacted by continued lowering of groundwater levels during the transition period from January 2020 to December 2040. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4). Lowering groundwater levels below the total depth of shallow domestic wells could lead to added costs to haul in water supplies, tie into other available supplies, consolidation with existing water service providers, or requiring other form of mitigation

Industrial

Potential effects to industrial beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4).

Municipal

Potential effects of lowered groundwater levels on municipal beneficial uses and users of groundwater include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Attachment 4). All of the potentially impacted wells are in the City of Porterville. The City of Porterville has indicated that these potential effects can be mitigated through management actions by distributing pumping in such a way as to avoid the impacts.

To address potential effects on agricultural, domestic and industrial beneficial uses and ensure access to water until the Subbasin reaches a sustainable groundwater level condition, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7..

4.3.3 Degraded Water Quality

4.3.3.1 *Causes of Groundwater Conditions That Could Lead to Undesirable Results (§354.26(b)(1))*

Pursuant to 23 Cal. Code Regs. §354.26(b)(1), degraded water quality can occur for a variety of reasons, some reasons that are not a result of GSP implementation. An undesirable result would be the significant and unreasonable degradation of groundwater quality due to groundwater pumping and recharge projects such that the quality of groundwater is no longer generally suitable for agricultural and/or domestic use. For the purposes of SGMA, degraded water quality causation will include those changes to groundwater quality resulting from the implementation of a GSP. These significant and unreasonable conditions in the subbasin were informed through the evaluation outlined in Attachment 5.

Projects and management actions will be implemented by each GSA in order to decelerate and arrest the degradation of groundwater quality caused by irrigation and septic return flows or lowering of groundwater elevations within the Tule Subbasin by 2040.

4.3.3.2 *to Define Undesirable Results (§354.26(b)(2))*

Pursuant to 23 Cal. Code Regs. §354.26(b)(2), the criteria for an undesirable result for the degradation of groundwater quality is defined as the exceedance of a minimum threshold at a groundwater quality RMS in any given GSA resulting from the implementation of a GSP. This condition would indicate that more aggressive management actions were needed to mitigate the overdraft.

Measurement Methodology: Utilize Data collected by others (Public Water Systems, Irrigated Lands Regulatory Program, other Regulated Dischargers) at the RMS well sites identified in

Attachment 1. Groundwater degradation will be evaluated relative to established Maximum Contaminate Levels (MCL) or the agricultural constituents of concern (COC) by applicable regulatory agencies. The metrics for degraded water quality shall be measured for compliance—MCL or the agricultural water quality objective (WQO)—depending on the dominant beneficial use or user of groundwater determined at each RMS well (see **Attachment 1**). These metrics will address the following constituents where applicable to the beneficial use or user:

- Arsenic
- Nitrate
- Hexavalent Chromium
- Dibromochloropropane (DBCP)
- 1,2,3-Trichloropropane (TCP)
- Tetrachloroethylene (PCE)
- Sodium
- Chloride
- Perchlorate
- Total Dissolved Solids (TDS)

4.3.3.3 *Potential Effects on Beneficial Uses and Users (§354.26(b)(3))*

Pursuant to 23 Cal. Code Regs. §354.26(b)(3), the following beneficial uses and users of groundwater may be impacted by the Minimum Thresholds:

- Municipal, Small Community, Underserved Communities, and Domestic Well Sites
- Agricultural Supply

Generally, the avoidance of an undesirable result for degraded groundwater quality is to protect the those using the groundwater, which varies depending on the beneficial use of the groundwater. Degraded groundwater quality may impact crop growth or impact drinking water systems, both of which would cause additional expense of treatment to obtain suitable water. To address impacts to beneficial uses and users as a result of minimum threshold exceedances for degraded water quality at RMS wells, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

4.3.4 Land Subsidence

4.3.4.1 *Causes of Groundwater Conditions That Could Lead to Undesirable Results (§354.26(b)(1))*

Land subsidence in the Tule Subbasin is caused by prolonged pumping induced groundwater level declines in portions of the Subbasin with substantial thicknesses of fine-grained deposits beneath the water table. The chronic lowering of groundwater levels throughout the Subbasin since 1987 has contributed to historical land subsidence that has caused reduced flow capacity in the Friant-Kern Canal (FKC). Continued lowering of groundwater levels during the transition period from 2020 to 2040 has the potential to result in additional land subsidence in various parts of the Subbasin resulting in impacts to gravity-driven conveyance facilities, changes in flood control conditions, and damage to roads and other surface infrastructure.

4.3.4.2 *Criteria to Define Undesirable Results (§354.26(b)(2))*

Land subsidence that occurs during the transition period from 2020 to 2040 will be considered significant and unreasonable if damage and/or loss of functionality of a structure or a facility occurs to the extent that the structure or facility cannot reasonably operate without either repair or replacement, as determined by the GSA where the structure and facility are located or where beneficial use is impacted due to the damage and/or loss of functionality of the structure or facility. Any land subsidence occurring after 2040 that is not attributable to recoverable compaction is considered an undesirable result. It is acknowledged that residual land subsidence resulting from historical groundwater conditions may occur after 2040. Additional studies and data are needed to assess the rate and extent of residual land subsidence that could occur after 2040 and the potential for this subsidence to cause undesirable results.

The criteria to define undesirable results for land subsidence was developed based on:

- Development of a detailed hydrogeologic conceptual model of the subbasin that included an assessment of the conditions causing land subsidence along the FKC (see Attachment 1)
- Development of a calibrated numerical groundwater flow model of the subbasin that included a land subsidence package for estimating potential future land subsidence (see Attachment 3)
- Analysis of potential future land subsidence using the model and incorporating each GSA's planned projects and management actions (Attachment 3),
- Comparison of the forecasted rate and extent of land subsidence through the transition period from 2020 to 2040 with surface land uses and critical infrastructure throughout the Subbasin (see Attachment 6), and
- Coordination with Friant Water Authority staff and consultants.

Each GSA has followed a public process through stakeholder workshops, Technical Advisory Committee meetings, and meetings of individual GSA Board of Directors to communicate potential undesirable results and receive feedback from the various beneficial uses and users of groundwater within its jurisdictional area.

Groundwater flow model analysis forecast as much as three feet of additional land subsidence at some locations of the FKC during the transition period from 2020 to 2040 (see Attachment 6). Through coordination with the Friant Water Authority staff and consultants, this value became the basis for engineering design modifications to restore canal flow capacity to its original condition. Land subsidence along the canal exceeding three feet was determined to be an undesirable result because it would be beyond what the engineering design could accommodate to restore the flow capacity to its original condition and what the parties to the FWA/ETGSA/Pixley GSA settlement agreement agreed to mitigate.

In other areas of the Tule Subbasin, apart from the FKC, the rate and extent of land subsidence forecast by the groundwater flow model for the 2020 to 2040 transition period was the basis for establishing undesirable results (see Attachment 6). In most areas of the Tule Subbasin, the GSAs determined that the forecasted land subsidence during the transition period, which was of a similar magnitude to what had been historically measured, was not anticipated to result in undesirable results to land uses or critical infrastructure because no undesirable results had previously been reported as a result of historical land subsidence in those areas. Nonetheless, for unforeseen impacts due to land subsidence during this period, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

Aside from mitigation provisions for impacted land uses, the quantitative definition of undesirable results for land subsidence is ongoing land subsidence below the minimum threshold at any given RMS Site that cannot be attributable to recoverable land subsidence, as described in Attachment 6.

Additional land subsidence beyond that forecast for the transition period was considered an undesirable result as long as it was not attributable to recoverable land subsidence from seasonal changes in groundwater levels.

4.3.4.3 *Potential Effects on Beneficial Uses and Users (§354.26(b)(3))*

In the Tule Subbasin, the most common structures impacted by land subsidence from groundwater withdrawal are surface water conveyance canals where the elevation of a segment of the canal drops faster than other segments, resulting in sags that restrict the ability to deliver water downstream of the impacted area. As an example, land subsidence in the vicinity of the FKC is being monitored and managed under Eastern Tule Groundwater Sustainability Agency's Land Subsidence Monitoring and Management Plans.

Potentially impacted land uses in the Tule Subbasin have been divided into high priority land uses and low priority land uses.

High priority land uses are those that are potentially impacted by regional land subsidence regardless of if there is differential land subsidence. These high priority land uses include:

- Gravity-Driven Water Conveyance
  - Canals
  - Turnouts
  - Stream Channels
  - Water Delivery Pipelines
  - Basins
- Wells
- Flood Control Infrastructure

Low priority land uses are not typically impacted by regional land subsidence but are susceptible to differential land subsidence if it occurs. Based on the available information, these land uses have not been impacted by the regional land subsidence that has historically occurred in the Tule Subbasin. Similarly, the additional land subsidence that is projected to occur in the transition period from 2020 to 2040, and upon which the Minimum Thresholds were established, is not anticipated to result in significant and unreasonable impacts to these land uses as greater subsidence has occurred in these areas historically than projected during the period between 2020 and 2040 (see Attachment 6). The low priority land uses include:

- Highways and Bridges
- Railroads
- Other Pipelines
- Wastewater Collection
- Utilities
- Buildings

Damage to infrastructure and other land uses in the Tule Subbasin from land subsidence could result in financial impacts to beneficial users of groundwater associated with fixing the damaged infrastructure and providing alternative means to meet the services provided by such infrastructure until they are fixed.

To address potential impacts due to land subsidence, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7. The ETGSA and Pixley GSA have entered into a settlement agreement with the FWA to mitigate the cost to repair sections of the FKC within ETGSA associated with land subsidence that occurs during the transition period from 2020 to 2040.

Projects and management actions will be implemented by each GSA to reduce land subsidence rates within the Tule Subbasin during the transition period from 2020 to 2040, and minimize land subsidence after 2040. This will include measures necessary to minimize land subsidence significantly and unreasonably affecting the functionality or a structure or facility, such as the FKC.

4.3.5 Depletion of Interconnected Surface Waters (Regs. §354.26 (d) & §354.28 (e))

No interconnected surface waters have been identified in any Tule Subbasin GSAs as described more thoroughly in relevant portions of the Basin Setting. Thus, no criteria need be established.

4.3.6 Seawater Intrusion (Regs. §354.26 (d) & §354.28 (e))

Seawater intrusion is defined as "the advancement of seawater into a groundwater supply that results in degradation of water quality in the basin and includes seawater from any source." (23 Cal. Code Regs. §351(af).) As described more thoroughly in the basin setting, there is no potential for the advancement of seawater into any portion of the Tule Subbasin. Thus, no criteria need be established.

4.4 Minimum Thresholds (Reg. § 354.28)

A Minimum Threshold is "…the quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with Minimum

Thresholds at other monitoring sites, may cause an undesirable result(s) in the basin…"[5] In consideration of input received through public stakeholders workshops, public Technical Advisory Committee meetings, and individual GSA Board meetings and Stakeholder meetings, each GSA in the Tule Subbasin has established Minimum Thresholds at their representative monitoring sites in consideration of the groundwater beneficial uses and users in their GSA. Minimum Thresholds for groundwater levels and land subsidence were informed, in part, from analysis of forecasted future groundwater levels and land subsidence using the calibrated numerical groundwater flow model of the Tule Subbasin (see Attachment 3). The MTs were then adjusted based on the beneficial uses and users across each of the GSAs.

4.4.1 Groundwater Level Minimum Thresholds

4.4.1.1 *Criteria Used to Establish Minimum Thresholds (§354.28(b)(1))*

Based on the best available data collected to date and groundwater model analysis (see Section 4.3.1.2), each GSA established groundwater level minimum thresholds designed to reasonably protect access to groundwater for the majority of beneficial users. For those uses such as shallow domestic well owners where impacts to groundwater access may occur, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

4.4.1.2 *Relationship to Other Sustainability Indicators (§354.28(b)(2))*

Lowering of groundwater levels is directly related to the sustainability indicators for changes in groundwater in storage and land subsidence. By maintaining groundwater levels above the Minimum Thresholds, undesirable results associated with reduction of groundwater in storage and land subsidence should be minimized.

4.4.1.3 *Relationship to Adjacent Basins (§354.28(b)(3))*

The Minimum Thresholds described in each GSA's GSP have been informed through an analysis of potential future groundwater levels in the Subbasin using a numerical groundwater flow model that incorporates future planned projects and management actions of each of the GSAs. Implementation of the projects and management actions are predicted to stabilize groundwater levels at the Tule Subbasin boundaries and areas immediately adjacent to the Subbasin, as long as the neighboring basins are successful in implementing their respective projects and management actions.

4.4.1.4 *Potential Effects (§354.28(b)(4))*

Maintaining groundwater levels above the Minimum Thresholds for the chronic lowering of groundwater levels is not anticipated to produce undesirable results for the majority of beneficial uses and users of groundwater. Potential effects on beneficial uses from groundwater level declines are described in Section 4.3.1.3. For those uses such as shallow domestic well owners where impacts to groundwater access may occur, each GSA will adopt a Mitigation Program or Programs consistent

[5] DWR, 2017. Best Management Practices for the Sustainable Management of Groundwater – Sustainable Management Criteria. Draft document dated November 2017.

with the Framework attached hereto as Attachment 7.

4.4.1.5 *Relationship with Federal, State, and Local Standards (§354.28(b)(5))*

There are no Federal, State or local standards specific to addressing the chronic lowering of groundwater levels in the Tule Subbasin.

4.4.1.6 *Measurement of Groundwater Levels Relative to Minimum Thresholds (§354.28(b)(6))*

Groundwater levels will be measured at the representative monitoring sites and according to the monitoring schedule described in **Attachment 1**. The status of groundwater levels relative to the Minimum Thresholds will be reported in Annual Reports and Five-Year Reports.

4.4.2 Reduction of Groundwater in Storage Minimum Thresholds

4.4.2.1 *Criteria Used to Establish Minimum Thresholds (§354.28(b)(1))*

The Minimum Threshold for reduction of groundwater in storage is a single value for the entire Tule Subbasin based on the Upper Aquifer Minimum Threshold for groundwater levels. It represents the volume of groundwater that would hypothetically be removed if groundwater levels were lowered to the minimum thresholds across the Subbasin. As lowering the groundwater levels below the Minimum Thresholds is considered indicative of an unsustainable condition and, therefore, an undesirable result, the associated reduction in groundwater in storage is also considered an undesirable result.

4.4.2.2 *Relationship to Other Sustainability Indicators (§354.28(b)(2))*

Reduction of groundwater in storage is directly related to the sustainability indicators for groundwater levels and land subsidence. By maintaining groundwater storage above the Minimum Threshold, undesirable results associated with lowered groundwater levels and land subsidence should be minimized if not eliminated.

4.4.2.3 *Relationship to Adjacent Basins (§354.28(b)(3))*

The Minimum Thresholds described in each GSA's GSP have been informed through an analysis of potential future groundwater levels in the Subbasin using a numerical groundwater flow model that incorporates future planned projects and management actions of each of the GSAs. Implementation of the projects and management actions are predicted to stabilize groundwater levels at the Tule Subbasin boundaries and areas immediately adjacent to the Subbasin, which will stabilize groundwater storage levels, as long as the neighboring basins are successful in implementing their respective projects and management actions.

4.4.2.4 *Potential Effects (§354.28(b)(4))*

Stabilizing groundwater storage levels above the Minimum Threshold is not anticipated to produce undesirable results for the majority of beneficial uses and users of groundwater. Potential effects on beneficial uses from depletion of groundwater in storage is described in Section 4.3.2.3. For those uses such as shallow domestic well owners where impacts to groundwater access may occur, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

4.4.2.5 *Relationship with Federal, State, and Local Standards (§354.28(b)(5))*

There are no Federal, State or local standards specific to addressing the reduction of groundwater in storage in the Tule Subbasin.

4.4.2.6 *Measurement of Groundwater Levels Relative to Minimum Thresholds (§354.28(b)(6))*

Changes in the volume of groundwater in storage will be assessed on an annual basis using the groundwater levels measured at the representative monitoring sites in accordance with the monitoring schedule described in **Attachment 1**.

4.4.3 Groundwater Quality Minimum Thresholds

4.4.3.1 *Criteria Used to Establish Minimum Thresholds (§354.28(b)(1))*

The criteria to establish the minimum thresholds for groundwater quality will be the established Maximum Contaminate Levels (MCL) or the water quality objective (WQO) depending on the dominant beneficial use of groundwater determined at each RMS well (see **Attachment 1**). These metrics will address the following constituents of concern as applicable to the beneficial use or user:

Constituent	Units	Minimum Threshold	
		Drinking Water Limits (MCL/SMCL)	Agricultural WQOs
Arsenic	ppb	10	N/A
Nitrate as N	ppm	10	N/A
Hexavalent Chromium	ppb	10	N/A
Dibromochloropropane (DBCP)	ppb	0.2	N/A
1,2,3-Trichloropropane (TCP)	ppt	5	N/A
Tetrachloroethene (PCE)	ppb	5	N/A
Chloride	ppm	500	106
Sodium	ppm	N/A	69
Total Dissovled Solids	ppm	1,000	450
Perchlorate	ppb	6	N/A

The methodology used to distinguish between the applicability of either MCLs or Ag WQO for setting minimum thresholds at RMS wells is summarized below (detailed in Attachment 5):

- At each RMS well, determine the dominant beneficial use for that monitoring well based on the classification of wells within one mile of the RMS well.
  - If the majority of the beneficial use (greater than 50% the wells within a determined area) is agricultural and there are no public water systems (including schools) the minimum threshold would be a host of agricultural water quality constituents.
  - If an RMS well is located within an urban area, within one mile of a public water system, which includes schools, or the dominant beneficial use (greater than 50% of the wells within the determined area) is drinking water, then the minimum threshold would be set at the MCL for drinking water.
  - In cases where both of the above criteria are found to be true, the minimum thresholds would be established for both drinking water MCLs and Ag WQO's and minimum thresholds would be set at the most stringent of the two when considering common constituents.
  - If drinking water MCLs or Ag WQOs were historically exceeded at an RMS well or found not be a result of implementation of a GSP, the GSA will coordinate with the responsible regulatory agency to prevent GSA SGMA activities from further degrading groundwater quality.

4.4.3.2 *Relationship to Other Sustainability Indicators (§354.28(b)(2))*

Groundwater quality is directly related to the sustainability indicator for change in groundwater storage and lowering of groundwater levels.

4.4.3.3 *Relationship to Adjacent Basins (§354.28(b)(3))*

The Minimum Thresholds for groundwater quality are based upon MCL and WQO established by the State for the beneficial uses and user within the Central Valley of California. Implementation of the projects and management actions within the GSA that may impact degraded groundwater quality will be consistent with the requirements established by the State and therefore would not adversely impact adjacent basins.

4.4.3.4 *Potential Effects (§354.28(b)(4))*

The Minimum Thresholds for the degrading of groundwater quality is not anticipated to produce undesirable results for agricultural, municipal, and industrial beneficial uses. If beneficial uses and users of groundwater have their groundwater quality impacted by GSA actions, each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

4.4.3.5 *Relationship with Federal, State, and Local Standards (§354.28(b)(5))*

The minimum thresholds established are based on the Federal, State and Local Standards for groundwater quality maximum contaminant level (MCL) for drinking water or Agricultural Water

Quality Objective (WQO) based on the beneficial use or user of the groundwater. Each groundwater quality RMS has been designated as representative of drinking water beneficial use, agricultural beneficial use, or both using the criteria defined in Section 4.4.3.1.

4.4.3.6 *Measurement of Groundwater Quality Relative to Minimum Thresholds (§354.28(b)(6))*

Groundwater quality will be measured at the representative monitoring sites and according to the monitoring schedule described in **Attachment 1**. The status of groundwater quality relative to the Minimum Thresholds will be reported in Annual Reports and Five-Year Reports.

4.4.4 Land Subsidence Minimum Thresholds

4.4.4.1 *Criteria Used to Establish Minimum Thresholds (§354.28(b)(1))*

Minimum Thresholds for land subsidence were established throughout the Tule Subbasin based on the best available data collected to date and groundwater model analysis, as described in Section 4.3.4.2.

Groundwater flow model analysis forecast as much as three feet of additional land subsidence at some locations of the FKC during the transition period from 2020 to 2040 (see Attachment 3; Figure 44). Through coordination with the Friant Water Authority staff and consultants, this value became the basis for engineering design modifications to restore canal flow capacity to its original condition. Land subsidence along the canal exceeding three feet was determined to be an undesirable result because it would be beyond what the engineering design could accommodate to restore the flow capacity to its original condition and what the parties to the FWA/ETGSA/Pixley GSA settlement agreement agreed to mitigate. Accordingly, the minimum threshold for land subsidence along the FKC was established at three feet of additional land subsidence after January 2020.

In other areas of the Tule Subbasin, apart from the FKC, the rate and extent of land subsidence forecast by the groundwater flow model for the 2020 to 2040 transition period was the basis for establishing minimum thresholds (see Attachment 6). In most areas of the Tule Subbasin, the GSAs determined that the forecasted land subsidence during the transition period, which was of a similar magnitude to what had been historically measured, was not anticipated to result in undesirable results to land uses or critical infrastructure because no undesirable results had previously been reported as a result of historical land subsidence in those areas. Thus, the maximum amount of land subsidence forecast during the transition period from 2020 to 2040 using the calibrated groundwater flow model is the basis for the land subsidence minimum thresholds throughout the Subbasin.

4.4.4.2 *Relationship to Other Sustainability Indicators (§354.28(b)(2))*

Land subsidence is directly related to the sustainability indicators for lowered groundwater levels and reductions in groundwater in storage. By maintaining groundwater levels above the Minimum Thresholds, undesirable results associated with land subsidence should be minimized.

4.4.4.3 *Relationship to Adjacent Basins (§354.28(b)(3))*

The Minimum Thresholds described in each GSA's GSP have been informed through an analysis of potential future land subsidence in the Subbasin using a numerical groundwater flow model that incorporates future planned projects and management actions of each of the GSAs. Implementation of the projects and management actions, including the mitigation program by participating GSAs, are predicted to stabilize groundwater levels at the Tule Subbasin boundaries and areas immediately adjacent to the Subbasin, as long as the neighboring basins are successful in implementing their respective projects and management actions. Stabilizing groundwater levels will have the effect of minimizing land subsidence.

4.4.4.4 *Potential Effects (§354.28(b)(4))*

Regional land subsidence could result in impacts to gravity-driven water conveyance and other infrastructure. Land uses vulnerable to regional land subsidence are considered high priority and include:

- Gravity-Driven Water Conveyance
    - Canals
    - Turnouts
    - Stream Channels
    - Water Delivery Pipelines
    - Basins
- Wells
- Flood Control

The Tule Subbasin GSAs have developed a mitigation framework for each GSA to utilize to address claims of impact that can be attributed to land subsidence (see Attachment 7). The ETGSA and Pixley GSA have entered into a settlement agreement with the FWA to mitigate the cost to repair sections of the FKC within ETGSA associated with land subsidence that occurs during the transition period from 2020 to 2040 (see ETGSA and Pixley GSA GSPs).

Differential land subsidence and associated damage to infrastructure has not been reported in the Tule Subbasin and is not anticipated to result in adverse impacts to infrastructure or land uses. These land uses are considered low priority, as it relates to land subsidence impacts, and include:

- Highways and Bridges
- Railroads
- Other Pipelines
- Wastewater Collection
- Utilities
- Buildings

Claims of impact related to land subsidence for these categories are more likely to come from public utilities, municipalities, or state agencies whereas each GSA will adopt a Mitigation Program or Programs consistent with the Framework attached hereto as Attachment 7.

4.4.4.5 *Relationship with Federal, State, and Local Standards (§354.28(b)(5))*

There are no Federal, State or local standards specific to addressing land subsidence in the Tule Subbasin.

4.4.4.6 *Measurement of Land Subsidence Relative to Minimum Thresholds (§354.28(b)(6))*

Land elevations will be measured at the representative monitoring sites and according to the monitoring schedule described in **Attachment 1**. Additional monitoring, above and beyond that specified in Attachment 1, will be implemented for the ETGSA Land Subsidence Management Area along the FKC. The status of land subsidence relative to the Minimum Thresholds will be reported in Annual Reports and Five-Year Reports.

4.5 Measurable Objectives (Reg. § 354.30)

Measurable Objectives, including interim milestones in increments of five years, will be quantified at each RMS for each applicable sustainability indicator, defined as the numeric value in 2040, to achieve the sustainability goal in 20-year of plan implementation. Each measurable objective and interim milestones will be defined and described separately by each GSA in the GSP.

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V. MONITORING PROTOCOLS, NETWORKS, AND IDENTIFICATION OF DATA GAPS (§§352.2, 354.32.)

5.1 Monitoring Network and Representative Monitoring (§§354.34-354.36)

The minimum monitoring network to be used to collect data in the Tule Subbasin is described in the Tule Subbasin Monitoring Plan (see **Attachment 1**). The types of data to be collected as part of the plan include:

 Surface water flow Surface water quality Groundwater levels Groundwater quality Land surface elevation from Global Positioning System (GPS) stations Land surface elevation changes from satellite data Land subsidence data from extensometers

The monitoring plan ensures that the data collected within the Subbasin is of sufficient quality, frequency and distribution to provide meaningful results for evaluating changing conditions within the Subbasin and informing the decision-making process.

The minimum monitoring network identified in the Tule Subbasin Monitoring Plan is both flexible and iterative, allowing for the addition or subtraction of monitoring features, as necessary, and to accommodate changes in monitoring frequency and alternative methodologies, as appropriate. Any changes to the minimum monitoring network or monitoring protocols identified in **Attachment 1** shall be approved by the Tule Subbasin TAC.

Individual GSAs may include additional monitoring features, not specifically identified in the Tule Subbasin Monitoring Plan, for collecting data to include in their respective GSPs and Annual Reports. Any monitoring features utilized for the collection of data to be included in GSPs and Annual Reports that are not identified in the Tule Subbasin Monitoring Plan must meet the minimum design and construction requirements specified in Section 3 of this Coordination Agreement and the Tule Subbasin Monitoring Plan. Any monitoring features not in the Tule Subbasin Monitoring Plan that are to be used by a GSA to collect data for incorporation into GSPs or Annual Reports will be shared with the Tule Subbasin TAC.

5.1.1 Procedures for Collecting the Data

The Tule Subbasin Monitoring Plan (**Attachment 1**) includes detailed procedures for the collection of surface water flow data, groundwater elevation data, and land surface elevation data. Groundwater quality data will be coordinated with and through the Irrigated Lands Regulatory Program and the existing coalitions. The data collection procedures will ensure that the data collected have the level of accuracy and precision necessary for evaluating conditions relative to minimum thresholds, estimating change in groundwater storage as required for Annual Reports, and measuring progress toward achieving sustainability. The data collection processes and procedures shall apply to monitoring features specifically identified in the Tule Subbasin Monitoring Plan as well as any additional monitoring features utilized for the collection of data by individual GSAs.

5.1.2 Entities Responsible for Data Collection

All data collection work, as specified in the Tule Subbasin Monitoring Plan (**Attachment 1**) will be performed by each GSA through individuals working under the direct supervision of a California Registered Professional Civil Engineer, Professional Geologist, or Certified Hydrogeologist and who meet the minimum qualifications and training requirements required by the Tule Subbasin TAC's technical consultant. The collection of groundwater quality data will be coordinated with and through the Irrigated Lands Regulatory Program and the existing coalitions. All data will be collected in accordance with the protocols specified in **Attachment 1**.

Nothing in this Agreement prevents multiple GSAs from using the same consultant. It is understood by and among the Parties that there will be individual GSA-specific data that can be collected either through the Tule Subbasin TAC's technical consultant or through the consultant/staff hired by that GSA. The goal is that the data collection be done following the same processes and procedures throughout the Tule Subbasin. If a GSA prefers to use the technical consultant hired by the Tule Subbasin TAC for the purposes of collecting information beyond what is required for Tule Subbasin Monitoring Plan, then that GSA shall pay for the consultant's fees and costs separately and above what the Tule Subbasin GSAs agree to cost share. In the event that a GSA hires its own consultant for site or GSA-specific data collection, such data shall be shared through the data sharing provisions of this Agreement.

All data collected by the GSAs shall be submitted to the Tule Subbasin TAC's technical consultant in accordance with the schedule described in Section 4.1.3 for QA/QC and entry into the Tule Subbasin Water Management Database (see Section 4.3).

5.1.3 How and When Data are Distributed to the GSAs

The complete Tule Subbasin Water Management Database will be available to authorized representatives as set forth by the GSAs of the Tule Subbasin GSAs at any time upon request.

The schedule to distribute data to the individual GSAs for preparation of Annual Reports has been prepared to enable the Tule Subbasin TAC to submit the compiled Annual Reports by the SGMA reporting deadline of April 1 following a water year. As per Groundwater Sustainability Plan Regulations Section 356.2, Annual Reports will include data and analyses for the preceding water year (October 1 through September 30). The distribution of data to the GSAs for the preparation of Annual Reports will be in accordance with the following schedule:

- The Tule Subbasin TAC's technical consultant will update the database between October 1 and January 30 following a subject water year.
- Individual GSAs will be required to submit groundwater extractions (i.e. pumpage) to the technical consultant by January 1 following a subject water year.
- Following Quality Assurance/Quality Control checks by the technical consultant, the previous water year's data will be submitted to each GSA by February 1 so the

GSAs can prepare their respective Annual Reports. The data will be formatted for easy incorporation into Annual Reports and distributed electronically. Annual reports will be submitted to the Tule Subbasin TAC for compilation by March 1 following the preceding water year. All Annual Reports will be submitted to the California Department of Water Resources by April 1 following the preceding water year.

5.2 Assessment and Improvement of Monitoring Network and Identification of Data Gaps (§354.38.)

The Tule Subbasin TAC will periodically evaluate the monitoring network in **Attachment 1** to determine if there are data gaps that could affect the ability of the Subbasin to meet its sustainability goals. Current data gaps are identified in **Attachment 1**. Every five years, the Tule Subbasin TAC will provide an evaluation of data gaps in the five-year assessment, including steps to be taken to address data gaps before the next five-year assessment.

5.3 Data Management System (DMS) (§357.4(e))

Efficient data management will be a critical to ensure that each GSA can access the data needed to prepare their respective Annual Reports in a timely manner and to ensure that the Tule Subbasin TAC can meet deadlines for submittal of the coordinated reports. The Monitoring Plan, **Attachment 1**, describes the Tule Subbasin Water Management Database, the procedures for updating and maintaining the database, and protocols for database security, file access and reporting. Data to be managed will include:

A. Historical data used as a basis for preliminary estimates of the Water Budget and Sustainable Yield of the Tule Subbasin.
B. Data to be collected in accordance with the Tule Subbasin Monitoring Plan (**Attachment 1**).

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VI. IMPLEMENTATION OF GSPS (§357.4(c))

Pursuant to 23 Cal. Code Regs. §357.24(c), the coordination agreement shall explain how the GSPs when implemented together satisfy the requirements of SGMA and are in substantial compliance with its regulations. SGMA requires the development and implementation of GSPs by GSAs to achieve sustainable groundwater management by 2040.

Throughout this Coordination Agreement, the Tule Subbasin GSAs have agreed upon various data and methodologies critical to understanding the hydrogeology of the Subbasin, and addressing and understanding what remedies are available to avoid undesirable results.

The GSAs within the Tule Subbasin will work together to implement their respective GSPs within the Tule Subbasin. The Tule Subbasin TAC, the technical advisory committee composed of representatives from each GSA, has developed Subbasin-wide data and methodologies for each of the following items, and made them available to each GSA to adopt and utilize in the development of its respective GSP:

- Groundwater elevation data.
- Groundwater extraction data.
- Surface water supply.
- Total water use.
- Change in groundwater storage.
- Water budget.
- Sustainable yield.

The GSAs understand there is local, site-specific data particular to each GSA which each GSA may utilize in the development of its respective GSP in addition to the Subbasin-wide data. If an individual GSA has identified monitoring features for use in collecting data specific to its jurisdictional area and the features are not included in Section 3 or **Attachment 1** of this Coordination Agreement, then the GSA can incorporate the features and data into its GSP upon confirming that those particular monitoring features meet the minimum criteria specified in Section 3 and that the data has been collected in accordance with this Coordination Agreement.

Each GSA shall submit its respective GSP, and any updates thereto, to the Tule Subbasin TAC so that the other Tule Subbasin GSAs may review and comment prior to documents being submitted to DWR. Each GSA shall comply with 23 Cal. Code Regs. §354.10, regarding comments received on the GSP, and such GSP shall be made available on the GSA's website.

Each GSA acknowledges and agrees that it is responsible to ensure that its GSP complies with the statutory requirements of SGMA. The GSAs further acknowledge the obligation for each GSA to coordinate the implementation of their respective GSPs in order to, collectively, achieve the Sustainability Goal for the Subbasin, as required by SGMA.

Additionally, to better implement and refine the projects and management actions adopted in their respective GSPs, the GSAs are committed to work together on developing and maintaining a data management system and are implementing quality control and quality assurance measures to collect reliable GSA-specific and Subbasin-wide data to ensure Subbasin-wide Sustainability Goal is achieved.

The Tule Subbasin GSAs are committed to implementing their respective projects and management actions set forth in their respective GSPs for the purpose of reaching sustainability for the Subbasin by 2040. The GSAs are also committed to further refine and update their projects, management actions and GSPs in accordance with SGMA as more and better data becomes available.

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VII. TULE SUBBASIN ORGANIZATIONAL STRUCTURE

7.1 Tule Subbasin Technical Advisory Committee

The Tule Subbasin TAC was previously formed under a Memorandum of Agreement executed by all Tule Subbasin GSAs. The Parties agree to the continued existence of the Tule Subbasin TAC pursuant to the terms below. The Tule Subbasin TAC is an advisory committee only and has no authority or power to bind any individual GSA to any recommendation or action item taken by its members.

Nothing in this Agreement is intended to affect the statutory powers granted under SGMA, or any other applicable law, to the Tule Subbasin GSAs. Each Tule Subbasin GSA shall be solely responsible for the adoption and enforcement of any ordinances, bylaws, or other legally enforceable actions taken within their respective GSA boundaries to implement SGMA, including, but not limited to, the preparation of the GSP applicable within their GSA boundaries. Each GSA agrees that as required by this Coordination Agreement, they shall utilize the same data and methodologies contained in this Coordination Agreement. The Parties understand there will be basin-wide data, in addition to certain local site-specific data collected and/or utilized by each GSA.

7.1.1 Members and Voting

A Tule Subbasin TAC shall be formed with one (1) representative appointed from each GSA, as well as one (1) alternate from each GSA. The Subbasin TAC shall make technical recommendations regarding the Coordination Agreement and other Tule Subbasin related SGMA compliance issues to each GSA. The Tule Subbasin TAC shall meet as necessary. Each GSA shall be entitled to one (1) vote. Recommendations to each GSA shall only be made upon consensus of the Tule Subbasin TAC. Should consensus not be reached, the votes shall be reported to each GSA Board for further direction. A quorum shall exist when five of the seven GSAs have representatives in attendance. The chairperson and secretary will not hold any separate voting rights on the Tule Subbasin TAC.

7.1.2 Consultants

The Parties agree that the Tule Subbasin TAC should obtain the services of consultants to facilitate the collection of data and the submission of information to the Tule Subbasin GSAs. Prior to hiring consultants, or approving scopes of work, the TAC shall obtain approval from the Tule Subbasin GSAs.

7.1.3 Legal Services

The Tule Subbasin TAC shall not retain independent legal services, unless agreed upon by all Parties hereto. Each Party shall be responsible for any legal fees incurred by its own counsel in the course of performing any legal work related to Subbasin matters.

7.1.4 Chairman and Secretary

A Chairman and Secretary shall be appointed to serve the Tule Subbasin TAC. The Chairperson shall be responsible for managing all Tule Subbasin TAC meetings, preparing agenda materials, managing consultants hired by the Tule Subbasin TAC, and coordinating the delivery of information between GSAs and Tule Subbasin TAC consultants. The Secretary shall be responsible for distributing Tule Subbasin TAC agenda materials to all Tule Subbasin GSAs and to all interested parties that request to be notified of Tule Subbasin TAC meetings, as well as ensuring compliance with all applicable legal requirements, including, but not limited to, the Ralph M. Brown Act. The Secretary shall also be responsible for record keeping of the Tule Subbasin TAC group, maintaining minutes of Tule Subbasin TAC meetings, maintaining copies of all executed agreements, maintaining copies of documents produced by consultants, and providing such information to individual Tule Subbasin GSAs upon request. The appointed Chairperson or Secretary may meet with Tule Subbasin GSAs or GSA member agency employees as necessary.

7.1.5 Meetings

All meetings shall be subject to the Ralph M. Brown Act. The Chairman and Secretary shall be responsible for ensuring compliance. Interested parties shall be provided an opportunity to comment on Coordination Agreement issues. Parties acknowledge the Tule Subbasin TAC duties may include public outreach.

7.1.6 Cost Sharing and Governance

Parties shall share on an equitable basis the costs related to the preparation of the data required for the Coordination Agreement to be drafted. Costs shall be allocated between GSAs based on the number of acres within a GSA.

Each Party to this Agreement shall be responsible for their respective share of costs based on their proportionate acreage within the Tule Subbasin. Through a separate agreement, the Tule Subbasin GSAs have appointed a fiscal agent and that fiscal agent shall have authority to enter into any contract necessary to assist with the preparation of the Coordination Agreement, subject to the direction and authorization of the Tule Subbasin TAC. The fiscal agent shall be responsible for invoicing the respective GSAs and for providing an accounting of all funds received and spent on behalf of the GSAs. The fiscal agent shall attend all Tule Subbasin TAC meetings but has no separate voting rights on the Tule Subbasin TAC.

The Tule Subbasin TAC shall annually prepare a schedule, scope of work, and budget of items required for the Coordination Agreement, which shall identify the estimated expenses and the estimated portions each respective Tule Subbasin GSA will be expected to be responsible for payment. This information shall be submitted to the GSAs for review and approval. The Tule Subbasin TAC may request funds under the approved budget from the GSAs as needed to reimburse the GSA's fiscal agent and may also request budget amendments.

The Parties agree that if grant funds become available for the Coordination Agreement components, then the Parties shall utilize grant funds to pay for those costs. The Parties agree to coordinate specific grant application requests by separate agreement. The Parties agree that grant funds shall be utilized based on the grant application budget and that if any grant funds are available for distribution to the GSAs, then the remaining grant funds shall be distributed based on GSA acreage within the Tule Subbasin.

7.1.7 Procedures for Timely Exchange of Information (§357.4(b)(2))

7.1.7.1 *Exchange of Information*

Pursuant to 23 Cal. Code Regs. §357.4(b)(2), the GSAs acknowledge and recognize that for this Coordination Agreement to be effective in the enhancement of the goals of basin-wide groundwater sustainability and compliance with the SGMA and the basin level coordinating and reporting regulations, the GSAs will have an affirmative obligation to exchange certain minimally necessary information among and between the other GSA Parties. Likewise, the GSA Parties acknowledge and recognize that individual GSA Parties, in providing certain information, and in particular certain raw data, may contend that limitations apply in the sharing and other dissemination of certain types of said information, which may subject the individual GSA Party to certain duties regarding non-disclosure and privacy restrictions and protections.

7.1.7.2 *Procedure Governing the Exchange of Information*

The GSAs may exchange information through collaboration and/or informal requests made at the Tule Subbasin TAC. To the extent it is necessary to make a written request for information to another GSA, each GSA shall designate a representative to respond to information requests and provide the name and contact information of the designee to the Tule Subbasin TAC. Requests may be communicated in writing and transmitted in person or by mail, facsimile machine or other electronic means to the appropriate representative as named in this Agreement.

Nothing in this Agreement shall be construed to prohibit any Party from voluntarily exchanging information with any other Party by any other mechanism separate from the Tule Subbasin TAC.

7.1.8 Procedures for Resolving Disputes Dispute Resolution (§§357.4(b)(2), 357.4(h))

The Parties agree that all disputes under this Coordination Agreement that concern the applicability and requirements of SGMA by or between GSAs within the Tule Subbasin, shall be handled under the terms of this Agreement. Any GSA may choose to initiate a dispute resolution process by serving written notice to the remaining GSAs of the following: (1) identification of the conflict; (2) description of how the conflict may negatively impact the sustainability of the Tule Subbasin; and (3) a proposal for one or more resolutions. The Parties agree to designate representatives to meet and confer with each other within thirty (30) days of the date such notice is given and said representatives shall then meet within a reasonable time to address all issues identified in the notice. Should the representatives be unable to reach a resolution within ninety (90) days of the written notice, the Parties shall enter into informal mediation in front of a mutually agreeable mediator. After attempting to settle or resolve a dispute or disagreement through informal resolution and mediation, as described above, nothing within this Agreement shall prevent the Parties from pursuing legal action. The resolution of any dispute or claim related to a water right alleged by a Party is outside the scope contemplated in this Section 7.1.8 and the Coordination Agreement.

7.2 Amendments to this Coordination Agreement

This Coordination Agreement shall become effective on the dates executed by all Parties and shall remain in effect until revised or replaced by a subsequent agreement. This Agreement may be amended upon the mutual written agreement of all the Parties. Pursuant to 23 Cal. Code Regs. §357.4(i), this Coordination Agreement shall be reviewed as part of the five-year assessment, revised if necessary, and executed by all parties.

7.3 Construction

This Agreement is for the sole benefit of the Parties and shall not be construed as granting rights to or imposing obligations on any person other than the Parties.

7.4 Good Faith

Each Party shall use its best efforts and work in good faith for the expeditious completion of the purposes and goals of this Agreement and the satisfactory performance of its terms.

7.5 Execution

This Agreement may be executed in counterparts and the signed counterparts shall constitute a single instrument. The signatories to this Agreement represent that they have the authority to sign this agreement and to bind the Party for whom they are signing.

7.6 Third Party Beneficiaries

This Agreement shall not create any right of interest in any non-Party or in any member of the public as a third-party beneficiary.

7.7 Notices

All notices, requests, demands or other communications required or permitted under this Agreement shall be in writing unless provided otherwise in this Agreement, and shall be deemed to have been duly given and received on: (i) the date of service if personally served or served by electronic mail or facsimile transmission on the Party to whom notice is to be given at the address(es) below; (ii) on the first day after mailing, if mailed by Federal Express, U.S. Express Mail, or other similar overnight courier service; or (iii) on the third day after mailing if mailed to the Party to whom notice is to be given by first class mail, registered certified as follows:

Alpaugh Groundwater Sustainability Agency
Attn: Bruce Howarth
P.O. Box 129 Alpaugh, CA 93201

Delano-Earlimart Irrigation District Groundwater Sustainability Agency
Attn: Eric Quinley
14181 Avenue 24 Delano, CA 93215

Eastern Tule Groundwater Sustainability Agency
Attn: Rogelio Caudillo
881 W. Morton Avenue, Suite D Porterville, CA 93257

Lower Tule River Irrigation District GSA
Attn: Eric Limas
357 E. Olive Avenue Tipton, CA 93272

Pixley Irrigation District GSA
Attn: Eric Limas
357 E. Olive Avenue Tipton, CA 93272

Tri-County Water Authority GSA
Attn: Deanna Jackson
944 Whitley Avenue Suite E Corcoran, CA 93212

County of Tulare
c/o Denise England
County Administration Building
2800 W. Burrel Avenue Visalia, California 93291

7.8 No Waiver; No Admission

Nothing in this Coordination Agreement is intended to modify the water rights of any Party or of any Person (as that term is defined under Section 19 of the Water Code). Nothing in this Coordination Agreement shall be construed as an admission by any Party regarding any subject matter of this Coordination Agreement, including without limitation any water right or priority of any water right that is claimed by a Party or any Person. Nor shall this Coordination Agreement in any way be construed to represent an admission by a Party with respect to the subject or sufficiency of another Party's claim to any water or water right or priority or defenses thereto, or to establish a standard for the purposes of the determining the respective liability of any Party or Person, except to the extent otherwise specified by law. Nothing in this Coordination Agreement shall be construed as a waiver by any Party of its election to at any time assert a legal claim or argument as to water, water right or any subject matter of this Coordination Agreement or defenses thereto. The Parties hereby agree that this Coordination Agreement, to the fullest extent permitted by law, preserves the water rights of each of the Parties as they may exist as of the effective date of this Coordination Agreement or at any time thereafter. Any dispute or claim arising out of or in any way related to a water right alleged by a Party shall be separately resolved before the appropriate judicial, administrative or enforcement body with proper jurisdiction and is specifically excluded from the dispute resolution procedures set forth under this Coordination Agreement, including without limitation under Section 7.1.8.

7.9 It is understood and agreed that this Coordination Agreement supersedes that certain "Memorandum of Understanding to Develop and Implement a Coordination Agreement" and all oral agreements and negotiations between the Parties relating to the subject matter hereof.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement to be effective as of the date noted below.

______________________________	____________
Alpaugh Groundwater Sustainability Agency	Date
______________________________	____________
Delano Earlimart Irrigation District GSA	Date
______________________________	____________
Eastern Tule Groundwater Sustainability Agency	Date
______________________________	____________
Lower Tule River Irrigation District GSA	Date
______________________________	____________
Pixley Irrigation District GSA	Date
______________________________	____________
Tri-County Water Authority GSA	Date
______________________________	____________
Tulare County GSA	Date

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-1

Tule Subbasin Monitoring Plan

2024
2nd Amended Groundwater Sustainability Plan

TULE SUBBASIN COORDINATION AGREEMENT
ATTACHMENT 1

Tule Subbasin Monitoring Plan

July 2022

Prepared for

Tule Subbasin Technical Advisory Committee

Prepared by

Thomas Harder, PG, CHG
Principal Hydrogeologist

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Monitoring Plan Appendices

Acronyms

GSP	Groundwater Sustainability Plan
SGMA	Sustainable Groundwater Management Act, California's framework for the recovery and ongoing management of groundwater basins. SGMA empowers local agencies to form Groundwater Sustainability Agencies (GSAs) to manage basins sustainably and requires those GSAs to adopt Groundwater Sustainability Plans (GSPs) for crucial groundwater basins in California.
DWR	Department of Water Resources
GSA	Groundwater Sustainability Agency
TAC	Technical Advisory Committee
TSMP	Tule Subbasin Monitoring Plan
DO	Dissolved Oxygen
EC	Electrical Conductivity
TDS	Total Dissolved Solids
QAPP	Quality Assurance Project Plan
USGS	United States Geological Society
USBR	United States Bureau of Reclamation
GPS	Global Positioning System
NGS	National Geodetic Survey

TRA	Tule River Association
ACOE	Army Core of Engineers
ILRP	Irrigated Lands Regulatory Program
DMS	Data Management System, an application with a database back-end that will track and manage the data of the end users as well as provide administrative
SQL	structured query language
End User/User	Person who will use the product, but not a member of staff, administration, or development team.
UI	User Interface, the part of the application that end users and staff interact with.

1.0 Background

This monitoring plan has been prepared to describe the monitoring features and monitoring methodologies to be used to collect the data to be included in Tule Subbasin Groundwater Sustainability Plans (GSPs) and annual reports, as required by the Sustainable Groundwater Management Act (SGMA). This plan is for the Tule Subbasin (see Figure A1-1), as described in California Department of Water Resources (DWR) Bulletin 118.[1] The Tule Subbasin is subdivided into six Groundwater Sustainability Agencies (GSAs), each with their own GSP.

As required by Section 10727.2 of the Water Code, each GSP must include:

(d) Components relating to the following, as applicable to the basin:

(1) The monitoring and management of groundwater levels within the basin.

(2) The monitoring and management of groundwater quality, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin.

(3) Mitigation of overdraft.

(4) How recharge areas identified in the plan substantially contribute to the replenishment of the basin.

(5) A description of surface water supply used or available for use for groundwater recharge or in-lieu use.

(e) A summary of the type of monitoring sites, type of measurements, and the frequency of monitoring for each location monitoring groundwater levels, groundwater quality, subsidence, streamflow, precipitation, evaporation, and tidal influence. The plan shall include a summary of monitoring information such as well depth, screened intervals, and aquifer zones monitored, and a summary of the type of well relied on for the information, including public, irrigation, domestic, industrial, and monitoring wells.

(f) Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence, for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect

[1] DWR, 2016. Final 2016 Bulletin 118 Groundwater Basin Boundaries shapefile. http://www.water.ca.gov/groundwater/sgma/basin_boundaries.cfm

groundwater levels or quality or are caused by groundwater extraction in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.

The Tule Subbasin Technical Advisory Committee (TAC) has determined that a single monitoring plan that includes the entire Tule Subbasin is necessary in order to identify the types of data to be collected throughout the subbasin, the minimum number of monitoring features from which to collect data, and the monitoring protocols to be followed by each GSA, in order to ensure that the same methodologies are followed as required by California Water Code Section 10727.6 of SGMA. This Tule Subbasin Monitoring Plan (TSMP) serves that purpose.

1.1 Plan Objectives 354.34 (b)

The TSMP has been prepared to meet the following subbasin-wide objectives:

- To ensure that the data collected within the basin are in sufficient quantities, areal distribution, frequency and accuracy to provide meaningful results for demonstrating progress toward achieving measurable objectives of each GSA and the sustainability goal of the subbasin as a whole.
- To monitor impacts to the beneficial uses and users of groundwater.
- To monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
- Enable the quantification of annual changes in water budget components.
- To identify data gaps and monitoring features to address the data gaps.
- To provide a standard methodology for the collection of surface water, groundwater, and land surface subsidence data within the Tule Subbasin.
- To provide for a central, secure monitoring database available to the GSAs for their use in preparing their respective groundwater sustainability plans and annual reports.

The TSMP is both flexible and iterative, allowing for the addition or subtraction of monitoring features, as necessary, and to accommodate changes in monitoring frequency and alternative methodologies, as appropriate.

1.2 Area Encompassed by the Monitoring Plan

The area addressed by this plan is the Tule Subbasin, as defined by the latest version of DWR Bulletin 118 as shown on Figure A1-1. The Tule Subbasin area is 744 square miles (475,895 acres). The Tule Subbasin has been subdivided into the following six GSAs (see Figure A1-1):

- Eastern Tule GSA

- Lower Tule River Irrigation District GSA
- Pixley Irrigation District GSA
- Delano-Earlimart GSA
- Tri-County Water Authority GSA
- Alpaugh GSA

1.3 Monitoring Plan Organization

The monitoring plan addresses the following types of data:

- Surface Water Data
- Groundwater Data
- Land Elevation and Subsidence Data

Each data type will be addressed in its own section that includes a description of the monitoring features for collecting data, the data collection protocols, and the monitoring frequency.

The final section of the monitoring plan describes the data management program that includes a description of the database management platform, criteria for data QA/QC, file storage, security and access, database maintenance and documentation.

2.0 Monitoring Networks 354.34

This monitoring plan presents the minimum groundwater monitoring network to be relied on by the Tule Subbasin GSAs to prepare their annual reports. Data to be collected from the monitoring network will include surface water flow, surface water quality, groundwater levels, groundwater quality and land elevation data. Groundwater levels and quality data will be collected from a network of monitoring wells spaced throughout the Tule Subbasin. The monitoring well network includes existing monitoring wells, existing domestic and agricultural wells, and new wells to be added. As some of the existing wells require further investigation prior to formal inclusion in the monitoring network, and the exact locations of new monitoring wells are yet to be determined, it will be necessary to modify the monitoring network over time to add/remove monitoring features and adjust locations.

2.1 Chronic Lowering of Groundwater Levels 354.34 (c) (1)

As there are significant differences in hydraulic head and aquifer characteristics with depth in the Tule Subbasin, monitoring wells have been identified to enable the collection of data from each of the significant subsurface hydrogeologic units in the area. These units include (in order from shallowest to deepest):

- The Upper Aquifer
- The Lower Aquifer
- The Santa Margarita Formation

The depths of each of these units follow the hydrogeological conceptual model of the Tule Subbasin outlined in the hydrogeological conceptual model and incorporated into the Tule Subbasin Groundwater Flow Model.[2] The Upper Aquifer is generally located above the Corcoran Clay in the western part of the subbasin and above other confining beds in the eastern part of the subbasin. The Upper Aquifer is generally unconfined to semi-confined. The Upper Aquifer varies in depth from approximately 400 ft below ground surface (ft bgs) in the western portion of the basin to less than 100 ft bgs in the northeastern portion. The Lower Aquifer is below the Corcoran Clay and extends to depths ranging from approximately 2,200 ft bgs in the western portion of the

[2] TH&Co, 2017a. Hydrogeological Conceptual Model and Water Budget for the Tule Subbasin. Prepared for the Tule Subbasin MOU Group. Dated August 1, 2017.

TH&Co, 2019. Groundwater Flow Model for the Tule Subbasin. Prepare for the Tule Subbasin MOU Group. In Progress.

Tule Subbasin to 400 ft bgs near State Route 99. The Santa Margarita Formation occurs at depths ranging from 700 to 2,000 ft bgs in the southeastern portion of the Tule Subbasin.

Monitoring wells are identified with perforations exclusively in the Upper Aquifer, Lower Aquifer, or Santa Margarita Formation. Individual wells perforated across multiple aquifer layers (i.e. "composite wells") will not be allowed in the monitoring plan unless no other wells are available for monitoring in the area. Over time, wells in the monitoring network that are perforated across multiple aquifers will be replaced with nested or cluster wells with perforations specific to the Upper or Lower aquifers.

2.1.1 Monitoring Features

2.1.1.1 Upper Aquifer Monitoring Wells

Upper aquifer monitoring wells are shown on Figure A1-2. A total of 78 monitoring wells have been identified for monitoring the Upper Aquifer. Of these wells, 27 have been designated as RMS wells (see Table A1-A). The Upper Aquifer monitoring wells are further described below.

Existing Upper Aquifer Monitoring Wells with Historical Records

Of the 82 wells identified for monitoring the Upper Aquifer, 36 have historical groundwater level records and meet the minimum criteria specified in Section 3.2.1.1 of the Coordination Agreement. Groundwater level hydrographs for these wells are provided in Appendix A.

Existing Upper Aquifer Monitoring Wells – No Historical Records (to be Investigated)

There are numerous existing wells with documented total depth and perforation interval(s) within the Upper Aquifer that could be incorporated into the monitoring network but require further investigation. These wells have no historical groundwater level records and owner permission for access the wells has not been pursued. However, if access is approved by the owner and the wells are demonstrated to meet the minimum criteria for monitoring wells, they may be incorporated into the monitoring plan. Many of these existing Upper Aquifer wells, to be confirmed through further investigation, have been identified for consideration in the monitoring plan (see Figure A1-2; Table A1-1). In addition, 48 wells that are part of the water quality monitoring network are included in the groundwater level monitoring network. These wells have been selected to help fill aerial coverage data gaps for monitoring Upper Aquifer groundwater levels.

Potential existing Upper Aquifer wells for which access has been denied or, upon investigation, do not otherwise meet the minimum criteria specified in Section 3.2.1.1 of the Coordination Agreement, will be removed and replaced with an alternate existing well with documented total depth and perforation interval located in the same area. If no other wells exist in the area, a new Upper Aquifer monitoring well may be constructed in the area.

Proposed New Upper Aquifer Monitoring Wells

New monitoring wells will be drilled in areas where there are no existing wells for monitoring in order to fill the data gaps. General areas for future monitoring wells are identified on Figure A1-2.

The depths and perforation intervals of the new Upper Aquifer monitoring wells will vary depending on location within the subbasin. In general, Upper Aquifer monitoring wells will be perforated from approximately 10 ft below the then current static groundwater level to the bottom of the Upper Aquifer, as defined by the Tule Subbasin conceptual model[3] (see Figure A1-2). New Upper Aquifer wells constructed on the west side of the subbasin will be the deepest and new Upper Aquifer wells constructed on the east side of the subbasin will be shallowest. It is noted that the depths presented herein are for planning purposes. The final well construction details will be refined in the field during drilling once site-specific data have been obtained and reviewed. As such, the final well depths and perforation intervals may be adjusted for site specific conditions.

A conceptual well design drawing for new Upper Aquifer monitoring wells is shown on Figure A1-3. In general, new monitoring wells shall be constructed of 5-inch diameter Schedule 80 PVC blank and slotted casing. A filter pack for the new wells will be placed in the annular borehole space opposite the perforations from the total borehole depth to at least 10 feet above the top of perforations. The upper portion of the annular space shall be backfilled with a seal consisting of bentonite or other approved sealing material. The surface completion for each new monitoring well will include a steel above-ground riser equipped with a protective locking cap for keeping the wellhead secure. The above-ground riser will be surrounded by cement-filled steel bollards for further protection.

