

2.3. Groundwater Conditions

This section describes the groundwater conditions for Terra Bella Irrigation District (TBID) Groundwater Sustainability Agency (GSA) Groundwater Sustainability Plan (GSP) and includes information for the entire Tule Subbasin (Subbasin). Groundwater conditions within the TBID Plan Area were developed in accordance with California Code of Regulations (CCR), Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2, Section 354.16, and are described using publicly available data and work by Thomas Harder & Co (**Appendix A-2**). Chapter 2.2 of the *Tule Subbasin Setting* (**Appendix A-2**) describes groundwater conditions for the entire Subbasin and fulfills the regulatory requirements outlined in 23 CCR § 354.16.

2.3.1. Historical Groundwater Levels

Groundwater levels were evaluated using publicly available data, local datasets from TBID, and information included in the 2024 Tule Subbasin Coordination Agreement (2024 Coordination Agreement) (**Appendix A**), Attachment 2 *Tule Subbasin Setting* (**Appendix A-2**). There is some degree of uncertainty in which aquifer wells with historical water level data are screened. The following descriptions of groundwater levels across the Subbasin are based on Section 2.2.1 of the *Tule Subbasin Setting*.

2.3.1.1 Upper Aquifer

From approximately 1987 until 2015, groundwater levels in the Upper Aquifer wells consistently showed a downward trend. This occurred despite short periods of high rainfall, such as between 1995 and 1999 and in wet years like 2005 and 2011, which only temporarily caused levels to recover. Since 2015, however, groundwater levels in many Upper Aquifer wells across the Subbasin have generally stabilized, and some wells in the City of Porterville area currently show levels higher than those measured in 2015. Hydrographs showing historical groundwater levels across the area are presented in **Figure 2-18**.

Groundwater levels for four wells within the TBID Plan Area are presented in **Figure 2-19a**. Three (3) of the four wells do not include construction information. One well (E0037) is a composite well screened from 160 to 530 feet bgs. This composite well, screened on the eastern side of the TBID Plan Area near the Subbasin boundary, has had stable groundwater levels around 575 feet bgs since 2019. The other three monitoring wells without construction data have records going back to as early as the 1930's. Each of these locations has shown stable conditions across the TBID Plan Area, with groundwater levels around 450 feet in the central portion of the TBID Plan Area and approximately 350 feet bgs along the western side of the TBID Plan Area. All four wells in recent years have shown minimal seasonal fluctuations, which is indicative of limited groundwater pumping.

2.3.1.2 Lower Aquifer

Figure 2-19b illustrates groundwater level trends in wells that are perforated in the Lower Aquifer. These trends differ based on the well's location within the Subbasin. In the northwest area (Tri-County GSA Plan Area) of the Subbasin, groundwater levels have demonstrated a downward trend from 1999 to 2023. Groundwater levels in the areas have declined from approximately -25 feet msl to -175 feet msl during the drought from 2020 to 2022. In the southern part (Tri-County GSA Plan Area) of the Subbasin,

groundwater levels were relatively stable between 1987 and 2007, at which point water levels started to decline. Groundwater levels at this location have declined from approximately 50 feet msl in 1987 to -150 feet msl around 2023. A well located in the south-central portion of the Subbasin (Delano-Earlimart Irrigation District [DEID] GSA Plan Area) includes a Lower Aquifer well that has declined by approximately 60 feet from 2010 through 2023. Groundwater levels at this site were at historic lows during the drought from 2012 to 2016.

2.3.1.3 Pliocene Deposits

Figure 2-19c presents two Pliocene Deposit monitoring wells and one Santa Margarita monitoring well in the area of Tule East, Kern-Tule Water District (KTWD), and DEID Plan Areas. The Pliocene deposits are layers of siltstone containing minor interbedded sandstone that act to separate the underlying Santa Margarita Formation Aquifer from the Lower Aquifer. KTWD has confirmed that some private domestic wells within their Plan Area are completed in this formation. Groundwater levels measured in wells exclusively perforated in the Pliocene deposits suggest that these levels are, at least in local areas, higher than those observed in either the Lower Aquifer or the Santa Margarita Aquifer. As presented in **Figure 2-19c**, 24S26E1R1M and TSMW-6L have shown stable water levels over the past five years with groundwater elevations between 160 and 200 feet msl. These measurements in the Pliocene deposits are 140 and 260 feet higher than measurements made at the Santa Margarita monitoring TSMW-6SM, which ranged from -80 to 40 feet msl. Lower Aquifer water levels across the subbasin range from approximately 100 feet msl in the eastern portion of the Subbasin to approximately -150 feet msl in the western portion of the Subbasin.

2.3.1.4 Santa Margarita Aquifer

Groundwater levels within the Santa Margarita Aquifer exhibit both seasonal and long-term trends (**Figure 2-19d**). Seasonal fluctuations can be significant, with levels varying by as much as 140 feet between the seasonal high and low periods, and these large seasonal differences are most pronounced during dry hydrologic conditions. On a longer-term basis, seasonal high groundwater levels have generally remained stable since records became available around 2013, with variations ranging from approximately 20 to 30 feet. Historically, groundwater flow in the Santa Margarita Aquifer in the southeastern part of the subbasin (specifically the KTWD area) was to the west/southwest. Although data is limited, comparisons of groundwater levels in different wells within the Santa Margarita Aquifer suggest that this west/southwest flow direction persists during the wet season (October to May). However, during the primary pumping season (June to September), groundwater levels indicate a reversal in flow, with water appearing to move eastward in the central KTWD area. Since 2020, groundwater levels in the Santa Margarita formation have ranged from -90 to 70 feet msl.

2.3.2. Contours of Equal Groundwater Elevation, Flow Direction, and Gradients by Aquifer

Groundwater elevations are generally lower in the western portion of the TBID Plan Area in both the Upper and Lower Aquifers. Contours of equal groundwater elevations were obtained from Attachment 2 (*Tule Subbasin Setting*) (**Appendix A-2**) of the 2024 Coordination Agreement (**Appendix A**). These contours represent both seasonal high (spring) and seasonal low (fall) conditions for Water

Year (WY) 2022 and WY2024, representing dry and wet conditions, respectively. There is some degree of uncertainty in groundwater flow directions due to the use of wells with unknown construction within the contour figures.

2.3.2.1 Upper Aquifer

Groundwater flow patterns in the Upper Aquifer of the Subbasin have remained consistent since at least 1990. The primary regional feature is a persistent pumping depression situated in the west-central portion of the Subbasin, specifically west of Highway 99 and east of Highway 43, between the Tule River and Deer Creek. This feature, present since at least 1987, has fundamentally altered regional hydraulics by reversing natural flow directions in the western Subbasin and inducing subsurface inflow along the southern and western boundaries. While recharge from the Tule River creates a flow divide along the northern boundary, most groundwater moves from eastern recharge areas toward this central depression.

Seasonal conditions for the Upper Aquifer in WY2022, a critically dry year, are presented in **Figures 2-20a** and **2-20b**. For both spring and fall contours, groundwater flows from the eastern side of the Subbasin, where water levels are approximately 500 feet msl, to a cone of depression in the western portion of the subbasin, where groundwater levels are less than 20 feet msl. Within the TBID Plan Area, the Upper Aquifer was dry across more than 50% of the TBID Plan Area in the central and southeast portions. In the Northeast, where groundwater contours are present, flow is generally east to west, starting at approximately 500 feet in the east and declining to 300 feet in the west. The gradient across TBID for this period was 40 feet/mile. Groundwater conditions across TBID during Fall 2022, as presented in **Figure 2-20b**, Groundwater elevations across the contiguous portion of TBID in the Fall of 2022 are similar to the Spring of 2022, where groundwater elevation in the east is approximately 500 feet amsl, and groundwater levels to the west decline to about 320 feet amsl. Groundwater elevations across the western non-contiguous portion of TBID were approximately 320 feet amsl to 300 feet amsl from east to west. Consistent with spring conditions, groundwater flow across the Subbasin is generally to the west toward the existing cone of depression. The groundwater level gradient during the fall of 2022 was approximately 33 feet/mile.

WY2024 was designated as an Above Normal Year, with spring and fall conditions for WY2024 presented in **Figures 2-21a** and **2-21b**. Groundwater flow patterns in 2024 are generally consistent with WY2022, where groundwater flow is from east to west, towards the apparent cone of depression within the PIXID Plan Area. Groundwater elevations were slightly higher during this Above Normal Year throughout the Subbasin but remained stable within the TBID Plan Area. Groundwater elevations during the spring and fall of 2024, within the contiguous portion of the TBID Plan Area, ranged from 500 feet amsl in the east to 320 feet amsl in the west (**Figure 2-21a** and **2-21b**). In the non-contiguous portion of the TBID Plan Area, groundwater elevations ranged from 320 feet amsl in the east to 300 feet amsl in the west (**Figures 2-21a** and **2-21b**). During the spring and fall of WY2024, the groundwater flow gradient was approximately 33 feet/mile toward the southwest.

2.3.2.2 Lower Aquifer

In the Lower Aquifer, the direction of groundwater flow is toward the west and southwest. While this direction of flow has remained consistent over time, groundwater pumping in the central and western portions of the Subbasin has created lower groundwater elevations similar to the Upper Aquifer. Unlike the Upper Aquifer, a distinct cone of depression is not consistently present within the Subbasin for the Lower Aquifer. If a cone of depression is present, it appears to extend beyond the boundaries of the Subbasin. Contours of equal groundwater elevations from the *Tule Subbasin Setting* (**Appendix A-2**) for the Lower Aquifer are presented in **Figures 2-22a, 2-22b, 2-23a, and 2-23b**. There is a higher degree of uncertainty for groundwater flow direction in the Lower Aquifer, compared to the Upper Aquifer, due to fewer wells with known construction data within the Lower Aquifer and the use of data from wells with incomplete well construction data. Contours of equal groundwater elevations within the TBID Plan Area are projected in part based on surrounding wells outside of TBID.

During the spring of 2022, across the contiguous portion of TBID, groundwater elevations were 500 feet amsl to the east and declined to about 120-100 feet amsl on the western boundary (**Figure 2-22a**). Groundwater elevations across the eastern non-contiguous portion of TBID near the Friant-Kern Canal (FKC) ranged from 140 feet amsl to less than 100 feet amsl from east to west (**Figure 2-22a**). The groundwater level gradient during the spring of 2022 for the Lower Aquifer was about 34 feet/mile. During the fall of 2022, groundwater elevations for the Lower Aquifer had a greater degree of uncertainty and were projected using wells outside of TBID due to limited data from wells within the TBID Plan Area. In the contiguous portion of TBID, groundwater elevations were similar to those in the spring of 2022 and ranged from 500 feet amsl to 100 feet amsl from east to west (**Figure 2-22b**). Groundwater elevations across the non-contiguous portion of TBID ranged from 61 feet amsl to 20 feet amsl from east to west (**Figure 2-22b**). The groundwater level gradient during the fall of 2022 was approximately 76 feet/ mile. The groundwater elevation in the vicinity of the Upper Aquifer cone of depression is between -100 and -140 feet amsl in the spring and between -100 and -160 feet amsl in the fall.

Spring and fall conditions for WY2024 are presented in **Figures 2-23a and 2-23b**. During the spring of 2024, groundwater elevations were between 400 feet and 160 feet amsl throughout the contiguous portion of the TBID Plan Area (**Figure 2-23a**). The western-most non-contiguous portion had elevations between 140 feet amsl and less than 120 feet amsl from east to west. The groundwater flow gradient was approximately 41 feet/mile during the spring of 2024. A cone of depression is present in the northwestern corner of the PIXID Plan Area, with a groundwater elevation of -100 feet amsl. During the fall of 2024, Lower Aquifer groundwater elevations were approximately 400 feet amsl to approximately 300 feet amsl for the majority of the Plan Area (**Figure 2-23b**). The non-contiguous portion of the Plan Area to the west had elevations between 100 feet amsl and 40 feet amsl from east to west (**Figure 2-23b**). The groundwater flow gradient during the fall was approximately 24 feet/mile. The groundwater elevation in the Lower Aquifer at the location of the Upper Aquifer cone of depression is -140 feet amsl in the fall of 2024.

2.3.2.3 Vertical Hydraulic Gradients

A vertical hydraulic gradient refers to either upward or downward flow that occurs within a given aquifer. There is minimal data from monitoring wells with known construction within the TBID Plan Area. Well 23S28E04K001M, presented in **Figure 2-19a**, shows water levels from a well screen across both the Upper and Lower Aquifers with a screen interval between 160 and 530 feet below ground surface. Based on the groundwater elevation contours discussed in the previous section, which utilize groundwater elevation from outside of TBID, Upper Aquifer groundwater levels are typically between 500 feet msl in the east and 300 feet msl in the west. In the Lower Aquifer, groundwater elevations are typically between 400-500 feet in the east and approximately 100 feet msl to the west. This suggests that across TBID, there is a downward gradient that increases moving east to west.

2.3.3. Change In Groundwater Storage

Section 2.3 of the *Tule Subbasin Setting* describes the historical cumulative and annual change in groundwater storage for the entire Subbasin, from years WY1987 to WY2023. The average annual change in groundwater storage is estimated to be 192,800 acre-feet/year (AFY), with a cumulative total change of -7,000,000 acre-feet (AF).

Based on the water budget developed for the TBID Plan Area using the Tule Subbasin groundwater flow model, the average annual change in groundwater storage for the TBID Plan Area is estimated to be -1,800 AFY when accounting for lateral groundwater flows. The average annual change in groundwater storage when discounting for subsurface inflows and outflows was -500 AFY. The cumulative change in storage from WY1987 to WY2024 is -67,800 AF. The average annual groundwater pumping simulated in TBID was -10,200 AFY, which will be verified with the implementation of groundwater metering programs. Groundwater pumping and change in storage values for TBID are represented in **Figure 2-24**.

2.3.4. Land Subsidence

2.3.4.1 Historical Subsidence

Land subsidence in the Tule Subbasin is attributed to the decrease in groundwater levels due to groundwater pumping in areas where the subsurface sediments are composed of thick sequences of fine-grained material, such as silt and clay (Lofgren and Klausning, 1969). Historical subsidence in the Tule Subbasin prior to the early 1980s has been relatively well-documented. However, data in more recent decades have been limited due to a decrease in subsidence data collection. Subsidence has been evaluated based on studies that use a combination of the following data sources: benchmark surveys, extensometers, Interferometric Synthetic Aperture Radar (InSAR), and Global Positioning Systems (GPS).

Land subsidence based on InSAR data (DWR, 2025) collected throughout the Tule Subbasin from January 2015 to January 2020 is presented in **Figure 2-25a**. In addition to the cumulative subsidence over the Subbasin, **Figure 2-25a** also includes the average pumping for each GSA over the historical period (**Appendix A**). Subsidence across the Subbasin ranged from 0 feet (and minor uplift) along the eastern boundary to over 3 feet in the western/northwestern portion of the Subbasin. The southwest corner of the Subbasin in the Tri-County Water Authority GSA Plan Area experienced less subsidence than the

areas to its north, with displacement between 0.25 and 2.5 feet. The entire eastern boundary of the Subbasin generally experienced less than 0.25 feet of subsidence, starting in the northern portion of PID, wrapping around to the southeastern part of the DEID Plan Area. Subsidence across the Subbasin appears to be radiating from a cone of depression located in the Lower Tule River ID GSA (LTRID GSA) and the Pixley ID GSA (PIXID GSA). These areas correspond to areas with the most groundwater pumping and the lowest groundwater elevation (**Figures 2-20 through 2-23**). Over the historical period, the LTRID GSA with a Plan Area of 100,000 acres pumped on average 245,000 AFY (2.45 AFY/acre), and the PIXID GSA with a Plan Area of 67,600 acres pumped approximately 157,000 AFY (2.3 AFY/acre). Additionally, the areas where most subsidence is occurring are the areas where the Corcoran Clay is present west of Highway 99. Pumping numbers were obtained from annual report data and water budget tables included in the *Tule Subbasin Setting* (**Appendix A-2**).

Figure 2-25b presents a subsidence profile showing the cumulative vertical displacement between 2015 and 2020 along an east-west transect crossing the TBID Plan Area to the western boundary of the Subbasin. Over this 5-year period, the greatest amount of subsidence occurred between Highway 99 and Highway 43. Average pumping in the TBID Plan Area over this 5-year period was 2,900 AFY. In the western portion of TBID, minor subsidence has occurred near the FKC, and subsidence increased to the west. The non-contiguous western portion of the TBID Plan Area, which shares a boundary with the TBID Plan Area, had cumulative subsidence of up to approximately one foot. The non-contiguous western portion of TBID does not account for any groundwater pumping and is used to recharge surface water from Deer Creek (S. Geivet, Personal Communication, April 24, 2025).

The pattern of subsidence in the DEID GSA is similar to that of the TBID Plan Area. Most of the DEID GSA experienced minimal to no subsidence, with a gradient of increasing subsidence to its northwest toward PIXID GSA. The southeast part of the DEID Plan Area saw less than 0.25 feet of subsidence. The northwest corner of the DEID Plan Area, along its boundary with Tri County Water Authority and PIXID Plan Areas, saw as much as 1.5 feet of subsidence, similar to the PID Plan Area western and southern boundary with the LTRID Plan Area. For comparison, the TBID Plan Area pumped on average 10,200 AFY over 13,900 acres (0.76 AFY per acre). The TBID Plan Area, like the DEID Plan Area, is being affected by groundwater conditions in the western part of the Subbasin. Along the FKC, the largest amount of subsidence within the DEID Plan Area was along the DEID Plan Area's northern boundary, where there was as much as one foot of subsidence.

Data from a continuous GPS monitoring station (P056) and a US Geological Survey (USGS) extensometer are presented in **Figures 2-26 and 2-27**. A UNAVCO continuous GPS monitoring station is typically constructed by installing a stable geodetic monument into bedrock or a stable concrete structure. The purpose of this station is to measure changes in land surface elevation that are directly related to land subsidence caused by groundwater pumping. The USGS extensometer consists of a 2-inch diameter steel pipe that is anchored within a 12-inch diameter well at a depth of 1,180 feet bgs. The well is perforated from 1,083 feet to 1,280 feet, and groundwater measurements are collected daily using a pressure transducer. GPS station P056 has the longest record with surface elevation measurements starting in November 2005. This station is located west of TBID at the Porterville Municipal Airport. Extensometer (22S/27E-30D2) has the second-longest data set with records starting in 2018 (USGS, 2025), and it is located on the eastern boundary of the Saucelito Irrigation District (SID) Plan Area along the FKC. The last

site, a GPS monitoring station (PORT) located in the city of Porterville, directly north of TBID, has data since October 2021 (SOPAC-CSRC, 2025). To determine annual compaction from the extensometer and subsidence from the other two land surface stations, data from these sites are compared using January measurements in order to discount for any elastic subsidence.

Data for P056 is presented in **Figure 2-26**. From January 2006 to January 2020, the total vertical displacement was 2.55 feet. This figure also depicts the annual change in subsidence (secondary y-axis) and the water year type for each year (x-axis) based on the San Joaquin River Index. Subsidence was minimal (<0.1 foot/year) prior to 2012.

Between 2012 and 2020, there were five consecutive Dry or Critical Dry Years, two wet years, and one below normal year, which led to an additional 2.15 feet of subsidence at P056. In 2016, the fifth year of one of California's worst droughts on record, there was an additional 0.44 feet of subsidence in one year.

Data from 22S/27E-30D2 (extensometer) and PORT (GPS station) are presented in **Figure 2-27**. Data collection for the extensometer began in June 2018 (USGS, 2025). From January 2019 to January 2020, this monitoring site recorded 0.32 feet of compaction. Extensometer data indicate a declining trend in vertical displacement prior to 2022. After 2022, vertical displacement plateaus with minor seasonal variation, with a positive trend near the end of 2024 and beginning of 2025 (**Figure 2-27**). The PORT monitoring site had not been constructed prior to GSP implementation. Similar to the extensometer data, the vertical displacement shows a positive trend near the end of 2024 and the beginning of 2025, suggesting a decrease in land subsidence.

In addition to InSAR, GPS, and extensometer data, subsidence has been monitored by surveying benchmarks, primarily in the vicinity of the FKC. Benchmarks along the FKC were surveyed by the FWA between two separate ranges of time: 1) from 1959 to the early 1980's, and 2) from 2017 to 2019. Survey data indicated that cumulative land subsidence along the FKC ranged from 1.7 feet, where the canal and Tule River intersect near Porterville, to approximately 9 feet of land subsidence near Deer Creek between 1959 and 2017.

2.3.4.2 Subsidence During GSP Implementation (January 2020 – January 2025)

Cumulative land subsidence based on InSAR data throughout the Tule Subbasin from January 2020 to January 2025 is presented in **Figure 2-28a**. The general pattern of subsidence across the Subbasin is consistent with the 2015 to 2020 period. The eastern portion of the subbasin experienced minimal to no subsidence, with the greatest amount of subsidence occurring in the western portions of the subbasin. The amount of subsidence over this time frame is greater than the previous period, with values greater than 3.5 feet in the LTRID Plan Area and the PIXID Plan Area.

Figure 2-28b is an east-west land subsidence profile across the TBID Plan Area and the Subbasin. This figure illustrates the difference in magnitude of subsidence that has occurred in the eastern and western portions of the Subbasin based upon cumulative InSAR data from 2020 to 2025. This transect shows that along the central part of the basin, the gradient of land subsidence is gradual from the basin boundary near the base of the Sierra Nevada Mountain Range to just east of the FKC. The amount of subsidence increases westward, starting near the FKC, with the greatest levels of subsidence within the PIXID Plan

Area, which has a cumulative subsidence of just over three feet. Near the eastern end of the transect, within the TBID Plan Area, land surface displacement was minimal, with subsidence of up to approximately 0.1 feet. This figure, along with others for subsidence and water levels, illustrates the regional impact of groundwater management. Groundwater flow is to the west for both the Upper and Lower Aquifers (**Figures 2-20a** through **2-23b**). Areas with the lowest groundwater elevation and the greatest amount of subsidence correspond to the areas with the most groundwater pumping. Due to the relatively small areal extent of the TBID Plan Area, as well as its historic pumping that is less than its in-Plan Area recharge, propagation of groundwater pumping-induced subsidence from GSAs west of the TBID Plan Area to the area underlying the non-contiguous portion of the TBID Plan Area and the FKC can be misinterpreted as subsidence caused solely by TBID.

In addition to the land subsidence profile across the east-west transect between 2020 and 2025 (**Figure 2-28b**), InSAR data collected and evaluated over one-year timeframes for each of these years are represented in **Figures 2-29a** through **2-29f**. For each profile, vertical displacement associated with land subsidence is represented beginning with January 1st of each designated year, with the exception of 2025. As 2025 is in progress, **Figure 2-29f** represents land subsidence that occurred from February 1st, 2024, to February 1st, 2025.

Within the TBID Plan Area, during the time period of January 2020 to January 2025, InSAR data indicate that a maximum of 1.75 feet of land subsidence occurred in the western non-contiguous portion of the Plan Area near the vicinity of Deer Creek and on the east side of the FKC. Minimal subsidence occurred throughout the eastern contiguous portion of the Plan Area, with some minor uplift occurring in the eastern half of the Plan Area (**Figures 2-28a** and **2-28b**). The average amount of subsidence within the TBID Plan Area was 0.2 feet from January 2020 to January 2025.

Subsidence is greatest 10 to 20 miles west of the TBID Plan Area, where the vertical displacement ranged from 2.5 feet to approximately 3 feet within the LTRID Plan Area and PIXID Plan Area. It appears as if the amount of groundwater pumping west of TBID, which has resulted in a steep western gradient for lateral groundwater flow, has contributed to subsidence in the eastern portion of the Subbasin and along the FKC.

In DEID, subsidence from 2020-2025 appears to have increased from the previous 5-year period, especially along its northwest boundaries. Areas south of the White River saw up to 0.75 feet of subsidence, with areas to the north experiencing up to 1.75 feet along the FKC. This increase in subsidence near the FKC could have been the result of increased pumping across the Subbasin. Average pumping based on the DEID Plan Area, based on the water budget tables in the *Tule Subbasin Setting*, was 44,600 AF/year (**Appendix A-2**). From 2020 through 2024, the average pumping within the DEID Plan Area has increased to 72,000 AF/year (INTERA, 2023).

Figure 2-26 presents vertical displacement data for P0056. Post-GSP implementation, annual subsidence has decreased from what occurred prior to the drought from 2012 through 2016. The annual subsidence was still relatively high from 2020 through 2022, which were all Dry or Critically Dry Years, but 2023 saw the lowest annual subsidence since 2011, with less than 0.1 feet/year. From 2020 through 2024, the cumulative subsidence increased from -2.54 to -3.39 feet, or an average of 0.21 feet/year.

Figure 2-27 includes vertical displacement data from GPS station PORT and compaction data from the extensometer 22S/27E-30D2. PORT, which began measuring land surface elevation in 2021, has shown near-zero subsidence near the City of Porterville. These measurements are consistent with InSAR data for this same area. 22S/27E-30D2, as of Spring 2025, has measured approximately 0.85 feet of compaction, which is consistent with the change in land surface elevation from InSAR. The InSAR data indicated a change in land surface elevation between 0.75 and one foot at the extensometer location between 2020 and 2025.

