

Appendix G

Phase I Water Supply Evaluation for Tulare County



APPENDIX G

Water Supply Evaluation Technical Appendix

Appendix G provides a copy of the Water Supply Evaluation Report (June 2009) prepared for the General Plan 2030 Update. This report provides the water supply information that was used to determine the adequacy of future water supply resources necessary to serve the proposed project.

TULARE COUNTY GENERAL PLAN UPDATE

PHASE 1- WATER SUPPLY EVALUATION

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Prepared by:



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Section 1 – Introduction

The Phase 1 – Water Supply Evaluation provides an initial analysis and information to support the determination of environmental impacts to water resources in Tulare County associated with adoption of the General Plan Update.

The focus of the following sections are to describe and analyze the present and future water supplies and demands in Tulare County, specifically focusing on the geographic areas of the County that comprise the vast majority of the agricultural and urban water demands. Using data readily available from the Department of Water Resources (DWR) for the Tulare County region for 1999, 2002 and 2003, as well as land use data available from various sources, including the County, this analysis provides a representation of ‘existing’ supply and demand conditions and projects ‘future’ conditions contemplated by the General Plan Update.

The document is separated into the following sections:

- ◆ **Section 2** – This section provides analysis of existing and projected demand conditions, focused primarily on the ‘valley floor’ portion of the County’s water users, and reflects the potential change in demand resulting from anticipated displacement of irrigated agricultural lands with mixed-use urban development as contemplated by the General Plan Update.
- ◆ **Section 3** – This section describes the surface and groundwater resources available to the County and qualitatively contemplates the potential issues that may affect their long-term reliability and availability.
- ◆ **Section 4** – This section integrates the water supply and demand conditions, under a defined set of scenarios, to represent the potential impact on the County’s surface and groundwater resources attributed to the General Plan Update.

Section 2 – Demand Conditions

This section provides information used to represent the existing water demand condition as well as an analysis of potential future demand conditions, based upon the land use changes contemplated by the General Plan Update.

2.1 EXISTING WATER DEMAND

Existing water demand conditions were estimated based upon planning data available from the California Department of Water Resources (DWR). DWR subdivides California into geographical study areas for planning purposes. Existing Tulare County water demand conditions were calculated based on water demand data provided by DWR at the finest level of detail available – the Detailed Analysis Unit (DAU).

The DAUs included in this water demand analysis are: Alta, Consolidated, Deer Creek, Kaweah Delta, Kaweah River, Kaweah-Tule Interstream, Kings River, Kings-Kaweah Interstream, Northeastern Kern, Orange Cove, Poso Creek, Tulare Lake, Tule Delta, Tule River, and Upper Kern River (see **Figure 2.1**). Where some DAUs straddle the Tulare County line, only the portion of the DAU inside the county boundary was considered for purposes of the water demand analysis.

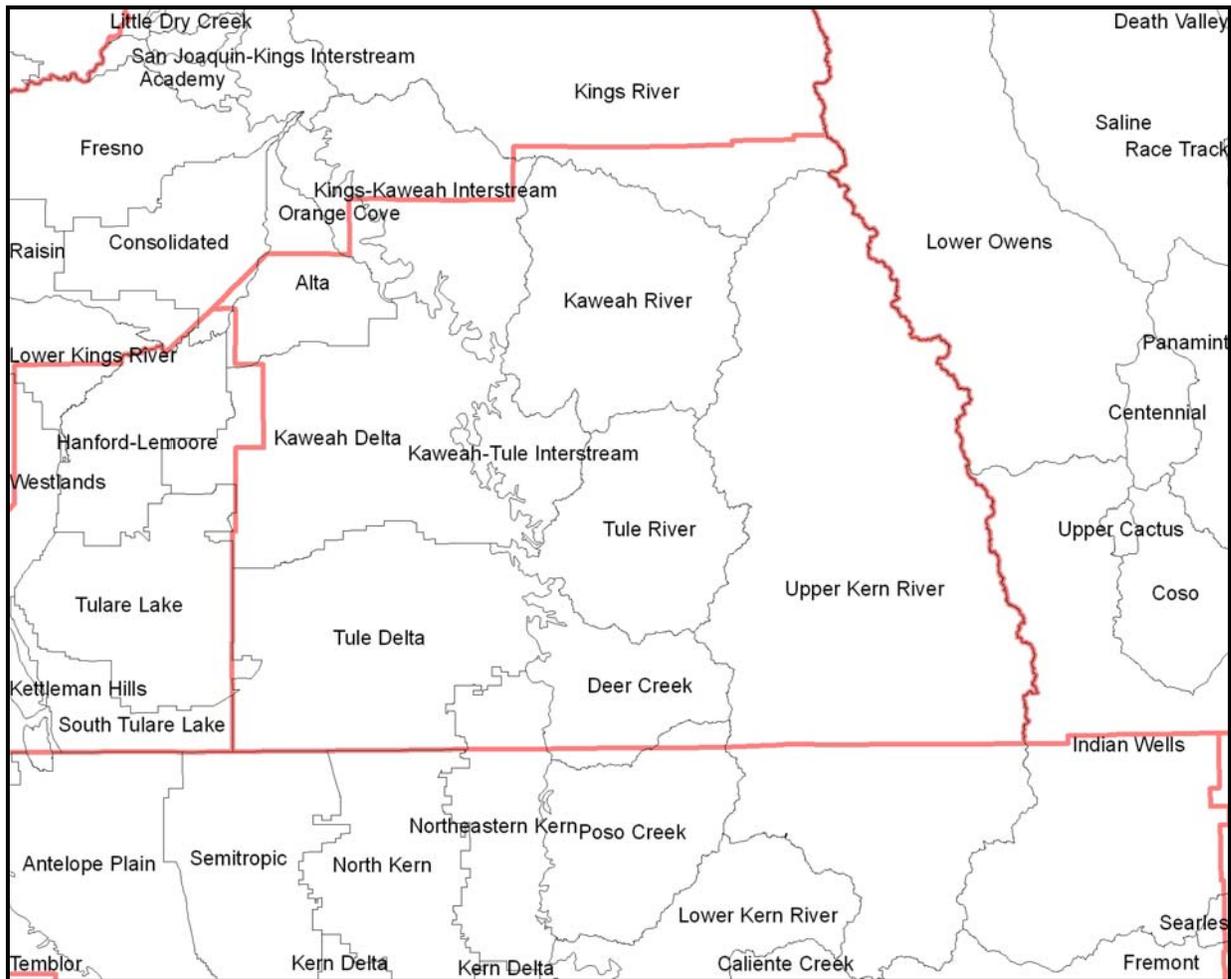
Based upon water demand data developed by DWR for the 2009 Water Plan Update, existing water demand in Tulare County is assumed to be similar to the annual demand for 2003 represented in water budgets developed by DWR for the aforementioned DAUs. For the 2009 Water Plan Update, DWR is using Water Years 1999, 2002 and 2003 to represent water demands under various hydrologic conditions. Compared to 1999 and 2002, 2003 was an average water year in the Tulare Lake Hydrologic Region and thus, assumed to be ‘average’ within Tulare County. This was determined by reviewing average historic precipitation in the City of Visalia – and comparing the average precipitation with the precipitation in 1999, 2002 and 2003. Average precipitation in Visalia is approximately 11.03 inches per year.¹ In 2003, the precipitation measured at Visalia, California was 7.49 inches.² Notably, while not approaching the average, 2002 was considerably drier (than 2003), while 1999 saw slightly more precipitation (than 2003).

¹<http://www.weather.com>.

² California Irrigation Management Information System (CIMIS) indicates that precipitation was 5.69 in. and 8.11 in. in 2002 and 1999 respectively.

Figure 2.1 – Map of DWR Detailed Analysis Units

(source: DWR)



Another indication that 2003 was an average year compared to 1999 and 2002 is that Central Valley Project deliveries to the Friant-Kern Canal contractors were significantly greater than in 2002, and still slightly less than in 1999.³ While 1999 and 2003 showed similarities in terms of precipitation and CVP deliveries, because 2003 is more current data, it was selected as the most representative of existing demands.

For each DAU, DWR calculates *Agricultural*, *Urban* and *Environmental* demands. Within the *Agricultural* demand category, DWR calculates applied water demands for both crop production and conveyance purposes. For the *Urban* demand category, DWR subdivides applied water demands by Large Landscape, Commercial, Industrial, Energy Production, Residential – Interior, and Residential – Exterior land-use categories. DWR also estimates applied water demands in the *Urban* demand category for both conveyance

³ Friant-Kern Canal deliveries were 1,091,241 AF, 770,071 AF, and 1,022,012 AF in 1999, 2002, and 2003 respectively.

and groundwater recharge. The *Environmental* demands are divided into Instream, Wild and Scenic, Required Delta Outflow, and Managed Wetlands categories. For purposes of this analysis, only the Managed Wetlands demand component will be estimated because it is the only *Environmental* demand category directly related to Tulare County land uses.

Existing water demands are presented by DAU in **Table 2.1**. For 2003, total applied water demand for the *Agricultural*, *Urban* and *Environmental* demand components described above, was 2,702,100 acre-feet. Notably, 97 percent of total demand was in the three DAUs with the majority of the high quality agricultural land – Alta, Kaweah Delta and Tule Delta. Also, 97 percent of *Urban* demand is within the same three DAUs, as the largest communities in Tulare County are located in and around the prime agricultural land.

Not only are the demands in these three DAUs important for the existing demand calculation but these same DAUs are important for the future condition demand analysis because the incorporated cities, communities and hamlets Tulare County has identified as potential urban growth areas are located on the valley floor in proximity to the productive agricultural lands.

As explained in the next subsection, a portion of the existing irrigated agricultural lands in these areas are assumed to be taken out of production and replaced with urban growth. Therefore, the future water demand analysis will focus on the change in land uses in and around these areas.

