

Memorandum

To: North Kings GSA Members

From: Owen Kubit, Ronald Samuelian

Subject: Groundwater Impact by Agency in the North Kings Groundwater Sustainability Agency

Date: June 30, 2019

INTRODUCTION

This memorandum documents the estimated overdraft responsibility for each agency in North Kings Groundwater Sustainability Agency (NKGSA). In addition to tracking overall changes in groundwater storage in the GSA, the NKGSA desires to track groundwater impact by agency since groundwater pumping agencies desire to mitigate for their entity's individual groundwater impacts. 'Groundwater Impact' is an agency's net impact on the aquifer, which is essentially the volume of groundwater that is pumped and consumed minus natural and intentional forms of recharge. Following are discussions on the overall NKGSA water budget, methodology for calculating Groundwater Impact, native safe yield, wastewater effluent export credits, uncertainty in the analysis, and the results for historical, current and future 2040 conditions. **Attachment 1** is a map of the water agencies in the NKGSA

WATER BUDGET ANALYSIS

Water budgets were prepared for the North Kings GSA for the periods illustrated in **Figure 1**. The water budgets include individual data for each of the twelve agencies in the NKGSA. This data was aggregated to provide water budgets for the GSA as a whole.

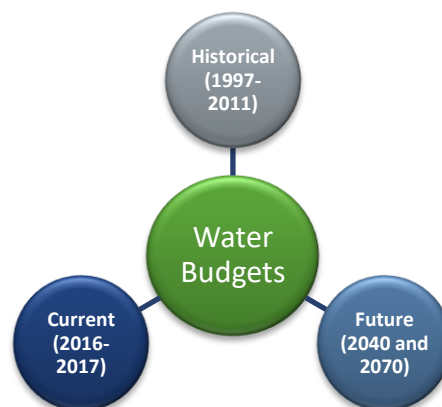


Figure 1 – Water Budget Periods

Refer to Section 3.3 – Water Budget Information of the NKGSP for more information on the water budget, including the water budget requirements, study period, methodology, description of variables, assumptions, uncertainty in analysis, and the final results.

GROUNDWATER IMPACT METHODOLOGY

A methodology was developed for estimating the impact each agency has on groundwater supplies. This can generally be done in two ways: 1) Groundwater level analysis; or 2) Water budget approach. Groundwater levels can be useful on a regional scale, but they are generally not reliable on an agency-by-agency level since they can be impacted by neighboring pumping depressions, neighboring recharge efforts, and regional groundwater flows patterns. Consequently, a water budget approach is being used to estimate the overdraft by calculating the ‘Groundwater Impact’. **Figure 1** shows the general variables included in the Groundwater Impact calculations.

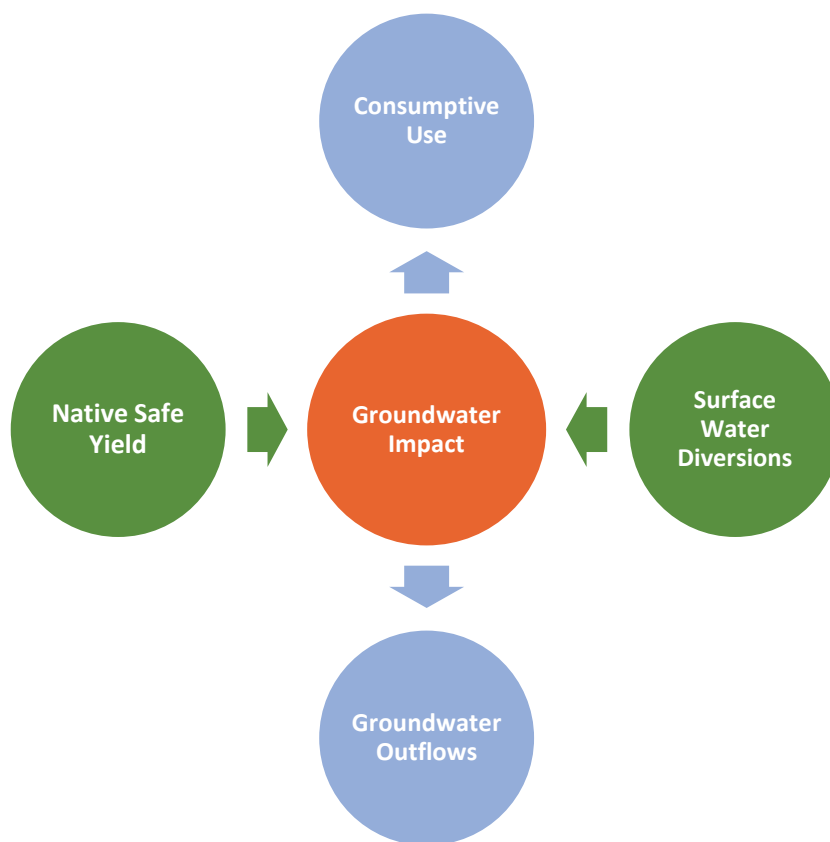


Figure 2 – Variables Impacting Groundwater Impact

The formula for Groundwater Impact is shown below:

$$\text{Groundwater Impact} = \text{SW} + \text{NSY} - \text{CU} \pm \text{GWF}$$

where:

SW = Surface water diversions

NSY = Native Safe Yield

CU = Consumptive Use of Applied Water

GWF = Groundwater Flows

Each of these variables is described below in more detail.

Surface Water Diversions (SW)

$$\text{SW} = \text{ISW} + \text{MISW} + \text{FKCS}$$

Where:

ISW = Irrigation surface water diversions

MISW = M&I surface water diversions

FKCS = Friant-Kern Canal seepage

For the water balance approach being used, the fate of the surface water is essentially irrelevant. Whether the surface water is used to directly meet demands, intentionally recharged, or incidentally recharged (seepage), it positively impacts groundwater and reduces the net Groundwater Impact.

Native Safe Yield (NSY)

$$\text{NSY} = \text{DPP} + \text{SWR} + \text{LSR} + \text{RS}$$

Where:

DPP = Deep percolation of precipitation

SWR = Stormwater recharge

LSR = Local stream recharge

RS = River seepage

More information on Native Safe Yield is provide in the subsequent section.

Consumptive Use (CU)

$$\text{CU} = \text{AGET} + \text{MIET} + \text{EVAP} + \text{SP}$$

Where:

AGET = Evapotranspiration of applied water for agricultural crops

MIET = Evapotranspiration of applied water for M&I demands, including landscape, pool water and wash water

EVAP = Evaporation from canals, basins and reservoirs

SP = Operational spills from surface water systems that leave the GSA

Groundwater Flows (GWF)

$$\text{GWF} = \text{GWI} - \text{GWO}$$

Where:

GWI = Groundwater Inflows

GWO = Groundwater Outflows

There are no significant groundwater inflows to the GSA. Groundwater outflows occur in the confined and unconfined aquifer.

NATIVE SAFE YIELD

As defined here, native safe yield is the volume of water from native or natural sources, such as precipitation and rivers, that recharge an aquifer under current cultural conditions. The native safe yield represents the long-term average replenishment of the aquifer from these sources. The native safe yield is less than the overall sustainable yield of a basin, since sustainable yield usually includes some intentional and incidental groundwater recharge, such as percolation of unused irrigation applications. Each agency in the NKGSA derives some native safe yield from one or more of the following variables:

Deep Percolation of Precipitation / Stormwater Recharge. Each agency obtains some benefit from deep percolation of rainfall. The method for estimating the recharge varies in rural versus urban areas. Deep percolation of precipitation occurs in rural and agricultural areas. Stormwater recharge occurs in urban areas.

Local Stream Recharge. This includes recharge from several local streams that originate in the foothills just east of the NKGSA. The estimated flows were split evenly among three agencies that have a pending water rights application for the stream water (City of Clovis, City of Fresno and Fresno Irrigation District).

San Joaquin River Recharge. San Joaquin River recharge was assumed to benefit only those agencies that directly abut the River, since seepage benefits do not likely travel more than a few miles from the river's edge. The seepage benefits were apportioned based primarily on the length of riverfront boundary in each agency, with a small reduction of 2,000 AF/year to account for likely lower recharge in the upper reaches due to high groundwater and high bedrock levels.

Kings River Recharge. The Kings River flows through a small portion of the southeast portion of the GSA. The river only abuts Fresno County lands, and all of the recharge is attributed to Fresno County.

The total Native Safe Yield for the GSA is estimated to average about 100,200 AF/year, with varying amounts assigned to each agency in the NKGSA reflecting the assumptions above. Refer to the Section 3.3 of the NKGSA Groundwater Sustainability Plan for more details on the native safe yield variables. The Native Safe Yield calculations are summarized in **Attachment 2**.

