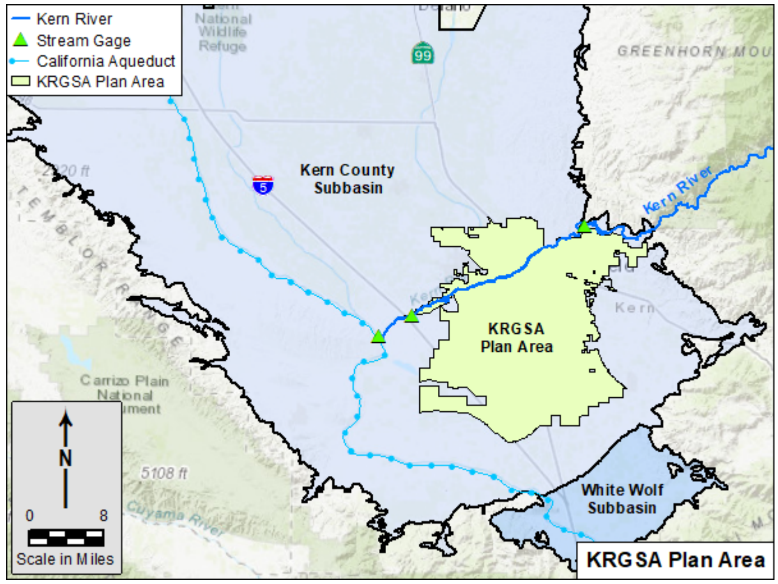
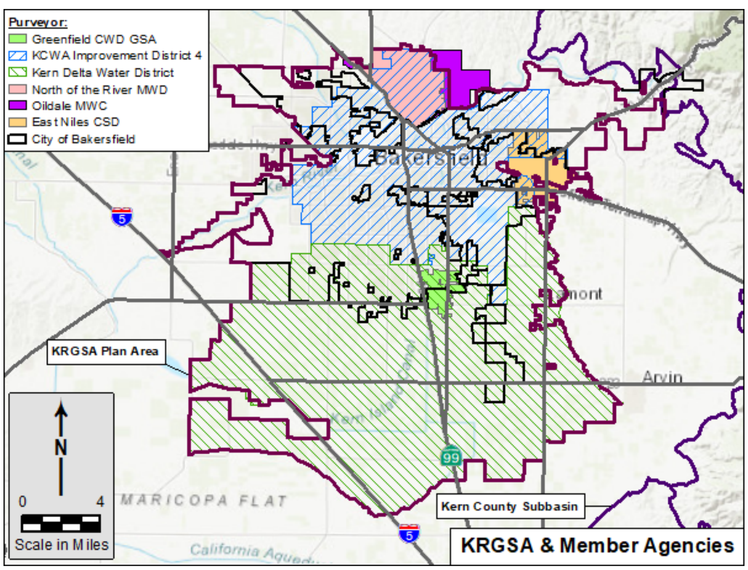
EXECUTIVE SUMMARY

The Kern River Groundwater Sustainability Agency (KRGSA) has prepared this Groundwater Sustainability Plan (GSP) to cooperatively manage shared groundwater resources in a sustainable manner. The GSP is being submitted in coordination with four additional GSPs that collectively cover the entire Kern County Subbasin, the largest groundwater subbasin in California. The KRGSA GSP Plan Area covers 361 square miles, about 13 percent of the 2,834-mile Subbasin.



ES-1 KRGSA Administrative Information and Sustainability Goal



The KRGSA is an exclusive Groundwater Sustainability Agency (GSA) composed of member agencies including the City of Bakersfield, Kern Delta Water District (KDWD), Kern County Water Agency (KCWA) Improvement District No. 4 (ID4), North of the River Municipal Water District/Oildale Mutual Water Company (NORMWD/OMWC), and East Niles Community Services District (ENCSD).

The Plan Area will be cooperatively managed by member agencies of the KRGSA along with Greenfield County Water District, which is its own GSA and is cooperatively participating in the KRGSA GSP. The KRGSA has a diverse portfolio of water sources managed by member agencies and other entities in the Plan Area. Local surface water from the Kern River, imported water from the State Water Project (SWP), recycled water, and other surface water sources provide about one-half of the total water supply to the Plan Area (about 327,786 AFY on an average annual basis) to support beneficial uses. These surface water sources are supplemented by groundwater (average of about 321,871 AFY) and managed conjunctively throughout the Plan Area.

The **Sustainability Goal** of the KRGSA GSP (Water Code §10721(u)) is to manage groundwater sustainably in the KRGSA Plan Area to:

- Support current and future beneficial uses of groundwater including municipal, agricultural, industrial, public supply, domestic, and environmental
- Optimize conjunctive use of surface water, imported water, and groundwater
- Avoid or eliminate undesirable results throughout the planning horizon.

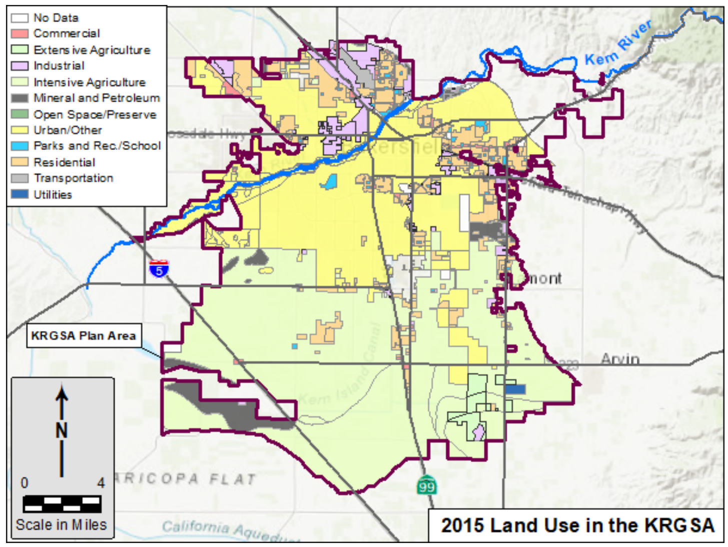
This GSP also acknowledges the coordinated sustainability goal for the entire Kern County Subbasin and incorporates it into this GSP as a supplemental goal by reference.

ES-2 PLAN AREA

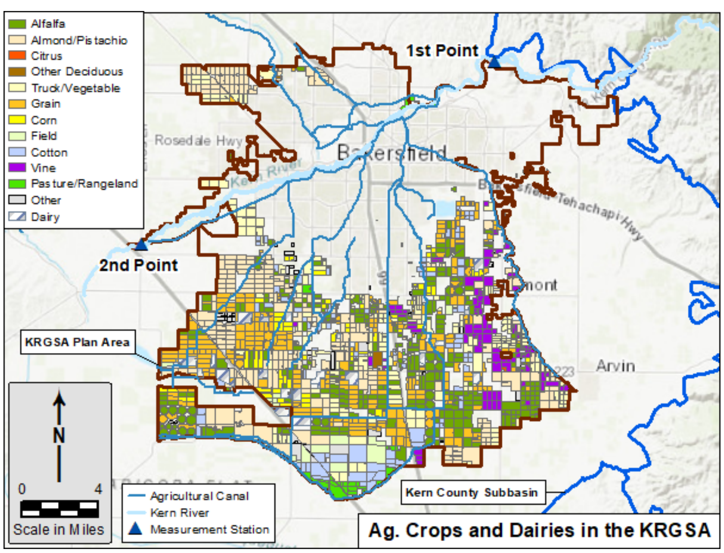
The primary land uses in the KRGSA Plan Area are approximated as follows:

- 41% Agricultural
- 33% Urban/residential/industrial
- 26% Undeveloped

The northern KRGSA Plan Area includes most of the Bakersfield city limits with primarily urban land uses. Sparsely populated or undeveloped areas cover most of the northeast Plan Area. The west-central Plan Area is dominated by recharge basins and groundwater banking projects, mostly along the Kern River.