Additionally, land subsidence has been monitored, primarily in the northeastern region of the Tule Subbasin for the Eastern Tule Groundwater Sustainability Area (ETGSA) Land Subsidence Monitoring Program (LS Monitoring Plan) provided as **Appendix G**. One of the objectives of the LS Monitoring Plan is to implement sustainable groundwater management measures in order to mitigate non-recoverable land subsidence along the FKC between 2020 and 2040. Additional details for this program are discussed in the ETGSA Land Subsidence 2021/22 and 2022/23 Annual Reports (Thomas Harder & Co, 2023; 2024). The LS Monitoring Plan entails the collection of benchmark, GPS, extensometer, and InSAR data throughout a 4-mile-wide LS Monitoring Plan Area centered around the FKC (**Figure 2-30**), and it is a subset of a larger benchmark monitoring network that extends throughout the Tule Subbasin. In addition to the Tule East Plan Area, the LS Monitoring Plan Area also encompasses areas within the vicinity of the TBID Plan Area and along the boundaries of adjacent GSP Plan Areas.

Benchmark identification numbers are indicated on **Figure 2-30**, which correlate with subsidence data from 2021 to 2025 provided in **Table 2-5**. Subsidence monitoring by means of benchmark surveys began at varying times between 2020, 2021, and 2022. Vertical displacement associated with land subsidence was calculated based on annual benchmark surveys, which are represented in **Table 2-5**. All presented measurements were collected annually during the summer months (June-August) of each year. Based on the surveys, cumulative land subsidence that occurred between 2021 and 2025 ranged from 0.31 feet (Benchmark ID: E0057_B_FKC) to 1.32 feet (P0094_B_RMS) over a four-year period. Additionally, 0.13 feet of Uplift occurred at one location (E0085_B_RMS).

2.3.5. Water Supply

TBID operates under a long-term water service contract with the US Bureau of Reclamation (USBR), entitling the district to up to 29,000 AFY of Class 1 water from the Friant Division of the Central Valley Project (CVP). This Class 1 designation represents the most reliable tier of CVP supply, intended for perennial agricultural use and prioritized ahead of Class 2 (interruptible) water during shortages. Water is captured in Millerton Lake behind Friant Dam on the upper San Joaquin River and released into the Friant-Kern Canal (FKC), a 152.1-mile, unlined, gravity-fed concrete channel completed in 1951 and jointly managed by USBR and the Friant Water Authority. Deliveries to TBID began in the early 1960s following turnout construction and contractual finalization, marking the transition from reliance on limited local runoff and early groundwater wells to a federally backed surface supply system. The FKC remains TBID's primary and dominant source of irrigation water, delivering untreated river water directly to farm gates via a network of 160 miles of district pipelines, with flow regulated by USBR scheduling, canal capacity, and real-time demand. Over time, the canal has enabled the sustained irrigation of

approximately 11,340 irrigable acres, primarily supporting frost-protected citrus orchards that form the economic backbone of the Terra Bella community.

Since 1961, the average annual surface water delivery to TBID has been approximately 17,900 acre-feet, equivalent to roughly 62% of the full contract amount, reflecting a combination of full allocations in wet and normal years, significant reductions during major droughts, and operational adjustments. This long-term average is calculated from USBR delivery logs, Friant Division water accounting reports, and district records. Delivery variability is driven by Sierra Nevada snowpack, reservoir operations, and mandated releases under the San Joaquin River Restoration Program (SJRRP), which, since 2009, has reallocated a portion of historic Friant water to restore downstream fisheries. In recent years (2017–2025), surface water deliveries have stabilized and aligned closely with the historical average, ranging between 14,800 AF and 18,900 AF annually. This consistency follows the extreme 2012–2016 drought, when allocations fell to 0% in 2014 and 2015, where surface water needs were met with alternative supplies. Historical surface water use, including USBR CVP deliveries, occasional State Water Project exchanges, Tule River inflows conveyed under Warren Act agreements, and minor local diversions, is presented in **Figure 2-31** of the TBID GSP.

2.3.5.1 Imported Surface Water and Distribution

Figure 2-32 presents TBID’s water conveyance system. The TBID Plan Area is supplied with imported surface water via the FKC and Deer Creek. The FKC runs north to south, along Road 208, through the western boundary of the non-contiguous portion of the Plan Area. Water supplied by the FKC is distributed within the TBID Plan Area by means of natural waterways, man-made ditches, unlined canals, and pipeline distribution systems. A major point of diversion is at milepost 102.65 of the FKC, known as the Deer Creek Complex. The complex consists of two turnouts and a siphon inlet/outlet structure.

2.3.6. Surface Water Features

Surface water features within the Subbasin include the Tule River, White River, Deer Creek, and Lake Success, as described in Chapter 2.1.5 of the *Tule Subbasin Setting*. Artificial features include Lake Success and the FKC. Lake Success is formed by Success Dam across the Tule River Canyon. The FKC is a man-made aqueduct used to convey imported water throughout the Subbasin. All natural waterways flow to the west from the Sierra Nevada Mountains.

The primary natural waterway within the TBID Plan Area is Deer Creek, which flows from the Sierra Nevada Mountains westward along the northern boundaries of the TBID Plan Area, toward the lakebed of the historic Tulare Lake. A minor tributary to Deer Creek is Fountain Springs Gulch, which is an intermittent stream in the northwest region of the TBID Plan Area. Surface water features within the vicinity of the TBID Plan Area are depicted in **Figure 2-33**.

2.3.7. Interconnected Surface Water

Interconnected surface water (ISW) systems are defined as surface water that is hydraulically connected to the underlying aquifer through a continuous saturated zone, and the overlying surface water is not completely depleted. The relationship between surface water and groundwater in the Subbasin can be characterized in three ways: the surface water gains water from groundwater (a "gaining stream"), the

surface water loses water to groundwater (a "losing stream"), or it experiences both conditions spatially or temporally. A losing stream is considered "disconnected" if there is an unsaturated zone separating the surface water from the aquifer. Changes in groundwater levels due to pumping near a gaining stream can impact the flow within that stream. The exact locations and timing of ISW in the Tule Subbasin are currently unknown. However, an initial analysis consistent with The Nature Conservancy's ICON database identified three areas of potential ISW:

Upper Tule River Area: From the subbasin boundary near Success Dam down to Road 192.

Upper Deer Creek Area: From the subbasin boundary down to the Friant-Kern Canal.

Upper White River Area: From the subbasin boundary down to Highway 65.

These areas are generally considered "Likely Connected - Losing" if the groundwater elevation is between 0 and 20 feet below the surface water elevation, indicating water is likely moving from the surface water body to the aquifer.

For the Tule River, Upper Aquifer groundwater levels below Success Reservoir Dam suggest a periodic connection with surface water, especially during wet hydrologic conditions (e.g., WY2023) when groundwater rose to within 10 to 25 feet of the land surface, near the streambed elevation. The nearest monitoring well in the Upper Deer Creek Area shows groundwater elevations within 15 feet of the streambed during high groundwater conditions (February 2023). Conversely, data for the Upper White River Area is limited to one well outside the potential ISW area, where groundwater levels were around 250 feet below ground surface (bgs), which is too deep to be considered interconnected with surface water.

The lack of monitoring wells specifically constructed along the streambeds to monitor ISW is identified as a data gap. This gap is addressed in the Coordination Agreement by planning for the development and implementation of an Interconnected Surface Water Monitoring Plan. Potential areas of ISW are presented in **Figure 2-34**.

2.3.8. Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are natural communities that rely on groundwater that is shallow or discharges at the land surface for their survival. Potential GDEs in the Tule Subbasin have been identified using the California Department of Fish and Wildlife's (CDFW) Vegetation Classification and Mapping Program (VegCAMP) data. GDEs may be hydrologically linked to Interconnected Surface Water (ISW) systems, as ISW features like rivers and shallow groundwater are likely to support aquatic communities or species dependent on groundwater.

Within the Upper Tule River Area, most potential GDEs are concentrated between Success Dam and Martin Hill. Some groves of trees are also mapped in the Tule River channel between Martin Hill and the Friant-Kern Canal. These GDEs primarily consist of riparian trees such as Sycamore, Fremont Cottonwood, and Willow. In the Upper Deer Creek Area, the majority of potential GDEs are located east of Highway 65 and include species like Sycamore, Oak, and Willow. Similarly, in the Upper White River

area, the potential GDEs are mostly situated within the upper three miles of the channel closest to the Subbasin boundary, featuring Sycamore, Oak, and Willow.

Potential GDEs within the TBID Plan Area are all along Deer Creek and are presented in **Figure 2-35**.

2.3.9. Aquifer Water Quality

Groundwater quality varies with depth across the aquifer system throughout the Subbasin. According to Thomas Harder & Co. (**Appendix A-1** and **Appendix A-2**), the native groundwater quality is generally considered relatively good; However, groundwater quality issues have resulted from regional point-source contamination and non-point source groundwater quality degradation.

Groundwater quality issues in the Subbasin have been evaluated based on the Maximum Contaminant Level (MCL) for drinking water beneficial uses. Throughout the Subbasin, naturally occurring and anthropogenic constituents of concern (COCs) that exceed the applicable regulatory standards based on MCLs have been detected and are depicted in **Figure 2-36**. MCL exceedances are based on data provided by the California State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) Program (SWRCB, 2025a). While not all of the COCs-listed below have been detected in the TBID Plan Area, they are included in monitoring programs as they have been detected in other wells within the Subbasin, which are as follows:

Naturally occurring COCs

- Arsenic
- Hexavalent chromium
- Uranium

Anthropogenic COCs

- 1, 2, 3-trichloropropane (TCP)
- Chloride
- Dibromo-3-chloropropane (DBCP)
- Nitrate as N
- Perchlorate
- Tetrachloroethene (PCE)
- Total Dissolved Solids (TDS), some of which are naturally occurring

Definitions and descriptions for each of the listed COCs, along with the potential causes and resulting groundwater quality issues, are described later in this section. Additionally, the COCs monitored throughout the Subbasin are included in the table below with units expressed in terms of parts per billion (ppb), micrograms per liter ($\mu\text{g/L}$), milligrams per liter (mg/L), and picocuries per liter (pCi/L). The MCL for constituents evaluated in this section are presented in **Table 2-6**.

Table 2-6. Constituents of Concern Minimum Thresholds in Groundwater

Constituent	Units	Minimum Threshold Drinking Water Limits (MCL/SMCL)
Arsenic	µg/L	10
Nitrate as N	mg/L	10
Hexavalent Chromium	µg/L	10
Dibromo-3-chloropropane (DBCP)	ppb	0.2
1,2,3-Trichloropropane (1,2,3-TCP)	µg/L	0.005
Tetrachloroethene (PCE)	µg/L	5
Chloride	mg/L	500
Total Dissolved Solids (TDS)	mg/L	750
Perchlorate	µg/L	6
Uranium	pCi/L	20 pCi/L

MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level; µg/L = micrograms per liter; mg/L = milligrams per liter; ppb = parts per billion; pCi/L = picocuries per liter

Of the COCs listed above, MCL exceedances of Nitrate as Nitrogen (NO_3^- as N, or Nitrate as N) have been the most prominent across the Subbasin between 2005 and 2025, with the exception of the southwestern and southeastern-most regions. Additionally, COC exceedances of arsenic, hexavalent chromium, 1, 2, 3-TCP, and uranium were detected from more wells in the western half of the Subbasin than in the eastern half. The distribution of each COC detection within the designated timeframe is included in **Figure 2-36**. It should also be noted that chloride exceedances have not been reported as detected since before the 2005-2025 timeframe (SWRCB, 2025a); However, it is still a monitored COC for the Subbasin, and is therefore still included in this GSP.

Within the TBID Plan Area, two COCs have been detected that exceed the MCLs for drinking water beneficial uses based on data between 2005 and 2025, which include Nitrate as nitrogen (NO_3^- as N, or Nitrate as N) and uranium (SWRCB, 2025a). **Table 2-7** provides MCL exceedances within the TBID Plan Area, as well as the dates during which the contaminants were detected. Between 2005 and 2025, Nitrate as N exceedances were detected above the MCLs from 5 wells and 61 samples, of which 7 of the samples were collected after January 2015 (SWRCB, 2025a). From the same time period, one Uranium exceedance was detected in 2005. The Uranium and the majority of the Nitrate as N exceedances were detected from one well on the east-central region of TBID Plan Area, as depicted in **Figure 2-37** with sample details provided in **Table 2-7**.

MCL exceedances throughout the Tule Subbasin were detected from wells that are categorized by the following sources: domestic, irrigation, industrial, monitoring, municipal, and water supply wells. Each COC exceedance is depicted by type in **Figure 2-37** and in **Table 2-7**. MCL exceedances of the COCs listed

above were detected from three municipal wells and two domestic wells within the TBID Plan Area between 2005 and 2025 (SWRCB, 2025a)

Descriptions of the above COCs are provided as follows:

Arsenic (As): Arsenic is a naturally occurring constituent that is present in rocks and minerals, and it can dissolve into groundwater as rocks weather. Other known sources of arsenic contamination in groundwater include industrial activities and former agricultural use; however, use of arsenic compounds has been phased out in California. Additionally, naturally occurring arsenic in aquifer materials can be drawn as a result of overpumping of groundwater. Arsenic has an MCL of 10 parts per billion (ppb), and exceedances have been detected in municipal water systems and provide wells within the Tule Subbasin and just outside of the western boundary of the contiguous TBID Plan Area (**Figure 2-36**).

Hexavalent Chromium (Cr[VI]): Hexavalent chromium is a form of elemental chromium, which is a naturally occurring element present in soil and rocks. Hexavalent chromium contamination in groundwater can result from natural sources, such as weathering and erosion of rocks, as well as from industrial activities that include chromium plating, wood treatment, and chemical manufacturing. Improper disposal of chromium materials in landfills, leaching into groundwater, and the generation of hexavalent chromium as a byproduct during some wastewater treatment processes are additional sources of groundwater contamination. Hexavalent chromium has an MCL of 10 ppb, and exceedances have been detected in municipal water systems within the Tule Subbasin.

Uranium (U): Uranium is a naturally occurring radioactive element that is present in soil and rocks, which can contaminate groundwater. In addition to natural sources from geologic formations, industrial activities and agricultural practices are also known sources of uranium contamination in groundwater. Naturally occurring arsenic in aquifer materials can be drawn as a result of overpumping of groundwater. Uranium has an MCL of 30 ppb or 20 picocuries per liter (pCi/L), and exceedances have been detected in municipal water systems and provide wells within the Tule Subbasin and the TBID Plan Area (**Figure 2-38**).

1,2,3- Trichloropropane (1,2,3-TCP): 1,2,3-TCP is a synthetic chlorinated hydrocarbon that has been historically used as a soil fumigant in agricultural practices, as well as a solvent and extracting agent in industrial activities. It was banned in soil fumigants and was added to SWRCB's list of carcinogens in 1992 (Prop 65); However, 1,2,3-TCP is still currently used as a chemical intermediate in the production, synthesis, and cross-linking agent of other chemicals. Additional sources of 1,2,3-TCP contamination can result from improper disposal of 1,2,3-TCP materials in landfills. Overpumping can cause an increase in mobility of 1,2,3-TCP already present in the subsurface, which can expand zones of influence within the aquifer. 1,2,3-TCP has an MCL of 5 parts per trillion (ppt), and exceedances have been detected in municipal and domestic wells within the Tule Subbasin.

Chloride (Cl): Chloride is derived from chlorine, and it is a negatively charged ion present in dissolved groundwater. Chloride can occur naturally in groundwater when chloride minerals (i.e., Halite and Sylvite) are dissolved in water. Exceedances of chloride can be caused by municipal and industrial wastewater discharges. Additionally, saline water and certain fertilizers used for agricultural practices

can increase chloride levels in groundwater. Over-pumping can increase mobilization and concentrations of chloride in groundwater under certain geologic features. Chloride has a secondary MCL of 500 parts per million (ppm), and exceedances have been detected in small concentrations within the Tule Subbasin.

Dibromo-3-chloropropane (DBCP): DBCP is a halogenated hydrocarbon that has historically been used as a soil fumigant to control nematodes. It was banned in the United States in 1979; however, it is considered a legacy contamination issue that remains in aquifer systems. DBCP detections in the Tule Subbasin predate SGMA and are, therefore, an issue that is considered by the State Regional Water Quality Control Board, rather than identified as a GSA issue. Overpumping can increase mobility and cause existing DBCP contamination plumes to spread and increase their impact on groundwater. DBCP has an MCL of 0.2 ppb, and exceedances have been detected in municipal and domestic supply wells within the Tule Subbasin.

Nitrate as N: Nitrate is a form of nitrogen in groundwater. The primary source of nitrate contamination in groundwater is from agricultural fertilizers, while secondary sources include septic systems and animal waste. Overpumping of groundwater can draw contaminants from shallow water or soil into the aquifer. Nitrates in groundwater have an MCL of 10 ppm, and exceedances have been detected throughout the Tule Subbasin, including the TBID Plan Area (**Figure 2-38**).

Perchlorate: Perchlorate is a negatively charged ion; however, it is not used as a measurement of groundwater quality or for determining water balance in the same way as Sulfate, Chloride, Nitrate, and Bicarbonate. It is a manufactured constituent that is used in industrial processes and explosives. Primary sources of contamination from perchlorate in groundwater include improper disposal of perchlorate in landfills and spills during transportation of perchlorate materials. Overpumping groundwater can potentially draw contaminated shallow water into the aquifer, which may potentially contain perchlorate. Perchlorate has an MCL of 6 ppb, and exceedances have been detected in the Tule Subbasin between 2005 and 2025.

Tetrachloroethane (PCE): PCE is a synthetic chlorinated solvent that is used as a degreaser for industrial activities and purposes. Primary sources of contamination include storage tank leaks and improper disposal of PCE waste. Overpumping can cause an increase in mobility of PCE already present in the subsurface, which can expand zones of influence within the aquifer. PCE has an MCL of 5 ppb, and exceedances have been detected in municipal water systems within the Tule Subbasin.

Total Dissolved Solids (TDS): TDS is a measurement of the total amount of inorganic and organic substances in water. Common natural sources of TDS include mineral dissolution from soil and rocks, and cations contribute to high TDS values in groundwater. In addition to natural sources, TDS in groundwater can result from urban runoff and agricultural activities. TDS has a secondary MCL of 1,000 ppm, and high TDS can be an indication of impacted groundwater. However, exceedances of TDS have generally been low in the Tule Subbasin.

Point-source COCs within the TBID Plan Area are also evaluated within the Tule Subbasin, and 15 active cleanup sites have been identified on the GeoTracker website. Although there are no active clean-up sites within the TBID Plan Area, historical cleanup program sites have been identified within the TBID Plan Area and are now closed. Additionally, outside of the western boundary of TBID, on the west side of

Highway 65, a Leaking Underground Storage Tank (LUST) site has been identified that is currently open (**Figure 2-39**) (GeoTracker, 2025). According to the site's cleanup status history (GeoTracker ID #T0610700064), the case opened in 1986 during the tank closure and removal. The site assessment status is currently listed as an open case. Although no remedial action information has been reported in GeoTracker, groundwater, soil, and soil vapor investigations have continued through 2025. Laboratory results reported that groundwater samples contained the following contaminants in June and July 2025: gasoline range organics (GRO), benzene, toluene, ethylbenzene, total xylenes, naphthalene, and volatile organic compounds (VOCs).

The Tule Basin Water Quality Coalition (TBWQC) operates as the third-party group under the Irrigated Lands Regulatory Program to address agricultural impacts to water quality within the Tule Subbasin. Additionally, the Tule Basin Management Zone also addresses nitrate exceedances within the Subbasin.

Additional constituents of potential concern include PFAS, which are manmade compounds that have historically been used in a variety of common products, including fire-fighting foams, clothing, carpets, cookware, etc. PFAS are also frequently detected in wastewater discharges. In April 2024, the United States Environmental Protection Agency (USEPA) published the National Primary Drinking Water Regulation (NPDWR) for six PFAS and established enforceable MCL's between 4 - 10 parts per trillion (ppt or ng/L), depending on the chemical. Under the NPDWR, public water systems must complete initial monitoring by 2027 and implement solutions that reduce exceedances of PFAS chemical MCLs by 2029. Additionally, the State Water Resources Control Board (SWRCB) issued General Order 2024-0002- DDW, which requires monitoring for PFAS pursuant to Health and Safety Code Section 116378. The GSAs will determine the impacts and degradation of groundwater by PFAS in the Tule Subbasin as data becomes available.

Table 2-5. Benchmark Data within the LS Monitoring Plan Area (2021-2025)

Benchmark ID	Owner	Latitude	Longitude	Measurement Date					Elevation (ft amsl)					Subsidence (ft)				2021 - 2025 Cumulative Subsidence (ft)
				2021	2022	2023	2024	2025	2021	2022	2023	2024	2025	2021 to 2022	2022 - 2023	2023 - 2024	2024 - 2025	
E0035_B_RMS	Tule Subbasin TAC	35.946759	-119.179535	7/20/2021	8/16/2022	7/18/2023	7/8/2024	7/16/2025	341.44	341.11	340.92	340.76	340.52	0.33	0.19	0.16	0.24	0.92
E0047_B_RMS	Tule Subbasin TAC	36.007967	-119.143592	7/21/2021	8/16/2022	7/20/2023	7/4/2024	6/26/2025	365.73	365.35	365.09	364.94	365.13	0.38	0.26	0.15	-0.19	0.60
E0048_B_RMS	Tule Subbasin TAC	35.963965	-119.143187	7/22/2021	8/16/2022	7/19/2023	7/8/2024	7/7/2025	369.89	369.13	369.04	368.96	368.82	0.76	0.09	0.08	0.14	1.07
E0049_B_RMS	Tule Subbasin TAC	35.921217	-119.143854	7/21/2021	8/16/2022	8/3/2023	7/16/2024	7/7/2025	402.61	401.95	401.77	401.66	401.5	0.66	0.18	0.11	0.16	1.11
E0051_B_FKC	FWA	36.065720	-119.107738	7/19/2021	8/30/2022	7/27/2023	6/30/2024	6/25/2025	397.06	396.78	396.63	396.66	396.4	0.27	0.15	-0.03	0.26	0.66
E0053_B_FKC	FWA	35.978021	-119.107469	7/22/2021	8/16/2022	7/20/2023	7/1/2024	7/7/2025	399.32	399.17	399.16	398.94	398.83	0.15	0.01	0.22	0.11	0.49
E0056_G_FKC	FWA	36.080733	-119.083891	7/19/2021	8/16/2022	6/29/2023	6/30/2024	6/24/2025	406.75	406.69	406.64	406.82	406.42	0.06	0.05	-0.18	0.40	0.33
E0057_B_FKC	FWA	36.065853	-119.101469	7/21/2021	8/16/2022	7/18/2023	6/30/2024	6/24/2025	399.12	398.92	399.01	398.89	398.81	0.20	-0.09	0.12	0.08	0.31
E0058_B_FKC	FWA	36.046115	-119.088891	7/21/2021	8/4/2022	6/30/2023	6/30/2024	6/25/2025	407.68	407.38	407.12	407.11	406.93	0.30	0.26	0.01	0.18	0.75
E0059_B_FKC	FWA	36.023157	-119.080043	7/21/2021	8/4/2022	7/27/2023	7/1/2024	6/30/2025	417.67	417.17	417.02	416.84	416.75	0.50	0.15	0.18	0.09	0.92
E0060_B_FKC	FWA	36.022253	-119.104147	7/21/2021	8/16/2022	7/20/2023	7/1/2024	6/30/2025	393.41	393.00	392.93	392.66	392.55	0.41	0.07	0.27	0.11	0.86
E0061_B_FKC	FWA	36.007748	-119.095966	7/22/2021	8/16/2022	7/27/2023	7/1/2024	6/30/2025	403.54	403.21	402.93	402.94	402.66	0.33	0.28	-0.01	0.28	0.88
E0062_B_FKC	FWA	35.993320	-119.107673	7/22/2021	8/16/2022	1/16/2023	No Data	No Data	403.22	403.07	No Data	No Data	No Data	0.15	NA	NA	NA	NA
E0063_G_FKC	FWA	35.978046	-119.106731	7/22/2021	8/16/2022	7/20/2023	7/1/2024	7/1/2025	402.85	402.49	402.39	402.3	402.1	0.36	0.10	0.09	0.20	0.75
E0064_B_FKC	FWA	35.977592	-119.107239	7/22/2021	8/16/2022	7/20/2023	7/2/2024	7/1/2025	400.61	400.17	400.06	400.01	399.82	0.44	0.11	0.05	0.19	0.79
E0065_B_FKC	FWA	35.964394	-119.107485	8/12/2021	8/16/2022	7/20/2023	8/5/2024	7/1/2025	400.14	400.06	399.86	399.51	399.15	0.08	0.20	0.35	0.36	0.99
E0066_B_FKC	FWA	35.964278	-119.097250	7/21/2021	8/16/2022	7/24/2023	7/16/2024	7/8/2025	411.62	411.29	411.00	410.83	410.68	0.33	0.29	0.17	0.15	0.94
E0067_B_FKC	FWA	35.949757	-119.107021	8/12/2021	8/16/2022	7/19/2023	7/14/2024	7/8/2025	407.47	407.29	407.04	406.77	406.47	0.18	0.25	0.27	0.30	1.00
E0068_B_FKC	FWA	35.942592	-119.128878	7/21/2021	No Data	No Data	No Data	No Data	390.67	No Data	No Data	No Data	No Data	NA	NA	NA	NA	NA
E0069_B_FKC	FWA	35.928049	-119.137364	7/21/2021	No Data	No Data	No Data	No Data	397.14	No Data	No Data	No Data	No Data	NA	NA	NA	NA	NA
E0085_B_RMS	Tule Subbasin TAC	36.015027	-119.029953	7/26/2021	No Data	7/27/2023	7/1/2024	7/2/2025	480.47	No Data	480.54	480.54	480.6	NA	NA	0.00	-0.06	-0.13
E0086_B_RMS	Tule Subbasin TAC	35.982697	-119.046424	7/26/2021	No Data	7/27/2023	8/5/2024	7/2/2025	447.26	No Data	447.05	446.87	446.89	NA	NA	0.18	-0.02	0.37
E0087_B_RMS	Tule Subbasin TAC	35.891593	-119.054074	7/26/2021	No Data	7/13/2023	7/4/2024	7/2/2025	530.90	No Data	530.61	530.64	530.45	NA	NA	-0.03	0.19	0.45
E0088_B_RMS	Tule Subbasin TAC	35.859012	-119.107779	7/26/2021	No Data	7/13/2023	No Data	No Data	457.16	No Data	457.22	No Data	No Data	NA	NA	NA	NA	NA
E0089_B_LSMA	ETGSA	35.949882	-119.121121	No Data	8/30/2022	7/19/2023	7/16/2024	7/7/2025	No Data	404.45	404.21	404.13	403.88	NA	0.24	0.08	0.25	NA
E0090_B_LSMA	ETGSA	35.935379	-119.133460	No Data	8/30/2022	7/19/2023	7/16/2024	7/7/2025	No Data	404.31	404.15	404.16	403.85	NA	0.16	-0.01	0.31	NA
E0091_B_LSMA	ETGSA	35.964221	-119.125305	No Data	No Data	8/3/2023	7/8/2024	7/1/2025	No Data	No Data	378.29	378.16	377.95	NA	NA	0.13	0.21	NA
E0092_B_LSMA	ETGSA	35.949994	-119.144013	No Data	8/30/2022	7/18/2023	7/8/2024	7/2/2025	No Data	372.48	372.33	372.28	372.07	NA	0.15	0.05	0.21	NA