WASTEWATER EFFLUENT EXPORT

Several agencies export wastewater to the Fresno-Clovis Regional Wastewater Reclamation Facility (RWRF) for treatment and disposal of the effluent. These agencies include the City of

Clovis, Pinedale County Water District, Bakman Water Company and California State University Fresno. The City of Fresno also deliver effluent to the plant, which is located in the southwestern part of their City boundary. Other urban agencies (City of Kerman and Malaga County Water District) recharge effluent at local treatment facilities in their service area. The City of Clovis also has tertiary treatment facility within its jurisdiction that treats a small portion of its effluent.

The majority of the wastewater in the North Kings GSA is delivered to the Fresno-Clovis RWRP, treated and then percolated in basins. As a result, the majority returns to the aquifer at the facility location, minus a small loss due to evaporation. A small amount is directly used for irrigation in the area. While the effluent is recharging within the North Kings GSA as a whole, the distance between where the pumping occurs and where the effluent is recharged can result in Undesirable Results of continuing declining groundwater levels in the location of pumping, or continual/increased groundwater flows into the location of the groundwater pumping.

The GSA is actively discussing this issue of displacement of pumped groundwater and the undesirable results, but no formal agreements have been reached. For now, the Groundwater Impact is presented as a 50% credit for exported effluent percolation. It is recognized that the agencies may pursue projects to utilize their wastewater to mitigate the potential declining groundwater levels at the location of pumping. Projects that may be considered include recycled water systems that deliver treated wastewater back to the locations of agency pumping, or developing/expanding programs to exchange wastewater for surface water that can be recharged at the location of the pumping.

Wastewater effluent originates from two sources: pumped groundwater and treated surface water. Only the effluent originating from groundwater would be considered a stranded asset, since it directly displaces local groundwater. Effluent from treated surface water does not negatively impact groundwater levels, so it is not considered in this evaluation. Hence, if agencies increase surface water treatment in the future, the impact from the exported effluent will be reduced.

UNCERTAINTY IN ANALYSIS

Water budgets inherently contain a fair amount of computational uncertainty. The results presented in Section 3.3 – Water Budget of the GSP, and the groundwater impact calculations, are generally based on standard water budget procedures. However, the data used in the analyses were often incomplete, had to be estimated, or were based on numerous assumptions.

The groundwater impact results presented below are reported to the nearest 100 AF, however the analyses are generally not that precise. Each variable in the water budget has a confidence interval ranging from 5% to 50%. Cumulatively these confidence intervals can result in a large range of answers, however they can also tend to cancel each other out. For simplicity, the accuracy is estimated based on assumed confidence intervals of 10% for consumptive use and the native safe yield. This provides a range of Groundwater Impacts, with the mid-point provided that perhaps could be a current long-term goal. *The water budget, and groundwater impact calculations, should therefore be considered an approximate model for the NKGSA hydrologic system, and the values should be used as guides rather than precise values.*

RESULTS

The Groundwater Impact results are provided in the following attachments:

Attachment 2: Native Safe Yield

Attachment 3: Summary for Historical, Current and Future Groundwater Impacts
Attachment 4: Groundwater Impact – Historical Period
Attachment 5: Groundwater Impact – Current Period
Attachment 6: Groundwater Impact – Future Period

Groundwater Impacts are provided for each agency. Since there is considerable computational uncertainty in water budgets, a range of accuracy of also provided for each value.

McMullin Groundwater Flows. An important component of the historical water budget is groundwater outflow to McMullin GSA. Through analysis of groundwater conditions that was reviewed in coordinated meetings with all of the GSAs, it was determined that groundwater pumping and lack of surface water in McMullin GSA (which is located directly west of North Kings GSA) has induced additional groundwater flow out of NKGSA. Recent flows were compared to historical flows from the 1920's before there was considerable development. The comparison determined that McMullin GSA is inducing an increase of approximately 43,000 AF/year from NKGSA. This value is included in the historical water budget but is removed in the future water budget discussed later, since McMullin GSA is expected to mitigate these groundwater flows through water supply and demand reduction projects. In the Groundwater Impact calculation this value is also removed. As a result, the Groundwater Impact results represent what would need to be mitigated after McMullin GSA has corrected the groundwater outflow, which may not occur until 2040.

Water Budget versus Groundwater Level Change in Storage. The water budget includes two methods for estimating change in groundwater storage: Method 1 - Water Budget and Method 2 - Groundwater Level Analysis. These two values do not match, but are relatively close and help to validate each other. The Groundwater Impact is based on specific water budget data for each agency, and hence is related to Method 1 - Water Budget. The actual change in storage to be mitigated different slightly from the values in the water budget (by a few thousand acre-feet), due to rounding errors, and small items in the water budget not utilized in the Groundwater Impact Analysis. This discrepancy is well within the computational accuracy of the water budget.