At some locations, the well will be completed as a nested well with two 5-inch diameter casings within the same borehole. One casing will be constructed in the Upper Aquifer and the other casing will be constructed in the Lower Aquifer (see Figure A1-4). A bentonite seal will be placed in the annular space between the two perforation intervals to ensure that the data collected from each casing will be specific to the aquifer in which it is perforated.

A dedicated reference point shall be established and marked on the top of each monitoring well casing. All groundwater level measurements shall be obtained relative to the reference point. The elevation of the reference point shall be surveyed to an accuracy of 0.1 foot relative to mean sea

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[3] TH&Co, 2017a. Hydrogeological Conceptual Model and Water Budget for the Tule Subbasin. Prepared for the Tule Subbasin MOU Group. Dated August 1, 2017.

level (NAVD88) by a California licensed land surveyor. The location of each well will be surveyed to an accuracy of 1 foot.

2.1.1.2 Lower Aquifer Monitoring Wells

Lower Aquifer monitoring wells are shown on Figure A1-2. A total of 66 monitoring wells have been identified for monitoring the Lower Aquifer. For the purpose of this TSMP, an additional 15 composite wells and 4 Santa Margarita Aquifer wells are included with the Lower Aquifer wells. Of the Lower Aquifer, composite, and Santa Margarita Aquifer wells, 29 have been designated as RMS wells (see Table A1-2). These wells are further described below.

Existing Lower Aquifer Monitoring Wells with Historical Records

Of the 66 existing wells identified for monitoring the Lower Aquifer, nine are existing wells with historical groundwater level records and meet the minimum criteria specified in Section 3.2.1.1 of the Coordination Agreement. Groundwater level hydrographs for these wells are provided in Appendix B.

Existing Lower Aquifer Monitoring Wells – No Historical Records (to be Investigated)

There are numerous existing wells with documented total depth and perforation interval(s) within the Lower Aquifer that could be incorporated into the monitoring network but require further investigation. These wells have no historical groundwater level records and owner permission to access the wells has not been pursued. However, if access is approved by the owner and the wells are demonstrated to meet the minimum criteria for monitoring wells, they may be incorporated into the monitoring plan. Many of these existing Lower Aquifer wells, to be confirmed through further investigation, have been identified for consideration in the monitoring plan (see Figure A1-2; Table A1-2). In addition, 20 wells that are part of the water quality monitoring network are included in the groundwater level monitoring network. These wells have been selected to help fill aerial coverage data gaps for monitoring Lower Aquifer groundwater levels.

Potential existing Lower Aquifer wells for which access is denied or, upon investigation, do not otherwise meet the minimum criteria specified in Section 3.2.1.1 of the Coordination Agreement, will be removed and replaced with an alternate existing well with documented total depth and perforation interval located in the same area. If no other wells exist in the area, a new Lower Aquifer well will be constructed in the area.

Proposed New Lower Aquifer Monitoring Wells

New monitoring wells are planned to be constructed in the Lower Aquifer (see Figure A1-2). New Lower Aquifer monitoring wells will be drilled in areas where there are no existing wells for monitoring in order to fill data gaps. General areas for future monitoring wells are identified on Figure A1-2.

The depths and perforation intervals of the new Lower Aquifer monitoring wells will vary depending on location within the subbasin. In general, Lower Aquifer monitoring wells will be perforated below the Corcoran Clay, where it has been mapped, or at depths where the aquifer is assumed to be confined, as defined by the Tule Subbasin conceptual model.[4] New Lower Aquifer monitoring wells will be constructed with total depths ranging from 400 to 1,000 ft bgs, with the deepest wells in the western part of the subbasin and shallowest wells on the east side of the subbasin. It is noted that the depths presented herein are for planning purposes. The final well construction details will be refined in the field during drilling once site-specific data have been obtained and reviewed. As such, the final well depths and perforation intervals may be adjusted for site specific conditions.

A conceptual well design drawing for new Lower Aquifer monitoring wells is shown on Figure A1-5. In general, new monitoring wells shall be constructed of 4-inch diameter PVC blank and slotted casing. A dedicated reference point shall be established and marked on the top of each monitoring well casing. All groundwater level measurements shall be obtained relative to the reference point. The elevation of the reference point shall be surveyed to an accuracy of 0.1 foot relative to mean sea level (NAVD88) by a California licensed land surveyor. The location of each well will be surveyed to an accuracy of 1 foot.

2.1.2 Monitoring Procedure

Groundwater level measurements shall be collected from each well using either a steel tape, a calibrated well sounder, or a pressure transducer. Where possible, groundwater level measurements shall be collected with a steel tape or an electrical groundwater level sounder calibrated to the nearest 0.01 ft. For pre-existing wells with limited access, a calibrated steel tape and chalk may be used. All equipment must be in good working condition. No damaged or refurbished electrical sounding tape shall be used. All new monitoring wells shall be equipped with calibrated pressure transducers.

Groundwater level measurements must be representative of static (i.e. non-pumping) groundwater level conditions. To ensure measurement of static groundwater levels in active pumping wells, the field technician collecting the data must verify that the pump has been off for at least 24 hours prior to collecting the data.

[4] TH&Co, 2017a. Hydrogeological Conceptual Model and Water Budget for the Tule Subbasin. Prepared for the Tule Subbasin MOU Group. Dated August 1, 2017.

2.1.2.1 Manual Groundwater Level Measurements

The following monitoring procedure shall be used to obtain manual groundwater level measurements in the field:

- Upon arrival at each site, the field technician shall note the well name, time of day, and date on the standard groundwater level data form (see Appendix C).
- All monitoring equipment shall be cleaned prior to lowering it into the well(s) using the following decontamination procedure:
    - Wash equipment with an Alconox solution which is followed by a deionized water rinse.
    - Triple rinse equipment with deionized water.
    - Place equipment on clean surface such as teflon or polyethylene sheet to air dry.
- To measure the depth to groundwater with a steel tape or an electrical sounder or meter, slowly lower the steel tape or water level electrical tape into the designated sounding port for production wells and into the main well for monitoring wells. Steel tapes and electrical tapes are lowered to the water surface, as determined by the audio signal, meter, or technician. Depths to groundwater are measured relative to the dedicated reference point at the top of the casing or sounding tube. Depth to groundwater shall be immediately recorded on the standard groundwater level data form (see Appendix C). Depths to groundwater shall be compared to previous measurements in the field and re-measured if significantly different.
- For wells with limited access (such as agricultural wells or domestic wells equipped with a pump), a steel tape and chalk may be used. For this method, chalk is applied to a 1- to 3-foot section of the steel tape prior to lowering in the well. The steel tape is lowered to a depth at least 1-ft below the static groundwater level and a whole number on the calibrated tape is matched to the reference point at the surface. Both the foot mark held at the reference point and the groundwater level observed on the chalk shall be recorded on the standard field forms (see Appendix D). The difference between the two is the depth to groundwater.
- When finished sounding the groundwater level, all downhole equipment shall be removed, and where existing, the well cap shall be replaced, and the riser locked.
- Prior to leaving the monitoring well site, the field representative shall note any physical changes in the concrete well pad and riser pipe, such as erosion, cracks or damage. All changes shall be recorded on the standard field forms provided in Appendices C, D, and E.

2.1.2.2 Automatic Groundwater Level Measurements Using Transducers

Transducers shall be installed in all new monitoring wells and existing monitoring wells identified as representative monitoring sites. Transducers shall be installed below the groundwater level with enough submergence to accommodate anticipated groundwater level fluctuations.

2.1.3 Frequency of Measurement

Groundwater level measurements from existing domestic and irrigation wells shown on Figure A1-2 will be collected semi-annually in the Spring (February/March) and in the Fall (October/November). To the extent possible, groundwater level monitoring events will be coordinated between GSAs so that measurements are taken at the time of greatest recovery and maximum depth.

Groundwater level measurements from all new monitoring wells and wells designated as representative monitoring sites will be collected using pressure transducers permanently installed in the wells and set to collect one measurement per day. Pressure transducers will be downloaded on a semi-annual basis. During each download session, the field technician will also obtain a manual groundwater level measurement in order to verify transducer readings and ensure that the instruments are working properly.

2.2 Reduction in Groundwater Storage § 354.34 (c) (2)

Changes in groundwater storage within the Tule Subbasin will be estimated using either of the methods identified in Section 3.6 of the Tule Subbasin Coordination Agreement. Groundwater level data to be relied on for the change in groundwater storage estimates will be collected as described in Section 2.1 of this TSMP.

2.3 Seawater Intrusion § 354.34 (c) (3)

Seawater intrusion cannot occur in the Tule Subbasin due to its location with respect to the Pacific Ocean. The Tule Subbasin is approximately 110 miles inland of the Pacific Ocean and is separated from the ocean by approximately 90 miles of sedimentary rocks that make up the Coast Ranges. These sedimentary rocks effectively separate the Pacific Ocean hydraulically from the aquifer system in the San Joaquin Valley. Further, the Coast Ranges are dissected by multiple northwest trending faults, the largest of which is the San Andreas Fault. These faults form groundwater flow barriers, which further act to separate the San Joaquin Valley aquifers from the Pacific Ocean. Accordingly, groundwater pumping in the Tule Subbasin cannot induce seawater intrusion. As such, monitoring for seawater intrusion is not necessary and is not included in this monitoring plan.

2.4 Degraded Water Quality § 354.34 (c) (4)

Groundwater samples shall be collected and analyzed annually, during summer months, from the wells shown on Figure A1-6 consistent with the Tule Basin Water Quality Coalition Groundwater Quality Trend Monitoring Program Workplan.[5] The groundwater sampling protocols described herein will ensure that:

- Groundwater quality data are collected from the correct location
- Groundwater quality data are accurate and reproducible
- Groundwater quality data represent conditions that inform appropriate basin management decisions
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity

2.4.1 Groundwater Quality Constituents to be Analyzed

Annual water quality monitoring of the wells shown on Figure A1-6 will include laboratory analysis for nitrate as N only (see Table A1-3). Prior to collecting the samples in the field, the field technician will collect measurements of temperature, pH, dissolved oxygen (DO) and electrical conductivity (EC) from the well discharge, as described in Section 2.4.2 herein.

Every five years, samples from the wells shown on Figure A1-6 will be analyzed for an expanded list of analytes. In addition to nitrate, samples will be analyzed for total dissolved solids (TDS) and major cations and anions (see Table A1-3). Prior to collecting the samples in the field, the field technician shall collect measurements of temperature, pH, DO and EC from the well discharge, as described in Section 2.4.2 herein.

2.4.2 Groundwater Quality Samples from Existing Domestic Water Supply or Irrigation Wells

Domestic water supply and irrigation wells shall be sampled after purging the well for a period of time adequate to remove at least three well volumes removed prior to sampling (see Appendix E). If the well is currently pumping, this step is not necessary.

During pumping and prior to sample collection, the field technician shall obtain measurements of temperature, pH, DO and EC from water collected from the sample port. Meters for measuring pH, DO and EC shall be field calibrated in accordance with manufacturer's specifications at the beginning of each sampling day. Samples will be collected when: (1) a minimum of four sets of

[5] Tule Basin Water Quality Coalition, 2017. Groundwater Trend Monitoring Workplan. January 6, 2017.

parameter readings have been obtained; and (2) the temperature, pH, and EC reach relatively constant values.

All samples shall be collected from the discharge point nearest the well head and placed in laboratory-prepared sample containers. The technician collecting the sample shall wear new latex or neoprene gloves while collecting the sample. Sample containers shall be labeled before or immediately after sampling with self-adhesive tags having the following information written in waterproof ink:

- Project number
- Sample I.D. number
- Sample location
- Date and time sample was collected
- Initials of sample collector

2.4.3 Groundwater Quality Samples from Monitoring Wells

All groundwater samples from monitoring wells will be collected consistent with procedures described in the United States Environmental Protection Agency's (USEPA's) Low-flow (Minimal Drawdown) Groundwater Sampling Procedures.[6] Low-flow purging can be conducted using either portable or dedicated (leave in well) pump systems. A submersible pump, diaphragm pump, or positive displacement pump, which may contain a bladder, may be used for evacuating (purging) the monitoring well casing and collecting the samples. The pump-intake should be set in the middle or slightly above the middle of the screened interval in the well. Other equipment necessary for collecting groundwater samples using the low-flow sampling method include:

- A water level measurement device, or water level sounder
- In-line flow through cell to monitor water quality parameters
- Field forms for documenting water quality parameters measured at each monitoring well
- Chain of custody forms
- Laboratory prepared sample containers from a State-certified laboratory with the appropriate labels for the analytes being measured
- Gloves
- Cleaning supplies for decontaminating
- Tubing for the pump

[6] Puls, R.W., and Barcelona, M.J., 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. EPA document 540/S-95-504.

All samples shall be collected from a discharge port at the wellhead and placed in laboratory-prepared sample containers. For dissolved trace metal analyses, samples will be collected in unpreserved bottles, then filtered through a 0.45-micron filter and acidified prior to analysis. The technician collecting the sample shall wear new latex or neoprene gloves while collecting the sample. Sample containers shall be labeled before or immediately after sampling with self-adhesive tags having the following information written in waterproof ink:

- Project number
- Sample I.D. number
- Sample location
- Date and time sample was collected
- Initials of sample collector

2.4.4 Well Sampling Records

Data collected during groundwater sampling will be recorded on the standard forms provided in Appendix F. Information and data to be recorded shall include:

- Sample I.D.
- Duplicate I.D., if applicable
- Date and time sampled
- Name of sample collector
- Well designation (State well numbering system for water supply wells)
- Owner's name, or other common designation
- Well diameter
- Depth to water on day sampled
- Casing volume on day sampled
- Method of purging (bailing, pumping, etc.)
- Extraordinary circumstances (if any)
- Field measurements temperature (0º C), pH, specific electrical conductivity (at 25ºC µs/cm), and dissolved oxygen (mg/l)
- Number and type of sample container(s)
- Times corresponding to water quality measurements
- Pumping rate at time of sampling

In addition to the standard forms for collecting data, the field technician shall keep a daily field record for each day of fieldwork. Following review by the project manager, the original records shall be kept in the project file.

2.4.5 Handling, Storage and Transportation of Samples

Upon collection and labeling, all samples shall be placed immediately into a clean chest/cooler with ice in order to keep samples cool. Exposure to dust, direct sunlight, high temperature, adverse weather conditions, and possible contamination shall be avoided.

All samples will be transported to a State-certified analytical laboratory within 24 hours of collection. Samples shall be transported under chain-of-custody procedures, which document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis shall be recorded on a Chain-of-Custody Record, which includes instructions to the laboratory for analytical services.

Information contained on the triplicate Chain-of-Custody Record shall include:

- Project number
- Signature of sampler(s)
- Date and time sampled
- Sample I.D.
- Number of sample containers
- Sample matrix (water)
- Analyses required
- Remarks, including preservatives, special conditions, or specific quality control measures
- Turnaround time and person to receive laboratory report
- Method of shipment to the laboratory
- Release signature of sampler(s), and signatures of all people assuming custody
- Condition of samples when received by laboratory

Blank spaces on the Chain-of-Custody Record will be crossed out between the last sample listed and the signatures at the bottom of the sheet.

The field sampler shall sign the Chain-of-Custody Record and record the time and date at the time of transfer to the laboratory or to an intermediate person. A set of signatures is required for each relinquished/reserved transfer, including intermediate transfers. The original imprint of the Chain-of-Custody Record will accompany the sample containers. A duplicate copy shall be placed in the project file.

If the samples are to be shipped to the laboratory, the original Chain-of-Custody will be sealed inside a plastic bag within the ice chest, and the chest shall be sealed with custody tape which has been signed and dated by the last person listed on the Chain-of-Custody. U. S. Department of Transportation shipping requirements shall be followed and the sample shipping receipt retained in the project file as part of the permanent chain-of-custody document. The shipping company (e.g. Federal Express, UPS, DHL) will not sign the chain-of-custody forms as a receiver, instead the laboratory shall sign as a receiver when the samples are received.

2.4.6 Quality Control Samples

Quality control samples shall consist of duplicates and blanks. At least one duplicate sample shall be collected during each day of sampling. The duplicate sample shall be collected from the same well as the original and immediately after the original sample. At least one blank sample shall be included with each batch of samples delivered to the laboratory. Blank samples shall consist of laboratory prepared deionized water that is containerized at the laboratory and delivered with the sample containers. Duplicate and blank samples will be analyzed by the laboratory, as specified in the project Quality Assurance Project Plan (QAPP)[7] or by the project manager (see Appendix E).

2.4.7 Frequency of Measurement

Groundwater quality samples will be collected from the wells shown on Figure A1-6 on an annual basis, during the summer, and analyzed as described in Section 2.4.1 herein.

2.5 Land Subsidence 354.34 (c) (5)

Land surface subsidence has been observed in multiple areas within the Tule Subbasin. Based on United States Geological Survey (USGS) measurements and analysis of land subsidence that occurred in the area in the 1950s and 1960s,[8] it has been determined that the land subsidence is associated with lowered groundwater levels due to groundwater pumping in areas where the subsurface contains a significant amount of clay and silt. Recent land subsidence in the Tule Subbasin has resulted in lowered flow capacity in the Friant-Kern Canal. Subsidence has also been observed from satellite data in the western portion of the subbasin.

2.5.1 Monitoring Features

Monitoring of changes in land surface elevation related to groundwater withdrawal will be conducted through global positioning surveys, data collected from extensometers, and satellite data.

[7] Tule Basin Water Quality Coalition, 2017. Groundwater Trend Monitoring Workplan. January 6, 2017.
[8] Lofgren, B.E., and Klausing, R.L., 1969. Land Subsidence Due to Ground-Water Withdrawal, Tulare-Wasco Area of California. USGS Professional Paper 437-B.

2.5.1.1 Global Positioning Surveys

A total of 60 benchmark stations have been established to monitor changes in land elevation across the subbasin using GPS measurements (see Figure A1-7). Each survey station is a benchmark labeled with the station identification. An additional 34 benchmark stations established by the Friant Water Authority (FWA) are included in the monitoring network. In addition to the existing benchmark network, additional benchmarks may be established in the subbasin in the future.

Land surface elevations from the Porterville GPS Station (Station P056), located at the Porterville Airport (see Figure A1-7), are also included in this plan. The data is available through the University NAVSTAR Consortium (UNAVCO) website.

2.5.1.2 Extensometers

The USGS collects data on aquifer system compaction, which causes land subsidence, from one existing extensometer near Porterville (22S/27E-30D2; see Figure A1-7). This station is located adjacent to the Friant-Kern Canal approximately one mile north of the Deer Creek crossing. Data from this extensometer can be accessed via the USGS website.

In addition to the existing extensometer, additional extensometers may be established at strategic locations of the subbasin in the future.

2.5.1.3 Satellite Data (InSAR)

Changes in land surface elevation over time can be observed on a regional scale using satellite data. The data is generated using interferometric synthetic aperture radar (InSAR). InSAR data is available and will be obtained from the CDWR on a quarterly basis.

2.5.2 Monitoring Procedure

2.5.2.1 Global Positioning Surveys

The GPS network will be established and monitored in accordance with National Geodetic Survey (NGS) Guidelines for Establishing GPS-Derived Ellipsoid Heights (National Oceanographic and Atmospheric Administration and Guidelines for Establishing GPS-Derived Orthometric Heights.[9] All GPS-derived elevations will be constrained to an established NGS benchmark located on Lake

[9] NOAA, 1997.

Success Dam (KT 200). All land surface elevation readings will be to an accuracy of 0.1 feet relative to NAVD88.

Land surface elevations from the Porterville GPS Station will be downloaded from the UNAVCO website as needed.

2.5.2.2 Extensometers

The USGS extensometer is equipped with a continuous monitoring device to record aquifer system compaction. Aquifer system compaction data will be downloaded from the USGS website for analysis as data updates are available.

2.5.2.3 Satellite Data (InSAR)

InSAR data will be obtained from the Jet Propulsion Laboratory, USGS, or European Space Agency for processing. The data will be analyzed and interpreted by an outside professional (Neva Ridge Technologies, Inc. or approved equal) in order to develop maps showing regional land surface changes.

2.5.3 Frequency of Measurement

2.5.3.1 Global Positioning Surveys

GPS surveys of the stations shown on Figure A1-7 will be conducted on an annual basis correlated to groundwater quality sampling events. GPS surveys of stations located within the Friant-Kern Canal Monitoring Zone will be conducted on a quarterly basis.

2.5.3.2 Extensometers

Aquifer system compaction is measured on a continuous basis at the USGS extensometer. Aquifer system compaction data will be downloaded from the USGS website for analysis as data updates are available.

2.5.3.3 Satellite Data (InSAR)

InSAR data will be obtained and analyzed on a quarterly basis.

2.6 Depletions of Interconnected Surface Water 354.34 (c) (6)

Surface water flow in the Tule River and Deer Creek ultimately flow into the historical Tulare Lake but only during periods of prolonged above-normal precipitation. Surface water flow in the White River does not reach the Tulare Lake bed. Surface water flow in the Tule River, including flow beyond the Tule Subbasin, is monitored and managed by the Tule River Association (TRA).

Surface water flow in the Deer Creek and White River are monitored by the USGS and USBR. The monitoring features, monitoring procedures, and monitoring frequency for surface water in the Tule Subbasin follows the features, procedures, and frequency already in place by these organizations.

2.6.1 Monitoring Features

A primary source of water to the Tule Subbasin is surface water runoff originating in the Sierra Nevada Mountains. The primary rivers/streams contributing surface water to the subbasin include the Tule River, Deer Creek, and White River (see Figure A1-8). Each of these rivers/streams contain existing surface water monitoring stations for the collection of both stream flow and surface water quality. The following summarizes the key monitoring features and locations in the subbasin.

2.6.1.1 Tule River

Stream flow in the portion of the Tule River that is within the Tule Subbasin is determined by controlled releases from Lake Success, measured by the Army Corps of Engineers (ACOE). Stream flow entering Lake Success is measured and distributed to various water rights holders as allocated at Success Dam in accordance with the Tule River Water Diversion Schedule and Storage Agreement.[10] The accounting of surface water flow, storage, streambed losses, and diversions is documented for each water year in the TRA annual reports from 1962 through 2017.

Tule River Stream Flow – Main Channel

Stream flow in the Tule River is measured by the ACOE below Success Dam, at Rockford Station downstream of Porterville, and at Turnbull Weir by the TRA (see Figure A1-8). In addition, releases of imported Central Valley Project water into the Tule River and Porter Slough from the Friant-Kern Canal are conducted at two locations, which are measured via weir structures managed by the USBR. Details regarding the location and construction of each stream flow gage are provided in Table A1-4.

[10] TRA, 1966. Tule River Diversion Schedule and Storage Agreement. Dated February 1, 1966; revised June 16, 1966.

Tule River Diversions - Structures and Headgates

Between Lake Success Dam and the Turnbull Weir, water is diverted from the Tule River to various water right holders. Diversion locations are shown on Figure A1-8 and described as follows:

Pioneer Water Company:

The headgate is a portion of the Success Reservoir outlet works and consists of a 42-inch gated conduit. The gaging station is a standard 5-foot concrete Parshall flume located 100 feet downstream of the reservoir outlet works at a point approximately 2,100 feet south and 1,400 feet east of the northwest corner of Section 35, Township 21 South, Range 28 East, M.D.B.&M., being in the southeast quarter of the northeast quarter of said Section 35.

Porter Slough at Headgate

The Porter Slough Headgate diverts water from the main channel of the Tule River to the Porter Slough, an ancestral branch of the Tule River that extends from the headgate to the LTRID No. 4 Canal (see Figure A1-8). The headgate is located in the southeast quarter of the northeast quarter of Section 4, Township 22 South, Range 28 East, M.D.B.&M. Five bays of flashboards control the diversions from the Tule River in Porter Slough.

Flows at the headgate of Porter Slough are computed by the addition of 5 cubic-feet per second to the daily mean flows measured at the Porter Slough at Porterville (B Lane) gaging station.

Porter Slough at Porterville

The gaging station is a rated section of the natural channel situated approximately 2,900 feet west and 1,100 feet north of the southeast corner of Section 32, Township 21 South, Range 28 East, M.D.B.&M. and 1.4 miles below the Porter Slough headgate in the Boydston Weir.

Porter Slough Ditch Company

The headgate is located in the Porter Slough check structure at Putnam Street being approximately 2,500 feet west and 1,500 feet north of the Southeast corner of Section 26, Township 21 South, Range 27 East, M.D.B.&M., being in the northwest quarter of the southeast quarter of said Section 26. The gaging station is a rated section 150 feet below the headgate.

Porter Slough Below Avenue 192

Porter Slough terminates with discharge through a concrete check structure into the No. 4 Canal of LTRID located near the center of Section 11, Township 21 South, Range 26 East, M.D.B.&M., one-half mile easterly of Tulare County Road 192. A daily weir measurement is used for recording the flow of Porter Slough Below 192.

Downstream of Avenue 192, the Porter Slough discharges into a series of unlined canals that deliver water to farmers in the LTRID.

Campbell and Moreland Ditch Company:

The headgate is located near the South end of Boydston Weir at a point approximately 600 feet west and 1,700 feet south of the northeast corner of Section 4, Township 22 South, Range 28 East, M.D.B.&M., being in the southeast quarter of the northeast quarter of said Section 4. The gaging station is a rated concrete lined canal section 2,600 feet below the headgate.

Vandalia Ditch Company:

The headgate is located in the south end of Vandalia Weir at a point approximately 1,160 feet west and 170 feet north of the southeast corner of Section 32, Township 21 South, Range 28 East, M.D.B.&M., being in the southeast quarter of the southeast quarter of said Section 32. The gaging station is a rated section 1,000 feet below the headgate.

Hubbs & Miner Ditch Company:

The canal diverts along the North levee of the Tule River at a point approximately 2,600 feet west and 2,100 feet north of the southeast corner of Section 35, Township 21 South, Range 27 East, M.D.B.&M., being in the northwest quarter of the southeast quarter of said Section 35. The gaging station is a rated section 3,100 feet below the canal diversion and 85 feet downstream of the River bypass headgate structure.

Poplar Irrigation Company:

The canal diverts along the south levee of the Tule River at a point approximately 740 feet west and 1,000 feet north of the southeast corner of Section 36, Township 21 South, Range 27 East, M.D.B.&M., being in the southeast quarter of the southeast quarter of said Section 36. The gaging station is a rated section 3,400 feet below the canal diversion and 325 feet downstream of the River bypass headgate structure.

Woods-Central Ditch Company:

The headgate structure is located in the South bank of the Tule River at a point approximately 2,300 feet west and 2,200 feet north of the southeast corner of Section 30, Township 21 South, Range 27 East, M.D.B.&M., being in the northwest quarter of the southeast quarter of said Section 30. The gaging station is a rated section 150 feet below the River diversion.

2.6.1.2 Deer Creek

Deer Creek is a natural drainage that originates in the Sierra Nevada Mountains, flowing in a westerly direction north of Terra Bella and between Pixley and Earlimart (see Figure A1-8). The Deer Creek channel extends to the Homeland Canal, although surface water flow rarely reaches that location.

Deer Creek Stream Flow

Stream flow in Deer Creek is measured at the United States Geological Survey (USGS) gage at Fountain Springs (five miles east of, and outside of, the Tule Subbasin boundary), Trenton Weir, and at the point where Deer Creek outlets to the Homeland Canal (see Figure A1-8). Details regarding the location and construction of each stream flow gage are provided in Table A-4 and summarized below.

Friant-Kern Canal Discharges into Deer Creek

Friant-Kern Canal water is also discharged into Deer Creek approximately five miles upstream of Trenton Weir and measured by the USBR (see Figure A1-8).

2.6.1.3 White River

The White River drains out of the Sierra Nevada Mountains east of the community of Richgrove in the southern portion of the Tule Subbasin (see Figure A1-8). The White River channel extends as far as State Highway 99 but does not reach the historical Tulare Lake bed. Streamflow in this river is currently monitored manually at Road 208 by the Tule Basin Water Quality Coalition and the Delano-Earlimart Irrigation District.

2.6.2 Monitoring Procedure

2.6.2.1 Surface Water Flow Measurements

With the exception of the White River Turnbull Weir at Road 208, Porter Slough at 192, and Deer Creek outlet to Homeland Canal, all gaging stations and diversion structures on the Tule River and Deer Creek are equipped with water stage recorders that collect water stage readings automatically every 15 minutes. The gage on the Tule River Below Success Dam is operated and managed by the ACOE. The Trenton Weir on Deer Creek is operated and managed by the ACOE. All other gages (with the exceptions noted) report data electronically in real time to the TRA/LTRID.

Stream flow at the Turnbull Weir is measured manually when flow passes the gage. Manual measurements involve recording the reading on the staff gage in the river and conducting current meter measurements for verifying the rating curve and table. Current meter measurements will be collected within the rated section of the natural channel under laminar flow conditions. The required frequency of manual measurements at the Turnbull Weir is addressed in Section 2.6.3. Staff gage and current meter readings are recorded immediately after completion of the measurement and any significant shifts are verified immediately by re-measurement. All readings are recorded on standard forms that include the time the measurement began, the time the measurement was completed, the staff gage height in feet to the nearest hundredth, and any other pertinent data with respect to channel conditions, growth, etc.

For water stage recorders, should the flow double within any 24-hour period, the bi-hourly gage heights shall be converted to second-foot flows and the mean daily flow computed from the second-foot quantities rather than utilizing the normal procedure of obtaining a mean daily gage height and the gage height to a second-foot flow. In the final review of gage sheets, shifts shall be prorated through the period during which the change occurred as determined from the current meter measurements, unless the Hydrographer determines a specific reason for the shift to occur at a definite time.

2.6.2.2 Surface Water Quality Measurements

Surface water quality samples have historically been collected and analyzed from the Tule River, Deer Creek and White River by the Tule Basin Water Quality Coalition surface water quality program. Surface water quality monitoring stations are shown on Figure A1-8.

Surface Water Quality Monitoring Locations – Tule River

Porter Slough at Road 192

> Surface water quality samples are collected from Porter Slough upstream of the discharge into the LTRID canal (see Figure A1-8). This surface water monitoring site is located approximately eight miles northwest of Porterville, California.

Tule River at Road 144

> Surface water quality samples are collected from the North Fork of the Tule River at Road 144, approximately 3.5 miles northwest of Woodville, California.

Tule River at Road 92

> Surface water quality samples are collected from the Tule River at Road 92, approximately four miles northwest of Tipton, California.

Surface Water Quality Monitoring Locations – Deer Creek

Surface water samples are collected from the following locations in Deer Creek:

Deer Creek at Road 248

Located approximately 2.5 miles northeast of Terra Bella in the foothills of the Sierra Nevada Mountains.

Deer Creek at Road 176

Located at Trenton Weir.

Deer Creek at Road 120

Located approximately six miles southeast of Pixley, California at the Road 120 bridge.

Surface Water Quality Monitoring Locations – White River

Surface water quality samples are collected from the White River at Road 208 when flow occurs.

2.6.2.3 Surface Water Quality Constituents

Each surface water quality sample is analyzed by a State certified analytical laboratory for the constituents listed in Table A1-5. In general, these constituents include electrical conductivity (EC), pH, dissolved oxygen (DO), E. Coli bacteria, total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS), turbidity, selected metals, hardness, ammonia, nitrate as N, orthophosphate, and phosphorus.

2.6.3 Frequency of Measurement

2.6.3.1 Stream Flow

Stream flows at gaged stations and diversion points are measured on a continuous basis and electronically transmitted to the TRA/LTRID.

For stream flows at locations with no established gage (e.g. Turnbull Weir and Porter Slough at 192), a current meter measurement is made at least once every two weeks when flows occur. An initial current meter measurement is made as soon as flow is detected and a final current meter measurement is made just prior to discontinuance of flow. Current meter measurements are made when a major change in the stage of flow occurs whether the flow is an increase or a decrease.

2.6.3.2 Surface Water Quality

Surface water quality samples are collected from all of the surface water quality monitoring locations shown on Figure A1-8 on a monthly basis when flow occurs.

2.6.4 Stream Gage Calibration and Maintenance

Manual readings are conducted at each active gaging station at least once per month in order to assess the accuracy of the gage reading to the rating curve. Adjustments are made as necessary.

All gaging stations undergo maintenance at least once per year to clean and backwash inlet pipes, clean and adjust recorder and appurtenances, check and repair time clocks, and repaint the station enclosures, as needed. If the time is off more than one-half hour, or the pen is off more than 0.05 feet, the recorder is reset to correct readings, the pen shall conform to the tape, and the drum shall be rolled for restarting the operation on a new coordinate with revised gage heights denoted.

Gage sheets are reduced as readily as possible after removal from the recorder withadditional notations made for assistance in subsequent reviews. Such notations includeestimated flows should the recorder provide an incomplete recording due to fouling, clock malfunction or if growth is observed in the channel.

3.0 Representative Monitoring §354.36

3.1.1 Groundwater Levels

A subset of groundwater level monitoring features in the monitoring plan have been identified as representative monitoring sites to be relied on for the purpose of assessing progress with respect to groundwater level sustainability in the subbasin. The representative groundwater level monitoring sites are shown on Figure A1-2. At least one representative groundwater level monitoring site has been identified within each management area. Where possible based on available wells, representative monitoring sites have been chosen with perforations exclusively in either the Upper or Lower Aquifer. To provide adequate spatial coverage of the subbasin, some representative monitoring sites include perforations across multiple aquifers until new monitoring features can be constructed. Representative groundwater level monitoring wells will be equipped with pressure transducers to measure groundwater levels on a daily basis.

3.1.2 Reduction of Groundwater Storage

Changes in groundwater storage within the Tule Subbasin will be estimated using either of the methods identified in Section 3.6 of the Tule Subbasin Coordination Agreement. Groundwater level data to be relied on for the change in groundwater storage estimates will be collected as described in Section 2.1 of this TSMP from the monitoring network shown on Figures A1-2 and A1-5. As such, there are no single representative monitoring sites for evaluating progress with respect to groundwater sustainability as it relates to changes in groundwater storage in the subbasin.

3.1.3 Seawater Intrusion

Seawater intrusion cannot occur in the Tule Subbasin due to its location with respect to the Pacific Ocean (see Section 2.3 herein). As such, representative monitoring sites for evaluating progress with respect to groundwater sustainability as it relates to seawater intrusion are not needed.

3.1.4 Degraded Groundwater Quality

Groundwater quality degradation in the Tule Subbasin is being monitored and regulated under the Irrigated Lands Regulatory Program (ILRP) and CV Salts. Monitoring of groundwater quality as it relates to the sustainability of the Tule Subbasin is focused on potential changes in the direction and/or flow rate of existing point-source groundwater contaminant plumes. These plumes have been identified and described in Section 2.2.4 of the Tule Subbasin Setting (Attachment 2 of the Tule Subbasin Coordination Agreement). As changes in the movement of contaminant plumes occurs as a result of changes in groundwater levels, the representative monitoring sites identified for groundwater levels (Section 3.1.1 herein) serve as proxy representative monitoring sites for the potential movement of existing groundwater contaminant plumes.

3.1.5 Land Subsidence

Representative monitoring sites for land subsidence within the Tule Subbasin consist of the network of GPS benchmark stations shown on Figure A1-7. Land subsidence has been measured along the canal in the past and further land subsidence is considered an undesirable result as it restricts the ability to deliver water downstream of the area of subsidence. Measured subsidence at these GPS stations will inform progress as it relates to arresting future land subsidence along the canal.

3.1.6 Interconnected Surface Water

As described in Section 2.2.7 of the Tule Subbasin Setting (Tule Subbasin Coordination Agreement Attachment 2), there are no interconnected surface water systems within the Tule Subbasin. As such, representative monitoring sites for evaluating progress with respect to groundwater sustainability as it relates to interconnected surface water are not needed.

4.0 Assessment and Improvement of Monitoring Network §354.38

The TSMP is both flexible and iterative, allowing for the addition or subtraction of monitoring features, as necessary, and to accommodate changes in monitoring frequency and alternative methodologies, as appropriate.

4.1 Data Gaps §354.38 (b)

4.1.1 Groundwater Monitoring Data Gaps

Despite the number of existing monitoring wells that have been identified within the Tule Subbasin, there remain data gaps that, if addressed, would improve the ability to monitor groundwater level changes and flow patterns specific to the Upper and Lower aquifers. The current data gaps relate primarily to spatial coverage of monitoring features necessary to prepare complete groundwater level contour maps specific to the Upper and Lower aquifers in the subbasin.

In addition to groundwater level data gaps, there is a lack of aquifer parameter data, as obtained from controlled pumping tests of wells. The groundwater flow model has been developed based predominantly on short-term pumping tests, which enable the development of estimates of aquifer transmissivity. However, these tests are not as representative as long-term pumping tests (24-hr tests or longer). Further, pumping tests where groundwater level interference is measured in nearby monitoring wells have not been conducted. These tests enable the estimation of aquifer storage properties. During the construction of new monitoring features, it is anticipated that long-term pumping tests will be conducted to obtain aquifer parameter data specific to both the Upper and Lower aquifers. Further, pumping tests will be planned, where feasible, on existing high-capacity groundwater production wells.

Recommended Monitoring Features and Testing to Address Data Gaps §354.38 (d)

Identification of new monitoring well locations is an ongoing effort in the Tule Subbasin. Potential areas for new wells to address groundwater level data gaps are shown on Figure A1-2 and described in Sections 2.1.1.1 and 2.1.1.2 herein. The new monitoring wells, combined with existing monitoring wells, will improve the Tule Subbasin TAC's ability to develop detailed and representative groundwater contour maps and provide a better network of calibration targets for the subbasin-wide groundwater model. It is further anticipated that many of the new monitoring wells will eventually replace currently assigned representative monitoring sites.

As described in Section 2.1.1.1 herein, some of the new monitoring wells will be constructed as nested wells with two casing installed in the same borehole, each perforated in a distinct aquifer and isolated with a seal to ensure measurement of data unique to either the Upper or Lower aquifer.

In order to address the aquifer parameter data gaps, it is recommended to conduct controlled, long-term pumping tests in selected wells within the subbasin. Tests should be conducted in wells perforated exclusively in the Upper Aquifer and exclusively in the Lower Aquifer. Pumping wells will be selected near proposed monitoring wells in order to enable pumping interference measurements during the test. Each test will consist of a 24-hr constant rate pumping test.

4.1.2 Land Surface Monitoring Data Gaps

InSAR data that cover the entire Tule Subbasin have been historically available and indicate areas where land subsidence has been occurring. Confirmation of these data with more conventional land based survey methods such as GPS is ongoing. The USGS has refurbished one extensometer, which is located approximately one mile north of Deer Creek along the Friant-Kern Canal and is included in this plan. However, characteristics of aquifer system compaction in the northwestern portion of the subbasin, which is hydrogeologically different than the area where the existing extensometer is located, is unknown and represents a data gap.

Recommended Monitoring Features to Address Land Surface Monitoring Data Gaps §354.38 (d)

At least one new extensometer is recommended for the vicinity of the Homeland Canal at Highway 43 in the northwest portion of the subbasin. This instrument will provide the most accurate assessment of aquifer system compaction in the area of greatest subsidence in the subbasin.

4.1.3 Surface Water Monitoring Data Gaps

The following surface water monitoring data gaps have been identified for the Tule Subbasin:

- Tule River near Porterville - Channel infiltration losses in the upper portion of the Tule River are currently calculated between the gage below Success Dam and the gage at the Rockford Station, which is a 10-mile stretch of the river. It appears that more of the infiltration losses occur in the upper portion of the channel reach than in the lower. An intermediate gage between the Poplar diversion and Woods Central would be beneficial to understand the volume of infiltration losses above and below this point.

- Tule River at McCarthy Check - Channel infiltration losses between the Rockford Station and the Turnbull Weir are not well documented. An additional gage at the McCarthy Check at Road 96 (see Figure A1-8) would provide additional information on the channel losses upstream of this point and between McCarthy Check and Turnbull Weir.

- Deer Creek at Friant-Kern Canal – While the releases of imported water from the Friant-Kern Canal to the Deer Creek channel are well documented, the channel infiltration losses between the Friant-Kern Canal and the Trenton Weir are not. An additional gage immediately upstream of the Friant-Kern Canal would enable the measurement of flows attributed to both imported water and natural stream flow as well as a better estimate of channel losses between these two points.

- Deer Creek at Homeland Canal – Stream flows at the downstream end of Deer Creek periodically reaches, and are discharged to, the Homeland Canal (see Figure A1-8). The nature and historical records of this discharge are not available and present a data gap for the surface water budget of the subbasin. Further, a gage record at this location would provide information on streambed infiltration during periods of time when surface water in Deer Creek reaches Homeland Canal.

- White River – Historical stream flow in the White River has been measured by the USGS at the gage near Ducor (see Figure A1-8). However, this gage is no longer active leaving a data gap for the volume of surface water entering the subbasin from this river (current estimates of flow into the subbasin are based on correlations with flows of Deer Creek). Further, there are no established gages downstream of this point.

Recommended Surface Water Monitoring Features to Fill the Data Gaps §354.38 (d)

The following surface water monitoring features are recommended to address the surface water data gaps:

- Tule River – Establish a rated section of channel, concrete weir structure and water stage recorder at an appropriate location between the Poplar diversion and the Rockford Station gage; and establish a rated section of channel, concrete weir structure and water stage recorder at the McCarthy Check.

- Deer Creek – Establish a stream gage immediately upstream of the Friant-Kern Canal to enable the portion of flow in the channel attributed to native stream flow and the portion attributed to imported Central Valley Project releases. Investigate the discharge structure at the Deer Creek inlet to Homeland Canal and develop a gaging station.

- White River – Refurbish and reinstate the USGS gage immediately east of the Tule Subbasin boundary near Ducor. Establish a rated section of channel, concrete weir structure and water stage recorder at Road 208 (if this has not already occurred).

5.0 Tule Subbasin Data Management System

Efficient data management will be a critical aspect of the Coordination Agreement in order to ensure that each GSA can access the data needed to prepare their respective annual reports in a timely manner and to ensure that the Tule Subbasin TAC can meet deadlines for submittal of the coordinated reports. Data to be managed will include:

A. Historical data used as a basis for the Water Budget of the Tule Subbasin.
B. Data to be collected in accordance with the Tule Subbasin Monitoring Plan.

Both historical and future data collected as part of this TSMP will be stored in a single comprehensive electronic database. This section satisfies § 352.6 of SGMA Regulations, which requires each agency to develop and maintain a data management system (DMS) that is capable of storing and reporting information relevant to the development and implementation of the plan and monitoring of the basin. The following table outlines the sections of the Tule Subbasin DMS as they relate to the various components of the SGMA Regulations.

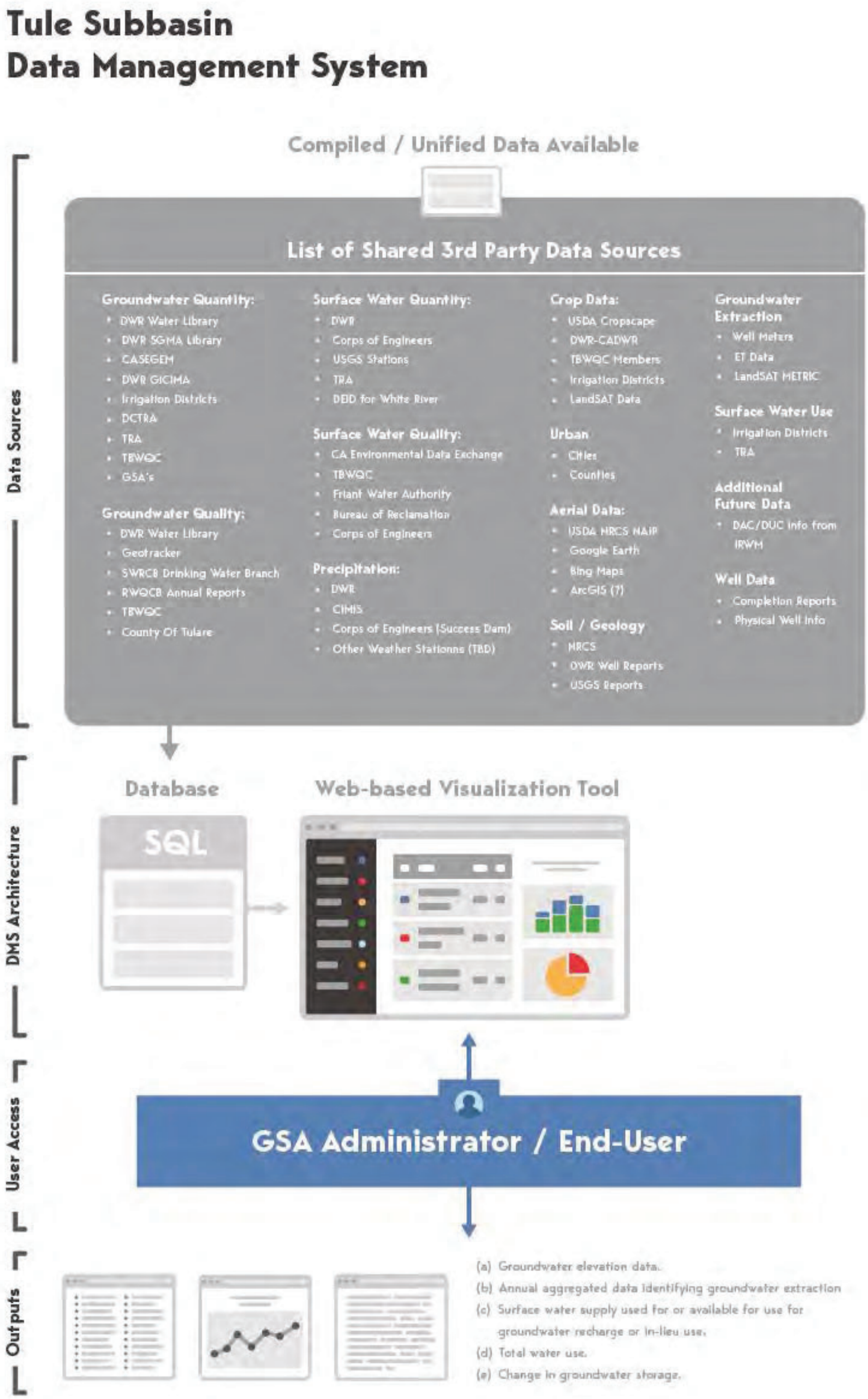
Table A1-6 – Tule Subbasin DMS SGMA Requirements

Tule Subbasin DMS SGMA Requirements		
SGMA Regulation Section No.	Coordination Agreement Corresponding Section	Description
§ 352.4	Section 5.2	Data and Reporting Standards
§ 352.6	Section 5	Data Management System
§ 353.4	Section 5.2.4.2	Reporting Provisions
§ 354.4	Section 5.2.4.2	Reporting Monitoring Data to the Department
§ 356.2	Section 5.2.4.2	Annual Reports

5.1 Overview of Tule Subbasin Data Management System

The Data Management System will allow users to view program data in comparison with all publicly available data from federal, state, and local jurisdictions to make the most informed decisions. Users will be able to submit, query, view, and analyze data as needed. The Tule Subbasin Data Management System (DMS) is comprised of two separate coordinated systems that include a SQL server and a web-based visualization platform. SQL will function as the storage and retrieval system to display the data in the web-based visualization platform. Users will have access to data sets through the web-based platform, to export data, import data, and view data in a dashboard format.

Figure A1-9 Data Management System Overview



5.2 Functionality of the Data Management System

The DMS will be comprised of various tools designed to assist GSAs in the development and implementation of their groundwater sustainability plans. At its Core, the DMS is a data storage system which grants users access to interact and upload data required to comply with SGMA regulations. Guiding the implementation of the DMS are the rules laid out in the following sections.

5.2.1 User and Data Access Permissions

User data access and permissions will be based on the predetermined user type and data source by the system administrator. User types include:

- System Admin - Users with this permission can perform all administrative functions.
- SGMA End-User - Users with this permission can perform all APN / Parcel Level functions and have access to Basin Level and GSA Level Public Data.
- End User Delegate - Users with this permission can perform all APN / Parcel Level functions and have access to Basin Level and GSA Level Public Data.
- GSA Staff - Users with this permission can perform all Farm Level and GSA Level functions and have access to Basin Level Public Data.
- GSA Manager - Users with this permission can perform all APN / Parcel Level and GSA Level functions and have access to Basin Level Public Data.
- Public User - Users may view published data but cannot import or edit information

Data viewing and access will be limited on geographic extent based on the user, such as a landowner will only be able to view data for land he/she owns or an administrator of the GSA can view data for the GSA he/she represents. Data from private or user sources will be protected in the system while publicly available data will be available basin wide. Data Source types include:

- Public - Federal, State, or local published data
- Private - District or agency specific data
- Shared - SGMA data available for all users of DMS excluding public users
- User - user specific data
- DMS - Data available from other programs (IRLP)
- Published - Data from SGMA/GSA sources available for public consumption

5.2.2 Data Entry and Validation

To encourage agency and user participation in the DMS, data entry and import tools are easy-to-use, accessible via web-based interface, and help maintain data consistency and standardization.

The DMS allows GSA Administrators and Users to enter data either manually via easy-to-use interfaces, or through an import tool utilizing standardized Microsoft Excel templates, ensuring data may be entered into the DMS consistently. The data imported will require validation by the managing GSAs Administrators or Users using a number of quality control checks prior to final import into the DMS. All data included in the system will comply with data standards laid out in § 352.4 of the SGMA Act.

5.2.2.1 Data Collection

The Tule Subbasin DMS is populated with data from various sources including public, private, contributing DMSs, and user data. Data collected in accordance with the Tule Subbasin Monitoring Plan as well as data regarding key water management areas, include:

- Precipitation
- Evapotranspiration
- Surface water flow
- Groundwater levels
- Groundwater quality
- Groundwater extraction
- Imported water deliveries
- Managed recharge
- Land surface elevation
- Land Subsidence measurements

5.2.2.2 Monitoring Data Entry (QA / QC)

For purposes of this plan, quality assurance (QA) is defined as the integrated program designed to assure reliability of monitoring and measurement data. Quality control (QC) is defined as the routine application of specified procedures to obtain prescribed standards of performance in the monitoring and measurement process.

Different monitoring protocols exist for the various data types stored in the DMS. Public sources included in the DMS as published from the source and referenced as such. User entry and private sourced data will be closely monitored for formatting and accuracy, in addition requiring chain of custody and acknowledgement of following protocols defined in the Monitoring Plan. These sources will be required to submit through pre-established forms to maintain the validity of the DMS.

5.2.2.3 Data Validation

Data Validation is required for non-public sources and will be performed in the following ways:

- **Standardized Form Input:** meant to comply with what is required by law

- **Using known possible values for a dataset:** This would represent a baseline range of what can be typed into an input. Ex: Parcels Assessed Acreage vs Irrigated Acreage
- **Data/Field Normalization:** Establishing unit consistency between datasets. The DMS will keep a normalized value behind the scenes for each variation of a reported unit. Regular Expressions on inputs to control the type/format of information being submitted to the DMS.
- **Outlier filtering:** Outlier filtering when interacting with publicly available data or data that has been mass imported. Using Statistical Analysis methods, any statistical outliers will be filtered out of reports unless the end user opts to have them included.

5.2.3 Visualizations and Analysis

The DMS will host a robust visualization and analysis component to allow end users the ability to view and provide context to the data. This can be performed in Map and Tabular views, as shown in Figure A1-10.

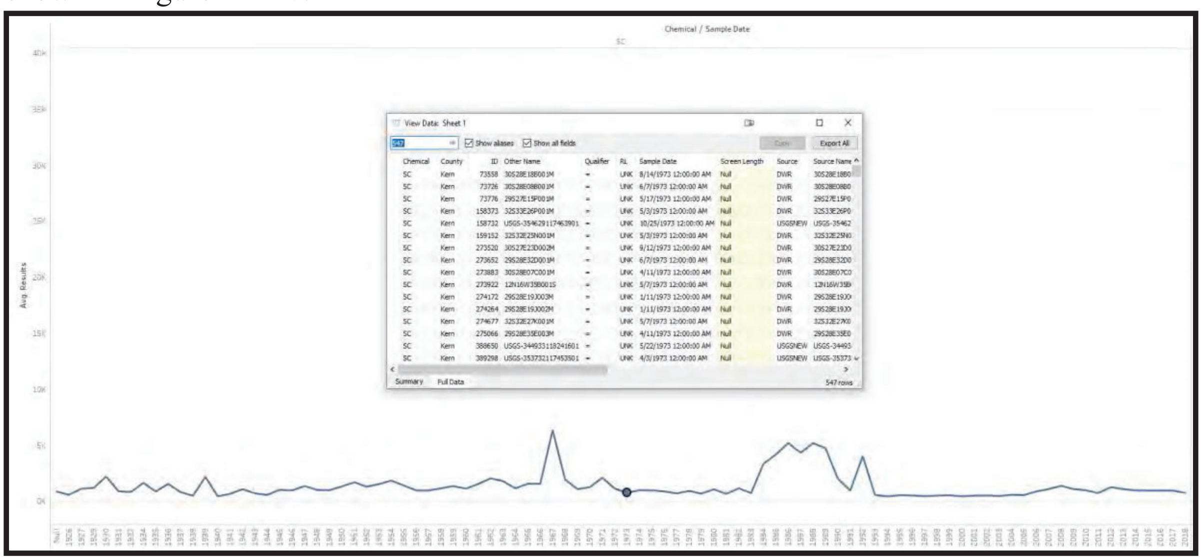


Figure A1-10: DMS Data Visualization Example - Average Specific Conductivity by Year within the Tule Sub Basin.

5.2.3.1 Map View

Map view in the DMS will allow users to visualize data that has spatial characteristics (wells, stream gages, precipitation stations, etc). **Figure A1-11** is an example of well data in the DMS. In map view users can scroll around the selected source data and click on the sites to bring up site specific information.

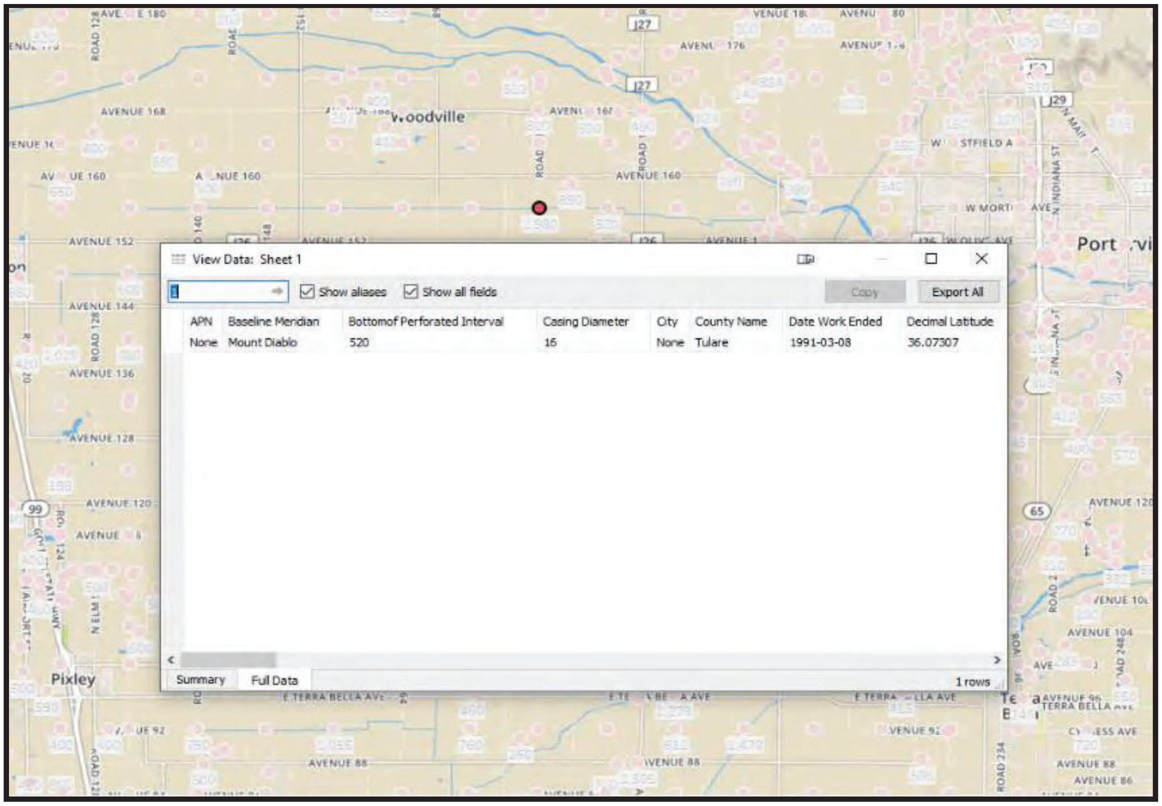


Figure A1-11: DMS Map View Example - Total Completed Well Depth Map

5.2.3.2 List View

List view presents all the data of a given dataset in tabular form. It will allow users to see all the data in the chosen data set and their attributes. Data is able to be filtered for specific attributes, geographic extent, and various other criteria.

