

TECHNICAL MEMORANDUM



4CREEKS

To: Greater Kaweah GSA Board of Directors

From: . Don Tucker – 4Creeks, Inc.

cc: Mark Larsen – GKGSA General Manager
David De Groot – 4Creeks, Inc
Thomas Harder – Thomas Harder & Company
Ben Lewis – Thomase Harder & Company

Date: September 22, 2023

Re: Greater Kaweah GSA – Water Year 2024 Groundwater Allocations

In accordance with the current amended Greater Kaweah Groundwater Sustainability Agency (GKGSA or GSA) Rules and Regulations adopted by the Board of Directors, the following technical memorandum summarizes the recommended Water Year 2024 (October 2023 through September 2024) groundwater allocations made available for landowners within the GSA. Article IV. Allocation of Water, Section 4.02 Determination of Allocations of the Rules and Regulations states the following:

“Each year prior to, or as soon as practical, October 1, the GKGSA Technical Group shall determine the allocations available for use within the GKGSA’s various Management Areas based on the data and calculations and the approved methodologies provided herein. The General Manager shall cause such determination to be noticed to all affected Owners prior to October 1, or as close as practical.”

Allocatable categories of groundwater within the GSA include the following:

1. Native Sustainable Yield
2. Temporary Tier 1 and Tier 2

Separately from Native Sustainable Yield, Actual Precipitation is be applied towards ET on a month-by-month basis. The combination of Native Sustainable Yield and Total Precipitation makes up the Sustainable Yield allocation.

The two water categories are described along the proposed allocation amount available to GKGSA landowners.

Sustainable Yield Allocation

A) Native Sustainable Yield –

Landowners within the Kaweah Subbasin share the native, natural occurring waters, which include mountain block inflow recharge from the Sierra Nevada's and natural channel loss from flows in the Kaweah River. The amount of Native Sustainable Yield available to Greater Kaweah GSA landowners is coordinated among the three Kaweah Subbasin GSAs and defined in the Kaweah Subbasin Coordination Agreement Appendix 3, Water Accounting Framework.

This water is referred to as the Native Sustainable Yield and when equally shared among the gross lands within the Kaweah Subbasin is the amount of **0.62 acre-feet per acre available for consumptive use**.

Temporary Tier 1 & Tier 2 Allocation

The GSA recognizes that a reasonable timeframe is needed for landowners to adjust from current overdrafting of groundwater to a sustainable amount to avoid substantial economic impact. This is referred to as Temporary Tier 1 & Tier 2 Water, for which the GSA has adopted a rampdown schedule for landowners to transition to sustainability. The adopted rampdown schedule for Temporary Tier 1 & Tier 2 is provided in **Table 1**.

Table 1: Greater Kaweah GSA Rampdown Schedule

Rampdown Schedule			
Water Years	Tier 1	Tier 2	Total Allowable
2023-2025	40%	50%	90%
2026-2030	40%	30%	70%
2031-2035	20%	20%	40%
2036-2040	20%	0%	20%

The Temporary Tier 1 & Tier 2 allocations are based on a historical volume of groundwater overdraft with no consideration to surface water deliveries, and are only made available to historically irrigated lands within the GKGSA. The formula for determining overdraft for the purpose of allocation Temporary water is provided below:

$$\text{Overdraft} = (\text{Total ET Consumption}) - (\text{Native Sustainable Yield}) - (\text{Total Precipitation})$$

**The evaluation criteria was based on the 24-year averages from the water year 1998/99 through water year 2021/22.*

Table 2 summarizes the results of this overdraft calculation for the greater Kaweah GSA.

Table 2 – Greater Kaweah GSA Overdraft

Irrigated Acreage	Total Consumption (AF)	NSY (AF)	Total Precipitation (AF)	Overdraft (AF)
161,100	454,000	99,882	130,230	223,888

Applying the calculated overdraft in **Table 2** of 223,888 AF to the rampdown schedule in **Table 1**, the resulting Temporary Teir 1 and Teir 2 allocations are **0.56** and **0.68 acre-feet per acre**, respectively, as shown in **Table 3**.