Historical

The historical water budget shows long-term average conditions from 1997-2011, which was determined to be a hydrologically average period based on Kings River diversions. This analysis was primarily used to help calibrate the water budget. The historical Groundwater Impact is shown in **Attachment 4**, including detailed data for each agency. These results are just informational, since future water management should be based on the Current and Projected Groundwater Impacts.

Current

Attachment 5 shows the Current Groundwater Impact for each agency. The Current Water Budget is based on demands for 2016 and 2017, and long-term average supplies. The current water budget is a short snapshot of water conditions and not considered as accurate as a long-term average water budget, since it lacks a sufficiently long-period that can help balance out inaccuracies. The water budget is not intended for comparison to actual changes in groundwater, since it would be inaccurate due to time lags in groundwater recharge and would not reflect the specific water supply conditions of 2016/2017. Additionally, some of the specific management practices in 2016/2017, such as water conservation related to a recent drought, may not persist

long-term. With these caveats, this water budget is considered to be the best representation of the current water budget under “normal” conditions.

The Current Water Budget shows an annual increase in groundwater storage of 39,200 AF/year, which primarily occurred due to water conservation efforts and increased surface water treatment. It should be noted that while the GSA was in overall surplus in 2016/2017, based on localized agency water budgets, several agencies are currently in overdraft and will be required to mitigate their condition. In addition, with future growth and possible climate change impacts, the surplus may be lost in the future.

Projected Water Budget

Projected water budgets (future water budgets) were developed for 2040 and 2070. The 2040 water budget is the focus of the analysis, since it represents near term periods and requires less speculative estimates of climate change impacts, population growth and land use change. The year 2070 is beyond the practical planning horizon for most agencies, so the Groundwater Impact was only estimated for 2040 (see **Attachment 6**).

The projected water budgets are based initially on the Current water budget, with changes made to various variables, as shown in the Figure below.

Climate Change	Urban Agencies	Agricultural Agencies	Projects / Programs
•Kings River •San Joaquin River •Precipitation •Evapotranspiration	•Population growth •Increased water demands •Water conservation •Annexations	•Changes in cropping patterns •De-annexations •Land conversion to urban use	•Increased surface water use •Water conservation •Land use policy

Figure 3- Variables Impacting Projected Water Budget

Refer to Section 3.3 of the GSP for more details on climate change assumptions. Most of the projected changes are the result of assumed land use and demand changes provided by the agencies (see Table 1). These can be modified as better information becomes available.

In the future, as agency footprints change through annexations or de-annexations, their corresponding Groundwater Impact will change. The area of an agency impacts safe yield, and can also impact demands.