5.2.4 Query and Reporting

Data in the DMS can be queried and reporting using various filtering and querying tools. The options are dependant on the source of the data. Reports can be prepared from the queried DMS for various formats based on the submitting agency.

5.2.4.1 Ad-hoc Query

As a relational database the DMS will have the ability to be queried by users with designed limitations for various end users (see section 5.2.1). Putting these limitations aside, any data included in the DMS can be queried based on the attributes which adhere to the data source (i.e data type, data source, parameters, geographic location, etc.). See **Figures A1-12 and A1-13** for querying examples.

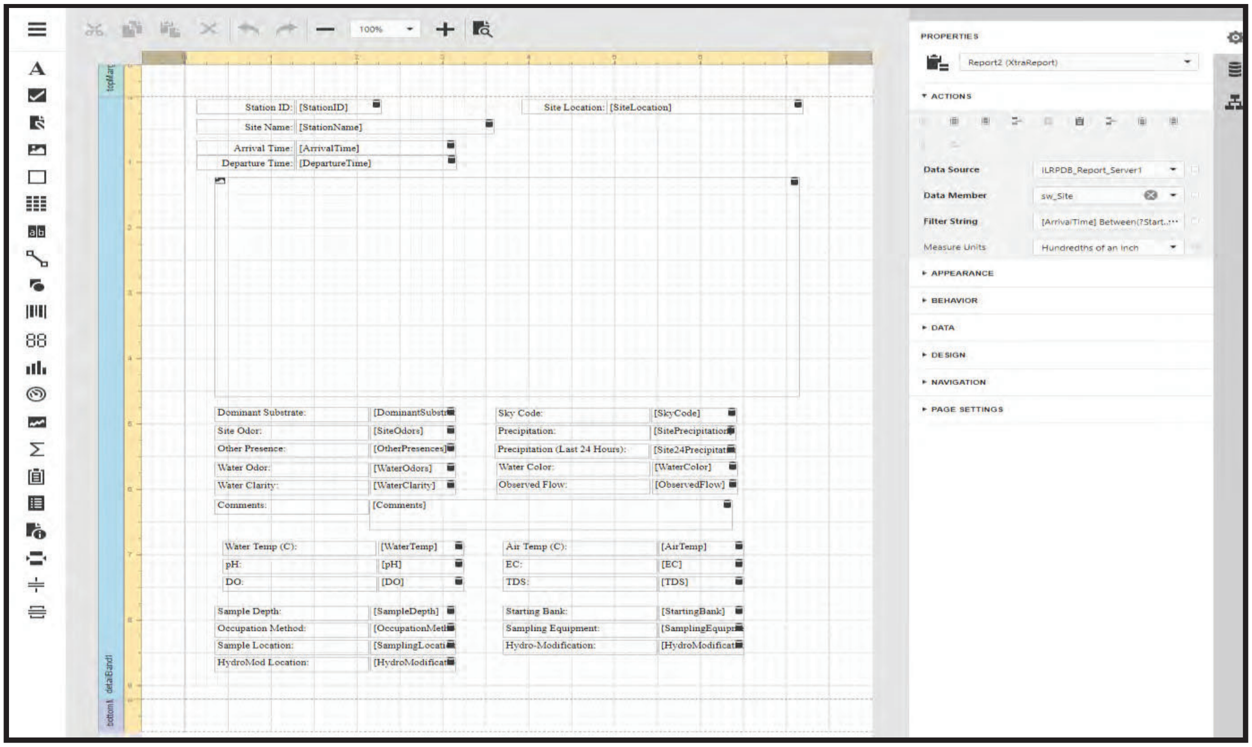


Figure A1-12: Ad Hoc Report Builder Designer View

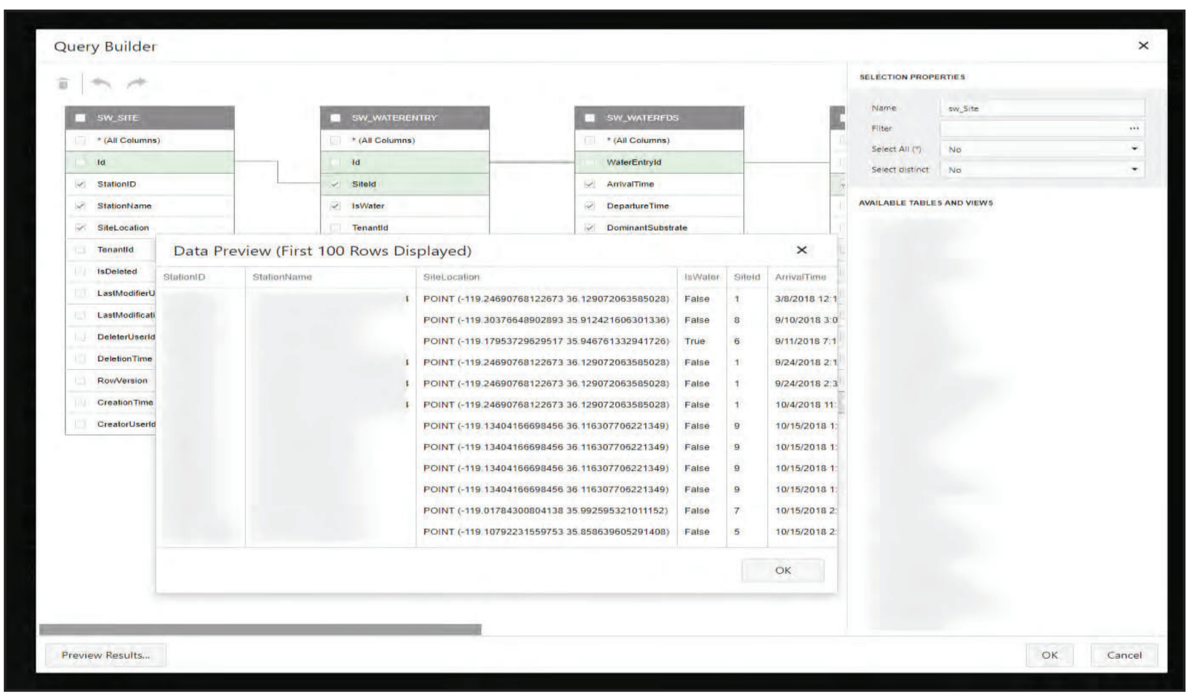


Figure A1-13: Redacted Ad Hoc Query Builder Example

5.2.4.2 Standard Reports

Standard report chart and table formats such as those included in the annual and 5-year reports can be generated utilizing the DMS. Additional reporting requirements can be created by end users. In order to provide end users with flexibility in reporting, the tools are intended to be self-serviced by the end-users. End-users will be able to create their own reports using data they have permission to access.

If commonality is discovered between participating agencies, a Standardized report can be created and shared with all agencies that as required. All generated reports and reporting tools will be built to comply with § 352.4 of the SGMA Act.

5.3 Data Included in the Data Management System

Table A1-7: Summary of Data included in DMS identifies the specific data type, the source of the data, and entry of the data in to the DMS.

Table A1-7: Summary of Data

Data Type	Source Name		Entry Type
Groundwater Quantity	DWR Water Library		Public Source
	DWR GICIMA		Public Source
	CASGEM		Public Source
	Irrigation Districts		Private Source
	DCTRA		Private Source
	TRA		Private Source
	TBWQC		DMS Transfer
	GSA'S		
	>	LTRID GSA	User Entry
	>	Pixley GSA	User Entry
	>	ET GSA	User Entry
	>	DEID GSA	User Entry
	>	Tri- County GSA	User Entry
		Tulare County GSA	User Entry

	>	Alpaught GSA	User Entry
Groundwater Quality	DWR Water Library		Public Source
	GAMA Geotracker		Public Source
	SCWRB Drinking Water Branch		Public Source
	RWQCB Annual Reports		Public Source
	TBWQC		Public Source
	County of Tulare		Public Source
Surface Water Quantity	Army Corps of Engineers		Public Source
	USGS Gaging Stations		Public Source
	Bureau of Reclamation		Public Source
	Tule River Authority		Private Source
	DWR - CDEC Stations		Public Source
Surface Water Quality	CA Environmental Data Exchange		Public Source
	TBWQC		DMS Transfer
	Friant Water Authority		Public Source
	Corps of Engineers		Public Source
Precipitation	DWR		Public Source
	CIMIS		Public Source
	Corps of Engineers		Public Source
	TBD		N/A
Crop Data	USDA Cropscape		Public Source
	DWR-CADWR		Public Source
	TBWQC Members		DMS Transfer
	Irrigation Districts		Public Source
	FMMP		Public Source
	LandSAT		Public Source
Urban	Cities		Public Source
	Counties		Public Source

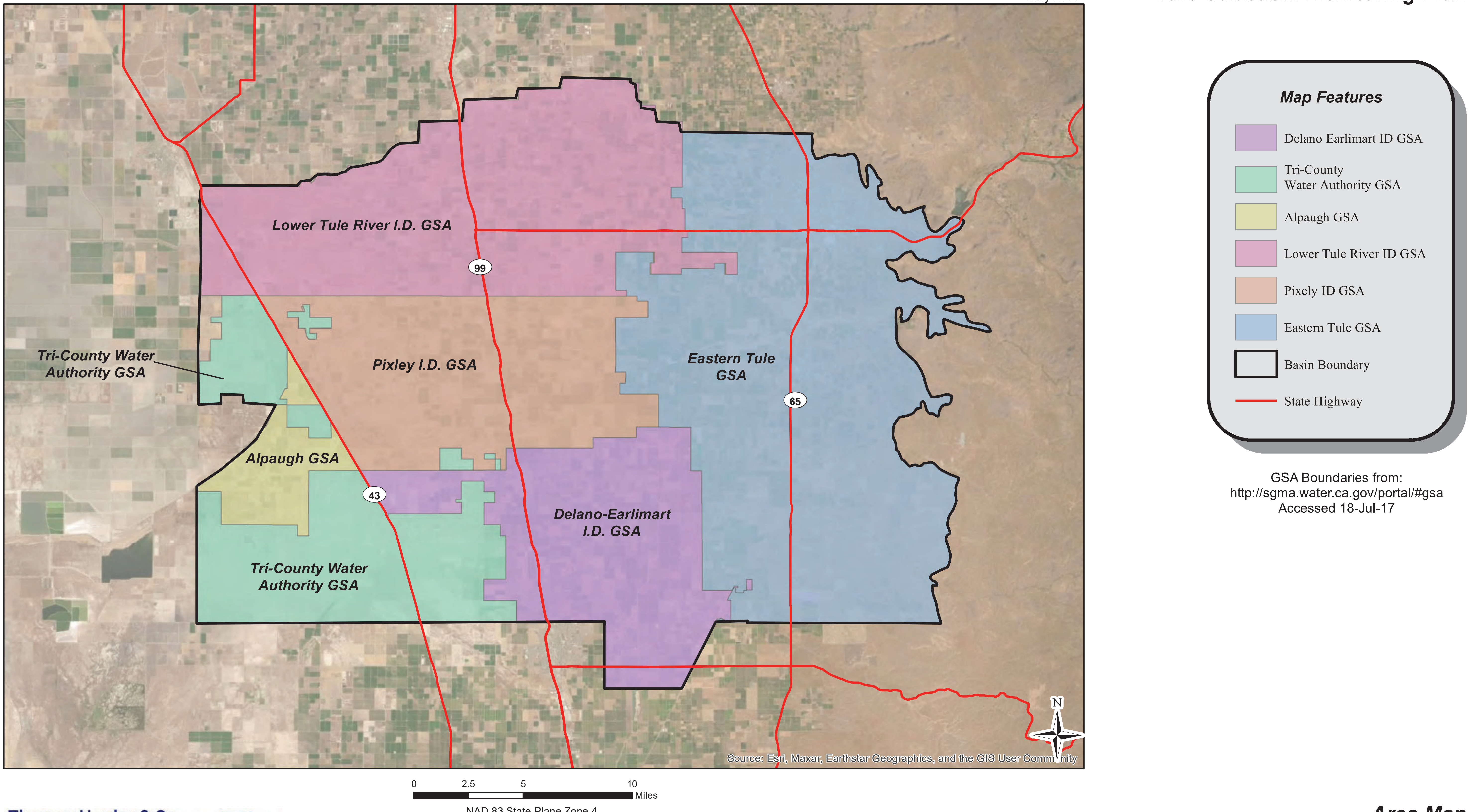
Soil/Geology	NRCS	Public Source
	DWR Well Reports	Public Source
	USGS Reports	Public Source
Subsidence	USGS	Public Source
	TBWQC	Public Source
	UNAVCO	Public Source
Groundwater Extraction	Well Meters	TBD
	ET Data	DMS Transfer
	LanSAT Metric	DMS Transfer
Surface Water Use	Irrigation Districts	Private Source
	TRA	Private Source
Future Sources	DAC/DUC IRWM Info	Private Source
Well Data	Well Completion Reports	Annually
	Physical Well Info	TBD

Figures

Tule Subbasin

July 2022

Tule Subbasin Monitoring Plan



GSA Boundaries from:
http://sgma.water.ca.gov/portal/#gsa
Accessed 18-Jul-17

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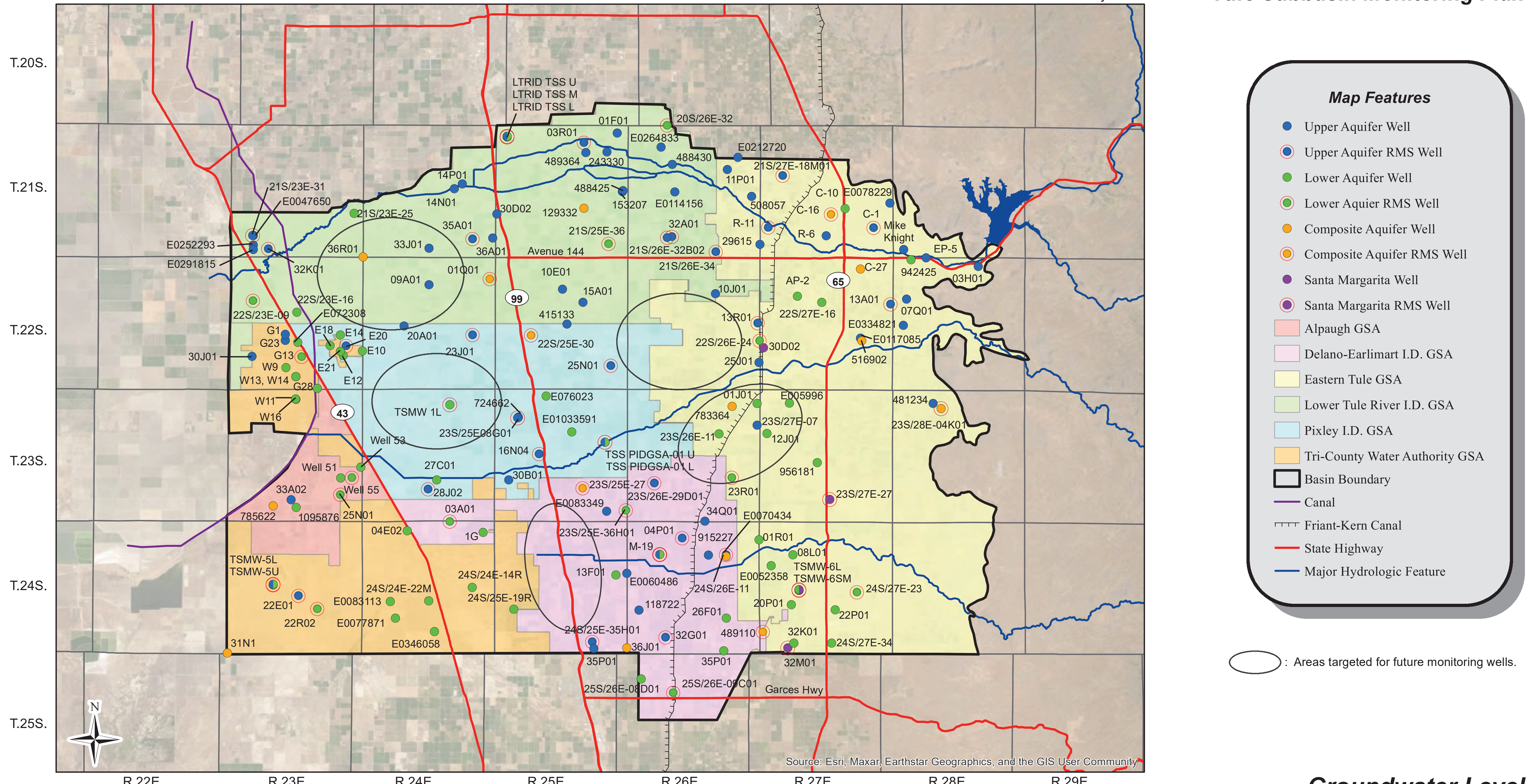
Groundwater Consulting

Area Map
Figure A1-1

Tule Subbasin July 2022



0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

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Groundwater Level Monitoring Network

Figure A1-2

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-2

Tule Subbasin Setting

2024
2nd Amended Groundwater Sustainability Plan

TULE SUBBASIN COORDINATION AGREEMENT ATTACHMENT 2

Tule Subbasin Setting

July 2022

Prepared for

Tule Subbasin Technical Advisory Committee

Prepared by

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Groundwater Consulting

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CHAPTER 2: TULE SUBBASIN SETTING §354.12

§ 354.12. Introduction to Basin Setting

This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.

The Tule Subbasin is located in the southern portion of the San Joaquin Valley Groundwater Basin in the Central Valley of California (see Figure 2-1). The area of the Tule Subbasin is defined by the latest version of CDWR Bulletin 118 (CDWR, 2016) and is shown on Figures 2-1 and 2-2. The Tule Subbasin area is approximately 744 square miles (475,895 acres) and includes the jurisdictional areas of multiple water management and service entities. The subbasin has been divided into seven individual Groundwater Sustainability Agencies (GSAs): Eastern Tule GSA, Lower Tule River GSA, Pixley GSA, Delano-Earlimart GSA, Alpaugh GSA, Tri-County Water Authority GSA, and Tulare County GSA (see Figure 2-3).

Communities within the subbasin include Porterville, Tipton, Pixley, Earlimart, Richgrove, Ducor and Terra Bella (see Figure 2-2). Neighboring CDWR Bulletin 118 subbasins include the Kern County Subbasin to the south, the Tulare Lake Subbasin to the west, and the Kaweah Subbasin to the north.

2.1 Hydrogeologic Conceptual Model §354.14

§ 354.14. Hydrogeologic Conceptual Model

(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

The hydrogeologic conceptual model is a description of the groundwater flow system of the Tule Subbasin and how it interacts with surface water and land use of the area. The conceptual model includes a description of the geologic setting, geologic structure, and boundary conditions including the principal aquifers and aquitards. The hydrogeologic conceptual model of the Tule Subbasin, as described herein, has been developed in accordance with the requirements of California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2 (§354.14) and in consideration of California Department of Water Resources' (CDWR) Best Management Practices (BMP) for the preparation of hydrogeologic conceptual models. The hydrogeologic conceptual model forms the basis for the numerical groundwater flow model of the subbasin.

2.1.1. Sources of Data

Compilation, review and analysis of multiple types of data were necessary to develop the hydrogeologic conceptual model and water budget of the Tule Subbasin. The various types of data included geology, soils/lithology, hydrogeology, surface water hydrology, climate, crop types/land use, topography, remote sensing, and groundwater recharge and recovery. Data were obtained from multiple sources:

Geological Data including geologic maps and cross sections were obtained from the United States Geological Survey (USGS), the California Geological Survey (CGS), and Kenneth D. Schmidt & Associates (KDSA) (Schmidt, 2018). Geophysical logs were obtained from the California Division of Oil, Gas and Geothermal Resources (DOGGR), Angiola Water District, Alpaugh Irrigation District, Kern-Tulare Water District (KTWD), KDSA, and private well owners.

Soils/Lithological Data were obtained from drillers' logs and reports from the CDWR, the City of Porterville, the USGS and the United States Department of Agriculture (USDA).

Hydrogeological Data including groundwater levels and pumping tests were obtained from the California Statewide Groundwater Elevation Monitoring (CASGEM) website, the Deer Creek and Tule River Authority (DCTRA), Angiola Water District, Alpaugh Irrigation District, KTWD, Delano-Earlimart Irrigation District (DEID), the City of Porterville, Kern County Water Agency, 4Creeks Inc., Schmidt (2011) and Schmidt (2018). Additional hydrogeological information was obtained from USGS reports, Semitropic Water Storage District Groundwater Banking Project Biennial Reports, and the Tulare Lake Bed Groundwater Management Plan.

Groundwater Quality Data including nitrate and electrical conductivity (EC) data from the Tule Basin Water Quality Coalition, multiple reports and studies associated with the Tulare Lakebed Municipal Delisting program, and contaminants identified in the California State Water Resources Control Board Geotracker website (Geotracker, 2018).

Groundwater Recharge and Recovery Data including spreading basin locations and dimensions, artificial recharge, water well construction, well locations, groundwater production, surface water diversions, canal losses, and river losses were obtained from Lower Tule River Irrigation District (LTRID), CDWR, Tule River Association (TRA) annual reports, and DCTRA annual reports.

Hydrological (i.e. Surface Water) Data consisting of stream gage data along the Tule River, Deer Creek, and White River were obtained from the USGS, DCTRA reports and TRA annual reports. Imported water deliveries were obtained from the United States Bureau of Reclamation (USBR) and the individual agencies within the subbasin.

Climate Data was acquired from CDWR's California Irrigation Management Information System (CIMIS) and the Western Regional Climate Center website.

Land Use Data was obtained from the CDWR, LTRID, the Kern County Department of Agriculture and Measurement Stands, and the USGS Earth Resources Observation and Science Center. Political boundaries were obtained from the California Cal-Atlas Geospatial Clearinghouse, Kern-Tulare Water District, and the LTRID.

In addition to the various types of data, numerous historical reports on the geology, hydrogeology and groundwater management of the Tule Subbasin were reviewed and analyzed. These reports included USGS publications, CDWR reports and bulletins, consultant reports, and academic publications. Publications relied on for the hydrogeological conceptual model and water budget are summarized in the References Section (Section 2.5).

2.1.2. Geologic Setting §354.14 (b)(1)

§ 354.14. (b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:

(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.

(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

The Tule Subbasin is located in the Tulare Lake Hydrologic Region of the Central Valley of California (see Figure 2-1). The Central Valley is a geographically significant structural depression that extends from the Cascade Range on the north to the Tehachapi Mountains on the south (Faunt, 2009). The Central Valley groundwater basin has been subdivided on a regional scale into the Sacramento Valley Groundwater Basin north of the Sacramento River Delta, and the San Joaquin Valley Groundwater Basin south of the Sacramento River Delta. The Tulare Lake Hydrologic Region is located in the southern portion of the San Joaquin Valley Groundwater Basin. The Tulare Lake Hydrologic Region is defined by a surface water drainage watershed that includes the Sierra Nevada Mountains to the east, the Tehachapi Mountains to the south and southeast, and the Coast Ranges to the west. The northern boundary of this hydrologic region is defined by the drainage divide between the San Joaquin River to the north and the Kings River to the south.

The portion of the Central Valley structural depression that is beneath the Tulare Lake Hydrologic Region is filled with marine and nonmarine sediments, which extend to depths of more than 32,000 feet in places (Planert and Williams, 1995). The deepest sediments were deposited within a marine environment associated with an inland sea that inundated the valley between 200 million years ago (Jurassic Period) and 2 million years ago (end of the Tertiary Period) (Croft, 1972). The deeper marine sediments are overlain by as much as 9,000 ft of nonmarine continental deposits associated with Quaternary (2 million years to present) lacustrine and alluvial deposition (Planert and Williams, 1995). The current depositional environment consists of multiple coalescing alluvial fans along the basin margins with localized lacustrine deposits at the terminus of the fans in the central portion of the basin.

The Tule Subbasin is located on a series of coalescing alluvial fans that extend toward the center of the valley from the Sierra Nevada Mountains (see Figure 2-4). The alluvial fans merge with lacustrine deposits of the Tulare Lake bed in the western portion of the subbasin. Land surface elevations within the Tule Subbasin range from approximately 850 ft above mean sea level (amsl) along the eastern margins of the subbasin to approximately 180 ft amsl at the western boundary (see Figure 2-4).

Geologic formations observed at the land surface and in the subsurface beneath the Tule Subbasin can be grouped into five generalized geologic units, described below in order of increasing age:

Unconsolidated Continental Deposits – These sediments consist of fluvial (i.e. streambed deposits), alluvial, flood plain, and lacustrine (i.e. lake bed) deposits (labeled “surficial deposits” on Figure 2-4). The unconsolidated continental deposits range in thickness from 0 ft at the eastern contact with the Sierra Nevada Mountains to more than 3,000 ft near the margins of Tulare Lake in the western part of the subbasin (see Figure 2-5; Lofgren and Klausing, 1969). Subsurface alluvial sediments consist of highly stratified layers of more permeable sand and gravel interbedded with lower permeability silt and clay. Clear correlation of individual sand or clay layers laterally across the Tule Subbasin is difficult due to the interbedded nature of the sediments. However, it is noted that the thickness of clay sediments in the upper 1,000 ft below ground surface (bgs) generally increases in the vicinity of Tulare Lake. The unconsolidated continental deposits form the primary groundwater reservoir in the Tule Subbasin.

The unconsolidated continental deposits range in age from recent in near-surface stream channels to Upper Pliocene (approximately 2.6 million years before present) at depth. In the eastern portion of the Tule Subbasin, Pleistocene sediments (2.6 million to 11,700 years before present) crop out at the land surface along the base of the Sierra Nevada Mountains, forming what is referred to as the dissected uplands (Lofgren and Klausing, 1969). These older continental deposits are semi-consolidated and contain a high percentage of clay. As such, they generally do not yield significant water to wells.

The lowermost portion of unconsolidated continental deposits is generally correlated with the Tulare Formation. The Tulare Formation is notable in that it includes the Corcoran Clay, a regionally extensive confining layer that has also been referred to as the “E-Clay” (see Figure 2-5) (Frink and Kues, 1954). The Corcoran Clay consists of a Pleistocene diatomaceous fine-grained lacustrine deposit (primarily clay; Faunt, 2009). In the Tule Subbasin, the Corcoran Clay is as much as 150 ft thick beneath the Tulare Lake bed but becomes progressively thinner to the east, eventually pinching out immediately east of Highway 99 (Lofgren and Klausing, 1969).

Pliocene Marine Deposits – These sediments underlie the continental deposits and consist of consolidated to loosely consolidated marine siltstone with minor interbedded sandstone beds. The marine siltstone unit thickens to the west, ranging from approximately 500 ft thick near State Highway 65 to more than 1,600 ft beneath State Highway 99 (Lofgren and Klausing, 1969; see Figures 2-5 and 2-6). The marine siltstone beds dip sharply from the base of the Sierra Nevada Mountains on the east to the central portion of the valley in the west. The Pliocene marine strata have relatively low permeability and do not yield significant water to wells.

Santa Margarita Formation – This formation occurs beneath the Pliocene marine strata and consists of Miocene (approximately 5.3 to 23 million years before present) sand and gravel that is relatively permeable and yields water to wells. The formation is approximately 150 to 520 feet thick and occurs at depths ranging from 1,200 feet near State Highway 65 to greater than 3,000 feet beneath State Highway 99. This formation is a significant source of groundwater to wells in the southeastern portion of the Tule Subbasin near the community of Richgrove.

Tertiary Sedimentary Deposits – Beneath the Santa Margarita Formation exists an interbedded assemblage of semi-consolidated to consolidated sandstone, siltstone and claystone of Tertiary age (approximately 2.6 to 66 million years before present). Some irrigation wells in the southeastern part of the Tule Subbasin are known to produce fresh water from the Olcese Sand Formation, which is in the uppermost portion of the unit (Ken Schmidt, 2019. Personal Communication). The water quality of the groundwater in the Tertiary sedimentary deposits becomes increasingly saline to the southwest and most of the groundwater in the unit is not useable for crop irrigation or municipal supply except near Highway 65.

Granitic Crystalline Basement – Sedimentary deposits beneath the Tule Subbasin are underlain by a basement consisting of Mesozoic granitic rocks that compose the Sierra Nevada batholith (Faunt, 2009). At depth, the basement rocks are assumed to be relatively impermeable.

There are no significant faults mapped in the Tule Subbasin that would form a groundwater flow barrier or affect groundwater flow.

2.1.3. Lateral Basin Boundaries §354.14 (b)(2)

The lateral boundaries of the Tule Subbasin are defined in CDWR Bulletin 118 and include both natural and political boundaries. The eastern boundary of the Tule Subbasin is defined by the surface contact between crystalline rocks of the Sierra Nevada and surficial alluvial sediments that make up the groundwater basin (see Figure 2-4). The northern boundary is defined by the LTRID and Porterville Irrigation District (PID) boundaries. The western boundary is defined by the Tulare

County/Kings County boundary, except for a portion of the Tulare Lake Basin Water Storage District that extends east across the county boundary and is excluded from the subbasin. The southern boundary is defined by the Tulare County/Kern County boundary except for the portion of the Delano-Earlimart Irrigation District (DEID) that extends south of the county boundary and is included in the subbasin. The total area of the Tule Subbasin is approximately 744 square miles (475,895 acres).

2.1.4. Bottom of Basin §354.14 (b)(3)

§ 354.14. (b) (3) The definable bottom of the basin.

The physical bottom of the Tule Subbasin is defined by the interface between the Tertiary sedimentary deposits and the relatively impermeable granitic bedrock below them. This depth ranges from zero at the eastern margins of the subbasin where the continental deposits meet the granitic bedrock to approximately 5,000 feet below ground surface in the western portion of the subbasin (Planert and Williams, 1995).

The physical bottom of the subbasin is deeper than the bottom of the fresh water aquifer. The total dissolved solids (TDS) concentration of the groundwater generally increases with increasing depth such that below a certain level, the groundwater is not suitable for municipal, irrigation or other beneficial uses. Accordingly, a better measure of the bottom of the basin is the fresh water/brackish water interface, as defined in Page (1973) by an electrical conductivity of 3,000 micromhos per centimeter (µmohs/cm), which is approximately correlative to a total dissolved solids (TDS) concentration of 2,000 milligrams per liter (mg/L).

In the Tule Subbasin, the fresh water/brackish water interface varies across the subbasin but is generally 1,500 to 3,000 feet below land surface (Page, 1973; Planert and Williams, 1995). The deepest fresh water occurs in the western portion of the Tule Subbasin. Agricultural irrigation wells in the western Tule Subbasin are as deep as 1,500 feet and some agricultural wells west of the Tulare/Kings County boundary are as deep as 2,200 feet. The bottom of the effective groundwater basin, based on the fresh water/brackish water interface, is shown on Figures 2-5 and 2-6.

2.1.5. Surface Water Features §354.14 (d)(5)

§ 354.14. (d) (5) Surface water bodies that are significant to the management of the basin.

2.1.5.1. Tulare Lake

Although now largely a dry lake bed, prior to the mid-1800s Tulare Lake was the largest fresh water lake, by area, west of the Mississippi River. The original area of the lake was approximately 570 square miles and was fed from surface water discharges at the terminus of the Kern River, Tule River, Kaweah River, and Kings River. Beginning in the mid-1800s, surface water from the rivers feeding the lake was diverted for agricultural irrigation and municipal supply. By 1900, the lake was dry except for residual marshes and wetlands and occasional flooding. This condition continues to the present.

2.1.5.2. Lake Success

Lake Success is a manmade reservoir created by the construction of Success Dam that was completed in 1961 and serves as a flood control and water conservation project for the Tule River. Success dam and reservoir are managed by the United States Army Corps of Engineers (ACOE). Water storage in Lake Success is subject to the ACOE's flood control diagram and released as directed by the ACOE and downstream water rights holders as administered by the Tule River Association (TRA), in accordance with the Tule River Water Diversion Schedule and Storage Agreement (TRA, 1966).

2.1.5.3. Tule River

The Tule River is the largest natural drainage feature in the Tule Subbasin. From its headwaters in the Sierra Nevada Mountains, the Tule River flows first into Lake Success and then, through controlled releases at the dam, flows through the City of Porterville where it is diverted at various points before flowing into the LTRID. A significant diversion point is the Porter Slough, which flows to the north and semi-parallel to the main river channel and is used to convey surface water to various recharge facilities and canals. Downstream of Porterville, the Tule River ultimately discharges onto the Tulare Lakebed during periods of above-normal precipitation. Stream flow is measured via gages located below Success Dam, at Rockford Station downstream of Porterville, and at Turnbull Weir (see Figure 2-7). From water years 1986/87 to 2016/17, releases from Lake Success to the Tule River, quantified in TRA annual reports as the sum of Pioneer Water Company diversion and stream flow at the Below Success Dam gage, has ranged from 8,820 acre-ft in water year 2014/15 to 439,125 acre-ft in water year 1997/98 with an annual average during this time period of approximately 118,300 acre-ft.

Releases of water below Lake Success dam are diverted from the Tule River channel at various locations in accordance with TRA (1966). Diversion points along the river are located at the Porter Slough headgate, Campbell and Moreland Ditch Company, Vandalia Water District, Poplar Irrigation Company, Hubbs and Miner Ditch Company, and Woods-Central Ditch Company. The lower portion of the Tule River channel is also used as a conveyance mechanism to convey imported water from the Friant-Kern Canal to the PID and LTRID. Within the PID and LTRID, a combination of natural stream flow and imported water are further diverted into unlined canals for distribution to artificial recharge basins and farmers. Any residual stream flow left in the Tule River after diversions is measured at the Turnbull Weir, located at the west end of the LTRID (see Figure 2-7).

2.1.5.4. Deer Creek

Deer Creek is a natural drainage that originates in the Sierra Nevada Mountains, flowing in a westerly direction north of Terra Bella and into Pixley (see Figure 2-7). Although the Deer Creek channel extends past Pixley, discharges rarely reach the historical Tulare Lakebed. Stream flow in Deer Creek has been measured at the USGS gaging station at Fountain Springs from 1968 to present time. Average annual flow at this gage between water year 1986/87 and 2016/17 was approximately 17,800 acre-ft/yr with a low of approximately 2,000 acre-ft in water year 2014/15 and a high of approximately 88,000 acre-ft in water year 1997/98. Stream flow has also been measured at a second USGS gaging station on Deer Creek at Terra Bella although the period of record (1971 through 1987) is not as complete as the station at Fountain Springs. Friant-Kern Canal water is also diverted and monitored into Deer Creek and again measured at Trenton Weir before being delivered to riparian lands via unlined canals (see Figure 2-7). During wet years, water that reaches the terminus of Deer Creek is discharged into the Homeland Canal.

2.1.5.5. White River

The White River drains out of the Sierra Nevada Mountains east of the community of Richgrove in the southern portion of the Tule Subbasin (see Figure 2-7). Stream flow in the White River has been measured at the USGS gaging station near Ducor from 1972 to 2005. Data after 2005 has been interpolated. Average annual flow between water year 1986/87 and 2016/17 was approximately 5,800 acre-ft/yr with a low of approximately 250 acre-ft in water year 2014/15 and a high of approximately 37,000 acre-ft in 1997/98. The White River channel extends as far as State Highway 99 but does not reach the historical Tulare Lakebed.

2.1.5.6. *Imported Water §354.14 (d)(6)*

> § 354.14. (d) (6) The source and point of delivery for imported water supplies.

Most of the water imported into the Tule Subbasin is from the Central Valley Project (CVP) and delivered via the Friant-Kern Canal (see Figure 2-7). Angiola Water District also imports water from other various sources including the King's River and State Water Project. The water is delivered to farmers and recharge basins via the Tule River and Deer Creek channels, unlined canals, and pipeline distribution systems of PID, LTRID, Terra Bella Irrigation District, Teapot Dome Water District, DEID, and Saucelito Irrigation District.

Distribution of stream flow diversions and imported water occur via a system of manmade canals and pipeline distribution systems that extend throughout the Tule Subbasin. The largest of these is the Friant-Kern Canal, which supplies imported water through the Federal Central Valley Project (CVP). The Friant-Kern Canal is concrete lined and trends approximately north-south through the eastern part of the Tule Subbasin (see Figure 2-7). Numerous other canals and pipeline distribution systems are located within the Tule Subbasin to convey surface water from the Friant-Kern Canal, Tule River and Deer Creek to various recharge facilities and agricultural areas. The canals are unlined and occur primarily in the LTRID, Pixley Irrigation District, PID, Alpaugh Irrigation District, and Atwell Island Water District. The Angiola Water District receives deliveries from the Tule River and Kings River via the Homeland Canal and distributes that water via an internal system of unlined canals.

Many of the irrigation districts and water districts in the Tule Subbasin that receive imported water from the Friant-Kern Canal distribute the water exclusively via pipeline distribution systems. These districts include the Delano-Earlimart Irrigation District, Kern-Tulare Water District, Terra Bella Irrigation District, Saucelito Irrigation District, and Tea Pot Dome Water District.

2.1.6. Areas of Groundwater Recharge and Discharge §354.14 (d)(4)

> § 354.14. (d) (4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

Groundwater recharge in the Tule Subbasin occurs within stream channels, unlined canals, in managed recharge basins, and in areas of the subbasin with irrigated agriculture. Favorable areas for deep percolation of surface water are characterized by relatively permeable surface soils (see Figure 2-8), and lack of subsurface impediments to groundwater recharge.

The University of California at Davis has developed a Soil Agricultural Groundwater Banking Index (SAGBI) that identifies favorable areas of recharge based on deep percolation potential, root zone residence time, topography, chemical limitations, and soil surface condition. The SAGBI zones for the Tule Subbasin are shown on Figure 2-9. In general, the most favorable areas for recharge are within the stream channels of the Tule River, Deer Creek and White River, in the Porterville area, and in a north-south zone in the west-central portion of the subbasin. Areas that are not favorable for deep percolation of surface water and recharge of groundwater are in the furthest east portion of the subbasin along the base of the Sierra Nevada Mountains and in the furthest west portion of the subbasin coincident with Tulare Lake lacustrine deposits. It is noted that the SAGBI zones shown on Figure 2-9 are limited to the surface deposits and any areas to be considered for additional recharge basins should be further investigated with boreholes and recharge tests to confirm the recharge potential of the location.

There are no areas of groundwater discharging at the land surface in the Tule Subbasin due to the depth of the groundwater. The primary source of groundwater discharge is pumping from wells (see Section 2.3.1.1.4), which occurs across most of the subbasin.

2.1.7. Principal Aquifers and Aquitards §354.14 (b)(4)

§ 354.14. (b) (4) Principal aquifers and aquitards, including the following information:

(A) Formation names, if defined.

(B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

(C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.

2.1.7.1 Aquifer Formations §354.14 (b)(4)(A)

In general, there are five general aquifer/aquitard units in the subsurface beneath the Tule Subbasin (see Figures 2-5 and 2-6):

1. Upper Aquifer
2. The Corcoran Clay Confining Unit
3. Lower Aquifer
4. Pliocene Marine Deposits (generally considered an aquitard)
5. Santa Margarita Formation and Olcese Formation of the Southeastern Subbasin

The upper aquifer occurs across the entire Tule Subbasin area. This aquifer is generally unconfined to semi-confined. The upper aquifer occurs in the upper 450 ft of sediments on the western side of the subbasin and shallows to the east to less than approximately 100 ft of sediments in the Porterville area. In the southeastern portion of the basin, the upper aquifer is generally considered unsaturated although there may be local areas of groundwater.

The Corcoran Clay confining unit occurs beneath the upper aquifer in the western half of the Tule Subbasin (see Figures 2-4, 2-5 and 2-6). This unit consists primarily of blue or green diatomaceous clay although in places it is interbedded with sandy sediments. The Corcoran Clay is thickest in the western part of the subbasin and thins to the east, pinching out approximately two to three miles east of State Highway 99 (see Figure 2-4). It is noted that, in places, the Corcoran Clay, as formally defined in Frink and Kues (1954) and later Davis et al. (1959), is bounded above and below by fine-grained clay not specifically associated with the Corcoran Clay. As such, the thickness of the Corcoran Clay unit, as shown on Figures 2-5 and 2-6 has been defined to include these adjacent clays.

The lower aquifer extends across the entire western portion of the Tule Subbasin and beneath the northeastern portion of the subbasin. The total depth of this aquifer ranges from approximately 400 bgs in the eastern Tule Subbasin to more than 2,000 feet in the western portion of the subbasin. This aquifer is confined beneath the Corcoran Clay where this confining layer exists, and beneath other clay lenses in other parts of the subbasin. The lower aquifer system is conceptualized to be semi-confined in the northeastern portion of the subbasin east of the Corcoran Clay.

In the southeastern portion of the Tule Subbasin, the lower aquifer is separated from the underlying Santa Margarita Formation aquifer by a relatively thick (500 to 1,600 feet) layer of Pliocene marine deposits. These deposits consist primarily of siltstone with minor interbedded sandstone and are conceptualized as a confining unit that separates the deep alluvial aquifer from the Santa Margarita Formation aquifer. Some wells in the southeastern portion of the Tule Subbasin are perforated partially within this unit but the contribution of groundwater from the formation is low (Lofgren and Klausing, 1969).

The Santa Margarita Formation and Olcese Formation underlie the Pliocene marine deposits and forms a localized aquifer in the southeastern portion of the Tule Subbasin. This aquifer is a primary source of groundwater for agricultural irrigation in the southeastern portion of the subbasin. The aquifer is relatively permeable and well yields greater than 1,500 gallons per minute have been reported (Kern-Tulare Water District, 2018). Until additional data are collected, this localized aquifer is conceptualized as hydrologically separate from the deep aquifer in the rest of the subbasin.

2.1.7.2 Aquifer Physical Properties §354.14 (b)(4)(B)

Where saturated in the subsurface, the permeable sand and gravel layers form the principal aquifers in the Tule Subbasin and adjacent areas to the north, south and west. Individual aquifer layers consist of lenticular sand and gravel deposits of varying thickness and lateral extent. The aquifer layers are interbedded with low permeability silt and clay lenses. In general, shallow saturated sediments in the Tule Subbasin are unconfined to semi-confined. The aquifer beneath the Corcoran Clay unit in the western portion of the basin is confined. The hydrologic characteristics of the deeper aquifer system in the western portion of the subbasin are unknown but are expected to change with depth.

The ability of aquifer sediments to transmit and store water is described in terms of the aquifer parameters transmissivity, hydraulic conductivity, and storativity. The most reliable estimates of these parameters are obtained from long-term (e.g. 24-hr or more constant rate) controlled pumping tests in wells. In the absence of this type of test, estimates can be obtained through short-term pumping tests and/or assignment of literature values based on the soil types observed in driller's logs. Long-term pumping test data was obtained from KDSA and DEID for wells located in the southern part of the subbasin. Short-term pumping test data was obtained from driller's logs, KDSA for Angiola Water District and City of Porterville wells, and KTWD for selected wells. Where pumping test data were not available, aquifer parameters were assigned from literature values in published in Faunt (2009).

Transmissivity is a measure of the ability of groundwater to flow within an aquifer and is defined as the rate of groundwater flow through a unit width of aquifer under a unit hydraulic gradient (Fetter, 1994). Transmissivity was estimated from short-term pumping test data based on Theis et al., 1963 and the following relationship:

$$T = \frac{S_c \, x \, 2{,}000}{E}$$

Where:

T	=	Transmissivity (gpd/ft);
S_c	=	Specific Capacity (gpm/ft);
E	=	Well Efficiency (assumed to be 0.7)

Transmissivity values at individual wells were converted into hydraulic conductivity (i.e. aquifer permeability) by dividing by the aquifer thickness (in this case the perforation interval of the well). Horizontal hydraulic conductivity values for the upper aquifer are shown on Figure 2-10 and range from less than 5 ft/day to greater than 160 ft/day, the higher values indicating more permeable sediments. Hydraulic conductivity values for the lower aquifer are shown on Figure 2-11 and range from less than 5 ft/day to greater than 80 ft/day.

Storage properties of the upper aquifer are expressed in terms of specific yield since the majority of this aquifer is conceptualized as unconfined. Specific yield is the ratio of the volume of water sediment will yield by gravity drainage to the volume of the sediment. Specific yield values for the upper aquifer were assigned based on a USGS texture analysis published in Faunt (2009). Textural descriptions describe the percent coarse-grained sediment as inferred from drillers' logs from boreholes or wells drilled within or immediately outside the Tule Subbasin. Higher percent coarse-grained sediment descriptions are correlated with higher specific yield (see Figure 2-12). As shown, higher percent coarse-grained sediments are observed in the upper aquifer through most of the Tule Subbasin with the exception of the southwestern portion. Values of specific yield for the upper aquifer range from 0.05 to greater than 0.2.

The lower aquifer in the Tule Subbasin is confined to semi-confined and, as such, storage properties for this aquifer are expressed in terms of storativity. Storativity is a measure of the volume of water an aquifer can release from, or take into, storage per unit of aquifer surface area per unit change in hydraulic head. Storativity is derived from long-term pumping tests where pumping interference is measured in a monitoring well located a known distance from the pumping well. As no pumping interference data are available for the Tule Subbasin, storativity values for the lower alluvial aquifer were originally based on values published in Faunt (2009) and modified during calibration of the numerical model for the Tule Subbasin. Values for storativity in the deep aquifer range from 0.00015 to 0.001 (see Figure 2-13). These values indicate confined to semi-confined aquifer conditions.

2.1.7.3 Geologic Structures that Affect Groundwater Flow §354.14 (b)(4)(C)

There are no significant faults mapped in the Tule Subbasin that affect groundwater flow.

The Corcoran Clay unit is the most significant geologic feature that affects vertical groundwater flow in the Tule Subbasin. In general, the aquifer system above the clay unit is unconfined to semi-confined and the aquifer system below it is confined. The hydraulic head in the upper aquifer is higher than that of the lower aquifer, such that there is vertical downward hydraulic gradient between the two. Despite the low vertical hydraulic conductivity of the Corcoran Clay, the area for downward flow is large (hundreds of thousands of acres), and the vertical gradients are relatively steep (commonly 20 to 40 feet per 100 feet). This allows for significant downward flow of water through the clay on a regional basis. In addition, many wells in the subbasin are perforated across both the upper and lower aquifers (composite wells) creating communication between the two. As such, these wells facilitate some recharge of the lower aquifer from the upper aquifer. East of the Corcoran Clay, other localized confining beds are present that separate the upper aquifer from the lower aquifer.

2.1.7.4 Aquifer Water Quality §354.14 (b)(4)(D)

Groundwater quality in the Tule Subbasin varies across the subbasin and with depth in the aquifer system. Overall, the native groundwater quality is generally very good, with historical EC measurements generally less than approximately 600 µmohs/cm (Tule Basin Water Quality Coalition, 2017) (see Figure 2-14). Groundwater quality issues in the subbasin include both regional non-point sources of groundwater quality degradation and point-source contaminant issues.

On a regional level, non-point source constituents of concern for groundwater quality include nitrate, pesticides, 1,2-dibromo-3-chloropropane (DBCP), and 1,2,3, tricholoropropane (TCP) in the upper aquifer and arsenic, manganese, and, hydrogen sulfide for the lower aquifer. In the western part of the subbasin, color and methane gas are also non-point constituents of concern.

Nitrate is the primary non-point constituent of concern (Tule Basin Water Quality Coalition, 2017). Historical nitrate concentrations (reported as nitrate) in the subbasin range from non-detect to greater than 300 mg/L (see Figure 2-15). The highest nitrate concentrations have been detected in shallow groundwater in the northwest portion of the subbasin and are likely correlated with overlying land use.

Wells from which elevated EC values have been detected above the subbasin average occur in shallow groundwater in the northwest and southwest portions of the subbasin (see Figure 2-14). High EC values measured in groundwater in the northwest part of the subbasin are likely associated with overlying land use. High EC has also been detected in shallow and locally perched groundwater in the southwestern part of the subbasin. This area of the subbasin is on the historical Tulare Lakebed where the Regional Water Quality Control Board – Central Valley Region and California State Water Resources Control Board (SWRCB) has removed the municipal and agricultural beneficial use designation (SWRCB, 2017).

For point-source contaminants, there are 26 active cleanup sites in the Tule Subbasin identified on the California Geotracker website (see Figure 2-16; Table 2-1). Twelve of the point source contamination sites are associated with leaking underground storage tanks (LUSTs) for which the primary contaminant is petroleum hydrocarbons (gasoline, diesel and kerosene). There are 14 Regional Water Quality Control Board Cleanup Program or Department of Toxic Substance Control (DTSC) sites within the subbasin (see Figure 2-16). Contaminants associated with these sites include metals, volatile organic compounds (VOCs), pesticides, herbicides, cyanide, and polyaromatic hydrocarbons (PAHs). Groundwater contaminant plumes associated with these sites are highly localized.

2.1.7.5 *Aquifer Primary Uses §354.14 (b)(4)(E)*

The predominant beneficial use of groundwater in the Tule Subbasin is agricultural irrigation. Other beneficial uses include municipal water supply, private domestic water supply, and livestock washing and watering.

2.1.8. Uncertainty in the Hydrogeologic Conceptual Model §354.14 (b)(5)

§ 354.14. (b) (5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model

The primary sources of uncertainty in the hydrogeologic conceptual model include:

- Knowledge of the hydraulic interaction between the shallow and deep aquifer
- Lack of aquifer-specific groundwater levels with adequate spatial distribution to enable preparation of representative groundwater level maps of each aquifer in parts of the subbasin
- Characteristics of the Santa Margarita Formation aquifer
- Groundwater underflow into the alluvial aquifer system from the Sierra Nevada mountain block
- Aquifer characteristics of hydraulic conductivity, transmissivity and storativity
- Agricultural groundwater pumping
- Well construction and pumping distribution between the shallow and deep aquifers
- Canal seepage
- Travel time for recharge from the land surface through the unsaturated zone to the groundwater

Uncertainty in the hydrogeologic conceptual model is being addressed through a sensitivity and uncertainty analysis of the numerical model results from the Tule Subbasin model (TH&Co, 2020) (see Section 2.3.2.7).

2.2 Groundwater Conditions §354.16

§ 354.16. Groundwater Conditions Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

2.2.1 Groundwater Occurrence and Flow §354.16 (a)

> § 354.16. (a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:
>
> (1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
>
> (2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

In general, groundwater in the Tule Subbasin flows from areas of natural recharge along major streams at the base of the Sierra Nevada Mountains on the eastern boundary towards a groundwater pumping depression in the west-central portion of the subbasin (see Figures 2-17 and 2-18). The pumping depression has reversed the natural groundwater flow direction in the western portion of the subbasin, inducing subsurface inflow along the southern and western boundaries.

In the upper aquifer, the pumping depression is most pronounced between the Tule River and Deer Creek west of Highway 99 and east of Highway 43. The pumping depression has persisted in this area since at least 1987, even during periods of above-normal precipitation when groundwater levels temporarily recovered. Recharge from the Tule River results in a groundwater flow divide in the upper aquifer along the northern boundary of the Tule Subbasin. As such, upper aquifer groundwater on the north side of the river flows to the north and out of the subbasin. Groundwater flow patterns in the upper aquifer have generally not changed significantly since 1990.

In the lower aquifer, groundwater flows to the southwest toward a pumping depression in the western portion of the subbasin (see Figure 2-19). This pumping depression extends from west of Corcoran in the northwest to the Alpaugh area in the southwestern Tule Subbasin west of Highway 43. There is inadequate data to prepare groundwater contour maps specific to the lower aquifer for spring and fall of 2017. The groundwater contour map provided on Figure 2-19 for 2010 is the most recent year for which data were available to prepare a contour map.

Groundwater level changes over time can be observed from hydrographs developed from wells monitored in the Tule Subbasin. Despite a relatively wet hydrologic period between 1995 and 1999 and periodic wet years (2005 and 2011), groundwater levels in upper aquifer wells show a persistent downward trend between approximately 1987 and 2017 (see Figure 2-20). Groundwater level trends in wells perforated exclusively in the lower aquifer vary depending on location in the subbasin. In the northwestern part of the subbasin, lower aquifer groundwater levels have shown a persistent downward trend from 1987 to 2017. In the southern part of the subbasin, groundwater levels were relatively stable between 1987 and 2007 but began declining after 2007 (see Figure 2-21).

Comparisons of hydrographs from wells perforated in the upper aquifer with wells perforated predominantly in the lower aquifer and in close proximity show that groundwater levels in the upper aquifer are higher than groundwater levels in the lower aquifer (see Figure 2-22). This indicates a downward hydraulic gradient and indicates that the upper aquifer is recharging the lower aquifer of the Tule Subbasin. This is corroborated by depth-specific isolated aquifer zone testing conducted by the City of Porterville in three wells in which the equilibrated groundwater level (i.e. hydraulic head) in the deepest isolated zones, which also correspond to the lower aquifer, were as much as 180 ft lower than the groundwater level in the shallowest isolated zones (Schmidt, 2009). Faunt (2009) has suggested that the recharge of the lower aquifer via wells that are perforated across both aquifers has increased with the number of deep wells constructed in the San Joaquin Valley.

2.2.2 Groundwater Storage §354.16 (b)

§ 354.16. (b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

Changes in groundwater storage within the Tule Subbasin have been estimated through analysis of the water budget for the subbasin. Annual change in groundwater storage in the subbasin between 1986/87 and 2016/17 is shown in Table 2-3 and is graphically presented on Figure 2-23. Comparison of the groundwater inflow elements of the water budget with the outflow elements shows a cumulative change in groundwater storage over the 31-year period between 1986/87 and 2016/17 of approximately -4,948,000 acre-ft. The average annual change in storage resulting from the groundwater budget is approximately -160,000 acre-ft/yr over this time period.

2.2.3 Seawater Intrusion §354.16 (c)

§ 354.16. (c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

Seawater intrusion cannot occur in the Tule Subbasin due to its location with respect to the Pacific Ocean. The Tule Subbasin is approximately 110 miles inland of the Pacific Ocean (see Figure 2-1) and is separated from the ocean by approximately 90 miles of sedimentary rocks that make up the Coast Ranges. These sedimentary rocks effectively separate the Pacific Ocean hydraulically from the aquifer system in the San Joaquin Valley. Further, the Coast Ranges are dissected by multiple northwest trending faults, the largest of which is the San Andreas Fault. These faults form groundwater flow barriers, which further act to separate the San Joaquin Valley aquifers from the Pacific Ocean. Accordingly, groundwater pumping in the Tule Subbasin cannot induce seawater intrusion.

2.2.4 Groundwater Quality Issues §354.16 (d)

§ 354.16. (d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.

Groundwater quality issues have been designated based on agricultural and drinking water beneficial uses of groundwater in the Tule Subbasin. The nine constituents of concern for drinking water beneficial uses are arsenic, nitrate, hexavalent chromium, dibromochloropropane (DBCP), 1,2,3-Trichloropropane (TCP), tetrachloroethene (PCE), chloride, total dissolved solids (TDS), and perchlorate Concentrations. Concentrations of these constituents of concern based on 2017 to 2022 available data are shown on Figures 2-14a through 2-14i. The three constituents of concern for agricultural uses are chloride, sodium, and TDS. The available data from 2017 to 2022 for these constituents are shown on Figures 2-15a, 2-15b, and 2-15c.