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Table 2.1 – Existing Demand Condition by Detailed Analysis Unit
 (Source: California Department of Water Resources – draft water budget data for 2003)

	Tulare Lake Tulare Co	Consolidated Tulare Co	Alta Tulare Co	Orange Cove Tulare Co	Kaweah Delta Tulare Co	Tule Delta	Kings River Tulare Co	Kings-Kaweah Interstream Tulare Co	Kaweah River Tulare Co	Kaweah-Tule Interstream Tulare Co	Tule River Tulare Co	Deer Creek Tulare Co	Poso Creek Tulare Co	Upper Kern River Tulare Co	Northeastern Kern Tulare Co	Total SJD
	DAU 241	DAU 236	DAU 239	DAU 240	DAU 242	DAU 243	DAU 222	DAU 223	DAU 224	DAU 225	DAU 226	DAU 227	DAU 228	DAU 229	DAU 257	
	Thousand Acre Feet															
Agricultural Demand																
Applied Water Use	4.7	9.6	268.6	34.3	937.1	1,162.9	0.0	4.8	0.0	0.0	4.0	0.0	0.0	0.0	26.0	2,452.0
Conveyance Applied Water Use	0.2	0.5	10.2	1.5	48	37.4	0	0	0	0	0	0	0	0	1.3	99.1
Total	4.9	10.1	278.8	35.8	985.1	1,200.3	0.0	4.8	0.0	0.0	4.0	0.0	0.0	0.0	27.3	2,551.1
Urban Demand																
AW - Residential Use - Single Family - Interior	0.0	0.1	4.3	0.1	15.8	6.6	0.0	0.1	0.2	0.1	0.3	0.1		0.0	0.1	27.8
AW - Residential Use - Single Family - Exterior	0.0	0.1	6.5	0.2	24.2	10.0	0.0	0.1	0.3	0.1	0.5	0.1		0.0	0.1	42.2
AW - Residential Use - Multi-Family - Interior	0.0	0.1	4.5	0.1	16.7	6.9	0.0	0.0	0.2	0.1	0.3	0.1		0.0	0.1	29.1
AW - Residential Use - Multi-Family - Exterior	0.0	0.1	2.7	0.1	10.0	4.1	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	17.3
AW - Commercial Use	0.0	0.0	1.6	0.0	5.8	2.4	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	10.0
AW - Industrial Use	0.0	0.0	2.3	0.1	8.3	3.4	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	14.4
AW - Urban Large Landscape	0.0	0.0	0.7	0.0	2.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
AW - Energy Production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Applied Water - Groundwater recharge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conveyance - Applied Water	0.0	0.0	0.5	0.0	1.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Total	0.0	0.4	23.1	0.6	85.0	35.1	0.0	0.2	1.0	0.3	1.6	0.3	0.0	0.0	0.3	147.9
Managed Wetlands Demand																
Applied Water Use	0	0	0	0	0	3.1	0	0	0	0	0	0	0	0	0	3.1
Total	0	0	0	0	0	3.1	0	0	0	0	0	0	0	0	0	3.1
Total	4.9	10.5	301.9	36.4	1,070.1	1,238.5	0.0	5.0	1.0	0.3	5.6	0.3	0.0	0.0	27.6	2,702.1

2.2 FUTURE WATER DEMAND

Currently, all land in the communities and hamlets, as well as the land in the Urban Development Boundary of each incorporated city is under Tulare County land-use jurisdiction. The future water demand condition assumes that Tulare County retains land-use jurisdiction over all communities and hamlets, as well as development within the Urban Development Boundary. Assuming that the County retains land-use jurisdiction, even if not ultimately the situation, the future demand estimate reflects the most conservative (highest) representation of the potential water resources impacts related to the land-use planning decisions by Tulare County.

First, to estimate the future demand condition, the land use change is analyzed. The change in land use assumes a certain number of irrigated agricultural acres are removed from production and that mixed-use urban development exists instead.⁴ The estimate of irrigated agricultural acres removed assumes that all Prime Farmland, Farmland of Statewide Importance and Unique Farmland located within the defined growth boundaries of the identified hamlets, communities and cities changes from irrigated agriculture to urban uses. The assumed values are provided in **Table 2.2**.⁵ For each acre of agricultural land removed, a commensurate reduction in the annual applied water quantity for the associated historic crop is assumed to also occur.

To estimate the change in applied agricultural water demand (i.e., acre-feet of water per acre of crop) based upon the elimination of irrigated agricultural land, a weighted unit demand was developed using an assumed crop mix, estimated crop evapotranspiration of applied water (ETAW) and assumed irrigation efficiencies. As shown in **Table 2.3**, the future demand analysis divides irrigated crops into five broad categories – Citrus, Field Crops-Other, Field Crops-Alfalfa/Pasture, Orchards and Vineyards.⁶ For each crop category an ETAW is provided.⁷ For the Field Crop and Orchard categories, ETAW is reported as the average of multiple crops in each category.

⁴ This approach was taken pursuant to conversations with Dave Bryant and Ray Weiss on May 19, 2009.

⁵ The Prime Farmland, Farmland of Statewide Importance and Unique Farmland categories were developed by the California Department of Conservation. Importantly, both Prime Farmland and Farmland of Statewide Importance are irrigated lands. Unique Farmland is usually irrigated but may include non-irrigated orchards. Importantly, the farmland categories do not include confined animal agriculture, which Department of Conservation tracks separately. Therefore, all acres identified as farmland are assumed to have a water demand.

⁶ The acreage totals were obtained from the 2003 Tulare County Agricultural Commissioner's Report. The Agricultural Commissioner's estimate for irrigated pasture was reduced significantly based upon conversations with DWR field staff, which indicated that very little "improved" irrigated grass pasture remains in Tulare County.

⁷ ETAW was obtained from the Department of Water Resources based upon field work for the 2009 California Water Plan.

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**Table 2.2
Tulare County Agricultural Land**

		Prime (acres)	Statewide Importance (acres)	Unique (acres)	Total (acres)
Communities					
	Alpaugh	0	20	0	20
	Cutler-Orosi	460	780	100	1,340
	Delano	170	0	0	170
	Ducor	10	190	0	200
	Earlimart	540	50	0	590
	East Orosi	0	90	0	90
	East Porterville	40	30	0	70
	Goshen	710	120	0	830
	Ivanhoe	60	270	0	330
	Kingsburg	5	210	0	215
	Lemon Cove	220	200	10	430
	London	110	20	0	130
	Patterson Tract	150	0	0	150
	Pixley	1,230	0	0	1,230
	Plainview	20	40	20	80
	Poplar-Cotton Center	490	20	0	510
	Richgrove	60	140	0	200
	Springville	10	10	50	70
	Strathmore	0	340	0	340
	Terra Bella	60	650	0	710
	Three Rivers	10	130	0	140
	Tipton	270	0	0	270
	Traver	0	450	0	450
	Woodville	270	0	0	270
Hamlets					
	Allensworth	0	180	0	180
	Delft Colony	10	30	0	40
	East Tulare Villa	0	0	0	0
	Lindcove	0	190	0	190
	Monson	90	60	0	150
	Seville	10	0	0	10
	Teviston	400	0	0	400
	Tonyville	0	0	0	0
	Waukena	80	0	0	80
	West Goshen	30	110	0	140
	Yettern	0	10	0	10
City UDB					
	Dinuba	2,210	1,060	0	3,270
	Exeter	1,920	530	0	2,450
	Farmersville	880	0	0	880
	Lindsay	1,810	3,420	40	5,270
	Porterville	2,770	3,760	760	7,290
	Tulare	6,620	130	10	6,760
	Visalia	20,370	970	80	21,420
	Woodlake	570	1,490	210	2,270
	TOTAL				59,645

Table 2.3
Evapotranspiration of Applied Water

Orchard	
	ETAW (in./yr.)
	Typical
Other Deciduous	33.70
Pistachios	34.68
Average	34.19
Field Crops - Pasture & Hay	
	ETAW (in./yr.)
	Typical
Alfalfa - Hay	40.33
Pasture/Range Irrigated	41.08
Average	40.71
Field Crops - Other	
	ETAW (in./yr.)
	Typical
Cotton	26.94
Corn and Grain	24.46
Average	25.70
Citrus	
	ETAW (in./yr.)
	Typical
Citrus	26.84
Vineyards	
	ETAW (in./yr.)
	Typical
Grape Vines	22.39

To generate the unit demand for each crop type, an irrigation efficiency between 70 and 80 percent was assumed, depending on typical irrigation methods for crops in each category.⁸ A weighted unit demand was then developed by multiplying the percentage of total irrigated acreage for each crop category by the unit demand. As shown in **Table 2.4**, the total weighted unit water demand factor of 3.3 acre-feet per acre was generated by adding all of the crop-specific weighted unit demand factors. Thus, it is assumed that for each acre of agricultural land that comes out of production within the designated areas of urban growth, there is a reduction in applied water demand of 3.3 acre-feet per year (prior to the commensurate increase due to the new urban demand, which is discussed later).

To estimate the reduction in agricultural demand, the weighted unit demand factor shown in **Table 2.4** is applied to each acre of agricultural land coming out of production as shown in **Table 2.2**. The estimated reduction in agricultural demand is approximately 200,000 AF/YR is shown in **Table 2.5**.

⁸ Estimated irrigation efficiencies were obtained from DWR. Actual irrigation efficiencies may be higher in many instances. However, the assumptions used in this analysis are conservative.

Table 2.4
Weighted Agricultural Unit Demand

Crop Category	2003 Acres	% of Total Acres	Estimated ETcrop (inch/ac)	Assumed Irrigation Efficiency	Unit Demand (af/ac)	Weighted Unit Demand (af/ac)
Citrus	109,363	14%	26.8	75%	3.0	0.4
Alfalfa and Pasture	104,149	13%	40.7	69%	4.9	0.7
Field Crops - Other	359,163	46%	25.7	70%	3.1	1.4
Orchards (Deciduous)	142,144	18%	34.2	80%	3.6	0.7
Vineyards	60,903	8%	22.4	74%	2.5	0.2
Total	775,722	100%				3.3

To estimate the commensurate increase in demand from the new mixed-use urban land use (that is assumed to replace the irrigated agricultural use), a weighted unit demand for the urban classification was developed. An approximate land-use mix was developed based upon review of the City of Fresno’s Urban Water Management Plan (UWMP) and professional judgment from other studies. It is assumed that residential units comprise about 60 percent of the land use in the developing urban areas, with associated land uses such as commercial, industrial, parks and public uses accounting for another 35 percent of the land uses. It is assumed that 5 percent of the land is comprised of other uses such as roads, and it is assumed that these areas are not irrigated. The unit demand factors were taken from the City of Fresno’s UWMP as well.