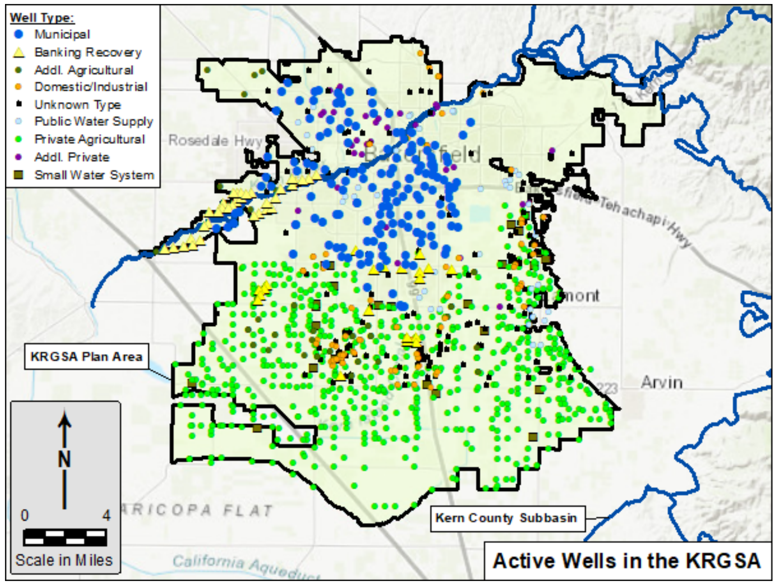
2015 Land Use in the KRGSA



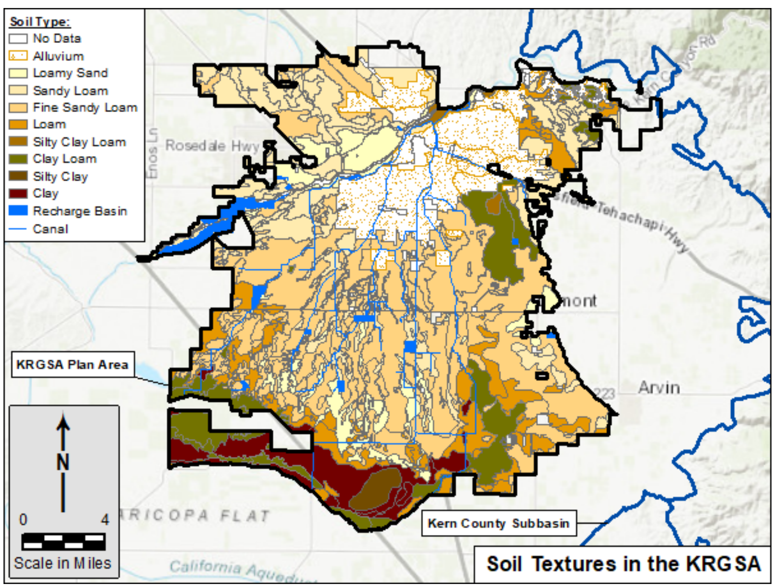
Ag. Crops and Dairies in the KRGSA

Agriculture is the primary land use in the southern Plan Area with small areas of additional agriculture in the north. About 90,000 acres and 16,000 acres of irrigated lands are farmed in the southern and northern Plan Area, respectively. The agricultural areas support a variety of crop types, including both perennial (e.g., vines and almonds) and annual (e.g., alfalfa, grains and field crops, cotton, and vegetables). Approximately 20 dairies also operate in the southern Plan Area, contributing to the local agricultural economy. Numerous businesses and industries in the Plan Area support these agricultural activities including three food processing plants and numerous equipment, supply, and processing facilities.

The KRGSA relies heavily on groundwater, including recovery of recharged and banked surface water supplies, with more than 1,000 active wells. Most northern wells are used for municipal supply (blue dots). Recovery wells at groundwater banking projects operate mostly in the west-central and central KRGSA (yellow triangles). Southern wells are mostly used for agricultural irrigation (green dots). Small community water systems and additional private wells occur throughout the Plan Area.



Fluvial and alluvial fan deposition has created a thick sequence of sediments beneath the KRGSA; the depositional history has influenced the soils and shallow alluvial sediments of the Plan Area. The map at left shows soils color-coded according to type and grain-size (texture), with more permeable alluvium and sandy soils indicated by shades of yellow and light orange. These are the dominant soil textures in the GSA and represent the areas of higher natural recharge. Soil textures are generally less permeable to the south and east, where clay soils are associated with paleo-lakebeds and flood basin deposits. The more permeable soils and shallow alluvial sediments along the Kern River create optimal conditions for managed groundwater recharge in the river channel and at groundwater banking projects as evidenced by the numerous recharge basins in the western Plan Area. Managed recharge also occurs along the numerous unlined canals and recharge basins as shown throughout the south-central Plan Area.



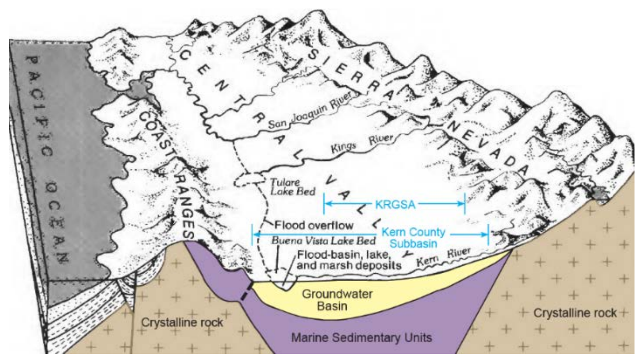
ES-3 Basin Setting

The basin setting of the Plan Area provides the foundation on which to evaluate sustainability indicators, select appropriate sustainability criteria, and develop management actions and projects to maintain sustainable groundwater management.

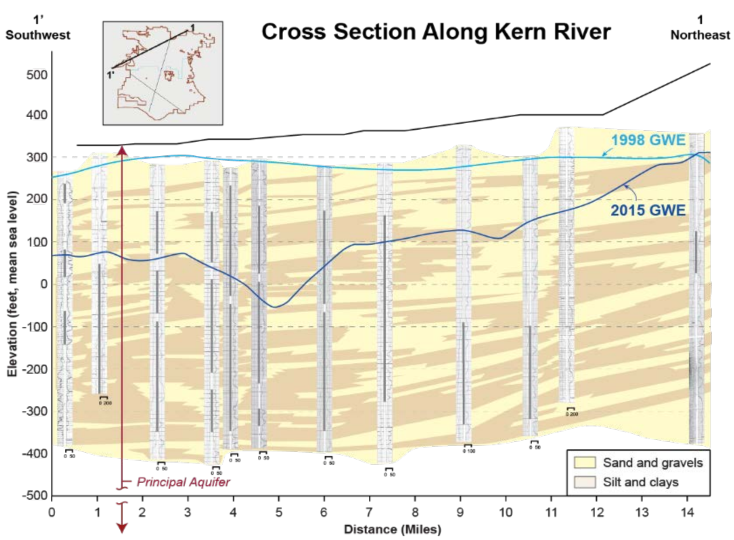
The Basin Setting is based collectively on three related analyses:

1. **Hydrogeologic Conceptual Model** - describes the physical conditions of the groundwater basin including the geologic setting, basin geometry, and aquifers and aquitards (GSP Section 3),
2. **Groundwater Conditions** - provides an understanding of groundwater occurrence and flow, groundwater quality, land subsidence, and interconnected surface water (GSP Section 3).
3. **Water Budgets** – analyzes the inflows, outflows, and changes in groundwater in storage for historical, current, and future conditions, including climate change analyses (GSP Section 4).