Existing groundwater quality monitoring programs within the Tule Subbasin are summarized in the following table:

Programs or Data Portals	Tule Subbasin Agency Coordinating with GSAs	Parameters	Monitoring Frequency	Program Objectives
AB-3030 and SB-1938 Groundwater Management Plans	Tule Subbasin GSAs, requirements incorporated into GSP Annual Reports	• Water levels are typically monitored annually. • Ag Suitability analysis (limited suite of general minerals) monitoring frequency between annual to once every 3 years.	Semiannual to Annual	-
California SDWIS	Varies Public Water Systems	Database for all public water system wells and historical sample results. Data available includes all Title 22 regulated constituents.	• Title 22 General Minerals and Metals every 3 years. • Nitrate as N annually, if ≥ 5 ppm, sampled quarterly • VOCs and SOCs sampled every 3 years. • Uranium sampling depends on historical results but varies between 1 sample every 3 (when ≥ 10 pCi/L), 6 (when < 10 pCi/L) or 9 (when no historical detection) years.	Demonstrate compliance with Drinking Water Standards through monitoring and reporting water quality data.
CV-SALTS	Tule Basin Management Zone, Tule Basin Water Foundation	Sampling parameters required through Waste Discharge Requirements (WDR): typically include monthly sodium, chloride, electrical conductivity, nitrogen species (N, NO2, NO3, NH3), pH and other constituents of concern identified in the Report of Waste Discharge. A limited suite of general minerals is required quarterly from the source and annually from the wastewater.	Most constituents sampled monthly, quarterly general minerals from source water and annual general minerals from waste discharge.	To monitor degradation potential from wastewaters discharged to land application areas and provide interim replacement water when MCL for nitrate as N is exceeded while developing long term solutions for safe drinking water.
Department of Pesticide Regulation	County of Tulare	Pesticides	Annual	DPR samples groundwater to determine: (1) whether pesticides with the potential to pollute groundwater are present, (2) the extent and source of pesticide contamination, and (3) the effectiveness of regulatory mitigation measures.
GAMA (Collaboration with SWQCB, RWQCB, DWR, DPR, NWIS, LLNL)		• Constituents sampled vary by the Program Objectives. • Typically, USGS is the technical lead in conducting the studies and reporting data.	Varies	• Improve statewide comprehensive e groundwater monitoring. • Increase the availability of groundwater quality and contamination information to the public.
Geotracker and Envirostor Databases		Many contaminants of concern, organic and inorganic.	Depends on program. Monthly, Semiannually, Annually, etc.	Records database for cleanup program sites, permitted waste dischargers
ILRP	Tule Basin Water Quality Coalition	• Annually: static water level, temperature, pH, electrical conductivity, nitrate as nitrogen, and dissolved oxygen. • Once every five years: general minerals collection	Annual and Every 5 years	Monitor impacts of agricultural and fertilizer
USGS California Water Science Center		Conducted multiple groundwater quality studies of the Tule Subbasin.	Reports, factsheet, and data publications range from 1994through 2017.	Special studies related to groundwater quality that provide comprehensive studies to characterize the basin.

There are 26 active cleanup sites in the Tule Subbasin identified on the California Geotracker website (see Figure 2-16; Table 2-1). Twelve of the point source contamination sites are associated with LUSTs for which the primary contaminant is petroleum hydrocarbons (gasoline, diesel and kerosene). There are 14 Regional Water Quality Control Board Cleanup Program or Department of Toxic Substance Control (DTSC) sites within the subbasin (see Figure 2-16). Contaminants associated with these sites include metals, VOCs, pesticides, herbicides, cyanide, and PAHs.

2.2.5 Land Subsidence §354.16 (e)

> § 354.16. (e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

Land surface subsidence in the Tule Subbasin as a result of lowering the groundwater level from groundwater production has been well documented (Ireland et al., 1984; Faunt, 2009; Luhdorff and Scalmanini, 2014). Prior to 1970, as much as 12 ft of land surface subsidence was documented for the area immediately south of Pixley (Ireland et al., 1984). As groundwater levels rose in the area throughout the 1970s and early 1980s, land subsidence was largely arrested. During this time, monitoring for land subsidence that had previously been conducted along the portion of the Friant-Kern Canal that is within the Tule Subbasin was discontinued.

From the late 1980s into the 2000s, it is suspected that land subsidence in the Tule Subbasin was reactivated as groundwater levels declined. Groundwater flow model simulations of land subsidence in the Central Valley by Faunt et al. (2009), which were calibrated to historical land subsidence that occurred in the 1960s, simulated an additional two to four feet of land subsidence between 1986 and 2003.

The reactivation of land subsidence was confirmed in the late 2000s based on data from Interferometric Synthetic Aperture Radar (InSAR) satellites and one Global Positioning System (GPS) station located in Porterville, California. InSAR data showed as much as four feet of additional land subsidence occurring in the northwestern portion of the Tule Subbasin between 2007 and 2011 (see Figure 2-24) (Luhdorff and Scalmanini, 2014). Approximately 0.4 ft of land subsidence occurred in the Porterville area between 2007 and 2011. From 2015 through 2018, land subsidence in the Tule Subbasin, as observed from InSAR data, continued with as much as 2.75 ft of additional land subsidence in the northwest portion of the subbasin and as much as 0.75 ft of additional land subsidence at the Porterville GPS station (see Figure 2-25). Based on benchmarks located along the Friant-Kern Canal and monitored by the Friant Water Authority, cumulative land subsidence along the canal between 1959 and 2017 has ranged from approximately 1.7 ft in the Porterville area to 9 feet in the vicinity of Deer Creek (see Figure 2-24).

For the time period between 1987 and 2018, cumulative subsidence across the Tule Subbasin was estimated (in feet) based on model simulation results of land subsidence using a groundwater flow model equipped with a subsidence simulation package calibrated to observed land subsidence from InSAR and GPS data. The highest cumulative land subsidence for the time period was estimated for the northwestern portion of the subbasin where approximately 12 feet was simulated. The lowest rates of land subsidence were observed in the southeast portion of the subbasin between Delano and Richgrove where less than one foot of cumulative land subsidence was simulated.

The rate of land subsidence in the Tule Subbasin varies both spatially, according the geology of the subsurface sediments, and temporally with changes in groundwater levels. The average rate of change in land surface elevation between 1987 and 2018 for the area of maximum subsidence was estimated to be approximately 12 feet over the 32-year period for a rate of 0.4 ft/yr. At the Porterville GPS station, the annual rate of subsidence between 2006 and 2013 was approximately 0.09 ft/yr but increased to approximately 0.29 ft/yr between 2013 and 2019 (see Figure 2-25).

2.2.6 Interconnected Surface Water Systems §354.16 (f)

> § 354.16. (f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

Interconnected surface water is surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. As of January 2015, there are no areas within the Tule Subbasin where the depth to groundwater is within 25 ft of the land surface (see Figure 2-26). Based on the depth to groundwater, it is assumed that an unsaturated zone exists between surface water features and the aquifer system during average and dry periods. It is noted that there may be periods of time when the groundwater level temporarily rises to within 25 feet of the land surface in only a few relatively small areas of the Tule Subbasin, namely along the Tule River in and upstream of Porterville, and in the upper reaches of Deer Creek and White River. However, this condition, if it occurs, would be temporary and is not the normal hydrologic relationship between surface water and groundwater in these areas.

2.2.7 Groundwater Dependent Ecosystems §354.16 (g)

> § 354.16. (g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.

Groundwater dependent ecosystems require shallow groundwater or groundwater that discharges at the land surface. Throughout the Tule Subbasin, the depth to groundwater is well below the level required to support riparian vegetation (vegetation that draws water directly from groundwater) or near surface ecosystems, except some areas along the Tule River east of Porterville. Based on the CDWR Groundwater Dependent Ecosystems database (www.groundwaterresourcehub.org), the deepest root zones for groundwater dependent plants in the Tule Subbasin are for Valley Oak, which can reach a depth of approximately 25 feet. Figure 2-26 is a depth to groundwater map based on groundwater levels in January 2015. As shown, there were no areas of the subbasin where the groundwater was within 25 feet of the land surface at that time. It is noted that there may be periods of time when the groundwater level is within 25 feet of the land surface in some areas of the subbasin. The areas most likely to support groundwater dependent ecosystems are along the Tule River in and upstream of Porterville, and in the upper reaches of Deer Creek and White River.

2.3 Water Budget §354.18

§ 354.18. Water Budget

(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

2.3.1. Surface Water Budget

The surface water budget for the Tule Subbasin was developed for the 31-year period from 1986/87 to 2016/17 (see Table 2-2a for Inflow Terms and Table 2-2b for Outflow Terms). Inflow terms for the surface water budget include precipitation, stream inflow, imported water, and discharge to the land surface from wells. Outflow terms include infiltration of precipitation, evapotranspiration of precipitation from areas of native vegetation and crops, stream infiltration, canal loss, recharge in basins, return flow, and consumptive use.

Ideally, the total surface water inflow to the subbasin would equal the total surface water outflow, indicating a complete and accurate accounting of water at the surface. In reality, there is uncertainty in many of the surface water budget terms for the Tule Subbasin that does not allow for a perfect surface water accounting. These include estimates for agricultural groundwater production, crop consumptive use, precipitation recharge, surface water outflow to Homeland Canal from Deer Creek, and others. For the Tule Subbasin surface water budget, the percent difference between the average annual surface water inflow (1,477,000 acre-ft; Table 2-2a) and average annual outflow (1,474,000 acre-ft; Table 2-2b) is approximately 0.2 percent. This represents a very good match between surface water inflows and outflows and indicates that the water budget is a good representation of actual conditions. As additional data become available, it is anticipated that the surface water budget will become more accurate with time.

It is noted that many of the surface water outflow terms are also groundwater inflow (i.e. groundwater recharge) terms. Of the surface water outflow terms that become groundwater recharge, many are associated with water diverted in accordance with pre-existing water rights or purchased imported water. Sources of surface water outflow that become groundwater recharge and are associated with existing rights and/or imported water deliveries are excluded from the Sustainable Yield estimate and are indicated with magenta-colored columns in Table 2-2b. Surface water losses that become groundwater recharge and are used to estimate Sustainable Yield are indicated with blue-colored columns in Table 2-2b. Surface water losses that do not become groundwater recharge, such as through evapotranspiration, crop consumptive use, or surface water outflow are indicated with yellow-colored columns in Table 2-2b (page 2).

Details of the individual surface water budget terms are provided in the following sections.

2.3.1.1 Surface Water Inflow §354.18 (b)(1)

§ 354.18. (b) The water budget shall quantify the following, either through direct measurements or estimates based on data:

(1) Total surface water entering and leaving a basin by water source type.

2.3.1.1.1. Precipitation

The annual volume of water entering the Tule Subbasin as precipitation was estimated for the surface water budget based on the long-term average annual isohyetal map shown on Figure 2-27 and the annual precipitation data reported for the Porterville precipitation station. As annual precipitation values are not available throughout the entire Tule Subbasin, it was assumed that the relative precipitation distribution for each year was the same as that shown on the isohyetal map. The magnitude of annual precipitation within each isohyetal zone was varied from year to year based on the ratio of annual precipitation at the Porterville Station (see Figure 2-28) to annual average precipitation at the Porterville isohyetal zone multiplied by the isohyetal zone average annual precipitation. Using this method, total annual precipitation in the Tule Subbasin between water years 1986/87 and 2016/17 ranged from approximately 99,000 to 728,000 acre-ft/yr with an average of 306,000 acre-ft/yr (see Column A of Table 2-2a).

2.3.1.1.2. Stream Inflow

Surface water inflow to the Tule Subbasin occurs primarily via three native streams: Tule River, Deer Creek, and the White River (see Columns B through D of Table 2-2a). Flow in the Tule River is controlled through releases from Lake Success, which are documented in TRA annual reports. For water years 1986/87 to 2016/17, annual surface water inflow to the Tule Subbasin via the Tule River, measured as releases from Lake Success, ranged from 8,820 to 439,125 acre-ft/yr with an average of 118,300 acre-ft/yr. The long-term 114-year average (1904 to 2017) inflow to Lake Success via the Tule River channels is 139,187 acre-ft/year.

Annual inflow from Deer Creek is measured at Fountain Springs by the USGS and has varied from approximately 2,000 to 88,000 acre-ft/yr with an average of 17,800 acre-ft/yr over water years 1986/87 to 2016/17. The long-term average inflow via Deer Creek for the period of record from 1920 to 2017 is 22,035 acre-ft/year. It is noted that although the Fountain Springs gage is located approximately five miles upstream of the Tule Subbasin, the creek flows over granitic bedrock between the gage and the alluvial basin boundary and losses along this reach are assumed to be limited to evapotranspiration.

Surface water inflow from the White River is based on USGS stream gage data from the White River station near Ducor. The measured data from this station is only available from 1971 to 2005. In order to estimate annual streamflow from 1986/87 to2016/17, it was assumed that the magnitude of flow in the White River is proportional to the magnitude of flow in Deer Creek. TH&Co plotted monthly White River streamflow against monthly Deer Creek streamflow for the period 1971 to 2005. A linear regression through the data resulted in a correlation coefficient of 0.91, suggesting that the relationship is applicable (see Figure 2-29). White River streamflow between 2006 and 2017 was based on the linear interpolation of measured data. Based on the measured and interpolated data, annual inflows from the White River ranged from approximately 250 to 37,000 acre-ft/yr and averaged 5,800 acre-ft/yr from water years 1986/87 to 2016/17.

2.3.1.1.3. Imported Water

Imported water is delivered to eleven water agencies within the Tule Subbasin from the Friant-Kern Canal (see Columns E through O of Table 2-2a). Data from PID, Saucelito Irrigation District, Tea Pot Dome Water District, Alpaugh Irrigation District, Atwell Island Irrigation District, and Terra Bella Irrigation District was obtained from USBR Central Valley Operation Annual Reports. Imported water data for the other agencies was provided by the respective agencies. Based on these data, an average of 345,600 acre-ft/yr was imported into the Tule Subbasin for the period from 1986/87 to 2016/17.

2.3.1.1.4. Discharge to Crops from Wells

Water applied to crops from wells is assumed to be the total applied water minus surface water deliveries from imported water and diverted streamflow (see Figure 2-30). The total crop demand was estimated based on consumptive use estimates and an assumed irrigation efficiency of 79 percent. The estimated average annual discharge to crops from wells for water years 1986/87 to 2016/17was approximately 664,000 acre-ft/yr (see Column P of Table 2-2a).

2.3.1.1.5. Municipal Deliveries from Wells

Groundwater pumping for municipal supply is conducted by the City of Porterville and small municipalities for the local communities in the Tule Subbasin. From water years 1986/87 to

2016/17, municipal pumping from wells was estimated to average approximately 20,000 acre-ft/yr (see Column Q of Table 2-2a).

It is noted that there are some households in the rural portions of the Tule Subbasin that rely on private wells to meet their domestic water supply needs. However, given the low population density of these areas, the volume of pumping from private domestic wells is considered negligible compared to the other pumping sources.

2.3.1.2 Surface Water Outflow

2.3.1.2.1 Areal Recharge from Precipitation

Areal recharge from precipitation falling on the valley floor in the Tule Subbasin was estimated based on Williamson et al., (1989). As part of a regional hydrogeological study of the California Central Valley, Williamson et al., (1989) developed a monthly soil-moisture budget for the Sacramento Valley and San Joaquin Valley areas. The soil moisture budget was based on precipitation records for the 50-yr period from 1922 to 1971. The analysis considered potential evapotranspiration, assumed plant root depth, soil moisture-holding capacity, and precipitation. Monthly precipitation that exceeded monthly potential evapotranspiration and soil-moisture storage was computed as net infiltration to the groundwater system. The results were simplified with a linear regression model that estimates net infiltration (i.e. groundwater recharge) from annual precipitation (herby referred to as the Williamson Method). The resulting relationship for the San Joaquin Valley region was:

$$PPT_{ex} = (0.64)PPT - 6.2$$

Where:

PPT_{ex}	=	Excess Annual Precipitation (ft/yr);
PPT	=	Annual Precipitation (ft/yr)

It is noted that the Williamson Method applied to the San Joaquin Valley results in no groundwater recharge if average annual precipitation is less than 9.69 inches per year. Results of the net infiltration analysis from Williamson et al., (1989) were used in the development of the Central Valley Groundwater Model developed by the USGS and documented in Faunt (2009).

For each year, annual groundwater recharge from precipitation (i.e. PPT_{ex}) was estimated for each isohyetal zone (see Section 2.3.1.1.1 and Figure 2-27) using the above equation from the Williamson Method. The resulting annual groundwater recharge from areal precipitation for the period 1986/87 to 2016/17ranged from 0 acre-ft/yr to 219,000 acre-ft/yr with an average of approximately 21,000 acre-ft/yr (see Column A of Table 2-2b) or approximately 7 percent of total precipitation.

2.3.1.2.2 Streambed Infiltration (Channel Loss)

Tule River

The Tule River is a losing stream such that infiltration of surface water within the stream channel recharges the groundwater system beneath it. Total channel loss (i.e. streambed infiltration) in the Tule River between Lake Success and Oettle Bridge is based on TRA annual reports. Streambed infiltration in the Tule River between Oettle Bridge and Turnbull Weir was estimated based on LTRID monthly water use summaries and TRA annual reports. Measured channel loss includes infiltration as well as evapotranspiration. Therefore, infiltration is equal to channel loss, as reported in TRA reports, minus evapotranspiration (described in Section 2.3.1.2.6).

It is noted that there are two sources of water in the Tule River channel: 1) native flow associated with releases from Lake Success and 2) imported water from the Friant-Kern Canal. Surface water in the Tule River channel from Lake Success to Oettle Bridge is exclusively native water (Column B of Table 2-2b). Surface water in the Tule River channel from Oettle Bridge to Turnbull Weir is primarily native flow but periodically includes imported water released to the channel from the Friant-Kern Canal.

As there is no current accounting of Tule River channel loss from Oettle Bridge to Turnbull Weir, it was necessary to estimate it based on available data and an assumed loss factor. The loss factor was based on the assumption that the ratio of streamflow to channel losses upstream of Oettle Bridge is the same as the ratio downstream. Thus, the ratio of streamflow to channel losses observed upstream of Oettle Bridge (the "loss factor") was applied to measured flow Below Oettle Bridge. The loss factor was applied separately to native Tule River water and imported water releases to develop streambed infiltration estimates specific to both. From water years 1986/87 to 2016/17, average annual streambed infiltration from Success to Oettle Bridge was approximately 16,500 acre-ft/yr (Column B of Table 2-2b). During the same time period, average annual streambed infiltration between Oettle Bridge and Turnbull Weir was approximately 3,200 acre-ft/yr (see Column C of Table 2-2b).

Deer Creek

Deer Creek is a losing stream such that infiltration of surface water within the stream channel recharges the groundwater system beneath it. Streambed infiltration (channel loss) is estimated for the stream reaches between the Fountain Springs gaging station and Trenton Weir and between Trenton Weir and Homeland Canal. The difference in streamflow between Fountain Springs station and Trenton Weir is assumed to be total channel loss along this section. Streambed and canal infiltration in the Deer Creek channel between Trenton Weir and Homeland Canal were estimated based on Pixley Irrigation District monthly water use summaries. Measured channel loss includes infiltration as well as evapotranspiration. Therefore, infiltration is channel loss minus evapotranspiration (described in Section 2.3.1.2.6).

It is noted that there are two sources of water in the Deer Creek channel: 1) native flow and 2) imported water from the Friant-Kern Canal. Imported water is introduced into the Deer Creek channel by the Friant Water Authority via controlled and measured releases from the Friant-Kern Canal upstream of Trenton Weir. Thus, until a stream gage is established upstream of the Friant-Kern Canal/Deer Creek intersection, the separate accounting of losses associated with imported water and native Deer Creek surface flow will have to be approximated.

Deer Creek channel loss from Fountain Springs to Trenton Weir was estimated based on the difference in measured flows between the two stations. The surface flow between these two stations is assumed to be, for this water budget, native Deer Creek water. Average annual infiltration from Fountain Springs to Trenton Weir was approximately 12,100 acre-ft/yr between water years 1986/87 to 2016/17 (see Column D of Table 2-2b).

Flow in the Deer Creek channel from Trenton Weir to Homeland Canal is a combination of native Deer Creek water and imported water purchased by the Pixley Irrigation District for distribution in their service area. For this water balance, it is assumed that all of the water that flows through Trenton Weir is either delivered to riparians and farmers or becomes channel or canal loss (i.e. there is no data available to document surface flow from the Deer Creek channel to Homeland Canal although it is known that this occurs during periods of above normal precipitation). The infiltration of native Deer Creek water in the Deer Creek channel downstream of Trenton Weir is estimated for each month based on Pixley Irrigation District's annual water use summaries in the following way:

1. Imported water deliveries discharged from the Friant-Kern Canal to the Deer Creek channel were subtracted from the total flow measured at Trenton Weir to estimate the volume entering Pixley Irrigation District that is attributed to native Deer Creek flow.
2. Pixley Irrigation District sales and deliveries to basins were subtracted from the total flow through Trenton Weir to determine the volume of water presumably lost as infiltration in the Deer Creek channel and canals.
3. The total loss in No. 2 was multiplied by the ratio of Deer Creek water to total water measured at Trenton Weir to estimate the total losses attributed to native Deer Creek water.
4. A ratio was developed for the length of Deer Creek channel versus the length of canals downstream of the Trenton Weir (0.21).
5. The total loss attributed to native Deer Creek flow, as estimated from No. 3, was multiplied by the ratio of Deer Creek channel length to canal length from No. 4 to estimate the volume of native Deer Creek flow loss estimated to occur in the Deer Creek channel.
6. The volume of native Deer Creek flow lost in canals was estimated as the total loss (No. 3) minus the loss estimated to occur in the Deer Creek channel (No. 5).

Using the methodologies described above, average annual native Deer Creek infiltration from Fountain Springs to Trenton Weir for water years 1986/87 to 2016/17 was 12,100 acre-ft/yr (see

Column D of Table 2-2b). The average annual native Deer Creek infiltration in the Deer Creek channel between Trenton Weir and Homeland Canal was approximately 700 acre-ft/yr (see Column E of Table 2-2b).

White River

All of the surface water flow measured or interpolated at the White River stream gage, after accounting for ET losses, is assumed to become streambed infiltration. Average annual infiltration from White River flow for water year 1986/87 to 2016/17was estimated to be approximately 5,600 acre-ft/yr (see Column F of Table 2-2b).

2.3.1.2.3 Canal Losses

Canal Losses from Tule River Diversions

A portion of the native Tule River water that is diverted into unlined canals is lost through infiltration into the subsurface groundwater subbasin. For PID, Vandalia Water District, and Woods-Central Ditch Co., delivery losses in unlined canals are accounted for in the portion of the water budget that address deep percolation of applied water.

In the LTRID, canal losses attributed to Tule River diversions are estimated from the District's annual water use summaries reports. Total canal losses within the LTRID (which include both native river water and imported water) are estimated by subtracting streambed infiltration and ET from the total losses reported in the annual water use summaries. Canal losses attributed to native Tule River water are based on the ratio of native Tule River water to imported water (Table 2-2b, Column G). The average annual Tule River canal loss from water years 1986/87 to 2016/17 was approximately 22,300 acre-ft/yr.

Canal Losses from Deer Creek Diversions

It is assumed that canal losses from delivery of native Deer Creek water to riparians and farmers occur only within the Pixley Irrigation District. To estimate canal losses within the Pixley Irrigation District, the estimated infiltration and ET within the Deer Creek channel (see Section 2.3.1.2.6) was subtracted from total losses. The average annual Deer Creek canal loss for water years 1986/87 to 2016/17was approximately 2,600 acre-ft/yr (see Column H of Table 2-2b).

Canal Losses from Imported Water Deliveries

With the exception of canal losses within the Angiola Water District and PID, imported water that infiltrates into the subsurface groundwater subbasin from the Tule River channel, Deer Creek channel, and unlined canals is grouped together. Within the Angiola Water District and PID, canal losses are accounted for in the portion of the water budget that addresses deep percolation of applied water.

For the LTRID GSA and Pixley Irrigation District GSA areas, imported water losses in channels and canals are estimated by subtracting infiltration losses attributed to native Tule River and Deer Creek water from the total losses estimated to occur in the LTRID and Pixley Irrigation District service areas as documented in their respective annual water use summary reports. The resulting estimate of average annual imported water canal loss for water years 1986/87 to 2016/17 was approximately 50,600 acre-ft (see Column I of Table 2-2b).

2.3.1.2.4 Managed Recharge in Basins

Managed Recharge of Tule River Diversions

Managed recharge (i.e. recharge in basins) of diverted streamflow, imported water, and recycled water is accomplished within the Tule Subbasin via multiple recharge facilities (see Figure 2-7). Native Tule River water is diverted to basins for recharge by Pioneer Water Company, Campbell and Moreland Ditch Company, Vandalia Water District, PID, and LTRID. All of the water diverted to basins by Campbell and Moreland Ditch Company and Vandalia Water District is native Tule River flow. To estimate the portion of basin recharge attributable to native Tule River water in LTRID basins downstream of Oettle Bridge, TH&Co multiplied the ratio of Tule River gaged flow below Oettle Bridge to the total water delivered to the LTRID by the total recharge in basins reported in the LTRID annual water use summaries. Using this methodology, the average annual Tule River recharge in basins from water years 1986/87 to 2016/17 was approximately 11,600 acre-ft (see Column J of Table 2-2b).

Managed Recharge of Deer Creek Diversions

Managed recharge (i.e. recharge in basins) of diverted Deer Creek streamflow is accomplished via multiple recharge facilities (see Figure 2-7). Native Deer Creek water is diverted to basins for recharge by Pixley Irrigation District and DCTRA. Artificial recharge attributed to native Deer Creek water is estimated by multiplying the total recharge in basins reported in Pixley Irrigation District annual water use summaries by the ratio of native Deer Creek water to total water flowing through the Trenton Weir. The average annual Deer Creek recharge in basins for water years 1986/87 to 2016/17was estimated to be approximately 800 acre-ft/yr (see Column K of Table 2-2b).

Managed Recharge of Imported Water

Managed recharge of imported water is accomplished via multiple recharge facilities within the LTRID, Pixley Irrigation District, PID, Teapot Dome Water District and DEID. Managed recharge attributed to imported water in the LTRID is estimated by multiplying the total recharge in basins reported in annual water use summaries by the ratio of imported water to total surface water flow available. Managed recharge attributed to imported water in the Pixley Irrigation District is estimated by multiplying the total recharge in basins reported in annual water use summaries by the ratio of imported water to total water flowing through the Trenton Weir. Volumes of imported water delivered to recharge in basins for PID, Teapot Dome Water District, and DEID were provided by the respective agencies. The resulting estimated average annual imported water recharge in basins for water years 1986/87 to 2016/17 was approximately 11,100 acre-ft (see Column L of Table 2-2b).

Recharge of Recycled Water in Basins

A portion of recycled water from the City of Porterville is discharged to basins where it infiltrates into the subsurface. Artificial recharge of recycled water was estimated as 75 percent of all available recycled water from 1990/91 to 2003/04 based on California Regional Water Quality Control Board Order No. R5-2008-0034. Artificial recharge was assumed to be 2,000 acre-ft/yr from 2004/05 to 2009/10 based on Schmidt (2009). The average annual recycled water recharge for water years 1986/87 to 2016/17 was estimated to be approximately 3,200 acre-ft/yr (see Table 2-2b, Column M).

2.3.1.2.5 Deep Percolation of Applied Water

Deep Percolation of Applied Tule River Diversions

A portion of native Tule River water that is delivered and applied for agricultural irrigation is assumed to infiltrate below the root zones of plants and become deep percolation to the groundwater. Deep percolation from irrigated agriculture was applied to the various land uses in the Tule Subbasin according to the irrigation method (e.g. drip irrigation, flood irrigation, micro sprinkler, etc.) for each land use type reported in CDWR on-line land use maps. Irrigation efficiencies were applied to the different irrigation methods based on tables reported in California Energy Commission (2006).

Tule River water is diverted for agricultural irrigation by the Pioneer Water Company, Porter Slough Headgate, Porter Slough Ditch Company, Campbell and Moreland Ditch Company, Poplar Irrigation Company, Woods-Central Ditch Company, Hubbs and Miner Ditch Company, and LTRID. In the LTRID, applied water attributed to native Tule River water is based on the ratio of total native Tule River water entering the LTRID to the total water available to the district (including imports) multiplied by the volume of water delivered for irrigation. Using this methodology, the average annual deep percolation of native Tule River water for water years 1986/87 to 2016/17was approximately 14,200 acre-ft/yr (see Column N of Table 2-2b).

Deep Percolation of Applied Deer Creek Diversions

The portion of native Deer Creek water delivered for agricultural use within the Pixley Irrigation District is estimated by multiplying the total deliveries reported in Pixley Irrigation District annual water use summaries by the ratio of native Deer Creek water to total water flowing through the

Trenton Weir. Deep percolation of applied Deer Creek diversions is estimated based on the irrigation method (e.g. drip irrigation, flood irrigation, micro sprinkler, etc.) for each land use type reported in DWR on-line land use maps. Irrigation efficiencies were applied to the different irrigation methods based on tables reported in California Energy Commission (2006). From water years 1986/87 to 2016/17, average annual deep percolation of native Deer Creek water was estimated to be approximately 300 acre-ft/yr (see Column O of Table 2-2b).

Deep Percolation of Applied Imported Water

The estimate of imported water delivered and applied to crops within the agencies that receive imported water is based on the total imported water delivery minus losses and recharge in basins. Deep percolation of applied imported water is estimated based on the irrigation method (e.g. drip irrigation, flood irrigation, micro sprinkler, etc.) for each land use type reported in DWR on-line land use maps. Irrigation efficiencies were applied to the different irrigation methods based on tables reported in California Energy Commission (2006). For water years 1986/87 to 2016/17, the estimated average annual deep percolation from imported water was approximately 64,300 acre-ft/yr (see Column P of Table 2-2b).

Deep Percolation of Applied Recycled Water

The estimate of recycled water delivered and applied to crops was provided by the City of Porterville. Deep percolation of applied recycled water is estimated based on the irrigation method (e.g. drip irrigation, flood irrigation, micro sprinkler, etc.) for each land use type reported in DWR on-line land use maps. Irrigation efficiencies were applied to the different irrigation methods based on tables reported in California Energy Commission (2006). For water years 1986/87 to 2016/17, the estimated average annual deep percolation from recycled water was approximately 400 acre-ft/yr (see Column Q of Table 2-2b).

Deep Percolation of Applied Native Groundwater for Agricultural Irrigation

The balance of agricultural irrigation demand not met by imported water or stream diversions is assumed to be met by groundwater pumping. Deep percolation of applied native groundwater is estimated based on the irrigation method (e.g. drip irrigation, flood irrigation, micro sprinkler, etc.) for each land use type reported in DWR on-line land use maps. Irrigation efficiencies were applied to the different irrigation methods based on tables reported in California Energy Commission (2006). For water years 1986/87 to 2016/17, average annual deep percolation from applied agricultural pumping was approximately 145,400 acre-ft/yr (see Column R of Table 2-2b).

Deep Percolation of Applied Native Groundwater for Municipal Irrigation

Deep percolation from applied landscape irrigation was estimated for the urbanized portions of the Tule Subbasin. Because the cities within the Tule Subbasin do not have surface water rights on the Tule River or Deer Creek and do not purchase imported water, 100 percent of their water demand is met from groundwater pumping. For the City of Porterville, landscape irrigation was estimated to be 47 percent of the total water delivered to each home based on an analysis of the total groundwater production and influent flows to the wastewater treatment plant (City of Porterville draft Urban Water Management Plan 2010 Update, 2014). Of the water used for irrigation, 25 percent was assumed to become return flow.

For the other smaller communities in the Tule Subbasin, wastewater discharge was assumed to be through individual septic systems. For water discharged to septic systems, it was assumed that 100 percent of the discharge became return flow. As with the City of Porterville, 47 percent of total water use was assumed to be for landscape irrigation and 25 percent of the landscape irrigation is assumed to become return flow.

For water years 1986/87 to 2016/17, average annual return flow from municipal production was estimated to be approximately 6,700 acre-f/yr (see Column S of Table 2-2b).

2.3.1.2.6 Evapotranspiration

Evapotranspiration of Precipitation from Crops and Native Vegetation

Evapotranspiration (ET) is the loss of water to the atmosphere from free-water evaporation, soil-moisture evaporation, and transpiration by plants (Fetter, 1994). Evapotranspiration of precipitation is assumed to be the balance between total precipitation and areal recharge. This value includes evapotranspiration of precipitation from crops as well as native vegetation. From water years 1986/87 to 2016/17, evapotranspiration of precipitation was estimated to average approximately 286,000 acre-ft/yr (see Column T of Table 2-2b, Page 2).

Evapotranspiration of Surface Water within the Tule River Channel

Evapotranspiration of surface water within the Tule River channel is a function of the ET rate and wetted channel surface area. The ET rate was based on published data for riparian vegetation in an intermittent stream (Leenhouts et al., 2005). As the channel width of the Tule River varies, TH&Co identified reaches with similar average channel width using aerial photographs (Google Earth). The ET rate was applied to the surface area of each reach to obtain an estimate of ET. The sum of reach by reach ET estimates between Lake Success and the western Tule Subbasin boundary represents the total Tule River ET shown in Table 2-2b, Page 2, Column U. The resulting average annual ET is approximately 700 acre-ft/yr for water years 1986/87 to 2016/17 (see Table 2-2b, Page 2, Column V).

Evapotranspiration of Surface Water within the Deer Creek Channel

Evapotranspiration within the Deer Creek channel was estimated using the same methodology as for the Tule River. Average annual ET within the Deer Creek channel was estimated to be approximately 300 acre-ft/yr for water years 1986/87 to 2016/17 (see Table 2-2b, Page 2, Column X).

Evapotranspiration of Surface Water within the White River Channel

Evapotranspiration in the White River channel was estimated using the same methodology as for the Tule River. For water year 1986/87 to 2016/17, the average annual evapotranspiration was estimated to be approximately 100 acre-ft/yr (see Column Y of Table 2-2b, Page 2).

Evapotranspiration of Recycled Water in Basins

Evapotranspiration of recycled water delivered to recharge basins was estimated to be 50 acre-ft/yr (see Column AB of Table 2-2b, Page 2) based on Schmidt (2009).

Agricultural Consumptive Use

Columns U, W, Z, AA and AC of Table 2-2b includes agricultural consumptive use of applied water, not including the portion of the consumptive use met by precipitation, which is included in Column T. Historical agricultural crop water demand (i.e. applied water demand) was estimated based on records of the types and areas of crops grown, estimates of consumptive use for each crop, and estimates of the irrigation efficiency. Information on the types and areas of crops for the LTRID and Pixley Irrigation District were obtained from annual crop surveys from each respective district. The types and areas of crops in other parts of the Tule Groundwater Subbasin within Tulare County were estimated from land use maps and associated data published by the CDWR for 1993, 1999, and 2007 (see Figure 2-31). For the portion of the Subbasin in Kern County (DEID), land use maps were obtained from CDWR (1990) and Kern County Department of Agriculture and Measurement Standards (1999 and 2007). Consumptive use estimates for the various crop types were based on crop coefficients published in ITRC (2003). In order to estimate a total agricultural irrigation water demand, the consumptive use estimates for each crop were multiplied by the area of the crop, which in turn was multiplied by a return flow factor reflecting the irrigation efficiency (see Section 2.3.1.2.5).

The estimated average annual agricultural consumptive use for the period of the groundwater budget was approximately 773,900 acre-ft/yr (sum of Columns U, W, Z, AA and AC of Table 2-2b).

Municipal Consumptive Use

Consumptive use of landscaping associated with applied municipal groundwater pumping was estimated based on an assumed applied water to landscaping and return flow factor. As presented in Section 2.3.1.2.5, it is assumed 47 percent of municipal water use is applied to landscaping. It is assumed that 75 percent of applied water to landscaping is consumptively used by the plants and

25 percent becomes return flow. For water years 1986/87 to 2016/17, estimated average annual municipal consumptive use was approximately 6,800 acre-ft/yr (see Column AD of Table 2-2b).

2.3.1.2.7 Surface Water Outflow

Tule River

Any residual stream flow in the Tule River that reaches the Turnbull Weir, located at the west (downstream) end of the Tule Subbasin, is assumed to flow out of the subbasin (see Figure 2-7). From water years 1986/87 to 2016/17, surface water outflow ranged from 0 to 121,000 acre-ft/yr and averaged 14,000 acre-ft/yr (see Table 2-2b, Page 2, Column AE).

It is noted that additional outflow may occur at smaller canal outlets at the west end of the Tule Subbasin. The data for these outflows was unavailable for this report.

Deer Creek

During periods of above-normal precipitation, residual stream flow left in the Deer Creek after diversions has historically flowed into Homeland Canal, located at the west end of the Tule Subbasin (see Figure 2-7). The data for this outflow was unavailable for this report (see Column AF of Table 2-2b, Page 2). As this data becomes available, it will be incorporated into the surface water budget.

2.3.2. Groundwater Budget §354.18 (b)(2)

The groundwater budget describes the sources and estimates the volumes of groundwater inflow and outflow within the Tule Subbasin (see Table 2-3). A fundamental premise of the groundwater budget is the following relationship:

$$\text{Inflow} - \text{Outflow} = +/- \Delta S$$

Inflow terms include groundwater recharge to the subbasin including areal recharge from precipitation, recharge in stream/river channels, artificial recharge, canal losses, return flow, release of water from compression of aquitards, and subsurface inflow. It is noted that many of the groundwater inflow terms are surface water outflow terms from Table 2-2b. Outflow terms include groundwater pumping, evapotranspiration, and subsurface outflow. The difference between the sum of inflow terms and the sum of outflow terms is the change in groundwater storage (ΔS) (see Table 2-3).

As with the surface water budget tables, the individual columns in the groundwater budget table are color coded to reflect their role in the Sustainable Yield estimate. Sources of groundwater recharge (i.e. inflow) that are associated with pre-existing water rights and/or imported water deliveries are indicated with magenta-colored columns in Table 2-3 and are not used to estimate the Sustainable Yield. Groundwater recharge elements that are used to estimate Sustainable Yield are indicated with blue-colored columns. Groundwater pumping is not used in the equation to estimate Sustainable Yield and is shown as yellow-colored columns in Table 2-3.

2.3.2.1 Sources of Groundwater Recharge §354.18 (b)(2)

> § 354.18. (b) (2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.

2.3.2.1.1 Areal Recharge

Groundwater recharge from precipitation falling on the valley floor in the Tule Subbasin was estimated based on Williamson et al., (1989) (see Section 2.3.1.1.1). The resulting annual groundwater recharge from areal precipitation using this method ranged from 0 acre-ft/yr to 219,000 acre-ft/yr with a 31-yr average of approximately 21,000 acre-ft/yr (see Column A, Table 2-3).

2.3.2.1.2 Groundwater Recharge from the Tule River

Groundwater recharge of native Tule River water occurs as streambed infiltration, infiltration of water in unlined canals, recharge in basins, and deep percolation of applied water. Tule River water that becomes groundwater recharge is described in Section 2.3.1.2 and summarized in Columns B through F of Table 2-3. Average annual groundwater recharge of native Tule River water was estimated to be approximately 67,800 acre-ft/yr for water years 1986/87 to 2016/17.

2.3.2.1.3 Groundwater Recharge from Deer Creek

Groundwater recharge of native Deer Creek water occurs as streambed infiltration, canal loss, recharge in basins, and deep percolation of applied water. Deer Creek water that becomes groundwater recharge is described in Section 2.3.1.2 and summarized in Columns G through K of Table 2-3. For water years 1986/87 to 2016/17 average annual groundwater recharge of native Deer Creek water was estimated to be approximately 16,500 acre-ft/yr.

2.3.2.1.4 Streambed Infiltration in the White River

Groundwater recharge of White River water occurs as streambed infiltration as described in Section 2.3.1.2 and summarized in Column L of Table 2-3. Estimated average annual groundwater recharge from White River water was approximately 5,600 acre-ft/yr for water years 1986/87 to 2016/17.

2.3.2.1.5 Groundwater Recharge from Imported Water Deliveries

Groundwater recharge of imported water occurs as canal loss, recharge in basins, and deep percolation of applied water as described in Section 2.3.1.2 and summarized in Columns M through O of Table 2-3. For water years 1986/87 to 2016/17 average annual groundwater recharge from imported water was estimated to be approximately 126,000 acre-ft/yr.

2.3.2.1.6 Recycled Water

Groundwater recharge of recycled water occurs as artificial recharge and return flow of applied water as described in Section 2.3.1.2 and summarized in Columns R and S of Table 2-3. For water years 1986/87 to 2016/17 average annual groundwater recharge from recycled water was estimated to be approximately 3,600 acre-ft/yr.

2.3.2.1.7 Deep Percolation of Applied Water from Groundwater Pumping

A portion of irrigated agriculture and municipal applied water from groundwater pumping becomes deep percolation and groundwater recharge as described in Section 2.3.1.2.5 and summarized in Columns P and Q of Table 2-3. For water years 1986/87 to 2016/17 average annual groundwater recharge associated with return flow from groundwater pumping was estimated to be approximately 152,100 acre-ft/yr.

2.3.2.1.8 Release of Water from Compression of Aquitards

Prolonged lowering of groundwater levels in the Tule Subbasin results in the drainage of water from low permeability subsurface aquitards that occur beneath the potentiometric groundwater surface. Aquitards are low permeability layers with relatively high silt and clay content. As the aquitards are compressible, the release of pore pressure caused by the lowering of groundwater levels also results in compression of the low permeability layers. Within a limited range of groundwater level fluctuation, the compressed aquitard can accept water back into its structure when groundwater levels rise resulting in elastic rebound. However, if groundwater levels are maintained at low elevations for long enough periods of time as a result of groundwater pumping, the compression of aquitards becomes permanent. This permanent compression of subsurface layers results in land surface subsidence, which has been observed in the Tule Subbasin prior to 1970 (Ireland et al., 1984) and between 2007 and 2011 (Luhdorff and Scalmanini, 2014). The slow release of water from the permanent compaction of subsurface aquitards also results in a one-time contribution of water to the aquifer system. However, it is noted that this is not a renewable source of water to the aquifer.

The estimate of the volume of water contributed to the aquifer through compression of aquitards between 1986 and 2017 was based on groundwater flow model analysis and output using the subsidence package in MODFLOW. The total volume of water contributed to the aquifer from aquitard compression during this time period is estimated to be approximately 2,400,000 acre-ft with an annual average of approximately 77,000 acre-ft/yr (see Column T of Table 2-3).

2.3.2.1.9 Subsurface Inflow

The Tule Subbasin is not a closed basin and the aquifer is in hydrologic connection with adjacent subbasins to the north, west and south. Groundwater flow into and out of the Tule Subbasin along these boundaries varies over time in accordance with the groundwater level conditions and flow patterns within and outside the subbasin. The only source of subsurface inflow to the Tule Subbasin along the eastern boundary is mountain-front inflow resulting from infiltration of precipitation in the secondary porosity features (joints and fractures) of the bedrock east of the basin and along the mountain front. This recharge enters the alluvial groundwater basin where the alluvium is in hydrologic connection with the fractures in the bedrock in the subsurface.

A summary of subsurface inflow values estimated for 1986/87 to 2016/17 is provided in Table 2-3 (Column U). As shown, inflow through the southern and western boundary across both the shallow and deep aquifers ranges from 83,000 acre-ft in 2009/10 to 144,000 acre-ft in 1990/91 with an average over the years of interest of 118,000 acre-ft/yr. The average net inflow into the Tule Subbasin along the south and west boundaries for the time period is approximately 53,000 acre-ft/yr after accounting for outflow (see Section 2.3.2.3.4).

2.3.2.1.10 Mountain Front Recharge

Mountain front recharge represents the infiltration of precipitation into the fractures in the bedrock east of the Tule Subbasin, which eventually flows into the alluvial aquifer system of the Tule Subbasin in the subsurface where the fractured rock aquifer system in in hydrologic communication with the alluvial aquifer system. Subsurface inflow along the eastern Tule Subbasin boundary was estimated through a parameter estimation calibration process of the groundwater flow model of the subbasin. In this calibration method, the model was given a wide range of potential recharge along the eastern Tule Subbasin. The model automatically varied aquifer parameters and mountain-front recharge through an iteration process until it arrived at an optimum fit of measured and model-generated groundwater levels. Tule Subbasin mountain-front recharge that resulted in the best model calibration was approximately 29,000 acre-ft/yr (see Column V of Table 2-3 and Column J of Table 2-4).

2.3.2.2 Sources of Groundwater Discharge §354.18 (b)(3)

> § 354.18. (b) (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

2.3.2.2.1 Municipal Groundwater Pumping

Groundwater pumping for municipal supply is conducted by the City of Porterville and small municipalities for the local communities in the Tule Subbasin as described in Section 2.3.1.1.5. For water years 1986/87 to 2016/17, municipal groundwater production was estimated to average approximately 19,400 acre-ft/yr (see Column W of Table 2-3, Page 2).

2.3.2.2.2 Agricultural Groundwater Pumping

Agricultural groundwater production is estimated as the total applied water demand for crops minus surface deliveries. The estimated average annual discharge to crops from wells for water years 1986/87 to 2016/17 is approximately 664,000 acre-ft/yr (see Column X of Table 2-3, Page 2).

2.3.2.2.3 Groundwater Pumping for Export Out of the Tule Subbasin

Some of the groundwater pumping that occurs on the west side of the Tule Subbasin is exported out of the subbasin for use elsewhere. Angiola Water District and the Boswell/Creighton Ranch have historically exported pumped groundwater out of the Tule Subbasin. Annual groundwater exports have ranged from 0 between 1995 and 1999 to 63,640 acre-ft in the 2012/13 water year (see Column Y of Table 2-3, Page 2) with the average for water years 1986/87 to 2016/17 of 28,200 acre-ft/yr. This water is accounted for separately because the water is not applied within the subbasin and there is no associated return flow.

2.3.2.2.4 Subsurface Outflow

Outflow estimates (Table 2-3; Column AA) range from 51,000 acre-ft in 1988/89 to 92,000 acre-ft in 2009/10, with an average of 65,000 acre-ft/yr.

2.3.2.3 Changes in Groundwater Storage §354.18 (b)(4)

> § 354.18. (b) (4) The change in the annual volume of groundwater in storage between seasonal high conditions.

Comparison of the groundwater inflow elements of the water budget with the outflow elements shows a cumulative change in groundwater storage over the period between 1986/87 to 2016/17 of approximately -4,948,000 acre-ft (see Table 2-3). The average annual change in storage resulting from the groundwater budget is approximately -160,000 acre-ft/yr. It is noted that this time period was used as it matches the calibration period for the Tule Subbasin groundwater flow model used to evaluate future projects and management actions for the subbasin. However, the average hydrology over the time period is relatively dry (see Figure 2-28) and the resulting change in storage is not representative of long-term average conditions. A groundwater change in storage value representative of average hydrological conditions is provided in Section 2.3.2.5 for the period 1990/91 to 2009/10.

2.3.2.4 Overdraft §354.18 (b)(5)

> § 354.18. (b) (5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

The average annual change in groundwater storage over the period from 1990/91 to 2009/10, which represents average hydrologic conditions within the Tule Subbasin, was approximately -115,300 acre-ft/yr. This value represents the average annual historical overdraft of the subbasin.

2.3.2.5 Water Year Type §354.18 (b)(6)

> § 354.18. (b) (6) The water year type associated with the annual supply, demand, and change in groundwater stored.

All water budget elements and change in groundwater storage presented herein are based on a water year, which begins October 1 and ends September 30. Water year types with respect to hydrologic conditions (i.e. above average, average or below average precipitation conditions based on Figure 2-28) are shown in the historical water budget tables (Tables 2-2a, 2-2b, and 2-3).

2.3.2.6 Sustainable Yield §354.18 (b)(7)

> § 354.18. (b) (7) An estimate of sustainable yield for the basin.

Sustainable yield is defined in the Sustainable Groundwater Management Act (SGMA) Chapter 2, §10721 (v) as:

The maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

The Sustainable Yield of the Tule Subbasin is a function of the overall water balance of the area. Changes in surface water/groundwater inflow to the basin and surface water/groundwater outflow from the basin impact the Sustainable Yield. As groundwater management and land use changes impact the water balance, they also impact the Sustainable Yield. A generalized expression of the water balance is as follows:

$$\text{Inflow} - \text{Outflow} = +/- \text{ Change in Storage} \qquad (1)$$

The water balance equation for pre-developed conditions (prior to human occupation) can be further expressed as:

$$(I_{pr} + I_{str} + I_{ss} + I_{mb}) - (O_{ss} + O_{et}) = \Delta S \qquad (2)$$

Where:

I_{pr} = Inflow from Areal Recharge of Precipitation

I_{str} = Inflow from Infiltration of Runoff in Stream Beds

I_{ss} = Inflow from Subsurface Underflow

I_{mb} = Inflow from Mountain-Block Recharge

O_{ss} = Subsurface Outflow

O_{et} = Evapotranspiration

ΔS = Change in Groundwater Storage

Under pre-developed conditions, the groundwater basin would be in a state of equilibrium such that the inflow and outflow would balance and there would be no significant long-term change in storage assuming a static climatic condition. Under this condition, groundwater levels would be relatively stable.

Under developed land use conditions, the water balance changes as groundwater is pumped from the basin for irrigation and municipal supply. Lowering of the groundwater table resulting from pumping reduces the amount of groundwater that would otherwise leave the basin and reduces evapotranspiration losses in areas of shallow groundwater (e.g. Tulare Lake). Some of the pumped groundwater used for irrigation infiltrates past the roots of the plants and returns to the groundwater as return flow. Water imported into the area is applied to crops but some is lost as infiltration in unlined canals and as return flow. Groundwater return flow also occurs as a result of discharges from individual septic systems. Other sources of recharge to the groundwater under developed land use include wastewater treatment plant discharges and artificial recharge in spreading basins.

The water balance equation for developed land use conditions can be modified as follows:

$$(I_{pr} + I_{str} + \mathbf{I_{can}} + \mathbf{I_{ar}} + \mathbf{I_{rfgw}} + \mathbf{I_{rfimp}} + \mathbf{I_{com}} + I_{ss} + I_{mb}) - (O_{ss} + O_{et} + \mathbf{O_{p}}) = \Delta S \qquad (3)$$

Where:

I_{can} = Inflow from Canal Losses

I_{ar} = Inflow from Artificial Recharge

I_{rfgw} = Inflow from Return Flow of Applied Water from Groundwater Pumping

I_{rfimp} = Inflow from Return Flow of Applied Water from Imported Water

I_{com} = Inflow of Water Released from Compression of Aquitards

O_p= Outflow from Groundwater Pumping

If the inflow terms exceed the outflow terms, then the groundwater in storage increases (become positive) and groundwater levels rise. If the outflow terms exceed the inflow, then the groundwater in storage decreases (become negative) and groundwater levels drop. It is assumed that the Sustainable Yield of the Tule Subbasin is the long-term average groundwater pumping rate, under projected land use conditions, that results in no significant long-term net negative change in groundwater storage in the basin. Based on this premise, the water balance equation can be rearranged and simplified to estimate Sustainable Yield:

$$\text{Sustainable Yield} = \Delta S + O_p - \mathbf{I_{can}} - \mathbf{I_{ar}} - \mathbf{I_{rfimp}} - \mathbf{I_{com}} \qquad (4)$$

Thus, if the change in groundwater storage over the planning period is zero and there is no imported water or release of water from compression of aquitards, then the Sustainable Yield is equal to the pumping. This relationship is valid if the following conditions are met:

1. The Sustainable Yield incorporates a hydrology that is representative of a relatively long period of record that includes multiple wet and dry hydrologic cycles.
2. The land use conditions are representative of the time period.

The Sustainable Yield can also be expressed as all of the components of the water balance not explicitly expressed in Equation 4:

$$\text{Sustainable Yield} = I_{pr} + I_{str} + I_{rfgw} + I_{ss} + I_{mb} - O_{ss} \qquad (5)$$

It is noted that the Tule Subbasin Technical Advisory Committee has determined that recharge to the Tule Subbasin associated with the delivery of imported water and the diversion of water from the Tule River and Deer Creek associated with Pre-1914 water rights will not be included in the Sustainable Yield of the subbasin. This includes canal losses from delivery of imported water and diverted stream flow, deep percolation of applied imported water and diverted stream flow, and managed recharge in basins.

Applying Equations 4 and 5 to the historical water budget of the Tule Subbasin does not result in a representative Sustainable Yield because the subbasin was in overdraft during the historical water budget period. Groundwater pumping depressions that have developed in the western portion of the subbasin have historically captured groundwater that would have otherwise left the subbasin.

This increase in groundwater inflow and subsequent decrease in groundwater outflow increased the apparent Sustainable Yield, which was reported to be approximately 257,725 acre-ft/yr based on the water budget from water year 1990/91 to 2009/10 (TH&Co, 2017). However, since the downward groundwater trends that resulted in this condition are not sustainable, the associated Sustainable Yield from this water budget is not representative.

The Sustainable Yield of the Tule Subbasin will change in the future as a result of changes in groundwater levels and flow associated with planned projects and management actions and changes in deep percolation of applied water (i.e. return flow) from reduced groundwater pumping. Most of the GSAs in the subbasin plan management actions that include a reduction in irrigated acreage to address the need to reduce groundwater production. This necessary action will change the water budget by not only decreasing outflow from groundwater pumping but also reducing deep percolation of applied water (return flow) and changing the dynamics of inflow and outflow at the subbasin boundaries. This new water budget regime will result in a Sustainable Yield that is different from what was realized historically. Thus, the Sustainable Yield of the Tule Subbasin presented herein was estimated based on the projected future water budget (see Section 2.3.5), which is more representative than the Sustainable Yield from the historical water budget.

The projected water budget that was the basis for the Sustainable Yield estimate was developed using a calibrated groundwater flow model of the Tule Subbasin (TH&Co, 2020). The projected water budgets incorporated all planned projects and management actions of the Tule Subbasin GSAs as well as adjustments to hydrology and water deliveries from climate change guidelines provided by the CDWR (see Section 2.3.5). In order to address uncertainty in the model results, the projected water budget was initially analyzed with 240 realizations of the groundwater flow model. In each realization, aquifer parameters, consumptive use, and mountain front recharge were varied within acceptable ranges that produced acceptable overall model calibrations. The resulting water budgets were processed, based on Equation 5 above, to produce Sustainable Yield estimates for each year of the 50-yr implementation and planning horizon (2020 to 2070). Of the original 240 model realizations, 175 resulted in a projected average annual change in groundwater storage greater than -5,000 acre-ft/yr. The average Sustainable Yield for the time period from 2040 to 2050 was used as the Sustainable Yield for the 175 model realizations resulting in greater than -5,000 acre-ft/yr of annual storage change. The 175 estimates of Sustainable Yield formed a normal distribution when plotted (see Figure 2-32). The time period from 2040 to 2050 was selected because it occurs after all planned projects and management actions have been implemented but before the time when long-term climate change adjustments to hydrology and water deliveries are applied to the projected water budget (2050). The long-term climate change adjustments were not considered as reliable as the near-term adjustments.

The projected future Sustainable Yield of the Tule Subbasin, which is the 50^{th} percentile of the distribution of estimates derived from the uncertainty analysis, is estimated to be approximately 130,000 acre-ft/yr (see Table 2-4). The plausible range of Sustainable Yield was selected as the values between the 20th and 80th percentile, resulting in a range of approximately 108,000 to 162,000 acre-ft/yr (see Figure 2-32). The projected Sustainable Yield does not include:

- Water released to the aquifer system from the compression of aquitards,
- Diverted Tule River water canal losses, recharge in basins, and deep percolation of applied water,
- Diverted Deer Creek water canal losses, recharge in basins, and deep percolation of applied water,
- Imported water canal losses, recharge in basins, and deep percolation of applied water, and
- Deep percolation of applied recycled water and recycled water recharge in basins.

Each GSA will determine their allowable groundwater pumping by multiplying that GSA's proportionate areal coverage of the Tule Subbasin times the total Sustainable Yield of the subbasin (130,000 acre-ft/yr), as described in the Coordination Agreement. The estimated consumptive use rate that can be sustained under the Subbasin-wide Sustainable Yield is 65,000 acre-ft/yr. When applied across the entire 475,895 acres of the subbasin, this consumptive use rate is approximately 0.14 acre-ft/acre. This consumptive use rate incorporates consumptive use from both agriculture and municipal demand. This "sustainable" consumptive use rate does not equal the Sustainable Yield on an acre-ft/acre basis because it does not account for irrigation return flow and changes to subbasin inflow and outflow caused by changes in pumping stress within the subbasin. It is noted that the consumptive use rate of 0.14 acre-ft/acre is for irrigation water only (i.e. does not include consumptive use of precipitation) and is the baseline sustainable consumptive use as applied across the entire subbasin. Each GSA will individually estimate their total allowable consumptive use as the sum of the baseline sustainable consumptive use, available precipitation, and surface water supplies.

As additional data become available and as projects and management plans are implemented, the groundwater flow model used to estimate the Sustainable Yield of the Tule Subbasin will be updated and the Sustainable Yield may be adjusted to reflect the new data.

2.3.3. Current Water Budget §354.18 (c)(1)

§ 354.18. (c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.

The surface water and groundwater budget for the Tule Subbasin in 2017 is shown in Tables 2-2a, 2-2b, and 2-3. Total groundwater inflow to the subbasin for water year 2016/17 was approximately 855,000 acre-ft. Total groundwater outflow from the subbasin for water year 2016/17 was approximately 550,000 acre-ft. The net change in storage during the water year was approximately 305,000 acre-ft.