The residential demand factors will vary by unit density, so an assumed average figure is used to cover a range of densities in each category. The unit demand factors are consistent with observed unit demand factors in other Central Valley communities. For example, in the single-family residential category, assuming a dwelling unit density of five units per acre, the overall unit water demand factor would be 0.70 acre-feet per dwelling unit per year, including the water ‘lost’ from the system during delivery to the customer’s turnout. Assuming 10 percent of this demand is associated with system losses, unit demand would be 0.63 acre-feet per dwelling unit per year at the customer’s turnout, which is consistent with unit demands in other residential communities in the Central Valley. As shown in **Table 2.6**, the weighed unit demand factor is 3.1 acre-feet per acre.

By applying a weighed unit demand factor of 3.1 acre-feet per acre per year to the mixed-use urban land uses that are assumed to replace the irrigated lands, the resulting commensurate increase in demand is approximately 186,000 acre-feet per year (see **Table 2.5**). The difference between the existing agricultural demand and the future urban demand is about 13,000 acre-feet per year. Thus, it is assumed that there will be a slight reduction in water demand between that observed on the agricultural lands in the existing condition and that anticipated from the new mixed-use urban demands assumed in the future.

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**Table 2.5
Change in Water Demand**

		Reduced Ag Demand (af/yr)	Added Urban Demand (af/yr)	Difference (af/yr)
Communities				
	Alpaugh	-67	63	-4
	Cutler-Orosi	-4,486	4,188	-298
	Delano	-569	531	-38
	Ducor	-670	625	-45
	Earlimart	-1,975	1,844	-131
	East Orosi	-301	281	-20
	East Porterville	-234	219	-16
	Goshen	-2,778	2,594	-185
	Ivanhoe	-1,105	1,031	-73
	Kingsburg	-720	672	-48
	Lemon Cove	-1,439	1,344	-96
	London	-435	406	-29
	Patterson Tract	-502	469	-33
	Pixley	-4,117	3,844	-274
	Plainview	-268	250	-18
	Poplar-Cotton Center	-1,707	1,594	-113
	Richgrove	-670	625	-45
	Springville	-234	219	-16
	Strathmore	-1,138	1,063	-76
	Terra Bella	-2,377	2,219	-158
	Three Rivers	-469	438	-31
	Tipton	-904	844	-60
	Traver	-1,506	1,406	-100
	Woodville	-904	844	-60
		0		
Hamlets				
		0		
	Allensworth	-603	563	-40
	Delft Colony	-134	125	-9
	East Tulare Villa	0	0	0
	Lindcove	-636	594	-42
	Monson	-502	469	-33
	Seville	-33	31	-2
	Tevison	-1,339	1,250	-89
	Tonyville	0	0	0
	Waukena	-268	250	-18
	West Goshen	-469	438	-31
	Yettern	-33	31	-2
		0	0	
City UDB				
		0	0	
	Dinuba	-10,946	10,219	-728
	Exeter	-8,201	7,656	-545
	Farmersville	-2,946	2,750	-196
	Lindsay	-17,641	16,469	-1,173
	Porterville	-24,403	22,781	-1,622
	Tulare	-22,629	21,125	-1,504
	Visalia	-71,704	66,938	-4,766
	Woodlake	-7,599	7,094	-505
		-199,662	186,391	-13,271

Table 2.6
Weighted Urban Unit Demand

	% of Land Area Per Acre	Unit Factor (af/ac/yr)	Weighted Unit Demand (af/ac/yr)
SF Residential	48%	3.5	1.7
MF Residential	12%	6.0	0.7
Commercial	20%	1.9	0.4
Industrial	5%	1.9	0.1
Parks	5%	3.0	0.2
Public	5%	2.0	0.1
Other (e.g., Roads)	5%	0.0	0.0
Total	n/a	n/a	3.1

The reduction in demand also translates into a potential reduction in county-wide demand. Assuming the existing county-wide demand is 2,702,100 acre-feet, and demand is reduced by 13,000 acre-feet per year through a shift to urban uses, then future county-wide demand is assumed to be approximately 2,689,000 acre-feet per year.

On the county-wide scale, this reduction is negligible, especially when compared to overall County estimated demand determined by DWR for 1999 and 2002, which were approximately 2,602,000 acre-feet and 2,857,000 acre-feet per year, respectively. Given the range of demands across years – a factor of cropped acreage in any given year, crop types, urban variances and climatic conditions – the slight reduction in demand assumed to occur from the displacement of irrigated agricultural lands with mixed-use urban demands could be considered negligible.

For purposes of this evaluation and given the preceding analysis, the average County demand represented for 2003 is assumed to also approximate the future baseline water demand condition given the anticipated displacement of irrigated agriculture with mixed-use urban growth. For this evaluation, the future County-wide applied water demand is assumed to be 2,700,000 acre-feet per year, with 2,350,000 acre-feet the average demand for agriculture and 350,000 acre-feet the average demand for urban needs.⁹

2.3 THE EFFECT OF CONSERVATION AND DEMAND MANAGEMENT

Although efforts to conserve water within existing urban and agricultural uses have been on-going, more recent events, directives from the Governor and legislative action all indicate more conservation will be needed in the future. To reflect additional savings from long-term water

⁹ The subdivision of urban and agricultural demand reflects an estimated reduction of 200,000 acre-feet of agricultural demand, compared to the 2003 value in **Table 2.1**. A commensurate increase of 200,000 acre-feet occurs in urban demand, compared to the 2003 values in **Table 2.1**.

conservation and demand management efforts, the baseline future demand of 2,700,000 is assumed to be potentially reduced as follows:

- ◆ Urban demand is reduced by 10 percent – Implementation of 1) landscape ordinances required under State law¹⁰ (including water-budget assignments, turf use limitations, and installation of ET controllers), 2) volumetric pricing tied to meter installation, 3) compliance with best management practices (tied to participation in the California Urban Water Conservation Council or as may be required through legislation under consideration), and 4) potential mandates to reduce per-capita use by 20 percent by 2020 (as directed by the Governor in a February 2008 comprehensive water management plan) will have the effect of an average reduction across existing and to-be-built urban demands. Actual County-wide savings may exceed this estimate, but, for purposes of this evaluation, a conservative value is assumed.

- Future urban baseline (without conservation) = 350,000 acre-feet
- Future urban baseline (with conservation) = 315,000 acre-feet

- ◆ Agricultural demand is reduced by 5 percent – Agricultural land in Tulare County is already some of the most efficiently irrigated cropland in California. Driven by expensive imported contract water, high-lift groundwater pumping, and limitations on the available, managed local surface water, farmers have already implemented most of the cost-effective opportunities. Therefore, the additional savings is limited so as not to potentially overstate the actual potential.

- Future agricultural baseline (without conservation) = 2,350,000 acre-feet
- Future agricultural baseline (with conservation) = 2,230,000 acre-feet

When combined, the anticipated effects of conservation and demand management measures in the urban and agricultural sectors are assumed to result in the following County-wide demand estimates:

- Future County-wide baseline (without conservation) = 2,700,000 acre-feet
- Future County-wide baseline (with conservation) = 2,545,000 acre-feet

¹⁰ See pending *California Model Water Efficient Landscape Ordinance*, California Code of Regulations Title 23, Sections 490-495.

Section 3 – Supply Conditions

This section provides a discussion of the surface and groundwater resources available within Tulare County. A discussion of potential issues that may constrain these demands in the future is also included. This information is used to determine an existing condition as well as provide an analysis of potential future supply conditions, based upon the land use changes contemplated by the General Plan Update.

3.1 SURFACE WATER CHARACTERISTICS

The purpose of this subsection is to briefly characterize the surface water supplies in Tulare County. In short, Tulare County receives surface water supplies in approximately equal proportions from local streams and imported water from the Friant-Kern Canal and the Cross Valley Canal. Surface water planning efforts in the County address some identified issues but new challenges are emerging that may impact the overall reliability of Tulare County’s surface water.¹¹

3.1.1 Geographic Descriptions of Watersheds

Tulare County encompasses 4,863 square miles in the San Joaquin River Basin. Tulare County is primarily located within DWR’s Tulare Lake Hydrologic Region (Tulare HR).¹² The City of Visalia is the major population center in Tulare County, however it is entirely dependent on groundwater for its supply. Tulare HR imports more water than any other HR in the state.¹³ Surface water supply for Tulare County comes from local streams and rivers, and is imported through the CVP and SWP distribution systems.