Table 3 – Greater Kaweah Temporary Tier 1 & Tier 2 Allocations

Water Year 2024 Allocatable Temporary Water			
Tier	% Rampdown	Acre-Feet	AF/Acre
Tier 1	40%	89,555	0.56
Tier 2	50%	111,944	0.69
Total	90%	201,499	1.25

Summary of Water Year 2024 Allocation

Table 4 summarizes total groundwater allocations for the 2024 water year in the Greater Kaweah GSA.

Table 4 – Greater Kaweah Water Year 2024 Allocations

Category	2024 WY Allocation	
NSY	0.62	AF/acre
Total Precip*	N/A	AF/acre
Tier 1	0.56	AF/acre
Tier 2	0.69	AF/acre
Total	1.87	AF/acre

*Total Precipitation is the **Actual Precipitation** to have occurred within the Water Year allocation year, to be calculated and reported one calendar month after actual rainfall occurs. These credits will be applied towards ET consumption monthly and can be

estimated from the 1997/98 through 2017/18 water years 20-year average, amounting to **0.81 AF/acre**.

DRAFT

Recommendations for Water Year 2024 Groundwater Allocation

GREATER KAWEAH GSA

TAC PRESENTATION SEPTEMBER 21, 2023

Measuring Groundwater Usage

Pumped (meters) vs. Consumption (ET)

MEASURING GROUNDWATER PUMPED

Pros:

- Isolates groundwater usage from other sources of applied water