2.3.4. Historical Water Budget §354.18 (c)(2)

> § 354.18. (c) (2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:
>
> (A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.
>
> (B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.
>
> (C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.

The historical surface water and groundwater budgets for the Tule Subbasin are shown in Tables 2-2a, 2-2b, and 2-3 and described in Sections 2.3.1 and 2.3.2. Historical surface water and groundwater budgets for each of the six GSAs in the subbasin are provided in:

- Appendix A - LTRID GSA.
- Appendix B – ETGSA
- Appendix C – DEID GSA
- Appendix D – Pixley GSA
- Appendix E – Tri-County Water Authority GSA
- Appendix F – Alpaugh GSA

Sources of surface water supply to agriculture in the Tule Subbasin include diverted stream flow from the Tule River and Deer Creek and imported supplies delivered via the Friant-Kern Canal, State Water Project, and other diverted streamflow from streams located outside the subbasin (i.e. King's River). A comparison of water rights and annual water deliveries for the 10-yr period from 2007/08 to 2016/17 is provided for the Tule River and Friant-Kern Canal in Table 2-5. As shown, total Tule River water diversions during the 10-yr period are approximately 90 percent of the sum of diversion rights over that period. The primary reason for this is that the 10-yr period from 2007/08 to 2016/17 was relatively dry with precipitation approximately 69 percent of long-term average (see Figure 2-28). Friant-Kern Canal deliveries to agencies with contracts within the Tule Subbasin have also been below the sum of Class I and Class II contract amounts for most of the 10-yr period. However, many contractors sell a portion of their available supply from the canal to other agencies. Likewise, some contractors (e.g. Kern-Tulare Water District) purchase additional supplies from the canal from other contractors. Thus, while precipitation trends do effect the volume of water available to Friant-Kern Canal contractors (the precipitation amounts during the 10-yr period from 2007/08 to 2016/17 are below average), it is difficult to compare planned versus actual deliveries based on these data.

The primary surface water supply issue affecting the ability of agencies to operate within the Sustainable Yield of the subbasin is reduced delivery capacity in the Friant-Kern Canal due to land subsidence. Land subsidence has lowered the canal elevation in certain areas resulting in a reduction in downstream canal delivery capacity. Reduced deliveries due to land subsidence can result in greater groundwater pumping to meet agricultural water demand. While the reduced supply capacity of the Friant-Kern Canal is not the primary reason for the overdraft observed in the Tule Subbasin from 1986/87 to 2016/17, it is a contributing factor.

2.3.5. Projected Water Budget §354.18 (c)(3)

A projected water budget for the Tule Subbasin has been developed to incorporate the planned projects and management actions of each of the six GSAs for achieving sustainability (see Tables 2-6 and 2-7). The projects and management actions were incorporated into the groundwater flow model of the Tule Subbasin for the projected time period from 2020 to 2070 in order to assess the sustainability of the planned actions, assess the interaction of the planned actions on groundwater levels between the GSAs, and estimate the Sustainable Yield of the subbasin. The model projection also incorporated adjustments to the hydrology and water deliveries to account for potential climate change. The final projected water budget is the one that produced the 50th percentile Sustainable Yield estimate (see Section 2.3.2.7 herein). The projected surface water and groundwater budgets are shown in Tables 2-8a, 2-8b, and 2-9. Projected water budgets for each of the six GSAs are provided in Appendices A through F.

Baseline Tule River flows, Friant-Kern Canal deliveries, and the State Water Project's California Aqueduct deliveries used in the future projection for the model were adjusted to account for projections of future climate change. Adjustments were applied based on output from the DWR's CalSim-II model, which provided adjusted historical hydrology for major drainages and imported supplies based on scenarios recommended by the DWR Climate Change Technical Advisory Group.[1] Climate change adjustments to hydrology and surface water deliveries were applied over two time periods within the SGMA planning horizon, as defined by California Water Commission (2016)[2]:

1. A 2030 central tendency time period, which provides near-term projections of potential climate change impacts on hydrology, centered on the year 2030, and

[1] DWR Climate Change Technical Advisory Group, 2015. Perspectives and Guidance for Climate Change Analysis. DWR Technical Information Record.

[2] California Water Commission, 2016. Technical Reference – Water Storage Investment Program. Dated November 2016.

2. A 2070 central tendency time period, which provides long-term projections of potential climate change impacts on hydrology, centered on the year 2070.

For imported water supplies from the Friant-Kern Canal, TH&Co utilized projected delivery schedules from the Friant Water Authority (Friant Water Authority, 2018). The projected water deliveries include adjustments to supplies associated with the planned San Joaquin River Restoration Project (SJRRP). Adjustments to Friant-Kern Canal supplies to account for climate change and SJRRP were applied beginning in 2025. The adjustments were applied incrementally between 2025 and 2030 such that the full adjustments were in effect in 2030. TH&Co applied the 2070 central tendency time period climate-related adjustments to imported water deliveries in the Tule Subbasin model projection for the period from 2050 to 2070.

2.4 Management Areas §354.20

> § 354.20. Management Areas
>
> (a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.

Of the six GSAs within the Tule Subbasin, five have identified separate management areas within their boundaries (see Figure 2-33). The management areas are as follows:

LTRID GSA

Agricultural Management Area
Municipal Management Area
Tulare County MOU Management Area

ETGSA

Porterville Community Management Area
Terra Bella Community Management Area
Ducor Community Management Area
Kern-Tulare Management Area
Greater Eastern Tule Management Area

DEID GSA

Delano-Earlimart Irrigation District Management Area
Western Management Area
Richgrove Community Services District Management Area

Earlimart Public Utilities District Management Area

Pixley GSA

Pixley Irrigation District Management Area
Pixley Public Utilities District Management Area
Teviston Management Area

Tri-County Water Authority GSA

North Management Area
Southeast Management Area

In addition to the management areas identified for each GSA, a separate ETGSA Land Subsidence Monitored Area (ETGSA Monitored Area) has been identified for the eastern portion of the subbasin in the vicinity of the Friant-Kern Canal (see Figure 2-36; TH&Co, 2021). This ETGSA Monitored Area was developed based on the extent of historical land subsidence observed along the Friant-Kern Canal, including model results of cumulative land subsidence calibrated to historical land subsidence rates measured from InSAR satellite data. The ETGSA Monitored Area covers most of the ETGSA. The basis for the eastern and northern boundaries of the ETGSA Monitored Area is the limit of land subsidence detected by the 2015 – 2018 InSAR land subsidence map. This area is considered recently active and prone to continued subsidence in the future. These boundaries are approximately two to three miles east of the communities of Ducor and Terra Bella and approximately one mile north of the Tule River at the FKC. The western and southern boundaries of the ETGSA Monitored Area are the western and southern boundaries of the ETGSA. Also, the southeast portion of the Pixley Irrigation District GSA is included in the monitored area based on an agreement with the Friant Water Authority and ETGSA.

It is also noted that a portion of the ETGSA Monitored Area has been set aside as the ETGSA Managed Area (see Figure 2-36) where more urgent management actions may be needed to meet the land subsidence management goals. The ETGSA Managed Area was identified based on InSAR satellite data and groundwater flow model analysis of land subsidence. The ETGSA Managed Area extends two miles on either side of the Friant-Kern Canal from the Tule River to the southern boundary of the ETGSA. Management actions within this area will be separate from, and may be different than, planned management actions published in the ETGSA GSP for the greater ETGSA.

2.4.1 Criteria for Management Areas §354.20 (b)(1)

> § 354.20. (b) A basin that includes one or more management areas shall describe the following in the Plan:
>
> (1) The reason for the creation of each management area.

The majority of the management areas are associated with communities that provide municipal water supply. These communities have been delineated separately because the beneficial use of the groundwater produced within the management areas (municipal supply) is different than the beneficial use of groundwater across the majority of the subbasin (agriculture). Other management areas were identified for portions of the subbasin with unique hydrogeology and areas where access to imported water is different than other portions of the GSA in which they are located.

Management Areas categorized under the Community Management Area Type have been created to specifically address the needs of the Tule Subbasin's population centers and communities. Future projects and management actions focused in these areas will seek to achieve the Tule Subbasin sustainability goal and improve access to safe, reliable drinking water supplies. The boundaries for each Community Management Area consider existing County and/or City adopted Urban Development Boundaries, as well as the service area boundaries of the public water suppliers providing services to residents within these areas.

In addition to community management areas, LTRID GSA has delineated a management area, the Tulare County MOU Management Area, associated with lands outside and to the southwest of the LTRID service area that were annexed to the LTRID GSA (see Figure 2-33). This management area was formed because it does not have the same access to surface water deliveries as the LTRID service area and, therefore, will require separate management actions than the rest of the GSA.

ETGSA has delineated a separate management area for the Kern-Tulare Water District (Kern-Tulare Management Area). Wells from this area produce groundwater primarily from a deeper and separate aquifer system (i.e. Pliocene Marine and Santa Margarita Formation) than other parts of the ETGSA. Groundwater level conditions in wells in this area are different than other areas of the ETGSA. Additionally, the service area of Kern-Tulare Water District is divided between the Tule and Kern County Subbasins. Future projects and management actions in this Management Area will focus on enabling Kern-Tulare Water District to achieve the sustainability goals of both the Tule and Kern County Subbasins while minimizing the need to alter its operations. As such, Kern-Tulare Water District has developed their own monitoring plan for their service area.

DEID GSA has delineated a management area, the Western Management Area, associated with lands outside and to the west of the DEID service area. These lands were annexed to the DEID GSA. This Western Management Area was formed because it does not have the same access to surface water deliveries from the Friant-Kern Canal as the DEID service area and, therefore, will require separate management actions than the rest of the GSA.

TCWA GSA has delineated two separate management areas, the North and Southeast Management Areas. The North Management Area receives surface water and groundwater on the lands located within the Angiola Water District. It is noted that some areas within the North Management Area are outside the Angiola Water District but are included in the management area due to their proximity to Angiola Water District. The Southeast Management area is an undistracted area dependent on groundwater.

2.4.2 Minimum Thresholds and Measurable Objectives §354.20 (b)(2)

> § 354.20. (b) (2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.

2.4.2.1 Minimum Thresholds

Minimum thresholds and measurable objectives for each groundwater level and land subsidence representative monitoring site in each GSA are shown on the hydrographs and in the tables provided in Appendices A through F. The rational for determining the minimum thresholds and measurable objectives are not different by management area within a GSA.

2.4.3 Monitoring Plan §354.20 (b)(3)

> § 354.20. (b) (3) The level of monitoring and analysis appropriate for each management area.

The Tule Subbasin Technical Advisory Committee has developed a subbasin-wide monitoring plan, which describes the monitoring network and monitoring methodologies to be used to collect the data to be included in Tule Subbasin GSPs and annual reports. The subbasin-wide monitoring plan is included as Attachment 1 to the Coordination Agreement. Separate monitoring networks have been established for groundwater levels (see Figure 2-34), groundwater quality (see Figure 2-35), land subsidence (see Figure 2-36) and surface water (see Figure 2-7). For each monitoring network, the monitoring plan describes the monitoring features included in the plan, the monitoring procedure to be followed to collect the data, and the monitoring frequency. The monitoring plan also includes an assessment of data gaps and a data management plan.

A subset of groundwater level monitoring features in the monitoring plan have been identified as representative monitoring sites to be relied on for the purpose of assessing progress with respect to groundwater level sustainability in the subbasin. The representative groundwater level monitoring sites are shown on Figure 2-34. At least one representative groundwater level monitoring site has been identified within each management area. Where possible based on available wells, representative monitoring sites have been chosen with perforations exclusively in either the Upper or Lower Aquifer. To provide adequate spatial coverage of the subbasin, some representative monitoring sites include perforations across multiple aquifers until new monitoring features can be constructed. Representative groundwater level monitoring wells will be equipped with pressure transducers to measure groundwater levels on a daily basis.

A land surface elevation monitoring network has also been established and is shown on Figure 2-36. The monitoring network consists of 94 benchmarks installed in 2020 and 2021. Each benchmark is a representative monitoring site for land subsidence. The elevations of the benchmarks are surveyed annually..

2.4.4 Coordination with Adjacent Areas §354.20 (b)(4)

> § 354.20. (b) (4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.

The minimum thresholds described in each GSA's GSP have been informed through an analysis of potential future groundwater levels in the subbasin using a numerical groundwater flow model that incorporates future planned projects and management actions of each of the GSAs. The minimum thresholds have been developed such that maintenance of groundwater levels above those levels should preserve beneficial uses of the groundwater and prevent undesirable results with respect to groundwater levels, groundwater storage, and land subsidence within the management area, GSA and adjacent areas. Management of the Tule Subbasin is adaptive. As management actions and projects are implemented throughout the subbasin and as additional data are collected through the Tule Subbasin Monitoring Plan, minimum threshold values and measurable objectives may change. Changes to basin management to address undesirable results will be conducted through the Tule Subbasin TAC in accordance with the Tule Subbasin Coordination Agreement.

2.5 References

California Department of Water Resources, 2016. Final 2016 Bulletin 118 Groundwater Basin Boundaries shapefile. http://www.water.ca.gov/groundwater/sgm/basin_boundaries.cfm

California Energy Commission, 2006. PIER Project Report: Estimating Irrigation Water Use for California Agriculture: 1950s to Present. May 2006.

California Regional Water Quality Control Board, 2008. Order No. R5-2008-0034 Waste Discharge Requirements for City of Porterville Wastewater Treatment Facility Tulare County. Dated March 2008.

California State Water Resources Control Board, 2017. Resolution 2017-0048 Approving an Amendment to the Water Quality Control Plan for the Tulare Lake Basin to Remove the Municipal and Domestic Supply (MUN) and Agricultural Supply (AGR) Beneficial Uses from Groundwater within a Designated Horizontal and Vertical Portion of the Tulare Lake Bed. Adopted September 6, 2017.

City of Porterville, 2014. Draft Urban Water Management Plan. Dated August 2014.

Croft, M.G., 1972. Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California. USGS Water-Supply Paper 1999-H.

Davis, G.H., Green, J.H, Olmsted, F.H., and Brown, D.W., 1959. Ground-Water Conditions and Storage Capacity of the San Joaquin Valley, California. USGS Water-Supply Paper 1469, 287 p.

Faunt, C.C., 2009. *Groundwater Availability of the Central Valley Aquifer, California*. USGS Professional Paper 1766.

Fetter, C. W., 1994. Applied Hydrogeology. 3rd Edition. Macmillan College Publishing, New York.

Friant Water Authority, 2018. Technical Memorandum: Estimate of Future Friant Division Supplies for Use in Groundwater Sustainability Plans.

Frink, J.W., and Kues, H.A., 1954. *Corcoran Clay – A Pleistocene Lacustrine Deposit in San Joaquin Valley, California*. American Association of Petroleum Geologists Bulletin Vol. 38, No. 11, pgs. 2357 – 2371.

Ireland, R.L., Poland, J.F., and Riley, F.S., 1984. Land Subsidence in the San Joaquin Valley, California, as of 1980. U.S. Geological Survey Professional Paper 437-I.

ITRC, 2003. California Crop and Soil Evapotranspiration for Water Balances and Irrigation Scheduling/Design. ITRC No. 03-001, dated January 2003.

Kern-Tulare Water District, 2018. 2018 Groundwater Monitoring Report.

Leenhouts, J.M., Stromberg, J.C., and Scott R.L., 2005. *Hydrologic Requirements of and Consumptive Ground-Water Use by Riparian Vegetation along the San Pedro River, Arizona*. USGS Scientific Investigations Report 2005-5163.

Lofgren, B.E., and Klausing, R.L., 1969. Land Subsidence Due to Ground-Water Withdrawal Tulare-Wasco Area California. USGS Professional Paper 437-B.

Luhdorff and Scalmanini, 2014. Land Subsidence from Groundwater Use in California. Prepared in Cooperation with the California Water Foundation.

Page, R.W., 1973. Base of Fresh Ground Water in the San Joaquin Valley, California. USGS Hydrologic Investigations Atlas HA-489.

Planert, M. and Williams, J.S., 1995. Ground Water Atlas of the United States, Segment 1 – California and Nevada. USGS Hydrologic Investigations Atlas 730-B.

Schmidt, K., 2009. *Groundwater Conditions within the City of Porterville Urban Area Boundary*. Prepared for the City of Porterville, dated October 2009.

Schmidt, K., 2011. Groundwater Conditions in the Angiola Area. Prepared for the Angiola Water District, dated July 2011.

Schmidt, K., 2018. Hydrogeologic Conceptual Model and Groundwater Conditions for the Tri-County WA GSP. Prepared for Tri-County Water Authority. Dated September 2018.

Theis, C.V., Brown, R.H., Myer, R.R., 1963. Estimating the Transmissivity of a Water-table Aquifer from the Specific Capacity of a Well. USGS Water Supply Paper 1536-1, p 331-336.

Thomas Harder & Co., 2017. Hydrogeological Conceptual Model and Water Budget of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group.

Thomas Harder & Co., 2020. Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group.

Thomas Harder & Co., 2021. Eastern Tule Groundwater Sustainability Agency, Land Subsidence Monitoring Plan. Prepared for the Eastern Tule Groundwater Sustainability Agency.

Tule Basin Water Quality Coalition, 2017. Groundwater Quality Trend Monitoring Work Plan. Dated January 6, 2017.

Tule River Association, 1966. Tule River Water Diversion Schedule and Storage Agreement. Dated February 1, 1966; revised June 16, 1966.

Williamson, A.K., Prudic, D.E., and Swain, L.A., 1989. Ground-Water Flow in the Central Valley, California. USGS Professional Paper 1401-D.

Tables

Table 2-1

Summary of Active Cleanup Sites Within the Tule Subbasin

Geotracker Global ID	Site Type	Status	Constituent of Concern
60001606	School	Active	Metals, Pesticides, Petroleum
54360008	State Response or NPL	Active	Freon 113, Lead, VOCs
54070051	State Response or NPL	Active	Herbicides, Pesticides, Lead, VOCs
60002076	State Response or NPL	Active	Cyanide, PAHS, SVOCs
54070296	Voluntary Cleanup	Active	Pesticides
60001216	Evaluation	Active	PCE
54070288	Evaluation	Inactive - Needs Evaluation	Zinc
54280106	Evaluation	Inactive - Needs Evaluation	Pesticides/Herbicides
T10000010424	Cleanup Program Site	Open - Active	NA
T0610740454	LUST Cleanup Site	Open - Assessment & Interim Remedial Action	Gasoline
T0610700023	Cleanup Program Site	Open - Assessment & Interim Remedial Action	Gasoline, Benzene
T0610700454	LUST Cleanup Site	Open - Eligible for Closure	Gasoline
T10000010850	LUST Cleanup Site	Open - Eligible for Closure	Gasoline, MTBE, TBA, other fuel oxygenates
T0610700430	LUST Cleanup Site	Open - Eligible for Closure	Gasoline
T0610700127	LUST Cleanup Site	Open - Eligible for Closure	Gasoline
SLT5FS354453	Cleanup Program Site	Open - Inactive	Nitrate, other Petroleum
SL375384617	Cleanup Program Site	Open - Remediation	Gasoline, Diesel, other Petroleum
SL205734285	Cleanup Program Site	Open - Remediation	VOCs
T0610700216	LUST Cleanup Site	Open - Remediation	Gasoline
T0610700256	LUST Cleanup Site	Open - Site Assessment	Kerosene
T0610700058	LUST Cleanup Site	Open - Site Assessment	Gasoline
SLT5FU104564	Cleanup Program Site	Open - Site Assessment	Pesticides/Herbicides
T0610793749	LUST Cleanup Site	Open - Site Assessment	Gasoline

Table 2-1

Summary of Active Cleanup Sites Within the Tule Subbasin

Geotracker Global ID	Site Type	Status	Constituent of Concern
T0610700064	LUST Cleanup Site	Open - Site Assessment	Gasoline
T0610700099	LUST Cleanup Site	Open - Site Assessment	Gasoline
T0610700469	LUST Cleanup Site	Open - Verification Monitoring	Gasoline

Notes:
LUST = Leaky underground storage tank
NPL = National Priorities List
VOCs = Volatile Organic Compounds
PAHS = Polynuclear aromatic hydrocarbons
SVOCs = Semi-Volatile Organics
PCE = Perchloroethylene
MTBE = Methyl tert-butyl ether
TBA = Tertiary Butyl Alcohol
Source = https://geotracker.waterboards.ca.gov
NA = Not available

Table 2-2a

Tule Subbasin Historical Surface Water Budget

Water Year	Water Year Type	Surface Water Inflow (acre-ft)																	Total In
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
			Stream Inflow			Imported Water											Discharge from Wells		
		Precipitation	Tule River	Deer Creek	White River	Saucelito ID	Terra Bella ID	Kern-Tulare WD	Porterville ID	Tea Pot Dome WD	LTRID	Pixley ID	Delano-Earlimart ID	Angiola WD	Alpaugh ID	Atwell Island WD	Agriculture Pumping	Municipal Pumping	
1986 - 1987	Below Average	219,000	70,029	8,389	2,496	23,879	13,136	10,899	15,337	5,490	89,541	9,356	114,782	7,278	794	1,109	724,000	13,500	1,329,000
1987 - 1988	Average	315,000	39,842	6,095	1,420	19,666	21,961	12,210	13,067	5,493	64,654	0	110,345	3,530	0	0	768,000	15,100	1,396,000
1988 - 1989	Below Average	254,000	49,667	7,795	1,942	22,426	22,561	11,991	13,106	6,226	63,922	5,289	105,980	6,026	0	0	728,000	15,700	1,315,000
1989 - 1990	Below Average	245,000	29,342	4,706	778	16,166	23,159	11,371	11,520	6,193	24,325	0	83,837	3,847	0	0	838,000	16,300	1,315,000
1990 - 1991	Average	331,000	51,275	7,247	1,362	19,848	18,725	9,762	11,322	5,636	71,430	0	106,877	925	0	0	799,000	16,700	1,451,000
1991 - 1992	Below Average	285,000	34,325	4,080	739	21,336	20,743	11,700	15,569	6,607	51,949	0	92,567	1,611	0	0	817,000	17,000	1,380,000
1992 - 1993	Above Average	462,000	115,640	15,422	3,623	41,261	18,180	12,357	12,310	6,968	321,973	96,890	133,359	3,420	12,219	6,423	496,000	17,200	1,775,000
1993 - 1994	Below Average	293,000	61,313	6,908	1,148	22,064	18,740	14,255	12,895	6,526	71,784	7,793	92,394	3,640	3,605	2,000	791,000	17,600	1,427,000
1994 - 1995	Above Average	610,000	218,480	32,053	10,596	37,477	16,186	11,681	9,455	6,562	229,683	55,365	124,388	8,918	8,263	5,395	574,000	17,600	1,976,000
1995 - 1996	Average	321,000	174,473	23,095	5,957	48,924	21,617	15,415	13,808	7,993	236,845	60,931	144,069	12,551	11,130	5,267	508,000	17,800	1,629,000
1996 - 1997	Above Average	450,000	353,968	58,781	12,920	40,908	20,158	15,736	13,379	7,298	192,934	37,048	153,967	12,383	0	0	567,000	18,700	1,955,000
1997 - 1998	Above Average	728,000	439,125	88,360	36,764	28,221	13,165	11,745	10,159	4,913	101,180	41,823	119,815	7,460	0	0	630,000	17,900	2,279,000
1998 - 1999	Above Average	373,000	108,466	18,410	7,469	37,062	17,567	14,527	16,107	9,218	183,971	34,736	124,051	9,778	0	0	620,000	18,000	1,592,000
1999 - 2000	Average	354,000	102,354	15,230	4,878	39,734	19,200	16,476	15,545	7,191	177,192	40,076	134,272	8,118	0	253	651,000	18,900	1,604,000
2000 - 2001	Below Average	265,000	55,249	7,016	4,695	25,252	19,194	17,550	15,436	6,456	83,405	9,098	117,746	3,824	0	0	719,000	19,100	1,368,000
2001 - 2002	Below Average	252,000	73,206	10,370	6,176	26,131	20,234	15,088	13,628	6,388	78,511	13,588	126,747	2,932	0	0	713,000	20,900	1,379,000
2002 - 2003	Below Average	247,000	125,004	15,678	5,875	33,692	18,356	14,591	14,646	5,844	131,470	32,195	121,277	4,728	104	0	610,000	20,600	1,401,000
2003 - 2004	Below Average	207,000	51,738	6,882	2,350	26,988	20,352	15,755	14,698	6,913	71,472	9,839	127,364	3,434	0	0	656,000	21,700	1,242,000
2004 - 2005	Above Average	395,000	172,558	22,758	6,502	42,840	15,266	13,495	14,748	5,217	247,595	59,211	119,847	11,741	14,490	0	479,000	20,600	1,641,000
2005 - 2006	Above Average	401,000	195,667	23,868	7,588	45,106	21,763	14,507	13,251	6,436	194,019	60,634	121,005	10,909	16,112	0	490,000	21,600	1,643,000
2006 - 2007	Below Average	170,000	38,587	6,901	1,815	16,280	20,797	15,133	9,775	5,489	33,174	7,200	79,111	6,641	0	0	746,000	22,700	1,180,000
2007 - 2008	Below Average	189,000	74,030	8,411	2,355	24,083	18,192	17,689	12,988	6,894	71,872	12,243	106,470	2,165	0	0	637,000	23,000	1,206,000
2008 - 2009	Below Average	203,000	54,737	6,620	1,751	31,282	19,701	15,524	18,000	6,165	113,189	23,620	111,556	191	2,131	0	660,000	22,500	1,290,000
2009 - 2010	Average	325,000	144,778	16,470	5,080	42,855	17,574	14,027	14,335	5,845	200,064	32,972	118,671	3,243	2,671	0	483,000	21,800	1,448,000
2010 - 2011	Above Average	479,000	266,473	44,873	14,997	46,733	16,381	13,405	9,387	6,105	229,763	48,391	127,447	6,476	10,951	0	514,000	21,800	1,856,000
2011 - 2012	Below Average	302,000	87,533	11,311	3,334	19,189	19,757	14,309	9,318	4,680	67,684	5,914	114,108	3,156	943	0	730,000	22,500	1,416,000
2012 - 2013	Below Average	139,000	30,283	4,777	1,145	14,102	20,628	14,955	10,298	4,354	37,073	5,012	87,302	1,492	0	0	790,000	22,700	1,183,000
2013 - 2014	Below Average	99,000	13,171	2,957	535	5,724	12,390	9,986	178	1,030	0	0	38,106	1,048	0	0	900,000	21,900	1,106,000
2014 - 2015	Below Average	142,000	8,820	1,994	253	1,503	12,012	5,438	114	260	0	0	18,591	575	0	0	890,000	19,700	1,101,000
2015 - 2016	Below Average	217,000	74,330	14,559	4,547	20,049	14,357	11,805	13,271	4,627	73,382	3,442	93,806	587	0	0	614,000	19,700	1,179,000
2016 - 2017	Below Average	227,000	352,963	51,145	17,241	51,137	16,089	14,203	21,651	6,694	273,151	82,363	137,773	12,146	2,367	0	429,000	20,100	1,715,000
86/87-16/17 Avg		306,000	118,300	17,800	5,800	28,800	18,300	13,500	12,600	5,900	122,200	25,600	109,900	5,300	2,800	700	664,000	19,400	1,477,000

Table 2-2b

Tule Subbasin Historical Surface Water Budget

Water Year	Water Year Type	Surface Water Outflow (acre-ft)																		
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
		Areal Recharge of Precipitation	Streambed Infiltration					Canal Loss			Recharge in Basins				Deep Percolation of Applied Water					
			Tule River		Native Deer Creek		White River	Tule River	Deer Creek	Imported Water	Tule River	Deer Creek	Imported Water	Recycled Water	Tule River	Deer Creek	Imported Water	Recycled Water	Agricultural Pumping	Municipal Pumping
			Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir	Trenton Weir to Homeland Canal														
1986 - 1987	Below Average	0	11,600	1,100	8,100	0	2,400	20,700	0	52,500	5,400	0	0	2,600	8,500	0	56,100	200	169,900	5,200
1987 - 1988	Average	4,000	8,000	900	5,800	0	1,300	8,800	0	32,700	5,000	0	0	3,200	5,500	0	48,100	200	183,200	5,400
1988 - 1989	Below Average	0	8,700	0	7,500	0	1,800	7,400	0	20,500	6,200	0	0	3,400	6,100	0	51,800	200	172,100	5,600
1989 - 1990	Below Average	0	5,000	0	4,400	0	700	2,900	0	7,400	3,700	0	0	3,600	2,700	0	36,200	200	199,700	5,700
1990 - 1991	Average	7,000	6,400	300	6,900	0	1,300	6,800	0	24,300	5,200	0	0	3,700	5,900	0	46,900	200	190,300	5,800
1991 - 1992	Below Average	1,000	4,300	0	3,800	0	700	3,100	0	16,100	3,700	0	0	3,800	3,500	0	44,700	200	194,900	5,900
1992 - 1993	Above Average	57,000	18,500	3,000	15,100	0	3,500	27,800	0	184,400	8,200	0	5,600	3,900	16,800	0	118,000	200	111,300	6,000
1993 - 1994	Below Average	2,000	6,100	200	6,600	0	1,100	14,200	0	35,600	5,000	0	700	4,000	8,700	0	51,800	200	187,400	6,100
1994 - 1995	Above Average	144,000	36,400	10,400	21,200	1,000	10,500	39,500	3,800	128,500	7,800	1,800	10,400	3,900	34,600	1,000	88,900	200	130,900	6,100
1995 - 1996	Average	5,000	20,700	4,000	13,700	700	5,800	26,200	2,800	87,600	21,200	700	39,500	3,900	31,800	1,200	119,000	200	115,700	6,200
1996 - 1997	Above Average	50,000	34,600	9,700	45,100	1,800	12,800	47,300	6,900	64,200	25,300	1,900	14,100	4,300	31,400	700	117,300	200	130,700	6,300
1997 - 1998	Above Average	219,000	41,100	9,000	14,900	12,700	36,600	79,100	48,800	54,100	32,000	900	16,200	3,900	41,100	3,100	65,200	200	143,800	6,300
1998 - 1999	Above Average	18,000	14,300	2,800	13,300	600	7,300	19,500	2,500	58,200	17,600	400	19,800	3,900	14,100	300	88,700	200	143,200	6,400
1999 - 2000	Average	12,000	16,900	2,900	10,100	600	4,800	11,100	2,400	64,400	8,900	500	13,000	4,200	15,200	300	93,200	200	152,400	6,500
2000 - 2001	Below Average	0	12,300	0	6,700	0	4,600	7,000	0	28,500	5,000	0	2,700	4,300	7,800	0	61,700	200	169,600	6,600
2001 - 2002	Below Average	0	14,800	700	10,100	0	6,100	13,400	0	24,800	5,800	0	100	4,900	9,000	0	65,200	300	169,100	6,900
2002 - 2003	Below Average	0	19,700	3,700	13,600	100	5,800	22,800	400	53,600	12,200	300	5,000	4,800	11,500	200	65,700	200	123,200	6,900
2003 - 2004	Below Average	0	9,900	300	6,600	0	2,300	7,700	0	19,600	3,900	0	0	5,100	6,200	0	57,800	200	134,000	7,100
2004 - 2005	Above Average	26,000	24,200	4,700	14,400	400	6,400	22,900	1,500	91,200	19,000	2,900	32,000	2,400	15,300	700	89,700	500	92,600	7,100
2005 - 2006	Above Average	28,000	28,100	7,200	14,400	900	7,500	40,500	3,400	78,000	23,300	3,200	26,600	2,000	29,300	400	91,000	700	95,700	7,300
2006 - 2007	Below Average	0	6,200	1,500	6,600	0	1,700	5,100	0	15,500	4,300	0	100	2,000	4,800	0	36,000	700	151,600	7,500
2007 - 2008	Below Average	0	11,700	1,100	8,100	0	2,300	15,900	0	22,100	6,900	0	1,600	2,000	7,800	0	45,500	800	129,700	7,600
2008 - 2009	Below Average	0	9,500	1,400	6,300	0	1,600	7,100	0	43,800	5,200	0	8,100	2,000	7,600	0	57,400	700	135,300	7,600
2009 - 2010	Average	6,000	25,600	4,500	16,100	0	5,000	34,600	0	72,700	14,300	0	29,900	2,000	19,200	0	77,700	600	93,900	7,500
2010 - 2011	Above Average	65,000	37,100	7,500	24,400	1,300	14,800	82,400	5,000	89,500	39,000	9,700	45,700	2,000	30,300	1,400	84,700	600	101,900	7,600
2011 - 2012	Below Average	3,000	13,600	300	11,000	0	3,200	17,800	0	23,100	8,100	0	7,000	2,000	11,900	0	46,200	700	151,300	7,700
2012 - 2013	Below Average	0	4,900	0	4,500	0	1,000	4,400	0	13,000	5,300	0	100	2,000	3,400	0	35,000	700	165,100	7,800
2013 - 2014	Below Average	0	2,300	0	2,700	0	400	0	0	0	3,800	0	0	2,000	1,000	0	13,000	600	183,400	7,700
2014 - 2015	Below Average	0	1,000	0	1,800	0	200	0	0	0	3,600	0	0	2,000	1,100	0	5,600	500	178,800	7,500
2015 - 2016	Below Average	0	16,000	5,500	14,300	0	4,400	11,400	0	28,600	6,600	0	3,700	2,000	5,900	0	35,300	400	123,500	7,600
2016 - 2017	Below Average	0	42,100	15,900	37,000	800	17,100	82,600	3,100	133,700	37,300	3,700	61,000	2,000	41,400	1,400	99,000	500	83,300	7,700
86/87-16/17 Avg		21,000	16,500	3,200	12,100	700	5,600	22,300	2,600	50,600	11,600	800	11,100	3,200	14,200	300	64,300	400	145,400	6,700

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Table 2-2b

Tule Subbasin Surface Water Budget

		Surface Water Outflow (acre-ft)													
		T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	
		Evapotranspiration											Surface Outflow		
			Tule River		Deer Creek		White River	Imported Water		Recycled Water					
Water Year	Water Year Type	Precipitation Crops/Native	Agricultural Cons. Use	Stream Channel	Agricultural Cons. Use	Stream Channel	Stream Channel	Agricultural Cons. Use	Ag. Cons. Use from Pumping	Recharge in Basins	Agricultural Cons. Use	Municipal (Landscape ET)	Tule River	Deer Creek	Total Out
1986 - 1987	Below Average	219,000	24,700	800	0	300	100	183,000	553,900	50	700	4,800	0	0	1,332,000
1987 - 1988	Average	311,000	13,800	400	0	300	100	170,100	584,700	50	900	5,300	0	0	1,399,000
1988 - 1989	Below Average	254,000	17,600	400	0	300	100	185,200	556,200	50	1,000	5,500	0	0	1,312,000
1989 - 1990	Below Average	245,000	8,800	400	0	300	100	136,700	638,100	50	1,000	5,700	0	0	1,308,000
1990 - 1991	Average	324,000	16,800	500	0	300	100	173,300	608,700	50	1,000	5,900	0	0	1,442,000
1991 - 1992	Below Average	284,000	10,800	400	0	300	100	161,300	622,000	50	1,100	6,000	0	0	1,372,000
1992 - 1993	Above Average	406,000	34,900	800	0	400	100	357,500	385,000	50	1,100	6,100	0	0	1,771,000
1993 - 1994	Below Average	291,000	21,100	500	0	300	100	167,600	603,800	50	1,100	6,200	0	0	1,421,000
1994 - 1995	Above Average	466,000	71,600	900	2,900	400	100	285,600	442,700	50	1,100	6,200	25,000	0	1,983,000
1995 - 1996	Average	316,000	62,600	1,000	3,600	400	100	332,300	392,200	50	1,100	6,300	7,000	0	1,629,000
1996 - 1997	Above Average	399,000	57,100	1,000	2,000	400	100	298,200	436,100	50	1,200	6,600	121,000	0	1,927,000
1997 - 1998	Above Average	509,000	98,000	1,000	9,100	400	200	203,000	485,800	50	1,100	6,300	132,000	0	2,274,000
1998 - 1999	Above Average	354,000	37,700	1,000	1,000	400	200	280,600	477,200	50	1,100	6,300	0	0	1,591,000
1999 - 2000	Average	342,000	39,200	700	900	400	100	286,800	498,600	50	1,200	6,600	5,000	0	1,601,000
2000 - 2001	Below Average	264,000	21,900	700	0	300	100	205,000	548,900	50	1,200	6,700	0	0	1,366,000
2001 - 2002	Below Average	252,000	22,600	700	0	300	100	213,200	543,800	50	1,400	7,400	0	0	1,373,000
2002 - 2003	Below Average	247,000	37,500	700	700	400	100	252,500	487,300	50	1,400	7,300	5,000	0	1,390,000
2003 - 2004	Below Average	207,000	18,200	600	0	300	100	219,400	522,200	50	1,500	7,700	1,000	0	1,239,000
2004 - 2005	Above Average	369,000	43,800	800	2,500	400	100	322,200	386,800	50	3,300	7,300	22,000	0	1,612,000
2005 - 2006	Above Average	373,000	58,800	800	1,300	400	100	308,200	394,100	50	4,000	7,600	11,000	0	1,647,000
2006 - 2007	Below Average	170,000	14,200	400	0	300	100	142,000	594,200	50	4,400	8,000	0	0	1,177,000
2007 - 2008	Below Average	189,000	24,300	600	0	300	100	203,400	507,600	50	4,500	8,100	1,000	0	1,202,000
2008 - 2009	Below Average	203,000	22,300	500	0	300	100	233,000	524,600	50	4,200	7,900	0	0	1,290,000
2009 - 2010	Average	320,000	45,400	800	0	400	100	275,700	388,600	50	3,900	7,700	0	0	1,452,000
2010 - 2011	Above Average	414,000	65,300	800	4,700	400	200	295,900	412,300	50	3,800	7,700	8,000	0	1,863,000
2011 - 2012	Below Average	299,000	33,800	600	0	300	100	182,700	578,500	50	4,100	7,900	10,000	0	1,424,000
2012 - 2013	Below Average	139,000	10,300	500	0	300	100	147,100	625,000	50	4,200	8,000	0	0	1,182,000
2013 - 2014	Below Average	99,000	2,400	300	0	300	100	55,500	716,500	50	3,800	7,700	0	0	1,103,000
2014 - 2015	Below Average	142,000	2,300	300	0	200	100	32,900	711,500	50	2,700	7,000	0	0	1,101,000
2015 - 2016	Below Average	217,000	19,400	500	0	300	100	167,700	490,200	50	2,700	7,000	0	0	1,170,000
2016 - 2017	Below Average	227,000	67,100	900	4,800	400	200	323,800	345,900	50	2,800	7,100	71,000	0	1,721,000
86/87-16/17 Avg		286,000	33,000	700	1,100	300	100	219,400	518,200	50	2,200	6,800	14,000	0	1,474,000

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Table 2-3

Tule Subbasin Historical Groundwater Budget

Water Year	Water Year Type	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	Total In
		Groundwater Inflows (acre-ft)																						
			Tule River Infiltration					Deer Creek Infiltration						Imported Water Deliveries				Municipal Pumping						
																			Recycled Water					
		Areal Recharge from Precipitation	Success to Oettle Bridge Infiltration	Oettle Bridge to Turnbull Weir Infiltration	Canal Loss	Recharge in Basins	Return Flow	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration	Canal Loss	Recharge in Basins	Return Flow	White River Infiltration	Canal Loss	Recharge in Basins	Return Flow	Agricultural Pumping Return Flow	Return Flow	Agricultural Return Flow	Artificial Recharge	Release of Water from Compression of Aquitards	Sub-surface Inflow	Mountain-Block Recharge	
1986 - 1987	Below Average	0	11,600	1,100	20,700	5,400	8,500	8,100	0	0	0	0	2,400	52,500	0	56,100	169,900	5,200	200	2,600	120,000	113,000	28,000	605,000
1987 - 1988	Average	4,000	8,000	900	8,800	5,000	5,500	5,800	0	0	0	0	1,300	32,700	0	48,100	183,200	5,400	200	3,200	88,000	131,000	29,000	560,000
1988 - 1989	Below Average	0	8,700	0	7,400	6,200	6,100	7,500	0	0	0	0	1,800	20,500	0	51,800	172,100	5,600	200	3,400	71,000	131,000	29,000	522,000
1989 - 1990	Below Average	0	5,000	0	2,900	3,700	2,700	4,400	0	0	0	0	700	7,400	0	36,200	199,700	5,700	200	3,600	132,000	133,000	29,000	566,000
1990 - 1991	Average	7,000	6,400	300	6,800	5,200	5,900	6,900	0	0	0	0	1,300	24,300	0	46,900	190,300	5,800	200	3,700	126,000	144,000	29,000	610,000
1991 - 1992	Below Average	1,000	4,300	0	3,100	3,700	3,500	3,800	0	0	0	0	700	16,100	0	44,700	194,900	5,900	200	3,800	143,000	140,000	30,000	599,000
1992 - 1993	Above Average	57,000	18,500	3,000	27,800	8,200	16,800	15,100	0	0	0	0	3,500	184,400	5,600	118,000	111,300	6,000	200	3,900	44,000	93,000	30,000	746,000
1993 - 1994	Below Average	2,000	6,100	200	14,200	5,000	8,700	6,600	0	0	0	0	1,100	35,600	700	51,800	187,400	6,100	200	4,000	85,000	123,000	30,000	568,000
1994 - 1995	Above Average	144,000	36,400	10,400	39,500	7,800	34,600	21,200	1,000	3,800	1,800	1,000	10,500	128,500	10,400	88,900	130,900	6,100	200	3,900	33,000	101,000	30,000	845,000
1995 - 1996	Average	5,000	20,700	4,000	26,200	21,200	31,800	13,700	700	2,800	700	1,200	5,800	87,600	39,500	119,000	115,700	6,200	200	3,900	19,000	95,000	27,000	647,000
1996 - 1997	Above Average	50,000	34,600	9,700	47,300	25,300	31,400	45,100	1,800	6,900	1,900	700	12,800	64,200	14,100	117,300	130,700	6,300	200	4,300	19,000	111,000	28,000	763,000
1997 - 1998	Above Average	219,000	41,100	9,000	79,100	32,000	41,100	14,900	12,700	48,800	900	3,100	36,600	54,100	16,200	65,200	143,800	6,300	200	3,900	17,000	126,000	30,000	1,001,000
1998 - 1999	Above Average	18,000	14,300	2,800	19,500	17,600	14,100	13,300	600	2,500	400	300	7,300	58,200	19,800	88,700	143,200	6,400	200	3,900	18,000	122,000	30,000	601,000
1999 - 2000	Average	12,000	16,900	2,900	11,100	8,900	15,200	10,100	600	2,400	500	300	4,800	64,400	13,000	93,200	152,400	6,500	200	4,200	20,000	131,000	30,000	601,000
2000 - 2001	Below Average	0	12,300	0	7,000	5,000	7,800	6,700	0	0	0	0	4,600	28,500	2,700	61,700	169,600	6,600	200	4,300	42,000	142,000	30,000	531,000
2001 - 2002	Below Average	0	14,800	700	13,400	5,800	9,000	10,100	0	0	0	0	6,100	24,800	100	65,200	169,100	6,900	300	4,900	59,000	135,000	30,000	555,000
2002 - 2003	Below Average	0	19,700	3,700	22,800	12,200	11,500	13,600	100	400	300	200	5,800	53,600	5,000	65,700	123,200	6,900	200	4,800	42,000	123,000	29,000	544,000
2003 - 2004	Below Average	0	9,900	300	7,700	3,900	6,200	6,600	0	0	0	0	2,300	19,600	0	57,800	134,000	7,100	200	5,100	70,000	127,000	29,000	487,000
2004 - 2005	Above Average	26,000	24,200	4,700	22,900	19,000	15,300	14,400	400	1,500	2,900	700	6,400	91,200	32,000	89,700	92,600	7,100	500	2,400	26,000	96,000	29,000	605,000
2005 - 2006	Above Average	28,000	28,100	7,200	40,500	23,300	29,300	14,400	900	3,400	3,200	400	7,500	78,000	26,600	91,000	95,700	7,300	700	2,000	16,000	97,000	29,000	630,000
2006 - 2007	Below Average	0	6,200	1,500	5,100	4,300	4,800	6,600	0	0	0	0	1,700	15,500	100	36,000	151,600	7,500	700	2,000	78,000	125,000	29,000	476,000
2007 - 2008	Below Average	0	11,700	1,100	15,900	6,900	7,800	8,100	0	0	0	0	2,300	22,100	1,600	45,500	129,700	7,600	800	2,000	96,000	113,000	30,000	502,000
2008 - 2009	Below Average	0	9,500	1,400	7,100	5,200	7,600	6,300	0	0	0	0	1,600	43,800	8,100	57,400	135,300	7,600	700	2,000	125,000	108,000	30,000	557,000
2009 - 2010	Average	6,000	25,600	4,500	34,600	14,300	19,200	16,100	0	0	0	0	5,000	72,700	29,900	77,700	93,900	7,500	600	2,000	70,000	83,000	29,000	592,000
2010 - 2011	Above Average	65,000	37,100	7,500	82,400	39,000	30,300	24,400	1,300	5,000	9,700	1,400	14,800	89,500	45,700	84,700	101,900	7,600	600	2,000	34,000	93,000	29,000	806,000
2011 - 2012	Below Average	3,000	13,600	300	17,800	8,100	11,900	11,000	0	0	0	0	3,200	23,100	7,000	46,200	151,300	7,700	700	2,000	86,000	123,000	29,000	545,000
2012 - 2013	Below Average	0	4,900	0	4,400	5,300	3,400	4,500	0	0	0	0	1,000	13,000	100	35,000	165,100	7,800	700	2,000	145,000	130,000	29,000	551,000
2013 - 2014	Below Average	0	2,300	0	0	3,800	1,000	2,700	0	0	0	0	400	0	0	13,000	183,400	7,700	600	2,000	186,000	132,000	30,000	565,000
2014 - 2015	Below Average	0	1,000	0	0	3,600	1,100	1,800	0	0	0	0	200	0	0	5,600	178,800	7,500	500	2,000	189,000	124,000	30,000	545,000
2015 - 2016	Below Average	0	16,000	5,500	11,400	6,600	5,900	14,300	0	0	0	0	4,400	28,600	3,700	35,300	123,500	7,600	400	2,000	140,000	112,000	30,000	547,000
2016 - 2017	Below Average	0	42,100	15,900	82,600	37,300	41,400	37,000	800	3,100	3,700	1,400	17,100	133,700	61,000	99,000	83,300	7,700	500	2,000	61,000	95,000	29,000	855,000
86/87-16/17 Avg		21,000	16,500	3,200	22,300	11,600	14,200	12,100	700	2,600	800	300	5,600	50,600	11,100	64,300	145,400	6,700	400	3,200	77,000	118,000	29,000	617,000

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Tule Subbasin Groundwater Budget

Water Year	Water Year Type	Groundwater Outflows (acre-ft)					Total Out	Change in Storage (acre-ft)
		W	X	Y	Z	AA		
		Groundwater Pumping						
		Municipal	Irrigated Agriculture	Exports	Groundwater Banking Extraction	Sub-surface Outflow		
1986 - 1987	Below Average	13,500	724,000	6,550	0	61,000	805,000	-200,000
1987 - 1988	Average	15,100	768,000	34,180	0	53,000	870,000	-310,000
1988 - 1989	Below Average	15,700	728,000	38,290	0	51,000	833,000	-311,000
1989 - 1990	Below Average	16,300	838,000	50,430	0	53,000	958,000	-392,000
1990 - 1991	Average	16,700	799,000	46,300	0	61,000	923,000	-313,000
1991 - 1992	Below Average	17,000	817,000	41,250	0	52,000	927,000	-328,000
1992 - 1993	Above Average	17,200	496,000	14,550	0	73,000	601,000	145,000
1993 - 1994	Below Average	17,600	791,000	11,220	0	59,000	879,000	-311,000
1994 - 1995	Above Average	17,600	574,000	1,320	0	61,000	654,000	191,000
1995 - 1996	Average	17,800	508,000	0	0	65,000	591,000	56,000
1996 - 1997	Above Average	18,700	567,000	0	0	65,000	651,000	112,000
1997 - 1998	Above Average	17,900	630,000	0	0	62,000	710,000	291,000
1998 - 1999	Above Average	18,000	620,000	0	0	62,000	700,000	-99,000
1999 - 2000	Average	18,900	651,000	7,720	0	60,000	738,000	-137,000
2000 - 2001	Below Average	19,100	719,000	30,600	0	60,000	829,000	-298,000
2001 - 2002	Below Average	20,900	713,000	44,520	0	58,000	836,000	-281,000
2002 - 2003	Below Average	20,600	610,000	33,660	0	55,000	719,000	-175,000
2003 - 2004	Below Average	21,700	656,000	37,790	0	55,000	770,000	-283,000
2004 - 2005	Above Average	20,600	479,000	11,720	0	66,000	577,000	28,000
2005 - 2006	Above Average	21,600	490,000	150	0	64,000	576,000	54,000
2006 - 2007	Below Average	22,700	746,000	49,500	0	54,000	872,000	-396,000
2007 - 2008	Below Average	23,000	637,000	50,090	0	68,000	778,000	-276,000
2008 - 2009	Below Average	22,500	660,000	48,860	550	78,000	810,000	-253,000
2009 - 2010	Average	21,800	483,000	28,530	70	92,000	625,000	-33,000
2010 - 2011	Above Average	21,800	514,000	8,060	0	86,000	630,000	176,000
2011 - 2012	Below Average	22,500	730,000	43,570	3,860	76,000	876,000	-331,000
2012 - 2013	Below Average	22,700	790,000	63,640	5,990	68,000	950,000	-399,000
2013 - 2014	Below Average	21,900	900,000	58,030	5,590	69,000	1,055,000	-490,000
2014 - 2015	Below Average	19,700	890,000	53,270	1,150	64,000	1,028,000	-483,000
2015 - 2016	Below Average	19,700	614,000	50,000	70	70,000	754,000	-207,000
2016 - 2017	Below Average	20,100	429,000	11,330	0	90,000	550,000	305,000
		19,400	664,000	28,200	600	65,000	777,000	-160,000
							Cummulative Change in Storage	-4,948,000

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Projected Future Tule Subbasin Sustainable Yield

Water Year	Groundwater Inflows (acre-ft)										Groundwater Outflow (acre-ft)	Sustainable Yield
	A	B	C	D	E	F	G	H	I	J	K	
	Areal Recharge from Precipitation	Streambed Infiltration					Return Flow		Sub-surface Inflow	Mountain-Block Recharge	Sub-surface Outflow	
		Tule River		Deer Creek		White River	Irrigated Agriculture	Municipal				
		Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration							
2040 - 2041	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	51,000	32,000	90,000	127,700
2041 - 2042	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2042 - 2043	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2043 - 2044	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2044 - 2045	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2045 - 2046	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2046 - 2047	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2047 - 2048	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2048 - 2049	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2049 - 2050	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	88,000	131,700
40/41-49/50 Avg	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	89,000	129,700

Table 2-5

Historical Planned versus Actual Water Deliveries
2007/08 - 2016/17

Water Year	Water Year Type	Tule River			Friant-Kern Canal								
					Saucelito ID			Terra Bella ID			Kern-Tulare WD		
		Total Diversion Right	Total Delivered	Percent of Diversion Right (%)	Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)	Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)	Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)
2007 - 2008	Below Average	57,100	41,974	74%	54,300	24,083	44%	29,000	18,192	63%	5,000	17,689	354%
2008 - 2009	Below Average	57,100	32,290	57%	54,300	31,282	58%	29,000	19,701	68%	5,000	15,524	310%
2009 - 2010	Average	57,100	60,570	106%	54,300	42,855	79%	29,000	17,574	61%	5,000	14,027	281%
2010 - 2011	Above Average	57,100	106,619	187%	54,300	46,733	86%	29,000	16,381	56%	5,000	13,405	268%
2011 - 2012	Below Average	57,100	66,992	117%	54,300	19,189	35%	29,000	19,757	68%	5,000	14,309	286%
2012 - 2013	Below Average	57,100	23,406	41%	54,300	14,102	26%	29,000	20,628	71%	5,000	14,955	299%
2013 - 2014	Below Average	57,100	9,747	17%	54,300	5,724	11%	29,000	12,390	43%	5,000	9,986	200%
2014 - 2015	Below Average	57,100	6,417	11%	54,300	1,503	3%	29,000	12,012	41%	5,000	5,438	109%
2015 - 2016	Below Average	57,100	36,752	64%	54,300	20,049	37%	29,000	14,357	50%	5,000	11,805	236%
2016 - 2017	Below Average	57,100	128,361	225%	54,300	51,137	94%	29,000	16,089	55%	5,000	14,203	284%
	Total:	571,000	513,128	90%	543,000	256,657	47%	290,000	167,081	58%	50,000	131,341	263%

Water Year	Water Year Type	Friant-Kern Canal											
		LTRID			Delano-Earlimart ID			Porterville ID			Tea Pot Dome WD		
		Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)	Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)	Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)	Contract Amount[1]	Total Delivered[2]	Percent of Contract (%)
2007 - 2008	Below Average	299,200	71,872	24%	183,300	106,470	58%	45,000	12,988	29%	7,200	6,894	96%
2008 - 2009	Below Average	299,200	113,189	38%	183,300	111,556	61%	45,000	18,000	40%	7,200	6,165	86%
2009 - 2010	Average	299,200	200,064	67%	183,300	118,671	65%	45,000	14,335	32%	7,200	5,845	81%
2010 - 2011	Above Average	299,200	229,763	77%	183,300	127,447	70%	45,000	9,387	21%	7,200	6,105	85%
2011 - 2012	Below Average	299,200	67,684	23%	183,300	114,108	62%	45,000	9,318	21%	7,200	4,680	65%
2012 - 2013	Below Average	299,200	37,073	12%	183,300	87,302	48%	45,000	10,298	23%	7,200	4,354	60%
2013 - 2014	Below Average	299,200	0	0%	183,300	38,106	21%	45,000	178	0%	7,200	1,030	14%
2014 - 2015	Below Average	299,200	0	0%	183,300	18,591	10%	45,000	114	0%	7,200	260	4%
2015 - 2016	Below Average	299,200	73,382	25%	183,300	93,806	51%	45,000	13,271	29%	7,200	4,627	64%
2016 - 2017	Below Average	299,200	273,151	91%	183,300	137,773	75%	45,000	21,651	48%	7,200	6,694	93%
	Total:	2,992,000	1,066,178	36%	1,833,000	953,830	52%	450,000	109,540	24%	72,000	46,654	65%

Notes: [1]Sum of Class 1 and Class 2 Fraint-Kern Canal Contract Amount
[2]Total delivered water may include 16B water and water purchased from other Friant-Kern Canal contractors.
Likewise, delivered water may not reflect available supplies as contractors periodically sell water under their contract.