Benchmark ID	Owner	Latitude	Longitude	Measurement Date					Elevation (ft amsl)					Subsidence (ft)				2021 - 2025 Cumulative Subsidence (ft)
				2021	2022	2023	2024	2025	2021	2022	2023	2024	2025	2021 to 2022	2022 - 2023	2023 - 2024	2024 - 2025	
E0093_B_LSMA	ETGSA	35.935268	-119.109074	No Data	8/30/2022	7/13/2023	7/14/2024	8/6/2025	No Data	416.11	416.07	415.9	415.76	NA	0.04	0.17	0.14	NA
E0094_B_LSMA	ETGSA	35.942736	-119.107482	No Data	8/30/2022	7/24/2023	7/14/2024	8/6/2025	No Data	409.17	408.82	408.8	408.59	NA	0.35	0.02	0.21	NA
E0095_B_LSMA	ETGSA	35.949595	-119.089902	No Data	8/30/2022	7/19/2023	7/14/2024	8/6/2025	No Data	421.12	420.67	420.64	420.68	NA	0.45	0.03	-0.04	NA
E0096_B_LSMA	ETGSA	35.950024	-119.152902	No Data	8/30/2022	7/18/2023	7/8/2024	8/5/2025	No Data	363.86	363.56	363.33	363.08	NA	0.30	0.23	0.25	NA
E0097_B_LSMA	ETGSA	35.949814	-119.134855	No Data	8/19/2022	7/18/2023	7/14/2024	8/5/2025	No Data	378.83	378.70	378.57	378.29	NA	0.13	0.13	0.28	NA
E0098_B_LSMA	ETGSA	35.993449	-119.125472	No Data	8/30/2022	7/20/2023	7/15/2024	7/1/2025	No Data	381.42	381.37	381.27	381.05	NA	0.05	0.10	0.22	NA
E0099_B_LSMA	ETGSA	35.993207	-119.089254	No Data	8/30/2022	7/20/2023	7/15/2024	8/6/2025	No Data	413.66	413.52	413.36	413.05	NA	0.14	NA	0.31	NA
E0100_B_LSMA	ETGSA	35.978766	-119.125347	No Data	8/24/2022	7/20/2023	7/2/2024	8/6/2025	No Data	381.99	381.88	381.87	381.69	NA	0.11	0.01	0.18	NA
E0101_B_LSMA	ETGSA	35.978970	-119.116649	No Data	8/24/2022	7/20/2023	7/2/2024	7/1/2025	No Data	388.12	388.03	387.95	387.81	NA	0.09	0.08	0.14	NA
E0102_B_LSMA	ETGSA	36.007968	-119.125503	No Data	8/24/2022	7/20/2023	7/2/2024	6/26/2025	No Data	383.21	382.69	382.7	382.44	NA	0.52	-0.01	0.26	NA
E0103_B_LSMA	ETGSA	36.007749	-119.116638	No Data	8/24/2022	7/20/2023	7/2/2024	6/30/2025	No Data	389.38	389.14	389.01	388.72	NA	0.24	0.13	0.29	NA
E0104_B_LSMA	ETGSA	35.935325	-119.143992	No Data	8/30/2022	7/18/2023	7/15/2024	8/5/2025	No Data	379.59	379.53	379.55	379.19	NA	0.06	-0.02	0.36	NA
E0105_B_LSMA	ETGSA	36.051229	-119.097278	No Data	8/30/2022	7/31/2023	8/5/2024	7/7/2025	No Data	412.17	411.95	412.02	411.91	NA	0.22	-0.07	0.11	NA
E0106_B_LSMA	ETGSA	36.022501	-119.125537	No Data	8/30/2022	7/20/2023	7/2/2024	8/7/2025	No Data	382.57	381.93	381.76	381.66	NA	0.64	0.17	0.10	NA
E0107_B_LSMA	ETGSA	36.022307	-119.089109	No Data	8/30/2022	7/31/2023	7/1/2024	6/30/2025	No Data	409.12	408.89	408.76	408.94	NA	0.23	0.13	-0.18	NA
E0108_B_LSMA	ETGSA	36.051111	-119.116205	No Data	8/30/2022	7/31/2023	7/15/2024	6/25/2025	No Data	389.82	389.49	389.6	389.48	NA	0.33	-0.11	0.12	NA
E0109_B_LSMA	ETGSA	36.051318	-119.071165	No Data	8/30/2022	7/18/2023	7/15/2024	6/30/2025	No Data	421.06	421.11	420.97	420.99	NA	-0.05	0.14	-0.02	NA
E0110_B_LSMA	ETGSA	35.935271	-119.116447	No Data	8/30/2022	7/19/2023	7/8/2024	7/8/2025	No Data	409.47	409.44	409.51	409.14	NA	0.03	-0.07	0.37	NA
E0111_B_LSMA	ETGSA	35.964213	-119.085094	No Data	8/30/2022	7/24/2023	7/14/2024	8/6/2025	No Data	424.55	424.61	424.24	424.12	NA	-0.06	0.37	0.12	NA
E0112_B_LSMA	ETGSA	36.004220	-119.071361	No Data	8/30/2022	7/31/2023	7/1/2024	8/7/2025	No Data	417.28	416.91	416.93	416.83	NA	0.37	-0.02	0.10	NA
E0113_B_LSMA	ETGSA	36.036668	-119.079912	No Data	8/30/2022	7/20/2023	7/2/2024	8/7/2025	No Data	416.26	416.27	416.03	415.95	NA	-0.01	0.24	0.08	NA
E0114_B_FKC	FWA	35.964338	-119.110823	No Data	No Data	7/19/2023	7/16/2024	7/8/2025	No Data	No Data	392.66	392.55	392.27	NA	NA	0.11	0.28	NA
E0115_B_LSMA	ETGSA	35.978820	-119.134400	No Data	No Data	7/20/2023	7/2/2024	7/16/2025	No Data	No Data	372.52	372.54	372.32	NA	NA	-0.02	0.22	NA
E0116_B_LSMA	ETGSA	35.986050	-119.143410	No Data	No Data	7/20/2023	7/7/2024	7/2/2025	No Data	No Data	364.95	365.02	364.67	NA	NA	-0.07	0.35	NA
E0117_B_LSMA	ETGSA	35.987090	-119.179020	No Data	No Data	7/10/2023	7/7/2024	7/2/2025	No Data	No Data	338.24	337.87	337.61	NA	NA	0.37	0.26	NA
E0118_B_LSMA	ETGSA	35.974080	-119.178860	No Data	No Data	7/10/2023	7/7/2024	7/2/2025	No Data	No Data	341.75	341.71	341.44	NA	NA	0.04	0.27	NA
E0119_B_LSMA	ETGSA	35.964300	-119.169890	No Data	No Data	7/10/2023	7/8/2024	7/16/2025	No Data	No Data	350.32	350.09	349.85	NA	NA	0.23	0.24	NA
E0120_B_LSMA	ETGSA	35.964300	-119.152040	No Data	No Data	7/19/2023	7/8/2024	7/2/2025	No Data	No Data	361.00	360.77	360.59	NA	NA	0.23	0.18	NA
E0121_B_LSMA	ETGSA	35.964260	-119.135310	No Data	No Data	7/18/2023	7/8/2024	7/1/2025	No Data	No Data	370.26	370.1	369.95	NA	NA	0.16	0.15	NA
E0122_B_LSMA	ETGSA	35.971680	-119.161110	No Data	No Data	7/31/2023	7/7/2024	7/2/2025	No Data	No Data	355.14	354.99	354.64	NA	NA	0.15	0.35	NA
E0123_B_LSMA	ETGSA	35.978840	-119.152340	No Data	No Data	7/10/2023	7/7/2024	7/2/2025	No Data	No Data	357.25	357.14	356.88	NA	NA	0.11	0.26	NA
E0124_B_LSMA	ETGSA	35.985900	-119.161120	No Data	No Data	7/10/2023	7/7/2024	No Data	No Data	No Data	349.61	349.37	No Data	NA	NA	0.24	NA	NA
E0125_B_LSMA	ETGSA	35.972290	-119.143280	No Data	No Data	7/20/2023	7/7/2024	7/2/2025	No Data	No Data	366.74	366.88	366.6	NA	NA	-0.14	0.28	NA
E0126_B_LSMA	ETGSA	35.978920	-119.170040	No Data	No Data	7/10/2023	7/7/2024	7/2/2025	No Data	No Data	345.33	345.29	344.97	NA	NA	0.04	0.32	NA

Benchmark ID	Owner	Latitude	Longitude	Measurement Date					Elevation (ft amsl)					Subsidence (ft)				2021 - 2025 Cumulative Subsidence (ft)
				2021	2022	2023	2024	2025	2021	2022	2023	2024	2025	2021 to 2022	2022 - 2023	2023 - 2024	2024 - 2025	
P0036_B_RMS	Tule Subbasin TAC	35.971652	-119.205568	7/20/2021	8/16/2022	7/7/2023	7/23/2024	7/24/2025	323.07	322.71	322.53	322.38	322.17	0.36	0.18	0.15	0.21	0.90
P0037_B_RMS	Tule Subbasin TAC	36.002530	-119.197349	7/20/2021	8/16/2022	7/7/2023	7/23/2024	7/2/2025	324.07	323.57	323.45	323.32	323.15	0.50	0.12	0.13	0.17	0.92
P0090_B_RMS	Tule Subbasin TAC	35.921016	-119.161702	8/12/2021	8/16/2022	7/18/2023	7/16/2024	7/15/2025	368.39	368.06	367.85	367.78	367.61	0.33	0.21	0.07	0.17	0.78
P0093_B_RMS	Tule Subbasin TAC	35.921023	-119.179422	8/19/2021	8/16/2022	7/18/2023	7/16/2024	7/16/2025	349.96	349.76	349.51	349.42	349.51	0.20	0.25	0.09	-0.09	0.45
P0094_B_RMS	Tule Subbasin TAC	35.936825	-119.214756	8/19/2021	8/24/2022	7/25/2023	7/23/2024	7/9/2025	310.79	310.34	309.96	309.78	309.47	0.45	0.38	0.18	0.31	1.32
P0095_B_LSMA	ETGSA	35.939497	-119.161718	No Data	8/30/2022	7/18/2023	7/15/2024	7/16/2025	No Data	360.78	360.59	360.48	360.11	NA	0.19	0.11	0.37	NA
P0096_B_RMS	Tule Subbasin TAC	35.996666	-119.179127	No Data	8/30/2022	7/7/2023	7/8/2024	7/21/2025	No Data	336.53	336.28	336.23	335.91	NA	0.25	0.05	0.32	NA

Sources: Thomas Harder & Co., 2023 and 2024; Data provided from the Tule Subbasin Data Management System (4Creeks) and the *Eastern Tule GSA Land Subsidence 2021/22 and 2022/23 Annual Reports*

All presented measurements were collected annually during the summer months (June-August of each year)

Data from Tule Subbasin Monitoring Network. Positive subsidence is equivalent to uplift.

No Data = Data was not collected and/or not available

NA = Not Applicable

FWA = Friant Water Authority

Table 2-7. MCL Exceedances within TBID (2005-2025)

Constituent of Concern	COC Unit	Minimum Threshold: Drinking Water Limits (MCL)	Well ID	Well Type	Dataset/ Source	MCL Exceedance Detection Result	Sample Collection Date
Nitrate as N	mg/L	10	CA5410038_011_011	Municipal	DDW	13	2/22/2005
						13	5/16/2005
						13	8/22/2005
						13	12/19/2005
						12	2/28/2006
						13	5/9/2006
						13	7/25/2006
						14	10/24/2006
						18	2/13/2007
						14	6/12/2007
						14	8/28/2007
						14	10/23/2007
						13	3/18/2008
						12	6/9/2008
						12	11/18/2008
						12	2/12/2009
						12	5/12/2009
						12	8/25/2009
						13	11/16/2009
						13	5/25/2010
						11	8/19/2010
						11	11/16/2010
						11	3/17/2011

Constituent of Concern	COC Unit	Minimum Threshold: Drinking Water Limits (MCL)	Well ID	Well Type	Dataset/ Source	MCL Exceedance Detection Result	Sample Collection Date
Nitrate as N	mg/L	10				11	5/16/2011
						11	8/16/2011
						11	11/28/2011
						11	2/28/2012
						11	5/21/2012
						12	8/14/2012
						12	11/13/2012
						11	2/11/2013
						13	5/20/2013
						11	8/27/2013
						13	11/25/2013
						12	2/20/2014
						12	5/12/2014
						12	8/18/2014
						12	11/17/2014
						12	2/9/2015
						12	5/4/2015
						12	8/17/2015
						11	11/13/2015
						11	8/25/2016
						13	9/24/2018
						12	8/29/2019
			NO3_1005355	Municipal	UCD_NO3	13	2/22/2005
						13	5/16/2005

Constituent of Concern	COC Unit	Minimum Threshold: Drinking Water Limits (MCL)	Well ID	Well Type	Dataset/ Source	MCL Exceedance Detection Result	Sample Collection Date
Nitrate as N	mg/L	10	NO3_1005355	Municipal	UCD_NO3	13	8/22/2005
						13	12/19/2005
						12	2/28/2006
						13	7/25/2006
						14	10/24/2006
						18	2/13/2007
						14	6/12/2007
						14	8/28/2007
						13	3/18/2008
						12	2/12/2009
						12	5/12/2009
						12	8/25/2009
			NO3_1025324	Domestic	UCD_NO3	11	1/19/2006
			NO3_1025737	Domestic	UCD_NO3	12	5/13/2010
			NO3_1005356	Municipal	UCD_NO3	12	11/18/2008
Uranium	pCi/L	20	CA5410038_011_011	Municipal	DDW	49	12/19/2005

Notes:

Data provided from the California State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) Program (SWRCB, 2025a).

COC = Constituent of Concern

MCL = Maximum Contaminant Level

mg/L = milligrams per liter

DDW = Division of Drinking Water

UCD_NO3 = U.C. Davis Nitrate Report

pCi/L = picocuries per liter

* Data reported in ppm and µg/L units are equivalent in value.

