AGENDA

Turlock Irrigation District
Board Room
Main Office Building
333 East Canal Drive
Turlock, California

REGULAR MEETING
Tuesday, February 9, 2021
9:00 a.m.

A. CALL TO ORDER
This meeting is being conducted via webinar, pursuant to Executive Orders signed by Governor Gavin Newsom related to the ongoing COVID-19 pandemic, including provisions regarding the Brown Act. Members of the Board of Directors and the public may participate in the meetings by utilizing Zoom’s webinar feature or through a phone number, both of which are provided in the meeting agenda.

Members of the public will have the opportunity to provide public input via the webinar or phone features. Members of the public may also email their comments to the Board Secretary by 3:00 p.m. on the day prior to the Board meeting. Please email public comment to media@tid.org. All public comments submitted by email by the above time will be read during the TID Board meeting in the Public Comment Period of the agenda.

To join the meeting:
- Click here to join the video meeting

Or to join by phone, please dial (toll free) 669-900-9128 or 346-248-7799;
Meeting ID: 927 8980 6317

Please see the attached Addendum with instructions on how to join the TID Board meeting via Zoom and procedures to ensure an orderly meeting occurs for the public’s business.

Attachment: ADDENDUM
B. PLEDGE OF ALLEGIANCE

C. MOTION APPROVING CONSENT CALENDAR
   All matters listed hereunder will be acted upon by a single vote of the Board. There will be no individual discussion of these items unless a member of the Board or the public so requests, in which event the matter shall be removed from the Consent Calendar and considered as a separate agenda item.

   1. Approval of minutes of the regular meeting of January 26, 2021.
   5. Approval of the following Resolutions Approving Agreements to Abandon Use of ID Facilities:
      - Resolution 2021-4 Abandonment of 38.96-acres from IDs 01980 and 03730 by G3 Enterprises (ID Rule Section 5.2.2.2)
      - Resolution 2021-5 Abandonment of 0.40-acre from ID 06940 by Stellios Papadopoulos (ID Rule Section 5.2.1)

D. DISCUSSION OF ANY ACTION ITEM REMOVED FROM THE CONSENT CALENDAR

E. PUBLIC COMMENT PERIOD
   Interested persons in the audience are welcome to introduce any topic within the District’s jurisdiction. Matters presented under this heading may be discussed, but no action will be taken by the Board at this meeting.

F. WEEKLY/MONTHLY REPORTS

   1. Line/Engineering Report
      - Denver Hodges, Line Department Manager

   2. Water Report
      - Olivia Cramer, Utility Analyst-Hydrology

   3. Water Distribution Update
      - Mike Kavarian, Water Distribution Department Manager

G. ACTION ITEMS

   1. Resolution Authorizing Survey and Preparation of Charges for Proposed Assessment of Proposed Inclusion into Improvement District No. 09960, Known as Baetsahen-Rude Pump
      Consider adoption of a resolution and receipt of petition, authorizing the survey and preparation of charges to include 29.50-acres of Merced County APN 045-150-020, and 8.80-acres of APN 045-150-021 into Improvement District No. 09960, known as the Baetsahen-Rude Pump, both parcels owned by Joseph S. and Teresa O. Pierce.
      - Mike Kavarian, Water Distribution Department Manager

   2. Resolution Setting a Public Hearing to Obtain Comments on Proposed Revisions to the TIDs Agricultural Water Management Plan
      Consider setting a public hearing on March 23, 2021 at 9:00 a.m. to receive comments on proposed revisions to the District’s Ag Water Management Plan; and authorize staff to make the Draft Plan available for public review on the District website, publish in the local newspaper, and notify other agencies as required by the Water Code.
      - Debbie Montalbano, Water Planning Department Manager
3. Resolution Authorizing the General Manager to Execute a Pilot Project Memorandum of Understanding Between the U.S. Fish and Wildlife Service, Modesto Irrigation District, Turlock Irrigation District and the City and County of San Francisco-Public Utilities Commission for Implementation of a Pilot Project to Improve Habitat on the Lower Tuolumne River

Consider authorizing the District’s General Manager to execute said Memorandum of Understanding which outlines the intention of the Parties (TID, MID, USFWS, CCSF-PUC) for cooperation and funding, general implementation guidelines, and other matters related to habitat improvement work on the Tuolumne River prior to issuance of a new license for the Don Pedro Project (FERC No.2299), and original license for the La Grange Project (FERC No.14581).

- Michael Cooke, Director of Water Resources and Regulatory Affairs

4. Motion Canceling the Regular TID Board Meeting of February 16, 2021

Consider the proposed cancellation of the February 16, 2021 regular TID Board Meeting.

H. GENERAL MANAGER’S UPDATE

I. BUSINESS OF THE BOARD

J. MOTION TO ADJOURN TO CLOSED SESSION

1. Conference with Legal Counsel – Anticipated Litigation

   California Government Code Section 54956.9(d)

   Anticipated Litigation – one potential case
   - Amy Petersen, Rates and Risks Department Manager
   - Brian Stubbert, CFO/AGM Financial Services
   - Joe Fagundes, Legal Counsel

K. REPORT OF ANY ACTION TAKEN IN CLOSED SESSION

L. MOTION TO ADJOURN

The next regular meeting is Tuesday, February 23, 2021 at 9:00 a.m. via Zoom Webinar.
Instructions for Participating in TID Board Meeting via Zoom Webinar or Phone

Using your desktop/laptop/iPad or tablet:

*If you have not used Zoom prior to this meeting, you may want to give yourself additional time to allow the program to install before joining the meeting.*

1. To join the webinar, click the link published in the Agenda for the current meeting about five minutes before webinar is scheduled to begin.
2. Follow the on-screen prompts/instructions to install or launch the Zoom application.
3. If prompted, enter the meeting number published in the Agenda.
4. All public attendees will enter the meeting muted.
5. If you wish to speak under the Public Comment Period or after the Board President calls for Public Comment, click on the “Raise Hand” button to request to speak.
   a. Wait until your name or other identifying information is called by the Board President.
   b. Your five (5) minutes for public comment will begin at that time.

Using your phone:

1. To join the meeting by phone, call the number published in the Agenda for the current meeting.
2. Enter the meeting number published in the Agenda, then press the # symbol.
3. All public attendees will enter the meeting muted.
4. If you wish to speak under the Public Comment Period or after the Board President calls for Public Comment on a specific agenda item, press *9 on your phone to “Raise Hand” to request to speak.
   a. Wait until the last four digits of your phone number is called by the Board President.
   b. Your five (5) minutes for public comment will begin at that time.

**If you have problems joining the webinar, please contact TID’s Information Technology Support Staff at 209.883.8411**
MINUTES OF THE
BOARD OF DIRECTORS MEETING
OF THE TURLOCK IRRIGATION DISTRICT

Turlock, California
26 January 2021

The meeting of the Board of Directors of the Turlock Irrigation District was called to order at 9:00 a.m. in regular session on the 26th day of January 2021. Present (via Zoom) were: Directors Rob Santos (President), Michael Frantz (Vice-President), Ron Macedo (Secretary), Charles Fernandes and Joe Alamo, General Manager Michelle Reimers and Executive Secretary to the Board Tami Wallenburg.

Board President Rob Santos read the following statement:
“This meeting is being conducted via webinar, pursuant to Executive Orders signed by Governor Newsom related to the ongoing Covid-19 pandemic, including provisions regarding the Brown Act. Members of the public will have the opportunity to provide public input via the webinar or phone features.”

SALUTE TO THE FLAG

MOTION APPROVING CONSENT CALENDAR

Moved by Director Fernandes, seconded by Director Macedo, that the consent calendar consisting of the following be approved:

1. Minutes of the regular meeting of January 12, 2021.
2. Demands against the District represented by check numbers 399454 to 399863, inclusive, in the amount of $34,226,347.72.
5. Approval of the following sidegate applications:
   - Application of 15-Inch Sidegate in Ceres Main Canal by Andrea Bilson
   - Application of 18-inch Sidegate in Lower Lateral 2 Canal by Rick Nutcher

All voted in favor with none opposed. The President declared the motion carried.

PUBLIC COMMENT PERIOD

Customer Milt Treiwieler questioned whether the approved sidegates listed under the Consent Calendar will have flow meters to which Water Distribution Department Manager Mike Kavarian conveyed that all new sidegates are required to have flow meters installed.
WEEKLY REPORT

Utility Analyst/Hydrology Olivia Cramer reported on current water conditions. Accumulated precipitation measured at the three mountain stations in the Tuolumne River watershed from September 1, 2020 to present total 6.29 inches, or 35.4 percent of normal to date (Note: The precipitation water year begins on September 1 each year). Forecasted precipitation for the next 6-days is showing up to 8.9 inches at Hetch Hetchy, 7.5 inches at Don Pedro and approximately 3.6 inches in the Modesto area. The US Model predicts up to 13 inches in the next 16-days while the European model shows up to 10-inches. Another atmospheric event is expected in February though it will be weaker than the upcoming storm over the next few days. Forecasted temperatures show the highs averaging 5-6 degrees below average for this time of year ranging from 50-59 degrees, and lows averaging lower than normal between 33-47 degrees. San Francisco reservoirs contain 401,068 acre-feet and the Water Bank is at 544,878 acre-feet of credit. CCSF releases for the past 7-days averaged at 435 cfs with 238 cfs in diversions. Don Pedro contains 1,364,917, acre-feet and is currently at 770 elevation. Average combined releases were 203 cubic feet per second with 01 cfs to TID canals, 23 cfs to Modesto Irrigation District and the remaining 178 cfs going to the Tuolumne River. Computed natural flow for the current water-year is averaging 109 cfs, and computed natural flow to date is 21,833 af or 7.1 percent of average. Turlock Lake contains 7,675 acre-feet of water. The updated weekly watershed report shows Don Pedro elevation remained steady when compared to the previous week. Board President Rob Santos asked how the precipitation numbers are calculated with Ms. Cramer responding the data is received from three station indexes in Sonora, Yosemite and Hetch Hetchy. The Board President asked for comments from the public, with Customer Milt Trewieler asking about snowpack figures to which Ms. Cramer responded.

IRRIGATION UPDATE

Water Distribution Department Manager Mike Kavarian presented an update on the upcoming irrigation season. Staff received a few calls from growers the first part of January but these have decreased with the current precipitation forecast. Canal maintenance projects have been put on hold due to the atmospheric event over the next few days. Mr. Kavarian recommended not implementing an early irrigation period which will allow crews to finish repairs on the Main Canal and various laterals after the storm passes.

POWER REPORT

Trading and Scheduling Department Manager Bill Bacca reviewed power operations for the month of December. The Balancing Authority Area daily estimated system peaks averaged 353 megawatts for the month. The load was met with Thermal at 37.2 percent, ACS Specified at 31.4 percent, Spot purchases at 9.5 percent and Wind Exchange at 6.9 percent. The Tuolumne Wind Project (TWP) generated 25,028 MWh’s during the month of December at the Willis Substation, averaging at 25 percent of capacity. Natural gas prices at Pacific Gas & Electric Company’s Citygate averaged out at $3.61/mmBTU. Thermal generation and implied heat rates for December show Walnut Energy Center at 36,750 MWh and Almond 2 Power Plant at 32,166 MWh. Mr. Bacca also reviewed Powerdex pricing for the month using the hour-ahead market index and CAISO’s day-ahead and hour-ahead market selling prices. Electric operations for this period show all of Walnut Energy Center out of service November 26 to December 13 for the annual inspection; WEC
Unit 1 was online December 16-31 and Unit 2 remains out of service through January 4, 2021 for extended maintenance; Almond ran for 29 days, a combination of operations and economics; Upper Main Canal will be out of service from December 11 to February 28; EMS cutover was the week of December 15; and Rosamond Solar was reduced to 78 percent capacity. Director Frantz questioned if the executive order by the new Biden administration to halt drilling on federal property would have an impact to the District with Mr. Bacca noting he would discuss with Resource Planning Department Manager Willie Manuel and would respond at that time. The Board President asked for comments from the public, and there were none.

RESOLUTION NO. 2021 - 3
RESOLUTION ADOPTING A PROFESSIONAL SERVICE AGREEMENT WITH RANDY FIORINI FOR WATER RESOURCES RELATED CONSULTING SERVICES

WHEREAS, the Turlock Irrigation District (“District”) is in the process of relicensing Don Pedro Dam and is simultaneously obtaining its first ever license for La Grange Dam from the Federal Energy Regulatory Commission (“FERC”); and

WHEREAS, a requirement for a FERC license is a water quality certification from the State Water Resources Control Board (“Water Board”) pursuant to Section 401 of the federal Clean Water Act; and

WHEREAS, in issuing a water quality certification, the Water Board will require that Turlock Irrigation District and Modesto Irrigation District (“Districts”) comply with the 30-50% unimpaired flow requirements of their adopted Bay Delta Plan; and

WHEREAS, the Water Board has authorized a Voluntary Agreement process as an alternative means for water agencies to comply with the Bay Delta Plan; and

WHEREAS, Mr. Randy Fiorini is vastly experienced in California water resources having been a 10-year member of the Delta Stewardship Council, a past president of ACWA, and a past president of the California Farm Water Coalition. Mr. Fiorini’s connections, knowledge and acumen have proven vital in the Districts obtaining direct access to those engaged in the Voluntary Agreement process, including members of the Governor’s cabinet; and

WHEREAS, Mr. Fiorini also provides a number of other consulting services under this contract including, but not limited to: FERC Licensing / Relicensing, strategic water partnerships, comprehensive water planning, and mentoring to TID’s management team.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Turlock Irrigation District that a professional services contract with Randy Fiorini for water resources related consulting services is hereby approved.

Moved by Director Macedo, seconded by Director Frantz, that the foregoing resolution be adopted.

Upon roll call the following vote was had:
Ayes: Directors Fernandes, Frantz, Alamo, Macedo, Santos
Noes: Directors - None
Absent: Directors - None

The President declared the resolution adopted.

**MOTION ACCEPTING TREASURER’S REPORT ON TURLOCK IRRIGATION DISTRICT’S INVESTMENT PORTFOLIO AND SUMMARY OF INVESTMENT ACTIVITY**

Moved by Frantz, seconded by Fernandes, that the Investment Portfolio dated December 31, 2020 which was prepared by Public Financial Management, Inc. for the Turlock Irrigation District (District) and reviewed by the Board of Directors be hereby accepted, and that the Board of Directors hereby acknowledges the opinion of Treasurer Brian Stubbert, confirming the Investment Portfolio is in compliance with the District’s Investment Policy and verifying the District has the ability to meet budgeted expenditures for the next six months.

All voted in favor with none opposed. The President declared the motion carried.

**MOTION CANCELING THE TURLOCK IRRIGATION DISTRICT REGULAR BOARD MEETING OF FEBRUARY 2, 2021**

Moved by Director Alamo, seconded by Director Macedo, that the regular meeting of the Board of Directors of the Turlock Irrigation District scheduled for February 2, 2021, be canceled.

All voted in favor with none opposed. The President declared the motion carried.

**AGRICULTURAL WATER MANAGEMENT PLAN WORKSHOP**

Water Planning Department Manager Debbie Montalbano presented information regarding proposed revisions to the District’s Ag Water Management Plan (AWMP). The purpose of the Plan is to evaluate the water suppliers system and operations to ensure the most efficient use of available water supplies. The current AWMP was updated in 2015 and requires an update every five years. She reviewed Water Budget Boundaries which gives an accounting of all water flowing into and out of a defined area over a specified period of time (months or years). Staff analyzes changing patterns such as irrigation methods, cropping patterns and water supply/demand. Ms. Montalbano then reviewed the amount of acres for specific crop types with trees/vineyards being the highest, followed by corn. Irrigation types show flood irrigation remaining predominate though there is a slight increase in micro drip systems. She continued reviewing data on water supply, agricultural pumping (TID, private and rented pumps) and recharge (seepage and deep percolation). Another area staff takes into account is Climate Change and staff continues to evaluate potential impacts based on available studies while acknowledging wet years will be wetter, and dry years will be drier. The implementation of SBX7-7 requires districts to evaluate and implement two types of Efficient Water Management Practices (EWMPs): 1) Delivery Management, and 2) Volumetric pricing, and 14 Conditional EWMPs (if locally cost effective and technically feasible) including canal automation, conjunctive use, recycled water use, ordering flexibility, and spill/tail water recovery to name a few. Drought impacts on water
supply and demand were experienced from 2012-2016 which resulted in reduced available supplies, increased Grower outreach and resources, and use of the Adaptive Management Program. Ms. Montalbano concluded noting the revised AWMP is currently being finalized and plans to return to the Board on February 9th to set a public hearing date of March 23 at 9 a.m. to receive comments from the public. Board members had several comments regarding recharge, pumping and potential impacts to the SRWA Regional Surface Water Project agreement during dry year scenarios. The Board President asked for comments from the public, with Customer Milt Treiwieler asking questions regarding the 48-inch irrigation water allocation in normal years and the cost of the Tier 4 water rate within the SRWA Agreement to which staff responded.

GENERAL MANAGER’S UPDATE

General Manager Michelle Reimers asked Director of Water Resources Michael Cooke to comment on the recent denial by FERC on the District’s waiver petition. The District will now need certification from the State Water Board and staff plans to meet with the legal team the following week to discuss best options in moving forward.

BUSINESS OF THE BOARD

Director Frantz stated he is excited about the incoming precipitation.

MOTION TO ADJOURN TO CLOSED SESSION

Moved by Director Fernandes, seconded by Director Frantz, that the regular meeting of the Board of Directors be adjourned to closed session:

1. Conference with Legal Counsel – Anticipated Litigation
California Government Code Section 54956.9(d)
Anticipated Litigation – one potential case
- Michael Cooke, Director of Water Resources and Regulatory Affairs
- Art Godwin, Legal Counsel

All voted in favor with none opposed. The President declared the motion carried.

REPORT OF ANY ACTION TAKEN IN CLOSED SESSION

The President announced no action was taken in closed session.

MOTION TO ADJOURN

Hearing no further business, Director Alamo motioned, seconded by Director Frantz, that the regular meeting of the Board of Directors be adjourned.

All voted in favor with none opposed. The President declared the motion carried.

Executive Secretary to the Board of Directors
# Turlock Irrigation District
## Check Register
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## Turlock Irrigation District
### Check Register
#### 2/9/2021 - 2/9/2021

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## Turlock Irrigation District
### Check Register
#### 2/9/2021 - 2/9/2021

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Count: 180  
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# Turlock Irrigation District
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Count: 170

$3,118,642.74

Total Number of Checks: 172
Total Amount: $8,045,955.03
TO: Board of Directors

DATE: February 2, 2021

PREPARED BY: Carrie A. Kostecky

RE: Agreements to Abandon Use of Improvement District Facilities

Action Requested
Board approval during the meeting of February 9, 2021, of Agreements to Abandon Use of Improvement District Facilities from 3 improvement districts.

Discussion
Owners of the parcels listed below have requested abandonment from the listed improvement districts since they no longer use these improvement district facilities. Easements have been obtained where improvement district facilities exist on or adjacent to an abandoning parcel. Fees for qualifying parcels have been waived in accordance with Turlock Irrigation District (TID) Improvement District Rules, Section 5.1.3.1. All remaining parcels have paid prior year assessments, construction assessments, and water charges as a condition of abandonment.

These abandonments, representing 39.36 acres, to be acted upon by the Board. Section 5.2 of the TID Improvement District Rules allows parcels to abandon from improvement districts under the following circumstances:

- Parcels greater than one acre that are developing or are completely developed
- Non-urban parcels less than or equal to one acre
- Urban parcels five acres or less
- Agricultural parcels that receive District surface water through privately owned facilities or through the facilities of another improvement district.

One abandonment is for a parcel of land that is required to abandon or qualifies to abandon under TID Improvement District Rules for developing parcels. Where required, the developer is constructing improvements to development standards on the improvement district facilities.

APN: 086-014-028
G3 Enterprises, Inc.
38.96 Acres
ID No. 01980, Rogers
ID No. 03730, Lower Rogers

One abandonment is for urban parcels that are five acres or less that no longer utilize the improvement district facility of which they are members. This parcel is permitted to abandon under TID Improvement District Rules for urban parcels five acres or less.

APN: 127-052-036
Papadopoulos, Stelios
0.40 Acres
ID No. 06940, Stokes
ABANDONMENT REQUEST:
APN: 086-014-028

APN: 086-014-028
G3 ENTERPRISES INC.
36.96 ACRES
WHITMORE AVENUE, MODESTO

THIS PARCEL IS FULLY DEVELOPED.
A WAREHOUSE HAS BEEN BUILT ON
THE PARCEL.

THE DEVELOPER HAS REMOVED THE
PIPE AND SEALED AT THE NE CORNER OF
THE PARCEL.
AGREEMENT TO ABANDON USE OF IMPROVEMENT DISTRICT FACILITY

WHEREAS, Improvement District No. 01980, known as the Rogers, and Improvement District No. 03730, known as the Lower Rogers are improvement districts organized and existing under an Act of the Legislature of the State of California, known and designated as the "Irrigation District Improvement Act," which improvement districts are within the boundary of the Turlock Irrigation District; and

WHEREAS, G3 Enterprises, Inc., a Delaware corporation, the owner of the following described real property situated in the County of Stanislaus, State of California:

See Attached Exhibit "A"

APN: 086-014-028 38.96 Acres

AND WHEREAS, in the matter of Improvement District No. 01980, known as the Rogers and Improvement District No. 03730, known as the Lower Rogers within the boundary of the Turlock Irrigation District, the said land was included within the boundary of the said Improvement District Nos. 01980 and 03730, the owner now desires to withdraw the same.

NOW THEREFORE, in consideration of the Board of Directors of the Turlock Irrigation District permitting the withdrawal of the said land from the said Improvement District Nos. 01980 and 03730, the owner herein above named, G3 Enterprises, Inc., a Delaware corporation, does hereby forever relinquish and abandon to Improvement District No. 01980, known as the Rogers and Improvement District No. 03730, known as the Lower Rogers, and existing within the boundary of the Turlock Irrigation District, any right to use the facility or improvements of the said Improvement District Nos. 01980 and 03730, for the purpose of irrigating or draining any of the above described property.

This agreement is to apply to and bind the successors in interest and the assigns of the parties hereto.

IN WITNESS WHEREOF the said owner has hereunto set his hand this

[Signature]

6 day of October, 2020

Kevin Luttenegger, VP of Real Estate

G3 Enterprises, Inc., a Delaware corporation

Attach Notary Acknowledgment
ACKNOWLEDGMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California
County of Stanislaus

On October 6, 2020 before me, Christina L. Tyler - Notary Public

(insert name and title of the officer)

personally appeared Kevin Luftengger, who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

[Signature]

(Seal)

[Notary Seal]

[Notary Public Information]
ABANDONMENT REQUEST
APN: 127-052-036

ID NO. 06940
STOKES

APN: 127-052-036
PAPADOPOULOS
0.40 ACRES
2617 LAWRENCE STREET, CERES

THIS PARCEL HAS NO ACCESS TO
IRRIGATION WATER.
AGREEMENT TO ABANDON USE OF IMPROVEMENT DISTRICT FACILITY

WHEREAS, Improvement District No. 06940, known as Stokes, is an improvement district organized and existing under an Act of the Legislature of the State of California, known and designated as the "Irrigation District Improvement Act," which improvement districts are within the boundary of the Turlock Irrigation District; and

WHEREAS, Stelios Papadopoulos as Trustee of the Stelios Papadopoulos Revocable Trust Dated October 17, 2017, the owner of the following described real property situated in the City of Ceres, County of Stanislaus, State of California:

See Attached Exhibit "A"

APN: 127-052-036 0.40 Acres

AND WHEREAS, in the matter of Improvement District No. 06940, known as the Stokes within the boundary of the Turlock Irrigation District, the said land was included within the boundary of the said Improvement District No. 06940, the owner now desires to withdraw the same.

NOW THEREFORE, in consideration of the Board of Directors of the Turlock Irrigation District permitting the withdrawal of the said land from the said Improvement District No. 06940, the owner herein above named, Stelios Papadopoulos as Trustee of the Stelios Papadopoulos Revocable Trust Dated October 17, 2017, does hereby forever relinquish and abandon to Improvement District No. 06940, known as Stokes, and existing within the boundary of the Turlock Irrigation District, any right to use the facilities or improvements of the said Improvement District No. 06940, for the purpose of irrigating or draining any of the above described property.

This agreement is to apply to and bind the successors in interest and the assigns of the parties hereto.

IN WITNESS WHEREOF the said owner has hereunto set his hand this

23rd day of November, 2020

Stelios Papadopoulos, Trustee
Stelios Papadopoulos Revocable Trust Dated
October 17, 2017

Attach Notary Acknowledgment
EXHIBIT "A"

THE LAND REFERRED TO HEREIN BELOW IS SITUATED IN THE CITY OF CERES, COUNTY OF STANISLAUS, STATE OF CALIFORNIA, AND IS DESCRIBED AS FOLLOWS:

That portion of Lot 13 of the Smyre Park Tract, as per map filed February 21, 1903 in Vol. 1 of Maps, Page 79, Stanislaus County Records, described as follows:

Commencing at the Northwesterly corner of said Lot 13, said corner being a point on the North-South quarter section line through Section 14, Township 4 South, Range 9 East, Mount Diablo Base and Meridian and a point on the center line of Smyre Street, as shown on the map of Marrow Tract No. 2 filed in Vol. 16 of Maps, Page 69; thence from said point of commencement along the Northernly line of Lot 13 North 89° 57' 10" East 330 feet to the Northeast corner of the property conveyed to Grabender Daniel and his wife by deed recorded August 12, 1957 as Instrument No. 22465; said point being on the center line of a 40 foot road (since abandoned) running North and South through said Lot 13 as shown on the map of Smyre Park Tract; thence South 0° 15' 20" East along the center line of said Daniel property and being the center line of said abandoned road 97.2 feet to the Southeast corner of said Daniel property and being the point of beginning of this description; thence conveying South 0° 15' 20" East along the center line of said abandoned county road 208.71 feet to the North line of the county road conveyed to the county of Stanislaus by deed recorded June 29, 1956 as Instrument No. 2969; thence South 89° 57' 20" West along the North line of said county road 91.29 feet to the Southeast corner of the property conveyed to Cerise American Legion Post 849, Inc., by deed recorded May 21, 1955 as Instrument No. 3218; thence North 0° 15' 20" West along the East line of said "Legion" property 208.71 feet to the Northeast corner being a point on the South line of said Daniel property; thence North 89° 57' 20" East along the South line of said Daniel property 91.29 feet to the point of beginning.
CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California
County of _______________  

On _______________ before me, ____________________________ Notary Public
personally appeared ____________________________

who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

______________________________
Signature of Notary Public

Place Notary Seal Above

OPTIONAL

Though this section is optional, completing this information can deter alteration of the document or fraudulent reattachment of this form to an unintended document.

Description of Attached Document

Title or Type of Document: __________________
Number of Pages: ________
Signer(s) Other Than Named Above: __________________

Capacity(ies) Claimed by Signer(s)

Signer’s Name:
☐ Corporate Officer — Title(s):
☐ Limited ☐ General
☐ Individual ☐ Attorney in Fact
☐ Trustee ☐ Guardian or Conservator
☐ Other:
Signer is Representing: __________________

Signer’s Name:
☐ Corporate Officer — Title(s):
☐ Limited ☐ General
☐ Individual ☐ Attorney in Fact
☐ Trustee ☐ Guardian or Conservator
☐ Other:
Signer is Representing: __________________

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WATER RESOURCES ADMINISTRATION

MEMORANDUM

TO: Board of Directors

DATE: February 1, 2021

PREPARED BY: Carrie A. Kostecky

RE: Petition for Inclusion
   Into Improvement District No. 09960

Action Requested
Receipt of Petition and adoption of Resolution during the meeting of February 9, 2021, authorizing
the survey and preparation of charges for proposed inclusions into Improvement District (ID) No.
09960, known as Baetsahen-Rude Pump

Discussion
Attached is a petition to include Merced County Assessor’s Parcel Numbers (APN) M045-150-020,
containing 29.50 acres, and M045-150-021, containing 8.80 acres, both parcels owned by Joseph S.
Pierce and Teresa O. Pierce, into ID No. 09960, known as Baetsahen-Rude Pump. Inclusion of
these parcels will allow the owner to use the Baetsahen-Rude Pump to receive irrigation water from Lateral 7 through Side Gate 08-05.

A preliminary investigation shows that the improvement district facility can support irrigating the
parcel. The Report of Survey will detail this further.

In order for a parcel to use improvement district facilities, it must first be a member of that
improvement district. This is a request for that membership. The petition contains the following:

a) Statement of use,
b) Name of the owner including land into the improvement district,
c) Description of the land to be included into the improvement district,
d) Map of the improvement district, including the parcels to be included, and
e) Signature of the petitioner

<table>
<thead>
<tr>
<th>Presenter</th>
<th>Dept. Manager</th>
<th>Assistant GM</th>
<th>General Manager/COO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature/Date: Mike Kavarian 2/2/21</td>
<td>Signature/Date: Mike Kavarian 2/2/21</td>
<td>Signature/Date:</td>
<td>Signature/Date:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Van N.</td>
<td>Michelle R.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2/2/21</td>
<td>2/4/2021</td>
</tr>
</tbody>
</table>
RESOLUTION NO. 2021 -

RESOLUTION ADOPTING AUTHORIZING SURVEY AND PREPARATION OF CHARGES FOR PROPOSED ASSESSMENT OF PROPOSED INCLUSIONS INTO IMPROVEMENT DISTRICT NO. 09960, BAETSAHEN-RUDE PUMP

WHEREAS, a petition for the inclusion of additional land into Improvement District No. 09960, having been received by the Board of Directors of the Turlock Irrigation District, which petition was properly filed and signed by the owner of the additional land in accordance with California Water Code Section 23875-23876.

NOW, THEREFORE, BE IT HEREBY RESOLVED ORDERED that the Turlock Irrigation District's Water Resources Administration make a survey of the proposed inclusion. If, upon completion of such survey, the Water Resources Administration finds that the proposed inclusion is feasible, the Water Resources Administration is further ordered to prepare a statement of the proposed charge for such inclusion according to the benefits that will accrue to each parcel of land proposed to be included into the improvement districts.

IT IS FURTHER ORDERED that any survey and statement of proposed charge prepared pursuant to this resolution be filed with the Executive Secretary of the Turlock Irrigation District and said documents shall be subject to the inspection of all interested parties.

Moved by Director , seconded by Director , that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes: Directors
Noes: Directors
Absent: Directors

The President declared the resolution ____________.

I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 9th day of February, 2021.

__________________________________
Executive Secretary to the Board of Directors of the Turlock Irrigation District
PETITION FOR THE INCLUSION OF LANDS
INTO IMPROVEMENT DISTRICT NO. 09960, Baetsahen-Rude Pump
TO THE HONORABLE BOARD OF DIRECTORS OF THE TURLOCK IRRIGATION DISTRICT:

We, the undersigned petitioners, do hereby petition your Honorable Board of Directors for the inclusion of our lands into Improvement District No. 09960, granting us the right to use the facilities of said Improvement Districts for the purpose of irrigation.

NAME AND ADDRESS OF ALL OWNERS OF INTEREST IN THE PROPERTIES:

Joseph S. Pierce, Trustee
Teresa O. Pierce, Trustee
The Pierce 2005 Living Trust
19254 August Avenue
Hilmar, CA  95324-9302

DESCRIPTION OF TWO PARCELS TO BE INCLUDED:

The following described real property in the County of Merced, State of California:

The East three-quarters of the Southwest quarter of the Southeast quarter of Section 11, Township 6 South, Range 10 East, Mount Diablo Base and Meridian

APN:  M045-150-020
19372 August Avenue, Hilmar, CA

The following described real property in the County of Merced, State of California:

The West quarter of the Southwest quarter of the Southeast quarter of Section 11, Township 6 South, Range 10 East Mount Diablo Base and Meridian.

EXCEPT THEREFROM that portion thereof conveyed to Turlock Irrigation District by grant from Edwin Caristrom, dated March 11, 1912 and recorded March 28, 1912 in Volume 90 of Deeds at page 593, described as follows:

A strip of land 35 feet wide, the center line of which is described as follows:

BEGINNING at a point which 17.5 feet West of the Northwest corner of the Southwest quarter of the Southeast quarter of Section 11, Township 6 South, Range 10 East, Mount Diablo Base and Meridian; thence South and parallel to the West line of said quarter section to a point 17.5 feet East of the Southwest corner of said Southeast quarter of said Section 11.

ALSO EXCEPT THEREFROM the South 20 feet thereof.

APN:  M045-150-021
August Avenue, Hilmar, CA
The entire improvement district and the parcels requesting inclusion are shown on the attached map.

It is understood and agreed that we are to pay the future assessments that may be levied by the Turlock Irrigation District Board of Directors for maintenance and operation of the improvement district facilities, as well as the Inclusion Fee and the cost of preparation of the Report of Survey for the proposal.

Signed this ______ day of ____________________________ 20__. 

____________________________________
Joseph S. Pierce, Trustee
The Pierce 2005 Living Trust

____________________________________
Teresa O. Pierce, Trustee
The Pierce 2005 Living Trust
PETITION FOR THE INCLUSION OF LANDS

INTO IMPROVEMENT DISTRICT NO. 09960, Baetsahen-Rude Pump

TO THE HONORABLE BOARD OF DIRECTORS OF THE TURLOCK IRRIGATION DISTRICT:

We, the undersigned petitioners, do hereby petition your Honorable Board of Directors for the inclusion of our lands into Improvement District No. 09960, granting us the right to use the facilities of said Improvement Districts for the purpose of irrigation.

NAME AND ADDRESS OF ALL OWNERS OF INTEREST IN THE PROPERTIES:

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ALSO EXCEPT THEREFROM the South 20 feet thereof.

APN: M045-150-021
August Avenue, Hilmar, CA

The entire improvement district and the parcels requesting inclusion are shown on the attached map.

It is understood and agreed that we are to pay the future assessments that may be levied by the Turlock Irrigation District Board of Directors for maintenance and operation of the improvement district facilities, as well as the Inclusion Fee and the cost of preparation of the Report of Survey for the proposal.

Signed this 25 day of January 2020

Joseph S. Pierce, Trustee
The Pierce 2005 Living Trust

Teresa O. Pierce, Trustee
The Pierce 2005 Living Trust
TO: Board of Directors
DATE: February 1, 2021
PREPARED BY: Debbie Montalbano
RE: Ag Water Management Plan

Action Requested
Adoption of a Resolution setting a public hearing for March 23, 2021 to obtain public comment on proposed revisions to the Turlock Irrigation District’s Agricultural Water Management Plan.

Discussion
In November of 2009, the California legislature adopted SBx7-7, making it mandatory for all agricultural agencies serving over 25,000 acres to develop an Agricultural Water Management Plan (AWMP). SBx7-7 required plans to be adopted by December 31, 2012, and then updated by December 31, 2015, and every five (5) years thereafter. TID’s most recent plan was adopted in November 2015.

SBx7-7 requires agencies to develop an AWMP and take reasonable steps to implement the plan. Plans are submitted to and reviewed by the California Department of Water Resources (DWR). There are specific required components including a water budget analysis, a climate change assessment, drought management plan, and implementation of Efficient Water Management Practices (EWMPs). Agencies without an approved plan are not eligible for state funding. Additionally, agencies not submitting a plan will have a plan prepared for them, by a consultant procured by DWR, at the agency’s expense.

A draft AWMP has been developed that proposes an integrated approach to meeting all of the planning requirements. Included in the draft plan is a discussion of TID’s status regarding each of the Efficient Water Management Practices. Through a combination of the EWMP analyses, and a discussion of TIDs programs and practices, the Plan illustrates how water is put to beneficial use within the District boundaries, and how irrigation provides critical recharge within the Subbasin.

A key component of the AWMP is the water budget, which provides a unified framework for linking measured inflows and outflows, resulting in a comprehensive overview of water use District-wide. This framework provides insightful analysis of the likely effects of implementation the various Efficient Water Management Practices (EWMPs).

In interpreting the results of the water budget, and understanding water management within TID, it is vital to also consider water management in a regional context. Surface irrigation within TID is the primary source of recharge within the Turlock Groundwater Subbasin. A cone of depression has
formed on the eastern side of the subbasin where surface water is not available and groundwater is the only water supply for irrigation and other uses. TID’s import of surface water and its conjunctive management practices help support the municipal, agricultural and industrial users of groundwater both within the District and beyond its borders. The water budget shows the importance of continuing conjunctive management programs, and encouraging groundwater recharge through use of surface water supplies. Analyses of efficient water management practices within the draft revised AWMP include a review of the impacts associated with changes in practices to promote or encourage water conservation.

While preserving the practices that promote conjunctive use and groundwater recharge, the draft AWMP identifies several areas to continue efforts toward improved water management, including, but not limited to: continued water measurement from both sidegates and irrigation pumps; implementation of a pricing structure that facilitates conjunctive use; continued support of the CIMIS station, and other measures to enable growers to schedule irrigations efficiently; ongoing canal maintenance; various infrastructure improvements; maintenance and improvement in canal telemetry and automation; development of advanced watershed modeling and forecasting; and ongoing funding of improvement district facilities. Each of these measures will further improve water management within TID, consistent with the EWMPs and the requirements established by SBx7-7.

SBx7-7 requires that prior to adopting the AWMP, TID must make the proposed plan available for public inspection, and hold a public hearing on the plan. Prior to the hearing, notice of the time and place of hearing must also be published as specified.

**Recommendation**

It is recommended that the Board of Directors adopt the proposed Resolution setting a Public Hearing for March 23, 2021, and authorize staff to make the draft revised plan available for public review on TID’s website, publish the notice in the local paper, and notify other local agencies as required by the Water Code.
RESOLUTION NO. 2021 -

RESOLUTION SETTING A PUBLIC HEARING FOR MARCH 23, 2021 TO OBTAIN PUBLIC COMMENT ON PROPOSED REVISIONS TO THE TURLOCK IRRIGATION DISTRICT’S AGRICULTURAL WATER MANAGEMENT PLAN

WHEREAS, the Board of Directors of the Turlock Irrigation District adopted the existing Agricultural Water Management Plan in pursuant to the Water Code Section 10800, et. seq., Section 10900, and Section 10608.48 of the Water Code; and

WHEREAS, staff has prepared an update to the Plan as required; and

WHEREAS, staff recommends that the Board hold a noticed public hearing on adopting a revised Agricultural Water Management Plan to amend and supersede the existing Plan pursuant to Water Code Section 10841.

IT IS HEREBY ORDERED by the Board of Directors of the Turlock Irrigation District that a public hearing shall be held to allow public comment on the amended Agricultural Water Management Plan which will supersede the existing Agricultural Water Management Plan at 9:00 a.m. on the 23rd of March, 2021 via webinar pursuant to Executive Orders signed by Governor Gavin Newsom (including provisions regarding the Brown Act), and that proper and timely notice of said public hearing shall be given in accordance with Section 6066 of the Government Code and Section 10821 of the Water Code. Members of the public will have the opportunity to provide public input via the webinar and phone features. Instruction to access the meeting and the hearing will be included in the meeting Agenda posted on TID’s website (www.tid.org) prior to the meeting, and on the meeting Agenda posted outside the Turlock Irrigation District main office (at 333 East Canal Drive, in Turlock, CA).

Moved by Director , seconded by Director , that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes: Directors
Noes: Directors
Absent: Directors

The President declared the resolution ________.

I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 9th day of February, 2021.

__________________________________
Executive Secretary to the Board of Directors of the Turlock Irrigation District
TURLOCK IRRIGATION DISTRICT

2020 AGRICULTURAL WATER MANAGEMENT PLAN

PUBLIC REVIEW DRAFT

Prepared by:
Turlock Irrigation District
333 E. Canal Drive
Turlock, CA  95380

(Anticipate to be) March 2021

Prepared for compliance with:
The Water Conservation Act of 2009 (Senate Bill x7-7) and the 2018 Water Conservation Legislation (Assembly Bill 1668 and Senate Bill 606)
Preface

This Agricultural Water Management Plan (AWMP or Plan) has been prepared by Turlock Irrigation District (TID or District) in accordance with the requirements of the Water Conservation Act of 2009 (SBx7-7) and the 2018 Water Conservation Legislation (AB 1668 and SB 606). TID supplies agricultural water to more than 130,000 acres, and is therefore required by California law to adopt and implement an AWMP and submit the AWMP to the California Department of Water Resources (DWR).

SBx7-7 modified Division 6 of the California Water Code (CWC or Code), adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800). In particular, SBx7-7 requires all agricultural water suppliers to prepare and adopt an update to their AWMP as set forth in the CWC and the California Code of Regulations (CCR) on or before December 31, 2015. The Plan must be updated every 5 years thereafter (§10820 (a)). Additionally, the CWC requires suppliers to implement certain efficient water management practices (EWMPs).

The 2018 Water Conservation Legislation (AB 1668 and SB 606) updated the 2009 Water Management Planning Act to provide more information and analysis regarding the agricultural water supplier’s system management and evaluation.

This Plan is the 5-year update to the TID AWMP, last adopted and submitted to DWR in 2015 in accordance with SBx7-7. This update to the AWMP must be adopted by April 1, 2021, and electronically submitted to DWR no later than 30 days after adoption.

