# Table 2.3.8b(3)

| TRI-COUNTY GSA - SOUTHEAST AREA | | | | |
|---|---|---|---|---|
| Tule Subbasin Southeast Groundwater Area Groundwater Demand - 2017/18 Cropping Pattern - 2040 | | | | |
| **Southeast Groundwater Management Area - 2040** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results - 20 Year Analysis Based on 2017 Cropping Pattern** |
| Approximate Gross Acreage in Management Area | 49,300 Acres | 49,300 Acres | 49,300 Acres | |
| Farmed Area | 23,000 Acres | 23,000 Acres | 23,000 Acres | |
| Et Requirement | 61,100 Acre-feet | 63,100 Acre-feet | 67,100 Acre-feet | **Average Et: 63,000 AFY** |
| Applied Water Requirement | 69,500 Acre-feet | 71,800 Acre-feet | 76,400 Acre-feet | **Average AW: 71,700 AFY** |
| Surface Water Deliveries[1] | 0 Acre-feet | 0 Acre-feet | 0 Acre-feet | **Average SWD: 0 AFY** |
| Groundwater Requirement | 69,500 Acre-feet | 71,800 Acre-feet | 76,400 Acre-feet | **Average GWR: 71,700 AFY** |
| Applied Water Return Flow[2] | 8,400 Acre-feet | 8,700 Acre-feet | 9,300 Acre-feet | **Average AWRF: 8,700 AFY** |
| Net Groundwater Extractions | 61,100 Acre-feet | 63,100 Acre-feet | 67,100 Acre-feet | **Average NGE 63,000 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 2,400 Acre-feet | **Average RP: 300 AFY** |
| Net Groundwater Demand[4] | 61,100 Acre-feet | 63,100 Acre-feet | 64,700 Acre-feet | **Average NGWD: 62,700 AFY** |

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area. None go the the Southeast Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA. Southeast Area = 80% of total TCWA land area.
Therefore precip. Contrib. = 800 afy average or 2,400 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

## 2.3.8.3 FUTURE WATER BUDGET -2070 [§354.18(c)(1)]

**YEAR 2070**

The effects of continued climate change from 2040 to 2070 affect the groundwater balance, with the major effects of climate change being accounted for by the Year 2040 in the prior water balance calculations. It is not clear at this time what the actual effects will be by the end of the implementation period in 2040. The effects of future climate change will need to be accounted for throughout the implementation period and in the years beyond 2040.

**Chart 2.8.3**

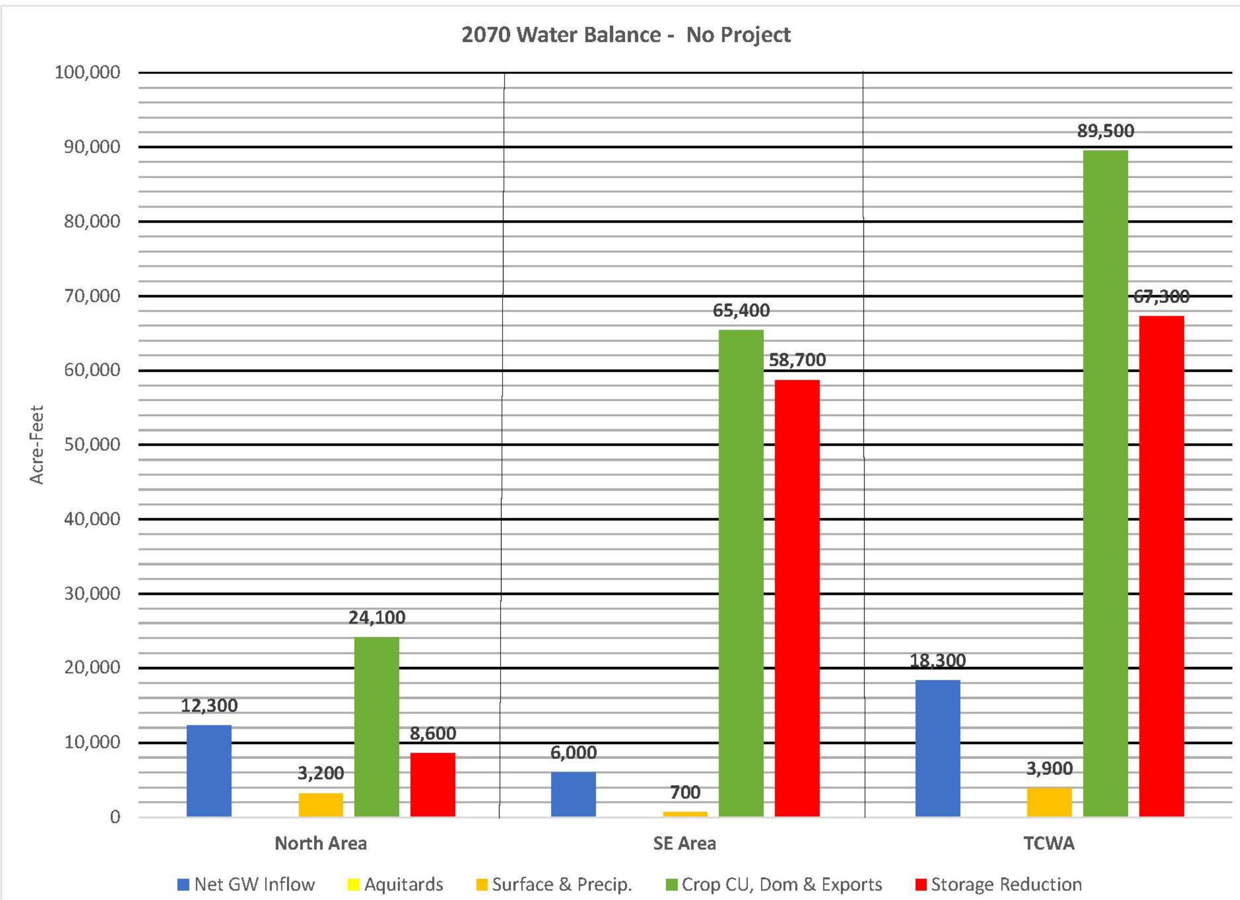


**Table 2.3.8c**
**Tri-County Water Authority**
**Summary of Groundwater Balance Tabulations**
**Results of Twenty-Year Study Periods for Year 2070 - No Project Conditions**

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| **Management Area** | **Farmed Acreage[1]** | **Crop Water Requirement (Etc)[2] (af)** | **Surface Water Contribution to Et Requirement[3] (af)** | **Rainfall Contribution to Groundwater[4] (af)** | **Net Subsurface Inflow into the GSA[5] (af)** | **Net Inflow from Compression of Aquitards[6] (af)** | **Estimated Net Municipal and Domestic Water Use[7] (af)** | **Groundwater Extractions Exported from the GSA[8] (af)** | **Net Change in Groundwater Storage in Upper Aquifer[9] (af)** |
| **YEAR 2070** | | | | | | | | | |
| Total for TCWA | 29,000 | 79,400 | 3,000 | 900 | 18,300 | 0 | 1,000 | 9,100 | **-67,300** |
| North Management Area | 6,000 | 14,600 | 3,000 | 200 | 12,300 | 0 | 400 | 9,100 | **-8,600** |
| SE Management Area | 23,000 | 64,800 | 0 | 700 | 6,000 | 0 | 600 | 0 | **-58,700** |

Reference: See Table 2.3.8 for footnotes

The following Tables 2.3.8c(1-3) develop the net groundwater demand for Year 2070. They are source tables for Table 2.3.8c.

# Table 2.3.8c(1)

| TRI-COUNTY GSA | | | | | |
|---|---|---|---|---|---|
| Tri-County GSA Groundwater Demand - 2017/18 Cropping Pattern - TULE SUBBASIN PORTION OF TCWA - 2070 | | | | | |
| **2070 Combined North & Southeast Groundwater Areas** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results -20 Year Analysis Based on 2017 Cropping Pattern** | |
| Approximate Gross Acreage in Management Area | 61,400 Acres | 61,400 Acres | 61,400 Acres | | |
| Farmed Area | 29,000 Acres | 29,000 Acres | 29,000 Acres | | |
| Et Requirement | 76,300 Acre-feet | 78,800 Acre-feet | 84,300 Acre-feet | **Average Et:** | **78,700 AFY** |
| Applied Water Requirement | 91,800 Acre-feet | 94,800 Acre-feet | 101,400 Acre-feet | **Average AW:** | **94,700 AFY** |
| Surface Water Deliveries[1] | 0 Acre-feet | 1,800 Acre-feet | 9,100 Acre-feet | **Average SWD:** | **2,200 AFY** |
| Groundwater Requirement | 91,800 Acre-feet | 93,000 Acre-feet | 92,300 Acre-feet | **Average GWR:** | **92,600 AFY** |
| Applied Water Return Flow[2] | 15,500 Acre-feet | 16,000 Acre-feet | 17,100 Acre-feet | **Average AWRF:** | **16,000 AFY** |
| Net Groundwater Extractions | 76,300 Acre-feet | 77,000 Acre-feet | 75,200 Acre-feet | **Average NGWE:** | **76,500 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 3,000 Acre-feet | **Average RP:** | **400 AFY** |
| Net Groundwater Demand[4] | 76,300 Acre-feet | 77,000 Acre-feet | 72,200 Acre-feet | **Average NGWD:** | **76,200 AFY** |

Notes
1. Approximately 25% of gross surface water deliveries go to the North Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA.
Therefore precip. Contrib. = 1,000 afy average or 3,000 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

## Table 2.3.8c(2)

| TRI-COUNTY GSA - NORTH AREA | | | | | |
|---|---|---|---|---|---|
| Tule Subbasin - North Groundwater Management Area Groundwater Demand - 2017/18 Cropping Pattern - 2070 | | | | | |
| **North Groundwater Management Area - 2070** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results - 20 Year Analysis Based on 2017 Cropping Pattern** | |
| Approximate Gross Acreage in Management Area | 12,100 Acres | 12,100 Acres | 12,100 Acres | | |
| Farmed Area | 6,000 Acres | 6,000 Acres | 6,000 Acres | | |
| Et Requirement | 13,900 Acre-feet | 14,400 Acre-feet | 15,700 Acre-feet | **Average Et:** | **14,400 AFY** |
| Applied Water Requirement[2] | 20,800 Acre-feet | 21,500 Acre-feet | 23,400 Acre-feet | **Average AW:** | **21,500 AFY** |
| Surface Water Deliveries[1] | 0 Acre-feet | 1,800 Acre-feet | 9,100 Acre-feet | **Average SWD:** | **2,200 AFY** |
| Groundwater Requirement | 20,800 Acre-feet | 19,700 Acre-feet | 14,300 Acre-feet | **Average GWR:** | **19,400 AFY** |
| Applied Water Return Flow | 6,900 Acre-feet | 7,100 Acre-feet | 7,700 Acre-feet | **Average AWRF:** | **7,100 AFY** |
| Net Groundwater Extractions | 13,900 Acre-feet | 12,600 Acre-feet | 6,600 Acre-feet | **Average NGWE:** | **12,200 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 600 Acre-feet | **Average RP:** | **100 AFY** |
| Net Groundwater Demand[4] | 13,900 Acre-feet | 12,600 Acre-feet | 6,000 Acre-feet | **Average NGWD:** | **12,200 AFY** |

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area.
2. 67% irrigation efficiency assumed., 33% of applied water returned.
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA.
North area = 20% of TCWA land area (Tule Subbasin).Therefore average precip. contribution = 200 afy, and precip. average = 600 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

## Table 2.3.8c(3)

| TRI-COUNTY GSA - SOUTHEAST AREA | | | | | |
|---|---|---|---|---|---|
| Tule Subbasin Southeast Groundwater Area Groundwater Demand - 2017/18 Cropping Pattern - 2070 | | | | | |
| **Southeast Groundwater Management Area - 2070** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results - 20 Year Analysis Based on 2017 Cropping Pattern** | |
| Approximate Gross Acreage in Management Area | 49,300 Acres | 49,300 Acres | 49,300 Acres | | |
| Farmed Area | 23,000 Acres | 23,000 Acres | 23,000 Acres | | |
| Et Requirement | 62,400 Acre-feet | 64,400 Acre-feet | 68,600 Acre-feet | **Average Et:** | **64,300 AFY** |
| Applied Water Requirement | 71,000 Acre-feet | 73,300 Acre-feet | 78,000 Acre-feet | **Average AW:** | **73,200 AFY** |
| Surface Water Deliveries[1] | 0 Acre-feet | 0 Acre-feet | 0 Acre-feet | **Average SWD:** | **0 AFY** |
| Groundwater Requirement | 71,000 Acre-feet | 73,300 Acre-feet | 78,000 Acre-feet | **Average GWR:** | **73,200 AFY** |
| Applied Water Return Flow[2] | 8,600 Acre-feet | 8,900 Acre-feet | 9,400 Acre-feet | **Average AWRF:** | **8,900 AFY** |
| Net Groundwater Extractions | 62,400 Acre-feet | 64,400 Acre-feet | 68,600 Acre-feet | **Average NGE** | **64,300 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 2,400 Acre-feet | **Average RP:** | **300 AFY** |
| Net Groundwater Demand[4] | 62,400 Acre-feet | 64,400 Acre-feet | 66,200 Acre-feet | **Average NGWD:** | **64,000 AFY** |

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area. None go the the Southeast Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA. Southeast Area = 80% of total TCWA land area.
Therefore precip. Contrib. = 800 afy average or 2,400 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: 1990 - 2010 Precip. records for Porterville (Harder HCM Table 2a) , CIMIS records for Shafter and Stratford.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

## 2.3.9 HISTORICAL WATER BUDGET [[§354.18(c)(2)]

The Tulare County 1993 cropping pattern shows most of the irrigated lands to be in the North Management Area with some irrigation in the Southeast Management Area. See Table 2.3.9 for the groundwater balance tabulation. The southern portion of the Southeast Area has been developed to permanent crops since 1993, with most of the development occurring between 2005 and the present.

Comparison: 1993 to 2017/18

There have been significant changes in the cropping pattern since the late part of the previous century. The following discussion develops the irrigation water requirements for the Year 1993. Table A-1d, Appendix A-1a, shows that the total farmed acreage in the Tule Subbasin portion of the TCWA for 1993 was 20,500 acres. This is compared to 29,000 acres in 2017/18. However, the North Area experienced a decrease in farmed acreage while the Southeast Area experienced an increase in farmed area.

**Chart 2.9.1**

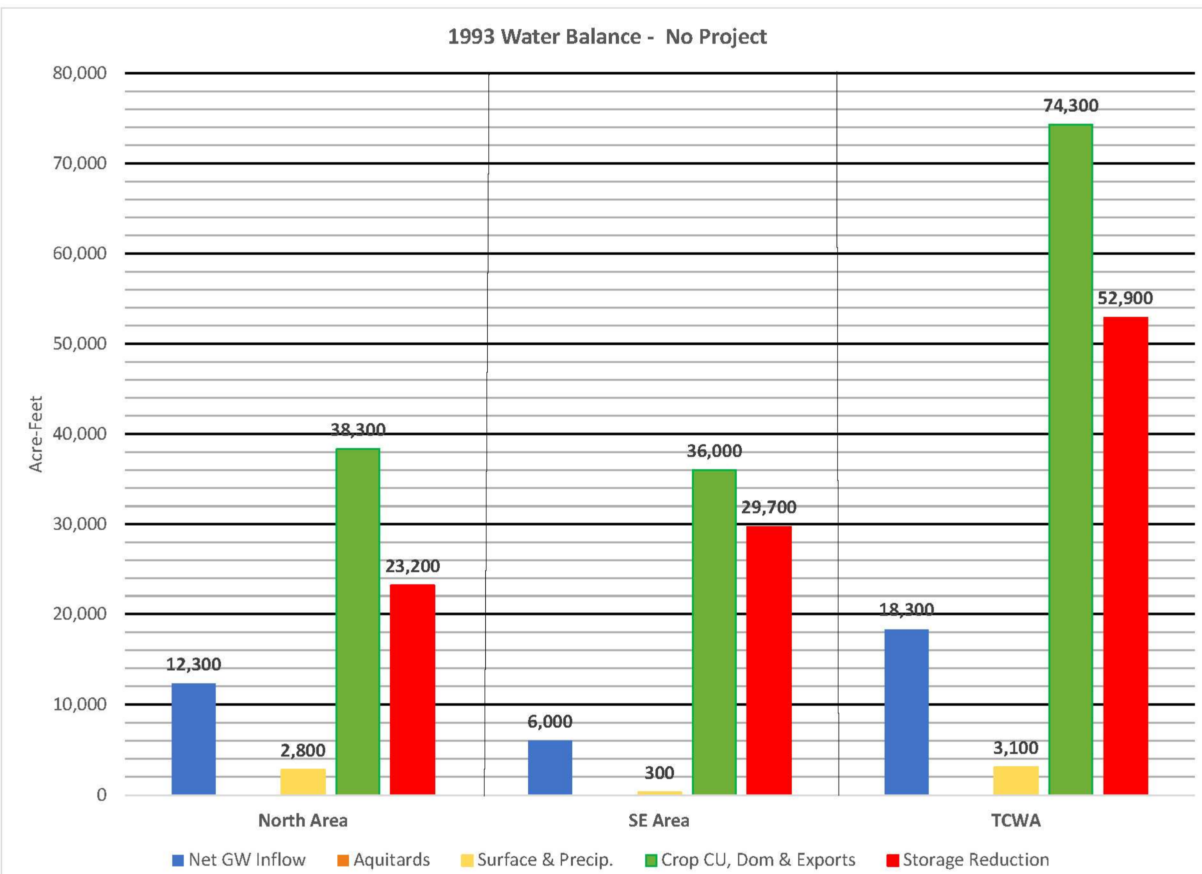


Table 2.3.9

**Tri-County Water Authority**

**Summary of Groundwater Balance Tabulations**

**Results of Twenty-Year Study Periods for Year 1993- No Project Conditions**

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| **Management Area** | **Farmed Acreage[1]** | **Crop Water Requirement (Etc)[2] (af)** | **Surface Water Contribution to Et Requirement[3] (af)** | **Rainfall Contribution to Groundwater[4] (af)** | **Net Subsurface Inflow into the GSA[5] (af)** | **Net Inflow from Compression of Aquitards[6] (af)** | **Estimated Net Municipal and Domestic Water Use[7] (af)** | **Groundwater Extractions Exported from the GSA[8] (af)** | **Net Change in Groundwater Storage in Upper Aquifer[9] (af)** |
| | | | | | | | | | |
| Total for TCWA | 20,500 | 64,900 | 2,700 | 400 | 18,300 | 0 | 300 | 9,100 | **-52,900** |
| North Management Area | 9,200 | 29,100 | 2,700 | 100 | 12,300 | 0 | 100 | 9,100 | **-23,200** |
| SE Management Area | 11,300 | 35,800 | 0 | 300 | 6,000 | 0 | 200 | 0 | **-29,700** |

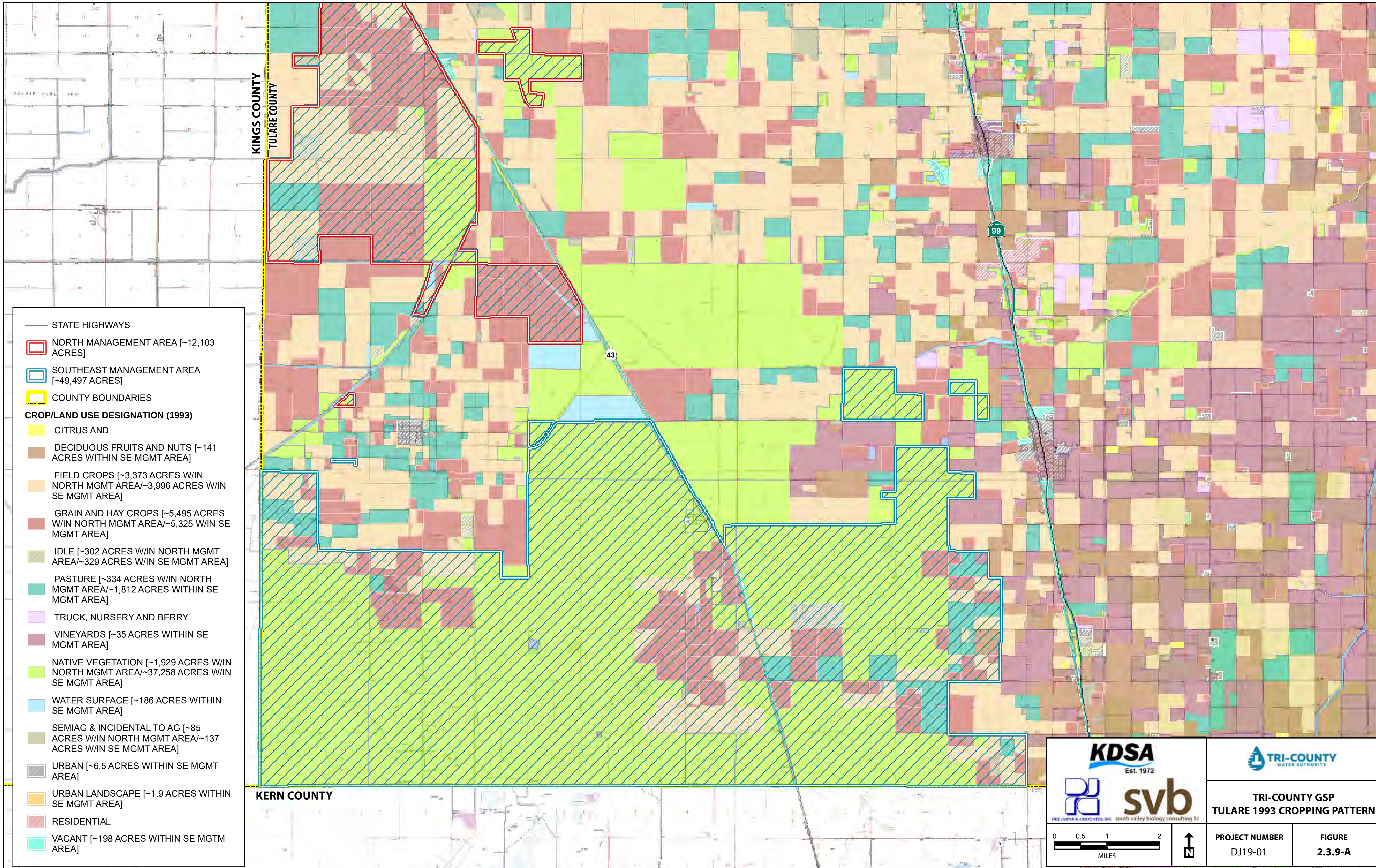
Reference: See Table 2.3.8 for footnotes

## North Area

A comparison of Tables 2.3.1a(1-3) and 2.3.9, demonstrates that the North Area experienced a decrease in farmed acreage, from 9,200 acres in 1993 to 6,000 acres in 2017/18, hay and grain crops experiencing the greatest reductions (Appendix A-1a, Tables A-1a and A-1d).

## Southeast Area

A comparison of Tables 2.3.1 and 2.3.9 shows that the Southeast Management Area experienced development of a significant amount of acreage. The Southeast Area is a “White” (Un-districted) Area. The comparison shows an overall increase in farmed acreage of from 11,300 acres in 1993 to 23,000 acres in 2017/18. This is an increase of 11,700 acres, all of which is on groundwater. Much of this acreage is in permanent crops, mainly Pistachios. It is estimated that significant Pistachio plantings began about ten to twenty years ago and has continued through recent years.




SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION

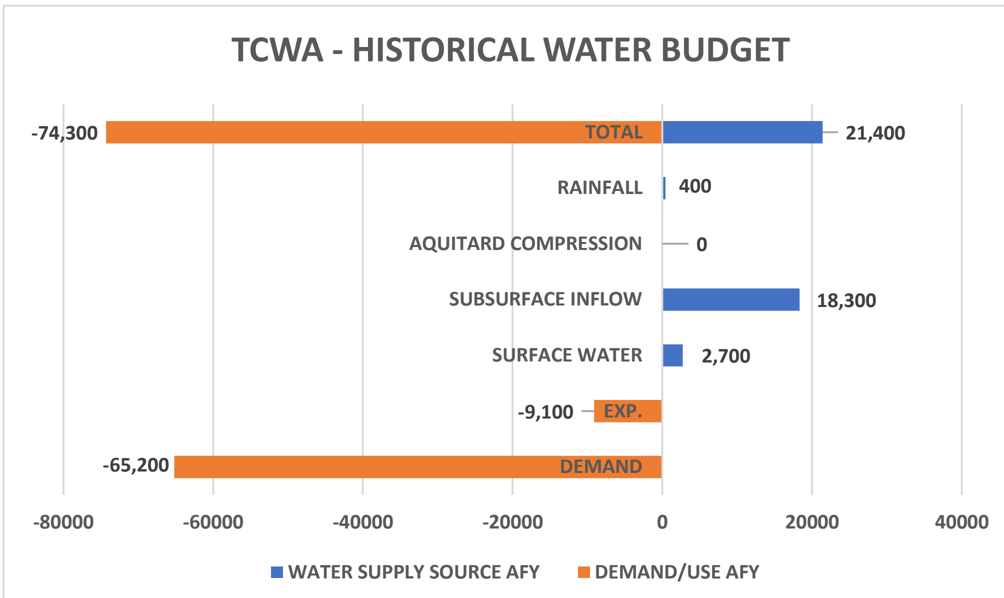
# HISTORICAL WATER BUDGET

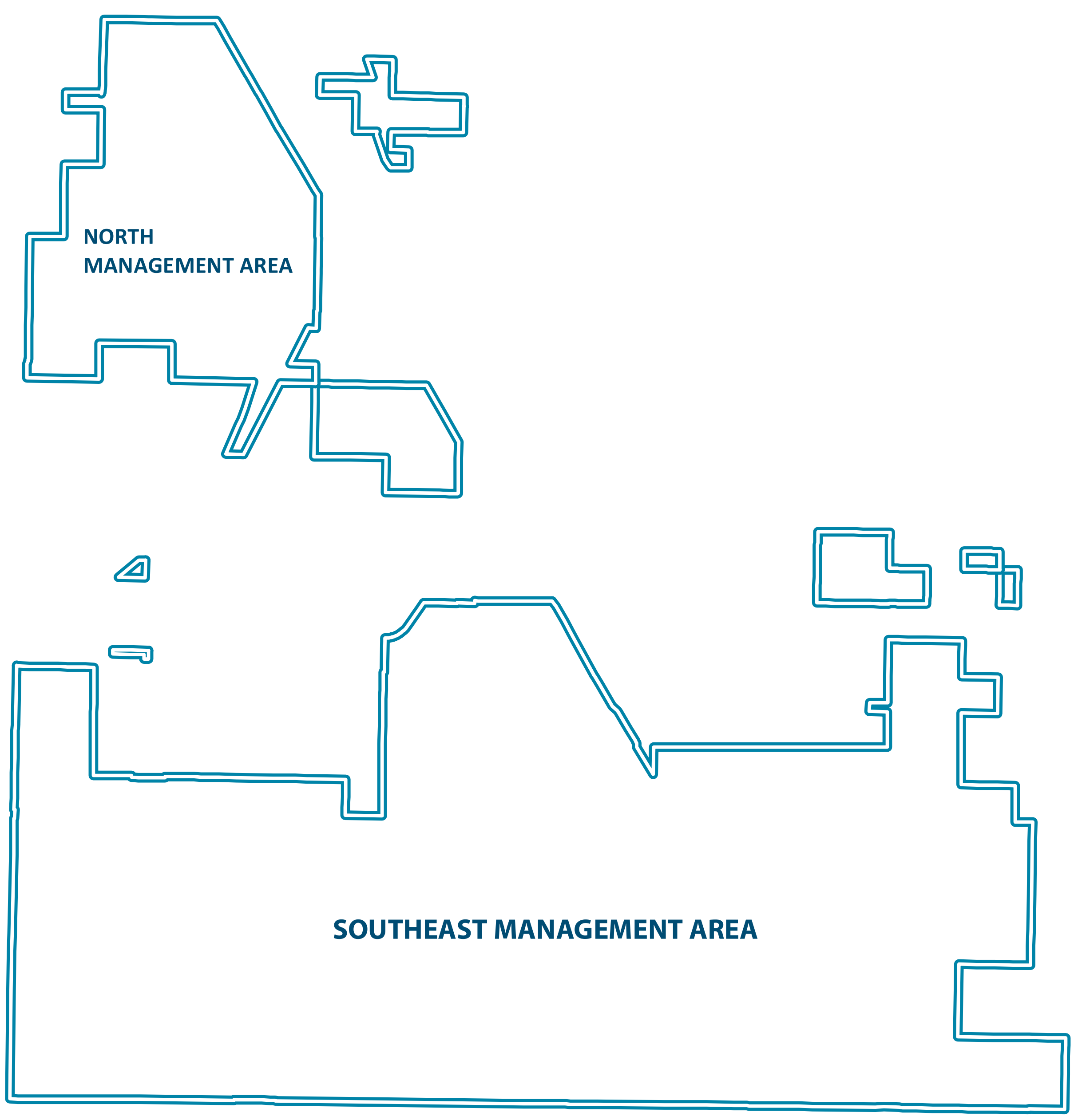
NET SUBSURFACE INFLOW & COMPRESSION OF
AQUITARDS AT LEGACY LEVEL OF 18,300 AFY

## TCWA PORTION OF THE TULE SUBBASIN

GROSS LAND ACRES = 61,400 ACRES
IRRIGATED AREA = 20,500 ACRES

GROUNDWATER DEFICIT = 52,900 AFY




TCWA GSA FOCUS AREA - TULE PORTION

KDSA Est. 1972

svb south valley biology consulting llc

TRI-COUNTY WATER AUTHORITY

TRI-COUNTY GSP
TCWA - NORTH & SE AREAS
HISTORICAL WATER BUDGET

0 0.5 1 2
MILES

N

PROJECT NUMBER
DJ19-01

FIGURE
2.3.9-B

SOURCE(S): CA DEPT. OF WATER RESOURCES/TRI-COUNTY WATER AUTHORITY/KDSA/DJA

## 1993 Water Budget

The following Tables 2.3.9a(1-3) develop the net groundwater demand for Year 2020. They are source tables for Table 2.3.9.

### Table 2.3.9a(1)

| TRI-COUNTY GSA | | | | |
|---|---|---|---|---|
| Tri-County GSA Groundwater Demand - 1993 Cropping Pattern - TULE SUBBASIN PORTION OF TCWA | | | | |
| **Combined North & Southeast Groundwater Areas** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results - 20 Year Analysis Based on 1993 Cropping Pattern** |
| Approximate Gross Acreage in Management Area | 61,400 Acres | 61,400 Acres | 61,400 Acres | |
| Farmed Area | 20,500 Acres | 20,500 Acres | 20,500 Acres | |
| Et Requirement | 63,600 Acre-feet | 65,800 Acre-feet | 63,800 Acre-feet | **Average Et: 64,900 AFY** |
| Applied Water Requirement | 94,600 Acre-feet | 98,000 Acre-feet | 94,900 Acre-feet | **Average AW: 96,500 AFY** |
| Surface Water Deliveries[1] | 1,800 Acre-feet | 1,800 Acre-feet | 9,100 Acre-feet | **Average SWD: 2,700 AFY** |
| Groundwater Requirement | 92,800 Acre-feet | 96,200 Acre-feet | 85,800 Acre-feet | **Average GWR: 93,800 AFY** |
| Applied Water Return Flow[2] | 31,000 Acre-feet | 32,200 Acre-feet | 31,100 Acre-feet | **Average AWRF: 31,700 AFY** |
| Net Groundwater Extractions | 61,800 Acre-feet | 64,000 Acre-feet | 54,700 Acre-feet | **Average NGWE: 62,100 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 3,000 Acre-feet | **Average RP: 400 AFY** |
| Net Groundwater Demand[4] | 61,800 Acre-feet | 64,000 Acre-feet | 51,700 Acre-feet | **Average NGWD: 61,700 AFY** |

Notes
1. Approximately 25% of gross surface water deliveries go to the North Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA.
Therefore precip. Contrib. = 1,000 afy average or 3,000 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: Precipitation data. See text.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

# Table 2.3.9a(2)

| TRI-COUNTY GSA - NORTH AREA | | | | |
|---|---|---|---|---|
| Tule Subbasin - North Groundwater Management Area Groundwater Demand - 1993 Cropping Pattern | | | | |
| **North Groundwater Management Area - 1993** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results - 20 Year Analysis Based on 1993 Cropping Pattern** |
| Approximate Gross Acreage in Management Area | 12,100 Acres | 12,100 Acres | 12,100 Acres | |
| Farmed Area | 9,200 Acres | 9,200 Acres | 9,200 Acres | |
| Et Requirement | 28,500 Acre-feet | 29,500 Acre-feet | 28,600 Acre-feet | **Average Et: 29,100 AFY** |
| Applied Water Requirement[2] | 42,500 Acre-feet | 44,000 Acre-feet | 42,600 Acre-feet | **Average AW: 43,300 AFY** |
| Surface Water Deliveries[1] | 1,800 Acre-feet | 1,800 Acre-feet | 9,100 Acre-feet | **Average SWD: 2,700 AFY** |
| Groundwater Requirement | 40,700 Acre-feet | 42,200 Acre-feet | 33,500 Acre-feet | **Average GWR: 40,600 AFY** |
| Applied Water Return Flow | 14,000 Acre-feet | 14,500 Acre-feet | 14,000 Acre-feet | **Average AWRF: 14,300 AFY** |
| Net Groundwater Extractions | 26,700 Acre-feet | 27,700 Acre-feet | 19,500 Acre-feet | **Average NGWE: 26,300 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 600 Acre-feet | **Average RP: 100 AFY** |
| Net Groundwater Demand[4] | 26,700 Acre-feet | 27,700 Acre-feet | 18,900 Acre-feet | **Average NGWD: 26,200 AFY** |

Notes
1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area.
2. 67% irrigation efficiency assumed., 33% of applied water returned.
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA.
North area = 20% of TCWA land area (Tule Subbasin).Therefore average precip. contribution = 200 afy, and precip. average = 600 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: Precipitation data. See text.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

# Table 2.3.9a(3)

| TRI-COUNTY GSA - SOUTHEAST AREA | | | | | |
|---|---|---|---|---|---|
| Tule Subbasin Southeast Groundwater Area Groundwater Demand - 1993 Cropping Pattern | | | | | |
| **Southeast Groundwater Management Area - 1993** | **Dry Year Conditions** | **Normal Year Conditions** | **Wet Year Conditions** | **Results - 20 Year Analysis Based on 1993 Cropping Pattern** | |
| Approximate Gross Acreage in Management Area | 49,300 Acres | 49,300 Acres | 49,300 Acres | | |
| Farmed Area | 11,300 Acres | 11,300 Acres | 11,300 Acres | | |
| Et Requirement | 35,100 Acre-feet | 36,300 Acre-feet | 35,200 Acre-feet | **Average Et:** | **35,800 AFY** |
| Applied Water Requirement | 52,100 Acre-feet | 54,000 Acre-feet | 52,300 Acre-feet | **Average AW:** | **53,200 AFY** |
| Surface Water Deliveries[1] | 0 Acre-feet | 0 Acre-feet | 0 Acre-feet | **Average SWD:** | **0 AFY** |
| Groundwater Requirement | 52,100 Acre-feet | 54,000 Acre-feet | 52,300 Acre-feet | **Average GWR:** | **53,200 AFY** |
| Applied Water Return Flow[2] | 17,000 Acre-feet | 17,700 Acre-feet | 17,100 Acre-feet | **Average AWRF:** | **17,400 AFY** |
| Net Groundwater Extractions | 35,100 Acre-feet | 36,300 Acre-feet | 35,200 Acre-feet | **Average NGWE:** | **35,800 AFY** |
| Areal Recharge from Precipitation[3] | 0 Acre-feet | 0 Acre-feet | 2,400 Acre-feet | **Average RP:** | **300 AFY** |
| Net Groundwater Demand[4] | 35,100 Acre-feet | 36,300 Acre-feet | 32,800 Acre-feet | **Average NGWD:** | **35,500 AFY** |

Notes

1. Approximately 25% of Angiola surface water deliveries go to the North Groundwater Management Area. None go the the Southeast Groundwater Management Area.
2. Applied water requirement minus Et requirement (crop water demand).
3. Recharge from precipitation averaged by Thomas Harder for the period 1987-2017 = 1,000 afy for TCWA. Southeast Area = 80% of total TCWA land area.
Therefore precip. Contrib. = 800 afy average or 2,400 af/wet year.
4. The net groundwater demand is the Et requirement less the surface water return flow, less rainfall contribution in wet years.
5. 13% of years are "Wet", 32% of Years are "Dry", 55% of Years are "Typical" or "Average". Source: Precipitation data. See text.
6. See text for explanation of the estimates for subsurface inflow and aquitard compression.

## Tables 2.3.9 & 2.3.8 Comparison

**Table 2.3.9**

**Tri-County Water Authority**

**Summary of Groundwater Balance Tabulations**

**Results of Twenty-Year Study Periods for Year 1993- No Project Conditions**

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| **Management Area** | **Farmed Acreage[1]** | **Crop Water Requirement (Etc)[2] (af)** | **Surface Water Contribution to Et Requirement[3] (af)** | **Rainfall Contribution to Groundwater[4] (af)** | **Net Subsurface Inflow into the GSA[5] (af)** | **Net Inflow from Compression of Aquitards[6] (af)** | **Estimated Net Municipal and Domestic Water Use[7] (af)** | **Groundwater Extractions Exported from the GSA[8] (af)** | **Net Change in Groundwater Storage in Upper Aquifer[9] (af)** |
| | | | | | | | | | |
| Total for TCWA | 20,500 | 64,900 | 2,700 | 400 | 18,300 | 0 | 300 | 9,100 | **-52,900** |
| North Management Area | 9,200 | 29,100 | 2,700 | 100 | 12,300 | 0 | 100 | 9,100 | **-23,200** |
| SE Management Area | 11,300 | 35,800 | 0 | 300 | 6,000 | 0 | 200 | 0 | **-29,700** |

Reference: See Table 2.3.8 for footnotes

**Table 2.3.8a**

**Tri-County Water Authority**

**Summary of Groundwater Balance Tabulations**

**Results of Twenty-Year Study Periods for Year 2020 - No Project Conditions**

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| **Management Area** | **Farmed Acreage[1]** | **Crop Water Requirement (Etc)[2] (af)** | **Surface Water Contribution to Et Requirement[3] (af)** | **Rainfall Contribution to Groundwater[4] (af)** | **Net Subsurface Inflow into the GSA[5] (af)** | **Net Inflow from Compression of Aquitards[6] (af)** | **Estimated Net Municipal and Domestic Water Use[7] (af)** | **Groundwater Extractions Exported from the GSA[8] (af)** | **Net Change in Groundwater Storage in Upper Aquifer[9] (af)** |
| **YEAR 2020** | | | | | | | | | |
| Total for TCWA | 29,000 | 74,300 | 3,200 | 900 | 44,100 | 12,000 | 300 | 9,100 | **-23,500** |
| North Management Area | 6,000 | 13,600 | 3,200 | 200 | 24,700 | 2,400 | 100 | 9,100 | **7,700** |
| SE Management Area | 23,000 | 60,700 | 0 | 700 | 19,400 | 9,600 | 200 | 0 | **-31,200** |

Reference: See Table 2.3.8 for footnotes

TCWA

A 20-year water budget based on the on the 1991-2010 ratios of wet, dry and normal years for the 2017/18 cropping pattern, (Appendix A-1a) shows an overall increase in Crop ET from 64,900 afy (1993) to a current demand of 74,300 afy for the North and Southeast Areas combined, an increase of 9,400 afy. Note that these numbers do not include the effects of net subsurface inflow, compression of aquitards, groundwater exports from the GSA, or offsets due to surface water.

North Area

Crop ET decreased from 29,100 afy in 1993 to 13,600 afy in 2017/18, a decrease of 15,500 afy.

Southeast Area

Crop ET increased from 35,800 afy in 1993 to 60,700 afy in 2017/18, an increase of 24,900 afy.

## 2.3.10 PROJECTED WATER BUDGET [§354.18(3)]

The following Tables present the results of a 20-year study of crop water demands based on the years 1991-2010, years that are considered to represent average climate conditions in the GSA. The 20-Year sequence includes 6 years (32%) of “Dry” conditions, 3 years (13%) of “Wet” conditions, and 11 years (55%) of “Typical” or “Normal” conditions. As discussed previously, ET is based on “type” years determined by precipitation on the valley floor, and surface water supply on “type” years as determined by Wood for the Tulare Lake Subbasin, which is adjacent to the west boundary of TCWA’s lands in the Tule Subbasin – which are the subject of this GSP. TCWA has a significant land area in the Tulare Lake Subbasin, however, very little irrigated agriculture. TCWA’s lands in the Tulare Lake Subbasin are covered by a separate GSP and are not a part of this GSP.

### Current Conditions

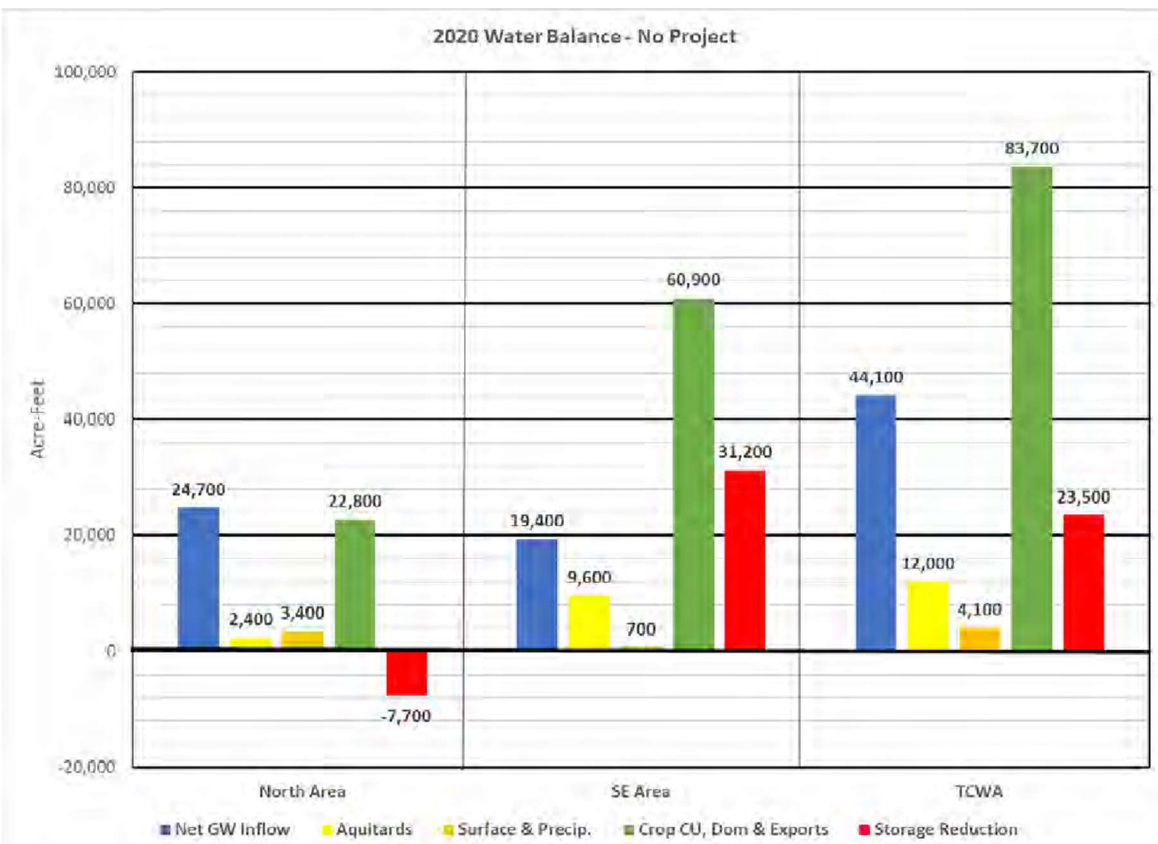
Previous tables (Tables 2.3.1 and 2.3.8) represent the “No Project” conditions. The following tables are based on average twenty-year forecasted future climate conditions, estimated to be an ET increase of 3.8% in the year 2040, and a decrease of 2.5% in precipitation and surface water supplies. The tables are based on an estimated 3% increase in ET and 2% decrease in precipitation and surface water supplies in 2030, and an estimated 6% increase in ET and a 4% decrease in precipitation and surface water supplies in 2070*. The percentages for intervening years were estimated based on a straight-line change in the parameters between 2020, 2030, and 2070.

For TCWA, it is currently extracting 44,100 afy of groundwater from external sources, and 12,000 afy of water from compression of aquitards. The sustainable amount of groundwater is estimated to be 18,300 afy (see Ken Schmidt January 6, 2020 groundwater flow study memorandum to Deanna Jackson, Executive Director of TCWA – Appendix A-7). The sustainable amount of water derived from the compression of aquitards is zero.

North Area

Chart 2.8.1, repeated below, depicts the "current" water balance (i.e. what 2020 would be if it were an average year – as determined by the 20-year averages of ET, surface water supplies, etc). The chart below shows a current net groundwater inflow of 24,700 afy, to which is added 2,400 afy from aquitard compression and 3,400 afy of surface water and rainfall inflow (3,200 afy of surface water and 200 afy of rainfall). These inputs total 30,500 afy. The current water consumption totals 22,800 afy (13,600 af of crop ET, 100 afy of domestic water consumption and 9,100 afy of exports). However currently the sustainable inputs to the North Area are a groundwater inflow of 12,300 afy, and surface water plus rainfall inflow of 3,400 afy totaling 15,700 afy. Therefore, the current non-sustainable production of groundwater in the North Area is 7,100 afy (22,800 afy less 15,700 afy = 7,100 afy). For the current water uses to continue, an additional 7,100 afy, on average, must be supplied to the North Area. (Note: This does not include the effects of climate change -which are discussed in previous sections of this chapter.)

**Chart 2.8.1**



Southeast Area

The Southeast Area currently is experiencing a net groundwater inflow of 19,400 afy from areas external to the Southeast Area, 9,600 afy from the compression of aquitards, and an average rainfall contribution of 700 afy, totaling 29,700 afy. The sustainable groundwater inflow is 6,000 afy combined with 700 afy of rainfall, totaling 6,700 afy. The current groundwater demand is 60,700 afy of consumptive use and 200 afy of domestic water consumption, totaling 60,900 afy. Therefore, the current non-sustainable production of groundwater in the Southeast Area is 54,200 afy (60,900 afy – 6,700 afy = 54,200 afy). For the current water uses to continue, an additional 54,200 afy, on average, must be supplied to the Southeast Area.

Combined North and Southeast Areas

The total additional water supplies that must be provided to the TCWA over the next 20 years is 61,300 afy in order to maintain the current levels of water consumption.

The above water supply deficit is based on the current knowledge of cropping patterns, crop evapotranspiration, and domestic water consumption, together with estimates of net groundwater inflows and water derived from aquitard compression, and the best current estimates of groundwater sustainability. The numbers are not exact. However, they are indicative of an average water supply deficit on the order of 60,000 afy, the majority of which is in the Southeast Area. The first five years of operation of this GSP will allow collection of surface water and groundwater information that will begin to fill the substantial gaps that currently exist, allowing for more informed decisions to be made.

### 2040 Conditions

Chart 2.8.2 is repeated below. This chart reflects the projected 2040 conditions with no projects or management actions.

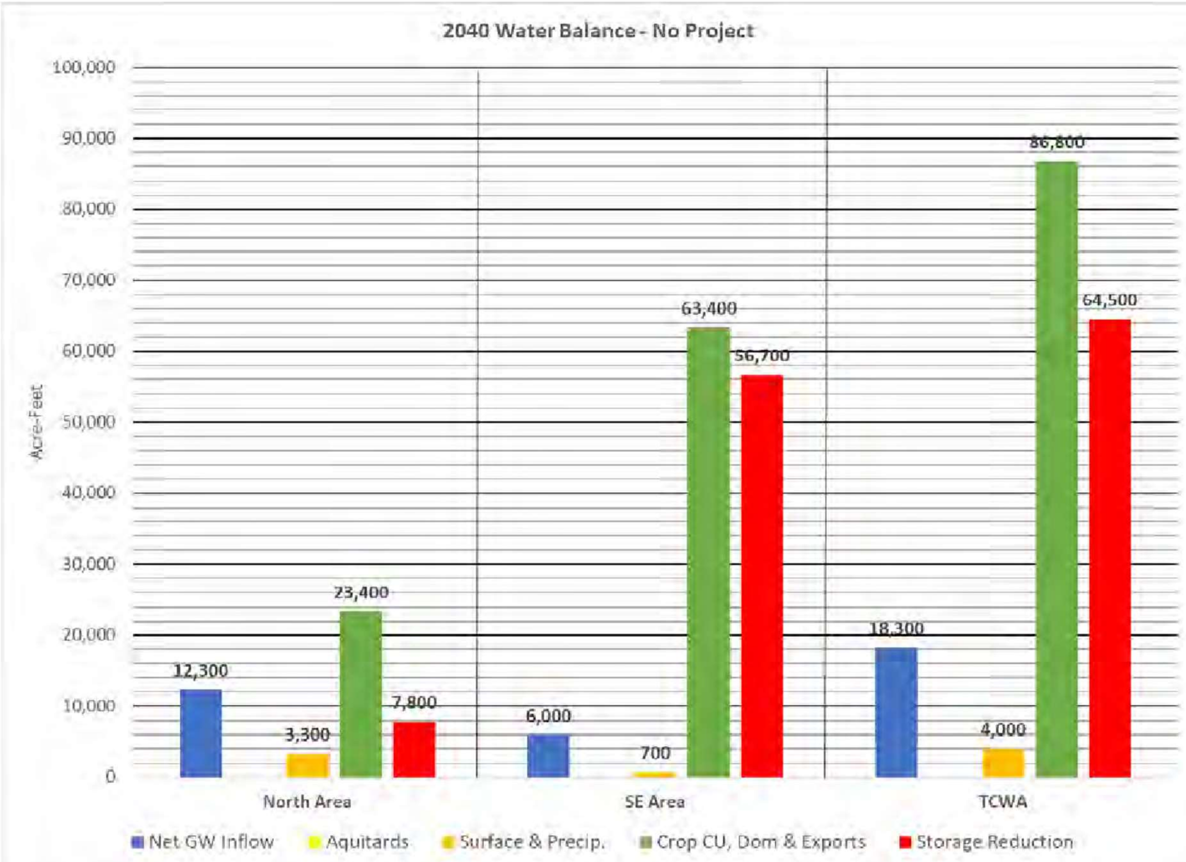
North Area

With no projects or management actions the North Area is forecasted to have a 7,800 afy shortfall by Year 2040. However, the North Area is supplied surface water by AWD and there are projects planned for the North Area. Chapter 5 describes the projects.

Southeast Area

With no surface water supply the Southeast Area will need to reduce groundwater deficits by developing a surface water supply and/or removing crops to the extent that groundwater sustainability is reached. The current deficit is forecast to increase from 54,200 afy to 56,700 afy by the year 2040 if no projects or management actions are implemented.

**Chart 2.8.2**




## 2040 Conditions with Planned Reductions in Crop Water Consumption

Chart 2.3.10-A depicts the 2040 – No Project condition, with reduction of net subsurface inflow to 18,300 afy, reduction of the recoverable volume of water from aquitard compression to zero, and with a 20% reduction in crop water consumption achieved by a reduction in groundwater pumpage and permanently idling cropland. The estimated effects of climate change are included.

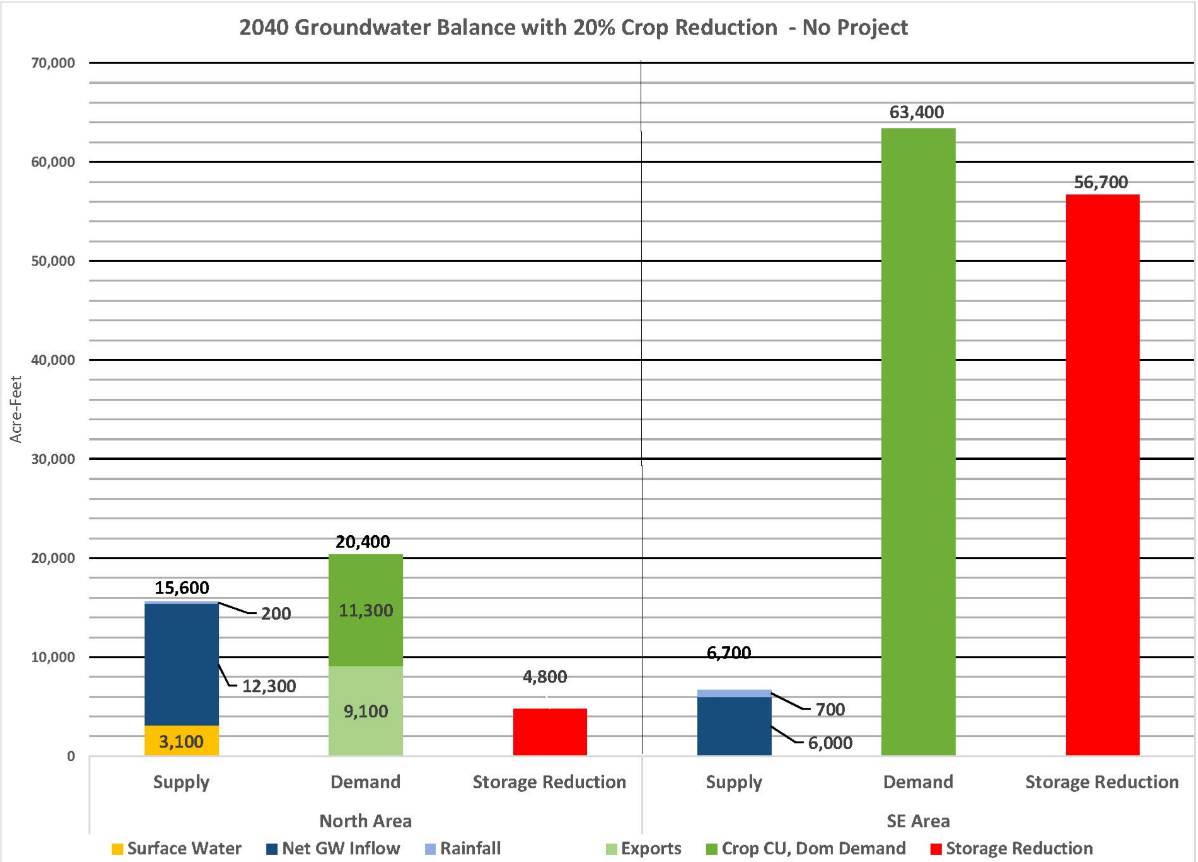
<u>North Area</u>

By 2040 an additional 4,800 afy of surface water must be developed to meet sustainability. This is in addition to the aforementioned 20% decrease in crop water consumption.

<u>Southeast Area</u>

By 2040, with a 20% decrease in crop water consumption by permanently idling croplands, a reduction in the net subsurface inflow from 19,400 afy to 6,000 afy, reduction of water available from compression of aquitards from 9,600 afy to zero, and some contributing rainfall, an annual storage decline of 43,700 acre-feet is forecasted. This will result in permanently idling more cropland to the extent that new surface water supplies cannot be developed.

**Chart 2.3.10-A**




<u>Proposed Corrective Measures</u>

It is recognized that the basin must be in compliance by 2040 – a twenty-year period. The concern over the impacts of subsidence is reason to make efforts to address them as soon as practicable. However, it is most important to understand what is happening in the basin prior to implementing corrective measures. Therefore, it is proposed to begin corrections only after taking the time to gather as much information as possible. This will take place between 2020 and 2025. Management measures (installation of meters on wells, groundwater pumping fees and record-keeping) will begin in 2020. Corrective measures are planned to begin in 2025, although some may be implemented earlier. The schedule provides time to make further corrections between 2030 and 2040 if things do not go as planned. Chart 2.3.10-B below demonstrates the corrections that are needed prior to the year 2030 in order to be in balance by 2030. This is an accelerated schedule, and while it is the goal of TCWA to achieve balance as soon as possible, it is also recognized that once more information is gathered between 2020 and 2025, the schedule may have to be extended beyond 2030.

The initial projects and management actions proposed for the period 2020-2030 that will balance the groundwater situation in both the North and Southeast Management Areas are shown on Chart 2.3.10-B. All proposed projects and management actions are discussed in Chapter 5. The chart depicts the corrections that are needed, including the currently planned management actions of a 10% reduction in crop water demands that will be implemented in 2025 and 2030, which will be a 20% reduction in demands in 2030 going forward.

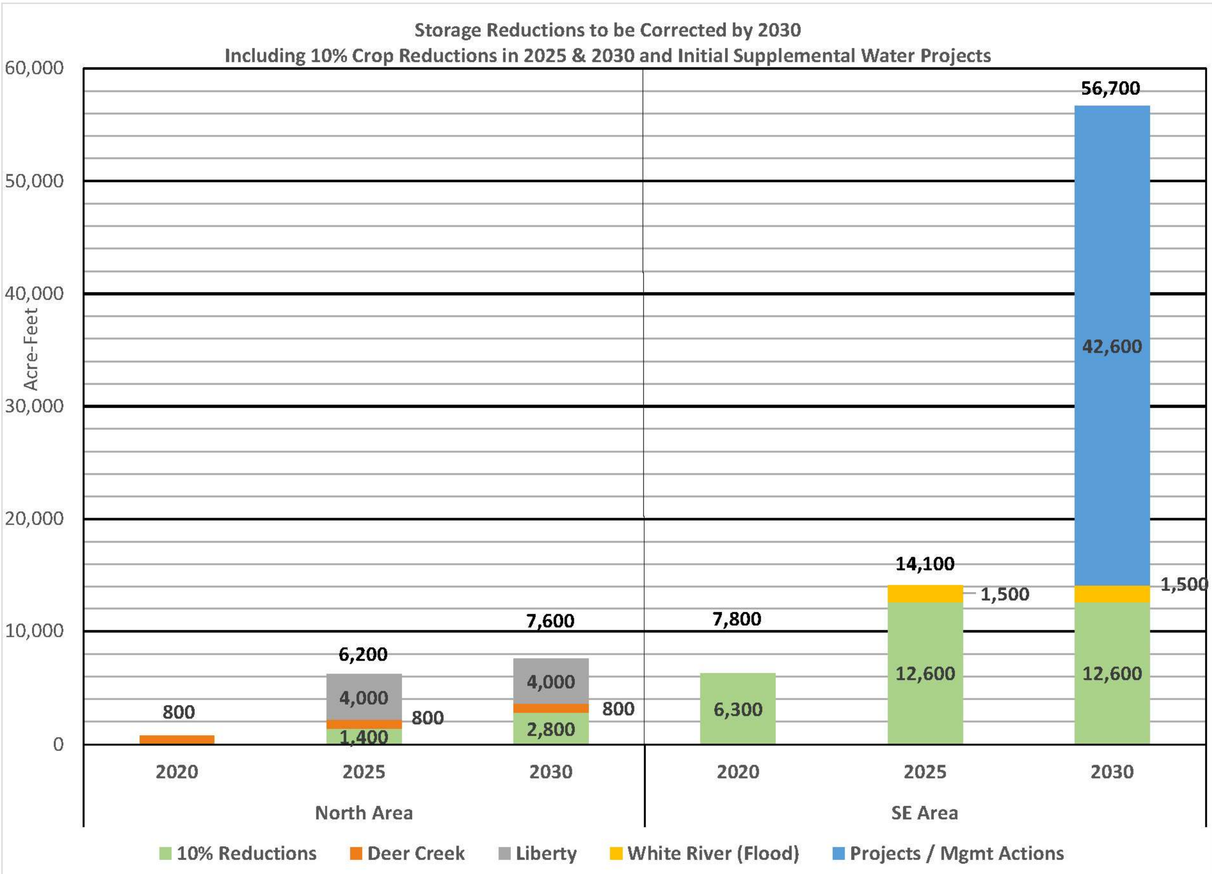
North Area

The North Area, after reducing crop water demands by 20% (a demand reduction of 2,800 afy), needs to correct 4,800 afy of storage reductions. It is planned to implement the Deer Creek project in 2020, which will recover an average of 800 afy of water, and add Phase 1 of the Liberty Project in 2025, which can add an additional 4,000 afy of water for the North Area. These projects and management actions are forecasted to create sustainability for the North Area. With a greater buildout of the Liberty Project, or otherwise addition of 2,800 afy more of supplemental surface water supplies, there will be no need for crop reductions in the North Area.

Southeast Area

For the Southeast Area a project on White River to capture an estimated 1,500 afy of excess flood waters is proposed. A 10% crop demand reduction 6,300 afy. A 20% decrease in crop demand implemented in 2025 would reduce demand by 12,600 afy. The White River flood project (1,500 afy), if implemented in 2025, would reduce the groundwater deficit of 56,700 afy by 14,100 afy, to 42,600 afy. The challenge would then be to implement projects and crop water use reductions in an effort to reduce the 42,600 afy deficit as much as possible. If sufficient short-term, flood water supplies can be obtained, it appears that the Liberty Project could provide the shortfall. To the extent that supplemental surface water supplies cannot be procured, crop reductions will be in order.

**Chart 2.3.10-B**




Proposed projects and management actions are discussed in Chapter 5.

**§354.20 Management Areas**

a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.

# 2.4 MANAGEMENT AREAS [§354.20]

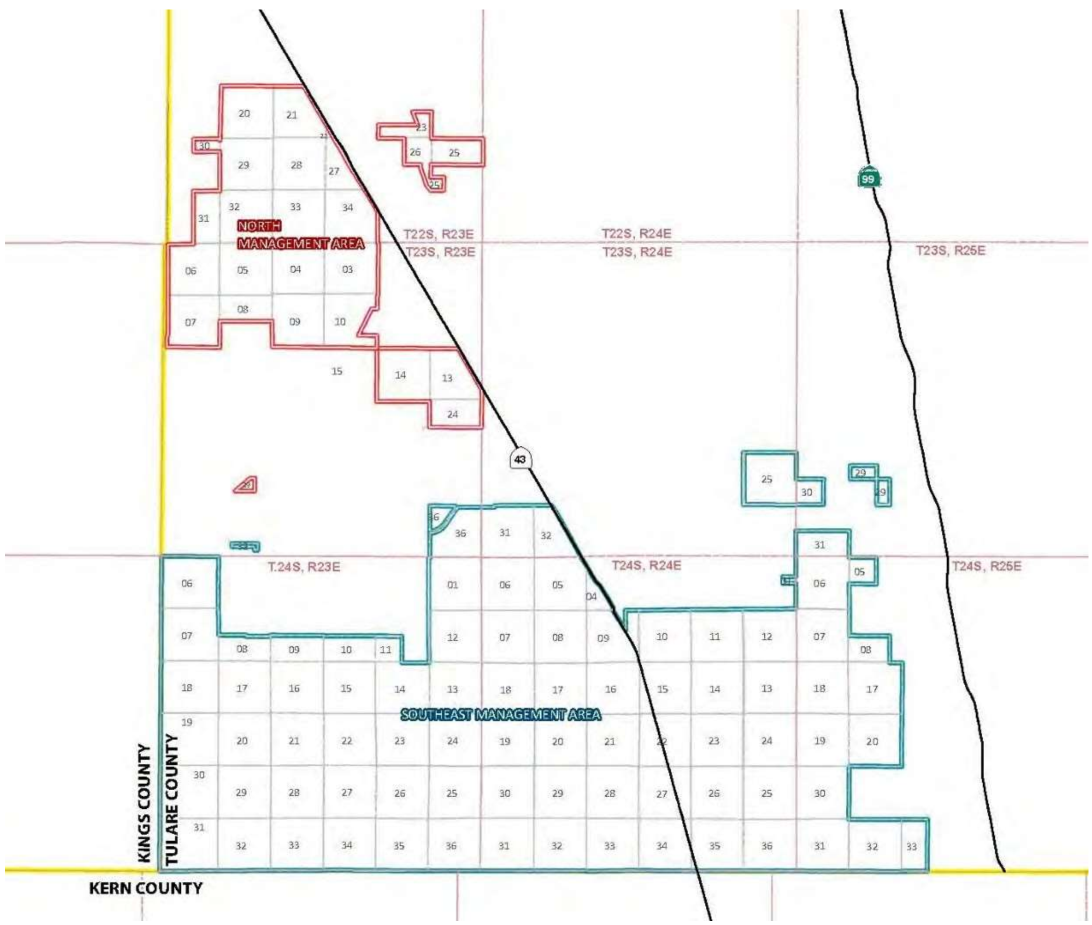



**Figure No. 1.4.0**
**TCWA MANAGEMENT AREAS**

## 2.4.1 INTRODUCTION [§354.20(a)]

TCWA has designated two Management Areas in its GSA. These areas are the North Management Area ("North Area") and the Southeast Management Area ("Southeast Area"). They are designated on Figure 1.4.0 repeated above.

**§354.20 Management Areas**

b) A basin that includes one or more management areas shall describe the following in the Plan:

1) The reason for the creation of each management area.

2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.

c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information require by this Subarticle sufficient to describe conditions in those areas.

## 2.4.2 JUSTIFICATION & DESCRIPTION of MANAGEMENT AREAS [§354.20(b)(1)(2),(c)]

REASON FOR CREATION OF THE MANAGEMENT AREAS

The reason for the creation of two management areas is two-fold: 1). The North Area receives surface water and groundwater on the lands located within the AWD (refer to Figure 1.4.7). These lands are therefore managed by a public agency. The remaining lands that are outside the district boundary are served by groundwater but benefit from improved groundwater levels due to their proximity to the District. 2). The Southeast Area is an un-districted area (a "white area") that is totally dependent on groundwater. A large portion of the current irrigated area has been developed to permanent crops in recent years and therefore has little flexibility to regulate demands in times of restricted water supplies.

Part of the North Area has been developed to irrigated agriculture for many years. Crops grown in the area are dominated by field crops. The District's two well fields are in this area. Groundwater is pumped from both upper and lower aquifers. The surface water supply has multiple sources (see Table 2.3.2), averaging about 17,000 afy. However, only about 25% of this water is used in the North Area* (*conversation with Deanna Jackson –AWD staff member prior to becoming the Executive Director of TCWA).

As stated above, the Southeast Area is dominated by permanent crops, mainly pistachios. The groundwater supply in this area varies from the eastern part to the western part. In the eastern part groundwater is pumped from both the upper and lower aquifers, while in the western part (roughly the west one-third of the Southeast Area) pumpage is generally only from the lower aquifer.

The North Management Area has an existing surface water supply and the infrastructure to increase surface water deliveries to lands within the area. Moreover, the AWD serves a majority of the lands in the area, and proportionately, the groundwater imbalance is smaller in the North Area than the Southeast Area. Additional surface water supplies should therefore have a more immediate effect on the groundwater balance by reducing pumping. It is anticipated that the area will be brought into balance much sooner than the Southeast Area because of the existing distribution infrastructure and the availability of surface water, whereas the Southeast Area must construct water infrastructure and procure a supply of surface water in order to reduce the dependence on groundwater. Therefore, measurable objectives should be attained sooner in the North Area than in the Southeast Area.

MINIMUM THRESHOLDS AND MEASURABLE OBJECTIVES FOR THE NORTH AND SOUTHEAST AREAS

While both areas pump groundwater from the upper and lower aquifers, the North Area is benefitted by the availability of surface water and contains two district-operated well fields that operate to make up for the variable nature of the surface water supplies. When there is adequate surface water the North Area District wells are operated minimally. When there is a shortage of surface water, the wells become the major source of water for the North Area. Over the period 2004 – 2018, surface water supplies in AWD averaged 17,100 afy, while groundwater sources averaged about 22,000 afy. Table 2.3.2 demonstrates the variable nature of the AWD's water supply. Therefore, water levels in the North Area do not reflect the same pumping conditions that the Southeast Area experiences, because the Southeast Area has no surface water supply to substitute for groundwater.

While lower aquifer water levels in both management areas have been trending downward historically, water levels in the upper aquifer have apparently been relatively stable. Since the DWR stopped measuring or recording groundwater levels in un-districted areas around 1988, there has been a lack of information in un-districted areas, due to the absence of an entity to measure and record water levels in these areas. Information will be developed over the next five years that will more accurately define groundwater levels in both the North and Southeast Areas. Minimum thresholds in the Southeast Area will be different compared to those in the North Area for the above reasons. Minimum thresholds are developed in Chapter 3.

**§354.20 Management Areas**

(b) A basin that includes one or more management areas shall describe the following in the Plan:

3) The level of monitoring and analysis appropriate for each management area.

4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.

## 2.4.3 MONITORING & ANALYSIS [§354.20(b)(3)(4)]

LEVEL OF MONITORING AND ANALYSIS FOR THE MANAGEMENT AREAS

A total of eight wells have been designated as potential for water level measurements. The breakdown is provided below.

**North Area**

Upper Aquifer

- T22S/R23E-25C (AWD E20)
- AWD W14

Lower Aquifer

- T22S/R23E-27F (AWD G-13)

**Southeast Area**

Upper Aquifer

- TSMU 5U
- T24S/R23E-22E1

Lower Aquifer

- T24S/R23E-22R2
- TSMU 5L

OPERATING UNDER DIFFERENT MINIMUM THRESHOLDS

Based on the current number of water level measurements in the North and the Southeast Areas, firm conclusions cannot be drawn at this time as to the impacts of operating under different minimum thresholds. Measurements taken over the next five years will aid in our understanding of water level conditions in both areas. At that time, it will be possible to develop more accurate determinations of the minimum thresholds and measurable objectives.

GROUNDWATER MONITORING PLAN FOR TCWA

This monitoring plan covers the part of TCWA that is in the Tule Sub-basin, which is in Tulare County. The major components of this monitoring are: 1) groundwater pumpage, 2) water levels, 3) groundwater quality, and 4) land subsidence. See Chapter 3 and Section 2 of the 2022 GSP Addendum for the establishment of Minimum Thresholds and Measurable Objectives. See Chapter 4 and Section 2 of the 2022 GSP Addendum for a detailed description of the monitoring plan. These objectives are developed separately for the North Management and the Southeast Management Areas.

**Water Levels**

Water levels will be measured semi-annually in a number of active wells for the first five years of the program. In order to prepare suitable maps, a significant number of wells will be measured, that will allow the preparation of water level elevation and direction-of-groundwater-flow maps. See Appendix A of the 2022 GSP Addendum for theTCWA monitoring network. The change in storage for the upper aquifer will be calculated from water level measurements and the specific yield of the upper aquifer. The change in storage for the lower aquifer will be estimated from land subsidence records. Depletion of groundwater will be determined by the difference between groundwater consumptive use and supplemental surface water supplies, rainfall contribution to groundwater, and the sustainable groundwater volume - estimated to be 18,300 afy.

**Pumpage**

Groundwater pumpage will be measured by installation of flow meters on all active large-capacity wells in the GSA. Pumpage recorded by these flow meters will be documented monthly and reported annually. The pumpage will be compared to the estimated consumptive use of applied water. Pumpage from each aquifer will be estimated for the wells perforated in both aquifers.

**Groundwater Quality**

Groundwater quality will be monitored by sampling active large-capacity wells during the time when these wells are being used for irrigation. Electrical conductivity will be the marker initially utilized. Water quality at the town of Allensworth is monitored and reported to the State of California and will be included in TCWA's annual reports. Further discussion of the TCWA groundwater quality network can be found in Section 4 of the 2022 GSP Addendum.

**Subsidence**

The Tule Subbasin proposes to install approximately 20 benchmarks at locations in TCWA to serve as subsidence monitoring locations. These will be measured annually by land-based GPS survey equipment. TCWA will utilize the Tule Subbasin monitoring results for its quarterly and annual subsidence reporting requirement. See Figure 3-11 of the 2022 GSP Addendum for current subsidence monitoring locations and Section 3 of the 2022 GSP Addendum for further details.

DATA GAPS

It is anticipated that approximately one well in each section would be part of a semi-annual water-level measurement program in order to allow water level maps to be prepared. Besides irrigation wells, there are some domestic and stock-watering wells that tap the upper aquifer in the Southeast Area. These wells will be evaluated and where possible, included in the upper aquifer water level measurement network. Further discussion of data gaps are presented in Sections 2,3, and 4 of the 2022 GSP Addendum.

**North Management Area**

There are data gaps in the records of groundwater levels and water quality in the North Area. However, there is information on the DWR website for certain wells that were measured by or reported to DWR until around the year 2008, when that program was discontinued. Recent measurements by AWD have been used to extend the record for wells for which the well construction data are available. The District will begin measuring groundwater levels in District wells on a semi-annual basis in 2020. Water quality will also be monitored by sampling these wells during the irrigation season. It is planned to include some private wells for which the construction data is available in the program as cooperative agreements with landowners are put in place.

**Southeast Management Area.**

Overall there has been a lack of suitable water-level measurements in the Southeast Area, as it has been a “white area”, where organized water districts have not been present to undertake such a program. Many of these wells also tap both aquifers, but in some cases they are the only wells known to be available for measurements. Wells will be designated for semi-annual water level measurements and for annual groundwater quality sampling. It is anticipated that agreements with private landowners will be signed that will allow the TCWA to measure and sample certain large capacity wells in the Southeast Area.