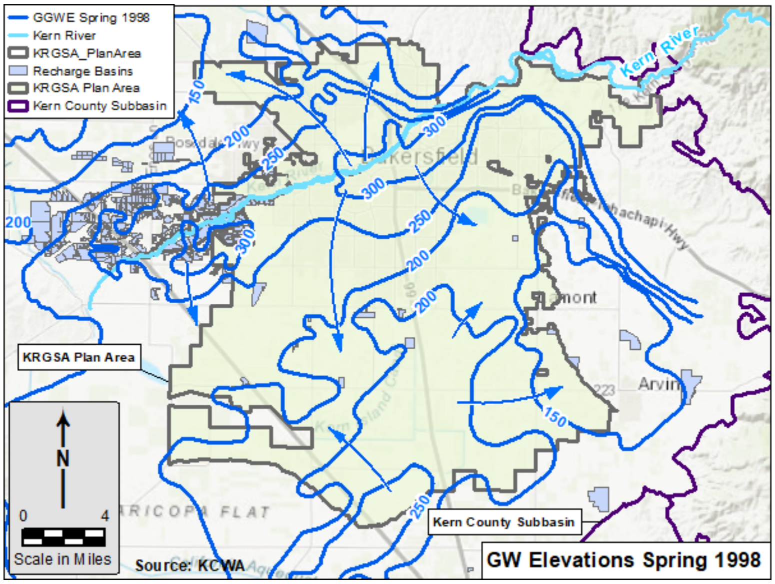
The Kern County Subbasin consists of the upper portion of a deep structural trough between the crystalline basement rocks of the Sierra Nevada and the Coast Ranges. The deeper portions of the trough contain mostly Miocene and older marine sedimentary units. The upper trough has been infilled over time with Upper Miocene/Pliocene and younger continental sediments, which contain most of the Subbasin groundwater.



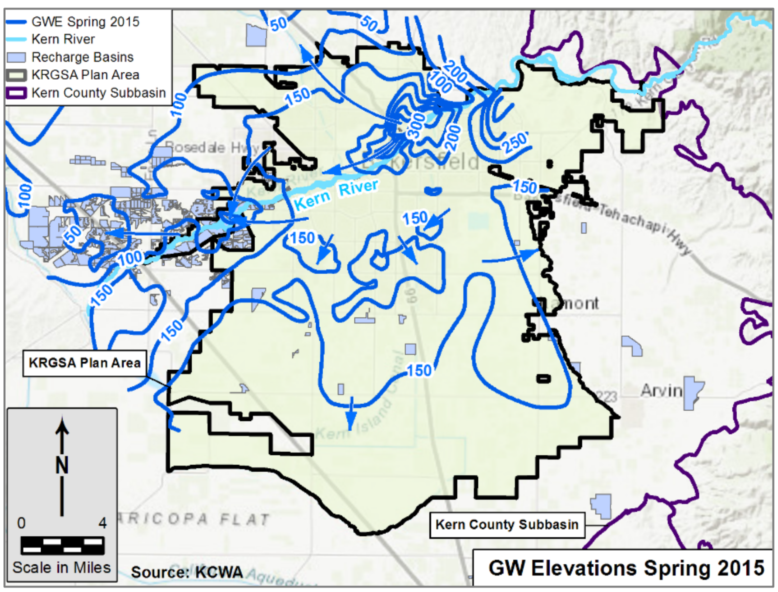
Groundwater beneath the Plan Area occurs under unconfined to semi-confined conditions in the continental sediments of the Kern River Formation and overlying alluvium, collectively forming the **Principal Aquifer**. The interbedded nature of the gravels, sands, silts, and clays of the Principal Aquifer are illustrated on the cross section below; although clay content generally increases with depth, clay layers are often discontinuous and most wells are screened over a large interval, making it difficult to clearly define more than one Principal Aquifer. The Subbasin extends several thousand feet beneath the Plan Area with the bottom defined by either the base of the Underground Source of Drinking Water (USDW, defined by USEPA), oilfield-exempted aquifers, or oil-producing zones, whichever is shallowest.



Trends and fluctuations in **groundwater elevations** are illustrated in the GSP by a series of hydrographs. Over time, water levels have declined and recovered during drought and wet periods with fluctuations of less than 50 feet to more than 150 feet (at groundwater banking areas). During the drought of 2013-2016, water levels declined an average of 50 feet across the Plan Area to reach historic lows. In some banking areas, the difference between the high water level (1998) and historic low water level (2015) is more than 350 feet as illustrated on portions of the cross section.



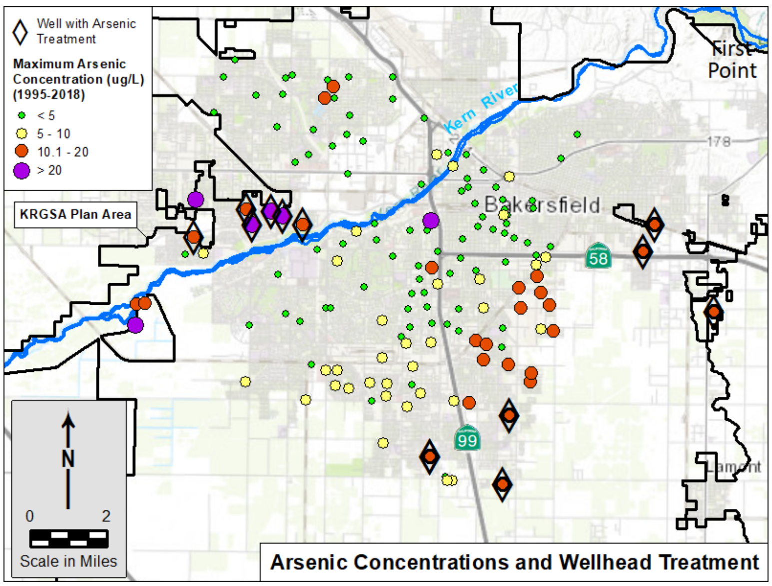
Groundwater elevations are illustrated by the KCWA Spring contour map for 1998 when water levels were the highest during the 20-year Study Period (WY 1995 – WY 2014). During the wet year of 1998, precipitation and Kern River flows were 223 percent and 236 percent of the long-term averages, respectively. As shown by the arrows, groundwater flows to the north and south away from the Kern River and away from downstream banking projects where mounding creates divergent flow patterns. Groundwater elevations are above 200 feet msl over most of the Plan Area in 1998. Throughout the Plan Area, groundwater elevations are influenced by recharge in the Kern River channel, unlined canals, and banking projects.



The groundwater elevation contour map for spring 2015 data illustrates the lowest water levels for any spring map during the Study Period. During spring 2015, groundwater elevations are lower than 200 feet msl over almost all of the Plan Area. Although groundwater elevations appear higher than 350 feet msl in the northeast, data are sparse, and contours are considered less accurate in this area. A comparison with the 1998 map shows that 2015 groundwater elevations are lower than 1998 elevations by about 50 feet to 100 feet throughout most of the Plan Area. The highest groundwater elevations along the Kern River are similar to 1998 levels, but cover a smaller area (e.g., areas higher than 300 feet msl).