Table 2-6

Summary of Projects Exclusive of Transitional Pumping

Eastern Tule GSA

No.	Lead Entity	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	City of Porterville	Population Increase	Increase GW Production	2.5%/yr 2020-2040	9,500 af/yr by 2040	N/A	High
2	City of Porterville	Recycling Increase	Increase RW Applied to Ag	2.5%/yr 2020-2040	1,900 af/yr by 2040	Recycled Water	High
3	City of Porterville	Recycling Increase	Increase RW Recharge	2.5%/yr 2020-2040	1,600 af/yr by 2040	Recycled Water	High
4	City of Porterville	Tule River Recharge	Recharge Project	Starting 2019/20	900 af/yr	Tule River	High
5	City of Porterville	FKC Recharge	Recharge Project	Starting 2020/21	1,100 af/yr	FKC via Porterville ID	High
6	Porterville ID	SA 1 & 2	Expand distribution system	Starting 2018/19	3,200 af/yr	Tule River and FKC	High
7	Porterville ID	Falconer Bank	Develop water bank	Starting 2020/21	3,300 af/yr of leave-behind	FKC and others	High
8	Porterville ID	Recharge Policy	On-Farm recharge	Starting 2019/20	3,000 af/yr	Tule River and FKC	High
9	Saucelito ID	Conway Bank	Develop water bank	Starting 2020/21	1,100 af/yr of leave-behind	FKC and others	High
10	Saucelito ID	Recharge Policy	On-Farm recharge	Starting 2019/20	2,000 af/yr	FKC	High
11	Kern-Tulare WD	In-District Pricing	Pricing change	Starting 2020/21	2,600 af/yr	N/A	High
12	Kern-Tulare WD	Reservoir Storage	Surface water storage	Starting 2029/30	500 af/yr	FKC and others	Medium
13	Kern-Tulare WD	CRC Pipeline	Deliver produced water	Starting 2024/25	680 af/yr	CRC Produced water	High
14	Terra Bella ID	Deer Creek Recharge	Divert and recharge DC	Starting 2017/18	800 af/yr	Deer Creek	High
15	PWC, VWD, & CMDC	SREP	Success Dam Enlargement	Starting 2024/25	400 af/yr	Tule River	High
16	Hope WD	In-District Recharge	Recharge Project	Starting 2022/23	5,000 af/yr every 3 years	FKC and others / unknown	Medium
17	Ducor ID	In-District Recharge	Pipeline and Recharge Project	Starting 2023/24	4,000 af/yr	FKC and others / unknown	High

LTRID GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	Creighton Ranch	Groundwater exports	Unknown	Unknown	Not applicable	N/A
2	LTRID - Pixley ID FKC	Continue FKC transfers to Pixley ID	Ongoing	13,670 af/yr	FKC	N/A
3	SREP	Success Dam Enlargement	Starting 2024/25	2,600 af/yr	Tule River	N/A

Pixley GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	LTRID - Pixley ID FKC	Continue FKC transfers from LTRID	Ongoing	13,670 af/yr	FKC	N/A

DEID GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
N/A	No planned projects	N/A	N/A	N/A	N/A	N/A

Tri-County GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	Deep Pumping Reduction	Replace deep pumping with 24 new shallow wells	Start in 2019/20, completed in 2023/24	24,000 af/yr	Not applicable	High
2	Duck Club Project	Duck Club water transferred to farms	2019/20	5,400 af every 7 years	Unknown	High
3	Liberty Project	Participation in the Liberty Project surface water storage	Start in 2019/20, completed in 2022/23	5,000 af/yr	FID, FKC, KR, TR, KW, SWP	High
4	Recharge Scenario	Confidential. Capture and recharge flood water	Unknown	1,200 to 1,800 af/yr	Unknown	N/A

Alpaugh GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	Water Capture	Deer Creek flood capture	Starting in 2022/23	1,100 af 2.5x per yr every 2 yrs	Deer Creek	N/A
2	Cropping Changes	Install drip irrigation on 1,900 acres	Starting 2019/20	Not applicable	Not applicable	N/A

Table 2-6

Summary of Projects Exclusive of Transitional Pumping

Notes:

N/A= Not Available
af/yr = acre-foot per year
ID = Irrigation District
GW = Groundwater
RW = Recycled water
Ag = Agricultural
DC = Deer Creek
FKC = Friant-Kern Canal
SA = Service Area
CRC = California Resources Corporation
PWC = Pioneer Water Company
VMD = Vandalia Water District
CMDC = Campbell Moreland Ditch Company
SREP = Success Reservoir Enlargement Project
WD = Water District
MA = Management Area
FID = Fresno Irrigation District (Fresno Slough)
KR = Kaweah River
TR = Tule River
KW = Kaweah River
SWP = State Water Project

Planned Transitional Pumping by GSA

	Eastern Tule GSA	LTRID GSA	Pixley ID GSA	DEID-District Area	DEID White Lands Area	Tri-Co GSA	Alpaugh GSA
2020-2025	90% of over-pumping[1]	2.0 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining no change	No Change/ Sustainable	100% of over-pumping	100% of over-pumping	Reduce cropped area by 880 acres; 80% of overpumping
2025-2030	80% of over-pumping	1.5 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 1.5 af/ac Over Cons. Use Target[2]		Linear Transitional Pumping	Reduce pumping 10,000 af/yr	
2030-2035	30% of over-pumping	1.0 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 1.0 af/ac Over Cons. Use Target				50% of overpumping
2035-2040	Sustainable	0.5 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 0.5 af/ac Over Cons. Use Target		Sustainable	Sustainable	20% of overpumping
2040+		Sustainable	Sustainable				Sustainable

Notes:

[1]Over-pumping means pumping in excess of the consumptive use target
[2]Over consumptive use target means over pumping

Projected Future Tule Subbasin Surface Water Budget

Water Year	Surface Water Inflow (acre-ft)																					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	
		Stream Inflow			Imported Water															Discharge from Wells		
	Precipitation	Tule River	Deer Creek	White River	Saucelito ID	Terra Bella ID	Kern-Tulare WD	Porterville ID	Tea Pot Dome WD	City of Porterville	Hope WD	Ducor ID	LTRID	Pixley ID	Delano-Earlimart ID	Angiola WD	Alpaugh ID	Atwell Island WD	Private	Agriculture Pumping	Municipal Pumping	Total In
2017 - 2018	306,000	131,258	19,410	6,347	34,567	18,786	15,335	19,803	6,528	0	0	0	143,186	31,763	116,902	5,911	3,680	0	0	549,000	21,700	1,430,000
2018 - 2019	306,000	131,258	19,410	6,347	34,567	18,786	15,335	19,803	6,528	0	0	0	143,186	31,763	116,902	5,911	3,680	0	0	548,000	23,400	1,431,000
2019 - 2020	306,000	131,258	19,410	6,347	34,567	18,786	15,335	23,103	6,528	0	0	0	143,186	31,763	116,902	7,961	3,680	0	0	529,000	25,000	1,419,000
2020 - 2021	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	0	0	143,186	31,763	116,902	9,211	3,680	0	0	526,000	25,400	1,422,000
2021 - 2022	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	0	0	143,186	31,763	116,902	10,461	3,680	0	0	524,000	25,700	1,422,000
2022 - 2023	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	1,667	0	143,186	31,763	116,902	13,590	3,680	0	0	523,000	26,100	1,426,000
2023 - 2024	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	1,667	4,000	143,186	31,763	116,902	18,926	3,680	0	0	522,000	26,500	1,435,000
2024 - 2025	306,000	134,258	19,410	6,347	34,893	20,304	18,229	24,339	6,594	1,100	1,667	4,000	135,513	31,763	117,661	24,261	3,680	0	1,500	494,000	26,900	1,412,000
2025 - 2026	306,000	134,258	19,410	6,347	34,118	21,823	17,843	25,575	6,661	1,100	1,667	4,000	127,841	31,763	118,420	29,597	4,813	0	1,500	487,000	27,400	1,407,000
2026 - 2027	306,000	134,258	19,410	6,347	33,343	23,341	17,458	26,812	6,727	1,100	1,667	4,000	120,168	31,763	119,180	34,933	4,751	0	1,500	481,000	27,800	1,402,000
2027 - 2028	306,000	134,258	19,410	6,347	32,568	24,860	17,072	28,048	6,793	1,100	1,667	4,000	112,496	31,763	119,939	40,268	4,689	0	1,500	474,000	28,200	1,395,000
2028 - 2029	306,000	134,258	19,410	6,347	31,794	26,378	16,687	29,285	6,860	1,100	1,667	4,000	104,823	31,763	120,698	43,725	4,627	0	1,500	468,000	28,700	1,388,000
2029 - 2030	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	4,565	0	1,500	412,000	29,200	1,328,000
2030 - 2031	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	413,000	29,600	1,331,000
2031 - 2032	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	410,000	30,100	1,328,000
2032 - 2033	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	407,000	30,600	1,326,000
2033 - 2034	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	405,000	31,100	1,324,000
2034 - 2035	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	345,000	31,700	1,265,000
2035 - 2036	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	32,200	1,266,000
2036 - 2037	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	32,800	1,266,000
2037 - 2038	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	33,300	1,267,000
2038 - 2039	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	33,900	1,267,000
2039 - 2040	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	303,000	34,500	1,227,000
2040 - 2041	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2041 - 2042	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2042 - 2043	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2043 - 2044	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2044 - 2045	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2045 - 2046	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2046 - 2047	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2047 - 2048	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2048 - 2049	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2049 - 2050	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2050 - 2051	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2051 - 2052	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2052 - 2053	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2053 - 2054	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2054 - 2055	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2055 - 2056	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2056 - 2057	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2057 - 2058	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2058 - 2059	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2059 - 2060	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2060 - 2061	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2061 - 2062	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2062 - 2063	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2063 - 2064	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2064 - 2065	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2065 - 2066	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2066 - 2067	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2067 - 2068	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2068 - 2069	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	45,214	7,793	0	1,500	297,000	34,500	1,191,000
2069 - 2070	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	24,476	7,793	0	1,500	297,000	34,500	1,170,000
17/18-69/70 Avg	306,000	132,500	19,200	6,300	31,200	25,700	17,800	28,300	6,700	1,000	1,500	3,500	100,500	31,800	117,100	37,800	6,600	0	1,300	361,000	32,000	1,268,000

Table 2-8b

Projected Future Tule Subbasin Surface Water Budget

Water Year	Surface Water Outflow (acre-ft)																		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
		Streambed Infiltration					Canal Loss			Recharge in Basins				Deep Percolation of Applied Water					
		Tule River		Native Deer Creek															
Water Year	Areal Recharge of Precipitation	Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir	Trenton Weir to Homeland Canal	White River	Tule River	Deer Creek	Imported Water	Tule River	Deer Creek	Imported Water	Recycled Water	Tule River	Deer Creek	Imported Water	Recycled Water	Agricultural Pumping	Municipal Pumping
2017 - 2018	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	12,200	1,300	15,900	2,000	15,500	800	66,900	600	110,400	7,900
2018 - 2019	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	12,200	1,300	15,900	2,000	15,500	800	66,900	700	110,300	8,100
2019 - 2020	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	19,200	2,500	15,500	800	68,100	400	106,600	8,300
2020 - 2021	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	21,400	2,600	15,500	800	68,700	400	106,000	8,300
2021 - 2022	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	21,400	2,600	15,500	800	68,900	400	105,700	8,400
2022 - 2023	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	23,000	2,700	15,500	800	69,100	500	105,400	8,400
2023 - 2024	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	27,000	2,800	15,500	800	69,100	500	105,300	8,500
2024 - 2025	21,000	17,900	3,900	11,600	600	6,200	18,200	2,100	62,400	13,700	1,300	27,900	2,800	15,800	800	69,600	500	100,200	8,500
2025 - 2026	21,000	17,900	3,900	11,600	600	6,200	18,400	2,100	59,600	13,700	1,300	27,300	2,900	15,800	1,100	70,200	500	98,900	8,600
2026 - 2027	21,000	17,900	3,900	11,600	600	6,200	18,700	2,100	56,800	13,700	1,300	26,700	3,000	15,800	1,100	70,500	500	98,000	8,600
2027 - 2028	21,000	17,900	3,900	11,600	600	6,200	19,000	2,100	53,900	13,700	1,300	26,100	3,100	15,800	1,100	70,900	500	97,000	8,700
2028 - 2029	21,000	17,900	3,900	11,600	600	6,200	19,300	2,100	51,100	13,700	1,300	25,500	3,100	15,800	1,100	71,300	500	96,000	8,700
2029 - 2030	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,200	15,500	1,100	71,800	500	86,900	8,800
2030 - 2031	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,300	15,500	1,100	72,100	600	86,900	8,800
2031 - 2032	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,400	15,500	1,100	72,100	600	86,400	8,900
2032 - 2033	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,500	15,500	1,100	72,100	600	85,900	8,900
2033 - 2034	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,500	15,500	1,100	72,100	600	85,400	9,000
2034 - 2035	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,600	15,500	1,100	72,100	600	74,000	9,100
2035 - 2036	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,700	15,500	1,100	72,400	600	73,700	9,100
2036 - 2037	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,800	15,500	1,100	72,400	700	73,700	9,200
2037 - 2038	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,900	15,500	1,100	72,400	700	73,700	9,300
2038 - 2039	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,000	15,500	1,100	72,400	700	73,700	9,300
2039 - 2040	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,400	700	64,300	9,400
2040 - 2041	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2041 - 2042	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2042 - 2043	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2043 - 2044	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2044 - 2045	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2045 - 2046	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2046 - 2047	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2047 - 2048	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2048 - 2049	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2049 - 2050	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2050 - 2051	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2051 - 2052	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2052 - 2053	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2053 - 2054	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2054 - 2055	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2055 - 2056	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2056 - 2057	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2057 - 2058	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2058 - 2059	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2059 - 2060	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2060 - 2061	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2061 - 2062	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2062 - 2063	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2063 - 2064	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2064 - 2065	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2065 - 2066	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2066 - 2067	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2067 - 2068	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2068 - 2069	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2069 - 2070	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
17/18-69/70 Avg	21,000	17,700	3,900	11,500	600	6,100	19,000	2,100	49,500	13,200	1,300	24,100	3,700	15,500	1,100	70,200	600	75,300	9,100

Projected Future Tule Subbasin Surface Water Budget

Water Year	Surface Water Outflow (acre-ft)													Total Out
	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	
	Evapotranspiration											Surface Outflow		
	Precipitation Crops/Native	Tule River		Deer Creek		White River	Imported Water	Ag. Cons. Use from Pumping	Recycled Water		Municipal (Landscape ET)	Tule River	Deer Creek	
		Agricultural Cons. Use	Stream Channel	Agricultural Cons. Use	Stream Channel	Stream Channel	Agricultural Cons. Use		Recharge in Basins	Agricultural Cons. Use				
2017 - 2018	285,000	47,400	700	2,900	300	100	250,700	438,600	50	3,500	7,700	15,000	0	1,431,000
2018 - 2019	285,000	47,400	700	2,900	300	100	250,700	437,800	50	4,300	8,200	8,000	0	1,425,000
2019 - 2020	285,000	47,400	700	2,900	300	100	254,400	420,400	50	2,600	11,200	8,000	0	1,414,000
2020 - 2021	285,000	47,400	700	2,900	300	100	257,400	417,300	50	2,600	11,400	8,000	0	1,417,000
2021 - 2022	285,000	47,400	700	2,900	300	100	258,200	416,100	50	2,700	11,600	8,000	0	1,417,000
2022 - 2023	285,000	47,400	700	2,900	300	100	259,000	414,900	50	2,800	11,800	8,000	0	1,418,000
2023 - 2024	285,000	47,400	700	2,900	300	100	259,000	414,500	50	2,800	12,000	8,000	0	1,422,000
2024 - 2025	285,000	48,500	700	2,900	300	100	262,700	392,000	50	2,900	12,200	8,000	0	1,400,000
2025 - 2026	285,000	48,500	700	3,800	300	100	266,800	385,800	50	3,000	12,400	8,000	0	1,396,000
2026 - 2027	285,000	48,500	700	3,800	300	100	269,800	380,300	50	3,000	12,600	8,000	0	1,390,000
2027 - 2028	285,000	48,500	700	3,800	300	100	272,900	374,800	50	3,100	12,800	7,000	0	1,383,000
2028 - 2029	285,000	48,600	700	3,800	300	100	276,000	369,300	50	3,200	13,100	7,000	0	1,378,000
2029 - 2030	285,000	47,400	700	3,800	300	100	280,300	322,400	50	3,300	13,300	7,000	0	1,322,000
2030 - 2031	285,000	47,400	700	3,800	300	100	281,200	323,200	50	3,400	13,600	7,000	0	1,325,000
2031 - 2032	285,000	47,400	700	3,800	300	100	281,200	321,100	50	3,400	13,800	7,000	0	1,323,000
2032 - 2033	285,000	47,400	700	3,800	300	100	281,200	319,000	50	3,500	14,100	7,000	0	1,321,000
2033 - 2034	285,000	47,400	700	3,800	300	100	281,200	316,900	50	3,600	14,300	7,000	0	1,318,000
2034 - 2035	285,000	47,400	700	3,800	300	100	281,200	268,900	50	3,700	14,600	7,000	0	1,260,000
2035 - 2036	285,000	47,400	700	3,800	300	100	282,200	267,800	50	3,800	14,900	7,000	0	1,260,000
2036 - 2037	285,000	47,400	700	3,800	300	100	282,200	267,700	50	3,900	15,200	7,000	0	1,261,000
2037 - 2038	285,000	47,400	700	3,800	300	100	282,200	267,600	50	4,000	15,500	7,000	0	1,261,000
2038 - 2039	285,000	47,400	700	3,800	300	100	282,200	267,500	50	4,100	15,800	7,000	0	1,261,000
2039 - 2040	285,000	47,400	700	3,800	300	100	282,200	236,000	50	4,200	16,100	7,000	0	1,221,000
2040 - 2041	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2041 - 2042	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2042 - 2043	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2043 - 2044	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2044 - 2045	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2045 - 2046	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2046 - 2047	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2047 - 2048	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2048 - 2049	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2049 - 2050	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2050 - 2051	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2051 - 2052	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2052 - 2053	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2053 - 2054	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2054 - 2055	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2055 - 2056	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2056 - 2057	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2057 - 2058	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2058 - 2059	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2059 - 2060	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2060 - 2061	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2061 - 2062	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2062 - 2063	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2063 - 2064	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2064 - 2065	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2065 - 2066	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2066 - 2067	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2067 - 2068	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2068 - 2069	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2069 - 2070	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
86/87-16/17 Avg	285,000	46,900	700	3,600	300	100	270,800	283,800	50	3,800	14,700	7,000	0	1,262,000

Table 2-9

Projected Future Tule Subbasin Groundwater Budget

Water Year	Groundwater Inflows (acre-ft)																						Total In
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
		Tule River Infiltration					Deer Creek Infiltration						Imported Water Deliveries				Municipal Pumping						
																		Recycled Water					
	Areal Recharge from Precipitation	Success to Oettle Bridge Infiltration	Oettle Bridge to Turnbull Weir Infiltration	Canal Loss	Recharge in Basins	Return Flow	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration	Canal Loss	Recharge in Basins	Return Flow	White River Infiltration	Canal Loss	Recharge in Basins	Return Flow	Agricultural Pumping Return Flow	Return Flow	Agricultural Return Flow	Artificial Recharge	Release of Water from Compression of Aquitards	Sub-surface Inflow	Mountain-Block Recharge	
2017 - 2018	21,000	17,900	3,900	17,000	12,200	15,500	11,600	600	2,100	1,300	800	6,200	65,200	15,900	66,900	110,400	7,900	600	2,000	52,000	73,000	33,000	537,000
2018 - 2019	21,000	17,900	3,900	17,000	12,200	15,500	11,600	600	2,100	1,300	800	6,200	65,200	15,900	66,900	110,300	8,100	700	2,000	56,000	71,000	33,000	539,000
2019 - 2020	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	19,200	68,100	106,600	8,300	400	2,500	58,000	68,000	33,000	540,000
2020 - 2021	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	21,400	68,700	106,000	8,300	400	2,600	60,000	64,000	33,000	541,000
2021 - 2022	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	21,400	68,900	105,700	8,400	400	2,600	62,000	60,000	33,000	539,000
2022 - 2023	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	23,000	69,100	105,400	8,400	500	2,700	64,000	57,000	33,000	539,000
2023 - 2024	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	27,000	69,100	105,300	8,500	500	2,800	66,000	55,000	33,000	543,000
2024 - 2025	21,000	17,900	3,900	18,200	13,700	15,800	11,600	600	2,100	1,300	800	6,200	62,400	27,900	69,600	100,200	8,500	500	2,800	61,000	51,000	33,000	530,000
2025 - 2026	21,000	17,900	3,900	18,400	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	59,600	27,300	70,200	98,900	8,600	500	2,900	59,000	50,000	33,000	524,000
2026 - 2027	21,000	17,900	3,900	18,700	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	56,800	26,700	70,500	98,000	8,600	500	3,000	59,000	50,000	33,000	520,000
2027 - 2028	21,000	17,900	3,900	19,000	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	53,900	26,100	70,900	97,000	8,700	500	3,100	59,000	50,000	33,000	516,000
2028 - 2029	21,000	17,900	3,900	19,300	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	51,100	25,500	71,300	96,000	8,700	500	3,100	59,000	51,000	33,000	514,000
2029 - 2030	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	71,800	86,900	8,800	500	3,200	52,000	51,000	33,000	495,000
2030 - 2031	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	86,900	8,800	600	3,300	50,000	50,000	33,000	492,000
2031 - 2032	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	86,400	8,900	600	3,400	49,000	51,000	33,000	492,000
2032 - 2033	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	85,900	8,900	600	3,500	48,000	51,000	33,000	490,000
2033 - 2034	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	85,400	9,000	600	3,500	47,000	51,000	33,000	489,000
2034 - 2035	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	74,000	9,100	600	3,600	38,000	50,000	33,000	468,000
2035 - 2036	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,100	600	3,700	35,000	50,000	33,000	465,000
2036 - 2037	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,200	700	3,800	34,000	50,000	32,000	463,000
2037 - 2038	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,300	700	3,900	33,000	51,000	32,000	463,000
2038 - 2039	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,300	700	4,000	32,000	53,000	32,000	465,000
2039 - 2040	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	64,300	9,400	700	4,100	23,000	51,000	32,000	444,000
2040 - 2041	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	21,000	51,000	32,000	442,000
2041 - 2042	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	20,000	52,000	32,000	442,000
2042 - 2043	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	19,000	52,000	32,000	441,000
2043 - 2044	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	19,000	52,000	32,000	441,000
2044 - 2045	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	18,000	52,000	32,000	440,000
2045 - 2046	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	17,000	53,000	32,000	440,000
2046 - 2047	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	17,000	53,000	32,000	440,000
2047 - 2048	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	16,000	53,000	32,000	439,000
2048 - 2049	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	16,000	53,000	32,000	439,000
2049 - 2050	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	16,000	53,000	32,000	439,000
2050 - 2051	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	16,000	52,000	31,000	423,000
2051 - 2052	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	16,000	52,000	32,000	424,000
2052 - 2053	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	16,000	53,000	31,000	424,000
2053 - 2054	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	15,000	53,000	31,000	423,000
2054 - 2055	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	15,000	53,000	31,000	423,000
2055 - 2056	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	15,000	53,000	32,000	424,000
2056 - 2057	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	53,000	31,000	422,000
2057 - 2058	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	53,000	31,000	422,000
2058 - 2059	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	53,000	31,000	422,000
2059 - 2060	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	54,000	31,000	423,000
2060 - 2061	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2061 - 2062	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2062 - 2063	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2063 - 2064	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2064 - 2065	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	54,000	31,000	421,000
2065 - 2066	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	54,000	31,000	421,000
2066 - 2067	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	54,000	31,000	421,000
2067 - 2068	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	55,000	31,000	422,000
2068 - 2069	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	11,000	55,000	31,000	421,000
2069 - 2070	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	11,000	55,000	31,000	421,000
17/18-69/70 Avg	21,000	17,700	3,900	19,000	13,200	15,500	11,500	600	2,100	1,300	1,100	6,100	49,500	24,100	70,200	75,300	9,100	600	3,700	30,000	54,000	32,000	462,000

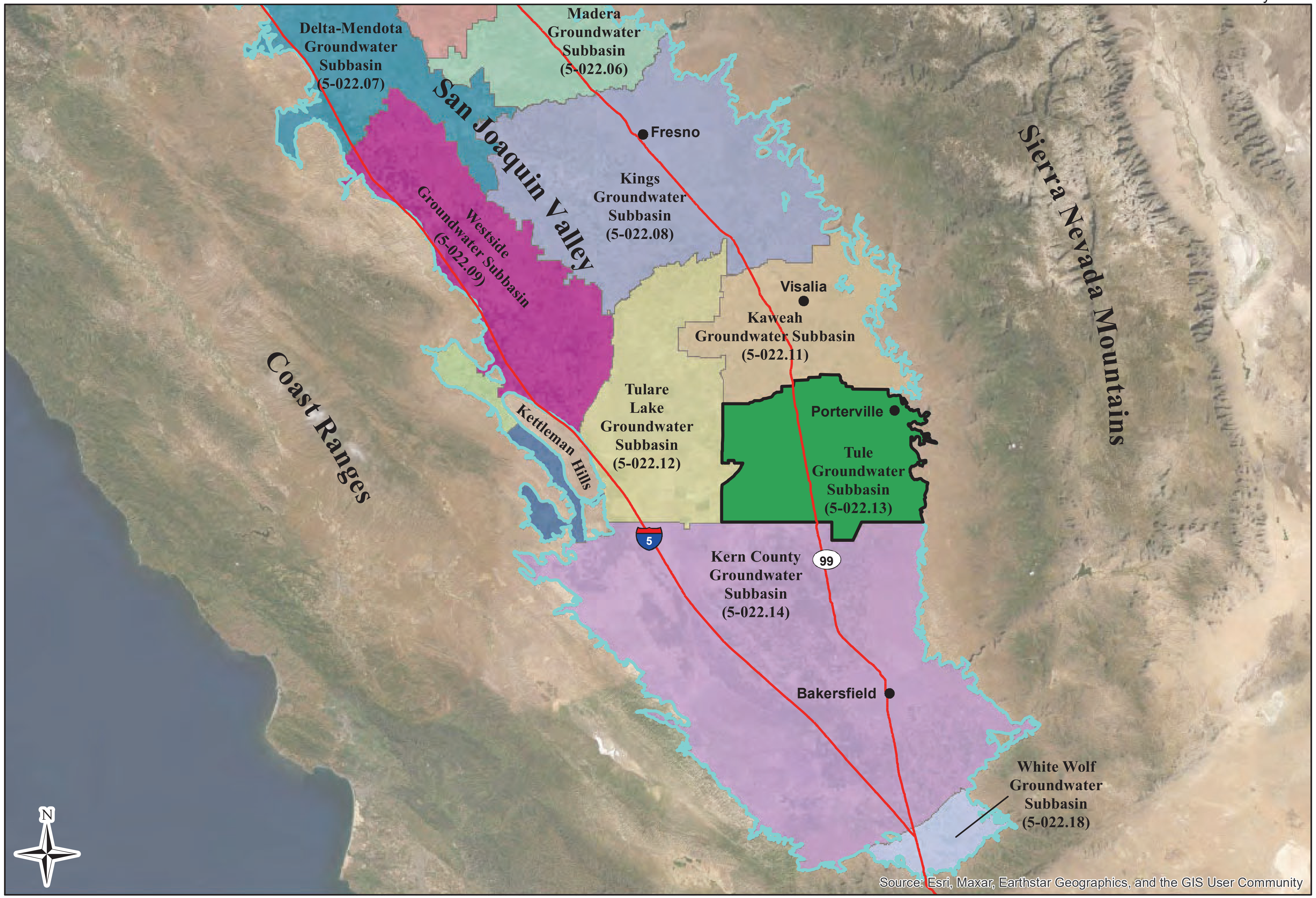
Projected Future Tule Subbasin Groundwater Budget

	Groundwater Outflows (acre-ft)						
	W	X	Y	Z	AA		
	Groundwater Pumping						
Water Year	Municipal	Irrigated Agriculture	Exports	Groundwater Banking Extraction	Sub-surface Outflow	Total Out	Change in Storage (acre-ft)
2017 - 2018	21,700	549,000	22,920	2,200	83,000	679,000	-142,000
2018 - 2019	23,400	548,000	22,920	2,200	82,000	679,000	-140,000
2019 - 2020	25,000	529,000	22,920	2,200	83,000	662,000	-122,000
2020 - 2021	25,400	526,000	22,920	2,200	83,000	660,000	-119,000
2021 - 2022	25,700	524,000	22,920	2,200	84,000	659,000	-120,000
2022 - 2023	26,100	523,000	22,920	2,200	85,000	659,000	-120,000
2023 - 2024	26,500	522,000	22,920	2,200	85,000	659,000	-116,000
2024 - 2025	26,900	494,000	22,920	2,200	86,000	632,000	-102,000
2025 - 2026	27,400	487,000	20,010	2,200	90,000	627,000	-103,000
2026 - 2027	27,800	481,000	20,010	2,200	92,000	623,000	-103,000
2027 - 2028	28,200	474,000	20,010	2,200	94,000	618,000	-102,000
2028 - 2029	28,700	468,000	20,010	2,200	96,000	615,000	-101,000
2029 - 2030	29,200	412,000	20,010	2,200	94,000	557,000	-62,000
2030 - 2031	29,600	413,000	17,100	2,200	95,000	557,000	-65,000
2031 - 2032	30,100	410,000	17,100	2,200	94,000	553,000	-61,000
2032 - 2033	30,600	407,000	17,100	2,200	93,000	550,000	-60,000
2033 - 2034	31,100	405,000	17,100	2,200	92,000	547,000	-58,000
2034 - 2035	31,700	345,000	17,100	2,200	93,000	489,000	-21,000
2035 - 2036	32,200	344,000	14,190	2,200	93,000	486,000	-21,000
2036 - 2037	32,800	344,000	14,190	2,200	91,000	484,000	-21,000
2037 - 2038	33,300	344,000	14,190	2,200	89,000	483,000	-20,000
2038 - 2039	33,900	344,000	14,190	2,200	88,000	482,000	-17,000
2039 - 2040	34,500	303,000	11,280	2,200	90,000	441,000	3,000
2040 - 2041	34,500	302,000	11,280	2,200	90,000	440,000	2,000
2041 - 2042	34,500	302,000	11,280	2,200	90,000	440,000	2,000
2042 - 2043	34,500	302,000	11,280	2,200	90,000	440,000	1,000
2043 - 2044	34,500	302,000	11,280	2,200	90,000	440,000	1,000
2044 - 2045	34,500	302,000	11,280	2,200	90,000	440,000	0
2045 - 2046	34,500	302,000	11,280	2,200	89,000	439,000	1,000
2046 - 2047	34,500	302,000	11,280	2,200	89,000	439,000	1,000
2047 - 2048	34,500	302,000	11,280	2,200	89,000	439,000	0
2048 - 2049	34,500	302,000	11,280	2,200	89,000	439,000	0
2049 - 2050	34,500	302,000	11,280	2,200	88,000	438,000	1,000
2050 - 2051	34,500	297,000	11,280	2,200	88,000	433,000	-10,000
2051 - 2052	34,500	297,000	11,280	2,200	88,000	433,000	-9,000
2052 - 2053	34,500	297,000	11,280	2,200	87,000	432,000	-8,000
2053 - 2054	34,500	297,000	11,280	2,200	87,000	432,000	-9,000
2054 - 2055	34,500	297,000	11,280	2,200	87,000	432,000	-9,000
2055 - 2056	34,500	297,000	11,280	2,200	87,000	432,000	-8,000
2056 - 2057	34,500	297,000	11,280	2,200	86,000	431,000	-9,000
2057 - 2058	34,500	297,000	11,280	2,200	86,000	431,000	-9,000
2058 - 2059	34,500	297,000	11,280	2,200	86,000	431,000	-9,000
2059 - 2060	34,500	297,000	11,280	2,200	86,000	431,000	-8,000
2060 - 2061	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2061 - 2062	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2062 - 2063	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2063 - 2064	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2064 - 2065	34,500	297,000	11,280	2,200	85,000	430,000	-9,000
2065 - 2066	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
2066 - 2067	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
2067 - 2068	34,500	297,000	11,280	2,200	84,000	429,000	-7,000
2068 - 2069	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
2069 - 2070	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
17/18-69/70 Avg	32,000	361,000	14,600	2,200	88,000	498,000	-36,000

Figures

Tule Subbasin

July 2022



0 5 10 20 Miles

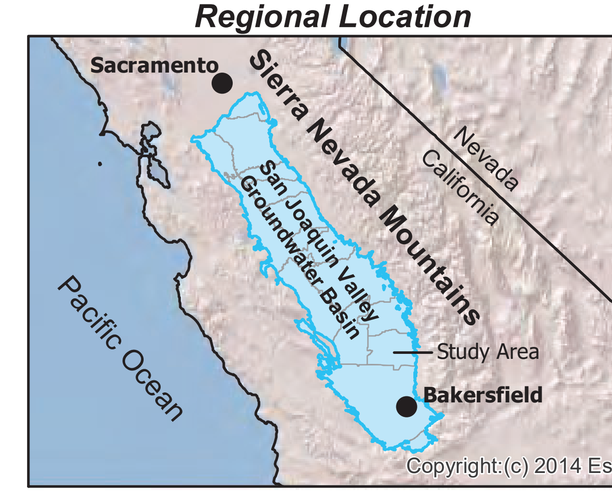
NAD 83 State Plane Zone 4

Map Features

- San Joaquin Groundwater Basin
- Major City
- Freeway/State Highway

Note: Groundwater basins from Bulletin 118, California Department of Water Resources Rev. 2016

Regional Location



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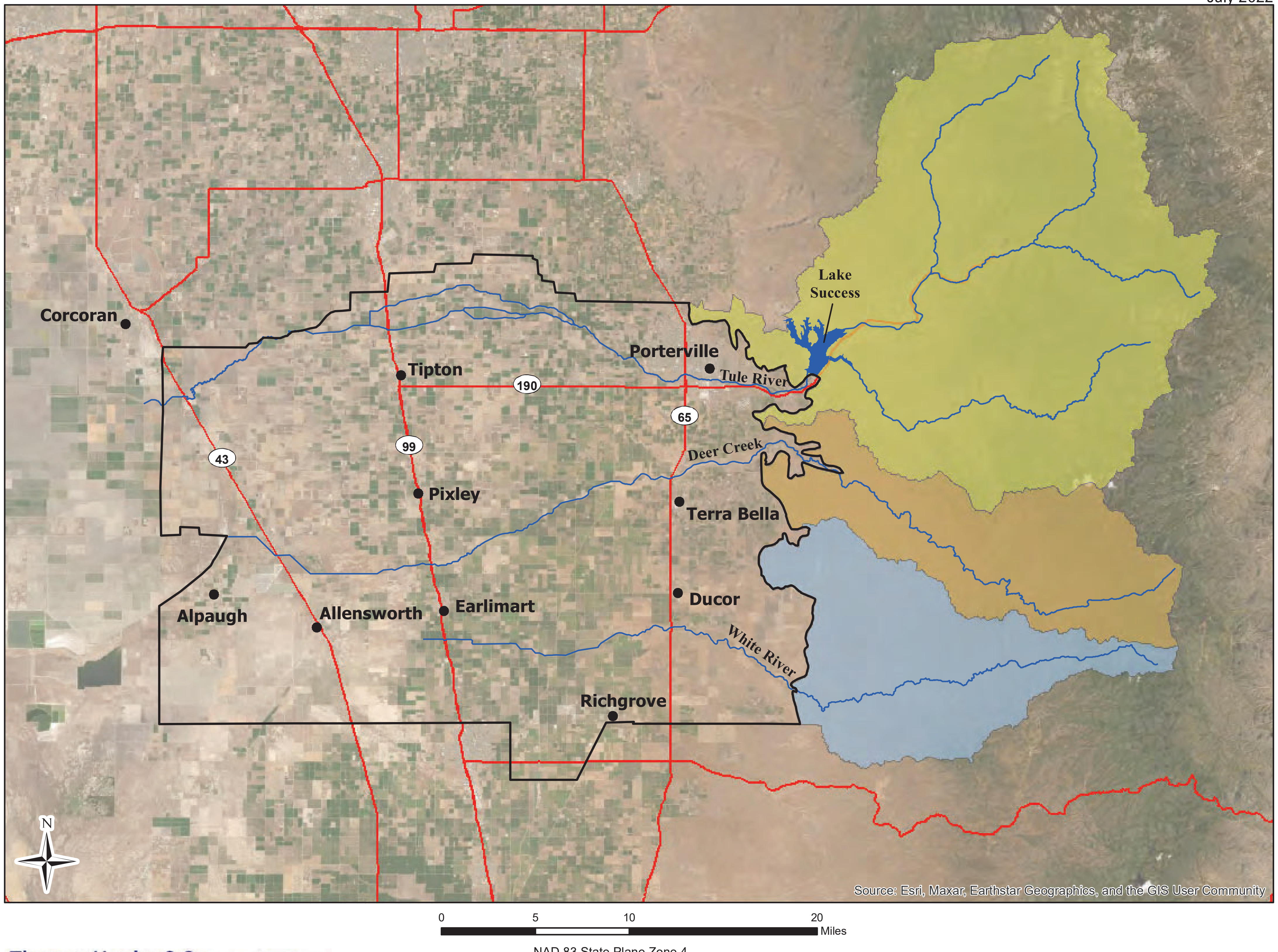
Regional Map

Figure 2-1

Tule Subbasin

July 2022



Map Features

- Tule Subbasin
- Tule River Drainage Basin
- California Hot Springs Drainage Basin
- White River Drainage Basin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

Notes: Drainage basins from California Interagency Watershed Map of 1999, California Department of Water Resources.

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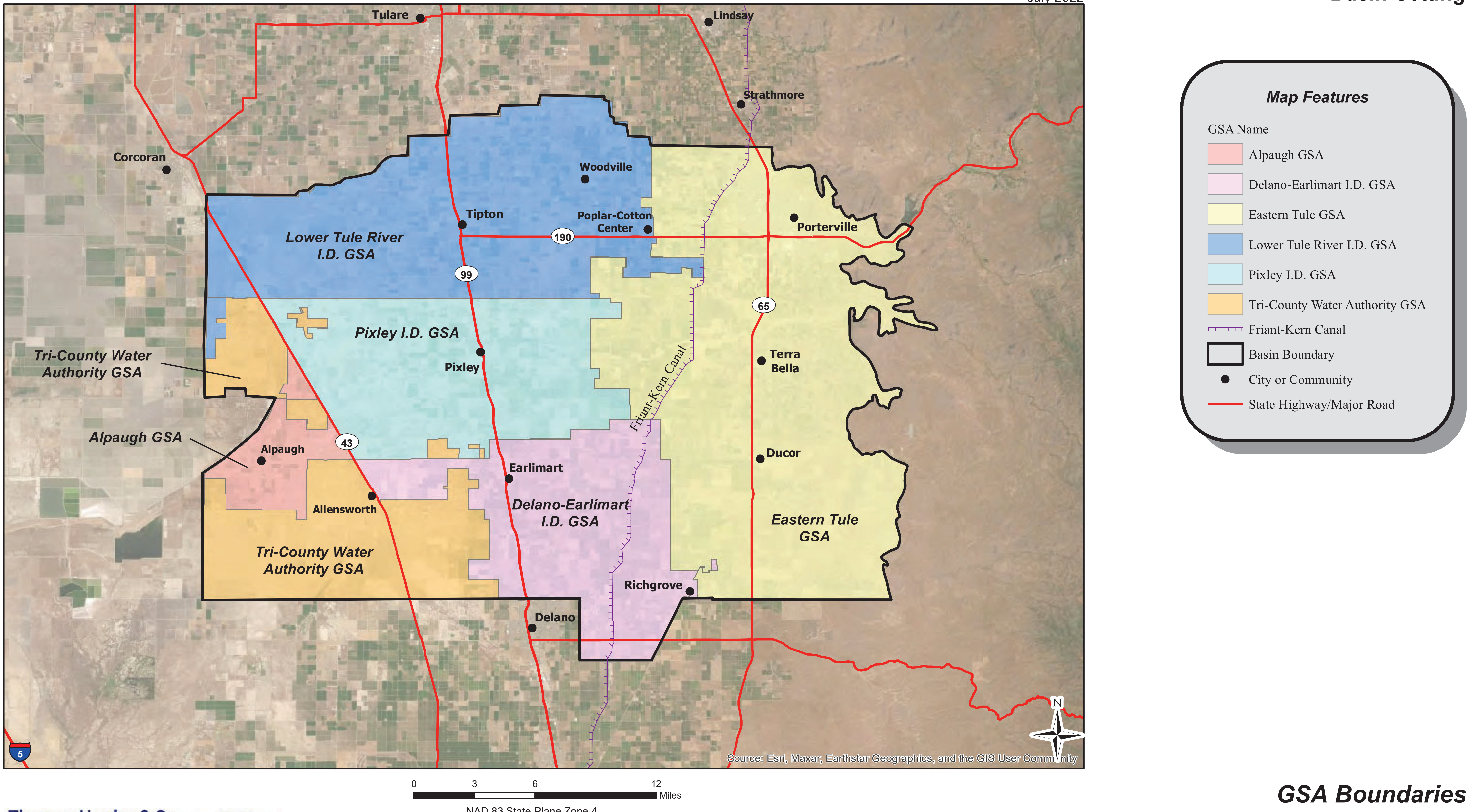
Tule Subbasin Area

Figure 2-2

Tule Subbasin

July 2022



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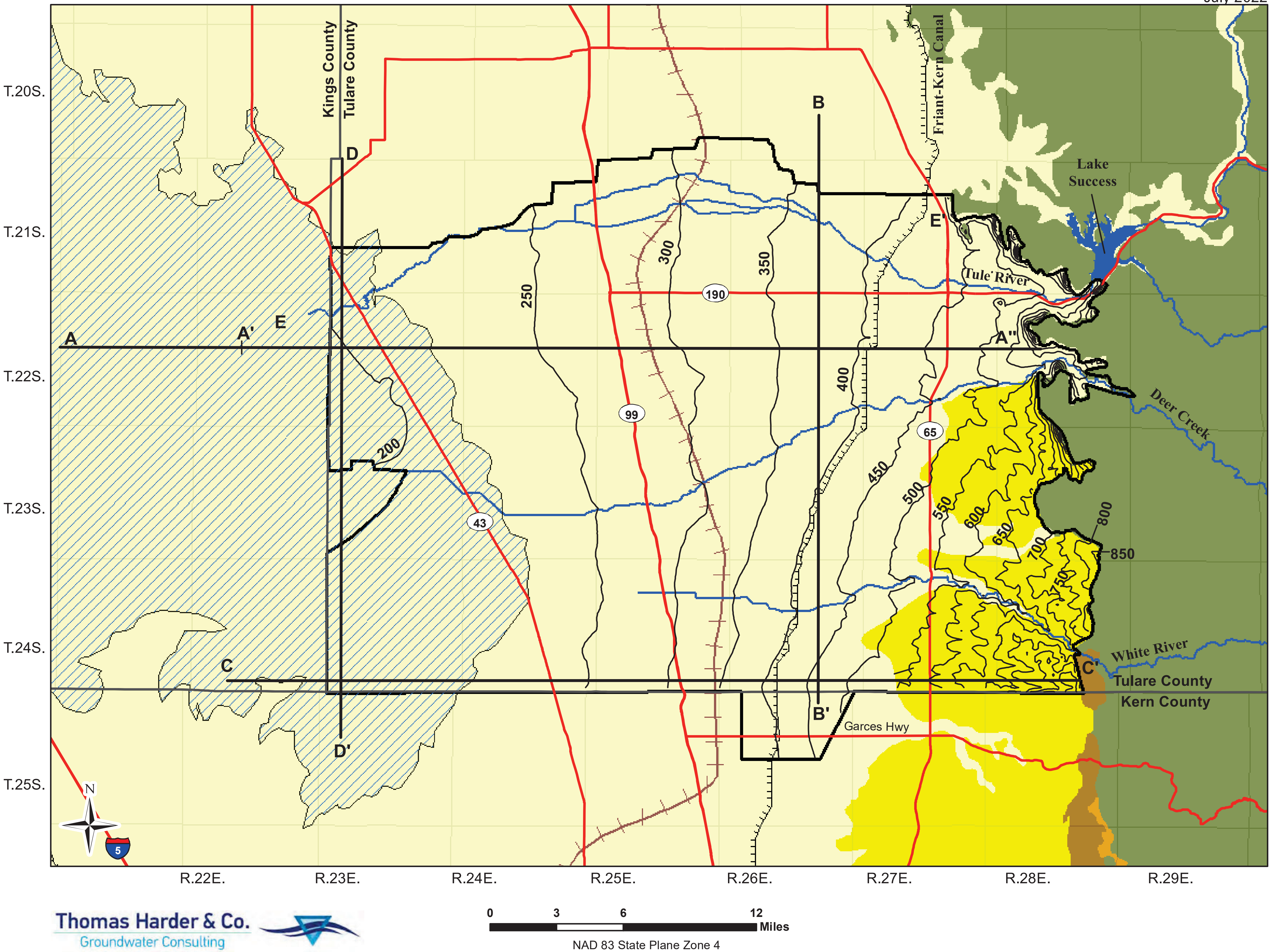
GSA Boundaries

Figure 2-3

Tule Subbasin

July 2022



Map Features

- Land Surface Elevation Contour (ft amsl)
- Cross Sections
- County Boundary
- Surficial Deposits
- Tertiary Loosely Consolidated Deposits
- Non-Marine Sedimentary Rocks
- Marine Sedimentary Rocks
- Crystalline Basement
- Approximate Eastern Extent of the Corcoran Clay
- Tulare Lake Surface Deposits
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Corcoran Clay from USGS Professional Paper 1766,
http://water.usgs.gov/GIS/dsdl/pp1766_CorcoranClay.zip

Geologic units modified from USGS Open-File Report 2005-1305

Lake Deposits from California Geological Survey Geologic Atlas of California Map No. 002 1:250,000 scale, Compiled by A.R. Smith, 1964 and Geologic Atlas of California Map No. 005, 1:250,000 scale, Compiled by: R.A. Matthews and J.L. Burnett

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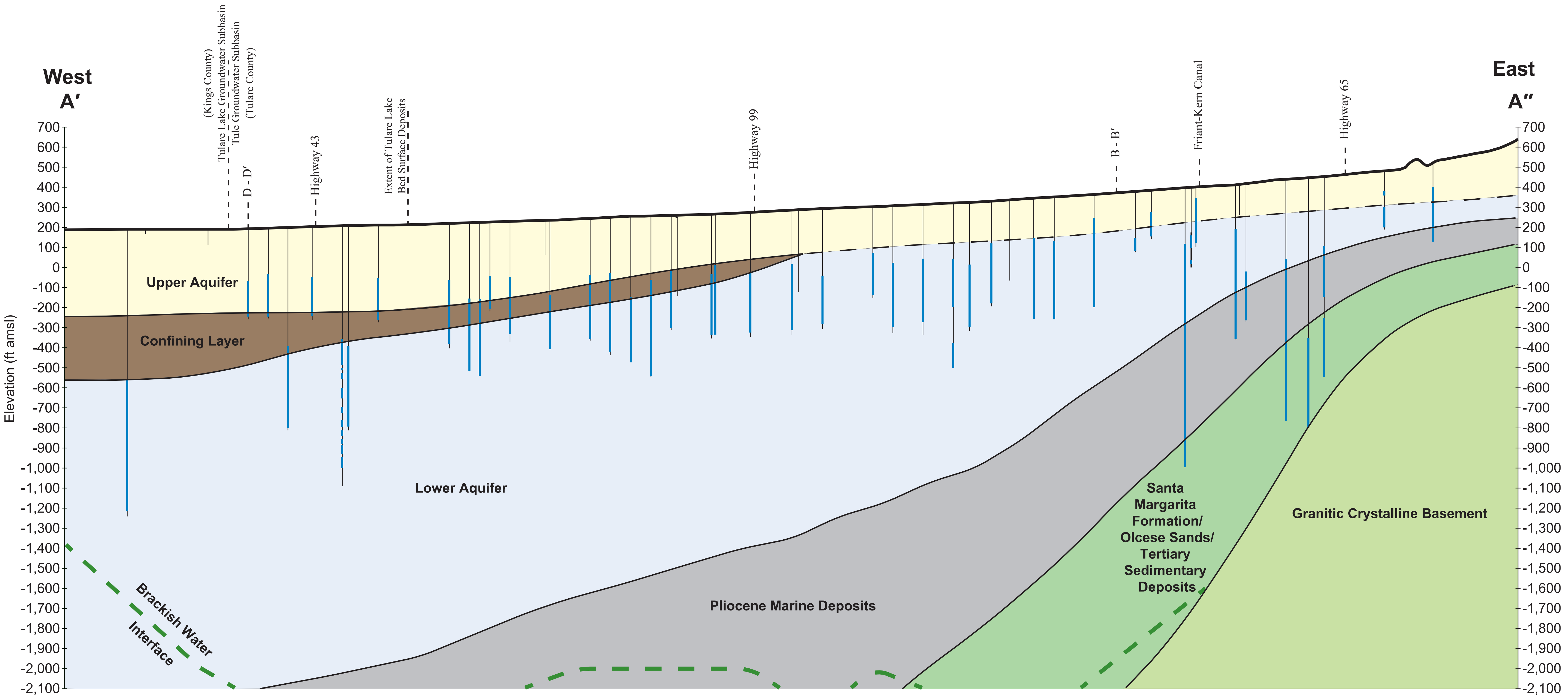
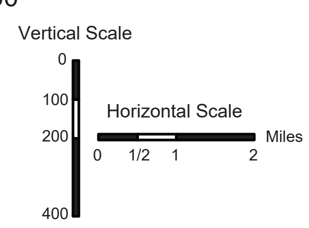
Geology and Cross Section Locations

Figure 2-4





Notes: Lithologic data from Department of Water Resources Well Compeletion Reports.
Wells within one half mile from cross section line unless otherwise noted by " * ".
Corcoran Clay from USGS Professional Paper 1766,
http://water.usgs.gov/GIS/dsdl/pp1766_CorcoranClay.zip

Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

| = Indicates well perforation interval

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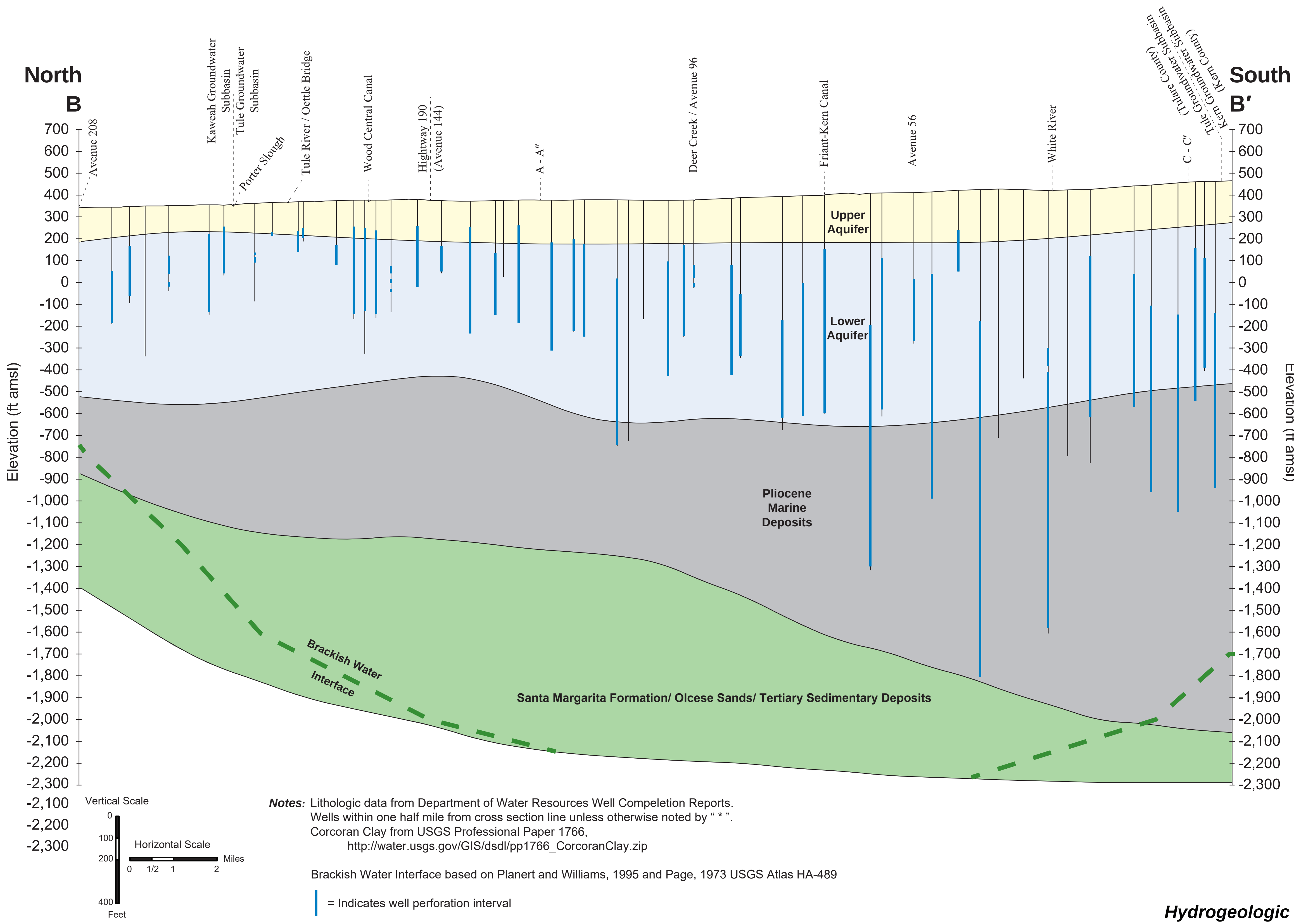
Hydrogeologic Cross Section A'-A"
Tule Groundwater Subbasin
Figure 2-5
July 2022



Notes: Lithologic data from Department of Water Resources Well Compeletion Reports.
Wells within one half mile from cross section line unless otherwise noted by " * ".
Corcoran Clay from USGS Professional Paper 1766,
http://water.usgs.gov/GIS/dsdl/pp1766_CorcoranClay.zip

Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

= Indicates well perforation interval

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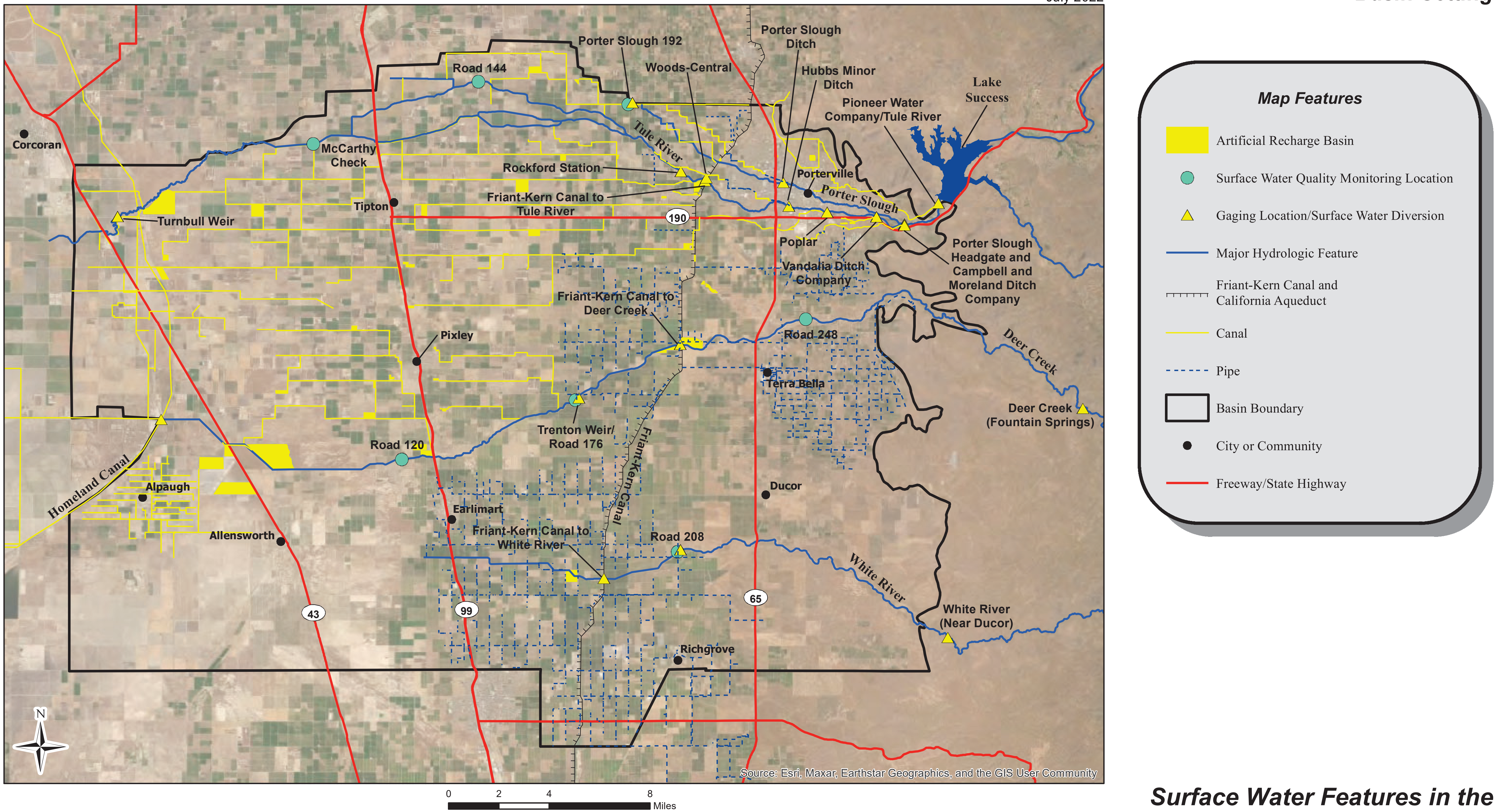
Hydrogeologic Cross Section B-B'
Tule Groundwater Subbasin
Figure 2-6
July 2022