**Land Subsidence**

There are presently very few land subsidence monitoring locations in or near TCWA GSA (see discussion, Section 4.4.1, “Land Subsidence”). Therefore, there is a data gap in recent land subsidence information. The Tulare Lake Subbasin and Tule Subbasin plan to install two compaction recorders; one in or near the North Area and one in or near the Southeast Area. These are planned to be installed in the first five years of the implementation period. In the meantime, the Tule Subbasin plans to install about 20 land subsidence monitoring stations in TCWA that will be monitored by conventional GPS survey equipment.

Further discussion of subsidence data gaps are presented in Section 3 of the 2022 GSP Addendum.

SURFACE WATER FLOW MEASUREMENTS

Section 2.6.1 of the Tule Subbasin Monitoring Plan describes the methodology for obtaining surface water flow and water quality measurements. The Tule Subbasin Monitoring Plan is appended hereto as Appendix G. See Chapter 4 of this GSP – Monitoring Network for a discussion of the monitoring features for surface water inflow into the TCWA portion of the Tule Subbasin. The surface water monitoring protocol described in the Tule Subbasin Monitoring Plan is hereby incorporated into this GSP.

# CHAPTER 3: SUSTAINABLE MANAGEMENT CRITERIA §354.22 – 354.30

**§354.22 Introduction to Sustainable Management Criteria**
This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.

This chapter describes criteria that constitute sustainable groundwater management for the TCWA, including its sustainability goal and the characterization and definition of undesirable results for each applicable sustainability indicator. Further discussion of sustainable management criteria is presented in the 2022 GSP Addendum.

## 3.1 SUSTAINABLE GROUNDWATER MANAGEMENT CRITERIA [§354.22]

Sustainable Management Criteria include:

- Sustainability Goals
- Undesirable Results
- Minimum Thresholds
- Measurable Objectives

The development of these criteria is dependent on the information developed in the Hydrologic Conceptual Model (HCM) and the Water Budget. This then culminates in the development of a Groundwater Sustainability Plan (GSP) that identifies the path by which the Sustainability Goals are achieved in order to avoid Undesirable Results. This involves development of management actions and projects that are to be implemented over the 20-Year implementation period that culminate in achieving sustainability by the end of the period and beyond that period into the future.

<u>Sustainability Indicators (Undesirable Results):</u>

- Chronic lowering of groundwater levels indicating a depletion of supply if it continues over the planning and implementation horizon;
- Significant and unreasonable reduction of groundwater storage;
- Significant and unreasonable seawater intrusion;

- Significant and unreasonable degraded water quality, including migration of poor-quality groundwater that impairs water supplies;
- Significant and unreasonable land subsidence that interferes with surface land uses or collapses wells;
- Depletion of interconnected surface water that adversely impacts beneficial uses of surface water.

**§354.24 Sustainability Goal**
Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

## 3.2 SUSTAINABILITY GOAL [§354.24]

The existing pumpage in the GSA is unsustainable.

North Management Area

The North Area has a surface water supply and is managed by the Angiola Water District. While there exist four of the six undesirable indicators, there are projects and management actions that can be implemented that should attain sustainability. There are data gaps for water levels and land subsidence, that will be filled over the next five years. There are no known interconnected surface – groundwater systems in the North Area and there is not a problem with sea water intrusion due to the distance from the Delta. (re. HCM).

- There is continued lowering of groundwater levels (pressure levels) in the lower aquifer but upper aquifer water levels have been relatively stable.
- There is continued depletion of groundwater storage.
- There is induced groundwater flow into the GSA from some adjoining areas.
- There are groundwater quality problems due to natural factors. However, well conduits in some areas are contributing to degradation.
- There is land subsidence due to pumping from the lower aquifer.

Southeast Management Area

The Southeast Area is a “white area” and therefore has lacked the water level monitoring and management benefits provided by a public water district. While four of the six undesirable sustainability indicators have been identified, the groundwater situation in this area has not been studied in detail. However, there is enough data that the general situation can be summarized as follows:

- There is continued lowering of groundwater levels (pressure levels) in the lower aquifer, but upper aquifer water levels have been relatively stable.
- There is continued depletion of groundwater storage.
- There is induced groundwater flow into the GSA from some adjoining areas.
- There are groundwater quality problems due to natural factors. However, well conduits in some areas are contributing to degradation.
- There is land subsidence due to pumping from the lower aquifer.

## 3.2.1 SUSTAINABILITY GOAL [§ 354.24]

The Sustainability Goal of the TCWA is the absence of significant and unreasonable undesirable results associated with groundwater pumping in TCWA, accomplished by 2040. Achievement of this goal will be coordinated with other Tule Subbasin GSAs. It is further the goal of the Tule Subbasin GSAs that coordinated implementation of their respective GSPs will achieve sustainability in a manner that facilitates the highest degree of collective economic, societal, environmental, cultural, and communal welfare and provides all beneficial uses and users the ability to manage the groundwater resource at the lowest cost. Moreover, this coordinated implementation is anticipated to ensure that the sustainability goal, once achieved, is also maintained through the remainder of the 50-year planning and implementation horizon, and thereafter.

In achieving the Sustainability Goal, this Plan will balance average annual inflows and outflows of its groundwater so that decreases in storage, over a normal hydrologic base period, do not occur.

**§354.26 Undesirable Results**

a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

b) The description of undesirable results shall include the following:

  2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.

d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

## 3.2.2 UNDESIRABLE RESULTS [§ 354.26]

Undesirable Results are caused by groundwater conditions occurring throughout a significant and unreasonable portion of the GSA that, for any sustainability indicator, are considered significant and unreasonable. These conditions, or sustainability indicators, are listed above in Sustainability Indicators (Undesirable Results).

The Tule Subbasin GSA has evaluated the potential for each of these groundwater conditions and have established criteria wherein, if any such significant and unreasonable conditions were to develop, they would constitute an undesirable result.

There following groundwater conditions must be evaluated due to their relative potential to cause significant and unreasonable effects within the GSA. These conditions, with their sustainability indicators, are:

- Lowering of groundwater levels indicating a depletion of supply if continued over the planning and implementation horizon. Groundwater levels will be measured semi-annually.
- Water level declines in wells that produce from confined aquifers indicate a drop in pressure levels. Reduction in pumpage from the lower aquifer is an indicator of improvement because less water is being removed.
- Degraded water quality including migration of poor-quality groundwater that impairs water supplies.
- Land subsidence that substantially interferes with surface land uses and causes wells to collapse is an undesirable condition. Reductions of subsidence reflects a reduction in groundwater

extracted from the compressible clay layers underlying the GSA due to pressure level declines. (Ref. Lofgren and Klausing, 1969 USGS Professional Paper 437-B, Page B85. "Compaction and subsidence are directly related to changes in effective stress, which in turn are caused by water level changes (declines)").

TCWA GSA has defined undesirable results for each of the four conditions listed above. Each conditions' undesirable result includes a description of:

1. The cause of groundwater conditions that would lead to or has led to undesirable results;
2. The criteria used to define when and where the effects of the groundwater conditions cause undesirable results; and
3. The potential effects on beneficial uses and users of groundwater, and land uses and property interests, and other potential effects that may occur.

Further discussion of undesirable results is presented in the 2022 GSP Addendum.

**§354.26 Undesirable Results**

b) The description of undesirable results shall include the following:

1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.

# 3.3 UNDESIRABLE RESULTS CRITERIA [§354.26(a)]

## 3.3.1 POTENTIAL CAUSES OF UNDESIRABLE RESULTS [§354.26(b)]

North Management Area

Potential causes of the undesirable results are primarily attributed to overdraft. In the North Area the overdraft is caused by pumping in excess of the sustainable yield of the lower aquifer. However, the North Area has a surface water supply from Angiola Water District to offset some of the irrigation demands in the GSA, thus reducing the overdraft which would otherwise occur.

Southeast Management Area

Potential causes of the undesirable results are primarily attributed to overdraft of the lower aquifer. The Southeast Area does not have a surface water supply and is dependent on groundwater pumping for its irrigation water. Wells in the Southeast Area pump from both the upper and lower aquifers in the eastern two-thirds of the area. In the western one-third, most pumpage is from the lower aquifer. Inspection of hydrographs for wells in the upper aquifer indicate that the upper aquifer is potentially in balance at this time. This is partly due to subsurface inflow from areas outside of the GSA.

**§354.26 Undesirable Results**

b) The description of undesirable results shall include the following:

3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

## 3.3.2 POTENTIAL EFFECTS OF UNDESIRABLE RESULTS [§354.26(b)(3)]

Potential effects of undesirable results resulting from continued overdraft in the TCWA GSA are increased pumping lifts, land subsidence, and potentially decreased water quality. The impact of these results are increased irrigation costs, increased well maintenance, periodic lowering of pumping equipment, drilling of replacement wells if groundwater levels drop below the well depth, uncertainty of a reliable supply, continued land subsidence causing damage to wells, canals, roads, structures, and the public infrastructure (see Figure 3.3.0).

## 3.3.3 EVALUATION OF MINIMUM THRESHOLDS [§354.26(c)]

### CHRONIC LOWERING OF GROUNDWATER LEVELS

Additional discussion is presented in Section 2 of the 2022 GSP Addendum.

Causation:

Chronic lowering of groundwater levels occurs when groundwater pumping exceeds the available recharge of the basin over a prolonged period of time. While TCWA GSA has experienced periodic fluctuations in its groundwater levels as a result of seasonal and short-term hydrological variability, development of new irrigated lands has led to a substantial imbalance in the groundwater budget, particularly in the Southeast Management Area.

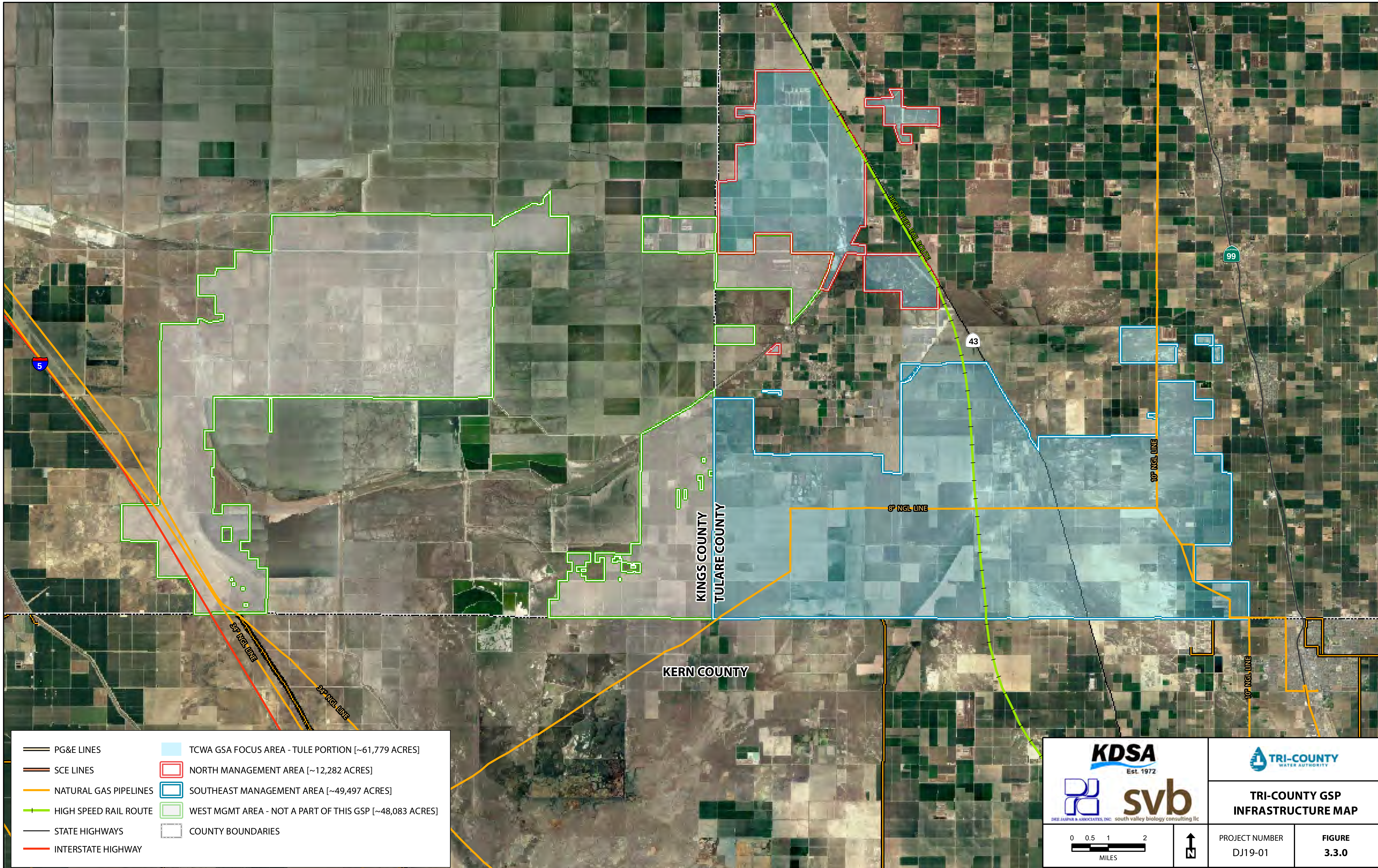
Projects and management actions will be implemented in order to decelerate and arrest chronic lowering of groundwater levels within TCWA by 2040.

Criteria:

Undesirable results for chronic lowering of groundwater levels is discussed in the 2022 GSP Addendum.

Effects:

An exceedance of minimum thresholds to the extent that an undesirable result for lowering of groundwater levels could induce well failures (e.g. collapsed casing due to land subsidence), additional operational costs for groundwater extraction from deeper pumping levels, and additional costs to lower pumps, deepen wells, or drill new wells. Corollary effects might include land subsidence resulting in damage to critical infrastructure. Additional discussion is presented in the 2022 GSP Addendum.




SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/CALIFORNIA ENERGY COMMISSION/CALIFORNIA HIGH-SPEED RAIL AUTHORITY

Minimum Thresholds:
See Section 2.3 of the 2022 GSP Addendum.

Measurable Objectives
Interim Milestones have been set to reflect a steady improvement in groundwater levels from the minimum thresholds to the Measurable Objective of recovering to water levels near the 2015 water levels.

TCWA Groundwater Model
Projections of groundwater elevations have been based on the observed trends in the subject wells over a historic period considered to be representative of long-term trends. Minimum thresholds reflect those projected trends. It is anticipated that measurable objectives and minimum thresholds will be revised in 2025 as more information is gained during the first five years of the plan/program.

Tule Groundwater Flow Model
Results from the Groundwater Flow Model will be compared to actual field measurements during this five-year period. It is anticipated that the Model will be updated with more information and the calibration will get closer to actual field conditions going forward.

## EXISTING WELLS TO BE MONITORED

The number of wells with recent water level measurements is limited, and the seven selected wells may be augmented or replaced with additional wells in the next five years. These wells, and possibly others, will be evaluated for inclusion in the TCWA's monitoring network. For candidate wells in the North Management Area and Southeast Management Area see Appendix A of the 2022 GSP Addendum. Further discussion is presented in Section 2 of the 2022 GSP Addendum.

### North Management Area

Upper Aquifer – Two Wells
Angiola Water District **Well E20** (T22SR23E-25C) will be used for the upper aquifer in this area. The well is in the East Well Field and is perforated from 240 – 480 feet in depth. Water level records are available for this well since 2008, however, good correlation has been established with measurements from Well E20 and from Well T22SR23E-16C1. Well 16C1 has records since 1960. Depth to water in Well E20 was 200 feet in Spring 2015, which is the deepest spring water level of record. Figure 3.3.1 and A-1 of Appendix A of the 2022 GSP Addendum is a water-level hydrograph for this well for spring measurements. The Minimum Threshold spring water level elevation for this well will be -223 feet mean sea level for two springs in a row.

Angiola Water District **Well W14** is also used to monitor the upper aquifer. The well is in the West Well field and is perforated from 240 – 480 feet in depth. Water level records are limited for this well and are available beginning in 2018. Figure A-7 of the 2022 GSP Addendum is a water level hydrograph for this well and was adapted from Appendix G, Tule Coordination Agreement. The Minimum Threshold

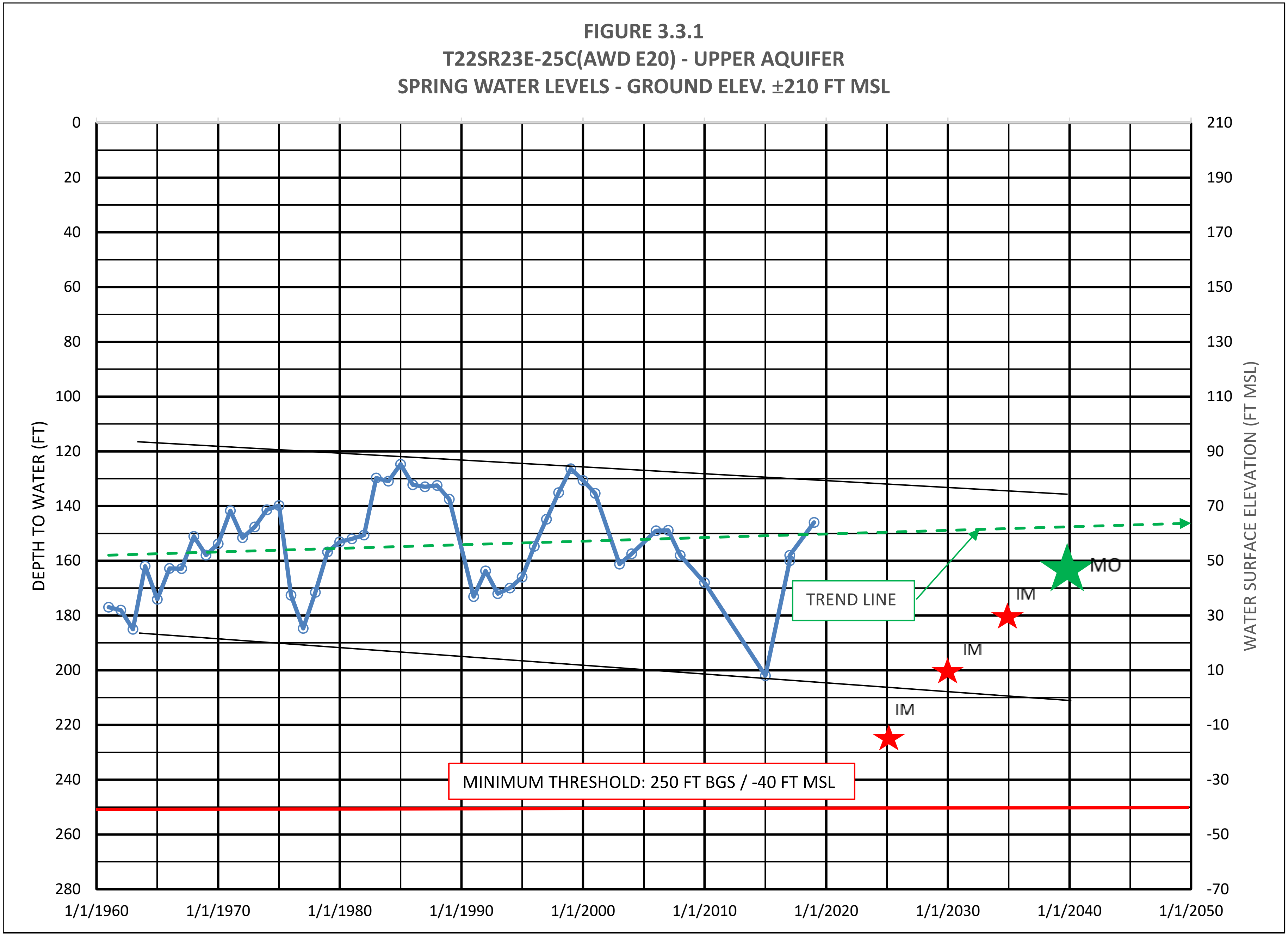


FIGURE 3.3.1
T22SR23E-25C(AWD E20) - UPPER AQUIFER
SPRING WATER LEVELS - GROUND ELEV. ±210 FT MSL
DEPTH TO WATER (FT)
WATER SURFACE ELEVATION (FT MSL)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
210
190
170
150
130
110
90
70
50
30
10
-10
-30
-50
-70
1/1/1960
1/1/1970
1/1/1980
1/1/1990
1/1/2000
1/1/2010
1/1/2020
1/1/2030
1/1/2040
1/1/2050
TREND LINE
MO
IM
IM
IM
MINIMUM THRESHOLD: 250 FT BGS / -40 FT MSL

elevation spring water level for this well will be an elevation of -223 feet mean sea level for two springs in a row.

Lower Aquifer – One Well

Angiola Water District **Well G-13** (T22SR23E-27F) will be used for the lower aquifer. This well is perforated from 782 to 1,604 feet in depth and is in the West Well Field. It is one of the deepest active wells that AWD operates. Spring water level measurements for this well are limited. Correlation with Well T22SR23E-28J was used to fill in the historical record for Well G-13. The depth to water in Spring 2015 was 326 feet, which is the deepest of record for spring measurements. Water levels have recently (Spring 2019) risen slightly to a depth of 310 feet. Figure 3.3.2 and Figure A-2 of Appendix A of the 2022 GSP Addendum are water level hydrographs for this well. The Minimum Threshold elevation spring water level will be -300 feet mean sea level for two springs in a row.

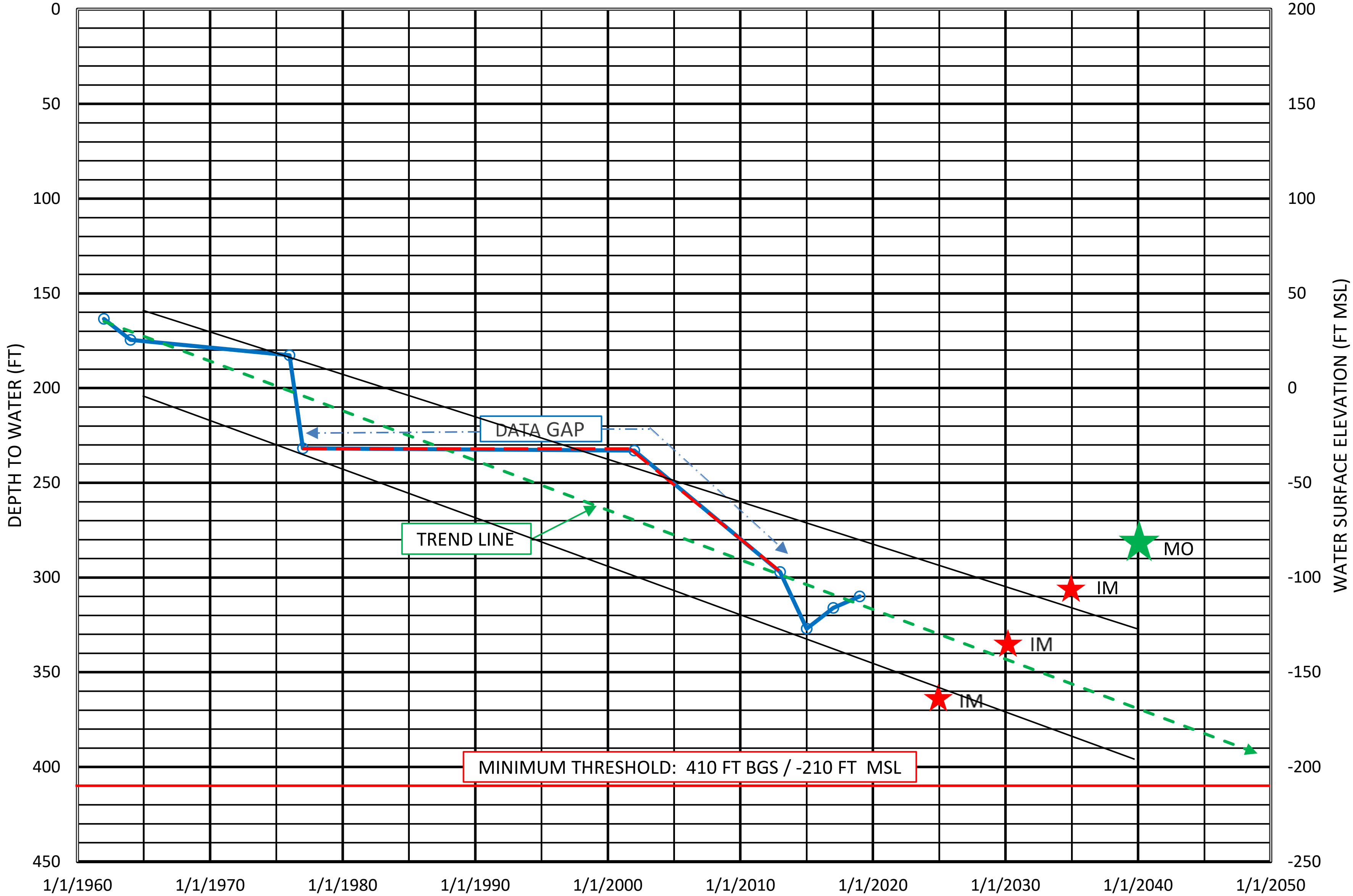
### Southeast Management Area

Upper Aquifer – Two Wells

Well **TSMW 5U** was recently drilled and installed by DWR as part of their Technical Support Services. The well was installed in July 2020 and fitted with a transducer. The well is screened from 170 – 280 feet below ground surface. Figure A-5 of Appendix A of the 2022 GSP Addendum is a hydrograph of transducer recordings and manually water level collections. The Minimum Threshold elevation at this well is 63 feet mean sea level for two springs in a row.

For **Well 22E1**, the water level record begins in 1960, prior to the construction of the California Aqueduct and continues to 2008, when the DWR discontinued reporting water levels. An attempt will be made to re- start water level measurements in this well. Figure 3.3.4A shows the depth to water measurements for 1960 - 2008. The effect of State Water Project water deliveries to Semi-Tropic Water Storage District to the south of the county line is clearly shown in the figure, with a decline in water levels from 1962 through the late 1970s, followed by rise in water levels after imported water deliveries began. The deepest spring water level before aqueduct deliveries began was 95 feet in depth in 1974. More recently, the spring water level in this well was 101 feet in depth in 1991. No water level measurements are available for this well from 2008 to the present. Figure 3.3.4B shows the record from 1980 to 2008, a period that is thought to reflect the effects of surface water deliveries. Even though the area does not receive surface water directly, the effects of surface water deliveries in Semi-Tropic Water Storage District just south of the Tulare County line are evident. Figure A-3 of Appendix A of the 2022 GSP Addendum combines Figure 3.3.4A and 3.3.4B with recent water level measurements. The Minimum Threshold elevation at this well is 63 feet mean sea level for two springs in a row.

FIGURE 3.3.2
T22SR23E-27F (G-13) LOWER AQUIFER
SPRING PRESSURE LEVELS - GROUND ELEV. ±200 MSL



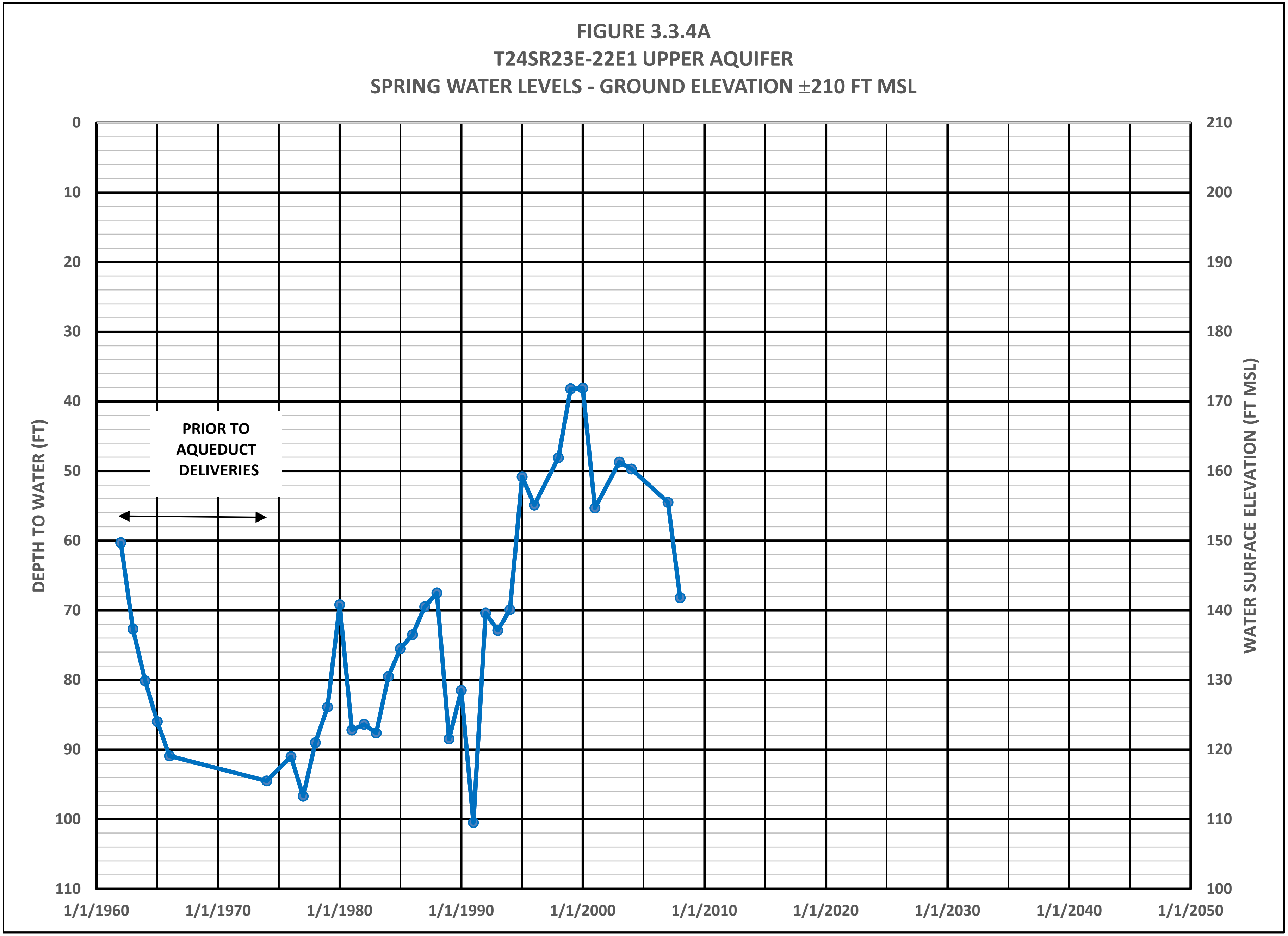


FIGURE 3.3.4A
T24SR23E-22E1 UPPER AQUIFER
SPRING WATER LEVELS - GROUND ELEVATION ±210 FT MSL
DEPTH TO WATER (FT)
WATER SURFACE ELEVATION (FT MSL)
PRIOR TO AQUEDUCT DELIVERIES
0
10
20
30
40
50
60
70
80
90
100
110
210
200
190
180
170
160
150
140
130
120
110
100
1/1/1960
1/1/1970
1/1/1980
1/1/1990
1/1/2000
1/1/2010
1/1/2020
1/1/2030
1/1/2040
1/1/2050

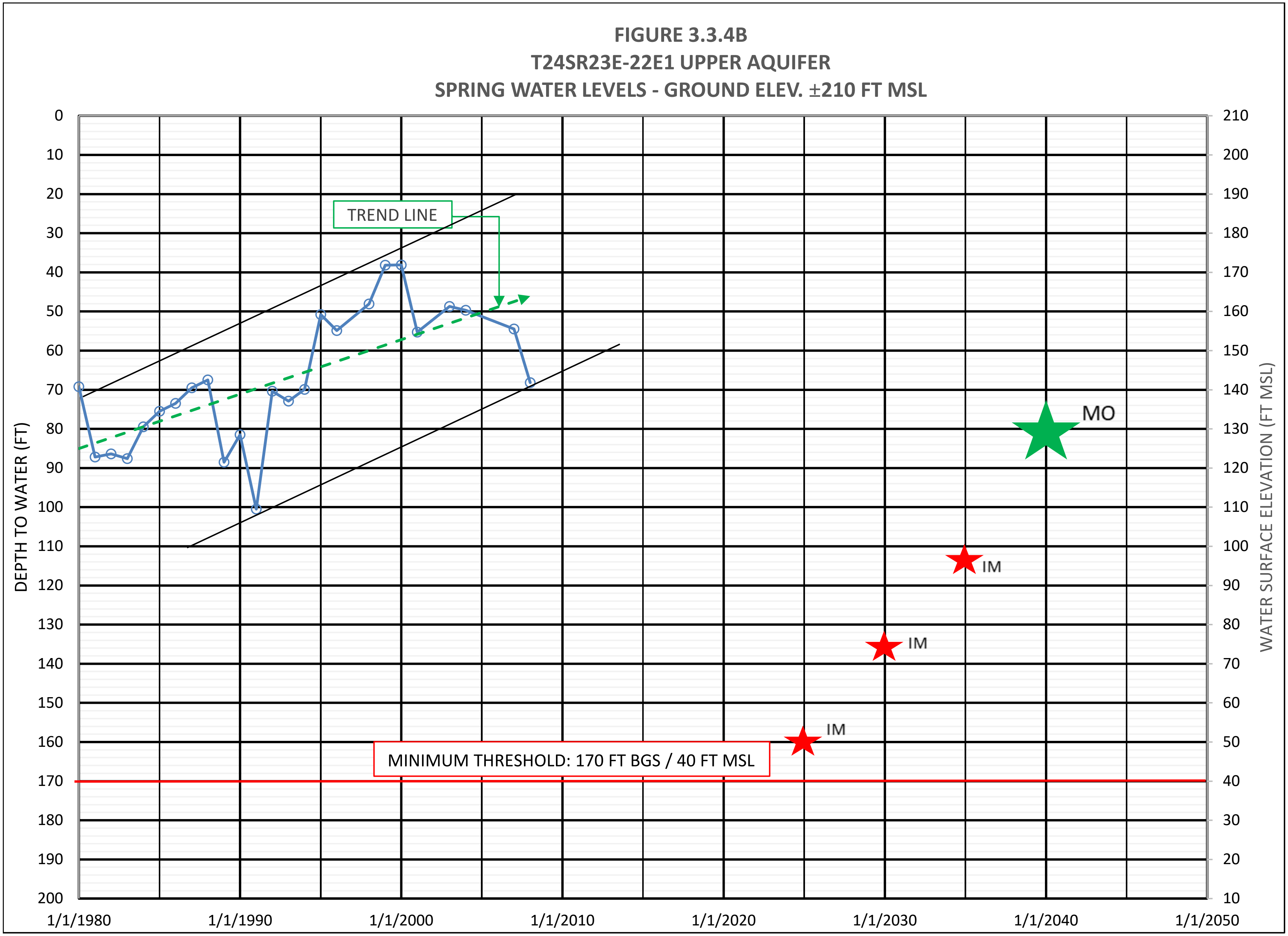


FIGURE 3.3.4B
T24SR23E-22E1 UPPER AQUIFER
SPRING WATER LEVELS - GROUND ELEV. ±210 FT MSL
DEPTH TO WATER (FT)
WATER SURFACE ELEVATION (FT MSL)
TREND LINE
MO
IM
IM
IM
MINIMUM THRESHOLD: 170 FT BGS / 40 FT MSL
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
1/1/1980
1/1/1990
1/1/2000
1/1/2010
1/1/2020
1/1/2030
1/1/2040
1/1/2050

Lower Aquifer – Two Wells

There are two RMS wells that are measured in the Southeast Area. One well has a history of measurements and is suitable to establish water level trends over the past twenty years or more. The second well is newly drilled and fills a data gap.

**Well TSMW 5L** was recently drilled and installed by DWR as part of their Technical Support Services. The well was installed in July 2020 and fitted with a transducer. The well is screened from 670 – 950 feet below ground surface. Figure A-6 of Appendix A of the 2022 GSP Addendum is a hydrograph of transducer recordings and manually water level collections. The Minimum Threshold elevation at this well is -100 feet mean sea level for two springs in a row.

**Well T24S/R23E-22R2**. Figure 3.3.5 and Figure A-4 of Appendix A of the 2022 GSP Addendum. This well is perforated from 400 feet to 1,200 feet in depth. Spring measurements are shown from 1978 - 2015. Trend lines for the shallowest and deepest water levels indicate water level declines. The deepest spring water level recorded was 336 feet in 2015. The Minimum Threshold level will be an elevation of -100 ft mean seal level for two springs in a row.

**REDUCTION of GROUNDWATER STORAGE**

Causation:

Reduction of groundwater storage occurs when pumping exceeds the available recharge of the aquifer over a hydrologic base period. The reduction in storage is based on usage above the sustainable yield of 18,300 afy. Water levels will be used for change in groundwater storage for the unconfined aquifer. The net groundwater use will be calculated based on pumpage, crop water usage (ET), municipal usage (minimal), subtracting from that amount the amount of surface water supplied, and rainfall contribution to groundwater storage (minimal). Projects and management actions will be implemented in order to decelerate and arrest chronic decreases in groundwater storage within TCWA GSA.

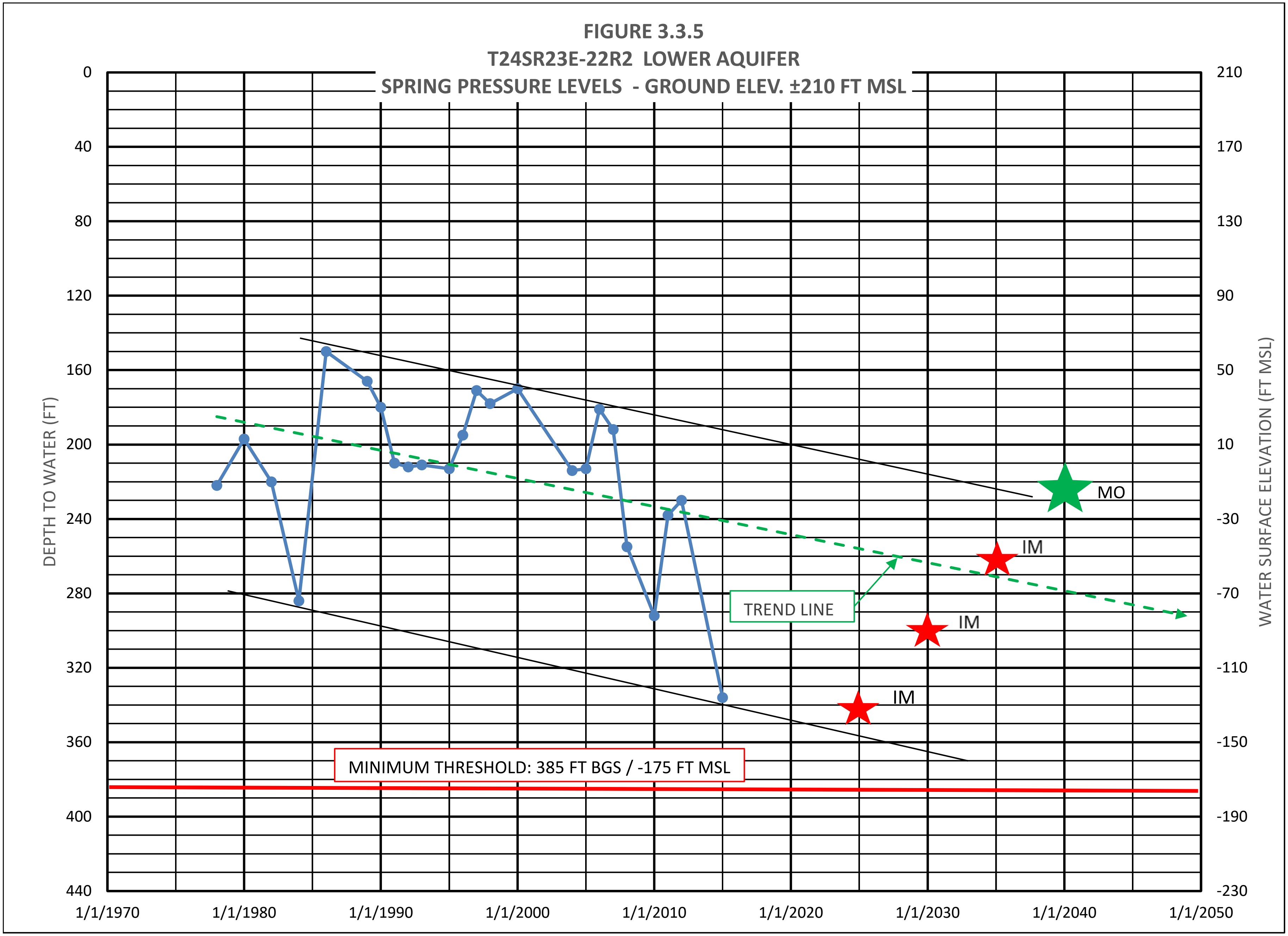


FIGURE 3.3.5
T24SR23E-22R2 LOWER AQUIFER
SPRING PRESSURE LEVELS - GROUND ELEV. ±210 FT MSL
DEPTH TO WATER (FT)
WATER SURFACE ELEVATION (FT MSL)
0
40
80
120
160
200
240
280
320
360
400
440
210
170
130
90
50
10
-30
-70
-110
-150
-190
-230
1/1/1970
1/1/1980
1/1/1990
1/1/2000
1/1/2010
1/1/2020
1/1/2030
1/1/2040
1/1/2050
MO
IM
IM
IM
TREND LINE
MINIMUM THRESHOLD: 385 FT BGS / -175 FT MSL

Criteria:

An undesirable result for TCWA would be the sustained lowering of groundwater levels in two consecutive reporting years, exceeding the minimum thresholds at Representative Monitoring Sites that collectively represent monitoring areas that comprise 50% or more of the TCWA GSA.

Effects:

An exceedance of minimum thresholds to the extent that an undesirable result for lowering of groundwater levels could induce well failures (e.g. collapsed casing due to land subsidence), additional operational costs for groundwater extraction from deeper pumping levels, and additional costs to lower pumps, deepen wells, or drill new wells. Corollary effects might include land subsidence resulting in damage to critical infrastructure, migration of poor quality groundwater, and production of poor water quality that would no longer be beneficially useable at a reasonable cost.

**THRESHOLDS:**

Upper Aquifer

Wells used for reduction of Groundwater Storage will be the same wells that have been selected for the upper aquifer for Chronic Lowering of Groundwater Levels. Spring water levels will be used to estimate the annual change in groundwater storage in the upper aquifer. Water levels are therefore a good gage of changes in groundwater storage for the upper aquifer. It should be noted that there has not been a chronic lowering of groundwater levels in the upper aquifer in TCWA GSA, in fact, water levels are stable.

Lower Aquifer

The lower aquifer is a confined aquifer. Therefore, water levels reflect pressure levels. Pressure levels cannot be used to calculate a volumetric change in storage, because the aquifer stays full, even with large pressure declines. Amounts of land subsidence indicate changes in storage within the confining layers, due to compaction of clay layers. This is considered the change in storage for the lower aquifer.

## DEGRADED GROUNDWATER QUALITY

Additional discussion is presented in Section 4 of the 2022 GSP Addendum.

Causation:

Groundwater quality may be degraded to the extent that it is not suitable for beneficial uses for the following reasons:

- Naturally occurring constituent concentrations that exceed regulatory levels or are otherwise undesirable, are encountered at certain depths and/or locations within the GSA.
- Irrigation practices and concentration of salts due to evapotranspiration;
- Application and use of fertilizer, chemical additives, or other soil amendments that leach into the subsurface and percolate to the groundwater;
- Influences of well conduits that allow poor quality groundwater to move downward and degrade the quality of deeper groundwater;
- Intentional and unintentional spills of toxic compounds.

TCWA will partner, as needed, with the appropriate entities already currently regulating activities that may have an effect on groundwater quality. Projects and management actions will be implemented in order to mitigate the degradation of groundwater quality within the TCWA GSA by 2040.

Criteria:

Refer to Section 4 of the 2022 GSP Addendum.

Effects:

An exceedance of minimum thresholds to the extent that an undesirable result for degraded groundwater quality is experienced would likely induce hardship on groundwater users such as groundwater quality that adversely affects crop growth, may create additional costs to treat water for household and drinking water use, may create additional costs to treat water for agronomic use, may cause acute and chronic health risks, may cause the inability to use existing wells for agricultural or municipal purposes, and may create significant costs to remediate degraded groundwater within the GSA.

**LAND SUBSIDENCE**

Additional discussion is presented in Section 3 of the 2022 GSP Addendum.

Causation:

Permanent or irreversible land subsidence is caused by the dewatering and subsequent compaction of clay layers above or within the lower aquifer. Land subsidence within the TCWA GSA has been a problem for many decades. One of the most notable effects has been hundreds, if not thousands, of well collapses. Projects and management actions will be implemented in order to decrease and eventually stop land subsidence in the TCWA GSA to the extent possible by 2040. The new High-Speed Rail Project passes through the GSA, and therefore this public infrastructure will be affected by land subsidence.

Criteria:

Refer to Section 3 of the 2022 GSP Addendum.

Effects:

An exceedance of minimum thresholds to the extent that the undesirable result for any single designated Management Area is experienced would likely critically impair critical infrastructure, degrade the ability of critical infrastructure to function as designed, harm property interests, and/or significantly increase the costs to design and construct future planned infrastructure (refer to Figure 3.3.0). Impairments to critical infrastructure would result in the accrual of excessive costs to fix, repair, or otherwise retrofit such infrastructure and may also result in an interim loss of benefits to the users of such infrastructure.

An exceedance of minimum thresholds to the extent that the undesirable result for TCWA GSA is experienced could likely induce financial hardship on land and property interests, such as fixing and retrofitting of existing infrastructure, and repair or replacement of water supply wells.

## THRESHOLDS

Refer to Section 3 of the 2022 GSP Addendum for details.

Pumping from beneath clay layers by deep wells decreases the pressure levels. The reduced pressure causes water contained within the clays to migrate out of the layers. The clays that collapse as water is expelled, cause land subsidence. Therefore, water levels in wells that are completed in the lower aquifer reflect changes in pressure levels in the lower aquifer. Rising pressure levels normally result in a reduction of subsidence. Therefore, measuring water levels in wells completed in the lower aquifer will be used as a surrogate for the absence or presence of subsidence in the interim period, and a correlation between measured land subsidence and these water levels will be developed.

### Southeast Management Area

Estimated land subsidence from 1949-2005 was greatest in the area near and south of Allensworth along Highway 43, where it ranged from 10 to 15 feet. Average annual rates ranged from about 0.2 to 0.35 feet per year. For most of the rest of the Southeast Management Area, the historical land subsidence ranged from about 5 to 10 feet per year. Average annual rates ranged from about 0.07 to 0.2 feet per year. Between May 7, 2015 and September 10, 2016, land subsidence in the Southeast Management Area was indicated by JPL to range from about 0.7 to 1.7 feet. This is equal to about 0.5 to 1.3 feet per year. Rates of land subsidence in this area also partly depend on pumping of wells south of the Kern County line. Water levels in wells completed in only the lower aquifer will be used as a surrogate for subsidence in the interim period, while a correlation between measured land subsidence and these water levels is developed.

As in the North Management Area, once results from the proposed subsidence monitoring program are available (after about five years), then threshold levels for land subsidence can be established at specific locations in the Southeast Management Area.

Refer to Section 3 of the 2022 GSP Addendum for more details.

**§354.28 Minimum Thresholds**

a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.

c) Minimum thresholds for each sustainability indicator shall be defined as follows:

1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:

A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.

B) Potential effects on other sustainability indicators.

2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

3) Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:

A) Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.

B) A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.

4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

**§354.28 Minimum Thresholds**

5) Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:

   A) Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.

   B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

6) Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:

   A) The location, quantity, and timing of depletions of interconnected surface water.

   B) A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.

d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

# 3.4 MINIMUM THRESHOLDS [§354.28(a)(d)(e)]

**§354.28 Minimum Thresholds**

b) The description of minimum thresholds shall include the following:

1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

2) The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

## 3.4.1 DESCRIPTION OF MINIMUM THRESHOLDS [§354.28(b)]

Pursuant to §354.28(a), (d), and (e), TCWA has established minimum thresholds: The following Table 3.4.1 and Chapter 2 of the 2022 GSAP A summarizes the Minimum Thresholds that are discussed and evaluated previously in Chapter 3.3.

# Table 3.4.1
## Minimum Thresholds

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Table 3.4.1** | | | | |
| TRI-COUNTY WATER AUTHORITY | | | | | | | |
| PROPOSED WELLS TO BE MONITORED | | | | | | | |
| Management Area | Aquifer | Well Identification | Approx. Ground Elevation (Feet MSL) | Perforated Interval | Period of Record | Minimum Threshold | |
| | | | | | | DTW (Feet) | Approx. Elevation (Feet MSL) |
| North Area | Upper | T22SR23E-25C (AWD E-20) | 210 | 240 - 480 | 1961 - 2022[1] | 433 | -223 |
| | Upper | W14 | 210 | 240 - 480 | 2018-2022 | 433 | -223 |
| | Lower | T22SR23E-27F (AWD G-13) | 200 | 782 -1604 | 1962 - 2022[2] | 500 | -300 |
| | | | | | | | |
| Southeast Area | Upper | TSMW 5U | 200 | 170 - 280 | 2020-2022 | 263 | 63 |
| | Upper | T24SR23E-22E1[3] | 210 | 150 - 210 | 1962 - 2022 | 147 | 63 |
| | Lower | T24SR23E-22R2 | 210 | 400 - 1200 | 1978 - 2022 | 310 | -100 |
| | Lower | TSMW 5L | 200 | 670 - 950 | 2020 – 2022 | -300 | -100 |

Notes

1. This well's records were combined with those of Well T22SR23E-16C1 to create the period of record.
2. This well's records are very limited. It's records were combined with Well T22SR23E-28J1 to develop a period of record.
3. This well's records extend from 1962 - 2008. It is included in the network because of the limited number of shallow wells with a long period of record.
   The period of record used to establish the Minimum Threshold and Measurable Objectives was 1980 -2008.

**§354.30 Measurable Objectives**

a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.

g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

# 3.5 MEASURABLE OBJECTIVES [§354.30(a), (b), (c), (d), (f), (g)]

## 3.5.1 MEASURABLE OBJECTIVES DESCRIPTION [§354.30(a)(b)]

Measurable Objectives and five-year Interim Milestones have been established for each of the wells that are planned to be monitored for Minimum Thresholds. See Figures 3.3.1 – 3.3.8. The following Table 3.5.1 presents the original 2020 GSP Measurable Objectives and Interim Milestones for the former eight RMS wells. Further discussion of TCWA's Measurable Objectives is presented in Section 2 of the 2022 GSP Addendum.

## Table 3.5.1
## Measurable Objective and Interim Milestones

**Table 3.5.1**

| TRI-COUNTY WATER AUTHORITY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Interim Milestones and Measurable Objectives | | | | | | | | | | |
| | | | Interim Milestones | | | | | | Measurable Objectives | |
| Management Area | Aquifer | Well Identification | 2025 | | 2030 | | 2035 | | 2040 | |
| | | | Depth to Water (Feet) | MSL Elevation (Feet) | Depth to Water (Feet) | MSL Elevation (Feet) | Depth to Water (Feet) | MSL Elevation (Feet) | Depth to Water (Feet) | Approx. Elevation (Feet MSL) |
| North Area | Upper | T22SR23E-25C (AWD E-20) | 225 | -15 | 200 | 10 | 180 | 30 | 165 | 45 |
| | Lower | T22SR23E-27F (AWD G-13) | 365 | -165 | 345 | -145 | 305 | -105 | 280 | -80 |
| | | | | | | | | | | |
| Southeast Area | Upper | T24SR24E-25J1 | 95 | 155 | 85 | 165 | 70 | 180 | 65 | 185 |
| | Upper | T24SR23E-22E1[3] | 50 | 160 | 75 | 135 | 95 | 115 | 80 | 130 |
| | Lower | T24SR23E-22R2 | 340 | -130 | 300 | -90 | 260 | -50 | 220 | -10 |
| | Lower | T23SR23E-25N1 | 300 | -90 | 270 | -60 | 240 | -30 | 210 | 0 |
| | Lower | T24SR23E-15R1 | 340 | -130 | 300 | -90 | 270 | -60 | 225 | -15 |
| | Lower | T24SR24E-4R1 | 200 | 10 | 185 | 25 | 165 | 45 | 150 | 60 |

Notes

1. This well's records were combined with those of Well T22SR23E-16C1 to create the period of record.
2. This well's records are very limited. It's records were combined with Well T22SR23E-28J1 to develop a period of record.
3. This well's records extend from 1962 - 2008. It is included in the network because of the limited number of shallow wells with a long period of record.\

Note: Table 3.5.1 presents the former RMS network for TCWA. Adjustments have been made to the RMS network and are discussed in the 2022 GSP Addendum.

### 3.5.2 MEASURABLE OBJECTIVES SAFETY MARGIN [§354.30(c)]

Minimum safety margins shall be set in the Measurable Objectives such that with establishment of the planned projects and management actions, there will be little chance of exceeding the Interim Milestones or the Minimum Thresholds, and that by 2040, the Measurable Objectives will have been attained. Further discussion of Measurable Objectives is presented in the 2022 GSP Addendum.

**§354.30 Measurable Objectives**

e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

### 3.5.3 PATH TO SUSTAINABILITY GOAL [§354.30(e)]

The path to sustainability is two-fold. It is anticipated that there will be a reduction in crop water demand and development of new water supply projects, to accomplish the goal of sustainability by 2040.

Projects

Chapter 5 lists projects that are proposed for the GSA. These will benefit both the North and the Southeast Areas. It is important to note that the projects proposed by the project proponents have not been vetted by TCWA. With respect to the projects that are relying on excess surface supplies such as flood flows, there is the underlying assumption that flood waters are available. The fallback for not achieving the proposed project yields is a reduction in crop water demand. This can be achieved by changing crop types (for example, from trees to vines), or from permanent crops to annual crops (for example, from trees to grain crops), or by a reduction in the amount of planted acreage.

It is anticipated that projects will be undertaken in five-year increments, beginning in 2020. The proposed schedule is to have the majority of the projects and management actions in place by 2030. However, there are many data gaps that must be filled in the initial years of the GSP. TCWA therefore utilizes an adaptive management approach that allows flexibility in the application of these measures. It is recognized that the projects that are proposed herein are not going to be the totality of projects that will be implemented over the planning period. It is anticipated that there will be additional recharge projects, additional projects developed that will be directed at arresting subsidence, and additional projects that will reduce groundwater pumpage by either land retirement or changes in cropping pattern. There will also be projects that will be developed to address habitat development and enhancement. It is also recognized that some proposed projects or portions of the projects may not be needed. Adaptive management will measure the effectiveness of the projects and management actions by monitoring the results of these actions over time, as required by SGMA.

Monitoring

Monitoring for the GSP will also begin in 2020 and it is planned to fill the data gaps that exist in the information that is required to effectively manage the GSA. The first five years of the implementation period for the GSP will be focused on gathering adequate information through monitoring, to develop a better understanding of the water demands, surface water supplies, groundwater levels and quality, and land subsidence in the GSA. Additional monitoring details are presented in the 2022 GSP Addendum.

Data Gaps

There are data gaps in measurements of groundwater pumpage and water levels, water quality, and the measurements of land subsidence. The following measures/actions will be implemented to address the data gaps. Data gaps are also discussed in the 2022 GSP Addendum.

Pumpage

Totalizing flow meters will be installed on all large-capacity wells in the GSA, beginning in 2020.

Water Level Measurements

Water level measurements will begin in 2020 for the Representative Monitoring Wells to establish progress towards the goal of sustainability. It is also planned to develop enough information on water levels that accurate water level elevation contour maps can be prepared for both aquifers in the GSA. These can then be used to better estimate lateral groundwater flows for both aquifers. Water Level measurements are also discussed in the 2022 GSP Addendum.

Water Quality Testing

Water samples will be collected in the GSA and other wells as required to develop changes in electrical conductivity in compliance with the Water Quality Control Plan for the Tulare Lake Basin (RWQCB 2018). Base electrical conductivity and the concentrations of constituents of concern (COCs) will be established during the first five years of the plan, from which the maximum average annual conductivity increase and change in concentrations of the COCs will be determined and reported. This will be done through coordination with the Tule Subbasin GSAs and the program implemented by the Tule Subbasin GSAs will be implemented by TCWA. Water quality testing is also discussed in the 2022 GSP Addendum.

Subsidence

There are plans to establish a network of GPS monitoring stations in the Tule Subbasin together with two extensometers to be installed in the Tule and Tulare Lake Subbasins over the next five years, pending procurement of financing. In the Tule Subbasin and in the TCWA GSA, a monitoring program has been proposed for land surface elevations utilizing GPS technology.

It has been demonstrated that effective stress in the clay layers increases when water is pumped from beneath the clays (see discussion in Chapter 3.3.3, above), causing compaction of the clays, and resulting in permanent land subsidence. Subsidence paths to reach TCWA's sustainability goal are also discussed in the 2022 GSP Addendum

## SCHEDULE – PATH TO SUSTAINABILITY

### 2020 through 2024

The path to sustainability begins in 2020 with the establishment of the Groundwater Sustainability Plan. As pointed out previously in this GSP, there is a lack of recent information on groundwater levels in the GSA. Angiola Water District has some information on water levels in District wells and these levels have been used to establish a reasonable approximation of the groundwater levels in the North Area. The Southeast Area, as noted previously in this GSP, is a "white area" and there is an overall lack of water level measurements after 2008, when the DWR ceased reporting water levels, except for the CASGEM program. Hence, the effects of the recent drought period were not recorded in sufficient detail to establish overall water level trends in TCWA. Wells for which water level measurements have been established have been used to develop the historical water levels. One of the first tasks of the TCWA will be to establish a repository for groundwater information – a data base – and collect information on pumpage, groundwater levels, groundwater quality, and land subsidence in the GSA. This will be done in the first five years of the implementation period. When a more complete understanding of the groundwater conditions is established, the Measurable Objectives will be modified to more accurately reflect conditions in the aquifers.

During the first five years of the plan, it is anticipated that several supplemental surface water augmentation projects will be initiated. These will be the First Phase of the Liberty Project, White Ranch Project, the Prosperity Farms project for the Southeast Area, together with design of Phases Two and Three of the Liberty Project. There will be no planned reduction in cropping during these first five years, so that crops will not needlessly be idled while the GSA is in the data gathering mode. However, some landowners may decide to idle some lands and move forward with surface water projects and conversion of lower aquifer pumping to upper aquifer pumping during this time period.

A groundwater extraction fee will be implemented in the first year of the implementation period that will apply to groundwater extractions in the GSA during the first years of GSP implementation.

Therefore, the anticipated work for these first five years will be:

- The first Annual Report will be issued in April 2020.
- Coordination with the Tule Subbasin member GSAs. Coordination with neighboring GSAs in Kern and Kings Counties.
- Data gathering.
- Flow meter installation on all large-capacity wells, and recordation of water pumped by wells.
- Assessment of wells to determine adequacy for groundwater monitoring.

- Groundwater tolls developed and put in place.
- Development and modification of the monitoring network – for pumpage, surface water supplies, water levels, groundwater quality, and land subsidence.
- Preparation of water level elevation and direction-of-groundwater-flow maps, additional well hydrographs, and water quality maps.
- Establishment of benchmarks and periodic re-surveys of land surface elevations at monitoring sites for both water levels and land subsidence.
- Initiation of supplemental surface water augmentation projects.
- Conversion of pumping from the lower aquifer to the upper aquifer at selected locations.
- Administrative functions, including operating budget and water toll fee establishment, report preparation, and communication. Development of staffing requirements for both field and administrative functions, including administrative and management costs levied by the Tule Subbasin.

**2025 through 2029**

Projects will be expanded and put in place during this period. The Liberty Project, which will provide supplemental surface water to the North Area and to the Southeast Area, will allow for reduced groundwater pumpage and improved subsidence conditions. The conversion of wells pumping from the lower aquifer to pumping from the upper aquifer will continue, and this will help reduce land subsidence. Potential impacts to the upper aquifer from the transition to upper aquifer pumping will be closely monitored. It is understood that there is a limited amount of conversion that can be accomplished, and this will be established through the monitoring program.

Measurable objectives will be modified to reflect a greater understanding of the groundwater conditions, the network of existing wells that are to be monitored will be modified with the addition of wells, and possible construction of monitor wells and an extensometer in the GSA.

Implementation of idling up to 10% of croplands will be considered, pending the results of the monitored data, progress on project implementation, well conversion programs, and coordination with neighboring GSAs.

The anticipated work during the second five-year period includes:

- Coordination with the Tule Subbasin member GSAs. Continued coordination with neighboring GSAs in Kern and Kings Counties.
- Continuation of data gathering and population of the data base.
- Reductions on groundwater pumping to be implemented.
- Groundwater tolls modified based on water use results and plan operating costs, to include tolls levied by the Tule Subbasin for administrative and management functions.
- Analysis of the results of the data gathered – to include rates of land subsidence, groundwater pumpage, changes in water quality, changes in water levels, calculation of groundwater flows into and out of the GSA, calculation of the changes in pumpage from the conversion of groundwater

pumping from the lower aquifer to the upper aquifer, and the effects of the change on subsidence and groundwater levels in the upper and lower aquifers.
- Administrative functions continue.

**2030 through 2034**

Projects will be expanded to completion during this period, data gathering will continue, additional restrictions on groundwater pumping will be implemented, and it is anticipated that this will result in another 10% reduction in lands that are cropped. Wells will continue to be converted from pumping from the lower aquifer to the upper aquifer, and groundwater extractions will continue to be reduced due to increased supplemental surface water availability to both the North and the Southeast Areas.

The anticipated work during this third five-year period includes:
- Coordination with the Tule Subbasin member GSAs. Continued coordination with neighboring GSAs in Kern and Kings Counties.
- Continuation of data gathering and population of the data base.
- Additional restrictions on groundwater pumping are anticipated, resulting in a reduction of planted acreage, but offset by the anticipated provision of supplemental surface water.
- Groundwater tolls to be evaluated and modified according to results obtained during the past five years and program management costs, including Tule Subbasin administrative/management costs.
- Groundwater tolls modified based on water use results and program operating costs, to include tolls levied by the Tule Subbasin for administrative and management functions.
- Analysis of the results of the data gathered – to include rates of subsidence, groundwater pumpage, changes in water quality, changes in water levels, calculation of groundwater flows into and out of the GSA, calculation of the changes in pumpage from the conversion of groundwater pumping from the lower aquifer to the upper aquifer and the effects of the change on subsidence and groundwater levels in the upper and lower aquifers.
- Administrative functions continue.

**2035 through 2039**

This fourth and final five-year period will include the evaluation of the programs put in place, which will include the effects of global warming, and the anticipated reduction in surface water supplies with the attendant increase in crop water use. Sustainability must be achieved by the end of this period. The program will evaluate changes that are needed to maintain the groundwater balance into the future to 2070. Additional adjustments may be required based on the results of the information gathered during the previous years, and with the possible development of additional surface water supplies during the twenty-year period. Plans will be prepared for the continuance of the program through the year 2070.

The anticipated work during this fourth five-year period includes:
- Coordination with the Tule Subbasin member GSAs. Continued coordination with neighboring GSAs in Kern and Kings Counties.
- Continuation of data gathering and population of the data base.

- Additional restrictions on groundwater pumping are anticipated, resulting in a reduction of planted acreage, but offset by the anticipated provision of supplemental surface water.
- Groundwater tolls to be evaluated and modified according to results obtained during the preceding five years and program management costs, including Tule Subbasin administrative/management costs.
- Groundwater tolls modified based on water use results and program operating costs, to include tolls levied by the Tule Subbasin for administrative and management functions.
- Analysis of the results of the data gathered – to include rates of subsidence, groundwater pumpage, changes in water quality, changes in water levels, calculation of groundwater flows into and out of the GSA, calculation of the changes in pumpage from the conversion of groundwater pumping from the lower aquifer to the upper aquifer and the effects of the change on subsidence and groundwater levels in the upper and lower aquifers.
- It is anticipated that sustainability will have been attained by the beginning of this period, and therefore the final report for the twenty-year period will be a review of the path that was taken to achieve sustainability and a plan for continuance of the program, modified as required, through the year 2070. The effects of global warming will have been evaluated and a greater understanding of these effects on surface water supplies and evapotranspiration will be considered in planning for continuance of the program through 2070. The influence of global warming is expected to be more than offset by watershed management and increased water yields from the Sierra Nevada mountains.
- Administrative functions continue.

# CHAPTER 4: MONITORING NETWORK §354.32 – 354.40

**§354.32 Introduction to Monitoring Networks**

This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

## 4.1 INTRODUCTION [§354.32]

**§354.34 Introduction to Monitoring Networks**

a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.

b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

   1) Demonstrate progress toward achieving measurable objectives described in the Plan.

   2) Monitor impacts to the beneficial uses or users of groundwater.

   3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.

   4) Quantify annual changes in water budget components.

There is not a great number of wells in the TCWA with both historical and recent groundwater level measurements. A search was made for wells with water level measurements that span a twenty-year period beginning before the recent drought and ending after the drought ended, around 2017. The search resulted in the wells listed in Tables 3.4.1 and 3.5.1, eight active large-capacity wells that have a history of water level measurements, some dating back to before the California Aqueduct began water deliveries.

The network of active wells to be measured in the North Area will be expanded over the next few years, and these wells will be used to develop groundwater contours in order to gain a more complete understanding of the direction of groundwater flow. There are a number of wells that do not have complete water level records but that have well completion reports. It is planned to eventually measure about one well per section in the GSA, if possible, in order to prepare suitable water level elevation maps.

There is a sufficient number of wells perforated only in the lower aquifer in the Southeast Area to develop groundwater level contours. Measurement of these wells will depend on landowners' permission and on provision of suitable access into the well casing for tanking measurements. There is not a sufficient number of wells perforated only in the upper aquifer. It is planned to expand the number of measurement locations in the upper aquifer by constructing monitor wells perforated only in this aquifer and to expand the network by using shallow stock wells and domestic wells with construction information that can be verified.

The Tule Subbasin Monitoring Program is considering an additional five lower aquifer wells to be used for representative monitoring sites. The information from these sites will be incorporated into TCWA's groundwater characterization. TCWA's RMS water level monitoring network consists of 7 wells with four wells monitoring the upper aquifer and three wells monitoring the lower aquifer.

## 4.2 MONITORING NETWORK OBJECTIVES [§354.34(a), (b)]

### 4.2.1 OBJECTIVE 1:

Determine the pumpage from each large capacity well in the GSA.

All large-capacity wells in the GSA will have flow meters installed by the end of the first year of the implementation period. Groundwater production will be recorded on a monthly basis and reported on an annual basis.

### 4.2.2 OBJECTIVE 2:

Determine the lateral direction of groundwater flow for each aquifer in the spring of each year.

Water levels will be measured in the spring of the year when the water levels are their shallowest, and in the fall, after the time of the lowest levels. Seasonal water level changes will be recorded in the GSA's database and shared with the Tule Subbasin GSAs. Water level elevation contours will be drawn and the direction of groundwater flow will be shown for the spring of each year.

### 4.2.3 OBJECTIVE 3:

Determine seasonal, annual, and long-term trends in depth to water for each aquifer, and to determine storage changes.

Water levels will be measured in the spring of the year when the water levels are their shallowest, and in the fall, after the time of the lowest levels. Spring measurements will be used to determine water level changes in the upper aquifer and, along with specific yield values, the change in storage in the upper aquifer can be determined. Seasonal water level changes will be recorded in the GSA's database and shared with the Tule Subbasin GSAs. Storage changes in the lower aquifer will be determined from measurements of land subsidence. These storage changes are due to compaction of confining beds. Further discussion of water levels is presented in Section 2 of the 2022 GSP Addendum.

### 4.2.4 OBJECTIVE 4:

Determine land subsidence on an annual basis in the GSA.

The Tule Subbasin plans to immediately begin installation of land subsidence measurement stations that will be monitored by conventional GPS surveying equipment until such time that remote controlled instrumentation is installed. Water level changes in the lower aquifer will be correlated with land settlement in an effort to determine if subsidence can be estimated by pressure levels in the lower aquifer. It is known that reduction in pressure levels is an indicator of subsidence and that stabilization or an increase in pressure levels indicates the absence of subsidence. TCWA plans to install elevation benchmarks at the wells that are used for measuring groundwater levels in the GSA. These benchmarks will be surveyed periodically to measure subsidence at these locations and to account for changes in land elevation so that accurate water level elevations are obtained. Additional information on land subsidence is presented in Section 3 of the 2022 GSP Addendum.

### 4.2.5 OBJECTIVE 5:

Determine groundwater quality for both aquifers, and establish long-term trends.

Water samples will be withdrawn from wells tapping the upper and lower aquifers during the irrigation season. The water quality trends in both the upper and lower aquifers will be established. The relationship between groundwater levels and groundwater quality will be studied. TCWA's groundwater quality program will be conducted in conjunction with the Tule Subbasin's program, with sampling and water quality testing performed by the Tule Subbasin. Surface water quality will be monitored by the Tule Subbasin. TCWA's surface water quality sampling and testing program will be performed by the Tule Subbasin. The Tule Subbasin will schedule water quality sampling with TCWA and copy TCWA on all water quality testing results. Further discussion on water quality is presented in Section 3 of the 2022 GSP Addendum.

### 4.2.6 OBJECTIVE 6:

Accumulate other information needed to prepare water budgets for the groundwater in each aquifer.

Annual water budgets will be developed based on crop consumptive use, groundwater pumpage, and surface water supplies, and estimates of groundwater inflow and outflow and change in storage. The groundwater balance will be calculated annually. As programs that make accurate determinations of evapotranspiration are developed, TCWA will transition out of land-based determinations of crop water use to satellite-based programs. However, groundwater extractions will continue to be measured and recorded for each large-capacity production well. Extraction fees will be based on actual extractions.

**§354.34 Introduction to Monitoring Networks**

c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:

   A. A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.

   B. Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.

3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:

   A. Flow conditions including surface water discharge, surface water head, and baseflow contribution.

   B. Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.

   C. Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.

   D. Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

**§354.34 Introduction to Monitoring Networks**

d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

**§354.38 Assessment and Improvement of Monitoring Network**

a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

   1) The location and reason for data gaps in the monitoring network.

   2) Local issues and circumstances that limit or prevent monitoring.

d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

   1) Minimum threshold exceedances.

   2) Highly variable spatial or temporal conditions.

   3) Adverse impacts to beneficial uses and users of groundwater.

   4) The potential to adversely affect the ability of an adjacent basin to implement or impede achievement of sustainability goals in an adjacent basin.

# 4.3 SUSTAINABILITY INDICATORS [§354.34(c)]

Refer to the discussions in Chapter 3 and the 2022 GSP Addendum for a complete discussion of sustainability indicators. The following sub-paragraphs discuss the selection of the wells to be monitored to develop the information required to determine progress towards the goal of sustainability.

## 4.3.1 CHRONIC LOWERING OF GROUNDWATER LEVELS [§354.34(c)(1)]

Refer to Chapter 3 and Section 2 of the 2022 GSP Addendum for a discussion of groundwater levels. Seven wells have been selected in the GSA to monitor this indicator. The criteria for selection was a history of water level measurements, construction information, and location in the GSA. All wells will be measured semi-annually. There are three in the North Area and four in the Southeast Area. Three Angiola Water District wells have been selected for the North Area; two tapping the upper aquifer and one tapping the lower aquifer. Four private wells have been selected in the Southeast Area. There are two that tap the upper aquifer and two others that tap the lower aquifer.

Upper Aquifer

It is planned to augment wells in the upper aquifer with (4”- 6” diameter) shallow monitor wells, and with existing shallow irrigation wells, stock-watering, and domestic wells for which construction information can be developed. Water levels in these wells will be measured to determine groundwater levels in the upper aquifer. Thomas Harder & Co. (TH&C), selected several candidates wells in the upper aquifer for Representative Monitoring Sites for the Tule Subbasin Monitoring Plan (“SMP”) (Figure A1-2, Appendix G). These wells were added to the original 2020 TCWA Monitoring Plan and then revised for the 2022 GSP Addendum for upper aquifer monitoring. TCWA Groundwater Level Representative Monitoring Sites (RMS) wells are identified in Appendix A of the 2022 GSP Addendum. A newly installed upper aquifer monitoring well was added to the TCWA Monitoring Plan and is shown on Figures A1-2 and 4.1.3 of Appendix A of the 2022 GSP Addendum. All candidate wells require inspection for access for water level measurements and require landowner permission to use for monitoring. TCWA will work with Tule Subbasin GSAs in this effort.

Lower Aquifer

For the lower aquifer the pressure levels in the three selected wells will be monitored. TH&C. proposed several wells in TCWA as RMS wells for the lower aquifer. These wells were integrated into the original 2020 TCWA Monitoring Plan and then also revised for the 2022 GSP Addendum (Figure 2-9 and Appendix A of the 2022 GSP Addendum). Figure A1-5 of Appendix A of the 2022 GSP Addendum shows selected lower aquifer wells to be monitored as well as proposed monitoring well locations which are designated by a letter (“L”) and a priority number.

Where needed, monitoring wells for the upper, nested upper and lower aquifer, and lower aquifer, will be installed. These new wells will be utilized if there are not enough irrigation wells in the area that can be used as Representative Monitoring Sites. A new lower aquifer monitoring well located in a former data gap area was installed in 2020 and added to TCWA Monitoring Plan under the 2022 GSP Addendum as agreed in the Final Tule SMP. Measuring procedures detailed in the Final Tule SMP, and modified below, will be used to obtain groundwater level measurements in the field.