During the drought of record, historic low water levels created significant management issues for the City and Cal Water, who collectively own more than 160 municipal supply wells in the northern Plan Area. Issues included declining capacity, well inefficiency, water levels falling below pump intakes, degraded water quality, and both pumping and static water levels falling below the top of well screens (i.e., cascading water). About 42 municipal wells (about 25 percent of the larger-capacity wells) were affected by cascading water primarily in the north-central KRGSA Plan Area.

These conditions required operational changes and significant capital expenditures by the City and Cal Water to re-distribute pumping, lower pumps, remove wells from service, secure supplemental supplies, and otherwise manage wellfield operations to meet water demands through the drought. Although the City and Cal Water were able to actively manage wells and secure supplemental supplies to meet demands during 2015 and 2016, numerous challenges remain with the municipal well system; only when water levels began to rise did the ongoing well problems subside. Future declines below the historic low water level may place more wells at risk.



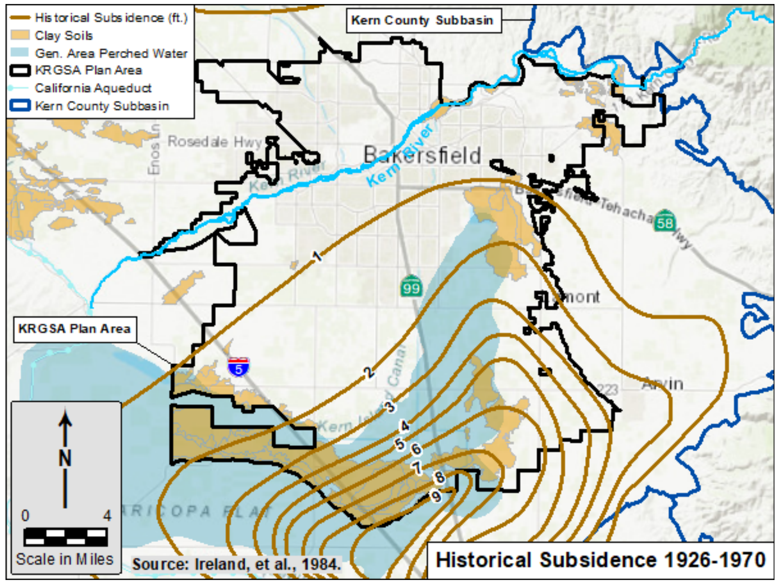
Arsenic Concentrations and Wellhead Treatment

The **water quality** of KRGSA groundwater is similar to local surface water with relatively low TDS levels resulting, in part, from decades of actively managed recharge of both local and imported surface water supplies in the Plan Area. In general, groundwater quality has been sufficient to meet designated beneficial uses including municipal, industrial, and agricultural water supply as well as recreational and environmental uses.

Two primary water quality constituents of concern have been identified in Plan Area drinking water – arsenic and 1,2,3-trichlorpropane (TCP). Arsenic is a naturally-occurring trace element in Subbasin groundwater with a California MCL of 0.010 mg/L (10 ug/L). In the northern Plan Area, numerous municipal wells have detected arsenic concentrations above the MCL (see red/purple dots on map above). Elevated arsenic concentrations are generally correlated with deeper groundwater as evidenced by the recent drought. Municipal well owners took costly measures to manage concentrations during this time including removing wells from service, blending, modifying well construction, and installing wellhead treatment facilities (black diamonds on map above). Even with these actions, many wells remain at risk if water levels continue to decline. KRGSA managers have determined chronic water level declines below the recent historic low levels to be an undesirable result, as defined by SGMA, for portions of the Plan Area.

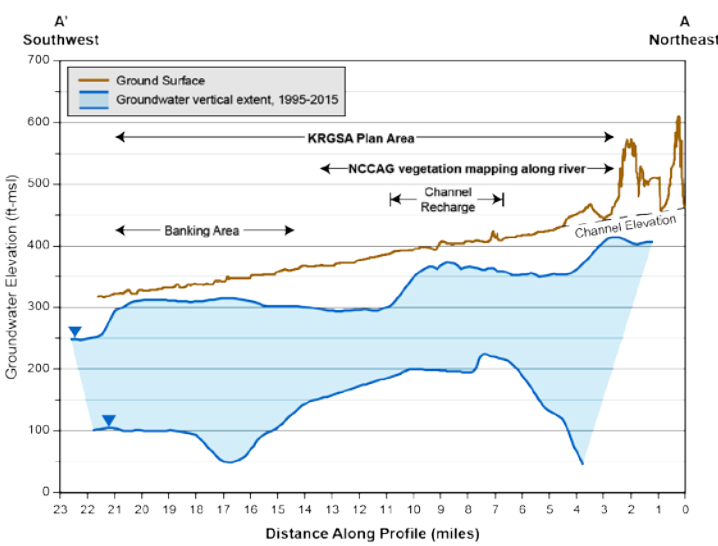
With regard to TCP, the 2017 adoption of a California MCL of .005 ug/L (5 parts per trillion) has resulted in increased sampling, lawsuits against soil fumigant manufacturers, and installation of numerous wellhead treatment facilities in the Plan Area, including those installed by the City and multiple other KRGSA water purveyors. Unlike arsenic, TCP concentrations do not appear to rise with declining water levels, but additional data are needed to characterize the nature and extent of TCP in the Plan Area. Public water supply wells will continue to be tested for TCP as required by the State; these data will be compiled periodically and reviewed by the KRGSA to ensure that management actions do not exacerbate the extent of TCP in groundwater.

The decline of water levels in the Plan Area, exacerbated by the recent drought, could contribute to **inelastic land subsidence** in susceptible areas. As water levels decline, dewatering and compaction of predominantly fine-grained clay deposits can cause the land surface to subside.



The USGS has mapped historical land subsidence in the southeastern KRGSA Plan Area where subsurface clay deposits are more prevalent. As indicated by the map, USGS estimated about two to eight feet of total land subsidence in the southeast as of 1970. Although satellite imagery indicates recent land subsidence, primarily in areas of historical subsidence, the rate and magnitude are uncertain. No surficial evidence or impacts to land use/critical infrastructure have been identified.

In the absence of adverse impacts to date, a multi-faceted approach to subsidence monitoring is proposed for the GSP, including control of water levels coupled with other local monitoring in the highest risk areas and participation with other GSAs in a Subbasin-wide monitoring program. In this manner, future risks from land subsidence can be more readily identified and managed.



The potential for **interconnected surface water and groundwater dependent ecosystems** (GDEs) in the KRGSA Plan Area was analyzed using mapped polygons provided by DWR, referred to as Natural Communities Commonly Associated with Groundwater (NCCAG). NCCAG maps contained 177 polygons of vegetation and 65 polygons for possible wetlands in the KRGSA Plan Area, most of which occurred along a 12-mile reach of the Kern River.

To analyze the NCCAG polygons along and near the Kern River channel, seasonal high water levels beneath the channel were plotted over a 20-year period, as shown by the profile above. The blue shading shows the range of high water levels for each year from WY 1995 through WY 2015. As indicated, only areas managed for groundwater recharge, including managed channel recharge and banking areas, have water levels generally shallower than 50 feet even during the wettest years.