Tule Subbasin

July 2022



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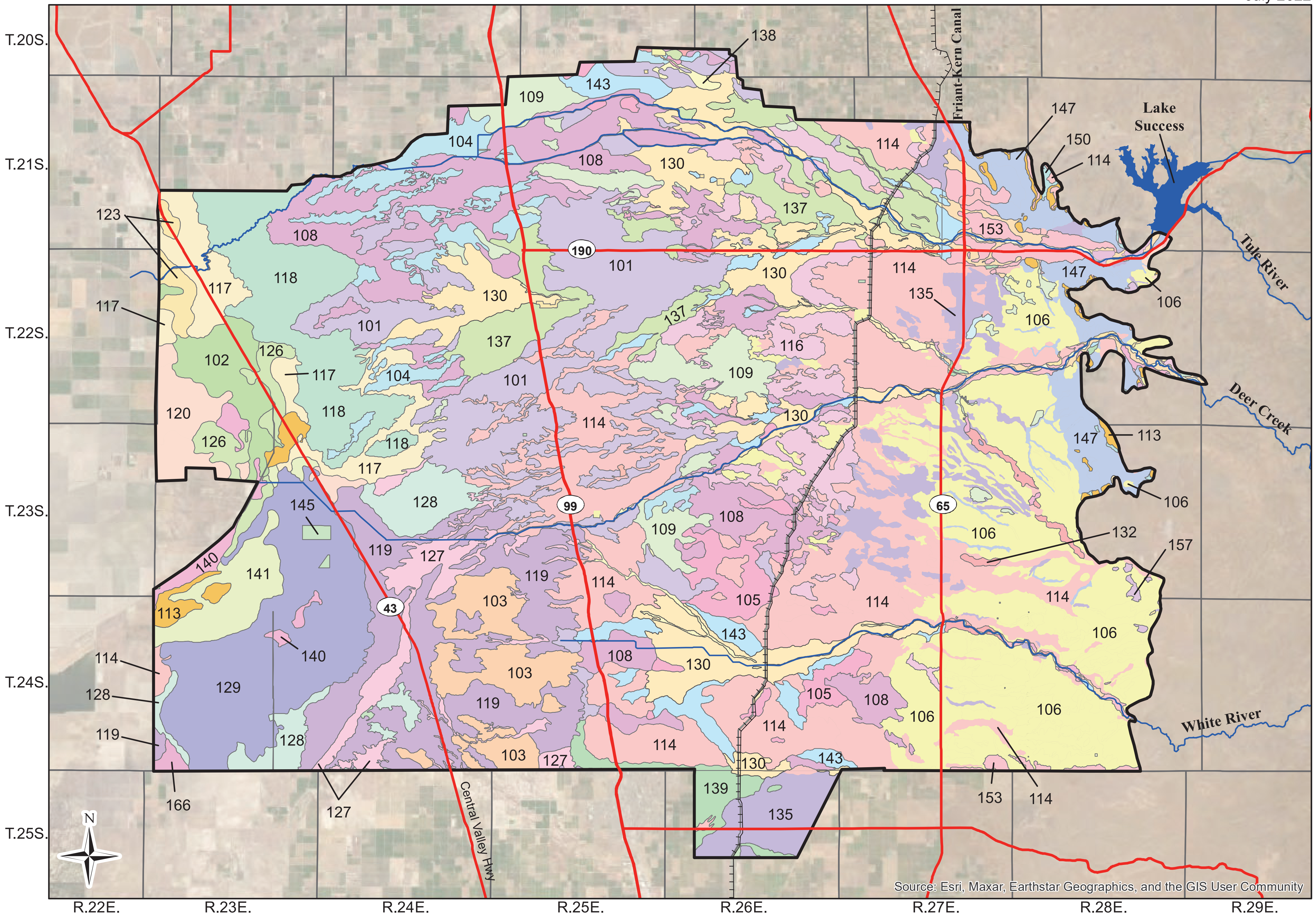
Surface Water Features in the Tule Subbasin and Vicinity
Figure 2-7

Tule Subbasin

July 2022



Map Features

- 101 - Akers-Akers, saline-sodic, complex, 0 to 2 percent slopes
- 102 - Armona sandy loam, partially drained, 0 to 1 percent slopes
- 103 - Atesh-Jerryslu association, 0 to 2 percent slopes
- 104 - Biggriz-Biggriz, saline-sodic, complex, 0 to 2 percent slopes
- 105 - Calgro-Calgro, saline-sodic, complex, 0 to 2 percent slopes
- 106 - Centerville clay, 0 to 30 percent slopes
- 108 - Colpien loam, 0 to 2 percent
- 109 - Crosscreek-Kai association, 0 to 2 percent slopes
- 113 - Cibo clay, 15 - 30 percent slopes
- 114 - Exeter loam, 0 to 5 percent slopes
- 116 - Flamen loam, 0 to 2 percent slopes
- 117 - Gambogy loam, drained, 0 to 1 percent slopes
- 118 - Gambogy-Biggriz, saline-sodic, association, drained, 0 to 2 percent slopes
- 119 - Gareck-Garces association, 0 to 2 percent slopes
- 120 - Gepford silty clay, partially drained, 0 to 1 percent slopes
- 123 - Grangeville fine sandy and silty loam, saline-sodic, 0 to 1 percent slopes
- 126 - Houser silty clay, drained, 0 to 1 percent slopes
- 127 - Kimberlina fine sandy loam, 0 to 2 percent slopes
- 128 - Lethent silt loam, 0 to 1 percent slopes
- 129 - Nahrub silt loam, overwashed, 0 to 1 percent slopes
- 130 - Nord fine sandy loam, 0 to 2 percent slopes
- 132 - Greenfield sandy loam, 0 to 5 percent slopes
- 134 - Riverwash/Havala loam, 0 to 2 percent slopes
- 135 - San Joaquin loam, 0 to 2 percent slopes
- 137 - Tagus loam, 0 to 2 percent slopes
- 138 - Tujunga loamy sand, 0 to 2 percent slopes
- 139 - Honcut sandy loam, 0 to 2 percent slopes
- 140 - Westcamp silt loam, partially drained, 0 to 1 percent slopes
- 141 - Posochanet silt loam, 0 to 2 percent slopes
- 143 - Yettem sandy loam, 0 to 2 percent slopes
- 144 - Youd loam, 0 to 1 percent slopes
- 145 - Water, perennial
- 146 - Pits
- 147 - Porterville clay, 0 to 15 percent slopes
- 150 - Porterville cobbly clay, 2 to 15 percent slopes
- 151 - Riverwash; 178; 179
- 152 - Rock outcrop
- 153 - San Emigdio loam
- 157 - Sesame sandy loam, 15 to 30 percent
- 164 - Tujunga Sand
- 166 - Vista coarse sandy loam, 15 to 30 percent slopes; 166ki
- 168 - Vista-Rock outcrop complex, 9 to 50 percent slopes
- 175 - Xerofluvents, flooded
- Major Hydrologic Feature
- Friant-Kern Canal and California Aqueduct

0 3 6 12 Miles

NAD 83 State Plane Zone 4

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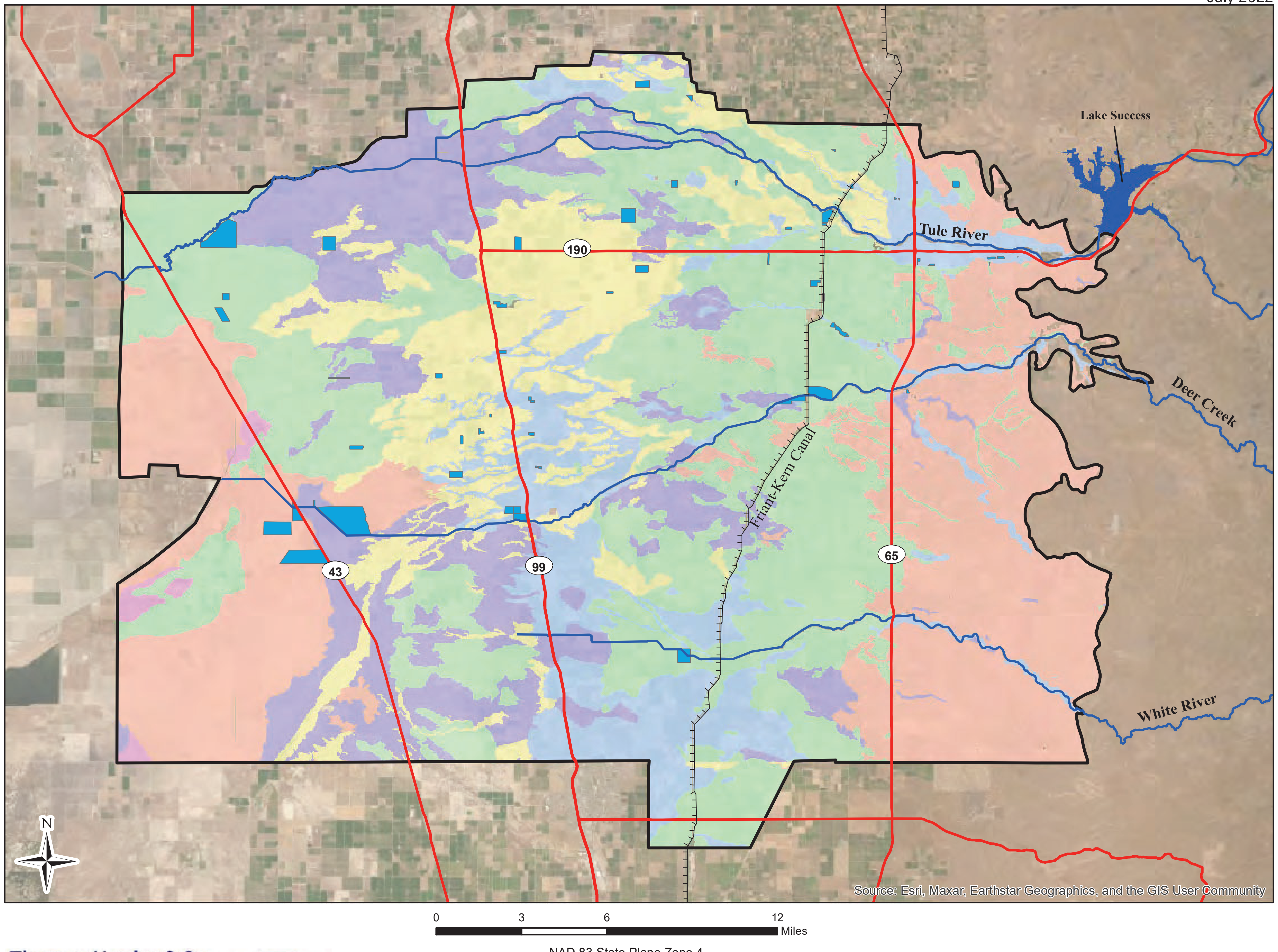
Source: USDA National Resources Conservation Service Soils - Web Soil Survey.
Associated reports inclued: USDA; Soil Survey of Tulare County, California, Western Part.
USDA; Soil Survey of Tulare County, California, Central Part.
and USDA; Soil Survey of Kern County, Northeastern Part, and Southeastern Part of Tulare County, California.

Soil Map
Figure 2-8

July 2022



Map Features

SAGBI Index

- Excellent
- Good
- Moderately Good
- Moderately Poor
- Poor
- Very Poor
- Basin Boundary
- Artificial Recharge Basin
- Friant-Kern Canal
- Major Hydrologic Feature
- State Highway/Major Road

The Soil Agricultural Groundwater Banking Index (SAGBI) is a suitability index for groundwater recharge on agricultural land. It is based on five factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

Source: SAGBI | Soil Agricultural Groundwater Banking Index interactive map. https://casoilresource.lawr.ucdavis.edu/sagbi/

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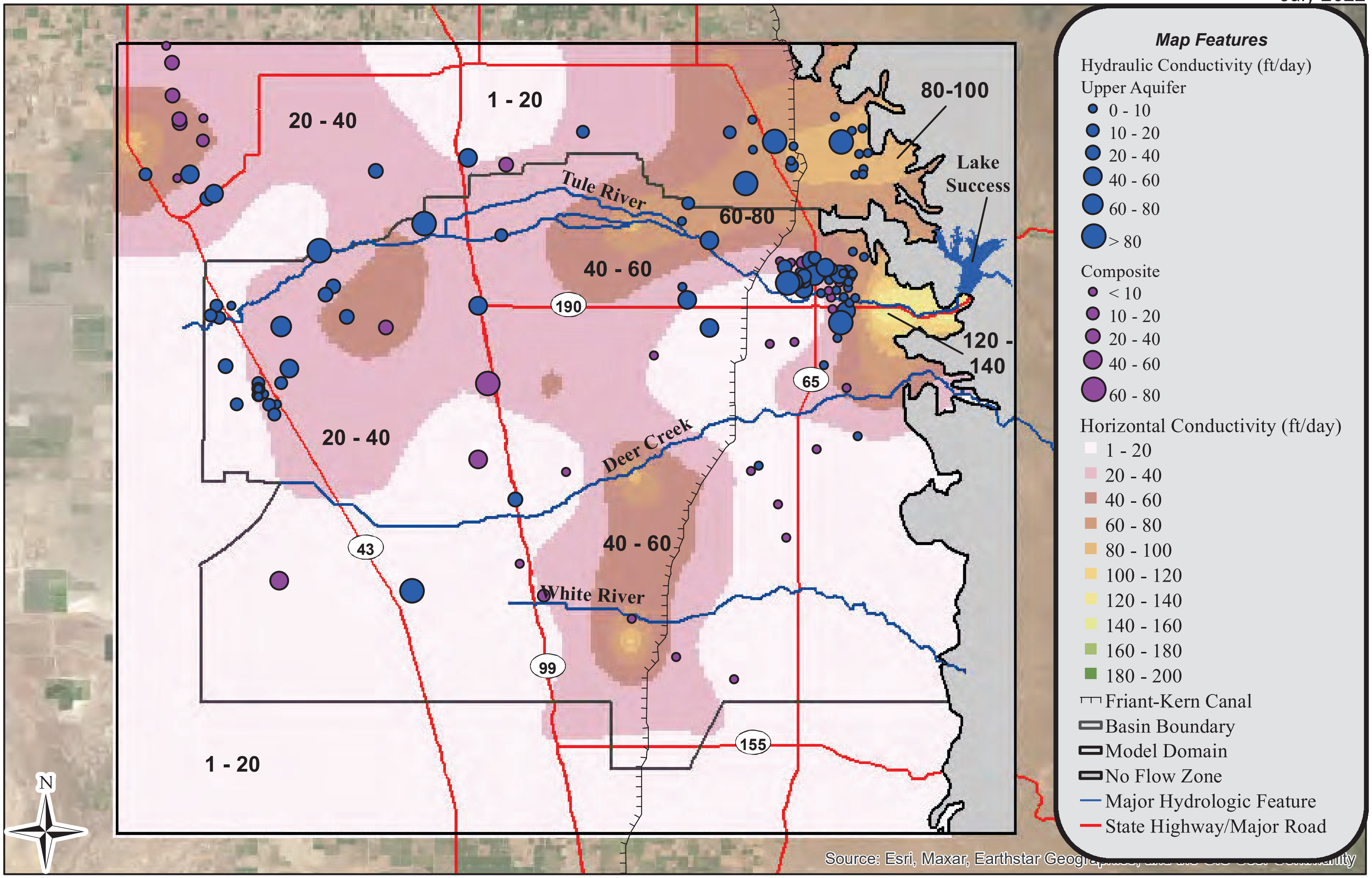
Recharge Basins and Favorable Areas for Recharge

Figure 2-9

Tule Subbasin



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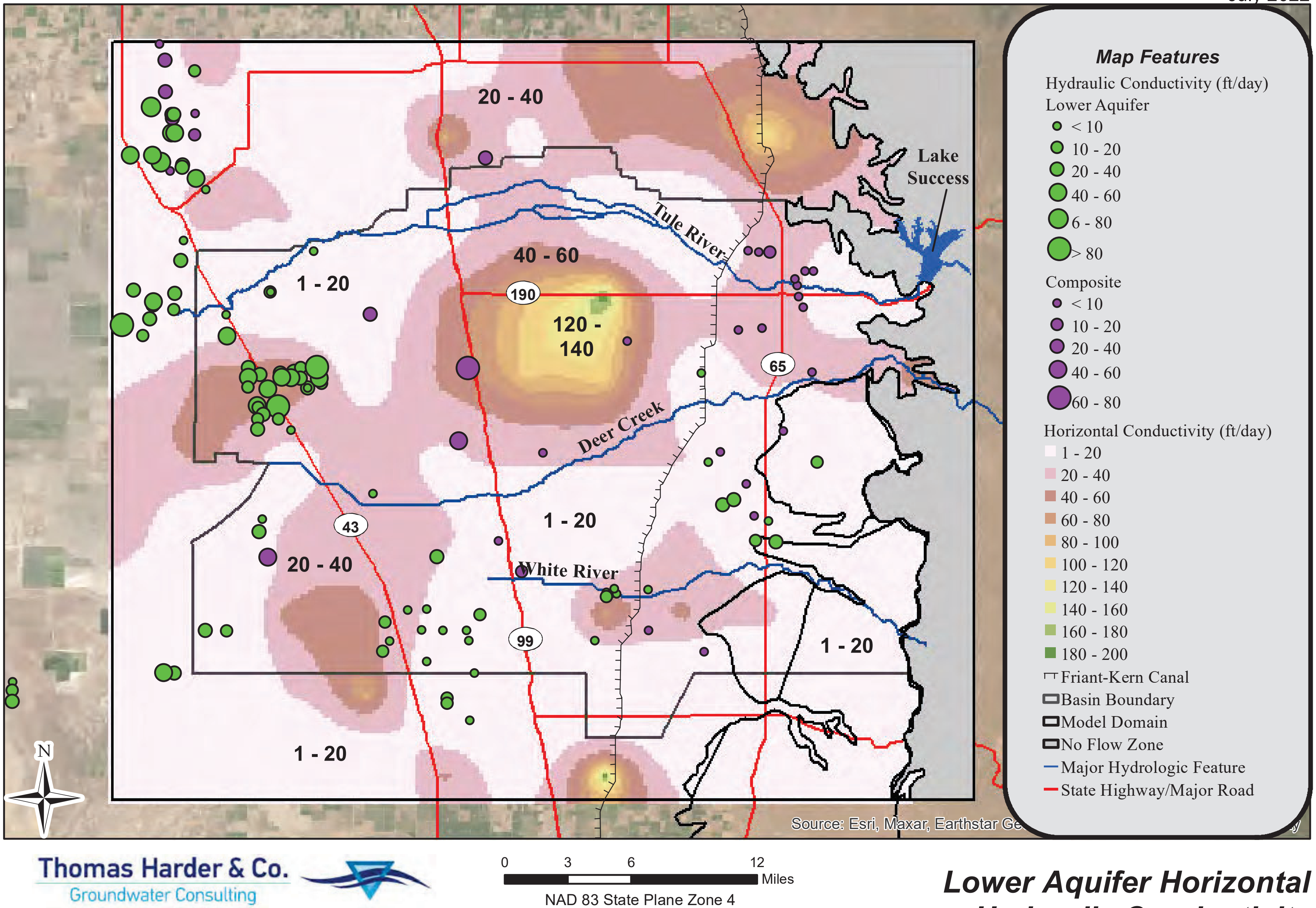
Upper Aquifer Horizontal Hydraulic Conductivity

Figure 2-10

Tule Subbasin

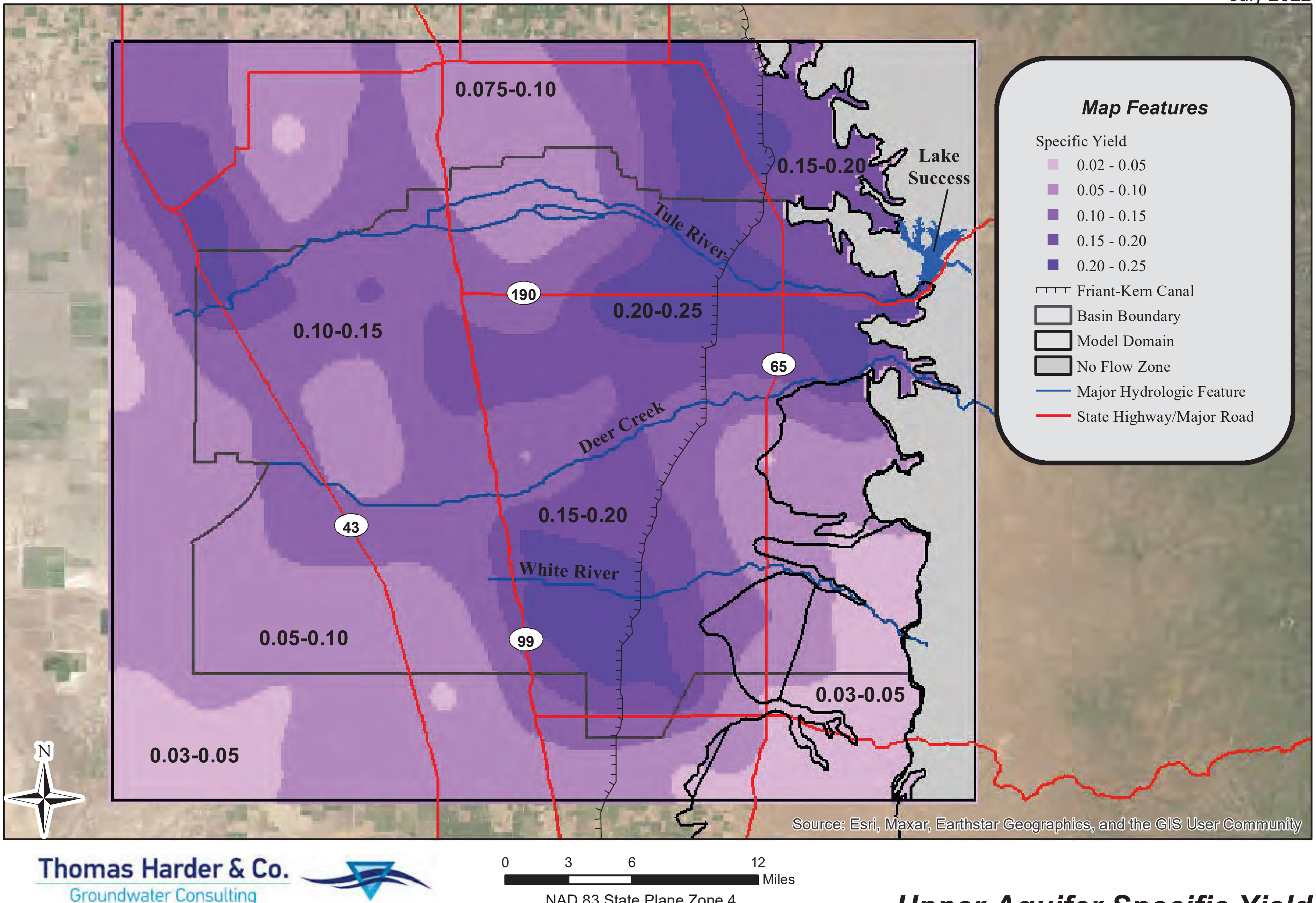


Thomas Harder & Co.
Groundwater Consulting

Lower Aquifer Horizontal Hydraulic Conductivity

Figure 2-11

Tule Subbasin



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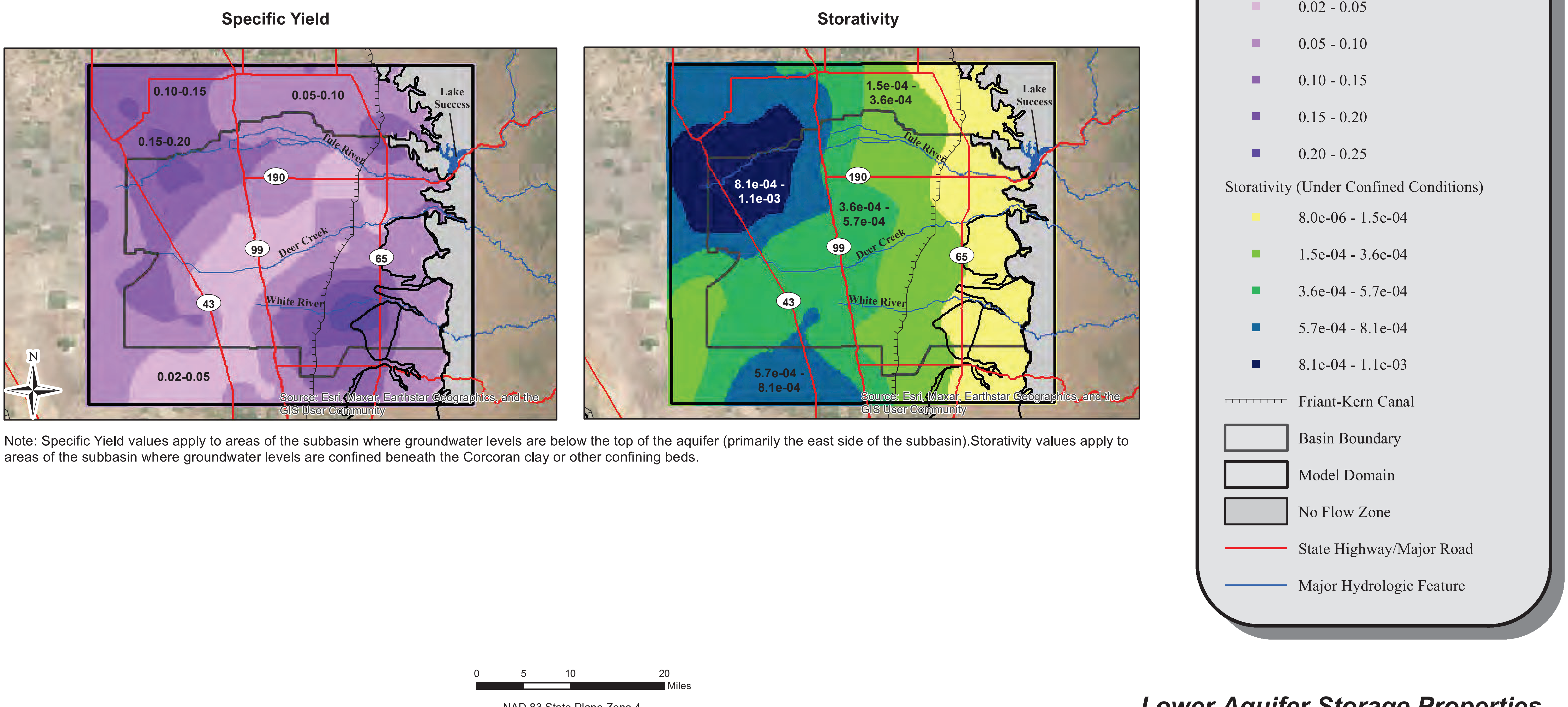
Upper Aquifer Specific Yield

Figure 2-12



Note: Specific Yield values apply to areas of the subbasin where groundwater levels are below the top of the aquifer (primarily the east side of the subbasin).Storativity values apply to areas of the subbasin where groundwater levels are confined beneath the Corcoran clay or other confining beds.

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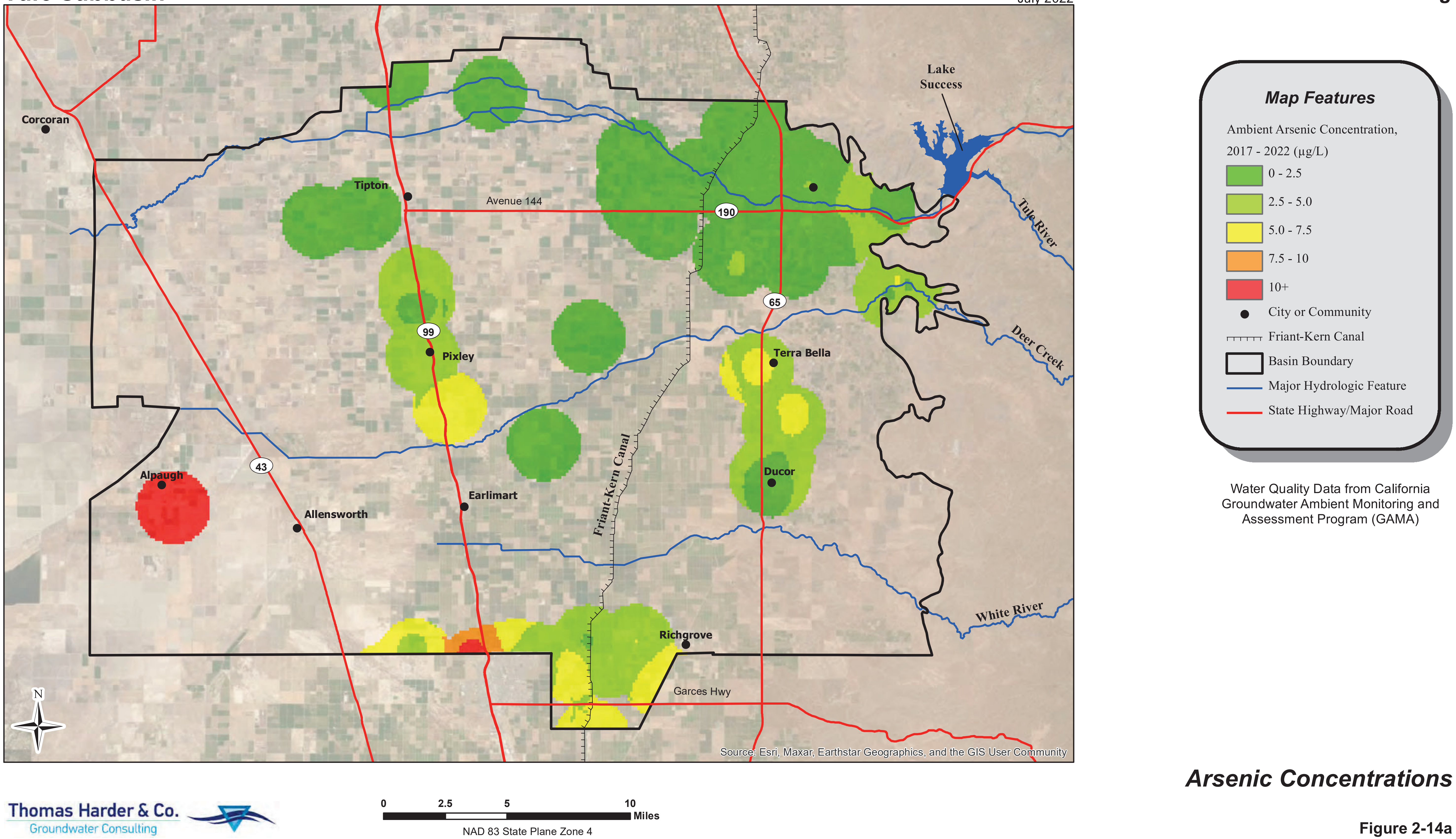
Lower Aquifer Storage Properties

Figure 2-13

Tule Subbasin

July 2022



Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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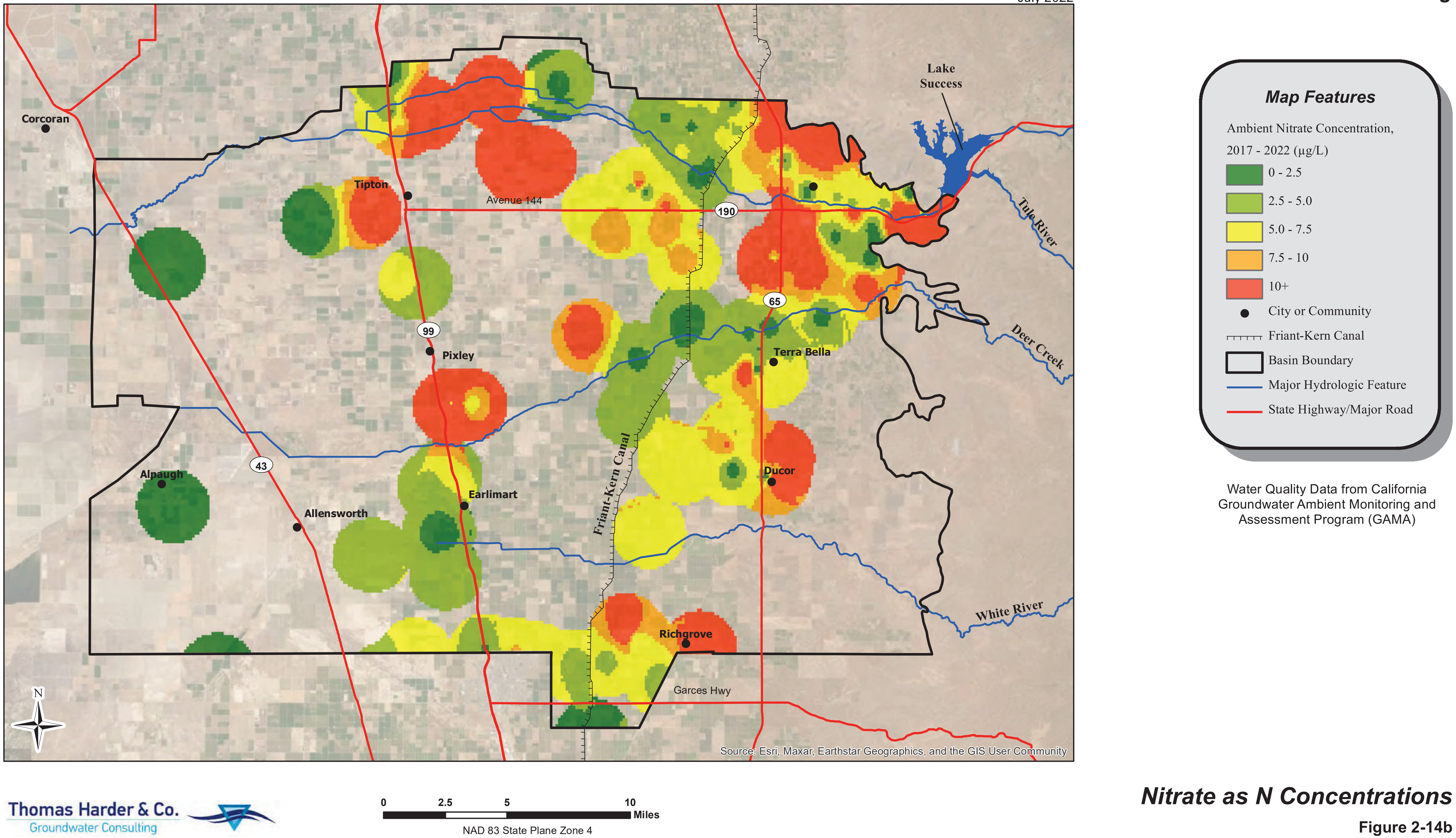
Groundwater Consulting

Arsenic Concentrations

Figure 2-14a

Tule Subbasin

July 2022



Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

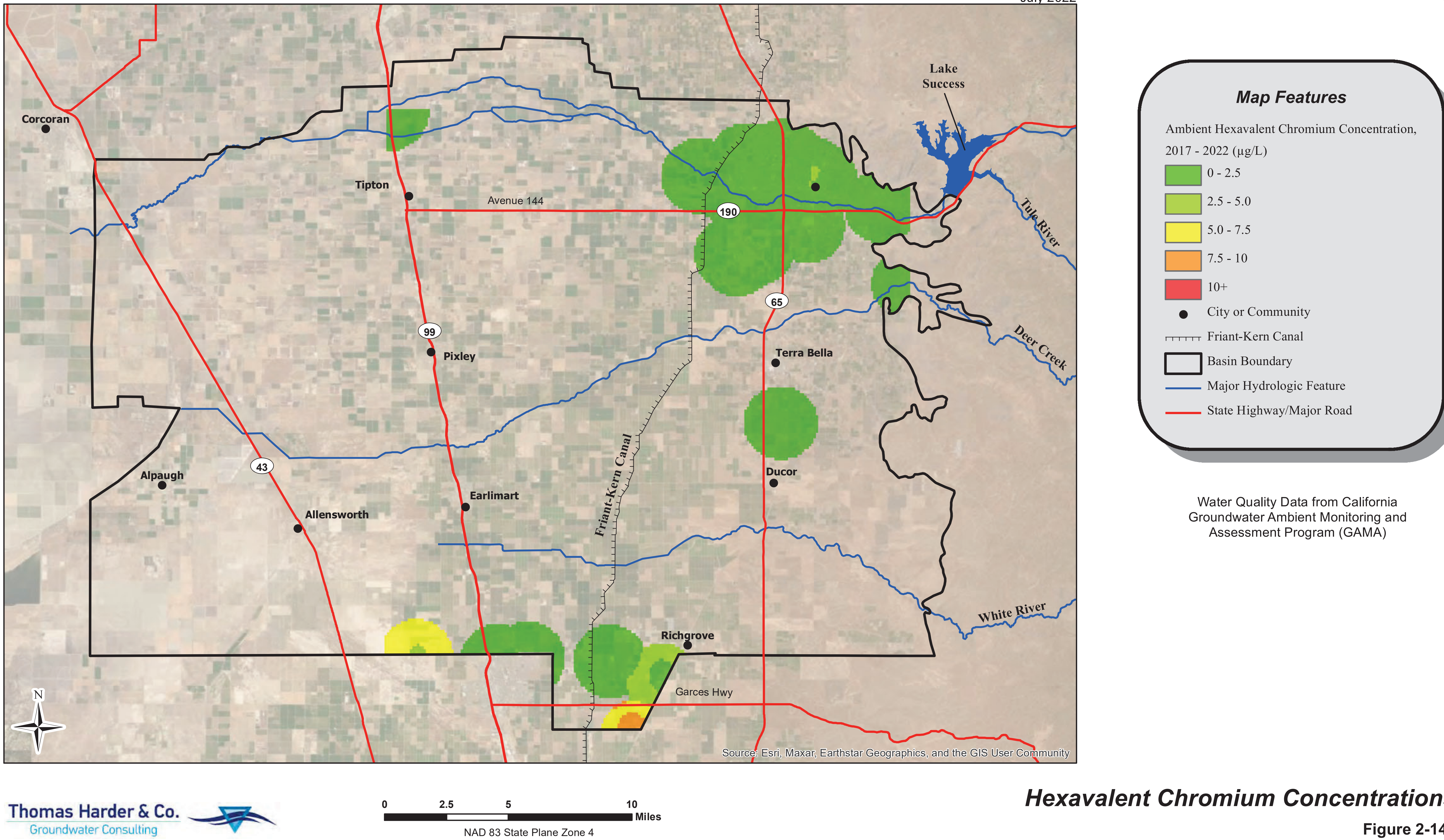
Thomas Harder & Co.
Groundwater Consulting

Nitrate as N Concentrations

Figure 2-14b

Tule Subbasin

July 2022



Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

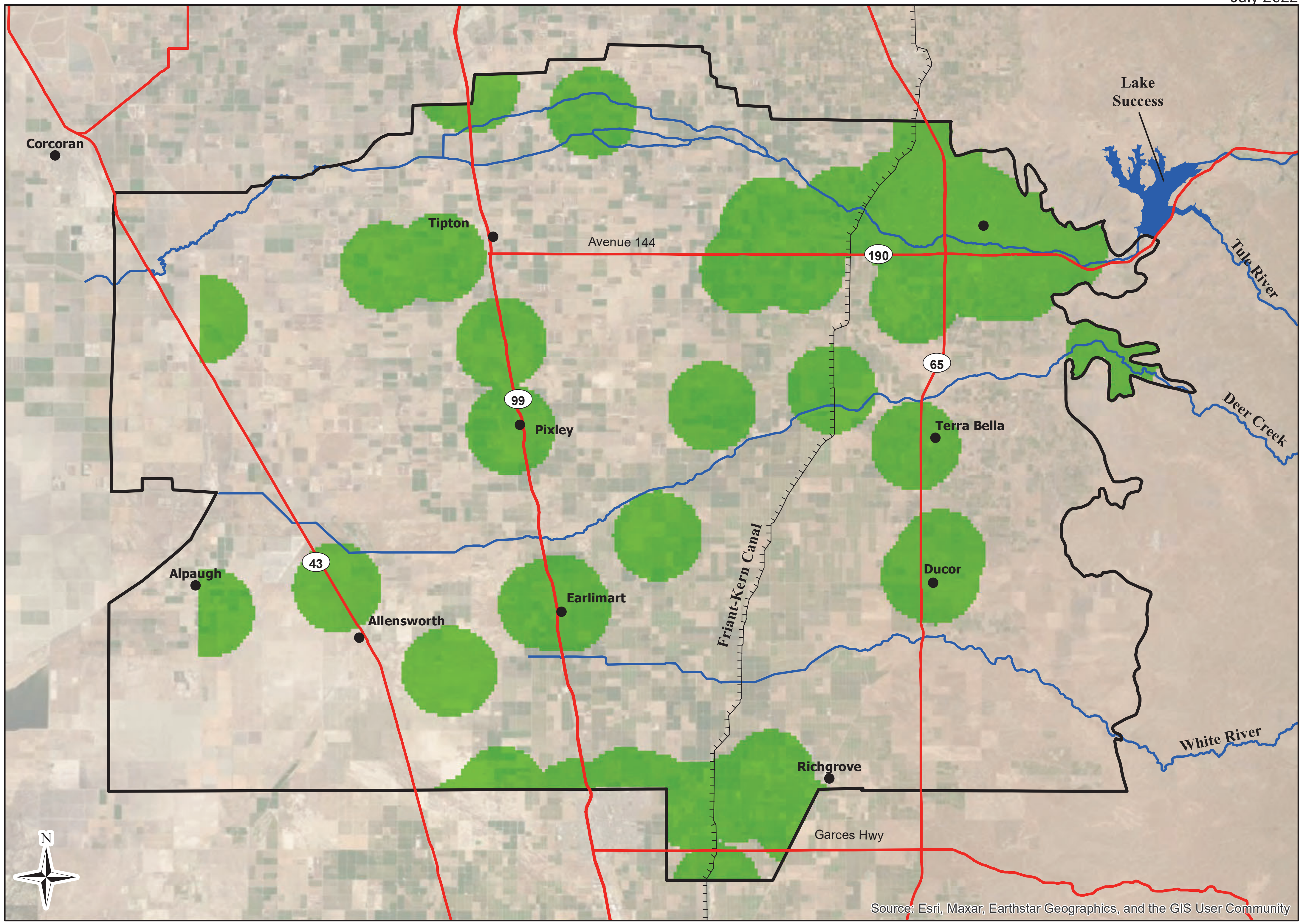
Thomas Harder & Co.
Groundwater Consulting

Hexavalent Chromium Concentrations

Figure 2-14c

Tule Subbasin

July 2022



Map Features

Ambient Dibromochloropropane Concentration, 2017 - 2022 (µg/L)

- 0 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.20
- 0.20+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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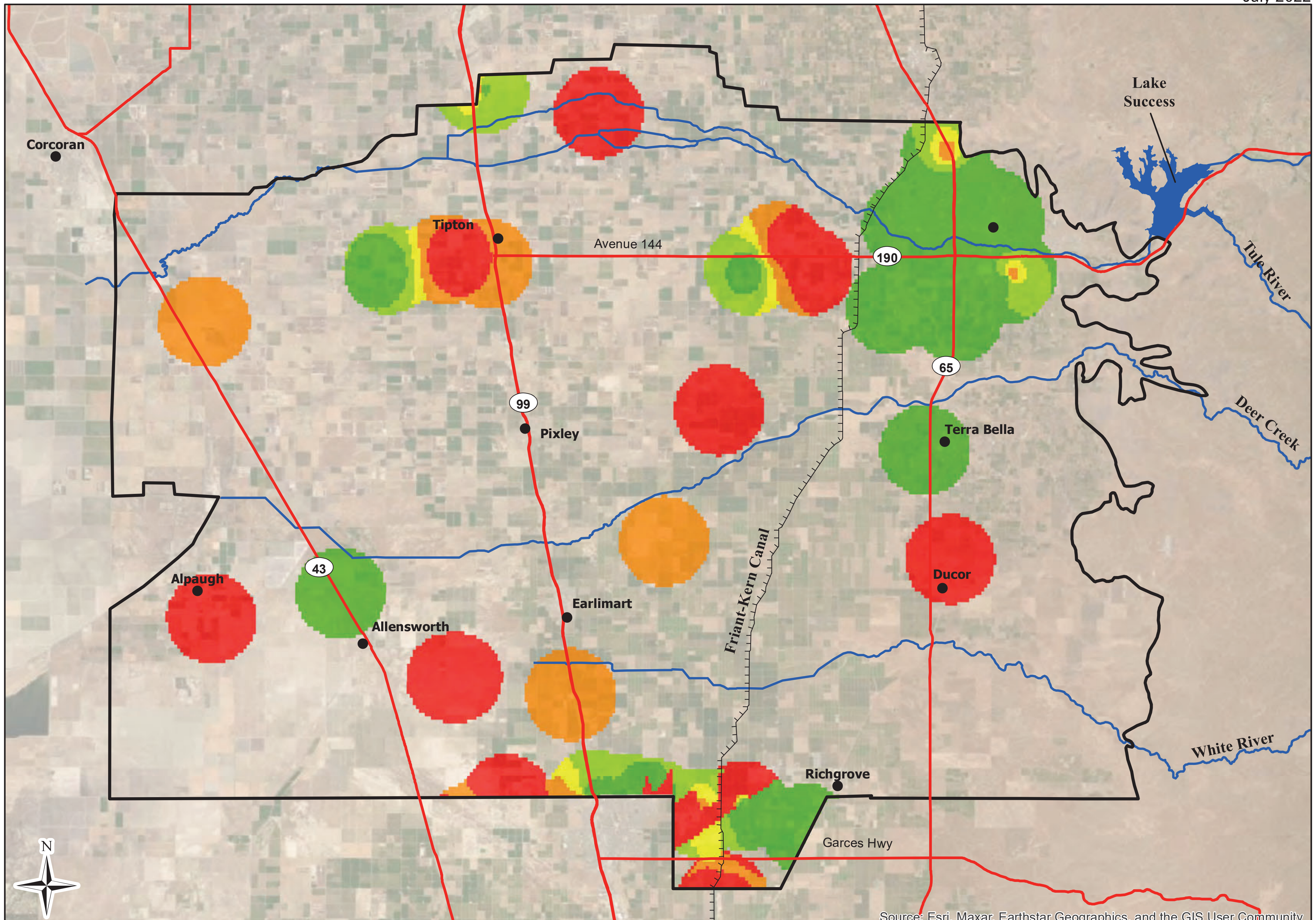
0 2.5 5 10 Miles
NAD 83 State Plane Zone 4

Dibromochloropropane Concentrations

Figure 2-14d

Tule Subbasin

July 2022



Map Features

Ambient 1,2,3-TCP Concentration, 2017 - 2022 (µg/L)

- 0 - 0.00125
- 0.00125 - 0.0025
- 0.0025 - 0.00375
- 0.00375 - 0.005
- 0.005+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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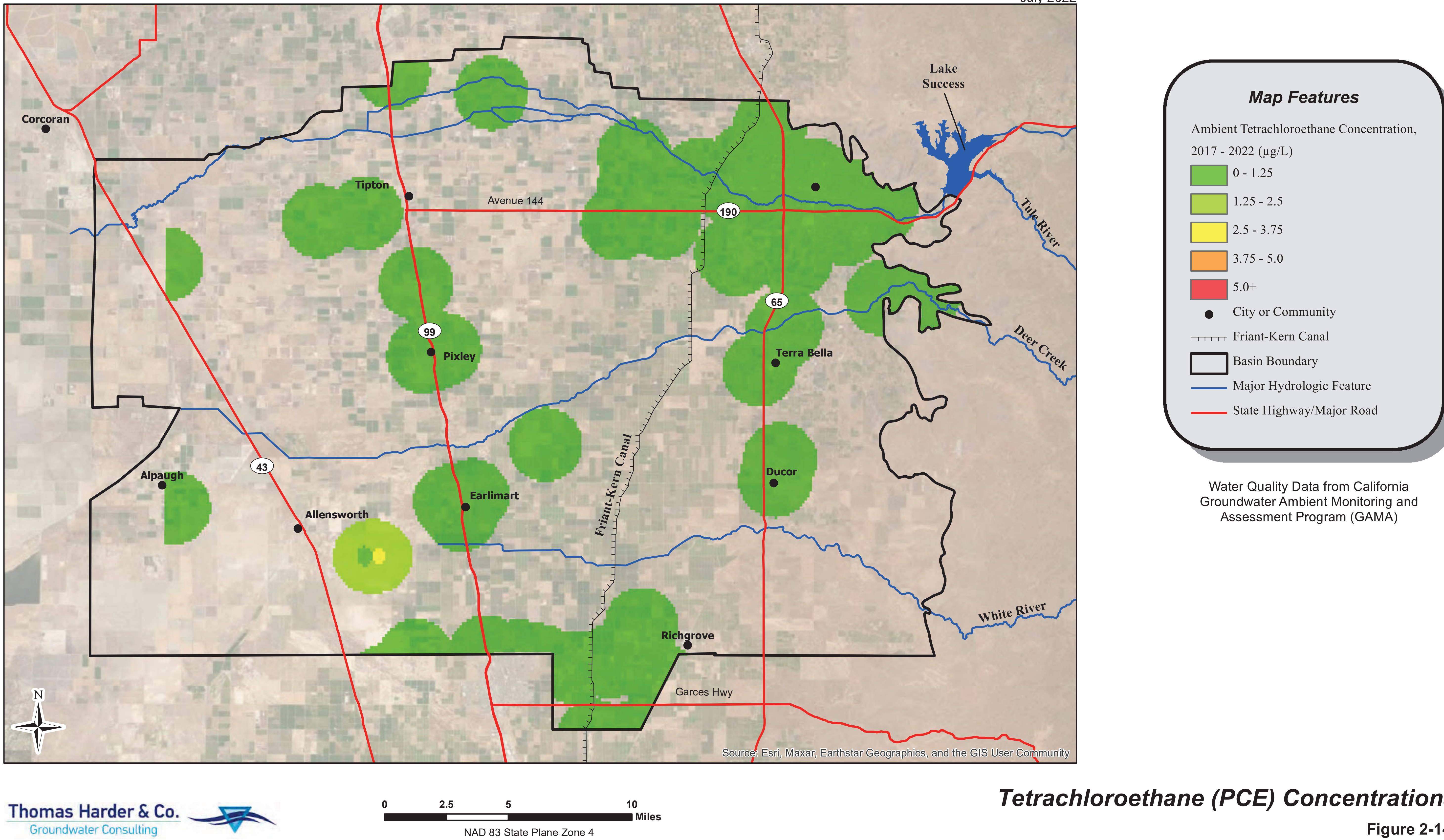
0 2.5 5 10 Miles
NAD 83 State Plane Zone 4

1,2,3-Trichloropropane (TCP) Concentrations

Figure 2-14e



Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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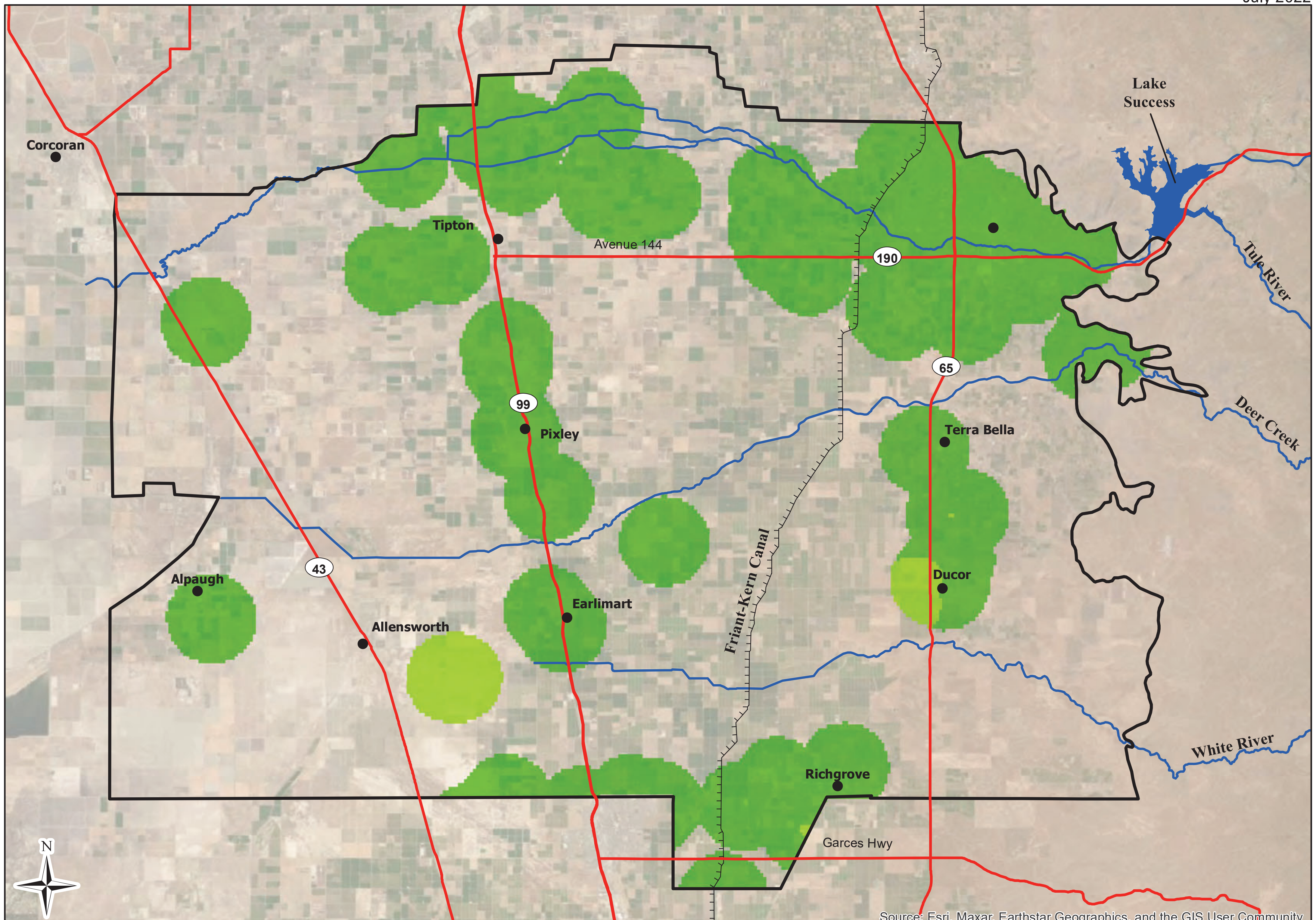
Tetrachloroethane (PCE) Concentrations

Figure 2-14f

Tule Subbasin

July 2022



Map Features

Ambient Chloride Concentration, 2017 - 2022 (µg/L)

- 0 - 125
- 125 - 250
- 250 - 375
- 375 - 500
- 500+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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Groundwater Consulting