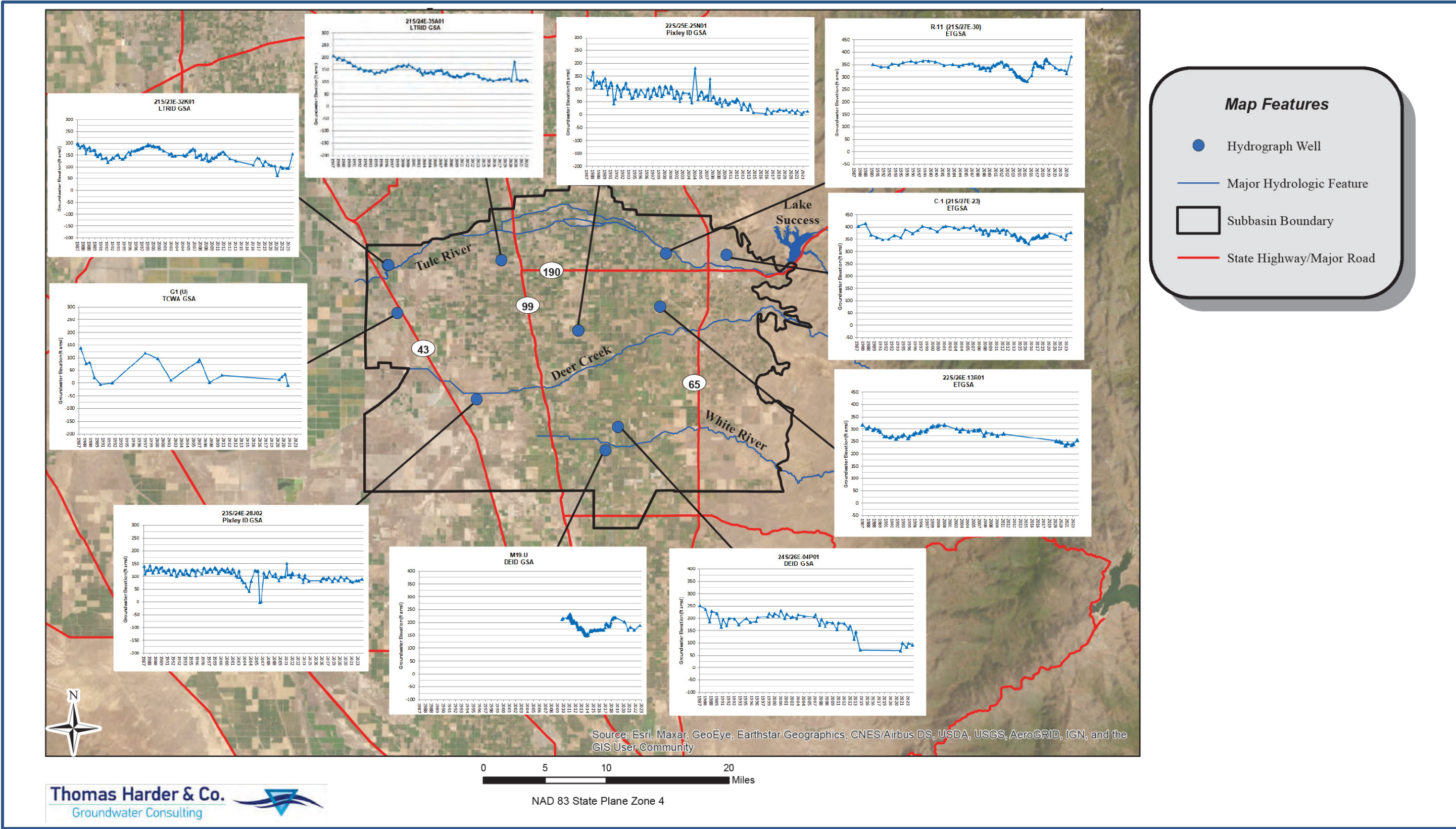


Figure 2-18. Tule Subbasin Upper Aquifer Hydrographs

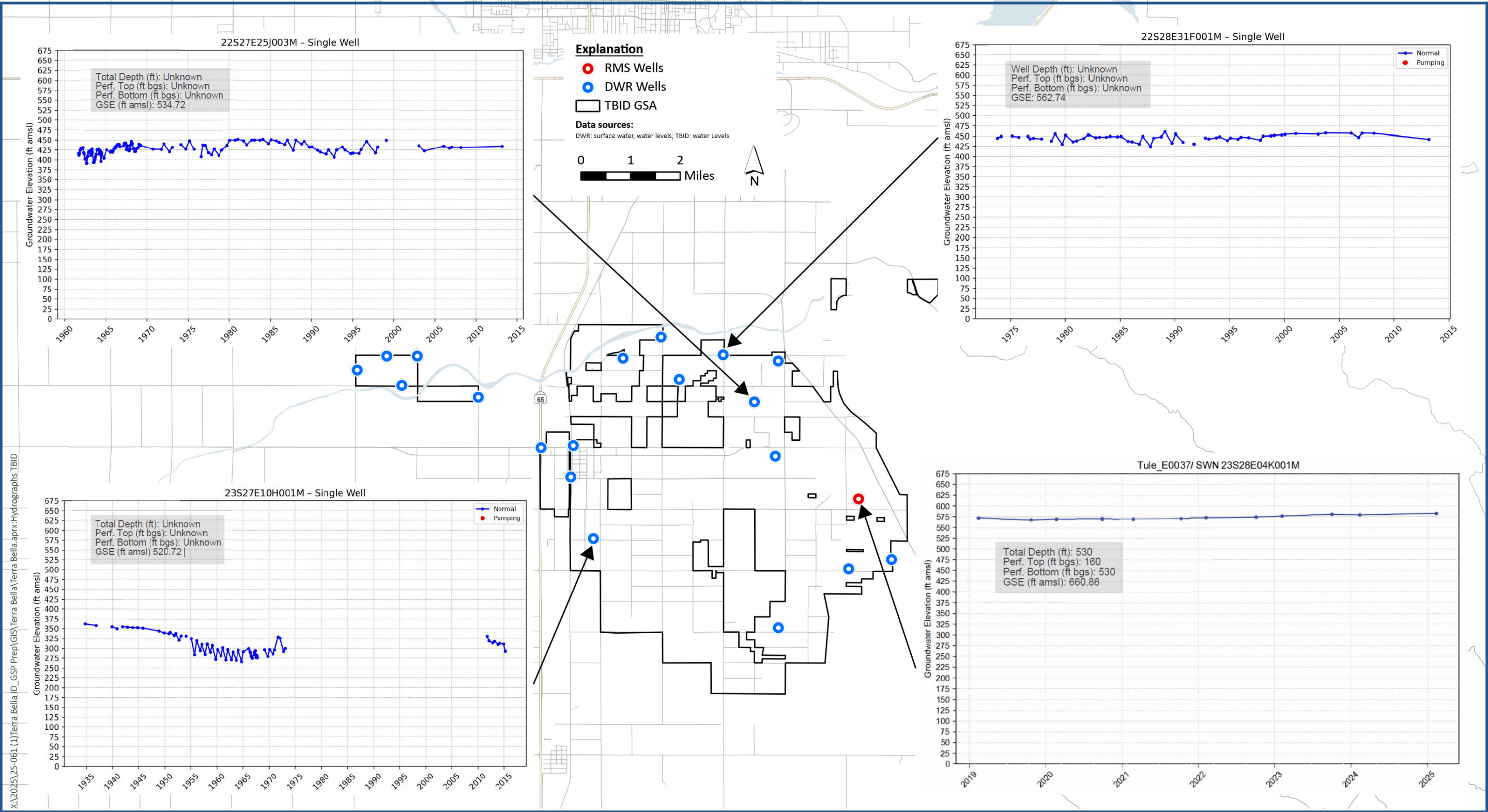


Figure 2-19a. TBID Hydrographs

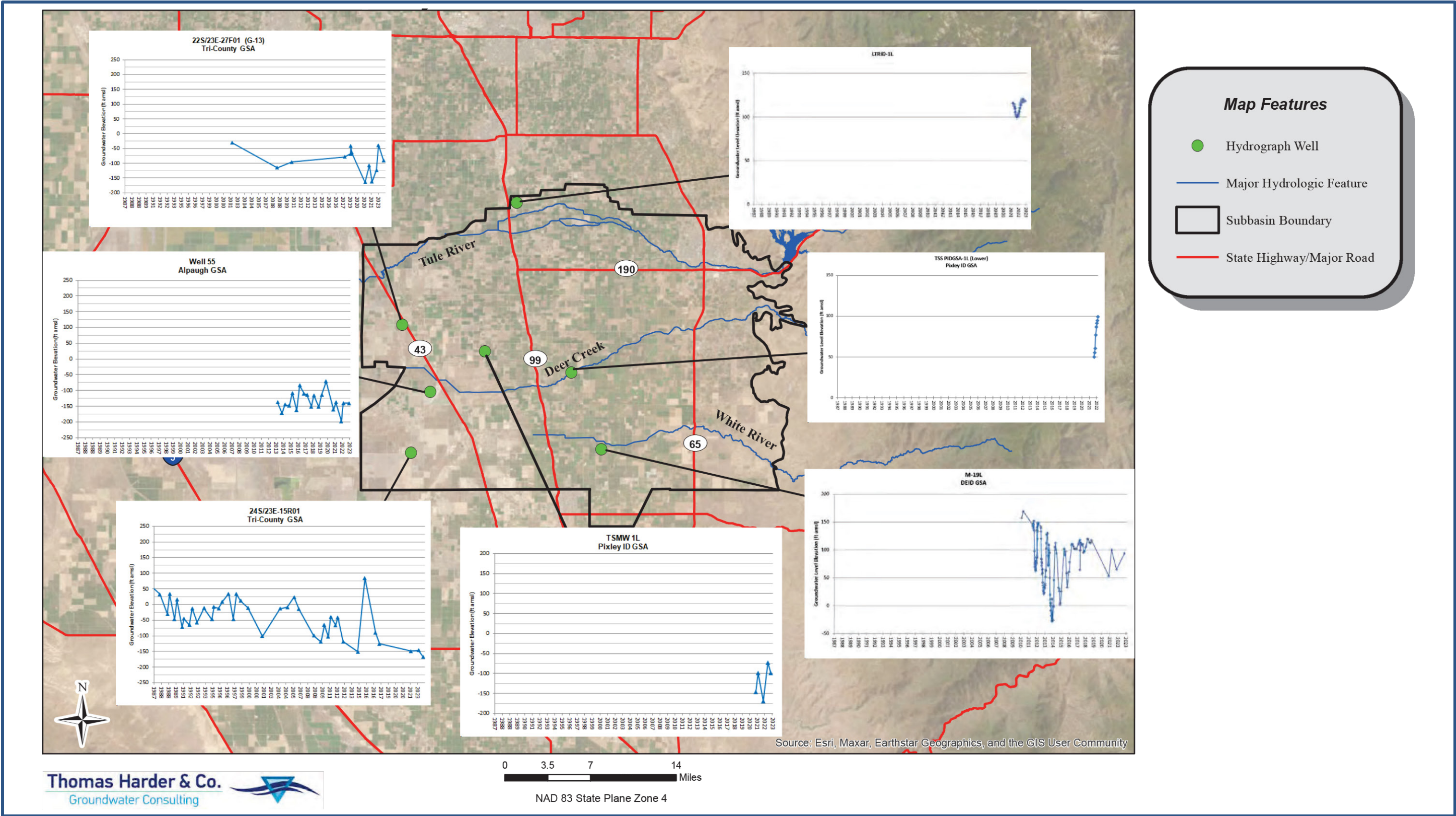


Figure 2-19b. Tule Subbasin Lower Aquifer Hydrographs

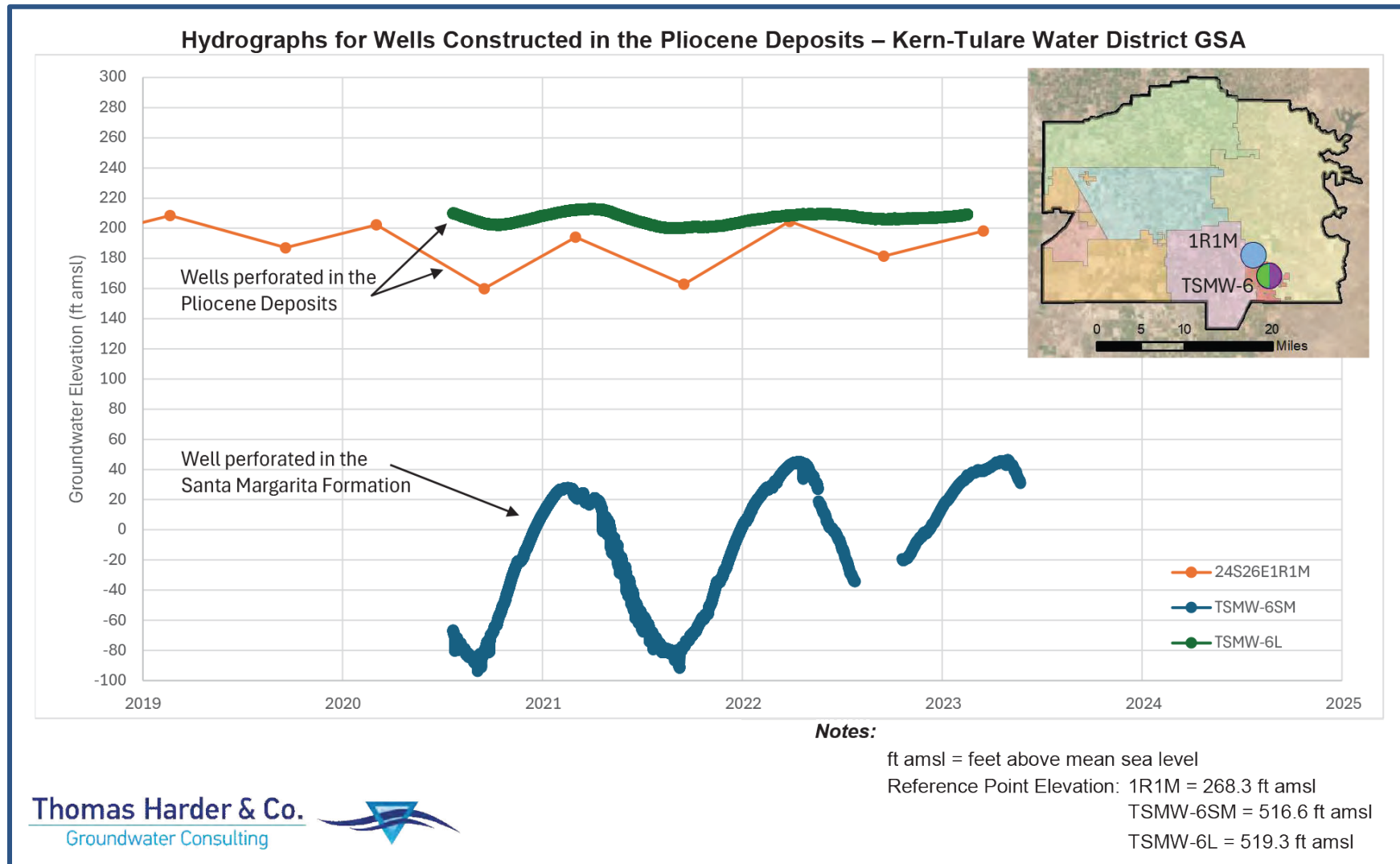


Figure 2-19c. Pliocene Deposit Hydrographs

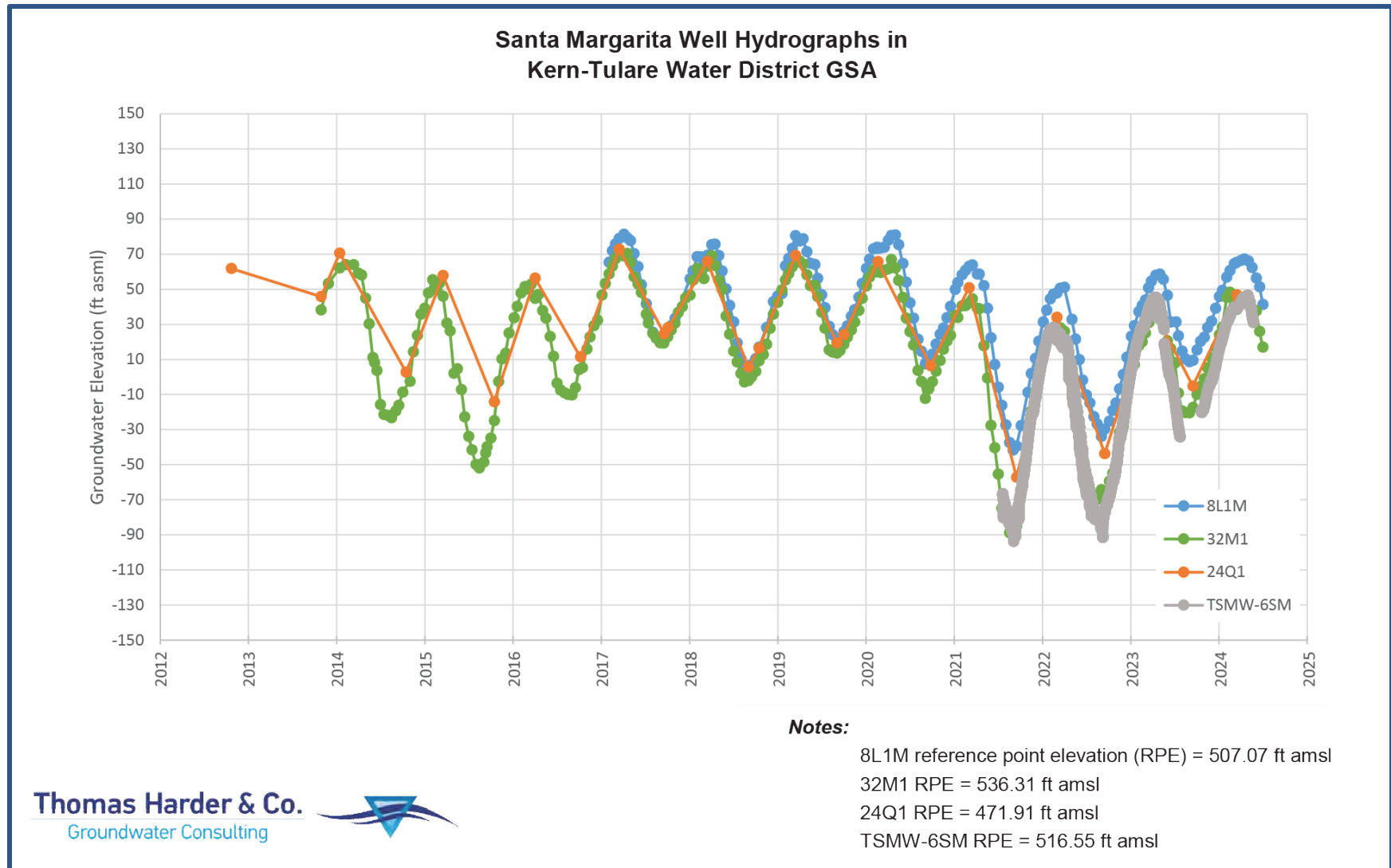


Figure 2-19d. Santa Margarita Hydrographs

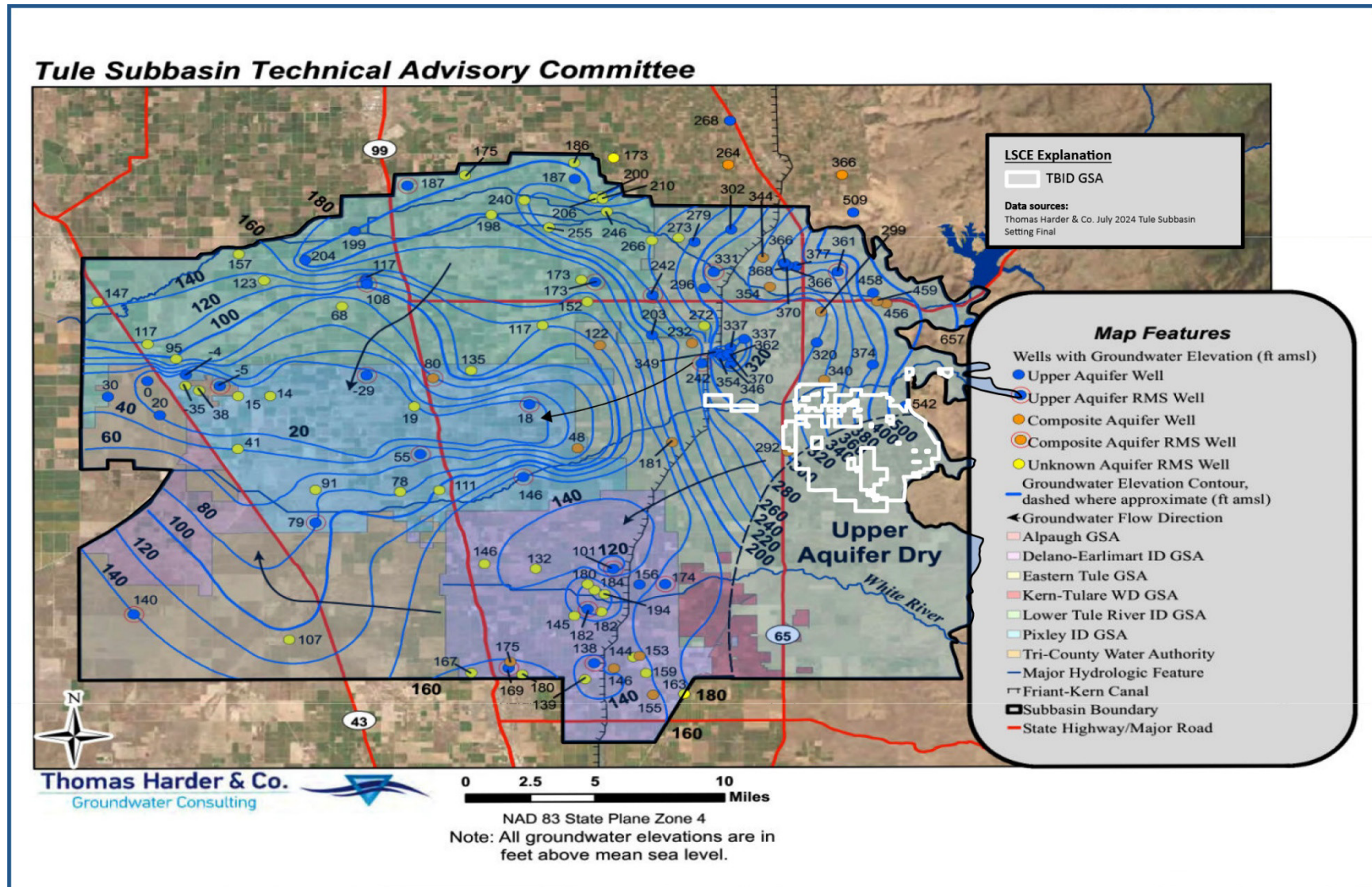


Figure 2-20a. Spring 2022 Upper Aquifer Ground Water Elevation Contours

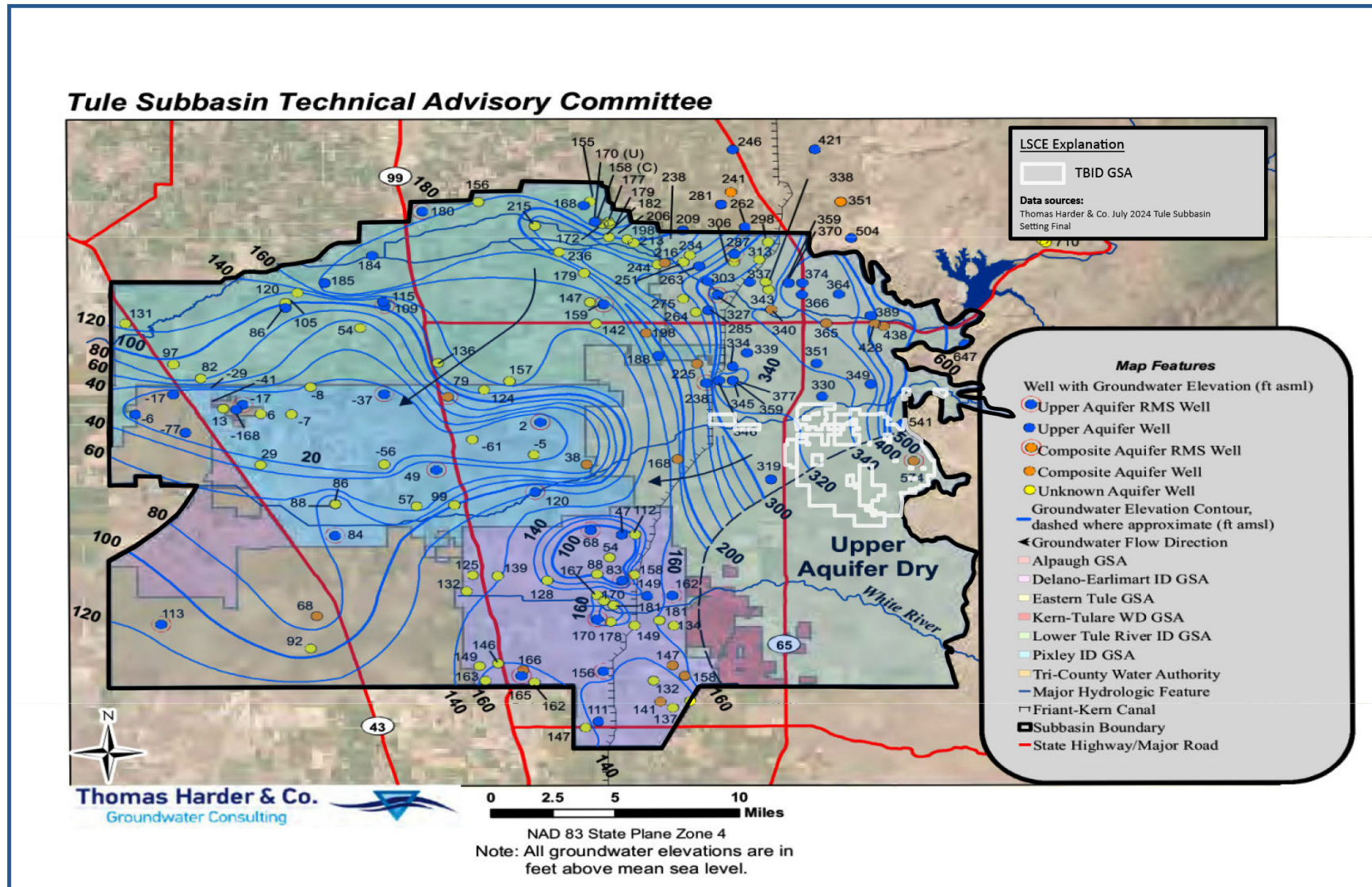


Figure 2-20b. Fall 2022 Upper Aquifer Ground Water Elevation Contours

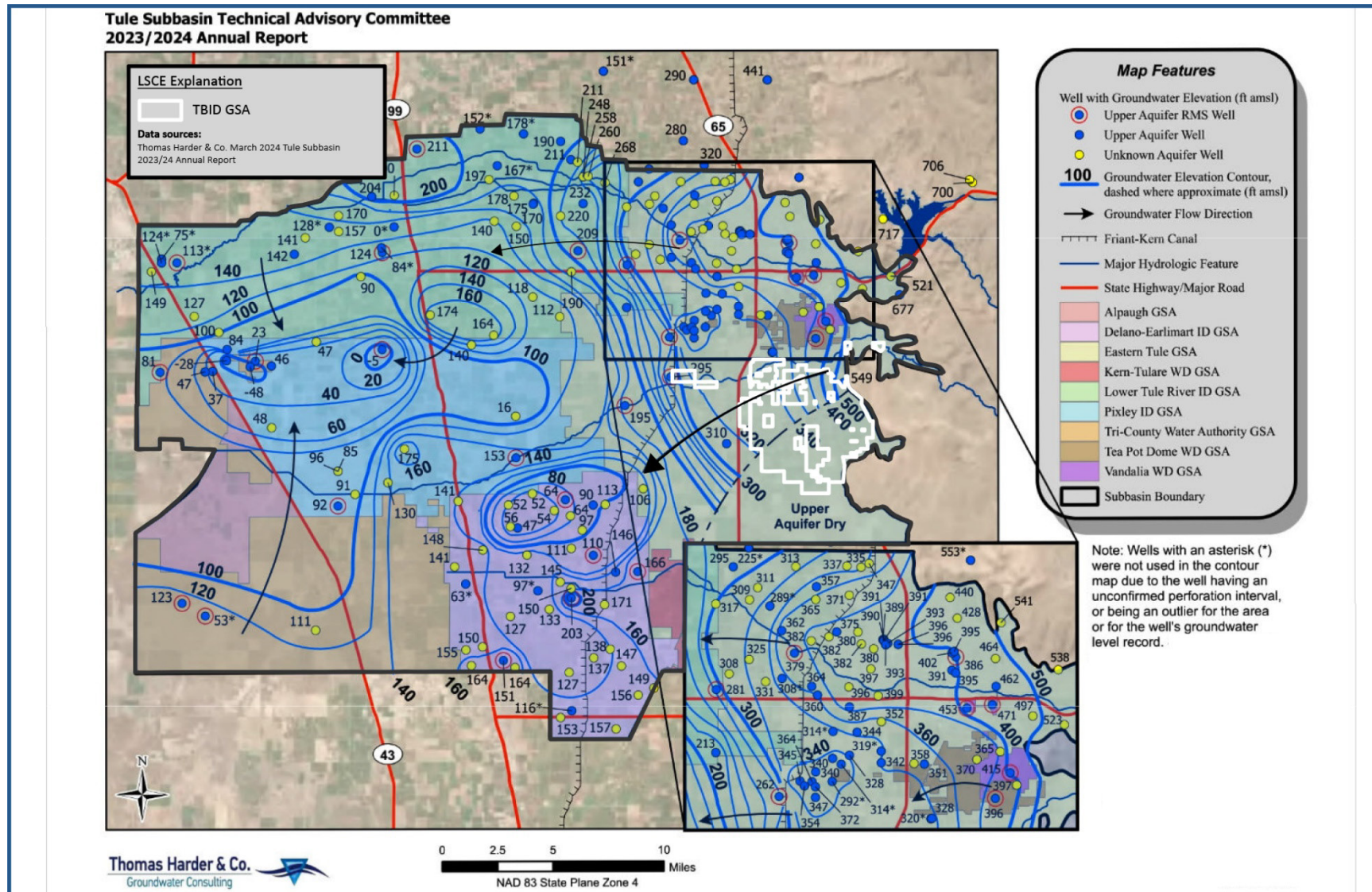
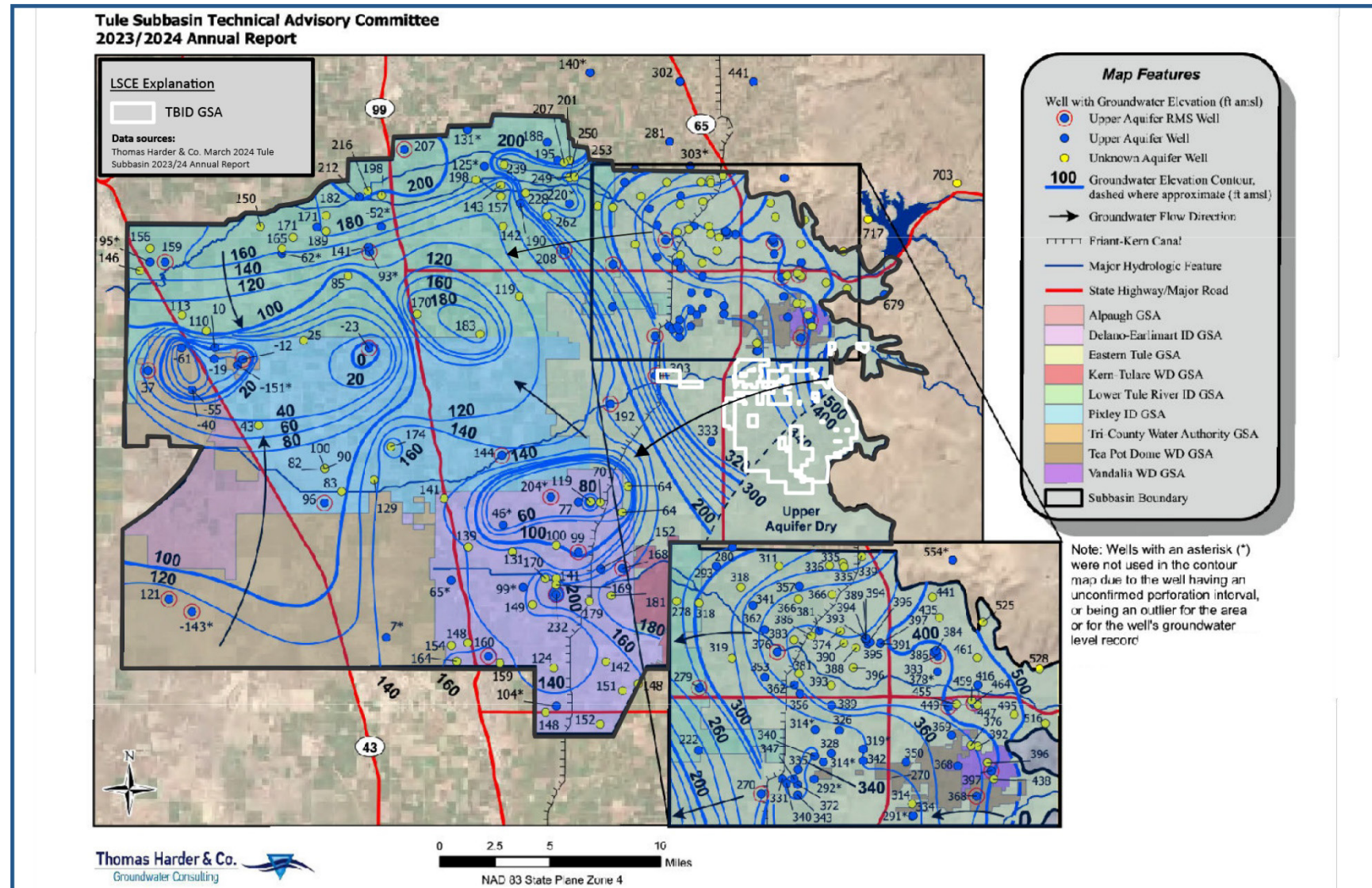