For irrigation wells - cleaning with Alconox solution, triple-rinsing with deionized water, and air drying of the electric sounding wire is not required. However, the decontamination procedure will be followed for the measurement of wells supplying domestic water. Transducers will be installed in all wells to be used as Representative Monitoring Wells, to the extent possible, within the first five years of the program. Measurements will be made in the Spring and the Fall and will be coordinated with member GSAs.

## 4.3.2 REDUCTION OF GROUNDWATER STORAGE [§354.34(c)(2)]

Water level measurements for the upper aquifer wells that have been selected (above), together with values of specific yield, will be used to develop the change in groundwater storage in the upper aquifer. Water levels in wells installed in the lower aquifer reflect pressure levels and not changes in storage. Instead, land subsidence will be used to determine change in storage of the lower aquifer due to compaction of confining beds. The annual groundwater pumpage less groundwater return flow, will be utilized to calculate net groundwater use. Crop water use will be determined either by cropping pattern review and ITRC water use parameters, or by crop water use values determined from satellite imagery. At the time of this writing the Tule Subbasin have not selected a contractor to provide this information.

The Tule Coordination Agreement describes the methods that the Tule Subbasin proposes to use for the estimation of the change in groundwater storage. Section 3.6 of the Coordination Agreement presents the methodology.

### Upper Aquifer

Tule Calculations – Coordination Agreement

Change in storage in the upper aquifer is calculated by the change in successive spring groundwater levels multiplied by the specific yield of the aquifer sediments, multiplied by the surface area of the aquifer. The calculations will be made using a grid composed of 300-foot squares, for which the change in spring groundwater levels and the specific yield (the vertical distribution of the specific yield) will be input, and the calculation of the change in storage from the previous spring will be made. All of this will be done digitally, and the results will be exported to a spreadsheet wherein the change in the upper aquifer groundwater storage will be calculated for each grid and all grids will be summed to get the change in storage for the Subbasin. TCWA will compare its calculations with those of the Tule GSAs and will meet and confer regarding the upper aquifer groundwater extractions to be reckoned to TCWA as calculated by both methodologies. Changes in storage shall be based on the sustainable yield.

TCWA Calculations

A variation of this technique will be done by TCWA, with groundwater levels measured at representative wells for each section, preparation of groundwater elevation maps, calculated specific yields (the vertical distribution) for each well based on representative cross sections, and groundwater storage changes calculated based on a denser water level network. Each large-capacity well in TCWA will be metered. Therefore, the amount of water extracted from the upper aquifer can be calculated directly from the total pumpage. Using crop information and calculated evapotranspiration, the net groundwater use can be calculated and compared to the amounts calculated by the above methodology after exports are accounted for. TCWA will compare its calculations with those of the Tule GSAs and will meet and confer regarding the upper aquifer groundwater extractions to be reckoned to TCWA as calculated by both methodologies.

**Lower Aquifer**

Tule GSA Determination

The groundwater flow model will be used to make this determination.

TCWA Determination

Changes in spring water levels indicate changes in hydraulic pressure. Assuming that the aquifer is full, the change in pressure cannot be used to calculate changes in storage in the lower aquifer. However, these pressure levels indicate either improving or declining groundwater conditions in the aquifer and are an indicator of the occurrence of subsidence, and of groundwater flow. Land subsidence will be used to determine storage changes in the lower aquifer due to compaction of the confining beds. All large capacity wells in the lower aquifer will be metered. Return flow from irrigated croplands replenishes the upper aquifer. The amount of water extracted from the lower aquifer can be calculated directly from pumpage. The amounts utilized by crops and exports will be accounted for and the net use of groundwater from the lower aquifer will be determined. Changes in storage shall be based on the sustainable yield.

TCWA will compare its calculations with those of the Tule GSAs, and will meet and confer regarding the upper aquifer groundwater extractions to be reckoned to TCWA as calculated by both methodologies.

### 4.3.3 SEAWATER INTRUSION [§354.34(c)(3)]

This indicator is not applicable in the GSA due to how far removed the GSA is from the Delta.

### 4.3.4 DEGRADED WATER QUALITY [§354.34(c)(4)]

Refer to Chapter 3 for a discussion of this indicator (degraded water quality) and Section 4 the 2022 GSP Addendum which outlines sustainability indicators and constituents of concern (COC's) sampled by TCWA. TCWA will implement the groundwater sampling protocols as outlined in the Final Tule SMP.

### 4.3.5 LAND SUBSIDENCE [§354.34(c)(5)]

This is considered one of the most important indicators. Refer to the discussion in Chapter 3 and Section 3 of the 2022 GSP Addendum. Measures that are proposed to reduce land subsidence in the GSA are discussed elsewhere and are briefly discussed below. Reduction of pumpage from the lower aquifer is the single most important parameter for reduction of subsidence. Lower aquifer pumpage will be monitored by flow meters. Initially, this will be done by interpretation of electric logs. The reduction of this pumpage will be measured and recorded over time as the projects and management actions take effect over time. The first five years of monitoring will establish current lower aquifer pumpage and a correlation between lower aquifer water levels and land subsidence. The effects of the projects and management actions will be measured by land elevation surveys at specific points in the GSA.

The Tule SMP addresses subsidence within the Tule Subbasin. Figure 3-11 of the 2022 GSP Addendum shows the four subsidence monitoring points within the GSA. The stand-alone stations are measured for elevation on an annual basis. This information alongside DWR's InSAR vertical displacement data will be incorporated into TCWA's annual reporting of subsidence. In the meantime, TCWA plans to coordinate with the Tule Subbasin GSAs to locate and install stand-alone ground elevation monitoring stations (bench marks) that will be monitored by ground-based (conventional) GPS equipment until the satellite network is installed. Prior to installation of the stand-alone stations, TCWA will utilize water level measurements of deep aquifer wells as a surrogate for the occurrence of subsidence. Water level measurements will be correlated with land subsidence once monitoring stations are installed and land elevation information is available.

The Tule Subbasin has applied for Proposition 1 financing for installation of one extensometer in or near TCWA. If financing is obtained, it is planned that this device will be installed in the North Area, however the exact location will be selected at a later date. This information will also be incorporated into TCWA's annual subsidence reporting program. Further discussion of TCWA's subsidence network is available in Section 3 of the 2022 GSP Addendum

### 4.3.6 DEPLETIONS OF INTERCONNECTED SURFACE WATER [§354.34(c)(6)]

This is not indicated to be an issue in the GSA because, according to current understanding, the groundwater and surface water aren't interconnected.

The Tule Monitoring Plan discusses surface water flow and water quality measurements in Subchapter 2.6 of the Monitoring Plan. TCWA's surface water monitoring plan is discussed in the following paragraphs and utilizes existing monitoring programs to the extent possible.

While surface water inflow to TCWA via Deer Creek, and White River are intermittent sources of supply, there are deliveries from the Kings and Tule Rivers, and the California Aqueduct, that make up the surface water supply for AWD. Occasionally overland flood flows from Poso Creek inundate portions of the Southeast Area and are a nuisance to farming in that area. These quantities are unmetered, and cost landowners time and expense to protect their crops and recover from the damage. It is understood that Semi-Tropic Water Storage District plans to capture this flow and contain it on the Kern County side of the Tulare/Kern County line. Table 2.3.2, repeated below, lists the sources of surface water for AWD.

## Table 2.3.2

| Angiola Water District 2004-2018 Water Supplies[1] | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | State Water Project | | | Tule River | Kings River[2] | Other | Flood | Local | Deer Ck. | Total Surface Sources | AWD District Pumpage | Total Supply |
| . | Total | Table A | Article 21 | Total | Total | Total | Total | Total | Total | Total | Total | Total |
| **2004** | 1,787 | 1,293 | 494 | 559 | 0 | 5,293 | 0 | 4,657 | 0 | 12,296 | 26805 | 39,101 |
| **2005** | 13,047 | 564 | 12,483 | 1,680 | 10,632 | 1,235 | 5,890 | 15,954 | 0 | 48,438 | 662 | 49,100 |
| **2006** | 11,289 | 614 | 10,675 | 795 | 14,253 | 0 | 7,973 | 6,134 | 0 | 40,444 | 141 | 40,585 |
| **2007** | 5,124 | 243 | 4,881 | 0 | 18,083 | 63 | 0 | 0 | 0 | 23,270 | 32,894 | 56,164 |
| **2008** | 762 | 761 | 1 | 828 | 4,756 | 0 | 0 | 0 | 0 | 6,346 | 32,502 | 38,848 |
| **2009** | 35 | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 37,798 | 37,833 |
| **2010** | 13 | 12 | 1 | 1,676 | 10,587 | 282 | 0 | 0 | 0 | 12,558 | 22,568 | 35,126 |
| **2011** | 1,835 | 1,835 | 0 | 1,170 | 14,383 | 434 | 10,011 | 0 | 1,516 | 29,349 | 3,615 | 32,964 |
| **2012** | 1,413 | 1,413 | 0 | 271 | 4,326 | 1,760 | 0 | 0 | 0 | 7,770 | 33,097 | 40,867 |
| **2013** | 1,080 | 1,080 | 0 | 0 | 0 | 4,912 | 0 | 0 | 0 | 5,992 | 30,603 | 36,595 |
| **2014** | 0 | 0 | 0 | 0 | 0 | 3,174 | 0 | 0 | 0 | 3,174 | 27,783 | 30,957 |
| **2015** | 0 | 0 | 0 | 0 | 0 | 2,439 | 0 | 0 | 0 | 2,439 | 30,220 | 32,659 |
| **2016** | 0 | 0 | 0 | 252 | 0 | 1,710 | 0 | 0 | 0 | 1,962 | 29,036 | 30,998 |
| **2017** | 3,849 | 3,849 | 0 | 6,908 | 13,182 | 0 | 23,457 | 0 | 0 | 47,396 | 2,750 | 50,146 |
| **2018** | 1,300 | 1,300 | 0 | 714 | 6,596 | 6,921 | 0 | 0 | 0 | 15,531 | 18,193 | 33,724 |
| **Total** | 41,534 | 12,998 | 28,536 | 14,853 | 96,798 | 28,223 | 47,331 | 26,745 | 1,516 | 257,000 | 328,667 | 585,667 |
| **Average** | 2,769 | 867 | 1,902 | 990 | 6,453 | 1,882 | 3,155 | 1,783 | 101 | 17,133 | 21,911 | 39,044 |

1. Source: Angiola Water District Records.
2. AWD's holdings as a Kings River Water Member Unit are used in the Tulare Lake Subbasin in lieu of pumping in the Tule Subbasin.

The Tule River is a surface water source to AWD, averaging about 1,000 afy. In a flood year the Tule has contributed upwards of 7,000 afy, and in dry years, contributes no surface water to AWD. Section 2.6.1.1 addresses stream flow in the Tule River. Flows from the Tule reach AWD through the Tule River Channel's connection to the Wilbur Ditch. The quantities are measured by AWD.

The Kings River Flows are diverted into AWD at Empire 1, and the Wilbur Ditch . This supply is used in AWD for a supplemental irrigation water supply. Kings River water flows into AWD via the Wilbur Ditch and the quantity is measured by the Kings River Water Association. The Kings River supply averages about 6,500 afy and has been as much as 18,000 afy in wet years. The flow has diminished to zero in dry years.

The State Water Project supply averages about 2,800 afy and this is a combination of Table A (900 afy average) and Article 21 waters (1,900 afy). Diversions from the State Water Project enter AWD via the Blakeley Canal and are measured by the Department of Water Resources.

Deer Creek flows directly into AWD at the White Ranch location at the southeast corner of Section 10, T23S, R23E, M.D.B.&M. The Deer Creek channel flows through the North Area of the GSA and terminates at the Homeland Canal, where floodwaters are diverted in flood years out of TCWA. AWD has a license to divert up to 5,370 afy from Deer Creek (Permit No. 016144, Lic. No. 10676). Table 2.3.2 shows that Deer Creek diversions have been non-existent in past years, being only 1,500 acre-feet in one year,2011. Going forward, AWD plans to exercise its rights on Deer Creek and capture an average of 800 afy for a supplemental irrigation water supply.

White River flows into TCWA are un-recorded. Estimates of flows in White River are included in the Tule Subbasin GSP. These flows were measured at a gaging station east of Ducor from 1971 through 2005. The stream gage was destroyed in 2006, and thereafter stream flow quantities were and continues to be estimated based on the historical relationship between Deer Creek flows and White River flows. See the discussion in Section 2.4.5 of the Tule Subbasin HCM (Appendix J). However, there are contributing areas west of the location of the now-destroyed stream gage, and water flows into the lower reaches of White River from these contributing areas. The Prosperity Ranch is developing a recharge project based on local experience with flood waters in the White River channel. The amount of water available will be determined by measurement of these flows over the next five to ten years. These amounts will be made a part of the record and will begin to establish the amounts of water available to the lower reaches of White River.

Amounts listed as “Other” and “Local” flows are a combination of Kaweah River water and other sources and are measured by the Tulare Lake Basin Water Storage District. Together, these flows add up to an annual average water supply of about 3,700 afy.

Flood Flows amount to about 3,200 afy, being as high as 23,500 acre-feet in 2017 and as little as zero in dry years. These intermittent flows are measured at all of the above source locations when available.

Section 2.6.2.1 “Surface Water Flow Measurements,” of the Final Tule SMP discusses the monitoring procedure for surface water flows in the Tule Subbasin. The following is an excerpt from the Tule Monitoring Plan.

Steam flow gages are water stage recorders for the Tule River and Deer Creek, and are read automatically every 15 minutes, with the exception of White River, Turnbull Weir at Road 208, Porter Slough at 192, and the Deer Creek outlet to the Homeland Canal. The Trenton Weir on Deer Creek is operated and managed by the Army Corps of Engineers (“ACOE”). Excluding the exceptions above, all gages report data electronically in real time to the Tule River Association / Lower Tule Irrigation District.

The following is a summary of the water quality program on Tule River and Deer Creek.

Section 2.6.2.2 “Surface Water Quality Measurements”

Surface water quality samples have historically been collected and analyzed from the Tule River, Deer Creek and White River for the Tule Basin Water Quality Coalition surface water quality program. On the Tule River there are three locations at which water sampling occurs (refer to Figure A1-9 of the Final Tule SMP). Of interest to TCWA are the water quality program results measured on the Tule River at Road 92. This station is the furthest west water quality testing location on the Tule River – and would be the location at which water from the Tule would be diverted to AWD.

Deer Creek is also sampled at three locations, the furthest west of which is at the Road 120 bridge, about 1 mile west of Highway 99. White River is sampled at one location, at Road 208, when flow occurs. This sampling point is about 3 miles east of the Friant-Kern Canal and roughly 2 ½ miles west of Highway 65.

Each surface water quality sample is analyzed by a State certified analytical laboratory for electrical conductivity, pH, dissolved oxygen, E. Coli bacteria, total organic carbon, total suspended solids, total dissolved solids, turbidity, selected metals, hardness, ammonia, nitrate as N, orthophosphate, and phosphorus.

Surface water quality samples are collected from all of the surface water quality monitoring locations on a monthly basis when flow occurs.

**§354.34 Introduction to Monitoring Networks**

f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

1) Amount of current and projected use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

## 4.4 MONITORING SITES DISTRIBUTION [§354.34(f)]

Appendix A and Figure 2.9 of the 2022 GSP Addendum shows the location of the wells that will be measured for water level thresholds in the GSA. There are seven wells shown. Spring and Fall water levels will be measured.

Refer to Figure 2.2.4 herein, and Figures A1-2 and A1-5 of the Tule Subbasin Monitoring Plan (Appendix G), for prospective locations of existing wells to be monitored for water levels. These are discussed in Section 4.3.1, above.

**§354.34 Introduction to Monitoring Networks**

g) Each Plan shall describe the following information about the monitoring network:

1) Scientific rationale for the monitoring site selection process.

2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

### 4.4.1 MONITORING SITE SELECTION CRITERIA [§354.34(g), (h), (i), (j)]

There are five types of items to be monitored. These are: 1) pumpage, 2) water-levels, 3) land subsidence, 4) groundwater quality, and 5) other monitoring necessary to prepare water budgets for the groundwater in each aquifer.

**PUMPAGE**

The Board of Directors of the TCWA has determined that the pumpage from all large capacity wells in the GSA is to be measured with totalizing flowmeters. Measurement of groundwater pumpage is considered essential in developing groundwater management activities. The flowmeters will be read and recorded on a monthly basis and the total pumpage reported annually by well.

**WATER LEVELS**

There are two main reasons for measuring water levels in the GSA. First, is to prepare water-level elevation maps for both the upper and lower aquifers on at least an annual basis, and possibly on a semi-annual basis. Such a program is in effect south of the Tulare County-Kern County Line, in and near the Semitropic Water Storage District. These maps are essential to determine the lateral direction of groundwater flows in specific areas. In areas of significant land subsidence, such as in the TCWA, it is necessary to periodically determine the elevation of the measuring points for the measured wells, as opposed to estimating these from out of date topographic maps. Second, is to track water-level changes in both aquifers, through preparation of water-level hydrographs. The DWR CASGEM program has focused entirely on the second of these reasons for measuring water levels. However, preparation of suitable water-level elevation maps generally requires a dense network of measured wells (on the order of one or more wells per section), as opposed to a much less dense network used to track representative water-level changes.

TCWA covers lands in both the Tulare Lake Subbasin and the Tule Subbasin. As provided in Section 1.1 this GSP is limited to the lands in the Tule Subbasin. Further, the Tule Subbasin part of the TCWA has been divided into two management areas. The North Area comprises the Angiola Water District well fields and other lands north of Avenue 60. The Southeast Area comprises lands south of Avenue 56, extending south to the Kern County line. This part covers most of the land south of Avenue 40 between the Tulare County-Kings County line in the west to near Road 126. See Figure 1.4.0.

Water-Level Elevations and Direction of Groundwater Flow

A significant data gap for historical water-level maps developed when the DWR stopped preparing detailed, large-scale lower aquifer maps in the San Joaquin Valley, as of about 1988. KDSA prepared a lower aquifer map (Figure 2.2.2 repeated below for ease of reference) covering the Northern Management Area for Spring 2007 (Figure 17 of HCM and Groundwater Conditions Report "HCM")). This map also included a number of wells to the northeast, between Angiola and Tipton. KDSA prepared a lower aquifer map (Figure 2.2.5 repeated below for ease of reference) for the southeast area more recently, but fewer water-level measurements were available (Figure 19 of HCM and Groundwater Conditions Report).

North Management Area

For the upper aquifer in the North Management Area, a number of water-level measurements have been available for the Angiola Water District wells (between Avenues 88 and 116), and for the area to the north, between Avenue 128 and the Tule River. There is a data gap for the area between Avenue 64 and Avenue 104. We have reviewed drillers logs (well completion reports) for wells in this area. Figure 2.9 and Figure 4.1.1 of Appendix A of the 2022 GSP Addendum shows the locations RMS wells with construction data that tap the upper aquifer in the North Management Area. Water levels are already being measured in upper aquifer wells in the Angiola Water District well fields. There are also some domestic and stock-watering wells that tap the upper aquifer in this area. Field surveys will be necessary to determine which ones have access for electric sounders, or other means of measuring the water level. Owner approval will also be necessary. It is expected that eventually, about one well in each section would be part of an annual or semi-annual water-level measurement program.

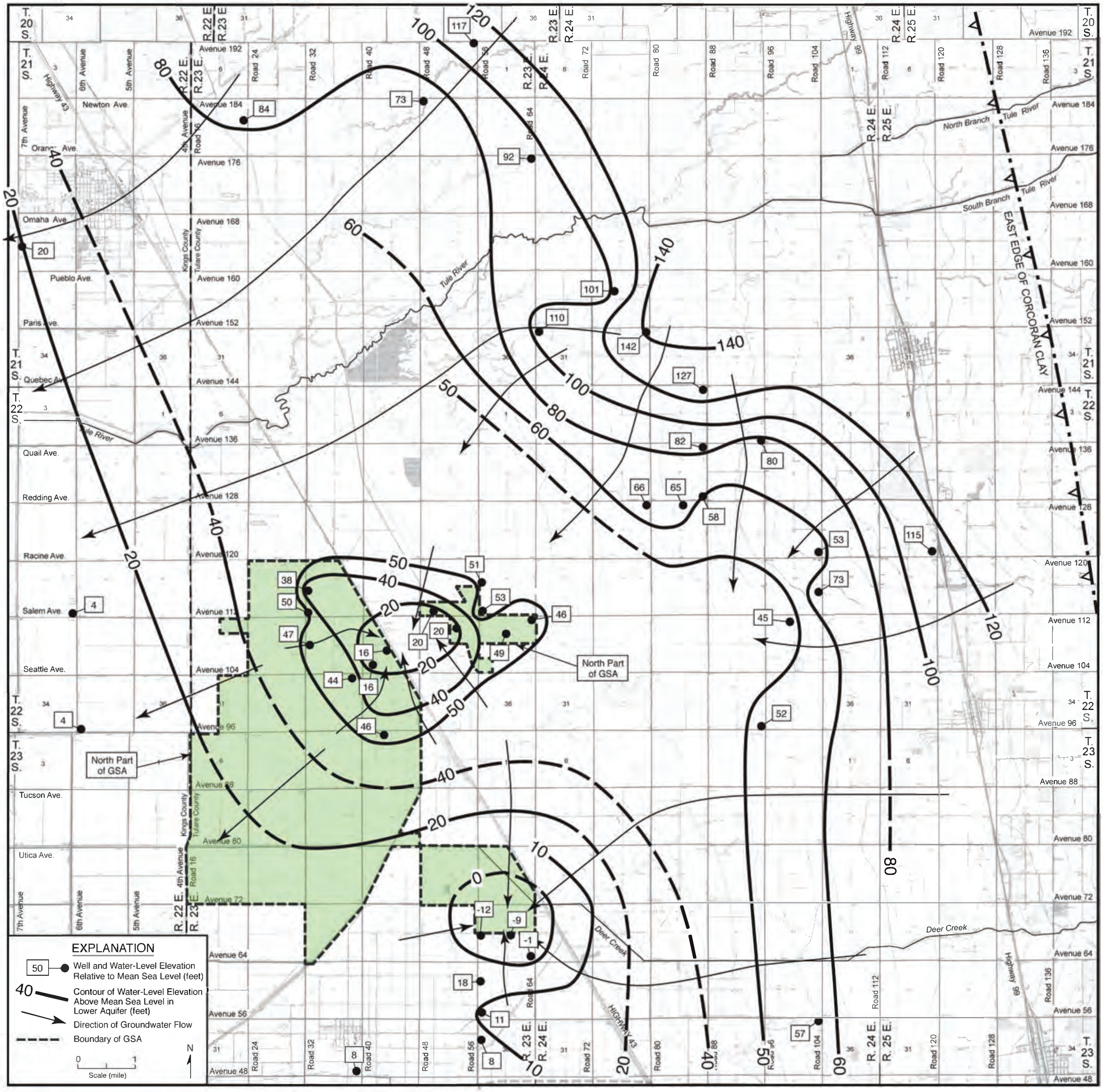



FIGURE 2.2.2- WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW IN THE LOWER AQUIFER IN AND EAST OF NORTH PART OF GSA (SPRING 2007)

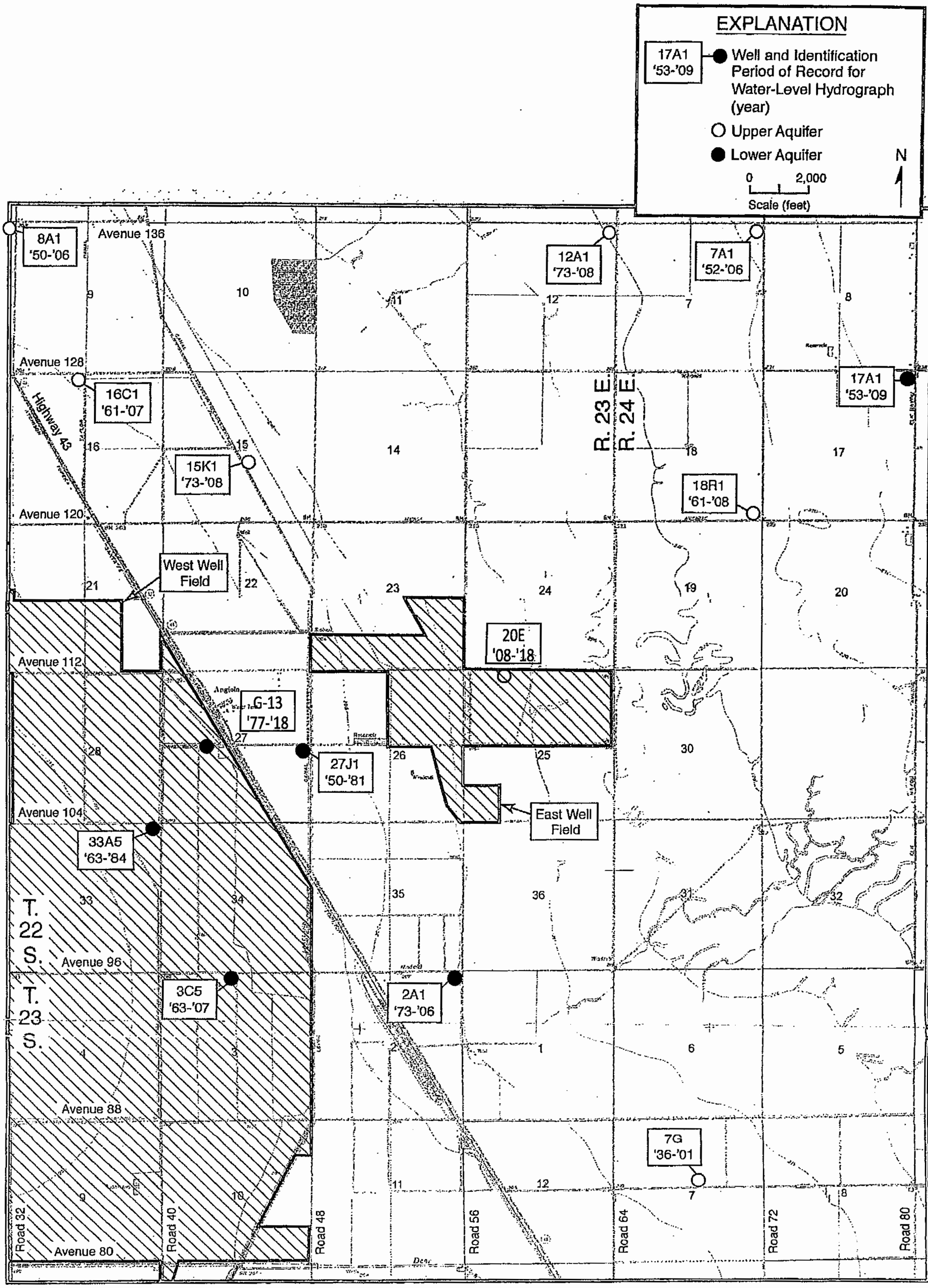



FIGURE 2.2.5 - LOCATIONS OF WELLS WITH WATER-LEVEL HYDROGRAPHS IN NORTH PART OF GSA

Figure 4.1.2 of Appendix A of the 2022 GSP Addendum shows the locations of candidate wells that tap the lower aquifer in the North Management Area. In general, there are water-level measurements for many lower aquifer wells in the Angiola Water District well field (between Avenue 96 and Avenue 116), and in the area northeast of Alpaugh. The largest data gaps are north, west, east, and south of the Angiola Water District well field. As discussed for the upper aquifer candidate wells, field surveys will be necessary to determine which wells have access for an electric sounder, or other means of water-level measurements, and it will be necessary to obtain owner approval.

Southeast Management Area

Overall there has been a lack of routine water-level measurements in this area, as it has been a "white area", where there has not been an organized water district to undertake such a program. Figure 7 of the HCM and Groundwater Conditions Report shows a detailed map of the depth to the top of the Corcoran Clay in the TCWA GSA. This map was used along with well logs to determine which aquifer was tapped by specific wells.

Figure 4.1.3 of Appendix A of the 2022 GSP Addendum shows upper aquifer candidate wells for water level measurements in the Southeast Management Area. A total of thirteen wells are shown. Many of these wells also tap the upper part of the lower aquifer, but they are the only irrigation wells known to be available. However, it is believed that a number of private domestic wells are present which tap only the upper aquifer. Figure 4.1.4 of Appendix A of the 2022 GSP Addendum shows candidate lower aquifer wells for water level measurements in the Southeast Management Area. A total of 44 wells, have been identified that only tap the lower aquifer. There is obviously an abundance of such wells, and it is assumed that at least half of them would eventually become part of the annual or semi- annual water-level measurement program in the Southeast Management Area. Again, field surveys are necessary to determine which wells can be measured, and well owners need to agree to participate in the program.

Eventually, the upper aquifer and lower aquifer water-level measurements for wells in the Southeast Management Area would be tied into the Semitropic Water Storage District water level monitoring program, so that there would be coordinated measurement times between subbasins. This will allow suitable water-level maps to be prepared on both sides of the Kern County line, so that groundwater flow directions and amounts of flow can be determined more precisely.

Nested Monitor Wells

For the Northern Management Area, there is an adequate number of upper aquifer and lower aquifer wells, and no nested monitor wells are necessary.

For the Southeast Management Area, there is a need to have more upper aquifer water-level measurements. Shallow single completion monitor wells (minimum 4-inch diameter) are recommended to fill in the data gaps where possible. The shallow monitor wells could be placed next to deep wells that can be measured, thus reducing the need for nested monitor wells in this area.

### Water-Level Trends

The following water level hydrographs show both fall and spring water level measurements, as opposed to those that are used to establish Minimum Thresholds based only on spring water level measurements (refer to Figures 3.3.1 -3.3.8 and Appendix A of the 2022 GSP Addendum). The following is a general discussion of historical seasonal and long-term water level trends. The following discussion refers to water level hydrographs that are presented in the Hydrologic Conceptual Model and Groundwater Conditions Report ("HCM") by Kenneth D. Schmidt and Associates ("KDSA") and included in the Appendix C of this GSP. The hydrographs are presented in Chapter 2.2.2 of this GSP and Appendix A of the 2022 GSP Addendum and are repeated in this section for the convenience of the reader.

North Management Area

Figure 2.2.6 is a water-level hydrograph for Well T22S/R23E-16C1 – which is located north of the AWD West Well Field. Records for this well extend back to 1960. Depth to water has ranged from 23 feet in Fall 1986 to 109 feet in Fall 1960. Water-levels in this well rose from 1961 to 1974, temporarily declined during 1975-77, rose from 1977-1981, temporarily declined during 1982-94, rose during 1995-98, fell during 1999-2002, rose during 2003-2005, then fell from 2005-10. The water levels in this well have thus risen during wet periods and fallen during dry periods. The measurements for this well do not extend to the present. The hydrograph of the spring water level measurements for this well have been combined with those of Well T22S/R23E-25C (AWD E20) in Figure 3.3.1 to establish sustainability indicators for the Upper Aquifer in the North Area. See discussion in Chapter 3. Water levels for Well E-20 do extend to the present. Figure A-1 of Appendix A of the 2022 GSP Addendum presents Well E-20's hydrograph with measurements collected after implementation.

Figure 2.2.8 of the HCM is a representative long-term water-level hydrograph for lower aquifer Well G-12 in the AWD West Well Field. This well is located near Avenue 36 and Road 44 and has been inactive since 1982. KDSA (1992) indicated that the water levels in this well were representative of the upper part of the lower aquifer (above a depth of about 900 feet). Records for this well extend back to 1962. Water levels in this well ranged from 84 feet in Spring 1986 to 232 feet in Fall 1992. Water levels in this well have also fluctuated according to climatic conditions. These levels are pressure levels, and the seasonal water-level variations are much greater than for the upper aquifer. This well is no longer available for measurement. Therefore, the hydrograph of the spring water level measurements for Well T22S/R23E-27F (AWD Well G-13) has been selected (Figure 3.3.2) to establish sustainability indicators for the Lower Aquifer in the North Area. See discussion in Chapter 3. Trends for Well G-12 are used to provide a longer historical period of record than Well G-13 currently has. Figure A-2 of Appendix A of the 2022 GSP Addendum presents G-13's hydrograph with measurements collected after implementation.

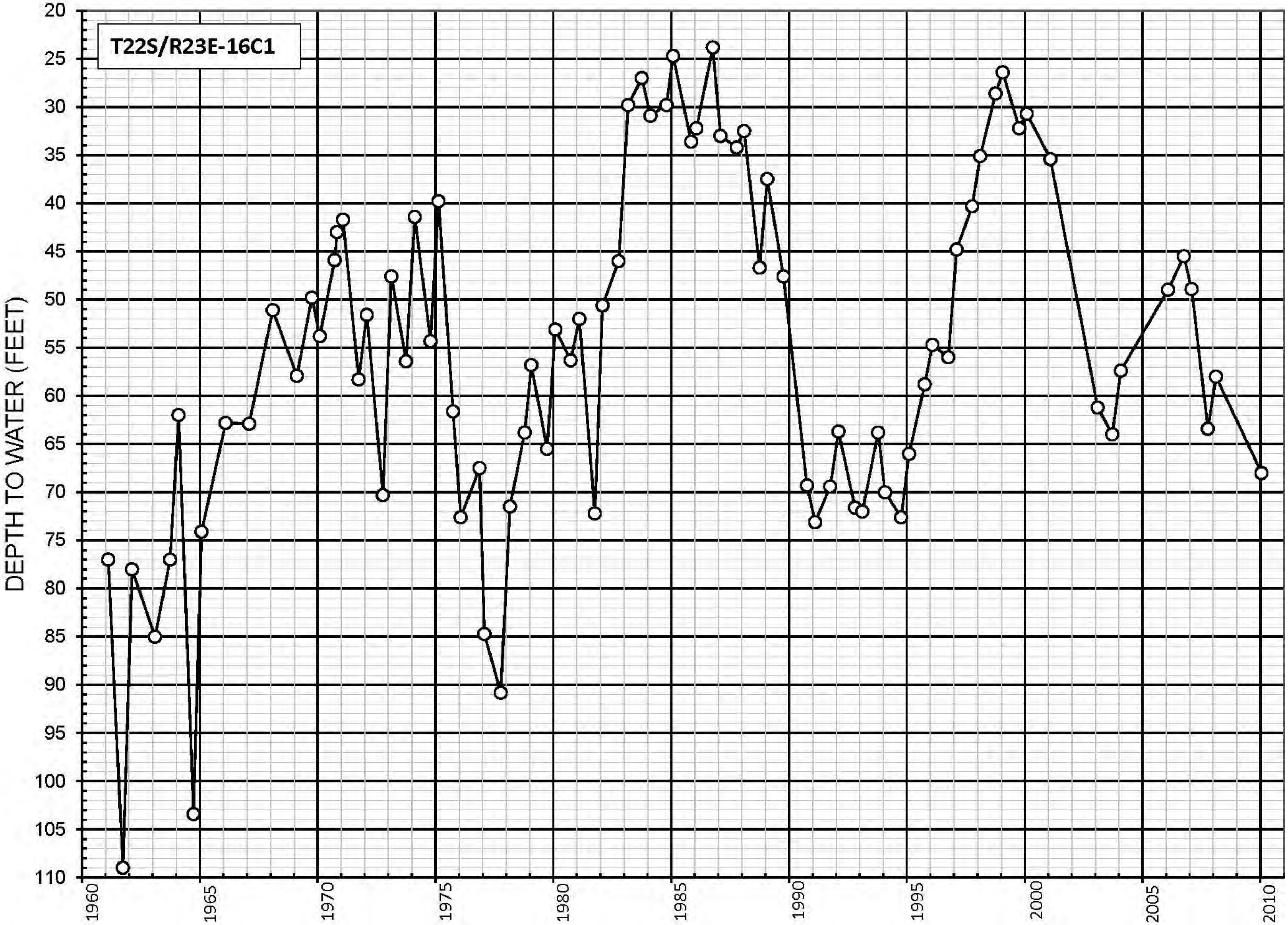



FIGURE 2.2.6 - LONG-TERM WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER WELL IN NORTH PART OF GSA

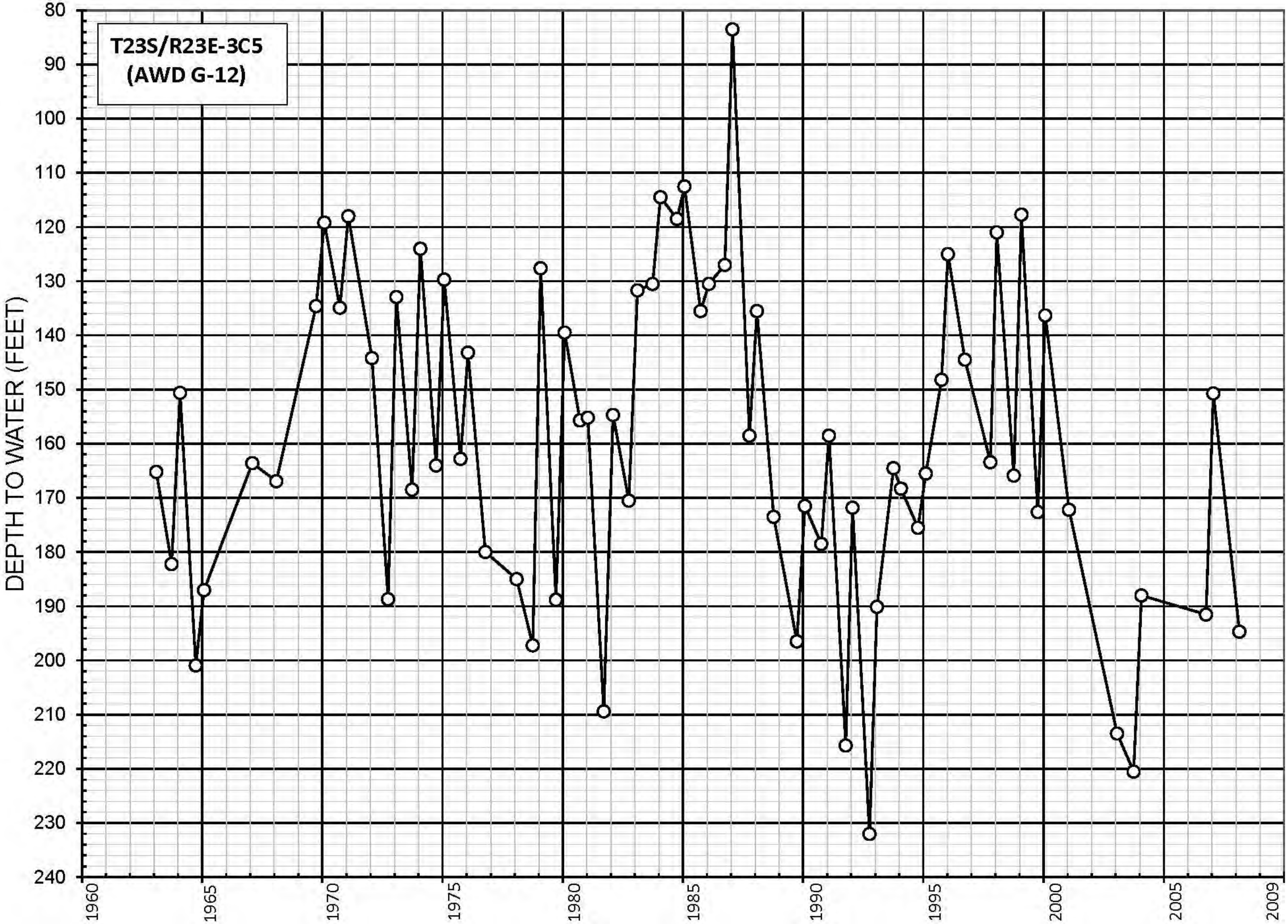



FIGURE 2.2.8 - LONG-TERM WATER-LEVEL HYDROGRAPH FOR LOWER AQUIFER WELL IN NORTH PART OF GSA

Based on records available, including the period covered by the water-level measurements and the well construction, the following wells would be used as sustainability indicators for the North Management Area:

- → Upper Aquifer: Well T22S/R23E-25C (AWD Well E20)
- → Lower Aquifer: Well T22S/R23E-27F (AWD Well G-13)

Southeast Management Area

Figure 2.2.7 is considered a representative long-term hydrograph for the upper aquifer in the Southeast Management Area. Well T24S/R23E-22E1 is located near Avenue 20 and Road 44. Water-level records are available back to 1961. Water levels in this well have been influenced by pumping in the Semitropic WSD to the south. Depth to water has ranged from 38 feet in Spring 2000 to 114 feet in Fall 1960. Water levels fell between 1962 and 1970, then generally rose through 2000, then fell thereafter. Seasonal water-level variations were greater after 1970. Spring water levels are plotted on Figures 3.3.4A and B to establish sustainability indicators for the Upper Aquifer for this well. This well is indicated to be a composite well, also tapping part of the lower aquifer. In the future a well will be located that only taps the upper aquifer. Figure A-3 of Appendix A of the 2022 GSP Addendum presents Figures 3.3.4A and B together with measurements collected after implementation.

Figure 2.2.9 is also considered a representative long-term hydrograph for the upper aquifer in the Southeast Management Area. Well T24S/R23E-34F1 is located near Avenue 4 and Road 92. Water levels in this well have also been influenced by pumping in the Semitropic WSD to the south. Water levels fell from 1941 to 1973. Water levels then rose from 1975 to 1987, associated with aqueduct deliveries to the Semitropic WSD and an accompanying decrease in pumpage. After 1987, water levels were fairly stable prior to the recent drought. A field search failed to locate this well. However, recently, there are indications that this well may be in a fenced farmstead. Therefore, this well may be added to the network of representative wells in the future. A second field search will be conducted to locate this well.

Figure 2.2.11 is considered a representative hydrograph for the lower aquifer in the Southeast Management Area. Well T24S/R23E-22R2 is located near Avenue 16 and Road 48. This well is perforated from 400 to 1,200 feet in depth. Depth to water has ranged from 150 feet in Spring 1981 to 352 feet in Fall 2014 and have fallen and been deeper during dry periods (1976-77, 1991-93, 2008-10, 2012-16). Seasonal fluctuations have ranged from about 20 to 60 feet. Spring water levels are plotted on Figure 3.3.5 to establish sustainability indicators for the Lower Aquifer for this well. Figure A-4 of Appendix A of the 2022 GSP Addendum presents Well 22R2's hydrograph with measurements collected after implementation.

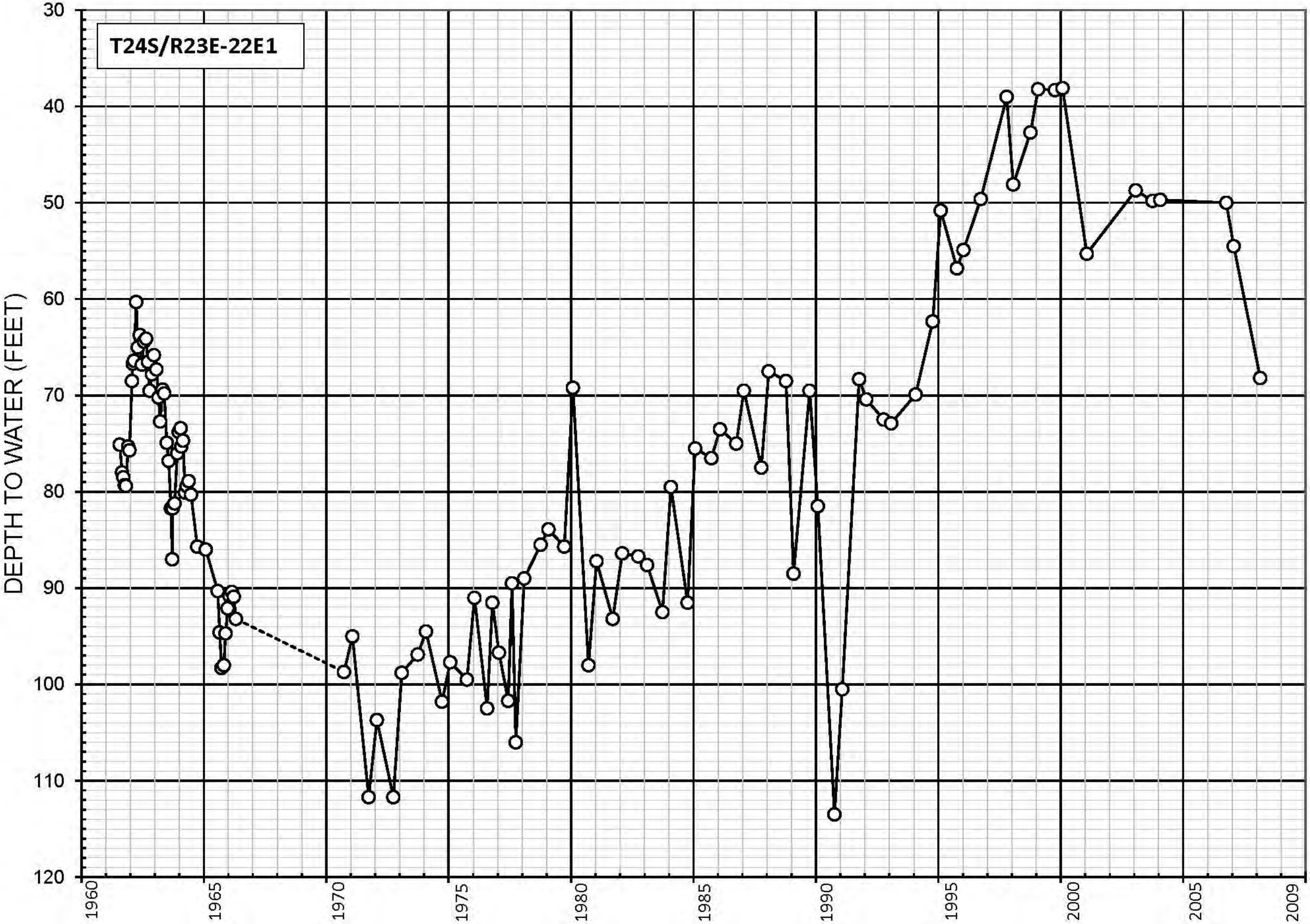



FIGURE 2.2.7- LONG-TERM WATER-LEVEL HYDROGRAPH
FOR UPPER AQUIFER WELL T24S/R23E-22E1

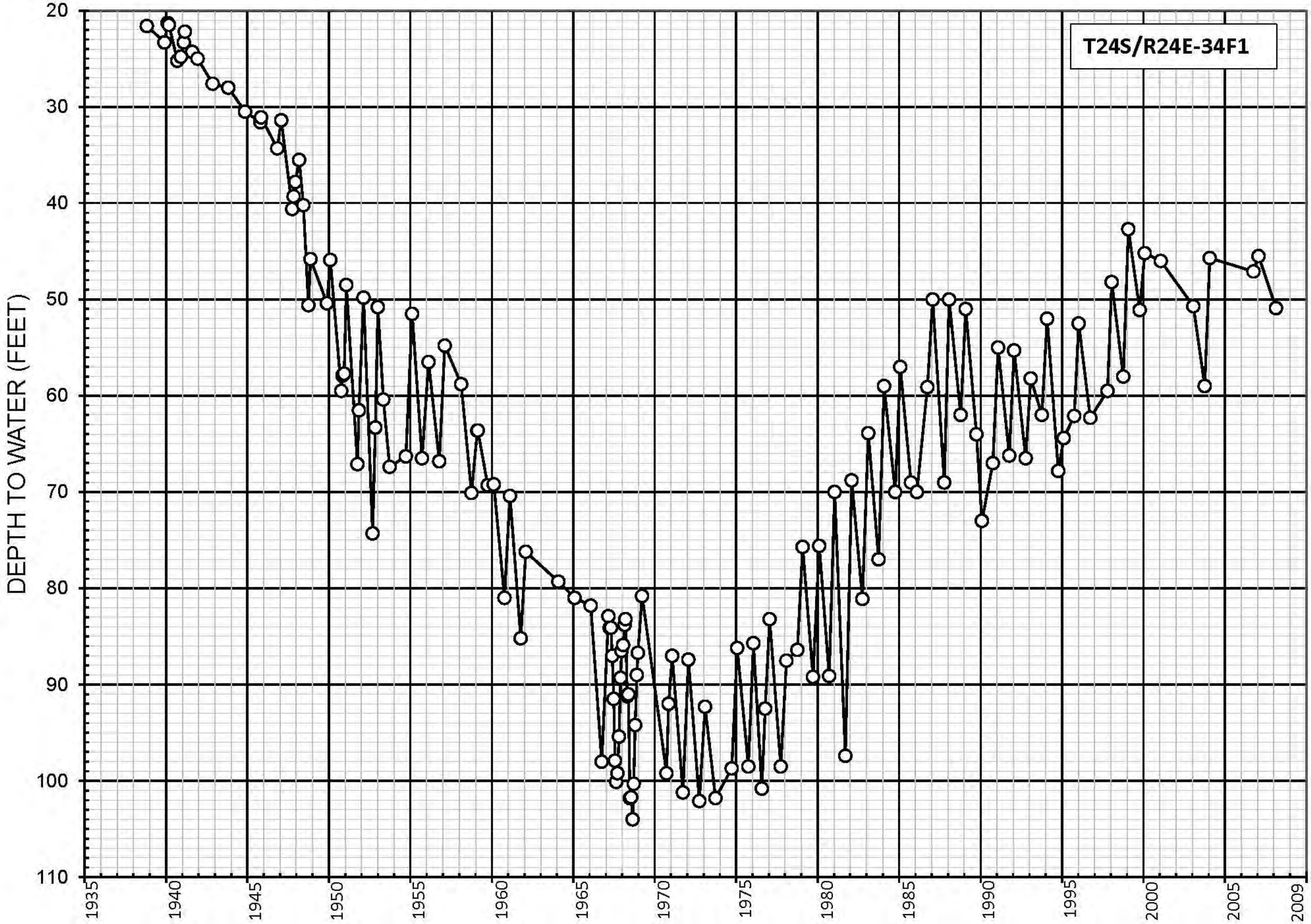



FIGURE 2.2.9 - LONG-TERM WATER-LEVEL HYDROGRAPH
FOR UPPER AQUIFER WELLT24S/R24E-34F1

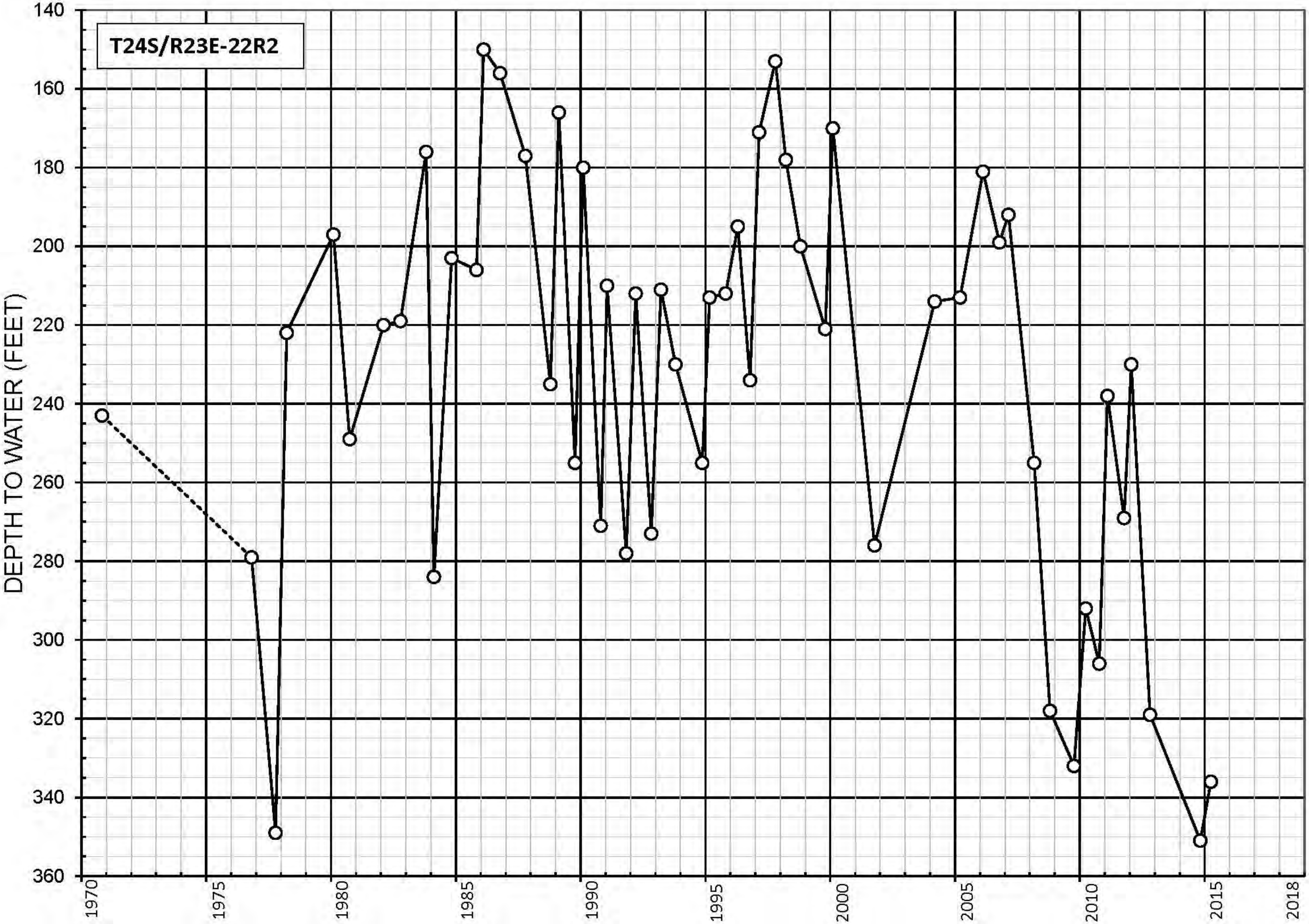



FIGURE 2.2.11- LONG-TERM WATER-LEVEL HYDROGRAPH
FOR LOWER AQUIFER WELL T24S/R23E-22R2

**GROUNDWATER QUALITY**

Discussion of groundwater quality monitoring site distribution is presented in Section 4 of the 2022 GSP Addendum.

**LAND SUBSIDENCE**

The U.S. Geological Survey (Lofgren and Klausing, 1969) evaluated land subsidence due to groundwater pumping in the Tulare-Wasco area. This area included both the North Management Area and the Southeast Management Area of the TCWA. The greatest subsidence in the Tulare-Wasco area as of 1962 was between Pixley and Delano, where it exceeded ten feet. Much of the compaction in the area was due to pumping of deep wells prior to importation of Friant-Kern Canal water to water districts in the area. Three extensometers were installed near Highway 99 near Teviston (between Pixley and Earlimart), and six others were installed near and west of Richgrove.

Historical land subsidence in the GSA was discussed by KDSA (Pages 75 – 77, HCM). Information was available from the DWR and the Jet Propulsion Laboratory. Thomas Harder & Co. has been evaluating land subsidence in the Tule Subbasin. See Figure A1-8 of the Tule Subbasin Monitoring Plan (Appendix G). Harder's evaluation included the Friant-Kern Canal area, primarily between Porterville and west of Ducor. Although an extensometer along the Friant-Kern Canal has been reactivated, there is no such recorder in the Tulare Lakebed area. Extensometers provide valuable information on the depth intervals where compaction of clay layers occurs. Two such recorders have been proposed, one for the Tulare Lake Subbasin and one for the Tule Subbasin. Other types of land subsidence monitoring focus on changes of the land surface elevations.

Figure 29 of the HCM indicates that the greatest land subsidence (10 to 15 feet) in the TCWA GSA for 1949-2005 was in the east part of the North Management Area, near the northwest edge of the Southeast Management Area, and in the part of the Southeast Management Area both west and east of Highway 43. The aforementioned Figure 2-36, land subsidence from 2015 to 2018, indicates that the northeast part of the North Area experienced the greatest amount of subsidence in TCWA (1.75 to 2.50 feet), with AWD's East Well Field showing the greatest amount (2.75 feet). Also – the east and northeast part of the Southeast Area experienced the greatest amount of subsidence for the Southeast Management Area (1.75 feet). The least amount of subsidence was in the west two thirds of the Southeast Management Area with about 0.75 to 1.25 feet of subsidence.

Whereas there has been considerable pumping from the upper aquifer in some parts of the North Management Area, records indicate that most of the pumpage in the Southeast Management Area has been from the lower aquifer.

Because water-level trends for upper aquifer wells in the North and Southeast Management Areas have shown little indication of overdraft, it appears that the focus of groundwater management needs to be on the effect of lower aquifer pumpage on land subsidence. A major difference between the two management areas is that lower aquifer pumpage has been going on for many decades in parts of the North Management Area, however large scale pumpage from the lower aquifer in the Southeast Management Area has largely been undertaken only during the past two decades. Further discussion of land subsidence is presented in Section 3 of the 2022 GSP Addendum.

Plans to mitigate land subsidence have been progressively implemented in the Angiola Water District. First, many of the deepest wells (greater than about 1,300 feet deep) have been abandoned. As of 2018, there were only six active District wells deeper than 1,330 feet. Second, as of 2018, there were nine active upper aquifer wells, and more are planned.

There are some parts of the Southeast Management Area where subsurface geologic conditions and/or poor groundwater quality limit development of new wells tapping the upper aquifer. Most of the existing wells tapping the upper aquifer in this management area are in Range 24E (east of Road 64). It appears that many replacement wells could be drilled to tap the upper aquifer in this part of the Southeast Management Area. In contrast, there appear to be relatively few wells in Range 22E and 23E that tap the upper aquifer. Subsurface conditions are considered to be less favorable for tapping the upper aquifer in this part of the Southwest Management Area, due to less permeable deposits and higher salinity groundwater.

Provost & Pritchard (2019) prepared a map showing existing and proposed land subsidence monitoring networks located in or near the Tulare Lake Subbasin. Included were Kings River Conservation District (KRCD) subsidence monitoring locations, where land subsurface elevations were regularly determined. One of these is located in or near the North Management Area and two others are located in or near the Southeast Management Area. A new extensometer was proposed for a site northwest of Corcoran. Thomas Harder & Co. have proposed a new extensometer between the AWD East and West Well Fields in the Tulare Sub-basin.

Tule Subbasin has proposed development of about 20 GPS monitoring stations in TCWA that will cover both the North Management Area and the Southeast Management Area where land surface elevations would be measured on a pre-determined schedule. These sites have been selected to provide both geographic coverage and to concentrate on the areas with greater potential land subsidence. In general, there is more potential for land subsidence where deeper wells are present. These deeper wells (more than about 1,200 or 1,300 feet deep) appear to primarily be in the North Management Area or in part of the Southeast Management Area that is east of Highway 43. Section 3 of the 2022 GSP Addendum provides a more detailed discussion of land subsidence monitoring.

**§354.36 Representative Monitoring**

Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:

d) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

e) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

   1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

   2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

f) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

## 4.5 REPRESENTATIVE MONITORING [§354.36(a), (b), (c)]

### PUMPAGE

Pumpage from all large capacity supply wells is to be measured by flow meters. AWD surface water supplies are measured at the delivery point. These two quantities, supplemented by a small amount of effective precipitation, represent the total water made available for irrigation of crops and other consumptive uses in the GSA. This total, reduced by consumptive use and exported water, together with the determination of net groundwater flows (inflow and outflow), results in the net groundwater loss or gain in the GSA.

### WATER LEVELS

Representative sites have been proposed for 1) intensive water-level measurement programs (once or twice a year), and 2) long-term measurements to determine water-level variations, including seasonal and annual trends. For the intensive water-level measurements, Figure 2.9 and Appendix A of the 2022 GSP Addendum show RMS wells which will be monitored in the North Management Area and the Southeast Management Area. These wells may be supplemented with additional wells in the future.

The wells, selected to represent long-term trends in the North and Southeast Management Areas, are shown in Appendix A and Figure 2.9 of the 2022 GSP Addendum. These were selected based on the length of record, the location of the wells, the perforated interval of the well, owner approval (to be obtained), and access for measurement.

**REDUCTION IN GROUNDWATER STORAGE**

Groundwater pumpage will be measured from all large capacity wells in the TCWA GSA, thus the reduction in groundwater storage will be derived from direct measurements of extractions, replenished by irrigation return flow and net groundwater inflow. Water level changes in the upper aquifer should reflect the information developed from direct measurements and will be cross-checked by calculations of net groundwater inflow.

**DEGRADED WATER QUALITY**

Representative water quality sampling will reflect the changes in groundwater quality and will verify compliance with the Irrigated Lands Regulatory Program and Central Valley Salinity Alternatives for Long-term Sustainability (CV SALTS), and the Basin Plan. There are no known contamination plumes affecting lands within TCWA. Further discussion is presented in Section 4 of the 2022 GSP Addendum.

**LAND SUBSIDENCE**

Land subsidence will be monitored by a network of elevation bench marks installed as stand-alone monitoring sites together with similar monuments installed at Representative Monitoring Wells in the GSA. During the first five years of the implementation period, while the land subsidence network is being installed, water levels in lower aquifer wells will be monitored and used as a surrogate for determining the presence of land subsidence. A correlation between changes in lower aquifer water levels and land subsidence will be developed during this period. Eventually, improvements in lower aquifer water levels will verify reductions in land subsidence resulting from compression of aquitards. Further discussion of land subsidence RMS is presented in Section 3 of the 2022 GSP Addendum.

## 4.6 MONITORING NETWORK EVALUATION [§354.38(a)]

### 4.6.1 IDENTIFICATION OF DATA GAPS [§354.38(b), (c)]

See Chapter 3, Sections 2.7, 3.8, and 4.8 of the 2022 GSP Addendum, and below for data gap discussions.

### 4.6.2 AREAS OF IMPROVEMENT [§354.38(d)]

**PUMPAGE**

Presently, the pumpage from AWD wells and the Allensworth CSD wells is measured with totalizing flowmeters. Pumpage from a presently unknown number of other wells (irrigation and dairies) is also measured with totalizing flowmeters. In some cases, irrigation or dairy pumpage is estimated from monthly power consumption records and pump tests, indicating the KWH per acre-feet pumped. This data gap is to be addressed by the GSA requirement to have all large capacity wells metered.

**SURFACE WATER MONITORING**

Surface water monitoring data gaps are discussed in Section 4.1.3 of the Tule Subbasin Monitoring Plan (Appendix G) together with recommended surface water monitoring features to fill the data gaps.

**WATER LEVELS**

The data gaps for water levels were discussed in Section 4.1. These are to be addressed by measuring additional wells selected from the candidate wells shown in Appendix A of the 2022 GSP Addendum.

**GROUNDWATER QUALITY**

Further discussion is available in Section 4 of the 2022 GSP Addendum.

**SURFACE WATER QUALITY**

See Section 2.6.2.2, Surface Water Quality Measurements, of the Tule Subbasin Monitoring Plan (Appendix G) for the surface water quality measurement program. Section 2.6.2.3 discusses surface water quality constituents. This program will be improved as more water quality information is developed in the years following GPS implementation.

**LAND SUBSIDENCE**

There has been a data gap for monitoring subsidence in recent decades in both management areas of the GSA. This is to be addressed by developing a number of stations to measure land surface elevations at least annually. In addition, it appears that one or two new extensometers may be installed. Further discussion of land subsidence data gaps is presented in Section 3.8 of the 2022 GSP Addendum.

### 4.6.3 EFFECTIVENESS OF MANAGEMENT ACTIONS [§354.38(e)]

Monitoring network objectives shall be implemented to 1) demonstrate progress toward achieving the objectives described in the plan, 2) monitor impacts to beneficial users of groundwater, 3) monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds, and 4) quantify annual changes in water budget components. Changes in groundwater conditions will be monitored relative to measurable objectives and minimum thresholds.

Highly variable spatial or temporal conditions will require evaluation. Adverse impacts to beneficial uses and users of groundwater will be avoided by management actions. The potential to adversely affect the ability of adjacent basins to implement sustainability goals or to impede achievement of sustainability goals, will be evaluated and management actions will be employed.

**§354.40 Reporting Monitoring Data to the Department**
Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

## 4.7 MONITORING DATA REPORTING REQUIREMENTS [§354.40]

**PUMPAGE**

A survey of well owners will be made to determine which large capacity wells already have flowmeters. Each well will be field checked and pictures taken of the discharge line and flowmeter. Notes will be taken on whether or not there are any problems, such a meter being placed too close to a bend in its discharge line, resulting in inaccurate pumpage measurements.

Incremental pumpage for each quarter (three months) of the year will be recorded from the totalizer flowmeters on each well. It is recommended that a photograph be taken of the totalizer reading, and the date and time added for documentation. The flowmeters will read in acre-feet. The totalizer readings would be reported electronically on forms provided by the DWR on an annual basis.

**WATER LEVELS**

Depth to water measurements will be made to the nearest 0.10 foot from below the measuring point. Pictures will be taken of the top of each well and the measuring point. Measuring point elevations will be determined to the nearest 0.01 foot. It is expected that this will be necessary about every five to ten years, until subsidence is substantially mitigated. In times of heavy groundwater extractions, such as in a drought, elevations will need to be evaluated on a more frequent basis. Both depth to water measurements and the water level elevations for each well will be provided annually.

**SURFACE WATER**

Surface water deliveries will be reported for each supply source and delivery point. These amounts will be recorded monthly and reported quarterly.

**SURFACE WATER QUALITY**

Surface water quality will be reported on an annual basis.

**GROUNDWATER QUALITY**

Water samples will be collected from large capacity well during heavy pumping periods in the summer. Each well will have been pumping for a least one day before the samples are taken. The approximate time that the well has been pumping would be recorded. The pumping rate at the time the water sample is collected will be recorded from the totalizing flowmeter. The water samples will be preserved and delivered to a certified testing laboratory, and chain-of-custody procedures will be followed. Each chemical analysis will be reviewed for QA/QC. Once this procedure is completed, the analyses will be placed electronically into the data base. Copies of the chemical analyses will be submitted electronically on forms provided by the DWR on an annual basis.

**LAND SUBSIDENCE**

The land subsidence monitoring initially proposed comprises annual measurements of land surface elevations. Licensed land surveyors will measure the land surface elevations and established stations to the nearest 0.01 foot. These measurements will be placed into the database and provided annually for each station and recorded electronically.

### 4.7.1 TULE SUBBASIN DATA MANAGEMENT SYSTEM

TCWA plans to implement the Tule Subbasin Data Management System (TSDMS) outlined in the *Final Tule Subbasin Monitoring Plan* prepared by Thomas Harder & Co., (TH&C, 20) (see Appendix G). As such, the Tule Subbasin Monitoring Plan is hereby incorporated by reference, and summarized below.

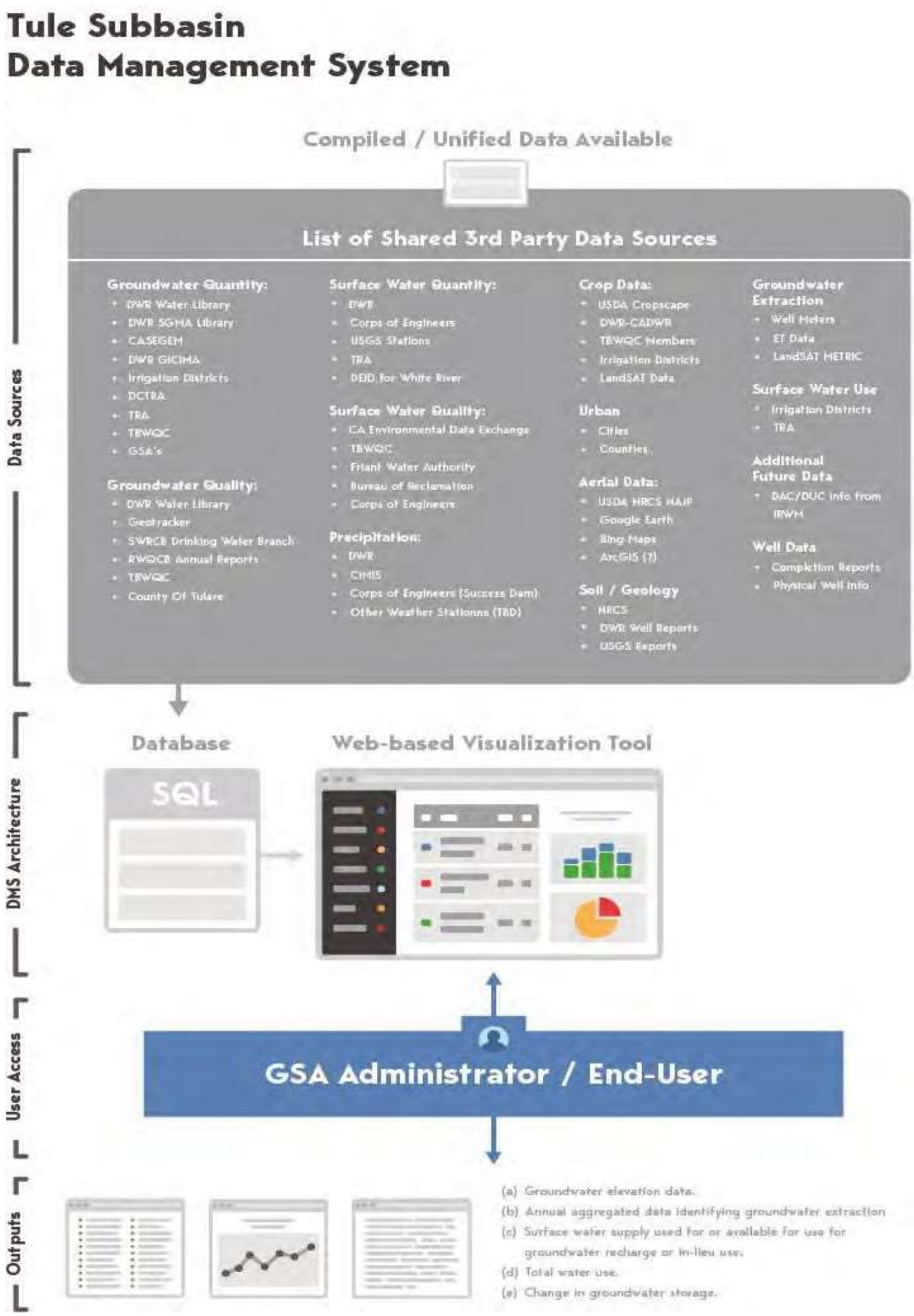
**5.0 Tule Subbasin Data Management System**

Efficient data management will be a critical aspect of the Coordination Agreement in order to ensure that each GSA can access the data needed to prepare their respective annual reports in a timely manner and to ensure that the Tule Subbasin Technical Advisory Committee (TAC) can meet deadlines for submittal of the coordinated reports. Data to be managed will include:

A. Historical data used as a basis for the Water Budget of the Tule Subbasin.
B. Data to be collected in accordance with the Tule Subbasin Monitoring Plan.

Both historical and future data collected as part of this TSDMS will be stored in a single comprehensive electronic database. This section satisfies § 352.6 of SGMA Regulations, which requires each agency to develop and maintain a data management system (DMS) that is capable of storing and reporting information relevant to the development and implementation of the plan and monitoring of the basin. The following table outlines the sections of the Tule Subbasin DMS as they relate to the various components of the SGMA Regulations.

**Figure A1-10: Data Management System Overview**



## 5.2 Functionality of the Data Management System

The DMS will be comprised of various tools designed to assist GSAs in the development and implementation of their groundwater sustainability plans. At its Core, the DMS is a data storage system which grants users access to interact and upload data required to comply with SGMA regulations. Guiding the implementation of the DMS are the rules laid out in the following sections.

### 5.2.1 User and Data Access Permissions

User data access and permissions will be based on the predetermined user type and data source by the system administrator. User types include:

- System Admin - Users with this permission can perform all administrative functions.
- SGMA End-User - Users with this permission can perform all APN / Parcel Level functions and have access to Basin Level and GSA Level Public Data.
- End User Delegate - Users with this permission can perform all APN / Parcel Level functions and have access to Basin Level and GSA Level Public Data.
- GSA Staff - Users with this permission can perform all Farm Level and GSA Level functions and have access to Basin Level Public Data.
- GSA Manager - Users with this permission can perform all APN / Parcel Level and GSA Level functions and have access to Basin Level Public Data.
- Public User - Users may view published data but cannot import or edit information

Data viewing and access will be limited on geographic extent based on the user, such as a landowner will only be able to view data for land he/she owns or an administrator of the GSA can view data for the GSA he/she represents. Data from private or user sources will be protected in the system while publicly available data will be available basin wide. Data Source types include:

- Public - Federal, State, or local published data
- Private - District or agency specific data
- Shared - SGMA data available for all users of DMS excluding public users
- User - user specific data
- DMS - Data available from other programs (IRLP)
- Published - Data from SGMA/GSA sources available for public consumption

### 5.2.2 Data Entry and Validation

To encourage agency and user participation in the DMS, data entry and import tools are easy-to- use, accessible via web-based interface, and help maintain data consistency and standardization.

The DMS allows GSA Administrators and Users to enter data either manually via easy-to-use interfaces, or through an import tool utilizing standardized Microsoft Excel templates, ensuring data may be entered into the DMS consistently. The data imported will require validation by the managing GSAs Administrators or Users using a number of quality control checks prior to final import into the DMS. All data included in the system will comply with data standards laid out in §352.4 of the SGMA Act.