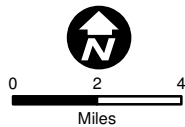
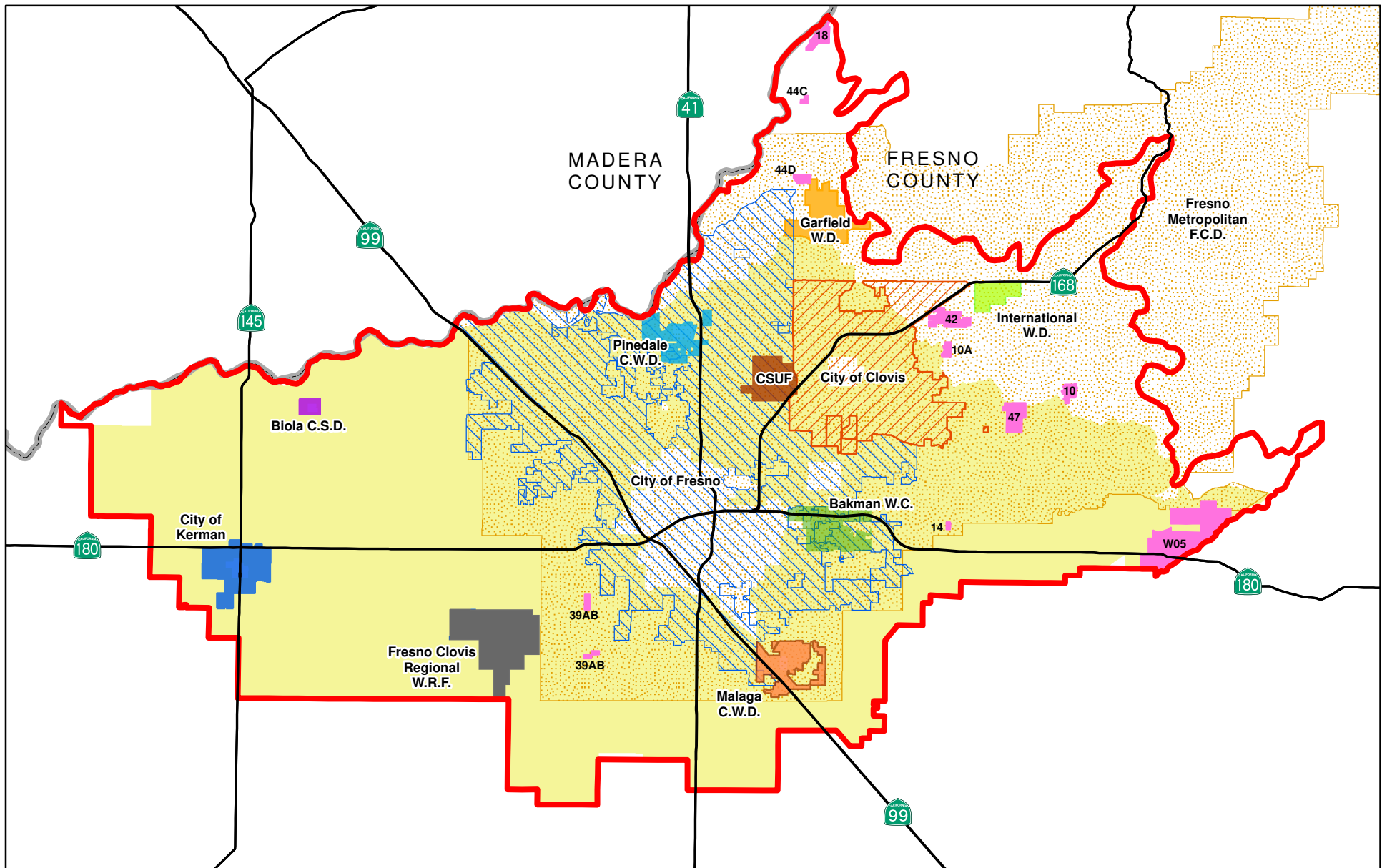
Table 1 – Future Water Demands Assumptions

Organization	Future Water Demand Assumptions ¹
Bakman Water Company	Demands increase from 2,900 AF/year (2016/17) to 6,200 AF/year (2040)
Biola Community Services District	No anticipated increase in net demands. Water conservation expected to offset any new demands.
City of Clovis	Demands increase from 21,300 AF/year (2016/17) to 47,800 AF/year (2040)
City of Fresno	Demands increase from 116,100 AF/year (2016/17) to 195,800 AF/year (2040)
City of Kerman	Demands increase from 2,800 AF/year (2016/17) to 5,300 AF/year (2040)
California State University Fresno	Increase student population by 5,500 by 2040 resulting in 240 AF increase in domestic demands. No change in agricultural demands.
FID (not including agency overlaps)	No changes in cropping patterns. Reduction in demand due to conversion of 8,500 acres to urban use.
Fresno County	No increase in demand. Combination of annexations by Cities and new land use policies assumed to offset any future demands.
Garfield W.D.	No changes in cropping patterns. Reduction in demand due to de-annexation of 500 acres by 2040.
International WD	No changes in cropping patterns. Reduction in demand due to de-annexation of 325 acres by 2040.
Malaga County W.D.	Increase in demands from 1,600 AF/year (2016/2017) to 1,900 AF/year (2040)
Pinedale County W.D.	No changes in demands since area is largely built out. Any remaining in-fill will be balanced out by savings from future residential metering.

1 – Demands due not include water used for intentional recharge

ATTACHMENTS

- 1 - Plan Participants
- 2 - Native Safe Yield
- 3 - Summary for Historical, Current and Future Groundwater Impacts
- 4 - Groundwater Impact – Historical Period
- 5 - Groundwater Impact – Current Period
- 6 - Groundwater Impact – Future Period



Legend

- | | | | |
|------------------|------------------------------|--|----------------------------|
| North Kings GSA | Garfield WD | CA State University Fresno | City of Clovis |
| International WD | Bakman Water Company | Malaga County WD | Fresno Clovis Regional WRF |
| Biola CSD | Pinedale County WD | Fresno ID | City of Fresno |
| City of Kerman | Fresno County Water Agencies | Fresno Metropolitan Flood Control District | County |