The main resources used to develop this 2020 Plan were the CWC itself, the 2015 Guidebook, the updated Public Review Draft 2020 Guidebook (when it became available in August 2020), and the relevant sections of the CCR. A cross-reference identifying the location(s) in the AWMP within which each of the applicable requirements of SBx7-7 and the corresponding sections of the CWC and CCR is addressed is provided on the following pages. This cross-reference is intended to support efficient review of the AWMP to verify compliance with the Law.
## AWMP Checklist

### Cross Reference Table of Turlock Irrigation District 2020 Agricultural Water Management Plan to Relevant Sections of the California Water Code

<table>
<thead>
<tr>
<th>AWMP Section</th>
<th>Guidebook Location</th>
<th>Description</th>
<th>Water Code Section (or as identified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>1.4</td>
<td>AWMP Required?</td>
<td>10820, 10608.12</td>
</tr>
<tr>
<td>Preface; 2.1</td>
<td>1.4</td>
<td>At least 25,000 irrigated acres</td>
<td>10853</td>
</tr>
<tr>
<td>N/A</td>
<td>1.4</td>
<td>10,000 to 25,000 acres and funding provided</td>
<td>10853</td>
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<tr>
<td>Preface; 1.3.1</td>
<td>1.4</td>
<td>April 1, 2021 update</td>
<td>10820 (a)</td>
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<tr>
<td>Preface; 1.3.2</td>
<td>1.4 A.2</td>
<td><strong>Added to the Water Code:</strong> New to the Water Code: AWMP submitted to DWR no later than 30 days after adoption; AWMP submitted electronically</td>
<td>10820(a)(2)(B)</td>
</tr>
<tr>
<td>Preface</td>
<td>1.4 B</td>
<td>5-year cycle update</td>
<td>10820 (a)</td>
</tr>
<tr>
<td>N/A</td>
<td>1.4 B</td>
<td>New agricultural water supplier after December 31, 2012 - AWMP prepared and adopted within 1 year</td>
<td>10820 (b)</td>
</tr>
<tr>
<td>N/A</td>
<td>1.6, 5</td>
<td>USBR water management/conservation plan:</td>
<td>10828(a)</td>
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<tr>
<td>N/A</td>
<td>1.6, 5.1</td>
<td>Adopted and submitted to USBR within the previous four years, AND</td>
<td>10828(a)(1)</td>
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<tr>
<td>N/A</td>
<td>1.6, 5.1</td>
<td>The USBR has accepted the water management/conservation plan as adequate</td>
<td>10828(a)(2)</td>
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<td>N/A</td>
<td>1.4 B</td>
<td>UWMP or participation in area wide, regional, watershed, or basin wide water management planning: does the plan meet requirements of SB X7-7 2.8</td>
<td>10829</td>
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<td>1.1</td>
<td>3.1A</td>
<td>Description of previous water management activities</td>
<td>10826(d)</td>
</tr>
<tr>
<td>1.2.2; Table 1.1; Appendix A</td>
<td>3.1 B.1</td>
<td>Was each city or county within which supplier provides water supplies notified that the agricultural water supplier will be preparing or amending a plan?</td>
<td>10821(a)</td>
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<tr>
<td>1.2.2; 1.3.3; Table 1.1; Appendix A</td>
<td>3.2 B.2</td>
<td>Was the proposed plan available for public inspection prior to plan adoption?</td>
<td>10841</td>
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<tr>
<td>AWMP Section</td>
<td>Guidebook Location</td>
<td>Description</td>
<td>Water Code Section (or as identified)</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>1.2.2; Table 1.1; Appendix A</td>
<td>3.1 B.2</td>
<td>Publicly-owned supplier: Prior to the hearing, was the notice of the time and place of hearing published within the jurisdiction of the publicly owned agricultural water supplier in accordance with Government Code 6066?</td>
<td>10841</td>
</tr>
<tr>
<td>1.2.2; Table 1.1; Appendix A</td>
<td>3.1 B.2</td>
<td>14 days notification for public hearing</td>
<td>GC 6066</td>
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<tr>
<td>1.2.2; Table 1.1; Appendix A</td>
<td>3.1 B.2</td>
<td>Two publications in newspaper within those 14 days</td>
<td>GC 6066</td>
</tr>
<tr>
<td>1.2.2; Table 1.1; Appendix A</td>
<td>3.1 B.2</td>
<td>At least 5 days between publications? (not including publication date)</td>
<td>GC 6066</td>
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<tr>
<td>N/A</td>
<td>3.1 B.2</td>
<td>Privately-owned supplier: was equivalent notice within its service area and reasonably equivalent opportunity that would otherwise be afforded through a public hearing process provided?</td>
<td>10841</td>
</tr>
<tr>
<td>1.3.1; Appendix A; Table 1.1</td>
<td>3.1 C.1</td>
<td>After hearing/equivalent notice, was the plan adopted as prepared or as modified during or after the hearing?</td>
<td>10841</td>
</tr>
<tr>
<td>1.3.2; Table 1.1; Appendix A</td>
<td>3.1 C.2</td>
<td>Was a copy of the AWMP, amendments, or changes, submitted to the entities below, no later than 30 days after the adoption?</td>
<td>10843(a)</td>
</tr>
<tr>
<td>1.3.2; Table 1.1; Appendix A</td>
<td>3.1 C.2</td>
<td>The department.</td>
<td>10843(b)(1)</td>
</tr>
<tr>
<td>1.3.3; Table 1.1; Appendix A</td>
<td>3.1 C.2</td>
<td>Any city, county, or city and county within which the agricultural water supplier provides water supplies.</td>
<td>10843(b)(2)</td>
</tr>
<tr>
<td>1.3.3; Table 1.1; Appendix A</td>
<td>3.1 C.2</td>
<td>Any groundwater management entity within which jurisdiction the agricultural water supplier extracts or provides water supplies.</td>
<td>10843(b)(3)</td>
</tr>
<tr>
<td>1.3.2; 1.3.3; Table 1.1; Appendix A</td>
<td>3.1 C.3</td>
<td>Adopted AWMP availability</td>
<td>10844</td>
</tr>
<tr>
<td>1.3.3; Table 1.1; Appendix A</td>
<td>3.1 C.3</td>
<td>Was the AWMP available for public review on the agricultural water supplier’s Internet Web site within 30 days of adoption?</td>
<td>10844(a)</td>
</tr>
<tr>
<td>AWMP Section</td>
<td>Guidebook Location</td>
<td>Description</td>
<td>Water Code Section (or as identified)</td>
</tr>
<tr>
<td>--------------</td>
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<td>---------------------------------------</td>
</tr>
<tr>
<td>1.3.2; Table 1.1; Appendix A</td>
<td>3.1 C.3</td>
<td>If no Internet Web site, was an electronic copy of the AWMP submitted to DWR within 30 days of adoption?</td>
<td>10844(b)</td>
</tr>
<tr>
<td>1.4</td>
<td>3.1 D.1</td>
<td>Implement the AWMP in accordance with the schedule set forth in its plan, as determined by the governing body of the agricultural water supplier.</td>
<td>10842</td>
</tr>
<tr>
<td>2</td>
<td>3.3</td>
<td>Description of the agricultural water supplier and service area including:</td>
<td>10826(a)</td>
</tr>
<tr>
<td>2.1.1</td>
<td>3.3 A.1</td>
<td>Size of the service area.</td>
<td>10826(a)(1)</td>
</tr>
<tr>
<td>2.1.2; Appendix D</td>
<td>3.3 A.2</td>
<td>Location of the service area and its water management facilities.</td>
<td>10826(a)(2)</td>
</tr>
<tr>
<td>2.1.3</td>
<td>3.3 A.3</td>
<td>Terrain and soils.</td>
<td>10826(a)(3)</td>
</tr>
<tr>
<td>2.1.4</td>
<td>3.3 A.4</td>
<td>Climate.</td>
<td>10826(a)(4)</td>
</tr>
<tr>
<td>2.2.1</td>
<td>3.3 B.1</td>
<td>Operating rules and regulations.</td>
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<td>ACWA</td>
<td>Association of California Water Agencies</td>
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<td>Ac</td>
<td>acre</td>
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<td>AF</td>
<td>acre-feet</td>
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<td>APAP</td>
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<td>Dissolved Oxygen</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>DPaw</strong></td>
<td>Deep percolation of applied water</td>
</tr>
<tr>
<td><strong>DPpr</strong></td>
<td>Deep percolation of precipitation</td>
</tr>
<tr>
<td><strong>DWR</strong></td>
<td>Department of Water Resources</td>
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<td><strong>EC</strong></td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td><strong>ESJWQC</strong></td>
<td>East San Joaquin Water Quality Coalition</td>
</tr>
<tr>
<td><strong>ESRIRWMP</strong></td>
<td>East Stanislaus Region Integrated Regional Water Management Plan</td>
</tr>
<tr>
<td><strong>ET</strong></td>
<td>Evapotranspiration</td>
</tr>
<tr>
<td><strong>ETa</strong></td>
<td>Actual Evapotranspiration</td>
</tr>
<tr>
<td><strong>ETaw</strong></td>
<td>Evapotranspiration of applied water</td>
</tr>
<tr>
<td><strong>ETc</strong></td>
<td>Crop evapotranspiration</td>
</tr>
<tr>
<td><strong>ETo</strong></td>
<td>Reference evapotranspiration</td>
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<tr>
<td><strong>ETpr</strong></td>
<td>Evapotranspiration of precipitation</td>
</tr>
<tr>
<td><strong>EWMP</strong></td>
<td>Efficient Water Management Practice</td>
</tr>
<tr>
<td><strong>FAO</strong></td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td><strong>FC</strong></td>
<td>Field capacity</td>
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<tr>
<td><strong>F-CO</strong></td>
<td>Forecast-Coordinated Operations</td>
</tr>
<tr>
<td><strong>FERC</strong></td>
<td>Federal Energy Regulatory Commission</td>
</tr>
<tr>
<td><strong>FIRO</strong></td>
<td>Forecast Informed Reservoir Operations</td>
</tr>
<tr>
<td><strong>GAR</strong></td>
<td>Groundwater Assessment Report</td>
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<tr>
<td><strong>GCMs</strong></td>
<td>Global Climate Models</td>
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<td><strong>GDD</strong></td>
<td>growing degree day</td>
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<td><strong>GSA</strong></td>
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<td><strong>GSP</strong></td>
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<td><strong>GWMP</strong></td>
<td>Groundwater Management Plan</td>
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<tr>
<td><strong>ID</strong></td>
<td>Improvement District</td>
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<tr>
<td><strong>IDC</strong></td>
<td>Integrated Water Flow Model Demand Calculator</td>
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<tr>
<td><strong>IFMP</strong></td>
<td>Irrigation Facilities Master Plan</td>
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<tr>
<td><strong>ILRP</strong></td>
<td>Irrigated Lands Regulatory Program</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
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</tr>
<tr>
<td>ITRC</td>
<td>Irrigation Training and Research Center</td>
</tr>
<tr>
<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
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<tr>
<td>K\textsubscript{sat}</td>
<td>Saturated hydraulic conductivity</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Groundwater Assistance</td>
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<tr>
<td>M&amp;I</td>
<td>Municipal and Industrial</td>
</tr>
<tr>
<td>METRIC</td>
<td>Mapping Evapotranspiration at High Resolution using Internalized Calibration</td>
</tr>
<tr>
<td>MID</td>
<td>Modesto Irrigation District</td>
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<td>MOU</td>
<td>Memorandum of Understanding</td>
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<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<tr>
<td>NCSS</td>
<td>National Cooperative Soil Survey</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
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<tr>
<td>NIWR</td>
<td>Net Irrigation Water Requirements</td>
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<tr>
<td>NMP</td>
<td>Nitrogen Management Plan</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
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<tr>
<td>NRCS</td>
<td>Natural Resources Conservation Service</td>
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<tr>
<td>ppm</td>
<td>parts per million</td>
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<tr>
<td>PU608</td>
<td>Planning Unit 608</td>
</tr>
<tr>
<td>PWP</td>
<td>Permanent wilting point</td>
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<tr>
<td>RWQCB</td>
<td>Regional Water Quality Control Board</td>
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<tr>
<td>SBx7-7</td>
<td>Water Conservation Act of 2009</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SCS</td>
<td>Soil Conservation Service</td>
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<td>SEBAL</td>
<td>Surface Energy Balance Algorithm for Land</td>
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<tr>
<td>SGMA</td>
<td>Sustainable Groundwater Management Act</td>
</tr>
<tr>
<td>SJTA</td>
<td>San Joaquin Tributaries Authority</td>
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<tr>
<td>SRWA</td>
<td>Stanislaus Regional Water Authority</td>
</tr>
<tr>
<td>SSURGO</td>
<td>Soil Survey Geographic database</td>
</tr>
</tbody>
</table>
LIST OF ACRONYMS

SWRCB................................................................. State Water Resources Control Board
TCC.............................................................. Total Channel Control
TDS............................................................ Total Dissolved Solids
TGBA.............................................................. Turlock Groundwater Basin Association
TID.............................................................. Turlock Irrigation District
TKN.............................................................. Total Kjeldahl Nitrogen
TOC.............................................................. Total Organic Carbon
USBR............................................................ United States Bureau of Reclamation
USDA............................................................ United States Department of Agriculture
USCID.......................................................... United States Committee for Irrigation and Drainage
VAMP.......................................................... Vernalis Adaptive Management Plan
WCRP.......................................................... World Climate Research Program
WDO............................................................ Water Distribution Operator
WDR............................................................ Waste Discharge Requirements
WMF............................................................ Water Management Fraction
WMP............................................................. Water Master Plan
WTSGSA..................................................... West Turlock Subbasin Groundwater Sustainability Agency
WUE............................................................. Water Use Efficiency
WWCRA.......................................................... West-Wide Climate Risk Assessment
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GLOSSARY

Glossary of Terms

Acre-Foot. The volume of water required to cover one acre of land one foot deep. Equal to 325,900 gallons.

Assessed Acres. Total acres, as determined by the county assessor’s office, for parcels that receive irrigation water. This acreage includes developed (non-irrigated) portions of the parcels such as roads, buildings and ditches.

Conjunctive Use. Using a combination of surface water and groundwater supplies to meet water demands.

Conjunctive Management. Coordinating operation and monitoring of surface water and groundwater supplies to meet defined objectives.

Evapotranspiration. The loss of water, to the atmosphere, by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues).

Gardenhead. A parcel (hobby farm) that is five acres or less, irrigates on a pre-set rotational group schedule, and grows small pastures, lawns, ornamentals, or produce for self-consumption.

Gross Acres. All lands within the irrigation service boundary such as cities, agricultural lands, roads and lake acreage.

Improvement District. An Improvement District (ID) is a mechanism that allows a group of growers to pool resources to construct irrigation facilities. IDs can be formed for a variety of reasons, such as constructing, operating, and maintaining ditches, pipes, and wells, as well as surface and subsurface drains. TID administers the improvement districts.

Irrigable Acres. All lands that could be irrigated within the irrigation service boundary. This designation includes both lands that are currently irrigated and lands that are not currently being irrigated but have access to irrigation water through an active irrigation service connection.

Irrigated Acres. An estimate of the actual amount of land surface to which irrigation water is being applied. A survey performed in the 1990’s found that approximately six percent of assessed acres are non-productive lands such as roads, buildings and ditches. Therefore, the Assessed Acres have been reduced by six percent to arrive at the Irrigated Acres.

Private Pumping. Groundwater pumping by growers or Improvement Districts using privately-owned wells. Private pumping is often used to supplement irrigation water supplied by TID.
Rented Pumping…………………Groundwater pumping by TID using rented pumps that are owned by private parties or Improvement Districts. TID rents pumps to supplement other irrigation water supplies.

Turlock Subbasin………………..The groundwater subbasin underlying the eastern portion of the San Joaquin Valley bounded by the Tuolumne River to the north and the Merced River to the south. The western and eastern boundaries of the groundwater subbasin are the San Joaquin River and the Sierra Nevada foothills, respectively. (California Department of Water Resources, 2006).
Executive Summary

INTRODUCTION

The Turlock Irrigation District (TID, or District) has prepared this Agricultural Water Management Plan (AWMP or Plan) to fulfill the requirements of the Water Conservation Act of 2009 (SBx7-7) and the 2018 Water Conservation Legislation (AB 1668 and SB 606).

TID understands that the intent of SBx7-7 and the 2018 Water Conservation Legislation is to encourage water suppliers to evaluate their water management operations and to implement locally cost-effective efficient water management practices (EWMPs) that improve the efficient use of irrigation water. In developing this Plan, TID has devoted considerable effort to evaluating ongoing and planned water management efforts. TID is committed to sustaining sound water management practices where they are already in place and to improving practices that can be strengthened.

This 2020 AWMP has been updated with all required elements described in the Agricultural Water Management Planning regulations. The AWMP Checklist included at the beginning of this plan provides a cross-reference between the sections of this AWMP and relevant sections of the California Water Code.

TID’S WATER SUPPLIES AND CONJUNCTIVE MANAGEMENT PERSPECTIVE

A key point highlighted by this AWMP is the District’s conjunctive management of both surface water and groundwater supply sources. The water balance developed as part of the AWMP shows that, on average, approximately 80 percent of the water supply in TID comes from surface sources, with the remainder coming primarily from groundwater (approximately 18%) with a relatively smaller volume of other supplies (approximately 2%)1. The computations performed for the water balance and presented throughout the Plan are based on water usage during the period 2015-2019 (near-term historical period) and 1991-2019 (long-term historical period). The 29-year long-term historical period encompasses 16 years of normal water supplies and 13 years of reduced water supplies (as characterized based on annual water supplies available from TID to growers), and illustrates how TID shifts between groundwater and surface water supply sources in response to hydrologic conditions. Through pricing, policies, and practices, the District encourages the use of surface water for crop production when it is available to reduce reliance on groundwater and to maintain long-term water supply reliability.

TID’s conjunctive management provides a significant amount of recharge to the Turlock Subbasin (or Subbasin). The water balance, as described in Section 5 (irrigation season water balance) and Appendix I (water year water balance), quantifies the various inflows and outflows

1 Surface water supply is comprised of irrigation releases from Turlock Lake. Groundwater supply is comprised of TID drainage pumping, TID rented pumping, and private pumping. Other water supplies include treated wastewater, spill recovery, and tailwater, tilewater, and runoff that flow to TID canals.
within the District’s service area. Between 1991-2019, the average net recharge\(^2\) to the Subbasin from TID’s conjunctive management practices ranged from approximately 0.9 acre-feet per acre (AF/ac) in dry years to 1.7 AF/ac in normal years.\(^3\) This recharge has helped TID and its customers to achieve a generally consistent and reliable water supply in all but the most severe droughts, enabling growers to meet crop requirements through pumping in drier years to make up for reduced surface water supplies.

Recent drought conditions reemphasize the importance of recharge from surface water supplies to achieve groundwater sustainability in the Turlock Subbasin, as envisioned by the Sustainable Groundwater Management Act of 2014 (SGMA). Past analyses have shown that seepage and deep percolation of a portion of TID’s surface water supply serves as the primary source of recharge to the groundwater system. Thus, while groundwater provides a significant portion of the water used by the District and others within the Turlock Subbasin, much of this groundwater is derived from management of surface water resources by TID and its irrigation customers.

Conjunctive management is promoted primarily through TID’s pricing policies and operating practices. These actions help support sustainable agricultural production within TID. In addition, the benefits of TID’s conjunctive management policies extend to municipal users within the District and to agricultural users outside of TID’s boundaries for whom groundwater is the only source of supply.

Surface water supplies are a crucial component of the District’s conjunctive use program. Water supplies and reservoir management is bolstered by airborne remote sensing of the snowpack within the Tuolumne River watershed, forecast-coordinated operations (F-CO), and cloud seeding, enabling the District to better manage surface water supplies, both in times of surplus and times of shortage.

Because of the long-term supply reliability offered by access to both surface water and groundwater as sources of supply, TID will continue to pursue conjunctive management through its own water management practices. As a member of the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA), TID will also continue to work with other agencies and stakeholders within the Turlock Subbasin to comply with SGMA. TID and other agencies in the Subbasin are already working together to develop the tools needed to achieve long-term groundwater sustainability by identifying additional ways to maximize local water supplies, enhance conjunctive management practices, and recharge the groundwater system.

**IMPLEMENTATION OF EFFICIENT WATER MANAGEMENT PRACTICES**

The CWC §10608.48 describes sixteen (16) efficient water management practices (EWMPs) covering the specific mechanisms for promoting improved water management. The CWC lists

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\(^2\) Net recharge is calculated as the total groundwater recharge (seepage and deep percolation) minus the total groundwater extraction, divided by the total irrigated area. The volume of groundwater recharge from deep percolation of precipitation includes both irrigation season and off-season recharge. All other recharge and extraction is summarized over the irrigation season.

\(^3\) These values are calculated for the TID system downstream of Turlock Lake, and as such, do not include recharge from Turlock Lake or seepage from the canal system upstream of Turlock Lake.
two types of EWMPs: two (2) critical EWMPs that are mandatory for all agricultural water suppliers subject to the Code, and fourteen (14) conditional EWMPs that are mandatory if found to be technically feasible and locally cost-effective based on conditions within TID.

The TID AWMP evaluates and describes TID’s current implementation of these EWMPs. **Table ES.1** of this Executive Summary summarizes the status of EWMP implementation for each of the EWMPs. TID has implemented and continues to implement all technically feasible EWMPs at a locally cost-effective level.

**CONCLUSION**

This update to the TID AWMP has provided the District with an opportunity to reexamine its water management practices and to evaluate how these practices support the District’s goals to provide reliable and high quality water supplies to its irrigation customers. The Plan demonstrates the critical importance of TID’s overall conjunctive management strategy to meeting these goals and responding to evolving customer needs. As demonstrated in this Plan, the District is committed to ongoing evaluation and implementation of EWMPs at locally cost-effective levels in support of TID goals while also complying with all Agricultural Water Management Planning regulations.
## EXECUTIVE SUMMARY

Table ES.1. Summary of TID Implementation Status for EWMPs Listed Under CWC 10608.48(b) & (c).

<table>
<thead>
<tr>
<th>Water Code Reference No.</th>
<th>EWMP</th>
<th>Implemented Activities (pre-2015 and ongoing)</th>
<th>Updates Since Last AWMP (2015-2020)</th>
<th>Planned Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical EWMPs</strong></td>
<td></td>
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</tbody>
</table>
| 10608.48.b(1) Measure deliveries with sufficient accuracy | **Initiated delivery measurement accuracy improvement program under a corrective action plan for SBIX-7 compliance:** | • Installed new permanent measurement devices with laboratory-certified flow rate accuracy at 142 sidegates serving roughly half the irrigated acreage in TID  
• Developed calibrated flow rates at remaining sidegates for each specific combination of sidegate-parcel-irrigation method-requested flow rate:  
  - Temporarily installed 57 mobile Rubicon FlumeMeters at 550 sidegates that serve 1,196 parcels (representing approximately 21 percent of TID)  
  - Used Hach FH950 meters to determine parcel-specific calibrated flow rates at 349 sidegates serving 536 parcels (approximately 13 percent of TID)  
  - Used Fuji Portaflow meters to determine parcel-specific calibrated flow rates at 471 sidegates serving 877 parcels (approximately 19 percent of TID) | • Completed initial corrective action plan goals, providing direct measurements or calibrated delivery flow rates to 100% of the assessed acreage served by active, non-exempted sidegates  
• Updated water ordering, delivery, and billing software to use the measured and calibrated flow rates for billing.  
• Used updated values to calculate the measured volume of water delivered for reporting to DWR  
• Conducted a formal certification of the volumetric measurement accuracy consistent with 23 CCR §597  
  - Verified accuracy of new permanent measurement devices  
  - Verified accuracy of existing measurement devices (progress delayed due to operational challenges associated with COVID-19)  
• Complete the last remaining actions needed for formal certification of the volumetric measurement accuracy of existing measurement devices, consistent with 23 CCR §597  
  - Verify accuracy of existing measurement devices that have not yet been field-tested and certified  
• Continue using the measured and calibrated flow rates for billing  
• Continue using the measured and calibrated flow rates to calculate the measured volume of water delivered for reporting to DWR  
• Continue flow rate calibrations in response to evolving needs of customers  
• Consider additional permanent measurement devices when funding is available and where it provides benefits (e.g. measurement accuracy and/or customer service improvements). |                   |
| **Conditional EWMPs**    |      |                                               |                                   |                   |
| 10608.48.c(1) Facilitate alternative land use (lands with exceptionally high water duties, or lands that contribute to significant problems, e.g. drainage) | **Tiered pricing structure based in part on quantity delivered:**  
  - Updated pricing structure based on volume of water delivered (in effect since 2013; current rate structure in effect since 2015 after completion of the Proposition 218 process) | • Continued using tiered volumetric pricing structure in effect since 2015  
• Updated water ordering, delivery, and billing software to use the measured and calibrated flow rates (described under 10608.48.b(1)) for billing. |                   |
| 10608.48.c(2) Facilitate recycled water use | **Dairy nutrient water and industrial process water from Hilmar Cheese is recycled and applied to TID irrigated lands:**  
• Treated M&I water is recycled and applied to TID irrigated lands  
• Spillage recovery and tilewater/tiltwater flow into canals, where this water is available for reuse downstream  
• Active spillage recovery from Harding Drain  
• Tertiary treated effluent from City of Turlock used for cooling at TID’s Walnut Energy Center  
• Completed Water Sales Agreement with SRWA in July 2015, with the provision that the SRWA will provide additional “offset” water to TID from recycled or stored groundwater supplies to offset a portion of the surface water supplies from TID | • Completed existing use of recycled water within TID service area, as listed in the previous column.  
• Continued support of SRWA’s Regional Surface Water Supply Project, which will eventually provide “offset” water to TID from recycled or stored groundwater supplies to offset a portion of the surface water supplies from TID | • Continue existing use of recycled water within TID  
• Continue working with cities and qualifying permitted dischargers to gain access to recycled water supplies. |
| 10608.48.c(3) Facilitate financing of capital improvements for on-farm irrigation systems | **TID has an active financing program for ID’s, which support on-farm capital improvements (low interest financing, 10-yr loan term)**  
• Offers engineering design and construction oversight for ID irrigation facilities  
• Offers at-cost maintenance and repair of ID irrigation facilities (assessment process)  
• Pursues grant funding to assist growers with on-farm improvements (WaterSMART, etc.) | • Continued offering existing programs and services, as listed in the previous column.  
• Continued searching for grant funding  
• Actively involved in ongoing development of Turlock Subbasin GSP, which could include projects that facilitate on-farm improvements that encourage continued use of surface water (list of projects is currently being developed) | • Continue offering existing programs and services  
• Continue searching for grant funding  
• Upon completion of GSP, there may be GSP projects that facilitate on-farm improvements that encourage continued use of surface water (list of projects is currently under development). |

March 2021  
Public Review Draft  
Turlock Irrigation District  
Agricultural Water Management Plan
EXECUTIVE SUMMARY

Water Code Reference No. | EWMP | Implemented Activities (pre-2015 and ongoing) | Updates Since Last AWMP (2015-2020) | Planned Activities
--- | --- | --- | --- | ---
10608.48.c(4) | Implement an incentive pricing structure that promotes one or more of the following: (A) More efficient farm water use, (B) Conjunctive use, (C) Groundwater recharge, (D) Reduction in problem drainage, (E) Environmental resources management, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions. | Continued using tiered volumetric pricing structure, as listed in the previous column. | Continue implementing a tiered volumetric pricing structure, although the price will likely change over time. |
10608.48.c(5) | Expand lining/piping of distribution systems, and construct regulatory reservoirs. | Continued gueste and lining maintenance program (~340,000 square feet of canal lining resurfaced each year (7.8 acres, or 0.012 square miles)). Expanded storage capacity of Lateral 8 Regulating Reservoir to 130 acre-feet in 2016 to allow more water to be regulated. Acquired land for a new regulating reservoir site, began design and began preparation of an Initial Study in accordance with CEQA for the new regulating reservoir. Conducted ponding tests at Turlock Lake as a means of evaluating existing reservoir operations, providing information about reservoir recharge to support efficient water management and to support decisions on future operations at Turlock Lake. | Continue gunite and lining maintenance program, as needed, to quantify seepage rates in canal reaches to improve and monitor the effectiveness of the lining maintenance program. Potentially pursue select TID system modernization projects to be proposed under Draft IFMP (in progress), including regulating reservoir construction projects. Upon completion of GSP, there could be other GSP modernization projects that work in combination or in concert with other TID projects, including the Draft IFMP projects. Complete design of the new reservoir. Obtain CEQA clearance to construct the new reservoir. Potentially construct reservoir, depending on funding. |
10608.48.c(6) | Increase flexibility in water ordering by, and delivery to, water customers | TID offers arranged-frequency demand deliveries (arranged day; requested delivery flow rate; duration is controlled by customer). Improvements to customer service: ○ Central Call Center moved to Customer Service Department (2008) ○ Online ordering and online water use information (since 2014). Expanded customers’ ability to request and receive non-standard delivery flows to serve drip and microirrigation systems (standard flood head is 15 cfs). Continued offering existing benefits to customers: ○ arranged-frequency demand deliveries ○ online ordering and online water use information ○ annual water use statement ○ access to real-time monitoring data. | Continue offering existing benefits to customers: ○ arranged-frequency demand deliveries ○ online ordering and online water use information ○ annual water use statement ○ access to real-time monitoring data. |
### EXECUTIVE SUMMARY

**Water Code Reference No.** | EWMP | Implemented Activities (pre-2015 and ongoing) | Updates Since Last AWMP (2015-2020) | Planned Activities |
--- | --- | --- | --- | --- |
| 10608.48.c(7) | Construct and operate supplier spill and tailwater recovery systems | - TID canals passively intercept spillage from the upper laterals allowing water to be utilized to the greatest extent possible for deliveries downstream  
- TID system intercepts undelivered irrigation water from ID pipelines  
- TID system recovers and reuses tilewater and tailwater that re-enter system  
- Spillage is actively recovered from Harding Drain  
- Lateral 8 Regulating Reservoir and TCC project regulates excess flows and reduces spillage from Lateral 8  
- WDOs use tablets and computers in the field to access real-time SCADA data at spillage sites and other locations in the system, allowing better control over the system to reduce spillage  
- Operation of drainage wells (many of which are remotely-operable) and rented wells provide a localized source of supply to match demand and reduce spillage.  
- Created and implemented SCADA Master Plan, which has helped to reduce spillage through increased mobile data access, remote operation and monitoring of irrigation control structures, and improved system redundancy. | - Continued interception and recovery of spillage and excess water in the TID system, utilizing this water to the greatest extent possible for deliveries downstream.  
- Expanded capacity of Lateral 8 Regulating Reservoir to 130 acre-feet in 2016, increasing the storage of excess flows and water that would have otherwise spilled from Lateral 8 and the Highline Canal  
- WDOs have continued remote monitoring of spillage sites using SCADA, and remote operation of drainage wells to reduce spillage  
- Ongoing implementation of the SCADA Master Plan | - Continue operating existing spillage and tailwater recovery systems  
- Potentially pursue select TID system modernization projects to be proposed under Draft IFMP (in progress) |
| 10608.48.c(8) | Increase planned conjunctive use of surface water and groundwater within the supplier service area | - TID implements a comprehensive conjunctive management program in its regular operations.  
- TID has a series of pre- and post-1914 water rights that provide secure surface water supplies.  
- In dry years, TID operates drainage wells and rents privately-owned wells to increase water supply.  
- Tiered pricing structure in normal and dry years  
  o Affordable pricing to promote the use of available surface water supplies in all years  
  o Lower volumetric prices in normal years to incentivize surface water use and recharge  
  o Higher volumetric prices and fixed charges in dry years to promote water conservation and to provide revenue to | - Continued conjunctive management program.  
- Enhanced conjunctive management by modifying operations to pump even less in normal and wetter years to further increase the use of available surface water and allow for in-lieu groundwater recharge, with lower rented pumping on average in the last five years as compared to the historical past.  
- Continued remote operation of drainage wells to carefully control pumping and increase groundwater recharge  
- Active participation in local groundwater entities and initiatives, including SGMA efforts.  
- Active engagement in the development of a groundwater recharge assessment tool for the Turlock Subbasin  
- Conducted ponding tests at Turlock Lake as a means of evaluating existing reservoir operations, providing information about reservoir recharge to | - Enhance conjunctive management program and related practices  
- As a member of the West Turlock Subbasin GSA, adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), with plans to achieve groundwater sustainability by 2042  
- Continue and expand groundwater and surface water monitoring under SGMA  
- Continue engagement in the development of a groundwater recharge assessment tool for the Turlock Subbasin  
- Continue active runoff forecasting and surface water supply management through the ARSS, F-CO, FIRO, and watershed monitoring programs. |
## EXECUTIVE SUMMARY

### Water Code Reference No. EWMP

<table>
<thead>
<tr>
<th>Implemented Activities (pre-2015 and ongoing)</th>
<th>Updates Since Last AWMP (2015-2020)</th>
<th>Planned Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>operate drainage and rented wells required to pump additional groundwater</td>
<td>support efficient water management and to support decisions on future operations at Turlock Lake.</td>
<td>Update water budget to include the Upper Main Canal and Turlock Lake, supporting better accounting for all inflows/outflows, including recharge.</td>
</tr>
<tr>
<td>• In certain wet years when sufficient water is available, TID promotes direct and in-lieu recharge through “replenishment water” sales within the Subbasin but outside of the TID service area.</td>
<td>• Continued active runoff forecasting and surface water supply management through the ARRS, F-CO, FIRO, and watershed monitoring programs.</td>
<td>• Improve monitoring and tracking of off-season flows through the system, supporting better management of this water and the District’s ability to make use of this water locally.</td>
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<tr>
<td>• Use of treated wastewater for cooling at the Walnut Energy Center, as a substitute for groundwater.</td>
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<tr>
<td>• Implementation of groundwater monitoring as part of CASGEM. Development of sophisticated groundwater and surface water models to support long term conjunctive use planning and management</td>
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<td></td>
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<tr>
<td>• TID actively forecasts runoff and manages surface water supply through ARRS, F-CO, FIRO, and watershed monitoring programs.</td>
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</tbody>
</table>

### TID0608.4K(9) Automatic canal control structures

- TID operates more than 845 automatic canal control structures, including 66 Meikle automatic gates, 227 long-crested weirs, flap gates (18 locations), Rubicon FlumeGates™ (31 locations), and other structures.
- TID has been installing Rubicon FlumeGates at many canal head gate structures, with SCADA integration and remote operability.
- Created and implemented SCADA Master Plan, and now operates 397 SCADA sites, providing control and/or real-time flow and water level information throughout the canals, including at lateral headgates.
- All structure modifications are designed to allow for future modification.
- Lateral 8 Regulating Reservoir and Total Channel Control (TCC) implemented on Lateral 8 beginning in 2015, allowing near full automated control of flows along Lateral 8.
- Continued operation of existing automatic canal control structures and SCADA sites.
- Continued installing Rubicon gates, now at 31 locations in the distribution system.
- Worked on Draft IFMP, creating a strategic plan and cost estimates for modernizing the TID system and infrastructure, including canal system automation projects.
- Ongoing implementation of TID’s Irrigation Capital Plan, which provides for automation and rehabilitation of canal control structures (drop structures, etc.) as part of normal TID operations.
- Continue operating existing automatic canal control structures and SCADA sites.
- Continue installing Rubicon gates.
- Potentially pursue select TID system modernization projects to be proposed under Draft IFMP (in progress), which include TID canal system automation projects.
- Ongoing implementation of TID’s Irrigation Capital Plan, which provides for automation and rehabilitation of canal control structures (drop structures, etc.) as part of normal TID operations.
- Continue to review delivery measurement accuracy and customer needs, and consider if additional permanent flow measurement devices should be installed.

### TID0608.4K(10) Facilitate or promote customer pump testing and evaluation

- TID conducts a pump testing program and provides testing services for private pumps upon request throughout the District’s irrigation and electrical service areas.
- TID historically tested rented pumps once per year.
- TID uses portable flow meters to test customer wells. Two staff members are available for water level testing and twelve WDOs plus additional staff are available for flow testing.
- TID trained employees in pump testing methods.
- Continued pump testing program for District-owned and rented pumps, and offering pump testing services for private pumps upon request (fewer tests over last 3-5 years as manpower has been redirected to delivery measurement accuracy field-testing efforts).
- Continue pump testing program and offering pump testing services.

### TID0608.4K(11) Designate a water conservation coordinator

- Water Conservation Coordinator position established in 1997.
- Position is currently filled by the District’s Water Planning Department Manager.
- Continue appointing Water Conservation Coordinator.
- Continue appointing Water Conservation Coordinator.

### TID0608.4K(12) Provide for the availability of water management services to water users.

- On-farm irrigation and drainage system evaluations:
  - TID provides services to build, operate, and maintain improvement district (ID) facilities, including on-farm distribution and irrigation facilities, subsurface drains, and deep wells.
  - TID staff provide testing upon request for pump flow rates and application rates through pressurized irrigation systems using Fuji flow meters.
  - Normal Year and Real-time Irrigation Scheduling and Crop Evapotranspiration Information
    - TID installed CIMS stations #168 (now inactive) and #168 at Denair in 2002 and 2009.
    - TID provides growers with CIMS irrigation information, tutorials, and data through links on the TID irrigation information web page.
  - Continued offering on-farm irrigation and drainage system services upon request:
    - o Engineering services for ID facilities, including on-farm distribution and irrigation facilities, subsurface drainage, and deep wells.
    - o Pump flow rate testing and irrigation system application rate testing.
    - o Continued offering irrigation scheduling and crop evapotranspiration information (links to CIMS information, weather, and precipitation forecasts on TID website).
    - o Continued monitoring and offering surface water, groundwater, and drainage water quantity and quality data to growers:
      - o Water use information online, upon request, and in annual water use report.
      - o Real-time flows, water level, and storage data available online.
- Continue offering existing on-farm irrigation and drainage system services upon request.
- Continue offering existing irrigation scheduling and crop evapotranspiration information.
- Continue monitoring and offering surface water, groundwater, and drainage water quality and quality data to growers:
  - o Continue SGMA-related public outreach and involvement.
  - o Adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP).
  - o Continue and expand groundwater and surface water monitoring under SGMA.
<table>
<thead>
<tr>
<th>Water Code Reference No.</th>
<th>EWMP</th>
<th>Implemented Activities (pre-2015 and ongoing)</th>
<th>Updates Since Last AWMP (2015-2020)</th>
<th>Planned Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TID provides growers with weather and precipitation forecasts on the TID weather web page</td>
<td>Pump tests conducted for groundwater supply wells</td>
<td>Continue providing agricultural water management educational programs and materials to growers, staff, and the public:</td>
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<td></td>
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<td>Surface water, groundwater, and drainage water quantity and quality data:</td>
<td>Continued CASGEM groundwater monitoring, and plans for SGMA groundwater monitoring</td>
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<td></td>
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<td>Parcel water use information available at any time online, or upon a grower’s request</td>
<td>Continued and formalized FIRO forecasting</td>
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<td></td>
<td></td>
<td>Water use information provided to all growers in year-end water use report</td>
<td>Continued monitoring suitability of surface water, groundwater, and drain water quality for irrigation (monitoring less frequent in recent years because of other operational efforts underway in TID)</td>
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<td></td>
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<td>Real time flows, water level, and storage are available on the TID website for various sites operated or used by TID:</td>
<td>* Real-time flows, water level, and storage available for six sites via TID’s WISKI web portal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Real-time flows, water level, and storage available for six sites via TID’s WISKI web portal</td>
<td>o Maintained and updated the “Irrigation Information” and “Education” webpages with resources and educational materials</td>
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<td>o Current report and link to current flows to the Tuolumne River below La Grange Dam available on TID website</td>
<td>o Maintained and updated the “Irrigation” webpage with links to educational materials and water data</td>
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<td>o Links to seven online telemetry gauges used by TID and reported by USGS NWIS are available through the TID website</td>
<td>o Continued targeted social media messaging</td>
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<td></td>
<td>CASGEM groundwater monitoring implemented by TID</td>
<td>o Continued supporting local educators by participating in school assemblies, demonstrations, and career days</td>
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<tr>
<td></td>
<td></td>
<td>Information about groundwater supply wells provided by TID staff through pump tests.</td>
<td>o Continued providing remote data access to staff and growers from SlipMeters and FlumeGates.</td>
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<td>Upper Tuolumne River watershed collaborative project to implement Forecast Informed Reservoir Operations (FIRO), a reservoir-operations forecasting strategy that is communicated to the TID Board of Directors, and available to the public through the Board process</td>
<td>o Began shifting away from annual grower meetings, and moving toward direct mailings and expanded use of new virtual communications mediums (social media, etc.) to enhance grower engagement.</td>
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<tr>
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<td></td>
<td>Suitability of surface water, groundwater, and drain water quality for irrigation is tested by TID staff and available to growers upon request</td>
<td>o Prepared and distributed “The Grower” irrigation newsletter</td>
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<td>o Surface water tested at Main Canal Drop 1 (Turlock Lake supply) and all spill locations twice during each irrigation season</td>
<td>o Maintained and updated the “Irrigation Information” and “Education” webpages with resources and educational materials</td>
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<td>o Groundwater samples from drainage wells and rented wells monitored as needed, upon request, and during the formation of a pump Improvement District.</td>
<td>o Maintained and updated the “Irrigation” webpage with links to educational materials and water data</td>
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<td>o Subsurface drainage at 32 tile drain discharge sites historically evaluated on a quarterly basis</td>
<td>o Continued targeted social media messaging</td>
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<td>o Canal flows monitored by multi-parameter water quality sondes at 18 canal and drain locations, recording EC and temperature and upload the data to TID’s SCADA system.</td>
<td>o Continued supporting local educators by participating in school assemblies, demonstrations, and career days</td>
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<td></td>
<td>Agricultural water management educational programs and materials:</td>
<td>o Continued providing remote data access to staff and growers from SlipMeters and FlumeGates.</td>
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<td>TID regularly prepares and distributes “The Grower” irrigation newsletter to growers, staff, and the public (now quarterly)</td>
<td>o Began shifting away from annual grower meetings, and moving toward direct mailings and expanded use of new virtual communications mediums (social media, etc.) to enhance grower engagement.</td>
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<td>TID’s “Irrigation Information” webpage provides a wealth of resources and educational materials in an accessible and user-friendly format</td>
<td>Continue providing agricultural water management educational programs and materials to growers, staff, and the public:</td>
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<tr>
<td></td>
<td></td>
<td>o Irrigation tips for water conservation</td>
<td>o Prepared and distributed “The Grower” irrigation newsletter</td>
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<td></td>
<td>o Information on Rubicon gates</td>
<td>o Maintained and updated the “Irrigation Information” and “Education” webpages with resources and educational materials</td>
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<tr>
<td></td>
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<td>o CIMIS weather station data</td>
<td>o Maintained and updated the “Irrigation” webpage with links to educational materials and water data</td>
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<tr>
<td></td>
<td></td>
<td>o Water measurement educational resources</td>
<td>o Continued targeted social media messaging</td>
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<tr>
<td></td>
<td></td>
<td>o Groundwater management educational resources</td>
<td>o Continued supporting local educators by participating in school assemblies, demonstrations, and career days</td>
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<tr>
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<td>o TID’s most recently adopted AWMP and supporting documents</td>
<td>o Continued providing remote data access to staff and growers from SlipMeters and FlumeGates.</td>
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<td>TID’s “Irrigation” webpage provides links to educational materials and data from Don Pedro Reservoir, La Grange Dam, Turlock Lake, and other locations in the TID distribution system</td>
<td>o Began shifting away from annual grower meetings, and moving toward direct mailings and expanded use of new virtual communications mediums (social media, etc.) to enhance grower engagement.</td>
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<tr>
<td></td>
<td></td>
<td>TID supports local educators by participating in school assemblies and demonstrations as well as career days, and has created an “Education” webpage that provides education guides and videos to the public.</td>
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</tbody>
</table>
**EXECUTIVE SUMMARY**

<table>
<thead>
<tr>
<th>Water Code Reference No.</th>
<th>EWMP</th>
<th>Implemented Activities (pre-2015 and ongoing)</th>
<th>Updates Since Last AWMP (2015-2020)</th>
<th>Planned Activities</th>
</tr>
</thead>
</table>
| **10608.48.c(13)**     |      | - TID has developed training videos for staff, irrigators, and growers that provide information on the operation of Rubicon sidegates. These videos are available in English and Spanish on the TID website.  
- TID provides remote data access to staff and growers, providing delivery flows data for sidegates with SlipMeters and permanent FlumeGates.  
- TID employs an assistant engineer with a background in agriculture who provides on-farm technical support. Services include support of micro/drip conversion and on-farm reservoir sizing.  
- TID conducted annual grower meetings.  
|                          |      | - TID conducts occasional seminars for growers on various water management topics.  
- TID partners with cooperating entities at Don Pedro Reservoir.  
- TID implements ARSS, F-CO, FIRO, and watershed monitoring to better track and understand the amount of water in the upper watershed and inform reservoir operations.  
|                          |      | - TID coordinates with applicable regulatory agencies that have the potential to impact the District’s flexibility in delivery and storage.  
|                          |      | - TID is a member of the West Turlock Subbasin GSA and is active in SGMA implementation and GSP development.  
|                          |      | - Continued partnership with cooperating agencies and applicable regulatory agencies that have the potential to impact the District’s flexibility in delivery and storage.  
|                          |      | - Implementation of ARSS, F-CO, FIRO, and watershed monitoring to better track and understand the amount of water in the upper watershed and optimize reservoir operations to balance flood storage and water supply storage.  
|                          |      | - Active participation in local groundwater entities and initiatives, including SGMA efforts.  
|                          |      | - TID is a member of the West Turlock Subbasin GSA and is active in SGMA implementation and GSP development.  
|                          |      | - Continue partnership with cooperating agencies and applicable regulatory agencies.  
|                          |      | - Continue implementation of ARSS, F-CO, FIRO, and watershed monitoring.  
|                          |      | - Continue participation in local groundwater entities and initiatives, including SGMA efforts.  
|                          |      | - As a member of the West Turlock Subbasin GSA, adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), with plans to achieve groundwater sustainability by 2042.  
|                          |      | - Continued pump testing program for District-owned and rented pumps, and offering pump testing services for private pumps upon request (limited testing over last 3-5 years as manpower has been redirected to delivery measurement accuracy field-testing efforts).  
|                          |      | - WDOs have continued remote operation of drainage wells to reduce pump wear and tear, prolong pump life, and improve pump efficiency.  
|                          |      | - Continue partnership with cooperating agencies and applicable regulatory agencies.  
|                          |      | - Continued pump testing program and offering pump testing services.  
|                          |      | - Continue providing remote pump operation capabilities to WDOs.  
| **10608.48.c(14)**     |      | - TID has historically tested District-owned and rented wells generally once per year when in use, or upon request.  
- TID has trained employees in pump efficiency testing.  
- TID has a pump capital improvement program to rehabilitate and replace pumps when necessary.  
- TID has provided remote operation capabilities for many drainage wells. WDOs are able to turn on and shut down pumps using portable tablets to reduce operational spillage, reduce pump wear and tear, prolong pump life, and improve pump efficiency.  
|                          |      | - Continued partnership with cooperating agencies and applicable regulatory agencies.  
- Continued implementation of ARSS, F-CO, FIRO, and watershed monitoring.  
- Active participation in local groundwater entities and initiatives, including SGMA efforts.  
- As a member of the West Turlock Subbasin GSA, adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), with plans to achieve groundwater sustainability by 2042.  
|                          |      | - Continued pump testing program and offering pump testing services.  
|                          |      | - Continue providing remote pump operation capabilities to WDOs.  