#### 5.2.2.1 Data Collection

The Tule Subbasin DMS is populated with data from various sources including public, private, contributing DMSs, and user data. Data collected in accordance with the Tule Subbasin Monitoring Plan as well as data regarding key water management areas, include:

- Precipitation
- Evapotranspiration
- Surface water flow
- Groundwater levels
- Groundwater quality
- Groundwater extraction
- Imported water deliveries
- Managed recharge
- Land surface elevation
- Land Subsidence measurements

#### 5.2.2.2 Monitoring Data Entry (QA / QC)

For purposes of this plan, quality assurance (QA) is defined as the integrated program designed to assure reliability of monitoring and measurement data. Quality control (QC) is defined as the routine application of specified procedures to obtain prescribed standards of performance in the monitoring and measurement process.

Different monitoring protocols exist for the various data types stored in the DMS. Public sources included in the DMS as published from the source and referenced as such. User entry and private sourced data will be closely monitored for formatting and accuracy, in addition requiring chain of custody and acknowledgement of following protocols defined in the Monitoring Plan. These sources will be required to submit through pre-established forms to maintain the validity of the DMS.

#### 5.2.2.3 Data Validation

Data Validation is required for non-public sources and will be performed in the following ways:

- **Standardized Form Input:** meant to comply with what is required by law

- **Using known possible values for a dataset:** This would represent a baseline range of what can be typed into an input. Ex: Parcels Assessed Acreage vs Irrigated Acreage
- **Data/Field Normalization:** Establishing unit consistency between datasets. The DMS will keep a normalized value behind the scenes for each variation of a reported unit. Regular Expressions on inputs to control the type/format of information being submitted to the DMS.
- **Outlier filtering:** Outlier filtering when interacting with publicly available data or data that has been mass imported. Using Statistical Analysis methods, any statistical outliers will be filtered out of reports unless the end user opts to have them included.

### 5.2.3 Visualizations and Analysis

The DMS will host a robust visualization and analysis component to allow end users the ability to view and provide context to the data. This can be performed in Map and Tabular views, as shown in Figure A1-11.

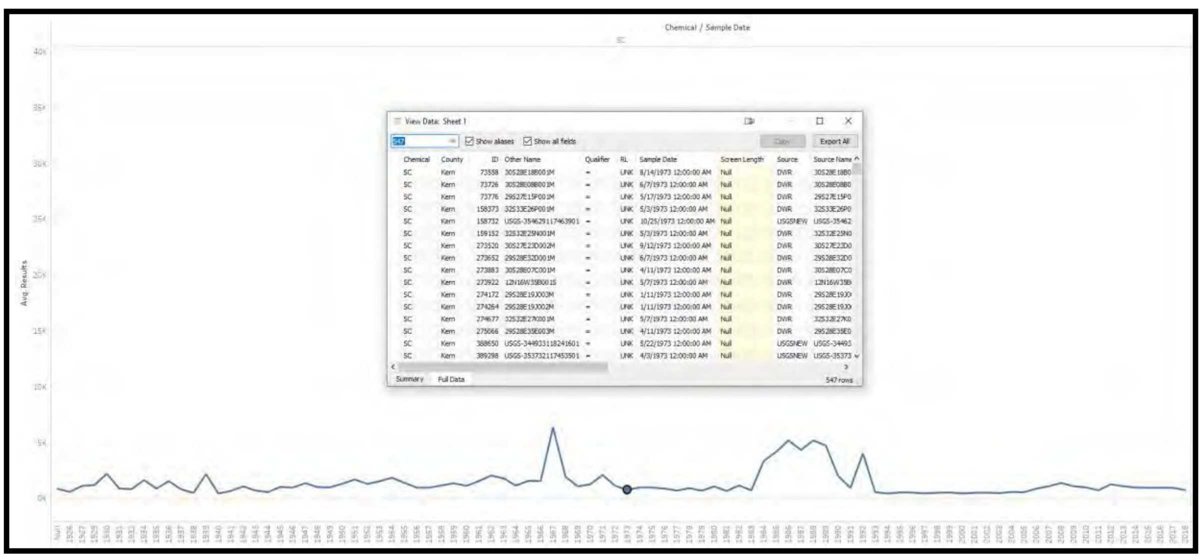


**Figure A1-11: DMS Data Visualization Example - Average Specific Conductivity by Year within the Tule Sub Basin.**

#### 5.2.3.1 Map View

Map view in the DMS will allow users to visualize data that has spatial characteristics (wells, stream gages, precipitation stations, etc). **Figure A1-12** is an example of well data in the DMS. In map view users can scroll around the selected source data and click on the sites to bring up site specific information.

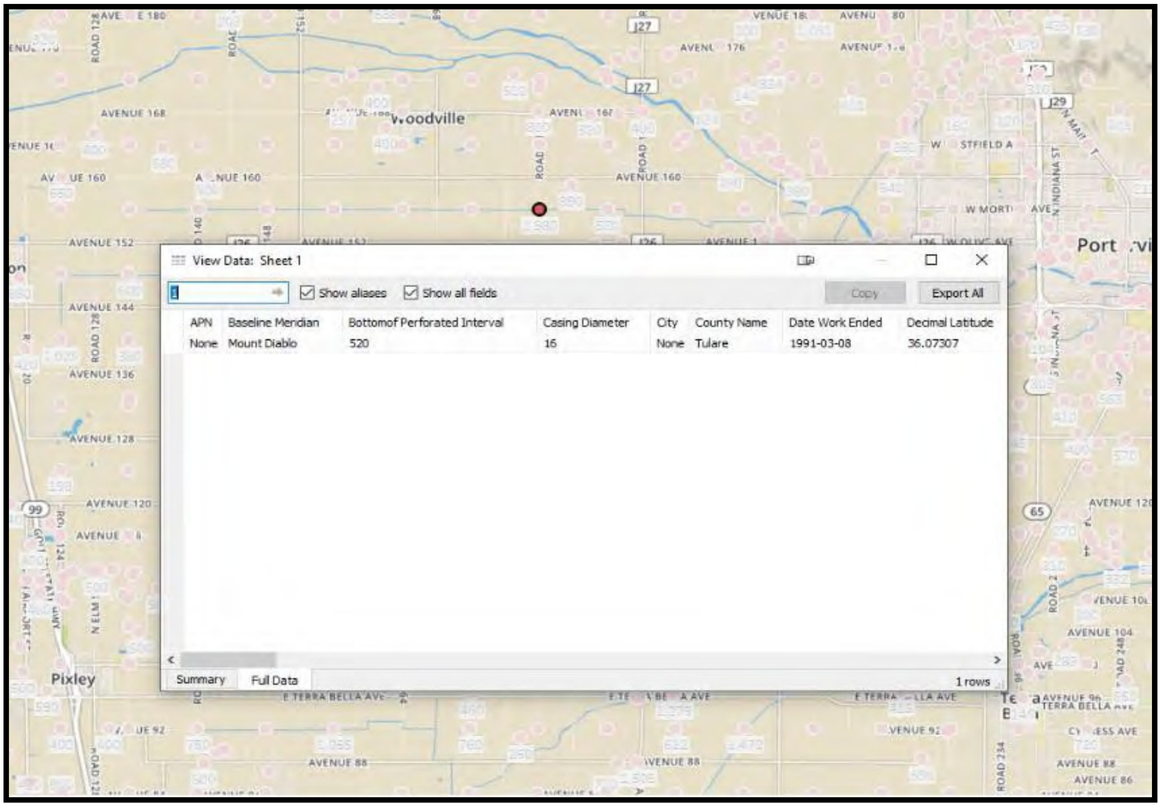



**Figure A1-12: DMS Map View Example - Total Completed Well Depth Map**

#### 5.2.3.2 List View

List view presents all the data of a given dataset in tabular form. It will allow users to see all the data in the chosen data set and their attributes. Data is able to be filtered for specific attributes, geographic extent, and various other criteria.

### 5.2.4 Query and Reporting

Data in the DMS can be queried and reporting using various filtering and querying tools. The options are dependent on the source of the data. Reports can be prepared from the queried DMS for various formats based on the submitting agency.

#### 5.2.4.1 Ad-hoc Query

As a relational database the DMS will have the ability to be queried by users with designed limitations for various end users (see section 5.2.1). Putting these limitations aside, any data included in the DMS can be queried based on the attributes which adhere to the data source (i.e. data type, data source, parameters, geographic location, etc.). See **Figures A1-13 and A1-14** for querying examples.

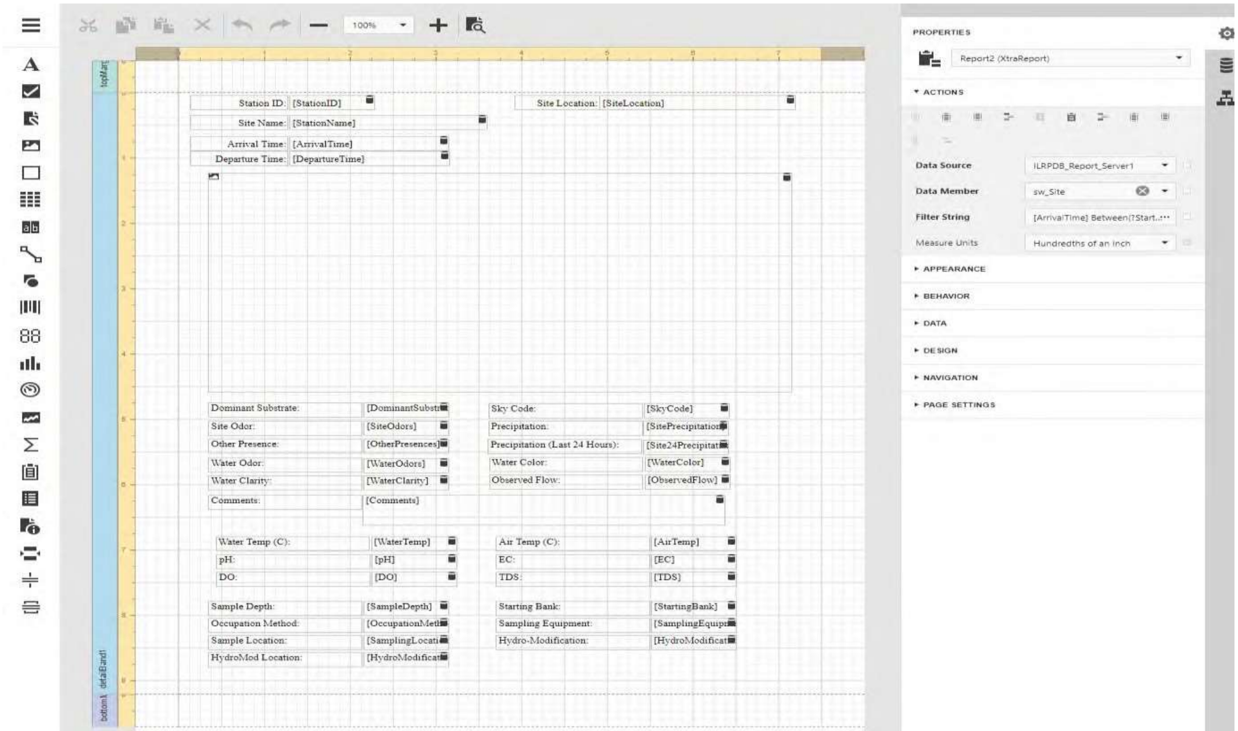



**Figure A1-13: Ad Hoc Report Builder Designer View**

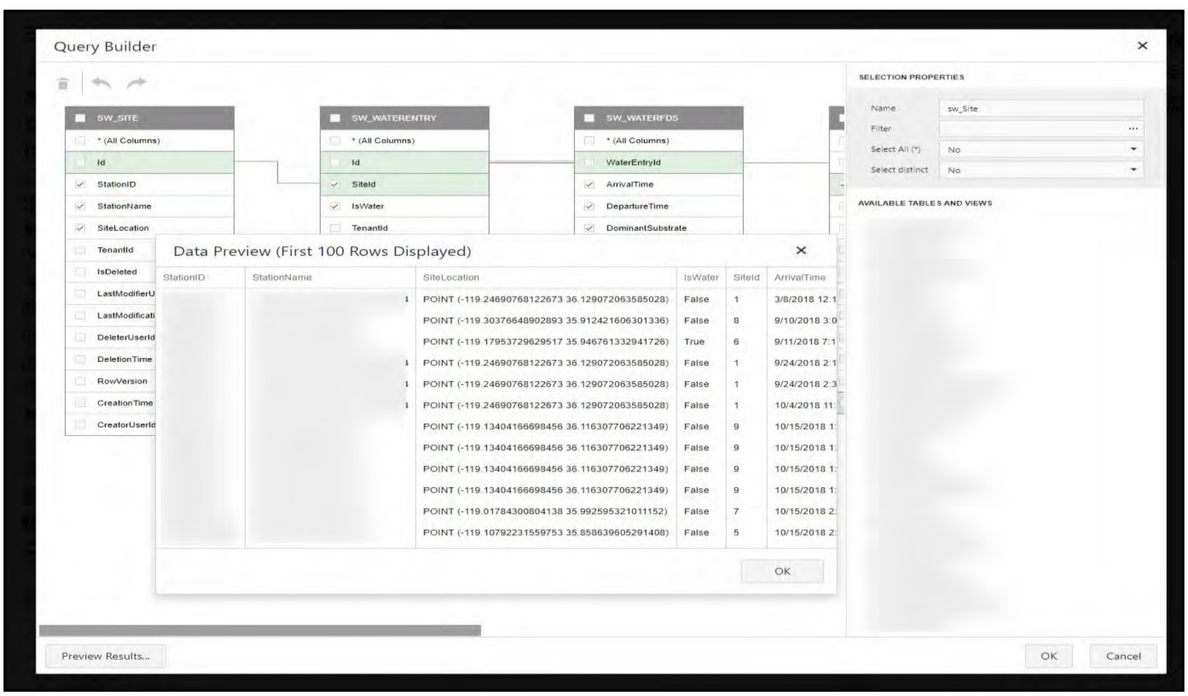



**Figure A1-14: Redacted Ad Hoc Query Builder Example**

#### 5.2.4.2 Standard Reports

Standard report chart and table formats such as those included in the annual and 5-year reports can be generated utilizing the DMS. Additional reporting requirements can be created by end users. In order to provide end users with flexibility in reporting, the tools are intended to be self-serviced by the end-users. End-users will be able to create their own reports using data they have permission to access.

If commonality is discovered between participating agencies, a Standardized report can be created and shared with all agencies that as required. All generated reports and reporting tools will be built to comply with § 352.4 of the SGMA Act.

### 5.3 Data Included in the Data Management System

Table A1-9: Summary of Data included in DMS identifies the specific data type, the source of the data, and entry of the data in to the DMS.

**Table A1-9: Summary of Data**

| Data Type | Source Name | | Entry Type |
|---|---|---|---|
| **Groundwater Quantity** | DWR Water Library | | Public Source |
| | DWR GICIMA | | Public Source |
| | CASGEM | | Public Source |
| | Irrigation Districts | | Private Source |
| | DCTRA | | Private Source |
| | TRA | | Private Source |
| | TBWQC | | DMS Transfer |
| | **GSAs** | | |
| | > | LTRID GSA | User Entry |
| | > | Pixley GSA | User Entry |
| | > | ET GSA | User Entry |
| | > | DEID GSA | User Entry |
| | > | Tri- County GSA | User Entry |
| | > | Tulare County GSA | User Entry |
| | > | Alpaugh GSA | User Entry |

| | | |
|---|---|---|
| **Groundwater Quality** | DWR Water Library | Public Source |
| | GAMA Geotracker | Public Source |
| | SCWRB Drinking Water Branch | Public Source |
| | RWQCB Annual Reports | Public Source |
| | TBWQC | Public Source |
| | County of Tulare | Public Source |
| **Surface Water Quantity** | Army Corps of Engineers | Public Source |
| | USGS Gaging Stations | Public Source |
| | Bureau of Reclamation | Public Source |
| | Tule River Authority | Private Source |
| | DWR - CDEC Stations | Public Source |
| **Surface Water Quality** | CA Environmental Data Exchange | Public Source |
| | TBWQC | DMS Transfer |
| | Friant Water Authority | Public Source |
| | Corps of Engineers | Public Source |
| **Precipitation** | DWR | Public Source |
| | CIMIS | Public Source |
| | Corps of Engineers | Public Source |
| | TBD | N/A |
| **Crop Data** | USDA Cropscape | Public Source |
| | DWR-CADWR | Public Source |
| | TBWQC Members | DMS Transfer |
| | Irrigation Districts | Public Source |
| | FMMP | Public Source |
| | LandSAT | Public Source |
| **Urban** | Cities | Public Source |
| | Counties | Public Source |

| | | |
|---|---|---|
| **Soil/Geology** | NRCS | Public Source |
| | DWR Well Reports | Public Source |
| | USGS Reports | Public Source |
| **Subsidence** | USGS | Public Source |
| | TBWQC | Public Source |
| | UNAVCO | Public Source |
| **Groundwater Extraction** | Well Meters | TBD |
| | ET Data | DMS Transfer |
| | LanSAT Metric | DMS Transfer |
| **Surface Water Use** | Irrigation Districts | Private Source |
| | TRA | Private Source |
| **Future Sources** | DAC/DUC IRWM Info | Private Source |
| **Well Data** | Well Completion Reports | Annually |
| | Physical Well Info | TBD |

# CHAPTER 5: PROJECTS & MANAGEMENT ACTIONS §354.42 – 354.44

**§354.40 Introduction to Projects and Management Actions**
This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.

## 5.1 INTRODUCTION [§354.40]

TCWA has divided its GSA into two distinct management areas, the North Management Area (North Area) and the Southeast Management Area (Southeast Area).

The North Management Area

The North Area, which is nearly all within Angiola Water District, has a groundwater supply that is supplemented by a surface water supply. The wells extract water from the lower and upper aquifers. Crops grown in the North Area are field crops that can be fallowed to satisfy water supply reductions in times or drought. The surface water supply comes from various sources, including the State Water Project (Article 21 water), the Central Valley Project via the Fresno Slough Water District and Mercy Springs Water District transfers, the Tule River (via the Bayou Vista Ditch Company), the Kings River, Deer Creek, and flood waters when available. AWD owns two well fields that together contain about 35 wells. The gross area contained within the North Area is approximately 12,000 acres.

The Southeast Management Area

The Southeast Area is an Un-Districted (“White Area”) that has no surface water supply. It relies on groundwater to supply its crop water needs. The east two-thirds of the area has access to both the upper and the lower aquifer. The west one-third has access only to the lower aquifer. Crops grown in the Southeast Area are predominantly permanent crops – mainly Pistachios. These crops cannot be fallowed in times of restricted water supplies, they must be idled, trees removed and land set aside. The gross area of the Southeast Area is about 50,000 acres.

Current Water Supply Conditions

Both management areas are in overdraft. Groundwater is extracted from both the lower and upper aquifers. Subsurface inflow from areas external to TCWA supplies a large portion the irrigation demands. About 13,000 afy of groundwater is exported out of the North Area under a prescripted water right. Groundwater extractions are not fully mitigated by surface water supplies in the North Area and are not mitigated at all in the Southeast Area. Deep wells pump water from below the Corcoran Clay causing land subsidence. Studies by Thomas Harder and Co. indicate that the current net inflow is 41,000 afy into TCWA. Studies by Ken Schmidt and Associates estimate this amount to be 44,100 afy. Additionally, Harder estimates that about 12,000 afy are added to the groundwater supply in TCWA by the release of water from compaction of the clays beneath the area. Schmidt agrees with this number.

**§354.44 Projects and Management Actions**

a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.

b) Each Plan shall include a description of the projects and management actions that include the following:

1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

A. A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

B. The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

3) A summary of the permitting and regulatory process required for each project and management action.

4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.

5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

**§354.44 Introduction to Projects and Management Actions**

c) Projects and management actions shall be supported by best available information and best available science.

d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

## 5.2 PROJECTS & MANAGEMENT ACTIONS [§354.44(a), (b), (c), (d)]

In recognition that the current conditions must be mitigated as required by SGMA, TCWA has proposed management actions to mitigate the current overdraft conditions and reduce subsidence. These actions include projects together with land retirement. The Southeast Area will need to develop projects to replace excess groundwater extractions with surface water and implement management actions resulting in reduction of consumptive use. Table 5.2 below provides a summary of the proposed projects. The analyses are preliminary in nature. Estimated water supply benefits have been provided by the project proponents. Project costs have been approximated and are estimates based on the limited information available at the time of the preparation of this GSP. Unit costs have been calculated based on this preliminary information. These projects have been proposed by landowners and have not been thoroughly vetted by TCWA and the preparers of this GSP. This GSP presents a pre-feasibility review of the projects and further work needs to be done in order to identify and substantiate the necessary surface supplies, some of which are excess flood flows, some of which are dependent on future state/federal water projects. If the projects fail to materialize, or fall short of the amounts of water forecasted to be developed, the solution will be to reduce demands by making changes in crops, cropping patterns, or reduce the cropped acreage.

In recognition of the data gaps that exist in water levels, water quality, subsidence measurements, groundwater pumpage, and groundwater storage, TCWA will implement an adaptive management approach that will take into consideration actual changes in groundwater conditions resulting from proposed projects, potential impacts from future extreme drought periods, impacts of climate change, and unknown impacts resulting from projects and management actions taken by TCWA and adjacent GSAs. This may result in the need for more extreme measures being implemented. The ability to make adjustments as more information is obtained, which reduces the currently-identified data gaps, allows for a flexible management approach where decisions can be adjusted to ensure a better outcome for all groundwater users. Management actions will take into account existing beneficial uses including DAC's, GDEs and undistricted areas subject to MOUs.

The availability of excess water to fill storage projects or supply recharge projects is subject to future analysis. The effects of proposed projects and land retirement programs implemented between 2020 and 2030 will determine the succeeding management actions taken by TCWA between 2030 and 2040.

Therefore, to the extent that projects cannot be developed or projected water supplies cannot be attained, the alternative is reduction in groundwater pumpage by crop changes, changes in irrigation practices, or idling land. These actions would be directed by the TCWA Board of Directors after consideration of information developed by the monitoring programs of TCWA and neighboring GSAs, and after input from all affected parties.

Provision of metering on all large capacity wells provides an accurate determination of groundwater pumpage. The net groundwater use can then be more accurately calculated by utilizing pan evaporation data, thereby developing better estimates of net groundwater use on a farm-by farm basis. This then will help each farm manager make accurate management decisions regarding cropping and irrigation practices.

## Table 5.1
## Projects List

| Tri-County Water Authority | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TCWA PRELIMINARY PROJECTS LIST | | | | | | | | |
| **Project Designation** | **Description** | **Primary Benefit Area** | **Implementation Date[1]** | **2020-2025** | **2025-2030** | **2030-2035** | **2035-2040** | **Comment** |
| **1. Deep Aquifer Pumping** | Replace lower aquifer pumping with upper aquifer pumping | North and Southeast Areas | 2020 - 2030 | 4,000 afy | 12,000 afy | 24,000 afy | 24,000 afy | Reduce subsidence and transfer pumping to the upper Aquifer, which is currently in balance |
| **2. White Ranch Project[2]** | Replace pumping in AWD's East & West Well Fields with surface water | North Area | 2022 | 5,800 afy | 5,800 afy | 5,800 afy | 5,800 afy | Replace groundwater pumping with surface water from Deer Creek (average 800 afy) and the Liberty Project (5,000 afy). |
| **3. Liberty Project[3]** | Build a storage facility on lands in Sec 26-35 of T23S,R21E | North and Southeast Areas | 2020 - 2030 | 7,000 afy | 40,000 afy | 60,000 afy | 60,000 afy | This project is a storage project that will convey 5,000 afy from the Liberty Project to the Deer Creek/Duck Club Project. The project can provideup to 40,000 af of storage by 2030 and up to 60,000 af of storage by 2035. A substantial amount of the project yield will go to the Southeast Area to reduce groundwater pumpage. |
| **4. Reduction in Crop Water Demand** | Reduce Pumping by about 10% primarily from the lower aquifer. | North and Southeast Areas | 2025 | 0 | 7,500 afy | 15,000 afy | 15,000 afy | This is a reduction in crop water demand to be implemented by individual farmers. The decision as to how the reduction will be accomplished will be up to each individual farmer. |
| **5. Prosperity Farms Project[4]** | Direct Recharge Project | Southeast Area | 2025 | 1,500 afy | 1,500 afy | 1,500 afy | 1,500 afy | This is a direct recharge project that will be implemented by a landowner. |
| **6. Metered Wells[5]** | Installation of Water Meters on all large-capacity wells | North and Southeast Areas | 2020 | n/a | n/a | n/a | n/a | This management action requires all large capacity wells to be wquipped with recording water meters. |

Notes:
1. For projects/management actions that involve construction , the implementation date is the beginning of the permitting and design process. The completion date will be within the five-year period in which design begins.
2. The White Ranch Project incorporates two water sources: Deer Creek and Phase 1 of the Liberty Project. Water stored in the Liberty Project will be released and used in lieu of pumping groundwater.
3. Phases 2 and 3 will provide water to both the North and the Southeast Areas.
4. This project is on White River and involves intercepton of excess flows form the lands that area contrubutory to While River directly upstream and in the vicinity of Prosperity Farms.
5. TCWA will implement this policy in February 2020.

### NORTH AREA

Liberty Project

→ The Liberty Project is a water storage project on about 20-sections of land on private lands within AWD in Kings County (see Figure 5.2.1). It will be built in phases.

→ This project will enable the capture and temporary storage of winter/spring flows from the Fresno Slough- Fresno Irrigation District, the CVP, the Kings, Tule and Kaweah Rivers, SWP Article 21 and CVP 215 waters.

→ The waters will be conveyed into, what ultimately, will be a 20-section storage reservoir constructed in Sections 14-23 and 26-35 of T.23S., R.21E., MDB&M, located south of Utica Avenue in Kings County. This water will be used in-lieu of groundwater for the irrigation of crops. The project will supply 5,000 af of water to the White Ranch area in Tulare County (Tule Subbasin).

→ The first phase of the project (permitting and design) is scheduled to begin in 2020. Two more successive phases are scheduled to be completed in the years 2025 and 2030. It appears that a total of three phases of the project covering 15 sections will achieve a groundwater balance. A fourth phase is optional depending on the results achieved with the first three phases.

- Phase 1 is estimated to develop an annual average of 5,000 af of supplemental surface water that will be conveyed into the North Area and recharged and/or supplied directly to farmlands in the District. Phase 1 involves development of storage facilities on two sections of land. Fifteen-feet-high levees impounding 11 feet of water, storing about 11,000 acre-feet of water.
- Phases 2 and 3 of the Liberty Project are outlined below in the section discussing projects that will benefit both the North and Southeast Areas.

→ The California Environmental Quality Act (CEQA) will apply to the project for which several studies will need to be completed. The project will be built under the authority of Section 6004 of Division 3, Dams and Reservoirs, Part 1, of the California Water Code, and will therefore not be under the jurisdiction of the Division of Safety of Dams.

→ Figures 5.2.1-A – 5.2.1-E show the configuration that was used to develop the feasibility costs and storage volumes that are discussed herein. These are feasibility-level designs. The final configuration will be determined at a later date.

White Ranch

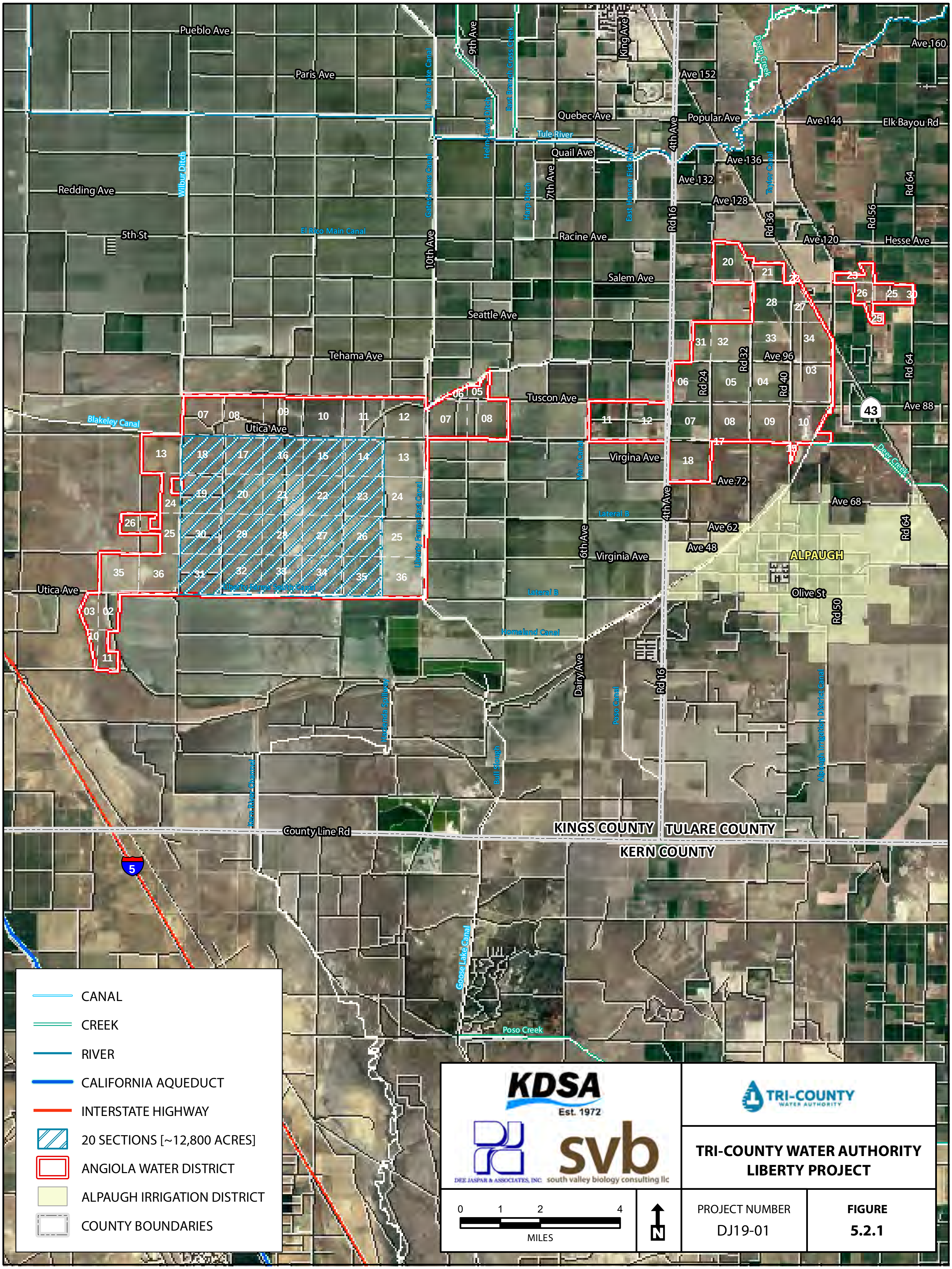
→ This project includes utilization of waters from the Liberty Project and capture of water from Deer Creek in flood years to reduce lower aquifer groundwater pumping in the Tule Subbasin.

→ It is anticipated that one year out of seven, Deer creek produces 5,400 acre-feet of streamflow that can be captured by AWD. This amounts to an average 800 acre-feet per year.

→ The projects goal is to reduce groundwater pumping from the lower aquifer by an average of 5,800 afy.

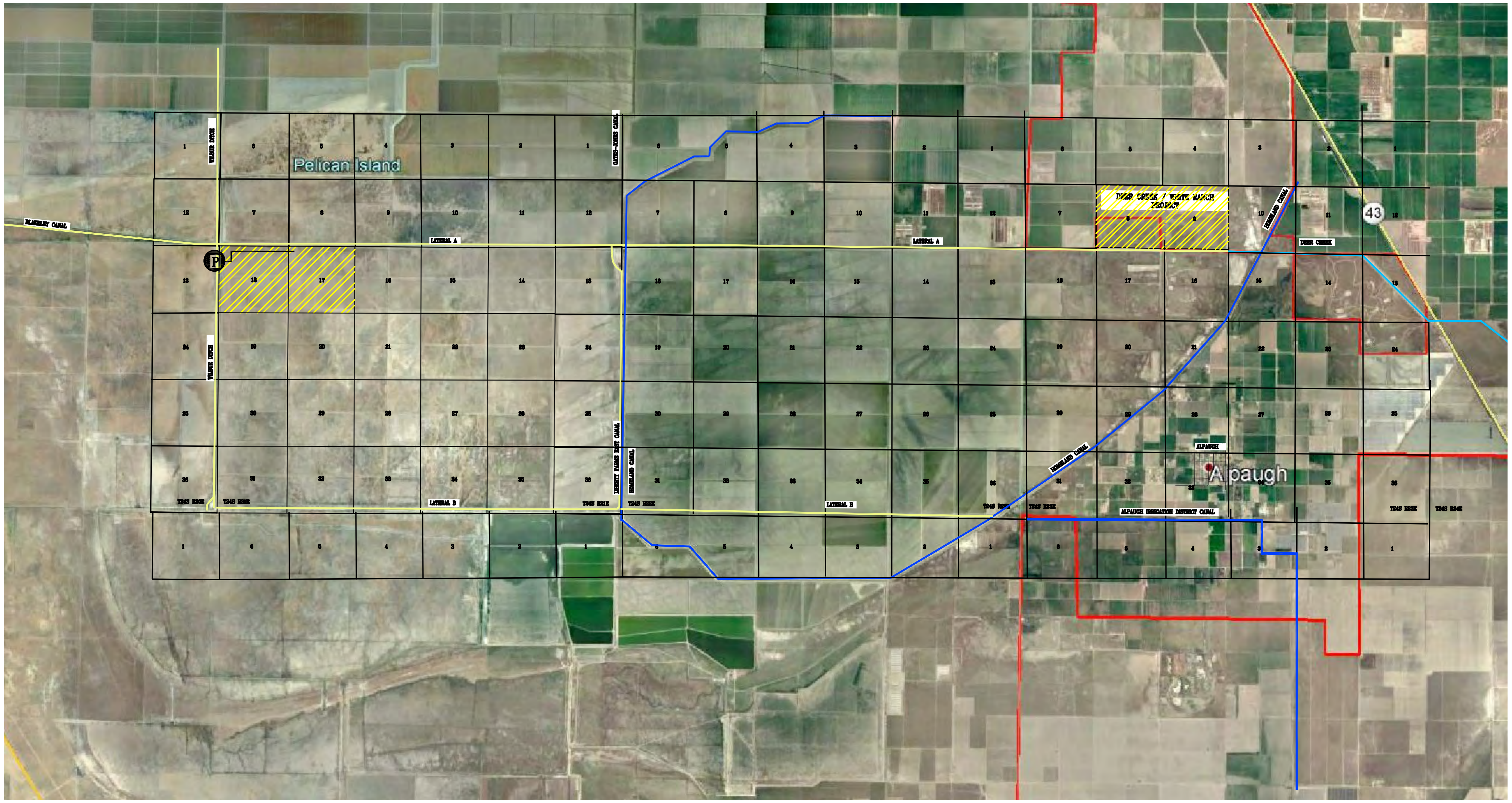
→ Water will be conveyed to the Deer Creek/White Ranch lands by existing canals, chiefly the Blakeley Canal and Lateral A to the terminus of Deer Creek near the east boundary of the North Area.

→ Design and permitting of the project are scheduled to begin in concert with the Liberty Project in 2020 and be completed in 2021-2022.



Pueblo Ave
Paris Ave
Redding Ave
5th St
Wilbur Ditch
El Rico Main Canal
Tulare Lake Canal
9th Ave
Helm Lewis Ditch
East Branch Cross Creek
King Ave
Quebec Ave
Tule River
Quail Ave
7th Ave
Racine Ave
Salem Ave
Seattle Ave
Tehama Ave
Tuscon Ave
10th Ave
4th Ave
Ave 152
Popular Ave
Ave 144
Elk Bayou Rd
Ave 160
Deer Creek
Ave 136
Ave 132
Ave 128
Ave 120
Hesse Ave
Rd 16
Rd 36
Rd 56
Rd 64
Ave 96
Rd 32
Rd 24
Rd 40
Ave 88
43
Blakeley Canal
Utica Ave
Virgina Ave
Main Canal
Ave 72
Ave 68
Ave 62
Ave 48
Lateral B
6th Ave
Virginia Ave
ALPAUGH
Olive St
Rd 50
Homeland Canal
Dairy Ave
Poso Canal
Bull Slough
Alpaugh Irrigation District Canal
Liberty Farms South Canal
Liberty Farms East Canal
County Line Rd
KINGS COUNTY
TULARE COUNTY
KERN COUNTY
5
Goose Lake Canal
Poso Creek
CANAL
CREEK
RIVER
CALIFORNIA AQUEDUCT
INTERSTATE HIGHWAY
20 SECTIONS [~12,800 ACRES]
ANGIOLA WATER DISTRICT
ALPAUGH IRRIGATION DISTRICT
COUNTY BOUNDARIES
KDSA Est. 1972
DEE JASPAR & ASSOCIATES, INC
svb south valley biology consulting llc
TRI-COUNTY WATER AUTHORITY
TRI-COUNTY WATER AUTHORITY
LIBERTY PROJECT
0 1 2 4
MILES
N
PROJECT NUMBER
DJ19-01
FIGURE
5.2.1

## FIGURE 5.2.1-A
## LIBERTY PROJECT - PHASE 1




Lands developed in this Phase

Ⓟ Lift Station and Return Flow Bypass

SCALE 1"=5,000'

0 5,000' 10,000' 20,000'

### LIBERTY PHASE 1 / WHITE RANCH PROJECT

DEVELOPMENT OF 11,000 AF STORAGE IN SECTIONS 17 & 18
PUMP WATER FROM LATERAL A INTO STORAGE AREA
RELEASE WATER FROM LIBERTY PHASE 1 INTO LATERAL A &
TRANSPORT WATER TO DEER CREEK / WHITE RANCH LANDS FOR
USE IN NORTH MANAGEMENT AREA

REDUCED NTS DRAWING

| REV. | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEE JASPAR & ASSOCIATES, INC.
CIVIL ENGINEERS

LIBERTY PROJECT PHASE 1
LIBERTY - WHITE RANCH PROJECT
NORTH AREA
TRI-COUNTY GSA
TULARE COUNTY, CALIFORNIA

| | |
|---|---|
| DRAWN | DJA |
| CHECKED | DJA |
| DATE | DATE |
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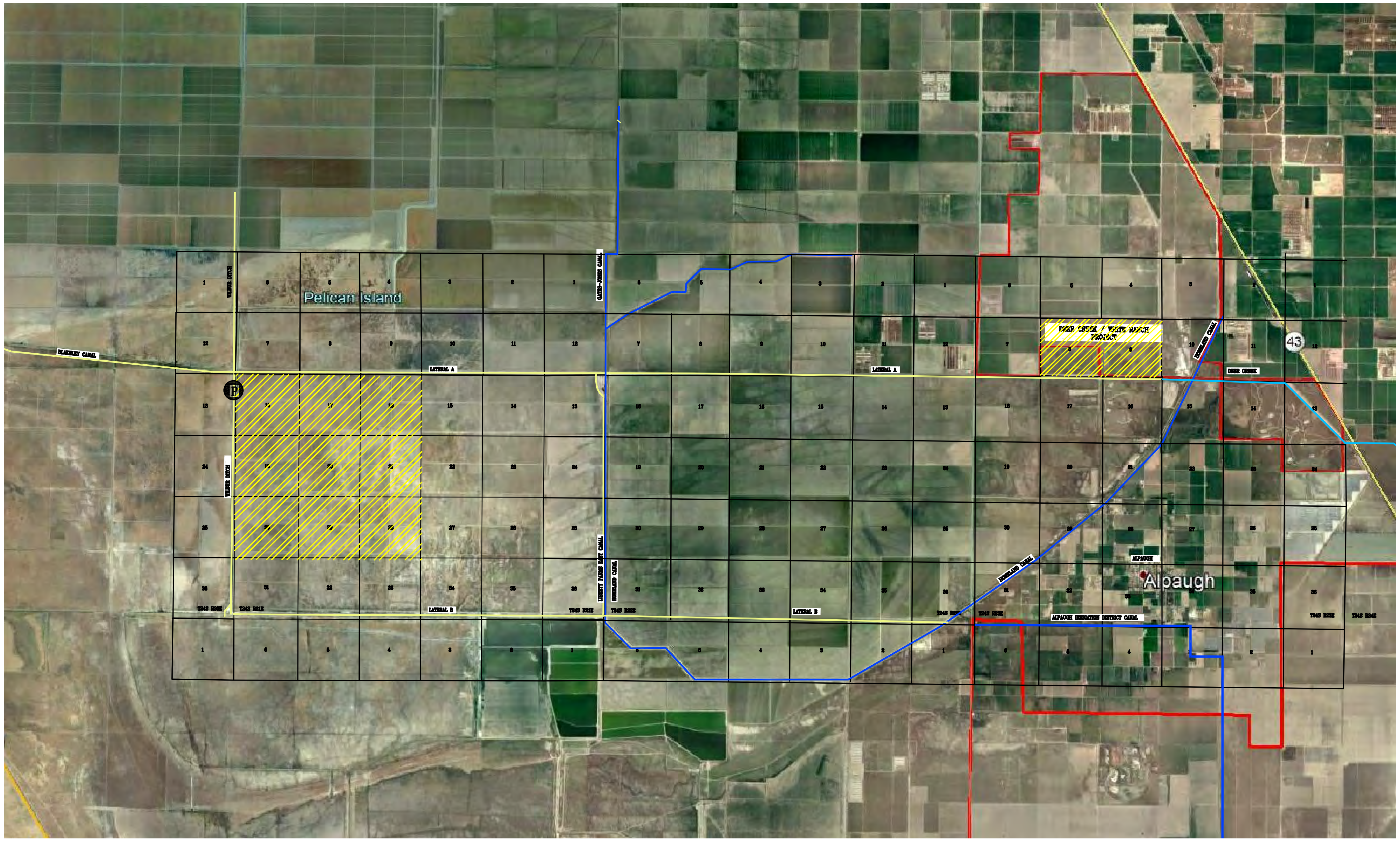
| OF | 5 SHEETS |

# FIGURE 5.2.1-B
# LIBERTY PROJECT - PHASE 2




## LIBERTY PROJECT – PHASE 2

DEVELOPMENT OF 56,000 AF STORAGE IN SECTIONS 14–23 &
SECTIONS 28–30 – 9 SECTIONS
PUMP WATER FROM WILBUR DITCH INTO STORAGE AREA
1. RELEASE WATER FROM LIBERTY PHASE 2 INTO LATERAL A &
TRANSPORT WATER TO DEER CREEK / WHITE RANCH LANDS
FOR USE IN NORTH AREA
2. RELEASE WATER TO LATERAL B (VIA WILBUR DITCH) FOR
USE IN SOUTHEAST AREA

Legend:
- Lands developed in this Phase
- Ⓟ Lift Station and Return Flow Bypass

SCALE 1"=5,000'

0 5,000' 10,000' 20,000'

REDUCED NTS DRAWING

REV. | DATE | DESCRIPTION | BY

DEE JASPAR & ASSOCIATES, INC.
CIVIL ENGINEERS

LIBERTY PROJECT PHASE 2
NORTH & SOUTHEAST AREA

TRI–COUNTY GSA
TULARE COUNTY, CALIFORNIA

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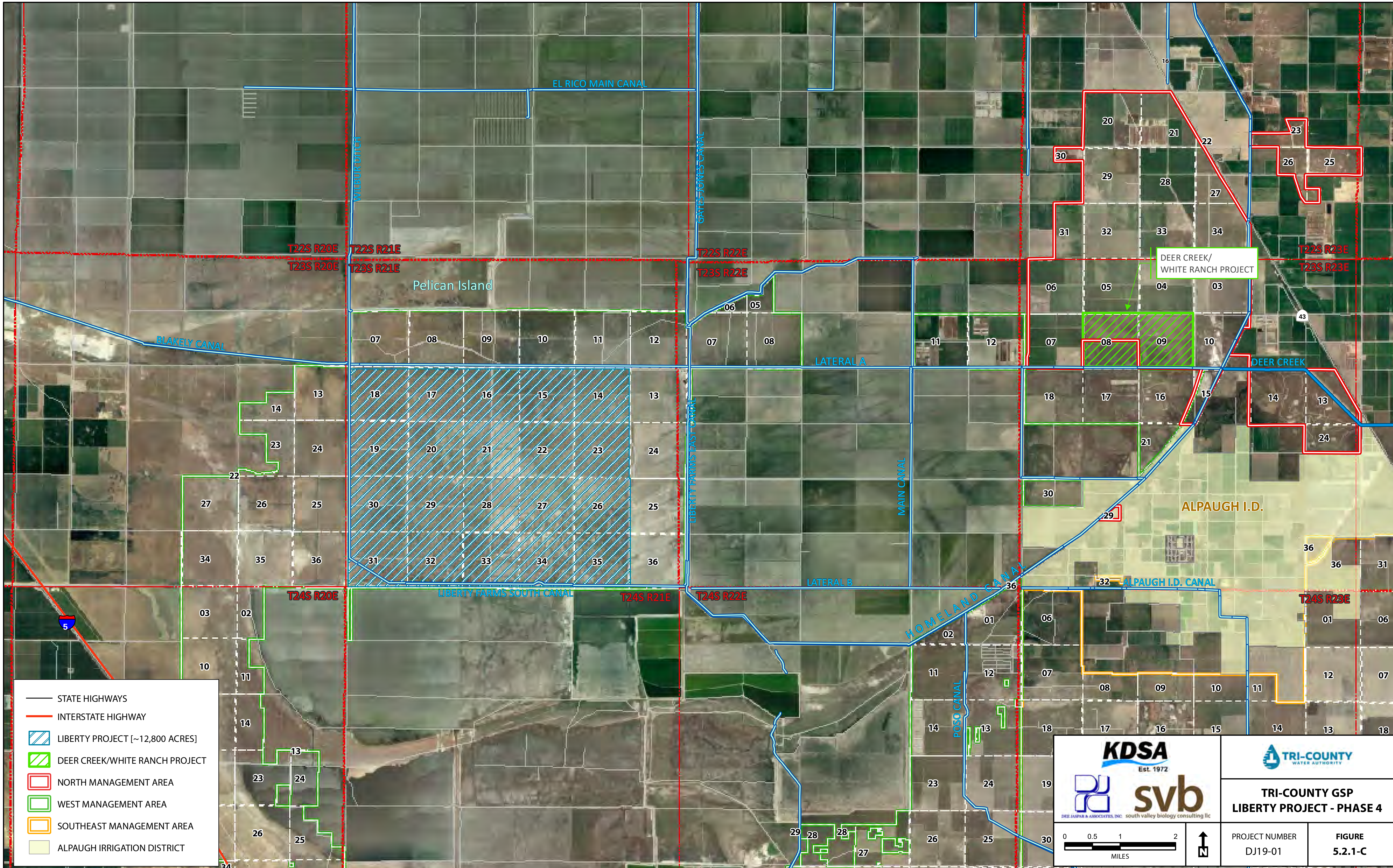
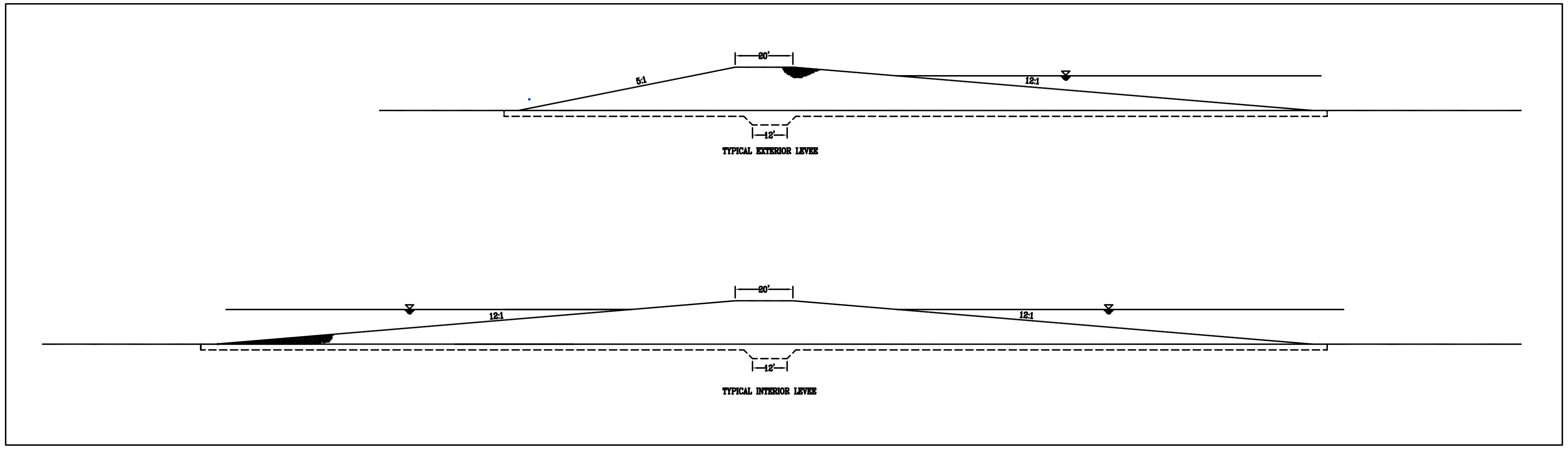



SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU

## FIGURE 5.2.1-D - LIBERTY PROJECT




# LIBERTY PROJECT

LEVEES: THE CONTAINMENT LEVEES ARE A MAXIMUM FIFTEEN FEET HIGH WITH SPILLWAYS SET TO MAINTAIN WATER LEVELS 11 FEET IN DEPTH AS MEASURED FROM THE LOWEST POINT ON THE DOWNSTREAM SIDE OF THE LEVEE TO THE UPSTREAM WATER SURFACE.

.

LEVEES ARE 20 FEET WIDE AT THE CREST WITH SIDE SLOPES OF 12:1 AGAINST WATER AND 5:1 ON THE EXTERIOR SIDES.

PUMPING PLANTS AND RETURN FLOW FACILITIES WILL BE SIZED TO MEET THE REQUIREMENTS BASED ON THE VOLUMES OF WATER ANTICIPATED TO BE AVAILABLE. WATER WILL BE RELEASED INTO EXISTING CANALS WHEN REQUIRED FOR IRRIGATION.

STORAGE AT THE WHITE RANCH SITE WILL BE TAYLORED TO THE CAPABIITY OF THE FACILITY TO STORE OR RECHARGE WATER. FACILITIES TO RECOVER WATER FROM THE WHITE RANCH WILL BE DESIGNED ONCE THESE PARAMETERS ARE DEVELOPED.

STORAGE AND DELIVERY OF WATER TO THE SOUTHEAST AREA WILL BE UNDERTAKEN DURING PHASE 2 OF THE PROJECT. FACILITIES TO DELIVER WATER TO THE SOUTHEAST AREA WILL BE DESIGNATED AS THE SUPPLY IS DEVELOPED AND IMPROVEMENTS WILL BE DESIGNED AND CONSTRUCTED AS NEEDED.

WATER SUPPLY WILL BE A COMBINATION OF CONTRACTED WATER, EXCESS WATER DURING WET YEARS, AND FLOOD WATER. AWD INDICATES THAT THERE ARE MULTIPLE AND ADEQUATE SOURCES OF WATER FOR THE PROJECT.

FLOODWATERS AND WATERS IN EXCESS OF CONTRACT DEMANDS ON THE MAJOR WATER DELIVERY SYSTEMS (I.E. ARTICLE 21 AND CVP 215 WATERS) WILL BE AVAILABLE FOR A LIMITED AMOUNT OF TIME AND THEREFORE PUMPING PLANTS HAVE BEEN SIZED TO PUMP THESE SHORT-TERM FLOWS DURING THE TIMES THAT THEY ARE AVAILABLE.

REDUCED NTS DRAWING

REV. | DATE | DESCRIPTION | BY

DEE JASPAR & ASSOCIATES, INC.
CIVIL ENGINEERS

LIBERTY PROJECT
MISCELLANEOUS PRELIMINARY DETAILS
TRI-COUNTY GSA
TULARE COUNTY, CALIFORNIA

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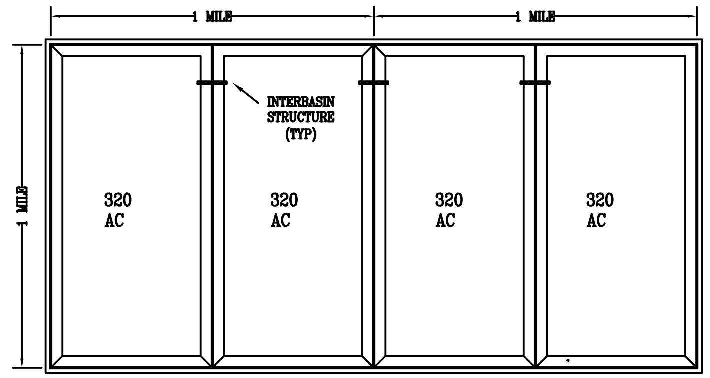
JOB NO.
SHEET 4
OF 5 SHEETS

# FIGURE 5.2.1-E - LIBERTY PROJECT

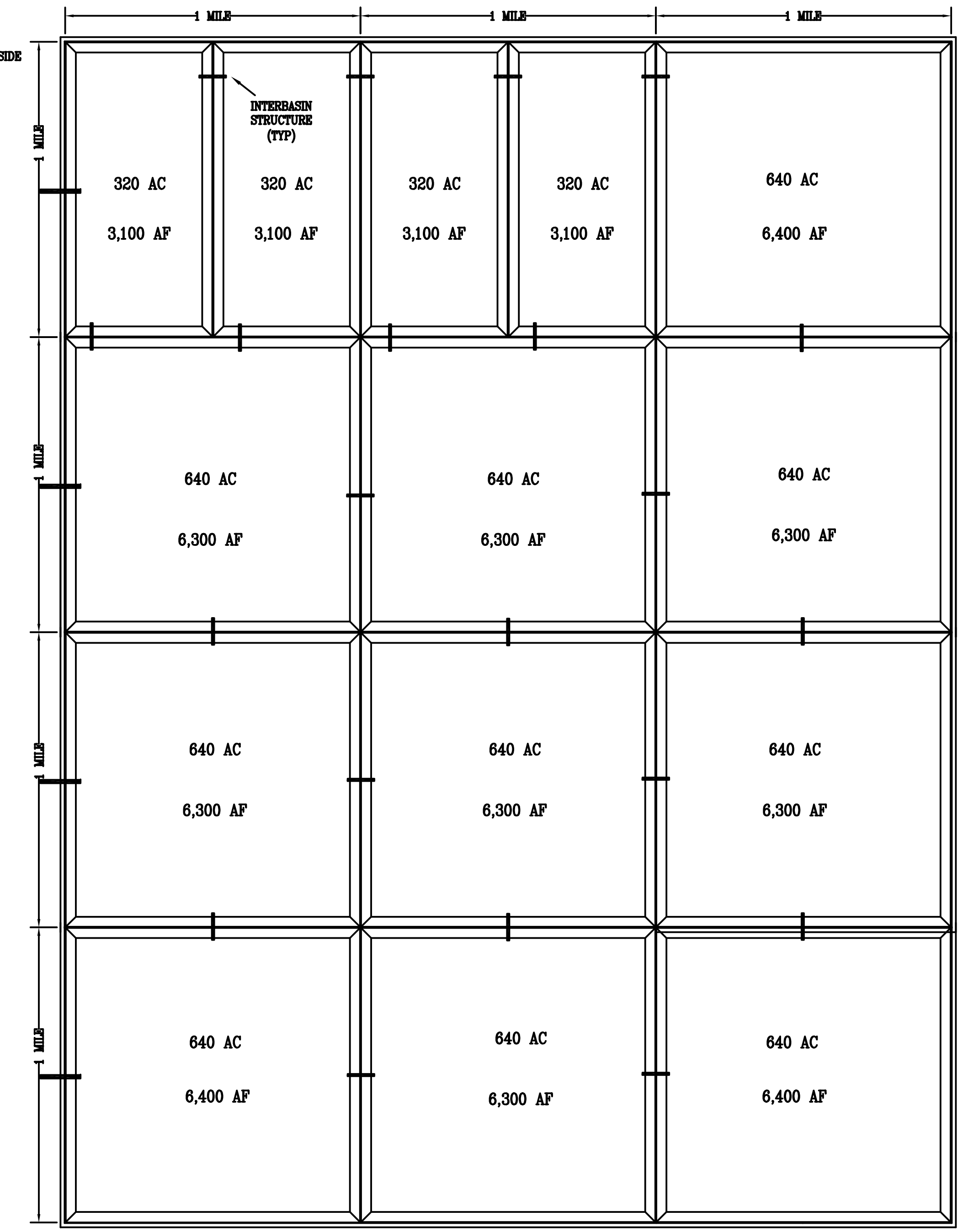



PHASE 1 LEVEES
15' HIGH, 11' OF WATER IMPOUNDED
5:1 SLOPES DRY SIDE, 12:1 SLOPES WET SIDE

FOUR 320-ACRE CELLS
2,850 AF/CELL
11,400 AF STORAGE

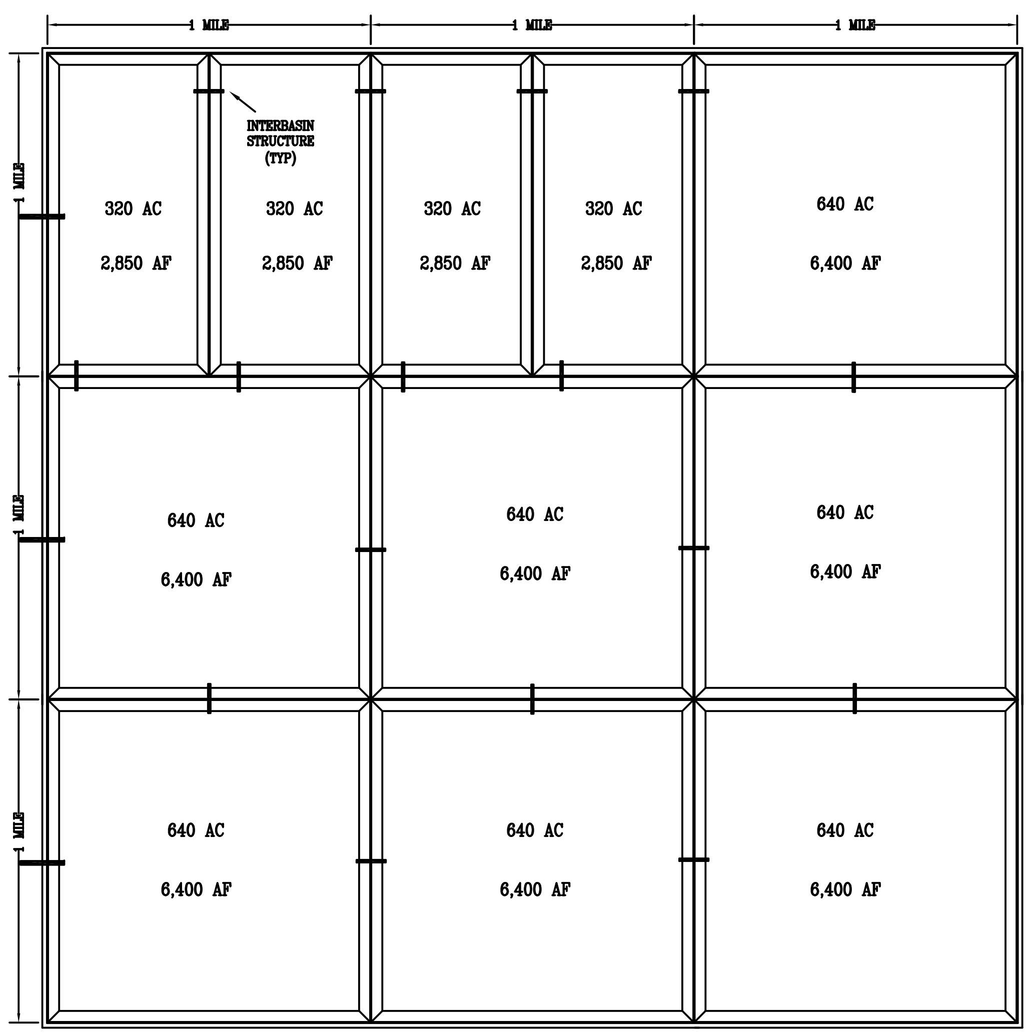
LIBERTY PROJECT PHASE 1

PHASE 3 LEVEES
15' HIGH, 11' OF WATER IMPOUNDED
5:1 SLOPES DRY SIDE, 12:1 SLOPES WET SIDE




FOUR 320-ACRE CELLS
ELEVEN 640-ACRE CELLS
94,000 AF STORAGE

LIBERTY PROJECT PHASE 3




PHASE 2 LEVEES
15' HIGH, 11' OF WATER IMPOUNDED
5:1 SLOPES DRY SIDE, 12:1 SLOPES WET SIDE

FOUR 320-ACRE CELLS
SEVEN 640-ACRE CELLS
56,800 AF STORAGE

LIBERTY PROJECT PHASE 2

REDUCED NTS DRAWING

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| 2 | | | |
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| 7 | | | |


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839 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275


LIBERTY PROJECT
MISCELLANEOUS PRELIMINARY DETAILS
TRI-COUNTY GSA
TULARE COUNTY, CALIFORNIA

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## SOUTHEAST AREA

TCWA GSA Recharge Project

- → This project is contemplated to be located in the northeast quadrant of the Southeast Area. The project will capture flood waters in years of seasonal flooding. Floodwaters would be directed to reservoirs constructed to capture and recharge these waters.
- → The project is in the feasibility study phase.
- → The goal is to capture about 1,200 – 1,800 afy of floodwaters for aquifer recharge.
- → A SWRCB permit will be required in order to capture this excess water.
- → A county grading permit will be required and CEQA would have to be satisfied.

## BOTH NORTH AND SOUTHEAST AREAS

Deep Aquifer Pumping Reduction

- → This project is to reduce pumping from the lower aquifer and thereby reduce land subsidence.
- → Pumping will be reduced or stopped for a number of wells tapping the lower ("deep") aquifer by replacing some of the wells pumping from the lower aquifer with wells pumping from the upper ("shallow") aquifer.
- → It is estimated that at least 80% of the groundwater pumping in TCWA is from the deep aquifer. Groundwater pumping is estimated to be about 60,000 afy, including groundwater exports out of the Subbasin. Therefore, an estimated 48,000 afy is being pumped out of the deep aquifer.
- → It is proposed to install 24 shallow wells and thereby reduce pumpage from the deep aquifer by an approximate 24,000 afy, or about half of the current deep aquifer pumpage.
- → The goal is to reduce land subsidence.
- → Certain AWD deep wells have already been replaced by shallow wells. Some landowners have replaced some of their deep wells with shallow wells. The project is currently underway and will continue for the next five years. The effects on the upper aquifer will be monitored as this program develops, as this increases demands on the upper aquifer.

Reduction of Groundwater Extractions by Idling

- → This is a TCWA management project whereby certain lands are fallowed in order to reduce groundwater extractions.
- → This project would place a fee on groundwater extractions beyond sustainable yield and designate the funds to be used for purchasing/leasing lands for idling purposes.

Reduction of Groundwater Extractions by Voluntarily Idling Lands

→ This program would be accomplished by private landowners in order to reduce groundwater extractions. It is hoped that implementation of projects will be sufficient to avoid idling lands.

→ Reduction of Impacts on Public Infrastructure This management action involves identifying and locating underground public infrastructure that is subject to damage due to localized groundwater pumping.

Phases 2 and 3 of the Liberty Project

→ Phase 2 of the project involves developing a nine-section storage facility and considers two levee heights. Design is scheduled to begin in 2025. 1. Ten-feet-high levees will impound 33,000 acre-feet, 2. Fifteen-feet high levees will impound 56,000 acre-feet. Four feet of freeboard is planned for both configurations.

→ Phase 3 involves developing 11 more sections of storage for a total of 20 sections, and again considers two levee heights. 1. Ten-feet high levees will impound 71,000 acre-feet, 2. Fifteen-feet high levees will impound 125,000 acre-feet.

→ Refer to Figures 5.2.1-A – 5.2.1-E, showing the configuration that was used to develop the feasibility costs and storage volumes that are discussed herein.

## Detailed Project Descriptions

The following is a description of proposed projects/management actions to be undertaken by TCWA and the water users of TCWA. The measurable objective that will benefit from the implementation of the projects management actions, a description of the circumstances that are triggering implementation of the projects/management actions, and a description of the process by which TCWA has determined that the projects/management actions are required, together with the process by which TCWA will inform the landowners and the Tule Subbasin MOU Group that the projects/management actions are being considered or being implemented. For ease of reference, the Water Budget Maps Figure 2.3.8-A and Figure 2.3.8-B are repeated below (after the proposed projects/management actions -Items 1 through 5).

TCWA must implement projects and management actions to solve a groundwater supply deficit of about 60,000 acre-feet annually. This deficit is due to crop demands and exported water demands that cumulatively, are greater than the summation of surface water supplies, rainfall, and natural (pre-development) groundwater inflow. The natural groundwater inflow has been estimated to be about 18,000 afy. Additionally, amounts of groundwater derived from compaction of clay layers will be reduced to zero. The following projects are planned to be implemented in phases over the first five years of the implementation period and beyond. It is planned to have a majority of the projects and management actions completed by 2030, but if they cannot be implemented in that timeframe, the remaining five to ten years is available to complete the process.

# Table 5.2
## Tri-County Water Authority
## PRELIMINARY PROJECT ANALYSIS[1]

| PROJECT DESIGNATION | PROJECT DESCRIPTION | TIME PERIOD | ACRE-FEET OF STORAGE[2] | CAPTIAL COST[3] ($) | ANNUAL PRINCIPAL & INTEREST[4] ($) | AVERAGE ANNUAL PROJECT YIELD[5] (AF) | UNIT CAPITAL COST[6] ($/AF) | ESTIMATED ANNUAL O&M COST[7] ($) | TOTAL ANNUAL COST[8] ($) | COST PER ACRE-FOOT[9] ($/AF) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Deep Aquifer Pumping** | Replace lower aquifer wells with shallow aquifer wells | | | | | | | | | |
| | 4 Wells @ 1,000 afy/well | 2022 | n/a | $600,000 | $32,866 | 4,000 | $8 | $383,569 | $416,435 | $104 |
| | 12 WellS @ 1,000 afy/well | 2025 | n/a | $1,800,000 | $98,598 | 12,000 | $8 | $1,150,708 | $1,249,306 | $104 |
| | 24 Wells @ 1,000 afy/well | 2030 | n/a | $3,600,000 | $197,196 | 24,000 | $8 | $2,301,415 | $2,498,612 | $104 |
| **Liberty Phase 1 / White Ranch[10]** | 5,800 afy from the Liberty Project (2 sections) and Deer Creek | 2022 | 11,400 | $23,000,000 | $1,845,580 | 7,700 | $240 | $362,695 | $2,208,275 | $287 |
| **Liberty Project Phase 2[11]** | Build 15' High Storage Facility on 9 Sections of Land | 2025 | 56,400 | $70,000,000 | $5,616,981 | 37,900 | $148 | $1,927,665 | $7,544,646 | $199 |
| **Liberty Project Phase 3[12]** | Build 15' High Storage Facility on 15 Sections of Land | 2030 | 93,300 | $105,000,000 | $8,425,472 | 61,300 | $137 | $3,188,850 | $11,614,322 | $189 |
| **Liberty Project Phase 4[13]** | Build 15' High Storage Facility on 20 Sections of Land | 2035 | 124,700 | $135,000,000 | $10,832,749 | 81,900 | $132 | $4,262,054 | $15,094,803 | $184 |
| **Recharge Project[14]** | Construction of a Recharge Area to Intercept Runoff and Flood Waters | 2020 | 1,800 | $1,500,000 | $120,364 | 1,500 | $80 | $61,200 | $181,564 | $121 |
| **Meter Installation[15]** | Installation of Recording Water Meters on all Large-Capacity Wells | 2020 | n/a | $200,000 | n/a | n/a | n/a | n/a | n/a | n/a |

Notes:
1. Timing adjusted to achieve groundwater balance by 2030. Based on sustainable yield of 22,000 afy.
2. Assumumption that 100% of available storage is filled every year.
3. All amounts are in 2020 dollars. Construction cost only. Land cost not included. Cost based on the configuration in Figure 5.5.
4. Loan payment at 5% interest / 20 year term.
5. Storage less estimated evaporation and seepage losses.
6. Annual P&I per acre-foot of yield.
7. Includes power, operation and maintenance. For Liberty Project: total storage times $34/acre-foot. For wells: power at $0.15/KWH and O&M at $25/acre-foot.
8. Annual P&I plus O&M.
9. Annual cost per acre-foot of project yield.
10. Water supplied by Liberty Project Phase 1. Water can be discharged directly into AWD Canal or dedicated to groundwater recharge. Liberty Project levees are 15' high, 20' wide crest, 12:1 slopes on the interior, 5:1 slopes on the exterior, 4 feet of freeboard.
11. Liberty Project Phase 2 involves development of a water storage facility on 9 sections of land. This is an expansion of Phase 1. Phase 2 includes the capital cost of Phase 1 as well. The estimated incremental cost would be the difference between Phases 1 & 2.
12. Liberty Project Phase 3 involves development of a water Storage facility on 15 sections of land. At this size groundwater balance is achieved. Incremental costs can be estimated as the difference between phase costs.
13. Liberty Project Phase 4 involves full development of the Liberty Project on 20 sections of land. Incremental costs can be estimated as the difference between phase costs.
14. The Prosperity Farms Project is a privately financed recharge project that has been constructed around existing infrastructure. It has multiple benefits, including the conversion of deep aquifer pumping to shallow aquifer pumping.
15. All large-capacity irrigation wells to be fitted with recording water meters I 2020. Estimated cost: 100 wells at $2,000 per well. $200,000. Privately financed.

## 1. Deep Aquifer Pumping Conversion to Upper Aquifer Pumping

This management action will require new wells to be constructed in the upper aquifer and, to the extent possible, will replace wells that are currently pumping from the lower aquifer with wells constructed in the upper aquifer.

1.1 Measurable Objective: Water levels in wells pumping from the lower aquifer. These levels have been in decline over the past 10-20 years, (ref. hydrographs Figs. 3.1.1 – 3.1.8). Decreasing water levels result in continued or increased land subsidence.

1.1.A Circumstance triggering implementation: Land subsidence.

Evidence by which the determination is made: 1. Evidence of continuing land subsidence. 2. Conversion of groundwater pumpage from the upper aquifer to the lower aquifer, and 3. Development of new lands to irrigated agriculture in the Southeast Area over the past two decades.

Reason for the proposed management action: Pumping from the deep aquifer occurs in both the North and Southeast Areas. It is planned to convert a portion of the lower aquifer extractions to upper aquifer pumping over the implementation period. This will result in a decrease in subsidence. The target is an 86% reduction in extractions from the lower aquifer.

1.1B Process by which landowners will be informed: The TCWA Board of Directors will notify landowners by written notification. Management actions will be taken during public board meetings after considering written evidence and oral testimony.

1.2 Proposed management action: 1. Fees on pumpage from the lower aquifer. 2. Restrictions on drilling new wells into the lower aquifer.

Description of the proposed management action: To the extent possible, wells pumping from the lower aquifer will be idled. These wells will be replaced by wells pumping from the upper aquifer. Hydrographs of wells in the upper aquifer show that it is in balance (ref. hydrographs Figs. 3.1.1 – 3.1.8). Wells in the west part of the Southeast Area will remain on the lower aquifer while surface water supplies are being developed for that area because of the absence of an upper aquifer in that area. It is proposed to transfer about 24,000 acre-feet/year of lower aquifer pumpage to the upper aquifer.

Mitigation of overdraft: This measure addresses reduction of land subsidence. It is a transfer of pumping from the lower aquifer to the upper aquifer. Demand reductions are addressed in the following projects/management actions.

1.3 Permitting and regulatory process: Permits from the County of Tulare will be required for drilling new wells.

1.4 Timetable for the initiation and completion of the management action: AWD has transferred several wells from the lower to the upper aquifer in the past several years and plans to remove several more between 2020 and 2025. Table 5.1 lists the proposed schedule.

1.5 Benefits from the proposed management action: Reduction of land subsidence.

1.6 Implementation Methodology: TCWA, in conjunction with the County, will need to adopt a policy restricting new wells to the upper aquifer and placing fees on pumpage from the lower aquifer.

1.7 Legal Authority: SGMA and County land planning authority.

1.8 Agency Costs: Costs of drilling replacement wells will be borne by individual landowners. Each new well will cost approximately $150,000.

1.9 Drought Effects and Offsets: This management action transfers pumpage to the upper aquifer from the lower aquifer. In periods of excess water supply, groundwater pumping will be replaced by surface water, as it has been historically in AWD. However, lands in the Southeast Area will need to be either annexed to an existing water district or a new water district will need to be created to develop and manage a surface water supply. It is anticipated that about 22,000 afy of groundwater demand in the TCWA will continue through 2040 and beyond.

## 2. White Ranch / Deer Creek Project

This project will construct about two sections (1,280 acres) of water storage in the Liberty Project (described below) that will be supplied with water from the Wilbur Ditch when this water is available, and transfer the water to the North Area via Lateral A to the Deer Creek/White Ranch lands for either recharge or transfer to the North Area via the AWD canal system. Additionally, it is estimated that about 800 afy is available from AWD's allotment on Deer Creek.