- Better understanding of location and level physical water is pumped (if well information available)

Cons:

- Groundwater usage relies on estimations of net pumped water which includes:
 - Evaporation of Pumped Water
 - Return flows NOT consumed by a crop
- Expensive and heavy administrative lift to implement and track, and meters can be manipulated

MEASURING GROUNDWATER CONSUMED (ET)

Pros:

- Removes return flow and evaporation assumptions
- Cost effective and easily implemented over a large area

Cons:

- Requires additional accounting of other applied water sources received by a crop to determine groundwater usage, BUT surface water and precip data is measured and readily available

Core Principles of ET Based Groundwater usage Measurement:

1. ET measures **Total Consumption** including all sources of water received by a crop and cannot directly measure **Groundwater Consumed**

Sources of received water

- Actual Precipitation
- Applied Surface Water
- Pumped Groundwater

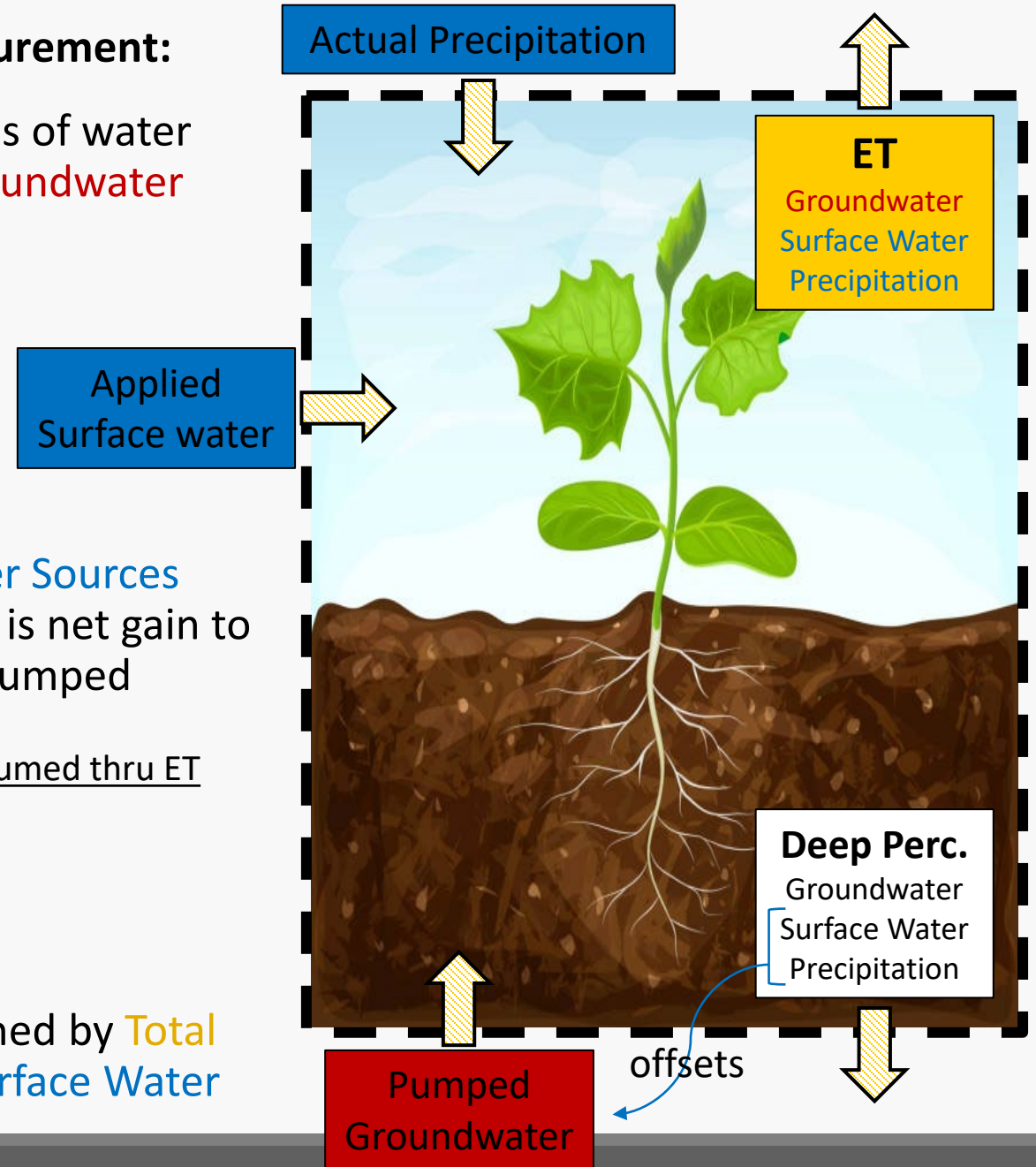
2. It can be reasonably assumed that **Non-groundwater Sources** received by a crop that is not consumed through ET is net gain to the groundwater budget and offsets groundwater pumped