North Kings GSA

Plan Participants

North Kings Groundwater Sustainability Agency Native Safe Yield

Precipitation **11.79** in/year
 Rural Area Recharge **15%**
 Urban Stormwater Recharge **20%**

San Joaquin River Seepage **36,600** AF/year
 River Length in GSA **38.71** miles
 Kings River Seepage **3,100** AF/year

Agency	Acres	Precipitation Recharge	Stormwater Recharge	Local Stream Recharge	San Joaquin River		Kings River Seepage	Total (AF)	Total (AF/acre)
					Length (mi)	Seepage			
Bakman Water Company	1,994	-	392	-	-	-	-	392	0.20
Biola	237	-	47	-	-	-	-	47	0.20
City of Clovis	15,666	-	3,078	3,300	-	-	-	6,378	0.41
City of Fresno	75,679	-	14,871	3,300	12.24	12,577	-	30,748	0.41
City of Kerman	2,089	-	411	-	-	-	-	411	0.20
CSUF	1,303	-	256	-	-	-	-	256	0.20
FID (not incl. agency overlaps)	169,685	25,007	-	3,300	12.00	12,346	-	40,653	0.24
Fresno County	38,475	5,670	-	-	14.00	11,237	3,100	20,007	0.52
Garfield W.D.	1,658	244	-	-	-	-	-	244	0.15
International WD	736	108	-	-	-	-	-	108	0.15
Malaga County W.D.	1,678	-	330	-	-	-	-	330	0.20
Pinedale County W.D.	1,170	-	230	-	0.44	416	-	646	0.55
Total	310,371	31,030	19,614	9,900	38.68	36,576	3,100	100,220	-

Notes:

San Joaquin River seepage borders Fresno County, City of Fresno, FID and Pinedale County Water District.. Seepage was split evenly based on length of riverfront lands in San Joaquin River and Bypass System 1-D Steady State HEC-RAS Model Documentation (Tetra Tech, November 2013). This same assumption was used, with a small adjustment of 2,000 AF/year to account for lower seepage in upstream County areas due to high groundwater levels and shallow bedrock.

North Kings GSA
Summary of Historical, Current and Future Groundwater Impacts

	Historical (1997-2011)		Current (2016-2017)		Future (2040)	
Agency	Groundwater Impact	Range of Accuracy (+/-)	Groundwater Impact	Range of Accuracy (+/-)	Groundwater Impact	Range of Accuracy (+/-)
Bakman Water Company	-2,700	200	-1,400	100	-3,300	200
Biola	-300	0	-300	0	-300	0
City of Clovis	-1,800	2,000	4,400	1,900	-15,500	3,600
City of Fresno	-30,700	10,600	13,000	7,600	-37,200	10,700
City of Kerman	-1,700	200	-1,500	200	-2,700	300
CSUF	-1,200	300	-500	300	-900	300
FID (not incl. agency overlaps)	49,200	41,200	44,700	40,200	37,000	41,300
Fresno County	-2,900	4,000	-900	3,800	-600	3,800
Garfield W.D.	-600	300	-300	300	100	200
International WD	-300	200	-800	200	-700	100
Malaga County W.D.	-700	100	-600	100	-800	100
Pinedale County W.D.	-1,600	200	-900	100	-900	100

Notes:

Groundwater Impact values based on 50% credit for exported wastewater effluent

Kings Basin Water Budget
Historical Water Budget (1997-2011)
Groundwater Impact

Total GW Outflow **79,000**

(all units in acre-feet)