2.1 Measurable Objective: 1. Reduced groundwater pumpage from the lower aquifer AWD wells. Recovery of water levels in the lower aquifer (ref. Hydrographs of AWD wells). 2. Reduced rate of land subsidence.

2.1.A Circumstance triggering implementation: Declining water levels in the lower aquifer, land subsidence.

Evidence by which the determination is made: Declining water levels in the lower aquifer and land subsidence.

Reason for the proposed management action: Reduction of pumpage from the lower aquifer will help stabilize water levels in the lower aquifer and thereby reduce land subsidence.

2.1B Process by which landowners will be informed: The TCWA Board of Directors will notify landowners by written notification. Management actions will be taken during public board meetings after considering written evidence and oral testimony.

2.2 Proposed management action: Replace groundwater pumpage with a surface water supply on AWD lands in the North Area.

Description of the proposed project: Construction of a 1,280-acre storage facility on Liberty lands together with the necessary pumping plant(s) and transfer facilities to move water from the Wilbur Ditch / Lateral A to storage and transfer the water to the Deer Creek/White Ranch lands for recharge or to the AWD canal system for direct application in lieu of groundwater.

Mitigation of overdraft: This project will replace groundwater pumpage with a surface water supply thereby reducing the decline of water levels in the lower aquifer and thereby reduce land subsidence the area.

2.3 Permitting and regulatory process: Grading/construction permits from the County of Kings. CEQA/National Environmental Policy Act (NEPA) cultural and biological studies (as well as other technical studies as required) will be completed in support of the proposed project. A SWRCB permit will be required for the capture of temporary flood flows.

2.4 Timetable for the initiation and completion of the management action: The project is proposed to start in 2022 and is estimated to be completed by 2025.

2.5 Benefits from the proposed management action: Reduction in declining groundwater levels in the lower aquifer and reduced land subsidence.

2.6 Implementation Methodology: 1. The project will be financed by private funding. Planning and construction will be approved by AWD. Water supplies for the project are from AWD's permit on Deer Creek and excess wet-year waters that will be captured by Phase I of the Liberty Project.

2.7 Legal Authority: SGMA

2.8 Agency Costs: The project is to be privately funded. The estimated cost of the project is $23,000,000. The annual cost of the water supply is projected to be $287/acre-foot.

2.9 Drought Effects and Offsets: This project will replace 5,800 acre-feet of groundwater pumpage in the North Area. This will reduce the decline of water levels in the lower aquifer.

## 3. Liberty Project

The Liberty Project is a large (20 sections – 12,800 acre) storage/transmission project that will store available water from multiple sources during periods of excess water supplies and distribute this water for in-lieu irrigation use and to remove some lands permanently from groundwater supplies. The project involves construction of an above-ground storage facility with pumping plants installed in the Wilbur Ditch or Blakeley Canal to pump water into the facility which will also incorporate facilities to return the water to Laterals A and B for distribution to lands in the North and Southeast Areas via existing canals. Agreements will be required with Alpaugh Irrigation District for use of the Alpaugh Canal to convey water to the Southeast Area for direct application to irrigation.

3.1 Measurable Objective: 1. To reduce groundwater pumpage in both the North and Southeast Areas. 2. To reduce pumpage from the lower aquifer resulting in increased water levels and reduced land subsidence. Increased groundwater levels will be used as a surrogate for reduced land subsidence during the first five years of implementation of the program.

3.1.A Circumstance triggering implementation: Declining water levels in the lower aquifer, land subsidence.

Evidence by which the determination is made: Declining water levels in the lower aquifer and land subsidence.
Process by which the determination is made: Water levels in the lower aquifer and land elevations will be measured and compared on an annual basis.
Reason for the proposed management action: Reduction of pumpage from the lower aquifer will help stabilize water levels in the lower aquifer and thereby reduce land subsidence.

3.1B Process by which landowners will be informed: The TCWA Board of Directors will notify landowners by written notification. Management actions will be taken during public board meetings after considering written evidence and oral testimony.

3.2 Proposed management action: Replace groundwater pumpage with a surface water supply on lands in the North and Southeast Areas.

Description of the proposed project: Construction of a 20-section storage facility in phases on Liberty lands together with the necessary pumping plant(s) and transfer facilities to move water from the Wilbur Ditch/Blakeley Canal/Laterals A and B to storage and then transfer the water for direct application to irrigation or to groundwater storage.

→ Phase 1 is the construction of a two-section (1,280-acre) above-ground reservoir facility that will contain about 11,000 acre-feet of flood water, entitlement water, and excess surface water supplies when available in wet years. It includes the construction of a pumping plant in either the Wilbur Ditch or the Blakeley Canal that will divert water from the canal to the reservoir. The plant is equipped with a bypass that will allow stored water to return to the source canal for distribution to irrigation. In order to fill the reservoir in a 90-day period in which it is estimated that excess water would be available, a pumping capacity of 100 cfs (200 acre-feet per day – accounting for a seepage loss on initial filling) will be installed. Levees are up to fifteen feet high and gently sloped to accommodate the shorebirds common to the Kern/Tulare/Kings County area. Phase 1 is the initial part of a larger project that is described as Phase 2. It is possible that Phase 1 will be bypassed by the larger project described as Phase 2, below.

→ Phase 2 is the construction of a nine section (5,760-acre) storage reservoir with a capacity of 30,000 - 60,000 acre-feet. This could be an expansion of Phase 1 or this project could be built in place of Phase 1. It is an expanded version of the facilities described in Phase 1, above. This will require a pumping capacity of up to 500 cfs (1,000 acre-feet per day) in order to fill the facility in a 90-day period. Construction of Phase 2 is scheduled to begin in 2025.

→ Phase 3 is construction of an additional 6 sections (3,840 acres) of storage, bringing the total amount of available storage in the Liberty Project to 93,000 acre-feet. This will require a total pumping capacity of about 500 cfs (1,000 acre-feet per day) in order to fill the facility in a 90-day period. Phase 3 is scheduled to begin in 2035.

→ Phase 4 is construction of storage on the remaining 5 sections. It is considered optional if Phases 1-3 achieve a balanced groundwater condition.

Mitigation of overdraft: This project will replace groundwater pumpage with a surface water supply thereby reducing the decline of water levels in the lower aquifer and thereby reduce land subsidence the area.

3.3 Permitting and regulatory process: Grading/construction permits from the County of Kings. CEQA/NEPA cultural and biological studies (as well as other technical studies as required) must be completed in support of the proposed project. It is anticipated that a SWRCB permit will be required in order to capture the flood flows that will comprise a part of the water supply for the Liberty Project.

3.4 Timetable for the initiation and completion of the management action: It is proposed to begin the design of the project in 2020. The project will be built in phases from 2020 – 2030. Construction dates will depend on design and permitting.

3.5 Benefits from the proposed management action: Reduction in declining groundwater levels in the lower aquifer and reduced land subsidence.

3.6 Implementation Methodology: 1. The project will be financed by private funding. Planning and construction will be approved by AWD. 2. The project will rely on water supplies that are outside of the jurisdiction of AWD. The source of water for the Liberty Project is excess waters that are normally available for short periods during the winter, but are usually by-passed because there are no facilities in which to store the water for later use or for recharge.

3.7 Legal Authority: SGMA

3.8 Agency Costs: The project is to be privately funded. The estimated costs of the Liberty Project are presented below. The costs are estimated based on constructing reservoirs contained by 15-feet high levees with side slopes of 12:1 on the interior and 5:1 on the exterior. Pumping capacity is governed by the brief time window in which water is available. All costs are feasibility-level estimates.

**Phase 1**: $22,000,000

→ Storage capacity: 11,400 acre-feet.

**Phase 2**: $ $70,000,000 (If expanded from Phase 1, an additional $50,000,000)

→ Storage capacity: 56,400 acre-feet.

**Phase 3**: $105,000,000 (If expanded from Phase 2, an additional $35,000,000)

→ Storage capacity: 93,000 acre-feet.

The annual cost of the water supply is projected to be $200 - $300 per acre-foot if the proposed volumes can be achieved on an average annual basis.

3.9 Drought Effects and Offsets: This project could ultimately replace approximately 60,000 acre-feet of groundwater pumpage in the TCWA. This will reduce the decline of water levels in the lower aquifer and maintain a groundwater balance in the upper aquifer.

**4. Reduction in Crop Water Demand by Taking Land Out of Production**

The first five years of the implementation period will be a data-gathering period. Flow meters will be installed on all large-capacity production wells, production wells will be field checked to determine access for well sounding equipment, reference point elevations will be established for these representative wells, all information will be entered into TCWA's database, together with the same information for the wells that are to be measured semi-annually for preparation of groundwater elevation maps. More accurate determinations of net groundwater inflow and pumpage will be made. Applied surface water, groundwater pumpage and crop consumptive use will be determined. Bench marks for field subsidence measurements will be installed and initial elevations will be recorded. During this period no changes in farming will be required. See Chapter 3, Section 3.5.1, for the listing of anticipated tasks to be performed by TCWA.

After the first five years it is anticipated that a 10% reduction in cropped acreage will be required. However, the actual reductions in cropped acreage, if required, will be determined after the first five years of data gathering. It has also been anticipated that a second 10% reduction in cropped acreage will be required in 2030. However, a determination will be made at that time based on information gathered during the previous ten years of Plan operation.

4.1 Measurable Objectives: 1. To reduce groundwater pumpage, 2. To improve groundwater levels in the lower aquifer and to maintain stability in the upper aquifer. Total pumpage and groundwater levels will be used to determine the need for a reduction in cropped acreage. The goal is to reduce the net groundwater inflow into the TCWA through implementation of the Plan. Groundwater contours and aquifer characteristics will be used to determine net groundwater inflow. Direct measurements of groundwater pumpage via flowmeters will allow tracking of this parameter.

4.1.A Circumstances triggering implementation: Water balance calculations that indicate the GSA is not making progress reducing net groundwater inflow nor decreasing groundwater demand by project implementation. Continued decline in water levels in the lower aquifer and a decline in water levels in the upper aquifer.

Evidence by which the determination is made: (listed in the above paragraph).

Process by which the determination is made: Water balance calculations and groundwater flow determinations will be made and compared annually.

Reason for the proposed management action: Continued imbalance in the water supply evidenced by water balance, absence of reductions in groundwater pumpage evidenced by flow meter readings, evidenced by continued decline in lower aquifer water levels, decline in upper aquifer water levels evidenced by declines in water levels, continued subsidence, evidenced by decreased water levels in the lower aquifer and land subsidence measurements.

4.1.B Process by which landowners will be informed: The TCWA Board of Directors will notify landowners by written notification. Management actions will be taken during public board meetings after considering written evidence and oral testimony.

4.2 Proposed management action: Mandatory reduction in crop water use by taking land out of production, thereby reducing groundwater pumpage. Enforced by implementation of tolls on water use.

4.3 Permitting and regulatory process: SGMA

4.4 Timetable for the management action: The first phase of the management action (10% reduction) is planned to be implemented in 2030. The second phase to be implemented in 2035.

4.5 Benefits of the proposed action: Reduction in the decline of groundwater levels, reduction in groundwater pumpage, and reduction in land subsidence.

4.6 Implementation methodology: Reductions will be required by TCWA and tolls initiated on excessive use of groundwater beyond that which is permitted by the TCWA. The TCWA's Board of Directors will implement policy at a public meeting after written and oral testimony is received and considered.

4.7 Legal authority: SGMA

4.8 Agency costs: Minimal increase in administrative costs.

4.9: Drought effects and offsets: Reduction in groundwater pumpage.

## 5. Landowner-sponsored Groundwater Recharge Project: The Prosperity Farms Project

This project has been initiated by a landowner located within TCWA's Southeast Area. It involves developing a recharge area in the northeast portion of the Southeast Area (see Figure 5.2.2). The plan is to capture excess runoff and floodwaters for recharge. The area has been identified as one of the areas that have potential for recharge, as it is in the vicinity of White River, and permeabilities are indicated to be acceptable.

5.1 Measurable Objectives: To improve groundwater levels in the lower aquifer and to maintain stability in the upper aquifer and reduce land subsidence. Increased groundwater levels will be used to measure the effectiveness of the program in mitigating subsidence, and for the first five years of the implementation period, will be used as a surrogate for reduced land subsidence until a GPS – based land elevation network is operational.

5.1.A Circumstance triggering implementation: Declining water levels in the lower aquifer, land subsidence.

Evidence by which the determination is made: Declining water levels in the lower aquifer and land subsidence.

Process by which the determination is made: Water levels in the lower aquifer and land elevations will be measured and compared on an annual basis.

Reason for the proposed management action: Reduction of pumpage from the lower aquifer will help stabilize water levels in the lower aquifer and thereby reduce land subsidence.

5.1B Process by which landowners will be informed: The TCWA Board of Directors will notify landowners by written notification. Management actions will be taken during public board meetings after considering written evidence and oral testimony.

5.2 Proposed management action: Replace groundwater pumpage with a surface water supply on lands in the Southeast Areas.

Description of the proposed project: Construction of a recharge facility on private lands in the vicinity of White River to recharge an average 1,500 afy of excess waters and floodwater in White River.

Mitigation of overdraft: This project will replenish the groundwater supply, reducing the decline of water levels in the lower aquifer and thereby reduce land subsidence the area.

Mitigation of Subsidence: Under consideration is the use of an existing deep well as a recharge well in the wintertime when wells are generally idle or used intermittently. Shallow wells on the farm would be manifolded into a deep well and this well would be used as an injection well to recharge the lower aquifer with water from the upper aquifer.

5.3 Permitting and regulatory process: Grading/construction permits from the County of Tulare, as required. CEQA/NEPA cultural and biological studies (as well as other technical studies), as required.

5.4 Timetable for the initiation and completion of the management action: Portions of the project are in place. Deep well injection could be in place at the first of the year. Portions of the recharge areas are in place. Portions of the White River Channel are available for recharge.

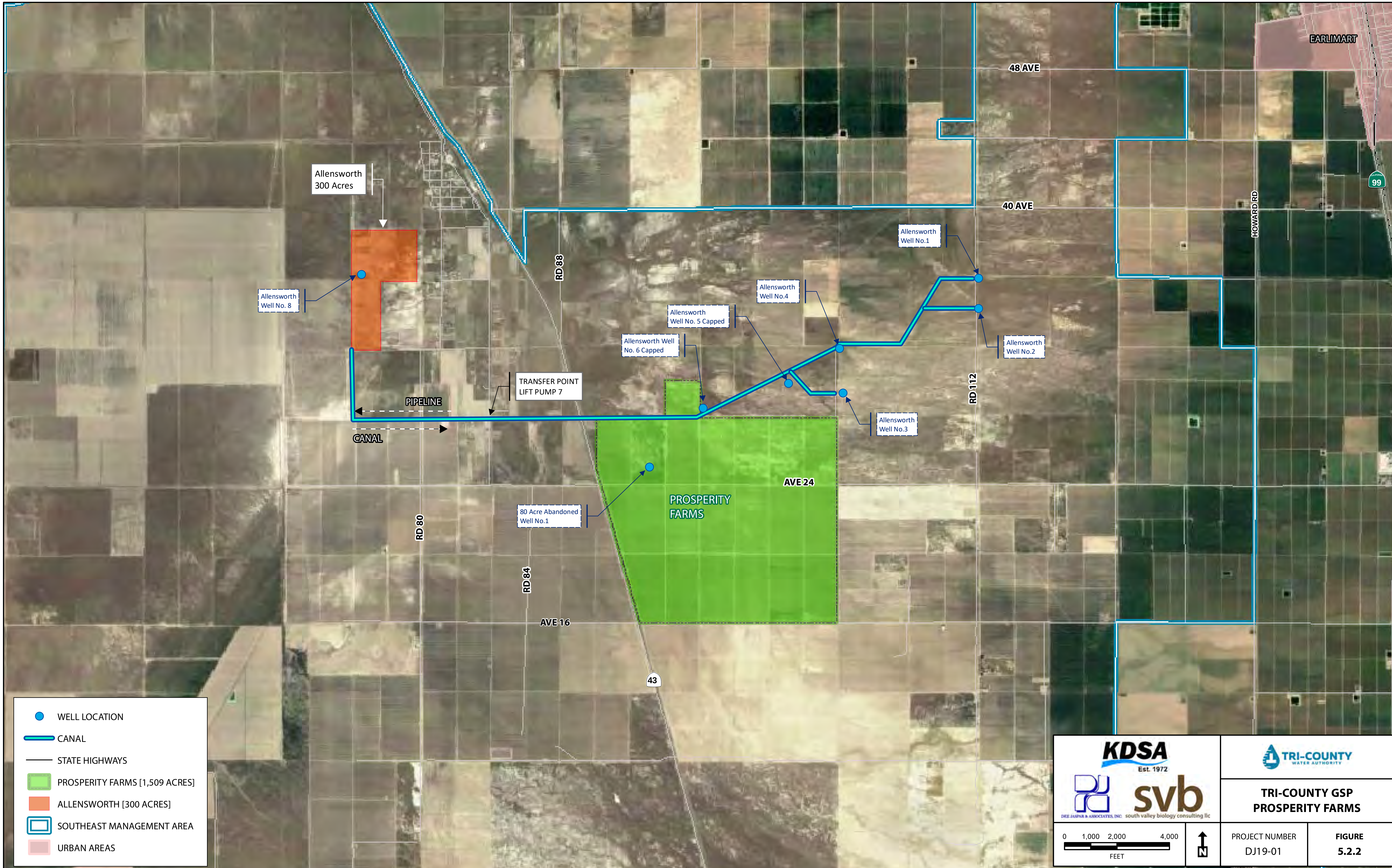
5.5 Benefits from the proposed management action: Reduction in declining groundwater levels in the lower aquifer and reduced land subsidence.

5.6 Implementation Methodology: 1. The project will be financed by private funding. Planning and construction will be approved by the County of Tulare. 2. The project will rely on floodwaters in White River.

5.7 Legal Authority: This project is subject to CEQA and permitting by the County of Tulare.

5.8 Agency costs: Minimal increase in administrative costs.

5.9: Drought effects and offsets: Improvement in the groundwater balance due to recharge. Mitigation of subsidence by replenishing the deeper aquifer.




TRI-COUNTY GSP
PROSPERITY FARMS

PROJECT NUMBER
DJ19-01

FIGURE
5.2.2

SOURCE(S): CA DEPT. OF WATER RESOURCES/CA DEPT. OF TRANSPORTATION/KENNETH D. SCHMIDT AND ASSOCIATES/U.S. CENSUS BUREAU

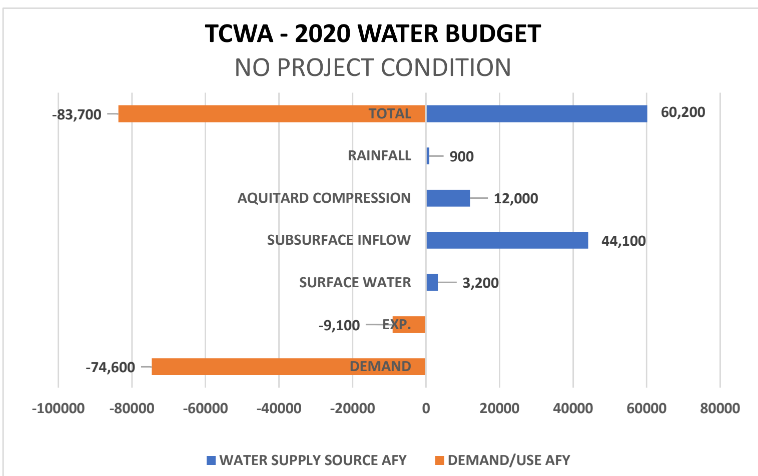
# 2020 NO PROJECT CONDITION

## TCWA PORTION OF THE TULE SUBBASIN

GROSS LAND ACRES = 61,400 ACRES
IRRIGATED AREA = 29,000 ACRES

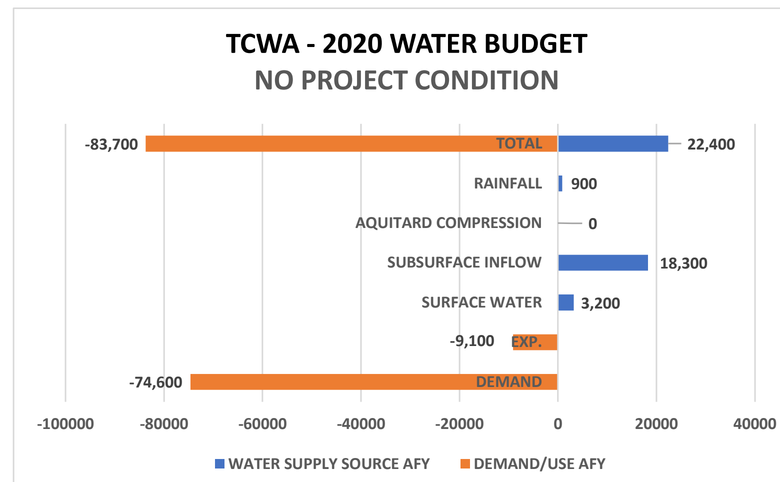
### NET SUBSURFACE INFLOW & COMPRESSION OF AQUITARDS AT CURRENT LEVEL OF 56,100 AFY

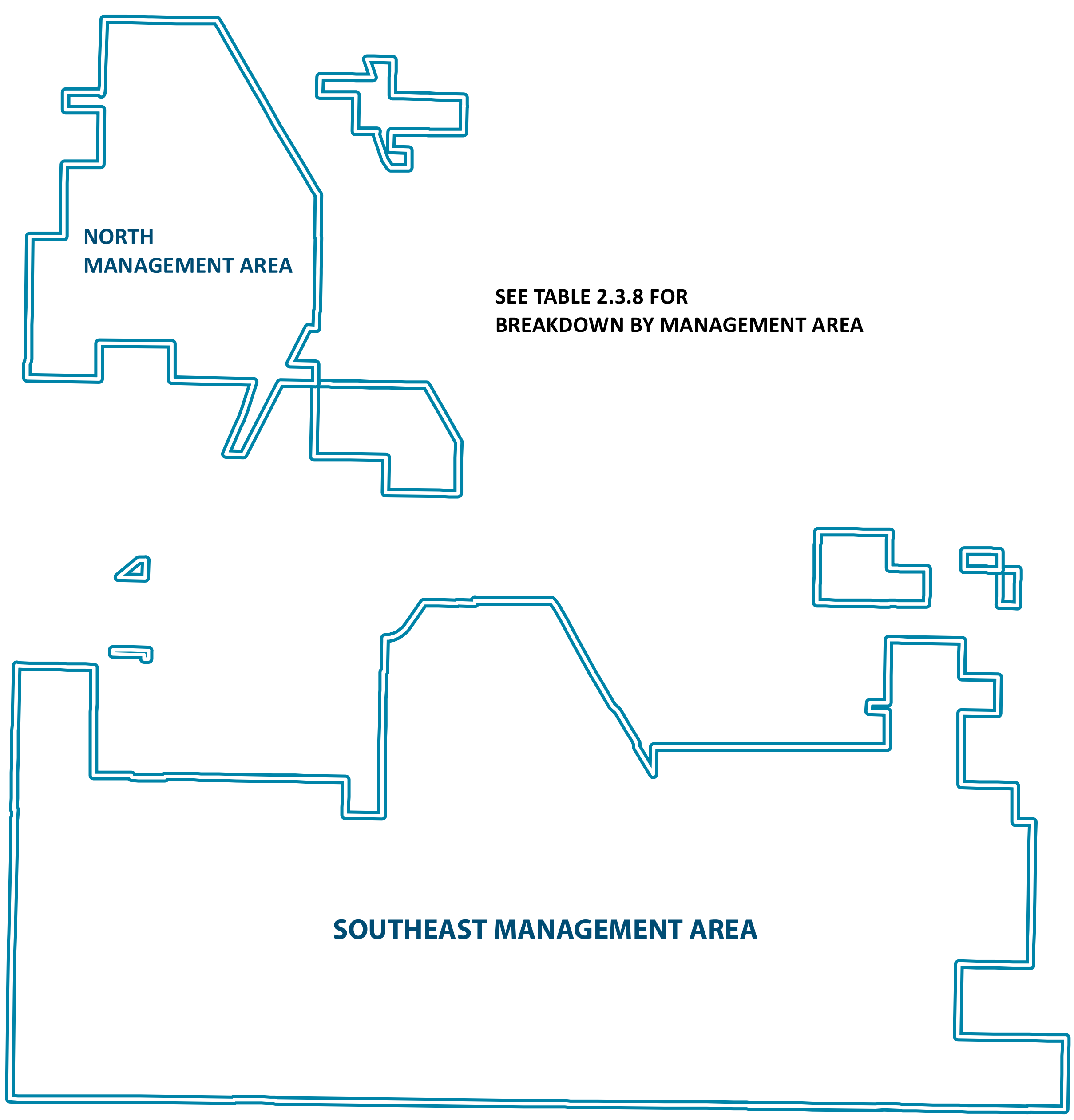
### GROUNDWATER DEFICIT = 23,500 AFY




### NET SUBSURFACE INFLOW & COMPRESSION OF AQUITARDS AT SUSTAINABLE LEVEL OF 18,300 AFY

### GROUNDWATER DEFICIT = 61,300 AFY




TCWA GSA FOCUS AREA - TULE PORTION

KDSA Est. 1972

TRI-COUNTY WATER AUTHORITY

TRI-COUNTY GSP
TCWA - NORTH & SE AREAS
WATER BUDGET - 2020 CONDITIONS

0 0.5 1 2 MILES

N

| PROJECT NUMBER | FIGURE |
|---|---|
| DJ19-01 | 2.3.8-A |

SOURCE(S): CA DEPT. OF WATER RESOURCES/TRI-COUNTY WATER AUTHORITY/KDSA/DJA

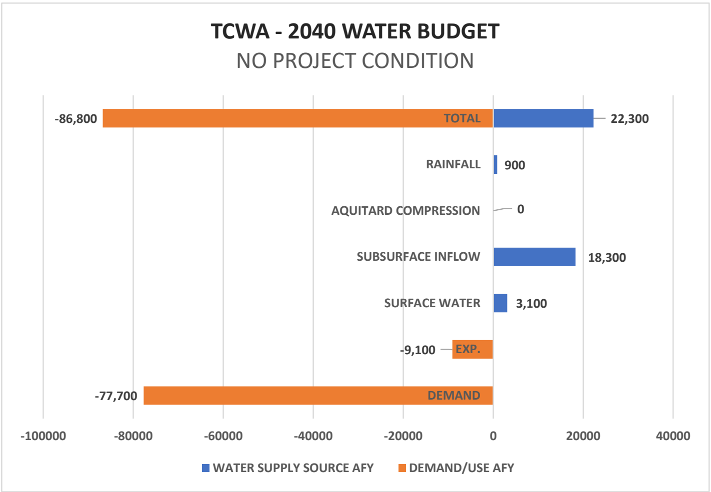
# 2040 NO PROJECT CONDITION

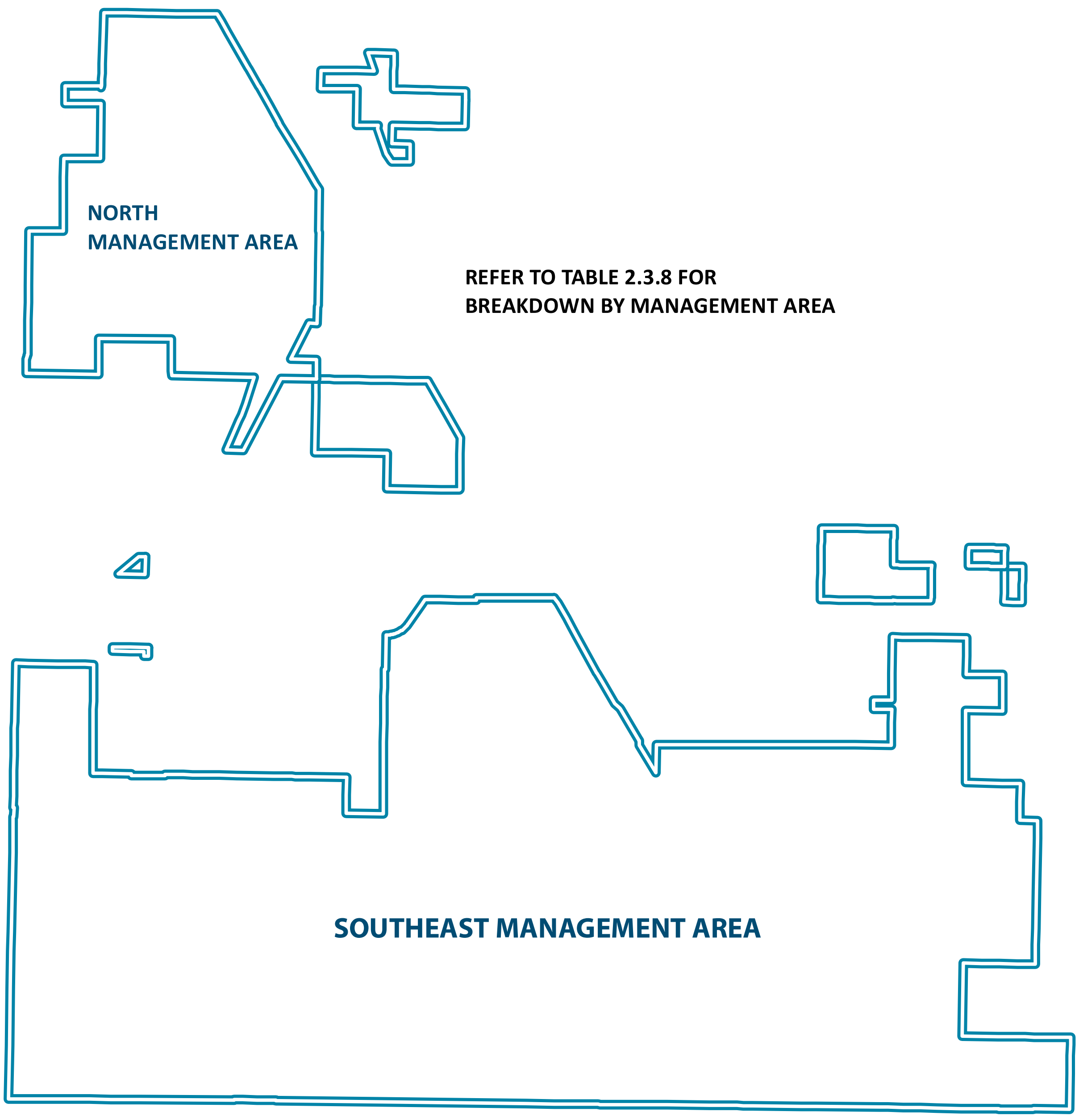
NET SUBSURFACE INFLOW & COMPRESSION
OF AQUITARDS REDUCED TO 18,300 AFY

## TCWA PORTION OF THE TULE SUBBASIN

GROSS LAND ACRES = 61,400 ACRES
IRRIGATED AREA = 29,000 ACRES

GROUNDWATER DEFICIT = 64,500 AFY




REFER TO TABLE 2.3.8 FOR
BREAKDOWN BY MANAGEMENT AREA

TCWA GSA FOCUS AREA - TULE PORTION

KDSA Est. 1972

svb south valley biology consulting llc

TRI-COUNTY WATER AUTHORITY

TRI-COUNTY GSP
TCWA - NORTH & SE AREAS
WATER BUDGET - 2040 CONDITIONS

0 0.5 1 2
MILES

N

| PROJECT NUMBER | FIGURE |
|---|---|
| DJ19-01 | 2.3.8-B |

SOURCE(S): CA DEPT. OF WATER RESOURCES/TRI-COUNTY WATER AUTHORITY/KDSA/DJA

**Reduction of Groundwater Deficit**

1. The projects and management actions that are described in the preceding paragraphs offer several options to achieving a groundwater balance in TCWA. One action is specifically targeted at reducing subsidence by reducing lower aquifer pumpage and replacing it with upper aquifer pumpage. This project does not create a reduction in pumpage, however, it addresses a problem that is equally important to sustaining the economy, by reducing damage to infrastructure caused by subsidence, and thus the cost of repair and replacement.
2. The White Ranch/Deer Creek Project offers the opportunity for either an in-lieu surface water delivery to reduce groundwater pumpage or to use the water supply for aquifer recharge. The benefit is 5,800 afy, with the bulk of the benefit (5,000 afy) coming from the Liberty Project.
3. The Liberty Project offers the greatest opportunity for correction of the groundwater deficit. Phase 1 yields 7,700 afy, 5,800 afy for the North Area and 1,900 afy for the SE Area; Phase 2 creates an even bigger benefit, accounting for a benefit of 37,900 afy – including the 7,700 afy Phase 1 yield – a gain of 32,100 afy for the SE Area. Phase 3 creates a benefit of 61,300 afy, enough to offset the SE Area's deficit of about 43,300 afy and provide 18,100 afy for the North Area, enough to offset the North Areas' annual water demand.
4. Taking lands out of production is an alternative that is available and likely will be employed to some extent, but the goal of this GSP and the projects that are listed herein, and others that will be developed over the implementation period, is to preserve as much productive agriculture as possible. Management actions that are being considered are to reduce the deficit by 10% in 2025 and another 10% in 2030. This would reduce the deficit by about 7,500 afy in 2025 and 15,000 afy in 2030. This management action will not be employed for the first five years while a better understanding of groundwater conditions is developed.
5. Landowner projects such as the one listed herein will be developed and implemented over the years to come. These projects will include some component of surface water, whether it is the capture of flood waters or development of supplies to capture and store waters in excess of demands during the winter / spring seasons when they are available.

   The water balance developed herein includes the effects of climate change, which do not appear to be extreme effects during the twenty years during which a groundwater balance must be achieved, but must be considered, addressed and sustained into the future. The water balance also includes the assumption that the sustainable yield for TCWA is 22,000 afy. Projects undertaken herein reflect these assumptions. The solutions are costly, not only from the standpoint of capital and operational costs, but also costly in the effects on the economy if lands are taken out of production. The effects of the assumptions herein will be monitored over the years ahead and will be modified as more data are collected. The following is a tabulation of the groundwater balance for the current (2020) condition and the forecast 2040 condition. The tables, which are for the No-Project Condition, display the estimated groundwater deficit to be addressed by projects and management actions. The overall deficit varies from about 58,000 afy in 2020 to 61,000 afy in 2040. It is the object of this GSP to develop projects and management actions to address this deficit. The deficit is forecast to increase further to 63,000 afy in 2070 - if no projects or management actions are taken. At this time, extending the management actions and projects to achieve the 2070 goal is feasible. However, as time goes on the magnitude of the groundwater conditions in 2070 will be better understood and additional projects and management actions can then be developed.

**Table 5.3.A**
**Tri-County Water Authority**
**2020 Groundwater Balance: No-Project Condition**

| Year | Item | Total | North | Southeast | Notes / Comments |
|---|---|---|---|---|---|
| 2020 | Gross Area | 61,400 | 12,100 | 49,300 | |
| | Irrigated Area | 29,000 | 6,000 | 23,000 | |
| | ET | 74,800 | 13,700 | 61,100 | From Table 2.3.8 |
| | Export | 9,100 | 9,100 | 0 | Export average |
| | Demand | 83,900 | 22,800 | 61,100 | Total groundwater demand |
| | Surface Water | 3,200 | 3,200 | 0 | |
| | Precipitation | 900 | 200 | 700 | |
| | Net Demand | 79,800 | 19,400 | 60,400 | |
| | Sustainable Yield | 22,000 | 4,336 | 17,664 | Proportionate share based on gross acreage |
| | Deficit | 57,800 | 15,064 | 42,736 | To be met by projects or land retirement |

**Table 5.3.B**
**Tri-County Water Authority**
**2040 Groundwater Balance: No-Project Condition**

| Year | Item | Total | North | Southeast | Notes / Comments |
|---|---|---|---|---|---|
| 2040 | Gross Area | 61,400 | 12,100 | 49,300 | |
| | Irrigated Area | 29,000 | 6,000 | 23,000 | |
| | ET | 77,700 | 14,300 | 63,400 | From Table 2.3.8 |
| | Export | 9,100 | 9,100 | 0 | Export average |
| | Demand | 86,800 | 23,400 | 63,400 | Total groundwater demand |
| | Surface Water | 3,200 | 3,200 | 0 | |
| | Precipitation | 900 | 200 | 700 | |
| | Net Demand | 82,700 | 20,000 | 62,700 | |
| | Sustainable Yield | 22,000 | 4,336 | 17,664 | Proportionate share based on gross acreage |
| | Deficit | 60,700 | 15,664 | 45,036 | To be met by projects or land retirement |

**Table 5.3.C**
**Tri-County Water Authority**
**2070 Groundwater Balance: No-Project Condition**

| Year | Item | Total | North | Southeast | Notes / Comments |
|---|---|---|---|---|---|
| 2070 | Gross Area | 61,400 | 12,100 | 49,300 | |
| | Irrigated Area | 29,000 | 6,000 | 23,000 | |
| | ET | 79,400 | 14,600 | 64,800 | From Table 2.3.8 |
| | Export | 9,100 | 9,100 | 0 | Export average |
| | Demand | 88,500 | 23,700 | 64,800 | Total groundwater demand |
| | Surface Water | 3,200 | 3,200 | 0 | |
| | Precipitation | 900 | 200 | 700 | |
| | Net Demand | 84,400 | 20,300 | 64,100 | |
| | Sustainable Yield | 22,000 | 4,336 | 17,664 | Proportionate share based on gross acreage |
| | Deficit | 62,400 | 15,964 | 46,436 | To be met by projects or land retirement |

The plan is to address the 2040 deficit by 2030, by the implementation of the projects and/or management actions described in Tables 5.1 and 5.2. The following charts display the Groundwater Deficits identified in the above tables (5.3.A and 5.3.B), and the Groundwater Projects developed to address the deficits. Projects to address forecasted 2070 deficits will be developed at a later date, as 2040 approaches.

**Chart 5.1**

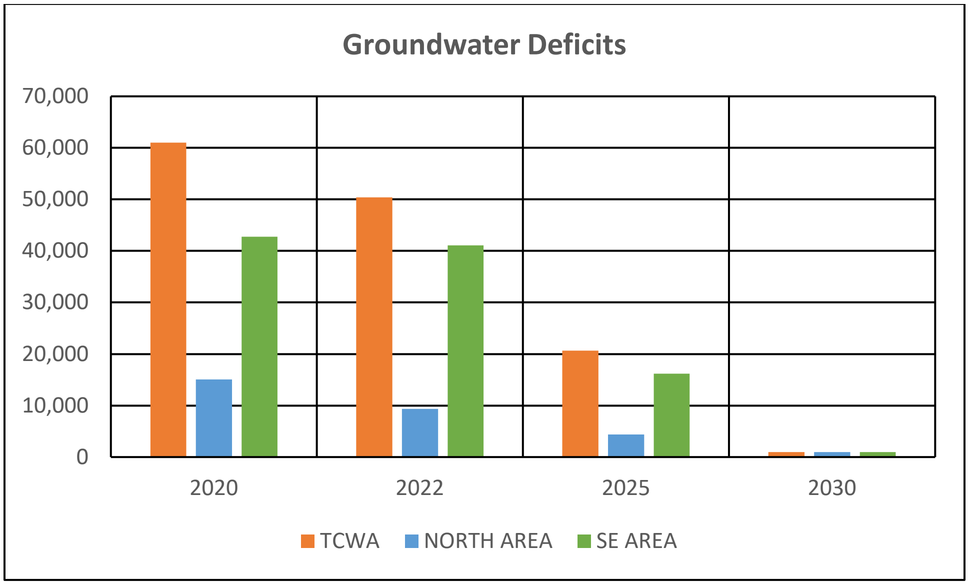
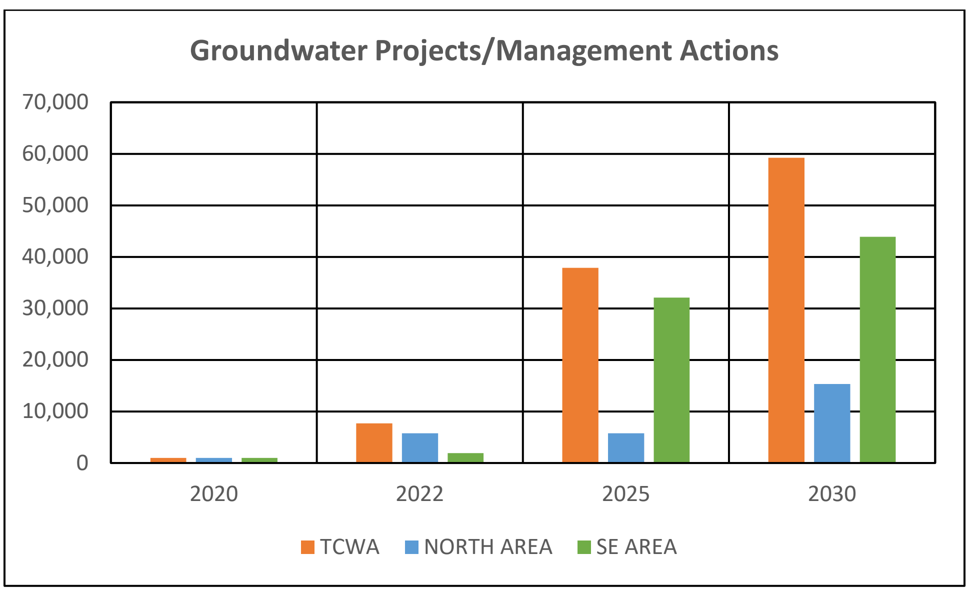



**Chart 5.2**



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# APPENDICES

# APPENDIX A

## DJA WORKSHEETS AND SUPPORTING DATA

# APPENDIX A

## Dee Jaspar & Associates
## Worksheets and Supporting Data

# APPENDIX A-1a

## CROP WATER REQUIREMENTS

## AND

## APPLIED WATER DEMAND
## TABLES A-1b through A-1e

## CROPPING PATTERN
## TABLE A-1f

## Table A-1a - 2020

### Tri-County Groundwater Authority

**Summary of 2017/18 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for GSA**

| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Dry Year Conditions[7] Net $ET_c$[4] (ft) | Dry Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Dry Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) | Typical Year Conditions[7] Net $ET_c$[4] (ft) | Typical Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Typical Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) | Wet Year Conditions[7] Net $ET_c$[4] (ft) | Wet Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Wet Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Corn / Sorghum/Wheat - Fodder Crops | 10,240 | 9,728 | 2.30 | 22,330 | 33,329 | 2.38 | 23,173 | 34,587 | 2.59 | 25,204 | 37,618 |
| Pistachios | 16,555 | 15,727 | 2.80 | 44,019 | 46,829 | 2.89 | 45,379 | 48,276 | 3.07 | 48,341 | 51,427 |
| Almonds | 787 | 747 | 3.23 | 2,415 | 2,569 | 3.36 | 2,508 | 2,668 | 3.26 | 2,436 | 2,592 |
| Grapes | 1,170 | 1,112 | 2.19 | 2,439 | 2,594 | 2.26 | 2,516 | 2,676 | 2.44 | 2,715 | 2,888 |
| Alfalfa | 224 | 213 | 3.81 | 809 | 1,208 | 3.94 | 837 | 1,249 | 3.66 | 777 | 1,160 |
| Total Irrigated Acreage | 28,976 | 27,527 | | 72,012 | 86,529 | | 74,414 | 89,457 | | 79,474 | 95,685 |

**Summary of 2017/18 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for North Area**

| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Dry Year Conditions[7] Net $ET_c$[4] (ft) | Dry Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Dry Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) | Typical Year Conditions[7] Net $ET_c$[4] (ft) | Typical Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Typical Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) | Wet Year Conditions[7] Net $ET_c$[4] (ft) | Wet Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Wet Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Corn / Sorghum/Wheat - Fodder Crops | 6,017 | 5,716 | 2.30 | 13,121 | 19,583 | 2.38 | 13,616 | 20,323 | 2.59 | 14,809 | 22,104 |
| Pistachios | 0 | 0 | 2.80 | 0 | 0 | 2.89 | 0 | 0 | 3.07 | 0 | 0 |
| Almonds | 0 | 0 | 3.23 | 0 | 0 | 3.36 | 0 | 0 | 3.26 | 0 | 0 |
| Grapes | 0 | 0 | 2.19 | 0 | 0 | 2.26 | 0 | 0 | 2.44 | 0 | 0 |
| Alfalfa | 0 | 0 | 3.81 | 0 | 0 | 3.94 | 0 | 0 | 3.66 | 0 | 0 |
| Total Irrigated Acreage | 6,017 | 5,716 | | 13,121 | 19,583 | | 13,616 | 20,323 | | 14,809 | 22,104 |

**Summary of 2017/18 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for Southeast Area**

| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Dry Year Conditions[7] Net $ET_c$[4] (ft) | Dry Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Dry Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) | Typical Year Conditions[7] Net $ET_c$[4] (ft) | Typical Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Typical Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) | Wet Year Conditions[7] Net $ET_c$[4] (ft) | Wet Year Conditions[7] Crop Water Requirement[5] (ac-ft) | Wet Year Conditions[7] Estimated Applied Water Demand[6] (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Corn / Sorghum/Wheat - Fodder Crops | 4,223 | 4,012 | 2.30 | 9,210 | 13,746 | 2.38 | 9,557 | 14,265 | 2.59 | 10,395 | 15,515 |
| Pistachios | 16,555 | 15,727 | 2.80 | 44,019 | 46,829 | 2.89 | 45,379 | 48,276 | 3.07 | 48,341 | 51,427 |
| Almonds | 787 | 747 | 3.23 | 2,415 | 2,569 | 3.36 | 2,508 | 2,668 | 3.26 | 2,436 | 2,592 |
| Grapes | 1,170 | 1,112 | 2.19 | 2,439 | 2,594 | 2.26 | 2,516 | 2,676 | 2.44 | 2,715 | 2,888 |
| Alfalfa | 224 | 213 | 3.81 | 809 | 1,208 | 3.94 | 837 | 1,249 | 3.66 | 777 | 1,160 |
| Total Irrigated Acreage | 22,959 | 21,811 | | 58,892 | 66,946 | | 60,798 | 69,134 | | 64,664 | 73,581 |

Notes:

1. Crops dervied from Tulare County Ag Comissioners Office - GIS mapping - Pesticide Permits Records for 2017/18. Year 2020 assumed to be the same.
2. Field area derived from Tulare County Ad Comissioners Office - GIS mapping - 2017/18 Crops
3. Field area reduced by 5% to provide for field roads, unplanted areas
4. Net Et taken from Cal Poly ITRC ETc Table for Irrigation District Water Balances - Zone 15 - less estimation of ET from Precipitation - Dry Year (33% eff), Typical Year(25% eff),and Wet Year(15%) Conditions -as applicable
5. Net Cropped Area times Net ETc
6. Assumed irrigation efficiency for permanent crops = 94%, assumed irrigation efficiency for field crops = 67%.
7. Dry, Typical and Wet Year Conditions are as designated by Cal Poly ITRC in Irrigation District Water Balance tables.

## Table A-1b - 2040

### Tri-County Groundwater Authority

**Summary of 2040 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for GSA**

| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 10,240 | 9,728 | 2.38 | 23,179 | 34,595 | 2.47 | 24,054 | 35,901 | 2.69 | 26,162 | 39,048 |
| Pistachios | 16,555 | 15,727 | 2.91 | 45,692 | 48,608 | 3.00 | 47,104 | 50,110 | 3.19 | 50,178 | 53,381 |
| Almonds | 787 | 747 | 3.35 | 2,507 | 2,667 | 3.48 | 2,604 | 2,770 | 3.38 | 2,529 | 2,690 |
| Grapes | 1,170 | 1,112 | 2.28 | 2,531 | 2,693 | 2.35 | 2,611 | 2,778 | 2.53 | 2,818 | 2,998 |
| Alfalfa | 224 | 213 | 3.95 | 840 | 1,254 | 4.09 | 869 | 1,296 | 3.80 | 807 | 1,204 |
| Total Irrigated Acreage | 28,976 | 27,527 | | 74,749 | 89,817 | | 77,241 | 92,856 | | 82,494 | 99,321 |

**Summary of 2040 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for North Area**

| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 6,017 | 5,716 | 2.38 | 13,619 | 20,327 | 2.47 | 14,134 | 21,095 | 2.69 | 15,372 | 22,943 |
| Pistachios | 0 | 0 | 2.91 | 0 | 0 | 3.00 | 0 | 0 | 3.19 | 0 | 0 |
| Almonds | 0 | 0 | 3.35 | 0 | 0 | 3.48 | 0 | 0 | 3.38 | 0 | 0 |
| Grapes | 0 | 0 | 2.28 | 0 | 0 | 2.35 | 0 | 0 | 2.53 | 0 | 0 |
| Alfalfa | 0 | 0 | 3.95 | 0 | 0 | 4.09 | 0 | 0 | 3.80 | 0 | 0 |
| Total Irrigated Acreage | 6,017 | 5,716 | | 13,619 | 20,327 | | 14,134 | 21,095 | | 15,372 | 22,943 |

**Summary of 2040 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for Southeast Area**

| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 4,223 | 4,012 | 2.38 | 9,559 | 14,268 | 2.47 | 9,920 | 14,807 | 2.69 | 10,790 | 16,104 |
| Pistachios | 16,555 | 15,727 | 2.91 | 45,692 | 48,608 | 3.00 | 47,104 | 50,110 | 3.19 | 50,178 | 53,381 |
| Almonds | 787 | 747 | 3.35 | 2,507 | 2,667 | 3.48 | 2,604 | 2,770 | 3.38 | 2,529 | 2,690 |
| Grapes | 1,170 | 1,112 | 2.28 | 2,531 | 2,693 | 2.35 | 2,611 | 2,778 | 2.53 | 2,818 | 2,998 |
| Alfalfa | 224 | 213 | 3.95 | 840 | 1,254 | 4.09 | 869 | 1,296 | 3.80 | 807 | 1,204 |
| Total Irrigated Acreage | 22,959 | 21,811 | | 61,129 | 69,490 | | 63,108 | 71,761 | | 67,122 | 76,378 |

Notes:

1. Crops dervied from Tulare County Ag Comissioners Office - GIS mapping - Pesticide Permits Records for 2017/18
2. Field area derived from Tulare County Ad Comissioners Office - GIS mapping - 2017 18 Crops
3. Field area reduced by 5% to provide for field roads, unplanted areas
4. Net Et taken from Cal Poly ITRC ETc Table for Irrigation District Water Balances - Zone 15 - less ITRC estimation of ET from Precipitation - Dry Year, Typical Year and Wet Year Conditions -as applicable
5. Net Cropped Area times Net ETc
6. Assumed irrigation efficiency for permanent crops = 94%, assumed irrigation efficiency for field crops = 67%.
7. Dry, Typical and Wet Year Conditions are as designated by Cal Poly ITRC in Irrigation District Water Balance tables. 33% Eff. Precip. - Dry Years; 25% Eff. Precip. - Typical Years;15% Eff. - Wet Years
8. 2017/2020 Crop ET increased 3.8% to reflect forecast climate change for the Year 2040.

## Table A-1c - 2070

### Tri-County Groundwater Authority

**Summary of 2070 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for GSA**

| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 10,240 | 9,728 | 2.43 | 23,670 | 35,328 | 2.53 | 24,564 | 36,662 | 2.75 | 26,716 | 39,875 |
| Pistachios | 16,555 | 15,727 | 2.97 | 46,660 | 49,638 | 3.06 | 48,102 | 51,173 | 3.26 | 51,242 | 54,513 |
| Almonds | 787 | 747 | 3.43 | 2,560 | 2,724 | 3.56 | 2,659 | 2,829 | 3.46 | 2,582 | 2,747 |
| Grapes | 1,170 | 1,112 | 2.32 | 2,585 | 2,750 | 2.40 | 2,667 | 2,837 | 2.59 | 2,878 | 3,062 |
| Alfalfa | 224 | 213 | 4.04 | 858 | 1,280 | 4.17 | 887 | 1,324 | 3.88 | 824 | 1,230 |
| Total Irrigated Acreage | 28,976 | 27,527 | | 76,333 | 91,721 | | 78,879 | 94,824 | | 84,242 | 101,426 |

**Summary of 2070 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for North Area**

| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 6,017 | 5,716 | 2.43 | 13,908 | 20,758 | 2.53 | 14,433 | 21,542 | 2.75 | 15,698 | 23,430 |
| Pistachios | 0 | 0 | 2.97 | 0 | 0 | 3.06 | 0 | 0 | 3.26 | 0 | 0 |
| Almonds | 0 | 0 | 3.43 | 0 | 0 | 3.56 | 0 | 0 | 3.46 | 0 | 0 |
| Grapes | 0 | 0 | 2.32 | 0 | 0 | 2.40 | 0 | 0 | 2.59 | 0 | 0 |
| Alfalfa | 0 | 0 | 4.04 | 0 | 0 | 4.17 | 0 | 0 | 3.88 | 0 | 0 |
| Total Irrigated Acreage | 6,017 | 5,716 | | 13,908 | 20,758 | | 14,433 | 21,542 | | 15,698 | 23,430 |

**Summary of 2070 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for Southeast Area**

| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net $ET_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 4,223 | 4,012 | 2.43 | 9,762 | 14,570 | 2.53 | 10,131 | 15,120 | 2.75 | 11,018 | 16,445 |
| Pistachios | 16,555 | 15,727 | 2.97 | 46,660 | 49,638 | 3.06 | 48,102 | 51,173 | 3.26 | 51,242 | 54,513 |
| Almonds | 787 | 747 | 3.43 | 2,560 | 2,724 | 3.56 | 2,659 | 2,829 | 3.46 | 2,582 | 2,747 |
| Grapes | 1,170 | 1,112 | 2.32 | 2,585 | 2,750 | 2.40 | 2,667 | 2,837 | 2.59 | 2,878 | 3,062 |
| Alfalfa | 224 | 213 | 4.04 | 858 | 1,280 | 4.17 | 887 | 1,324 | 3.88 | 824 | 1,230 |
| Total Irrigated Acreage | 22,959 | 21,811 | | 62,425 | 70,962 | | 64,445 | 73,282 | | 68,544 | 77,996 |

Notes:

1. Crops dervied from Tulare County Ag Comissioners Office - GIS mapping - Pesticide Permits Records for 2017/18
2. Field area derived from Tulare County Ad Comissioners Office - GIS mapping - 2017/18 Crops
3. Field area reduced by 5% to provide for field roads, unplanted areas
4. Net Et taken from Cal Poly ITRC ETc Table for Irrigation District Water Balances - Zone 15 - less ITRC estimation of ET from Precipitation - Dry Year, Typical Year and Wet Year Conditions -as applicable
5. Net Cropped Area times Net ETc
6. Assumed irrigation efficiency for permanent crops = 94%, assumed irrigation efficiency for field crops = 67%.
7. Dry, Typical and Wet Year Conditions are as designated by Cal Poly ITRC in Irrigation District Water Balance tables. 50% Eff. Precip. - Dry Years; 35% Eff. Precip. - Typical Years; 20% Eff. - Wet Years
8. 2017/2020 Crop ET increased 6.0% to reflect forecast climate change for the Year 2070.

Table A-1d - 1993

Tri-County Groundwater Authority

| Summary of 1993 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for GSA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Field Crops | 7,369 | 7,001 | 2.30 | 16,069 | 23,984 | 2.38 | 16,676 | 24,889 | 2.59 | 18,137 | 27,071 |
| Pistachios | 0 | 0 | 2.80 | 0 | 0 | 2.89 | 0 | 0 | 3.07 | 0 | 0 |
| Almonds (Deciduous Fruits and Nuts) | 141 | 134 | 3.23 | 433 | 461 | 3.36 | 450 | 478 | 3.26 | 437 | 464 |
| Grapes | 35 | 33 | 2.19 | 73 | 78 | 2.26 | 75 | 80 | 2.44 | 81 | 86 |
| Alfalfa (Grain & Hay) | 10,820 | 10,279 | 3.81 | 39,142 | 58,420 | 3.94 | 40,474 | 60,408 | 3.66 | 37,591 | 56,106 |
| Pasture | 2,146 | 2,039 | 3.84 | 7,819 | 11,670 | 3.97 | 8,102 | 12,093 | 3.69 | 7,515 | 11,217 |
| Total Irrigated Acreage | 20,511 | 19,485 | | 63,535 | 94,612 | | 65,776 | 97,949 | | 63,761 | 94,944 |

| Summary of 1993 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for North Area | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Field Crops | 3,373 | 3,204 | 2.30 | 7,355 | 10,978 | 2.38 | 7,633 | 11,393 | 2.59 | 8,302 | 12,391 |
| Pistachios | 0 | 0 | 2.80 | 0 | 0 | 2.89 | 0 | 0 | 3.07 | 0 | 0 |
| Almonds (Deciduous Fruits & Nuts) | 0 | 0 | 3.23 | 0 | 0 | 3.36 | 0 | 0 | 3.26 | 0 | 0 |
| Grapes | 0 | 0 | 2.19 | 0 | 0 | 2.26 | 0 | 0 | 2.44 | 0 | 0 |
| Alfalfa (Grain & Hay) | 5,495 | 5,220 | 3.81 | 19,878 | 29,669 | 3.94 | 20,555 | 30,679 | 3.66 | 19,091 | 28,494 |
| Pasture | 334 | 317 | 3.84 | 1,217 | 1,816 | 3.97 | 1,261 | 1,882 | 3.69 | 1,170 | 1,746 |
| Total Irrigated Acreage | 9,202 | 8,742 | | 28,450 | 42,463 | | 29,449 | 43,953 | | 28,562 | 42,631 |

| Summary of 1993 Cropping Pattern Crop Water Requirement and Estimated Applied Water Requirement - Total for Southeast Area | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dry Year Conditions[7] | | | Typical Year Conditions[7] | | | Wet Year Conditions[7] | | |
| Crop[1] | Field Area[2] | Net Cropped Area (ac)[3] | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) | Net ET$_c$[4] (ft) | Crop Water Requirement[5] (ac-ft) | Estimated Applied Water Demand[6] (ac-ft) |
| Corn / Sorghum/Wheat - Field Crops | 3,996 | 3,796 | 2.30 | 8,714 | 13,006 | 2.38 | 9,043 | 13,497 | 2.59 | 9,835 | 14,680 |
| Pistachios | 0 | 0 | 2.80 | 0 | 0 | 2.89 | 0 | 0 | 3.07 | 0 | 0 |
| Almonds | 141 | 134 | 3.23 | 433 | 461 | 3.36 | 450 | 478 | 3.26 | 437 | 464 |
| Grapes | 35 | 33 | 2.19 | 73 | 78 | 2.26 | 75 | 80 | 2.44 | 81 | 86 |
| Alfalfa (Grain & Hay) | 5,325 | 5,059 | 3.81 | 19,263 | 28,751 | 3.94 | 19,919 | 29,730 | 3.66 | 18,500 | 27,612 |
| Pasture | 1,812 | 1,721 | 3.84 | 6,602 | 9,853 | 3.97 | 6,841 | 10,211 | 3.69 | 6,346 | 9,471 |
| Total Irrigated Acreage | 11,309 | 10,744 | | 35,085 | 52,148 | | 36,328 | 53,995 | | 35,199 | 52,314 |

Notes:

1. Crops dervied from CA Dept. of Water Resources - GIS mapping - Crop Records for 1993
2. Field area derived from Tulare County Ad Comissioners Office - GIS mapping - 1993 Crops
3. Field area reduced by 5% to provide for field roads, unplanted areas
4. Net Et taken from Cal Poly ETc Table for Irrigation District Water Balances - ET Zone 15 - less ITRC estimation of ET from Precipitation - Dry Year (33%), Typical Year (25%) and Wet Year (15%) Conditions -as applicable
5. Net Cropped Area times Net ETc
6. Assumed irrigation efficiency for permanent crops = 94%, assumed irrigation efficiency for field crops = 67%.
7. Dry, Typical and Wet Year Conditions are as designated by Cal Poly ITRC in Irrigation District Water Balance tables

# Table A-1e

| ET Zone 15 - Deduct for Effective Precipitation | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DRY | | | | TYP | | | | WET | | | |
| CROP | DRY | Effective Precip. (33%) | Net Etc (in) | Net Etc (ft) | TYP | Effective Precip 25% | Net Etc (in) | Net Etc (ft) | WET | Effective Precip. (15%) | Net Etc (in) | Net Etc (ft) |
| Corn / Sorghum/Wheat - Fodder Crops | 29.36 | 1.82 | 27.55 | 2.30 | 30.51 | 1.93 | 28.59 | 2.38 | 33.07 | 1.98 | 31.09 | 2.59 |
| Pistachios | 35.60 | 2.01 | 33.59 | 2.80 | 36.60 | 1.98 | 34.63 | 2.89 | 38.73 | 1.85 | 36.89 | 3.07 |
| Almonds | 40.76 | 1.98 | 38.78 | 3.23 | 41.80 | 1.53 | 40.28 | 3.36 | 41.14 | 2.03 | 39.12 | 3.26 |
| Grapes | 28.30 | 1.98 | 26.32 | 2.19 | 28.98 | 1.83 | 27.16 | 2.26 | 31.24 | 1.94 | 29.31 | 2.44 |
| Alfalfa | 47.51 | 1.82 | 45.70 | 3.81 | 49.20 | 1.95 | 47.25 | 3.94 | 45.76 | 1.88 | 43.89 | 3.66 |
| Pasture | 48.10 | 2.08 | 46.02 | 3.84 | 49.69 | 2.00 | 47.69 | 3.97 | 46.20 | 1.97 | 44.24 | 3.69 |

Note: Dry year effective precipitation = 33%, Typical year effective precipitation = 25%, Wet year effective precipitation = 15%

## CROPPING PATTERN 2017/18

## Table A-1f

## TRI-COUNTY GSA

| DRAFT - 2017/18 IRRIGATED LANDS - Basin 5-022.13 - Tule Subbasin | | | | | |
|---|---|---|---|---|---|
| NORTH WATER MANAGEMENT AREA | | | | | |
| T | R | Sec | Portion | Cropped Area (ac) | Crop |
| **22** | **23** | 20 | NW/4 | 169.7 | Sorghum / Wheat - Fodder |
| | | | W Por NE/4 | 61.7 | Sorghum / Wheat/Corn/Oats - Fodder |
| | | | NE Por NE/4 | 63.4 | Sorghum / Wheat - Fodder |
| | | | SW/4 | 173.5 | Sorghum / Wheat - Fodder |
| | | | W Por SE/4 | 86.4 | Sorghum / Wheat - Fodder |
| | | | | **554.7** | |
| | | | | | |
| | | 21 | N/2 of NW/4 | 75.7 | Sorghum / Wheat - Fodder |
| | | | S/2 NW/4 | 74.0 | Sorghum / Wheat - Fodder |
| | | | W Por NE/4 | 60.6 | Sorghum / Wheat - Fodder |
| | | | W/2 SE/4 | 79.3 | Sorghum / Wheat - Fodder |
| | | | Por E/2 SE/4 | 63.8 | Sorghum / Wheat - Fodder |
| | | | | **353.4** | |
| | | | | | |
| | | 30 | N/2 NE/4 | 0.0 | NA |
| | | | | | |
| | | 29 | NW/4 | 152.9 | Sorghum / Wheat - Fodder |
| | | | NE/4 | 0.0 | NA |
| | | | SW/4 | 156.7 | Sorghum / Wheat - Fodder |
| | | | SE/4 | 160.1 | Sorghum / Wheat - Fodder |
| | | | | **469.7** | |
| | | | | | |
| | | 28 | NW/4 | 151.5 | Sorghum / Wheat - Fodder |
| | | | NE/4 | 158.8 | Sorghum / Wheat - Fodder |
| | | | SW/4 Por SE/4 | 175.7 | Sorghum / Wheat - Fodder |
| | | | Por SE/4 | 129.0 | Sorghum / Wheat - Fodder |
| | | | | **615.0** | |
| | | | | | |
| | | 27 | Por NW/4 | 0.0 | NA |
| | | | Por SW/4 | 0.0 | NA |
| | | | | | |
| | | | | | |
| | | 31 | E/2 | **320.9** | Sorghum / Wheat - Fodder |
| | | | | | |
| | | | | | |
| | | 32 | N/2 | 328.8 | Sorghum / Wheat - Fodder |
| | | | S/2 | 310.3 | Sorghum / Wheat - Fodder |
| | | | | **639.1** | |
| | | | | | |
| | | 33 | NW/4 | 158.1 | Sorghum / Wheat - Fodder |
| | | | Por NE/4 | 126.1 | Sorghum / Wheat - Fodder |
| | | | Por NE/4 | 36.3 | Sorghum / Wheat - Fodder |
| | | | SW/4 | 144.0 | Sorghum / Wheat - Fodder |
| | | | SE/4 | 152.1 | Sorghum / Wheat - Fodder |
| | | | | **616.6** | |
| | | | | | |
| | | 34 | Por W/2 | 0.0 | N/A |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **23** | **23** | 3 | Entire Section | | |
| | | | | | |
| | | 4 | N/2 | 311.7 | Sudan Grass/Barley |

| | | | | | |
|---|---|---|---|---|---|
| | | 4 | S/2 | 301.3 | Sudan Grass/Barley |
| | | | | **613.0** | |
| | | 5 | N/2 | 317.9 | Sudan Grass/Barley |
| | | 5 | S/2 | 318.1 | Sudan Grass/Barley |
| | | | | **636.0** | |
| | | 6 | N/2 | 296.5 | Sudan Grass/Barley |
| | | 6 | S/2 | 300.4 | Sudan Grass/Barley |
| | | | | **596.9** | |
| | | | | | |
| | | 7 | N/2 | 302.8 | Sudan Grass/Barley |
| | | 7 | S/2 | 298.8 | Sudan Grass/Barley |
| | | | | **601.6** | |
| | | | | | |
| | | 8 | N/2 | 0.0 | N/A |
| | | | | | |
| | | | | | |
| | | 9 | Entire Section | 0.0 | N/A |
| | | | | | |
| | | 10 | Por Sec in GSA | 0.0 | N/A |
| | | | | | |
| | | 13 | Por Sec in GSA | 0.0 | N/A |
| | | | | | |
| | | 14 | Entire Section | 0.0 | N/A |
| | | | | | |
| | | 24 | N/2 | 0.0 | N/A |
| | | | | | |
| | | 36 | Entire Section | 0.0 | N/A |
| | | | | 6,016.9 | |
| | | | | | |

| TRI-COUNTY GSA | | | | | |
|---|---|---|---|---|---|
| DRAFT - 2017 IRRIGATED LANDS AND CROP WATER USE REQUIREMENT - Basin 5-022.13 - Tule Subbasin | | | | | |
| SOUTHEAST WATER MANAGEMENT AREA | | | | | |
| T | R | Sec | Portion | Cropped Area (ac) | Crop |
| **23** | **24** | 25 | Ptn Entire Section | 0.0 | N/A |
| | | 25 | Ptn SE/4 | 15.4 | Grapes |
| | | 31 | Entire Section | 0.0 | N/A |
| | | 32 | Por Sec in GSA | 0.0 | N/A |
| | | | | **15.4** | |
| | | | | | |
| **23** | **25** | 30 | SW/4 | 0.0 | N/A |
| | | 29 | S/2 NW/4 | 0.0 | N/A |
| | | 29 | W/2 SE/4 | 0.0 | N/A |
| | | 29 | W/2 SE/4 | 11.1 | Grapes |
| | | 31 | S/2 | 0.0 | N/A |
| | | | | **11.1** | |
| | | | | | |
| 24 | 23 | 1 | Entire Section | 0.0 | N/A |
| | | | | | |
| | | | | | |
| | | 6 | Por NW/4 | 0.0 | N/A |
| | | | | | |
| | | | | | |
| | | 7 | Por NW/4 | 0.0 | N/A |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | 8 | S/2 | 0.0 | N/A |
| | | | | | |
| | | 9 | S/2 | 0.0 | N/A |
| | | | | | |
| | | 10 | S/2 | 0.0 | N/A |
| | | | | | |
| | | 11 | SW/4 | 0.0 | N/A |
| | | | | | |
| | | 12 | Entire Section | **635.5** | Pistacios |
| | | | | | |
| | | 18 | Entire Section | | N/A |
| | | | | | |
| | | 17 | Entire Section | | N/A |
| | | | | | |
| | | 16 | Entire Section | | N/A |
| | | | | | |
| | | 15 | Portion of E/2 | 79.6 | Wheat/Sudan Grass for Fodder |
| | | 15 | Portion of E/2 | 246.3 | Wheat/Sudan Grass for Fodder |
| | | 15 | Portiion of W/2 | 99.5 | Pistacios |
| | | 15 | Portiion of W/2 | 50.8 | Alfalfa Jan-July; Uncultivated Aug - Dec |
| | | | | **476.2** | |
| | | | | | |
| | | 14 | Entire Section | | |
| | | | | | |
| | | | | | |
| | | 13 | S/2; Ptn NW/4;Ptn NE/4 | 456.0 | Pistacios |
| | | 13 | Ptn NW/4;NE/4 | 110.0 | Pistacios |
| | | | | **566.0** | |
| | | | | | |
| | | 19 | Entire Section | **658.3** | Pistacios |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | 20 | Entire Section | **645.2** | Pistacios |
| | | | | | |
| | | 21 | N/2 | 318.8 | Pistacios |
| | | 21 | S/2 | 305.9 | Pistacios |
| | | | | **624.7** | |
| | | | | | |
| | | 22 | NW/4 | 166.9 | Pistacios |
| | | 22 | SW/4; SE/4;NE/4 | 458.7 | Wheat/Sudan Grass for Fodder |
| | | | | **625.6** | |
| | | | | | |
| | | 23 | Entire Section | | N/A |
| | | | | | |
| | | 24 | Entire Section | | N/A |
| | | | | | |
| | | 30 | Ptn Section | **564.6** | Pistacios |
| | | | | | |
| | | | | | |
| | | 29 | Entire Section | **649.4** | Pistacios |
| | | | | | |
| | | 28 | Ptn Section | **630.0** | Wheat/Sudan Grass for Fodder |
| | | | | | |
| | | | | | |
| | | 27 | NW/4 | 159.2 | Wheat/Sudan Grass for Fodder |
| | | 27 | NE/4 | 150.0 | Wheat/Sudan Grass for Fodder |
| | | 27 | SE/4 | 155.2 | Wheat/Sudan Grass for Fodder |
| | | 27 | SW/4 | 154.6 | Wheat/Sudan Grass for Fodder |
| | | | | **619.0** | |
| | | | | | |
| | | 26 | Entire Section | | N/A |
| | | | | | |
| | | 25 | N/2 | 313.0 | Pistacios |
| | | 25 | SW/4 | 155.5 | Pistacios |
| | | | | **468.5** | |
| | | | | | |
| | | 31 | Ptn of Section | **527.0** | Pistacios |
| | | | | | |
| | | 32 | S/2 | **329.9** | Pistacios |
| | | | | | |
| | | 33 | NW/4 | 153.7 | Wheat/Sudan Grass for Fodder |
| | | 33 | NE/4 | 157.3 | Wheat/Sudan Grass for Fodder |
| | | 33 | SE/4 | 159.5 | Wheat/Sudan Grass for Fodder |
| | | 33 | SW/4 | 159.6 | Wheat/Sudan Grass for Fodder |
| | | | | **630.1** | |
| | | | | | |
| | | 34 | NW/4 | 158.3 | Wheat/Sudan Grass for Fodder |
| | | 34 | NE/4 | 158.3 | Wheat/Sudan Grass for Fodder |
| | | 34 | SE/4 | 156.3 | Wheat/Sudan Grass for Fodder |

| | | | | | |
|---|---|---|---|---|---|
| | | 34 | SW/4 | 155.4 | Wheat/Sudan Grass for Fodder |
| | | | | **628.3** | |
| | | | | | |
| | | 35 | N/2 | 310.5 | Pistacios |
| | | 35 | S/2 | 318.4 | Wheat/Sudan Grass for Fodder |
| | | | | **628.9** | |
| | | | | | |
| | | 36 | Ptn SE/4 & SW/4 | 134.0 | New Pistacios |
| | | 36 | Ptn NE/4 | 24.0 | New Pistacios |
| | | | | **158.0** | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **24** | **24** | 6 | Entire Section | 0.0 | N/A |
| | | | | | |
| | | 5 | Por Section W of Hwy 43 | 0.0 | N/A |
| | | | | | |
| | | | | | |
| | | 4 | Allensworth St. Park | **104.9** | Municipal Development |
| | | | | | |
| | | | | | |
| | | 1 | Por NE/4 | 0.0 | N/A |
| | | | | | |
| | | 7 | Entire Section | **640.0** | Pistacios |
| | | | | | |
| | | 8 | Entire Section | | N/A |
| | | | | | |
| | | 9 | Ptn Section | | N/A |
| | | 9 | NW/4 | **22.1** | Grapes |
| | | | | | |
| | | | | | |
| | | 10 | Entire Section | | N/A |
| | | | | | |
| | | 11 | Portion Section | | N/A |
| | | 11 | Portion of E/2 | **103.3** | Grapes |
| | | | | | |
| | | | | | |
| | | 18 | Por N/2 | **180.0** | Pistacios |
| | | | | | |
| | | 17 | S/2 | **305.2** | Pistacios |
| | | | | | |
| | | 16 | SW/4 | 74.6 | Pistacios |
| | | 16 | SW/4 | 2.1 | Grapes |
| | | | | **76.7** | |
| | | | | | |
| | | 15 | SW/4 | 71.5 | Pistacios |
| | | 15 | E/2 | 112.9 | Pistacios |
| | | | | **184.4** | |
| | | | | | |
| | | 14 | S/2 | **310.6** | Pistacios |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | 13 | Entire Section | | N/A |
| | | | | | |
| | | 20 | Entire Section | **622.9** | Pistacios |
| | | | | | |
| | | 21 | Entire Section | **627.5** | Pistacios |
| | | | | | |
| | | 22 | W Portion | 252.4 | Pistacios |
| | | 22 | E Portion | 349.6 | Pistacios |
| | | | | **602.0** | |
| | | | | | |
| | | 23 | Entire Section | **635.8** | Pistacios |
| | | | | | |
| | | 24 | N/2 of N/2 | 157.7 | Pistacios |
| | | 24 | S/2 of N/2; S/2 | 377.1 | Pistacios |
| | | | | **534.8** | |
| | | | | | |
| | | 30 | Ptn of Section | **382.0** | New Pistacios |
| | | | | | |
| | | 29 | Ptn of Section | **320.1** | Pistacios |
| | | | | | |
| | | 28 | Entire Section | **620.9** | Pistacios |
| | | | | | |
| | | 27 | Ptn of Section - W of Hwy 43 | 196.1 | Pistacios |
| | | 27 | Ptn of Section - W of Hwy 43 | 159.1 | Pistacios |
| | | 27 | Ptn of Section - E of Hwy 43 | 178.9 | Pistacios |
| | | | | **534.1** | |
| | | | | | |
| | | 26 | Entire Section | **625.5** | Pistacios |
| | | | | | |
| | | 25 | N/2 & SW/4 | **486.4** | Pistacios |
| | | | | | |
| | | 31 | Ptn NW/4 | **128.0** | New Pistacios |
| | | | | | |
| | | 32 | Ptn Section | **322.8** | Pistacios |
| | | | | | |
| | | 33 | W/2 | **315.8** | New Pistacios |
| | | | | | |
| | | 36 | Ptn Section | **568.9** | Pistacios |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **24** | **25** | 6 | Entire Section | 0.0 | N/A |
| | | | | | |
| | | 5 | NW/4 | 0.0 | N/A |
| | | | | | |
| | | 7 | Entire Section | 0.0 | N/A |
| | | | | | |
| | | 8 | S/2 | 144.8 | Pistacios |
| | | 8 | S/2 of SE/4 | 78.1 | Almonds |
| | | | | **222.9** | |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | 17 | N/2 of N/2 | 156.2 | Pistacios |
| | | 17 | S/2 of N/2; S/2 | 469.7 | Grapes |
| | | | | **625.9** | |
| | | | | | |
| | | 19 | Portion of Section | **526.6** | Pistacios |
| | | | | | |
| | | 20 | NW/4 & Ptn SW/4 | 236.2 | Almonds |
| | | 20 | Ptn S/2 | 233.4 | Grapes |
| | | 20 | NE/4 | 153.6 | Almonds |
| | | | | **623.2** | |
| | | | | | |
| | | 30 | W/2 | 301.0 | Pistacios |
| | | 30 | W/2 of NE/4 | 79.9 | Almonds |
| | | 30 | E/2 of NE/4 | 80.6 | Almonds |
| | | 30 | W/2 of SE/4 | 79.0 | Almonds |
| | | 30 | E/2 of SE/4 | 79.3 | Almonds |
| | | | | **619.8** | |
| | | | | | |
| | | 31 | Ptn W/2 | 40.3 | Sorghum/Wheat for Fodder |
| | | 31 | Ptn E/2 | 108.6 | Sorghum/Wheat for Fodder |
| | | 31 | Ptn E/2 | 39.0 | Corn/Wheat/Sorghum for Fodder |
| | | 31 | Ptn E/2 | 74.9 | Corn/Wheat for Fodder |
| | | 31 | Ptn E/2 | 77.8 | Alfalfa |
| | | | | **340.6** | |
| | | | | | |
| | | 32 | Ptn W/2 | 228.3 | Corn/Wheat for Fodder |
| | | 32 | Ptn W/2 | 77.0 | Alfalfa |
| | | 32 | Ptn E/2 | 121.8 | Corn/Wheat for Fodder |
| | | 32 | Ptn E/2 | 18.1 | Alfalfa |
| | | 32 | Ptn E/2 | **445.2** | N/A |
| | | | | | |
| | | | | | |
| | | 33 | W/2 | **313.2** | Grapes |
| | | | | 22,431.9 | |
| | | | Crop Adjustment | 527.1 | |
| Notes | | | | **22,959.0** | |