3.1.1.1 Local watersheds

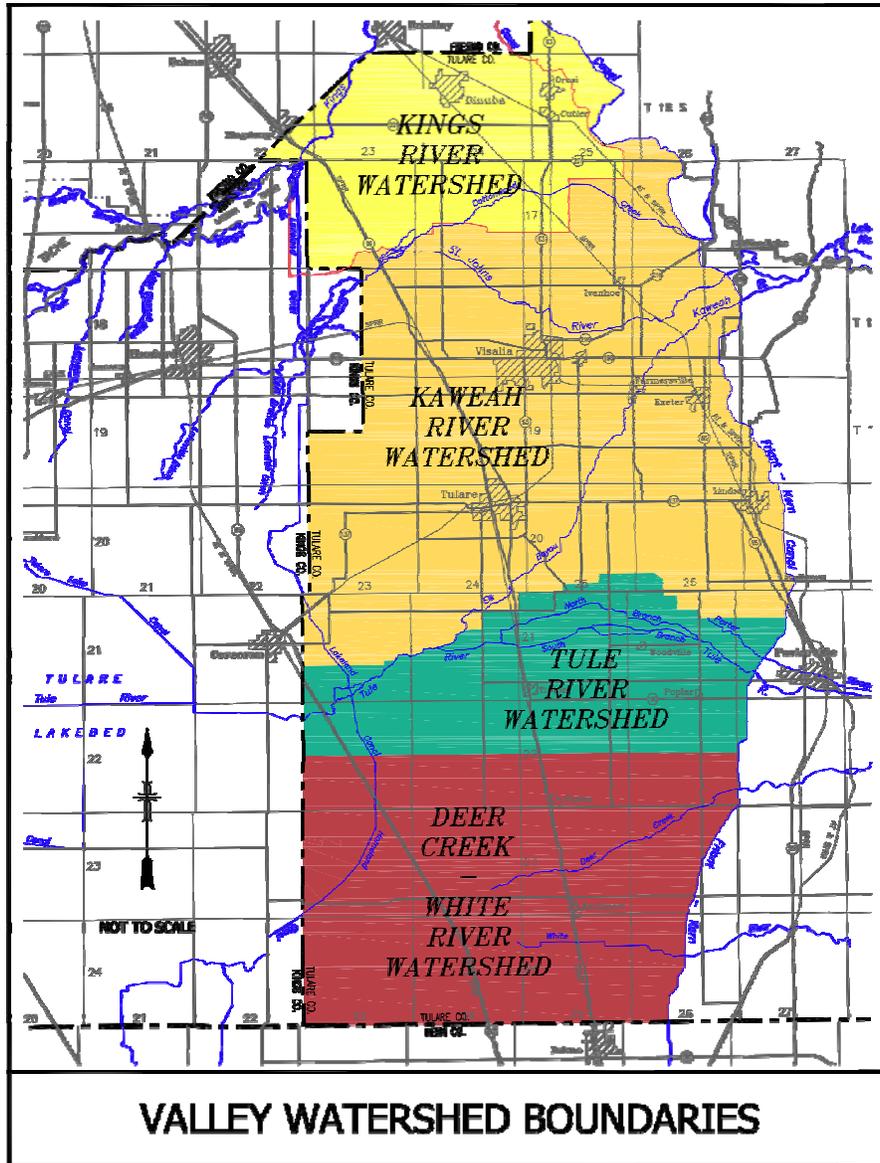
Local streams in Tulare County flow from the Sierra Nevada Mountains westwards towards the San Joaquin Valley. Tulare County General Plan defines four watersheds in the County: Kings River Watershed, Kaweah Watershed, Tule Watershed, and Deer Creek/White River Watershed (**Figure 3.1**). Water districts in the county have developed facilities consisting generally of unlined canals and gravity or low pressure pipelines to take advantage of these locally derived surface water resources.

¹¹ This analysis draws on data from several sources: The Tulare County General Plan Background Report, Chapter 10-2 “Water Resources”, December 2007 (“Chapter 10-2”); the Tulare County General Plan Background Appendix C, July 2007 (“Plan Appendix C”); DWR Bulletin 118-2003 and updated DWR subbasin information found at http://www.groundwater.water.ca.gov/bulletin118/basin_desc/basins_t-y.cfm (accessed May 31, 2009); and DWR Bulletin 160-2005.

¹² Some data, notably many of those compiled at the state level by DWR, are aggregated at the level of 10 Hydrologic Regions. Data at this level can be of limited use as these regions do not coincide with administrative or political boundaries, as in the case of Tulare County and Tulare Lake HR.

¹³ DWR Bulletin 160-2005.

Figure 3.1
Tulare County Watersheds¹⁴



The Kings River Watershed encompasses 1,742 square miles.¹⁵ Demand is primarily agricultural. The primary local water supply comes from the Kings River, through operation of Courtright Reservoir (123,200 acre-feet), Wishon Reservoir (128,300 acre-

¹⁴ Note that Figure 3.1 defines the upper boundaries of each watershed as coincident with the Friant-Kern Canal. While this definition is convenient in representing the bulk of the area to which water is supplied for agricultural and urban use, clearly the physical boundaries of each watershed are farther to the east.

¹⁵ Chapter 10-2.

feet), and Pine Flat Reservoir (1,000,000 acre-feet).¹⁶ Yearly average runoff for the Kings River is 1,689,700 acre-feet, although runoff varies greatly depending on annual climatic conditions.

The Kaweah Watershed is south of the Kings River Watershed. The Kaweah River drains 561 square miles of the Sierra Nevada Mountains, and is actually a tributary to the Tule River. The primary source of local water supply is the Kaweah River, and operations of Terminus Reservoir/Lake Kaweah. Lake Kaweah was recently enlarged to 183,800 acre-feet capacity to increase flood protection for downstream communities. Average annual runoff of the Kaweah River is approximately 430,000 acre-feet.

Farther south, the Tule River Watershed is primarily supplied by the Tule River, which drains 390 square miles above Lake Success (capacity 82,300 acre-feet). Average annual runoff of the Tule River is about 136,000 acre-feet.

The Deer Creek/White River Watershed is in the southern portion of the county. Surface supplies emanate from a low-elevation stream group. This area has the highest dependence on imported CVP water of any region in Tulare County. Camp Nelson Water Company diverts water from Belknap Creek for its supply. Springville Public Utility District owns pre-1914 water rights, including rights reserved for the eventual development of land within the district.¹⁷

3.1.1.2 Imported Water

The main source of imported water in Tulare County is the Friant Division of the Central Valley Project (CVP). Water is supplied to contractors in Tulare County through the Friant-Kern Canal (**Figure 3.1**), which runs from Friant Dam/Millerton Reservoir on the San Joaquin River (520,000 acre-feet capacity, 400,000 acre-feet useable to supply irrigation demands). The CVP supplies water to eighteen districts in Tulare County (**Table 3.1**), provided through an exchange agreement with water rights holders along the lower San Joaquin River. The San Joaquin River right holders are supplied with Delta water in exchange for letting the San Joaquin River water stored at Friant Dam to be delivered along the Friant-Kern canal.

¹⁶ Reservoir capacities from California Data Exchange Center, <http://cdec.water.ca.gov/misc/resinfo.html>, Accessed June 8, 2009.

¹⁷ Tulare County Plan Background Appendix C, C-6.

**Table 3.1
Irrigation Districts in Tulare County**

Watershed	Entity	Surface Water	Imported Water Source	Groundwater Extraction
Deer Creek/ White River	Alpaugh Irrigation District	NA	Friant-Kern Canal (1,000af average)	19,000 af
	Alta Irrigation District	King River 163,500 af/yr	Friant-Kern Canal (surplus)	230,000 af
Deer Creek/ White River	Atwell Island		50 (CVC)	
Tulare	City of Lindsay		2,500 (CVP); 50 (CVC)	
Deer Creek/ White River	Delano- Earlimart Irrigation District	NA	Friant-Kern Canal (146,050 af average)	8,000 af
Kaweah	Exeter Irrigation District	NA	Friant-Kern Canal (1,000 af average)	14,000 af
Deer Creek/ White River	Frasinetto Farms		400 (CVC)	
Kings	Hills Valley Irrigation District	NA	Cross Valley Canal (2,000 af average)	1,000 af
Kaweah	Ivanhoe Irrigation District	Kaweah River	Friant-Kern Canal (11,650 af average)	15,000 af
	Kaweah Delta Water Cons. District	Kaweah River	Friant-Kern Canal (24,000 af average)	130,000 af
Deer Creek/ White River	Kern-Tulare Water District	Kern River	Cross Valley Canal (41,000 af average)	33,000 af
Tulare	Lindmore Irrigation District	NA	Friant-Kern Canal (44,000 af average)	28,000 af
	Lower Tulare River Irrigation Dist.	Tule River	Friant-Kern Canal (180,200 af average) Cross Valley Canal (31,000 af average)	NA
Tulare	Lindsay- Strathmore Irrigation District	NA	Friant-Kern Canal (24,150 af average)	NA
Kings	Orange Cove Irrigation District	NA	Friant-Kern Canal (39,200 af average)	30,000 af
	Pioneer Water Irrigation District	Tule River		3,000 af

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Tulare	Pixley Irrigation District	NA	Friant-Kern Canal (1,700 af average) Cross Valley Canal (31,000 af average)	130,000 af
Tulare	Porterville Irrigation District	Tule River	Friant-Kern Canal (31,000 af average)	15,000 af
Deer Creek/ White River	Rag Gulch Water District	Kern River	Friant-Kern Canal (3,700 af average) Cross Valley Canal (13,300 af average)	
Tulare	Saucelito Irrigation District	Tule River	Friant-Kern Canal (37,600 af average)	15,000 af
Kaweah	Stone Corral Irrigation District	NA	Friant-Kern Canal (10,000 af average)	5,000 af
Deer Creek/ White River	Styro-Tek		45 (CVC)	
Tulare	Teapot Dome Irrigation District	NA	Friant-Kern Canal (5,600 af average)	
Deer Creek/ White River	Terra Bella Irrigation District	NA	Friant-Kern Canal (29,000 af average)	2,000 af
Kaweah	Tulare Irrigation District	Kaweah River	Friant-Kern Canal (100,500 af average)	65,000 af
Source: Bookman-Edmonston Engineering Inc. Water Resources Management in the Southern San Joaquin Valley, Table A-1.				

The Cross Valley Canal transfers water from the California Aqueduct to the east side of the San Joaquin Valley near Bakersfield. A complex series of conveyance and exchange agreements allows water to be swapped between the Arvin-Edison Water Storage District and five entities in Tulare County that contract for water from Shasta Dam and Reservoir. Water delivered from the Delta via the Cross Valley Canal to the Arvin-Edison Water Storage District is exchanged for a portion of Arvin-Edison’s CVP water supply. The reliability of deliveries from the SWP sources may impact the exchange arrangements with CVP users.

3.1.2 Surface Water Yields

The purpose of this section is to describe in general terms yields from local and imported surface water sources. In the baseline year 2003, Tulare County local and imported surface water supplies, as well as reused surface water supplies, were approximately

1,069,000 acre-feet. The remaining water supplies include groundwater and deep percolation of groundwater, which are discussed more specifically in Section 3.2.3.¹⁸

Table 3.2 describes local and imported surface water supplies and reused water supplies by watershed in Tulare County for the baseline year of 2003.^{19,20} Imported water and local supplies account for similar proportions of surface water deliveries in Tulare County, but this varies by watershed.