March 2021 9 Turlock Irrigation District  
Public Review Draft  
Agricultural Water Management Plan
1. Plan Preparation

A critical component in the development of an Agricultural Water Management Plan (AWMP or Plan) is the solicitation of feedback from interested parties. This section describes TID’s coordination with other agencies in the development of this AWMP, as well as TID’s past water management activities.

1.1 PAST WATER MANAGEMENT ACTIVITIES

The Turlock Irrigation District (TID or District) was the first irrigation district formed in California under the Wright Act in June 1887. Although the current Agricultural Water Management Planning requirements were recently established, water management planning is not a new concept for TID. The District continues to evaluate and implement new cost-effective approaches and technologies to support water management as they become available. These efforts ensure the District’s water resources are managed to meet local water supply needs and environmental stewardship requirements, both now and in the future.

TID was one of the first agencies in California to adopt a Groundwater Management Plan pursuant to Assembly Bill 3030, to sign on to the Memorandum of Understanding (MOU) establishing the Agricultural Water Management Council (AWMC), and to prepare an AWMP approved by the AWMC. TID’s first AWMP was adopted in July 1999 and approved by the AWMC in May 2001. TID was also one of the first agencies in California to comply with SBx7-7, and submit their plan to the California Department of Water Resources (DWR) in 2012. Since that time, TID has implemented all locally cost-effective and technically feasible Efficient Water Management Practices (EWMPs). Some key implementation efforts that benefit water management in TID include:

- Automation of canal control structures,
- Improved measurement of canal and delivery flows through TID’s extensive SCADA network and access to real-time data by field crews,
- Implementation of a comprehensive plan to accurately measure water deliveries to customers, in compliance with delivery measurement requirements (pursuant to 23 CCR §597). This plan has resulted in:
  - Installation of 151 new, permanent Rubicon measurement devices at sidegates, sites downstream of sidegates, and ID pipeline spillage sites throughout the District,
  - Calibration of delivery flow rates at all other active, existing sidegates in the District
- Installation of water quality monitoring telemetry,
- Lining or pipeline conversion of the District conveyance and distribution system, ongoing maintenance, and other facility modifications to improve delivery reliability and operational flexibility,
- Improved water balance accounting through the District’s semi-automated water balance application,
- Installation of a California Irrigation Management Information System (CIMIS) weather station to provide more accurate local crop ET information to growers,
- Adoption of a volumetric pricing structure,
• Employment of an assistant engineer with a background in agriculture to provide on-farm technical support,
• Improved access to water use and real-time water supply information, which are available to customers online or upon a grower’s request,
• Implementation of remote operation of District-owned pumps,
• Implemented improvements along Lateral 8 to test the pairing of regulating reservoirs and automation to provide Total Channel Control (TCC) features on TIDs open channel system,
• Ongoing development of a multi-year planning effort to improve irrigation service and modernize infrastructure, referred to as the TID draft Irrigation Facilities Master Plan (IFMP),
• Completion of the TID Irrigation Delivery Operations Assessment study to evaluate the efficiency and flexibility of TID’s irrigation delivery system operations, and recommend strategic actions for maintaining and improving operations in the future,
• Active participation in local groundwater initiatives and efforts for compliance with the Sustainable Groundwater Management Act of 2014 (SGMA), including membership in the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA) and development of the Turlock Subbasin Groundwater Sustainability Plan (GSP), and
• Continued implementation of numerous other measures to provide information to growers and to ensure water delivery reliability and flexibility.

All actions, programs, and efforts that TID has completed or plans to complete in the future to support efficient water management are described in Section 7 of this AWMP, and elsewhere throughout the plan.

1.2 AGENCY COORDINATION AND PUBLIC PARTICIPATION

Coordination with other agencies and public participation are critical components of the agricultural water management planning process. The following section describes the on-going coordination efforts between TID and the various local agencies in this region that manage water resources. Additionally, this section provides information on the public participation process used during the development, adoption, and implementation phases of the planning process.

1.2.1 Agency Coordination

TID holds joint water rights and ownership of Don Pedro Reservoir with the Modesto Irrigation District (MID). As such, the districts (TID and MID) continuously work together to coordinate and manage the shared resource. Additionally, TID maintains close relationships with irrigation districts on other tributaries of the San Joaquin River, and through those relationships is able to share information regarding successes and challenges to help shape irrigation programs. TID works and coordinates with the City and County of San Francisco, San Joaquin Tributaries Authority (SJTA), the East San Joaquin Water Quality Coalition (ESJWQC), as well as various water committees and groups forming at the county and state levels. Each authority and association is involved in activities that relate to different aspects of the District’s water management activities. Additionally, TID coordinates with various local, state, and federal agencies as outlined in the Drought Management Plan (Appendix G).
TID adopted its first Groundwater Management Plan (GWMP) in 1993. After that time, other agencies within the Turlock Subbasin became interested in groundwater management. As a result, the Turlock Groundwater Basin Association (TGBA) was formed in 1995 to develop a Subbasin-wide GWMP. The first plan was adopted in 1997 by the majority of the water agencies within the Subbasin. The TGBA continued to coordinate groundwater management activities, completed several studies, and updated the Subbasin-wide GWMP. TID adopted the most recent updated plan on March 18, 2008.

The TGBA continues to meet twice a year. The Subbasin agencies, under the umbrella of the TGBA, work together to implement groundwater monitoring and submit the data required to comply with the California Statewide Groundwater Elevation Monitoring (CASGEM) program, as required by SBx7-6.

Agencies within the Turlock Subbasin have formed two Groundwater Sustainability Agencies (GSAs) to comply with the Sustainable Groundwater Management Act of 2014 (SGMA). The West Turlock Subbasin GSA (WTSGSA) includes the area within the TID’s irrigation boundaries. The East Turlock Subbasin GSA (ETSGSA) generally covers the area to the east of the WTSGSA. TID is an active member of the WTSGSA, with staff helping to facilitate GSA activities. The GSAs have a Memorandum of Agreement that outlines the process by which the GSAs are working together to ensure the Subbasin is in compliance with SGMA. Both GSAs have been actively engaged in developing a single Groundwater Sustainability Plan (GSP) for the Subbasin. Two grants have been received to assist with the Subbasin’s SGMA efforts. The first grant is funding a significant portion of the GSP development. The second grant will fund a Groundwater Recharge Assessment Tool for the Subbasin, the installation of monitoring wells, and a Draft Programmatic Environmental Impact Report for the GSP. TID staff are administering these grants on behalf of the GSAs. The Turlock Subbasin GSP is due to the Department of Water Resources (DWR) in January 2022.

1.2.2 Plan Participation

TID has prepared this AWMP in accordance with the requirements of the Water Conservation Act of 2009, also known as SBx7-7, enacted November 9, 2009, and the 2018 Water Conservation Legislation (AB 1668 and SB 606). The Department of Water Resources also provided a draft guidebook for the 2020 plans due in April 2021. The legislation itself and the guidebook provide limited guidance regarding the outreach process to be followed while developing and adopting an AWMP, providing flexibility for agencies to implement an outreach process focused on the needs of the local area.

Table 1.1, below, describes the public participation process that was employed for this AWMP. TID patterned the agency coordination and public participation process in reference to the Department of Water Resources (DWR) guidebook for agencies, and after similar planning efforts implemented by local urban water suppliers, as well as past efforts for developing and implementing the Subbasin-wide Groundwater Management Plan, and the 2015 AWMP. The process made use of existing communication programs, association memberships and coordination to help to streamline the effort. Unfortunately, the ongoing public health guidelines resulting from the COVID-19 pandemic have, in some ways, limited outreach and traditional opportunities for public participation and discussion through informal interactions. As a result, the public outreach activities described in Table 1.1 includes more formal notices for this update.
including newsletter articles, public meetings, and newspaper notices, in addition to making documents available for review and comment.

**Table 1.1. AWMP Public Participation Process.**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date(s)</th>
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<tbody>
<tr>
<td>TID Website – AWMP update information added</td>
<td>December 22, 2020</td>
</tr>
<tr>
<td>Letter notice to local water agencies – Plan to update AWMP</td>
<td>December 22, 2020</td>
</tr>
<tr>
<td>Board Workshop – Review of draft AWMP and adoption process</td>
<td>January 26, 2021</td>
</tr>
<tr>
<td>TID Board – Sets Hearing for March 23, 2021* and directs staff to publish notice in newspaper, and make draft Plan available for public comment online (Requires 30 day public comment period) (Due to the COVID pandemic TID offices are closed to the public at this time)</td>
<td>February 9, 2021</td>
</tr>
<tr>
<td>Copies of draft AWMP available for review on-line (Due to the COVID pandemic TID office is closed to the public at this time but the draft plan is posted and able to be accessed online for review and comment)</td>
<td>February 10, 2021</td>
</tr>
<tr>
<td>Letters to local water agencies – Draft AWMP available for comment</td>
<td>February 10, 2021</td>
</tr>
<tr>
<td>Newspaper Notice – per Government Code Section 6066</td>
<td>(2 dates in February after February 10th)</td>
</tr>
<tr>
<td>Newsletter to TID growers – Status of AWMP update</td>
<td>February/March</td>
</tr>
<tr>
<td>Public outreach ahead of the public hearing and AWMP adoption meeting through social media messaging and/or email lists</td>
<td>February/March</td>
</tr>
<tr>
<td>Public Hearing &amp; AWMP adoption on same day (Due to the COVID pandemic, the hearing will be conducted online via Zoom)</td>
<td>March 23, 2021</td>
</tr>
<tr>
<td>Copies of approved AWMP will be available the TID’s website and distributed as required by SBx7-7</td>
<td>April 2021</td>
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</table>

Copies of the information circulated in the public outreach effort are included in **Appendix A**.

Ongoing coordination and implementation of the AWMP will be facilitated by continuing interactions with other local water agencies and TID customers. Examples of these programs include:

- Coordination with the MID through their partnership in management of Don Pedro Reservoir.
- Coordination with other local public agencies, including the counties and agricultural and urban water supply agencies, through meetings of the TGBA; an association that was formed to coordinate groundwater management activities within the Turlock Groundwater Subbasin. Information about the TGBA Groundwater Management Plan and a link to where the complete plan can be accessed and downloaded online are included in **Appendix B**.
- Coordination of SGMA activities with the local Groundwater Sustainability Agencies and the water agencies and counties engaged in those efforts.
- Stanislaus County has established a Water Advisory Committee and a Technical Advisory Committee to coordinate water issues within the County. TID has representatives on both committees. TID's involvement in these efforts will assist with outreach and coordination efforts.
• Growers in TID are kept informed of various TID activities and irrigation-related issues. Historically, this outreach was done through grower meetings typically held at the start of each irrigation season. However, staff are moving to incorporate more direct mailings and new virtual communications mediums (social media, etc.) to enhance grower engagement.

• TID staff have increased the publication frequency of “The Grower” newsletter to quarterly, and have completed a redesign of the newsletter to encourage greater engagement. Copies of past newsletters are available on TID’s website at http://tid.com/news-resources/publications/the-grower. An example newsletter is included in Appendix C.

• TID’s Board of Directors generally meets weekly. Board meetings provide an opportunity to educate and obtain feedback from the Board and the public regarding a wide range of water management related topics. The media and the public regularly attend these meetings. During each meeting, time is set aside to update the Board on District activities, and receive comments from the public. Due to the ongoing pandemic in 2020 and 2021, Board meetings have been held remotely, with the ability for the public to participate online. Meetings have been held generally twice per month at this time. Board meeting dates, times, agendas, and access information are available on the District’s website. Board meetings are also recorded and posted on the District website.

• The District’s communications staff regularly communicates with the media regarding a variety of topics, issuing press releases as needed regarding District activities. The media also regularly reports on the issues, policies and projects discussed at TID Board meetings.

• TID staff have conducted multiple focus groups with a diverse group of growers to discuss the latest regulatory actions that may impact TID operations.

• TID staff conducted a grower communication survey in 2020 to better understand how growers prefer to be communicated with, and what information they want to receive from the District.

• The District’s communications staff has increased its social media presence across multiple platforms, providing content specifically developed to keep the growers informed and up to date with the latest information.

• The TID website is updated regularly. It includes a variety of information regarding TID’s water management programs and practices. Information regarding the AWMP update is available at: www.tid.org/AWMP. Once adopted, the updated AWMP will be posted on the TID website.

1.3 PLAN ADOPTION AND SUBMITTAL

1.3.1 Plan Adoption

A copy of the signed Resolution of the 2020 Agricultural Water Management Plan Adoption is included in Appendix A, as an attachment to this AWMP.

This AWMP was adopted on March 23, 2021* (*tentative date, to be updated prior to final publishing of the 2020 AWMP), before the April 1, 2021 update deadline.
SECTION ONE

1.3.2 Plan Submittal
This AWMP has been submitted electronically to DWR through the AWMPs portal on the DWR WUE data website (https://wuedata.water.ca.gov/). Submittal occurred no later than 30 days after the plan adoption.

1.3.3 Plan Availability
This AWMP has been made available to the public, local water agencies, and other entities through the public participation process described in Table 1.1 and in Section 1.2.2, above. Information regarding the AWMP update is available at: www.tid.org/AWMP. The updated and adopted AWMP has been posted on the TID website within 30 days of adoption.

1.4 PLAN IMPLEMENTATION
TID has taken many actions to promote efficient and sustainable water management throughout its more than 130-year history. Today, TID continues to review and plan additional measures to accomplish improved and more efficient water management. For the purposes of this AWMP, TID’s past, ongoing, and planned actions have been organized and are reported with respect to the Efficient Water Management Practices (EWMPs) listed in Water Code §10608.48.

A summary of the past and planned implementation efforts for this AWMP are described in Section 7 of this AWMP, outlined according to the EWMPs that these efforts support (Tables ES.1 and 7.4). Other efforts specifically related to drought are described in the District’s Drought Management Plan (Appendix G). Drought resilience efforts are implemented in all years, while drought response efforts are implemented in years of reduced water availability, as determined by the District’s Board of Directors.

TID and its staff has long been active in agricultural water management planning, and affiliated with organizations that support excellence in water management, including the Association of California Water Agencies (ACWA), the California Farm Water Coalition (CFWC), the United States Committee for Irrigation and Drainage (USCID), the Irrigation Technology and Research Center (ITRC), the American Society of Civil Engineers (ASCE), the California Irrigation Institute (CII), the California Municipal Utilities Association (CMUA) and others. One of the benefits that TID’s active participation in these organizations brings is continuing exposure to water management innovations through conferences, trainings, and networking with water management professionals. Additionally, TID occasionally sends staff to water management trainings to enhance skill sets and increase basic understanding of efficient water management.

TID will continue its engagement agricultural water management planning and in the water management community, supporting water management advancements in the District, throughout California, and beyond.
2. Agricultural Water Supplier and Service Area

This section contains a description of the physical and operational organization of the Turlock Irrigation District, including TID’s history, geographic and environmental settings, operations, and policies.

2.1 PHYSICAL CHARACTERISTICS

2.1.1 History and Size

TID provides irrigation water to agricultural lands in Stanislaus and Merced counties in the Central Valley of California. TID was formed on June 6, 1887 and was the first irrigation district formed in California under the Wright Act. At the time of its formation, TID covered 179,527 acres. TID presently covers a service area of 197,261 gross acres, with approximately 157,800 acres that could be served by active TID irrigation service connections. The average assessed acreage from 2015 through 2019 was 143,762 acres, and the average irrigated acreage from 2015 through 2019 was 135,136 acres. The actual number of acres that irrigate each year varies depending on the decisions of the individual property owners. These and other key aspects of TID are summarized in Table 2.1. The increase in gross acreage from the time of District formation is attributed to the annexation of adjacent lands including Turlock Lake, the community of Delhi, and a portion of Don Pedro Reservoir.

<table>
<thead>
<tr>
<th>Date of formation</th>
<th>June 6, 1887</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local surface water source</td>
<td>Tuolumne River</td>
</tr>
<tr>
<td>Local groundwater source</td>
<td>Turlock Subbasin</td>
</tr>
<tr>
<td>Gross acreage at time of formation</td>
<td>179,527 acres</td>
</tr>
<tr>
<td>Present gross acreage</td>
<td>197,261 acres</td>
</tr>
<tr>
<td>Present irrigable acreage</td>
<td>157,800 acres</td>
</tr>
</tbody>
</table>

1. Acreage that could be served by active irrigation service connections.

2.1.2 Location and Facilities

TID’s irrigation service area is generally bounded on the north by the Tuolumne River, on the south by the Merced River and on the west by the San Joaquin River (see maps included in Appendix D). The communities of Turlock, Ceres, Keyes, Denair, Hughson, Delhi, South Modesto, Hickman, and Hilmar are within the boundaries of the TID irrigation service area. This section of the AWMP describes TID irrigation facilities and operations within its service area. A summary of TID’s irrigation facilities and operations is provided in Table 2.2.

The Tuolumne River provides the principal water supply for TID. Don Pedro Reservoir is located on the Tuolumne River and is TID’s principal storage reservoir, with a total capacity of 2,030,000 acre-feet (AF). Don Pedro Reservoir is jointly owned by TID and MID (68.46% by TID, and 31.54% by MID). TID operates the reservoir for the districts.

It is important to note that a portion of Don Pedro Reservoir’s storage capacity is reserved for flood control purposes each year and operated in compliance with the Army Corps of Engineers
(ACOE) requirements. To vacate the 340,000 AF flood control space, reservoir levels are lowered each fall to a specified elevation (801.9 feet above mean sea level) by October 7th. Levels are allowed to gradually increase again after April 27th.

### Table 2.2. TID Water Conveyance and Delivery System.

<table>
<thead>
<tr>
<th>Facility/System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage facilities</strong></td>
<td></td>
</tr>
<tr>
<td>Don Pedro Reservoir capacity</td>
<td>1,178,197 AF</td>
</tr>
<tr>
<td>Turlock Lake capacity</td>
<td>45,600 AF</td>
</tr>
<tr>
<td><strong>Conveyance facilities and other Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Unlined Canals</td>
<td>18.5 miles</td>
</tr>
<tr>
<td>Lined Canals</td>
<td>222 miles</td>
</tr>
<tr>
<td>Number of Canal Turnouts</td>
<td>1,434 operational sidegates (2019)</td>
</tr>
<tr>
<td>TID-owned Drains</td>
<td>18 miles</td>
</tr>
<tr>
<td>Drainage Wells</td>
<td>165</td>
</tr>
<tr>
<td>Rented Wells</td>
<td>45 to 187, depending on water year type and weather conditions</td>
</tr>
<tr>
<td><strong>Tailwater/Spill Recovery Facilities</strong></td>
<td></td>
</tr>
<tr>
<td>TID-operated</td>
<td>Operational spills</td>
</tr>
<tr>
<td>Grower-operated Tailwater/Spill Recovery</td>
<td>Individual grower tailwater systems</td>
</tr>
<tr>
<td><strong>Supplier Delivery System</strong></td>
<td></td>
</tr>
<tr>
<td>Order type/scheduling</td>
<td>Arranged-frequency demand (ASCE, 1991)</td>
</tr>
<tr>
<td>Operational constraints</td>
<td>Canal capacity flow limitations</td>
</tr>
<tr>
<td>Expected changes to service area</td>
<td>None</td>
</tr>
</tbody>
</table>

NOTES:

1. TID’s useable capacity in Don Pedro is 68.46 percent of overall 2,030,000 AF reservoir capacity minus 68.46 percent of the minimum operating pool.
2. Maximum lake capacity is 45,599 AF between April 1 and November 1 (summer operation) at an elevation of 240.6 feet, and 35,000 AF between November 1 and April 1 (winter operation) at an elevation 237.2 feet.
3. Miles of lined and unlined canals downstream of La Grange Diversion Dam.
4. TID accepts a minor amount of tailwater into its canals that is blended with surface water supplies for deliveries; spills from upper canals are intercepted by the Ceres Main Canal and utilized to the greatest extent possible for delivery to downstream canals. Spillage into ditches that flow back into TID canals can also be reused for distribution downstream. TID also recaptures spills from the Harding Drain.
5. Grower operated tailwater systems are installed to make use of water and to comply with relevant water quality requirements.

Flood control operations, combined with variable hydrology and operation of reservoirs upstream on the Tuolumne River, influence Don Pedro Reservoir storage levels and the available surface water supplies each year.

La Grange Diversion Dam was constructed in 1893 and is located on the Tuolumne River, downstream of Don Pedro Reservoir near the community of La Grange. Water released from Don Pedro Reservoir is diverted from the river into the TID Upper Main Canal at the La Grange Diversion Dam.
As shown in the maps included in Appendix D, TID’s distribution system begins at La Grange Diversion Dam where water, released from Don Pedro Reservoir for irrigation purposes, is diverted into the TID Upper Main Canal for conveyance to Turlock Lake. Turlock Lake is an important component of the TID’s irrigation system with a maximum capacity of 45,600 AF (Table 2.2). TID operates Turlock Lake to store and release irrigation water supplies, to balance irrigation deliveries with irrigation demand, and to minimize flow fluctuations in the District’s irrigation canals and laterals. From Turlock Lake, water is released into the Main Canal for distribution to downstream growers for irrigation purposes.

In total, TID’s conveyance and distribution system downstream of La Grange Diversion Dam consists of approximately 241 miles of canals, of which 222 miles are fully or partially lined (92%). The unlined canals are located primarily in upland areas underlain with hard clay soils with very low infiltration rates. TID has an active gunite and lining maintenance program and resurfaces an average of 340,000 square feet (7.8 acres, 0.012 square miles) of canal lining each year, based on data from the 2000-2019 period. During the winters of 2006-2007 and 2007-2008, TID lined approximately 4.5 miles of existing earthen canals for operational purposes.

Three main delivery canals run north to south, and laterals run east to west from the canals. Upper laterals terminate into the lower delivery canals, allowing any excess water in the upper laterals to be utilized for deliveries from the lower canals. Several interconnections between canals provide additional operational flexibility, enabling the District to capture water that may otherwise spill. Additionally, a small volume of tailwater flows to agricultural drains and is intercepted by the TID distribution system and blended with surface water supplies for delivery to TID growers. Additional information on tailwater in the TID irrigation service area is described in Sections 2.1.3, “Terrain and Soils” and 2.2.1.4, “Drainage and Tailwater Policies.”

TID owns and maintains the distribution system from Turlock Lake down to each sidegate: the point at which water is delivered from the District to the individual fields. Growers are responsible for building, operating and maintaining the distribution facilities from the sidegate to the field. A variety of private and improvement district facilities have been designed and built over time to meet this need. (See Section 2.1.2.1 for more information regarding Improvement Districts.)

TID’s canal distribution system is a gravity flow system. Water in the canals not utilized for irrigation purposes flows through the canals and is released into drains or downstream rivers. These locations are called spills. There are a total of 15 spill locations from the distribution system. Six of the spills flow directly to rivers and the remaining nine are consolidated into three drains that flow to the river system.

TID practices conjunctive management of surface water and groundwater, supplementing surface water releases by pumping groundwater from drainage wells and rented wells. Drainage wells are owned by TID and are used to lower groundwater levels in localized, high groundwater areas and to supplement other irrigation water supplies. Rented wells are owned by private parties or Improvement Districts, and are rented by TID to supplement irrigation supplies, particularly in drier years when surface water supplies are limited. The specific wells that are rented each year vary depending upon a variety of factors, including the anticipated amount of rented pumping needed, pumping costs, condition of the well, and the quality and quantity of the water pumped.
Water pumped from drainage wells and rented wells discharges either directly into a canal, into a pipeline that flows back to a canal, or into a pipeline that is utilized for irrigation purposes.

TID also utilizes supplemental groundwater pumping to help conserve water by reducing canal spillage. This is done by purposely releasing less surface water than is needed for irrigation into the head of each canal, and pumping groundwater into the lower sections of a canal to make up the difference. Utilization of available groundwater supplies in this manner provides greater flexibility to system operators to meet irrigation demand, while reducing distribution system spills. Recent pump automation has further facilitated this process, enabling many of TID’s drainage pumps to be turned on and off remotely, reducing both groundwater pumping and spillage.

### 2.1.2.1 Improvement Districts

TID’s responsibility for water delivery stops at the canal or lateral sidegate. Growers are responsible for the construction and maintenance of facilities to transport water from the TID canal to their land. Improvement Districts (IDs) are formed to allow groups of growers to pool resources to construct, operate and maintain these irrigation facilities, including ditches, pipes, wells, drip/micro irrigation systems, and surface and subsurface drainage facilities. TID offers low interest financing to IDs, generally with a 10-year loan term.

TID is the trustee and administrator for 1,046 IDs that deliver water from the TID canals and laterals to individual growers. ID facilities comprise approximately 700 miles of lined delivery ditches and pipelines serving 124,000 acres. Generally the District continues to work with IDs to pipe facilities whenever possible. An average ID is comprised of 12 parcels with an average parcel size of 18 acres. The average parcel size receiving surface water within TID’s irrigation service area is 27 acres. Parcels not belonging to IDs receive water through private pipelines and ditches served directly by sidegates on TID canals and laterals.

### 2.1.2.2 System Operational Constraints

There are a few capacity constraints in the TID distribution system that can cause delays in delivering ordered water. These capacity constraints are due, in part, to gradual changes in cropping patterns and irrigation systems over the years that have led to a demand for more frequent and time sensitive irrigation (e.g., a shift from irrigated pasture to corn and orchard crops, and a shift from flood irrigation to micro sprinkler and drip irrigation systems). To reduce delays in water deliveries and to improve customer service, TID processes irrigation orders and tracks current water use by parcel through its central Water Call Center (created in 1991) and its online ordering system (fully implemented beginning in 2014). TID also encourages irrigators that use drip and micro sprinkler irrigation systems to install small reservoirs that can be more easily filled with surface water deliveries, and then be drawn from by the grower’s system for irrigation.

To meet delivery requests in constrained areas, TID also rents pumps to supplement surface water supplies downstream of the capacity constraint. Pumps are used as needed to ensure that the customer is not affected by system constraints and receives the full ordered flow with as much flexibility in timing as practical. The rented pumps that are turned on for this purpose can
run continuously for up to several days per week during the summer peak demand time, until demand has diminished.

2.1.2.3 Changes to Service Area

Urban, rural residential, and semi-agricultural development has increased within TID’s irrigated service area in the last several decades. Currently, there are approximately 20,000 acres of urban development, based on County land use maps. Other semi-agricultural and rural residential land uses occupy approximately 5,000 acres within the TID service area. An evaluation of land use patterns in the TID service area completed in 2006 showed that idle cropland has gradually been converted to urban land uses, rather than land in active agricultural production. The economic downturn that began in about 2008 also influenced urban development in the region, a condition from which this area has been recovering. Hence, land use changes within the irrigation service area have not resulted in significant reductions in active irrigated acreage since the early 2000s.

Several local community water systems, including those found in Ceres, Turlock and the portion of Modesto south of the Tuolumne River, have studied the possibility of using TID surface water from the Tuolumne River to supplement groundwater supplies. In July 2015, TID and the Stanislaus Regional Water Authority (SRWA) completed a Water Sales Agreement, which represented a significant step forward in TID’s provision of surface water for municipal uses. In June 2020, the SRWA voted to approve a contract with CH2M Hill to design and construct the Tuolumne River treatment plant serving Turlock and Ceres. Construction could begin in 2021 and finish in 2023. (See Section 3.4 for more information regarding municipal and industrial water supplies.) Such a project would restore surface water service to land within TID’s current irrigation boundaries.

2.1.3 Terrain and Soils

Soils within TID vary from loam on the eastern edge of the irrigation service area to loamy sands on the western side. On average, land in TID is flat with an average fall of about 1 foot per 1,000 feet. Most irrigated lands in the TID irrigation service area are laser leveled, with the annual crop areas re-leveled every few years. The majority of land is flood irrigated using basin-check systems that generate little or no tailwater. As a general rule, private tailwater return systems are not permitted to discharge to the distribution system. Even on the eastern side of TID, where the land is somewhat steeper and more tailwater occurs, the majority of growers have control structures to prevent tailwater from flowing directly back into the distribution system.

A small quantity of tailwater is generated in the TID irrigation service area. Tailwater production is limited to approximately 10,900 acres (less than 7% of TID irrigable lands). The

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4 Rural residential and semi-agricultural land uses are summarized from 2016 Farmland Mapping and Monitoring Program data available from the California Department of Conservation, Division of Land Resource Protection. These land uses include land use classes R (rural residential land) and sAC (semi-agricultural and rural commercial land) in the TID service area.

tailwater first flows to agricultural drains that collect a mixture of tailwater, shallow groundwater, and occasionally rainfall runoff. Several of these drains are intercepted by the distribution system, enabling recovery and reuse of drain flows, including tailwater from approximately 2,700 acres (less than 2% of TID irrigable lands). The remainder of drains flow to local rivers. During the irrigation season, the intercepted water is blended with surface water supplies in the canals and used for irrigation. Approximately 8,200 additional acres within TID can also produce tailwater, but this water does not enter the TID distribution system. (See Section 2.2.1.4 for additional information regarding tailwater policies.)

On the western side of TID, localized perched water tables result from extensive clay lenses lying between 5 and 20 feet beneath the ground surface. These perched water tables developed soon after water was delivered into these areas in the early 1900s, and led TID to begin installing drainage wells as electricity became available in the 1920s. The drainage wells in these areas are run to help lower groundwater levels to maintain aerated root zones for crop production. TID makes monthly shallow groundwater elevation maps to guide the operation of the drainage pumps. TID currently owns 165 drainage wells and generally operates between 105 and 130 of them each year depending on rainfall and need for drainage. The pumped drainage water can contain elevated concentrations of Total Dissolved Solids (TDS) and nitrates, and is therefore blended with surface water and used for irrigation to the fullest extent possible.

The spatial variation in soils from east to west has resulted in the majority of the orchard crops being cultivated on the east side of TID, while the bulk of the field crops supporting the dairy industry are found on the west side. Micro sprinkler and drip irrigation systems are concentrated on the east side in the areas with lighter soils, and tend to use less water and produce less deep percolation (recharge) than surface irrigation methods. However, it should be noted that, where feasible, most new installations of drip irrigation and micro sprinkler systems use surface water and also maintain access to their historic flood irrigation facilities. The east side of TID is the area where recharge is most needed to overcome local groundwater level declines primarily resulting from groundwater pumping to the east of the TID service area, presenting a challenge to groundwater management in the Subbasin. Conversely, subsurface drainage systems have been installed in the western areas with higher groundwater levels.

2.1.4 Climate

TID’s service area is characterized by a Mediterranean-type climate. Summers are hot and dry, with average high temperatures over 90°F in July, and temperatures exceeding 100°F at times. Winters are cool and wet, with the majority of precipitation falling between November and March. The coldest months of the year are December and January, which have an average minimum temperature of 36°F. These characteristics are widely representative of the climate throughout the irrigation service area. Microclimates within TID do not vary greatly and, therefore, have little impact on TID operations or on-farm water demands. Average climate data for the period 1991 to 2019 are presented in Table 2.3. The twenty-nine year period from 1991 to 2019 provides a reasonable depiction of long-term climatic conditions within TID. Potential climate change effects are discussed in Section 6.

Natural precipitation generally meets the water needs of winter annuals, pasture and winter cover crops in the orchards; however, dry winters may require irrigation deliveries for these crops between November and February. In the past, early irrigations have typically occurred within a
two week period in either January or February. Water delivered during the winter is typically not counted towards a grower’s available water supplies (referred to as the “allotment” prior to 2013, and known as available water since then) for the irrigation season and is charged on a volumetric basis.

Although freezing temperatures do occur during the winter months at times, TID does not deliver water for frost protection. However, TID does allow pump owners to use the canals to convey their own deep well water to other parcels owned or rented by the pump owner. A condition of this use is that such activities cannot interfere with operation and maintenance of the canal or lateral.

Table 2.3. Average Climate Characteristics (1991-2019).

<table>
<thead>
<tr>
<th>Climate Characteristic</th>
<th>Parameter</th>
<th>Average Value¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>Average Annual Precipitation</td>
<td>12.4 inches</td>
</tr>
<tr>
<td></td>
<td>Average Monthly Minimum Precipitation</td>
<td>0.01 inches (August)</td>
</tr>
<tr>
<td></td>
<td>Average Monthly Maximum Precipitation</td>
<td>2.66 inches (January)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Average Monthly Minimum Temperature</td>
<td>36°F (January, December)</td>
</tr>
<tr>
<td></td>
<td>Average Monthly Maximum Temperature</td>
<td>91°F (July)</td>
</tr>
<tr>
<td>Reference Evapotranspiration (ET₀)</td>
<td>Average Annual ET₀</td>
<td>52.9 inches</td>
</tr>
<tr>
<td></td>
<td>Average Minimum Monthly ET₀</td>
<td>1.04 inches (December)</td>
</tr>
<tr>
<td></td>
<td>Average Maximum Monthly ET₀</td>
<td>8.23 inches (July)</td>
</tr>
</tbody>
</table>

¹Average precipitation values are from 1991 - 2002 records from the National Oceanic & Atmospheric Administration (NOAA) Station #49073 (Turlock #2), from California Irrigation Management Information System (CIMIS) Station #168 (Denair) for 2003 - April 2009, and from CIMIS Station #206 (Denair II) for April 2009 - December 2019.

Temperature values are from CIMIS Station #71 (Modesto) for 1991 - 2002, from CIMIS Station #168 (Denair) for 2003 - April 2009, and from CIMIS Station #206 (Denair II) for April 2009 - December 2019.

ET₀ values are from CIMIS Station #71 (Modesto) for 1991 - 2002, from CIMIS Station #168 (Denair) for 2003 - April 2009, and from CIMIS Station #206 (Denair II) for April 2009 - December 2019.

TID has been providing growers with local weather information for on-farm water management for nearly 20 years. In early 2002, TID installed the California Irrigation Management Information System (CIMIS) Station #168 (Denair). The station was installed in a central location in the TID irrigation service area, providing data for a previously underrepresented area in the CIMIS network. In April 2009, CIMIS Station #168 (Denair) was relocated approximately two miles to the southeast and assigned a new station number (#206). The station is currently located on an irrigated pasture with adequate fetch to provide reliable reference evapotranspiration estimates.

The station provides area-specific climate and reference evapotranspiration data to growers to allow them to effectively schedule irrigation events based on current and projected crop water usage. TID provides growers with the CIMIS website information and a web link to CIMIS tutorials and station data on the TID website (www.tid.org/irrigation/irrigation-information/cimis). Growers can also access the data directly from the DWR website.
2.2 OPERATIONAL CHARACTERISTICS

2.2.1 Operating Rules and Regulations

The current TID “Irrigation Rules” are provided in Appendix E and are publicly available on the TID website (www.tid.org/irrigation). The Irrigation Rules include rules for the distribution and use of irrigation water, governing rules for IDs, pump IDs, and subsurface drainage IDs, and the TID Drainage Policy. Updates to the irrigation rules occur from time to time as needed. Any changes to the irrigation rules are communicated to customers and readily available at TID offices, or via the TID website (www.tid.org).

2.2.1.1 Water Allocation Policies

Historically, the TID Board of Directors has established the baseline water allotment each year depending on projected runoff including the possibility of the occurrence of consecutive dry years, desired carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps. This baseline allotment was part of a three-tiered increasing block rate schedule, which is discussed in greater detail in Section 2.2.3, “Water Rate Schedules and Billing.” The baseline allotment was the quantity of water available equally to each acre of land within the TID service area. Additional water could be purchased, if available, and was charged on a volumetric basis. In average rainfall years, the baseline allotment was as high as 48 inches (4 AF per acre).

On June 12, 2012, the TID Board of Directors adopted a new volumetric pricing structure to comply with SBx7-7 water pricing requirements. As described in Section 2.2.3, the new structure is an increasing block rate structure combined with a fixed charge. Additionally, the structure includes two different fee schedules, one for “normal” water years and one for “dry” years. The new rate structure took effect in 2013. With the new structure, instead of establishing an “allotment,” the Board of Directors determines the amount of water available for purchase each year, and the fee schedule to be used (e.g. normal or dry year). These determinations are made based on projected runoff, including the possibility of the occurrence of consecutive dry years, desired carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps.

In establishing water available in a dry year, the District evaluates water supplies as if it is the first dry year of a multiple year dry cycle. For these analyses, the recent dry period from 2012 to 2016 is used as the drought of record for planning purposes. Other significantly dry periods are 1976 through 1977 and 1987 to 1992. These dry periods, and their impacts on water supply availability, are often utilized for reference in water supply planning.

Additionally, in most normal or above normal precipitation years, depending on carry-over storage, the TID Board of Directors may allow the sale of “replenishment water” to lands outside of, but adjacent to TID. This block of water is not always available. The bulk of the “replenishment water” goes to lands to the east of TID as a substitute for groundwater pumping or in lieu groundwater recharge. These lands have no surface water supply and groundwater pumping has caused a cone of depression to form on the eastern portion of the Turlock Subbasin. TID promotes in-lieu groundwater recharge during most years with normal or above normal precipitation by selling replenishment water at rates that are competitive with the cost to pump
groundwater. The last time replenishment water was made available in 2019, the cost was $20 per AF.