1. Allowance for field roads = 5% of net cropped acreage. Therefore net cropped acreage is 95% of gross farmed acreage.

**APPENDIX A-1b**

## PRECIPITATION RECORDS FOR PORTERVILLE, SHAFTER, AND STRATFORD

Sources: Porterville Figure 2-28: Tule Subbasin HCM - TH&Co. (Appendix J)
Stratford & Shafter: California Irrigation Management System (CIMIS)

| Porterville | | | | | | |
|---|---|---|---|---|---|---|
| | **Year** | **Precipitation** | | DRY | WET | TYPICAL |
| | 1927 | 11.9 | | 0 | 0 | 1 |
| | 1928 | 8.8 | | 0 | 0 | 1 |
| | 1929 | 9.3 | | 0 | 0 | 1 |
| | 1930 | 5.6 | | 1 | 0 | |
| | 1931 | 7.3 | | 1 | 0 | |
| | 1932 | 12.0 | | 0 | 0 | 1 |
| | 1933 | 10.5 | | 0 | 0 | 1 |
| | 1934 | 5.3 | | 1 | 0 | |
| | 1935 | 12.6 | | 0 | 0 | 1 |
| | 1936 | 11.6 | | 0 | 0 | 1 |
| | 1937 | 17.0 | | 0 | 1 | |
| | 1938 | 17.1 | | 0 | 1 | |
| | 1939 | 8.4 | | 0 | 0 | 1 |
| | 1940 | 13.6 | | 0 | 0 | 1 |
| | 1941 | 16.0 | | 0 | 1 | |
| | 1942 | 10.2 | | 0 | 0 | 1 |
| | 1943 | 14.8 | | 0 | 0 | 1 |
| | 1944 | 9.0 | | 0 | 0 | 1 |
| | 1945 | 12.0 | | 0 | 0 | 1 |
| | 1946 | 10.3 | | 0 | 0 | 1 |
| | 1947 | 7.5 | | 1 | 0 | |
| | 1948 | 8.2 | | 0 | 0 | 1 |
| | 1949 | 6.7 | | 1 | 0 | |
| | 1950 | 7.7 | | 1 | 0 | |
| | 1951 | 8.9 | | 0 | 0 | 1 |
| | 1952 | 16.2 | | 0 | 1 | |
| | 1953 | 11.3 | | 0 | 0 | 1 |
| | 1954 | 8.5 | | 0 | 0 | 1 |
| | 1955 | 8.9 | | 0 | 0 | 1 |
| | 1956 | 10.8 | | 0 | 0 | 1 |
| | 1957 | 10.5 | | 0 | 0 | 1 |
| | 1958 | 18.4 | | 0 | 1 | |
| | 1959 | 5.0 | | 1 | 0 | |
| | 1960 | 5.7 | | 1 | 0 | |
| | 1961 | 7.8 | | 1 | 0 | |
| | 1962 | 12.7 | | 0 | 0 | 1 |
| | 1963 | 9.8 | | 0 | 0 | 1 |
| | 1964 | 9.4 | | 0 | 0 | 1 |
| | 1965 | 12.3 | | 0 | 0 | 1 |
| | 1966 | 6.5 | | 1 | 0 | |
| | 1967 | 16.8 | | 0 | 1 | |
| | 1968 | 8.0 | | 0 | 0 | 1 |
| | 1969 | 21.2 | | 0 | 1 | |
| | 1970 | 7.4 | | 1 | 0 | |
| | 1971 | 11.7 | | 0 | 0 | 1 |
| | 1972 | 5.8 | | 1 | 0 | |
| | 1973 | 19.4 | | 0 | 1 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 1974 | 11.8 | | 0 | 0 | 1 |
| | 1975 | 10.0 | | 0 | 0 | 1 |
| | 1976 | 11.5 | | 0 | 0 | 1 |
| | 1977 | 4.0 | | 1 | 0 | |
| | 1978 | 22.0 | | 0 | 1 | |
| | 1979 | 9.0 | | 0 | 0 | 1 |
| | 1980 | 13.0 | | 0 | 0 | 1 |
| | 1981 | 10.0 | | 0 | 0 | 1 |
| | 1982 | 14.5 | | 0 | 0 | 1 |
| | 1983 | 20.0 | | 0 | 1 | |
| | 1984 | 7.3 | | 1 | 0 | |
| | 1985 | 8.2 | | 0 | 0 | 1 |
| | 1986 | 13.2 | | 0 | 0 | 1 |
| | 1987 | 6.6 | | 1 | 0 | |
| | 1988 | 9.5 | | 0 | 0 | 1 |
| | 1989 | 7.7 | | 1 | 0 | |
| | 1990 | 7.3 | | 1 | 0 | |
| | 1991 | 10.0 | | 0 | 0 | 1 |
| | 1992 | 8.6 | | 0 | 0 | 1 |
| | 1993 | 13.9 | | 0 | 0 | 1 |
| | 1994 | 8.8 | | 0 | 0 | 1 |
| | 1995 | 18.3 | | 0 | 1 | |
| | 1996 | 9.8 | | 0 | 0 | 1 |
| | 1997 | 13.5 | | 0 | 0 | 1 |
| | 1998 | 21.8 | | 0 | 1 | |
| | 1999 | 11.2 | | 0 | 0 | 1 |
| | 2000 | 10.6 | | 0 | 0 | 1 |
| | 2001 | 8.0 | | 0 | 0 | 1 |
| | 2002 | 7.5 | | 1 | 0 | |
| | 2003 | 7.4 | | 1 | 0 | |
| | 2004 | 6.2 | | 1 | 0 | |
| | 2005 | 11.8 | | 0 | 0 | 1 |
| | 2006 | 12.0 | | 0 | 0 | 1 |
| | 2007 | 5.0 | | 1 | 0 | |
| | 2008 | 5.7 | | 1 | 0 | |
| | 2009 | 6.1 | | 1 | 0 | |
| | 2010 | 9.8 | | 0 | 0 | 1 |
| | 2011 | 14.2 | | 0 | 0 | 1 |
| | 2012 | 9.0 | | 0 | 0 | 1 |
| | 2013 | 4.2 | | 1 | 0 | |
| | 2014 | 3.0 | | 1 | 0 | |
| | 2015 | 4.2 | | 1 | 0 | |
| | 2016 | 6.5 | | 1 | 0 | |
| | 2017 | 4.9 | | 1 | 0 | |
| 91 Year Average | | 10.4 | | 28 | 12 | 51 |
| 75% of Average | | 7.8 | DRY | 31% | | |
| 150% of Average | | 15.6 | WET | | 13% | |
| | | | TYPICAL | | | 56% |
| Therefore 31% of years are DRY, 56% are Typical and 13% are WET | | | | | | |

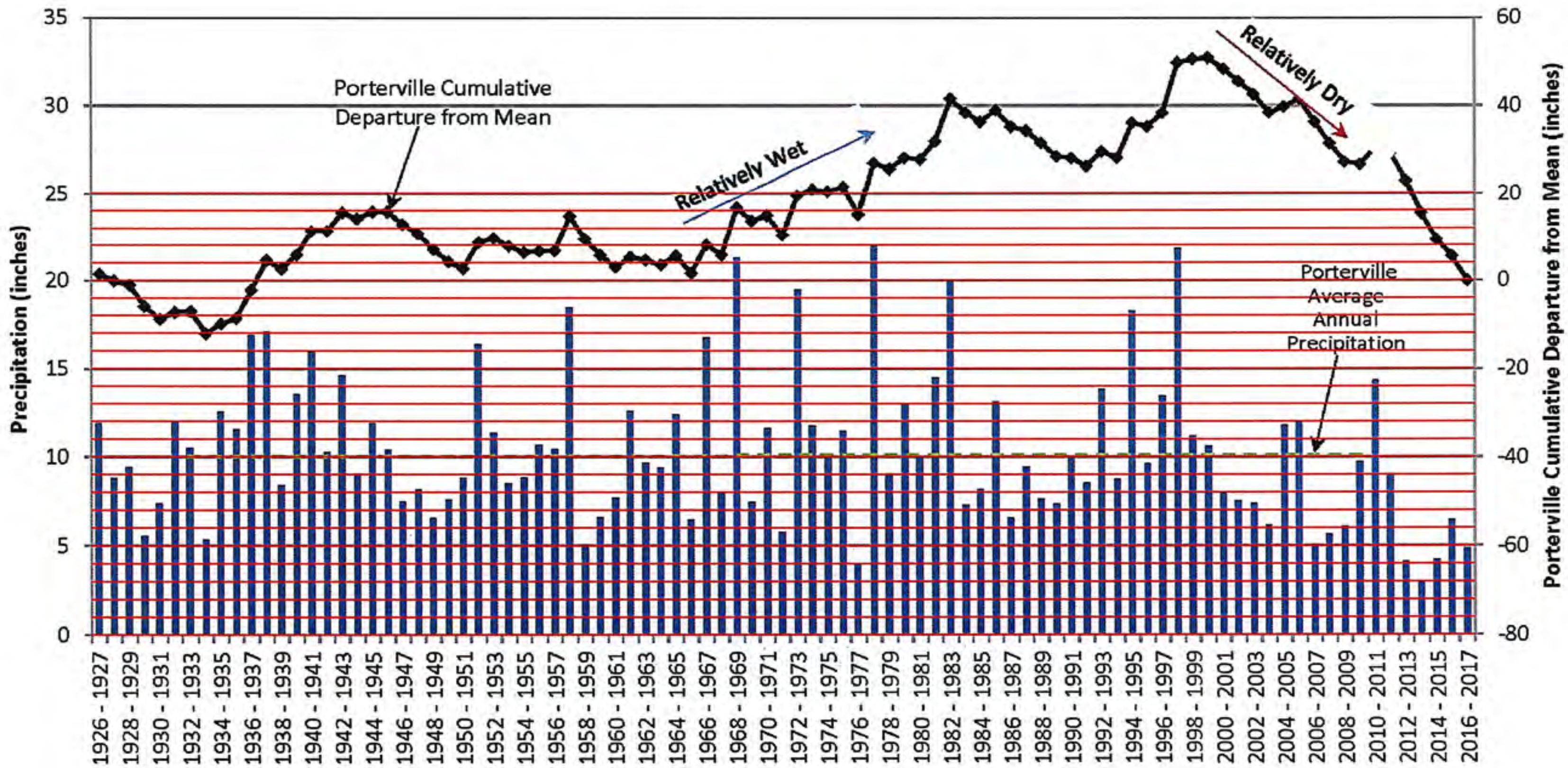
| Porterville 1991-2010 | | | | | | |
|---|---|---|---|---|---|---|
| | **Year** | **Precipitation** | | DRY | WET | TYPICAL |
| | 1991 | 10.0 | | 0 | 0 | 1 |
| | 1992 | 8.6 | | 0 | 0 | 1 |
| | 1993 | 13.9 | | 0 | 0 | 1 |
| | 1994 | 8.8 | | 0 | 0 | 1 |
| | 1995 | 18.3 | | 0 | 1 | 0 |
| | 1996 | 9.8 | | 0 | 0 | 1 |
| | 1997 | 13.5 | | 0 | 0 | 1 |
| | 1998 | 21.8 | | 0 | 1 | 0 |
| | 1999 | 11.2 | | 0 | 0 | 1 |
| | 2000 | 10.6 | | 0 | 0 | 1 |
| | 2001 | 8.0 | | 1 | 0 | 0 |
| | 2002 | 7.5 | | 1 | 0 | 0 |
| | 2003 | 7.4 | | 1 | 0 | 0 |
| | 2004 | 6.2 | | 1 | 0 | 0 |
| | 2005 | 11.8 | | 0 | 0 | 1 |
| | 2006 | 12.0 | | 0 | 0 | 1 |
| | 2007 | 5.0 | | 1 | 0 | 0 |
| | 2008 | 5.7 | | 1 | 0 | 0 |
| | 2009 | 6.1 | | 1 | 0 | 0 |
| | 2010 | 9.8 | | 0 | 0 | 1 |
| 20 Year Average | | 10.3 | | 7 | 2 | 11 |
| 75% of Average | | 7.7 | DRY | 35% | | |
| 150% of Average | | 15.5 | WET | | 10% | |
| | | | TYPICAL | | | 55% |
| Therefore 30% of years are DRY, 60% are Typical and 10% are WET | | | | | | |

| Stratford 1991-2010 | | | | | | |
|---|---|---|---|---|---|---|
| | **Year** | **Precipitation** | | DRY | WET | TYPICAL |
| | 1991 | 8.7 | | 0 | 0 | 1 |
| | 1992 | 9.5 | | 0 | 0 | 1 |
| | 1993 | 19.8 | | 0 | 1 | 0 |
| | 1994 | 7.4 | | 0 | 0 | 1 |
| | 1995 | 14.4 | | 0 | 1 | 0 |
| | 1996 | 22.4 | | 0 | 1 | 0 |
| | 1997 | 7.2 | | 0 | 0 | 1 |
| | 1998 | 11.9 | | 0 | 0 | 1 |
| | 1999 | 4.3 | | 1 | 0 | 0 |
| | 2000 | 6.4 | | 1 | 0 | 0 |
| | 2001 | 7.1 | | 0 | 0 | 1 |
| | 2002 | 3.5 | | 1 | 0 | 0 |
| | 2003 | 5.6 | | 1 | 0 | 0 |
| | 2004 | 6.9 | | 0 | 0 | 1 |
| | 2005 | 7.8 | | 0 | 0 | 1 |
| | 2006 | 9.3 | | 0 | 0 | 1 |
| | 2007 | 3.1 | | 1 | 0 | 0 |
| | 2008 | 4.4 | | 1 | 0 | 0 |
| | 2009 | 4.1 | | 1 | 0 | 0 |
| | 2010 | 12.6 | | 0 | 0 | 1 |
| 20 Year Average | | 8.8 | | 7 | 3 | 10 |
| 75% of Average | | 6.6 | DRY | 35% | | |
| 150% of Average | | 13.2 | WET | | 15% | |
| | | | TYPICAL | | | 50% |
| Therefore 35% of years are DRY, 50% are Typical and 15% are WET | | | | | | |

| Shafter 1991-2010 | | | | | | |
|---|---|---|---|---|---|---|
| | **Year** | **Precipitation** | | DRY | WET | TYPICAL |
| | 1991 | 7.4 | | 0 | 0 | 1 |
| | 1992 | 7.3 | | 0 | 0 | 1 |
| | 1993 | 6.9 | | 0 | 0 | 1 |
| | 1994 | 7.2 | | 0 | 0 | 1 |
| | 1995 | 9.9 | | 0 | 1 | 0 |
| | 1996 | 8.0 | | 0 | 0 | 1 |
| | 1997 | 5.8 | | 0 | 0 | 1 |
| | 1998 | 13.7 | | 0 | 1 | 0 |
| | 1999 | 5.6 | | 0 | 0 | 1 |
| | 2000 | 5.4 | | 0 | 0 | 1 |
| | 2001 | 8.0 | | 0 | 0 | 1 |
| | 2002 | 5.3 | | 0 | 0 | 1 |
| | 2003 | 5.9 | | 0 | 0 | 1 |
| | 2004 | 2.4 | | 1 | 0 | 0 |
| | 2005 | 3.6 | | 1 | 0 | 0 |
| | 2006 | 6.0 | | 0 | 0 | 1 |
| | 2007 | 2.6 | | 1 | 0 | 0 |
| | 2008 | 3.6 | | 1 | 0 | 0 |
| | 2009 | 4.4 | | 1 | 0 | 0 |
| | 2010 | 13.1 | | 0 | 1 | 0 |
| 20 Year Average | | 6.6 | | 5 | 3 | 12 |
| 75% of Average | | 5.0 | DRY | 25% | | |
| 150% of Average | | 9.9 | WET | | 15% | |
| | | | TYPICAL | | | 60% |
| Therefore 25% of years are DRY, 60% are Typical and 15% are WET | | | | | | |

**Figure 2-28**

## Annual Precipitation - Porterville Station




***Notes:***

Data in water years (October 1 to September 30).

Data from Western Regional Climate Center (1926-2001), California Irrigation Management Information System (2002-2016).

# APPENDIX A-1c

## Impact of Climate Change on Irrigation Water Availability, Crop Water Requirements and Soil Salinity in the San Joaquin Valley

**Jan W. Hopmans and Ed Maurer**

# Impact of Climate Change on Irrigation Water Availability, Crop Water Requirements and Soil Salinity in the San Joaquin Valley

**Jan W. Hopmans[1] and Ed Maurer[2]**
**[1]Department of Land Air and Water Resources, University of California, Davis**
**[2]Department of Civil Engineering, Santa Clara University**

*An assessment of potential climate change scenarios projected to the year 2100 concluded that irrigated agriculture in the western San Joaquin Valley may adapt for a wide range of climate change scenarios. Projected reductions in surface water supply are expected to be offset in part by reduced crop water requirements due to faster crop development, and by increased groundwater pumping. The model predictions indicated that groundwater pumping will likely reduce soil salinity and will not further increase land subsidence, though will increase groundwater salinity.*

The objective of the project is to assess the impact of potential climate change scenarios on the sustainability of irrigated agriculture in California; particularly, potential changes in irrigation water availability, crop water requirements, groundwater pumping, groundwater levels, and soil salinity. We consider three increased greenhouse gas (GHG) emission scenarios and study the potential impacts on the agro-hydro-climatological conditions in the region up to 2100. In particular, the analysis is broken down into four main impact areas: (i) climate responses, (ii) crop responses, (iii) agricultural water and crop management responses, and (iv) hydrologic responses.

Climate responses: For each of the three GHG emission scenarios we calculated the effect of increased atmospheric $CO_2$ levels on future climatic variables, i.e. daily precipitation, air temperature, and reference evapotranspiration (ET), at the regional-scale of the San Joaquin Valley (SJV) using projected output from two General Circulation Models (GCM's) until the year 2100. Relative to the no-climate change scenario, we predicted for the period 2070-2099 an annual average air temperature increase of 1.5 – 5 $^{o}$C, causing an increase of annual reference ET of 0 to 12%, while annual precipitation projections are not clear. Water supply projections were based on historical water supply numbers as a function of annual precipitation. Future water supply scenarios account for long-term trends in surface water supply as a function of long-term precipitation shifts, and preserve short-term statistical properties. Predicted changes in surface water supply to the entire study area for the period 2070-2099 relative to the no-climate-change scenario ranged from -25 to +12%.

Crop responses: We considered future changes in potential crop ET rates caused by (i) increased atmospheric $CO_2$ levels, (ii) increased reference ET, and (iii) increased air temperatures. For direct $CO_2$ effects on ET, we assumed that its increase by larger leaf biomass would be offset by a decrease through stomatal closure. We also accounted for the effects of projected temperature increases on crop development through the use of degree-days. Crop ET is estimated for all climate change scenarios and for various crops in the study area. Overall changes in crop ET ranged between -13 and +7%, for the period 2070-2099 relative to the no-climate-change scenario.

Management responses: We considered the following possible management responses to changes in surface water supplies and crop ET: (i) land fallowing and retirement, (ii) changes in cropping patterns, (iii) groundwater pumping, and (iv) technological adaptation. We predicted temporary land fallowing assuming it is inversely related to surface water supply, as indicated by historical fallowing during droughts in the study area. Predicted changes in land fallowing for the 2070-2099 period, relative to the no-climate-change scenario ranged from -20 to +40%. Aside from temporary fallowing we also included recent permanent retirement of agricultural land in all our predictive simulations. Predicted changes in total irrigation water requirements for the period 2070-2099 relative to the no-climate-change scenario ranged from -9 to -1%. The general decrease in crop water requirement is caused by a combination of (i) increased fallowing due to permanent reductions in surface water supply, and (ii) a decrease in crop ET by faster crop development. A comparison to changes in surface water supplies (from -25 to +12%) indicated that in some scenarios groundwater pumping will need to increase to compensate for the loss in surface water supply, despite the decrease in irrigation water requirements. Predicted changes in groundwater pumping for the period 2070-2099 relative to the no-climate-change scenario ranged from -59 to +110%. For the worst case scenario we concluded that a region-wide improvement in irrigation efficiency to 90% through improved irrigation technologies resulted in a 50% decrease in groundwater pumping.

Hydrologic responses: As a final step, the climate-change induced changes in crop ET, surface water supply, and groundwater pumping were used as input into a hydro-salinity model of the study area to assess resulting impacts on groundwater levels, land subsidence, soil salinity, and crop yields. This was done for 8 climate change scenarios, including a no-climate-change scenario and one that assumes a uniform irrigation efficiency of 90% by technological adaptations. Groundwater levels are largely determined by pumping rates. Predicted changes in shallow water table extent in the study area for the period 2070-2099 relative to the no-climate-change scenario ranged from -30 to +30%. These numbers indicate that there is significant uncertainty regarding effects of climate change on shallow water tables. In none of the scenarios did the computed confined groundwater levels fall below the historical maximum drawdown in the confined aquifer of 1965. Therefore, it can be concluded that climate-change induced increases in groundwater pumping (up to 110%) will not lead to significant land subsidence in the study area. Simulated soil salinity changes as a function of (i) salinity of applied irrigation water, with groundwater containing more salts than surface water, and (ii) drainage or leaching restrictions due to shallow water tables. Although scenarios differed significantly in the amount of groundwater applied, and the simulated extent of shallow water tables, soil salinity predictions do not vary greatly between scenarios, with a gradual decrease in the simulated extent of salt-affected soils. Wet scenarios resulted in less groundwater use, counteracted by a larger simulated extent of the shallow water table area. Dry scenarios used more groundwater, but caused a lowering of shallow water tables.

Overall, our results indicate that irrigated agriculture in the western SJV may adapt for a range of climate change scenarios. Possible reductions in surface water supply are partly offset by reductions in crop water demand and increased groundwater pumping. However, no significant negative effects are anticipated due to this increase in groundwater pumping, as our simulations predicted no land subsidence or soil salinity increase.

## Selected Professional Presentations

Hopmans, Jan W. Sustainability of Irrigated Agriculture, Pedofract, Madrid, Spain, June 2007.

Hopmans, Jan W. Sustainability of Irrigated Agriculture in the SJV: A historical and future perspective with climate change. University of Madison, WI, September 2007.

**For further information please contact:**

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**(408) 554-2178**
**http://www.engr.scu.edu/~emaurer/**

# APPENDIX A-2a

## THOMAS HARDER & CO.

# Table A-2





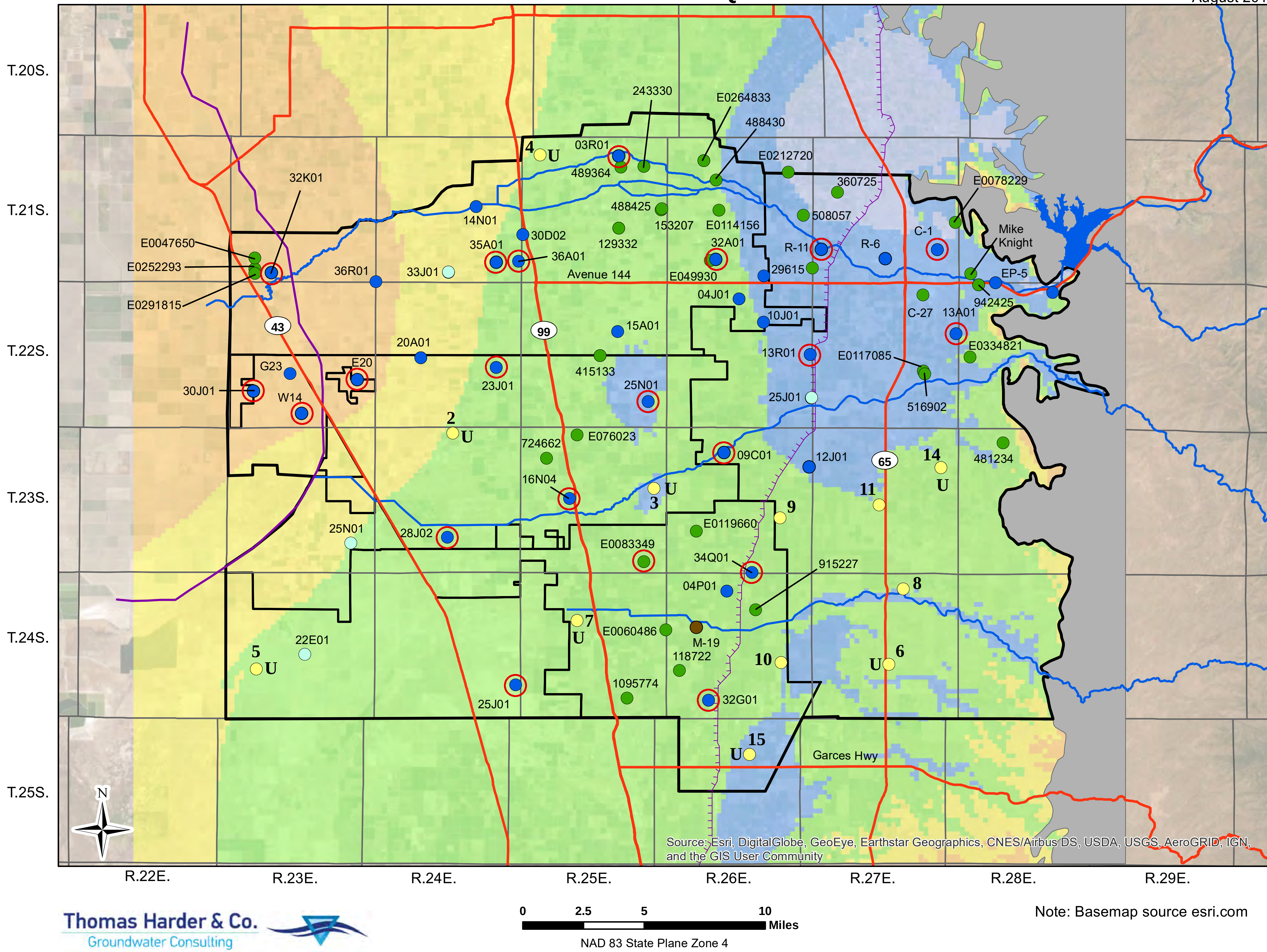
## Tri-County Water Authority GSA Groundwater Budget 1986/87 to 2016/17

| Water Year | Groundwater Inflows (acre-ft) | | | | | | | Groundwater Outflows (acre-ft) | | | | | Change in Storage (acre-ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Areal Recharge from Precipitation | Imported Water Deliveries | Agricultural Pumping | Release of Water from Compression of Aquitards | Sub-surface Inflow | | Total In | Groundwater Pumping | | Sub-surface Outflow | | Total Out | |
| | | Return Flow | Return Flow | | From Outside Subbasin | From Other GSAs | | Agricultural | Exports | To Outside Subbasin | To Other GSAs | | |
| 1986 - 1987 | 0 | 2,300 | 11,700 | 19,000 | 10,000 | 79,000 | 122,000 | 49,000 | 6,550 | 16,000 | 47,000 | 119,000 | 3,000 |
| 1987 - 1988 | 0 | 900 | 12,900 | 15,000 | 12,000 | 89,000 | 130,000 | 53,000 | 18,240 | 12,000 | 48,000 | 131,000 | -1,000 |
| 1988 - 1989 | 0 | 1,600 | 12,300 | 13,000 | 12,000 | 85,000 | 124,000 | 51,000 | 12,130 | 11,000 | 51,000 | 125,000 | -1,000 |
| 1989 - 1990 | 0 | 1,000 | 12,800 | 17,000 | 14,000 | 85,000 | 130,000 | 53,000 | 23,840 | 11,000 | 49,000 | 137,000 | -7,000 |
| 1990 - 1991 | 0 | 300 | 13,700 | 18,000 | 15,000 | 90,000 | 137,000 | 56,000 | 18,120 | 16,000 | 50,000 | 140,000 | -3,000 |
| 1991 - 1992 | 0 | 400 | 13,300 | 16,000 | 13,000 | 95,000 | 140,000 | 55,000 | 23,840 | 13,000 | 56,000 | 148,000 | -8,000 |
| 1992 - 1993 | 0 | 2,200 | 11,800 | 10,000 | 9,000 | 100,000 | 133,000 | 49,000 | 6,610 | 16,000 | 58,000 | 130,000 | 3,000 |
| 1993 - 1994 | 0 | 1,300 | 12,400 | 12,000 | 14,000 | 91,000 | 131,000 | 51,000 | 11,220 | 12,000 | 58,000 | 132,000 | -1,000 |
| 1994 - 1995 | 5,000 | 3,300 | 10,500 | 8,000 | 13,000 | 83,000 | 123,000 | 44,000 | 1,320 | 13,000 | 54,000 | 112,000 | 11,000 |
| 1995 - 1996 | 0 | 4,200 | 13,700 | 5,000 | 15,000 | 94,000 | 132,000 | 57,000 | 0 | 12,000 | 54,000 | 123,000 | 9,000 |
| 1996 - 1997 | 0 | 3,200 | 15,100 | 7,000 | 20,000 | 97,000 | 142,000 | 63,000 | 0 | 12,000 | 60,000 | 135,000 | 7,000 |
| 1997 - 1998 | 12,000 | 1,900 | 16,400 | 6,000 | 20,000 | 105,000 | 161,000 | 68,000 | 0 | 12,000 | 61,000 | 141,000 | 20,000 |
| 1998 - 1999 | 0 | 2,500 | 15,800 | 6,000 | 20,000 | 101,000 | 145,000 | 68,000 | 0 | 12,000 | 63,000 | 141,000 | 4,000 |
| 1999 - 2000 | 0 | 2,100 | 16,200 | 6,000 | 20,000 | 101,000 | 145,000 | 67,000 | 4,900 | 11,000 | 63,000 | 146,000 | -1,000 |
| 2000 - 2001 | 0 | 1,000 | 17,300 | 11,000 | 17,000 | 105,000 | 151,000 | 72,000 | 13,310 | 11,000 | 63,000 | 159,000 | -8,000 |
| 2001 - 2002 | 0 | 800 | 17,600 | 12,000 | 17,000 | 109,000 | 156,000 | 73,000 | 18,930 | 11,000 | 65,000 | 168,000 | -12,000 |
| 2002 - 2003 | 0 | 1,100 | 13,200 | 8,000 | 19,000 | 100,000 | 141,000 | 67,000 | 13,050 | 10,000 | 64,000 | 154,000 | -13,000 |
| 2003 - 2004 | 0 | 1,000 | 11,200 | 9,000 | 18,000 | 89,000 | 128,000 | 58,000 | 20,360 | 11,000 | 56,000 | 145,000 | -17,000 |
| 2004 - 2005 | 0 | 4,500 | 9,100 | 4,000 | 13,000 | 86,000 | 117,000 | 48,000 | 4,000 | 15,000 | 51,000 | 118,000 | -1,000 |
| 2005 - 2006 | 0 | 4,300 | 9,100 | 3,000 | 17,000 | 77,000 | 110,000 | 49,000 | 150 | 12,000 | 49,000 | 110,000 | 0 |
| 2006 - 2007 | 0 | 2,700 | 11,600 | 9,000 | 19,000 | 82,000 | 124,000 | 55,000 | 21,570 | 11,000 | 49,000 | 137,000 | -13,000 |
| 2007 - 2008 | 0 | 900 | 12,500 | 14,000 | 13,000 | 100,000 | 140,000 | 59,000 | 23,950 | 16,000 | 59,000 | 158,000 | -18,000 |
| 2008 - 2009 | 0 | 100 | 12,900 | 28,000 | 13,000 | 112,000 | 156,000 | 60,000 | 27,390 | 18,000 | 66,000 | 171,000 | -15,000 |
| 2009 - 2010 | 0 | 1,100 | 11,800 | 15,000 | 13,000 | 119,000 | 160,000 | 57,000 | 17,760 | 24,000 | 71,000 | 170,000 | -10,000 |
| 2010 - 2011 | 0 | 3,500 | 12,200 | 10,000 | 15,000 | 110,000 | 151,000 | 63,000 | 4,180 | 18,000 | 63,000 | 148,000 | 3,000 |
| 2011 - 2012 | 0 | 1,900 | 13,800 | 14,000 | 18,000 | 103,000 | 151,000 | 67,000 | 21,980 | 15,000 | 60,000 | 164,000 | -13,000 |
| 2012 - 2013 | 0 | 900 | 16,600 | 17,000 | 19,000 | 93,000 | 147,000 | 70,000 | 23,730 | 9,000 | 59,000 | 162,000 | -15,000 |
| 2013 - 2014 | 0 | 800 | 15,600 | 18,000 | 18,000 | 89,000 | 141,000 | 70,000 | 20,900 | 9,000 | 60,000 | 160,000 | -19,000 |
| 2014 - 2015 | 0 | 300 | 15,700 | 20,000 | 18,000 | 88,000 | 142,000 | 70,000 | 20,100 | 9,000 | 60,000 | 159,000 | -17,000 |
| 2015 - 2016 | 0 | 300 | 15,700 | 18,000 | 20,000 | 99,000 | 153,000 | 70,000 | 21,690 | 10,000 | 61,000 | 163,000 | -10,000 |
| 2016 - 2017 | 0 | 4,200 | 11,300 | 12,000 | 17,000 | 107,000 | 152,000 | 58,000 | 4,520 | 17,000 | 69,000 | 149,000 | 3,000 |
| 86/87-16/17 Avg | 1,000 | 1,800 | 13,400 | 12,000 | 16,000 | 96,000 | 140,000 | 60,000 | 13,000 | 13,000 | 58,000 | 144,000 | -4,000 |

Cumulative Change in Storage | -140,000

Groundwater Inflows or Outflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Groundwater Outflows Not Included in Sustainable Yield Estimates

**Tule Subbasin** **UPPER AQUIFER** August 2019




**Tule Subbasin Monitoring Plan**

***Map Features***

- Existing Upper Aquifer Monitoring Well with Known Depth, Perforation Interval, and Historical Record
- Existing Upper Aquifer Well with Known Depth, Perforation Interval, and Historical Record
- Existing Upper Aquifer Well with Known Depth and Historical Record
- Well To Be Used For Water Quality and Water Level Monitoring
- Proposed Upper Aquifer Well Location*
- Upper Aquifer Representative Monitoring Site

Depth to Bottom of Shallow Aquifer (ft bgs)

- < 100
- 100 - 200
- 200 - 300
- 300 - 400
- > 400
- Canal
- Friant-Kern Canal and California Aqueduct
- Basin Boundary
- GSA Boundaries
- State Highway/Major Road

Note: ft bgs = feet below ground surface

*Numbers indicate order of priority for construction (1 = highest priority, 10 = lowest priority)

Note: Basemap source esri.com

Thomas Harder & Co.
Groundwater Consulting

*DRAFT*

***Existing and Proposed Upper Aquifer Groundwater Level Monitoring Well Locations***

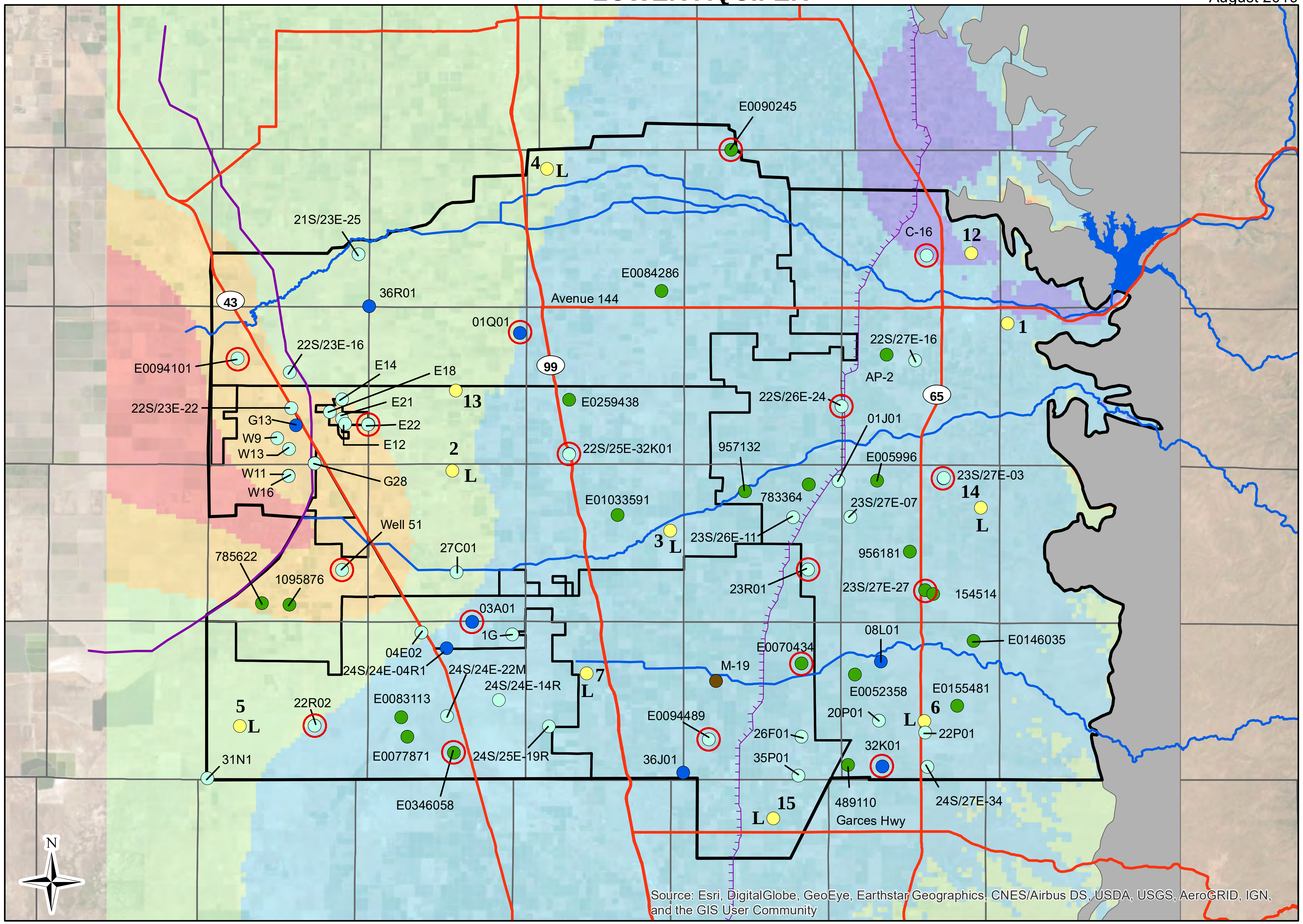
**Figure A1-2**

# Tule Subbasin Monitoring Plan

Tule Subbasin

LOWER AQUIFER

August 2019




0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

Note: Basemap source esri.com

## Map Features

- Existing Lower Aquifer Monitoring Well with Known Depth, Perforation Interval, and Historical Record
- Existing Lower Aquifer Well with Known Depth, Perforation Interval, and Historical Record
- Existing Lower Aquifer Well with Known Deep Depth and Perforation Interval, without Historical Record
- Well To Be Used For Water Quality and Water Level Monitoring
- Proposed Lower Aquifer Well Location*
- Lower Aquifer Representative Monitoring Site

Depth to Bottom of Confining Aquifer (ft bgs)

- <200
- 200-400
- 400-600
- 600-800
- >800
- Canal
- Friant-Kern Canal and California Aqueduct
- Basin Boundary
- GSA Boundaries
- State Highway/Major Road

Note: ft bgs = feet below ground surface

*Numbers indicate order of priority for construction (1 = highest priority, 10 = lowest priority)

DRAFT

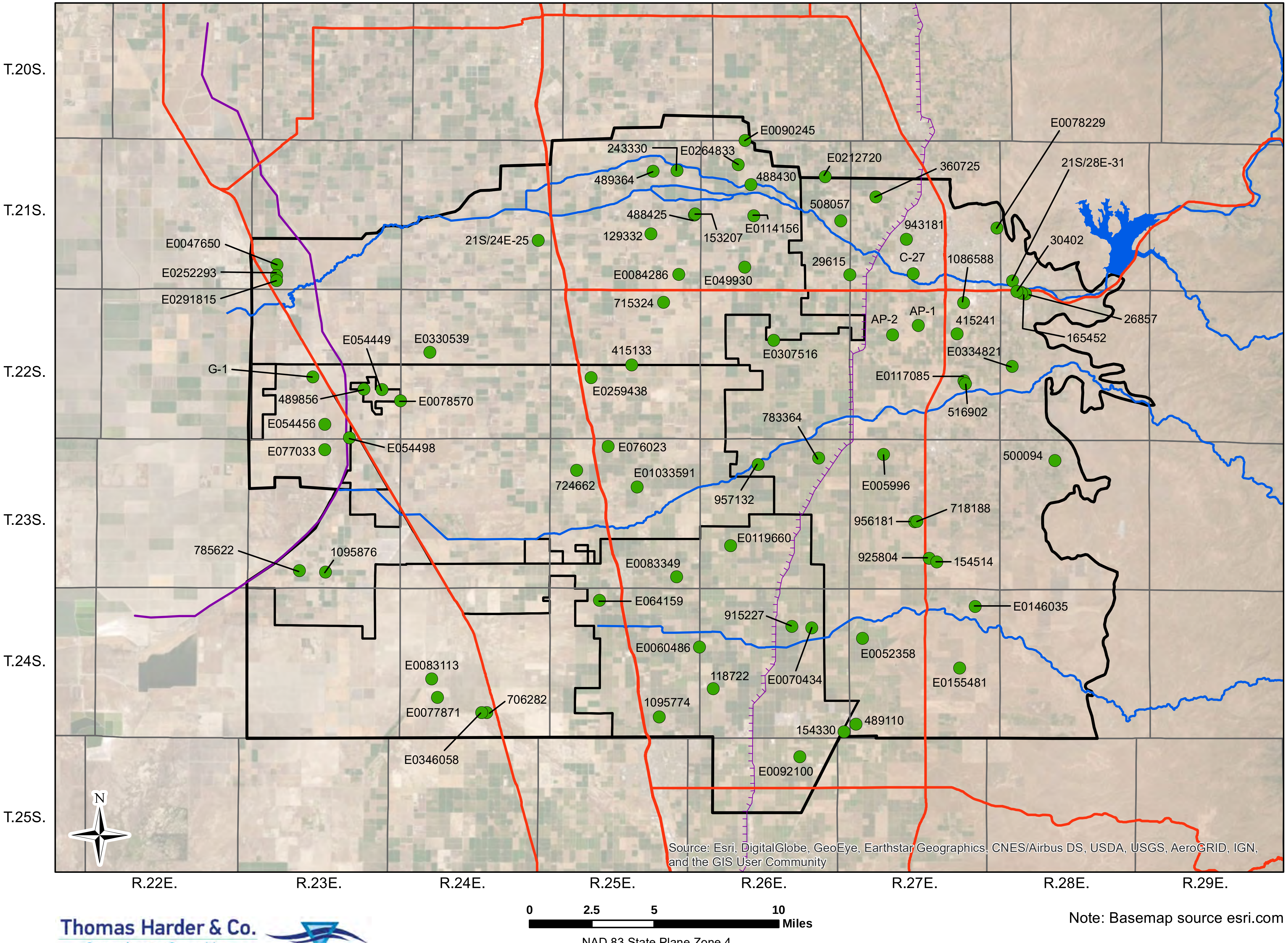
## Existing and Proposed Lower Aquifer Groundwater Level Monitoring Well Locations

Figure A1-5

# Tule Subbasin Monitoring Plan

## Tule Subbasin

August 2019




### Map Features

- Groundwater Quality Well Location
- Canal
- Friant-Kern Canal
- Basin Boundary
- GSA Boundaries
- State Highway/Major Road

Well Location data from:
Tule Basin Water Quality Coalition, 2017

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Groundwater Consulting

Note: Basemap source esri.com

**DRAFT**

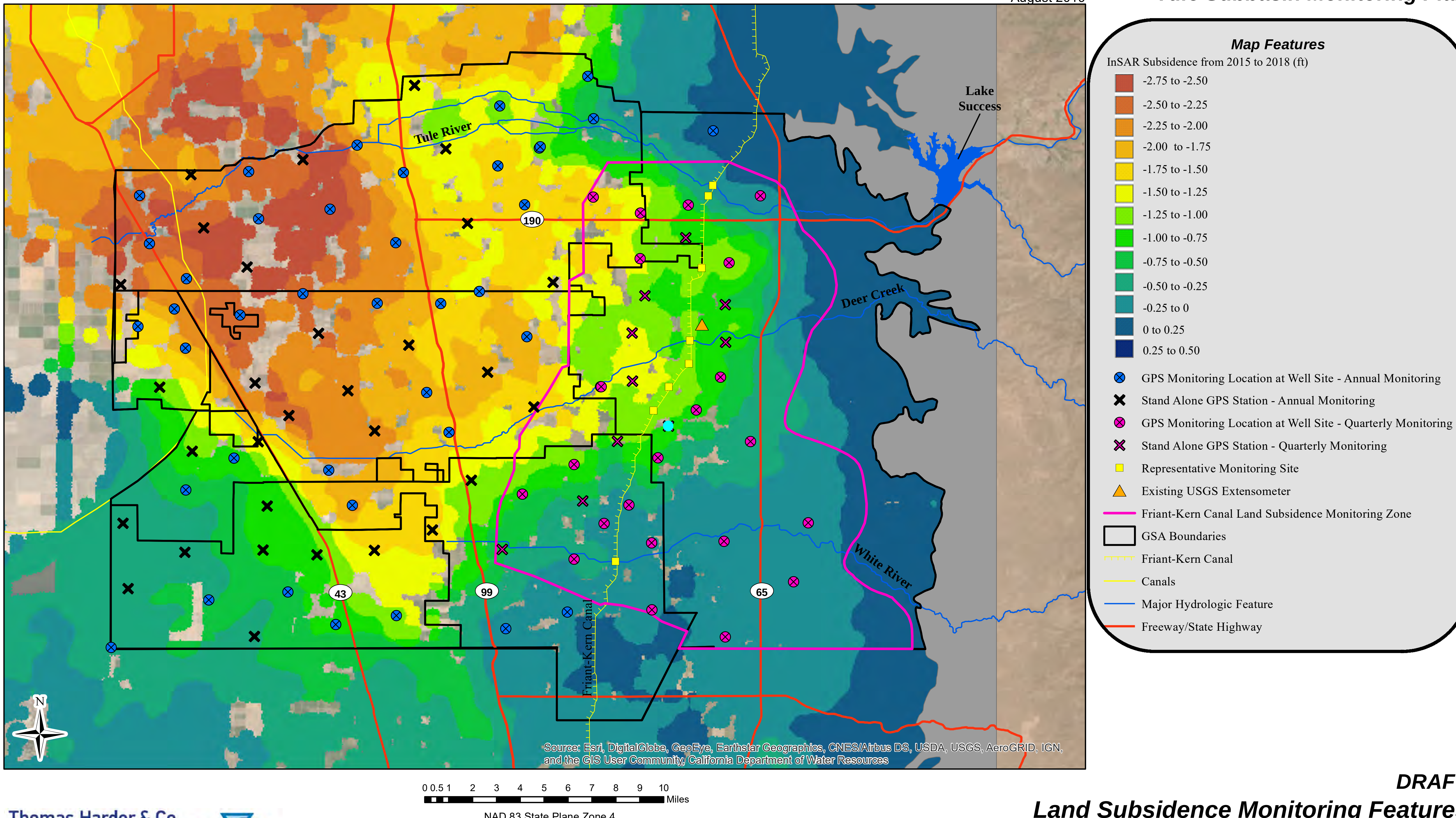
## Groundwater Quality Monitoring Network

**Figure A1-7**

# Tule Subbasin

August 2019

# Tule Subbasin Monitoring Plan

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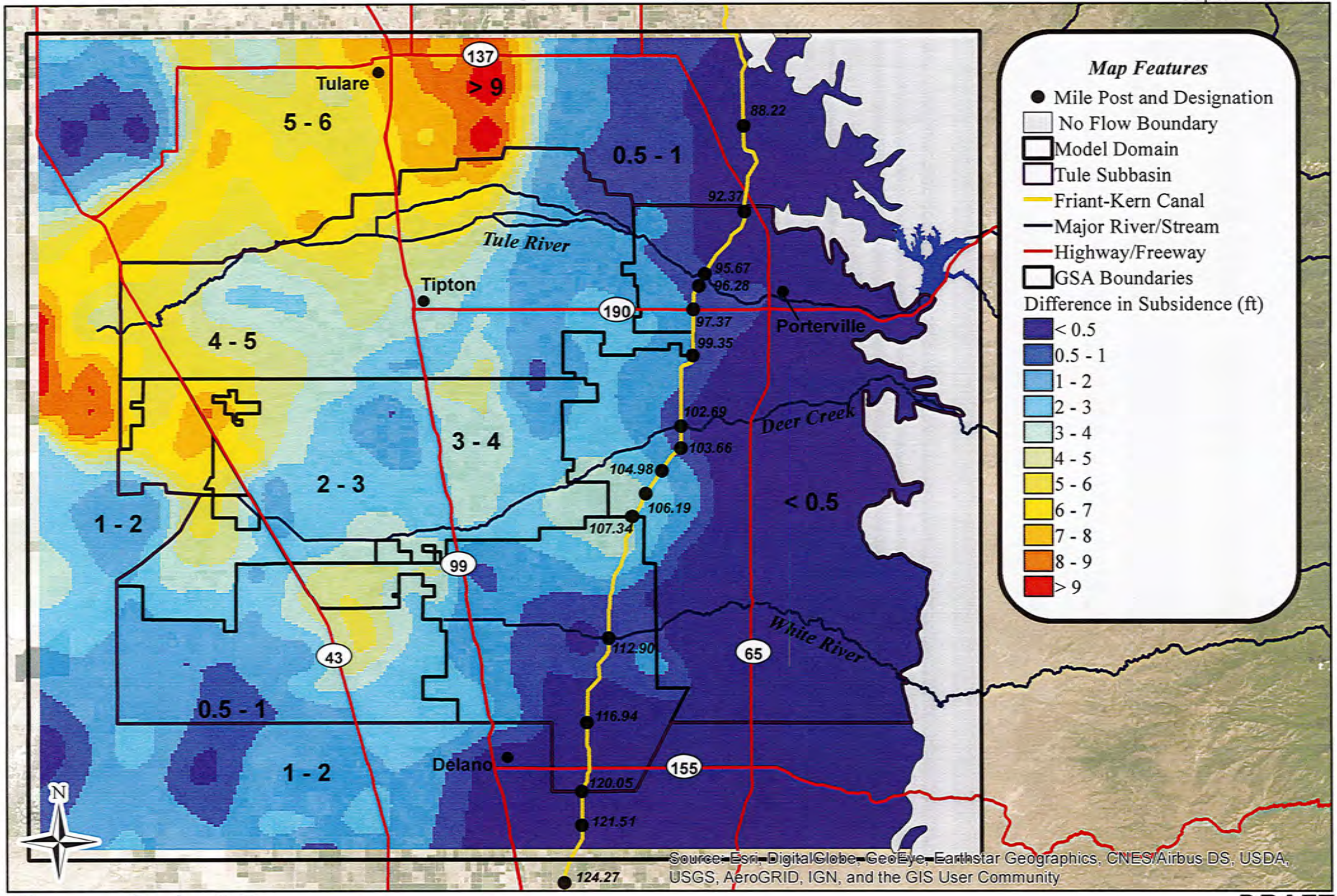
## Land Subsidence Monitoring Features

**Figure A1-8**

# Tule Subbasin Technical Advisory Committee

**Groundwater Flow Model of the Tule Subbasin**

September 2019

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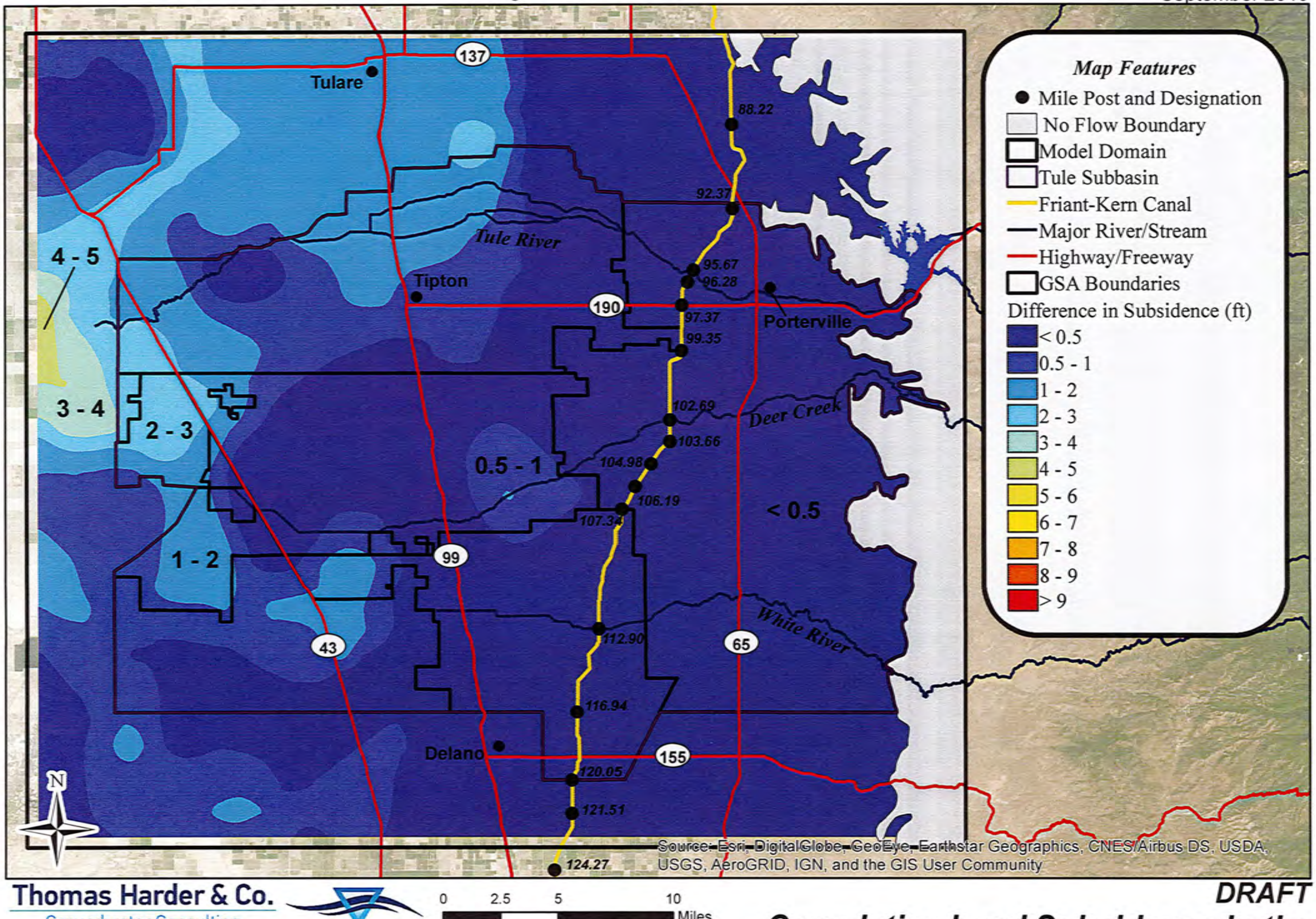
## Cumulative Land Subsidence in the Tule Subbasin from 2020 to 2040

**Figure 64**

Note: This map shows the difference in subsidence from September 30, 2019 to September 30, 2039.

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model
of the Tule Subbasin
September 2019




Thomas Harder & Co.
Groundwater Consulting

DRAFT

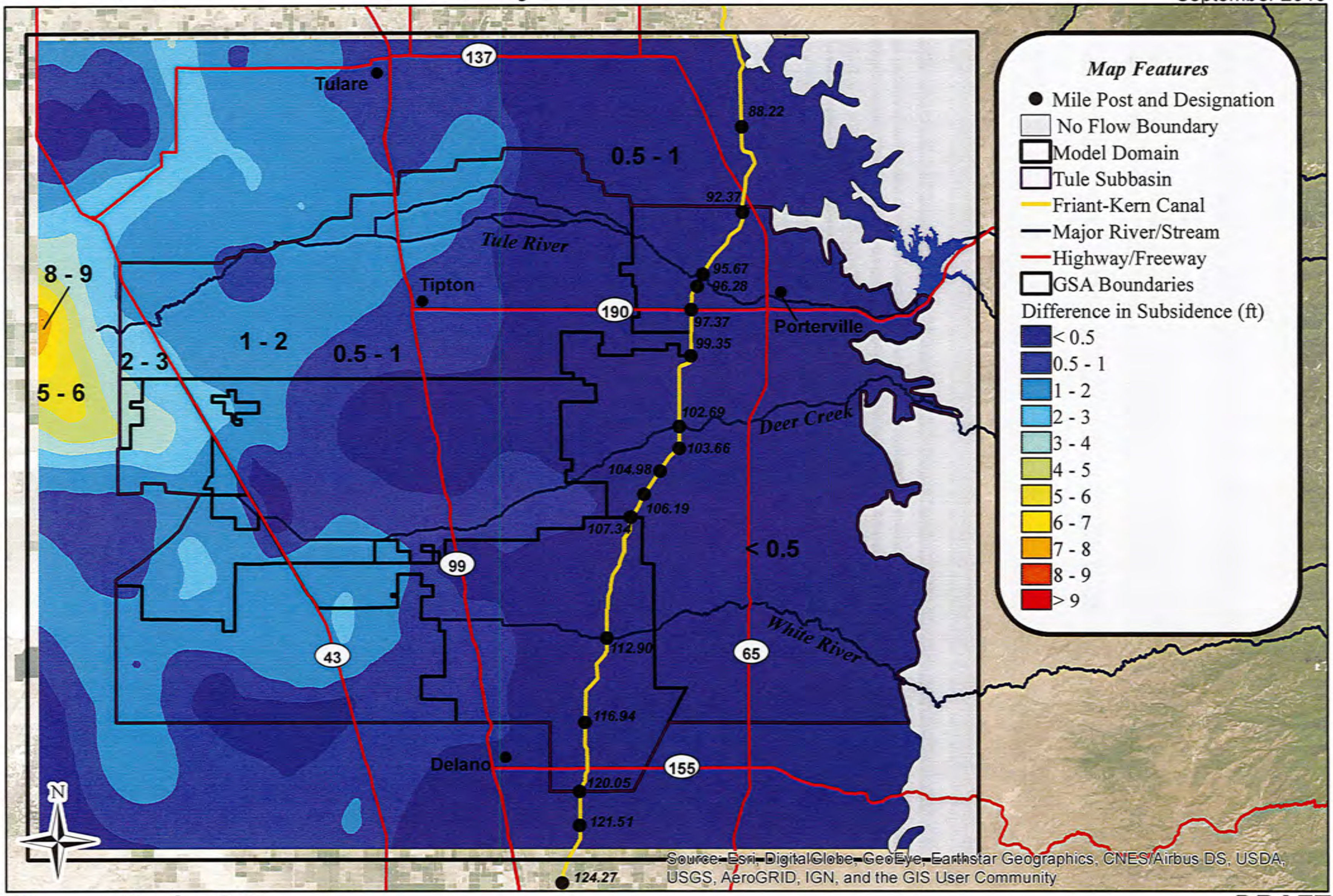
**Cumulative Land Subsidence in the Tule Subbasin from 2040 to 2050**

**Figure 65**

Note: This map shows the difference in subsidence from September 30, 2019 to September 30, 2039.

## Tule Subbasin Technical Advisory Committee

**Groundwater Flow Model of the Tule Subbasin**
September 2019




**Thomas Harder & Co.**
Groundwater Consulting

**DRAFT**

## Cumulative Land Subsidence in the Tule Subbasin from 2050 to 2070

**Figure 66**

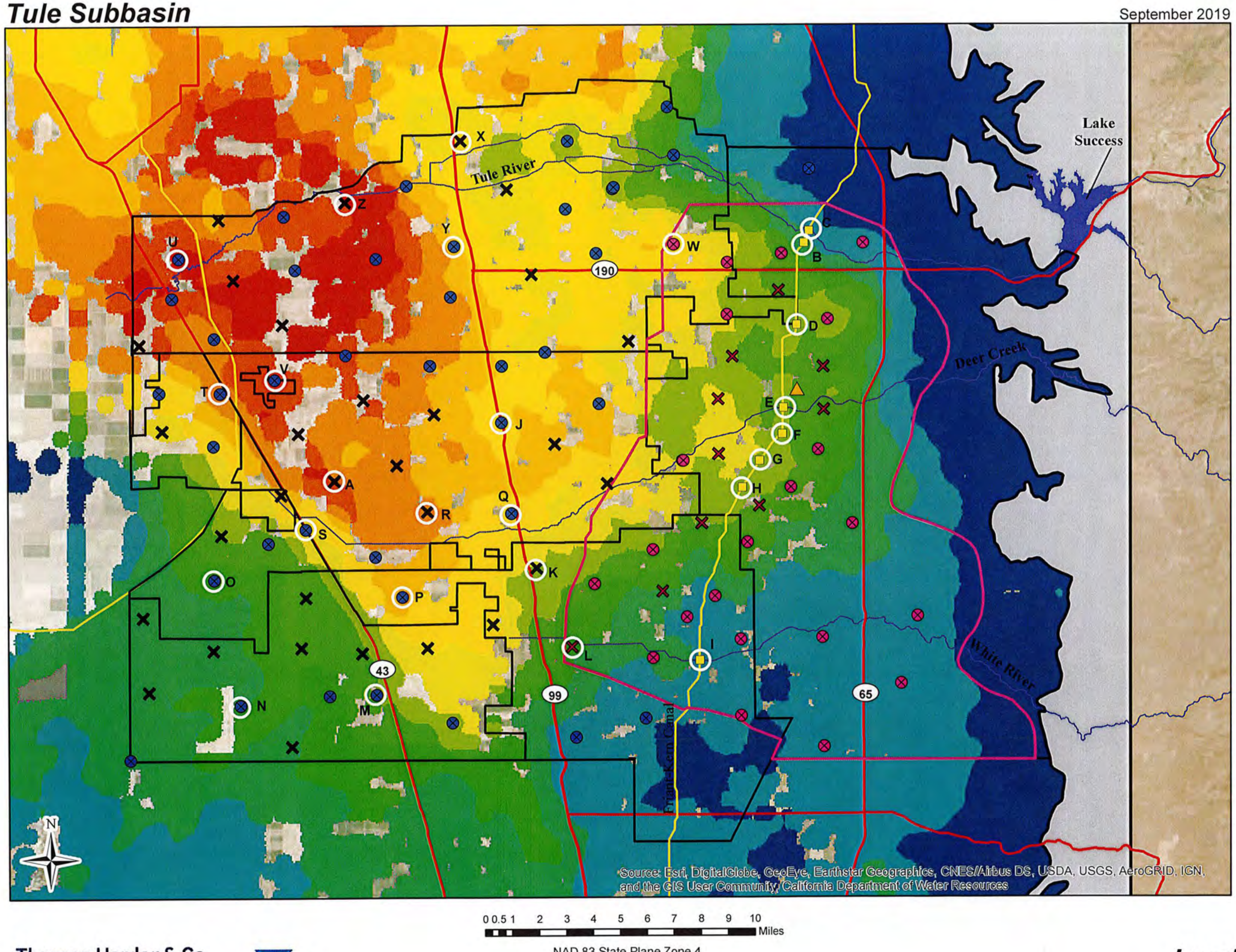
Note: This map shows the difference in subsidence from September 30, 2019 to September 30, 2039.