Portion of non-groundwater sources received by water not consumed thru ET

Deep Percolation of:

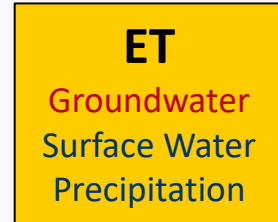
- Actual Precipitation
- Applied Surface Water

3. Therefore, **Consumed groundwater** can be determined by **Total Consumption** less **Actual Precipitation** & **Applied Surface Water**

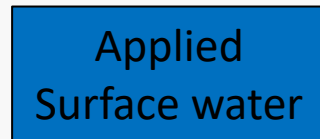


Determining Groundwater Consumption Using ET

1. Start with **Total ET Consumption**



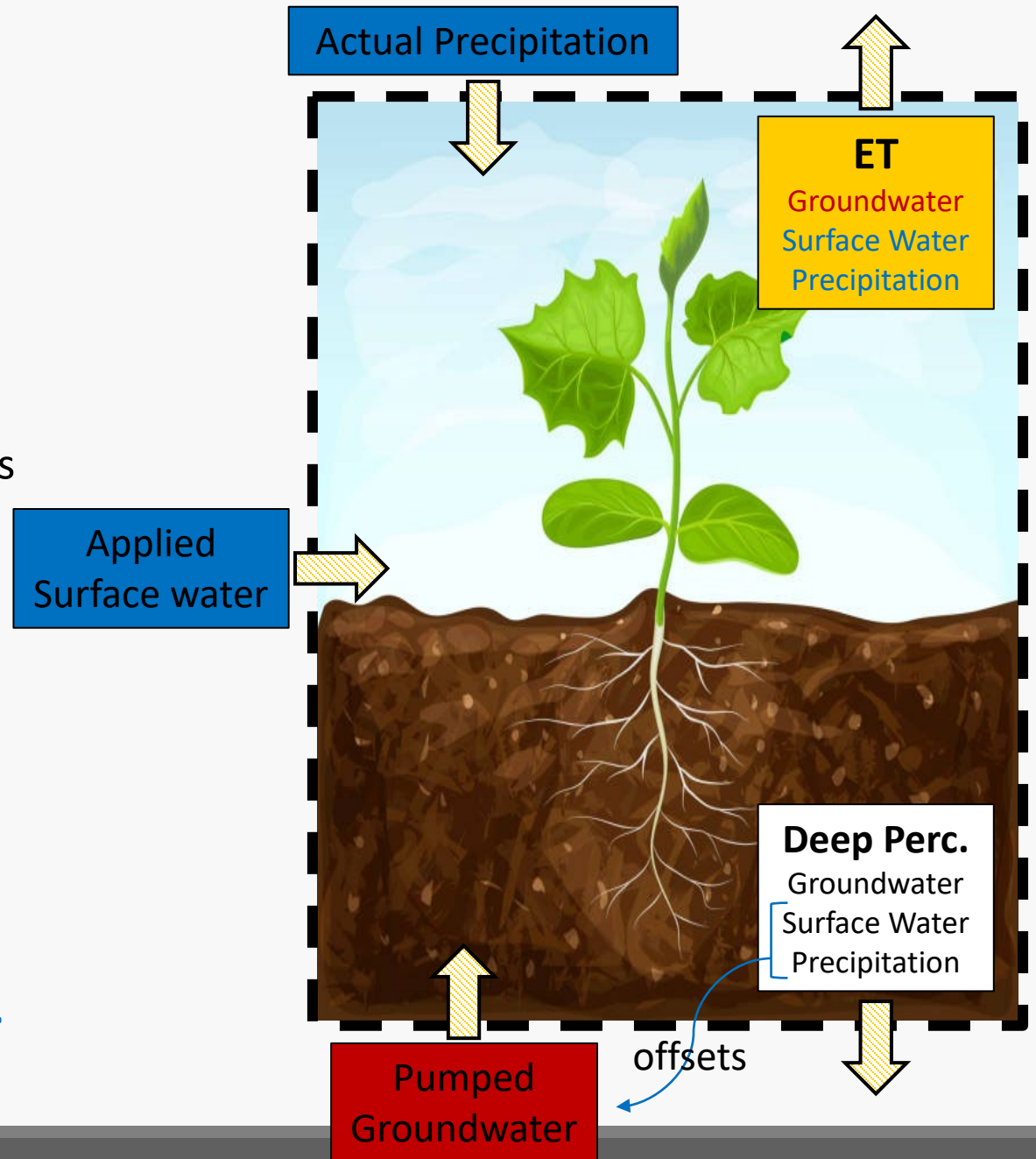
2. Credit **Non- Groundwater Sources** Received by Crops



3. Remaining ET Consumption equals Groundwater Consumed

Groundwater Consumed =

Total ET – **Actual Precipitation** – **Applied Surface Water**



Basis for Groundwater Allocations

Native Sustainable Yield [[GKGSA R&Rs Section 4.03\(a\)1\(A\)](#)]

“Long-term average natural channel loss within the natural tributaries of the Kaweah River and the calculated underflow from the Sierra Nevada Mountains”

Total Precipitation [[GKGSA R&Rs Section 4.03\(a\)1\(B\)](#)]

“Actual precipitation to have occurred within the Water Year allocation year, to be calculated and reported one calendar month after actual rainfall occurs”

Temporary Tier 1 & Tier 2 [[GKGSA R&Rs Section 4.03\(b\)](#)]

“..will ramp-down pumping overtime calculated by a percentage of total overdraft as follows”

Native Sustainable Yield

Native Sustainable Yield is derived from the Appendix 3- Water Accounting Framework of the Kaweah Subbasin Coordination Agreement.

The Total Native Sustainable Yield supply is allocated to the 219,440 gross acreage of the Greater Kaweah GSA.

Not all components of the Water Accounting Framework are consistent using an ET Computation Model.

- **Percolation of Precipitation** - ET consumption only measures losses through evaporation or transpiration therefore actual precipitation is credited separately and the portion that is not consumed would offset groundwater pumping.
- **Imported** – Imported water is not native to the subbasin and is purchased and credited to owners separately from NSY.
- **Salvaged** - Salvaged water reflects return flows of previously appropriated surface water supplies that has been credited separately and the portion that is not consumed would represent return flows that offset groundwater pumping.