2.2.1.2 Water Orders

TID uses an arranged-frequency demand system of water ordering and delivery. Under this system, the irrigation frequency (water delivery date) is arranged, flow rates are arranged subject to a maximum limit, and the delivery duration is under user control as growers are allowed to keep the water until they finish irrigating (ASCE, 1991). Cropping patterns in TID’s irrigation service area are very diverse, with trees, vines, alfalfa, and field crops often served by the same ID pipeline. An individual grower may adjust the duration and frequency of delivery and, less commonly, the flow rate to meet crop needs. For surface irrigation, flow rates are typically held constant from one irrigation event to the next to achieve consistent system performance.

Growers place orders for water with TID’s central Water Call Center, where a computer system tracks current water use by parcel. In addition, TID began implementing an online ordering system in 2011, with full implementation reached in 2014. The District has also made historical customer information available to growers online. Use of the new online system has been gradually increasing over time. In 2019 and 2020, about 25 to 30% of orders were completed online.

On average, between 2011 and 2019 growers have received water approximately 50 to 55 hours after they placed an order. Growers are allowed to keep the water until the irrigation is complete. Growers are billed for the total volume of water used, computed from calibrated delivery flow rates and the actual time of use rather than the time estimate given when the water order was placed. As described under “Irrigation Deliveries” below, most growers take a full flow (or “head”) of water. The TID Water Distribution Operator (WDO) notifies each irrigator of the name and contact information of the grower they will receive the water from, and the grower they will pass the water to when finished.

Growers that irrigate with micro systems or sprinklers using non-standard flow rates (less than the full “head” typically used by surface irrigation) set up weekly orders in the central Water Call Center and then communicate directly with the WDO to coordinate delivery. The WDO has the discretion to adjust the grower sequence from the Water Call Center water requests. This is done to minimize flow fluctuations in long pipelines by sequencing in continuous 24-hour blocks rather than making multiple flow adjustments throughout the day. Fixed two week rotation deliveries are also established for up to 604 “garden heads,” which are blocks of parcels 5 acres or smaller of non-commercial agriculture that are irrigated as a unit.

Wait times for water delivery are variable within a reasonable range, due to the discretion that WDOs have to adjust delivery sequences. The WDO must call the irrigator within 24 hours of receiving the irrigation request to give an estimate of the delivery time. The WDO then will attempt to contact the irrigator at least 12 hours in advance to notify the irrigator of any change in time of delivery. On average, between 2011 and 2019 growers have received water approximately 50 to 55 hours after they placed an order. The grower is responsible for contacting the next irrigator in the sequence to let him or her know when the water will be
available. The lead time, or notice, for the next irrigator is typically ½ hour to 1 hour before the preceding irrigation finishes.

The software system currently used by the Water Call Center to track water orders and irrigation deliveries and to bill customers is a proprietary system, referred to as the TXDB database, was created by TID software engineers in the early 1990s. The system has been updated as needed over time. In recent years, TID has evaluated commercially available software, and has also considered updating the existing proprietary system for water ordering, tracking and billing purposes. TID has chosen to modify the proprietary system to better track ordering, measurement, and billing data to meet the SBx7-7 requirements.

2.2.1.3 Irrigation Deliveries

The predominant irrigation practice in the TID service area has historically been a basin-check flood irrigation system. In the last ten years, irrigators in TID have increasingly adopted micro sprinkler and drip irrigation systems. This shift has been driven primarily by increased production of orchard crops supported by these types of irrigation systems.

TID supplies water by gravity to growers at ID or private sidegates. Growers are responsible for controlling their water while irrigating, and for passing the entire flow on to the next grower, as instructed by the WDO.

The standard “head” of water delivered is generally 15 cubic feet per second (cfs), and TID requires new flood irrigation facilities to be designed for a minimum of 15 cfs. Growers served through private pipelines or ditches generally receive a full standard head for flood irrigation systems. In most instances, growers served from an ID pipeline or ditch also receive the entire flow in their sidegate in the order the water is scheduled. The availability of these large delivery rates has enabled high application distribution uniformity using surface irrigation on the light textured soils found in the majority of the TID service area.

The recent shift in irrigation methods is expected to continue and presents some challenges for TID operations. Drip and micro sprinkler irrigation systems generally require lower flow rates, ranging from 2-4 cfs on average, and require longer irrigation durations compared to flood irrigation systems. TID’s gravity system is designed to convey large flood heads, but the increased use of drip and micro sprinkler systems has increased demand for “microheads,” with lower, varying flow rates and longer durations. TID must accommodate these microheads either by carrying the microheads together with larger flood heads, or by combining the microheads, which is challenging for WDOs due to their varying start and end times. The added challenges of these microheads result in greater difficulty for WDOs to “level” demands by arranging the sequence of deliveries. Regulating reservoirs, in particular, may be necessary to respond to these challenges as the number of drip and micro sprinkler systems continues to increase.

2.2.1.4 Drainage and Tailwater Policies

As a general rule, direct tailwater discharges are not permitted in the TID distribution system. The basin-check, sprinkler and drip/micro irrigation systems used in TID’s irrigation service area produce little or no tailwater. Overall, approximately 10,900 acres (less than 7% of TID’s irrigable acreage) generates tailwater. A small portion is collected in drains and discharged into
the distribution system where it blends with surface water and is reused for irrigation. The remainder flows to local drains, which in turn discharge to nearby rivers.

In 2000, TID began a systematic program to inventory the tailwater and storm drains that discharge to TID facilities. In 2004, TID received grant funding which allowed TID to complete the inventory for the entire District, and to provide financial assistance to growers for installing positive shut-off devices on their drains and for installing real-time water quality monitoring equipment. As part of this program, TID issues growers with drainage discharges a “Drainage Permit” which requires that a positive shut-off device be installed on each field drain, establishes a size limit on the drain and spells out the grower’s responsibilities with respect to the quality of their drainage water. An annual fee is also charged for each field drain to offset a portion of the maintenance costs.

The inventory shows that drain water that eventually enters TID canals comes from a small percentage of lands within TID (approximately 2,700 acres, or less than 2%). This drain water includes tailwater mixed with other source water such as groundwater and natural runoff from precipitation. The drain water is blended with surface water supplies for delivery to TID growers. Some tailwater is generated on approximately 8,200 additional acres within TID, but is not intercepted by the TID distribution system.

### 2.2.2 Water Delivery Measurements or Calculations

#### 2.2.2.1 Conveyance System Measurements

TID began installing a Supervisory Control and Data Acquisition (SCADA) system in 1997, with data collection beginning in 1998. Through its agricultural management planning process, TID improved upon its SCADA system to better monitor flows by adding additional SCADA sites throughout the canal system. In 2007, TID began upgrading the pressure transducers originally installed with the SCADA equipment to maintain data accuracy, and has since completed the upgrade at all sites.

Today, TID collects water measurement data from 397 SCADA sites, including nine miles of Rubicon Total Channel Control (TCC) automation and remote control systems for many of the District’s drainage pumps. TID monitors upstream water levels, gate openings, and measured flows at regular intervals. TID also collects water measurement data from TID-owned drainage wells, tile drain systems that discharge water into TID laterals, and spill sites at the end of TID laterals and canals.

These improvements have increased TID’s ability to monitor system operations. Staff routinely monitors flows at the heads of most laterals, main diversion points, 18 intermediate points in the distribution system, and at 14\(^6\) operational spillage sites, three (3) drains, and two (2) creeks.

Further, WDOs have remote access to the real time flow data through a program installed on their TID tablet computers, allowing them to rapidly check conditions throughout their service area. The installation of SCADA technology has increased the availability of flow.

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6 There are 15 operational spillage sites in the TID system. However, only 14 are used. The 15\(^{th}\) site can spill, but is very rarely used, and therefore is not included in the SCADA system at this time.
measurements throughout the TID distribution system. In addition to providing flow measurements at previously ungaged sites in the distribution system, the telemetry equipment replaced the Stevens chart recorders. The SCADA sites produce more accurate flow volumes because flows are recorded in real time and averaged for the daily flow volume. These flow data have improved the estimates of water use throughout the irrigation service area.

The measurement structures within the conveyance system are maintained annually to ensure the accuracy of recorded measurements. The calibration of the sensors at the SCADA sites is periodically checked throughout the year, and the SCADA data is regularly transferred into a data warehouse.

### 2.2.2.2 Delivery Measurements

The delivery point at which water is delivered from a TID canal or lateral to a grower’s parcel or an improvement district facility is called a sidegate. Sidegates are typically operated for measurement by setting the valve stem opening as needed to deliver the standard irrigation flow rate (generally 15 cfs for flood irrigation). The valve opening is determined by measuring the height of the gate stem above a standard reference point on the gate frame. Historically, the gate opening has been set such that the end (downstream-most) user receives at least the standard flow for that pipeline.

The gate opening required to deliver the standard flow has been determined from flow measurements made by trained TID employees using portable electromagnetic velocity meters or ultrasonic flow meters, which measure velocity in the irrigation pipeline or ditch downstream of the sidegate. Flow is calculated by multiplying the measured velocity by the cross-sectional area of the pipe. The required gate openings to provide a standard 15 cfs head are provided to the WDOs, the field staff who deliver the water, and to the growers served by each gate. A gate opening and associated flow rate is assigned to each parcel in the database record used to compute water use.

TID also provides an increasing number of non-standard delivery rates, mainly to parcels served by pressurized systems. Deliveries to these parcels are assigned a unique flow based on the individual configuration of each particular sidegate-parcel-irrigation method-requested flow rate combination, referred to as the parcel-specific calibrated flow rate.

Growers are billed for the volume of water delivered. When a grower completes an irrigation event, they contact the WDO to give the start and stop times for the irrigation, and the WDO records the times on a water receipt. The volume delivered is calculated by multiplying the calibrated delivery flow rate by the duration of the delivery.

Using TID sidegates to measure individual customer deliveries in this manner is complicated by a number of factors that make using this method, in some locations, potentially problematic for achieving accuracy standards specified in the California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597). Therefore, pursuant to 23 CCR §597.4(e) (4), a corrective action plan to be fully compliant with the new regulation by December 31, 2015 was developed, and included in Appendix F of the 2012 TID AWMP.

The corrective action plan included a two-pronged approach to delivery measurement. Pursuant to this plan, TID has established parcel-specific calibrated flow rates or installed new
measurement devices to directly measure the volume of water delivered to each parcel. Documentation of TID’s delivery measurement accuracy improvement program is provided in Appendix F of this AWMP.

As of December 31, 2019, TID has installed new continuous flow measurement devices with laboratory-certified flow rate accuracy on 142 sidegates that together serve roughly half the irrigated acreage in TID.

At existing sidegates without access vents in suitable locations for measurement, TID developed a system for temporarily installing Rubicon FlumeMeters to determine the parcel-specific calibrated flow rates. In total, TID has used 57 mobile FlumeMeters in this program to develop calibrated flow rates at 550 existing sidegates that serve 1,196 parcels, representing 32,187 assessed acres, or approximately 22 percent of the District.

Additionally, Hach FH950 meters have been used to determine parcel-specific calibrated flow rates at 349 sidegates serving 536 parcels that together represent 19,345 assessed acres, or approximately 13 percent of the District. Finally, Fuji Portaflow meters have been used to determine parcel-specific calibrated flow rates at 471 sidegates serving 877 parcels that together represent 29,798 assessed acres, or approximately 21 percent of the District.

As of 2019, TID has finished initial calibrations per the corrective action plan for active sidegates that don’t fall under DWR exemptions. In total, across all field testing methodologies, 100% of the assessed acreage served by the non-exempted active sidegates now receive calibrated delivery flow rates.

Plans for future flow measurements and calibrations are described in Appendix F. As TID moves forward with collecting additional flow measurements, TID will prioritize the sidegates in the random samples found to have a flow rate accuracy that is outside of the acceptable range to meet SBx7-7 requirements. These measurements will be collected to improve the accuracy of the average flow rate used as the calibrated flow rate for the sidegate-parcel-irrigation method-requested flow rate combination. TID will also provide new calibrations, as needed, to serve new flow requests from customers.

2.2.2.3 Private Pumping Measurements

Private pumping volumes in TID are estimated using a conversion factor that correlates the quantity of water pumped with electrical energy use. TID has reviewed and revised the conversion factor on several occasions, most recently in 2014. Revisions to this methodology have helped to improve the accuracy of private pumping volumes and to prevent overestimation resulting from other electricity usage associated with the same electric meter. TID will continue to review and revise the conversion factor in the future, as needed.

2.2.3 Water Rate Schedules and Billing

TID historically used a three-tiered, increasing block rate schedule based on three classes of water deliveries. The first block was the annual allotment which was available equally to each acre of land. The volume of the allotment varied depending upon the available surface water supply. The actual allotment, as well as any additional water available above the allotment, was set each year based on projected runoff including the possibility of the occurrence of consecutive
dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps.

TID’s historic pricing and water management practices enabled TID to conjunctively manage its surface water and groundwater resources. In normal and above normal water years, allotments (up to 48 inches per acre; now termed “available water”) encouraged growers to use surface water rather than pump groundwater. The majority of surface water applied but not consumed by the crop recharged the groundwater system. The recharge maintained groundwater storage that is pumped in dry years to supplement reduced surface water supplies. Additionally, the allotment was reduced in dry years, increasing the cost to the grower by moving deliveries into the higher tiered water prices sooner. This not only encouraged conservation in dry years, but also provided additional revenue to cover costs associated with additional pumping needed to supplement reduced surface water supplies.

In June of 2012, TID adopted a new volumetric pricing structure that became effective in 2013. This structure is designed to continue to support the District’s critically important conjunctive management objectives, but also to comply with the requirements of SBx7-7. The new structure included a fixed (per acre) charge, combined with a four-tiered increasing block rate schedule. The new rate structure also includes a split schedule, with one schedule established for dry years, and another for normal or above normal years. As with the previous pricing structure described above, the new “dry” schedule is at a higher rate, to help recover the additional pumping costs incurred in dry years. With the new pricing structure in place, the TID Board of Directors no longer determines the allotment each year. Instead, the Board determines the type of water year (and therefore the water pricing schedule to be used for the given year) as well as the amount of water available for purchase, based on projected runoff, including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps. The process now used to determine the volume of available water is similar to that used previously to establish the annual “allotment.”

The current irrigation rate schedule (shown in Table 2.4) was adopted by the TID Board of Directors in 2015, when the 2013 rate schedule (described above) was updated to fund system improvements and operating costs. The current rates have been in effect since the start of the 2015 irrigation season. This structure continues to support the District’s critically important conjunctive management objectives, and to comply with the SBx7-7 requirements.

In addition to the cost of water, the growers are responsible for the cost of the facilities to convey water from the TID canal sidegates to their fields.

TID also promotes in-lieu recharge in most years with normal and above normal precipitation. In these years, depending on carry-over storage, the TID Board of Directors may allow the sale of “replenishment water” to lands outside of, but adjacent to TID. This block of water is not always available. The bulk of these sales go to lands to the east of TID as a substitute for groundwater pumping for irrigation. These lands have no surface water supply, and groundwater pumping significantly impacts available groundwater supplies in the Subbasin. The District promotes groundwater recharge in those areas in years when surplus water is made available by selling the water at rates comparable to the cost to pump groundwater. Replenishment water was last available in 2019 at the cost of $20 per acre-foot.
Table 2.4. Description of 2020 Water Rates (Adopted in 2015).

<table>
<thead>
<tr>
<th>Water Charge Basis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage-based</td>
<td>Fixed charge on an acre basis, varies by normal or dry year</td>
</tr>
<tr>
<td>Quantity-based</td>
<td>Water charged on a per acre-foot (AF) basis, varies by normal or dry year</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Billing</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water costs include a fixed charge for access to water, plus volumetric charges for the water used. Charges are established in normal or dry year schedules. Volumetric charges are based on a four-tiered, increasing block rate structure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Normal Year Rate Schedule&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Dry Year Rate Schedule&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Charge</td>
<td>$60 per acre</td>
<td>$68 per acre</td>
</tr>
<tr>
<td>Tier 1 Water Rate</td>
<td>$2 per AF, up to 2 AF per acre</td>
<td>$2 per AF, up to 1 AF per acre</td>
</tr>
<tr>
<td>Tier 2 Water Rate</td>
<td>$3 per AF, up to 2 AF per acre</td>
<td>$3 per AF, up to 1.5 AF per acre</td>
</tr>
<tr>
<td>Tier 3 Water Rate</td>
<td>$15 per AF, up to 1 AF per acre</td>
<td>$15 per AF, up to 1 AF per acre</td>
</tr>
<tr>
<td>Tier 4 Water Rate</td>
<td>$20 per AF, additional available</td>
<td>$20 per AF, additional available</td>
</tr>
<tr>
<td>Frequency of Billing</td>
<td>Semi-annually</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup>Acreage based on assessed acres.

2.2.4 Water Shortage Allocation Policies and Drought Plan

TID’s water allocation guidelines were developed in response to the 1987-1992 drought and were reevaluated in response to the 2012-2016 drought. The water allocation guidelines are described in greater detail in TID’s Drought Management Plan (Appendix G). The guidelines rely on TID’s groundwater pumping capacity and management of carryover storage in Don Pedro Reservoir. Prudent water supply planning requires TID to consider that the first dry year encountered may just be the first year in a series of dry years similar to the 1987-1992 or the 2012-2016 drought periods.

Prior to 2013, the Board of Directors determined the available water and carryover storage each year based on runoff projections, the possibility of the occurrence of consecutive dry years, existing carryover storage, availability of groundwater and rented pumps, and instream flow requirements. The decision was made either to set the available water (or “allotment” prior to 2013) at normal levels, or to reduce the available water consistent with lower surface water diversions. Groundwater pumping was increased progressively in the first years of a drought, while the available water was progressively reduced. The gradual increase in groundwater use and corresponding decrease in water available to growers allowed for a more uniform increase in groundwater pumping balanced against annual reductions in the carryover storage reserve. Additional pumping and other operational changes helped to reduce spills, further extending limited supplies. However, there is a limit to the amount of pumping the District is able provide. As a drought continued, growers with access to private wells were able to use them to offset reduced District supplies.

The reduction in available water in the first drought years caused growers to go into higher priced water tiers more quickly, and was intended to promote water conservation at the farm and
supplier scales. For subsequent years of drought, the same process was used to make further adjustments in the water available and carryover storage. In critically dry or consecutive dry years, TID could cap water deliveries to lands receiving surface water. Historically, the one exception was that growers that rented pumps to TID were typically given access to an additional 12 inches of water, up to a maximum of 48 inches, on those lands able to be served by the pump. This was done to encourage growers to rent pumps to TID. Without this option, many rental pumps may not have been available, significantly reducing TID’s ability to supplement reduced surface water supplies in dry years.

Beginning in 2013, a new water rate structure in response to SBx7-7 changed the process described above. However, a similar type of water shortage allocation process has been implemented. In water short years, the Board of Directors determines whether to use the dry year rate schedule, and the amount of water available on a per acre basis, based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps.

As with past years, the decision to reduce surface water diversions in the future will be made based on available water supplies. Information including runoff and carryover storage projections, the availability of rented pumps, and instream flow requirements will be used to assist in making that determination. Similarly, groundwater pumping is expected to increase progressively in each drought year as supplies allow, and water available to the growers may be progressively reduced, as needed to balance supplies available with carryover storage requirements.

However, even with TID’s conjunctive water management, groundwater is not an unlimited supply. In accordance with the Sustainable Groundwater Management Act of 2014 (SGMA), local agencies must work together to achieve sustainable groundwater use in the Turlock Subbasin by 2042. TID is actively involved in preparing the Turlock Subbasin Groundwater Sustainability Plan (GSP) that will identify the actions needed to achieve groundwater sustainability. GSP development efforts are ongoing, and are on track to result in the adoption and submittal of a SGMA-compliant plan by January 2022. Following completion of GSP implementation efforts, groundwater is expected to generally remain available for use even during drought years because of recharge in normal and wetter years.

Water availability is treated equally for all crop types because a large proportion of field crop production occurs in conjunction with local dairy operations. This demand is as stable as the water demands for orchard crops. In the past, growers who paid the District’s water charge were provided with access to the same amount of available water, regardless of crop type. The current rate schedule is designed to act in a similar manner. Payment of the fixed charge provides growers with access to purchase the amount of water available that year, regardless of crop type. All water delivered is charged on a volumetric (per acre-foot) basis.

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7 To develop a methodology to quantify Water Use Efficiency (WUE), DWR considered the components of a water balance at three spatial scales—basin, water supplier, and field (DWR, 2012). Similarly, spatial scale must be considered when evaluating the influence of the amount of water available to growers.
Increased groundwater pumping during dry years also allows TID to increase water delivery efficiency by reducing operational spills. The use of extensive pumping allows a WDO to more closely match water supplies to demands in the downstream portion of a service area. This flexibility was utilized during the 1987-1992 drought, resulting in a substantial decrease in operational spills. TID has continued to rely on the practice of increased groundwater pumping to reduce spills in the dry years since the 1987-1992 drought, most notably 2007 through 2009 when operational spills were decreased to an average of five percent. Similarly, from 2012 through 2016 operational spills were progressively decreased each year to approximately five percent in 2014 through 2016.

2.2.4.1 Wasteful Use

TID’s Irrigation Rules (Appendix E) require that all water be applied efficiently and used in a reasonable and beneficial manner (Rule 4.2.1). During an irrigation delivery, the irrigator is responsible for the water at all times after it leaves the TID distribution system (Rules 4.1.3 and 4.1.4). Irrigators who waste water intentionally or as a result of carelessness, improper field preparation, or neglected facility maintenance may be refused TID water until the cause of the condition is remedied (Rule 4.2.2).

The predominant irrigation method in TID (basin-check flood irrigation system) promotes beneficial use of water. Deep percolation that does occur from the basin-check systems provides recharge that is put to beneficial use by TID and its customers, as well as others within the Subbasin that rely upon groundwater for their water supply. As noted in the introduction to this AWMP, even with the recharge provided by irrigation, the groundwater levels in the eastern portion of TID and in the eastern portion of the Turlock Subbasin have steadily declined (see Section 4.1.2), largely due to groundwater usage outside the eastern boundary of TID.

It is important to note that in areas where groundwater levels are higher and groundwater is pumped for drainage, the drainage water is blended with canal water and used as a part of the irrigation supply. Drawdown of groundwater levels due to the cone of depression on the eastern side of the Subbasin limits the amount of groundwater that can be pumped on the eastern side of the District in dry years. However, the District is able to maximize the use of higher groundwater levels on the western side of the Subbasin for beneficial use.

2.2.4.2 Enforcement of Irrigation Rules and Regulations

Enforcement of the Irrigation Rules and the appeal process available to growers are described in detail in the TID Irrigation Rules in Part I, Section 10 (Appendix E). Failure or refusal to comply with the TID rules and regulations by a landowner or irrigator may lead to termination of water delivery (Rule 10.1). Once terminated, water delivery cannot be resumed to the landowner or irrigator until the issue is resolved.

The Water Distribution Department Manager is authorized to issue a Notice and Order, or issue an oral or written warning to any irrigator or landowner in violation of a TID rule or regulation (Rule 10.2.1). The landowner or irrigator has ten calendar days from the date of service (of the Notice and Order) to file a written appeal to the General Manager or Board of Directors, depending on the type of notice, after which all rights to a hearing are waived (Rule 10.2.2). Water deliveries may be terminated immediately in certain circumstances (Section 10.3).
Once an order or decision has become final, the irrigator or landowner has seven calendar days to commence corrective action or repair and must pursue the action with sufficient diligence to meet the time established for compliance (Rule 10.5.4). When the landowner or irrigator re-establishes full compliance with all regulations, the eligibility to receive water deliveries is restored.
3. Description of the Quantity of Water Uses

This section of the AWMP describes the quantities of water used within the TID service area. As described in Section 2, the District co-owns Don Pedro Reservoir with Modesto Irrigation District (MID). The reservoir is outside of TID’s service area and is managed by TID and MID for water storage, power generation, and recreation (including water sports). TID supplies irrigation water for agriculture. TID also provides domestic drinking water (in conjunction with MID) for the community of La Grange. These and other water uses within TID’s service area, as well as uses related to TID’s operations are described in greater detail in the remainder of this section.

In this Section 3 (Quantity of Water Uses) and in the following Section 4 (Quantity and Quality of Water Resources), the following periods are used for the presentation and interpretation of water use and supply data:

1. **2015-2019 Period (Near-Term Historical):** The 2015-2019 data are reflective of recent TID operations and weather conditions. During this period, two of the years are considered dry and three are considered normal. The period 2012-2016, preceding and beginning the 2015-2019 near-term historical period, was the driest four-year period in TID’s 128-year history.
   a. Average: average annual value over 2015-2019, the last five years of operation.
   b. Minimum and Maximum: minimum and maximum annual values over 2015-2019, depicting the range of values under recent historical conditions.

   b. Normal year average: average annual value for years in which water supplies were sufficient to allow for 48 inches or more of available water to each acre of land (prior to 2013, this was referred to as the allotment). From a hydrological perspective, these years could be characterized as anywhere between normal and wet. Over the 29-year period from 1991-2019, 16 years fall into this category.
   c. Dry year average: average annual value for years in which water supplies were reduced, and the water available to each acre of land (referred to as the allotment prior to 2013) was less than 48 inches. Over the 29-year period from 1991-2019, 13 years fall into this category. The available water in these years ranged from a low of 18 inches (2015) to a high of 42 inches (2001 and 2003).

Water uses and water supplies within these AWMP sections are summarized on a calendar year basis to include a complete irrigation season, thus better describing irrigation practices and TID operations that support those practices. The typical irrigation season in TID extends into October and occasionally November, straddling two DWR-defined water years (October 1 to September 30). Water year summaries of the complete TID water budget are included in Appendix I.
3.1 AGRICULTURAL WATER USE

The TID service area covers a gross area of 197,261 acres, with approximately 157,800 acres that can currently be irrigated with surface water. Between 2015 and 2019, the average assessed acreage in TID was 143,760 acres. This translates to an average of approximately 135,140 irrigated acres when an estimate of field roads and other small non-irrigated areas are accounted for.

The climate and soils in the TID service area are suitable for a wide variety of crops (approximately 40 different crops were grown during the 29 years from 1991 through 2019). Table 3.1 lists the types of crops grown in the TID irrigation service area, and summarizes the average acreage planted of each between 2015 and 2019, and over the 1991 to 2019 period for both normal years\(^8\) and dry years. The minor differences in average acreages for normal and dry years reflect the high water supply reliability achieved by TID’s conjunctive management approach to water resources management. This high water supply reliability is also reflected in the large areas of permanent crops and crops supplying local dairies that require a steady water supply year after year. Permanent crops and crops that could be used to support local animal production together span approximately 130,000 acres, or approximately 96% of irrigated land within the TID service area\(^9\). The values in Table 3.1 represent irrigated acreages with double cropping included as a specific crop type. Thus, double counting of acres is avoided.

Seasonal crop water use is summarized in Table 3.2 for representative crop groups. Daily crop water use, or crop evapotranspiration (ET\(_c\)), is calculated for each crop group using the “crop coefficient – reference crop ET” methodology (Allen et al, 1998). In this process, the daily evapotranspiration from a known reference crop surface (ET\(_{ref}\)) is first calculated using local weather data. Then, daily ET\(_{ref}\) values are adjusted to represent the unique and varying daily ET\(_c\) rates of other crops throughout their growing seasons using specific crop coefficient (K\(_c\)) curves.

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\(^8\) Note that “normal” years, as described herein may include relatively wet years with respect to overall hydrology. As noted previously, for purposes of discussion, normal years refer to those years with 48-inches of available water (referred to as the “allotment” prior to 2013).

\(^9\) Combined total of approximately 64,000 acres of permanent orchard and vineyard crops (2015-2019 average), and approximately 66,000 acres of alfalfa, pasture, sudan, corn, unirrigated forage/corn, oats, oats/corn, clover, sorghum, and double-other crops that could be used to support animal production (2015-2019 average). The latter crops are available to support approximately 9,000 acres of confined animal agriculture facilities in TID (Farmland Mapping and Monitoring Program 2016 data for Stanislaus and Merced Counties, California Department of Conservation Division of Land Resource Protection).
### Table 3.1. Irrigated Area\(^1\) of Crops Grown on Lands Receiving TID Surface Water.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Normal Year Average</th>
<th>Dry Year Average</th>
<th>1991-2019 Average</th>
<th>2015-2019 Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>12,591</td>
<td>13,440</td>
<td>12,972</td>
<td>9,469</td>
</tr>
<tr>
<td>Almonds</td>
<td>45,240</td>
<td>44,618</td>
<td>44,961</td>
<td>52,656</td>
</tr>
<tr>
<td>Apples</td>
<td>721</td>
<td>648</td>
<td>688</td>
<td>459</td>
</tr>
<tr>
<td>Apricots</td>
<td>28</td>
<td>23</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>Beans</td>
<td>558</td>
<td>507</td>
<td>535</td>
<td>289</td>
</tr>
<tr>
<td>Beets</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Berries</td>
<td>27</td>
<td>41</td>
<td>35</td>
<td>22</td>
</tr>
<tr>
<td>Carrots</td>
<td>6</td>
<td>71</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>Cherries</td>
<td>383</td>
<td>360</td>
<td>373</td>
<td>438</td>
</tr>
<tr>
<td>Christmas Trees</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Citrus</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Clover</td>
<td>392</td>
<td>348</td>
<td>372</td>
<td>34</td>
</tr>
<tr>
<td>Corn</td>
<td>9,559</td>
<td>9,946</td>
<td>9,733</td>
<td>11,214</td>
</tr>
<tr>
<td>Double - Other</td>
<td>9,283</td>
<td>7,661</td>
<td>8,556</td>
<td>5,408</td>
</tr>
<tr>
<td>Eggplant</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Garden</td>
<td>81</td>
<td>77</td>
<td>80</td>
<td>106</td>
</tr>
<tr>
<td>Grain</td>
<td>166</td>
<td>151</td>
<td>160</td>
<td>72</td>
</tr>
<tr>
<td>Gypsophila</td>
<td>76</td>
<td>120</td>
<td>92</td>
<td>0</td>
</tr>
<tr>
<td>Kiwi</td>
<td>29</td>
<td>46</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>Lawn</td>
<td>1,139</td>
<td>1,205</td>
<td>1,168</td>
<td>1,327</td>
</tr>
<tr>
<td>Melons</td>
<td>272</td>
<td>240</td>
<td>258</td>
<td>398</td>
</tr>
<tr>
<td>Oats</td>
<td>2,171</td>
<td>3,061</td>
<td>2,570</td>
<td>1,325</td>
</tr>
<tr>
<td>Oats/Corn</td>
<td>16,058</td>
<td>16,742</td>
<td>16,365</td>
<td>10,661</td>
</tr>
<tr>
<td>Olives</td>
<td>83</td>
<td>93</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Onions</td>
<td>23</td>
<td>32</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Other Crops</td>
<td>446</td>
<td>361</td>
<td>407</td>
<td>510</td>
</tr>
<tr>
<td>Other Trees</td>
<td>350</td>
<td>363</td>
<td>356</td>
<td>348</td>
</tr>
<tr>
<td>Pasture</td>
<td>9,235</td>
<td>9,058</td>
<td>9,156</td>
<td>5,629</td>
</tr>
<tr>
<td>Peaches</td>
<td>4,840</td>
<td>4,655</td>
<td>4,757</td>
<td>3,188</td>
</tr>
<tr>
<td>Pears</td>
<td>8</td>
<td>13</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Peas</td>
<td>0</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Plums</td>
<td>29</td>
<td>24</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>Pumpkins</td>
<td>88</td>
<td>83</td>
<td>85</td>
<td>64</td>
</tr>
<tr>
<td>Sorghum</td>
<td>52</td>
<td>0</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Squash</td>
<td>32</td>
<td>26</td>
<td>29</td>
<td>18</td>
</tr>
<tr>
<td>Sudan</td>
<td>788</td>
<td>795</td>
<td>791</td>
<td>879</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>8</td>
<td>59</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>2,113</td>
<td>1,707</td>
<td>1,931</td>
<td>2,457</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Unirrigated Forage/Corn(^2)</td>
<td>11,935</td>
<td>12,832</td>
<td>12,337</td>
<td>21,373</td>
</tr>
<tr>
<td>Vineyard</td>
<td>2,582</td>
<td>2,374</td>
<td>2,489</td>
<td>953</td>
</tr>
<tr>
<td>Walnuts</td>
<td>4,919</td>
<td>5,219</td>
<td>5,054</td>
<td>5,773</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>136,350</strong></td>
<td><strong>137,040</strong></td>
<td><strong>136,703</strong></td>
<td><strong>135,280</strong></td>
</tr>
</tbody>
</table>

---

1 Irrigated area estimated as 94 percent of assessed area (to account for farm roads and non-irrigated areas). Due to rounding of individual crop acres, totals may differ slightly from 94 percent of assessed area.

2 Unirrigated (rainfed) forage followed by irrigated corn in a double cropped sequence.
Table 3.2. Growing Season (March through October) ET\(^1\) in Inches for Crops Receiving TID Surface Water.

<table>
<thead>
<tr>
<th>Crop</th>
<th>2015-2019 Average</th>
<th>1991-2019 Average</th>
<th>Normal Year Average</th>
<th>Dry Year Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa(^2)</td>
<td>39.9</td>
<td>38.3</td>
<td>37.5</td>
<td>39.3</td>
</tr>
<tr>
<td>Almonds(^3)</td>
<td>34.5</td>
<td>33.1</td>
<td>32.4</td>
<td>33.9</td>
</tr>
<tr>
<td>Corn(^4)</td>
<td>34.2</td>
<td>32.7</td>
<td>32.1</td>
<td>33.5</td>
</tr>
<tr>
<td>Other Crops(^5)</td>
<td>33.2</td>
<td>31.8</td>
<td>31.2</td>
<td>32.6</td>
</tr>
<tr>
<td>Other Trees(^6)</td>
<td>32.1</td>
<td>30.7</td>
<td>30.1</td>
<td>31.4</td>
</tr>
<tr>
<td>Pasture(^7)</td>
<td>35.8</td>
<td>34.3</td>
<td>33.6</td>
<td>35.2</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>21.8</td>
<td>20.8</td>
<td>20.4</td>
<td>21.2</td>
</tr>
<tr>
<td>Vineyard</td>
<td>20.8</td>
<td>19.8</td>
<td>19.5</td>
<td>20.3</td>
</tr>
</tbody>
</table>

\(^1\) Total ET derived from applied water and precipitation calculated with crop coefficients derived from a remotely sensed surface energy balance inherently account for "bare spots and reduced vigor" to represent the total water consumed.

\(^2\) Alfalfa also includes clover

\(^3\) ET for almonds includes ET from both young and mature almond orchards, thus the ET is less than would be expected from mature almond orchards.

\(^4\) Corn also includes grain, oats corn, oats, sorghum, sunflowers, beans, unirrigated forage corn, and double--other

\(^5\) Other Crops include carrots, berries, beets, eggplant, garden, gypsophila, melons, pumpkins, onions, tomatoes, sudan, squash and peas

\(^6\) Other Trees include apples, apricots, cherries, Christmas, plums, olives, pears, peaches, kiwi, walnuts, and citrus

\(^7\) Pasture includes lawn

Improved, local crop coefficients have been developed for the TID water balance (described in Section 5) that reflect actual, observed water use characteristics of crops within TID. Daily crop coefficients were derived from actual crop evapotranspiration (ET\(_a\)) estimates calculated using remotely sensed surface energy balance results over nine recent years. Two surface energy balances were applied to calculate ET\(_a\) in TID: Mapping EvapoTranspiration at high Resolution with Internalized Calibration (METRIC) and Surface Energy Balance Algorithm for Land (SEBAL). METRIC and SEBAL results both account for the many factors that impact ET\(_c\), including crop age, vegetation density, disease, salinity, deficit irrigation, and other stress factors. Studies by Bastiaanssen, et al. (2005), Allen, et al. (2007), Thoreson, et al. (2009), Allen, et al. (2011), and others have found that seasonal ET\(_a\) estimates by these models are expected to be within plus or minus five to fifteen percent of actual ET when performed by an expert analyst.

The seasonal crop water use totals summarized in Table 3.2 were calculated using these local, daily crop coefficients and daily reference evapotranspiration (ET\(_{ro}\)) rates reported by the CIMIS stations summarized in Table 2.3. The resulting daily ET\(_c\) rates are input to the physically-based Integrated Water Flow Model Demand Calculator (IDC) version 2015.0.0036 (DWR, 2015) to parse the relative fractions of total ET\(_c\) that are supplied by irrigation (ET of applied water, or ET\(_{aw}\)) and by precipitation (ET of precipitation, or ET\(_{pr}\)). As described in further detail in Section 5, IDC utilizes these inputs, as well as precipitation, soil parameters, and crop characteristics, to model inflows and outflows through the root zone on a daily time step. This approach ensures the most accurate and consistent calculation of historical ET\(_c\) and ET\(_{aw}\).
possible, and improves the reliability of the water balance and related performance indicators. Other relevant model input parameters and data sources are discussed in Section 5.

Table 3.3 summarizes the relative fractions of total ETc that are represented by ETaw and ETpr. ETaw is met by applied irrigation water that is delivered by TID, or that is privately pumped by irrigators. Water delivered by TID is a mixture of surface water releases from Turlock Lake, groundwater supplied by TID drainage pumping and/or rented well pumping, and recycled water supplied by tilewater drainage and spillage recovery. Section 5 summarizes the annual volumes of each source. Precipitation that falls in the TID service area supplies ETpr, and also contributes to deep percolation, runoff, and change in root zone storage.

Table 3.3. TID Growing Season (March through October) ET of Applied Water (ETaw), ET of Precipitation (ETpr), and Crop ET (ETc).

<table>
<thead>
<tr>
<th>Year</th>
<th>Year Type</th>
<th>ETaw (AF)</th>
<th>ETpr (AF)</th>
<th>ETc (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Dry</td>
<td>346,700</td>
<td>33,100</td>
<td>379,800</td>
</tr>
<tr>
<td>2016</td>
<td>Dry</td>
<td>317,700</td>
<td>54,600</td>
<td>372,300</td>
</tr>
<tr>
<td>2017</td>
<td>Normal</td>
<td>306,500</td>
<td>64,400</td>
<td>370,900</td>
</tr>
<tr>
<td>2018</td>
<td>Normal</td>
<td>331,800</td>
<td>50,300</td>
<td>382,100</td>
</tr>
<tr>
<td>2019</td>
<td>Normal</td>
<td>305,300</td>
<td>68,700</td>
<td>374,000</td>
</tr>
<tr>
<td>2015-2019</td>
<td>Average</td>
<td>321,600</td>
<td>54,200</td>
<td>375,800</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>305,300</td>
<td>33,100</td>
<td>370,900</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>346,700</td>
<td>68,700</td>
<td>382,100</td>
</tr>
<tr>
<td>1991-2019</td>
<td>Average</td>
<td>315,900</td>
<td>55,100</td>
<td>371,000</td>
</tr>
<tr>
<td></td>
<td>Normal Year Avg.</td>
<td>299,600</td>
<td>63,000</td>
<td>362,500</td>
</tr>
<tr>
<td></td>
<td>Dry Year Avg.</td>
<td>336,000</td>
<td>45,400</td>
<td>381,500</td>
</tr>
</tbody>
</table>

Table 3.4 summarizes the relative number and volume of irrigation deliveries supplied by TID according to irrigation method. Among all fields that receive surface water in the TID service area, the predominant irrigation practice is a basin-check flood irrigation system. Flood irrigation systems are used to irrigate virtually all types of crops in TID, especially alfalfa, pasture, corn, and various grains. TID also provides an increasing number of deliveries to parcels served by pressurized systems, including drip and sprinkler systems. Pressurized systems are largely used to irrigate almonds, other permanent orchard and vineyard crops, as well as sweet potatoes, and specialty crops.

Annual volumes of surface water supply, surface water deliveries, and estimated private groundwater pumping are summarized in Section 4.1 and Section 5. Between 2015-2019, TID delivered an estimated average of approximately 391,000 acre-feet of surface water each year. Over the same period, groundwater pumping from private wells in the TID service area was estimated to extract approximately 64,000 acre-feet per year. Surface water deliveries were estimated as the closure of the TID canal system water balance, while private groundwater pumping was estimated based on power meter records for individual wells multiplied by a power factor derived from pump tests.
### Table 3.4. Summary of Irrigation Deliveries by Irrigation Method for Crops Receiving TID Surface Water.¹

<table>
<thead>
<tr>
<th>Period</th>
<th>Irrigation Method</th>
<th>Number of Deliveries</th>
<th>Percent Total Number of Deliveries (%)</th>
<th>Delivery Volume (AF, rounded)</th>
<th>Percent Total Delivery Volume (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2019</td>
<td>Flood</td>
<td>35,195</td>
<td>68%</td>
<td>298,400</td>
<td>83%</td>
</tr>
<tr>
<td></td>
<td>Sprinklers</td>
<td>4,222</td>
<td>8%</td>
<td>23,500</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>Drip/Micro</td>
<td>12,549</td>
<td>24%</td>
<td>38,800</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td><strong>Total¹</strong></td>
<td><strong>51,966</strong></td>
<td><strong>100%</strong></td>
<td><strong>360,700</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>1991-2019</td>
<td>Flood</td>
<td>36,389</td>
<td>84%</td>
<td>329,500</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Sprinklers</td>
<td>3,216</td>
<td>7%</td>
<td>21,700</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Drip/Micro</td>
<td>3,637</td>
<td>8%</td>
<td>13,600</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td><strong>Total¹</strong></td>
<td><strong>43,242</strong></td>
<td><strong>100%</strong></td>
<td><strong>364,800</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

¹ Summary of total deliveries reported in TID delivery records, excluding replenishment water deliveries, deliveries with unlabeled or inaccurately labeled irrigation methods, and deliveries with no recorded volume.