# APPENDIX A-2b

## SUBSIDENCE MONITORING SITES

**Source: InSAR data plotted by 4 Creeks Engineering, Inc.**

# Tule Subbasin Monitoring Plan




**Map Features**

InSAR Subsidence from 2015 to 2018 (ft)

- -2.75 to -2.50
- -2.50 to -2.25
- -2.25 to -2.00
- -2.00 to -1.75
- -1.75 to -1.50
- -1.50 to -1.25
- -1.25 to -1.00
- -1.00 to -0.75
- -0.75 to -0.50
- -0.50 to -0.25
- -0.25 to 0
- 0 to 0.25
- 0.25 to 0.50
- Proposed Representative Monitoring Site at Well Site - Annual Monitoring
- GPS Monitoring Location at Well Site - Annual Monitoring
- Proposed Representative Monitoring Site at Well Site - Quarterly Monitoring
- GPS Monitoring Location at Well Site - Quarterly Monitoring
- Proposed Representative Monitoring Site - Stand Alone GPS Station - Annual Monitoring
- Stand Alone GPS Station - Annual Monitoring
- Proposed Representative Monitoring Site - Stand Alone GPS Station - Quarterly Monitoring
- Stand Alone GPS Station - Quarterly Monitoring
- Existing Representative Monitoring Site
- Existing USGS Extensometer
- Friant-Kern Canal Land Subsidence Monitoring Zone
- GSA Boundaries
- Canal
- Major Hydrologic Feature
- Freeway/State Highway

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Groundwater Consulting

**DRAFT**

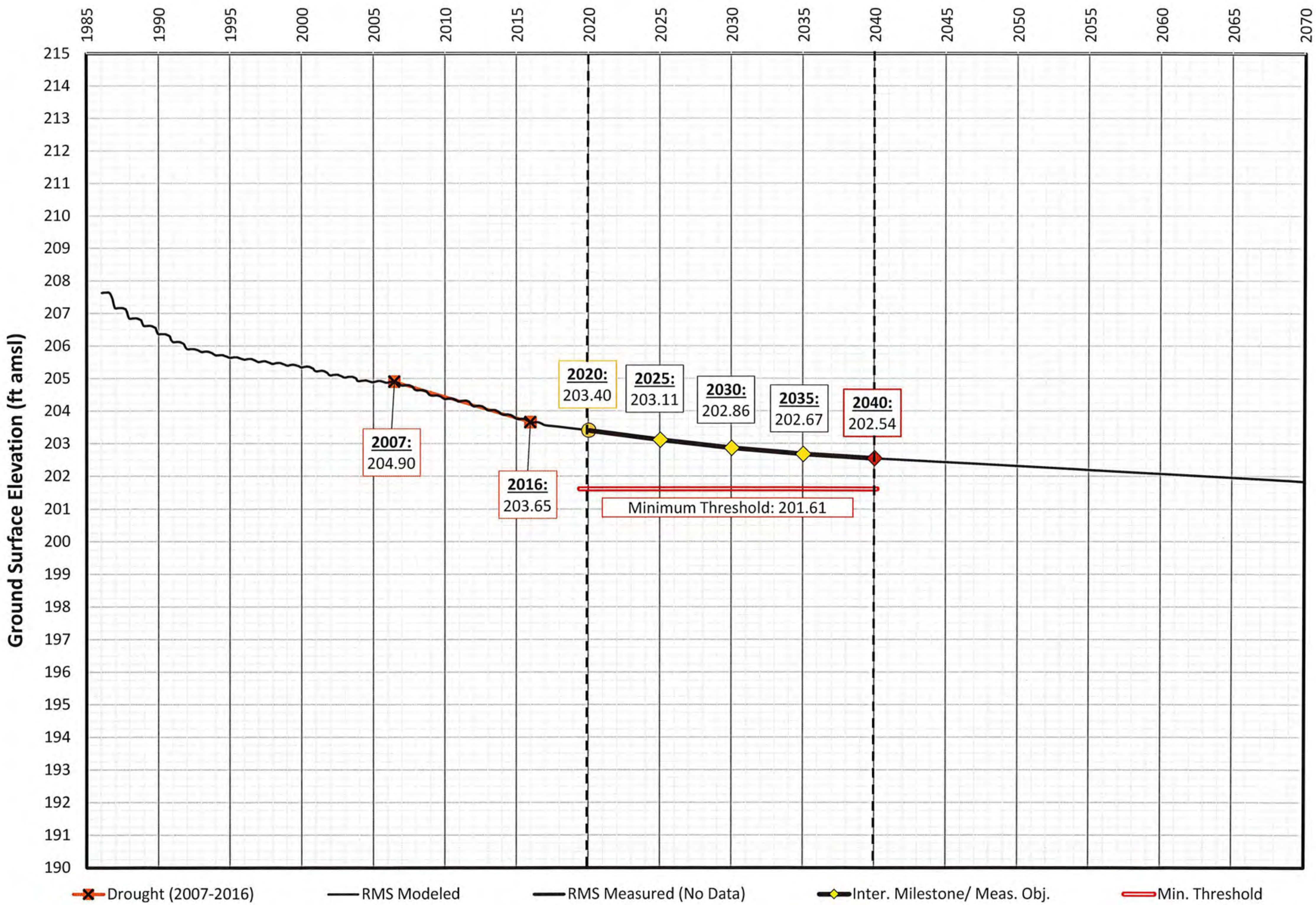
**Land Subsidence Monitoring Features**

Figure 2-36

# FIGURE 2-36a

**Subsidence RMS ID:** N

35.8191849, -119.4649519



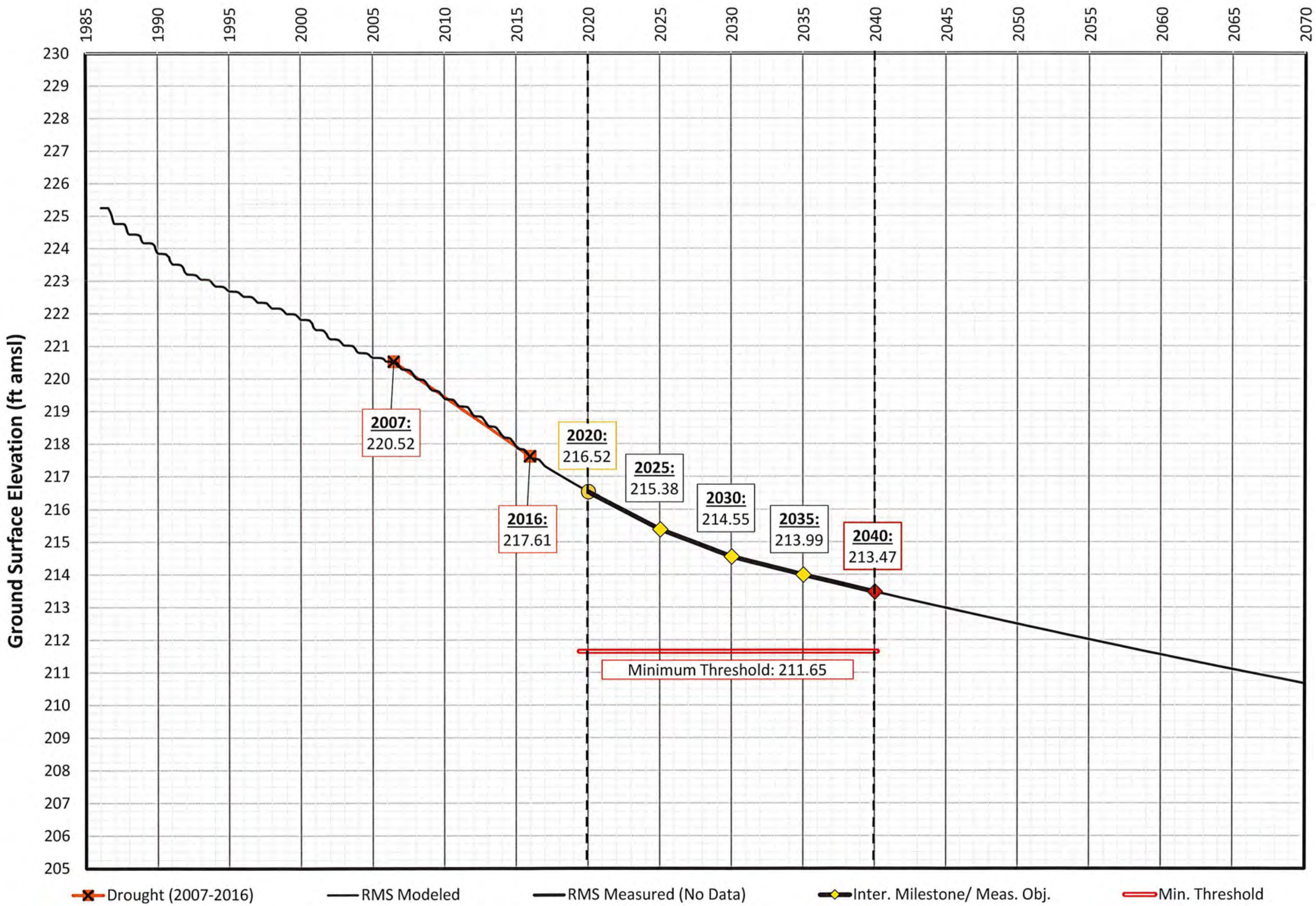

| | Measurable Obj. |
|---|---|
| Oct-20 | 203 |
| Oct-25 | 203 |
| Oct-30 | 203 |
| Oct-35 | 203 |
| Oct-40 | 203 |

| Minimum Threshold |
|---|
| 202 |

# FIGURE 2-36b

**Subsidence RMS ID:** M

35.8242735, -119.3752416



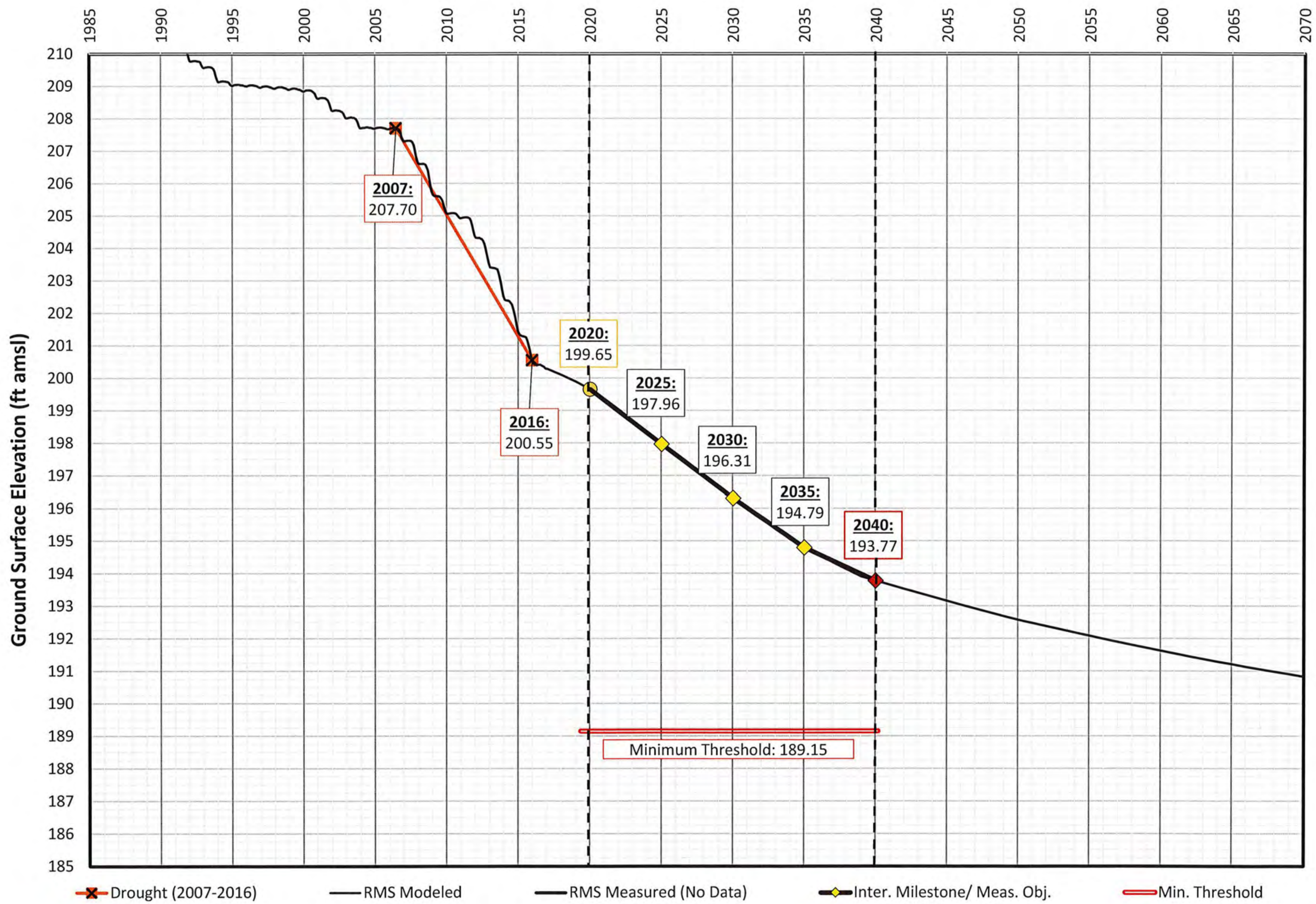

| | Measurable Obj. |
|---|---|
| Oct-20 | 217 |
| Oct-25 | 215 |
| Oct-30 | 215 |
| Oct-35 | 214 |
| Oct-40 | 213 |

| Minimum Threshold |
|---|
| 212 |

# FIGURE 2-36c

**Subsidence RMS ID:** V

35.9923882, -119.4425099




| | Measurable Obj. |
|---|---|
| Oct-20 | 200 |
| Oct-25 | 198 |
| Oct-30 | 196 |
| Oct-35 | 195 |
| Oct-40 | 194 |

| Minimum Threshold |
|---|
| 189 |

# APPENDIX A-3a

## TABLE A-3
## TULARE LAKE GSP

# Table A-3

**Annual Ac-Ft of Water in Kings River Watershed**

| | GSA | Tri-County | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agency | | | | | | | | | | |
| Kings River Water Years | Diversion | Poso Creek | *TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A* | *TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B* | Tule River-Tri County | *Deer Creek-70% of Deer Creek Total* | White River | Kings River-Tri County | Other Water | Imported Water | Tr-County |
| 71% | 1966 | - | - | - | - | - | - | - | - | - | 0 |
| 197% | 1967 | - | - | - | - | - | - | - | - | - | 0 |
| 49% | 1968 | - | 1,125 | 3,375 | - | - | - | - | - | - | 4,500 |
| 256% | 1969 | - | 317 | 952 | - | - | - | - | - | - | 1,270 |
| 78% | 1970 | - | 0 | 0 | - | - | - | - | - | - | 0 |
| 69% | 1971 | - | 5,192 | 15,575 | - | - | - | - | - | - | 20,766 |
| 50% | 1972 | - | 11,320 | 33,959 | - | - | - | - | - | - | 45,278 |
| 125% | 1973 | - | 5,000 | 15,000 | - | - | - | - | - | - | 20,000 |
| 122% | 1974 | 0 | 6,290 | 18,869 | 1,402 | 0 | 0 | 0 | 0 | - | 26,560 |
| 92% | 1975 | 0 | 8,809 | 26,428 | 224 | 0 | 0 | 2,642 | 0 | - | 38,103 |
| 32% | 1976 | 0 | 4,319 | 12,956 | 0 | 0 | 0 | 9,154 | 0 | - | 26,429 |
| 23% | 1977 | 0 | 775 | 2,324 | 0 | 0 | 0 | 950 | 0 | - | 4,048 |
| 201% | 1978 | 1,500 | 762 | 2,285 | 2,476 | 7,000 | 1,000 | 11,956 | 0 | - | 26,978 |
| 101% | 1979 | 0 | 5,209 | 15,627 | 185 | 0 | 0 | 6,575 | 0 | - | 27,596 |
| 178% | 1980 | 900 | 3,857 | 11,570 | 2,611 | 4,200 | 600 | 2,819 | 0 | - | 26,557 |
| 61% | 1981 | 0 | 6,138 | 18,413 | 223 | 0 | 0 | 8,983 | 0 | - | 33,757 |
| 181% | 1982 | 2,830 | 3,168 | 9,503 | 3,090 | 13,207 | 1,887 | 12,547 | 0 | - | 46,232 |
| 261% | 1983 | 6,075 | 0 | 0 | 340 | 28,350 | 4,050 | 0 | 0 | - | 38,815 |
| 115% | 1984 | 9,902 | 370 | 1,109 | 0 | 46,210 | 6,601 | 0 | 0 | - | 64,191 |
| 73% | 1985 | 0 | 7,172 | 21,517 | 826 | 0 | 0 | 1,586 | 0 | - | 31,101 |
| 190% | 1986 | 2,572 | 1,547 | 4,642 | 1,701 | 12,004 | 1,715 | 11,054 | 0 | - | 35,235 |
| 45% | 1987 | 0 | 4,289 | 12,866 | 0 | 0 | 0 | 9,366 | 0 | - | 26,520 |
| 48% | 1988 | 0 | 2,692 | 8,076 | 0 | 0 | 0 | 984 | 0 | - | 11,752 |
| 53% | 1989 | 0 | 5,616 | 16,847 | 150 | 0 | 0 | 0 | 1,580 | - | 24,192 |
| 40% | 1990 | 0 | 2,207 | 6,622 | 0 | 0 | 0 | 0 | 4,556 | - | 13,385 |
| 63% | 1991 | 0 | 20 | 60 | 604 | 0 | 0 | 1,604 | 0 | - | 2,288 |
| 41% | 1992 | 140 | 1,410 | 4,231 | 0 | 652 | 93 | 0 | 0 | - | 6,525 |
| 149% | 1993 | 50 | 689 | 2,066 | 1,155 | 235 | 34 | 6,919 | 2,575 | - | 13,722 |
| 50% | 1994 | 0 | 1,207 | 3,622 | 0 | 0 | 0 | 6,098 | 0 | - | 10,927 |
| 202% | 1995 | 1,142 | 3,697 | 11,092 | 6,040 | 5,331 | 762 | 4,902 | 0 | - | 32,965 |
| 122% | 1996 | 924 | 3,726 | 11,177 | 1,913 | 4,311 | 616 | 2,219 | 0 | - | 24,884 |
| 155% | 1997 | 4,610 | 2,311 | 6,932 | 1,701 | 21,513 | 3,073 | 4,729 | 0 | - | 44,869 |
| 181% | 1998 | 2,795 | 1,289 | 3,867 | 2,083 | 13,042 | 1,863 | 50 | 0 | - | 24,989 |
| 74% | 1999 | 0 | 116 | 349 | 274 | 0 | 0 | 167 | 0 | - | 906 |
| 90% | 2000 | 435 | 4,799 | 14,396 | 1,166 | 2,032 | 290 | 0 | 0 | - | 23,118 |
| 59% | 2001 | 0 | 1,253 | 3,759 | 0 | 0 | 0 | 3,044 | 3,000 | - | 11,056 |
| 67% | 2002 | 0 | 2,444 | 7,331 | 124 | 0 | 0 | 0 | 190 | - | 10,088 |
| 83% | 2003 | 0 | 2,624 | 7,872 | 790 | 0 | 0 | 6,652 | 160 | - | 18,098 |
| 61% | 2004 | 0 | 323 | 970 | 559 | 0 | 0 | 0 | 5,293 | - | 7,145 |
| 148% | 2005 | 884 | 141 | 423 | 1,680 | 4,123 | 589 | 10,632 | 1,235 | - | 19,707 |
| 172% | 2006 | 1,196 | 154 | 461 | 795 | 5,581 | 797 | 14,253 | 0 | - | 23,236 |
| 40% | 2007 | 0 | 61 | 182 | 0 | 0 | 0 | 18,083 | 63 | - | 18,389 |
| 72% | 2008 | 0 | 190 | 571 | 828 | 0 | 0 | 4,756 | 0 | - | 6,345 |
| 79% | 2009 | 0 | 9 | 26 | 0 | 0 | 0 | 0 | 0 | - | 34 |
| 121% | 2010 | 0 | 3 | 9 | 1,676 | 0 | 0 | 10,587 | 282 | - | 12,557 |
| 180% | 2011 | 0 | 83 | 250 | - | 0 | 0 | 0 | - | - | 333 |
| 49% | 2012 | 0 | 69 | 207 | - | 0 | 0 | 0 | - | - | 277 |
| 41% | 2013 | 0 | 71 | 212 | - | 0 | 0 | 0 | - | - | 283 |
| 32% | 2014 | 0 | 47 | 141 | - | 0 | 0 | 0 | - | - | 188 |
| 21% | 2015 | 0 | 55 | 0 | - | 0 | 0 | 0 | - | - | 55 |
| 75% | 2016 | 0 | | | - | 0 | 0 | 0 | - | - | 0 |
| 204% | 2017 | - | - | - | - | - | - | - | - | - | - |
| | Annual Averages | 705 | 2,215 | 6,641 | 666 | 3,227 | 470 | 3,333 | 364 | | 17,770 |

I:\FR18s\FR18161220 Tulare Lake GSP\Model\Decoupled\WaterBalance\2018 0809 External surface water diversions.xlsx

# APPENDIX A-3b

## DWR CHRONOLOGICAL RECONSTRUCTED
## SAN JOAQUIN VALLEY
## WATER YEAR CLASSIFICATION INDICES

.T WRWSIHIST 1905090746/
Department of Water Resources
California Cooperative Snow Surveys

Chronological Reconstructed Sacramento and San Joaquin Valley
Water Year Hydrologic Classification Indices

Based on measured unimpaired runoff (in million acre-feet), subject to revision.
*** See explanatory notes at bottom ***

| | [..........Sacramento Valley..........] | | | | | [.........San Joaquin Valley..........] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [.....Runoff (maf).....] | | | [..WY Index..] | | [.....Runoff (maf).....] | | | [..WY Index..] | |
| WY | Oct-Mar | Apr-Jul | WYsum | Index | Yr-type | Oct-Mar | Apr-Jul | WYsum | Index | Yr-type |
| 1901 | | | | | | 3.49 | 5.58 | 9.39 | 4.60 | W |
| 1902 | | | | | | 1.12 | 3.81 | 5.08 | 3.41 | AN |
| 1903 | | | | | | 1.45 | 4.13 | 5.71 | 3.45 | AN |
| 1904 | | | | | | 1.96 | 5.37 | 7.64 | 4.31 | W |
| 1905 | | | | | | 1.82 | 3.36 | 5.30 | 3.24 | AN |
| 1906 | 12.57 | 12.92 | 26.71 | 11.76 | W | 2.53 | 9.24 | 12.43 | 6.70 | W |
| 1907 | 18.96 | 13.45 | 33.70 | 14.07 | W | 3.67 | 7.61 | 11.82 | 6.20 | W |
| 1908 | 8.29 | 5.60 | 14.77 | 7.73 | BN | 0.98 | 2.17 | 3.32 | 2.40 | D |
| 1909 | 20.61 | 8.98 | 30.68 | 12.10 | W | 2.85 | 5.91 | 8.97 | 4.59 | W |
| 1910 | 13.12 | 6.11 | 20.12 | 9.38 | W | 2.87 | 3.62 | 6.64 | 3.65 | AN |
| 1911 | 12.27 | 13.12 | 26.38 | 11.74 | W | 3.63 | 7.52 | 11.48 | 5.97 | W |
| 1912 | 4.84 | 5.65 | 11.41 | 6.71 | BN | 0.54 | 2.57 | 3.21 | 2.55 | BN |
| 1913 | 5.72 | 6.29 | 12.85 | 6.24 | D | 0.44 | 2.34 | 3.00 | 2.00 | C |
| 1914 | 16.72 | 10.08 | 27.81 | 10.92 | W | 2.72 | 5.67 | 8.69 | 4.35 | W |
| 1915 | 11.41 | 11.42 | 23.86 | 10.99 | W | 1.29 | 4.95 | 6.40 | 4.10 | W |
| 1916 | 14.25 | 8.89 | 24.14 | 10.83 | W | 2.67 | 5.50 | 8.38 | 4.65 | W |
| 1917 | 7.25 | 9.14 | 17.26 | 8.83 | AN | 1.66 | 4.84 | 6.66 | 4.13 | W |
| 1918 | 5.27 | 4.89 | 10.99 | 6.19 | D | 1.07 | 3.40 | 4.59 | 3.08 | BN |
| 1919 | 8.12 | 6.77 | 15.66 | 7.00 | BN | 1.06 | 2.99 | 4.09 | 2.62 | BN |
| 1920 | 3.63 | 4.91 | 9.20 | 5.15 | C | 0.72 | 3.29 | 4.09 | 2.64 | BN |
| 1921 | 15.47 | 7.52 | 23.80 | 9.20 | AN | 1.97 | 3.84 | 5.90 | 3.23 | AN |
| 1922 | 6.63 | 10.57 | 17.98 | 8.97 | AN | 1.51 | 5.99 | 7.68 | 4.54 | W |
| 1923 | 6.21 | 6.27 | 13.21 | 7.06 | BN | 1.39 | 3.95 | 5.51 | 3.55 | AN |
| 1924 | 3.27 | 1.94 | 5.74 | 3.87 | C | 0.45 | 1.03 | 1.50 | 1.42 | C |
| 1925 | 8.76 | 6.51 | 15.99 | 6.39 | D | 1.45 | 3.93 | 5.51 | 2.93 | BN |
| 1926 | 6.37 | 4.79 | 11.76 | 5.75 | D | 0.89 | 2.56 | 3.49 | 2.30 | D |
| 1927 | 14.34 | 8.75 | 23.83 | 9.52 | W | 1.80 | 4.56 | 6.50 | 3.56 | AN |
| 1928 | 10.24 | 5.86 | 16.76 | 8.27 | AN | 1.69 | 2.64 | 4.37 | 2.63 | BN |
| 1929 | 4.00 | 3.84 | 8.40 | 5.22 | C | 0.52 | 2.29 | 2.84 | 2.00 | C |
| 1930 | 8.24 | 4.65 | 13.52 | 5.90 | D | 0.76 | 2.44 | 3.25 | 2.02 | C |
| 1931 | 3.52 | 2.09 | 6.10 | 3.66 | C | 0.46 | 1.18 | 1.66 | 1.20 | C |
| 1932 | 6.28 | 6.24 | 13.12 | 5.48 | D | 1.79 | 4.69 | 6.63 | 3.41 | AN |
| 1933 | 3.73 | 4.66 | 8.94 | 4.63 | C | 0.49 | 2.77 | 3.34 | 2.44 | D |
| 1934 | 5.68 | 2.45 | 8.63 | 4.07 | C | 0.98 | 1.26 | 2.28 | 1.44 | C |
| 1935 | 6.27 | 9.69 | 16.59 | 6.98 | BN | 1.26 | 5.03 | 6.41 | 3.56 | AN |
| 1936 | 10.32 | 6.41 | 17.35 | 7.75 | BN | 2.00 | 4.38 | 6.49 | 3.74 | AN |
| 1937 | 5.50 | 7.24 | 13.33 | 6.87 | BN | 1.78 | 4.66 | 6.53 | 3.99 | W |
| 1938 | 17.96 | 12.93 | 31.83 | 12.62 | W | 3.58 | 7.33 | 11.24 | 5.89 | W |
| 1939 | 4.56 | 3.04 | 8.18 | 5.58 | D | 1.00 | 1.83 | 2.90 | 2.20 | D |
| 1940 | 14.78 | 6.93 | 22.43 | 8.88 | AN | 2.49 | 4.04 | 6.59 | 3.36 | AN |
| 1941 | 16.32 | 9.77 | 27.08 | 11.47 | W | 2.22 | 5.51 | 7.93 | 4.43 | W |
| 1942 | 14.33 | 9.93 | 25.24 | 11.27 | W | 1.93 | 5.28 | 7.38 | 4.44 | W |
| 1943 | 13.37 | 6.90 | 21.13 | 9.77 | W | 2.86 | 4.28 | 7.28 | 4.03 | W |
| 1944 | 4.81 | 4.93 | 10.43 | 6.35 | D | 0.87 | 2.97 | 3.92 | 2.76 | BN |
| 1945 | 8.42 | 5.92 | 15.06 | 6.80 | BN | 2.07 | 4.37 | 6.60 | 3.59 | AN |
| 1946 | 10.89 | 5.97 | 17.62 | 7.70 | BN | 1.99 | 3.65 | 5.73 | 3.30 | AN |
| 1947 | 5.90 | 3.83 | 10.39 | 5.61 | D | 1.26 | 2.12 | 3.42 | 2.18 | D |
| 1948 | 5.39 | 9.55 | 15.75 | 7.12 | BN | 0.56 | 3.58 | 4.21 | 2.70 | BN |
| 1949 | 5.73 | 5.59 | 11.97 | 6.09 | D | 0.62 | 3.12 | 3.79 | 2.53 | BN |
| 1950 | 7.01 | 6.72 | 14.44 | 6.62 | BN | 1.02 | 3.57 | 4.65 | 2.85 | BN |
| 1951 | 16.77 | 5.42 | 22.95 | 9.18 | AN | 4.35 | 2.83 | 7.25 | 3.14 | AN |
| 1952 | 13.86 | 13.68 | 28.60 | 12.38 | W | 2.18 | 6.84 | 9.30 | 5.17 | W |
| 1953 | 10.84 | 8.26 | 20.09 | 9.55 | W | 1.07 | 3.18 | 4.35 | 3.03 | BN |
| 1954 | 9.74 | 6.81 | 17.43 | 8.51 | AN | 1.10 | 3.16 | 4.30 | 2.72 | BN |
| 1955 | 5.19 | 5.07 | 10.98 | 6.14 | D | 0.78 | 2.67 | 3.50 | 2.30 | D |
| 1956 | 20.32 | 8.60 | 29.89 | 11.38 | W | 4.14 | 5.29 | 9.67 | 4.46 | W |
| 1957 | 7.72 | 6.29 | 14.89 | 7.83 | AN | 1.02 | 3.19 | 4.29 | 3.01 | BN |
| 1958 | 16.37 | 12.24 | 29.71 | 12.16 | W | 1.67 | 6.40 | 8.36 | 4.77 | W |
| 1959 | 7.40 | 3.84 | 12.05 | 6.75 | BN | 0.98 | 1.85 | 2.98 | 2.21 | D |
| 1960 | 7.72 | 4.65 | 13.06 | 6.20 | D | 0.85 | 2.07 | 2.96 | 1.85 | C |
| 1961 | 6.87 | 4.39 | 11.97 | 5.68 | D | 0.54 | 1.50 | 2.10 | 1.38 | C |
| 1962 | 8.17 | 6.23 | 15.11 | 6.65 | BN | 1.26 | 4.24 | 5.61 | 3.07 | BN |
| 1963 | 12.01 | 10.09 | 22.99 | 9.63 | W | 1.68 | 4.37 | 6.24 | 3.57 | AN |
| 1964 | 5.90 | 4.37 | 10.92 | 6.41 | D | 0.93 | 2.14 | 3.14 | 2.19 | D |
| 1965 | 16.59 | 8.13 | 25.64 | 10.15 | W | 3.20 | 4.55 | 8.13 | 3.81 | W |
| 1966 | 7.42 | 4.84 | 12.95 | 7.16 | BN | 1.49 | 2.42 | 3.98 | 2.51 | BN |
| 1967 | 12.14 | 11.01 | 24.06 | 10.20 | W | 2.46 | 7.09 | 9.98 | 5.25 | W |
| 1968 | 8.66 | 4.12 | 13.64 | 7.24 | BN | 1.02 | 1.85 | 2.94 | 2.21 | D |
| 1969 | 15.33 | 10.68 | 26.98 | 11.05 | W | 3.84 | 8.14 | 12.29 | 6.09 | W |
| 1970 | 18.87 | 4.35 | 24.06 | 10.40 | W | 2.55 | 2.96 | 5.61 | 3.18 | AN |
| 1971 | 12.71 | 8.90 | 22.57 | 10.37 | W | 1.56 | 3.23 | 4.91 | 2.89 | BN |
| 1972 | 7.61 | 5.02 | 13.43 | 7.29 | BN | 1.25 | 2.22 | 3.57 | 2.16 | D |
| 1973 | 12.80 | 6.38 | 20.05 | 8.58 | AN | 1.87 | 4.48 | 6.47 | 3.50 | AN |
| 1974 | 21.69 | 9.78 | 32.50 | 12.99 | W | 2.43 | 4.53 | 7.12 | 3.90 | W |
| 1975 | 9.24 | 8.95 | 19.23 | 9.35 | W | 1.37 | 4.65 | 6.18 | 3.85 | W |
| 1976 | 4.63 | 2.75 | 8.20 | 5.29 | C | 0.78 | 1.07 | 1.97 | 1.57 | C |
| 1977 | 2.49 | 1.93 | 5.12 | 3.11 | C | 0.22 | 0.80 | 1.05 | 0.84 | C |
| 1978 | 14.90 | 8.12 | 23.92 | 8.65 | AN | 2.57 | 6.50 | 9.65 | 4.58 | W |
| 1979 | 6.06 | 5.64 | 12.41 | 6.67 | BN | 1.87 | 3.99 | 5.98 | 3.67 | AN |
| 1980 | 15.49 | 6.00 | 22.33 | 9.04 | AN | 3.74 | 5.41 | 9.47 | 4.73 | W |
| 1981 | 6.81 | 3.63 | 11.10 | 6.21 | D | 0.85 | 2.29 | 3.22 | 2.44 | D |
| 1982 | 20.56 | 11.82 | 33.41 | 12.76 | W | 3.78 | 7.00 | 11.41 | 5.45 | W |
| 1983 | 22.75 | 13.66 | 37.68 | 15.29 | W | 5.42 | 8.73 | 15.01 | 7.22 | W |
| 1984 | 15.98 | 5.52 | 22.35 | 10.00 | W | 3.51 | 3.48 | 7.13 | 3.69 | AN |
| 1985 | 6.24 | 4.00 | 11.04 | 6.47 | D | 1.11 | 2.41 | 3.60 | 2.40 | D |
| 1986 | 19.45 | 5.45 | 25.83 | 9.96 | W | 4.36 | 4.92 | 9.50 | 4.31 | W |
| 1987 | 5.85 | 2.80 | 9.27 | 5.86 | D | 0.55 | 1.48 | 2.08 | 1.86 | C |
| 1988 | 5.78 | 2.90 | 9.23 | 4.65 | C | 0.86 | 1.55 | 2.48 | 1.48 | C |
| 1989 | 9.03 | 5.07 | 14.82 | 6.13 | D | 1.07 | 2.42 | 3.56 | 1.96 | C |
| 1990 | 4.94 | 3.72 | 9.26 | 4.81 | C | 0.83 | 1.59 | 2.46 | 1.51 | C |
| 1991 | 3.90 | 4.01 | 8.44 | 4.21 | C | 0.56 | 2.57 | 3.20 | 1.96 | C |
| 1992 | 5.41 | 2.93 | 8.87 | 4.06 | C | 0.86 | 1.66 | 2.58 | 1.56 | C |
| 1993 | 12.44 | 8.98 | 22.21 | 8.54 | AN | 2.49 | 5.65 | 8.38 | 4.20 | W |
| 1994 | 4.55 | 2.73 | 7.81 | 5.02 | C | 0.66 | 1.80 | 2.54 | 2.05 | C |
| 1995 | 19.83 | 13.60 | 34.55 | 12.89 | W | 3.67 | 8.01 | 12.32 | 5.95 | W |
| 1996 | 13.05 | 8.37 | 22.29 | 10.26 | W | 2.57 | 4.51 | 7.22 | 4.12 | W |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 20.22 | 4.39 | 25.42 | 10.82 | W | 5.75 | 3.59 | 9.51 | 4.13 | W |
| 1998 | 17.65 | 12.54 | 31.40 | 13.31 | W | 2.82 | 7.11 | 10.43 | 5.65 | W |
| 1999 | 12.97 | 7.26 | 21.19 | 9.80 | W | 1.90 | 3.85 | 5.91 | 3.59 | AN |
| 2000 | 12.06 | 5.96 | 18.90 | 8.94 | AN | 1.98 | 3.78 | 5.90 | 3.38 | AN |
| 2001 | 5.64 | 3.46 | 9.81 | 5.76 | D | 0.92 | 2.23 | 3.18 | 2.20 | D |
| 2002 | 9.32 | 4.57 | 14.60 | 6.35 | D | 1.27 | 2.75 | 4.06 | 2.34 | D |
| 2003 | 10.71 | 7.74 | 19.31 | 8.21 | AN | 1.25 | 3.49 | 4.87 | 2.81 | BN |
| 2004 | 10.95 | 4.40 | 16.04 | 7.51 | BN | 1.51 | 2.25 | 3.81 | 2.21 | D |
| 2005 | 8.40 | 9.28 | 18.55 | 8.49 | AN | 2.73 | 6.28 | 9.21 | 4.75 | W |
| 2006 | 18.06 | 13.09 | 32.09 | 13.20 | W | 2.86 | 7.37 | 10.44 | 5.90 | W |
| 2007 | 6.59 | 3.04 | 10.28 | 6.19 | D | 0.99 | 1.46 | 2.51 | 1.97 | C |
| 2008 | 5.90 | 3.82 | 10.28 | 5.16 | C | 0.99 | 2.45 | 3.49 | 2.06 | C |
| 2009 | 7.05 | 5.30 | 13.02 | 5.78 | D | 1.51 | 3.35 | 4.94 | 2.72 | BN |
| 2010 | 7.45 | 7.78 | 16.01 | 7.08 | BN | 1.43 | 4.53 | 6.08 | 3.55 | AN |
| 2011 | 12.68 | 11.53 | 25.21 | 10.54 | W | 3.68 | 6.90 | 10.99 | 5.58 | W |
| 2012 | 5.69 | 5.46 | 11.84 | 6.89 | BN | 0.83 | 1.86 | 2.76 | 2.18 | D |
| 2013 | 8.52 | 3.01 | 12.19 | 5.83 | D | 1.33 | 1.67 | 3.05 | 1.71 | C |
| 2014 | 4.29 | 2.59 | 7.46 | 4.07 | C | 0.46 | 1.21 | 1.72 | 1.16 | C |
| 2015 | 6.91 | 1.77 | 9.23 | 4.00 | C | 0.67 | 0.74 | 1.44 | 0.81 | C |
| 2016 | 12.24 | 4.60 | 17.48 | 6.71 | BN | 2.03 | 2.98 | 5.06 | 2.35 | D |
| 2017 | 26.17 | 10.69 | 37.82 | 14.14 | W | 6.65 | 7.77 | 14.84 | 6.46 | W |
| 2018 | 7.09 | 5.05 | 12.86 | 7.14 | BN | 1.64 | 3.01 | 4.76 | 3.03 | BN |
| | | | | | | | | | | |
| min | 2.49 | 1.77 | 5.12 | 3.11 | | 0.22 | 0.74 | 1.05 | 0.81 | |
| mean | 10.75 | 6.29 | 17.85 | 8.05 | | 1.94 | 3.73 | 5.84 | 3.24 | |
| max | 26.17 | 13.68 | 37.82 | 15.29 | | 6.65 | 9.24 | 15.01 | 7.22 | |

1966-2015 mean

Eight River Runoff [maf]

| WY | Dec | Jan | Feb | Mar | Apr | May |
|---|---|---|---|---|---|---|
| 1901 | | | | | | |
| 1902 | | | | | | |
| 1903 | | | | | | |
| 1904 | | | | | | |
| 1905 | | | | | | |
| 1906 | 0.55 | 3.69 | 2.93 | 7.00 | 5.34 | 6.43 |
| 1907 | 2.14 | 2.83 | 6.01 | 10.40 | 7.32 | 5.86 |
| 1908 | 1.43 | 2.27 | 2.12 | 2.19 | 2.53 | 2.59 |
| 1909 | 0.66 | 11.14 | 6.85 | 3.71 | 4.22 | 4.78 |
| 1910 | 3.09 | 2.90 | 2.55 | 4.84 | 4.21 | 3.30 |
| 1911 | 1.15 | 4.11 | 3.61 | 5.88 | 6.36 | 5.71 |
| 1912 | 0.55 | 1.20 | 0.94 | 1.61 | 1.58 | 3.33 |
| 1913 | 0.77 | 1.60 | 1.01 | 1.32 | 2.81 | 3.31 |
| 1914 | 1.72 | 8.50 | 3.99 | 4.18 | 5.05 | 5.28 |
| 1915 | 0.76 | 1.86 | 5.43 | 3.54 | 4.43 | 6.38 |
| 1916 | 1.52 | 3.75 | 4.89 | 5.71 | 5.03 | 4.44 |
| 1917 | 1.28 | 1.01 | 3.13 | 2.15 | 4.29 | 4.37 |
| 1918 | 0.70 | 0.57 | 1.22 | 2.99 | 3.09 | 2.53 |
| 1919 | 0.68 | 1.20 | 3.13 | 2.74 | 3.89 | 4.06 |
| 1920 | 0.68 | 0.57 | 0.58 | 1.71 | 2.58 | 3.20 |
| 1921 | 2.90 | 4.34 | 3.15 | 4.22 | 3.30 | 4.01 |
| 1922 | 1.16 | 1.07 | 2.63 | 2.41 | 3.66 | 6.68 |
| 1923 | 2.03 | 1.75 | 1.20 | 1.51 | 3.38 | 3.66 |
| 1924 | 0.49 | 0.56 | 1.16 | 0.64 | 1.07 | 1.10 |
| 1925 | 0.92 | 0.94 | 4.99 | 2.18 | 3.82 | 3.70 |
| 1926 | 0.67 | 0.76 | 3.18 | 1.73 | 3.79 | 2.18 |
| 1927 | 2.01 | 2.22 | 6.05 | 3.53 | 4.82 | 4.28 |
| 1928 | 1.10 | 1.37 | 1.94 | 5.69 | 3.73 | 3.02 |
| 1929 | 0.64 | 0.61 | 1.12 | 1.29 | 1.63 | 2.49 |
| 1930 | 2.37 | 1.41 | 1.84 | 2.78 | 2.64 | 2.29 |
| 1931 | 0.39 | 0.80 | 0.78 | 1.20 | 1.23 | 1.18 |
| 1932 | 1.68 | 1.33 | 1.84 | 2.50 | 2.73 | 4.16 |
| 1933 | 0.42 | 0.70 | 0.58 | 1.89 | 1.97 | 2.36 |
| 1934 | 1.04 | 1.47 | 1.59 | 1.90 | 1.61 | 1.09 |
| 1935 | 0.79 | 1.87 | 1.56 | 2.13 | 6.18 | 4.74 |
| 1936 | 0.51 | 3.22 | 5.04 | 2.77 | 3.83 | 3.71 |
| 1937 | 0.45 | 0.54 | 2.36 | 3.28 | 3.77 | 4.92 |
| 1938 | 4.81 | 1.86 | 5.27 | 7.50 | 5.98 | 7.34 |
| 1939 | 0.80 | 0.79 | 0.81 | 1.91 | 2.26 | 1.47 |
| 1940 | 0.68 | 3.88 | 5.68 | 6.22 | 4.61 | 3.77 |
| 1941 | 3.41 | 4.28 | 5.07 | 4.72 | 4.62 | 5.75 |
| 1942 | 3.58 | 4.18 | 5.10 | 2.23 | 4.64 | 4.76 |
| 1943 | 1.83 | 4.67 | 2.84 | 5.33 | 4.23 | 3.59 |
| 1944 | 0.55 | 0.78 | 1.44 | 1.94 | 1.88 | 3.34 |
| 1945 | 1.50 | 1.07 | 4.13 | 2.17 | 2.82 | 3.82 |
| 1946 | 4.60 | 2.64 | 1.31 | 2.29 | 3.45 | 3.68 |
| 1947 | 1.06 | 0.64 | 1.57 | 2.51 | 2.20 | 2.05 |
| 1948 | 0.50 | 1.91 | 0.70 | 1.56 | 4.34 | 4.51 |
| 1949 | 0.66 | 0.53 | 0.92 | 3.32 | 3.27 | 3.39 |
| 1950 | 0.43 | 1.82 | 2.54 | 2.46 | 3.74 | 3.73 |
| 1951 | 5.95 | 3.40 | 3.52 | 2.66 | 2.81 | 3.15 |
| 1952 | 3.36 | 3.48 | 4.03 | 3.68 | 6.35 | 7.51 |
| 1953 | 1.92 | 5.40 | 1.52 | 2.06 | 3.25 | 3.38 |
| 1954 | 0.80 | 2.20 | 2.84 | 3.66 | 4.56 | 3.27 |
| 1955 | 1.35 | 1.16 | 0.96 | 1.27 | 1.97 | 3.22 |
| 1956 | 9.14 | 7.52 | 3.71 | 3.07 | 3.51 | 5.24 |
| 1957 | 0.61 | 0.79 | 2.65 | 3.41 | 2.36 | 3.85 |
| 1958 | 1.62 | 2.39 | 7.61 | 4.71 | 6.04 | 6.74 |
| 1959 | 0.58 | 2.25 | 2.50 | 1.98 | 2.27 | 1.82 |
| 1960 | 0.47 | 0.90 | 3.15 | 3.22 | 2.50 | 2.39 |
| 1961 | 1.36 | 0.86 | 2.14 | 1.93 | 2.02 | 2.16 |
| 1962 | 1.19 | 0.78 | 4.08 | 2.39 | 3.89 | 3.14 |
| 1963 | 1.90 | 1.70 | 4.66 | 2.10 | 5.60 | 4.99 |
| 1964 | 0.85 | 1.55 | 1.01 | 1.15 | 1.92 | 2.44 |
| 1965 | 8.66 | 5.61 | 2.26 | 1.97 | 4.74 | 3.81 |
| 1966 | 1.04 | 1.85 | 1.56 | 2.52 | 3.33 | 2.52 |
| 1967 | 2.98 | 3.34 | 2.52 | 4.09 | 3.82 | 6.26 |
| 1968 | 0.85 | 1.49 | 3.71 | 2.55 | 2.17 | 2.15 |
| 1969 | 1.77 | 7.91 | 4.73 | 3.36 | 5.44 | 7.34 |
| 1970 | 3.30 | 10.68 | 3.02 | 3.12 | 1.82 | 2.77 |
| 1971 | 3.26 | 3.05 | 1.83 | 3.73 | 3.40 | 4.18 |
| 1972 | 1.19 | 1.40 | 1.73 | 3.30 | 2.52 | 2.61 |
| 1973 | 1.83 | 4.08 | 3.66 | 3.27 | 3.08 | 4.76 |
| 1974 | 3.68 | 6.93 | 2.10 | 6.18 | 5.07 | 4.69 |
| 1975 | 0.86 | 1.01 | 2.92 | 4.65 | 2.89 | 5.40 |
| 1976 | 0.76 | 0.65 | 0.88 | 1.34 | 1.35 | 1.44 |
| 1977 | 0.38 | 0.47 | 0.48 | 0.54 | 0.69 | 0.91 |
| 1978 | 1.90 | 5.91 | 3.48 | 5.36 | 4.40 | 4.70 |
| 1979 | 0.53 | 1.44 | 2.10 | 2.90 | 2.67 | 4.50 |
| 1980 | 1.24 | 6.89 | 5.93 | 3.62 | 3.11 | 3.67 |
| 1981 | 0.92 | 1.57 | 1.76 | 2.48 | 2.32 | 2.11 |
| 1982 | 5.58 | 3.50 | 5.57 | 4.74 | 8.05 | 5.68 |
| 1983 | 3.69 | 4.25 | 6.46 | 10.57 | 4.87 | 6.96 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1984 | 6.72 | 2.85 | 2.29 | 3.08 | 2.50 | 3.60 |
| 1985 | 1.20 | 0.84 | 1.21 | 1.59 | 2.79 | 2.14 |
| 1986 | 1.25 | 2.62 | 11.55 | 7.09 | 3.19 | 3.56 |
| 1987 | 0.53 | 0.78 | 1.48 | 2.60 | 1.73 | 1.48 |
| 1988 | 1.70 | 1.84 | 1.01 | 1.26 | 1.48 | 1.59 |
| 1989 | 0.72 | 0.85 | 0.99 | 6.17 | 3.59 | 2.22 |
| 1990 | 0.45 | 1.27 | 0.88 | 1.84 | 1.80 | 1.77 |
| 1991 | 0.34 | 0.37 | 0.45 | 2.64 | 1.95 | 2.40 |
| 1992 | 0.47 | 0.58 | 2.41 | 1.99 | 2.17 | 1.33 |
| 1993 | 1.25 | 4.06 | 3.13 | 5.70 | 4.33 | 5.23 |
| 1994 | 0.78 | 0.78 | 1.23 | 1.49 | 1.57 | 1.79 |
| 1995 | 1.06 | 8.11 | 3.12 | 10.19 | 5.61 | 7.18 |
| 1996 | 1.72 | 2.47 | 6.25 | 4.25 | 3.97 | 5.50 |
| 1997 | 6.84 | 12.15 | 2.74 | 2.45 | 2.70 | 2.96 |
| 1998 | 1.18 | 5.19 | 7.44 | 5.11 | 4.53 | 5.53 |
| 1999 | 1.88 | 2.60 | 4.59 | 3.67 | 3.26 | 4.27 |
| 2000 | 0.65 | 2.55 | 5.49 | 4.08 | 3.55 | 3.62 |
| 2001 | 0.67 | 0.87 | 1.50 | 2.39 | 2.03 | 2.49 |
| 2002 | 2.50 | 2.70 | 1.74 | 2.31 | 2.82 | 2.60 |
| 2003 | 3.24 | 3.40 | 1.66 | 2.52 | 3.27 | 4.82 |
| 2004 | 2.14 | 1.90 | 3.98 | 3.47 | 2.64 | 2.29 |
| 2005 | 1.56 | 2.49 | 2.01 | 3.75 | 3.18 | 7.23 |
| 2006 | 5.83 | 5.16 | 3.42 | 5.38 | 8.56 | 6.84 |
| 2007 | 1.32 | 0.87 | 2.14 | 2.07 | 1.74 | 1.67 |
| 2008 | 0.70 | 1.70 | 1.81 | 1.79 | 1.89 | 2.68 |
| 2009 | 0.57 | 0.96 | 2.32 | 3.64 | 2.40 | 4.21 |
| 2010 | 0.71 | 2.48 | 2.31 | 2.31 | 3.25 | 3.70 |
| 2011 | 4.31 | 2.10 | 1.96 | 6.20 | 5.23 | 4.94 |
| 2012 | 0.49 | 0.96 | 0.74 | 3.03 | 3.70 | 2.27 |
| 2013 | 4.09 | 1.34 | 1.08 | 1.71 | 2.02 | 1.43 |
| 2014 | 0.38 | 0.36 | 1.22 | 2.05 | 1.71 | 1.18 |
| 2015 | 2.89 | 0.79 | 2.23 | 0.84 | 0.76 | 0.82 |
| 2016 | 1.26 | 3.67 | 2.10 | 6.50 | 2.92 | 2.53 |
| 2017 | 3.71 | 8.53 | 12.65 | 5.52 | 6.61 | 5.84 |
| 2018 | 0.73 | 1.47 | 0.81 | 3.85 | 4.23 | 2.13 |
| min | 0.34 | 0.36 | 0.45 | 0.54 | 0.69 | 0.82 |
| mean | 1.92 | 2.89 | 2.82 | 3.54 | 3.14 | 3.56 |
| max | 9.14 | 12.15 | 12.65 | 10.57 | 8.56 | 7.51 |

1966-2015 mean

Official Year Classifications based on May 1 Runoff Forecasts

| | Sacramento Valley Index | | San Joaquin Valley Index | |
|---|---|---|---|---|
| WY | Index | Yr-type | Index | Yr-type |
| 1995 | 12.4 | W | 5.5 | W |
| 1996 | 9.7 | W | 3.9 | W |
| 1997 | 11.0 | W | 4.2 | W |
| 1998 | 12.4 | W | 4.9 | W |
| 1999 | 10.0 | W | 3.4 | AN |
| 2000 | 9.2 | W | 3.3 | AN |
| 2001 | 5.9 | D | 2.3 | D |
| 2002 | 6.5 | D | 2.3 | D |
| 2003 | 8.0 | AN | 2.7 | BN |
| 2004 | 7.7 | BN | 2.2 | D |
| 2005 | 7.4 | BN | 4.2 | W |
| 2006 | 13.0 | W | 5.5 | W |
| 2007 | 6.2 | D | 1.9 | C |
| 2008 | 5.4 | C | 2.1 | C |
| 2009 | 5.5 | D | 2.4 | D |
| 2010 | 6.9 | BN | 3.5 | AN |
| 2011 | 10.0 | W | 5.1 | W |
| 2012 | 6.9 | BN | 2.2 | D |
| 2013 | 5.8 | D | 1.6 | C |
| 2014 | 4.0 | C | 1.1 | C |
| 2015 | 4.0 | C | 0.7 | C |
| 2016 | 7.1 | BN | 2.4 | D |
| 2017 | 14.9 | W | 6.2 | W |
| 2018 | 7.2 | BN | 3.0 | BN |

Abbreviations:

- WY — Water year (Oct 1 - Sep 30)
- W — Wet year type
- AN — Above normal year type
- BN — Below normal year type
- D — Dry year type
- C — Critical year type
- % exc. — Probability in % that a given value will be exceeded
- [maf] — Million acre-feet

Notes:

Unimpaired runoff represents the natural water production of a river basin, unaltered by upstream diversions, storage, export of water to or import of water from other basins.

Sacramento River Runoff is the sum (in maf) of Sacramento River at Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake. The WY sum is also known as the Sacramento River Index, and was previously referred to as the "4 River Index" or "4 Basin Index". It was previously used to determine year type classifications under State Water Resources Control Board (SWRCB) Decision 1485.

Sacramento Valley Water Year Index = 0.4 * Current Apr-Jul Runoff Forecast (in maf) + 0.3 * Current Oct-Mar Runoff in (maf) + 0.3 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 10.0, then 10.0 is used). This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the Sacramento Valley water year type as implemented in SWRCB D-1641. Year types are set by first of month forecasts beginning in February. Final determination is based on the May 1 50% exceedence forecast.

Sacramento Valley Water Year Hydrologic Classification:

| Year Type: | Water Year Index: |
|---|---|
| Wet | Equal to or greater than 9.2 |
| Above Normal | Greater than 7.8, and less than 9.2 |
| Below Normal | Greater than 6.5, and equal to or less than 7.8 |
| Dry | Greater than 5.4, and equal to or less than 6.5 |
| Critical | Equal to or less than 5.4 |

San Joaquin River Runoff is the sum of Stanislaus River inflow to New Melones Lake, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to Lake McClure, and San Joaquin River inflow to Millerton Lake (in maf).

San Joaquin Valley Water Year Index = 0.6 * Current Apr-Jul Runoff Forecast (in maf) + 0.2 * Current Oct-Mar Runoff in (maf) + 0.2 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 4.5, then 4.5 is used). This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the San Joaquin Valley water year type as implemented in SWRCB D-1641. Year types are set by first of month forecasts beginning in February. Final determination for San Joaquin River flow objectives is based

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   on the May 1 75% exceedence forecast.
San Joaquin Valley Water Year Hydrologic Classification:
    Year Type:      Water Year Index:
    Wet             Equal to or greater than 3.8
    Above Normal    Greater than 3.1, and less than 3.8
    Below Normal    Greater than 2.5, and equal to or less than 3.1
    Dry             Greater than 2.1, and equal to or less than 2.5
    Critical        Equal to or less than 2.1
Eight River Index = Sacramento River Runoff + San Joaquin River Runoff
   This Index is used from December through May to set flow objectives
   as implemented in SWRCB Decision 1641.

The 'reconstructed' table is based on observed runoff, and does NOT show the
   official year-types, which are based on May 1 forecasts of future runoff.
The current water year indices based on forecast runoff are posted at
   http://cdec.water.ca.gov/water_supply.html and published in DWR Bulletin 120
   (also available at http://cdec.water.ca.gov/snow/bulletin120)
These indices have been used operationally since 1995, and are defined in SWRCB
   Decision 1641
   (https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/decision_1641/)
This report is updated each fall once the data is available.

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Andy Reising               (916) 574-2181          andrew.reising@water.ca.gov
Ashok Bathulla             (916) 574-2634          ashok.bathulla@water.ca.gov
Steve Nemeth (Part-Time)                           stephen.nemeth@water.ca.gov


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# APPENDIX A-4

## TABLE A-4
## AWD HISTORICAL WATER DELIVERIES

**Table A-4**
**Angiola Water District**
**Historical Water Deliveries (Acre-Feet)**

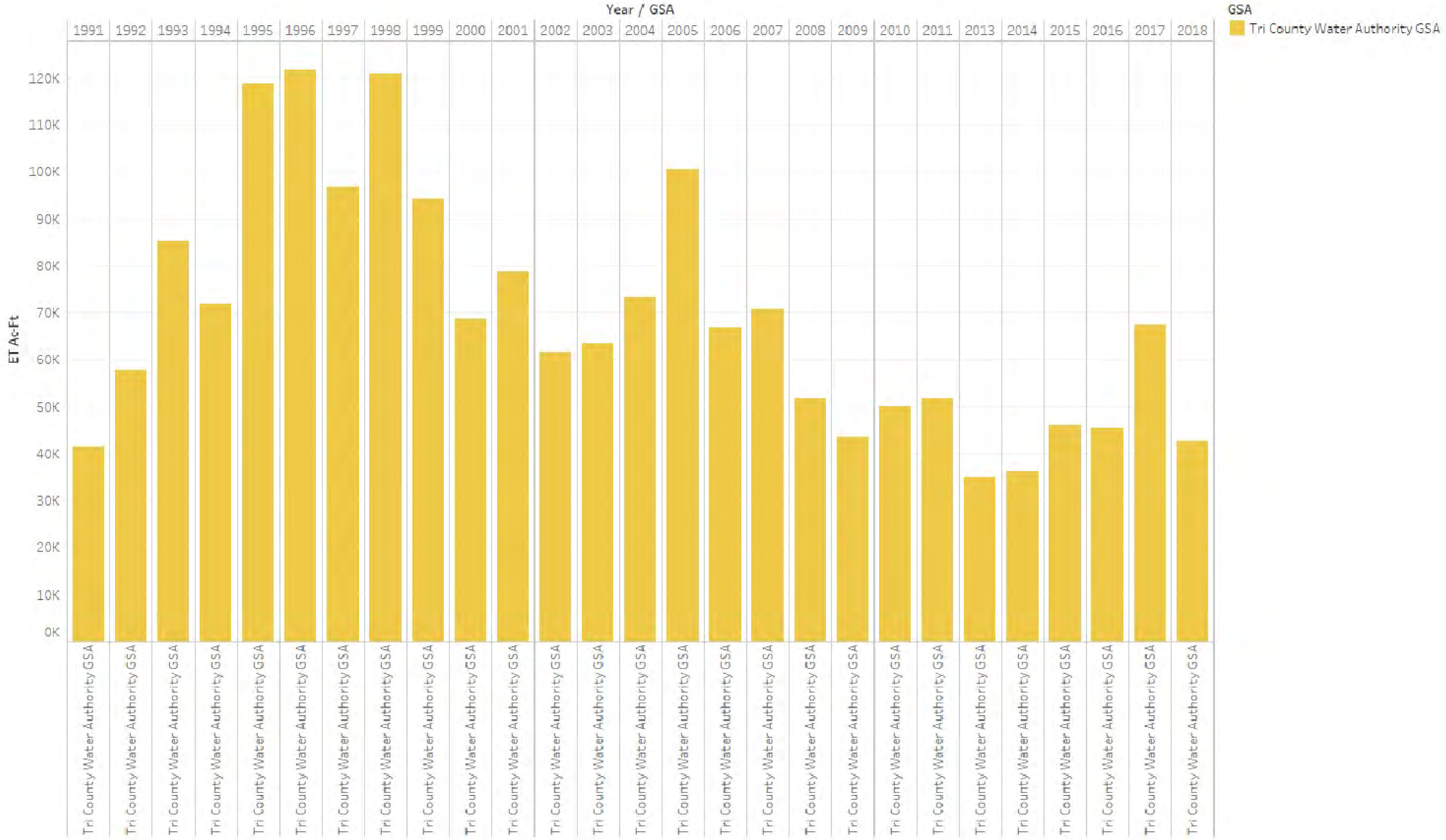
| Year | SWP Entitlement / CVP Water | Article 21 Turnback Water | Other Water | Kings River | Tule River | Pumped Groundwater | Purchased Local Water | Deer Creek | Flood Water | Total District Supply |
|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | 25,158 | 0 | 0 | 0 | 1,402 | 15,400 | 0 | 0 | 0 | 41,960 |
| 1975 | 35,237 | 0 | 0 | 2,642 | 224 | 5,500 | 0 | 0 | 0 | 43,603 |
| 1976 | 17,275 | 0 | 0 | 9,154 | 0 | 15,183 | 0 | 0 | 0 | 41,612 |
| 1977 | 3,098 | 0 | 0 | 950 | 0 | 26,400 | 0 | 0 | 0 | 30,448 |
| 1978 | 3,046 | 0 | 0 | 11,956 | 2,456 | 0 | 0 | 0 | 10,000 | 27,458 |
| 1979 | 20,836 | 0 | 0 | 6,575 | 185 | 15,400 | 0 | 0 | 0 | 42,996 |
| 1980 | 15,427 | 0 | 0 | 2,819 | 2,611 | 0 | 0 | 0 | 6,000 | 26,857 |
| 1981 | 24,551 | 0 | 0 | 8,963 | 223 | 20,359 | 0 | 0 | 0 | 54,096 |
| 1982 | 12,671 | 0 | 0 | 12,547 | 3,090 | 1,107 | 0 | 0 | 18,867 | 48,282 |
| 1983 | 0 | 0 | 0 | 0 | 340 | 0 | 0 | 0 | 40,500 | 40,840 |
| 1984 | 1,478 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 66,014 | 67,492 |
| 1985 | 28,689 | 0 | 0 | 1,586 | 826 | 12,400 | 0 | 0 | 0 | 43,501 |
| 1986 | 6,189 | 0 | 0 | 11,054 | 1,701 | 0 | 0 | 0 | 17,148 | 36,092 |
| 1987 | 17,154 | 0 | 0 | 9,366 | 0 | 10,000 | 0 | 0 | 0 | 36,520 |
| 1988 | 10,768 | 0 | 0 | 984 | 0 | 26,600 | 0 | 0 | 0 | 38,352 |
| 1989 | 22,462 | 0 | 1,580 | 0 | 150 | 15,240 | 0 | 0 | 0 | 39,432 |
| 1990 | 8,829 | 0 | 4,556 | 0 | 0 | 34,500 | 0 | 0 | 0 | 47,885 |
| 1991 | 80 | 0 | 0 | 1,604 | 604 | 23,396 | 0 | 0 | 0 | 25,684 |
| 1992 | 5,641 | 0 | 0 | 0 | 0 | 33,494 | 0 | 0 | 931 | 40,066 |
| 1993 | 2,755 | 0 | 2,575 | 6,919 | 1,155 | 5,956 | 0 | 0 | 335 | 19,695 |
| 1994 | 4,829 | 2,867 | 0 | 6,098 | 0 | 16,389 | 0 | 0 | 0 | 30,183 |
| 1995 | 14,789 | 2,897 | 0 | 4,902 | 6,040 | 0 | 0 | 0 | 7,615 | 36,243 |
| 1996 | 14,902 | 23,741 | 0 | 2,219 | 1,913 | 0 | 0 | 0 | 6,158 | 48,933 |
| 1997 | 9,243 | 251 | 0 | 4,729 | 1,701 | 0 | 0 | 0 | 30,733 | 46,657 |
| 1998 | 5,156 | 71 | 0 | 50 | 2,083 | 0 | 0 | 0 | 18,632 | 25,992 |
| 1999 | 465 | 37,943 | 0 | 167 | 274 | 0 | 0 | 0 | 0 | 38,849 |
| 2000 | 19,194 | 6,545 | 0 | 0 | 1,166 | 6,784 | 0 | 0 | 2,903 | 36,592 |
| 2001 | 5,012 | 1,539 | 3,000 | 3,044 | 0 | 23,244 | 0 | 0 | 0 | 35,839 |
| 2002 | 9,774 | 836 | 190 | 0 | 124 | 26,537 | 0 | 0 | 0 | 37,461 |
| 2003 | 10,496 | 672 | 160 | 6,652 | 790 | 22,429 | 0 | 0 | 0 | 41,199 |
| 2004 | 1,293 | 494 | 5,293 | 0 | 559 | 26,805 | 4,657 | 0 | 0 | 39,101 |
| 2005 | 564 | 12,483 | 1,235 | 10,632 | 1,680 | 662 | 15,954 | 0 | 5,890 | 49,100 |
| 2006 | 614 | 10,675 | 0 | 14,253 | 795 | 141 | 6,134 | 0 | 7,973 | 40,585 |
| 2007 | 243 | 4,881 | 63 | 18,083 | 0 | 32,894 | 0 | 0 | 0 | 56,164 |
| 2008 | 761 | 1 | 0 | 4,756 | 828 | 32,502 | 0 | 0 | 0 | 38,848 |
| 2009 | 34 | 1 | 0 | 0 | 0 | 37,798 | 0 | 0 | 0 | 37,833 |
| 2010 | 12 | 1 | 282 | 10,587 | 1,676 | 22,568 | 0 | 0 | 0 | 35,126 |
| 2011 | 1,835 | 0 | 434 | 14,383 | 1,170 | 3,615 | | 1,516 | 11,011 | 33,964 |
| 2012 | 1,413 | 0 | 1,760 | 4,326 | 271 | 33,097 | 0 | 0 | 0 | 40,867 |
| 2013 | 1,080 | 0 | 4,912 | 0 | 0 | 30,603 | 0 | 0 | 0 | 36,595 |
| 2014 | 0 | 0 | 3,174 | 0 | 0 | 27,783 | 0 | 0 | 0 | 30,957 |
| 2015 | 0 | 0 | 2,439 | 0 | 0 | 30,220 | 0 | 0 | 0 | 32,659 |
| 2016 | 0 | 0 | 1,710 | 0 | 252 | 29,036 | 0 | 0 | 0 | 30,998 |
| 2017 | 3,849 | 0 | 0 | 13,182 | 6,908 | 2,750 | 0 | 0 | 23,457 | 50,146 |
| 2018 | 1,300 | 0 | 6,921 | 6,596 | 714 | 18,193 | 0 | 0 | 0 | 33,724 |
| Average | 8,182 | 2,353 | 895 | 4,706 | 976 | 15,222 | 608 | 34 | 6,093 | 39,069 |

# APPENDIX A-5

## CAL POLY ITRC ET DATA

# Tri County Water Authority GSA - ETc/Year

Sheet 3



## Zone 15 - Drip/Micro Irrigation - Dry Year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Drip/Micro Irrigation Dry Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1999 (Dry Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 2.35 | 1.06 | 1.85 | 0.57 | 0.05 | 0 | 0.01 | Precipitation | 0 | 0.03 | 0 | 0.33 | 0.11 | 6.35 |
| Grass Reference ETo | 0.9 | 1.77 | 3.4 | 5.27 | 7.74 | 8.1 | 8.47 | Grass Reference ETo | 7.34 | 5.84 | 4.09 | 1.82 | 1.53 | 56.27 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.61 | 1.25 | 2.03 | 3.16 | 6.42 | 6.76 | 7.24 | Apple, Pear, Cherry, Plum and Prune | 6.16 | 4.61 | 1.98 | 0.25 | 0.14 | 40.63 |
| Apples, Plums, Cherries etc w/covercrop | 0.76 | 1.74 | 3.62 | 4.7 | 7.78 | 8.46 | 8.96 | Apples, Plums, Cherries etc w/covercrop | 7.79 | 5.78 | 3.03 | 1.22 | 0.88 | 54.72 |
| Peach, Nectarine and Apricots | 0.61 | 1.25 | 1.88 | 2.45 | 5.55 | 6.59 | 6.64 | Peach, Nectarine and Apricots | 5.96 | 4.37 | 1.82 | 0.25 | 0.14 | 37.52 |
| Immature Peaches, Nectarines, etc | 0.62 | 1.26 | 1.72 | 1.56 | 3.52 | 4.08 | 4.26 | Immature Peaches, Nectarines, etc | 3.64 | 2.68 | 1.14 | 0.25 | 0.14 | 24.86 |
| Almonds | 0.61 | 1.4 | 2.31 | 3.85 | 6.4 | 6.6 | 6.89 | Almonds | 5.96 | 4.41 | 1.93 | 0.25 | 0.14 | 40.76 |
| Almonds w/covercrop | 0.78 | 1.8 | 3.25 | 5.06 | 7.36 | 7.63 | 8.03 | Almonds w/covercrop | 6.91 | 4.91 | 2.45 | 0.85 | 0.6 | 49.66 |
| Immature Almonds | 0.62 | 1.34 | 2.01 | 2.71 | 4 | 4.1 | 4.34 | Immature Almonds | 3.73 | 2.64 | 1.02 | 0.25 | 0.14 | 26.9 |
| Walnuts | 0.61 | 1.25 | 2.12 | 2.59 | 6.17 | 7.72 | 8.21 | Walnuts | 7.12 | 4.86 | 2.13 | 0.28 | 0.14 | 43.19 |
| Pistachio | 0.61 | 1.25 | 1.55 | 1.52 | 2.37 | 5.48 | 7.83 | Pistachio | 7.01 | 5.15 | 2.4 | 0.28 | 0.14 | 35.6 |
| Pistachio w/ covercrop | 0.83 | 1.79 | 2.94 | 3.61 | 4.67 | 6.68 | 8.35 | Pistachio w/ covercrop | 7.28 | 5.65 | 3.12 | 1.23 | 0.9 | 47.06 |
| Immature Pistachio | 0.62 | 1.26 | 1.55 | 1.01 | 1.44 | 3.55 | 5.16 | Immature Pistachio | 4.55 | 3.33 | 1.42 | 0.31 | 0.14 | 24.34 |
| Misc. Deciduous | 0.61 | 1.25 | 2.09 | 3.16 | 6.11 | 6.47 | 6.71 | Misc. Deciduous | 5.84 | 4.36 | 2.07 | 0.25 | 0.14 | 39.06 |
| Cotton | 0.64 | 1.28 | 1.54 | 1.26 | 1.16 | 4.37 | 8.46 | Cotton | 7.63 | 5.5 | 1.5 | 0.25 | 0.14 | 33.72 |
| Beans | 0.64 | 1.28 | 2.46 | 1.53 | 2.52 | 7.24 | 7.65 | Beans | 2.67 | 0.03 | 0 | 0.25 | 0.14 | 26.4 |
| Misc. field crops | 0.64 | 1.28 | 2.46 | 1.53 | 2.52 | 7.24 | 7.65 | Misc. field crops | 2.67 | 0.03 | 0 | 0.25 | 0.14 | 26.4 |
| Small Vegetables | 0.83 | 1.59 | 3.11 | 4.97 | 0.84 | 0 | 0.01 | Small Vegetables | 0.95 | 1.2 | 0.71 | 1.19 | 1.34 | 16.76 |
| Tomatoes and Peppers | 0.64 | 1.28 | 2.03 | 1.13 | 3.75 | 8.05 | 7.17 | Tomatoes and Peppers | 0.64 | 0.03 | 0 | 0.25 | 0.14 | 25.1 |
| Potatoes, Sugar beets, Turnip etc.. | 0.92 | 1.46 | 2.5 | 5.06 | 7.78 | 8.14 | 7.17 | Potatoes, Sugar beets, Turnip etc.. | 0.07 | 0.03 | 0 | 0.25 | 0.14 | 33.52 |
| Melons, Squash, and Cucumbers | 0.64 | 1.28 | 1.54 | 0.59 | 0.77 | 0.8 | 4 | Melons, Squash, and Cucumbers | 4.83 | 1.52 | 0 | 0.25 | 0.14 | 16.36 |
| Onions and Garlic | 0.72 | 1.79 | 3.17 | 4.24 | 4.46 | 0.73 | 0.01 | Onions and Garlic | 0 | 0.03 | 0 | 0.94 | 0.36 | 16.46 |
| Strawberries | 0.64 | 1.28 | 2.46 | 1.53 | 2.52 | 7.24 | 7.65 | Strawberries | 2.67 | 0.03 | 0 | 0.25 | 0.14 | 26.4 |
| Flowers, Nursery and Christmas Tree | 0.61 | 1.25 | 2.09 | 3.16 | 6.11 | 6.47 | 6.71 | Flowers, Nursery and Christmas Tree | 5.84 | 4.36 | 2.07 | 0.25 | 0.14 | 39.06 |
| Citrus (no ground cover) | 0.91 | 1.85 | 3.34 | 4.05 | 4.73 | 5.03 | 5.28 | Citrus (no ground cover) | 4.57 | 3.57 | 2.6 | 1.28 | 1.13 | 38.34 |
| Immature Citrus | 0.76 | 1.6 | 2.53 | 2.51 | 3.04 | 3.09 | 3.34 | Immature Citrus | 2.83 | 2.19 | 1.55 | 0.86 | 0.58 | 24.89 |
| Avocado | 0.61 | 1.25 | 2.09 | 3.16 | 6.11 | 6.47 | 6.71 | Avocado | 5.84 | 4.36 | 2.07 | 0.25 | 0.14 | 39.06 |
| Misc Subtropical | 0.61 | 1.25 | 2.09 | 3.16 | 6.11 | 6.47 | 6.71 | Misc Subtropical | 5.84 | 4.36 | 2.07 | 0.25 | 0.14 | 39.06 |
| Grape Vines with 80% canopy | 0.62 | 1.26 | 1.8 | 1.66 | 3.83 | 5.74 | 5.94 | Grape Vines with 80% canopy | 4.52 | 2.52 | 0 | 0.25 | 0.14 | 28.3 |
| Grape Vines with cover crop (80% canopy) | 0.73 | 1.66 | 2.87 | 3.29 | 5.09 | 6.5 | 6.6 | Grape Vines with cover crop (80% canopy) | 5.25 | 3.32 | 1.7 | 0.83 | 0.59 | 38.44 |
| Immature Grapes Vines with 50% canopy | 0.63 | 1.26 | 1.72 | 1.27 | 2.63 | 3.65 | 3.79 | Immature Grapes Vines with 50% canopy | 2.8 | 1.59 | 0 | 0.25 | 0.14 | 19.73 |

**Zone 15 - Drip/Micro Irrigation - Typical Year**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Drip/Micro Irrigation Typical Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1997 (Typical Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 3.46 | 0.39 | 0.07 | 0.59 | 0.01 | 0.33 | 0.01 | Precipitation | 0 | 0.02 | 0.33 | 1.91 | 1.28 | 8.4 |
| Grass Reference ETo | 0.95 | 2.3 | 4.38 | 6.3 | 8.18 | 8.18 | 8.35 | Grass Reference ETo | 7.33 | 5.72 | 4.04 | 1.58 | 1.09 | 58.41 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.96 | 0.87 | 0.79 | 3.4 | 6.75 | 6.96 | 7.08 | Apple, Pear, Cherry, Plum and Prune | 6.21 | 4.52 | 2.08 | 0.75 | 1.01 | 41.39 |
| Apples, Plums, Cherries etc w/covercrop | 0.95 | 2.33 | 3.35 | 5.02 | 8.19 | 8.59 | 8.72 | Apples, Plums, Cherries etc w/covercrop | 7.7 | 5.52 | 3.44 | 1.15 | 1.1 | 56.06 |
| Peach, Nectarine and Apricots | 0.96 | 0.87 | 0.6 | 2.59 | 5.78 | 6.82 | 6.59 | Peach, Nectarine and Apricots | 5.93 | 4.26 | 2.1 | 0.75 | 1.01 | 38.26 |
| Immature Peaches, Nectarines, etc | 0.98 | 0.87 | 0.35 | 1.67 | 3.64 | 4.38 | 4.19 | Immature Peaches, Nectarines, etc | 3.7 | 2.57 | 1.39 | 0.76 | 1.02 | 25.54 |
| Almonds | 0.96 | 1.06 | 1.19 | 4.15 | 6.62 | 6.97 | 6.79 | Almonds | 5.98 | 4.24 | 2.07 | 0.75 | 1.01 | 41.8 |
| Almonds w/covercrop | 0.95 | 2.14 | 2.81 | 5.44 | 7.73 | 7.76 | 7.87 | Almonds w/covercrop | 6.97 | 4.89 | 2.63 | 1.05 | 1.09 | 51.35 |
| Immature Almonds | 0.98 | 0.99 | 0.75 | 2.98 | 4.15 | 4.51 | 4.21 | Immature Almonds | 3.69 | 2.61 | 1.29 | 0.77 | 1.02 | 27.95 |
| Pistachio w/ covercrop | 0.96 | 2.11 | 2.09 | 3.91 | 4.86 | 7.13 | 8.22 | Pistachio w/ covercrop | 7.25 | 5.56 | 3.23 | 1.28 | 1.12 | 47.7 |
| Immature Pistachio | 0.98 | 0.87 | 0.11 | 1.06 | 1.42 | 3.98 | 5.07 | Immature Pistachio | 4.46 | 3.28 | 1.6 | 0.78 | 1.02 | 24.64 |
| Misc. Deciduous | 0.96 | 0.87 | 0.78 | 3.32 | 6.46 | 6.62 | 6.79 | Misc. Deciduous | 5.8 | 4.25 | 2.24 | 0.75 | 1.01 | 39.85 |
| Cotton | 1.02 | 0.85 | 0.11 | 1.28 | 1.18 | 4.61 | 8.36 | Cotton | 7.61 | 5.34 | 1.54 | 0.79 | 1.05 | 33.76 |
| Misc. field crops | 1.02 | 0.85 | 1.1 | 1.7 | 2.54 | 7.42 | 7.53 | Misc. field crops | 2.72 | 0.02 | 0.31 | 0.79 | 1.05 | 27.04 |
| Small Vegetables | 1.03 | 1.44 | 3.55 | 5.92 | 0.94 | 0.36 | 0.01 | Small Vegetables | 1.02 | 1.16 | 1.01 | 1.18 | 1.16 | 18.78 |
| Tomatoes and Peppers | 1.02 | 0.85 | 0.81 | 1.15 | 3.88 | 8.14 | 7.13 | Tomatoes and Peppers | 0.73 | 0.02 | 0.31 | 0.79 | 1.05 | 25.87 |
| Potatoes, Sugar beets, Turnip etc.. | 1.02 | 1.16 | 2.09 | 6 | 8.24 | 8.25 | 6.93 | Potatoes, Sugar beets, Turnip etc.. | 0.08 | 0.02 | 0.31 | 0.79 | 1.05 | 35.93 |
| Melons, Squash, and Cucumbers | 1.02 | 0.85 | 0.11 | 0.56 | 0.73 | 1.15 | 3.96 | Melons, Squash, and Cucumbers | 4.86 | 1.45 | 0.31 | 0.79 | 1.05 | 16.84 |
| Onions and Garlic | 1.03 | 2.03 | 3.5 | 5.13 | 5.04 | 1.1 | 0.01 | Onions and Garlic | 0 | 0.01 | 0.31 | 1.42 | 1.1 | 20.68 |
| Strawberries | 1.02 | 0.85 | 1.1 | 1.7 | 2.54 | 7.42 | 7.53 | Strawberries | 2.72 | 0.02 | 0.31 | 0.79 | 1.05 | 27.04 |
| Flowers, Nursery and Christmas Tree | 0.96 | 0.87 | 0.78 | 3.32 | 6.46 | 6.62 | 6.79 | Flowers, Nursery and Christmas Tree | 5.8 | 4.25 | 2.24 | 0.75 | 1.01 | 39.85 |
| Citrus (no ground cover) | 0.97 | 2.22 | 2.86 | 4.33 | 5.1 | 5.29 | 5.16 | Citrus (no ground cover) | 4.54 | 3.56 | 2.67 | 1.38 | 1.13 | 39.19 |
| Immature Citrus | 0.98 | 1.52 | 1.6 | 2.75 | 3.1 | 3.44 | 3.25 | Immature Citrus | 2.79 | 2.2 | 1.78 | 1.05 | 1.11 | 25.58 |
| Misc Subtropical | 0.96 | 0.87 | 0.78 | 3.32 | 6.46 | 6.62 | 6.79 | Misc Subtropical | 5.8 | 4.25 | 2.24 | 0.75 | 1.01 | 39.85 |
| Grape Vines with 80% canopy | 0.98 | 0.87 | 0.48 | 1.77 | 3.97 | 5.95 | 5.82 | Grape Vines with 80% canopy | 4.62 | 2.42 | 0.34 | 0.76 | 1.02 | 28.98 |
| Grape Vines with cover crop (80% canopy) | 0.97 | 1.9 | 2.19 | 3.38 | 5.51 | 6.57 | 6.55 | Grape Vines with cover crop (80% canopy) | 5.34 | 3.22 | 1.94 | 1.01 | 1.11 | 39.68 |
| Immature Grapes Vines with 50% canopy | 0.99 | 0.86 | 0.35 | 1.35 | 2.73 | 3.86 | 3.77 | Immature Grapes Vines with 50% canopy | 2.88 | 1.49 | 0.3 | 0.77 | 1.03 | 20.4 |