Kaweah Watershed has the greatest yields of local supplies in the County, and thus relies less than the other watersheds on groundwater and contract deliveries. The Kings Watershed is least reliant on imported supplies as surface flows out of the Kings River are generally plentiful. Of the Tulare County watersheds, lands in the Tule Watershed are the most reliant on imported contract water (from a percentage basis).

**Table 3.2
Water Deliveries by Source, 2003**

Water deliveries by source, TAF						
	Kings	Kaweah	Tule	Deer Creek- White River	Upper	Total
Local supplies	114.3	322.7	58.4	1.4	0.0	496.8
CVP and SWP Contract Deliveries	15.4	188.9	341.3	0.7	14.5	560.8
Other (Reused Surface Water)	1.4	7.2	2.8	0.0	0.0	11.4
Total	131.1	518.8	402.5	2.1	14.5	1069.0

3.1.2.1 Local Streams

Alta Irrigation District delivers the full yield of the Kings River to end users. Deliveries to Alta ID were 114,000 acre-feet in 2003,²¹ and annual deliveries average 163,500 acre-feet.²²

Deliveries from the Kaweah River to irrigation districts in Tulare County were 323,000 acre-feet in 2003,²³ and the river has an average annual yield of 430,009 acre-feet.²⁴

The average historical annual yield of the Tule River is 141,960 AF,²⁵ and the entire yield is typically put to use within the Tule River Watershed.²⁶

¹⁸ Source: DWR 2003 water budget for Tulare County.

¹⁹ DWR includes instream flows and managed wetlands supplies in the category Reused Surface Water. For purposes of the Water Supply Evaluation, only the managed wetlands supplies are included because the Water Supply Evaluation is considering water demands and supplies associated with land applications of water. Notably, Table 3.2 does not contain substantial environmental flows in the “Upper” watershed categorized by DWR as Reused Surface Water. Data source: DWR.

²⁰ “Upper” watersheds refer to areas outside those watersheds defined by Tulare County, as described in the text. Data source: DWR.

²¹ DWR 2003 water budget for Tulare County

²² Tulare County Plan Background Appendix C, p. C-7.

²³ DWR 2003 water budget for Tulare County

²⁴ Tulare County Plan Background Appendix C, p. C-9

Deer Creek and White River have only limited and intermittent surface water flows.

3.1.2.2 Imported water

Contracts with the Friant Division of the CVP are very significant for contractors within Tulare County. Class 1 water is the first 800,000 acre-feet of ‘firm’ Friant supply, from which contractors in the County receive a total of 404,900 acre-feet per year.²⁷ Class 2 supplies start to develop after all Class 1 contracts have been filled and total 565,200 acre-feet per year in the County.²⁸ Class 1 supplies are thus much more reliable than Class 2 supplies. CVP facilities statewide deliver their full contract allocations only 20 percent of the time. Tulare County CVP Contractors may also receive “221 Water” which is water available through the CVP system in times of surplus.

Cross Valley Canal deliveries bring up to 128,300 acre-feet of additional water into the region.

Table 3.1 describes in greater detail the contract amounts in each watershed.

3.2 GROUNDWATER CHARACTERISTICS

The purpose of this section is to briefly characterize the groundwater supplies in Tulare County. Historically groundwater resources have been extracted to satisfy about one third of existing urban and agricultural demands, but are limited by groundwater basin yield in some locations and water quality issues in others. Groundwater planning efforts in the County address some identified issues but new challenges are emerging that may impact the overall reliability of the County’s groundwater supplies.

3.2.1 Geographic and Hydrogeologic Characteristics

Tulare County encompasses 4,863 square miles in the San Joaquin Valley. This analysis focuses on the western portion of the county that overlies the aquifers discussed below. As noted previously, Tulare County is primarily located within DWR’s Tulare Lake Hydrologic Region (Tulare HR).²⁹ The City of Visalia is the major population center in Tulare County, and is entirely dependent on groundwater for its supply.

Tulare County has unconfined groundwater throughout the entire county, and confined groundwater in its western portion underlying the Kings, Kaweah, and Tule Subbasins.

²⁵ Tulare County Plan Background Appendix C, p. C-14

²⁶ Tulare County Plan Background Appendix C, p. C-14

²⁷ Tulare County Plan Background Appendix C, p. C-25, and see tables

²⁸ Tulare County Plan Background Appendix C, p. C-25, and see tables.

²⁹ Some data, notably many of those compiled at the state level by DWR, are aggregated at the level of 10 Hydrologic Regions. Although these data may be the best available on some topics, data at this level can be of limited use as these regions do not coincide with administrative or political boundaries as in the case of Tulare County and Tulare Lake HR.

Areas near the King, Kaweah, and Tule Rivers contain highly permeable soils with opportunities for natural and artificial recharge, while the areas between the alluvial fans have less permeable soils. Alluvial deposits containing fresh water commonly exceed 1,000 feet in depth, with the maximum thickness of deposits in the southern end of the San Joaquin Valley at 4,400 feet. An important structure is the Corcoran Clay layer, which can be found in the Kaweah and Tule Subbasins. Where present, this layer restricts water movement, dividing groundwater into a confined layer below the Corcoran Clay and an unconfined layer above it.

Tulare County is primarily underlain by three groundwater subbasins within the San Joaquin Valley basin.³⁰ These subbasins are Kings (5-22.08), Kaweah (5-22.11) and Tule (5-22.13), as defined by DWR. Figure 3.3 shows Tulare County in the context of the State's aquifers.

The Kings Subbasin underlies 976,000 acres of Fresno, Kings, and Tulare Counties, and is roughly bounded on its southern end by the Kings River Watershed boundary.³¹ The bulk of this subbasin underlies Fresno County, including the City of Fresno. In the Kings Subbasin, groundwater flows from areas underlying Fresno County into aquifers underlying the Kings River area. Well yields in the Kings Subbasin average 500-1,500 gallons per minute (gpm), with a maximum of 3,000 gpm, and an average depth of 210 feet.

The Kings Subbasin is a "Type C," or low level of knowledge, basin, indicating that there is not enough data to estimate its groundwater extraction or a groundwater budget.³² Estimates of specific yields for the basin ranges from 0.2 percent to 36 percent, with a recent estimate of 11.3 percent on average.³³

The Kaweah Subbasin underlies 446,000 acres, primarily in Tulare County, with its western portion underlying Kings County. Within Tulare County, the Kaweah Subbasin coincides with the Kaweah River Watershed. Well yields in Kaweah Subbasin average 1,000-2,000 gallons per minute (gpm), with a maximum of 2,500 gpm, with well depths ranging from 100-500 feet. The estimated average specific yield for this subbasin is 10.8 percent.³⁴

³⁰ DWR Bulletin 118-2003, and see **Figure 3.3**. Note that these basin designations may not be based on detailed local study.

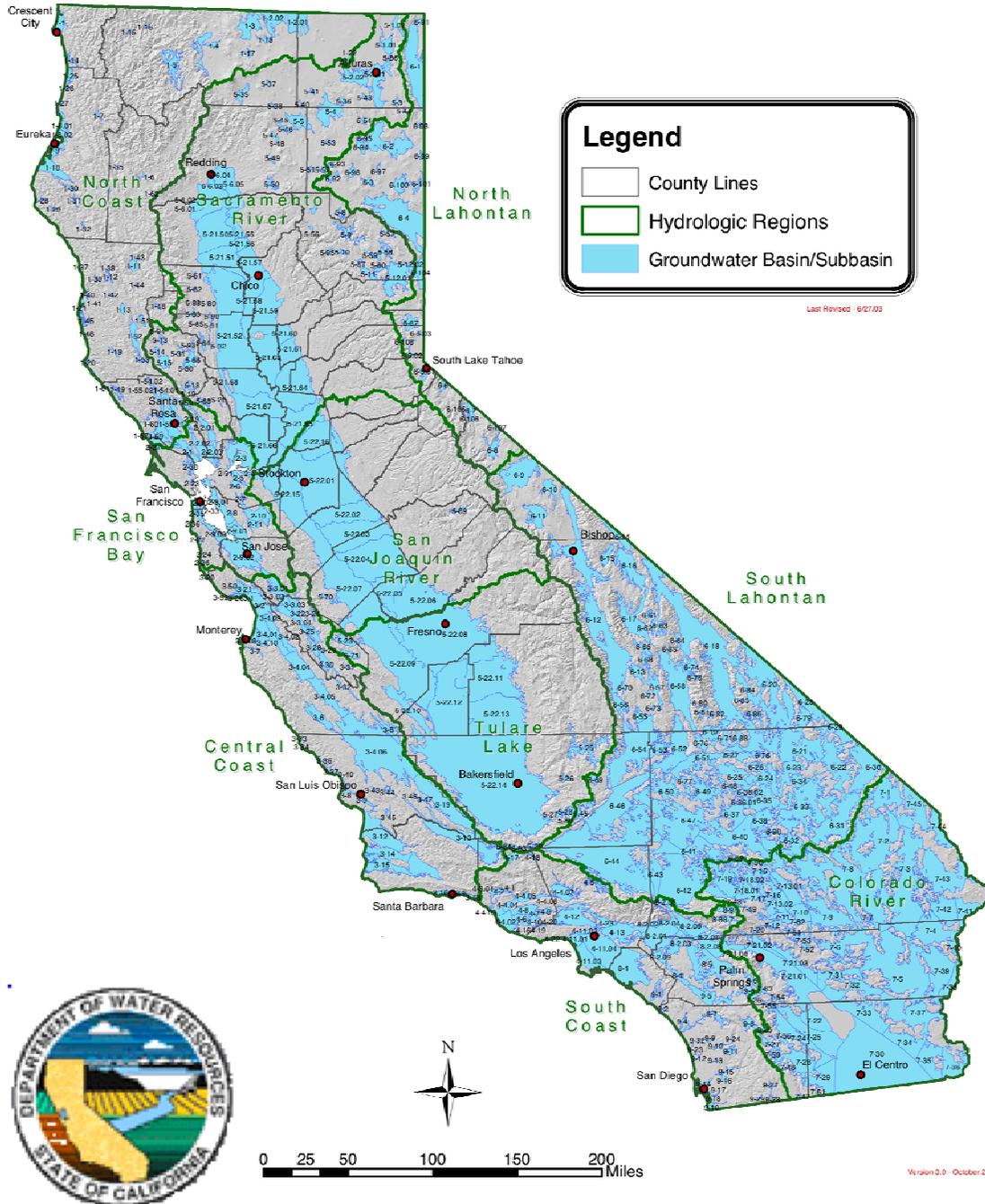
³¹ Watershed boundaries referred to here are as described in the Tulare County General Plan, and shown in **Figure 3.1**.