Besides irrigation, other uses of applied water include leaching of salts and frost protection for orchards and vineyards. The use of TID’s agricultural water supply is to irrigate crops, while these other uses are limited and would be supplied privately. Due to the generally low salinity of TID irrigation water, the required leaching fraction is small for the crops grown in the District. Growers that irrigate crops using groundwater of relatively higher salinity could require leaching to maintain production for sensitive crops. Should the use of groundwater increase, leaching requirements would also be expected to increase, to the extent that groundwater salinity is greater than surface water salinity. Similarly, frost protection may be necessary in certain circumstances. Frost protection is typically applied outside of the irrigation season and, although not provided by TID, growers may use private or ID wells as water sources for frost protection.

### 3.2 ENVIRONMENTAL WATER USE

There are no natural environmental resource delineations within the irrigation service area that are supported by TID diversions. However, the Federal Energy Regulatory Commission (FERC) license requirements for Don Pedro Reservoir include an extensive set of minimum instream flow release requirements that vary with the water year type. Instream flows and irrigation releases come from the Don Pedro Reservoir supplies. Releases to the Tuolumne River for environmental purposes therefore reduce the remaining supplies available for irrigation. In 1996, instream flow requirements were significantly increased. The annual volume of these flows ranges from 94,000 acre-feet in dry years to 301,000 acre-feet in wet years, up from 64,000 acre-feet and 123,000 acre-feet under the previous license requirements for dry and wet years, respectively. TID contributes approximately 68 percent of these releases. Diversions for irrigation are made after the instream requirements are met. (Note: The FERC dry and wet year distinctions described in this paragraph are based on regulatory requirements and are different than other hydrologic water year descriptions referenced in this AWMP.)
During a 45-day period between October 15 and December 1 (e.g., October 17 through November 30), flow fluctuations in the Tuolumne River are minimized to protect fall-run Chinook salmon. For the period extending from October 15 through March 15, river flow changes are also subject to certain ramping rates to protect salmon, which can require additional flows.

Between 2000 and 2011, a portion of the years analyzed by this AWMP, TID also participated in the Vernalis Adaptive Management Plan (VAMP). VAMP was designed to test the effects of various 30-day pulse flows (as measured at Vernalis on the main stem of San Joaquin River) on out-migrating salmon smolts while the state and federal export pumps were operated at specified levels. Under the division agreement among the VAMP participants, TID contributed up to an additional 11,000 acre-feet of water each year depending upon the basin hydrology and designated targets.

In the future, the Stanislaus Regional Water Authority project (described in Section 3.4), will provide additional flows in the Tuolumne River between LaGrange Dam and the Geer Road Bridge where the municipal flows will be diverted through an infiltration gallery to a treatment plant and transported to the communities of Ceres and Turlock. These additional instream flows will provide added environmental benefits in the stretch of the Tuolumne River above Geer Road.

### 3.3 RECREATIONAL WATER USE

While there are recreational uses of TID diversions, there is no mandated supply dedicated to recreational use, nor are the current recreational uses consumptive in nature.

The State of California Department of Parks and Recreation manages recreation at Turlock Lake as a part of the California State Park System ([www.parks.ca.gov/?page_id=555](http://www.parks.ca.gov/?page_id=555)). During the irrigation season, the water level in the lake is generally kept between water levels corresponding to 28,000 and 32,000 acre-feet of water to allow recreation along the shoreline and to assure steady deliveries to the distribution system. During consecutive dry years TID may lower the operating lake level in order to reduce seepage. By the end of the irrigation season, the lake is drawn down to allow for maintenance and to provide stormwater capacity for the McDonald Creek watershed, which drains into the Upper Main Canal. The lake is used for duck hunting and other recreational uses conducive to the lower reservoir levels typical of the non-irrigation season.

### 3.4 MUNICIPAL AND INDUSTRIAL WATER USE

TID, in conjunction with MID, operates the La Grange Domestic Water System serving 66 connections. Total water use is approximately 30 acre-feet per year, based on data available beginning in 2010 after water meters were installed. This use occurs upstream of Turlock Lake, and is therefore not included in the TID water balance. La Grange is the only community to which TID serves domestic water. All other municipalities, industries, and small domestic uses of water in the TID service area rely on groundwater for their supply.

If groundwater remains the sole source of municipal water supply, it is expected that municipal groundwater use will increase over time. However, for a number of years some local community
water systems have been studying the possibility of using TID surface water from the Tuolumne River in conjunction with existing groundwater supplies.

In July 2015, TID and the Stanislaus Regional Water Authority (SRWA) completed a Water Sales Agreement which represented a significant step forward in TID’s provision of surface water for municipal uses. Pursuant to the agreement, TID agreed to provide up to a combined 30,000 AF of surface water annually for the SRWA’s Regional Surface Water Supply Project. In this project, Tuolumne River water will be withdrawn from the river through an existing infiltration gallery near Geer Road. After being withdrawn, the water will be treated and distributed to the communities through facilities to be designed and built by the SRWA. The agreement also stipulated that during less than normal irrigation years, the SRWA will provide “offset” water to TID from recycled or stored groundwater supplies to reduce the impact of the project on TID irrigation supplies.

Since 2015, significant progress has been made toward implementing the project. The SRWA obtained grant funding in the amount of $31.5 million and also engaged the State of California’s Clean Water State Revolving Fund (SRF) program to obtain a low-interest loan to fund the majority of the Project. TID has also made progress by preparing and submitting a change petition to the State Water Resources Control Board (SWRCB) to authorize the use of the District’s post-1914 water rights to transfer surface water to the SRWA. In June 2020, the SRWA voted to approve a contract with CH2M Hill to design and construct the Tuolumne River treatment plant serving Turlock and Ceres. Construction could begin in 2021 and finish in 2023. Once implemented, the project will reduce municipal reliance on groundwater supplies and result in in-lieu recharge of the Turlock Subbasin.

The uses of groundwater described in this section are not directly included in the TID Water Balance as they are not a part of the TID system. However, the municipal, industrial and small domestic use of groundwater does have a potential to influence the groundwater supplies available for irrigation purposes in the future.

### 3.5 GROUNDWATER RECHARGE USE

Groundwater recharge is an important component of TID’s conjunctive management strategy to achieve water supply reliability. As described further in Section 4, TID is a leader in groundwater management in the Turlock Subbasin. The majority of groundwater recharge within the Subbasin occurs indirectly as a result of agricultural practices in the irrigation service area. The discussion of conjunctive management in Section 4 demonstrates how TID encourages the use of available surface water supplies and reduced groundwater pumping in normal years, resulting in significant in-lieu groundwater recharge. Groundwater recharge that occurs within TID consists of passive seepage from TID canals and facilities, as well as deep percolation of precipitation and applied irrigation water. The combined recharge is widely distributed across the TID service area and provides a means to replenish the Subbasin to the benefit of TID water users, communities within TID, and surrounding areas that share the groundwater resource.

Estimates of groundwater recharge from these sources were derived from the water balance analysis described in Section 5. Canal seepage was calculated based on soil characteristics and the canal wetted perimeters, overall lengths, and wetting frequency. Deep percolation of
irrigation water was calculated as the closure term\(^\text{10}\) of the TID irrigated lands water balance accounting center (described in \textbf{Section 5}). Deep percolation of precipitation was calculated based on daily results of the IDC root zone water balance model (introduced in \textbf{Section 3.1}, and described further in \textbf{Section 5}). Annual seepage and deep percolation volumes for 2015 to 2019 are provided in \textbf{Table 3.5}, along with total recharge expressed as a volume and as a depth of water relative to the cropped area in each year. Notably, the total recharge is only for the area within the water balance boundaries. Thus, considerable volumes of seepage from Turlock Lake and the Upper Main Canal are not included in these net recharge values.

\textbf{Table 3.5. TID Total Groundwater Recharge for the Service Area below Turlock Lake.}\(^\text{1,2}\)

<table>
<thead>
<tr>
<th>Year</th>
<th>Year Type</th>
<th>Canal Seepage (AF)</th>
<th>Deep Percolation of Applied Water (AF)</th>
<th>Deep Percolation of Precipitation(^\text{3}) (AF)</th>
<th>Total Recharge(^\text{3}) (AF)</th>
<th>(AF/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Dry</td>
<td>31,100</td>
<td>70,500</td>
<td>26,100</td>
<td>127,600</td>
<td>0.9</td>
</tr>
<tr>
<td>2016</td>
<td>Dry</td>
<td>36,100</td>
<td>144,500</td>
<td>93,600</td>
<td>274,100</td>
<td>2.0</td>
</tr>
<tr>
<td>2017</td>
<td>Normal</td>
<td>37,200</td>
<td>139,500</td>
<td>99,600</td>
<td>276,300</td>
<td>2.0</td>
</tr>
<tr>
<td>2018</td>
<td>Normal</td>
<td>42,100</td>
<td>155,400</td>
<td>61,400</td>
<td>259,000</td>
<td>1.9</td>
</tr>
<tr>
<td>2019</td>
<td>Normal</td>
<td>36,100</td>
<td>121,500</td>
<td>103,300</td>
<td>261,000</td>
<td>1.9</td>
</tr>
<tr>
<td>2015-2019 Average</td>
<td></td>
<td>36,500</td>
<td>126,300</td>
<td>76,800</td>
<td>239,600</td>
<td>1.8</td>
</tr>
<tr>
<td>2015-2019 Minimum</td>
<td></td>
<td>31,100</td>
<td>70,500</td>
<td>26,100</td>
<td>127,600</td>
<td>0.9</td>
</tr>
<tr>
<td>2015-2019 Maximum</td>
<td></td>
<td>42,100</td>
<td>155,400</td>
<td>114,300</td>
<td>276,300</td>
<td>2.0</td>
</tr>
<tr>
<td>1991-2019 Average</td>
<td></td>
<td>36,100</td>
<td>180,900</td>
<td>70,400</td>
<td>287,500</td>
<td>2.1</td>
</tr>
<tr>
<td>1991-2019 Normal Year Avg.</td>
<td></td>
<td>36,900</td>
<td>192,800</td>
<td>86,800</td>
<td>316,500</td>
<td>2.3</td>
</tr>
<tr>
<td>1991-2019 Dry Year Avg.</td>
<td></td>
<td>35,200</td>
<td>166,400</td>
<td>50,300</td>
<td>251,900</td>
<td>1.8</td>
</tr>
</tbody>
</table>

\(^{1}\) Volumes rounded to 100 AF.
\(^{2}\) Volumes do not include recharge in Turlock Lake or upstream of Turlock Lake.
\(^{3}\) Includes deep percolation of precipitation during the irrigation season and during the off-season.

Total recharge between 2015 and 2019 ranged from approximately 128,000 AF to 276,000 AF per year, or from 0.9 AF to 2.0 AF per irrigated acre per year (including deep percolation of precipitation both during the irrigation season and during the off-season). On average, total recharge was estimated to be approximately 240,000 AF per year (1.8 AF/acre) for the period 2015-2019 and 288,000 AF per year (2.1 AF/acre) for the period 1991-2019. Over the 1991-2019 period, total recharge was estimated to be over 60,000 AF greater in normal years than dry years, on average. Approximately 13 percent of recharge originates from canal seepage, 63 percent of recharge originates from deep percolation of applied water, and 24 percent of recharge originates from deep percolation of precipitation occurring both during the irrigation season and during the off-season winter months.

TID relies on local groundwater supplies to supplement surface water deliveries, particularly in dry years. Other users within TID and the rest of the Subbasin also rely on groundwater to some extent in all years. These users include urban areas, industrial pumpers, private agricultural...
pumpers and private domestic pumpers. To enhance groundwater recharge within the Subbasin, TID has participated in a small, ten-year pilot groundwater recharge project with the Eastside Water District (see Section 7.4.8). These deliveries and subsequent recharge are not accounted for separately within the water balance, due to the small nature of the pilot project, but are included in the overall recharge estimates.

TID is also continuing to take an active leadership role in implementation of the Sustainable Groundwater Management Act of 2014 (SGMA), and development of the Groundwater Sustainability Plan (GSP) for the Turlock Subbasin. As discussed in Section 4.1.2, analyses have shown that seepage and deep percolation of a portion of TID’s surface water supply serves as the primary source of recharge to the groundwater system. Thus, while groundwater provides a significant portion of the water used by the District and others within the Turlock Subbasin, much of this groundwater is derived from management of surface water resources by TID and its irrigation customers. Because of the long-term supply reliability offered by access to both surface water and groundwater as sources of supply, TID will continue to pursue a deliberate course of conjunctive management. In addition to its own water management practices, TID will also continue to work with local interests to develop the tools needed to achieve long-term groundwater sustainability by identifying additional ways to maximize local water supplies, enhance conjunctive management practices, and recharge the groundwater system.

Table 3.6 summarizes the net groundwater recharge in the TID service area, calculated by subtracting total pumping volumes from total recharge volumes. Total pumping volumes include TID drainage pumping, TID rented well pumping, and private pumping volumes calculated based on electrical energy use. Total recharge volumes include deep percolation of applied water and precipitation from farms as well as seepage from TID canals and drains (Table 3.5). Net recharge provides a measure of the net impact of TID’s operations on groundwater storage volumes.

### Table 3.6. TID Net Groundwater Recharge below Turlock Lake by Irrigation Season

<table>
<thead>
<tr>
<th>Year</th>
<th>Hydrologic Year Type</th>
<th>Total Recharge (AF)</th>
<th>Groundwater Pumping (AF)</th>
<th>Net Recharge (AF)</th>
<th>Net Recharge (AF/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Dry</td>
<td>127,600</td>
<td>181,000</td>
<td>-53,300</td>
<td>-0.4</td>
</tr>
<tr>
<td>2016</td>
<td>Dry</td>
<td>274,100</td>
<td>136,000</td>
<td>138,100</td>
<td>1.0</td>
</tr>
<tr>
<td>2017</td>
<td>Normal</td>
<td>276,300</td>
<td>63,900</td>
<td>212,400</td>
<td>1.6</td>
</tr>
<tr>
<td>2018</td>
<td>Normal</td>
<td>259,000</td>
<td>99,200</td>
<td>159,700</td>
<td>1.2</td>
</tr>
<tr>
<td>2019</td>
<td>Normal</td>
<td>261,000</td>
<td>63,500</td>
<td>197,500</td>
<td>1.5</td>
</tr>
<tr>
<td>2015-2019</td>
<td>Average</td>
<td>239,600</td>
<td>108,700</td>
<td>130,900</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>127,600</td>
<td>63,500</td>
<td>-53,300</td>
<td>-0.4</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>276,300</td>
<td>181,000</td>
<td>212,400</td>
<td>1.6</td>
</tr>
<tr>
<td>1991-2019</td>
<td>Average</td>
<td>287,500</td>
<td>107,100</td>
<td>180,400</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Normal Year Avg.</td>
<td>316,500</td>
<td>88,100</td>
<td>228,300</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Dry Year Avg.</td>
<td>251,900</td>
<td>130,400</td>
<td>121,500</td>
<td>0.9</td>
</tr>
</tbody>
</table>

1 Volumes rounded to 100 AF.
2 Volumes do not include recharge in Turlock Lake or upstream of Turlock Lake.
3 Includes deep percolation of precipitation during the irrigation season and during the off-season.
Between 2015-2019, net recharge ranged from a low of approximately -53,000 AF in 2015 to a high of 212,000 AF in 2017, or from -0.4 AF to 1.6 AF per irrigated acre per year (including deep percolation of precipitation both during the irrigation season and during the off-season). On average, net recharge was estimated to be approximately 131,000 AF per year (1.0 AF/acre) for the period 2015-2019, and 180,000 AF per year (1.3 AF/acre) for the period 1991-2019. On average, net recharge was over 100,000 AF, or about 0.8 AF/acre, greater in normal years compared to dry years over the 1991-2019 period. Notably, the computed net recharge is for the area within the water balance boundaries. Thus, considerable volumes of seepage from Turlock Lake or the Upper Main Canal are not included in these net recharge values.

### 3.6 TRANSFERS AND EXCHANGES

During normal water supply years, “replenishment” surface water may be sold to lands outside but adjacent to the TID irrigation service boundary. These sales reduce demands on groundwater supplies, providing in-lieu and direct groundwater recharge in the area of the cone of depression east of TID. Approximately 3,400 acres adjacent to, but outside, TID are able to purchase “replenishment” water from TID. On average only 1,200 acres use about 1,800 acre-feet of water in years when replenishment water is sold. No water is transferred into the TID service area from external sources.

During periods of surface water shortage, growers use internal water transfers to balance individual crop irrigation needs within the District. These types of transfers enable growers to make use of water unused on one parcel for the benefit of another parcel so long as both parcels are either owned by the same grower or under long-term lease.

### 3.7 OTHER WATER USES

Other incidental uses of water within TID include watering of roads for dust abatement, agricultural spraying, and stock watering by TID water users. TID also supplies water for flood irrigation of church yards and school fields. The volume of water used for such purposes is negligible relative to other uses and is included in the delivery volume, but has not been quantified separately from the other uses discussed above.
4. Quantity and Quality of Water Resources

This section of the AWMP describes the quantity and quality of the water resources available to TID.

As described at the beginning of Section 3, the following periods are used for the presentation and interpretation of water supply data:

1. **2015-2019 Period (Near-Term Historical):** The 2015-2019 data are reflective of recent TID operations and weather conditions.\(^{11}\)


### 4.1 WATER SUPPLY QUANTITY

Over the last five years, total TID water supply averaged about 546,000 AF (Table 4.1). Usage patterns within the TID irrigation service area as depicted by the water balance analysis, a central component of this AWMP, are described in Section 5.

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)(^2)</th>
<th>Year Type</th>
<th>Surface Water Supply(^3) (AF)</th>
<th>Groundwater Supply(^4) (AF)</th>
<th>Other Water Supply(^5) (AF)</th>
<th>Total Supply (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>18</td>
<td>Dry</td>
<td>281,700</td>
<td>181,000</td>
<td>11,600</td>
<td>474,300</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>384,000</td>
<td>136,000</td>
<td>14,900</td>
<td>534,900</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>472,800</td>
<td>63,900</td>
<td>15,600</td>
<td>552,300</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>509,300</td>
<td>99,200</td>
<td>14,900</td>
<td>623,400</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>470,300</td>
<td>63,500</td>
<td>13,200</td>
<td>547,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2019 Average</td>
<td></td>
<td></td>
<td>423,600</td>
<td>108,700</td>
<td>14,000</td>
<td>546,400</td>
</tr>
<tr>
<td>2015-2019 Minimum</td>
<td></td>
<td></td>
<td>281,700</td>
<td>63,500</td>
<td>11,600</td>
<td>474,300</td>
</tr>
<tr>
<td>2015-2019 Maximum</td>
<td></td>
<td></td>
<td>509,300</td>
<td>181,000</td>
<td>15,600</td>
<td>623,400</td>
</tr>
<tr>
<td>1991-2019 Average</td>
<td></td>
<td></td>
<td>480,000</td>
<td>107,100</td>
<td>12,300</td>
<td>599,300</td>
</tr>
<tr>
<td>Normal Year Avg.</td>
<td></td>
<td></td>
<td>513,500</td>
<td>88,100</td>
<td>12,600</td>
<td>614,200</td>
</tr>
<tr>
<td>Dry Year Avg.</td>
<td></td>
<td></td>
<td>438,800</td>
<td>130,400</td>
<td>11,800</td>
<td>581,000</td>
</tr>
</tbody>
</table>

1Irrigation season values, rounded to 100 AF.

2Depth of water in inches available equally to each acre of land. Prior to 2013, this was referred to as the allotment.

3Irrigation releases from Turlock Lake.

4Includes TID drainage pumping, TID rented pumping, and private pumping.

5Includes reused tailwater and subsurface drainage, measured drain pumping at TID Pump 152, and treated Municipal and Industrial (M&I) effluent delivered to farms.

11 The period 2012-2016, preceding and beginning the 2015-2019 near-term historical period, was the driest four-year period in TID’s 128 year history.
TID practices conjunctive water management, the coordinated operation and monitoring of surface water and groundwater supplies to meet defined objectives. In TID’s case, the main objective is to provide a firm, reliable water supply to the TID service area. As discussed in this AWMP, given the nature of the crops grown in the TID service area, the water demand in TID varies little from year to year. TID has been able to meet this firm demand in both normal and dry years by using available surface water in normal years to irrigate and recharge groundwater, and by using more groundwater in dry years when the surface water supply is reduced (Table 4.2).

However, even with TID’s conjunctive water management, groundwater is not an unlimited supply. In accordance with the Sustainable Groundwater Management Act of 2014 (SGMA), local agencies must work together to achieve sustainable groundwater use in the Turlock Subbasin by 2042. As a member of the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA), TID is actively involved in preparing the Turlock Subbasin Groundwater Sustainability Plan (GSP) that will identify the actions needed to achieve groundwater sustainability. GSP development efforts are ongoing, and are on track to result in the adoption and submittal of a SGMA-compliant plan by January 2022. Following completion of GSP implementation efforts, groundwater is expected to generally remain available for use even during drought years because of recharge in normal and wetter years.

### Table 4.2. Summary of Water Supplies within TID as a Percentage of Total Supply.\(^1\)

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)(^2)</th>
<th>Year Type</th>
<th>Surface Water Supply(^3) (%)</th>
<th>Groundwater Supply(^4) (%)</th>
<th>Other Water Supply(^5) (%)</th>
<th>Total Supply (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>18</td>
<td>Dry</td>
<td>59%</td>
<td>38%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>72%</td>
<td>25%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>86%</td>
<td>12%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>82%</td>
<td>16%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>86%</td>
<td>12%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>2015-2019 Average</td>
<td></td>
<td></td>
<td>77%</td>
<td>21%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td>59%</td>
<td>12%</td>
<td>2%</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td>86%</td>
<td>38%</td>
<td>3%</td>
<td>N/A</td>
</tr>
<tr>
<td>1991-2019 Average</td>
<td></td>
<td></td>
<td>80%</td>
<td>18%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>Normal Year Avg.</td>
<td></td>
<td></td>
<td>84%</td>
<td>14%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>Dry Year Avg.</td>
<td></td>
<td></td>
<td>75%</td>
<td>23%</td>
<td>2%</td>
<td>100%</td>
</tr>
</tbody>
</table>

\(^1\)Percentages rounded to whole percent, totaling 100%.
\(^2\)Depth of water in inches available equally to each acre of land. Prior to 2013, this was referred to as the allotment.
\(^3\)Irrigation releases from Turlock Lake.
\(^4\)Includes TID drainage pumping, TID rented pumping, and private pumping.
\(^5\)Includes reused tailwater and subsurface drainage, measured drain pumping at TID Pump 152, and treated Municipal and Industrial (M&I) effluent delivered to farms.
The subsections below provide more detail describing water supplies in TID. The facilities referred to in this section are described in greater detail in Section 2 of the AWMP, and are shown in the map provided in Appendix D.

### 4.1.1 Surface Water Supply

The Tuolumne River is the source of TID’s surface water supply. TID diverts water according to a series of pre- and post-1914 flow and storage water rights recognized by the State of California. TID’s surface water supply is dependent upon annual hydrologic and reservoir storage conditions. Irrigation water from Don Pedro Reservoir is diverted into the TID Upper Main Canal at La Grange Diversion Dam. Diversions flow via gravity through the Upper Main Canal to Turlock Lake for temporary storage and re-regulation for irrigation deliveries. Hydrology can vary widely, but is somewhat mitigated by storage capacity at the Don Pedro Reservoir. While Don Pedro Reservoir is large, TID’s share is only 68.46 percent of the reservoir’s available storage, above the minimum operating pool.

Table 4.3 summarizes annual TID releases from Turlock Lake for irrigation purposes. Annual surface water supply volumes are provided along with the portion of total water supply that comes from surface water.

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)²</th>
<th>Year Type</th>
<th>Surface Water Supply</th>
<th>Percent of Total Water Supply³</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>18</td>
<td>Dry</td>
<td>281,700</td>
<td>59%</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>384,000</td>
<td>72%</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>472,800</td>
<td>86%</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>509,300</td>
<td>82%</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>470,300</td>
<td>86%</td>
</tr>
<tr>
<td>2015-2019 Average</td>
<td>423,600</td>
<td></td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>281,700</td>
<td></td>
<td>59%</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>509,300</td>
<td></td>
<td>86%</td>
<td></td>
</tr>
<tr>
<td>1991-2019 Average</td>
<td>480,000</td>
<td>Normal Year Avg.</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Dry Year Avg.</td>
<td>438,800</td>
<td></td>
<td>75%</td>
<td></td>
</tr>
</tbody>
</table>

¹Irrigation season values, rounded to 100 AF. Volumes may differ slightly from other tables due to rounding.
²Depth of water in inches available equally to each acre of land. Prior to 2013, this was referred to as the allotment.
³Total water supplies are shown in Table 4.1.

Table 4.4 summarizes the monthly distribution of surface water releases as a percentage of total annual surface water releases into the TID distribution system. Note that these values represent the typical irrigation season of March through October. In special circumstances, such as very dry years, TID can provide a limited amount of water for irrigation during the winter months or, in very wet years, the irrigation season could extend into November.
4.1.2 Groundwater Supply

The Turlock Subbasin (also referred to in this document as the Subbasin) is located on the eastern side of the San Joaquin Valley and underlies TID. The Turlock Subbasin is a subunit of the San Joaquin Valley Groundwater Basin. The Turlock Subbasin lies in the eastern portions of Stanislaus and Merced counties and has an area extent of approximately 347,000 acres (542 mi²). The Subbasin is bounded by the Tuolumne River on the north, the Merced River on the south, the San Joaquin River on the west, and the Sierra Nevada foothills to the east (DWR, 2006).

A variety of water agencies overlie the Turlock Subbasin, including both agricultural and urban entities (Figure 4.1). Ballico-Cortez Water District and Eastside Water District are both located to the east of TID and do not have surface water supplies. They were formed to represent growers and private domestic water users in their areas, who rely entirely upon groundwater for their water supply. In fulfillment of SGMA requirements, two Groundwater Sustainability Agencies (GSAs) were formed that together cover and are responsible for managing the entire Turlock Subbasin. These GSAs are the West Turlock Subbasin GSA, of which TID is a member, and the East Turlock Subbasin GSA (Figure 4.2)
Figure 4.1. Turlock Subbasin and Local Agency Boundaries (TGBA, 2008).
Figure 4.2. Turlock Subbasin and Groundwater Sustainability Agency Boundaries.
Groundwater within the Subbasin occurs under unconfined and confined conditions. A portion of the Subbasin is separated by the Corcoran Clay into two zones: an upper, unconfined aquifer and a lower, confined aquifer. There is also a deeply buried confined aquifer containing saline brine that extends upward into the unconsolidated sediments (Figure 4.3).

There are three principle aquifers within the Turlock Subbasin: an unconfined aquifer which occurs in unconsolidated deposits above the Corcoran Clay on the western side of the Subbasin; a semi-confined aquifer that occurs east of the Corcoran Clay; and a confined aquifer that occurs below the Corcoran Clay on the western side of the Subbasin. In the area separated by the Corcoran Clay, the top of the clay is the base of the unconfined aquifer. The depth and thickness of the Corcoran Clay varies across the western portion of the Subbasin. The unconfined aquifer is used for both agricultural and domestic supply in the western part of the Subbasin. Relatively shallow (less than 150 feet deep) agricultural and domestic wells generally draw from the unconfined aquifer.

The general direction of regional groundwater flow in the unconfined aquifer would normally be westward and southward towards the valley trough. However, private pumping for irrigated agriculture east of the TID has created a large cone of depression that results in portions of the groundwater flow reversing direction and moving to the east, out from under TID. Agricultural development east of TID began in the 1950s and continues to expand with no source of surface water supply. As a result, the areas east of TID rely entirely on groundwater for their water supply. As of 2014, approximately 89,000 acres east of TID were irrigated using groundwater (Todd Groundwater, 2014).
The confined aquifer within the Turlock Subbasin occurs in the unconsolidated deposits that underlie the Corcoran Clay. Accordingly, the areal extent of the confined aquifer is limited to the extent of the Corcoran Clay. In the eastern part of the Subbasin, the aquifer is only semi-confined. The top of the consolidated rocks is the base of the aquifer. The confined aquifer provides extensive municipal and agricultural supplies to the Subbasin. Wells generally greater than 200 feet deep draw from the confined aquifer, but may also receive flow from the unconfined aquifer. Based on general groundwater hydrologic considerations, the direction of groundwater flow in the confined aquifer is probably similar to that in the unconfined aquifer, westward and southward.

Under historical conditions, the hydraulic head in the confined aquifer was greater than that of the unconfined aquifer, which caused water to flow upwards through the Corcoran Clay from the confined to the unconfined system. Under present conditions, the pumping that has occurred in the unconfined aquifer would tend to maintain or possibly increase the upward gradient (head differential) between the aquifers. Historically, the Corcoran Clay served as an “impermeable” barrier but with wells perforated above and below the clay in both aquifers, the effectiveness of the barrier is now greatly reduced.
At the present time the urban and private, rural domestic water systems within TID rely almost exclusively on groundwater for their source of water supply\(^{12}\). Groundwater extraction for urban and domestic water use in the Subbasin has averaged 39,000 AF per year between 1991-2015. The majority of municipal groundwater used in the Subbasin is drawn from the confined aquifer below the Corcoran Clay, while rural and small private residential groundwater is drawn from both the confined and unconfined aquifers. Urban groundwater use has decreased in recent years due to urban water conservation practices.

For a number of years some local community water systems have been studying the possibility of using TID surface water from the Tuolumne River in conjunction with existing groundwater supplies. A variety of work has been done over the years on this project, including preliminary design and environmental review work, and the purchase of a parcel to locate the plant near the Fox Grove Fishing Access along the Tuolumne River.

Most recently, the Stanislaus Regional Water Authority (SRWA) representing the cities of Turlock and Ceres entered into renewed negotiations with TID for a drinking water project, referred to as the Regional Surface Water Supply Project. On July 28, 2015 the TID Board of Directors approved the final negotiated Water Sales Agreement for the transfer of water to the SRWA. Pursuant to the agreement, TID agreed to provide up to a combined 30,000 AF per year of surface water to the SRWA. In this project, Tuolumne River water will be withdrawn from the river through an existing infiltration gallery near Geer Road. After being withdrawn, the water will be treated and distributed for municipal uses through facilities to be designed and built by the SRWA. The agreement also stipulated that during less than normal irrigation years, the SRWA will provide “offset” water to TID from recycled or stored groundwater supplies to reduce the impact of the project on TID irrigation supplies. Since 2015, significant progress has been made toward implementing the project. The SRWA obtained grant funding in the amount of $31.5 million and also engaged the State of California’s Clean Water State Revolving Fund (SRF) program to obtain a low-interest loan to fund the majority of the Project. TID has also made progress by preparing and submitting a change petition to the State Water Resources Control Board (SWRCB) to authorize the use of the District’s post-1914 water rights to transfer surface water to the SRWA. In June 2020, the SRWA voted to approve a contract with CH2M Hill to design and construct the Tuolumne River treatment plant serving Turlock and Ceres. Construction could begin in 2021 and finish in 2023. Multiple actions still need to take place before construction and operation of a SRWA water treatment plant to serve domestic water. However, this project represents a historic step toward the future delivery of surface water for drinking water purposes to several of the communities within the Turlock Subbasin. Once implemented, the project will reduce municipal reliance on groundwater supplies and result in in-lieu recharge of the Turlock Subbasin.

The volume of groundwater utilized during the irrigation season on lands that receive surface water from TID is summarized in Table 4.5. The total volume includes groundwater pumped from TID-owned drainage wells (TID drainage pumping), from Improvement District or privately-owned wells that are rented by TID (TID rented pumping), and from Improvement

\(^{12}\) TID and Modesto ID jointly provide surface water to the small community of La Grange located along the Tuolumne River, east of the TID service area. As the volume of water used is relatively small (30 AF/year, on average) and does not directly impact agricultural water management within TID, it is not described in detail herein.
District or privately-owned wells (private pumping). The total TID pumping is greater in dry years, reflecting TID’s conjunctive management approach to managing water supplies to achieve high water supply reliability. Prior to the 2012-2016 drought, private pumping volumes were comparatively small relative to total TID pumping and varied little between normal and dry years, illustrating the effectiveness of TID’s conjunctive management policies. However, the high volumes of private pumping in 2015 indicate that, when required by extreme drought, recharge resulting from TID’s conjunctive management policies generally supports groundwater pumping by growers when necessary.

Table 4.5. Summary of Groundwater Use for Irrigation within TID.¹

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)²</th>
<th>Year Type</th>
<th>TID Drainage Pumping (AF)³</th>
<th>TID Rented Pumping (AF)³</th>
<th>Private Pumping (AF)⁴,⁵</th>
<th>Total Groundwater Supply Acre-Feet</th>
<th>Percent of Total Supplies within TID⁶</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>18</td>
<td>Dry</td>
<td>20,200</td>
<td>35,600</td>
<td>125,300</td>
<td>181,100</td>
<td>38%</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>22,400</td>
<td>52,100</td>
<td>61,400</td>
<td>135,900</td>
<td>25%</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>19,300</td>
<td>6,600</td>
<td>38,000</td>
<td>63,900</td>
<td>12%</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>28,200</td>
<td>8,600</td>
<td>62,400</td>
<td>99,200</td>
<td>16%</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>26,900</td>
<td>6,200</td>
<td>30,500</td>
<td>63,600</td>
<td>12%</td>
</tr>
<tr>
<td>2015-19</td>
<td>Average</td>
<td>23,400</td>
<td>21,800</td>
<td>63,500</td>
<td>108,700</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>2015-19</td>
<td>Minimum</td>
<td>19,300</td>
<td>6,200</td>
<td>30,500</td>
<td>63,500</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>2015-19</td>
<td>Maximum</td>
<td>28,200</td>
<td>52,100</td>
<td>125,300</td>
<td>181,000</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>1991-19</td>
<td>Average</td>
<td>45,200</td>
<td>30,700</td>
<td>31,200</td>
<td>107,100</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>1991-19</td>
<td>Normal Year Avg.</td>
<td>48,700</td>
<td>14,300</td>
<td>25,100</td>
<td>88,100</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>1991-19</td>
<td>Dry Year Avg.</td>
<td>41,000</td>
<td>50,700</td>
<td>38,700</td>
<td>130,400</td>
<td>23%</td>
<td></td>
</tr>
</tbody>
</table>

¹ Irrigation season values only, rounded to 100 AF. Volumes may differ slightly from other tables due to rounding.
² Depth of water in inches available equally to each acre of land. Prior to 2013, this was the allotment.
³ TID pumping values are based on recent or annual pump tests and power consumption data.
⁴ Private pumping volumes estimated from power consumption data and private pumping survey.
⁵ In 2014-2015, TID allowed growers to pump groundwater into the canals and receive a delivery “credit” equal to the volume they supplied. This volume is included in the private pumping volumes and water receipts in 2014-2015. In future water budgets, TID will consider separately accounting and reporting the volume of private pumping used in this practice.
⁶ Total water supplies are shown in Table 4.1.

Note that estimates of private groundwater pumping are not taken from direct measurement, but are derived from data describing power consumption. Since TID’s first AWMP, estimates of private pumping have been refined on several occasions, most recently in 2014. Revisions to this methodology have helped to improve the accuracy of private pumping volumes and to prevent overestimation resulting from other electricity usage associated with the same electric meter. TID will continue to review and revise the conversion factor in the future, as needed.
4.1.2.1 Groundwater Conditions

Figure 4.4 provides a map of TID and the surrounding vicinity showing groundwater elevations in 1962, before the majority of land east of TID was converted to irrigated agriculture. Figure 4.5 shows groundwater elevations measured in 1989, after more than 25 years of groundwater extraction to the east of TID. Comparison of these figures illustrates the development of a pumping depression in the eastern portion of the Turlock Subbasin. Figures 4.6, 4.7, 4.8, 4.9, and 4.10 provide groundwater elevations from 1998, 2005, spring 2011, spring 2015, and spring 2018, respectively. These figures illustrate that the cone of depression continued to expand after 1986. Land development to the east has continued to expand over time. Localized groundwater declines are most concentrated east of TID and in some municipalities. As a result, the flow of groundwater on the eastern side of TID is generally from the TID service area to the east.

Figure 4.4. Groundwater Elevations – 1962 (DWR, n.d.).
Figure 4.5. Groundwater Elevations – 1989 (DWR, n.d.).
Figure 4.6. Groundwater Elevations – 1998 (DWR, n.d.).
Figure 4.7. Groundwater Elevations – 2005 (DWR, n.d.).
Figure 4.8. Groundwater Elevations – Spring 2011 (DWR, 2020).

Figure 4.9. Groundwater Elevations – Spring 2015 (DWR, 2020).
TID adopted the updated Turlock Subbasin Groundwater Management Plan on March 18, 2008, representing the lands in its service area that are outside of the boundaries of the local municipalities (Appendix B).

Following the 2008 update of the Groundwater Management Plan by TID and other local public agencies, management efforts have resulted in continued monitoring and evaluation of groundwater conditions to determine whether additional management actions should be considered.

Studies completed with limited data from the eastern side of the Subbasin suggest that additional agricultural development on the eastern side of the Subbasin has the potential to significantly impact groundwater availability. One study found that even if some community water systems began to use surface water supplies from the Tuolumne River (as suggested in the SRWA’s Regional Surface Water Supply Project), groundwater levels would decline, particularly in dry years (Timothy J. Durbin, Inc. 2008).

In 2012, the TGBA was awarded a Local Groundwater Assistance grant by DWR to compile existing available data, and evaluate groundwater conditions on the eastern side of the Turlock Subbasin. The grant project was conducted to provide an updated understanding of the geology and groundwater conditions on the eastern side of the Subbasin, which is dependent entirely on groundwater for its supply and where limited information has been available historically. The grant work was completed as of March 2016, and is documented in the report “Final Report – Hydrogeological Characterization of the Eastern Turlock Subbasin” (Appendix H).

Agencies within the Turlock Subbasin are also working together to comply with the Sustainable Groundwater Management Act of 2014 (SGMA). Under SGMA, local agencies must work
SECTION FOUR QUANTITY AND QUALITY OF WATER RESOURCES

together to ultimately achieve sustainable groundwater use in the Turlock Subbasin by 2042. SGMA requires a series of intermediate steps be achieved to demonstrate SGMA compliance, including formation of Groundwater Sustainability Agencies (GSAs) by June 30, 2017 and development of Groundwater Sustainability Plans (GSPs) by January 2022 to identify actions needed to achieve groundwater sustainability. A Memorandum of Understanding (MOU) has been developed and adopted by local agencies to demonstrate their intent to work together to comply with SGMA requirements including: (1) identifying the best approach to forming Groundwater Sustainability Agencies (GSAs) within the Subbasin; (2) working together to develop a single Groundwater Sustainability Plan (GSP) for the Subbasin; and (3) compiling data and developing tools that will be needed for SGMA related activities. Two GSAs have been formed to completely cover the Turlock Subbasin and are coordinating to develop a single GSP for the Subbasin. GSP development efforts are ongoing, and are on track to result in the adoption and submittal of a SGMA-compliant plan by January 2022.

Unfortunately, due to the timing of the GSP development process, much of the GSP is still in draft form. As a result, this AWMP was developed based on data publicly available at this time. Future versions of the AWMP will benefit from the availability of the GSP and annual reports prepared pursuant to SGMA. These documents will contain significant information related to groundwater resources, land use, and other related data which will be useful for updating and coordinating groundwater and agricultural water management planning efforts. It is anticipated that future AWMPs will make use of these resources to update figures, document groundwater conditions and management efforts, and evaluate future opportunities to coordinate water management planning efforts.

4.1.2.2 Conjunctive Management

TID’s conjunctive management program is designed to encourage irrigators to use surface water supplies during periods of normal and above normal surface water availability. Surface water from the Tuolumne River, applied within the TID service area via flood irrigation, is the primary source of groundwater recharge within the Subbasin. Use of surface water during normal and wetter years recharges the aquifer, enabling TID to rely more heavily on groundwater during years when surface supplies are below normal. During dry years TID increases the volume of groundwater pumped into the distribution system from rented and drainage wells to supplement surface water supplies. For example, in the 1976-1977 and 1987-1992 droughts, TID rented large numbers of Improvement District (ID) and private wells to supplement supplies from TID-owned wells. Table 4.5 shows that, on average, TID pumped approximately 29,000 more acre-feet of groundwater through rented wells and drainage pumping in dry years than in normal years between 1991 and 2019.

Sustained use of surface water for irrigation is a key component of TID’s conjunctive management of surface water and groundwater supplies. The TID water balance indicates that over the period from 1991 to 2019 total net groundwater recharge within the TID service area ranged from an average of 0.9 AF per acre during dry years to an average of 1.7 AF per acre during normal years. Table 4.6 provides a summary of net recharge within TID, including the contributions of irrigation, seepage from canals and drains, and precipitation. These results show the importance of continuing irrigation with surface water to maintain groundwater recharge for storage of water supplies that can be used in drier years. TID’s tiered volumetric pricing structure for surface water (described in Section 2.2.3) is designed to encourage growers to use...
available surface water supplies to provide appropriate in-lieu and direct groundwater recharge. Having two rate schedules, one for normal or wetter years and one for dry years, encourages different water use practices between normal and dry water year types. In normal and wetter years, lower pricing of surface water encourages growers to use available surface water supplies. In dry years, the pricing encourages conservation of limited surface water supplies, and provides additional revenue to recover increased pumping costs. However, even in dry years, surface water is priced affordably compared to private groundwater pumping. An important aspect of TID’s conjunctive management strategy includes setting the price of TID water appropriately to discourage growers from becoming permanently reliant on groundwater.

The TID water balance, described in Section 5, shows the annual volumes of each water source used in TID. During the period from 1991 to 2019, surface water from the Tuolumne River supplied, on average, 80 percent of the water used by lands that received deliveries from TID. Groundwater supplied 18 percent of average annual demand, while the remaining 2 percent came from other sources (Table 4.2). In normal and wetter years, when more surface water was available, these average percentages shifted to 84 percent surface water, 14 percent groundwater, and 2 percent other supplies. In dry years, the average percentages were 75 percent surface water, 23 percent groundwater, and 2 percent other supplies.