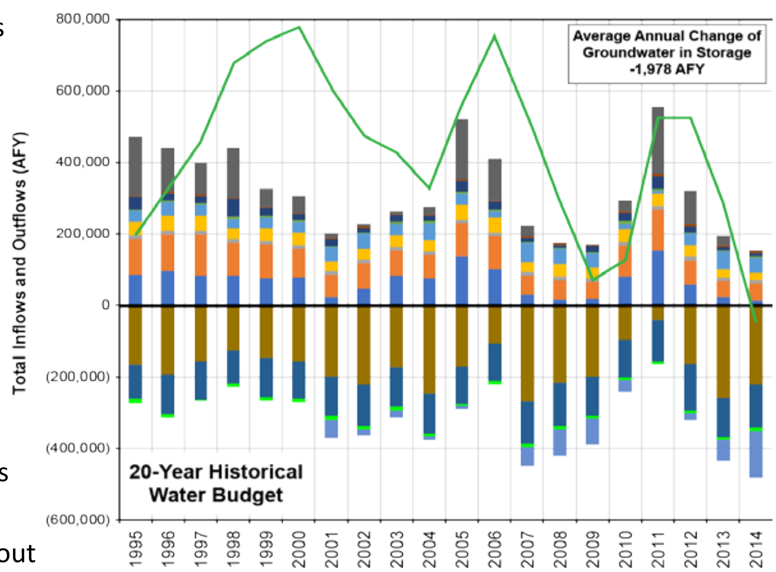
As described in the GSP, flows in the Kern River are managed through controlled reservoir releases and diverted into a complex network of canals just as the River enters the Plan Area. More than 80 percent of the flow is diverted above the Calloway Weir, leaving a mostly dry river channel for about two thirds of the NCCAG polygon areas. Upstream, the channel elevation rises into the basin uplands where water levels are even deeper. The riparian vegetation along the Kern River appears to be maintained by regulated releases and supplemented by surface water irrigation conducted in some areas by the City of Bakersfield. Water recharged in the channel does not appear to be interconnected surface water. A shallow monitoring well at the Calloway Weir is included in the GSP monitoring network to support future analyses, as needed.

In the southern Plan Area, many of the NCCAG polygons were associated with recharge facilities, irrigation canal spills, locally constructed ski lakes on clay soils, and other human-constructed features. Shallow perched water from agricultural return flows on clay sediments could be supporting other local vegetation. The perched zone is not pumped due to its sporadic occurrence and the low permeability of the clay deposits; it is not part of a Principal Aquifer. The perched zone is likely to continue to contain water from ongoing surface water irrigation.

ES-4 Water Budgets

Historical (WY 1995 – WY 2014), current (WY 2015), and projected (WY 2020 – WY 2070) water budgets were analyzed to provide an understanding of average annual change in groundwater in storage associated with past and current inflows and outflows and the projected changes in these flows under specified future conditions including climate change.

Three independent water budget methods indicate slightly negative (-1,978 AFY as indicated on graph) to slightly positive changes for groundwater in storage over the historical period, and collectively indicate no significant reduction in groundwater in storage over average hydrologic conditions (see Table ES4-1 on the following page). This conclusion suggests that there were no undesirable results occurring beneath the KRGSA as of the SGMA baseline of January 2015 for this sustainability indicator. The water budget analysis indicates a sustainable yield of about 321,871 AFY.



However, when adjusted for banking obligations outside of the KRGSA and recharge inside of the KRGSA attributable to others, a negative change in groundwater in storage was identified at about -29,153 AFY (see **Table ES4-1** below), suggesting a lower sustainable yield of about 290,740 AFY. In order to protect against future overdraft, this deficit is added to potential future deficits for planning purposes.

Table ES4-1: Average Annual Change in Groundwater in Storage – Comparison of Methods

Water Budget Method	Change in Groundwater in Storage (AFY)	Comments
Checkbook	-1,978 AFY	Tabulates recharge and pumping for the physical groundwater system beneath the KRGSA Plan Area (Table 4-3, Figure 4-1)
C2VSimFG-Kern Model	4,055 AFY	Simulated inflows and outflows as above, but also includes subsurface flows (Tables 4-6 and 4-7, Figure 4-5)
Groundwater Elevation Contour Maps	-2,912 AFY	Subtraction of spring groundwater elevation contour maps over average conditions for the KRGSA Plan Area (Figure 3-28)
Adjusted Checkbook	-29,153 AFY	Removes recharge and pumping attributable to non-KRGSA parties; also removes banking obligations outside of KRGSA. Adds outside banking attributable to KRGSA agencies (Table 4-5)

Historically, KRGSA agencies have also relied on about 326,321 AFY of local and imported surface water. For future planning, the total amount of surface water supplies controlled by KRGSA agencies is more than 437,780 AFY, as tabulated on **Table ES4-2** below (described more fully in GSP Section 4.6.1).

Table ES4-2: Total Surface Water Supplies Managed by the KRGSA

Agency	Average Annual Surface Water Supplies	Description
City of Bakersfield	163,139 AFY	Kern River entitlement (incl. KRC&I and South Fork)
	29,171	Recycled water and stormwater conservation
Kern Delta Water District	201,943 AFY	Kern River entitlement
	15,765 AFY	SWP, Table A SWP Allocation – Current Conditions
	1,257 AFY	11% “leave behind” from Groundwater Banking Program
Improvement District No. 4	51,281 AFY	SWP Table A Allocation – Current Conditions
	1,432 AFY	SWP Article 21 Allocation – Current Conditions
	9,000 AFY	Kern River, Lower River Water Right (KCWA)
		Additional miscellaneous surface supplies not quantified
		Not all water budget components included in table
TOTAL	437,780 AFY	(see additional explanations in GSP Table 4-12 footnotes)

Table ES4-2 repeats GSP Table 4-12, which contains numerous explanatory footnotes that document the supply amounts above. As summarized by Table 4-12 footnotes and described in Section 4.6.1, amounts in **Table ES4-2** represent average annual conditions, do not include all components of the water budget (e.g., precipitation), and do not quantify additional surface water that may also be available for future use (such as Kern River released water). The footnotes also acknowledge that a relatively small portion of this water (less than 10 percent of the total) is obligated to others both inside and outside of the

KRGSA. Notwithstanding these qualifications, the table documents a substantial amount of surface water that is managed by the KRGSA and is available for optimizing conjunctive use and achieving sustainable groundwater management.

In order to analyze future supply requirements, a projected future water budget was developed. This analysis evaluated three future projected scenarios (including baseline, 2030, and 2070 climate change conditions) to identify a range of future supplies and demands. Those amounts were compared to historical amounts to estimate potential future deficits from decreased supplies or increased demands. Potential future deficits are tabulated in Table ES4-3 and combined with historical deficits (-29,153 AFY in Table ES4-1) for GSP project planning.