³² See DWR Bulletin 118-2003, p. 110 for category descriptions.

³³ DWR Bulletin 118, Kings Subbasin Update, 1/20/06.

³⁴ DWR Bulletin 118, Kaweah Subbasin Update, 2/27/04.

Figure 3.3³⁵
Groundwater basins in California.



³⁵DWR Bulletin 118-2003.

The Kaweah subbasin has a “Type B” level of groundwater balance knowledge, indicating a use-based estimate of its groundwater budget. The Kaweah River is the major source of recharge to the area. DWR estimates natural recharge to be 62,400 acre-feet per year. There are approximately 286,000 acre-feet of applied water recharged into the subbasin, and an unknown amount of artificial recharge. Annual urban and agricultural extraction is estimated to be 58,800 acre-feet and 699,000 acre-feet, respectively. Other extractions and subsurface inflow were not determined.

The Tule Subbasin is in the southwestern portion of Tulare County, underlying 467,000 acres. Within Tulare County, the Tule Subbasin coincides with the Tule River, Deer Creek and White River watersheds. There are hydrogeologic connections between Tulare County and Kern and/or Kings Counties adjoining Tule Subbasin.³⁶ The estimated average specific yield for this subbasin is 9.5 percent.³⁷ Land subsidence of 12 to 16 feet has occurred in the subbasin in the past. Maximum well yields in the Tule Subbasin are 3,000 gpm, with average yields not reported.

Tule Subbasin has a “Type B” level of groundwater balance knowledge. Natural recharge is estimated at 34,000 acre-feet per year, and there are about 201,000 acre-feet of applied water recharge. Annual urban extraction is estimated to be 19,300 acre-feet per year, and annual agricultural extraction was estimated to be 641,000 acre-feet per year. Other extractions and subsurface inflow and outflow were not determined.³⁸

In the Foothills region outside of these defined Subbasins, groundwater is also used, with extractions primarily derived from unconfined aquifers. In the eastern portion of the county in the Sierra Foothills, wells are less productive as the groundwater aquifer characteristics are less suitable to large-scale groundwater storage. Specifically, moving into the foothills the permeable and loamy soils give rise to fractured rock aquifers. Nevertheless, in certain areas communities have been successful in harnessing groundwater from these types of aquifers.

Figure 3.4 shows the enumerated groundwater sub-basins underlying Tulare County.

³⁶ The Tule Subbasin is probably at least partially defined based on political, rather than hydrogeologic characteristics. A small portion of Tulare Lake Subbasin (5-22.12) underlies Tulare County, but is not detailed in this analysis.

³⁷ DWR B118, Tule Subbasin Update, 2/27/04.

³⁸ DWR Bulletin 118, Tule Subbasin Update, 2/27/04.

Figure 3.4³⁹
Groundwater Subbasins - Tulare Hydrologic Region



³⁹ DWR Bulletin 118-2003.
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3.2.2 Overview of Groundwater Quality

Detailed discussion of groundwater quality is beyond the scope of this effort, but below is a general overview of groundwater quality in Tulare County. In most areas of Tulare County, groundwater quality is acceptable for agricultural and urban uses through normal treatment and delivery operations. Where local impairments exist, the primary constituents of concern are high TDS, nitrate, arsenic, and organic compounds such as herbicides, pesticides and fertilizers, as well as instances of radiological parameters such as uranium and radium 228. However, these are not of significant concern across most of the subbasins.

The salinity of groundwater typically increases in a westward direction across the San Joaquin Valley. Conversely, nitrates and radiological components present near the Sierra foothills region decrease with distance from the Foothills.

The Kings Subbasin's groundwater near the Sierra foothills may be high in nitrates and sometimes radiological contaminants, and there are localized instances of pesticide impairment.⁴⁰ Farther from the foothills, naturally occurring contaminants are diluted by surface water recharge, and replaced with organic contaminants. All communities in the Kings Subbasin are influenced by water quality issues to some extent.⁴¹

The Kaweah subbasin has high nitrate areas on its eastern side where TDS values typically range from 300-600 mg/L.

The Tule Subbasin has some of the most significant issues in the County, with chlorides, nitrates, and DBCP extending several miles from the Sierra foothills including beneath the City of Lindsay. Water quality in this area is variable. Communities along the Highway 99 axis have access to good quality deep and shallow sources, while water quality in other areas is unacceptable due to arsenic and other naturally occurring contaminants. Arsenic is a locally specific problem. For example, several communities, such as Alpaugh, had wells brought into noncompliance when Maximum Contaminant Levels for arsenic were reduced from 50 ppb to 10 ppb.

3.2.3 Groundwater use and overdraft in Tulare County

As mentioned in Section 3.1.2, Tulare County relies on a combination of local surface water, imported surface water, and groundwater to meet its agricultural and urban demands. Groundwater is particularly important as a water source in the region. DWR classifies groundwater supplies according to two distinct categories. The first is *Net Groundwater* and the second is *Deep Percolation of Surface and Groundwater*. Net

⁴⁰ DWR B118, Kings Subbasin Update, 1/20/06.

⁴¹ Plan Appendix C, C-8.

Groundwater is the remainder of Total Groundwater Supply (calculated based upon groundwater withdrawals) and Deep Percolation of Surface and Groundwater. Deep Percolation of Surface and Groundwater is a distinct supply that ultimately resides in the groundwater basin, but originates as applied water from both surface and groundwater sources prior to percolation into the basin. Thus, the baseline groundwater supply is assumed to be the combination of these two sources, which for 2003 was about 1,633,000 acre-feet.

Table 3.2
Water Deliveries by Groundwater Source

Water deliveries by source, TAF						
	Kings	Kaweah	Tule	Deer Creek- White River	Upper	Total
Groundwater (Net)	111	226	462	3	14	815
GW (Deep Perc. of Surface and GW)	107	326	374	0	12	818
Total	218	551	836	3	25	1633

Groundwater has historically accounted for 41% of total water supply in Tulare HR, among the highest percentages in the State.⁴² In addition, the sum total use of groundwater in Tulare HR is higher than the total groundwater use in any other HR. The Kings, Tule, and Kaweah Basins were all among 11 basins identified by DWR in 1980 as being in a ‘critical condition of overdraft’.⁴³

Groundwater pumping increases in Tulare County when surface supplies available to the County are reduced. Surface water supplies have been reduced in recent years due to drought, environmental restrictions, and other factors (see **Section 3.3** below).

Estimates of groundwater overdraft vary for the Tulare Lake HR. Total overdraft has been recently estimated at 820,000 acre-feet per year,⁴⁴ while historical overdraft has been estimated at 308,000 acre feet per year for the period 1921-1993.⁴⁵ DWR estimated changes in groundwater storage for the Tulare HR over a range of recent water year types as +263,000 acre feet in 1998, -1,625,000 acre-feet in 2000, and -4,115,000 acre feet in 2001.⁴⁶

⁴² DWR Bulletin 118-2003, Table 12, p. 113.

⁴³ Water Code §12924. ‘A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.’ (DWR Bulletin 118-2003, p. 98). As of 2003, this determination has not been revisited.

⁴⁴ Chapter 10-2, citing DWR.

⁴⁵ U.S. Bureau of Reclamation (1997) Central Valley Project Improvement Act, Draft Programmatic Environmental Impact Statement. Documents and Model Runs. USBR, Sacramento, CA, as cited in Harou, J. and J. Lund (2008). "Ending groundwater overdraft in hydrologic-economic systems." *Hydrogeology Journal* **16**(6): 1039-1055.

⁴⁶ DWR Bulletin 160-2005, p. 8-7.

In Tulare County, groundwater yields tend to increase with distance from the foothills. However, since demands for groundwater increase as well, groundwater overdraft also tends to increase in the westward direction.⁴⁷

Subsidence has occurred in various parts of the County. In the Kaweah Subbasin, subsidence of up to 4 feet has occurred due to compaction.

In response to such overdraft, there are at least 19 entities in Tulare County with active groundwater management programs.⁴⁸ Among the larger programs are those administered by the Kaweah Delta Water Conservation District, the Kings River Water Conservation District, the Tulare Irrigation District, the Lower Tule Water Users Association, and the Alta Irrigation District, and the Kings River Water Conservation District.

3.3 ISSUES AFFECTING SUPPLIES

Section 3.3 describes specific issues affecting surface water and groundwater supplies in Tulare County that could have an impact on land-use planning decisions over the 20 year planning period. These issues include: Groundwater Overdraft; the San Joaquin River Restoration Settlement; Population Growth within and near Tulare County; Joint Management of Shared Aquifers; Groundwater Adjudications; Water Transfers and Exchanges; Delta Supply Issues; Climate Change and Variability; and Institutional Changes to the Water Regulatory Framework, .

3.3.1 Groundwater Overdraft

As described in previous sections, the groundwater basin in the Tulare Lake HR has experienced substantial overdraft. In addition to depletion of water faster than it can be naturally or artificially recharged, declining water tables can impact the basin as a resource. Impacts can include (i) increased pumping expenses, (ii) impacts to water quality, and (iii) subsidence that can in some cases permanently decrease the storage capacity of the aquifer. Thus, overdraft itself can have effects beyond depletion of an existing quantity of water, but also can impact the ability to use the basin as a storage facility. The future value of such storage capacity in California is potentially very high, and should be taken into account in today's groundwater management. It should also be noted that such impacts are not limited to the portions of the basin directly underlying the water user responsible for the overdraft, but can impact neighboring users as well.