### Table 4.6. Summary of TID Net Recharge downstream of Turlock Lake by Irrigation Season.1

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)²</th>
<th>Year Type</th>
<th>Net Recharge³ (AF/acre)</th>
<th>Irrigation and Distribution System Seepage⁴</th>
<th>Precipitation⁵</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>20</td>
<td>Dry</td>
<td>-0.6</td>
<td>0.2</td>
<td>0.7</td>
<td>-0.4</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>0.3</td>
<td>0.7</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>0.8</td>
<td>0.7</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>0.7</td>
<td>0.5</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>0.7</td>
<td>0.8</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>2015-2019 Average</td>
<td></td>
<td></td>
<td>0.4</td>
<td>0.6</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>2015-2019 Minimum</td>
<td></td>
<td></td>
<td>-0.6</td>
<td>0.2</td>
<td>-0.4</td>
<td></td>
</tr>
<tr>
<td>2015-2019 Maximum</td>
<td></td>
<td></td>
<td>0.8</td>
<td>0.8</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>1991-2019 Normal Year Avg.</td>
<td></td>
<td></td>
<td>1.0</td>
<td>0.6</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>1991-2019 Dry Year Average</td>
<td></td>
<td></td>
<td>0.5</td>
<td>0.4</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

¹ Volumes do not include recharge in Turlock Lake or upstream of Turlock Lake.
² Depth of water in inches available equally to each acre of land. Prior to 2013, this was the allotment.
³ Net recharge is calculated as the total groundwater recharge (seepage and deep percolation) minus the total groundwater extraction, divided by the total irrigated area.
⁴ Volume of net recharge attributed to irrigation and distribution system seepage is calculated as the sum of deep percolation of applied water and seepage from canals and drains, minus total groundwater pumping. Seepage is summarized for the distribution system downstream of Turlock Lake. Does not include seepage losses from Turlock Lake or the Upper Main Canal system.
⁵ Volume of net recharge attributed to precipitation is calculated as the sum of irrigation season and off-season deep percolation of precipitation.
In 2015, a historically dry year, the percentage of water supplied by pumping was even greater (38 percent). TID pumped even more in past dry cycles (1976-1977) and (1987-1988). Unfortunately, the high rates of groundwater extraction in 1977 (67 percent) and 1988 (56 percent) can no longer be achieved because of the decline in groundwater levels, particularly along TID’s eastern boundary.

TID developed a drought conjunctive management plan in response to these increased volumes of groundwater used in the 1976-1977 and the 1987-1992 droughts. One outcome of the plan has been improved management of groundwater pumping throughout TID. Despite TID’s efforts to improve water resources management within the District, the ability to sustain groundwater supplies beneath the TID service area is hindered by substantial groundwater pumping for irrigation of over 89,000 acres of crops east of TID. Irrigators outside TID, in the eastern portion of the Turlock Subbasin, have no available surface water supply. The substantial pumping required for irrigation outside TID, along with the small area of groundwater-only irrigation within TID, continues to contribute to the decline in water levels of the aquifers underlying TID, particularly during periods of drought. More efficient irrigation techniques being used in the groundwater-irrigated areas has helped lessen the impact of agricultural expansion on groundwater levels; however, this may be counteracted by the additional agricultural development continuing to expand eastward within the Subbasin, and to a lesser extent, by the increasing use of pressurized irrigation systems in the eastern portion of TID, which tend to produce less deep percolation than traditional surface irrigation methods.

### 4.1.3 Other Water Supplies

TID cooperates with local municipalities, industries and agriculture water uses to safely utilize recycled water. Categories of recycled water identified within TID are subsurface drainage (tilewater), tailwater, spillage recovery, and recycled treated wastewater (Table 4.7).

In the 1990s, growers began installing subsurface drainage systems (or tile drains) to help control shallow groundwater. These drains discharge into the TID canals where the water is blended with water in the canals and utilized to the greatest extent possible. Based on measurements of tile drain discharge, these subsurface drainage systems pump an average of 6,600 AF of tilewater per year into TID canals (2015-2019).

Some tailwater also enters TID canals indirectly through drainage channels that are intercepted by the distribution system. This recovered tailwater is blended with water in the canals and utilized to the greatest extent possible. Based on water deliveries to parcels identified as having tailwater flows to drains that are intercepted by the TID distribution system, it is estimated that an average of approximately 1,200 AF of tailwater flows into the TID distribution system each year (2015-2019).

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**SECTION FOUR QUANTITY AND QUALITY OF WATER RESOURCES**
Table 4.7. Summary of TID Other Water Supplies.

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)</th>
<th>Year Type</th>
<th>Subsurface Drainage (Tilewater) (AF)</th>
<th>Tailwater to Canals (AF)</th>
<th>Spillage Recovery (AF)</th>
<th>Treated Wastewater Delivered to Farms (AF)</th>
<th>Total Other Supplies (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>18</td>
<td>Dry</td>
<td>4,200</td>
<td>800</td>
<td>900</td>
<td>5,700</td>
<td>11,600</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>6,100</td>
<td>1,100</td>
<td>700</td>
<td>7,000</td>
<td>14,900</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>8,700</td>
<td>1,500</td>
<td>1,400</td>
<td>4,000</td>
<td>15,600</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>7,000</td>
<td>1,400</td>
<td>2,100</td>
<td>4,400</td>
<td>14,900</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>6,800</td>
<td>1,300</td>
<td>1,100</td>
<td>4,000</td>
<td>13,200</td>
</tr>
<tr>
<td>2015-2019</td>
<td>Average</td>
<td></td>
<td>6,600</td>
<td>1,200</td>
<td>1,200</td>
<td>5,000</td>
<td>14,000</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td></td>
<td>4,200</td>
<td>800</td>
<td>700</td>
<td>3,900</td>
<td>11,600</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td></td>
<td>8,700</td>
<td>1,500</td>
<td>2,100</td>
<td>7,000</td>
<td>15,600</td>
</tr>
<tr>
<td>1991-2019</td>
<td>Average</td>
<td></td>
<td>6,000</td>
<td>1,400</td>
<td>800</td>
<td>4,100</td>
<td>12,300</td>
</tr>
<tr>
<td></td>
<td>Wet Year Avg.</td>
<td></td>
<td>6,700</td>
<td>1,400</td>
<td>700</td>
<td>3,800</td>
<td>12,600</td>
</tr>
<tr>
<td></td>
<td>Dry Year Avg.</td>
<td></td>
<td>5,200</td>
<td>1,300</td>
<td>900</td>
<td>4,400</td>
<td>11,800</td>
</tr>
</tbody>
</table>

1 Irrigation season values only, rounded to 100 AF.
2 Depth of water in inches available equally to each acre of land. Prior to 2013, this was the allotment.
3 Subsurface drainage is estimated based on flow meters and power records.
4 Estimated based on survey of tailwater producing lands.
5 Estimated based on flow measurements.
6 City of Modesto, Hilmar Cheese, City of Turlock reported annual volumes prorated based on days in the irrigation season.

Additionally, some long improvement district pipelines were designed and constructed so they terminate at a TID canal in order to recover undelivered irrigation water where it can be used for irrigation delivery downstream. This undelivered water originates from fill up and run down water, or, rarely, when growers choose to not take a delivery. The volume of water that is recovered in this manner has not been quantified independently due to its intermittent nature.

The Harding Drain is a multi-use facility that has been used to transport treated effluent from the City of Turlock (until the end of 2014), urban runoff, drainage from lands adjacent to the drain, groundwater accretions, and canal spillage; however, the percentages of each are unknown. Historically, TID utilized water from the Harding Drain to supplement supplies in Lateral 5½. However, water reuse regulations restricted TID’s ability to recapture those flows for a period of time until the City of Turlock implemented tertiary treatment. TID was able to resume the reuse from the Harding Drain in July 2008. For the period from 2015 to 2019, an average of 1,200 AF of water per year was reused.

Another component of recycled water use is the application of recycled treated wastewater from the City of Modesto and City of Turlock. Dairy nutrient water and industrial process water from Hilmar Cheese are also used to irrigate lands within TID. Over the period of 1998 through 2019, an average of approximately 4,900 AF per year of recycled water from these sources has been used to irrigate approximately 2,000 acres of crops within the TID boundaries. Over the period 2015 to 2019, the average volume of recycled treated wastewater used for irrigation was approximately 5,000 AF per year.
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TID also assists growers who wish to receive nutrient water by allowing dairies to transport nutrient water through improvement district conveyance facilities. This recycling of dairy runoff reduces discharge, enables growers to utilize the nutrient water as fertilizer for forage crops, and provides water for irrigation. This component is difficult to estimate independently and is not currently included in the water balance.

Similarly, TID supports the practice of reusing industrial process water from Hilmar Cheese Company by allowing Hilmar Cheese to transport the process water through improvement district conveyance facilities. Using the existing improvement district facilities in this manner enables Hilmar Cheese to apply the process water for agricultural use, and the growers on those facilities to benefit from the water supply year-round, including the non-irrigation season when TID supplied irrigation water isn’t available. This type of reuse has increased over time as the Hilmar Cheese facility has diversified and expanded. Approximately 2,000 AF of process water is recycled per year, on average, and is included in the recycled treated wastewater used for irrigation described above.

At the end of 2014, the City of Turlock moved the wastewater that historically flowed through the Harding Drain and began discharging directly to the San Joaquin River. As a result, starting in 2015 the spill recovery data for water pumped from the Harding Drain does not include tertiary treated wastewater as a component of the supply. TID does, however, continue to recover spill water and other flows in the Harding Drain for reuse. Additionally, as a part of the SRWA Regional Surface Water Supply Project, the City of Turlock has agreed to provide TID with tertiary treated wastewater for agricultural use, which will help to offset the loss of surface water supplies provided through the project for municipal use. TID is actively working with the City of Turlock to obtain access to this additional supply.

4.2 WATER SUPPLY QUALITY AND MONITORING PRACTICES

TID actively monitors the water quality of canals and wells through samples collected under several different water quality programs. Some of these programs are voluntary and self-directed, such as the agricultural suitability (Ag Suitability) monitoring program. Other programs are required regulatory programs, such as TID’s monitoring under the Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges (Aquatic Pesticide Permit). Sample water quality data are summarized in Table 4.8, showing the average and range of values for the various constituents monitored at sites throughout the District in recent years.

4.2.1 Surface Water Supply and Agricultural Suitability Monitoring

Agricultural suitability (Ag Suitability) monitoring is regularly performed at Turlock Lake and all spill locations to monitor long-term water quality trends in the TID system. Samples collected at Turlock Lake are representative of source water quality. As described in Section 2, surface water supply in TID originates from Don Pedro Reservoir, and is initially stored in Turlock Lake before it is delivered to irrigation customers. Samples collected at spillage locations are not representative of source water quality; however, because they are at the bottom end of the canal system they do represent a possible worst case scenario of water quality of waters delivered to growers. The Ag Suitability water quality data is provided to growers upon request. The agricultural suitability monitoring conducted approximately twice each season.
includes analysis for a standard “ag panel”: sodium, calcium, magnesium, carbonate, bicarbonate, chloride, phosphorus, potassium, nitrate, sulfate, boron, total dissolved solids (TDS), pH, electrical conductivity (EC), and adjusted sodium adsorption ratio (adj. SAR).

4.2.2 Groundwater Supply Monitoring

TID has monitored the water quality of most TID-owned drainage wells plus the rented wells used for irrigation supply. Groundwater samples have historically been analyzed for the same “ag panel” listed above. Data gathered over the years shows that water quality does vary between wells, but not significantly from year to year. As funds allow, drainage wells and rented wells are sampled to maintain a good understanding of the quality of groundwater entering the canal system. Additionally, if there are concerns regarding water quality in a specific area or from a particular well, samples are collected to confirm the current water quality conditions. Testing of TID drainage wells and rented wells has not occurred regularly in recent years on account of staffing constraints during recent drought periods and expansion of automation across the TID system.

During droughts, one of the objectives of TID’s conjunctive management program is to provide a water supply that satisfies irrigation demands in terms of quantity, timing of deliveries, and water quality. To this end, the process for selecting wells that are used to supplement surface water supplies includes consideration of well salinity levels. WDOs are provided pump salinity levels, and utilize that information to provide the growers with the best water quality possible, including minimizing the use of wells with elevated salinity levels when it could affect germination of crops.
### Table 4.8. Summary of TID Water Quality Monitoring Results.

<table>
<thead>
<tr>
<th>Site Type</th>
<th>Constituent</th>
<th>Average</th>
<th>Range</th>
<th>Units²</th>
<th>Data Period</th>
<th>Number of Sites Evaluated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill Locations</td>
<td>Sodium</td>
<td>1.0</td>
<td>0.04-5.4</td>
<td>meq/L</td>
<td>2018-2019</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>1.1</td>
<td>0.2-4.2</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnesium</td>
<td>0.5</td>
<td>0.1-2.2</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bicarbonate</td>
<td>1.2</td>
<td>0.3-4.7</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>0.6</td>
<td>0.1-3.3</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>0.3</td>
<td>0.03-1.2</td>
<td>dS/m</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pH</td>
<td>7.4</td>
<td>6.3-8.5</td>
<td>standard units</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphorus</td>
<td>0.2</td>
<td>&lt;0.0-2.8</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potassium</td>
<td>2.6</td>
<td>0.4-20.1</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nitrate</td>
<td>28.3</td>
<td>&lt;2.0-196.0</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulfate</td>
<td>13.7</td>
<td>1.0-82.0</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boron</td>
<td>0.0</td>
<td>0.00-0.2</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TDS</td>
<td>194</td>
<td>23.0-823</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>adj. SAR</td>
<td>0.9</td>
<td>0.1-4.1</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tile Drains</td>
<td>Sodium</td>
<td>3.9</td>
<td>0.22-28.1</td>
<td>meq/L</td>
<td>2013-2015</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>5.4</td>
<td>0.4-8.6</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnesium</td>
<td>2.8</td>
<td>0.2-6.3</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bicarbonate</td>
<td>5.7</td>
<td>0.7-11.8</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>2.4</td>
<td>0.1-30.1</td>
<td>meq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>1.3</td>
<td>0.1-4.7</td>
<td>dS/m</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pH</td>
<td>7.1</td>
<td>6.4-7.9</td>
<td>standard units</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphorus</td>
<td>3.3</td>
<td>0.1-9.9</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potassium</td>
<td>25.6</td>
<td>1.4-93.2</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nitrate</td>
<td>196.0</td>
<td>2.0-436.0</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulfate</td>
<td>60.7</td>
<td>4.0-244.0</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boron</td>
<td>0.2</td>
<td>0.01-1.2</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TDS</td>
<td>957</td>
<td>74-2,896</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>adj. SAR</td>
<td>2.5</td>
<td>0.2-13.3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Pumps</td>
<td>TDS</td>
<td>753</td>
<td>309-1,607</td>
<td>ppm</td>
<td>2000-2009</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>Boron</td>
<td>0.10</td>
<td>0.01-0.42</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rented Pumps</td>
<td>TDS</td>
<td>727</td>
<td>193-2,179</td>
<td>ppm</td>
<td>2002-2009</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>Boron</td>
<td>0.10</td>
<td>0.01-0.82</td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ EC: electrical conductivity; TDS: total dissolved solids; adj. SAR: adjusted sodium adsorption ratio  
² meq/L: milliequivalents per liter; dS/m: deciSiemens per meter; ppm: parts per million, equivalent to mg/L
Samples collected from TID-owned drainage wells and rented wells show that some wells provide water with elevated TDS levels. A few wells provide water with TDS levels that exceed 2,000 parts per million (ppm). Across all measurements made by TID, the average groundwater TDS is 738 ppm. The pumped groundwater is mixed with surface water in the distribution system, resulting in irrigation water of acceptable quality. Groundwater salinity generally increases from east to west across TID and with well depth. In the western third of TID, wells that go below the Corcoran Clay can be too salty for normal use.

TID also collects an “ag panel” groundwater sample during the formation of a pump Improvement District. As a general policy, if the EC of the new well is above 1.5 dS/m (or about 1,000 ppm TDS), TID staff recommends that the Improvement District not be formed.

4.2.3 Tile Drain Monitoring

Starting in the 1990s, growers in TID began installing subsurface drainage systems (tile drains) to help control shallow water table levels. Discharge from these subsurface drains enters the TID canal system and becomes a part of the overall water supply. TID has historically sampled and evaluated the water quality of 32 tile drain discharges on a quarterly basis. The samples are analyzed for the same “ag panel” described above, and the data are provided to the Improvement Districts. Growers are encouraged to implement on-farm measures to improve water quality should it not meet TID’s water quality standards. Testing of tile drains has not occurred regularly in recent years on account of staffing constraints.

4.2.4 Real-time Canal Monitoring

In 2005 TID began installing water quality telemetry to better understand the quality of water within the canal and drainage system. TID installed YSI 600XL multi-parameter water quality sondes at 18 canal and drain spill locations, and is now replacing these sensors with In-situ Aqua Troll 100 sondes. These sondes measure EC and temperature on a real-time basis. The data is uploaded into TID’s SCADA system where it can be viewed by staff. The data is useful in determining how canal water quality changes as a result of different operational scenarios.

4.2.5 Irrigated Lands Regulatory Program Monitoring

Between 2004 and 2010, TID performed additional water quality sampling and reporting in compliance with the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Irrigated Lands Regulatory Program). During that time, TID sampled three spill locations twice during the irrigation season and two spill locations twice during a storm event. Samples were collected and analyzed for general water quality parameters (pH, EC, Dissolved Oxygen (DO), temperature, turbidity, TDS, Total Organic Carbon (TOC), Total Kjeldahl Nitrogen (TKN), phosphorus and potassium) as well as the active ingredients of any pesticides or herbicides utilized by TID along the canals, which included up to eleven active ingredients from herbicides used for terrestrial weed control purposes.

Beginning in 2011, TID joined the East San Joaquin Water Quality Coalition (ESJWQC) for coverage under the Irrigated Lands Regulatory Program (ILRP). Members of the ESJWQC collective pay for administering a group permit for compliance with the ILRP. As of January 2019, the ESJWQC represents over 2,600 members and over 572,000 acres east of the San
Joaquin River. The ESJWQC aims to characterize discharge from irrigated agricultural lands, identify locations and potential sources of water quality violations, and promote water quality management practices among landowners. Toward these goals, the ESJWQC has an elaborate monitoring program that surveys a wide variety of constituents in a number of local drains and canals. The program is designed to rotate throughout the watershed, and as a result, the sampling locations and constituents are subject to change.

A new Waste Discharge Requirements (WDR) order for the ESJWQC was approved by the Regional Water Quality Control Board (RWQCB) in December 2012, which brought groundwater into the regulatory framework of the ILRP. While surface water monitoring continues under the new WDR, the new program is focused more on a management approach with an emphasis on managing inputs of various pollutants (e.g. nutrients and sediment) rather than strictly focusing on water quality monitoring. Toward this effort, the ESJWQC developed and is implementing a Nitrogen Management Plan (NMP) which requires growers to document how much nitrogen is added and removed from their lands. This information is then submitted to the Coalition once per year, which summarizes and reports it to the RWQCB. A Sediment and Erosion Control Plan was also developed. The template for the plan has been approved by RWQCB staff, and is now being sent to growers whose farms have the potential to discharge sediment to off-farm surface water. Growers can complete and submit the template to the Coalition if they have attended training, or they can have a trained and certified individual complete and submit the template for them.

Under the new WDR the ESJWQC also completed a Groundwater Assessment Report (GAR) and submitted it to the RWQCB in 2014. The GAR compiled all available groundwater data (both level and quality) in an effort to identify high and low vulnerability areas within the Coalition. These designations will then be used while implementing the plans described above. In addition, the ESJWQC must develop and implement a groundwater trend monitoring program. The ESJWQC began sampling groundwater wells in 2018 to comply with the Groundwater Trend Monitoring Program. The first “trend analysis” will be performed within the next three years, then subsequently every five years.

Since the 2012 WDR adoption, ESJWQC and other Central Valley coalitions collectively formed the Central Valley Groundwater Monitoring Collaborative (CV-GMC). This will allow the ESJWQC to pool data and resources with the other coalitions to meet the requirements of the groundwater trend monitoring program. Together, the coalitions have produced five-year reports and cooperated on other technical issues related to groundwater monitoring, such as development of a single database to house groundwater results that enable efficiencies in shared reporting and data management. Future collaboration opportunities with other groundwater monitoring programs include data gathering for SGMA-related efforts and the Surveillance and Monitoring Program (SAMP) under the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS).

As members of the ESJWQC, TID continues to coordinate with ESJWQC staff regarding water quality issues. To facilitate this process, a TID staff member has served on the ESJWQC Board of Directors, and regularly attends Coalition meetings. Information from the 2012 WDR will provide additional information regarding surface and groundwater quality in the TID service area.
4.2.6 Aquatic Pesticide Permit

TID maintains coverage for its applications of Magnacide-H and endothall-based herbicides under the Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges. Both the Magnacide-H and endothall products are aquatic herbicides for the control of submerged aquatic weeds and algae. These products are used in the District’s canals, along with mechanical removal and other practices necessary to maintain the flow of water in the canal system. In 2016, TID submitted a new Aquatic Pesticide Application Plan (APAP) for two additional aquatic herbicides: glyphosate and imazamox. These are also used for treating emergent aquatic weeds in the drains and along the sides of the canals.

As part of the permit, monitoring is required for general water quality parameters (pH, EC, DO, temperature and turbidity) as well as the active ingredient of the permitted herbicide.

4.2.7 Source Water Quality Monitoring

The surface water supply for TID originates as snowmelt from the Sierra Nevada Mountains and is of very high quality. Water quality is regularly tested at Turlock Lake as part of TID’s Ag Suitability monitoring program. Results of these tests show that source water diverted from the Tuolumne River has an average TDS of 38 parts per million (ppm), nitrate concentration of less than 2 ppm, phosphorus concentration of less than 0.04 ppm, and potassium concentration of less than 2 ppm. This high quality water poses no restrictions for irrigation. However, some growers do need to add gypsum to heavier soils to overcome infiltration problems associated with such low TDS water.
5. Water Accounting and Water Supply Reliability

5.1 INTRODUCTION

This section describes the various water uses and water supplies within TID, providing an overall picture of how TID’s water supplies are used to meet water demands within the District’s service area. The water budget is provided to quantify all significant inflows and outflows of water to and from key accounting centers within the District.

The water budget presented in this AWMP covers the most recent 5-year period from 2015 through 2019. This period was selected to utilize the highest quality data available and to support the development of useful conclusions regarding TID’s current operations, particularly since the 2012-2016 drought. To understand TID’s conjunctive management approach to water resources management, it is also useful to take a longer view to identify changes in water supplies and water uses over time, as well as the differences between normal and dry years. Consequently, average volumes from the 1991 through 2019 water budget are also reported.

The water uses and water budgets are also discussed in relation to hydrologic conditions, which vary from year to year. Key hydrologic drivers of water management in a given year include available surface water supply based on Don Pedro Reservoir inflows, precipitation within the TID service area, and evaporative demand. Average water budget results are reported for both normal years (years with 48 inches of available water) and dry years (years with less than 48 inches of available water).

Water budget results presented in this AWMP section are provided on an irrigation season basis, thus better describing irrigation practices and TID operations that support those practices. The typical irrigation season in TID begins in March and extends into October and occasionally November, straddling two DWR-defined water years (October 1 to September 30). Water year summaries of the complete TID water budget are included in Appendix I.

5.2 WATER BUDGET OVERVIEW

The TID water budget includes two separate accounting centers for the TID distribution system downstream of Turlock Lake13 (Distribution System accounting center) and the irrigated lands that receive TID deliveries (Irrigated Lands accounting center). A total of twenty-three individual flow paths are quantified as part of the water budget. A schematic of the water budget structure is provided in Figure 5.1.

In general, flow paths are quantified on a monthly basis using available TID data sources, weather data sources, and root zone water budget model results (described in Section 5.3). For each accounting center, all but one flow path is determined independently based on measured data or calculated estimates. The remaining flow path is then calculated based on the principal

13 The TID water budget has historically been calculated for the distribution system and irrigated lands downstream of Turlock Lake, beginning with irrigation releases from Turlock Lake. As reporting needs change and use of the TID water budget evolves, TID is planning to update the water budget to include the Upper Main Canal and Turlock Lake. These future updates are expected to occur within the next five years, and will be included in the next AWMP update.
of conservation of mass (Equation 5-1), which states that the difference between total inflows and outflows to an accounting center for a given period of time is equivalent to the change in stored water within that accounting center.

\[
\text{Inflows – Outflows} = \text{Change in Storage (monthly time step)} \quad [5-1]
\]

The flow path that is calculated as the difference between all other inflows and outflows is referred to as the “closure term” because the mass balance equation is solved or “closed” for the unknown quantity. The closure term is selected based on consideration of the availability of data or other information to support an independent estimate, as well as the volume of water representing the flow path relative to the size of other flow paths. Generally speaking, the largest, most uncertain flow path is selected as the closure term.

### 5.3 WATER BUDGET CALCULATION AND UNCERTAINTY

Monthly volumes for the flow paths shown in Figure 5.1 were estimated based on direct measurements or based on calculations using measurements and other data. As described previously, those flow paths not estimated independently were calculated as the closure term of each accounting center.

The data sources and methodologies used to quantify these flow paths are described below.

#### 5.3.1 Surface Water and Groundwater Data Sources

This section describes the data sources used to quantify TID’s surface water supplies and deliveries, as well as surface water supplies from other water sources. Drainage, evaporation, and infiltration of surface water are also described below.

##### 5.3.1.1 TID Surface Water Supplies and Deliveries

TID’s surface water supplies from Don Pedro Reservoir are diverted into TID’s Upper Main Canal for conveyance to Turlock Lake. From Turlock Lake, water is released into the Main Canal for distribution to downstream growers for irrigation purposes. Between 1991-2001, irrigation releases from Turlock Lake are calculated as the sum of the ordered daily flow rates from Turlock Lake during the irrigation season. Since 2002, irrigation releases from Turlock Lake are measured at a broad-crested weir and recorded by TID. The TID water budget has historically been calculated for the distribution system and irrigated lands downstream of Turlock Lake, beginning with irrigation releases from Turlock Lake. As reporting needs change and use of the TID water budget evolves, TID is planning to update the water budget to include the Upper Main Canal and Turlock Lake. Following these future updates, surface water inflows to the TID water budget will be revised to surface water releases from Don Pedro Reservoir. These updates are expected to occur within the next five years, and will be included in the next AWMP update.
Figure 5.1. TID Water Budget Structure.
Farm deliveries are calculated as the water balance closure for the TID Distribution System accounting center. TID also measures and records deliveries to irrigators using its TXDB database system, which has been modified in recent years to better track ordering, measurement, and billing data to meet the SBx7-7 requirements. The farm deliveries closure is compared to the sum of all recorded deliveries each year as a check for the overall accuracy of TID’s recorded deliveries and water balance.

5.3.1.2 TID Groundwater Pumping

TID practices conjunctive management of surface water and groundwater, supplementing surface water releases by pumping groundwater from drainage wells and rented wells. Water pumped from drainage wells and rented wells discharges either directly into a canal, into a pipeline that flows back to a canal, or into a pipeline that is utilized for irrigation purposes.

Drainage wells are owned and operated by TID primarily to lower groundwater levels in localized, high groundwater areas and also to supplement other irrigation water supplies. Rented wells are owned by private parties or IDs, and are rented by TID to supplement irrigation supplies, particularly in drier years when surface water supplies are limited. Both drainage and rented pumping volumes are calculated based on power meter records for individual wells multiplied by a power factor derived from pump tests.

5.3.1.3 Private Groundwater Pumping

As described in Section 2, private pumping volumes in TID are calculated using a conversion factor that correlates the quantity of water pumped with electrical energy use. TID has reviewed and revised the conversion factor on several occasions, most recently in 2014. Revisions to this methodology have helped to improve the accuracy of private pumping volumes and to prevent overestimation resulting from other electricity usage associated with the same electric meter. TID will continue to review and revise the conversion factor in the future, as needed.

In some dry years, TID allows growers to pump groundwater into the canals and then receive a delivery “credit” equal to the volume they supplied at any sidegate that serves their property. This practice supplements the water supply available to downstream users, and allows growers the flexibility to transport water that they pump to any of their fields served by an active sidegate. In the 2014-2015 water budgets, the volume of private pumping used in this practice is included in the total private pumping volume, since the same volume that is pumped is also delivered for irrigation. This volume is also included in TXDB water receipts. In future updates to the water budget, TID will consider accounting and reporting the volume of water used in this practice separately from other private pumping.

5.3.1.4 Other Water Supplies

Other surface water supplies available to irrigators in TID include subsurface drainage (tilewater), surface drainage (tailwater), spillage recovery, and treated wastewater.

Subsurface drainage, or tilewater drainage, from fields in TID is calculated as the sum of all measured, calculated, or estimated tilewater from 35 tile drain systems. The majority of tilewater drainage is calculated from power meter records using a power factor that was derived from tile drain systems with both flow meter records and power meter records. Some tile drain...
systems are measured with flow meters, while the remaining few are estimated based on historical average drainage values. Subsurface discharge from all tilewater drains enters the TID distribution system, where it blends with surface water supplies and becomes available for deliveries downstream.

Tailwater drainage from irrigated lands in TID is estimated as 0.42% of the recorded deliveries for 1991-2002 and 2006-2019. For 2003-2005, measurements at Woods Drain were available, while the tailwater drainage for other drains was estimated as 0.26% of recorded deliveries. These estimated percentages are based on available records at Woods Drain and an inventory of tailwater drainage from lands in TID that was first conducted in 2004 and later updated in 2009. This inventory found that tailwater drainage only comes from a small percentage of lands within TID, with approximately 2,700 acres generating tailwater that flows to District canals, and an additional 8,200 acres generating tailwater that drains to natural waterways adjoining TID.\(14\)

TID also recovers spillage from Harding Drain at Pump 152, which pumps into Lateral 5.5 to supply downstream deliveries. The volume of spillage recovery is calculated by TID based on power meter records multiplied by a power factor derived from pump tests. The TID distribution system is also designed to provide passive spillage recovery from the upper laterals through interception by the Ceres Main Canal, and spillage recovery from 34 ID pipelines that spill into canals. This passive spillage recovery is an internal flow path within the TID distribution system, and is not included in the water budget.

Recycled water comes to farms from a variety of sources, including recycled treated wastewater from the City of Modesto and City of Turlock, and untreated dairy nutrient water and industrial process water from Hilmar Cheese Company. City of Modesto and Hilmar Cheese Company each report the volumes they delivered. The City of Turlock is not currently providing recycled water for use outside of city parks and other city facilities; however, they historically provided recycled water for agricultural use, and could in the future.

In the non-irrigation season, the TID canals are drained of Tuolumne River surface water supplies. However, they are still used to convey subsurface drainage, drainage pumping, urban runoff from local communities, and storm water flows from east of the irrigation service area to the rivers. During the off-season, TID works with growers who wish to capture these flows, boarding up drops so long as it does not conflict with maintenance or other activities. This type of use is not significant, and is not considered a TID irrigation delivery. As such, it is included in the off-season water budget as part of the total “Off-Season Unmeasured System Outflows” at this time (see Appendix I). This water may be separately quantified in future updates to the water budget.

\subsection*{5.3.1.5 Spillage, Evaporation, and Canal Seepage}

Losses from the distribution system at the water supplier scale include seepage, spillage, and evaporation. Of the three loss types, only evaporation losses are non-recoverable as seepage.

\(14\) The 2009 updated inventory of tailwater drainage from TID lands identified particular fields that generate tailwater and drain to canals or to the river system. Tailwater to rivers was not estimated prior to 2009 due to lack of available data.
recharges the underlying groundwater system and spillage is available by downstream water users.

Canal spillage from the TID distribution system is measured and recorded by TID’s extensive network of SCADA sites. SCADA equipment is installed at 14\textsuperscript{15} spillage sites located at the ends of lower laterals and main canals (see the District Map in Appendix D). The TID distribution system is designed so that upper laterals terminate into the lower delivery canals, allowing any excess water in the upper laterals to be utilized for deliveries from the lower canals before spillage occurs. Water in the canals that is not utilized for irrigation purposes is released into drains or downstream rivers at the spillage sites. Six of the spillage sites flow directly to rivers, while the remaining spillage is consolidated into three drains that flow to the river system.

Evaporation from the TID distribution system is calculated as the canal water surface area multiplied by a water surface evaporation coefficient\textsuperscript{16} and by daily ET\textsubscript{o}, minus daily precipitation.

Seepage (groundwater recharge) from the TID distribution system is calculated based on published seepage rates by soil type, estimated canal wetted areas, and wetted duration during the irrigation season when water is flowing through TID canals. Representative ponding tests have also been conducted in the past to provide spot checks of the seepage rates.

### 5.3.2 Weather and Climate Data Sources

Precipitation data are measured at weather stations within the TID service area. For 1991-2002, precipitation data are summarized from weather station #049073 “Turlock #2” (37.5006, -120.855) operated by the National Oceanic and Atmospheric Administration (NOAA). For 2003-2009, precipitation data come from the California Irrigation Management Information System (CIMIS) Station #168 “Denair” (37.5531, -120.7793). Beginning in April 2009, the Denair CIMIS station was deactivated, moved to a nearby location, and renamed Station #206 “Denair II” (37.5459, -120.7545).

Reference evapotranspiration (ET\textsubscript{o}) data are likewise reported by CIMIS stations in and around TID. ET\textsubscript{o} rates are used to calculate evaporation from TID canals, and for calculating crop evapotranspiration (ET\textsubscript{c}) in the root zone water budget model, described in the next section. For 1991 – 2002, ET\textsubscript{o} rates are reported from CIMIS Station #71 “Modesto” (37.6452, -121.1878). Like precipitation data, ET\textsubscript{o} rates are derived from CIMIS Station #168 (Denair) for 2003 through April 2009, and from CIMIS Station #206 (Denair II) for April 2009 through 2019.

\textsuperscript{15} There are 15 operational spillage sites in the TID system. However, only 14 are used. The 15\textsuperscript{th} site can spill, but is very rarely used, and therefore is not included in the SCADA system at this time.

\textsuperscript{16} Free surface evaporation coefficient of 1.10, obtained from the University of California Cooperative Extension Leaflet 21427 (UCCE, 1989)
5.3.3 Irrigated Lands Root Zone Water Budget Model

5.3.3.1 Background

A daily root zone water budget model was used to support water budget development for the TID Irrigated Lands accounting center. A daily root zone water budget is a generally accepted and widely used method to accurately and consistently calculate crop evapotranspiration (ETc), effective precipitation, crop consumptive use of applied irrigation water, and other water budget flow paths in the root zone (ASCE, 2016 and ASABE, 2007).

Flows through the root zone and plant surfaces were modeled using the Integrated Water Flow Model (IWFM) Demand Calculator, referred to as IDC. The physically-based IDC version 2015.0.0036 (DWR, 2015) is developed and maintained by DWR. Similar to the water budgets described in this AWMP, the IDC root zone water budget calculates a daily balance of inflows and outflows to and from the root zone and crop surfaces. Key inputs required by IDC include weather and climate data, soil characteristics, and crop characteristics. IDC uses these inputs to accurately calculate the balance of inflows and outflows, and to parse ETc into the fractions of crop consumptive use met by precipitation (effective precipitation, or ET of precipitation) and by applied irrigation water (ET of applied water).

The TID IDC root zone water budget model was used to develop time series estimates for the following flow paths:

- Evapotranspiration of applied water, or ETaw (also referred to as crop consumptive use of applied irrigation water)
- Evapotranspiration of precipitation, or ETpr (also referred to as effective precipitation17)
- Deep percolation of precipitation, or DPpr18
- Uncollected surface runoff of precipitation
- Change in storage of root zone soil moisture from precipitation

5.3.3.2 Required IDC Inputs and Data Sources

Major required inputs provided to the IDC root zone water budget model are summarized below, along with their respective data sources.

5.3.3.2.1 Crop Evapotranspiration

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17 Effective precipitation is defined as the portion of total precipitation that remains on the foliage or in the soil that is available for evapotranspiration, and reduces the amount of applied water required for evapotranspiration (ETaw) by a like amount (ASCE, 2016).

18 Deep percolation of applied water (DPaw) is also calculated by IDC based on deliveries estimated by IDC. However, because farm deliveries are available from the water balance, DPaw served as the Irrigated Lands water budget closure term.
Daily crop evapotranspiration (ETc) rates are quantified and provided to the TID IDC application for crops and land uses in TID. ETc inputs to the TID IDC represent actual ET (ETa) (as compared to potential ET) for the water budget period. ETc rates are calculated by multiplying daily reference ET (ET0) by the appropriate crop coefficient for each crop and land use. Daily ETa rates are reported by CIMIS stations in and around TID, as described in the previous section. Local crop coefficients are developed from ETa estimates calculated using remotely sensed surface energy balance results over nine recent years. Two surface energy balances were applied to calculate ETa in TID: Mapping EvapoTranspiration at high Resolution with Internalized Calibration (METRIC) and Surface Energy Balance Algorithm for Land (SEBAL). METRIC and SEBAL results both account for the many factors that impact ETc, including crop age, vegetation density, disease, salinity, deficit irrigation, and other stress factors. Studies by Bastiaanssen, et al. (2005), Allen, et al. (2007), Thoreson, et al. (2009), Allen, et al. (2011), and others have found that seasonal ETa estimates by these models are expected to be within plus or minus five to fifteen percent of actual ET when performed by an expert analyst.

5.3.3.2.2 Precipitation
Daily precipitation data provided as inputs to the IDC model were derived from the weather stations described in Section 5.3.2. Daily precipitation rates are used by IDC to quantify ETpr (or effective precipitation, as noted in Section 5.3.3.1), DPpr, runoff of precipitation, and change in storage of root zone soil moisture from precipitation. IDC calculates a daily precipitation balance that balances the precipitation inflow with these other outflows and change in storage.

5.3.3.2.3 Soil Characteristics
Soil characteristics for the predominant soil textures in TID are required for IDC to simulate the availability of soil moisture in the root zone. Soil textural classes and associated soil hydraulic parameters were estimated from the Soil Survey Geographic (SSURGO) database (Soil Survey Staff, 2014) for use in IDC. The SSURGO database contains information collected by the National Cooperative Soil Survey (NCSS) about soils in the United States. The United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS), formerly known as the Soil Conservation Service (SCS), organizes the NCSS and publishes soil surveys.

The following soil parameters are based on SSURGO data for soils in TID:

- Permanent wilting point (PWP), dimensionless
- Field capacity (FC), dimensionless
- Total porosity (φ), dimensionless
- Pore size distribution index (λ), dimensionless
- Saturated hydraulic conductivity (Ksat), in feet per day (ft/day)

A description of each parameter and its role in IDC is provided in the IDC documentation prepared and published by DWR.  

5.3.3.2.4 Other Irrigation and Crop Characteristics

Other key characteristics are also required by IDC to define irrigation periods, irrigation practices, and crop development in TID:

- Irrigation period: Identification of days in each year when crops are irrigated or non-irrigated.
- Target soil moisture fraction: Dimensionless fraction of field capacity to establish the level of soil saturation targeted by irrigation.
- Minimum soil moisture: Dimensionless fraction of field capacity to establish the minimum soil saturation at which irrigation begins.
- Runoff curve numbers: Dimensionless number relating the relative runoff characteristics of each soil (and crop surface) in TID. IDC uses a modified version of the SCS curve number (SCS-CN) method to compute runoff of precipitation. Curve numbers are used as described in the National Engineering Handbook Part 630 (USDA, 2004, 2007) based on land use or cover type, treatments (straight rows, bare soil, etc.), hydrologic condition, and hydrologic soil group.
- Rooting depth: Depth of crop roots as the irrigation season progresses, in feet.

A description of each parameter and its role in IDC is likewise provided by DWR in the IDC documentation available online at the link above.

5.3.4 Accounting Center Closure Terms

The monthly volume of farm deliveries are calculated as the closure term for the TID Distribution System accounting center. Farm deliveries were selected as the closure because they represent the largest outflow from the TID distribution system, and historically they were subject to the inaccuracies inherent in TID’s use of sidegates as delivery measurement devices. As described in Section 2.2.2.2, delivery measurements have substantially improved in accuracy as a result of TID’s delivery measurement accuracy improvement program and other efforts following SBx7-7. Alongside these improvements, TID has also increased the accuracy of other distribution system flow paths with the expansion and enhancement of its SCADA system. Consequently, farm deliveries are still calculated as the Distribution System accounting center closure. The closure is compared with delivery records each irrigation season to verify the completeness and overall accuracy of both the delivery records and the TID water budget.

Deep percolation of applied water (DPaw) is calculated as the closure term for the TID Irrigated Lands accounting center, which includes all lands served by TID deliveries. Deep percolation of applied water was selected as the closure because it represents a relatively large outflow from irrigated lands to the groundwater system, and it is difficult to measure accurately.

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20 DWR IDC documentation available online at: https://water.ca.gov/Library/Modeling-and-Analysis/Modeling-Platforms/Integrated-Water-Flow-Model-Demand-Calculator
5.3.5 Flow Path Uncertainty

The results of the TID water budget are reported for each flow path with a high level of precision (nearest whole acre-foot) that implies a higher degree of accuracy in the values than is actually justified. To identify the level of uncertainty associated with each flow path, an estimated percent uncertainty has been defined for each measured or estimated flow path, approximately representing a 95 percent confidence interval. These uncertainty values are quantified based on the accuracy of measurement devices, typical values quantified in other water budgets, or professional judgment. Then, based on the relative magnitude of each flow path, the resulting uncertainty in each closure term can be estimated by assuming that errors in estimates are random, following the procedure described by Clemmens and Burt (1997). Errors in estimates for individual flow paths may cancel each other out to some degree, but the net error due to the collective uncertainty in the various flow paths is ultimately expressed in the closure term.