Figure 2-21a. Spring 2024 Upper Aquifer Ground Water Elevation Contours



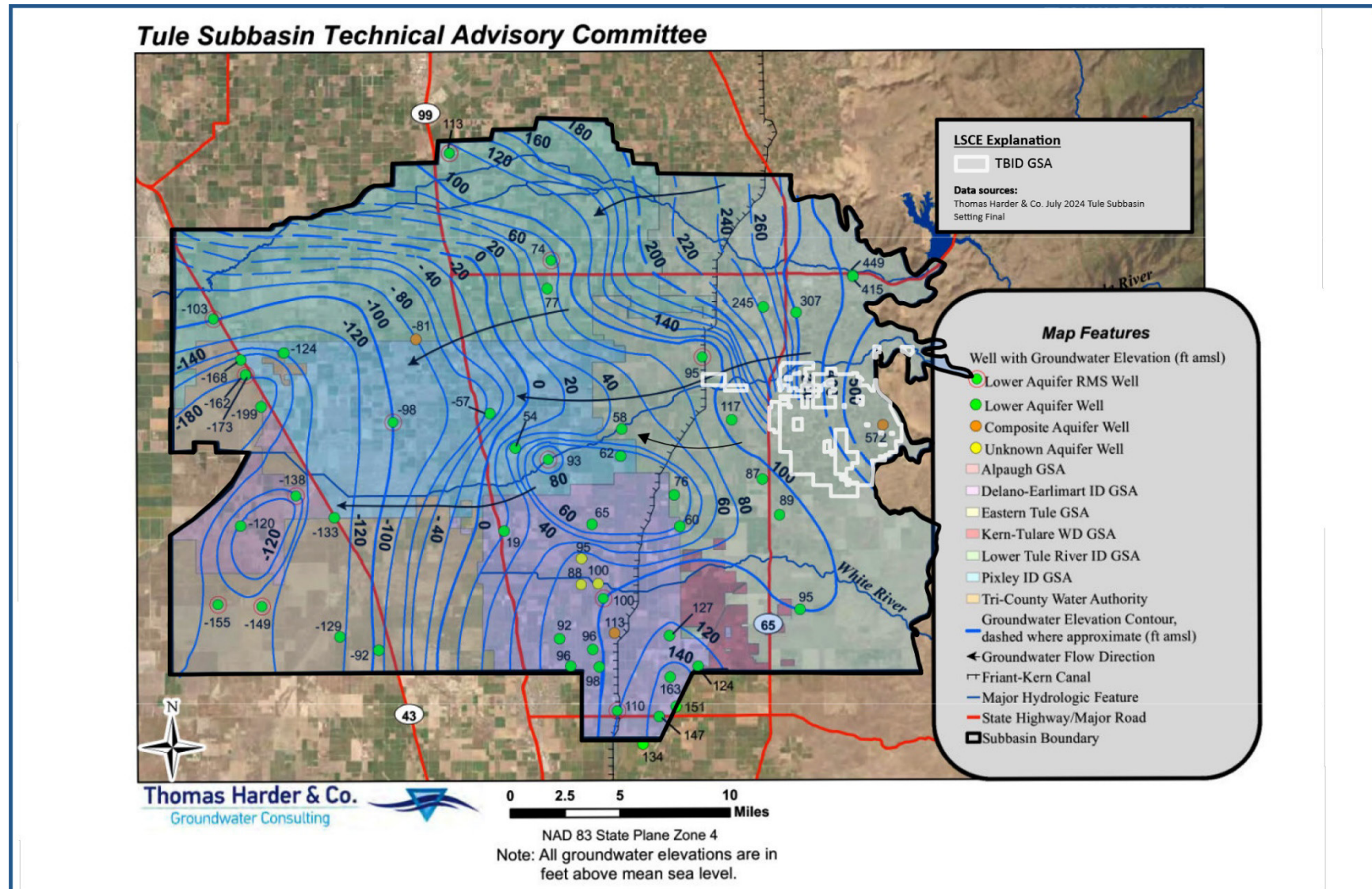


Figure 2-22a. Spring 2022 Lower Aquifer Ground Water Elevation Contours

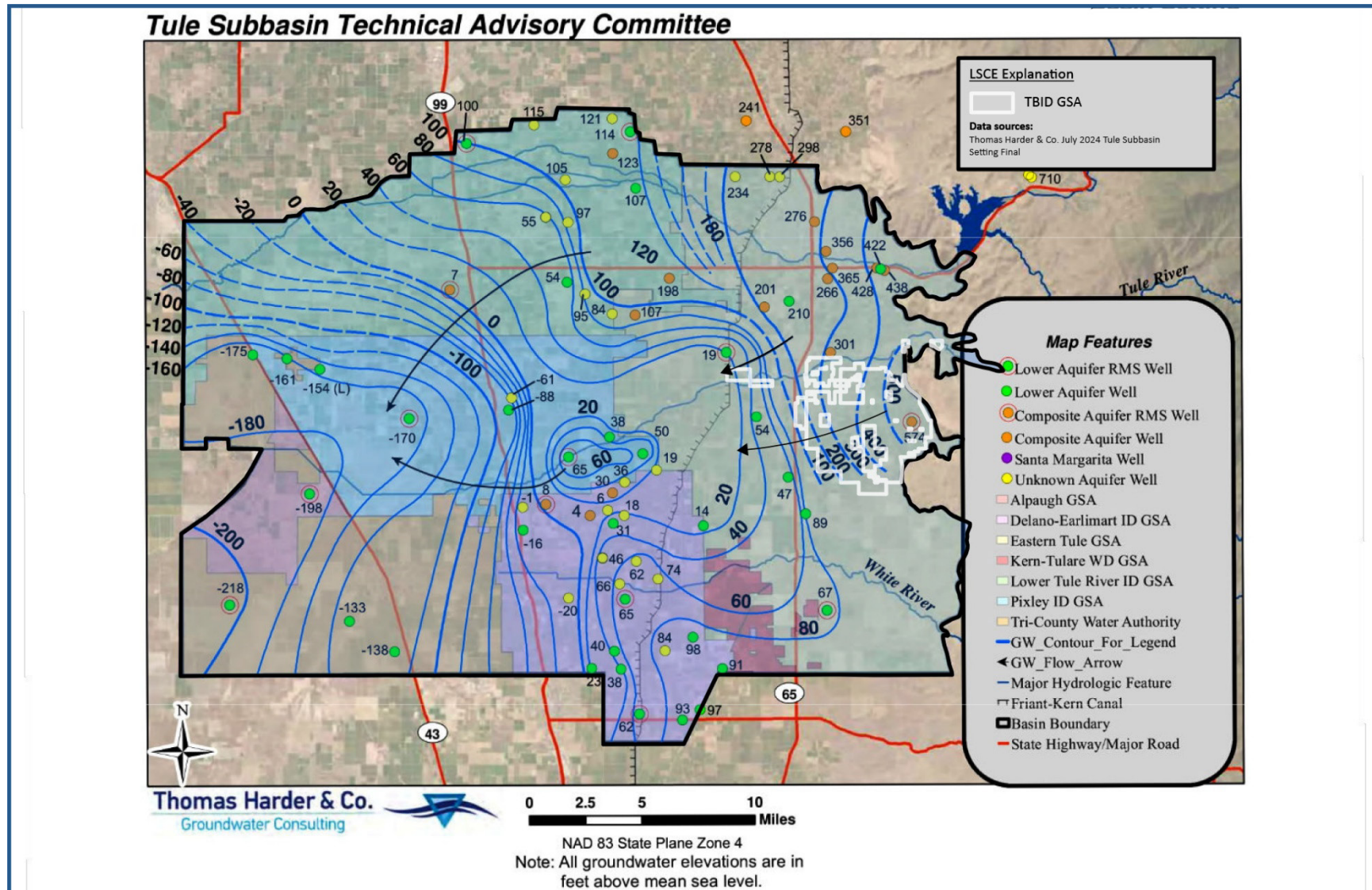


Figure 2-22b. Fall 2022 Lower Aquifer Ground Water Elevation Contours

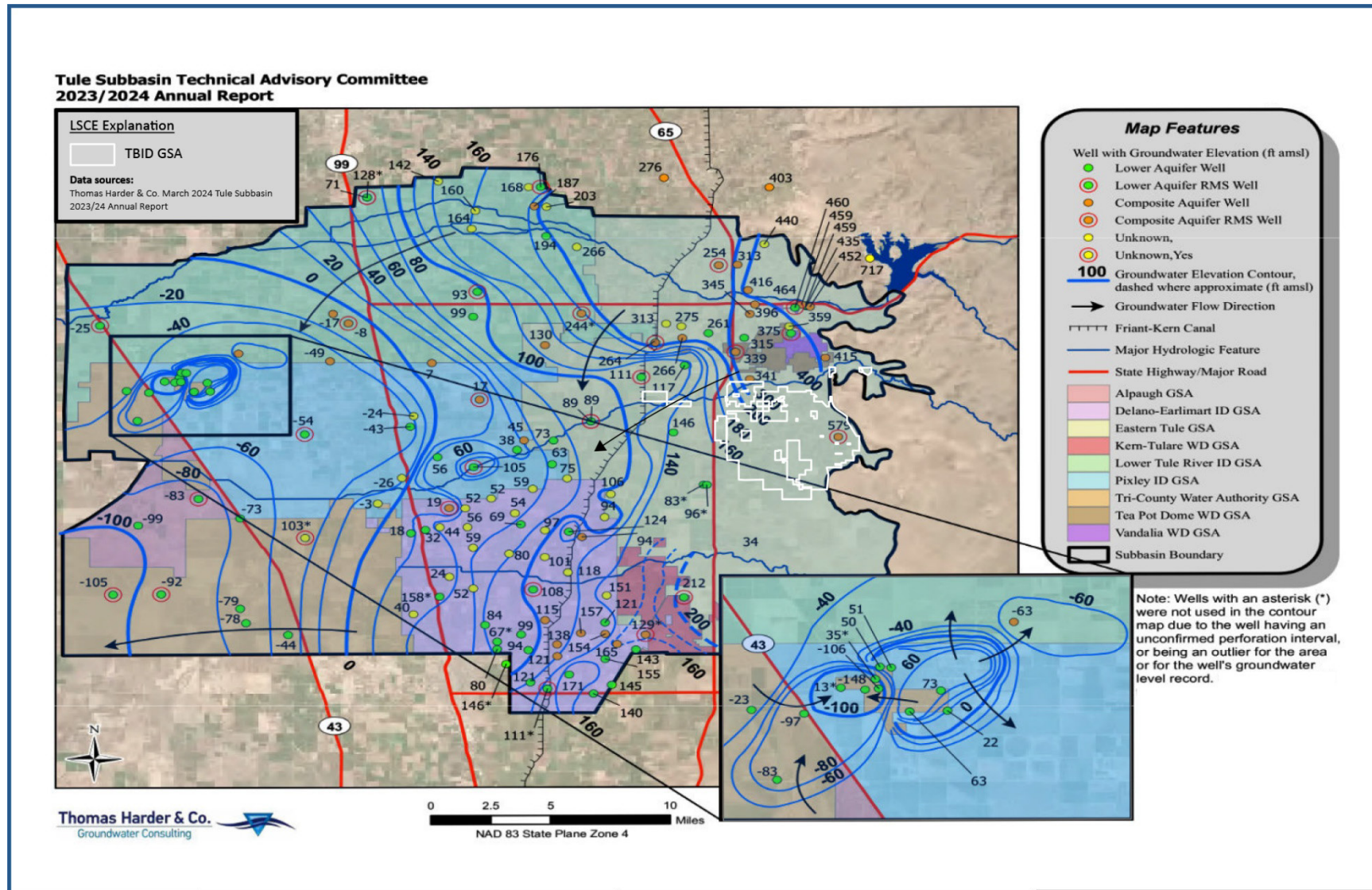


Figure 2-23a. Spring 2024 Lower Aquifer Ground Water Elevation Contours

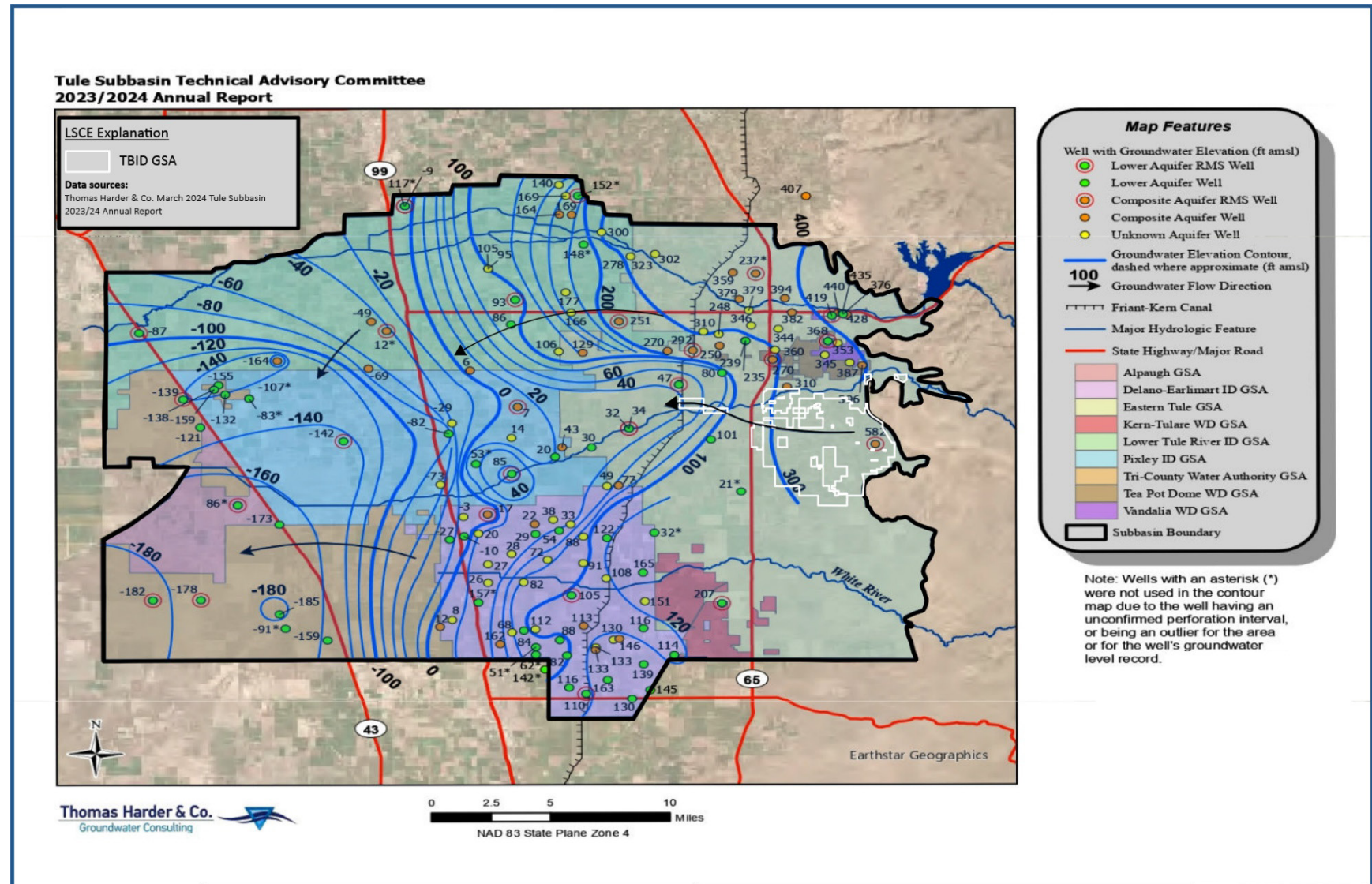
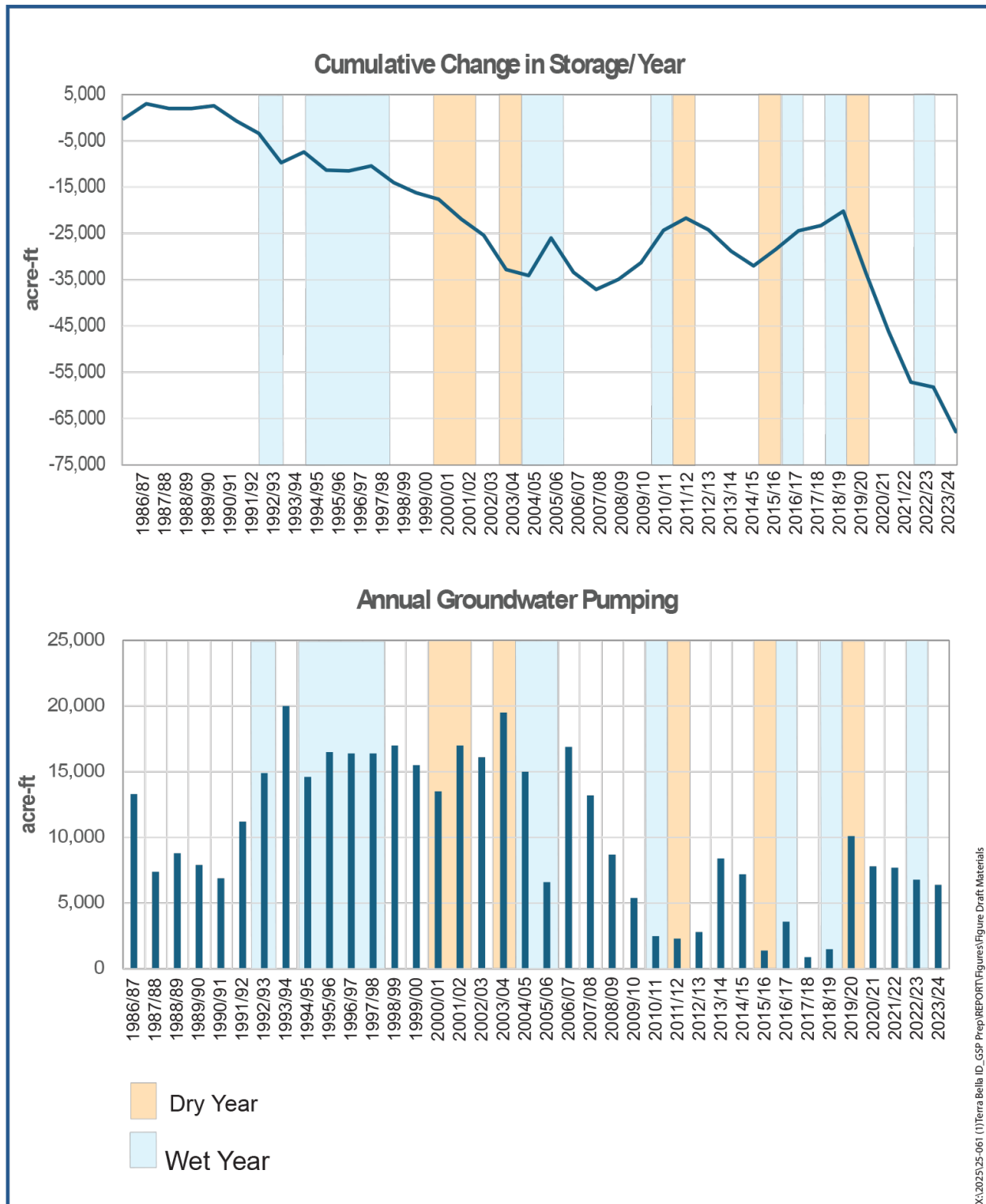


Figure 2-23b. Fall 2024 Lower Aquifer Ground Water Elevation Contours



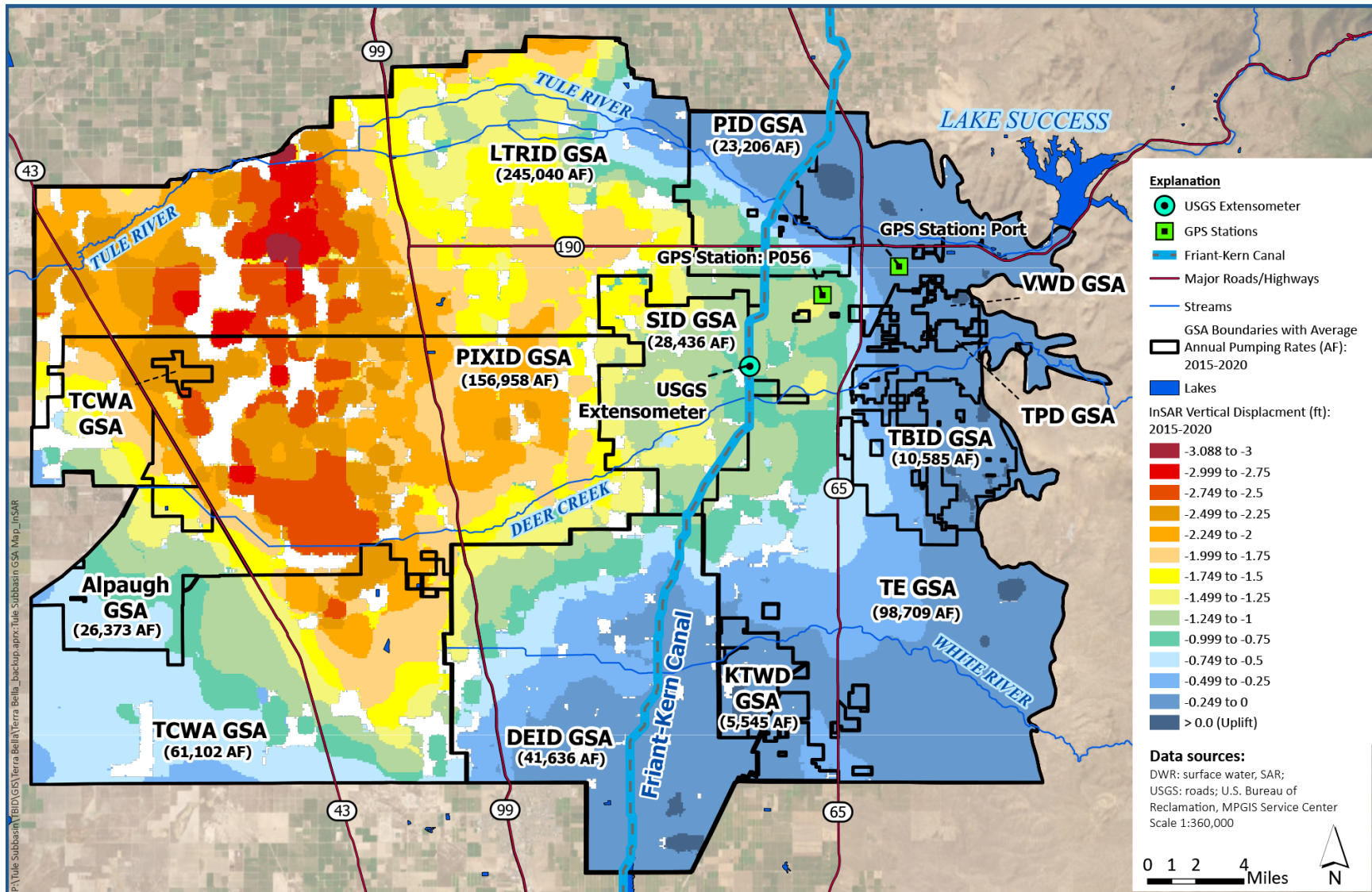


Figure 2-25a. Cumulative Land Subsidence (January 2015 - January 2020)

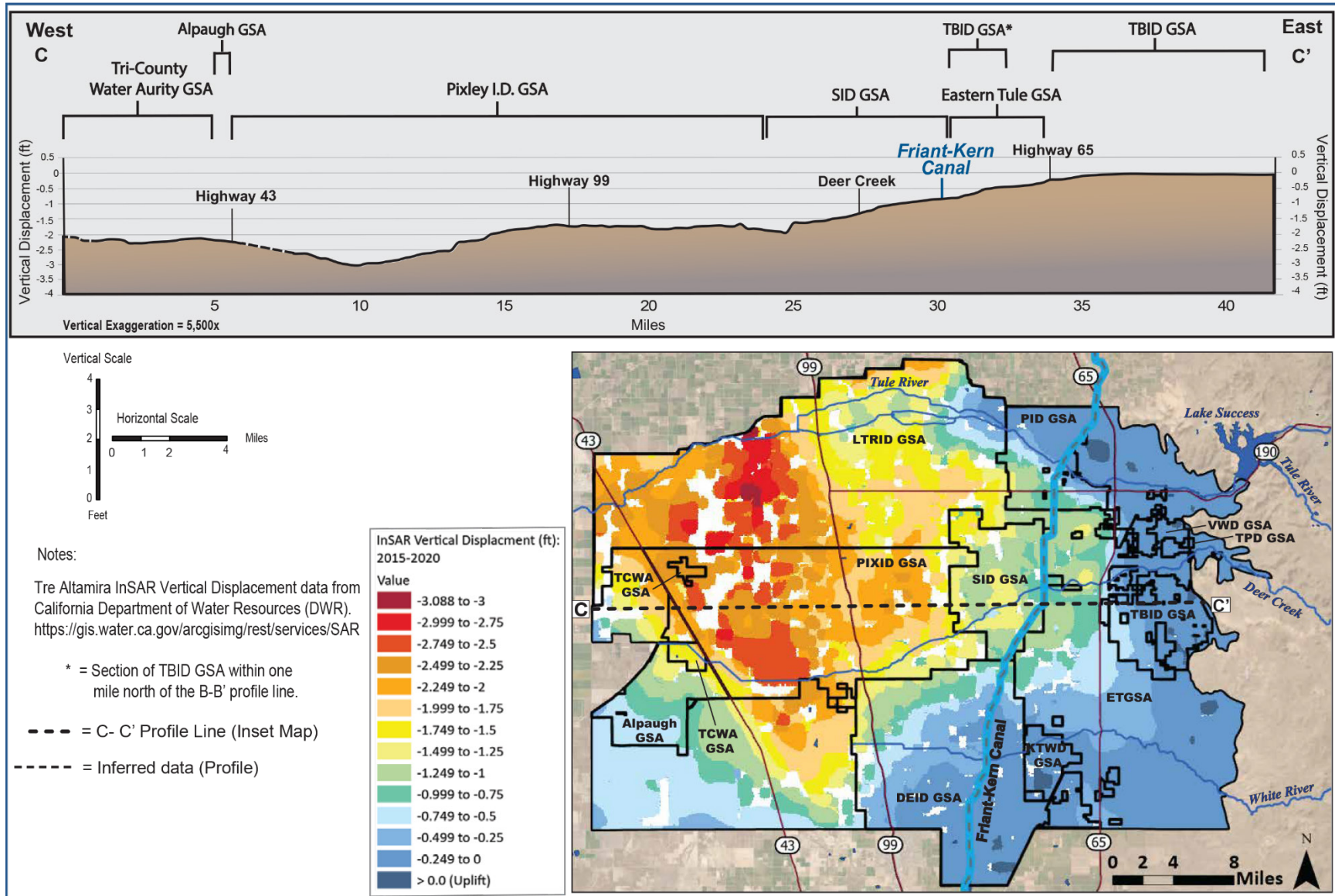


Figure 2-25b. Land Subsidence Profile (January 2015 - January 2020)