⁴⁷ Plan Appendix C.

⁴⁸ Chapter 10-2.

3.3.2 San Joaquin River Restoration Settlement

The San Joaquin River Restoration Settlement (SJR Settlement) could lead to decreased flows in the Friant-Kern Canal, resulting in reduced imported surface water supplies to some CVP contractors in Tulare County (see **Table 3.1**). One of the main purposes of building the Friant-Kern Canal was to reduce groundwater pumping in the southern San Joaquin Valley. As such, to the extent that these surface supply reductions cannot be compensated for by increased water use efficiency, water users may increase groundwater pumping in the region. The result may be exacerbation of existing declining water tables or initiation of overdraft where an aquifer was previously in a general balanced condition. Though the specific impact to Tulare County CVP contractors from the SJR Settlement is not fully understood (e.g. the SJR Settlement calls for mitigation, but will require substantial time and investment), this analysis cannot speculate on any reduction in surface water resources that would be directly attributable to the SJR Settlement.

3.3.3 Population Growth Within and Near Tulare County

Cities in the region, including Visalia, Exeter, Fresno, Bakersfield, and others, rely on groundwater for much or all of their water supply. Increases in urban water demand resulting from population growth may be offset by decreases in other forms of water use (i.e. agricultural water conversion) or increases in water use efficiency. But the nature and extent of agricultural water conversion and water use efficiency measures is not known. Moreover, the hydrogeologic implications of increased localized pumping in groundwater basins (i.e. the potential for cones of depression) are not known. Current regional trends suggest that future urban growth may rely on groundwater supplies to meet demand.

In addition to its increase in demands for groundwater, urbanization may negatively affect groundwater recharge. Urbanization generally reduces the amount of permeable surfaces for percolation of water into underlying basins. Urban planning efforts that include development of permeable surfaces in urban settings, infiltration basins, and other measures for stormwater capture can offset such effects, while providing flood control benefits. Nevertheless, the extent and impacts of future urban growth in Tulare County on natural groundwater recharge is not fully known and should be considered in future planning efforts.

3.3.4 Joint Management of Shared Aquifers

Declining groundwater levels adjacent to Tulare County can affect groundwater yields and sustainability in Tulare County. Any development or management in adjacent counties that overly shared subbasins may adversely impact Tulare County's ability to manage its own groundwater supplies.

The importance of managing groundwater across political boundaries in this region has been recognized. For example, an Integrated Regional Water Management Plan for the Kings River Basin acknowledges the need for collaboration between Fresno, Kings, and Tulare Counties, and includes recharge efforts to help mitigate for historic overdrafting of the basin.

3.3.5 Groundwater Adjudications

Although hydrologic connections between surface water and groundwater are well-documented, California groundwater law is for the most part separate from surface water law. Landowners overlying groundwater aquifers may drill wells and extract water for use on their land, correlative to neighboring landowners. Where surplus groundwater supplies are available, groundwater may be appropriated for use on non-overlying lands. Most agricultural extractions are considered overlying use while urban extractions are generally considered groundwater appropriations.

Conflicts over the nature and extent of groundwater use can result in lawsuits that force adjudication of a groundwater basin. In such cases, a court determines how much groundwater each owner can extract, and enforces limitations on each user's water allocations. An adjudication process within any of the subbasins in the County could impact supplies available to manage for existing and anticipated demands.

3.3.6 Water Transfers and Exchanges

As patterns of demand change in Tulare County, both spatially and with respect to classes of use, water transfers and exchanges may become increasingly important. As described above, water exchange arrangements already provide some imported water supplies to the County. Short-term transfers negotiated on the spot market currently make up the bulk of water transfers in the state, and can be an effective solution to drought conditions. However, reducing the long-term risk of drought-induced water shortfalls may necessitate the increase of longer-term agreements such as dry-year options that are triggered by specific water conditions. Challenges in water transfers are largely institutional: they include the need for better quantification and monitoring of water rights, the need to document and alleviate third-party impacts, and the need to streamline the water transfer process. Expanding the potential for transfer and exchanges in Tulare County may expand the portfolio of water supplies available to the County – thereby improving overall water supply reliability when some sources decline. In contrast, if locally generated water resources are allowed to transfer outside of the County, an impact to the overall availability and reliability of water for County needs could result.

3.3.7 Delta Supply Issues

Delta water issues have broad implications throughout the state of California – even to areas that seem far removed from its locale. In Tulare County, water supplies are derived directly from the San Joaquin River via the Friant-Kern Canal and the Sacramento-San Joaquin Delta via the California Aqueduct and Cross Valley Canal through exchange arrangements with State Water Project water users. Any change to the water distribution systems in the Delta has immediate impact on the reliability of surface deliveries in Tulare County. The complex legal framework links deliveries of San Joaquin water directly to deliveries from the Delta.

For instance, the San Joaquin River Basin Exchange Contractors hold contract rights with the United States Bureau of Reclamation to replace the Contractors' San Joaquin River water rights with water exported from the Sacramento-San Joaquin Delta in order to build and use Friant Dam. If USBR is unable to deliver Delta water to the Exchange Contractors, the Exchange Contractors may call for the water to be released from Friant Dam under the terms of their contracts, assuring their water supply but impacting Friant Division CVP contractors in Tulare County. Accordingly, issues affecting Delta exports have direct impacts on the water supply reliability issues in Tulare County.

3.3.8 Climate Change and Variability

Climate change will affect California's water resources through changes in precipitation patterns⁴⁹ and through temperature warming that will change the seasonal patterns of streamflow around which California's water resources system has been developed.⁵⁰ California's water system depends on the storage of water in three different ways: seasonal snowpack that delays runoff from winter precipitation until later in the water year when demands are higher; surface storage in the form of dams, lakes and reservoirs; and groundwater percolation and storage.

While there is growing consensus among scientists and water managers that climate change will impact water systems, the implications of climate change on these three classes of reservoirs are understood with varying levels of clarity. First, it is understood with high confidence that results of temperature modeling consistently suggest that California's snowpack will decrease in coming decades, resulting in earlier patterns of runoff.

Second, it is very likely that operations of California's surface water system will be affected from both the increased difficulty of balancing flood control and water storage,

⁴⁹ Seager, R., M. Ting, et al. (2007). "Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America." *Science* **316**(5828): 1181-1184.

⁵⁰ Vicuna, S. and J. Dracup (2007). "The evolution of climate change impact studies on hydrology and water resources in California." *Climatic Change* **82**(3): 327-350.

increasing the risk of sub-optimal use of storage. Also, increasing demands may be expected based on higher ET requirements or changed cropping patterns.

Third, there are reasons to expect that climate change may impact groundwater even though the direct climate connection is less well-understood.⁵¹ For example, changes in patterns of recharge are expected to result from changes in runoff patterns. However, the expected runoff change only increases the flow during existing peak recharge periods, so capturing of the additional runoff may be challenging. Climate change may also alter demands for groundwater indirectly, through changes in demand for and supply of surface water.

3.3.9 Institutional Issues Affecting Water Supplies

The purpose of this section is to briefly note some institutional factors, including legal, regulatory, and legislative, that may impact both groundwater and surface water supplies in Tulare County over the coming decades.

3.3.9.1 Potential changes in California Groundwater Law

The potential also exists for future legislation to change California's groundwater regulations, and if so might change the way groundwater is used in Tulare County and elsewhere.⁵²

Other states have recognized the potential for problems arising from lack of groundwater management. The Arizona legislature, for example, implemented policies in the 1980s and 1990s to quantify rights to use groundwater supplies and to store groundwater. Colorado has integrated rights to pump groundwater with surface water rights doctrine, and has a watershed-based system of regional water governance, as opposed to California's reliance largely on local decision-making.

The point of describing other legal frameworks is to highlight the fact that there are other ways of managing groundwater and surface water, and to point out that the law evolves over time. If future legislation changes the way groundwater and surface water are regulated in California, it could change the way the resource can be used in Tulare County.

⁵¹ Dettinger, M. D. and S. Earman (2007). "Western ground water and climate change—Pivotal to supply sustainability or vulnerable in its own right?" Association of Ground Water Scientists and Engineers Newsletter **June 2007, 4-5.**

⁵² Groundwater depletion can have long-term adverse impacts not only on the basin directly underlying a groundwater user, but also on neighboring property owners. Thus, an unregulated groundwater basin can result in a 'tragedy of the commons' where the resource as a whole is impacted because it is not managed for the collective good. Such commons problems can be seen as motivation for increased regulation.

3.3.9.2 Regulatory Risk

The term “regulatory risk” when used by drinking water purveyors refers to the uncertainty in future regulations. For example, risks to the acceptability of drinking water quality in a given water source can be brought on not by changes in the quality of the water supply itself, but by tightening of drinking water standards, or by uncertainty in the impacts of regulation.⁵³ Trends towards more restrictive water quality standards may continue in future, possibly rendering existing sources of water unusable for some purposes.

3.3.9.3 Water Supply and Use Legislation

In recent years, policies have been introduced to mitigate increasing water use in the State. One pending example is DWR’s 20 x 2020 program, which seeks to reduce per capita urban water use by 20% across the state per the February 2008 directive from the Governor. While legislation is still pending, if passed it will affect demand trajectories. Naturally, urban demands are a function of efficiency and population, so population growth greater than 20% could outstrip potential total demand reduction benefits from efficiency measures, resulting in continued increased demand and groundwater impacts. But the rate of decline may be slowed or reversed by such legislation, at least in the short term. Similarly, there has been increasing attention in California towards connections between land use change and water supply.⁵⁴ For example, a water purveyor must prove that it has sufficient water to meet the demands of a development that has 500 units or more. Such trends in water planning and management are likely to continue as the fresh water resources become more scarce.