Table 3.2
(values in acre-feet)

	Native Water			
	East	Greater	Mid	Total
Perc of Precip (Ag and 'Native' non-Ag land)	23,666	44,213	20,974	88,854
Streambed Perc from Kaweah River Sources	16,767	31,324	14,860	62,952
Irrigation Ret. Flow from Pumped GW	41,484	77,501	36,766	155,752
Mountain Front Recharge	14,976	27,978	13,273	56,227
Total Native	96,894	181,017	85,874	363,784
GSA % of Total Native	27%	50%	24%	
	Foreign Water			
	East	Greater	Mid	Total
Streambed Perc from Imported Sources	0	11,730	2,523	14,253
Ditch Perc from Imported Sources	0	1,204	21,745	22,949
Basin Perc from Imported Sources	0	1,050	14,305	15,355
Irrigation Ret. Flow from Imported Sources	12,073	1,241	7,140	20,453
Total Foreign	12,073	15,225	45,713	73,010
GSA % of Total Foreign	17%	21%	63%	
	Salvaged Water			
	East	Greater	Mid	Total
Ditch Perc from Kaw River Sources	8,835	49,771	34,880	93,486
Additional Recharge	226	6,892	5,697	12,815
Stormwater Return Flows	508	2,370	8,491	11,368
WWTP Return Flows	1,470	3,129	13,878	18,477
Basin Perc from Kaweah River Sources	0	16,005	23,479	39,484
Irrig. Ret. Flow from Kaweah River Sources	4,555	31,039	11,581	47,574
Total Salvaged	15,593	109,205	98,406	223,205
GSA % of Total Salvaged	7%	49%	44%	
	East	Greater	Mid	Total ^(*)
	124,560	305,447	229,992	659,999
Grand Total	124,560	305,447	229,992	659,999
GSA % of Total	19%	46%	35%	

(*) Excludes net sub-surface inflow of 60 taf/yr

Note: All data is derived from the Basin Setting and is based on water budget for the period Water Year 1997 to 2017 for the Kaweah Subbasin.

Native Sustainable Yield

Components of Groundwater Inflow that are incorporated into Native Sustainable Yield Allocation include sources only from the Native category except for Percolation of Rainfall.

Table 3.1

Components of Groundwater Inflow

Native

- ✓ Percolation from rainfall
 - Streambed percolation (natural channels) from Kaweah River watershed sources
 - Agricultural land irrigation returns from pumped groundwater
 - Mountain front recharge

Foreign

- ✓ Streambed percolation from imported sources
- ✓ Basin recharge from imported sources
- ✓ Ditch percolation from imported sources
- ✓ Agricultural land irrigation returns from imported sources

Salvaged

- ✓ Ditch percolation from previously appropriated Kaweah River sources
- ✓ Additional ditch/field recharge from over-irrigation
- ✓ Captured storm water returns
- ✓ Wastewater treatment plant returns
- ✓ Basin percolation from previously stored Kaweah River sources
- ✓ Agricultural land irrigation returns from Kaweah River watershed sources

*Except for mountain front recharge, sub-surface inflows in and out of the Subbasin are excluded from this accounting methodology and no ownership claims are asserted nor disavowed per this methodology.

Applicable Components of the Water Accounting Framework under a Consumptive Model

Total Native Sustainable Yield Supply within the Greater Kaweah GSA

136,803 AF

Allocated over 219,440 gross acres of the GKGSA amounts to

0.62 AF/acre

Native	Greater	Description
Perc of Percip	44,213	Total Precip Credited Seperately
Kaweah River Streambed Perc	31,324	Native Supply
Pump GW Return Flow	77,501	Not debited in Consumptive Model
Mountain Front Recharge	27,978	Native Supply
Native Total	136,803	AF
Imported	Greater	Description
Imported Streambed Perc	11,730	Non-native. Credit as SW to Owner
Imported Ditch Perc	1,204	Non-native. Credit as SW to Owner
Imported Basin Perc	1,050	Non-native. Credit as SW to Owner
Imported Irrigation Return Flow	1,241	Non-native. Credit as SW to Owner
Imported Total	-	
Salavage	Greater	Description
Kaweah River Ditch Perc	49,771	Previously appropriated Kaweah River Source
Additional Recharge	6,892	Originated as SW Credit to Owner
Stormwater Return Flow	2,370	Total Precip Credited Seperately
WWTP Return Flow	3,129	GW Origin
Kaweah River Basin Perc	16,005	Originated as SW Credit to Owner
Kaweah River Irrigation Return Flow	31,039	Originated as SW Credit to Owner
Salavage Total	-	AF
Native Sustainable Yield Total	136,803	AF
GKGSA Gross Acres	219,440	Acres
Native Sustainable Yield Allocation	0.62	AF/acre