## Zone 15 - Drip/Micro Irrigation - Wet Year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Drip/Micro Irrigation Wet Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1998 (Wet Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 1.65 | 7.3 | 2.74 | 1.11 | 1.59 | 0.35 | 0.02 | Precipitation | 0 | 0.15 | 0.76 | 0.88 | 0.7 | 17.25 |
| Grass Reference ETo | 0.93 | 1.37 | 3.13 | 4.73 | 5.39 | 7.11 | 8.52 | Grass Reference ETo | 7.69 | 5.3 | 3.61 | 1.6 | 1.2 | 50.58 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.86 | 1.42 | 2.08 | 4.01 | 4.96 | 6.19 | 7.3 | Apple, Pear, Cherry, Plum and Prune | 6.44 | 4.2 | 2.46 | 0.73 | 0.78 | 41.44 |
| Apples, Plums, Cherries etc w/covercrop | 0.92 | 1.43 | 3.29 | 4.82 | 5.37 | 7.73 | 8.84 | Apples, Plums, Cherries etc w/covercrop | 8.07 | 5.24 | 3.05 | 1.4 | 1.03 | 51.18 |
| Peach, Nectarine and Apricots | 0.86 | 1.42 | 1.96 | 3.33 | 4.91 | 5.96 | 6.74 | Peach, Nectarine and Apricots | 6.21 | 4.06 | 2.2 | 0.73 | 0.78 | 39.15 |
| Immature Peaches, Nectarines, etc | 0.88 | 1.43 | 1.86 | 2.49 | 3.66 | 3.76 | 4.37 | Immature Peaches, Nectarines, etc | 3.78 | 2.58 | 1.49 | 0.73 | 0.78 | 27.81 |
| Almonds | 0.86 | 1.42 | 2.26 | 4.48 | 5 | 5.98 | 6.92 | Almonds | 6.23 | 4.17 | 2.3 | 0.73 | 0.78 | 41.14 |
| Almonds w/covercrop | 0.9 | 1.43 | 3.21 | 4.9 | 5.31 | 7.07 | 8 | Almonds w/covercrop | 7.24 | 4.53 | 2.73 | 1.42 | 1.09 | 47.85 |
| Immature Almonds | 0.88 | 1.44 | 2.07 | 3.25 | 3.84 | 3.87 | 4.41 | Immature Almonds | 3.87 | 2.44 | 1.53 | 0.73 | 0.78 | 29.11 |
| Walnuts | 0.85 | 1.41 | 2.19 | 3.39 | 5.18 | 7.06 | 8.32 | Walnuts | 7.31 | 4.31 | 2.45 | 0.88 | 0.78 | 44.13 |
| Pistachio | 0.86 | 1.42 | 1.75 | 2.4 | 3.19 | 5.09 | 8.1 | Pistachio | 7.24 | 4.71 | 2.32 | 0.87 | 0.78 | 38.73 |
| Pistachio w/ covercrop | 0.92 | 1.43 | 3.17 | 3.94 | 4.48 | 6.19 | 8.56 | Pistachio w/ covercrop | 7.66 | 5.08 | 3.15 | 1.57 | 1.17 | 47.32 |
| Immature Pistachio | 0.88 | 1.43 | 1.76 | 1.99 | 2.4 | 3.35 | 5.21 | Immature Pistachio | 4.78 | 3.08 | 1.74 | 0.79 | 0.79 | 28.2 |
| Misc. Deciduous | 0.86 | 1.42 | 2.08 | 3.92 | 4.83 | 6 | 6.86 | Misc. Deciduous | 6.11 | 4.11 | 2.32 | 0.73 | 0.78 | 40.02 |
| Cotton | 0.92 | 1.47 | 1.76 | 1.62 | 2.23 | 4.14 | 8.56 | Cotton | 7.98 | 5.07 | 2.04 | 0.73 | 0.79 | 37.31 |
| Misc. field crops | 0.92 | 1.47 | 2.22 | 2.38 | 3.22 | 6.42 | 7.74 | Misc. field crops | 2.72 | 0.14 | 0.55 | 0.73 | 0.79 | 29.31 |
| Small Vegetables | 0.99 | 1.49 | 3.03 | 4.64 | 2 | 0.33 | 0.02 | Small Vegetables | 1.03 | 1.23 | 1.07 | 1.34 | 1.21 | 18.37 |
| Tomatoes and Peppers | 0.92 | 1.47 | 2.22 | 2.09 | 3.82 | 7.02 | 7.04 | Tomatoes and Peppers | 0.62 | 0.14 | 0.55 | 0.73 | 0.79 | 27.4 |
| Potatoes, Sugar beets, Turnip etc.. | 0.95 | 1.48 | 2.57 | 4.89 | 5.51 | 7.18 | 7.11 | Potatoes, Sugar beets, Turnip etc.. | 0.07 | 0.14 | 0.55 | 0.73 | 0.79 | 31.98 |
| Melons, Squash, and Cucumbers | 0.92 | 1.47 | 1.76 | 1.58 | 1.7 | 1.05 | 4.09 | Melons, Squash, and Cucumbers | 5.09 | 1.6 | 0.55 | 0.73 | 0.79 | 21.33 |
| Onions and Garlic | 0.95 | 1.49 | 3.09 | 4.14 | 3.9 | 1.08 | 0.02 | Onions and Garlic | 0 | 0.14 | 0.55 | 1.27 | 0.95 | 17.57 |
| Strawberries | 0.92 | 1.47 | 2.22 | 2.38 | 3.22 | 6.42 | 7.74 | Strawberries | 2.72 | 0.14 | 0.55 | 0.73 | 0.79 | 29.31 |
| Flowers, Nursery and Christmas Tree | 0.86 | 1.42 | 2.08 | 3.92 | 4.83 | 6 | 6.86 | Flowers, Nursery and Christmas Tree | 6.11 | 4.11 | 2.32 | 0.73 | 0.78 | 40.02 |
| Citrus (no ground cover) | 0.93 | 1.43 | 3.22 | 4.2 | 4.59 | 4.61 | 5.33 | Citrus (no ground cover) | 4.77 | 3.42 | 2.5 | 1.56 | 1.21 | 37.77 |
| Immature Citrus | 0.92 | 1.44 | 2.53 | 3.1 | 3.39 | 3.12 | 3.24 | Immature Citrus | 2.89 | 2.16 | 1.84 | 1.23 | 1.1 | 26.97 |
| Misc Subtropical | 0.86 | 1.42 | 2.08 | 3.92 | 4.83 | 6 | 6.86 | Misc Subtropical | 6.11 | 4.11 | 2.32 | 0.73 | 0.78 | 40.02 |
| Grape Vines with 80% canopy | 0.88 | 1.43 | 1.91 | 2.59 | 4.1 | 5.06 | 6.05 | Grape Vines with 80% canopy | 4.64 | 2.52 | 0.55 | 0.73 | 0.78 | 31.24 |
| Grape Vines with cover crop (80% canopy) | 0.93 | 1.44 | 2.98 | 3.82 | 4.57 | 5.81 | 6.83 | Grape Vines with cover crop (80% canopy) | 5.53 | 3.12 | 1.78 | 1.25 | 1.05 | 39.11 |
| Immature Grapes Vines with 50% canopy | 0.89 | 1.44 | 1.86 | 2.22 | 3.04 | 3.42 | 3.85 | Immature Grapes Vines with 50% canopy | 2.95 | 1.53 | 0.55 | 0.73 | 0.79 | 23.27 |

## Zone 15 - Sprinkler Irrigation - Dry Year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Sprinkler Irrigation Dry Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1999 (Dry Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 2.35 | 1.06 | 1.85 | 0.57 | 0.05 | 0 | 0.01 | Precipitation | 0 | 0.03 | 0 | 0.33 | 0.11 | 6.35 |
| Grass Reference ETo | 0.9 | 1.77 | 3.4 | 5.27 | 7.74 | 8.1 | 8.47 | Grass Reference ETo | 7.34 | 5.84 | 4.09 | 1.82 | 1.53 | 56.27 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.61 | 1.25 | 2.03 | 3.34 | 6.4 | 6.75 | 7.2 | Apple, Pear, Cherry, Plum and Prune | 6.25 | 4.73 | 2.2 | 0.25 | 0.14 | 41.16 |
| Apples, Plums, Cherries etc w/covercrop | 0.71 | 1.72 | 3.69 | 4.87 | 7.68 | 8.28 | 8.72 | Apples, Plums, Cherries etc w/covercrop | 7.69 | 5.69 | 3.17 | 1.11 | 0.79 | 54.1 |
| Peach, Nectarine and Apricots | 0.61 | 1.25 | 1.88 | 2.48 | 5.98 | 6.95 | 7.23 | Peach, Nectarine and Apricots | 6.34 | 4.84 | 2.03 | 0.25 | 0.14 | 39.98 |
| Immature Peaches, Nectarines, etc | 0.62 | 1.26 | 1.72 | 1.59 | 3.97 | 4.98 | 5.02 | Immature Peaches, Nectarines, etc | 4.39 | 3.14 | 1.44 | 0.25 | 0.14 | 28.53 |
| Almonds | 0.61 | 1.45 | 2.33 | 3.68 | 6.12 | 6.03 | 6.32 | Almonds | 6.08 | 4.06 | 2.12 | 0.25 | 0.14 | 39.18 |
| Almonds w/covercrop | 0.82 | 1.82 | 3.1 | 4.84 | 6.83 | 7.22 | 7.78 | Almonds w/covercrop | 6.56 | 4.51 | 2.74 | 1.07 | 0.79 | 48.08 |
| Immature Almonds | 0.62 | 1.34 | 2.01 | 3.17 | 5.21 | 5.49 | 5.74 | Immature Almonds | 4.92 | 3.54 | 1.48 | 0.25 | 0.14 | 33.92 |
| Walnuts | 0.61 | 1.25 | 2.13 | 2.62 | 6.74 | 8.28 | 8.78 | Walnuts | 7.61 | 5.28 | 2.49 | 0.37 | 0.14 | 46.3 |
| Pistachio | 0.61 | 1.25 | 1.55 | 1.62 | 2.53 | 5.89 | 8.23 | Pistachio | 7.14 | 5.46 | 2.68 | 0.3 | 0.14 | 37.4 |
| Pistachio w/ covercrop | 0.86 | 1.82 | 3.03 | 3.93 | 5.39 | 7.59 | 8.96 | Pistachio w/ covercrop | 7.8 | 6.17 | 3.65 | 1.34 | 0.88 | 51.41 |
| Immature Pistachio | 0.62 | 1.26 | 1.55 | 1.02 | 1.42 | 4.31 | 5.9 | Immature Pistachio | 5.23 | 3.92 | 1.71 | 0.48 | 0.14 | 27.57 |
| Misc. Deciduous | 0.61 | 1.25 | 2.23 | 3.19 | 6.12 | 6.44 | 6.87 | Misc. Deciduous | 5.92 | 4.53 | 2.07 | 0.25 | 0.14 | 39.63 |
| Grain and Grain Hay | 0.72 | 1.86 | 3.55 | 5.29 | 3.66 | 0.01 | 0.01 | Grain and Grain Hay | 0 | 0.03 | 0 | 0.78 | 0.37 | 16.29 |
| Cotton | 0.64 | 1.28 | 1.55 | 1.26 | 2.11 | 4.6 | 8.31 | Cotton | 7.44 | 5.36 | 1.31 | 0.25 | 0.14 | 34.24 |
| Corn and Grain Sorghum | 0.64 | 1.28 | 2.46 | 1.48 | 2.57 | 6.89 | 8.27 | Corn and Grain Sorghum | 5.01 | 0.35 | 0 | 0.25 | 0.14 | 29.35 |
| Misc. field crops | 0.64 | 1.28 | 2.46 | 1.48 | 2.54 | 7.23 | 7.67 | Misc. field crops | 2.52 | 0.03 | 0 | 0.25 | 0.14 | 26.24 |
| Alfalfa Hay and Clover | 0.94 | 1.85 | 3.56 | 5.2 | 6.53 | 6.85 | 7.04 | Alfalfa Hay and Clover | 6.23 | 4.79 | 1.65 | 1.43 | 1.45 | 47.51 |
| Pasture and Misc. Grasses | 0.64 | 1.8 | 2.88 | 4.38 | 7.09 | 7.5 | 7.79 | Pasture and Misc. Grasses | 6.85 | 5.34 | 3.01 | 0.69 | 0.14 | 48.1 |
| Small Vegetables | 0.95 | 1.59 | 3.09 | 5.22 | 2.34 | 0 | 0.01 | Small Vegetables | 0.95 | 1.5 | 1.44 | 1.39 | 1.43 | 19.9 |
| Tomatoes and Peppers | 0.64 | 1.28 | 2.03 | 1.16 | 4.06 | 8.02 | 6.84 | Tomatoes and Peppers | 0.41 | 0.03 | 0 | 0.25 | 0.14 | 24.86 |
| Potatoes, Sugar beets, Turnip etc.. | 0.92 | 1.46 | 2.57 | 5.31 | 8.04 | 8.32 | 7.42 | Potatoes, Sugar beets, Turnip etc.. | 0.07 | 0.03 | 0 | 0.25 | 0.14 | 34.52 |
| Melons, Squash, and Cucumbers | 0.64 | 1.28 | 1.55 | 0.59 | 0.76 | 1.97 | 5.28 | Melons, Squash, and Cucumbers | 5.7 | 1.58 | 0 | 0.25 | 0.14 | 19.74 |
| Onions and Garlic | 0.72 | 1.79 | 3.23 | 4.42 | 4.72 | 0.73 | 0.01 | Onions and Garlic | 0 | 0.03 | 0 | 0.94 | 0.35 | 16.95 |
| Strawberries | 0.64 | 1.28 | 2.46 | 1.48 | 2.54 | 7.23 | 7.67 | Strawberries | 2.52 | 0.03 | 0 | 0.25 | 0.14 | 26.24 |
| Flowers, Nursery and Christmas Tree | 0.61 | 1.25 | 2.23 | 3.19 | 6.12 | 6.44 | 6.87 | Flowers, Nursery and Christmas Tree | 5.92 | 4.53 | 2.07 | 0.25 | 0.14 | 39.63 |
| Citrus (no ground cover) | 0.91 | 1.85 | 3.35 | 4.51 | 5.5 | 5.78 | 5.84 | Citrus (no ground cover) | 5.33 | 4.12 | 2.88 | 1.46 | 1.28 | 42.82 |
| Immature Citrus | 0.79 | 1.6 | 2.5 | 2.92 | 3.51 | 3.89 | 3.81 | Immature Citrus | 3.43 | 2.77 | 1.93 | 1.07 | 0.64 | 28.87 |
| Misc Subtropical | 0.61 | 1.25 | 2.23 | 3.19 | 6.12 | 6.44 | 6.87 | Misc Subtropical | 5.92 | 4.53 | 2.07 | 0.25 | 0.14 | 39.63 |
| Grape Vines with 80% canopy | 0.62 | 1.26 | 1.86 | 1.67 | 3.94 | 5.7 | 6.14 | Grape Vines with 80% canopy | 4.47 | 2.88 | 0 | 0.25 | 0.14 | 28.92 |
| Grape Vines with cover crop (80% canopy) | 0.77 | 1.71 | 2.96 | 3.13 | 5.45 | 6.46 | 6.97 | Grape Vines with cover crop (80% canopy) | 5.38 | 3.25 | 1.17 | 0.59 | 0.4 | 38.21 |
| Immature Grapes Vines with 50% canopy | 0.63 | 1.26 | 1.71 | 1.25 | 3.06 | 4.5 | 4.69 | Immature Grapes Vines with 50% canopy | 3.42 | 2.1 | 0 | 0.25 | 0.14 | 23.02 |

## Zone 15 - Sprinkler Irrigation - Typical Year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Sprinkler Irrigation Typical Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1997 (Typical Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | | July | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches | inches |
| Precipitation | 3.46 | 0.39 | 0.07 | 0.59 | 0.01 | 0.33 | Precipitation | 0.01 | 0 | 0.02 | 0.33 | 1.91 | 1.28 | 8.4 |
| Grass Reference ETo | 0.95 | 2.3 | 4.38 | 6.3 | 8.18 | 8.18 | Grass Reference ETo | 8.35 | 7.33 | 5.72 | 4.04 | 1.58 | 1.09 | 58.41 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.96 | 0.87 | 0.79 | 3.53 | 6.68 | 7.27 | Apple, Pear, Cherry, Plum and Prune | 7.08 | 5.98 | 4.78 | 2.17 | 0.76 | 1.01 | 41.88 |
| Apples, Plums, Cherries etc w/covercrop | 0.96 | 2.37 | 3.52 | 4.96 | 8.08 | 8.78 | Apples, Plums, Cherries etc w/covercrop | 8.63 | 7.61 | 5.46 | 3.66 | 1.28 | 1.1 | 56.42 |
| Peach, Nectarine and Apricots | 0.96 | 0.87 | 0.6 | 2.66 | 6.31 | 7.22 | Peach, Nectarine and Apricots | 7.2 | 6.14 | 4.42 | 2.67 | 0.75 | 1.01 | 40.82 |
| Immature Peaches, Nectarines, etc | 0.98 | 0.87 | 0.35 | 1.62 | 4.23 | 5.03 | Immature Peaches, Nectarines, etc | 5.07 | 4.21 | 3.06 | 1.85 | 0.76 | 1.03 | 29.06 |
| Almonds | 0.96 | 1.06 | 1.2 | 4.06 | 6.24 | 6.44 | Almonds | 6.73 | 5.52 | 4.1 | 1.89 | 0.76 | 1.01 | 39.97 |
| Almonds w/covercrop | 0.94 | 2.16 | 2.38 | 5.4 | 7.58 | 7.51 | Almonds w/covercrop | 7.28 | 6.41 | 4.67 | 2.67 | 1.11 | 1.07 | 49.16 |
| Immature Almonds | 0.98 | 0.99 | 0.76 | 3.55 | 5.43 | 5.74 | Immature Almonds | 5.64 | 4.92 | 3.48 | 1.77 | 0.76 | 1.03 | 35.05 |
| Walnuts | 0.96 | 0.88 | 0.91 | 2.74 | 7.12 | 8.54 | Walnuts | 8.66 | 7.46 | 5.33 | 2.58 | 1 | 1.01 | 47.19 |
| Pistachio | 0.96 | 0.87 | 0.11 | 1.55 | 2.5 | 6.28 | Pistachio | 8.2 | 7.18 | 5.24 | 2.88 | 0.8 | 1.01 | 37.59 |
| Pistachio w/ covercrop | 0.97 | 2.14 | 2.4 | 4.59 | 5.61 | 8 | Pistachio w/ covercrop | 8.86 | 7.82 | 6.01 | 3.77 | 1.29 | 1.12 | 52.57 |
| Immature Pistachio | 0.98 | 0.87 | 0.11 | 1.06 | 1.43 | 4.33 | Immature Pistachio | 5.94 | 5.32 | 3.81 | 1.89 | 0.91 | 1.03 | 27.68 |
| Misc. Deciduous | 0.96 | 0.87 | 0.78 | 3.09 | 6.66 | 6.92 | Misc. Deciduous | 6.69 | 6.07 | 4.49 | 2.32 | 0.75 | 1.01 | 40.63 |
| Grain and Grain Hay | 1.03 | 2.23 | 4.42 | 6.44 | 3.69 | 0.37 | Grain and Grain Hay | 0.01 | 0 | 0.01 | 0.31 | 0.82 | 1.1 | 20.43 |
| Cotton | 1.02 | 0.85 | 0.11 | 1.27 | 1.7 | 4.95 | Cotton | 8.19 | 7.44 | 5.35 | 1.64 | 0.79 | 1.05 | 34.35 |
| Safflower and Sunflower | 1.02 | 1.09 | 1.63 | 5.73 | 8.81 | 7.54 | Safflower and Sunflower | 1.13 | 0 | 0.01 | 0.31 | 0.79 | 1.05 | 29.12 |
| Corn and Grain Sorghum | 1.02 | 0.85 | 1.1 | 1.52 | 2.69 | 6.98 | Corn and Grain Sorghum | 8.09 | 5.02 | 0.36 | 0.31 | 0.79 | 1.05 | 29.8 |
| Misc. field crops | 1.02 | 0.85 | 1.1 | 1.53 | 2.65 | 7.24 | Misc. field crops | 7.55 | 2.59 | 0.01 | 0.31 | 0.79 | 1.05 | 26.7 |
| Alfalfa Hay and Clover | 1.02 | 2.25 | 3.98 | 5.7 | 6.95 | 7.23 | Alfalfa Hay and Clover | 6.93 | 6.05 | 4.72 | 1.93 | 1.29 | 1.17 | 49.2 |
| Pasture and Misc. Grasses | 1.02 | 1.35 | 2.05 | 5 | 7.49 | 7.66 | Pasture and Misc. Grasses | 7.68 | 6.75 | 5.2 | 3.25 | 1.19 | 1.05 | 49.69 |
| Small Vegetables | 1.03 | 1.44 | 3.86 | 10.37 | 2.38 | 0.36 | Small Vegetables | 0.01 | 1.02 | 1.51 | 2.49 | 1.68 | 1.16 | 27.31 |
| Tomatoes and Peppers | 1.02 | 0.85 | 0.8 | 1.49 | 4.21 | 8.1 | Tomatoes and Peppers | 6.63 | 0.46 | 0.01 | 0.31 | 0.79 | 1.05 | 25.73 |
| Potatoes, Sugar beets, Turnip etc.. | 1.02 | 1.16 | 2.3 | 6.27 | 8.48 | 8.55 | Potatoes, Sugar beets, Turnip etc.. | 7.21 | 0.08 | 0.01 | 0.31 | 0.79 | 1.05 | 37.25 |
| Melons, Squash, and Cucumbers | 1.02 | 0.85 | 0.11 | 0.57 | 0.56 | 2.17 | Melons, Squash, and Cucumbers | 5.2 | 5.68 | 1.66 | 0.31 | 0.79 | 1.05 | 19.97 |
| Onions and Garlic | 1.03 | 2.04 | 3.57 | 5.37 | 4.92 | 0.76 | Onions and Garlic | 0.01 | 0 | 0.01 | 0.31 | 1.42 | 1.1 | 20.54 |
| Strawberries | 1.02 | 0.85 | 1.1 | 1.53 | 2.65 | 7.24 | Strawberries | 7.55 | 2.59 | 0.01 | 0.31 | 0.79 | 1.05 | 26.7 |
| Flowers, Nursery and Christmas Tree | 0.96 | 0.87 | 0.78 | 3.09 | 6.66 | 6.92 | Flowers, Nursery and Christmas Tree | 6.69 | 6.07 | 4.49 | 2.32 | 0.75 | 1.01 | 40.63 |
| Citrus (no ground cover) | 0.97 | 2.23 | 3.26 | 4.66 | 5.81 | 6.19 | Citrus (no ground cover) | 5.89 | 5.15 | 4 | 3.18 | 1.39 | 1.13 | 43.86 |
| Immature Citrus | 0.98 | 1.52 | 1.49 | 3.39 | 3.59 | 4.25 | Immature Citrus | 3.85 | 3.36 | 2.69 | 2.32 | 1.06 | 1.11 | 29.62 |
| Misc Subtropical | 0.96 | 0.87 | 0.78 | 3.09 | 6.66 | 6.92 | Misc Subtropical | 6.69 | 6.07 | 4.49 | 2.32 | 0.75 | 1.01 | 40.63 |
| Grape Vines with 80% canopy | 0.98 | 0.87 | 0.48 | 1.79 | 4.16 | 5.98 | Grape Vines with 80% canopy | 5.85 | 4.66 | 2.38 | 0.5 | 0.76 | 1.03 | 29.43 |
| Grape Vines with cover crop (80% canopy) | 0.98 | 1.92 | 2.43 | 3.39 | 5.82 | 6.8 | Grape Vines with cover crop (80% canopy) | 6.69 | 5.04 | 3.8 | 2.15 | 1.08 | 1.12 | 41.21 |
| Immature Grapes Vines with 50% canopy | 0.99 | 0.86 | 0.35 | 1.32 | 3.21 | 4.56 | Immature Grapes Vines with 50% canopy | 4.61 | 3.49 | 2.06 | 0.31 | 0.77 | 1.03 | 23.58 |

## Zone 15 - Sprinkler Irrigation - Wet Year

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | | |
| Sprinkler Irrigation Wet Year | | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | | |
| | 1998 (Wet Year) | | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual | |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches | |
| Precipitation | 1.65 | 7.3 | 2.74 | 1.11 | 1.59 | 0.35 | 0.02 | Precipitation | 0 | 0.15 | 0.76 | 0.88 | 0.7 | 17.25 | |
| Grass Reference ETo | 0.93 | 1.37 | 3.13 | 4.73 | 5.39 | 7.11 | 8.52 | Grass Reference ETo | 7.69 | 5.3 | 3.61 | 1.6 | 1.2 | 50.58 | |
| | | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.86 | 1.42 | 2.08 | 4.03 | 4.98 | 6.39 | 7.29 | Apple, Pear, Cherry, Plum and Prune | 6.4 | 4.02 | 2.7 | 0.76 | 0.78 | 41.7 | |
| Apples, Plums, Cherries etc w/covercrop | 0.91 | 1.43 | 3.29 | 4.86 | 5.2 | 7.44 | 8.79 | Apples, Plums, Cherries etc w/covercrop | 7.87 | 5.25 | 3.22 | 1.34 | 0.96 | 50.55 | |
| Peach, Nectarine and Apricots | 0.86 | 1.42 | 1.96 | 3.33 | 5.1 | 6.31 | 7.26 | Peach, Nectarine and Apricots | 6.53 | 4.28 | 2.58 | 0.74 | 0.78 | 41.15 | |
| Immature Peaches, Nectarines, etc | 0.88 | 1.43 | 1.86 | 2.49 | 3.76 | 4.66 | 4.98 | Immature Peaches, Nectarines, etc | 4.53 | 3.03 | 1.79 | 0.74 | 0.78 | 30.92 | |
| Almonds | 0.86 | 1.43 | 2.26 | 4.53 | 4.63 | 5.72 | 6.64 | Almonds | 6 | 3.73 | 2.19 | 0.73 | 0.78 | 39.49 | |
| Almonds w/covercrop | 0.88 | 1.43 | 3.21 | 4.73 | 4.74 | 6.73 | 7.61 | Almonds w/covercrop | 6.89 | 4.24 | 2.95 | 1.47 | 1.13 | 46 | |
| Immature Almonds | 0.88 | 1.44 | 2.07 | 3.31 | 4.21 | 5.08 | 5.81 | Immature Almonds | 5.16 | 3.2 | 2.04 | 0.73 | 0.78 | 34.72 | |
| Walnuts | 0.86 | 1.41 | 2.19 | 3.4 | 5.5 | 7.45 | 8.82 | Walnuts | 7.89 | 4.78 | 2.74 | 0.94 | 0.79 | 46.76 | |
| Pistachio | 0.86 | 1.42 | 1.76 | 2.39 | 3.22 | 5.28 | 8.36 | Pistachio | 7.61 | 4.92 | 2.57 | 0.88 | 0.79 | 40.06 | |
| Pistachio w/ covercrop | 0.92 | 1.43 | 3.17 | 4.01 | 4.92 | 6.93 | 9.12 | Pistachio w/ covercrop | 8.17 | 5.47 | 3.59 | 1.63 | 1.2 | 50.54 | |
| Immature Pistachio | 0.88 | 1.43 | 1.76 | 1.99 | 2.38 | 3.97 | 5.93 | Immature Pistachio | 5.4 | 3.63 | 2.16 | 0.84 | 0.79 | 31.14 | |
| Misc. Deciduous | 0.86 | 1.42 | 2.08 | 3.93 | 5.01 | 5.98 | 6.91 | Misc. Deciduous | 6.13 | 4.19 | 2.41 | 0.74 | 0.78 | 40.44 | |
| Grain and Grain Hay | 0.95 | 1.49 | 3.33 | 4.89 | 3.17 | 0.35 | 0.02 | Grain and Grain Hay | 0 | 0.14 | 0.55 | 1.11 | 0.93 | 16.93 | |
| Cotton | 0.92 | 1.48 | 1.76 | 1.62 | 2.23 | 4.18 | 8.46 | Cotton | 7.75 | 5.05 | 2.08 | 0.73 | 0.79 | 37.04 | |
| Safflower and Sunflower | 0.92 | 1.48 | 2.38 | 4.9 | 5.85 | 6.59 | 0.92 | Safflower and Sunflower | 0 | 0.14 | 0.55 | 0.73 | 0.79 | 25.25 | |
| Corn and Grain Sorghum | 0.92 | 1.48 | 2.22 | 2.32 | 3.21 | 6.16 | 8.13 | Corn and Grain Sorghum | 6.03 | 0.51 | 0.55 | 0.73 | 0.79 | 33.03 | |
| Misc. field crops | 0.92 | 1.48 | 2.22 | 2.32 | 3.19 | 6.44 | 7.74 | Misc. field crops | 3.01 | 0.14 | 0.55 | 0.73 | 0.79 | 29.52 | |
| Alfalfa Hay and Clover | 0.99 | 1.49 | 3.23 | 5.09 | 5.74 | 6.62 | 7.09 | Alfalfa Hay and Clover | 6.33 | 4.47 | 1.95 | 1.5 | 1.25 | 45.76 | |
| Pasture and Misc. Grasses | 0.92 | 1.49 | 2.8 | 4.31 | 5.31 | 6.61 | 7.84 | Pasture and Misc. Grasses | 7.07 | 4.87 | 3.03 | 1.15 | 0.8 | 46.2 | |
| Small Vegetables | 0.99 | 1.49 | 3.03 | 4.77 | 2.67 | 0.33 | 0.02 | Small Vegetables | 0.81 | 1.09 | 1.2 | 1.33 | 1.18 | 18.92 | |
| Tomatoes and Peppers | 0.92 | 1.48 | 2.2 | 2.09 | 3.87 | 7.12 | 7.08 | Tomatoes and Peppers | 0.6 | 0.14 | 0.55 | 0.73 | 0.79 | 27.56 | |
| Potatoes, Sugar beets, Turnip etc.. | 0.95 | 1.48 | 2.58 | 4.97 | 5.68 | 7.37 | 7.61 | Potatoes, Sugar beets, Turnip etc.. | 0.08 | 0.14 | 0.55 | 0.73 | 0.79 | 32.93 | |
| Melons, Squash, and Cucumbers | 0.92 | 1.48 | 1.76 | 1.58 | 1.69 | 1.19 | 5.19 | Melons, Squash, and Cucumbers | 5.89 | 1.57 | 0.55 | 0.73 | 0.79 | 23.33 | |
| Onions and Garlic | 0.95 | 1.49 | 3.1 | 4.3 | 3.68 | 0.86 | 0.02 | Onions and Garlic | 0 | 0.14 | 0.55 | 1.27 | 0.95 | 17.31 | |
| Strawberries | 0.92 | 1.48 | 2.22 | 2.32 | 3.19 | 6.44 | 7.74 | Strawberries | 3.01 | 0.14 | 0.55 | 0.73 | 0.79 | 29.52 | |
| Flowers, Nursery and Christmas Tree | 0.86 | 1.42 | 2.08 | 3.93 | 5.01 | 5.98 | 6.91 | Flowers, Nursery and Christmas Tree | 6.13 | 4.19 | 2.41 | 0.74 | 0.78 | 40.44 | |
| Citrus (no ground cover) | 0.93 | 1.43 | 3.23 | 4.31 | 4.92 | 5.47 | 5.91 | Citrus (no ground cover) | 5.46 | 3.82 | 2.84 | 1.59 | 1.24 | 41.14 | |
| Immature Citrus | 0.92 | 1.44 | 2.53 | 2.99 | 3.79 | 3.6 | 3.88 | Immature Citrus | 3.6 | 2.6 | 2.01 | 1.32 | 1.12 | 29.8 | |
| Misc Subtropical | 0.86 | 1.42 | 2.08 | 3.93 | 5.01 | 5.98 | 6.91 | Misc Subtropical | 6.13 | 4.19 | 2.41 | 0.74 | 0.78 | 40.44 | |
| Grape Vines with 80% canopy | 0.88 | 1.43 | 1.91 | 2.59 | 4.08 | 5.08 | 6.09 | Grape Vines with 80% canopy | 5.02 | 2.37 | 0.55 | 0.73 | 0.78 | 31.51 | |
| Grape Vines with cover crop (80% canopy) | 0.93 | 1.44 | 2.98 | 3.86 | 4.54 | 6.13 | 6.92 | Grape Vines with cover crop (80% canopy) | 5.65 | 3.06 | 2.2 | 1.35 | 1.1 | 40.18 | |
| Immature Grapes Vines with 50% canopy | 0.89 | 1.45 | 1.86 | 2.22 | 3.04 | 4.03 | 4.79 | Immature Grapes Vines with 50% canopy | 3.67 | 1.84 | 0.62 | 0.73 | 0.79 | 25.91 | |

## Zone 15 - Surface Irrigation - Dry Year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Surface Irrigation Dry Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1999 (Dry Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 2.35 | 1.06 | 1.85 | 0.57 | 0.05 | 0 | 0.01 | Precipitation | 0 | 0.03 | 0 | 0.33 | 0.11 | 6.35 |
| Grass Reference ETo | 0.9 | 1.77 | 3.4 | 5.27 | 7.74 | 8.1 | 8.47 | Grass Reference ETo | 7.34 | 5.84 | 4.09 | 1.82 | 1.53 | 56.27 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.61 | 1.25 | 2.03 | 3.34 | 6.42 | 6.75 | 7.2 | Apple, Pear, Cherry, Plum and Prune | 6.25 | 4.73 | 2.11 | 0.25 | 0.14 | 41.08 |
| Apples, Plums, Cherries etc w/covercrop | 0.72 | 1.73 | 3.68 | 4.85 | 7.67 | 8.29 | 8.72 | Apples, Plums, Cherries etc w/covercrop | 7.69 | 5.67 | 2.89 | 0.87 | 0.6 | 53.39 |
| Peach, Nectarine and Apricots | 0.61 | 1.25 | 1.88 | 2.48 | 5.92 | 6.83 | 7.25 | Peach, Nectarine and Apricots | 6.36 | 4.79 | 2.03 | 0.25 | 0.14 | 39.81 |
| Immature Peaches, Nectarines, etc | 0.62 | 1.26 | 1.72 | 1.58 | 3.86 | 4.45 | 4.84 | Immature Peaches, Nectarines, etc | 4.01 | 3.02 | 1.26 | 0.26 | 0.14 | 27.01 |
| Almonds | 0.61 | 1.44 | 2.32 | 3.68 | 6.1 | 6.01 | 6.37 | Almonds | 6.06 | 4.05 | 2.11 | 0.25 | 0.14 | 39.14 |
| Almonds w/covercrop | 0.82 | 1.82 | 3.12 | 4.8 | 6.88 | 7.24 | 7.73 | Almonds w/covercrop | 6.58 | 4.5 | 2.69 | 1.07 | 0.81 | 48.05 |
| Immature Almonds | 0.62 | 1.34 | 2 | 3.09 | 5.06 | 5.14 | 5.54 | Immature Almonds | 4.83 | 3.3 | 1.49 | 0.25 | 0.14 | 32.81 |
| Walnuts | 0.61 | 1.25 | 2.12 | 2.62 | 6.73 | 8.3 | 8.78 | Walnuts | 7.61 | 5.28 | 2.46 | 0.34 | 0.14 | 46.24 |
| Pistachio | 0.61 | 1.25 | 1.55 | 1.56 | 2.51 | 5.86 | 8.23 | Pistachio | 7.11 | 5.46 | 2.6 | 0.29 | 0.14 | 37.17 |
| Pistachio w/ covercrop | 0.87 | 1.83 | 3.09 | 3.85 | 5.21 | 7.41 | 8.98 | Pistachio w/ covercrop | 7.78 | 6.14 | 3.59 | 1.14 | 0.83 | 50.72 |
| Immature Pistachio | 0.62 | 1.26 | 1.55 | 1 | 1.52 | 3.87 | 5.79 | Immature Pistachio | 5.06 | 3.65 | 1.6 | 0.31 | 0.14 | 26.37 |
| Misc. Deciduous | 0.61 | 1.25 | 2.17 | 3.15 | 6.05 | 6.5 | 6.94 | Misc. Deciduous | 5.79 | 4.69 | 1.99 | 0.25 | 0.14 | 39.54 |
| Grain and Grain Hay | 0.72 | 1.86 | 3.55 | 5.29 | 3.66 | 0.01 | 0.01 | Grain and Grain Hay | 0 | 0.03 | 0 | 0.78 | 0.37 | 16.29 |
| Rice | 0.64 | 1.28 | 1.55 | 1.25 | 7.05 | 9.08 | 9.7 | Rice | 8.34 | 2.41 | 0 | 0.25 | 0.14 | 41.68 |
| Cotton | 0.64 | 1.28 | 1.54 | 1.26 | 1.53 | 4.64 | 8.3 | Cotton | 7.43 | 5.36 | 1.16 | 0.25 | 0.14 | 33.54 |
| Safflower and Sunflower | 0.84 | 1.45 | 2.33 | 5.03 | 8.32 | 7.17 | 0.67 | Safflower and Sunflower | 0 | 0.03 | 0 | 0.25 | 0.14 | 26.23 |
| Corn and Grain Sorghum | 0.64 | 1.28 | 2.46 | 1.53 | 2.54 | 6.92 | 8.27 | Corn and Grain Sorghum | 4.99 | 0.34 | 0 | 0.25 | 0.14 | 29.36 |
| Beans | 0.64 | 1.28 | 2.46 | 1.53 | 2.52 | 7.22 | 7.67 | Beans | 2.52 | 0.03 | 0 | 0.25 | 0.14 | 26.26 |
| Misc. field crops | 0.64 | 1.28 | 2.46 | 1.53 | 2.52 | 7.22 | 7.67 | Misc. field crops | 2.52 | 0.03 | 0 | 0.25 | 0.14 | 26.26 |
| Alfalfa Hay and Clover | 0.94 | 1.85 | 3.56 | 5.2 | 6.53 | 6.85 | 7.04 | Alfalfa Hay and Clover | 6.23 | 4.79 | 1.65 | 1.43 | 1.45 | 47.51 |
| Pasture and Misc. Grasses | 0.64 | 1.8 | 2.88 | 4.38 | 7.09 | 7.5 | 7.79 | Pasture and Misc. Grasses | 6.85 | 5.34 | 3.01 | 0.69 | 0.14 | 48.1 |
| Small Vegetables | 0.86 | 1.59 | 3.09 | 5.22 | 1.68 | 0 | 0.01 | Small Vegetables | 0.95 | 1.24 | 0.91 | 1.34 | 1.41 | 18.3 |
| Tomatoes and Peppers | 0.64 | 1.28 | 2.03 | 1.16 | 4.01 | 8.03 | 6.87 | Tomatoes and Peppers | 0.43 | 0.03 | 0 | 0.25 | 0.14 | 24.87 |
| Potatoes, Sugar beets, Turnip etc.. | 0.92 | 1.46 | 2.57 | 5.31 | 8.04 | 8.32 | 7.42 | Potatoes, Sugar beets, Turnip etc.. | 0.07 | 0.03 | 0 | 0.25 | 0.14 | 34.52 |
| Melons, Squash, and Cucumbers | 0.64 | 1.28 | 1.54 | 0.59 | 0.77 | 1.16 | 4.95 | Melons, Squash, and Cucumbers | 5.63 | 1.65 | 0 | 0.25 | 0.14 | 18.61 |
| Onions and Garlic | 0.72 | 1.79 | 3.23 | 4.42 | 4.72 | 0.73 | 0.01 | Onions and Garlic | 0 | 0.03 | 0 | 0.94 | 0.35 | 16.95 |
| Strawberries | 0.64 | 1.28 | 2.46 | 1.53 | 2.52 | 7.22 | 7.67 | Strawberries | 2.52 | 0.03 | 0 | 0.25 | 0.14 | 26.26 |
| Flowers, Nursery and Christmas Tree | 0.61 | 1.25 | 2.17 | 3.15 | 6.05 | 6.5 | 6.94 | Flowers, Nursery and Christmas Tree | 5.79 | 4.69 | 1.99 | 0.25 | 0.14 | 39.54 |
| Citrus (no ground cover) | 0.91 | 1.85 | 3.42 | 4.29 | 5.18 | 5.47 | 5.66 | Citrus (no ground cover) | 4.89 | 3.85 | 2.79 | 1.32 | 1.25 | 40.88 |
| Immature Citrus | 0.76 | 1.6 | 2.48 | 2.76 | 3.19 | 3.41 | 3.59 | Immature Citrus | 2.99 | 2.53 | 1.62 | 0.94 | 0.7 | 26.58 |
| Misc Subtropical | 0.61 | 1.25 | 2.17 | 3.15 | 6.05 | 6.5 | 6.94 | Misc Subtropical | 5.79 | 4.69 | 1.99 | 0.25 | 0.14 | 39.54 |
| Grape Vines with 80% canopy | 0.62 | 1.26 | 1.85 | 1.67 | 3.92 | 5.7 | 6.11 | Grape Vines with 80% canopy | 4.5 | 2.85 | 0 | 0.25 | 0.14 | 28.87 |
| Grape Vines with cover crop (80% canopy) | 0.71 | 1.63 | 2.89 | 3.31 | 5.2 | 6.36 | 6.89 | Grape Vines with cover crop (80% canopy) | 5.5 | 3.29 | 1.4 | 0.73 | 0.5 | 38.42 |
| Immature Grapes Vines with 50% canopy | 0.63 | 1.26 | 1.72 | 1.27 | 2.97 | 4.24 | 4.77 | Immature Grapes Vines with 50% canopy | 3.37 | 2.08 | 0.01 | 0.25 | 0.14 | 22.69 |
| Idle | 0.65 | 1.29 | 1.54 | 0.59 | 0.05 | 0 | 0.01 | Idle | 0 | 0.03 | 0 | 0.25 | 0.14 | 4.55 |

## Zone 15 - Surface Irrigation - Typical Year

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETc Table for Irrigation District Water Balances | | | | | | | | | | | | | | |
| Zone 15 Monthly Evapotranspiration | | | | | | | | | | | | | | |
| Surface Irrigation Typical Year | | | | | | | | | | | | | | |
| IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo | | | | | | | | | | | | | | |
| Table includes adjustments for bare spots and reduced vigor | | | | | | | | | | | | | | |
| | 1997 (Typical Year) | | | | | | | | | | | | | |
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 3.46 | 0.39 | 0.07 | 0.59 | 0.01 | 0.33 | 0.01 | Precipitation | 0 | 0.02 | 0.33 | 1.91 | 1.28 | 8.4 |
| Grass Reference ETo | 0.95 | 2.3 | 4.38 | 6.3 | 8.18 | 8.18 | 8.35 | Grass Reference ETo | 7.33 | 5.72 | 4.04 | 1.58 | 1.09 | 58.41 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.96 | 0.87 | 0.79 | 3.53 | 6.68 | 7.27 | 7.08 | Apple, Pear, Cherry, Plum and Prune | 5.98 | 4.78 | 2.11 | 0.75 | 1.01 | 41.82 |
| Apples, Plums, Cherries etc w/covercrop | 0.96 | 2.37 | 3.49 | 4.95 | 8.07 | 8.65 | 8.63 | Apples, Plums, Cherries etc w/covercrop | 7.54 | 5.59 | 3.52 | 1.25 | 1.11 | 56.14 |
| Peach, Nectarine and Apricots | 0.96 | 0.87 | 0.6 | 2.66 | 6.27 | 7.22 | 7.21 | Peach, Nectarine and Apricots | 6.14 | 4.41 | 2.55 | 0.75 | 1.01 | 40.66 |
| Immature Peaches, Nectarines, etc | 0.98 | 0.87 | 0.35 | 1.63 | 3.91 | 4.87 | 4.69 | Immature Peaches, Nectarines, etc | 4.11 | 2.96 | 1.3 | 0.76 | 1.02 | 27.44 |
| Almonds | 0.96 | 1.06 | 1.19 | 4.06 | 6.24 | 6.44 | 6.73 | Almonds | 5.52 | 4.1 | 1.87 | 0.76 | 1.01 | 39.94 |
| Almonds w/covercrop | 0.94 | 2.15 | 2.37 | 5.38 | 7.58 | 7.52 | 7.28 | Almonds w/covercrop | 6.41 | 4.66 | 2.61 | 1.11 | 1.07 | 49.07 |
| Immature Almonds | 0.98 | 0.99 | 0.76 | 3.38 | 5.34 | 5.56 | 5.48 | Immature Almonds | 4.64 | 3.31 | 1.54 | 0.76 | 1.02 | 33.77 |
| Walnuts | 0.96 | 0.88 | 0.91 | 2.74 | 7.12 | 8.54 | 8.66 | Walnuts | 7.46 | 5.33 | 2.54 | 0.95 | 1.01 | 47.1 |
| Pistachio | 0.96 | 0.87 | 0.11 | 1.55 | 2.53 | 6.07 | 8.24 | Pistachio | 7.13 | 5.27 | 2.85 | 0.8 | 1.01 | 37.4 |
| Pistachio w/ covercrop | 0.97 | 2.14 | 2.45 | 4.37 | 5.46 | 7.87 | 8.86 | Pistachio w/ covercrop | 7.82 | 6 | 3.66 | 1.32 | 1.12 | 52.05 |
| Immature Pistachio | 0.98 | 0.87 | 0.11 | 1.06 | 1.41 | 4.18 | 5.74 | Immature Pistachio | 4.99 | 3.63 | 1.86 | 0.85 | 1.02 | 26.69 |
| Misc. Deciduous | 0.96 | 0.87 | 0.78 | 3.11 | 6.64 | 6.91 | 6.69 | Misc. Deciduous | 6.04 | 4.45 | 2.3 | 0.75 | 1.01 | 40.52 |
| Grain and Grain Hay | 1.03 | 2.23 | 4.42 | 6.44 | 3.69 | 0.37 | 0.01 | Grain and Grain Hay | 0 | 0.01 | 0.31 | 0.82 | 1.1 | 20.43 |
| Rice | 1.02 | 0.85 | 0.11 | 1.2 | 7.33 | 9.18 | 9.57 | Rice | 8.33 | 2.56 | 0.31 | 0.79 | 1.05 | 42.31 |
| Cotton | 1.02 | 0.85 | 0.11 | 1.28 | 1.54 | 4.84 | 8.21 | Cotton | 7.45 | 5.28 | 1.44 | 0.79 | 1.05 | 33.87 |
| Safflower and Sunflower | 1.02 | 1.09 | 1.63 | 5.73 | 8.81 | 7.54 | 1.13 | Safflower and Sunflower | 0 | 0.01 | 0.31 | 0.79 | 1.05 | 29.12 |
| Corn and Grain Sorghum | 1.02 | 0.85 | 1.1 | 1.68 | 2.62 | 7.06 | 8.12 | Corn and Grain Sorghum | 5.48 | 0.42 | 0.3 | 0.79 | 1.05 | 30.51 |
| Misc. field crops | 1.02 | 0.85 | 1.1 | 1.69 | 2.6 | 7.31 | 7.5 | Misc. field crops | 2.54 | 0.01 | 0.31 | 0.79 | 1.05 | 26.77 |
| Alfalfa Hay and Clover | 1.02 | 2.25 | 3.98 | 5.7 | 6.95 | 7.23 | 6.93 | Alfalfa Hay and Clover | 6.05 | 4.72 | 1.93 | 1.29 | 1.17 | 49.2 |
| Pasture and Misc. Grasses | 1.02 | 1.35 | 2.05 | 5 | 7.49 | 7.66 | 7.68 | Pasture and Misc. Grasses | 6.75 | 5.2 | 3.25 | 1.19 | 1.05 | 49.69 |
| Small Vegetables | 1.03 | 1.44 | 3.86 | 6.29 | 1.73 | 0.36 | 0.01 | Small Vegetables | 1.02 | 1.4 | 1.24 | 1.28 | 1.16 | 20.8 |
| Tomatoes and Peppers | 1.02 | 0.85 | 0.81 | 1.34 | 4.17 | 8.09 | 6.78 | Tomatoes and Peppers | 0.54 | 0.01 | 0.31 | 0.79 | 1.05 | 25.75 |
| Potatoes, Sugar beets, Turnip etc.. | 1.02 | 1.16 | 2.3 | 6.27 | 8.48 | 8.55 | 7.21 | Potatoes, Sugar beets, Turnip etc.. | 0.08 | 0.01 | 0.31 | 0.79 | 1.05 | 37.25 |
| Melons, Squash, and Cucumbers | 1.02 | 0.85 | 0.11 | 0.56 | 0.68 | 1.44 | 4.93 | Melons, Squash, and Cucumbers | 5.6 | 1.65 | 0.31 | 0.79 | 1.05 | 18.99 |
| Onions and Garlic | 1.03 | 2.04 | 3.57 | 5.37 | 4.92 | 0.76 | 0.01 | Onions and Garlic | 0 | 0.01 | 0.31 | 1.42 | 1.1 | 20.54 |
| Strawberries | 1.02 | 0.85 | 1.1 | 1.69 | 2.6 | 7.31 | 7.5 | Strawberries | 2.54 | 0.01 | 0.31 | 0.79 | 1.05 | 26.77 |
| Flowers, Nursery and Christmas Tree | 0.96 | 0.87 | 0.78 | 3.11 | 6.64 | 6.91 | 6.69 | Flowers, Nursery and Christmas Tree | 6.04 | 4.45 | 2.3 | 0.75 | 1.01 | 40.52 |
| Citrus (no ground cover) | 0.97 | 2.23 | 2.89 | 4.78 | 5.42 | 5.77 | 5.5 | Citrus (no ground cover) | 4.96 | 3.93 | 2.88 | 1.34 | 1.13 | 41.81 |
| Immature Citrus | 0.98 | 1.52 | 1.47 | 3.12 | 3.28 | 3.78 | 3.45 | Immature Citrus | 3.19 | 2.36 | 1.89 | 1.1 | 1.11 | 27.26 |
| Misc Subtropical | 0.96 | 0.87 | 0.78 | 3.11 | 6.64 | 6.91 | 6.69 | Misc Subtropical | 6.04 | 4.45 | 2.3 | 0.75 | 1.01 | 40.52 |
| Grape Vines with 80% canopy | 0.98 | 0.87 | 0.48 | 1.79 | 4.16 | 5.94 | 5.84 | Grape Vines with 80% canopy | 4.66 | 2.37 | 0.47 | 0.76 | 1.02 | 29.34 |
| Grape Vines with cover crop (80% canopy) | 0.98 | 1.93 | 2.38 | 3.41 | 5.73 | 6.73 | 6.67 | Grape Vines with cover crop (80% canopy) | 5.12 | 3.6 | 2.2 | 1.13 | 1.13 | 41.03 |
| Immature Grapes Vines with 50% canopy | 0.99 | 0.86 | 0.35 | 1.33 | 3.15 | 4.51 | 4.5 | Immature Grapes Vines with 50% canopy | 3.46 | 1.96 | 0.39 | 0.77 | 1.03 | 23.3 |
| Idle | 1.04 | 0.84 | 0.11 | 0.56 | 0.01 | 0.35 | 0.01 | Idle | 0 | 0.01 | 0.31 | 0.8 | 1.07 | 5.13 |

Zone 15 - Surface Irrigation - Wet Year

ETc Table for Irrigation District Water Balances
Zone 15 Monthly Evapotranspiration
Surface Irrigation Wet Year
IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo
Table includes adjustments for bare spots and reduced vigor

| | 1998 (Wet Year) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | | August | September | October | November | December | Annual |
| | inches | inches | inches | inches | inches | inches | inches | | inches | inches | inches | inches | inches | inches |
| Precipitation | 1.65 | 7.3 | 2.74 | 1.11 | 1.59 | 0.35 | 0.02 | Precipitation | 0 | 0.15 | 0.76 | 0.88 | 0.7 | 17.25 |
| Grass Reference ETo | 0.93 | 1.37 | 3.13 | 4.73 | 5.39 | 7.11 | 8.52 | Grass Reference ETo | 7.69 | 5.3 | 3.61 | 1.6 | 1.2 | 50.58 |
| | | | | | | | | | | | | | | |
| Apple, Pear, Cherry, Plum and Prune | 0.86 | 1.42 | 2.08 | 4.03 | 4.98 | 6.39 | 7.29 | Apple, Pear, Cherry, Plum and Prune | 6.4 | 4.02 | 2.62 | 0.75 | 0.78 | 41.61 |
| Apples, Plums, Cherries etc w/covercrop | 0.92 | 1.43 | 3.29 | 4.86 | 5.19 | 7.44 | 8.79 | Apples, Plums, Cherries etc w/covercrop | 7.86 | 5.23 | 3.17 | 1.37 | 0.98 | 50.54 |
| Peach, Nectarine and Apricots | 0.86 | 1.42 | 1.96 | 3.33 | 5.1 | 6.31 | 7.26 | Peach, Nectarine and Apricots | 6.53 | 4.26 | 2.52 | 0.73 | 0.78 | 41.06 |
| Immature Peaches, Nectarines, etc | 0.88 | 1.43 | 1.86 | 2.49 | 3.7 | 4.42 | 4.57 | Immature Peaches, Nectarines, etc | 4.35 | 2.81 | 1.69 | 0.77 | 0.79 | 29.74 |
| Almonds | 0.86 | 1.42 | 2.26 | 4.53 | 4.63 | 5.72 | 6.64 | Almonds | 6 | 3.73 | 2.17 | 0.73 | 0.78 | 39.48 |
| Almonds w/covercrop | 0.88 | 1.43 | 3.21 | 4.74 | 4.74 | 6.73 | 7.61 | Almonds w/covercrop | 6.89 | 4.23 | 2.88 | 1.47 | 1.13 | 45.93 |
| Immature Almonds | 0.88 | 1.44 | 2.07 | 3.3 | 4.16 | 4.88 | 5.61 | Immature Almonds | 5.01 | 3.1 | 1.75 | 0.74 | 0.78 | 33.72 |
| Walnuts | 0.85 | 1.41 | 2.19 | 3.39 | 5.5 | 7.45 | 8.82 | Walnuts | 7.89 | 4.78 | 2.69 | 0.93 | 0.78 | 46.69 |
| Pistachio | 0.86 | 1.42 | 1.75 | 2.39 | 3.22 | 5.26 | 8.32 | Pistachio | 7.63 | 4.92 | 2.5 | 0.89 | 0.78 | 39.95 |
| Pistachio w/ covercrop | 0.92 | 1.43 | 3.17 | 4.01 | 4.85 | 6.83 | 9.12 | Pistachio w/ covercrop | 8.17 | 5.48 | 3.46 | 1.64 | 1.22 | 50.29 |
| Immature Pistachio | 0.88 | 1.43 | 1.76 | 1.99 | 2.38 | 3.79 | 5.7 | Immature Pistachio | 5.3 | 3.32 | 1.93 | 0.85 | 0.79 | 30.09 |
| Misc. Deciduous | 0.86 | 1.42 | 2.08 | 3.92 | 5.01 | 5.98 | 6.91 | Misc. Deciduous | 6.13 | 4.19 | 2.3 | 0.73 | 0.78 | 40.31 |
| Grain and Grain Hay | 0.95 | 1.49 | 3.33 | 4.89 | 3.17 | 0.35 | 0.02 | Grain and Grain Hay | 0 | 0.14 | 0.55 | 1.11 | 0.93 | 16.93 |
| Rice | 0.92 | 1.48 | 1.76 | 1.94 | 5.53 | 7.97 | 9.77 | Rice | 8.7 | 2.29 | 0.55 | 0.73 | 0.79 | 42.41 |
| Cotton | 0.92 | 1.47 | 1.76 | 1.62 | 2.23 | 4.19 | 8.48 | Cotton | 7.69 | 5.09 | 1.99 | 0.73 | 0.79 | 36.97 |
| Safflower and Sunflower | 0.92 | 1.48 | 2.38 | 4.9 | 5.85 | 6.59 | 0.92 | Safflower and Sunflower | 0 | 0.14 | 0.55 | 0.73 | 0.79 | 25.25 |
| Corn and Grain Sorghum | 0.92 | 1.47 | 2.22 | 2.38 | 3.21 | 6.16 | 8.13 | Corn and Grain Sorghum | 6.02 | 0.5 | 0.55 | 0.73 | 0.79 | 33.07 |
| Misc. field crops | 0.92 | 1.47 | 2.22 | 2.38 | 3.19 | 6.42 | 7.74 | Misc. field crops | 3.01 | 0.14 | 0.55 | 0.73 | 0.79 | 29.55 |
| Alfalfa Hay and Clover | 0.99 | 1.49 | 3.23 | 5.09 | 5.74 | 6.62 | 7.09 | Alfalfa Hay and Clover | 6.33 | 4.47 | 1.95 | 1.5 | 1.25 | 45.76 |
| Pasture and Misc. Grasses | 0.92 | 1.49 | 2.8 | 4.31 | 5.31 | 6.61 | 7.84 | Pasture and Misc. Grasses | 7.07 | 4.87 | 3.03 | 1.15 | 0.8 | 46.2 |
| Small Vegetables | 0.99 | 1.49 | 3.03 | 4.77 | 2.42 | 0.33 | 0.02 | Small Vegetables | 1.03 | 1.24 | 1.13 | 1.33 | 1.24 | 19.01 |
| Tomatoes and Peppers | 0.92 | 1.47 | 2.22 | 2.09 | 3.87 | 7.12 | 7.08 | Tomatoes and Peppers | 0.6 | 0.14 | 0.55 | 0.73 | 0.79 | 27.58 |
| Potatoes, Sugar beets, Turnip etc.. | 0.95 | 1.48 | 2.58 | 4.97 | 5.68 | 7.37 | 7.61 | Potatoes, Sugar beets, Turnip etc.. | 0.08 | 0.14 | 0.55 | 0.73 | 0.79 | 32.93 |
| Melons, Squash, and Cucumbers | 0.92 | 1.47 | 1.76 | 1.58 | 1.7 | 1.15 | 5.01 | Melons, Squash, and Cucumbers | 5.82 | 1.57 | 0.55 | 0.73 | 0.79 | 23.04 |
| Onions and Garlic | 0.95 | 1.49 | 3.1 | 4.3 | 3.68 | 0.86 | 0.02 | Onions and Garlic | 0 | 0.14 | 0.55 | 1.27 | 0.95 | 17.31 |
| Strawberries | 0.92 | 1.47 | 2.22 | 2.38 | 3.19 | 6.42 | 7.74 | Strawberries | 3.01 | 0.14 | 0.55 | 0.73 | 0.79 | 29.55 |
| Flowers, Nursery and Christmas Tree | 0.86 | 1.42 | 2.08 | 3.92 | 5.01 | 5.98 | 6.91 | Flowers, Nursery and Christmas Tree | 6.13 | 4.19 | 2.3 | 0.73 | 0.78 | 40.31 |
| Citrus (no ground cover) | 0.93 | 1.43 | 3.23 | 4.28 | 4.82 | 5.17 | 5.7 | Citrus (no ground cover) | 5.14 | 3.65 | 2.67 | 1.6 | 1.22 | 39.83 |
| Immature Citrus | 0.92 | 1.44 | 2.53 | 2.99 | 3.62 | 3.27 | 3.6 | Immature Citrus | 3.21 | 2.28 | 1.85 | 1.38 | 1.11 | 28.19 |
| Misc Subtropical | 0.86 | 1.42 | 2.08 | 3.92 | 5.01 | 5.98 | 6.91 | Misc Subtropical | 6.13 | 4.19 | 2.3 | 0.73 | 0.78 | 40.31 |
| Grape Vines with 80% canopy | 0.88 | 1.43 | 1.91 | 2.59 | 4.08 | 5.08 | 6.09 | Grape Vines with 80% canopy | 5.02 | 2.36 | 0.55 | 0.73 | 0.78 | 31.5 |
| Grape Vines with cover crop (80% canopy) | 0.94 | 1.44 | 2.98 | 3.86 | 4.47 | 6.26 | 6.9 | Grape Vines with cover crop (80% canopy) | 5.62 | 3.04 | 1.8 | 1.26 | 1.04 | 39.6 |
| Immature Grapes Vines with 50% canopy | 0.89 | 1.44 | 1.86 | 2.22 | 3.04 | 4 | 4.71 | Immature Grapes Vines with 50% canopy | 3.65 | 1.79 | 0.55 | 0.73 | 0.79 | 25.65 |
| Idle | 0.94 | 1.49 | 1.76 | 1.58 | 1.47 | 0.33 | 0.02 | Idle | 0 | 0.14 | 0.55 | 0.73 | 0.79 | 9.79 |

Cal Poly ITRC

ET from Precipitation

Annual Values by DWR ETo Zone and Year

For use with Annual (Jan-Dec) ETc Values

| | Zone 12 | | | Zone 15 | | | Zone 16 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1999 (Dry) | 1997 (Typ) | 1998 (Wet) | 1999 (Dry) | 1997 (Typ) | 1998 (Wet) | 1999 (Dry) | 1997 (Typ) | 1998 (Wet) |
| Crop | Inches | Inches | Inches | Inches | Inches | Inches | Inches | Inches | Inches |
| Apple, Pear, Cherry, Plum and Prune | 7.7 | 9.8 | 15.0 | 9.8 | 6.9 | 12.3 | 5.9 | 8.3 | 12.4 |
| Apple, Pear, Cherry etc w/cover crop | 9.1 | 10.3 | 15.5 | 9.9 | 8.1 | 14.1 | 6.2 | 8.3 | 14.2 |
| Immature Apple, Pear, Cherry etc | 7.3 | 6.7 | 13.4 | 8.8 | 6.6 | 11.3 | 5.6 | 7.4 | 11.0 |
| Peach, Nectarine and Apricots | 7.9 | 7.7 | 14.7 | 8.7 | 7.7 | 12.1 | 6.3 | 8.7 | 13.5 |
| Immature Peach, Nectarine and Apricots | 7.5 | 6.7 | 13.1 | 8.8 | 7.1 | 11.9 | 5.5 | 6.8 | 11.1 |
| Almonds | 7.7 | 9.0 | 14.5 | 9.4 | 7.5 | 13.5 | 6.0 | 8.5 | 13.2 |
| Almonds w/ cover crop | 9.3 | 10.4 | 15.5 | 10.1 | 8.1 | 13.6 | 6.0 | 8.5 | 14.9 |
| Immature Almonds | 7.3 | 6.4 | 12.9 | 8.5 | 6.8 | 11.6 | 5.6 | 7.3 | 11.7 |
| Walnuts | 8.6 | 8.5 | 14.7 | 10.0 | 7.0 | 12.5 | 6.1 | 7.9 | 11.9 |
| Immature Walnuts | 7.3 | 6.7 | 13.4 | 8.7 | 6.7 | 11.4 | 5.8 | 7.4 | 11.2 |
| Pistachio | 7.8 | 8.6 | 14.6 | 10.2 | 7.9 | 12.3 | 6.1 | 8.9 | 13.3 |
| Pistachio w/ cover crop | 9.4 | 8.0 | 14.6 | 9.6 | 7.8 | 13.3 | 6.1 | 8.9 | 14.5 |
| Immature Pistachio | 7.3 | 6.7 | 13.4 | 8.6 | 6.6 | 11.3 | 5.6 | 7.6 | 11.7 |
| Misc. Deciduous | 7.6 | 8.5 | 14.8 | 10.3 | 8.2 | 13.3 | 6.2 | 7.8 | 13.3 |
| Immature Misc. Deciduous | 7.5 | 6.8 | 13.2 | 8.8 | 7.1 | 11.8 | 5.4 | 6.8 | 11.2 |
| Grain and Grain Hay | 9.0 | 6.4 | 13.4 | 8.2 | 5.9 | 11.7 | 5.4 | 6.5 | 11.8 |
| Rice | 7.8 | 9.6 | 14.6 | 10.0 | 8.4 | 14.0 | 6.4 | | |
| Cotton | 8.2 | 10.1 | 14.9 | 9.6 | 8.2 | 13.8 | 6.3 | 9.1 | 14.2 |
| Safflower and Sunflower | 8.0 | 10.7 | 16.0 | 8.5 | 7.2 | 11.5 | 4.8 | 7.8 | 14.2 |
| Corn and Grain Sorghum | 7.0 | 10.2 | 14.7 | 9.6 | 7.7 | 13.2 | 5.5 | 8.7 | 14.0 |
| Beans | 6.8 | 9.1 | 13.9 | 8.3 | 7.3 | 12.6 | 5.4 | 8.4 | 12.6 |
| Misc. field crops | 6.8 | 8.9 | 13.8 | 8.3 | 7.3 | 12.6 | 5.5 | 8.5 | 12.7 |
| Alfalfa Hay and Clover | 8.8 | 8.5 | 14.0 | 8.2 | 7.8 | 12.5 | 5.5 | 8.8 | 12.8 |
| Pasture and Misc. Grasses | 8.8 | 8.7 | 14.1 | 8.9 | 8.0 | 13.1 | 6.3 | 8.7 | 13.7 |
| Small Vegetables (Double Crop) | 7.2 | 5.7 | 11.8 | 7.6 | 5.4 | 10.6 | 3.9 | 6.3 | 11.1 |
| Tomatoes and Peppers | 7.9 | 11.1 | 16.4 | 10.8 | 8.5 | 14.5 | 6.5 | 9.4 | 15.5 |
| Potatoes, Sugar beets, Turnip etc. | 8.6 | 8.4 | 14.6 | 8.8 | 6.9 | 11.5 | 5.0 | 7.5 | 11.6 |
| Melons, Squash, and Cucumbers | 7.9 | 8.4 | 14.0 | 9.5 | 8.0 | 12.4 | 6.6 | 8.9 | 12.9 |
| Onions and Garlic | 9.2 | 6.7 | 13.5 | 8.6 | 6.3 | 12.0 | 5.6 | 7.0 | 12.2 |
| Strawberries | 7.0 | 8.9 | 14.0 | 8.6 | 7.6 | 13.0 | 5.7 | | |
| Flowers, Nursery and Christmas Tree | 7.9 | 8.6 | 15.2 | 10.6 | 8.3 | 13.4 | 6.3 | 8.3 | 13.6 |
| Citrus (no ground cover) | 8.7 | 9.1 | 14.5 | 9.3 | 7.4 | 12.9 | 5.2 | 7.4 | 11.8 |
| Immature Citrus | 9.0 | 7.7 | 13.7 | 9.1 | 7.1 | 12.4 | 5.9 | 7.3 | 12.0 |
| Avocado | 7.6 | 9.0 | 15.4 | | | | | | |
| Misc Subtropical | 8.7 | 9.0 | 14.4 | 9.3 | 7.4 | 13.0 | 5.2 | 7.5 | 11.9 |
| Grape Vines with 40% canopy | | | | | | | | | |
| Grape Vines with cover crop (60% canopy) | | | | | | | | | |
| Grape Vines with 60% canopy | | | | | | | | | |
| Grape Vines | 8.1 | 8.3 | 14.3 | 10.4 | 7.3 | 12.9 | 6.0 | 8.2 | 12.2 |
| Grape Vines w/ cover crop | 9.3 | 10.1 | 15.8 | 10.7 | 7.9 | 14.0 | 6.1 | 8.4 | 14.6 |
| Immature Grape Vines | 7.3 | 7.1 | 13.2 | 8.8 | 6.5 | 11.3 | 5.9 | 7.5 | 11.5 |
| Idle | | | | | | | | | |
| | | | | | | | | | |
| Total Precipitation | 9.9 | 16.5 | 30.6 | 13 | 8.4 | 17.2 | 6.4 | 9.2 | 20.5 |

# APPENDIX A-6

## ALLENSWORTH CSD

# I. Geographic Location

Allensworth is a small rural community located in southwestern Tulare County in Sections 9 & 16, Township 24 South, Range 24 East, M.D.B. & M. Allensworth was founded in 1908 and is located where once was the southeastern edge of the ancestral Tulare Lake. Allensworth has an estimated population of approximately 471 people. Water is served to the community by the Allensworth Community Services District (ACSD) which was established in 1981. The District is bounded by Avenue 24 to the south, Highway 43 to the east, its western boundary extends approximately 1/8-mile west of Young Road, and its northern boundary extends approximately ½-mile north of Avenue 39. Its service area encompasses approximately 804 acres and is comprised of 146 occupied households, one school, and the Allensworth State Historic Park.

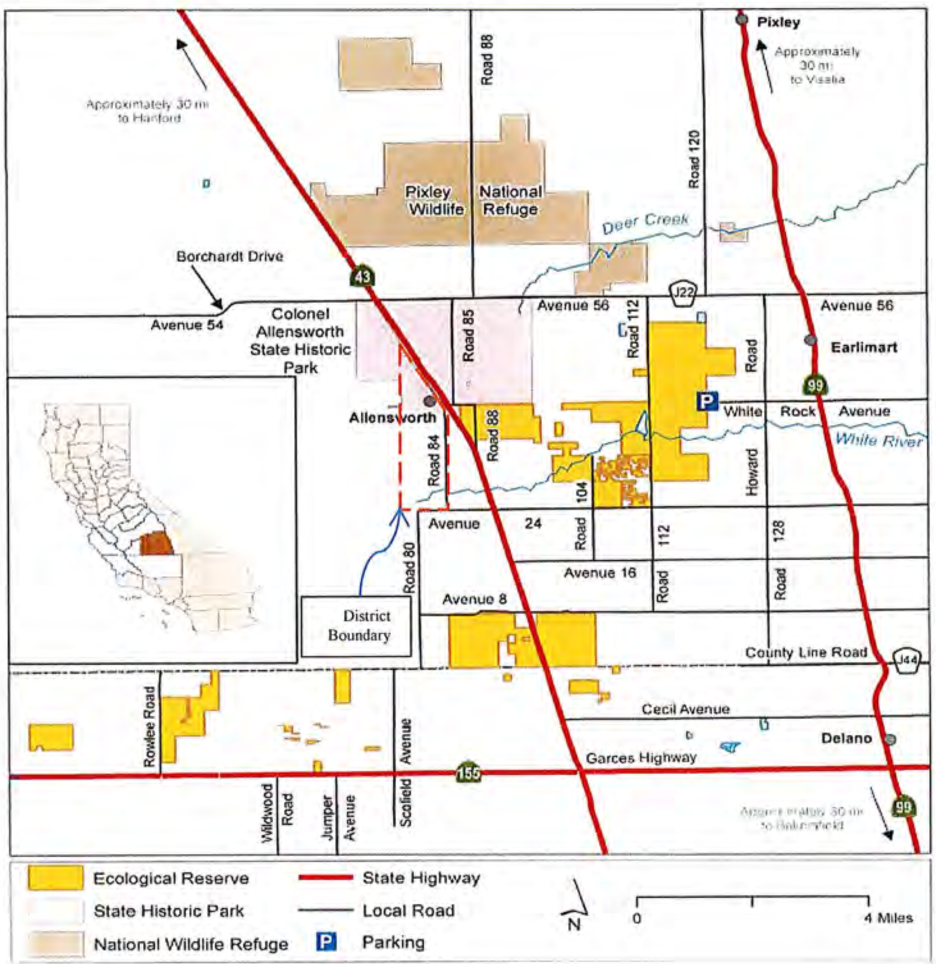



*Figure 1*

Vicinity Map – Allensworth, California