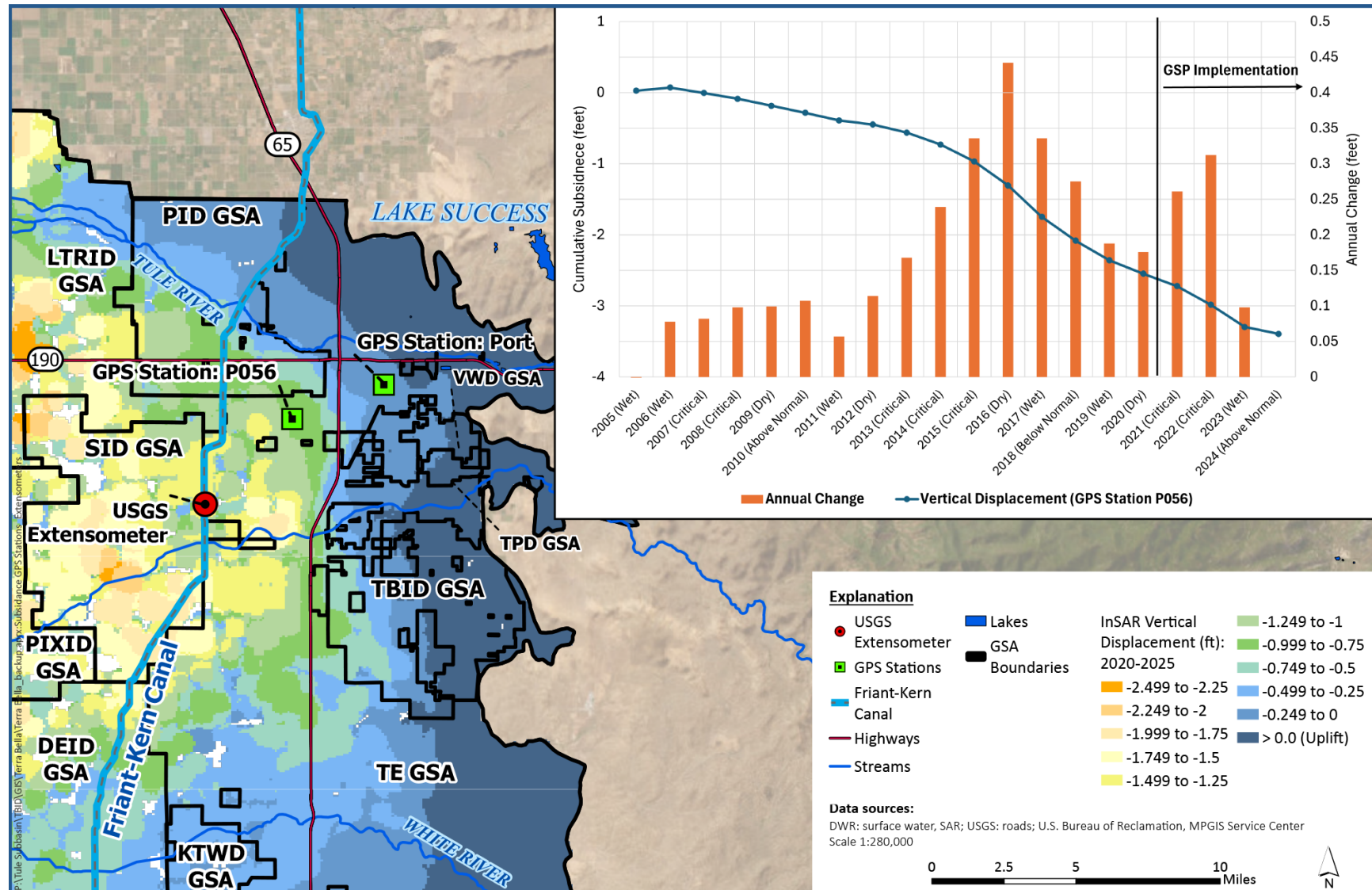


Figure 2-26. Land Subsidence: Continuous GPS Station P056

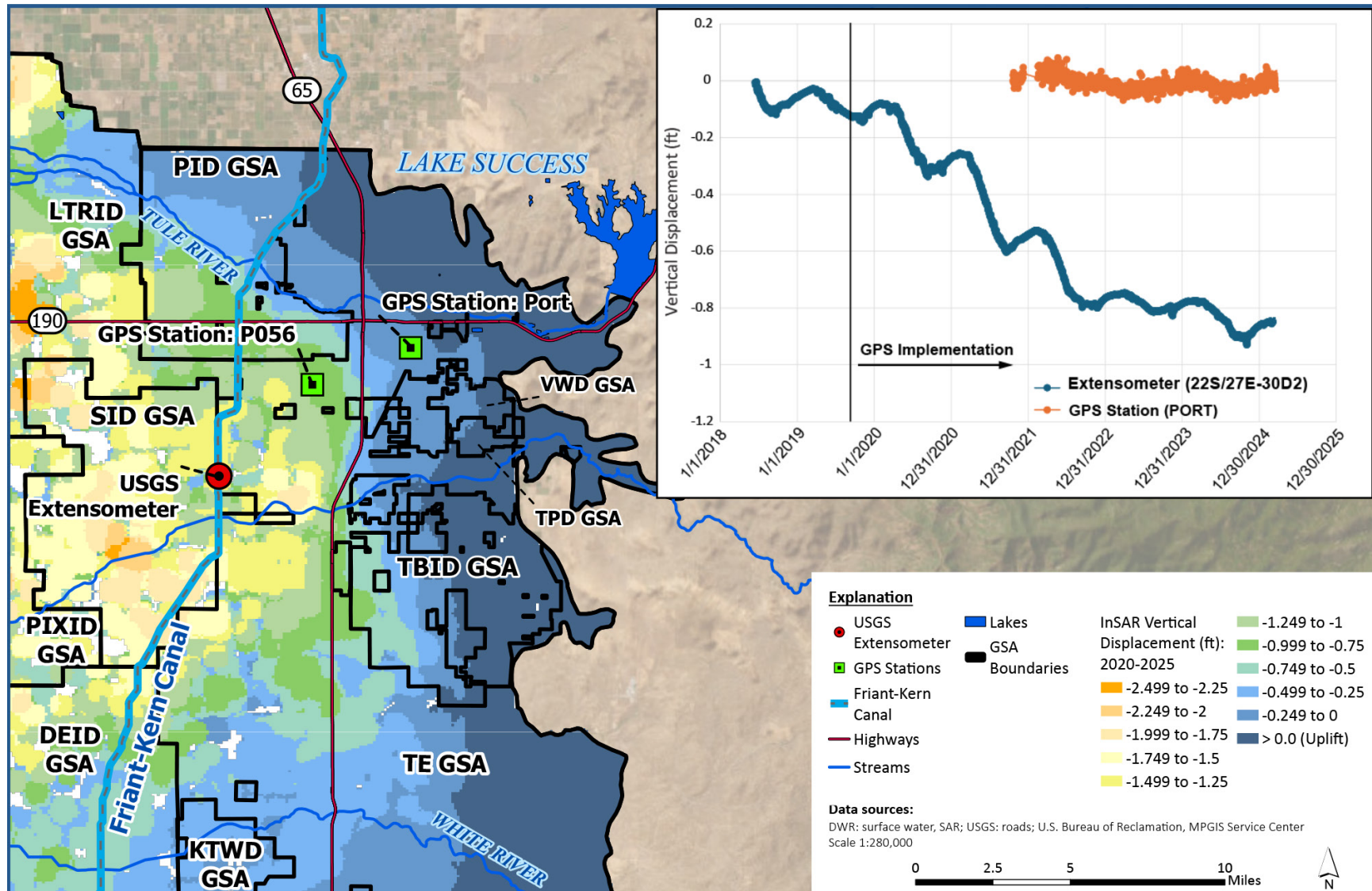


Figure 2-27. Land Subsidence: Continuous GPS Station (Port) and Extensometer (22S/27E-30D2)

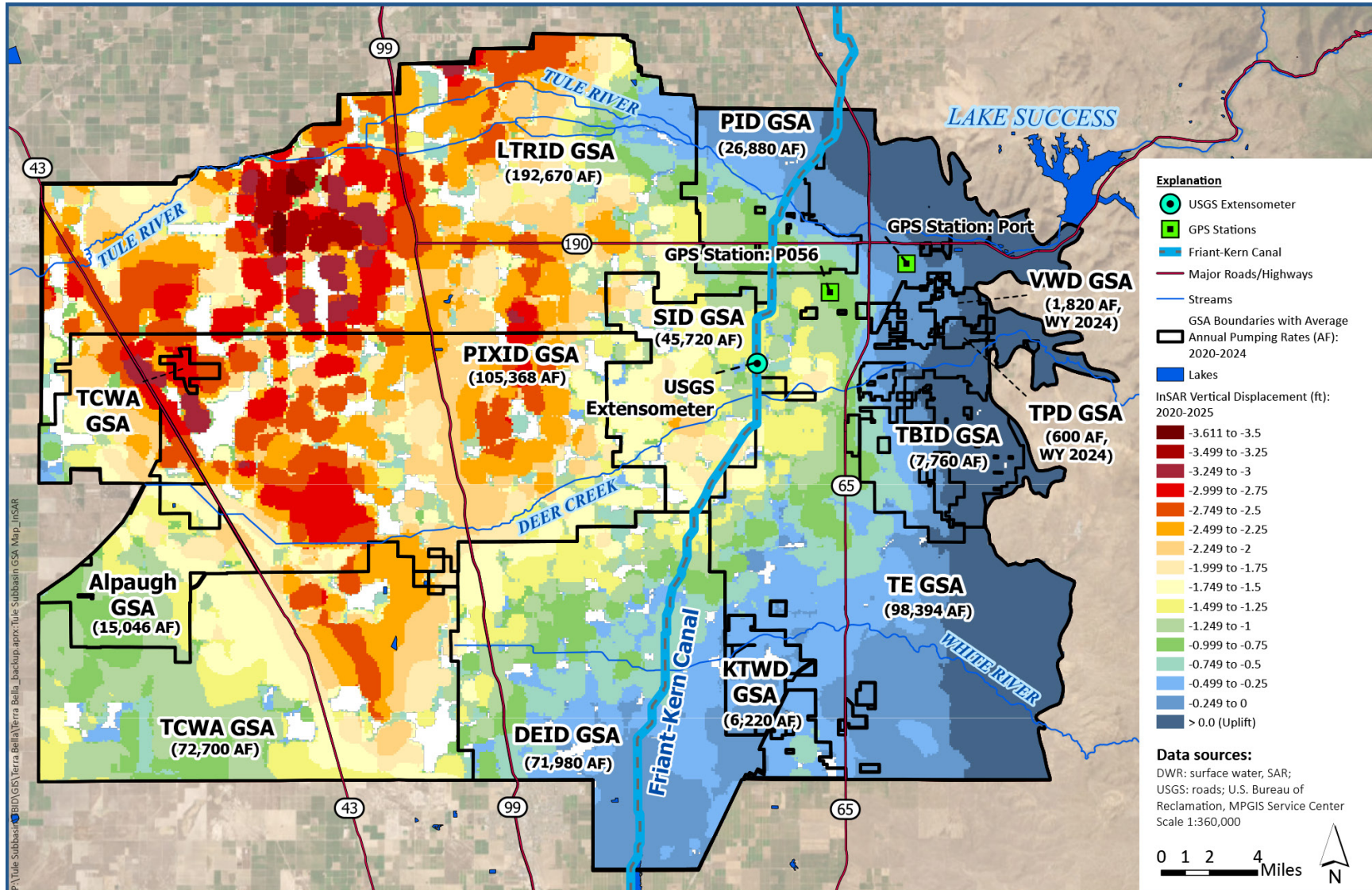


Figure 2-28a. Cumulative Land Subsidence (January 2020-January 2025)

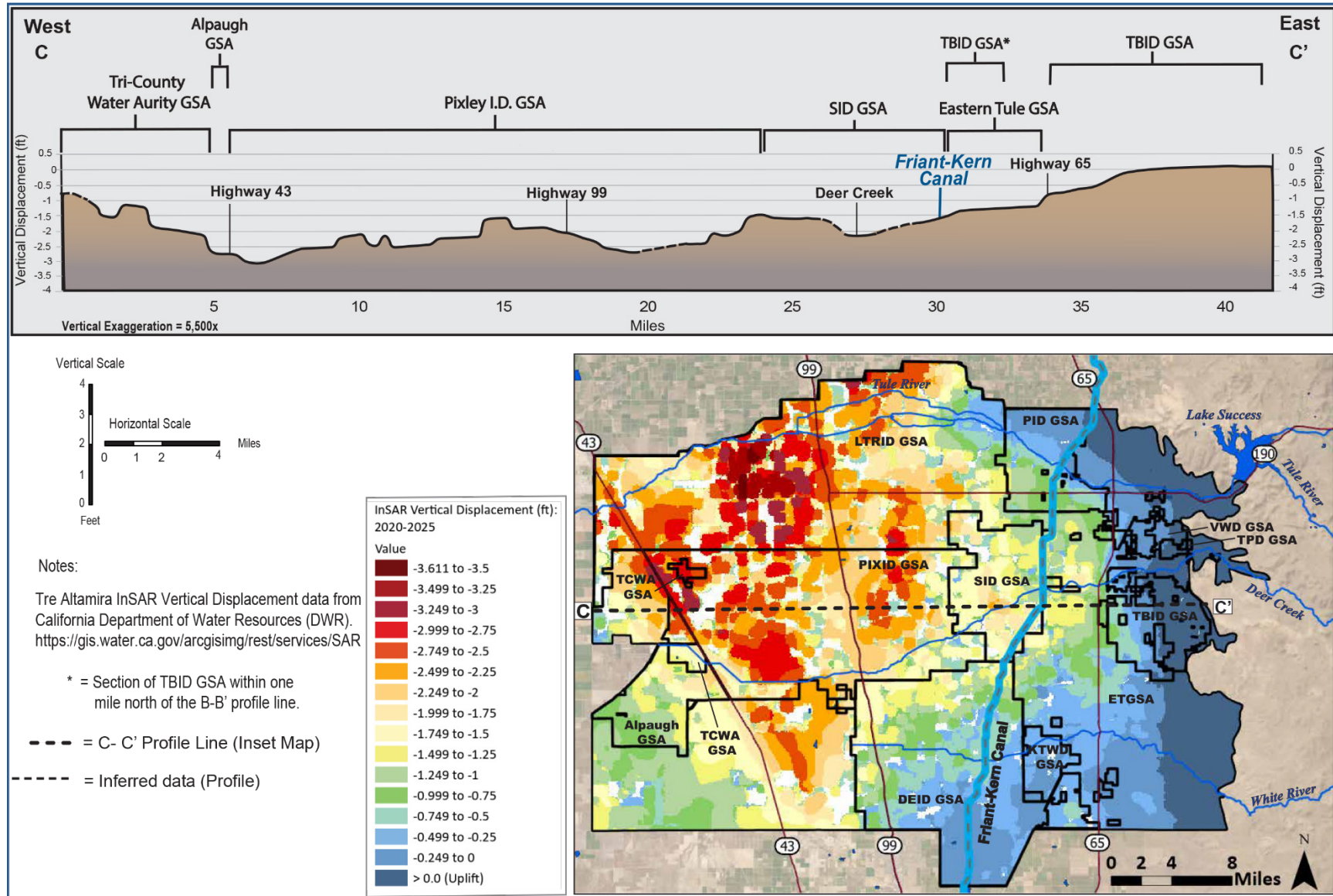


Figure 2-28b. Land Subsidence Profile (January 2020-January 2025)