Agency	Total Acres	Surface Water				Consumptive Use						Waste Water Export ⁶ (50%)	Native Safe Yield ³	GW Outflows ⁴	Groundwater Impact ⁵	Range of Accuracy (+/-) ⁷
		Irrigation Water	M&I Water	Friant-Kern Canal Seepage	Total	Crop ET	M&I ET ¹	Channel Evaporation	Basin Evaporation ²	Operational Spills	Total					
Bakman Water Company	1,994	0	0	0	0	0	1,542	0	95	0	1,637	950	392	500	-2,700	200
Biola	237	0	0	0	0	0	193	0	6	0	199	0	47	100	-300	0
City of Clovis	15,666	0	12,700	0	12,700	0	13,011	0	738	0	13,749	3,139	6,378	4,000	-1,800	2,000
City of Fresno	75,679	0	59,200	3,310	62,510	0	69,781	0	5,160	0	74,941	29,741	30,748	19,300	-30,700	10,600
City of Kerman	2,089	0	0	0	0	0	1,530	0	57	0	1,588	0	411	500	-1,700	200
CSUF	1,303	2,000	0	0	2,000	2,413	705	0	5	0	3,122	46	256	300	-1,200	300
FID (not incl. agency overlaps)	169,685	422,300	0	824	423,124	357,223	7,445	2,930	1,636	2,100	371,334	0	40,653	43,200	49,200	41,200
Fresno County	38,475	6,500	414	0	6,914	17,475	2,523	0	17	0	20,014	0	20,007	9,800	-2,900	4,000
Garfield W.D.	1,658	2,500	0	170	2,670	2,988	122	0	0	0	3,109	0	244	400	-600	300
International WD	736	1,400	0	95	1,495	1,738	5	0	0	0	1,743	0	108	200	-300	200
Malaga County W.D.	1,678	0	0	0	0	0	621	0	43	0	664	0	330	400	-700	100
Pinedale County W.D.	1,170	0	0	0	0	0	1,072	0	75	0	1,147	750	646	300	-1,600	200
Total	310,371	434,700	72,314	4,400	511,414	381,836	98,550	2,930	7,832	2,100	493,248	34,627	100,220	79,000	4,700	59,300

Notes:

- 1) M&I ET includes evapotranspiration of landscaping and evaporation of other outdoor water uses (i.e. swimming pools, washing, etc.). These are assumed to be 85% of total outdoor water use.
- 2) Basin evaporation includes evaporation of recharge basins, regulation reservoirs, and effluent percolation ponds
- 3) Native safe yield includes safe yield from precipitation, stormwater, local streams and local rivers
- 4) Sum of existing confined groundwater outflows (35,000 AF/year), estimated historical outflows from the 1920's (24,000 AF/year), and an additional 20,000 AF/year unconfined flows, distributed evenly based on acreage
- 5) Groundwater Impact= Surface Water Diversions - Consumptive Use + Native Safe Yield - Groundwater Outflows
- 6) Wastewater exported outside of surface area. Only includes wastewater originating from pumped groundwater. The Groundwater Impact only gives credit for 50% of exported effluent percolation.
- 7) The range of accuracy is estimated as the sum of 10% of the consumptive use and 10% of the native safe yield

Kings Basin Water Budget
Current Water Budget
Groundwater Impact

Total GW Outflow **79,000**

(all units in acre-feet)

Agency	Total Acres	Surface Water				Consumptive Use						Waste Water Export ⁶ (50%)	Native Safe Yield ³	GW Outflows ⁴	Groundwater Impact ⁵	Range of Accuracy (+/-) ⁷
		Irrigation Water	M&I Water	Friant-Kern Canal Seepage	Total	Crop ET	M&I ET ¹	Channel Evaporation	Basin Evaporation ²	Operational Spills	Total					
Bakman Water Company	1,994	0	275	0	275	0	434	0	105	0	539	1,051	392	500	-1,400	100
Biola	237	0	0	0	0	0	193	0	6	0	199	0	47	100	-300	0
City of Clovis	15,666	0	17,000	0	17,000	0	12,395	0	654	0	13,049	1,895	6,378	4,000	4,400	1,900
City of Fresno	75,679	0	69,900	3,310	73,210	0	40,056	0	5,202	0	45,258	26,364	30,748	19,300	13,000	7,600
City of Kerman	2,089	0	0	0	0	0	1,305	0	57	0	1,362	0	411	500	-1,500	200
CSUF	1,303	2,000	0	0	2,000	1,725	705	0	5	0	2,435	46	256	300	-500	300
FID (not incl. agency overlaps)	169,685	407,300	0	824	408,124	346,850	7,445	2,825	1,636	2,100	360,856	0	40,653	43,200	44,700	40,200
Fresno County	38,475	6,500	414	0	6,914	15,513	2,523	0	17	0	18,052	0	20,007	9,800	-900	3,800
Garfield W.D.	1,658	2,500	0	170	2,670	2,650	122	0	0	0	2,772	0	244	400	-300	300
International WD	736	1,400	0	95	1,495	2,163	5	0	0	0	2,168	0	108	200	-800	200
Malaga County W.D.	1,678	0	0	0	0	0	536	0	43	0	578	0	330	400	-600	100
Pinedale County W.D.	1,170	0	0	0	0	0	398	0	75	0	473	750	646	300	-900	100
Total	310,371	419,700	87,589	4,400	511,689	368,900	66,116	2,825	7,800	2,100	447,740	30,106	100,220	79,000	54,900	54,800