Total Precipitation

- Total Precipitation is the actual precipitation to have occurred within the Water Year allocation year, to be calculated and reported one calendar month after actual rainfall occurs.
- Land IQ reports Actual Precipitation on a field-by-field basis. Actual Precipitation will be calculated and reported to Water Dashboard accounts monthly.
- The 1997-2017 Kaweah Subbasin 20-year average amounts to 9.7 inches or 0.81 Acre-Feet per Acre per the Kaweah Subbasin Setting.

Temporary Tier 1 & Tier 2 Allocations

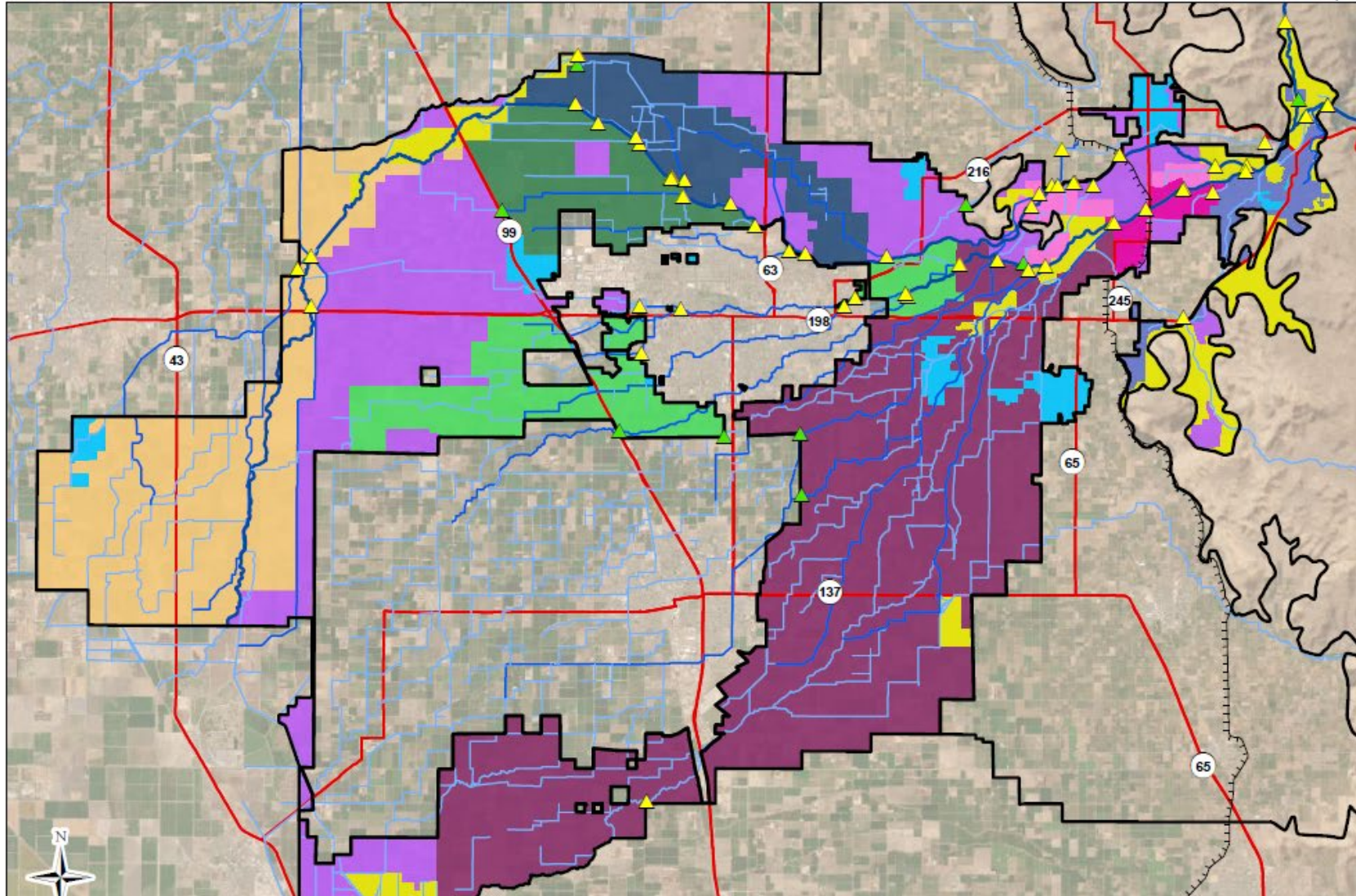
Temporary Tier 1 & Tier 2 ramp-downs allowable groundwater overdraft pumping overtime calculated by a percentage of total overdraft.