Table ES4-3: Projected Water Budget Components and Potential Deficits (Checkbook Method)

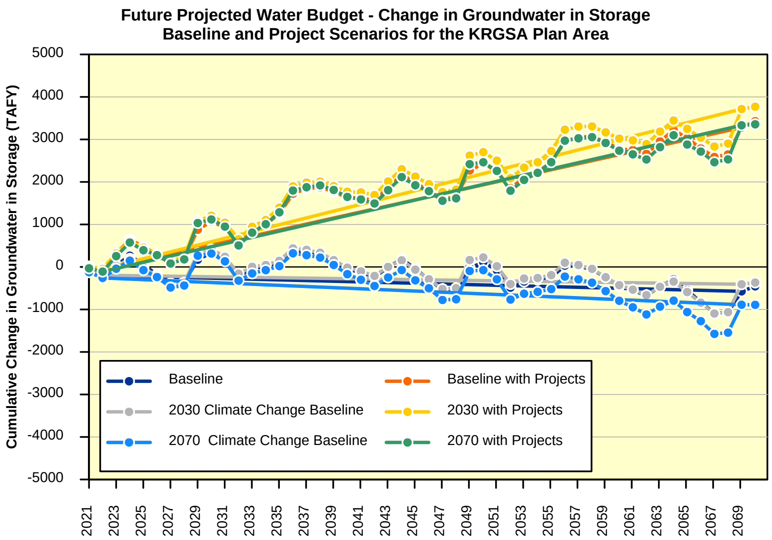
Water Budget Component	Historical Average Annual Amounts (AFY)	Baseline Conditions (AFY)	2030 Climate Change Conditions (AFY)	2070 Climate Change Conditions (AFY)
SWP[1] – ID4	74,035	52,758	51,182	48,759
SWP - KDWD	18,655	15,765	15,294	14,537
TOTAL SWP	92,690	68,523	66,476	63,296
Net decrease in SWP from historical:		**24,167**	**26,214**	**29,394**
Agriculture Demand	261,019	261,019	271,460	281,460
Urban Demand[2]	167,970	182,290	178,115	254,117
TOTAL DEMAND	428,989	443,309	449,575	535,577
Net increase in demand from historical:		**14,320**	**20,586**	**106,588**
Potential Future Water Budget Deficits[3]:		-38,487	-46,800	-135,982
Deficit from Historical Water Budget[4]:		-29,153	-29,153	-29,153
Combined Future Water Budget Deficits:		**-67,640**	**-79,953**	**-165,135**

[1] *Table A Allocation and Article 21 water*

[2] *Baseline Conditions urban demand from WY 2013. Urban demand for 2030 based on area-weighted population growth (average 1.1% annually) and per capita water demand estimates from UWMPs (average 248 gpcd). Population growth rates for the County (0.8% annually) used for years 2040 through 2070.*

[3] *Sum of net decrease in SWP and net increase in demand from data in upper table.*

[4] *Remaining average annual deficits from adjusted checkbook method of the historical water budget; see **Table 4-5**.*

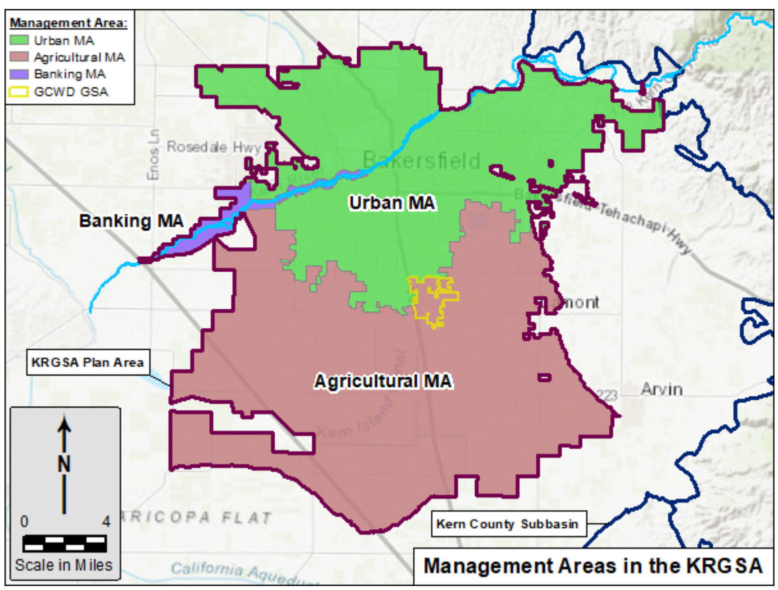


GSP projects were developed to address the combined future water budget deficits quantified above; projects were analyzed with the C2VSimFG-Kern model. As shown by the graph at left, the three baseline conditions (blue/gray lines) indicate ongoing future deficits and overdraft conditions. However, with the addition of GSP projects (green/orange lines), those conditions are mitigated. In this manner, future projections indicate sustainable groundwater management (i.e., positive changes in groundwater in storage).

The modeling analysis contains both recharge and recovery in the KRGSA attributable to others, which suggests more positive changes in the physical groundwater system than would occur from KRGSA management activities alone. Nonetheless, the significant increase of groundwater in storage as demonstrated by the model – even during drought and banking recovery operations – illustrates the ability of the KRGSA to mitigate future potential overdraft. As documented in Section 7.1, the additional supply associated with GSP projects demonstrates that projected future deficits can be mitigated.

ES-5 Management Areas and Sustainable Management Criteria

In order to better manage the KRGSA for sustainable management criteria, three Management Areas (MAs) have been delineated based on land use and primary groundwater use across the KRGSA Plan Area. As indicated on the map at right, the MAs are designated as the Urban Management Area (Urban MA), the Agricultural Management Area (Agricultural MA), and the Banking Management Area (Banking MA).



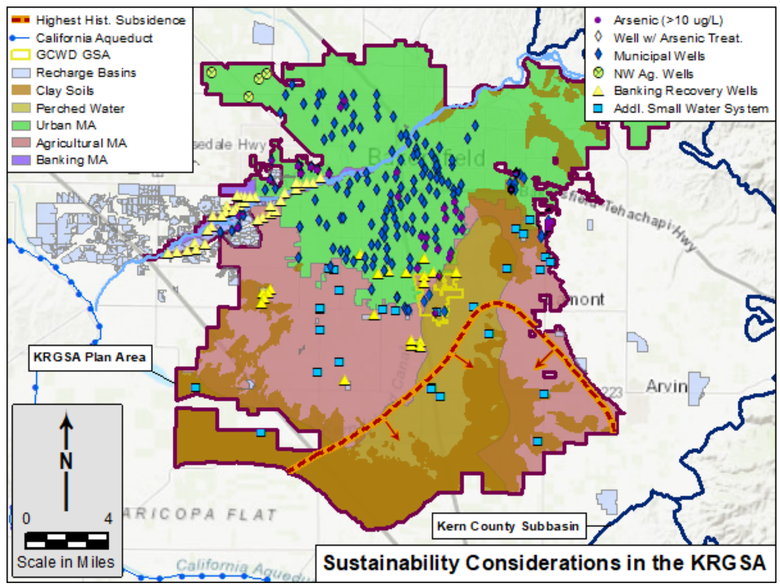
It is noted that there are urban areas in the Agricultural MA, banking areas in both the Urban and Agricultural MAs, and urban wells in the Banking MA. Accordingly, the sustainable management criteria varies across each MA to consider this overlap and provide operational flexibility so that conjunctive use and groundwater management can be best optimized.

Conditions in the Plan Area MAs were evaluated for each of the applicable sustainability indicators shown in Table ES5-1 (a sixth sustainability indicator for seawater intrusion is not applicable as dicussed in GSP Section 5.6). Undesirable results for any of the sustainability indicators occur if the indicator is determined to be significant and unreasonable for the KRGSA Plan Area.

Table ES5-1: Sustainability Indicators for the KRGSA Plan Area

Chronic Lowering of Water Levels	**Reduction of Groundwater in Storage**	**Degraded Water Quality**	**Inelastic Land Subsidence**	**Depletion of Interconnected Surface Water**

To assist with the analysis, key issues in the Plan Area were identified and considered with regard to each sustainability indicator. Issues are illustrated on the map at right. As explained in the section on groundwater levels, historic low water levels during the recent drought adversely affected a number of municipal wells, resulting in undesirable results as defined by SGMA. As discussed in the section on groundwater quality, arsenic has been problematic for municipal wells when water levels are lowered, also potentially creating an undesirable result. As indicated in the section on land subsidence, the southeastern KRGSA is susceptible to future subsidence if water levels are significantly lowered.