Table 5.1 lists each flow path included in the water budget, indicating which accounting center(s) it belongs to, whether it is an inflow or an outflow, whether it was measured or calculated, the supporting data used to determine it, and the estimated uncertainty, expressed as a percent. As indicated, estimated uncertainties vary by flow path from three percent to 35 percent of the estimated value, with uncertainties generally being less for measured flow paths and greater for calculated flow paths. The estimated uncertainty of each closure term is also shown, calculated based on the concept of propagation of random errors as described above.

As indicated, the estimated uncertainty in farm deliveries is five percent. This uncertainty is relatively small due to the relatively low uncertainty in system inflows from Turlock Lake, which represent the largest flow path in the distribution system balance. The estimated uncertainty in deep percolation of applied water is 30 percent. Despite the inevitable uncertainties in some estimated flow path quantities, the water budget provides useful insights into TID’s water management.
## Table 5.1. TID Water Budget Flow Paths, Supporting Data, and Estimated Uncertainty.

<table>
<thead>
<tr>
<th>Accounting Center</th>
<th>Flow Path Type</th>
<th>Flow Path</th>
<th>Source</th>
<th>Supporting Data</th>
<th>Typical Volume (AF)(^1)</th>
<th>Typical Uncertainty (%(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution System</td>
<td>Inflows</td>
<td>Irrigation Releases from Turlock Lake</td>
<td>Measurement</td>
<td>Broad-crested weir measurement site just downstream of Turlock Lake</td>
<td>423,620</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drainage Pumping</td>
<td>Measurement</td>
<td>TID drainage well pump power use measurements</td>
<td>23,398</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rented Pumping</td>
<td>Measurement</td>
<td>TID rented well pump power use measurements</td>
<td>21,908</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tilewater (to Canals)</td>
<td>Measurement</td>
<td>Flow meter where reliable records available, remainder based on power use or estimated</td>
<td>6,575</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tailwater (to Canals)</td>
<td>Calculation</td>
<td>Estimated as a percentage of deliveries to the specific parcels identified as draining to canals</td>
<td>1,218</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spill Recovery</td>
<td>Measurement</td>
<td>Pump 152 power use measurements</td>
<td>1,228</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Runoff of Precipitation (to Canals)</td>
<td>Calculation</td>
<td>Root zone simulation model, CIMIS precipitation data, NRCS curve number method</td>
<td>30</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Farm Deliveries</td>
<td>Closure (Distribution System)</td>
<td>Difference of total inflows and measured/estimated outflows for Distribution System accounting center</td>
<td>391,413</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Canal Spillage</td>
<td>Measurement</td>
<td>TID operational spill measurements</td>
<td>48,382</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seepage</td>
<td>Calculation</td>
<td>NRCS soils data, published seepage rates by soil type, estimated wetted duration, representative ponding tests</td>
<td>36,524</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaporation</td>
<td>Calculation</td>
<td>CIMIS reference ET data, estimated evaporation coefficient, estimated/wetted surface area</td>
<td>1,557</td>
<td>30%</td>
</tr>
<tr>
<td>Irrigated Lands</td>
<td>Inflows</td>
<td>Private Pumping</td>
<td>Calculation</td>
<td>Power use of power accounts with deep wells within the TID service area, estimated groundwater only area, average TID ET(\text{aw}) and CCUF</td>
<td>63,510</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treated Wastewater</td>
<td>Measurement</td>
<td>Measurements received from City of Modesto, Hilmar Cheese, City of Turlock, and Treated Wate-water prorated based on days in the irrigation season</td>
<td>4,980</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precipitation</td>
<td>Calculation</td>
<td>Quality-controlled precipitation from Denair CIMIS station, TID cropped area</td>
<td>54,598</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ET of Applied Water (ET(\text{aw}))</td>
<td>Calculation</td>
<td>CIMIS reference ET, estimated crop coefficients from METRIC and SEBAL analysis, cropped area by crop, root zone simulation model (IDC) to divide total ET into applied water and precipitation components</td>
<td>321,591</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tailwater (to Canals)</td>
<td>Calculation</td>
<td>Estimated as a percentage of deliveries to the specific parcels identified as draining to canals</td>
<td>1,218</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tailwater (to Rivers)</td>
<td>Calculation</td>
<td>Estimated as a percentage of deliveries to the specific parcels identified as draining to rivers</td>
<td>3,122</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tilewater (to Canals)</td>
<td>Measurement</td>
<td>Flow meter where reliable records available, remainder based on power use</td>
<td>6,575</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tilewater (to Rivers)</td>
<td>Measurement</td>
<td>Flow meter where reliable records available, remainder based on power use</td>
<td>1,125</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Percolation of Applied Water (DP(aw))</td>
<td>Closure (Irrigated Lands)</td>
<td>Difference of total inflows and measured/estimated outflows for Irrigated Lands accounting center applied water balance</td>
<td>126,282</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ET of Precipitation (ET(\text{p}))</td>
<td>Calculation</td>
<td>CIMIS reference ET, estimated crop coefficients from METRIC and SEBAL analysis, cropped area by crop, root zone simulation model (IDC) to divide total ET into applied water and precipitation components</td>
<td>54,216</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep Percolation of Precipitation (DP(\text{p}))</td>
<td>Calculation</td>
<td>Root zone simulation model, NRCS soils characteristics, CIMIS precipitation data</td>
<td>33,225</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Runoff of Precipitation (to Canals)</td>
<td>Calculation</td>
<td>Root zone simulation model, CIMIS precipitation data, NRCS curve number method</td>
<td>30</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Runoff of Precipitation (to Rivers)</td>
<td>Calculation</td>
<td>Root zone simulation model, CIMIS precipitation data, NRCS curve number method</td>
<td>147</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change in Root Zone Storage of Precipitation(^2)</td>
<td>Calculation</td>
<td>Root zone simulation model, negative values indicate a net decrease in stored precipitation due to consumption or deep percolation</td>
<td>-33,020</td>
<td>30%</td>
</tr>
</tbody>
</table>

1 Typical irrigation season volume and closure uncertainty estimated based on 2015-2019 average irrigation season volume. Due to rounding inflows and outflows may not be exactly equal (see Tables 5.3 and 5.4 for detailed water budget results). Typical uncertainty values of all flow paths that are not accounting center closure terms are based on the measurement device accuracy, the combined accuracy of supporting data used in the flow path calculation, or are estimated based on typical values given in technical literature or reported in similar water budgets.

2 Change in Root Zone Storage of Precipitation accounted as outflow. Negative outflow indicates a net positive inflow of root zone soil moisture from precipitation that is extracted by crops during the irrigation season.
### 5.4 HYDROLOGIC YEAR TYPES FOR EVALUATION OF WATER MANAGEMENT

Development of a multi-year water budget allows TID to better evaluate the effects of surface water supply variability, precipitation variability, and other hydrologic changes as they impact water management in TID. Specifically, a multi-year water budget that includes both dry and normal years is essential to evaluate and plan for conjunctive management as practiced by TID. This multi-year water budget also supports the EWMP “planned conjunctive use of surface water and groundwater” that is discussed in Section 7.

To support the review and interpretation of water uses and water supplies over time, the TID water budget is presented alongside the depth of annual “available water” according to the assignment determined each year by the TID Board of Directors (see Section 2.2.3) and related water year types. Table 5.2 shows the annual available water and water year type for 2015-2019 together with the total calendar year precipitation and the total water year reference evapotranspiration (ETo), compared to average values across 1991-2019.

Years with reduced inflows to Don Pedro Reservoir due to reduced precipitation in the watershed typically correspond to years with reduced precipitation and increased evaporative demand in the TID service area. Based on the annual amount of water generally available to growers, the years 1991-2019 have been assigned to “normal” or “dry” year types for purposes of discussing water uses and water supplies in TID over time. As described in Sections 2 and 3, the TID Board of Directors determines (1) the year type (and therefore the water pricing schedule to be used for the given year), and (2) the amount of water available for purchase. In years assigned a “normal” designation for this analysis, the available water was 48 inches. In years assigned as “dry,” the available water was less than 48 inches. These year type classifications are for this analysis only, and are not meant to correspond with water year classifications used for regulatory or other purposes.

As discussed previously, TID has a reliable source of water from Don Pedro Reservoir through a variety of water rights on the Tuolumne River. TID growers have received full available water supplies (48 inches) in 16 of the last 29 years. During the 2015 to 2019 period, available water was reduced in 2015 and 2016, with full water supplies available in 2017 through 2019.

In the 5-year period from 2015 to 2019, the average ETo during the irrigation season (generally March to October) has been approximately 49 inches. Water year precipitation (October through September) in the TID service area tends to be less in dry years as compared to normal years, with an average between 1991 and 2019 of approximately 10 inches and 15 inches for dry and normal years, respectively.

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21 Between 1991 and 2012, the “available water” was considered the “allotment” or “allocation,” for purposes of comparing water year types for this report. Starting in 2013, implementation of a volumetric pricing system eliminated the “allocation” system. Therefore, starting in 2013, available water, for the purposes of this report, is considered the amount of water available equally to each acre of land.
Table 5.2. TID Available Water, Water Year Precipitation, and Irrigation Season ET\textsubscript{o}, and Hydrologic Year Type.

<table>
<thead>
<tr>
<th>Year</th>
<th>Irrigation Season</th>
<th>Number of Days</th>
<th>Available Water (inches)\textsuperscript{1}</th>
<th>Year Type</th>
<th>Precipitation, Water Year (inches)</th>
<th>ET\textsubscript{o}, Mar - Oct (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>9-Apr 7-Oct</td>
<td>182</td>
<td>18</td>
<td>Dry</td>
<td>8.9</td>
<td>50.0</td>
</tr>
<tr>
<td>2016</td>
<td>6-Apr 2-Nov</td>
<td>211</td>
<td>36</td>
<td>Dry</td>
<td>14.7</td>
<td>49.0</td>
</tr>
<tr>
<td>2017</td>
<td>30-Mar 1-Nov</td>
<td>217</td>
<td>48</td>
<td>Normal</td>
<td>19.5</td>
<td>49.0</td>
</tr>
<tr>
<td>2018</td>
<td>1-Mar 31-Oct</td>
<td>245</td>
<td>48</td>
<td>Normal</td>
<td>9.3</td>
<td>50.0</td>
</tr>
<tr>
<td>2019</td>
<td>4-Apr 30-Oct</td>
<td>210</td>
<td>48</td>
<td>Normal</td>
<td>14.3</td>
<td>48.5</td>
</tr>
<tr>
<td></td>
<td>2015-2019</td>
<td></td>
<td></td>
<td></td>
<td>Average</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Minimum</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Maximum</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td>1991-2019</td>
<td></td>
<td></td>
<td></td>
<td>Average</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Normal Year Average</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry Year Average</td>
<td>9.5</td>
</tr>
</tbody>
</table>

\textsuperscript{1}Depth of water in inches available equally to each acre of land. Prior to 2013, this was the allotment.

In addition to having reduced surface water supplies and below-normal precipitation, dry years also tend to have slightly higher evaporative demand compared to normal years, resulting in increased crop irrigation requirements. Thus, in dry years TID faces increased irrigation demands while surface water supplies are reduced. As a result, in dry years groundwater use is increased to supplement reduced surface water supplies reflecting TID’s conjunctive management approach.

5.5 IRRIGATION SEASON WATER BUDGET

The TID water budget structure was shown previously in Figure 5.1. The water budget was prepared for two accounting centers: (1) the TID Distribution System, representing TID canals, drains, and facilities below Turlock Lake and the Upper Main Canal, and (2) the TID Irrigated Lands, representing all land that receives deliveries within the TID irrigation service area. An accounting center representing the groundwater system is also included in Figure 5.1 to account for exchanges between the vadose zone and the aquifers underlying TID. However, a complete balance for the underlying aquifer is not calculated because not all subsurface inflows and outflows have been estimated as part of the AWMP water budget. Tabulated water budget results for each accounting center are provided in Tables 5.3 and 5.4.

In this AWMP section, the water budget is presented on an irrigation season time step (generally March through October or November) in order to better describe irrigation practices and TID operations that support those practices. Summary results are provided for the 2015 to 2019 period as well as for the 1991 to 2019 period. Underlying the irrigation season time step is a more detailed water budget in which all flow paths are determined on a monthly basis or more frequently. The winter months are excluded from the summaries in this section because the non-
irrigation season water budget is influenced by unmeasured intercepted stormwater, and the information provided does not pertain to TID irrigation water management activities.

Water year summaries (October 1 through September 30) are provided in Appendix I, in compliance with AWMP guidelines.

### 5.5.1 Distribution System Water Budget

Over the 2015 to 2019 period, the District distribution system (also referred to as the canal system) had total irrigation releases from Turlock Lake ranging from approximately 282,000 AF to nearly 510,000 AF over each irrigation season, with an average of approximately 424,000 AF per season. Over the 1991 to 2019 period, normal year irrigation releases averaged over 513,000 AF, and dry year releases averaged approximately 439,000 AF, with an overall average of 480,000 AF. Releases are greater in normal years due to the greater availability of surface water.

Other sources of TID supply include drainage pumping and rented pumping, subsurface drainage (tilewater) and tailwater that drains directly into the distribution system, and treated wastewater that is recycled and discharged to TID irrigated lands.

As indicated in Table 5.3, TID drainage pumping ranged from 19,000 AF to 28,000 AF between 2015 and 2019, with an average of over 23,000 AF per season. The 1991-2019 normal and dry year averages were 49,000 and 41,000 AF, respectively, with an overall average of 45,000 AF. The decrease in drainage pumping volumes in recent years is attributable to several factors. Recent automation of many drainage pumps in TID has allowed WDOs to operate and control these pumps more closely, resulting in lower volumes pumped into the distribution system. Also, since the 1990s TID has changed the methodology that is used to quantify drainage pumping volumes, from estimation based on operating hours to calculation based on power usage. This change has improved the accuracy of drainage pumping volumes since that time.

TID rented pumping ranged from 6,000 AF to 52,000 AF between 2015 and 2019. The overall average for the five year period was 22,000 AF. The normal and dry year averages over the 1991 to 2019 period were 14,000 AF and 51,000 AF, respectively, with an overall average of 31,000 AF. Rented pumping generally increases in dry years because rented wells are used as an additional groundwater supply to meet increased irrigation demands and to compensate for reduced surface water availability. As part of conjunctive management, TID intentionally pumps less in normal and wetter years to maximize the use of available surface water and allow for in-lieu groundwater recharge. These practices and TID’s conjunctive management efforts have resulted in reduced rented pumping on average in the last five years, as compared to the historical past.

For TID, the fraction of supply from surface water provides a means of evaluating variability in TID’s use on surface water supplies compared to groundwater supplies over time. The surface water supply fraction in TID is calculated according to Equation 5-2:

\[
\text{Surface Water Supply Fraction} = \frac{\text{Irrigation Releases from Turlock Lake}}{\text{Irrigation Releases from Turlock Lake} + \text{Drainage Pumping} + \text{Rented Pumping}} \tag{5-2}
\]
### Table 5.3. TID Distribution System Water Budget Results.¹

<table>
<thead>
<tr>
<th>Year ¹</th>
<th>Available Water (inches)²</th>
<th>Irrigation Season</th>
<th>Number of Days</th>
<th>Surface Water Supply</th>
<th>Groundwater Supply</th>
<th>Other Supply</th>
<th>Inflows (AF)</th>
<th>Outflows (AF)</th>
<th>Closure (AF)</th>
<th>Performance Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Irrigation Releases from Turlock Lake</td>
<td>Drainage Pumping</td>
<td>Rented Pumping</td>
<td>Tidewater (to Canals)</td>
<td>Tidewater (to Canals)</td>
<td>Spill Recovery</td>
<td>Runoff of Precipitation (to Canals)</td>
</tr>
<tr>
<td>2015 18</td>
<td>9-Apr 7-Oct</td>
<td>182</td>
<td>281,667</td>
<td>20,156</td>
<td>35,557</td>
<td>4,234</td>
<td>797</td>
<td>891</td>
<td>343,302</td>
<td>16,041 31,060 1485 294,716 83% 86%</td>
</tr>
<tr>
<td>2016 36</td>
<td>6-Apr 2-Nov</td>
<td>211</td>
<td>384,036</td>
<td>22,393</td>
<td>52,146</td>
<td>6,123</td>
<td>1,053</td>
<td>670</td>
<td>466,521</td>
<td>24,200 36,080 1497 404,744 84% 87%</td>
</tr>
<tr>
<td>2017 48</td>
<td>30-Mar 1-Nov</td>
<td>217</td>
<td>472,798</td>
<td>19,332</td>
<td>6,600</td>
<td>8,674</td>
<td>1,464</td>
<td>1,421</td>
<td>510,291</td>
<td>52,996 37,240 1596 418,459 95% 82%</td>
</tr>
<tr>
<td>2018 48</td>
<td>1-Mar 31-Oct</td>
<td>245</td>
<td>509,326</td>
<td>28,247</td>
<td>8,569</td>
<td>6,996</td>
<td>1,432</td>
<td>2,057</td>
<td>556,664</td>
<td>79,560 42,130 1652 433,222 93% 78%</td>
</tr>
<tr>
<td>2019 48</td>
<td>4-Apr 30-Oct</td>
<td>210</td>
<td>470,271</td>
<td>26,863</td>
<td>6,166</td>
<td>6,849</td>
<td>1,342</td>
<td>1,100</td>
<td>512,603</td>
<td>69,115 36,110 1553 405,825 93% 79%</td>
</tr>
<tr>
<td>2015-2019</td>
<td>Average</td>
<td>213</td>
<td>423,620</td>
<td>23,398</td>
<td>21,808</td>
<td>6,575</td>
<td>1,218</td>
<td>1,228</td>
<td>477,876</td>
<td>48,382 36,524 1557 391,413 90% 82%</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>182</td>
<td>281,667</td>
<td>19,332</td>
<td>6,166</td>
<td>4,234</td>
<td>797</td>
<td>670</td>
<td>343,302</td>
<td>16,041 31,060 1485 294,716 83% 78%</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>245</td>
<td>509,326</td>
<td>28,247</td>
<td>52,146</td>
<td>8,674</td>
<td>1,464</td>
<td>2,057</td>
<td>556,664</td>
<td>79,560 42,130 1652 433,222 95% 87%</td>
</tr>
<tr>
<td>1991-2019</td>
<td>Overall Average</td>
<td>215</td>
<td>479,999</td>
<td>45,228</td>
<td>30,650</td>
<td>6,006</td>
<td>1,384</td>
<td>793</td>
<td>564,070</td>
<td>55,683 36,131 1517 470,746 86% 83%</td>
</tr>
<tr>
<td></td>
<td>Normal Year Average</td>
<td>219</td>
<td>513,458</td>
<td>48,664</td>
<td>14,325</td>
<td>6,676</td>
<td>1,437</td>
<td>730</td>
<td>585,303</td>
<td>73,512 36,908 1483 473,400 89% 81%</td>
</tr>
<tr>
<td></td>
<td>Dry Year Average</td>
<td>210</td>
<td>438,819</td>
<td>40,999</td>
<td>50,742</td>
<td>5,182</td>
<td>1,318</td>
<td>869</td>
<td>537,938</td>
<td>33,739 35,175 1558 467,479 83% 87%</td>
</tr>
</tbody>
</table>

¹ Irrigation season water balance summary. Water year water balance summary is provided in Appendix I.
² Depth of water in inches available equally to each acre of land. Prior to 2013, this was the allotment.
³ Evaporation is equal to the evaporation from canals minus precipitation that falls on the canal water surface.
⁴ The Surface Water Supply Fraction is equal to Irrigation Releases from Turlock Lake divided by the sum of all TID Surface Water Supply (Irrigation Releases from Turlock Lake) and all TID Groundwater Supply (Drainage Pumping, Rented Pumping).
⁵ The Delivery Fraction (DF) is equal to Farm Deliveries divided by TID Total Supply (TID Surface Water Supply, TID Groundwater Supply, and TID Other Supply (Tidewater (to Canals), Tailwater (to Canals), Spill Recovery, and Runoff of Precipitation (to Canals)).
⁶ In 2014-2015, TID allowed growers to pump groundwater into the canals and receive a delivery “credit” equal to the volume they supplied. This volume is included in the private pumping volumes and water receipts in 2014-2015. In future water budgets, TID will consider separately accounting and reporting the volume of private pumping used in this practice.
### Table 5.4. TID Irrigated Lands Water Budget Results.

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)</th>
<th>Farm Deliveries</th>
<th>Private Pumping</th>
<th>Treated Wastewater</th>
<th>Total Irrigation Supply</th>
<th>Precipitation</th>
<th>ET of Applied Water (ETaw)</th>
<th>Tailwater (to Canals)</th>
<th>Tailwater (to Rivers)</th>
<th>Tilewater (to Canals)</th>
<th>Tilewater (to Rivers)</th>
<th>Deep Percolation of Precipitation (DPpr)</th>
<th>Runoff of Precipitation (to Canals)</th>
<th>Runoff of Precipitation (to Rivers)</th>
<th>Change in Root Zone Storage of Precipitation</th>
<th>Net Recharge (AF/acre)</th>
<th>Crop Consumptive Use Fraction (CCUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>18</td>
<td>294,716</td>
<td>125,273</td>
<td>5,679</td>
<td>425,668</td>
<td>346,701</td>
<td>797</td>
<td>2,597</td>
<td>4,234</td>
<td>816</td>
<td>70,523</td>
<td>18,918</td>
<td>33,061</td>
<td>16,120</td>
<td>0</td>
<td>1</td>
<td>-30,264</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>404,744</td>
<td>61,448</td>
<td>6,955</td>
<td>473,147</td>
<td>317,667</td>
<td>1,053</td>
<td>2,884</td>
<td>6,123</td>
<td>957</td>
<td>144,463</td>
<td>92,874</td>
<td>54,622</td>
<td>47,698</td>
<td>100</td>
<td>536</td>
<td>-10,082</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>418,459</td>
<td>37,950</td>
<td>4,021</td>
<td>460,430</td>
<td>306,485</td>
<td>1,464</td>
<td>2,926</td>
<td>8,674</td>
<td>1,404</td>
<td>139,477</td>
<td>39,607</td>
<td>64,442</td>
<td>34,221</td>
<td>2</td>
<td>10</td>
<td>-59,068</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>433,322</td>
<td>62,407</td>
<td>4,373</td>
<td>500,102</td>
<td>331,791</td>
<td>1,432</td>
<td>3,337</td>
<td>6,996</td>
<td>1,140</td>
<td>155,406</td>
<td>61,366</td>
<td>50,282</td>
<td>31,339</td>
<td>37</td>
<td>151</td>
<td>-20,443</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>405,825</td>
<td>30,474</td>
<td>3,918</td>
<td>440,217</td>
<td>305,309</td>
<td>1,342</td>
<td>3,867</td>
<td>6,849</td>
<td>1,310</td>
<td>121,540</td>
<td>60,226</td>
<td>68,673</td>
<td>36,747</td>
<td>12</td>
<td>37</td>
<td>-45,243</td>
</tr>
<tr>
<td>2015-2019 Average</td>
<td>391,413</td>
<td>63,510</td>
<td>4,989</td>
<td>459,913</td>
<td>321,591</td>
<td>1,218</td>
<td>3,122</td>
<td>6,575</td>
<td>1,125</td>
<td>126,282</td>
<td>54,598</td>
<td>54,216</td>
<td>33,225</td>
<td>30</td>
<td>147</td>
<td>-33,020</td>
<td></td>
</tr>
<tr>
<td>2015-2019 Minimum</td>
<td>294,716</td>
<td>30,474</td>
<td>3,918</td>
<td>425,668</td>
<td>305,309</td>
<td>797</td>
<td>2,597</td>
<td>4,234</td>
<td>816</td>
<td>70,523</td>
<td>18,918</td>
<td>33,061</td>
<td>16,120</td>
<td>0</td>
<td>1</td>
<td>-59,068</td>
<td></td>
</tr>
<tr>
<td>2015-2019 Maximum</td>
<td>433,322</td>
<td>125,273</td>
<td>6,955</td>
<td>500,102</td>
<td>346,701</td>
<td>1,464</td>
<td>3,867</td>
<td>8,674</td>
<td>1,404</td>
<td>155,406</td>
<td>92,874</td>
<td>68,673</td>
<td>47,698</td>
<td>100</td>
<td>536</td>
<td>-10,082</td>
<td></td>
</tr>
<tr>
<td>1991-2019 Overall Average</td>
<td>470,746</td>
<td>31,202</td>
<td>4,077</td>
<td>506,025</td>
<td>315,908</td>
<td>1,384</td>
<td>2,975</td>
<td>666</td>
<td>6,672</td>
<td>180,933</td>
<td>48,324</td>
<td>55,111</td>
<td>28,683</td>
<td>10</td>
<td>2,386</td>
<td>-37,867</td>
<td></td>
</tr>
<tr>
<td>1991-2019 Normal Year Average</td>
<td>473,400</td>
<td>25,138</td>
<td>3,780</td>
<td>502,318</td>
<td>299,571</td>
<td>1,437</td>
<td>3,133</td>
<td>706</td>
<td>7,382</td>
<td>192,753</td>
<td>56,120</td>
<td>62,972</td>
<td>33,042</td>
<td>12</td>
<td>2,950</td>
<td>-42,856</td>
<td></td>
</tr>
</tbody>
</table>

1 Irrigation season water balance summary. Water year water balance summary is provided in Appendix I.
2 Depth of water in inches available equally to each acre of land. Prior to 2013, this was the allotment.
3 In 2014-2015, TID allowed growers to pump groundwater into the canals and receive a delivery “credit” equal to the volume they supplied. This volume is included in the private pumping volumes and water receipts in 2014-2015. In future water budgets, TID will consider separately accounting and reporting the volume of private pumping used in this practice.
4 Tailwater to rivers was not estimated prior to 2009, so the average flows are calculated from 2009-2019.
5 Net recharge is calculated as the total groundwater recharge (seepage and deep percolation) minus the total groundwater extraction, divided by the total irrigated area. The volume of groundwater recharge from deep percolation of precipitation includes both irrigation season and off-season recharge. All other recharge and extraction is summarized over the irrigation season.
6 Crop Consumptive Use Fraction (CCUF) is equal to ET of Applied Water divided by Total Irrigation Supply (Farm Deliveries, Private Pumping, and Treated Wastewater).
Between 2015 and 2019, the surface water supply fraction ranged from 83% to 95% with an average of 90%. Over the 29-year period from 1991 to 2019, the fraction of supply from surface water averaged 89% and 83% in normal and dry years, respectively, with an overall average of 86%. In dry years, the reduction in the fraction of TID’s water supply that comes from surface water demonstrates TID’s conjunctive management of surface water and groundwater supplies to maintain overall water supply reliability.

The Delivery Fraction (DF) may also be calculated to compare the total farm deliveries made by TID to meet irrigation demand versus the total supply available to TID, providing an indicator of distribution system performance. The DF is calculated on an irrigation season basis and for the TID distribution system below Turlock Lake according to Equation 5-3, by dividing the TID’s total farm deliveries to growers by the total supply available to TID. The total supply includes all surface water, groundwater, and other supplies provided by TID through its distribution system:

\[
DF = \frac{\text{Farm Deliveries}}{\text{Total Supply}} \tag{5-3}
\]

For TID, the DF ranged from 79% to 87% between 2015 and 2019, with an average of 83%. The DF over the 1991 to 2019 period averaged 81% and 87% in normal and dry years, respectively, with an overall average of 84%.

Losses from the distribution system at the water supplier scale include spillage, seepage, and evaporation. Of the three loss types, only evaporation losses are non-recoverable. Seepage recharges the underlying groundwater system and spillage is available to downstream water users. Between 2015 and 2019, seepage ranged between 31,000 AF and 42,000 AF with an average of nearly 37,000 AF over the irrigation season. Over the 1991 to 2019 period, seepage averaged 37,000 AF in normal years and 35,000 AF in dry years, with an overall average of 36,000 AF. The primary driver of seepage is the irrigation season length, which is generally longer in normal years and shorter in dry years compared to the average season length. TID continually evaluates canal lining condition, and maintains lining and relines canals as needed to limit seepage. However, while seepage reduction due to lining increases the available water supply for farm deliveries, it also decreases groundwater recharge benefits to the Turlock Subbasin.

Spillage losses varied from 16,000 AF to 80,000 AF between 2015 and 2019 with an average of 48,000 AF per season. Spillage losses for the 1991 to 2019 period averaged 74,000 AF and 34,000 AF in normal and dry years, respectively, with an overall average of 56,000 AF per irrigation season. In dry years, spillage losses have historically been reduced by purposely releasing less surface water from Turlock Lake than needed, and using wells in the lower reaches of the distribution system to make up the difference. This enables operators to reduce spills by turning pumps on and off to minimize spillage while meeting irrigation demands.

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22 In 2014-2015, TID allowed growers to pump groundwater into the canals and receive a delivery “credit” equal to the volume they supplied. This volume is included in the private pumping volumes and TXDB water receipts in 2014-2015. In future water budgets, TID will consider separately accounting and reporting the volume of private pumping used in this practice.
Evaporation losses are relatively small and generally constant over time. Variations from irrigation season to irrigation season result primarily from differences in season length and evaporative demand (i.e., weather) over time. Between 2015 and 2019, evaporation losses varied from 1,500 AF to 1,700 AF, with an average of 1,600 AF in losses per irrigation season. The 1991-2019 averages reflect a similar range.

### 5.5.2 Irrigated Lands Water Budget

Over the 2016 to 2019 period, TID farm deliveries ranged from approximately 405,000 AF to 433,000 AF over each irrigation season. Over the 1991 to 2019 period, farm deliveries averaged approximately 473,000 AF in normal years and 467,000 AF in dry years, with an overall average of 471,000 AF per irrigation season. On account of historic drought conditions in 2015, only 295,000 AF of water was delivered in that irrigation season. This reduction is attributed mainly to lower available water supplies from Don Pedro Reservoir, and TID’s relatively lower use of rented pumps in 2015 compared to historical dry years (approximately 36,000 AF in 2015, compared to 51,000 AF on average in dry years between 1991-2019). The reduction in deliveries in 2015 was largely offset by an increase in private groundwater pumping. Altogether, the total irrigation supply in 2015 was approximately 426,000 AF, compared to an average of 506,000 AF per year between 1991-2019, and a range of 440,000 AF to 500,000 AF in 2016-2019.

As indicated in Table 5.4, private pumping ranged from 30,000 AF to 125,000 AF between 2015 and 2019, with an overall average 64,000 AF. Private pumping generally increases in dry years, particularly in 2015 after multiple consecutive drought years. As described previously, in some dry years TID also allows growers to pump groundwater into the canals and receive a delivery “credit” equal to the volume they supplied at any sidegate that serves their property. This practice supplements the water supply available to downstream users, and allows growers the flexibility to transport water that they pump to any of their fields served by an active sidegate. In the 2014-2015 water budgets, the volume of private pumping used in this practice is included in the total private pumping volume, since the same volume that is pumped is also delivered for irrigation.

TID’s conjunctive management strategy provides a reliable District supply in all but the driest years, so that the extra groundwater pumped by growers in dry years is replenished by groundwater recharge, in normal and wetter years. This is confirmed by TID’s net recharge – the total recharge in TID minus the total groundwater extraction in TID during a given year. Across the 1991 to 2019 period, the average annual total recharge in TID was 2.1 AF per acre per year, the average annual total groundwater extraction was 0.8 AF per acre per year, and the average annual net recharge was 1.3 AF per acre per year. This positive net recharge value indicates that TID, on average, recharges more water than is extracted within the TID service area.

Recycled water reuse is relatively steady over time due to steady generation of wastewater by the dischargers. Recycled treated wastewater applied directly to TID irrigated lands averaged 5,000 AF over the five year period of 2015 through 2019. The overall average for the 1991 to 2019 period is 4,000 AF, with little difference between normal and dry years.

The objective of irrigation is to meet crop consumptive demand (ET$_{aw}$) along with any other agronomic on-farm water needs. Comparing total applied irrigation water to ET$_{aw}$, a Crop
Consumptive Use Fraction (CCUF) may be calculated to provide an indicator of on-farm irrigation performance. The CCUF is calculated on an irrigation season basis by dividing total ET_{aw} by total applied irrigation water according to Equation 5-4:

\[ \text{CCUF} = \frac{\text{ET of Applied Water}}{\text{Total Irrigation Supply}} \]  \hspace{1cm} [5-4]

For TID, the CCUF ranged from 0.66 to 0.81, or 66% to 81%, between 2015 and 2019 with an average of 0.70 (70%). For the 1991 to 2019 period, the CCUF is lower in normal years, averaging 0.60 as compared to 0.66 in dry years. This is attributed in part to lower farm deliveries in drier years and higher effort in using water efficiently, particularly in the driest years.

Losses of applied water from irrigated lands in TID include tailwater (surface drainage that discharges to canals or rivers), tilewater (subsurface drainage through tile drains that discharges to canals or rivers), and deep percolation of applied water. All of the losses are recoverable, as tailwater and tilewater may be used by downstream water users for irrigation or other purposes, and deep percolation of applied water recharges the underlying groundwater system.

Between 2015 and 2019, tailwater discharged to rivers was estimated to be just over 3,000 AF, on average, during the irrigation season. During the same period, tailwater returning to the distribution system was estimated to average 1,400 AF during the irrigation season. Deep percolation of applied water varied from approximately 71,000 AF to 155,000 AF between 2015 and 2019, with an average of 126,000 AF per season.

Over the 2015-2019 irrigation seasons, precipitation inflows to TID ranged between 19,000 AF and 93,000 AF, and averaged 55,000 AF per season. Losses of precipitation from irrigated lands in TID include deep percolation of precipitation and runoff of precipitation. Evapotranspiration of precipitation (equivalent to effective precipitation, as described in Section 5.3.3.1) occurs both during the winter rainy season and during the irrigation season as some precipitation is also stored within the root zone, particularly during the winter months, and is gradually consumed by crops during the early spring. The precipitation balance outside of the irrigation season is included in the water year summaries in Appendix I.

### 5.6 WATER SUPPLY RELIABILITY

TID requires a firm water supply to meet crop irrigation demands. Almonds, a major crop grown in TID, require a large initial investment and a reliable water supply to establish and maintain economic crop production. Forage crops are also widely grown in TID, and are required as a steady food supply for the many dairy herds within the District. TID’s water supplies support large areas of permanent crops and crops that could be used to support local animal production, which together span approximately 130,000 acres, or approximately 96% of irrigated land within TID.

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23 Tailwater to rivers was not estimated prior to 2009 due to lack of available data.
the TID service area\textsuperscript{24}. This firm irrigation demand drives TID’s conjunctive management strategy, which is designed to provide a relatively consistent water supply in all years.

Reliability of water supplies is dependent upon the availability of surface water and groundwater supplies. As discussed in detail in Sections 3 and 4, TID’s programs and practices have improved water supply reliability through the conjunctive management of surface water and groundwater resources. However, the overall availability of surface water supplies depends on numerous factors, including future hydrology, water rights, and instream flow requirements. Similarly, while Tuolumne River water imported by TID provides the majority of recharge within the Turlock Subbasin, groundwater supplies are relied upon by various irrigation, domestic, industrial and municipal water users within the Subbasin, both within and outside TID boundaries. As a result, the reliability of groundwater resources is dependent upon continued recharge of the Subbasin, and the ability of the various groundwater users to work cooperatively to manage the water supply. TID works with the other agencies within the Turlock Subbasin to facilitate that effort. Although water supply reliability is not within TID’s sole discretion, TID will continue to manage the resources available to it, and adjust its programs and practices as needed to provide the most reliable water supplies for its customers today, and into the future.

In addition to the reliability of the supplies themselves, water supply reliability is dependent upon TID’s ability to transport the water to where it is used for irrigation. TID owns, operates, and maintains its distribution system, up to and including the sidegate. TID regularly inspects the distribution system, with a focus on identifying and fixing potential problems before they occur. The majority of the canal maintenance and system improvements are performed in the non-irrigation season (typically November through February) to minimize disruption of irrigation deliveries.

Distribution facilities from the canal to irrigated parcels are owned and maintained by individual growers or groups of growers who have formed IDs. TID assists IDs in maintaining the facilities, and recovers the costs from the growers. Administering IDs in this way enables quick responses when maintenance issues arise, and improves system reliability by reducing the downtime associated with repairs.

Specific programs and planning efforts that will have a significant impact on the future availability and reliability of water supplies are described below.

\textbf{5.6.1 Bay-Delta Plan and FERC Relicensing of Don Pedro Reservoir}

The State Water Board is responsible for adopting and updating the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta Plan), which

\textsuperscript{24} Combined total of approximately 64,000 acres of permanent orchard and vineyard crops (2015-2019 average), and approximately 66,000 acres of alfalfa, pasture, sudan, corn, unirrigated forage/corn, oats, oats/corn, clover, sorghum, and double-other crops that could be used to support animal production (2015-2019 average). The latter crops are available to support approximately 9,000 acres of confined animal agriculture facilities in TID (Farmland Mapping and Monitoring Program 2016 data for Stanislaus and Merced Counties, California Department of Conservation Division of Land Resource Protection).
establishes water quality control measures and flow requirements needed to provide reasonable protection of beneficial uses in the watershed.

On December 12, 2018, the State Water Board adopted an update to the Bay-Delta Plan which established Lower San Joaquin River flow objectives and revised southern Delta salinity objectives. These initial amendments to the Plan (“Phase 1”) apply to three tributaries to the San Joaquin River: the Merced, Tuolumne, and Stanislaus Rivers.

The new flow objectives for the Tuolumne would require MID and TID to release 40 percent of unimpaired flows into the Tuolumne River from February 1 to June 30 for salmon and salinity control in the Delta.

Currently, the Districts and the San Francisco Public Utilities Commission (SFPUC) release approximately 17 percent of the unimpaired flows to the Tuolumne River, while the remainder is diverted for beneficial use.

The impacts of Phase 1 of the Bay-Delta Plan on TID and its growers are significant. Water available for diversion for farmland irrigation and municipal supply will be reduced in all water year types, but will be most severe during drier years. For instance, were the Bay-Delta Plan in effect in 2013-2015 at the peak of the 2012-2016 drought, the water available to growers in TID would be as indicated in Table 5.5.

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual Available Water (inches/acre)</th>
<th>Theoretical Available Water Under the Bay-Delta Plan (inches/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>34</td>
<td>16</td>
</tr>
<tr>
<td>2014</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>18</td>
<td>0</td>
</tr>
</tbody>
</table>

In adopting the amendments to the Bay-Delta Plan, the State Water Board agreed to support efforts by the California Natural Resources Agency to negotiate a Delta watershed-wide agreement, including potential flow and non-flow measures for the Tuolumne River, as an alternative to the Bay-Delta Plan update. This Voluntary Settlement Agreement (VA) process would grant the Tuolumne River some relief from the unimpaired flow requirements of the Bay-Delta Plan. Throughout 2019 and 2020, TID staff were in discussions with various State agencies regarding alternative measures that could be incorporated into a VA.

Concurrent with this VA effort is the Federal FERC relicensing of Don Pedro Reservoir. Under the Federal Power Act, the State Water Board is authorized to issue a Water Quality Certification under Section 401 of the Clean Water Act to address the water quality impacts of the Don Pedro project. The Water Quality Certification also provides the State Water Board with the opportunity to implement the Bay-Delta Plan’s unimpaired flow regime on the Districts.
The new flow objectives under the Bay-Delta Plan will affect the future reliability of water supplies, significantly reducing the volume of water available for diversion by TID, and reducing the water supply available to growers. While a VA will still require the District to release more water to the Tuolumne for ecosystem benefits, a VA offers the District the best opportunity to mitigate the impacts of the Bay-Delta Plan on its growers.

5.6.2 Sustainable Groundwater Management Act and Groundwater Sustainability Plan

The Sustainable Groundwater Management Act of 2014 (SGMA) provides for local control of groundwater resources while requiring sustainable management of these resources. Specifically, SGMA requires groundwater subbasins to establish governance by forming local Groundwater Sustainability Agencies (GSAs) with the authority to develop, adopt, and implement a Groundwater Sustainability Plan (GSP). Under the GSP, GSAs must adequately define and monitor groundwater conditions in the subbasin and establish criteria to maintain or achieve sustainable groundwater management within 20 years of GSP adoption.

Agencies within the Turlock Subbasin have formed two GSAs to comply with SGMA. The West Turlock Subbasin GSA (WTSGSA) includes the area within the TID’s irrigation boundaries. TID is an active member of the WTSGSA, with staff helping to facilitate GSA activities. The East Turlock Subbasin GSA (ETSGSA) generally covers the area to the east of the WTSGSA. The GSAs have a Memorandum of Agreement that outlines the process by which the GSAs are working together to ensure the Subbasin is in compliance with SGMA. Both GSAs have been actively engaged in developing a single GSP for the Subbasin, which must be submitted to DWR in January 2022.

In accordance with SGMA, the WTSGSA and the ETSGSA must work together to achieve sustainable groundwater use in the Turlock Subbasin by 2042. Although TID has effectively implemented conjunctive management of groundwater and surface water supplies, groundwater is not an unlimited supply. Achievement of groundwater sustainability in the Turlock Subbasin may require changes in the way that TID has historically supplemented surface water with groundwater to serve its customers. Projects and/or management actions are currently being developed for the Turlock Subbasin GSP with the goal of achieving long-term groundwater sustainability. While the details of these actions are not yet finalized, these actions may impact the future availability and reliability of TID water supplies.

5.7 WATER MANAGEMENT OBJECTIVES

Since its formation as the first irrigation district in California, TID has been driven by its mission to provide reliable and affordable irrigation water and electric service, while being a good steward of local water resources and providing high levels of customer satisfaction.