3.4 SUMMARY OF WATER SUPPLIES

The baseline water supplies generally include surface and ground water. Specifically, surface water supplies include imported and local supplies as well as reused surface water (primarily managed wetlands applications). Also, groundwater includes both net groundwater and deep percolation of surface and ground water. Based on the analysis in Section 3, the baseline (2003) supply condition used in Section 4 assumes the following:

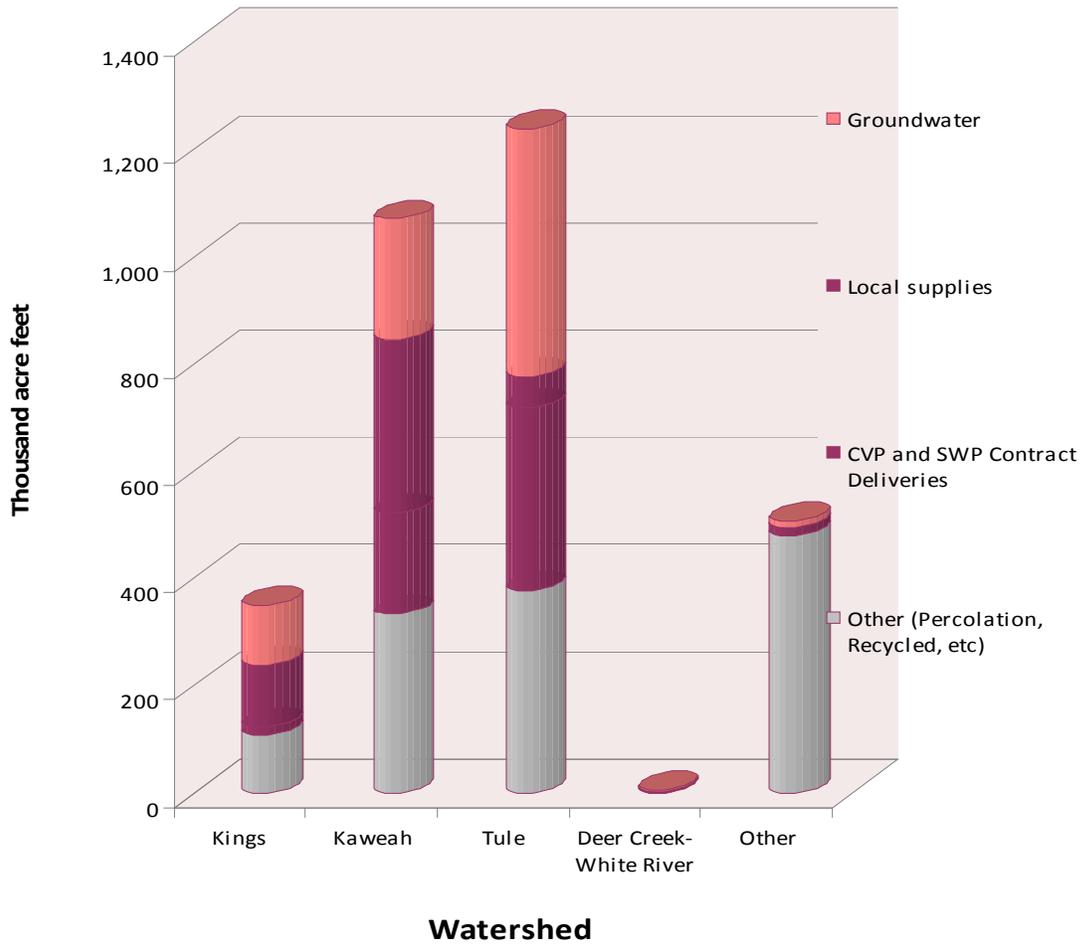
- ◆ 1,069,000 surface water; and
- ◆ 1,633,000 acre feet of groundwater.

⁵³ MacGillivray, B. H., P. D. Hamilton, et al. (2006). "Risk analysis strategies in the water utility sector: An inventory of applications for better and more credible decision making." Critical Reviews in Environmental Science and Technology **36**(2): 85-139.

⁵⁴ Arnold, C. A., Ed. (2005). Wet Growth: Should Water Law Control Land Use. Washington DC, Environmental Law Institute.

For purposes of the integration of supply and demand in Section 4, the baseline surface water supply is reduced to account for the potential of 1) reduced CVP contract supplies due to the San Joaquin River settlement agreement, and 2) reduced local runoff from climate change effects on local precipitation quantities and timing. These aggregate supply sources are represented by watershed in **Figure 3.5**.

Figure 3.5 - Tulare County Water Supply Sources, 2003



Section 4 – Integration

Integrating the supply and demand information detailed in Sections 2 and 3 provides an understanding of the potential availability of water supplies to serve the land use changes anticipated with adoption of the General Plan Update.

4.1 FUTURE SCENARIOS

To assist with determining potential impacts from the policies and land use changes contemplated by the General Plan Update, several scenarios were developed to represent plausible future supply and demand conditions. The resulting integration of the supply and demand scenarios are shown in **Table 4.1**. Scenarios were developed using the information from Sections 2 and 3 and include:

- ◆ Scenario 1 – this scenario represents the future baseline demand without conservation and assumes that the surface water and groundwater supplies are available as historically used;
- ◆ Scenario 2 – this scenario represents future demands with the conservation savings discussed in Section 2.3, with surface and groundwater supplies available as historically used;
- ◆ Scenario 3 – this scenario represents future baseline demands without conservation and assumes surface water resources are constrained, as discussed in Section 3;
- ◆ Scenario 4 – this scenario represents future demands with conservation and assumes surface water resources are constrained.

For each scenario, demand is represented for ‘normal’ and ‘dry’ conditions, where dry conditions reflect a 5 percent increase in overall demand due to reduced rainfall and increased temperatures, resulting in increased evapotranspiration of agricultural crops and urban landscaping.

Table 4.1 – Integration of Supply and Demand Conditions

Condition	Hydrologic Year Type	Water Demand (ac-ft/year)			Applied Water Requirements			Projected Additional Groundwater (ac-ft/year) ²	
		Urban	Agriculture	Total	Assumed Baseline Groundwater (ac-ft/year)	Assumed Available Surface Water (ac-ft/year)	Total Available Water Supply (ac-ft/year)		
Existing (2003)¹	Normal	147,900	2,551,000	2,698,900	1,633,100	1,069,000	2,702,100	-----	
Future	Scenario 1 (baseline)	Normal	350,000	2,350,000	2,700,000	1,633,100	1,069,000	2,702,100	(2,100)
		Dry	367,500	2,467,500	2,835,000			2,702,100	132,900
	Scenario 2 (w/ conservation)	Normal	315,000	2,230,000	2,545,000			2,702,100	(157,100)
		Dry	330,750	2,341,500	2,672,250			2,702,100	(29,850)
	Scenario 3 (w/ less surface water)	Normal	350,000	2,350,000	2,700,000		900,000	2,533,100	166,900
		Dry	367,500	2,467,500	2,835,000			2,533,100	301,900
	Scenario 4 (w/ conservation and less surface water)	Normal	315,000	2,230,000	2,545,000			2,533,100	11,900
		Dry	330,750	2,341,500	2,672,250			2,533,100	139,150

Note: 1. Existing (2003) data is from DWR's 2003 draft water budget for Tulare County. The demand and supply do not match exactly because of minor variances in the items included from the budget for both the demand and supply values
 2. The Projected Additional Groundwater value for each scenario represents what may likely be pumped to meet the projected demand above and beyond the 'assumed baseline groundwater,' which is set equal to the existing (2003) value. If the value shown is positive, it represents additional pumping and would be additive to the 'assumed baseline' value. If the value is negative, then it would be a reduction in pumping from the 'assumed baseline' value.

A few important facts should be noted when reviewing the representative values in the table. These include:

- For 1999 and 2002, the DWR water budgets for Tulare County indicated that total groundwater extractions to meet agricultural and urban applied water demands were approximately 1,485,000 and 1,960,000 acre-feet per year, respectively. Under Scenario 3, which reflects 1) no additional savings from conservation, 2) increased demand from dry climatic conditions, and 3) reduced surface water availability, the groundwater extraction would be approximately 1,935,000 acre-feet – within the range of historic use. Though the 2002 groundwater extraction was likely contributing to overdraft of the basin, this scenario of changed land uses contemplated by the General Plan Update would not be expected to exacerbate conditions historically experienced or anticipated regardless of the General Plan Update land use changes. Under Scenario 2, conversely, groundwater pumping would be reduced from the 2003 baseline to approximately 1,476,000 acre-feet – also approximately within the range of the historic data.
- Conservation will be an important factor in helping mitigate current overdraft and/or reductions in surface water supplies. Land use changes contemplated by the General Plan Update provide an opportunity for the County to proactively implement available conservation measures. As demonstrated in **Table 4.1**, conservation can reduce demand by nearly 150,000 acre-feet annually.

- ◆ The surface water supply under Scenarios 3 and 4 are arbitrarily assumed to be reduced to 900,000 acre-feet. This reflects an unknown but potential reduction in 1) CVP contract supplies imported into the County due to the San Joaquin River settlement agreement, and 2) reduced local runoff from climate change effects on local precipitation quantities and timing.

4.2 CONCLUSION

As demonstrated in this analysis, the actions contemplated in the General Plan Update are not anticipated to cause overall demand in the County to vary from within the range of demands seen historically and documented by DWR – a range of about 2,600,000 acre-feet to 2,850,000 acre-feet.

However, the shift in land use from irrigated agriculture to mixed-use urban development will likely result in the following two potential impacts:

- ◆ Urban uses will predominantly seek to be served by pumping groundwater on lands that may have previously been served with surface water. Though a few instances of treated surface water for urban needs are in place or being discussed, the vast majority of current urban needs in the County are met with groundwater. Thus, there may be an increase in groundwater extraction to serve the expanded urban needs. [Note that if irrigated agricultural lands displaced by the new urban demand were previously using groundwater, there is theoretically no change in the amount of groundwater extraction. Only in cases where lands were previously served with surface water would there be a likely increase in the total extraction of groundwater.]
 - As discussed in Section 3, there is also a likelihood of increased groundwater extraction regardless of adoption of the General Plan Update. This increase, though impacting the County, is not an impact caused by the actions contemplated by the General Plan Update.
- ◆ Because new or existing urban purveyors will be serving these new urban demands with groundwater, a potentially different supply source than that used by agricultural purveyors on the same land, urban purveyors will be expanding water supply entitlements to the groundwater.