Notwithstanding all of these considerations that indicate the need to maintain higher water levels, numerous banking recovery wells throughout the KRGSA need to draw water levels down during droughts to obtain critical stored supplies; not being able to do so could result in undesirable results for those wells. As indicated by the potentially conflicting need for high water levels in some areas and lower water levels in others, the sustainable management criteria were balanced for each MA and to meet the needs for local sustainable management.

As indicated above, each sustainability indicator relevant to the KRGSA is related to water levels; accordingly, water levels are used as a proxy for setting the sustainable management criteria, including minimum thresholds (MTs) and measurable objectives (MOs), for all of the indicators.

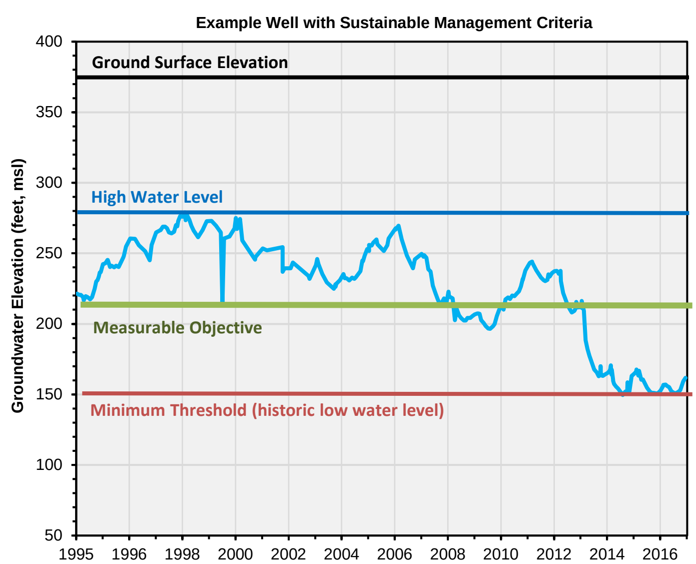
Table ES5-2 summarizes the analysis for setting MTs and defining undesirable results in various areas of the MAs. Because water levels are used as the MT for each sustainability indicator, the shallow-most indicator is the controlling MT for any representative monitoring well. Also, because water levels can drop below the MTs for a certain number of wells and time period before undesirable results occur, a percentage of wells and duration of exceedances are incorporated into the definition of the undesirable results.

Table ES5-2: Summary of Undesirable Results Definition for the KRGSA

KRGSA Management Area (MA)	MA Subarea and Considerations for Management		Sustainability Indicator and Minimum Threshold (MT)			
			Chronic Lowering of Water Levels	Reduction of Groundwater in Storage	Degraded Water Quality	Land Subsidence
KRGSA Urban MA	Central/South	Municipal wellfields	Historic Low WL	Historic Low WL	Historic Low WL	Historic Low WL
	Northeast	ENCSD wellfield	50' below Historic Low WL	50' below Historic Low WL	50' below Historic Low WL	50' below Historic Low WL
	Northwest corner	Transition to agricultural lands	20' below Historic Low WL	20' below Historic Low WL	20' below Historic Low WL	20' below Historic Low WL
KRGSA Agricultural MA	Along southern Urban MA	Transition with municipal wells	Historic Low WL	50' below Historic Low WL	Historic Low WL	50' below Historic Low WL
	North-Central	Greenfield CWD wells	Historic Low WL	50' below Historic Low WL	Historic Low WL	10' below Historic Low WL
	West	Agricultural and recovery wells	50' below Historic Low WL	50' below Historic Low WL	50' below Historic Low WL	50' below Historic Low WL
	Southeast	Subsidence potential	50' below Historic Low WL	50' below Historic Low WL	50' below Historic Low WL	20' below Historic Low WL
	East	Transition to small system wells	Historic Low WL	50' below Historic Low WL	Historic Low WL	50' below Historic Low WL
KRGSA Banking MA	Kern River Channel	ID4/KCWA/City recovery activities	20' below Historic Low WL	Not applicable	20' below Historic Low WL	50' below Historic Low WL
	Berrenda Mesa	KCWA operational area	Historic Low WL	Not applicable	Historic Low WL	50' below Historic Low WL
	COB 2800 Facility	City of Bakersfield municipal wells	Historic Low WL	Not applicable	Historic Low WL	50' below Historic Low WL

Historic low water level (WL) is the lowest level observed in an area during the recent drought of 2013-2016.
Measurable Objective (MO) for each sustainability indicator is the average of the MT and the historical high groundwater elevation during the historical Study Period.
Highlighted green cell indicates the controlling sustainability indicator(s) for that area in each MA.

Although not included on **Table ES5-2**, the MO for each well is defined as the average of the historic high water level during the Study Period (usually 1998) and the MT for each well. This midpoint approach for the MO provides a target within an operational range that would indicate ongoing sustainable management over average hydrologic conditions.



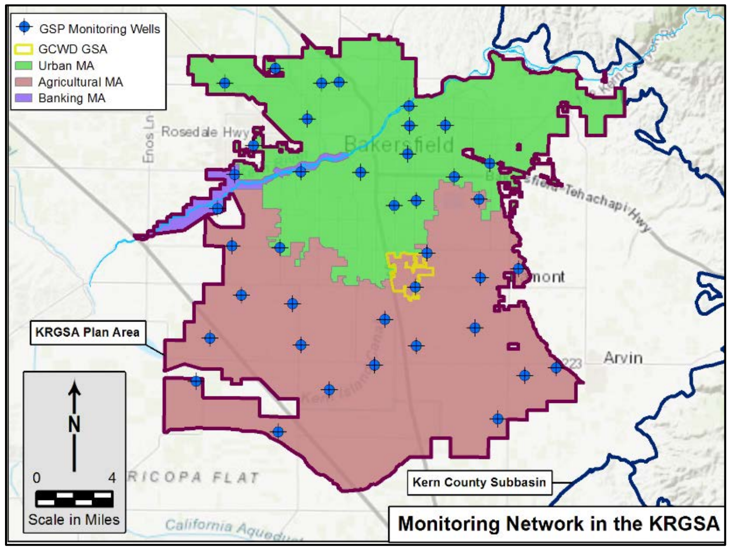
An example hydrograph at left illustrates the process by which MTs and MOs were set for each of the representative monitoring wells. For this particular example monitoring well, the MT is set at the historic low water level. The MO is defined as the average between the MT and the historic high water level.

ES-6 MONITORING NETWORKS

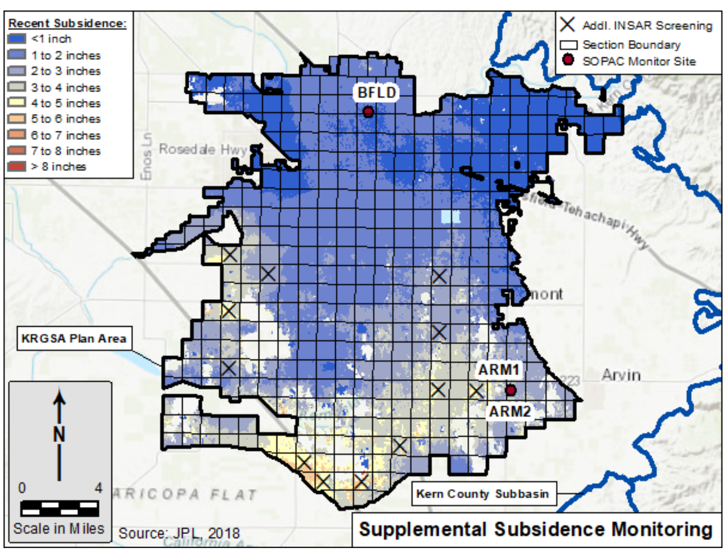
The KRGSA GSP monitoring network is designed to support the KRGSA GSP Sustainability Goal by providing the ability to detect undesirable results as defined in Section 5. The monitoring network also allows performance monitoring for GSP implementation. As provided in GSP regulations, the monitoring network, when implemented, is designed to accomplish the following:

- Demonstrate progress toward achieving MOs.
- Monitor impacts to the beneficial uses or users of groundwater.
- Monitor changes in groundwater conditions relative to MOs and MTs.
- Quantify annual changes in water budget components. (§354.34).