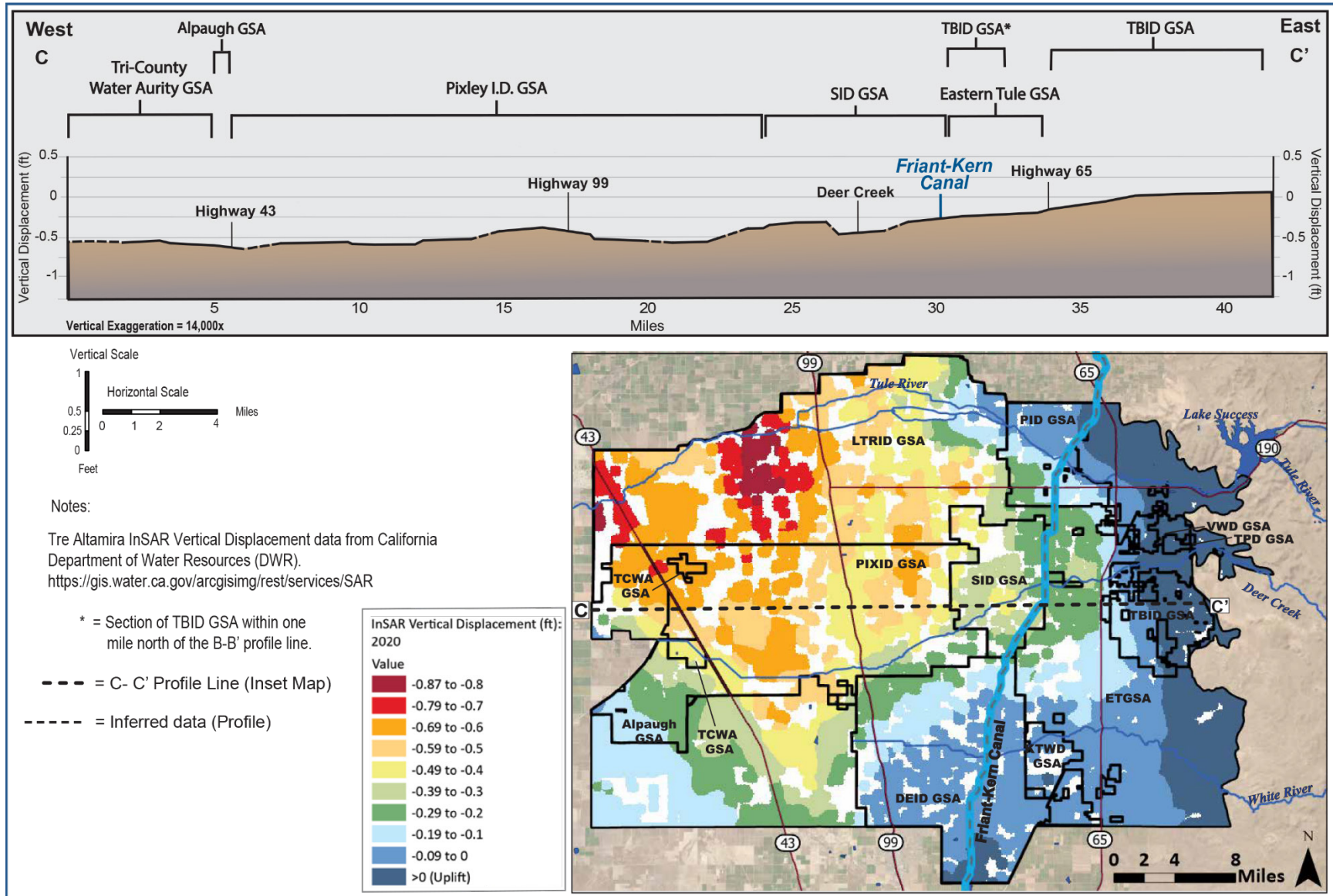


Figure 2-29a. Land Subsidence Profile: 2020

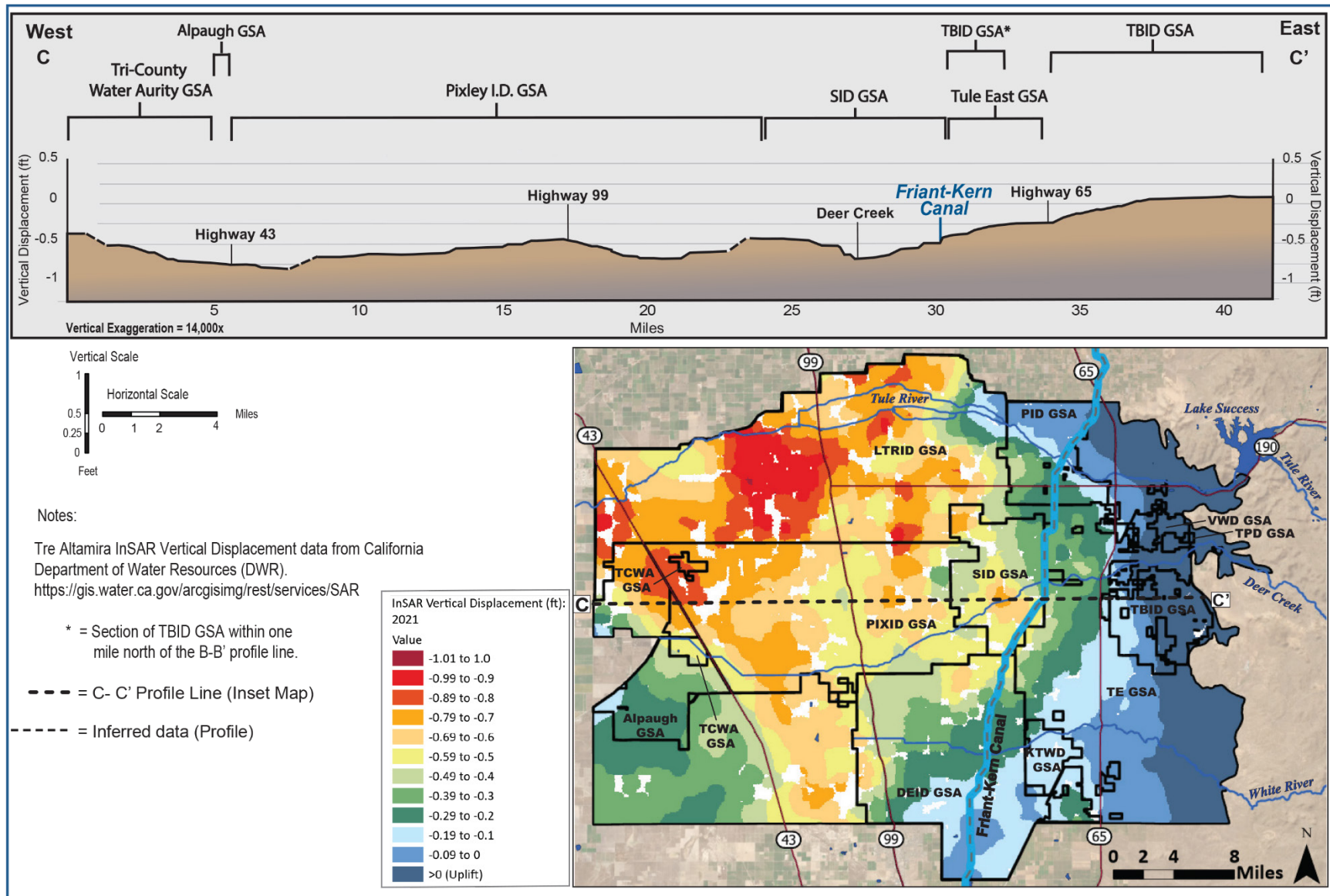


Figure 2-29b. Land Subsidence Profile: 2021

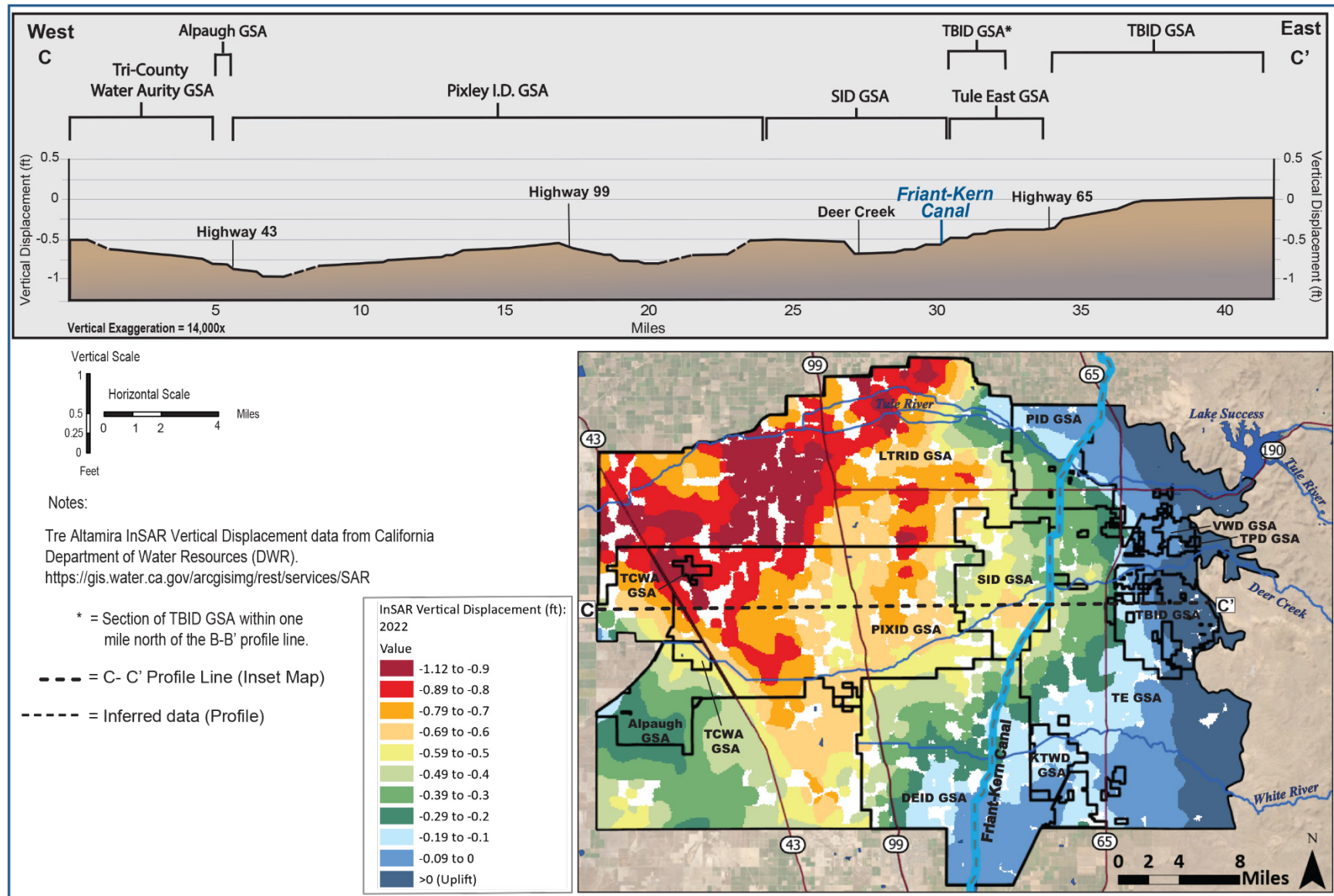


Figure 2-29c. Land Subsidence Profile: 2022

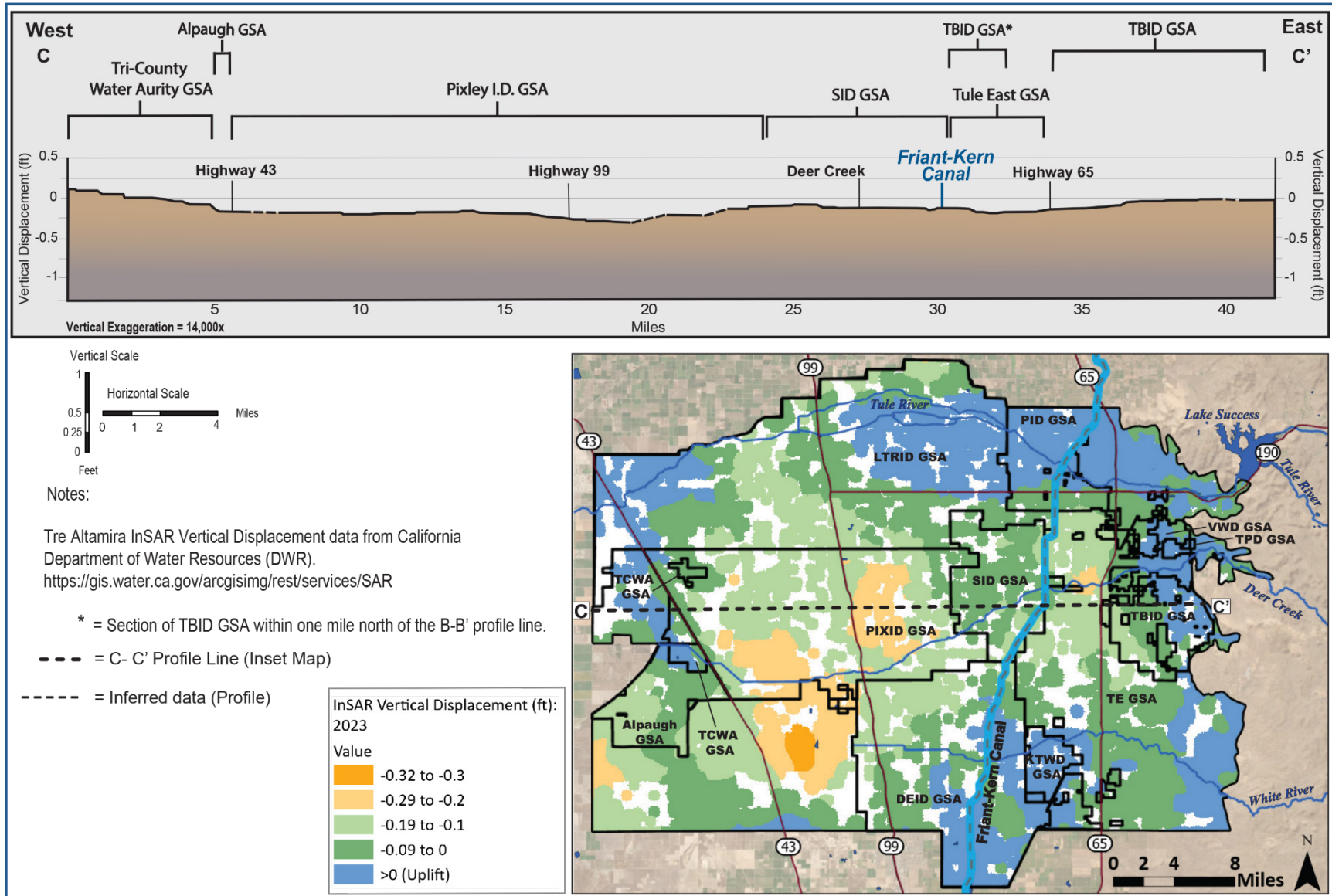


Figure 2-29d. Land Subsidence Profile: 2023

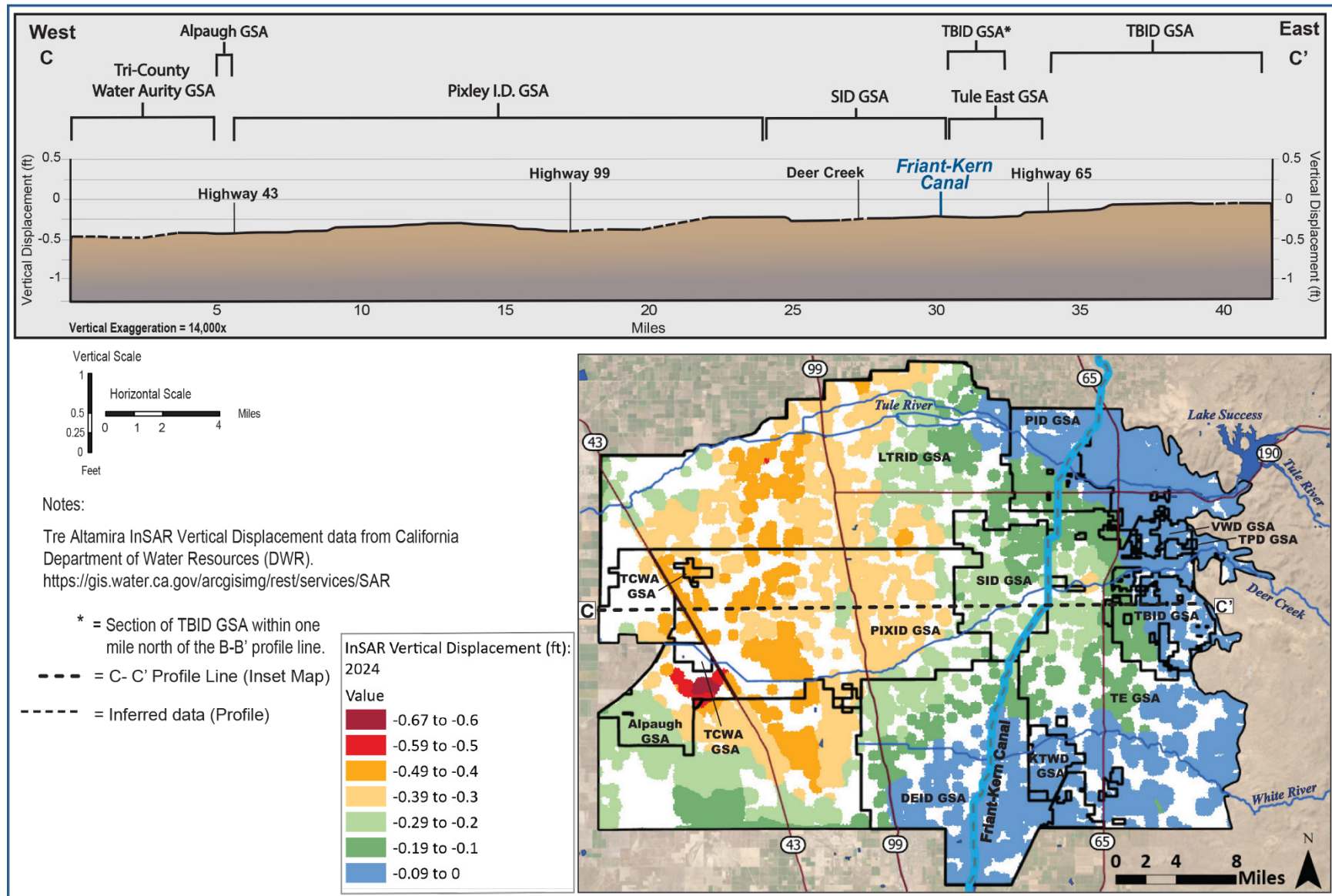


Figure 2-29e. Land Subsidence Profile: 2024

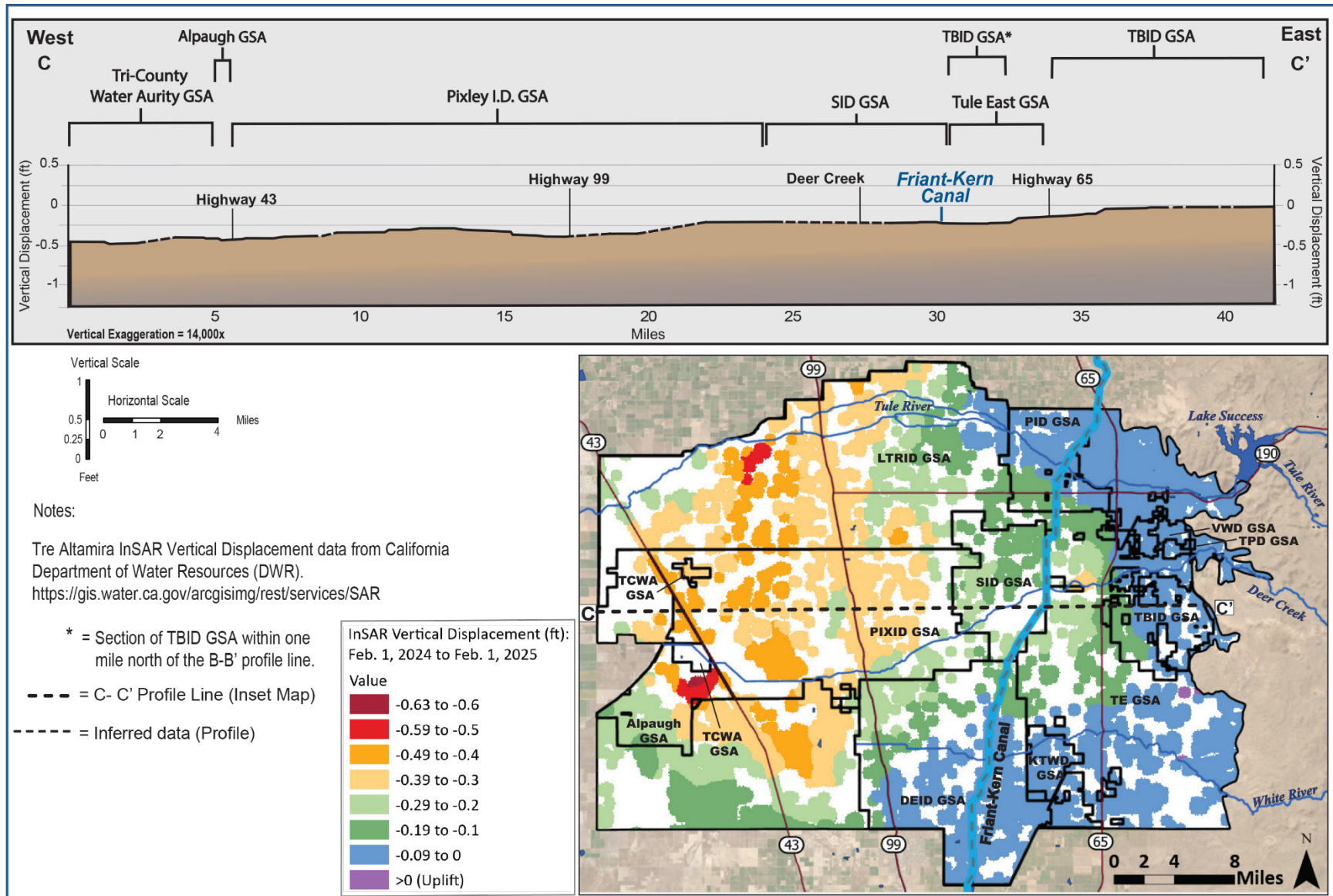


Figure 2-29f. Land Subsidence Profile: 2025

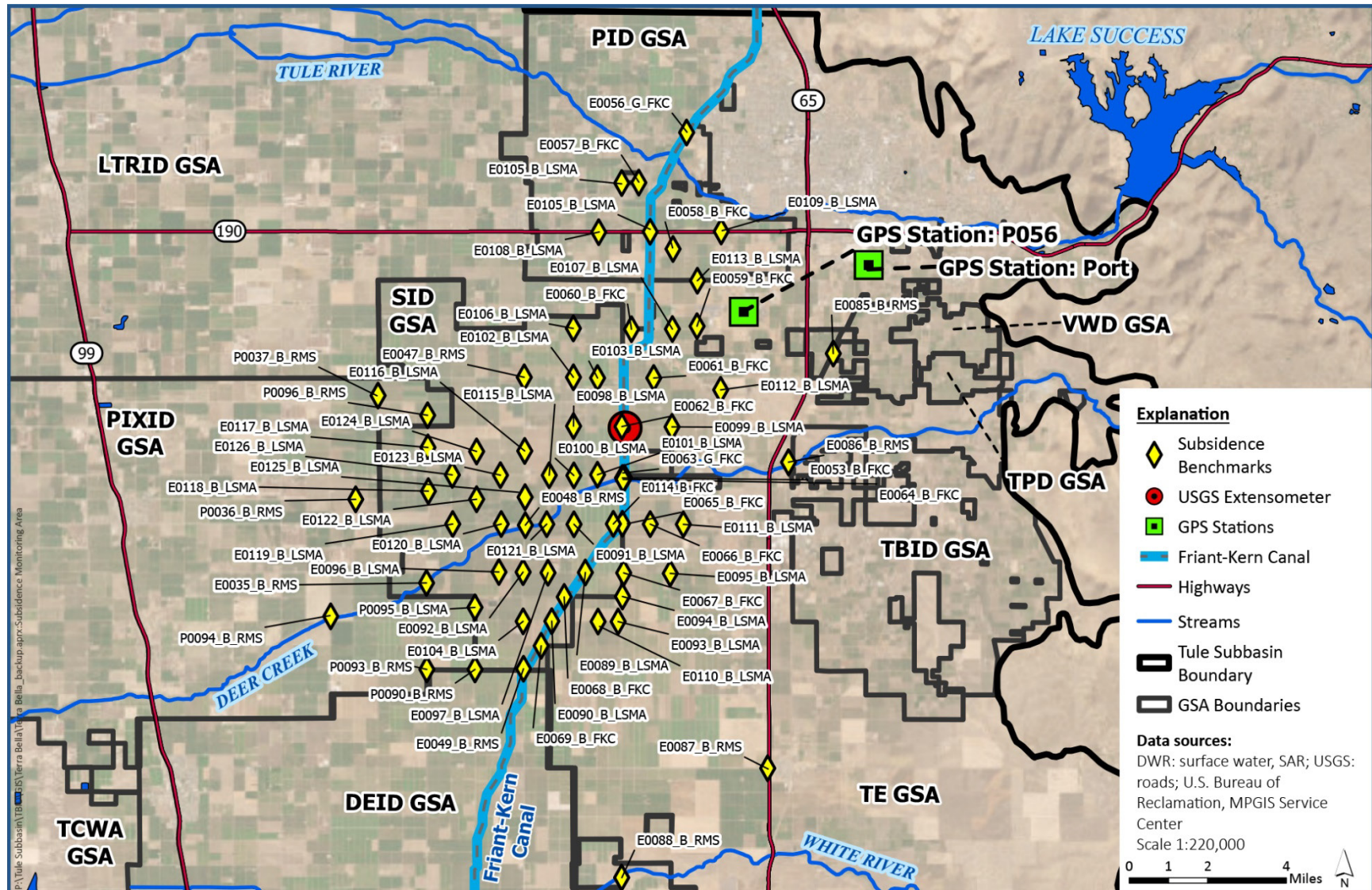


Figure 2-30. Land Subsidence Monitoring Plan Area

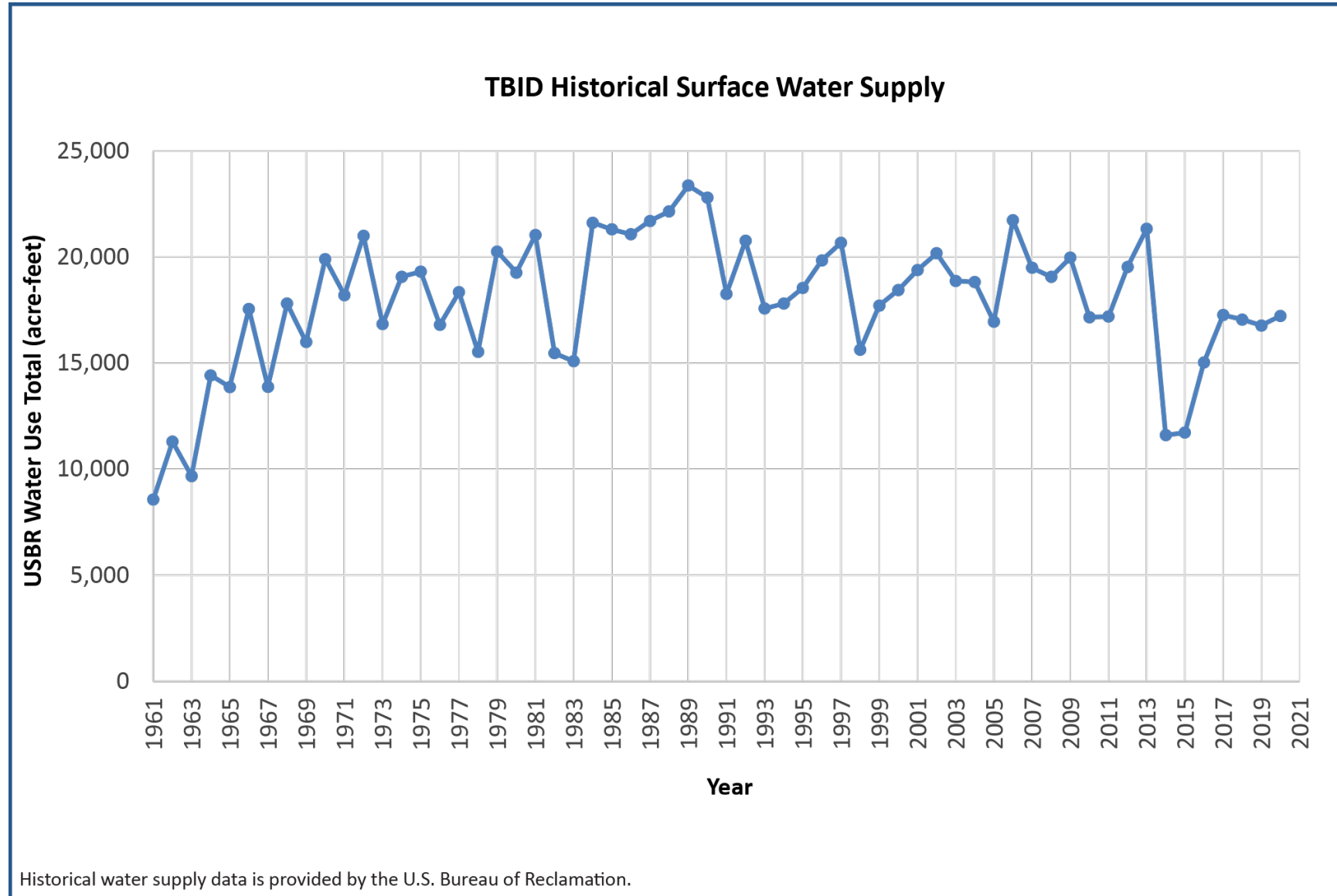


Figure 2-31. TBID Historical Water Supply (2015 to 2023)