Notes:

- 1) M&I ET includes evapotranspiration of landscaping and evaporation of other outdoor water uses (i.e. swimming pools, washing, etc.). These are assumed to be 85% of total outdoor water use.
- 2) Basin evaporation includes evaporation of recharge basins, regulation reservoirs, and effluent percolation ponds
- 3) Native safe yield includes safe yield from precipitation, stormwater, local streams and local rivers
- 4) Sum of existing confined groundwater outflows (35,000 AF/year), estimated historical outflows from the 1920's (24,000 AF/year), and an additional 20,000 AF/year unconfined flows, distributed evenly based on acreage
- 5) Groundwater Impact= Surface Water Diversions - Consumptive Use + Native Safe Yield - Groundwater Outflows
- 6) Wastewater exported outside of surface area. Only includes wastewater originating from pumped groundwater. The Groundwater Impact only gives credit for 50% of exported effluent percolation.
- 7) The range of accuracy is estimated as the sum of 10% of the consumptive use and 10% of the native safe yield

Kings Basin Water Budget
Future Water Budget (2040)
Groundwater Impact

Total GW Outflow **79,000**

(all units in acre-feet)

Agency	Total Acres	Surface Water				Consumptive Use						Waste Water Export ⁶ (50%)	Native Safe Yield ³	GW Outflows ⁴	Groundwater Impact ⁵	Range of Accuracy (+/-) ⁷
		Irrigation Water	M&I Water	Friant-Kern Canal Seepage	Total	Crop ET	M&I ET ¹	Channel Evaporation	Basin Evaporation ²	Operational Spills	Total					
Bakman Water Company	1,994	0	275	0	275	0	944	0	229	0	1,173	2,287	392	500	-3,300	200
Biola	237	0	0	0	0	0	193	0	6	0	199	0	47	100	-300	0
City of Clovis	20,200	0	17,000	0	17,000	0	27,816	0	1,049	0	28,865	5,848	7,269	5,100	-15,500	3,600
City of Fresno	84,162	0	69,900	3,161	73,061	0	67,033	0	7,276	0	74,309	47,097	32,438	21,300	-37,200	10,700
City of Kerman	2,089	0	0	0	0	0	2,515	0	110	0	2,625	0	411	500	-2,700	300
CSUF	1,303	2,000	0	0	2,000	1,900	881	0	6	0	2,787	58	256	300	-900	300
FID (not incl. agency overlaps)	161,185	411,400	0	1,054	412,454	359,865	7,445	2,853	1,636	2,100	373,899	0	39,355	40,900	37,000	41,300
Fresno County	35,875	6,500	414	0	6,914	15,600	2,523	0	17	0	18,139	0	19,687	9,100	-600	3,800
Garfield W.D.	1,158	2,240	0	146	2,386	2,020	122	0	0	0	2,142	0	171	300	100	200
International WD	411	616	0	40	656	1,288	5	0	0	0	1,293	0	61	100	-700	100
Malaga County W.D.	1,678	0	0	0	0	0	656	0	53	0	709	0	330	400	-800	100
Pinedale County W.D.	1,170	0	0	0	0	0	398	0	75	0	473	750	630	300	-900	100
Total	311,463	422,756	87,589	4,400	514,745	380,673	110,531	2,853	10,456	2,100	506,614	56,041	101,045	78,900	-25,800	60,700

Notes:

- 1) M&I ET includes evapotranspiration of landscaping and evaporation of other outdoor water uses (i.e. swimming pools, washing, etc.). These are assumed to be 85% of total outdoor water use.
- 2) Basin evaporation includes evaporation of recharge basins, regulation reservoirs, and effluent percolation ponds
- 3) Native safe yield includes safe yield from precipitation, stormwater, local streams and local rivers
- 4) Sum of existing confined groundwater outflows (35,000 AF/year), estimated historical outflows from the 1920's (24,000 AF/year), and an additional 20,000 AF/year unconfined flows, distributed evenly based on acreage
- 5) Groundwater Impact= Surface Water Diversions - Consumptive Use + Native Safe Yield - Groundwater Outflows
- 6) Wastewater exported outside of surface area. Only includes wastewater originating from pumped groundwater. The Groundwater Impact only gives credit for 50% of exported effluent percolation.
- 7) The range of accuracy is estimated as the sum of 10% of the consumptive use and 10% of the native safe yield