0 2.5 5 10 Miles

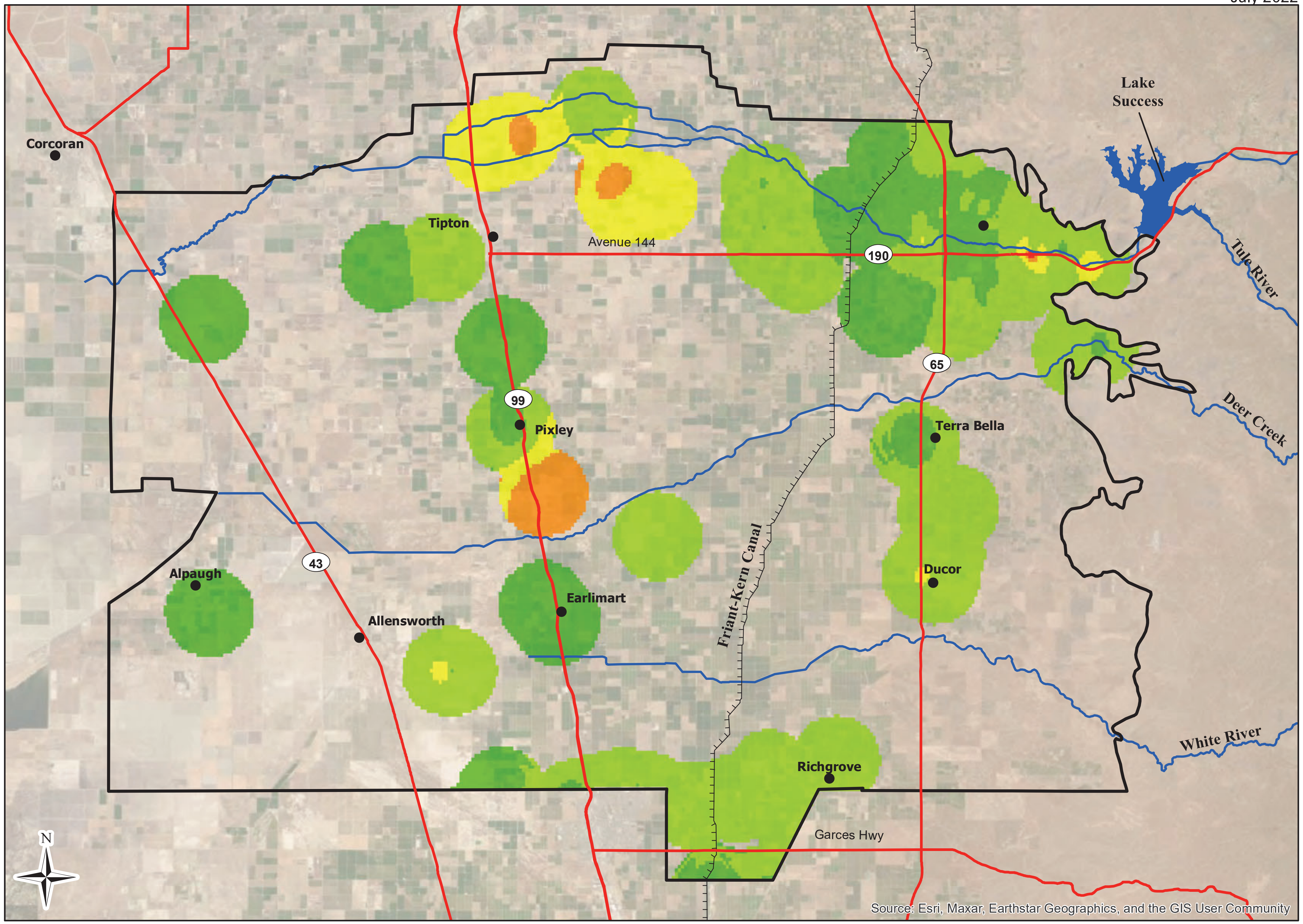
NAD 83 State Plane Zone 4

Chloride Concentrations

Figure 2-14g

Tule Subbasin

July 2022



Map Features

Ambient TDS Concentration, 2017 - 2022 (µg/L)

- 0 - 250
- 250 - 500
- 500 - 750
- 750 - 1,000
- 1,000+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

Thomas Harder & Co.
Groundwater Consulting

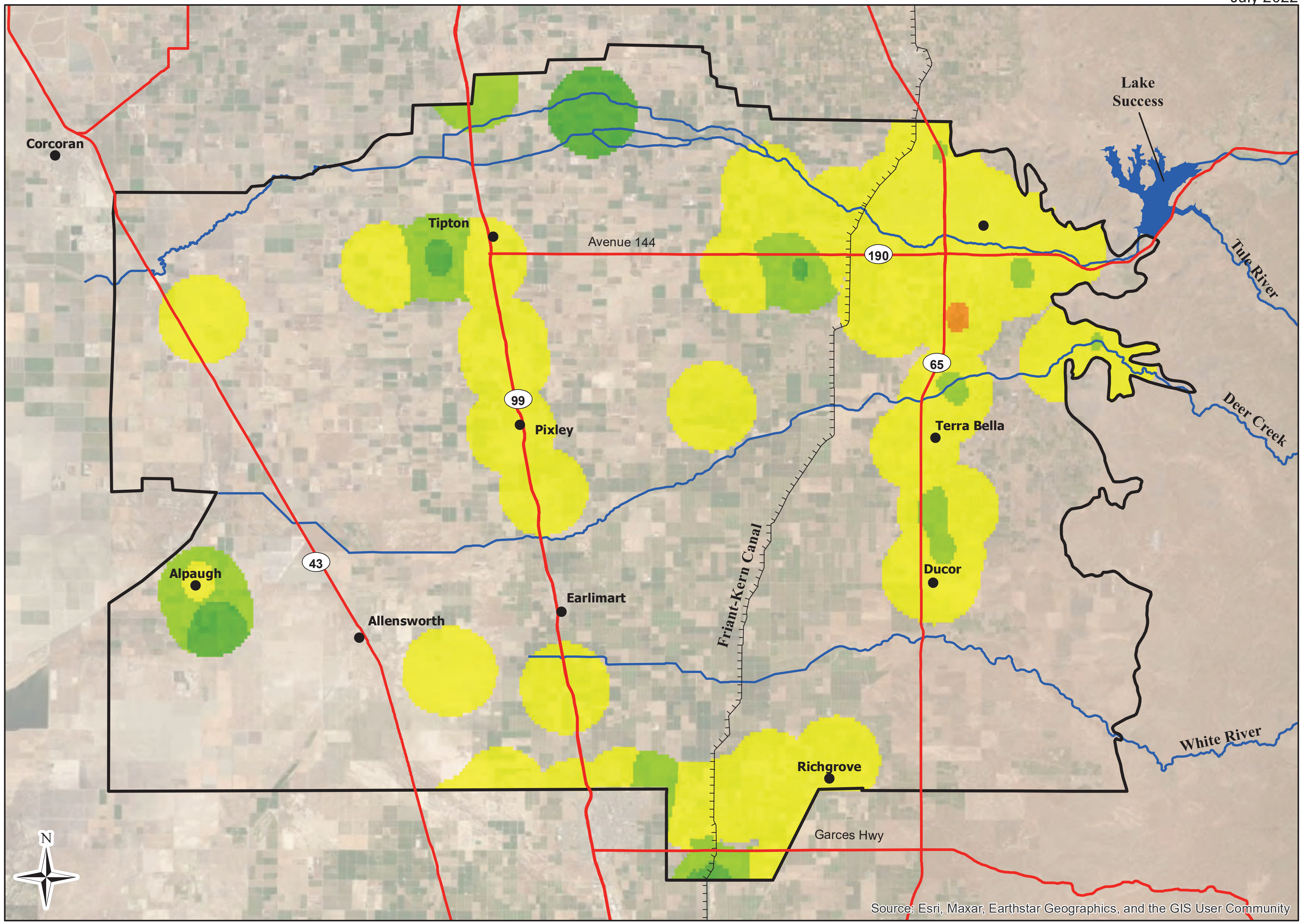
0 2.5 5 10 Miles
NAD 83 State Plane Zone 4

Total Dissolved Solids Concentrations

Figure 2-14h

Tule Subbasin

July 2022



Map Features

Ambient Perchlorate Concentration, 2017 - 2022 (µg/L)

- 0 - 1.5
- 1.5 - 3.0
- 3.0 - 4.5
- 4.5 - 6.0
- 6.0+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

Thomas Harder & Co.
Groundwater Consulting

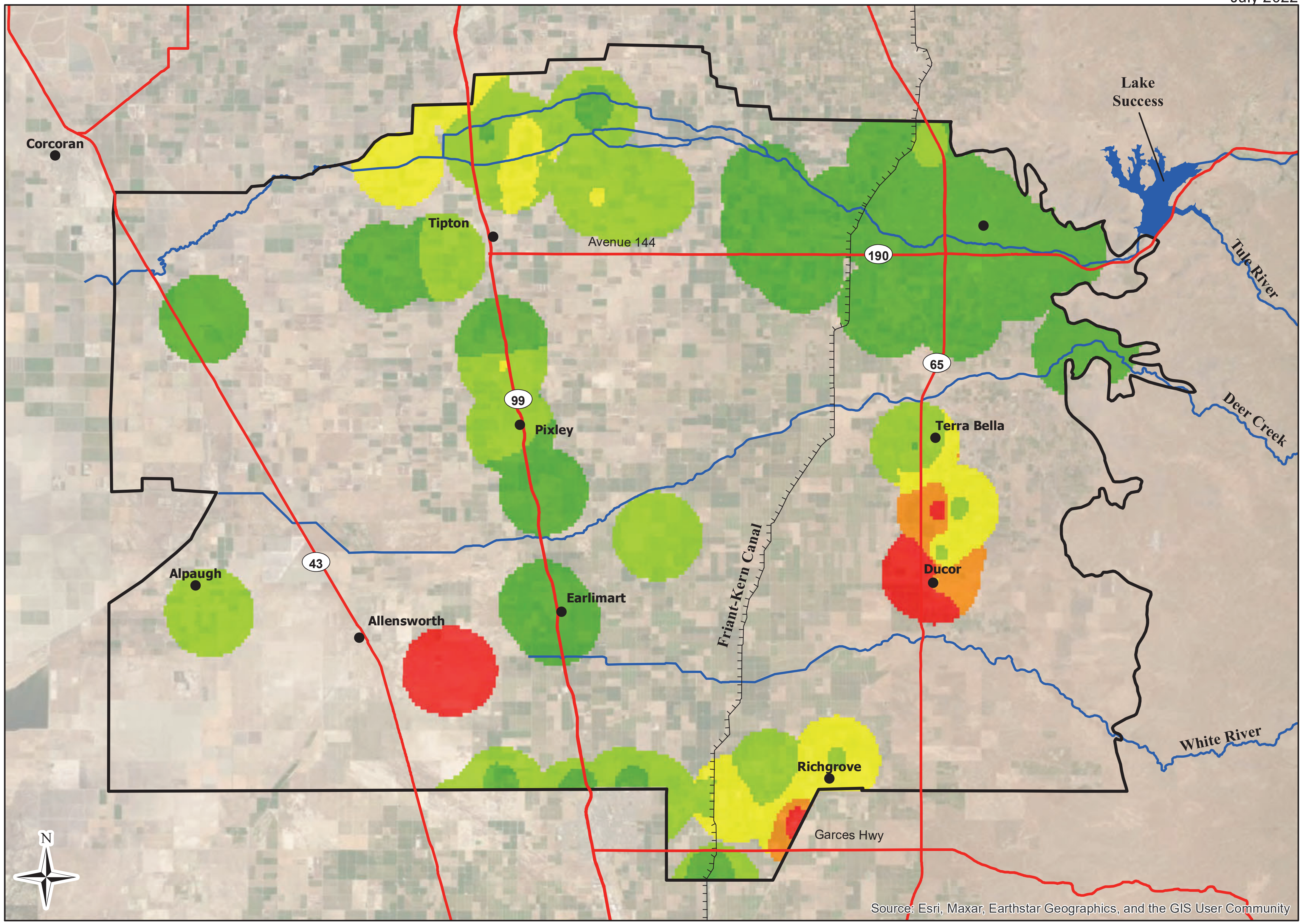
0 2.5 5 10 Miles
NAD 83 State Plane Zone 4

Perchlorate Concentrations

Figure 2-14i

Tule Subbasin

July 2022



Map Features

Ambient Chloride Concentration, 2017 - 2022 (µg/L)

- 0 - 26.5
- 26.5 - 53
- 53 - 79.5
- 79.5 - 106
- 106+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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Groundwater Consulting

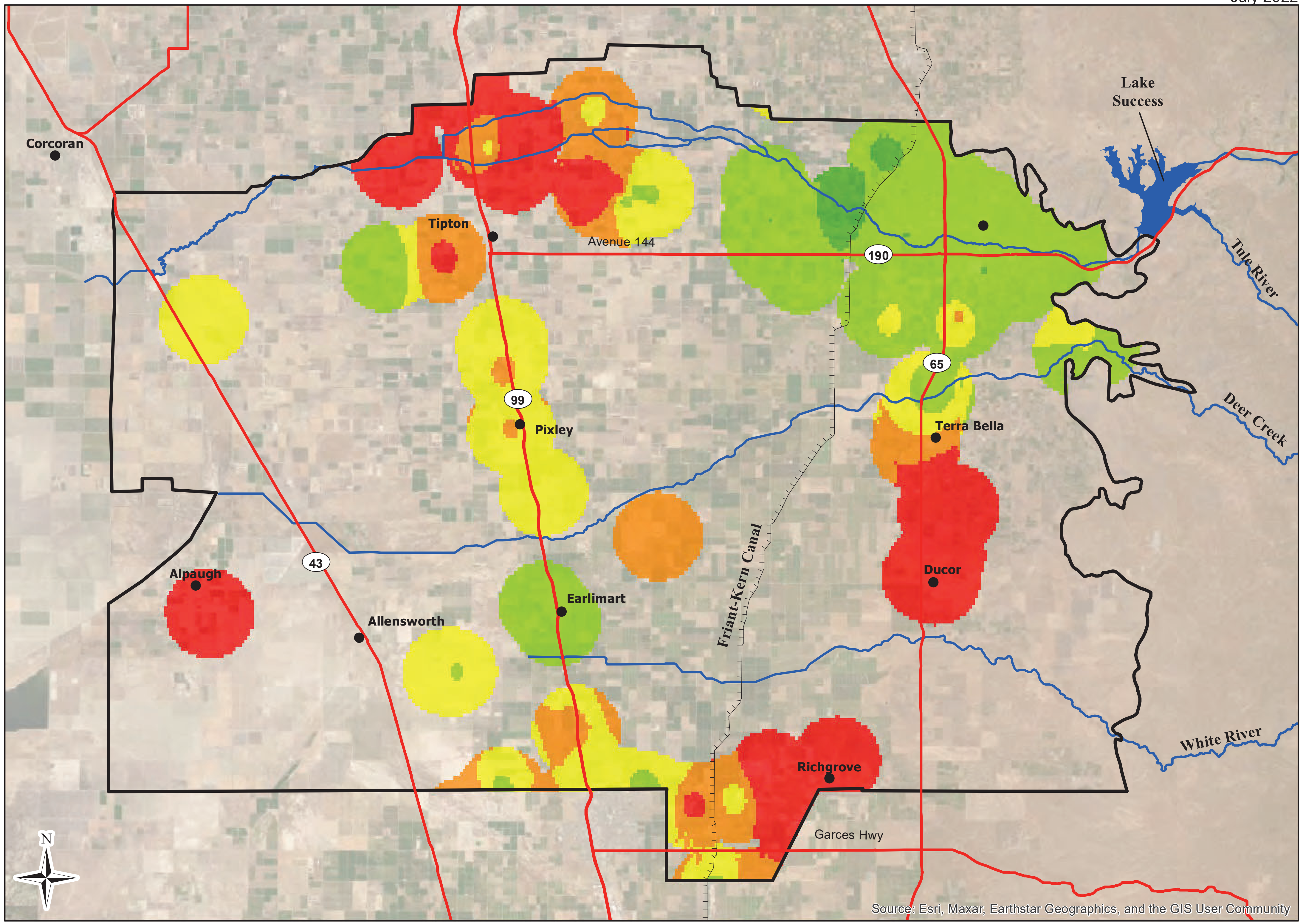
0 2.5 5 10 Miles
NAD 83 State Plane Zone 4

Chloride Concentrations

Figure 2-15a

Tule Subbasin

July 2022



Map Features

Ambient Sodium Concentration, 2017 - 2022 (µg/L)

- 0 - 17.25
- 17.25 - 34.5
- 34.5 - 51.75
- 51.75 - 69
- 69.0+
- City or Community
- Friant-Kern Canal
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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Groundwater Consulting

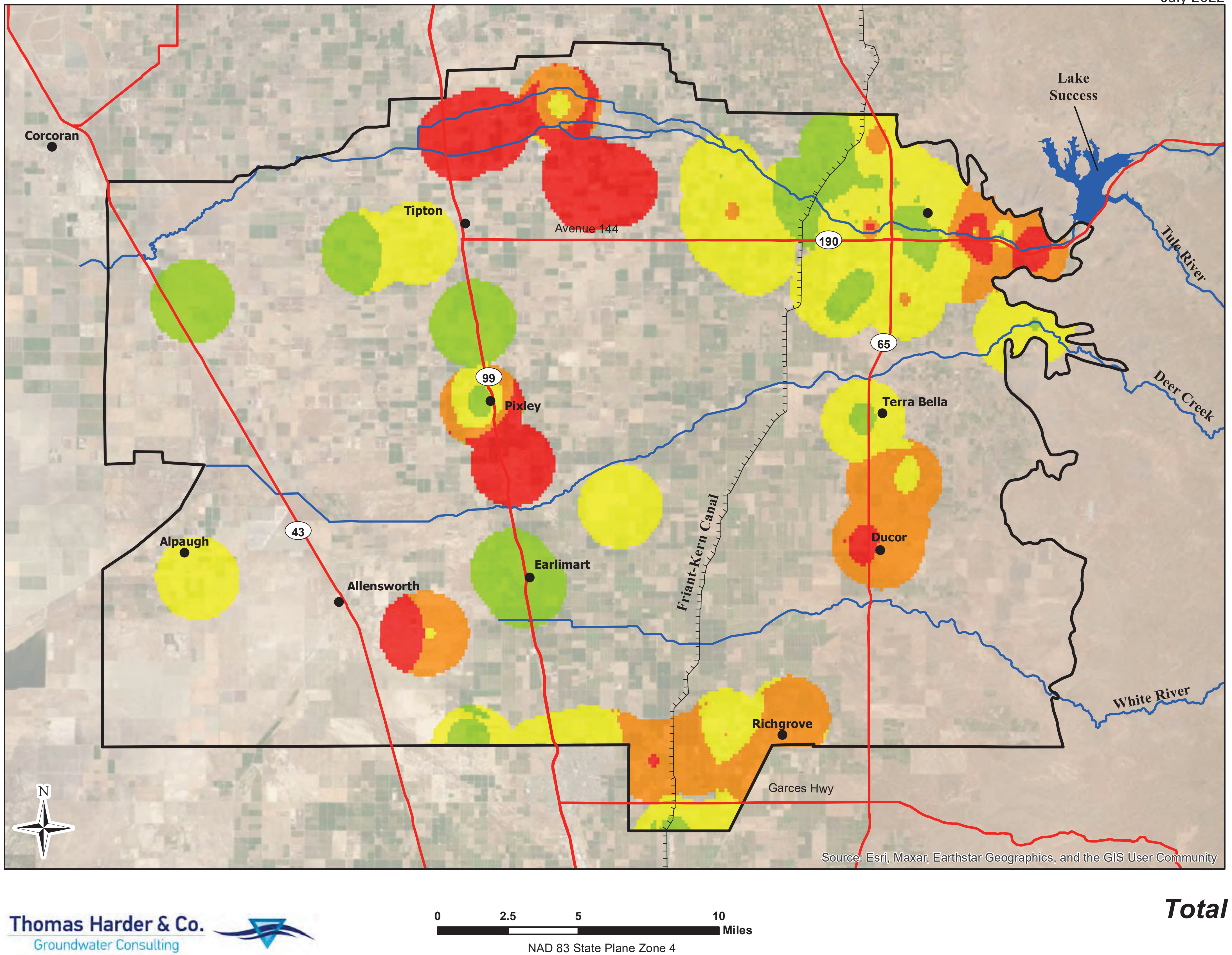
0 2.5 5 10 Miles
NAD 83 State Plane Zone 4

Sodium Concentrations

Figure 2-15b

Tule Subbasin

July 2022



Water Quality Data from California Groundwater Ambient Monitoring and Assessment Program (GAMA)

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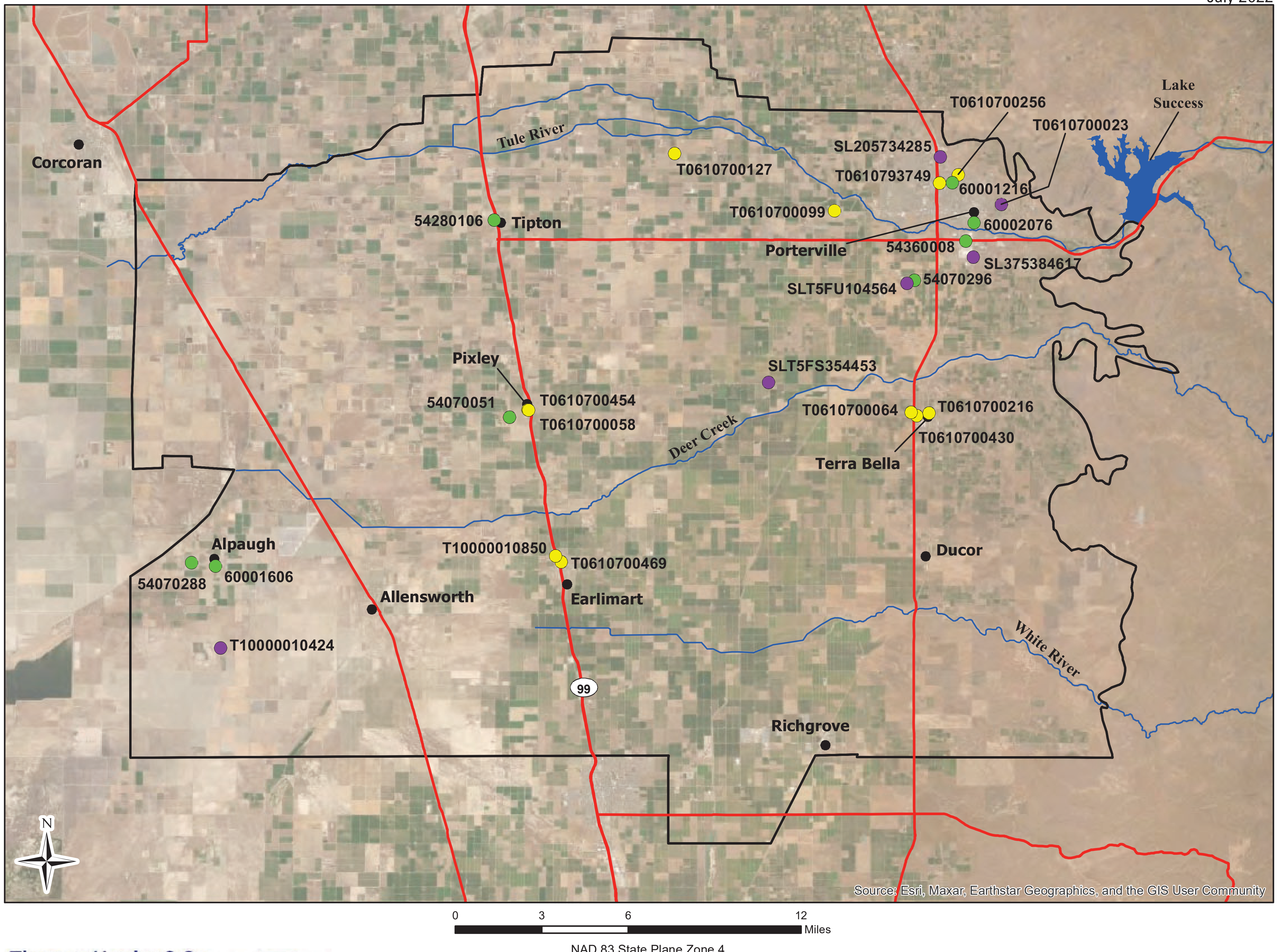
Total Dissolved Solids Concentrations

Figure 2-15c

Tule Subbasin

July 2022



Map Features

Active Cleanup Site
- Cleanup Program Site
- DTSC
- LUST Cleanup Site
- Freeway/State Highway
- Tule Subbasin
- City or Community
- Major Hydrologic Feature

Source: https://geotracker.waterboards.ca.gov

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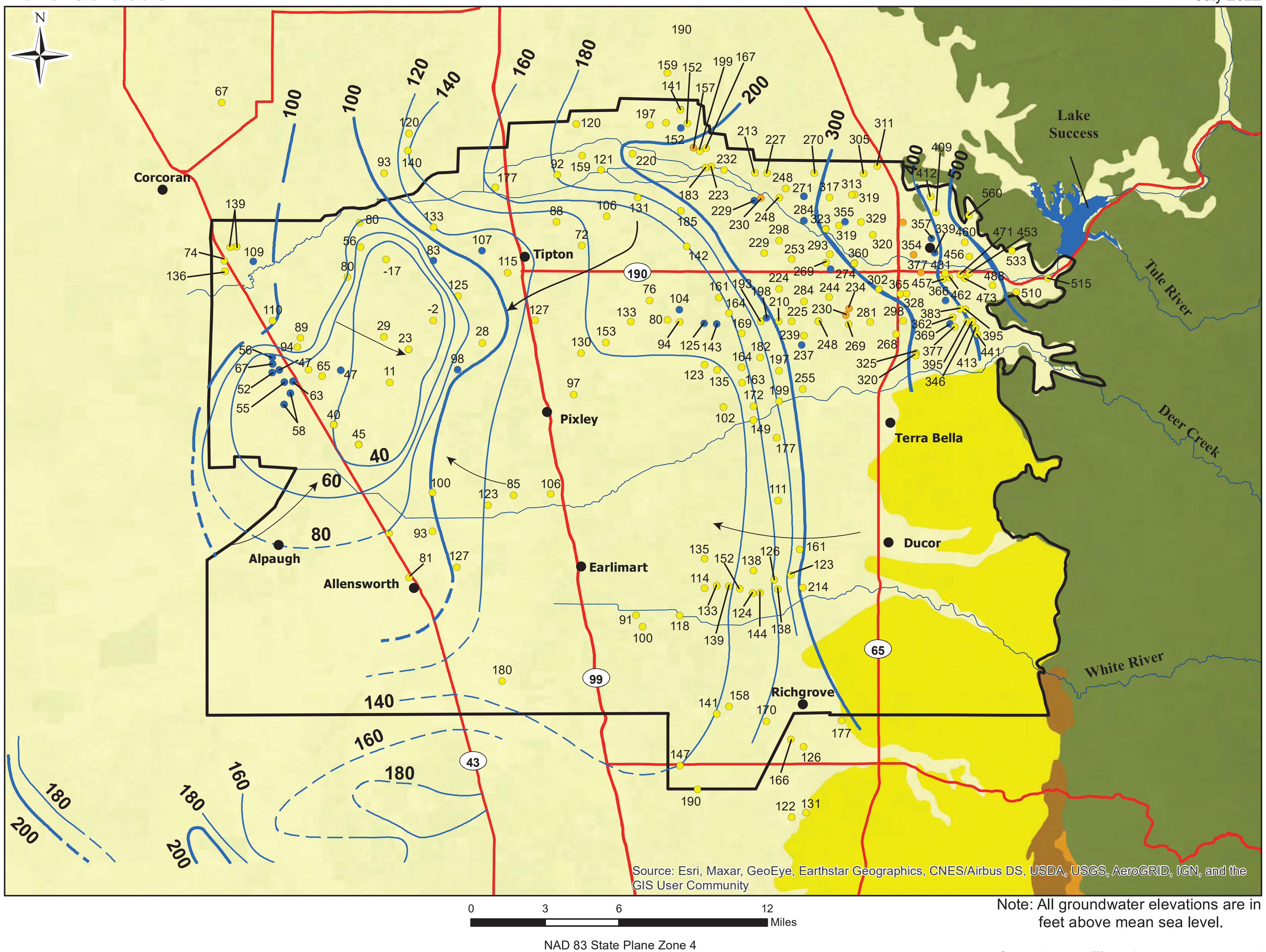
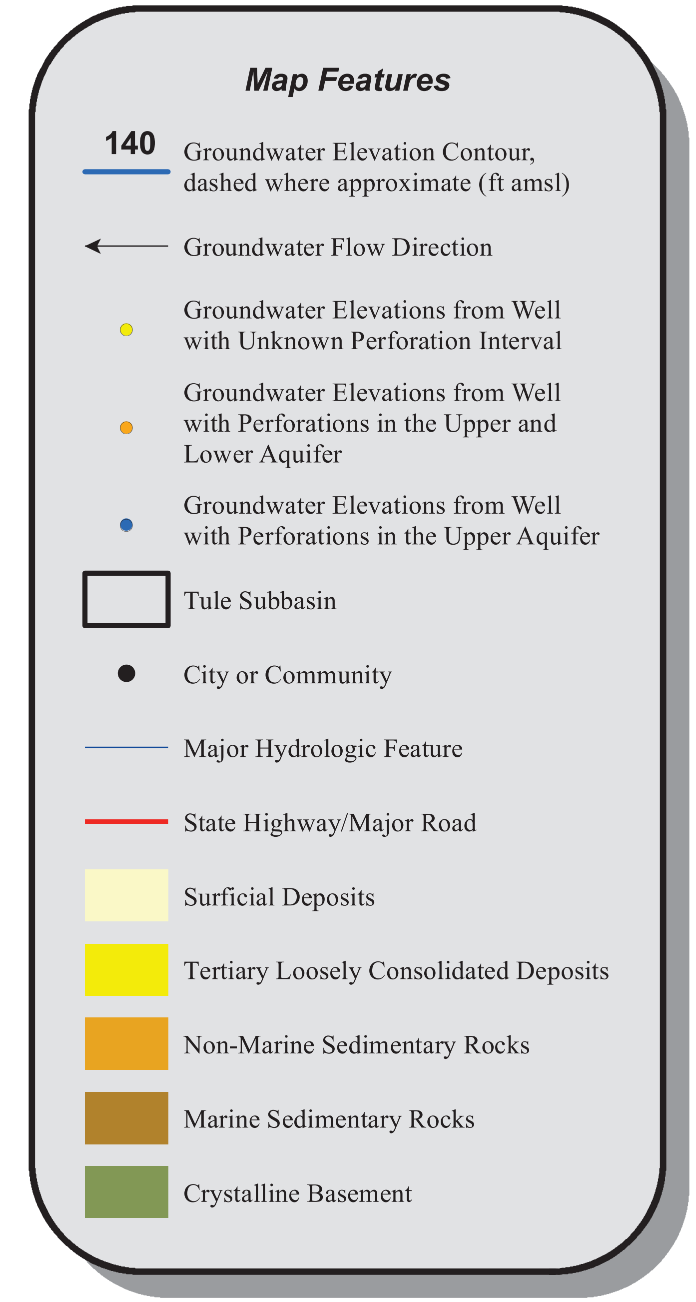
Active Cleanup Sites within the Tule Subbasin

Figure 2-16

Tule Subbasin

July 2022





Groundwater contours shown south of the Tule Subbasin and west of Highway 43 are depicted based on Water-Level Elevations And Direction of Groundwater Flow For the Upper Zone (Spring 2017)

Note: All groundwater elevations are in feet above mean sea level.

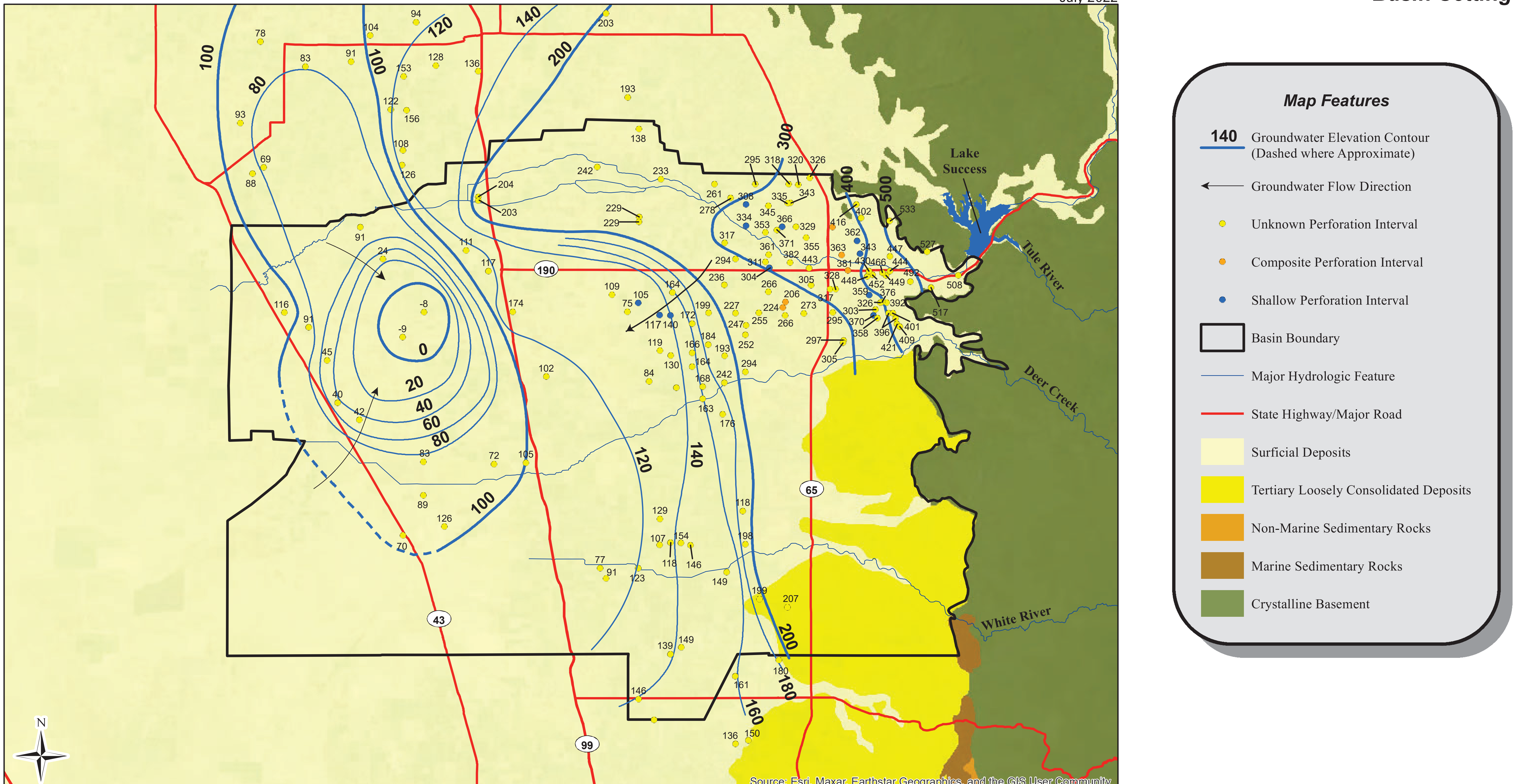
Groundwater Elevations are measured from January to May.

Spring 2017 Upper Aquifer Groundwater Elevation Contours

Figure 2-17

Tule Subbasin

July 2022



0 3 6 12 Miles

NAD 83 State Plane Zone 4

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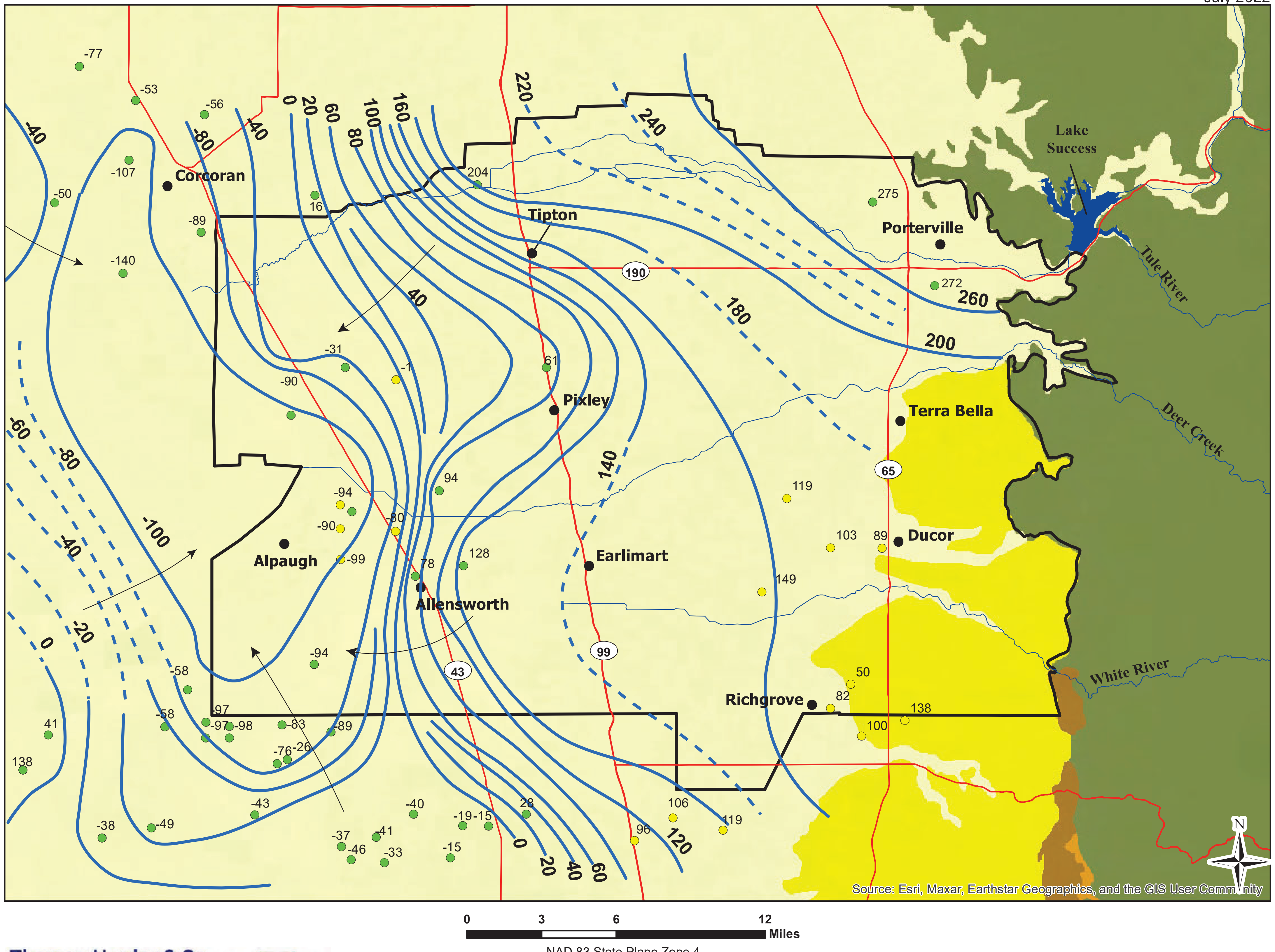
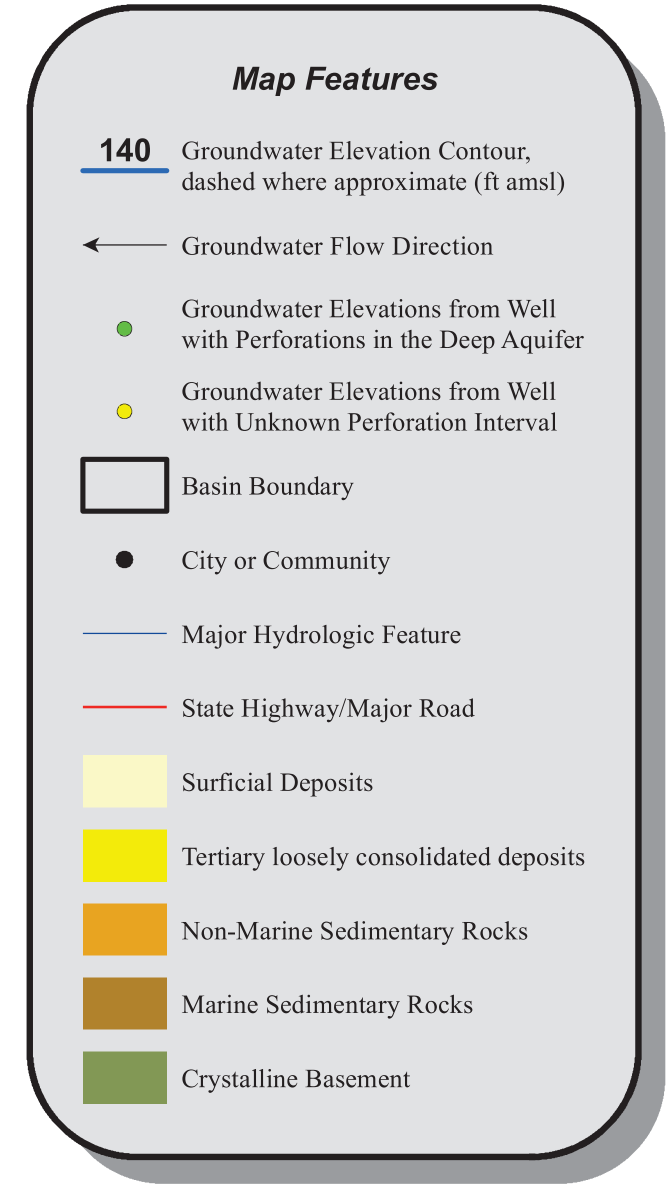
Fall 2017 Upper Aquifer Groundwater Elevation Contours

Figure 2-18

Tule Subbasin

July 2022





Note: All groundwater elevations are in feet above mean sea level.

Groundwater Elevations are measured from October to December.

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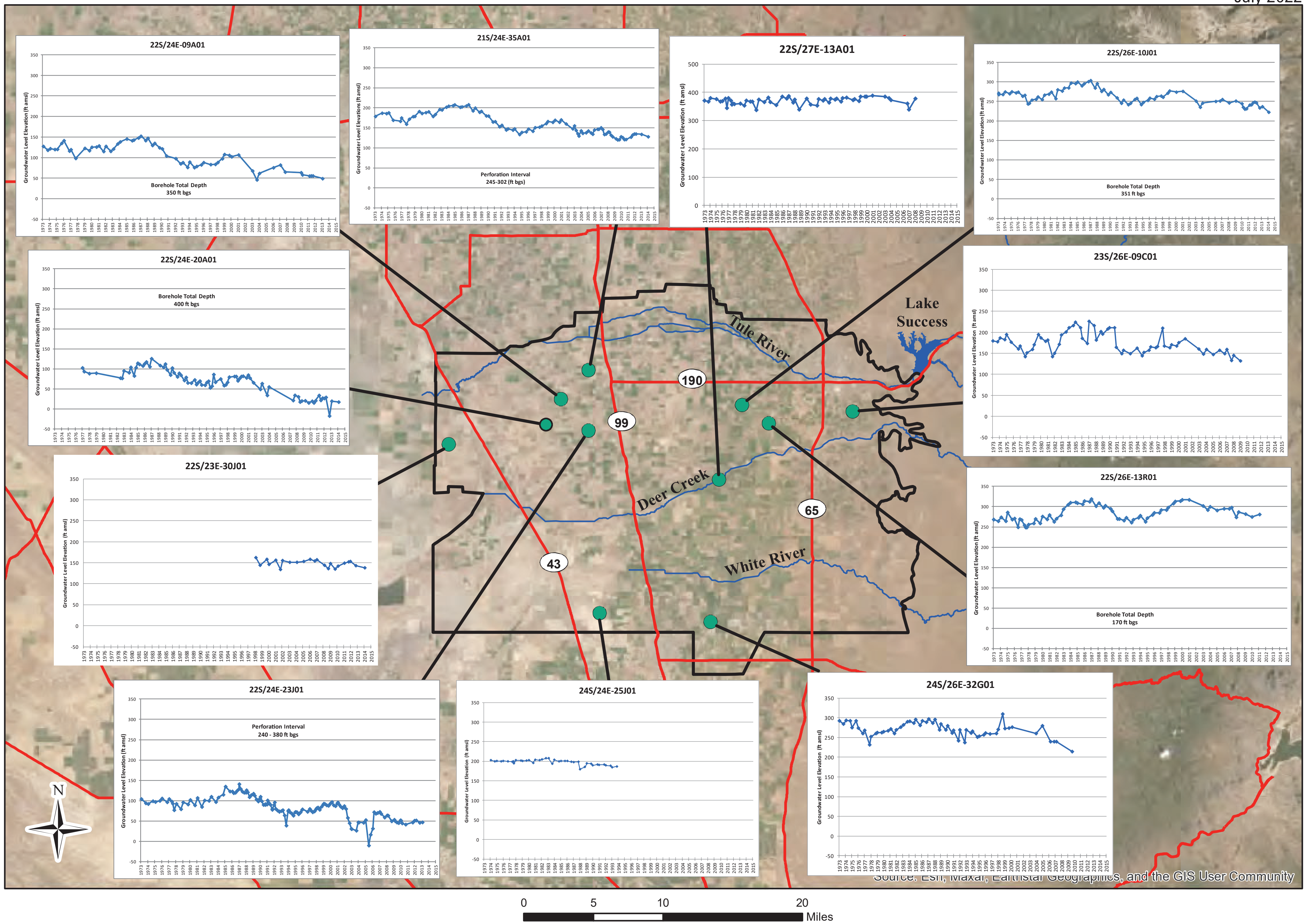
Fall 2010 Lower Groundwater Elevation Contour Map

Figure 2-19

Tule Subbasin

July 2022



NAD 83 State Plane Zone 4

Map Features

- Hydrograph Well
- Tule Subbasin
- Major Hydrologic Feature
- State Highway/Major Road

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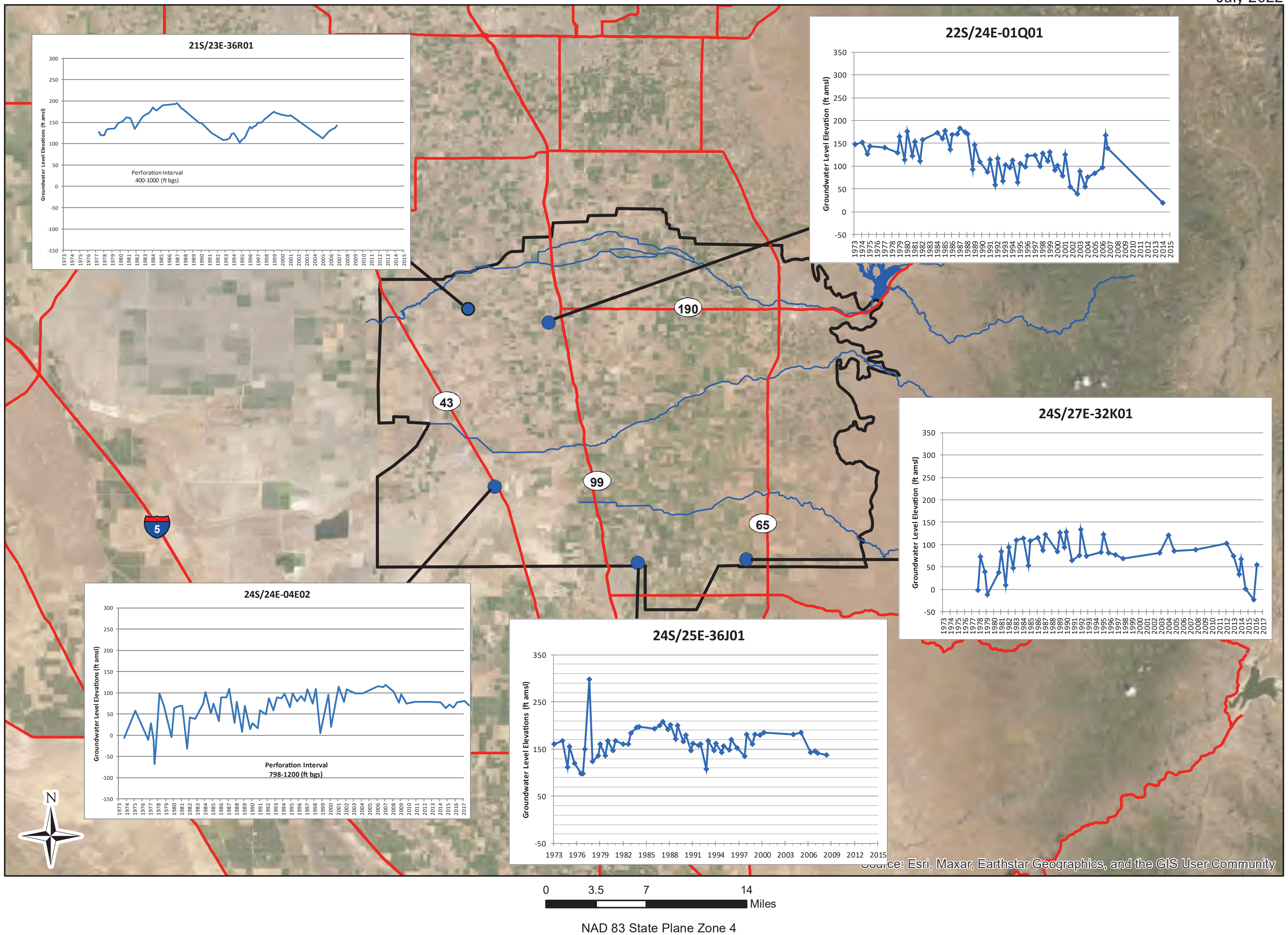
Upper Aquifer Groundwater Level Hydrographs

Figure 2-20

Tule Subbasin

July 2022



Map Features

- Hydrograph Well
- Basin Boundary
- Major Hydrologic Feature
- State Highway/Major Road

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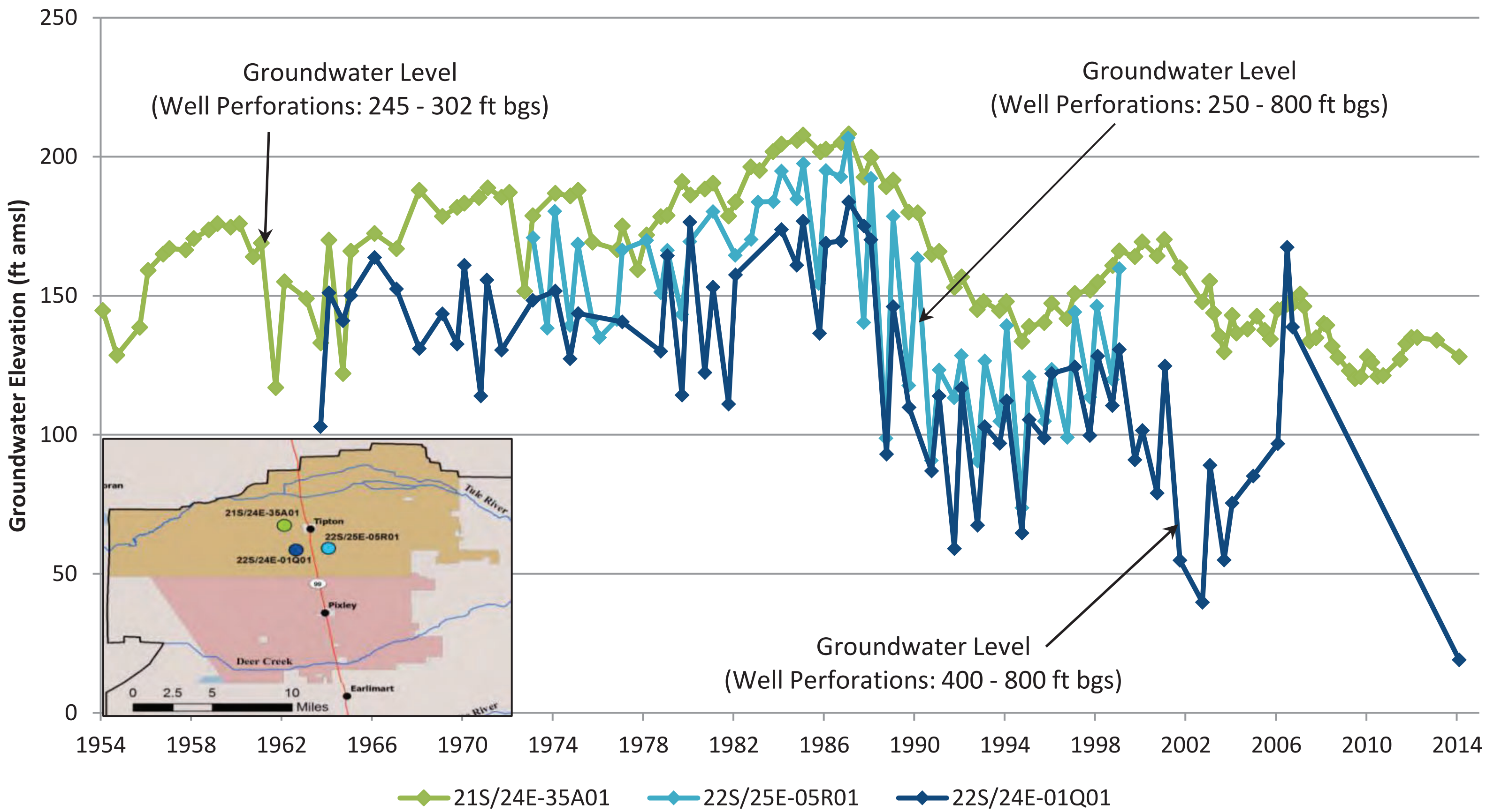
Lower Aquifer Groundwater Level Hydrographs

Figure 2-21

Figure 2-22

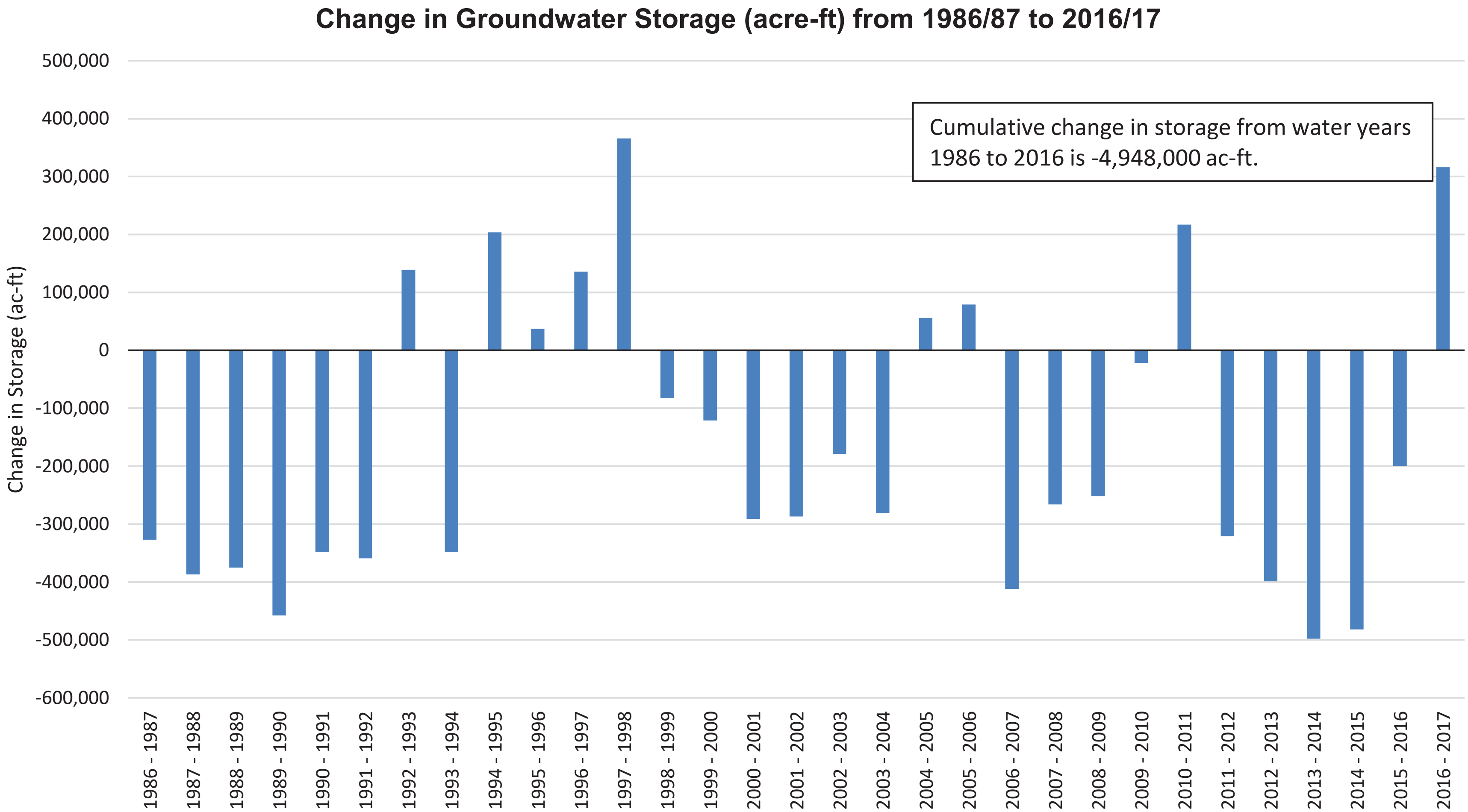
Groundwater Levels Near Tipton



Note:

ft bgs = feet below ground surface.

Figure 2-23



Note: Data in water years (October 1 to September 30).