The allocations are only made available to 161,100 irrigated acres within the Greater Kaweah Management Area.

Rampdown Schedule			
Water Years	Tier 1	Tier 2	Total Allowable
2023-2025	40%	50%	90%
2026-2030	40%	30%	70%
2031-2035	20%	20%	40%
2036-2040	20%	0%	20%

Greater Kaweah GSA

13-Sep-23



Water Budget Analysis

Map Features

Water Budget Subregion (WBS) Group

- Upper Kaweah River
- Upper Lower Kaweah River
- Upper St Johns River
- North of Lower St Johns River
- South of Lower St Johns River
- Downstream of Lower Kaweah River
- South of Lower Kaweah River
- Kings River / Cross Creek Area
- Groundwater Only
- Community
- Native

- Kaweah Subbasin GSA Boundary
- Diversion, Riparian Pump, or Gage
- Ungaged Outflow (Inter-GSA or Intra-GSA)
- Major River/Stream
- Major Surface Delivery Channel
- Minor Surface Delivery Channel
- Friant-Kern Canal
- State Highway

Overdraft Scenarios for Temporary Water Allocation

To determining overdraft for the purpose of allocation Temporary Tier 1 & Tier 2 allocations, the Greater Kaweah GSA Board of Directors directed staff to calculate overdraft for the purpose of Temporary Water allocation independent of Surface Water Deliveries within the GSA.

Determining overdraft based on the circumstances of no surface water provides a better representation of overdraft that would occur on irrigated lands that do not have access to surface water, as well as overdraft that would occur on irrigated lands with access to surface water in a drought year when little to no surface water is available to offset crop demand.

The following calculation was used to determine overdraft for the purpose of Tier 1 & Tier 2 Temporary Water Allocations in the Greater Kaweah GSA:

$$[\text{Overdraft}_{irr. \text{ acreage}}] = [\text{Total Consumptive Use}_{irr. \text{ Acreage}}] - [\text{NSY}_{irr. \text{ acreage}}] - [\text{Total Precipitation}_{irr. \text{ acreage}}]$$

**The evaluation criteria was based the 24- year averages from the water year 1998/99 through water year 2021/22.*

Overdraft Scenarios for Temporary Water Allocation

➤ Irrigated Acreage that receives Temporary Allocation

- ✓ 161,100 acres

➤ Total Consumption on Irr. Acreage

- Average from 1998/99 to 2021/22
- ✓ 454,000 acre-feet

➤ Native Sustainable Yield Allocation for Irr. Acreage

- $0.65 \text{ AF/acre} * 161,100 \text{ acres}$
- ✓ 99,882 acre-feet

➤ Total Precipitation for Irr. Acreage

- $0.81 \text{ AF/acre} * 161,100 \text{ acres}$
- ✓ 130,230 acre-feet

➤ Average Irr. Acreage Overdraft w/o Surface Water

- $[454,000 \text{ AF}] - [99,882 \text{ AF}] - [130,230 \text{ AF}]$
- ✓ 223,888 acre-feet

Irrigated Acreage	Total Consumption (AF)	NSY (AF)	Total Precipitation (AF)	Overdraft (AF)
161,100	454,000	99,882	130,230	223,888

Water Year 2024 Allocatable Temporary Water			
Tier	% Rampdown	Acre-Feet	AF/Acre
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Total	1.87	AF/acre

*Total Precipitation is the **Actual Precipitation** to have occurred within the Water Year allocation year, to be calculated and reported one calendar month after actual rainfall occurs. Credits to offset ET Consumption during the Water Year can be estimated from the 1997/98 through 2017/18 water years 20-year average amounting to **0.81 AF/acre**.