The GSP monitoring network, shown at right, includes 39 wells where water level monitoring will be conducted. A MT and MO are set at each monitoring well for ongoing analysis of undesirable results.



Wells in other monitoring programs were prioritized to take advantage of site access, long established records, and publicly-available data for transparency and multiple uses. Subbasin GSAs have coordinated on water level monitoring protocols; those protocols are adopted into the KRGSA GSP.



Although no undesirable results for land subsidence have been identified in the KRGSA, a multi-faceted approach for land subsidence monitoring has been developed for the GSP monitoring network. Water level monitoring is supplemented with data from two KRGSA GPS monitoring sites, shown by the red dots on the map at left. In addition, KRGSA managers will download and evaluate publicly-available InSar data as published periodically by DWR. InSar monitoring will focus on susceptible square mile areas as shown by the “X” on the map at left. Finally, the land subsidence monitoring program will include KRGSA participation in the coordinated Subbasin-wide monitoring program for regionally-significant critical infrastructure.

ES-7 Projects, Management Actions and GSP Implementation

Multiple projects and management actions have been identified to support the KRGSA and Kern County Subbasin sustainability goals. *Projects* involve substantial efforts that provide an increase in water supply, increased recharge and groundwater storage, or a reduction in demand for the KRGSA. *Actions* provide a framework for groundwater management including establishing GSP policies and filling data gaps. Phase One projects and management actions will begin during the first five years of GSP implementation; Phase Two projects will be initiated after the first two five-year evaluations in 2030, as needed for sustainable management.

The KRGSA already has under its control sufficient Kern River and imported SWP water to achieve sustainability under a variety of future demand scenarios. By using its available Kern River entitlement conjunctively with imported water and recycled water supplies, the KRGSA intends to implement Phase One projects that collectively provide:

- Increases in recharge and banking to offset potential future deficits and avoid overdraft.
- Decreases and re-distribution of municipal and agricultural pumping.
- Improvements in drinking water quality for disadvantaged communities.
- Mitigation for the potential of land subsidence in the KRGSA.
- Optimal conjunctive management of imported SWP water and local Kern River water with groundwater resources through direct use and groundwater banking and recovery.

Imported SWP Water

Kern River Water

Groundwater Banking and Recovery

Six Phase One projects are summarized in **Table ES7-1**, followed by primary attributes of three key projects. Collectively, Phase One projects provide an additional water supply of up to about 150,823 AFY to eliminate projected future deficits associated with baseline and 2030 Climate Change conditions. Additional Phase Two projects will be implemented for more extreme 2070 Climate Change conditions, as needed.

Table ES7-1: Phase One Project Summary for KRGSA GSP

Project	Description	Project Water Supply
Water Allocation Plan	KDWD plans to use its full Kern River entitlement as prioritized in its Water Allocation Plan (WAP) for the Agricultural MA. The WAP total average supply has been corrected for planned sales to NKWSD.	20,797 AFY
Kern River Optimized Conjunctive Use	The City plans to use its available Kern River entitlement for increased banking in the River channel and banking projects to mitigate undesirable results for water levels and water quality in the Urban MA.	89,619 AFY
Expand Recycled Water Use in the KRGSA	The City will increase recycled water use inside of the KRGSA from its WWTP No. 3 in 2026 when a contract for use outside of the KRGSA expires (about 72% currently used outside of the KRGSA).	11,556 to 13,407 AFY
Conversion of Agricultural Lands to Urban Use	Approximately 10,000 acres of current KRGSA agricultural lands is expected to be urbanized; this future urban demand is already included in the projected water budget, so 100% of this agricultural water use represents a demand reduction.	27,000 AFY
ENCSD North Weedpatch Highway Water System Consolidation	Up to six small water systems in the northeast KRGSA will be consolidated into the ENCSD system for benefits to drinking water quality, including to disadvantaged communities (DACs).	No new supply; improved water quality to DACs
Possible Water Exchange	KRGSA member agencies can perform exchanges of surface water and groundwater for benefits to water quality, including to DACs.	No new supply; improved water quality to DACs

Attributes and benefits of the Water Allocation Plan, the Kern River Optimized Conjunctive Use, and the ENCSD North Weedpath Highway Water System Consolidation projects are summarized below as examples of:

- Additional water supply to the Agricultural MA,
- Optimized water supplies to avoid undesirable results in the Urban MA, and
- Water quality improvements for drinking water in KRGSA disadvantaged communities, respectively.

Water Allocation Plan

- Optimizes managed Kern River recharge over the entire Agricultural MA using canals and spreading basins.
- Provides irrigation water to reduce agricultural pumping.
- Allows local maintenance of water levels to avoid undesirable results.
- CEQA compliance completed in 2018; implementation has begun.

Kern River Optimized Conjunctive Use

- Prioritizes use of City's available Kern River water for future demands.
- Water availability increases over the implementation and planning horizon.
- Increases recharge and groundwater banking in the Kern River channel and banking projects for subsequent recovery and use.
- Reduces and manages municipal pumping to avoid undesirable results.
- Meets future projected water budget deficits.

East Niles CSD North Weedpatch Water System Consolidation

- Consolidates up to 6 small water systems with ENCSD to address water quality concerns.
- Reduces nitrate concentrations in drinking water.
- Provides for 1,2,3-TCP and arsenic treatment to improve drinking water for disadvantaged communities.

GSP Phase One Management Actions

Management actions provide a framework for overall groundwater management including establishing GSP policies and filling data gaps. Ten management actions have been identified for implementation in Phase One as listed below:

- 5-Step Action Plan if Minimum Thresholds are exceeded.
- Optimize Conjunctive Use in the KRGSA.
- Implement a Well Metering Program.
- Implement a Groundwater Extraction Reporting Program.
- Support California Delta Conveyance to Preserve Imported Supplies.
- Incorporate Climate Change Adaptation Strategies.
- Support Sustainable Groundwater Supplies for KRGSA Disadvantaged Communities.
- Improve Groundwater Monitoring in the KRGSA Plan Area.
- Incorporate a Policy of Adaptive Management in the GSP Process.

GSP Phase Two Projects and Management Actions

Phase Two projects and actions involve early expansion of a surface water treatment plant, re-negotiations of banking projects, capital improvements to municipal wells, expanded recharge facilities, improvements to monitoring, a series of demand reductions involving an allocation of agricultural supply, urbanization of agricultural lands, and additional urban conservation measures. It is recognized that demand reduction projects could have a detrimental impact on the local economy, livelihood of residents and business owners, and the well-being of Metropolitan Bakersfield and Kern County. Therefore, potential demand reductions are targeted for later in the implementation period (i.e., Phase Two) to allow water supply projects the opportunity to sustainably support current and projected growth in the beneficial uses of groundwater.

Future Reporting and Evaluation

In accordance with GSP regulations, the KRGSA will coordinate with the Subbasin on Annual Reporting and Five-Year re-evaluation of the GSP. Implementation of the GSP is summarized in Section 8.