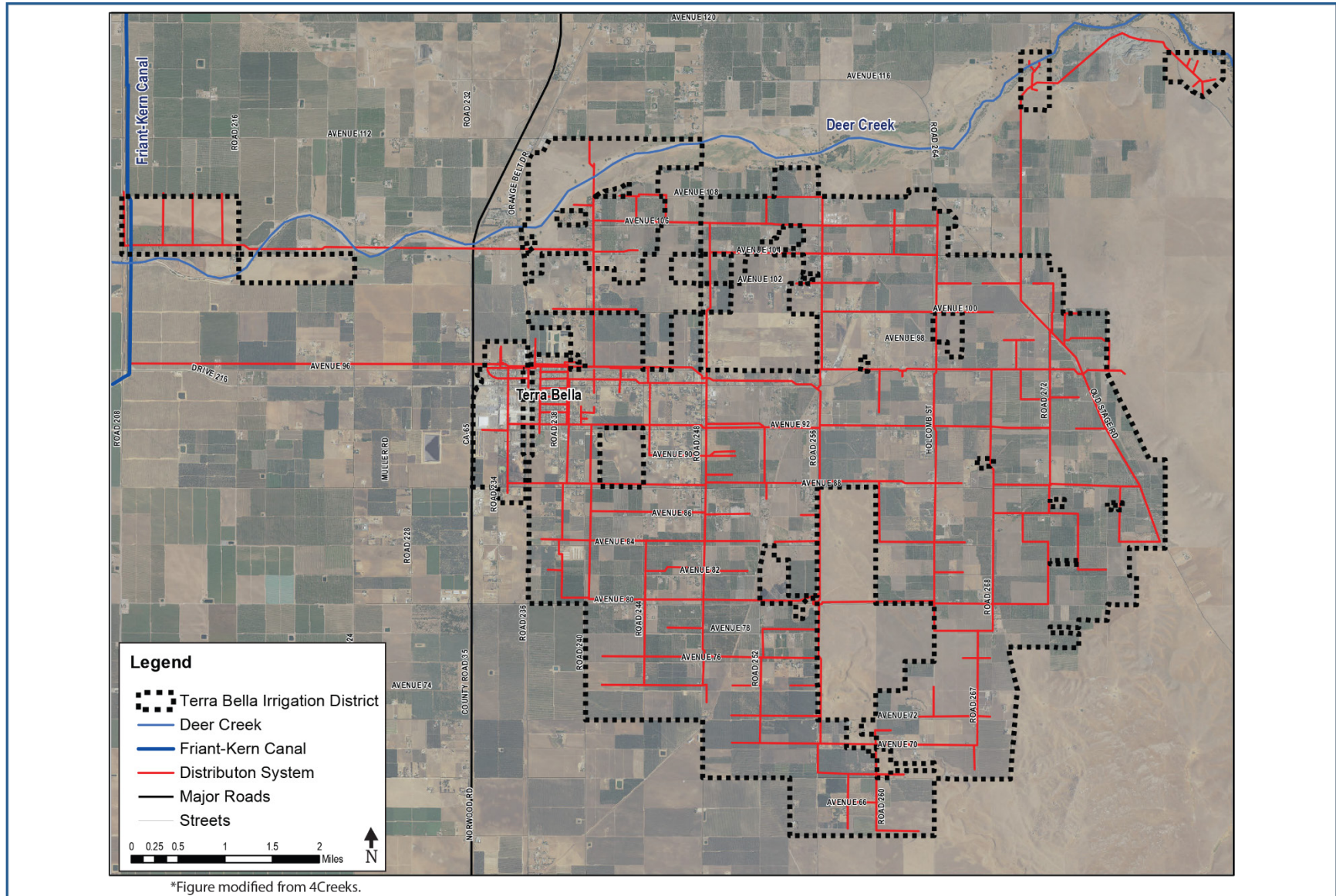


Figure 2-32. TBID Distribution System

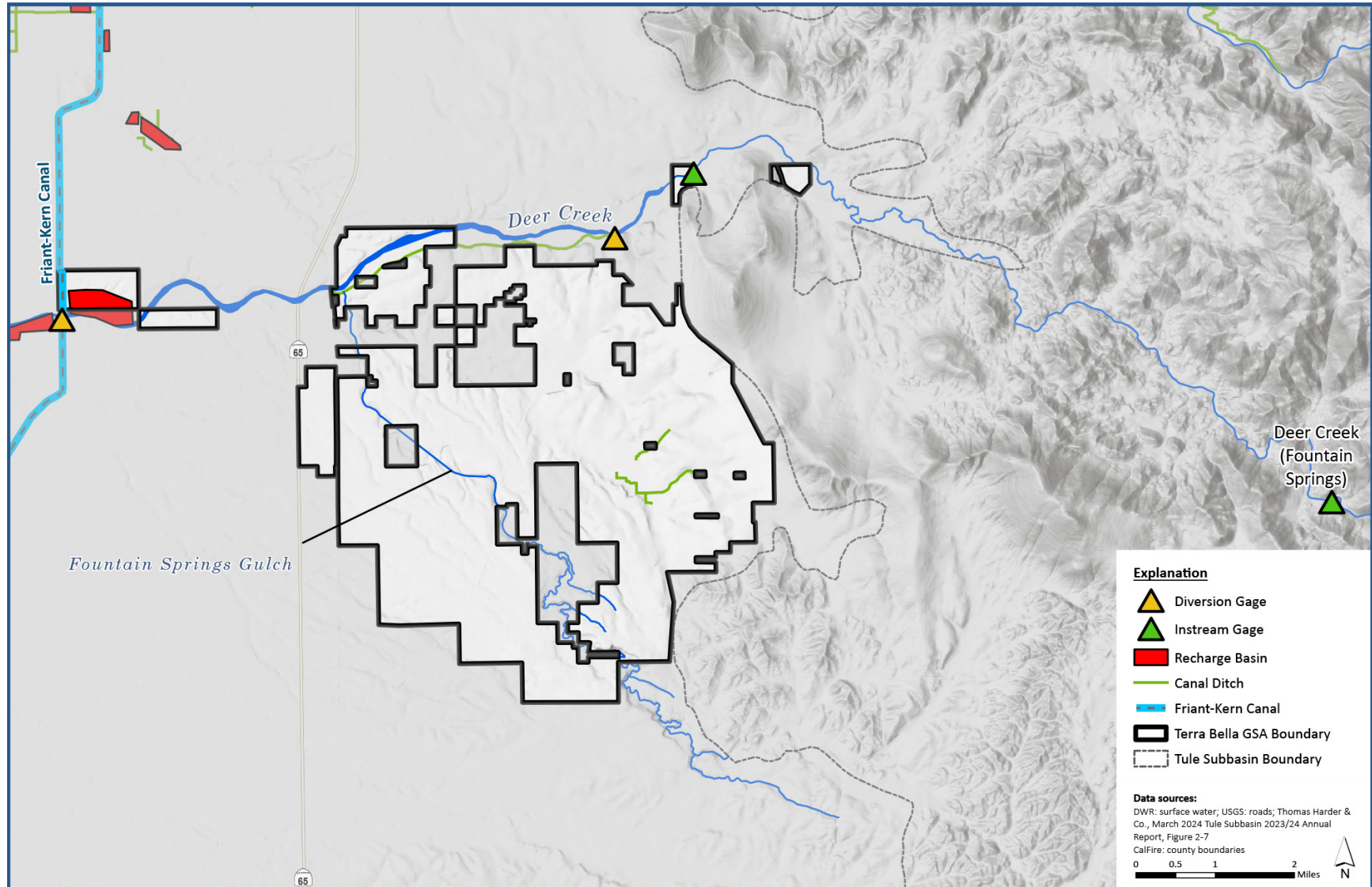


Figure 2-33. Surface Water Features

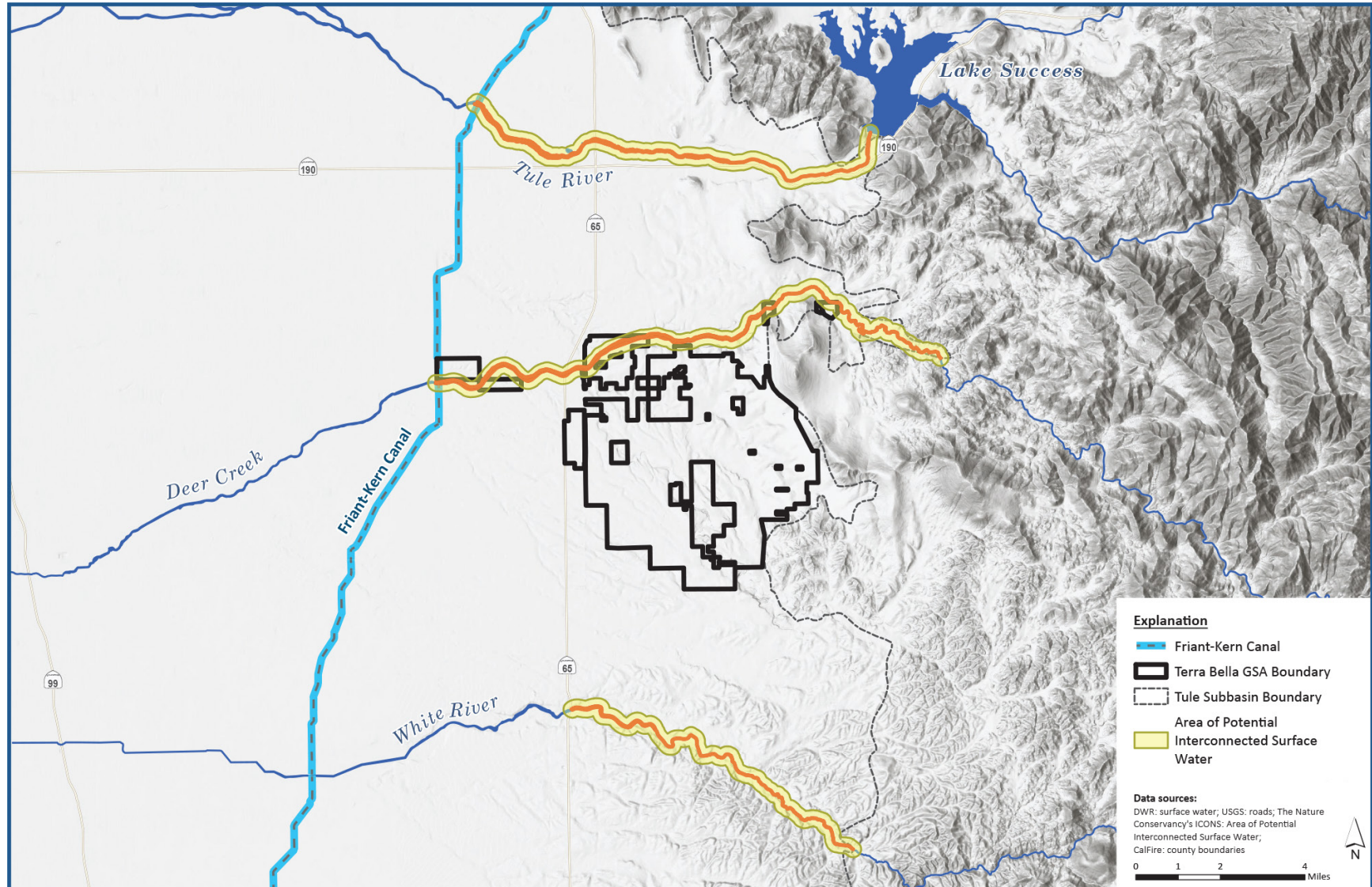


Figure 2-34. Interconnected Surface Water

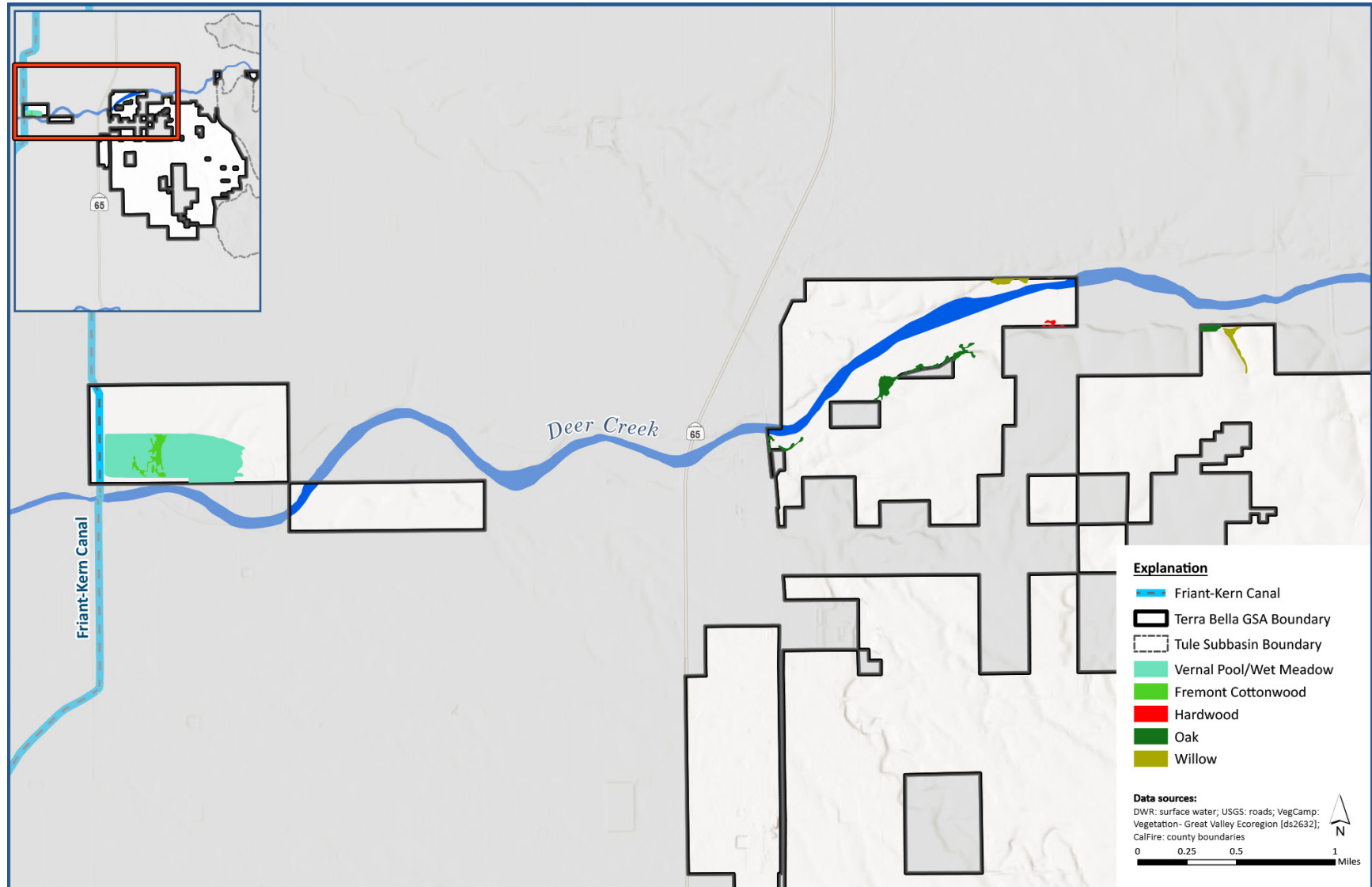


Figure 2-35. Groundwater Dependent Ecosystems

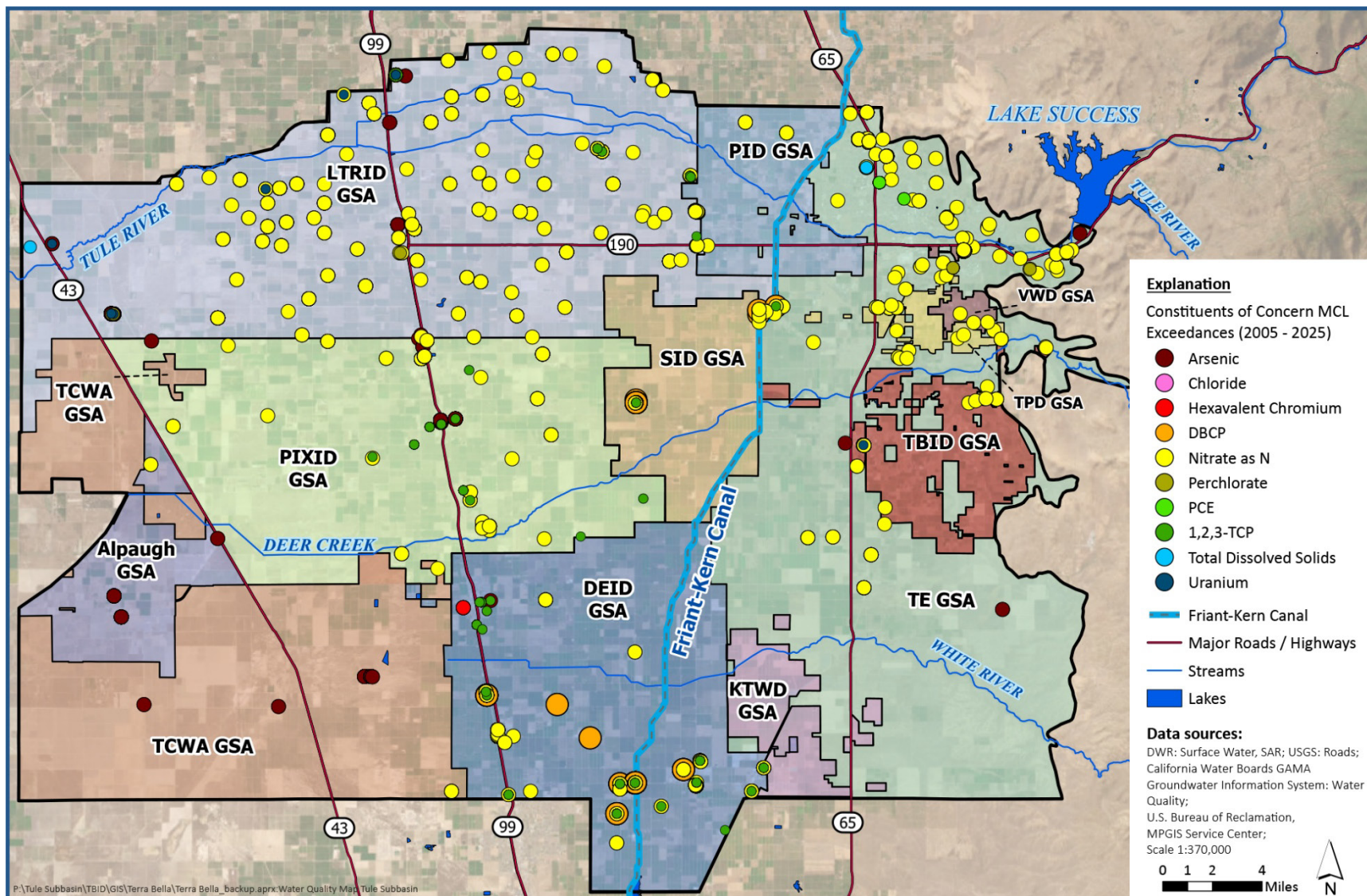


Figure 2-36. Tule Subbasin Constituents of Concern MCL Exceedances: (2005-2025)

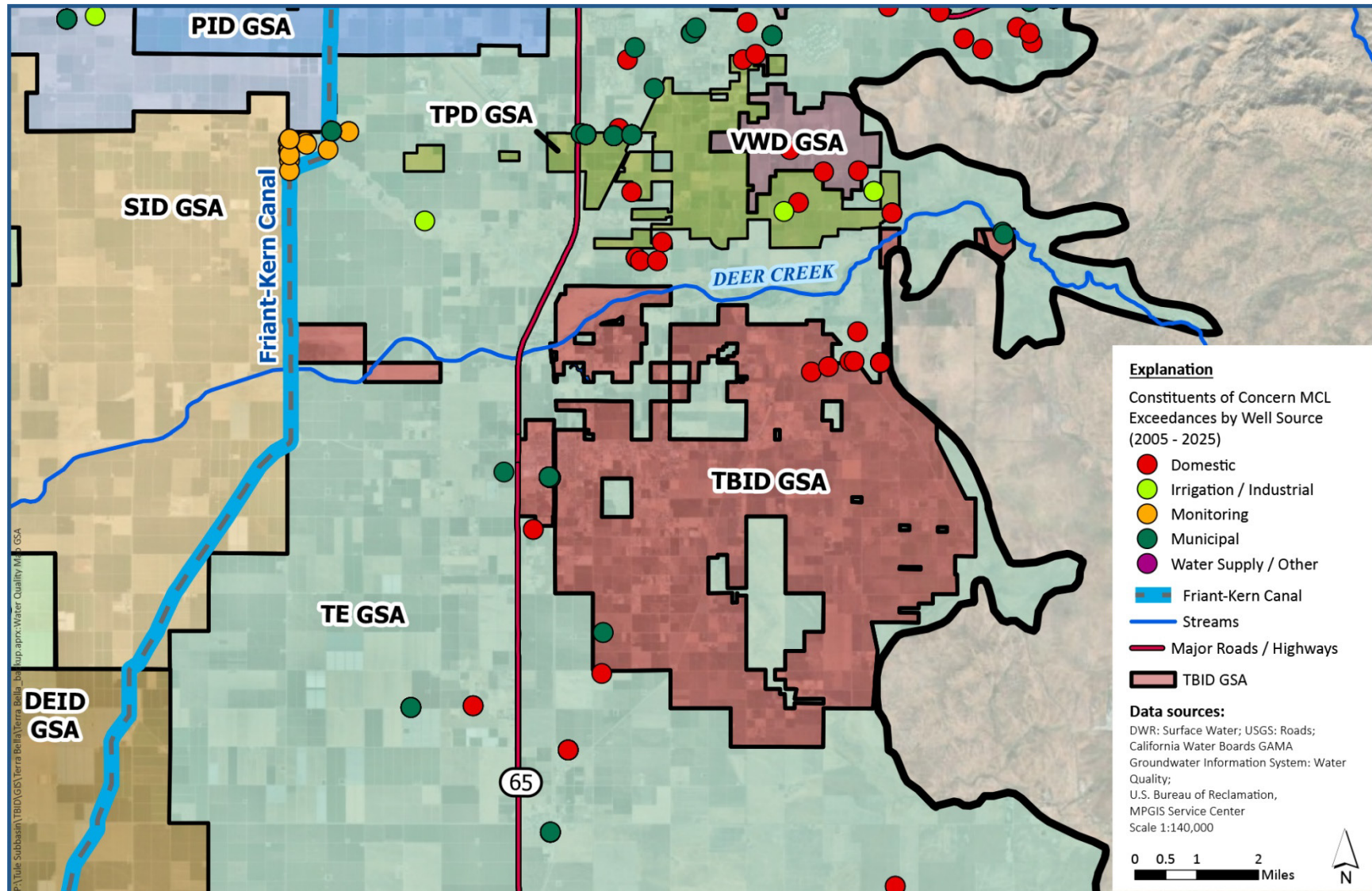


Figure 2-37. Constituents of Concern MCL Exceedances by Well Type within the TBID Vicinity

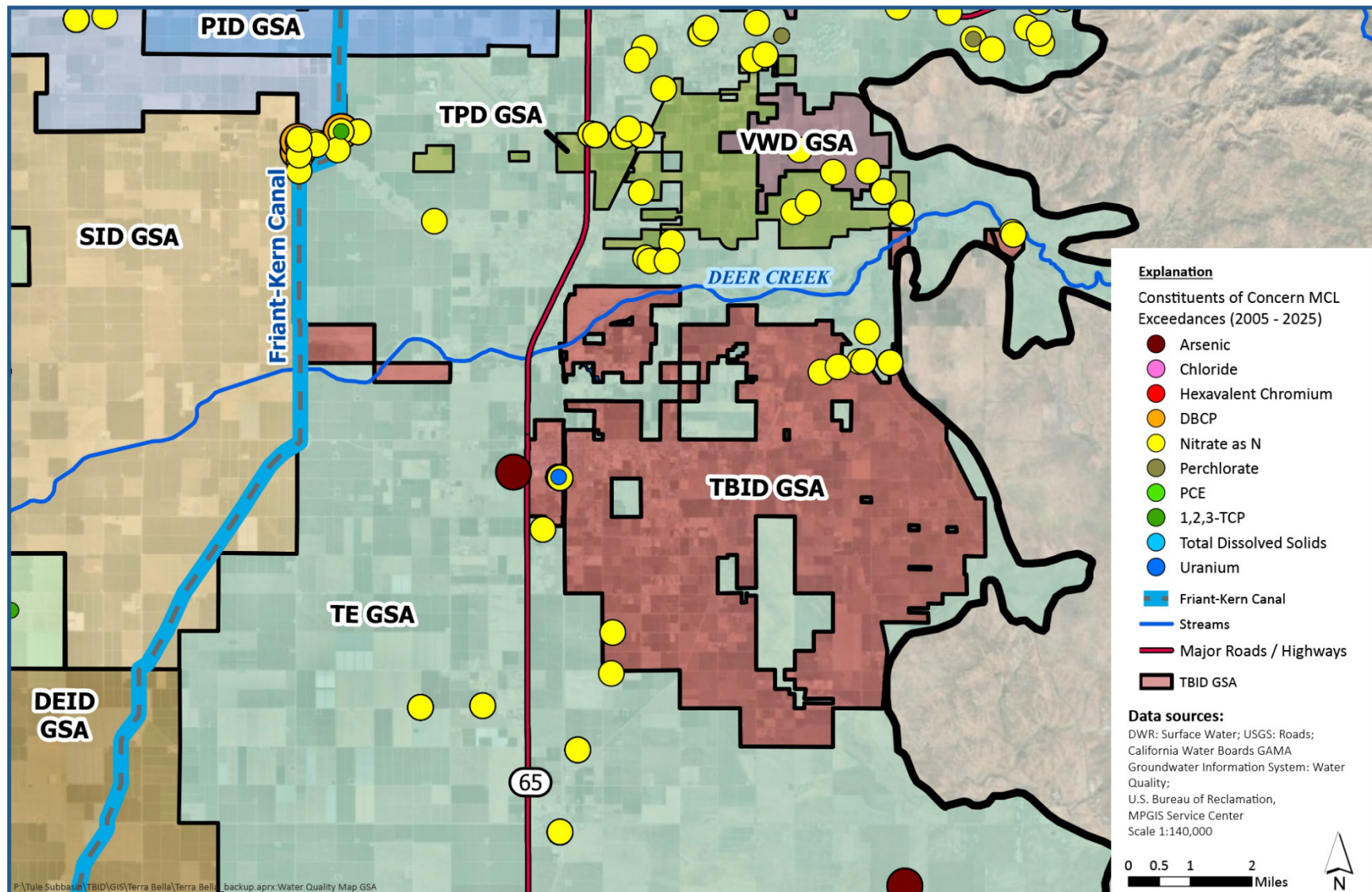


Figure 2-38. Constituents of Concern MCL Exceedances within the Vicinity of TBID (2005-2025)

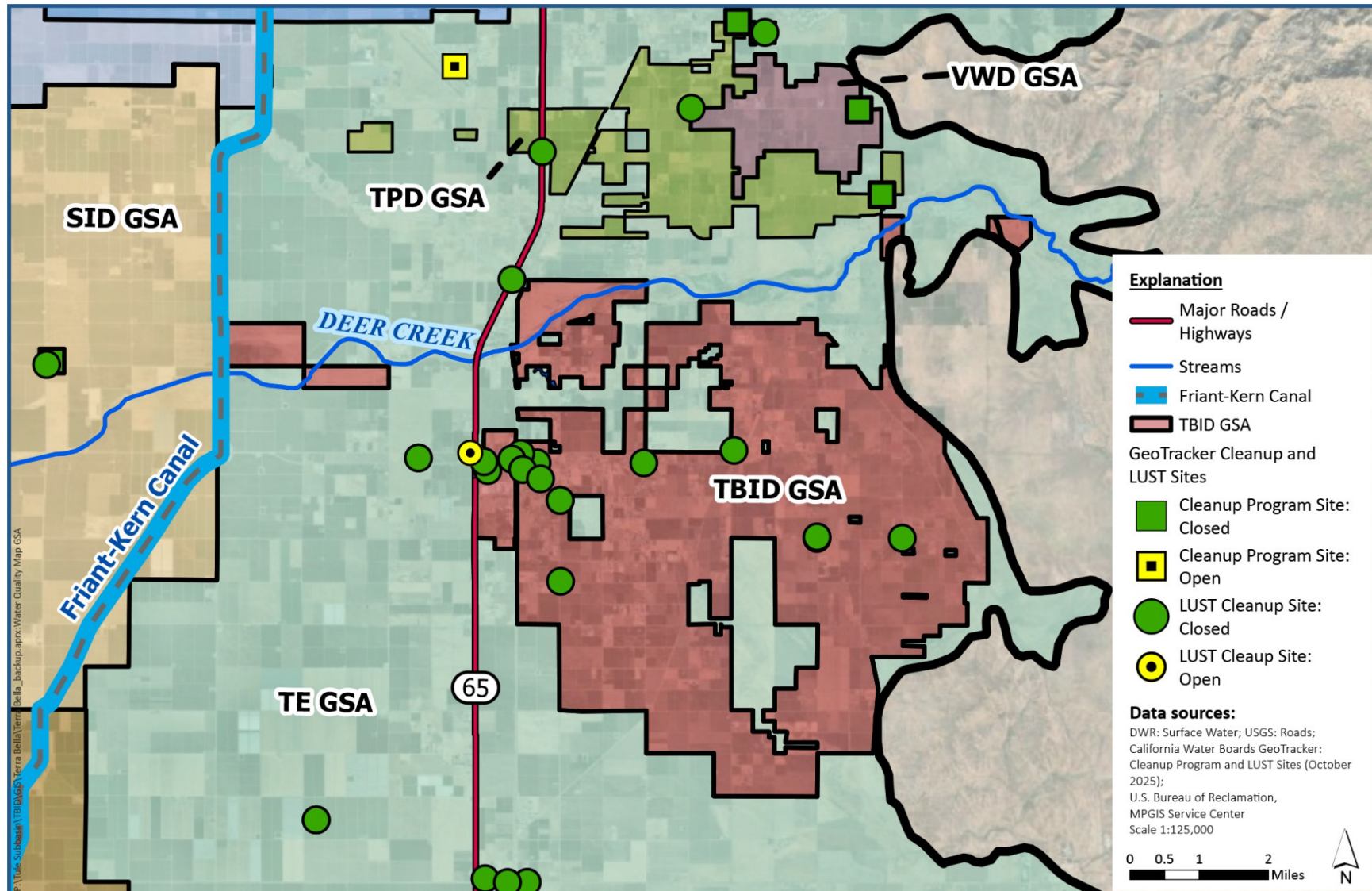


Figure 2-39. Remediation Sites within the TBID Vicinity