TID desires to cultivate water management practices that align its efforts with the vision, mission, and values of its companywide Strategic Plan. Most notable of these elements are TID’s goals to:

- Maintain reliable water supply
- Increase efficiencies in its resources and infrastructure
• Rise to meet and exceed evolving customer expectations  
• Leverage technology to benefit customers  
• Demonstrate leadership in managing its resources and infrastructure  
• Balance near-term decision making with the long-term well-being of its customers

Towards these goals, TID has implemented a number of water management strategies and embarked on a number of water planning efforts, including:

• **Conjunctive Management.** As described in Section 4.1.2.2, TID practices conjunctive management of surface water and groundwater, coordinating the operation and monitoring of surface water and groundwater supplies to provide reliable water supplies for its customers. Groundwater recharge of high quality, low TDS surface water from Don Pedro Reservoir benefits groundwater supply availability in dry years, and helps to improve groundwater quality.

• **Affordable, Tiered Pricing Structure.** As described in Section 2.2.3, TID offers water on two rate schedules, one for “normal” (or wetter) years and one for “dry” years, encouraging different water use practices between water year types. In normal and wetter years, lower pricing of surface water encourages growers to maximize their use of available surface water and allows for in-lieu recharge. In dry years, higher pricing encourages conservation of limited surface water supplies, and provides additional revenue to recover increased pumping costs. However, even in dry years, surface water is priced affordably compared to private groundwater pumping. An important aspect of TID’s conjunctive management strategy includes setting the price of TID water appropriately in all years to discourage growers from becoming permanently reliant on groundwater. This structure is designed to continue to support the District’s critically important conjunctive management objectives, while also complying with the requirements of SBx7-7.

• **Available Water Policies.** As described in Section 2.2.4, TID’s Board of Directors determines the amount of water available to customers each year, with the goal of meeting and exceeding customer expectations while also balancing near-term and long-term water supply availability. The Board makes two key decisions: whether to use the “normal” or “dry” year rate schedule, and the amount of water available on a per acre basis. These decisions are based on projected runoff, including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps.

• **Operational Efficiency Improvements.** TID has long been proactive in improving the operational efficiency of its distribution system. Key efforts include automation, monitoring, infrastructure improvements, and WDO training. TID began installing a Supervisory Control and Data Acquisition (SCADA) system in 1997, with data collection beginning in 1998. Today, TID collects water measurement data from 397 SCADA sites, including nine miles of Rubicon Total Channel Control (TCC) automation and remote drainage pump controls. These improvements have resulted in more accurate flows throughout TID’s service area, and have enhanced the ability of WDOs to carefully and strategically operate canals to meet and exceed evolving customer expectations.
In 2019, TID completed a multi-year planning effort that culminated in the TID Irrigation Facilities Master Plan (IFMP). The IFMP evaluated existing service levels in TID, and then identified a comprehensive list of projects to strategically and cost-effectively rehabilitate and modernize TID irrigation facilities with the goal of maintaining and improving the level of irrigation service provided to its growers. In 2019, TID also completed its Irrigation Delivery Operations Assessment that evaluated TID operational efficiency through comparison of efficiency indicators with other irrigation water suppliers in California, and through observation and interviews with WDOs. The assessment identified opportunities to improve efficiency through increased modernization of District software, strategic SCADA monitoring, and expanded training for District WDOs and other field staff.

5.8 WATER USE EFFICIENCY

Water use efficiency is a core consideration in TID’s operations. As stated above, TID’s mission is to be a good steward of its water resources while also providing high levels of customer satisfaction. Efficient water use at all levels benefits this mission by conserving or utilizing water for maximal benefit to TID’s customers and downstream water users.

Key water use components and water use efficiency in TID are quantified in the sections below.

5.8.1 Water Use Efficiency Components

Four types of water use serve as the basis for water use efficiency calculations: crop water use, agronomic water use, environmental water use, and recoverable flows. These water use efficiency components are quantified in Table 5.6, and are described in the sections below.

5.8.1.1 Crop Water Use

Crop water use, or crop consumptive use, in TID represents the portion of total applied water withdrawn by crops that is evaporated, transpired, incorporated into products or crops, or otherwise removed from the immediate water environment for consumptive use (ASCE, 2016).

In the water budget presented in this AWMP, crop water use of applied water is referred to as evapotranspiration of applied water (ET\textsubscript{aw}). ET\textsubscript{aw} is quantified as an outflow of the IDC root zone water budget described in Section 5.3.3. Table 5.6 summarizes the ET\textsubscript{aw} in TID in 2015 through 2019.

5.8.1.2 Agronomic Water Use

Agronomic water use in TID represents the portion of total applied water that is directly used for crop cultivation practices, but that is not consumed by crops (i.e., excluding ET\textsubscript{aw}). Sample agronomic water uses include soil leaching, seedbed preparation, and climate control. In TID, agronomic water uses mainly include pre-irrigation of corn for germination, and additional small water volumes used for salt leaching and frost protection.

Agronomic water use for pre-irrigation of corn was estimated based primarily on data used in the water budget. First, using TID delivery data, the irrigation volume delivered during the first delivery (assumed to be a pre-irrigation) was reviewed for each corn field in TID during each
season. The ET\textsubscript{aw} that occurred between the first and second irrigations to the same parcel in the same year was subtracted from the first irrigation volume, so as not to double-count ET\textsubscript{aw} from pre-irrigation as both an “agronomic water use” and a “crop consumptive water use”. On average, this analysis found that approximately 4 inches of water was delivered during the first irrigation and approximately 2 inches of water was consumed as ET\textsubscript{aw} between the first and second irrigation resulting in an estimate of 2 inches of water used for agronomic purposes. It was assumed that 2 inches was applied for agronomic use, on average, to all fields identified as “corn” in all years. In normal years, it was assumed that 2 inches was also applied to all fields in which unirrigated forage was grown before corn (“unirrigated forage/corn”), while in dry years, it was assumed that 2 inches was applied to only 50% of all fields identified as “unirrigated forage/corn.”

Table 5.6. Water Use Efficiency Components.

<table>
<thead>
<tr>
<th>Water Use Efficiency Component</th>
<th>Year (Year Type\textsuperscript{1}, Available Water\textsuperscript{2})</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(D, 18&quot;) (D, 36&quot;) (N, 48&quot;) (N, 48&quot;) (N, 48&quot;)</td>
<td>346,701</td>
<td>317,667</td>
<td>306,485</td>
<td>331,791</td>
<td>305,309</td>
<td>321,591</td>
</tr>
<tr>
<td>Crop Consumptive Use (ET\textsubscript{aw})</td>
<td></td>
<td>3,413</td>
<td>3,841</td>
<td>4,330</td>
<td>4,477</td>
<td>5,177</td>
<td>4,248</td>
</tr>
<tr>
<td>Agronomic Use\textsuperscript{3}</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Environmental Use\textsuperscript{4}</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recoverable Flows of Applied Water</td>
<td></td>
<td>70,523</td>
<td>144,463</td>
<td>139,477</td>
<td>155,406</td>
<td>121,540</td>
<td>126,282</td>
</tr>
<tr>
<td>Recoverable Flows to Groundwater (DP\textsubscript{aw})</td>
<td></td>
<td>3,413</td>
<td>3,841</td>
<td>4,330</td>
<td>4,477</td>
<td>5,177</td>
<td>4,248</td>
</tr>
<tr>
<td>Total Recoverable Flows of Applied Water</td>
<td></td>
<td>73,936</td>
<td>148,304</td>
<td>143,807</td>
<td>159,883</td>
<td>126,717</td>
<td>130,529</td>
</tr>
<tr>
<td>Recoverable Flows of Total Water Supply</td>
<td></td>
<td>101,583</td>
<td>180,543</td>
<td>176,717</td>
<td>197,536</td>
<td>157,650</td>
<td>162,806</td>
</tr>
<tr>
<td>Recoverable Flows to Groundwater (DP\textsubscript{aw}, Seepage)</td>
<td></td>
<td>19,454</td>
<td>28,041</td>
<td>57,326</td>
<td>84,037</td>
<td>74,292</td>
<td>52,630</td>
</tr>
<tr>
<td>Total Recoverable Flows of Total Water Supply</td>
<td></td>
<td>121,037</td>
<td>208,584</td>
<td>234,043</td>
<td>281,573</td>
<td>231,942</td>
<td>215,436</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Year types, as determined by the TID Board of Directors, are normal (N) or dry (D).

\textsuperscript{2} The amount of water available for purchase by irrigators in TID, in inches per acre per season.

\textsuperscript{3} Assuming pre-irrigation of corn, frost protection, and leaching requirements for crops served along laterals with higher TDS (average >500 ppm more than one year).

\textsuperscript{4} Assuming negligible environmental use within TID service area (Tuolumne River instream flow requirements are met before irrigation releases and considered to be outside the TID service area).

Surface water released from Turlock Lake is of very high quality, with low salinity and low TDS, resulting in generally low leaching requirements for the crops grown in the District. However, the salinity of groundwater and drainage in TID is markedly higher, increasing the TDS of water in canals downstream of where these supplies are mixed. To estimate the agronomic water use from leaching, a reach-by-reach water quality model was used. This model was developed to support the aforementioned draft IFMP and calculates the mass balance of TDS in each reach based on the TDS concentration and volume of all inflows to that reach. Following recommended water management practices per FAO Irrigation Water Management:
Training Manual No. 1 (Brouwer et al., 1985), leaching was estimated for all parcels along or downstream of reaches in which the water quality model average TDS exceeded 500 ppm in more than one irrigation season. Considering all crop types served along each lateral, weighted by the volume of water delivered to each crop type, an average required leaching fraction of 5% was calculated for these parcels.\textsuperscript{25}

Agronomic water use for frost protection was estimated assuming a typical, average required frost protection application rate of 0.15 inches per hour for cold-sensitive crops on days when the minimum, average, or maximum temperature was below 32°F (assuming 12, 18, or 24 hours of potential frost protection is needed, based on which temperature, respectively, was below 32°F). Crops requiring potential frost protection were assumed to vary by month, with citrus and vineyard requiring frost protection in November through January, and with citrus, vineyards, and early blooming orchards (apricots, cherries, peaches, pears, plums) requiring frost protection in February through March. The total volume of potential frost protection was then adjusted so as not to exceed the monthly applied water used by irrigators from private pumping.

Table 5.6 summarizes these total combined agronomic water uses in TID.

### 5.8.1.3 Environmental Water Use

As described in Section 3.2, there are no natural environmental resource delineations within the irrigation service area that are supported by TID diversions.

While the Federal Energy Regulatory Commission (FERC) license requirements for Don Pedro Reservoir include an extensive set of minimum instream flow release requirements, these instream requirements are met before irrigation diversions are made. Releases to the Tuolumne River for environmental purposes therefore reduce the remaining supplies available for irrigation, and are not met from TID’s irrigation water supplies.

During the non-irrigation season of certain wetter years, TID has released water from Don Pedro Reservoir through the TID distribution system to stay within the capacity of the Tuolumne River downstream of Don Pedro Reservoir and to maintain sufficient storage capacity in the reservoir for flood flows. TID allows irrigators to utilize this water and apply it to fields for recharge, while also providing some spillage to the Tuolumne, Merced, and San Joaquin rivers. While these uses provide potential environmental benefits to the Turlock Subbasin and the Tuolumne, Merced, and San Joaquin rivers, they are accounted as recoverable flows for the purposes of this AWMP.

### 5.8.1.4 Recoverable Flows

Recoverable flows in TID encompass the portion of total applied water, or total water supply, that are neither consumed by crops nor evaporated from the distribution system, but that are recoverable for other beneficial uses within TID, downstream of TID, or in other areas overlying the Turlock Subbasin. Recoverable flows of applied water are represented in this water budget

\textsuperscript{25} Average crop-specific leaching requirements are estimated to be approximately equal to the requirements given in CIMIS Drought Tips Report #92-16 for EC\textsubscript{i} = 0.5 dS/m, recognizing that the salinity of irrigation water is not always in excess of 500 ppm TDS.
by deep percolation of applied water (DP$_{aw}$), as well as tailwater and tilewater drainage to rivers outside the TID service area. As described in Section 5.3.3, DP$_{aw}$ is quantified as the closure term of the irrigated lands accounting center in TID’s water budget.

Of the total water supplies available to TID, recoverable surface flows include spillage from the TID distribution system, which is measured by TID’s network of SCADA sites. Recoverable flows to groundwater include seepage (Section 5.3.1.5).

Table 5.6 summarizes the combined recoverable flows from TID in 2015 through 2019.

### 5.8.2 Water Use Efficiency Fraction

The water use efficiency fraction most applicable to TID is the water management fraction (WMF). As depicted in Figure 5.1, there is extensive interconnection between the two accounting centers due, in part, to recapture and reuse of water by TID. Conjunctive management efforts by TID also promote the sustainable recharge of groundwater in wetter years and recovery in drier years. Some reuse also occurs directly by water users at the farm level, while other users outside of TID are also able to recover surface water and groundwater made available from spillage and seepage of TID water supplies. These methods of water recovery, recharge, and reuse result in higher levels of system performance and water use efficiency than would otherwise occur.

The water management fraction (WMF) can be calculated in two ways: (1) by comparing consumptive use of applied water (ET$_{aw}$) and the recoverable flows of applied water to the total applied water in TID, and (2) by comparing consumptive use of applied water and all recoverable flows in the TID distribution system and irrigated lands to the total water supplies available within TID. The WMF is calculated on an irrigation season basis at the water supplier scale according to Equation 5-5:

**Total Water Supply Basis:**

\[
WMF = \frac{ET_{aw} + DP_{aw} + Tailwater to Rivers + Tilewater to Rivers + Canal Spillage + Seepage}{Total Water Supply^{26}} \quad [5-5]
\]

Over the 2015 to 2019 irrigation seasons, the WMF varied from 98 to 99 percent (Table 5.7). This high WMF indicates that essentially all of TID’s water supply is used to meet irrigation demands or is recoverable for beneficial use by down gradient surface water and groundwater users. The only water budget flow path that is not recoverable or consumed by crops in TID is evaporation from the TID distribution system.

---

26 Total water supply is equal to the sum of Irrigation Releases from Turlock Lake, Drainage Pumping, Rented Pumping, Tilewater (to Canals), Tailwater (to Canals), Spill Recovery, Treated Wastewater, and Private Pumping.
### Table 5.7. Water Use Efficiency Fraction (Total Water Supply Basis).

<table>
<thead>
<tr>
<th>Year</th>
<th>Evapotranspiration of Applied Water (AF/year)</th>
<th>Recoverable Flows of Total Water Supply(^2) (AF/year)</th>
<th>Total Water Supply(^3) (AF/year)</th>
<th>Water Management Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>346,701</td>
<td>121,037</td>
<td>474,254</td>
<td>99%</td>
</tr>
<tr>
<td>2016</td>
<td>317,667</td>
<td>208,584</td>
<td>534,824</td>
<td>98%</td>
</tr>
<tr>
<td>2017</td>
<td>306,485</td>
<td>234,043</td>
<td>552,260</td>
<td>98%</td>
</tr>
<tr>
<td>2018</td>
<td>331,791</td>
<td>281,573</td>
<td>623,407</td>
<td>98%</td>
</tr>
<tr>
<td>2019</td>
<td>305,309</td>
<td>231,942</td>
<td>546,983</td>
<td>98%</td>
</tr>
</tbody>
</table>

1. Reported for irrigation season, as TID generally only operates the distribution system to supply irrigation deliveries during the irrigation season.
2. Recoverable flows of total water supply include DP\(_{aw}\), Seepage, Canal Spillage, Tailwater (to Rivers) and Tilewater (to Rivers).
3. Total water supply includes Irrigation Releases from Turlock Lake, Drainage Pumping, Rented Pumping, Tilewater (to Canals), Tailwater (to Canals), Spill Recovery, Private Pumping, and Treated Wastewater.
6. Climate Change

6.1 INTRODUCTION

In the last 25 years, the District has experienced record breaking droughts, floods, and temperature periods compared with the last 100-year record. The District has taken these experiences and developed an evolving suite of tools and adaptation techniques to manage its water resources. The District is committed to adapting to climate change in a manner that continues to maximize water supply reliability for TID customers through conjunctive management, while satisfying Tuolumne River instream flow obligations. These tools and techniques developed to address past changes will be invaluable as we study and experience addition changes in climate and impacts to water resources in the future. Some of these tools include:

- Airborne Remote Sensing for Snowpack Program
- Forecast-Informed Reservoir Operations (FIRO) Program, with support from the Forecast-Coordinated Operations (F-CO) for the San Joaquin River watershed
- Real-Time Hydrologic Modeling of the Tuolumne River Watershed, in partnership with Hydrocomp
- Weather Resources Management Program
- Weather Generator Model
- Sustainable Groundwater Management Planning

These programs and planning efforts are described in further detail in Section 6.5, “Strategies to Mitigate Climate Change Impacts.” The near-term benefits of these programs dovetail with TID’s evolving need to prepare for and respond to the effects of climate change on water supply and demand. In the face of future climate uncertainty, TID’s leadership in these efforts is now more important than ever.

Over its history, TID has also completed numerous other programs and projects, and enacted policies to enhance the reliability and efficient management of its water resources. Section 7 of this AWMP describes TID’s efficient water management practices and related efforts in recent years.

Section 6 discusses the potential effects of climate change on the District and its water supply, water quality, and water demand. Finally, this section identifies actions currently underway that support climate change preparedness, and actions that could be implemented to help mitigate future impacts of climate change.

6.2 POTENTIAL CLIMATE CHANGE EFFECTS

TID has long recognized the effects of climate change on water supply and demand, including reduced winter snowpack, more variable and extreme weather conditions, shorter winters, and increased evaporative demand. Additionally, climate change could affect water quality through increased flooding and erosion; greater concentration of contaminants, if any, in the water supply; and warmer water, which could lead to increased growth of algae and other aquatic plants. Rising sea level and increased risks of flooding are also potential effects of climate change.
The discussion of potential climate change effects in this AWMP focuses on the potential effects related to TID’s water supply and demand, and does not discuss potential effects of rising sea level or increased flooding risks except in the context of reduced firm yield. TID is not located within or adjacent to the Sacramento-San Joaquin River Delta, and is not expected to be directly impacted by rising sea level. TID is also required to follow the flood management criteria established by the Army Corps of Engineers at Don Pedro Reservoir. While the District conveys some stormwater for communities in adjacent urban areas, TID’s distribution system and facilities merely provide conveyance to the river system. Stormwater management is the responsibility of the communities.

6.2.1 Sources of Information Describing Potential Climate Change Effects

Potential climate change effects are evaluated based on existing historical data and projections of future hydrology and climate parameters, such as temperature and precipitation. The information sources used to quantify these historical values and projected effects are described below.

6.2.1.1 Hydrology

In this AWMP, the potential impacts of climate change on TID water supplies are evaluated using historical data for full natural flow (unimpaired runoff) in the Tuolumne River below La Grange, along with projected changes to Tuolumne River hydrology over the next 100 years.

Historical full natural flows along the Tuolumne River are reported by DWR’s California Cooperative Snow Surveys, available through the California Data Exchange Center.

Projected changes to Tuolumne River flows are derived from a number of studies prepared by the United States Bureau of Reclamation (USBR), DWR, and TID.

TID, in cooperation with the San Francisco Public Utilities Commission, conducted a study completed in 2012 that estimated the sensitivity of upper Tuolumne River flows to various climate change scenarios, with the goal of better understanding potential climate change effects on the District’s surface water supply (Hydrocomp et al. 2012). The study evaluated changes in streamflow and watershed hydrologic response to potential temperature and precipitation changes for the years 2040, 2070, and 2100, as compared to the base year of 2010. Hydrologic processes were simulated using a physically-based conceptual model. The results of this study have been summarized as part of this section, with additional details in Section 6.2.2.

More recent projections of future streamflow along the Tuolumne River at Don Pedro Reservoir were also extracted from climate change models described by Pierce et al. (2018) in contribution to California’s Fourth Climate Change Assessment. Projected future monthly and annual flows were quantified from 32 coarse-resolution (~100 km) global climate models (GCMs). Results of the GCMs were bias corrected, downscaled, and then applied to a land surface model to estimate soil moisture, runoff, surface energy fluxes, and other parameters. Results were reported for a number of models across two key climate change scenarios: scenario RCP 4.5, in which greenhouse gas emissions peak around 2040 and then decline thereafter, with projected statewide warming of 2-4°C; and scenario RCP 8.5, in which greenhouse gas emissions continue to rise through 2050 and plateau around 2100, with projected statewide warming of 4-7°C. Key results of this study have also been summarized as part of this section, with additional details in Section 6.2.2.
Earlier projections of future flows in the Stanislaus River at New Melones Dam (north of the Tuolumne) and in the Merced River at Pohono Bridge near Yosemite National Park (south of the Tuolumne) are also presented to provide further comparisons of future changes in the hydrology of the Tuolumne River watershed. Like the report by Pierce et al. (2018), projected future flows were obtained from projections developed using GCMs reported by USBR (Gangopadhyay and Pruitt, 2011). Projected hydrologic trends in the Stanislaus River to the north and the Merced River to the south are likely similar to those that will occur in the Tuolumne River watershed and can be compared to the results of the Hydrocomp et al. (2012) and Pierce et al. (2018) studies to further evaluate potential future climate change trends affecting surface water supply.

6.2.1.2 Climate Parameters

The potential impacts of climate change on crop water demand in TID are evaluated using historical data for precipitation, temperature, and ET₀ in and around TID.

Historical precipitation data are reported by the National Oceanic and Atmospheric Administration (NOAA) weather station #49073 “Turlock Number 2” for the period 1927-2019. Historical temperature and ET₀ data in an agricultural setting are reported by the Modesto CIMIS station (#71; 1987-2020), located in the vicinity of TID. The Denair CIMIS station (#168; 2003 - April 2009), and the Denair II CIMIS station (#206; April 2009 - 2019) also report historical temperature and ET₀ data in an agricultural setting within the TID service area, but with shorter periods of record. To prevent differences in station locations from obscuring changes in temperature and ET₀ over time, only the Modesto CIMIS station is evaluated in this section.

Potential effects of climate change on crop evapotranspiration (ET) are evaluated based on results from the study developed by USBR titled: “West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections” (USBR, 2015).

6.2.2 Summary of Potential Climate Change Effects

6.2.2.1 Changes in Timing of Runoff

6.2.2.1.1 Historical Runoff

Based on available historical data and projected future streamflow, the amount of annual runoff occurring during the spring-summer period from April through July has decreased over the past century and will likely continue to decrease in the next century.

From 1901 to 2019, unimpaired flow (i.e., full natural flow) along the Tuolumne River below La Grange shows a decreasing trend in April to July runoff as a percentage of total water year runoff (Figure 6.1). Conversely, increasingly more runoff has occurred during the fall-winter period, outside of the irrigation season.

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27 Incomplete precipitation data from NOAA weather station #49073 are available at beginning in 1893, though the generally complete data record begins in 1927.
Figure 6.1. Unimpaired Runoff for Tuolumne River below La Grange, April-July Runoff as a Percent of Total Water Year Runoff.

6.2.2.1.2 Projected Runoff

The percentage of total runoff occurring during the April-July period is also expected to continue to decline over the next century, as demonstrated by the results of the study conducted by Hydrocomp (2012). This study projected monthly unimpaired runoff volumes in 2040, 2070, and 2100 for two alternative climate scenarios representing moderate temperature increase with no precipitation change (scenario 2A) and moderate temperature increase with a decrease in precipitation (scenario 2B). The projections suggest that Tuolumne River runoff at Don Pedro Reservoir occurring during the April to July period could decrease from around 60 percent of total runoff in 2010 to only 30 to 40 percent of total runoff in 2100 (Figure 6.2).

Other streamflow projections reported by Pierce et al. (2018) for California’s Fourth Climate Change Assessment suggest similar future trends in Tuolumne River flows under average climate change conditions (simulation CanESM2). If greenhouse gas emissions continue to rise through 2050 and plateau around 2100 (scenario RCP 8.5, with projected statewide warming of 4-7°C), flows in April to July are expected to decrease from approximately 60 percent of total runoff in 2010 to just over 40 percent, on average, by 2099. However, if greenhouse gas

28 Scenario 2A corresponds to a 6.1°F increase in mean annual temperature by 2100 as compared to 2010 with no change in mean annual precipitation. Scenario 2B corresponds to a 6.1°F increase in mean annual temperature by 2100 as compared to 2010 with a 15 percent decrease in mean annual precipitation in the watershed.
emissions peak around 2040 and then decline thereafter (scenario RCP 4.5, with projected statewide warming of 2-4°C), flows in April to July are expected to decrease to just over 50 percent, on average, by 2099.

**Figure 6.2** also shows the projected changes in April to July runoff for the Stanislaus River at New Melones Reservoir and the Merced River at Pohono Bridge (Gangopadhyay and Pruitt, 2011) for comparison. Projected trends are similar for each of the three rivers.

![Projected Unimpaired Runoff, April-July Runoff as a Percent of Total Water Year Runoff for Tuolumne River (Hydrocomp et al., 2012, and Pierce et al, 2018) and Stanislaus and Merced Rivers (Gangopadhyay and Pruitt, 2011).](image)

### 6.2.2.2 Changes in Total Runoff

Projections reported by Hydrocomp et al. (2012), Pierce et al. (2018), and Gangopadhyay and Pruitt (2011) suggest that total runoff could decrease over the next 100 years.

The Hydrocomp et al. study provides estimates of Tuolumne River total annual runoff as a percentage of 2010 total runoff for 2040, 2070, and 2100 for the following six alternative climate change scenarios and corresponding changes in mean annual temperature and precipitation in the Tuolumne River watershed by 2100:

- **1A** – low temperature increase (+3.6°F by 2100); no precipitation change
- **2A** – moderate temperature increase (+6.1°F by 2100); no precipitation change
• 2B – moderate temperature increase (+6.1°F by 2100); precipitation decrease (-15% from base in by 2100)
• 2C – moderate temperature increase (+6.1°F by 2100); precipitation increase (+6% from base in by 2100)
• 3A – high temperature increase (+9.7°F by 2100); no precipitation change
• 3B – high temperature increase (+9.7°F by 2100); precipitation decrease (-15% from base in by 2100)

As shown in Figure 6.3, total runoff in the Tuolumne River at Don Pedro Reservoir could decrease to as little as 70 percent of the 2010 total by 2100, with an average projection that total runoff in 2100 will be approximately 87 percent of the 2010 total.

![Figure 6.3. Total Annual Projected Tuolumne River Runoff as a Percent of 2010 Runoff, by Climate Change Scenario (Source: Hydrocomp et al., 2012).](image)

The Pierce et al. study similarly provides estimates of Tuolumne River runoff at Don Pedro Reservoir in each water year through 2099 using a number of alternative climate change simulations. Of these simulations, four were selected by California’s Climate Action Team as priority models for research contributing to California’s Fourth Climate Change Assessment:

• HadGEM2-ES – A “warmer/drier” simulation
• CNRM-CM5 – A “cooler/wetter” simulation
• CanESM2 – An “average” simulation
• MIROC5 – A “complement” simulation that is most unlike the first three, providing the best coverage of all possibilities
The total water year runoff from these simulations was averaged and summarized across each decade between the 2010s (2010-2019) and the 2090s (2090-2099). As shown in Figure 6.4, the total water year runoff in the Tuolumne River varies greatly between periods and among simulations, with the highest expected runoff in the “cooler/wetter” (CNRM-CM5) simulation and the lowest expected runoff in the “warmer/drier” (HadGEM2-ES) and “complement” (MIROC5) simulations. Across all periods and simulations, the mean water year runoff is expected to vary between approximately 80% and 110% of the runoff in the 2010s.

![Figure 6.4. Average Total Water Year Projected Tuolumne River Runoff, by Decade and by Climate Change Simulation (Source: Pierce et al., 2018).](image)

Projections of total runoff over the next century reported by USBR (2011) for the Stanislaus River to the north and in the Merced River to the south also suggest a slight decrease in total runoff (Figures 6.5 and 6.6). The figures show the 5th percentile, median, and 95th percentile annual runoff for 2010 to 2100 based on 112 separate hydrologic projections. The percent of total water year runoff decrease in 2100 for the Stanislaus River and Merced River is similar to the projected decrease for the Tuolumne River.
Figure 6.5. Annual Stanislaus River Runoff at New Melones Reservoir Based on 112 Hydrologic Projections (Gangopadhyay and Pruitt, 2011).

Figure 6.6. Annual Merced River Runoff at Yosemite Based on 112 Hydrologic Projections (Gangopadhyay and Pruitt, 2011).
6.2.2.3 Changes in Climate Parameters and Crop Evapotranspiration

Climate change has the potential to affect crop evapotranspiration and resulting irrigation water demands within TID. Changes in precipitation, temperature, and atmospheric CO₂ each affect crop evapotranspiration (ET) and net irrigation water requirements (NIWR).

Historical precipitation, air temperature, and reference ET (ET₀) are first summarized to provide context for the projected changes in climate parameters due to climate change. Precipitation records in TID, including annual precipitation, mean annual precipitation, and cumulative departure²⁹ from the mean annual precipitation, are shown in Figure 6.7. Between water years 1927 and 2019, the mean annual precipitation was approximately 12 inches per year in TID. As shown, wet periods (indicated by a positive slope in the cumulative departure from mean curve) have historically occurred over a shorter duration within TID than drier periods (indicated by a negative slope in the cumulative departure from mean curve), even since the 1930s and 1940s. Notable drought periods, including 1976-1977, 1987-1992, and 2012-2016, are seen as generally falling at the end of extended drier periods, ending with the beginning of a significantly wetter period.

Figure 6.8 shows the mean daily temperatures at the Modesto CIMIS station near TID. CIMIS stations are specially sited within agricultural areas to provide climate parameters that are most representative of the conditions experienced by irrigated agriculture. Between water years 1988 and 2019, the average daily air temperatures in TID have averaged approximately 59°F, while the maximum and minimum daily temperatures have averaged 73°F and 45°F, respectively. Although temperatures vary from year to year at the Modesto CIMIS station, average air temperatures have slightly increased in the last 10 years compared to earlier averages. Between water years 1988 and 1997 – the first 10 complete years of available data at the Modesto CIMIS station – average air temperatures were similar to the 1988-2019 averages. Between water years 2010 and 2019 – the most recent 10 years of available data – average temperatures increased by about one degree, with an average daily air temperature of approximately 60°F, and with maximum and minimum daily temperatures averaging 74°F and 46°F, respectively.

Figure 6.9 shows the annual reference evapotranspiration (ET₀) rate reported at the Modesto CIMIS station near TID. Between water years 1988 and 2019, the average annual ET₀ was approximately 53 inches per year, ranging from a high of nearly 58 inches in 2014 to a low of 46 inches in 2005. The total ET₀ in every water year since 2012 has been at or above the average ET₀ between 1988 to 2019.

²⁹ Cumulative departure curves are useful to illustrate long-term hydrologic characteristics and trends during drier or wetter periods relative to the mean annual precipitation or streamflow. Downward slopes of the cumulative departure curve represent drier periods relative to the mean, while upward slopes represent wetter periods relative to the mean. A steep slope indicates a drastic change in dryness or wetness during that period, whereas a flat slope indicates average conditions during that period, regardless of whether the total cumulative departure falls above or below zero.
Figure 6.7. Historical Annual Precipitation and Cumulative Departure from the Mean Annual Precipitation.

Figure 6.8. Historical Mean Daily Temperatures at the Modesto CIMIS Station.
Figure 6.9. Historical Annual Reference ET at the Modesto CIMIS Station.

While a number of methods have been used to project future climate change and related impacts on crop water demands, Global Climate Models (GCMs) are considered a standard for climate change analyses. In particular, the USBR released a report entitled “West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections” (WWCRA) in February 2015, with the goal of providing a consistent, baseline assessment of climate change impacts to water supply and demand across the West (USBR, 2015). The study uses climate change projections to calculate future ET and NIWR throughout the Western U.S., including California’s Central Valley. Projections for the Central Valley were developed for DWR planning units, which are typically used to evaluate statewide water supplies and demands as part of the California Water Plan. As shown in Figure 6.10, TID’s service area falls within Planning Unit 608 (PU608).

This section describes potential changes in crop ET, a climate change effect, while impacts on NIWR are described in Section 6.4, below.

The Bureau of Reclamation’s study utilizes future climate projections from GCMs to simulate crop ET under various climate change scenarios, and to estimate resulting changes in NIWR. The specific dataset selected for predicting future irrigation demands was the World Climate Research Program (WCRP) Coupled Model Intercomparison Project Phase 3 (CMIP3). Original GCM projections are developed at a spatial resolution of 100 to 250 km. In order to develop data on a usable scale to support local and regional planning, CMIP3 projections were downscaled to 12 km square sections using the statistical algorithm known as bias comparison
and spatial disaggregation (BCSD). One hundred and twelve BCSD-CMIP3 projections were created based on combinations of GCM and potential future greenhouse gas emission scenarios.

Crop ET and NIWR were estimated using a model simulating crop growth and irrigation demands over time under baseline and modified climate scenarios. Specifically, the ET Demands model was used to estimate crop ET and NIWR. The ET Demands model is a daily root zone water balance simulation that applies a dual crop coefficient approach to quantify crop ET and other flows into and out of the root zone. Reference ET was calculated based on climate projections for each of the five modeled climate scenarios using the Food and Agricultural Organization (FAO) Report 56 (FAO 56) reference ET approach. The GCMs climatic conditions were limited to only daily maximum and minimum temperature and daily precipitation. Therefore, other climate parameters needed to estimate reference ET, such as solar radiation, humidity, and wind speed, were approximated for baseline and future time periods using empirical equations (USBR, 2015). In order to evaluate potential impacts of changes in temperature on the timing of crop growth and overall season length, simulations were conducted assuming both static and dynamic crop phenology. To simulate dynamic phenology, crop coefficient curves based on growing degree days (GDD) were used. By incorporating GDD into the analysis, projected changes in temperature influence the timing and speed of crop growth. Increased temperatures result in earlier, shorter growing seasons for annual crops. Crop evapotranspiration is projected to increase in areas where perennial crops are grown and smaller increases are projected for areas where annual crops are grown.
Potentially, each of the 112 climate projections could be simulated in the ET Demands model to develop projections of future ET and NIWR; however, due to the wide variety of crop types and agricultural practices in the West this would create enormous computation and data handling requirements. Instead, five different climate change scenarios were created using the ensemble hybrid formed delta method. The future conditions of warm-dry, warm-wet, hot-dry, hot-wet and central tendency were used. Three future periods were selected to project climate change according to these five climate change scenarios, including the 2020s (2010-2039), 2050s (2040-2069) and 2080s (2070-2099).

Average air temperature in PU608 is projected to increase for each of the five scenarios in all future periods, as shown in Figure 6.11. Projected temperature increases range from 1.3 to 2.6°F during the 2020s period, 2.7 to 4.5°F during the 2050s period, and 3.9 to 6.9°F during the 2080s period.

Potential changes in precipitation resulting from climate change are relatively uncertain for California’s Central Valley due to uncertainty in the future position of the jet stream. As a result, some GCMs and greenhouse gas emission scenario combinations predict increased precipitation under climate change, while other combinations predict decreased precipitation. Percent changes in projected average annual precipitation for PU608 are shown in Figure 6.12. Under wetter conditions increases in precipitation of 3.8 to 10.0 percent are predicted in the various future periods, while under drier conditions, decreases in precipitation of up to 16.2 percent are predicted. The central tendency results in a slight decrease in the predicted precipitation from 2.1 percent during the 2020s period to 3.9 percent during the 2080s period.
From the projected temperature and precipitation results, WWCRA used the FAO 56 approach and the ET Demands model to develop projected reference ET and actual ET estimates for each of the modeled climate scenarios. The results are shown below in Figures 6.13 and 6.14, respectively. Increases in both reference ET and actual ET are projected. Across all scenarios, projected reference ET increases range from 1.8 to 3.7 percent during the 2020s period, from 3.8 to 6.4 percent during the 2050s period, and from 5.3 to 9.5 percent during the 2080s period. Across all scenarios, projected actual ET increases range from 0.5 to nearly 1.2 percent during the 2020s period, from 0.9 to 1.3 percent during the 2050s period, and from nearly 0.9 to over 1.2 percent during the 2080s period. According to the WWCRA projections, reference ET is expected to increase more than actual ET due to changes in phenology of annual crops, discussed in the following paragraph.

Figure 6.12. WWCRA Projected Precipitation Change.
Projected actual ET estimates assume non-static phenology for annual crops rather than static phenology. Non-static phenology is believed to be more accurate as plant growth depends heavily on temperature. With expected increases in temperature across all scenarios, crop
growing seasons are expected to be shorter. This effect is accounted for in non-static phenology by using growing degree days (GDD) to advance the crop coefficient curves across the growing season according to daily temperatures. Consequently, there is less projected impact on actual ET with non-static phenology than when static phenology is assumed. If static crop phenology is assumed, percent changes in actual ET would be similar to the projected changes in reference ET. Reference ET is expected to increase significantly more due to the projected temperature increases.

6.3 POTENTIAL IMPACTS ON WATER SUPPLY AND QUALITY

The shift in runoff to the winter period and projected reduction in total runoff have the potential to impact surface water supply in the future if sufficient storage is not available to retain winter runoff until it is needed to meet irrigation demands and to provide additional carryover storage from wet years to dry years.

Increased erosion and turbidity under climate change, if it occurs, would likely not significantly affect the water quality of the Tuolumne River in a capacity that affects agricultural irrigation. Additionally, there are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff were to decrease, particularly due to the dilution of such contaminants in reservoirs upstream of the District. Increased water temperature could exacerbate the challenges of controlling aquatic plants in TID’s distribution system to maintain capacity, provided that the temperature increase is great enough to escalate plant growth. Increased turbidity and algae growth in the canals, if substantial, could pose challenges to irrigators that must filter canal water for their micro irrigation systems.

According to the East Stanislaus Region Integrated Regional Water Management Plan (ESRIRWMP, 2013) and other sources, climate change is expected to bring more frequent and more severe droughts in the future. Changing rainfall patterns could affect the volumes and patterns of groundwater recharge provided from infiltration of precipitation and runoff. Groundwater pumping volumes have historically been at their greatest during droughts because there is less surface water to meet water demands.

TID’s conjunctive management strategy is important to maintaining water supply reliability in an uncertain future. TID’s stable surface water supply and tiered water pricing strategy encourage irrigators to use surface water in wetter years, resulting in significant in-lieu recharge through reduced pumping and direct recharge through infiltration. TID also utilizes shallow groundwater wells and rented deep wells to supplement surface water supply in drier years. Additionally, individual growers may also supplement surface water supply with groundwater produced by private wells in dry years. TID has developed and implemented methods to monitor and model groundwater extractions and recharge in the District’s service area. TID has been actively involved in groundwater management planning in the region for years, and is currently involved in the development a Groundwater Sustainability Plan (GSP) for the Turlock Subbasin as a member of the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA), one of the two GSAs within the Subbasin.
6.4 POTENTIAL IMPACTS ON WATER DEMAND

As discussed in Section 6.2.2.3, crop ET is expected to increase in the future due to the effects of climate change, including projected temperature increases and changes in other climate factors modeled based on the WWCRA (USBR, 2015). The net irrigation water requirements (NIWR) of crops – the fraction of crop ET that must be met through irrigation – are also expected to increase for all climate scenarios presented in the WWCRA, as shown in Figure 6.15. Additionally, future changes in precipitation timing and quantities could also result in greater irrigation requirements to meet ET demands. Changes in the timing of crop planting, development, and harvest could also result in changes to the timing of irrigation demands during the year. All of these factors have the potential to impact the NIWR. Across all climate change scenarios evaluated, the projected increased in NIWR range from 0.7 to 2.4 percent during the 2020s period, from 0.9 to 2.9 percent during the 2050s period, and from 0.15 to 3.2 percent during the 2080s period. Projected NIWR values are based on non-static crop phenology for annual crops (described in Section 6.2.2.3).

![Figure 6.15. WWCRA Projected Net Irrigation Water Requirement Change Assuming Non-Static Phenology.](image)

When interpreting results, several uncertainties must be accounted for. For instance, the effects of carbon dioxide (CO₂) on irrigation demand are estimated using physiological crop growth models, and were not included in the WWCRA. In general, increased atmospheric CO₂ is expected to reduce stomatal conductance and transpiration, which would lead to reduced ET, all else equal. Changes in the types of crops grown, irrigated area, and irrigation efficiencies also affect the amount of irrigation water requirements. For further information, please refer to the “West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections” (USBR, 2015).
6.5 STRATEGIES TO MITIGATE CLIMATE CHANGE IMPACTS

Although TID recognizes that climate change is occurring, and many scientists concur that the effects of climate change are already being observed, the timing and magnitude of future climate change impacts remain uncertain. The District will mitigate climate change impacts with this uncertainty in mind through an adaptive management approach in cooperation with other regional stakeholders, including municipalities within the District, neighboring irrigation districts, and other interested parties. Under adaptive management, key metrics and uncertainties will be identified and monitored (e.g., April – July runoff as a percentage of annual runoff, total runoff, average temperature, and reference evapotranspiration), and strategies will be developed to address the related climate change impacts. As the impacts are observed to occur, the strategies will be prioritized, modified as needed, and implemented.

6.5.1 Ongoing Climate Change Preparedness

Several of the ongoing programs and planning efforts that TID is implementing to mitigate climate change impacts are described below. These programs highlight TID’s leadership in adapting and responding to climate change.

6.5.1.1 Airborne Remote Sensing for Snowpack Program

Emerging technologies have made it possible to use aerial remote sensing to collect snow data across various parameters and to use those data to calculate snow water content across a large, dynamic area.

In the Airborne Remote Sensing for Snowpack Program (ARSS), TID uses aerial snow monitoring tools and data to precisely map and quantify the water content of snow in the Upper Tuolumne River Watershed. This information, also supplemented with conventional snow surveys, allows TID to more accurately forecast runoff and to more efficiently manage water for particular purposes, such as flood control, dam safety, water supply, groundwater recharge, and other environmental objectives.

In all years, ARSS supports TID in making more informed water management decisions in response to actual, on-the-ground conditions. In dry years and drought periods, ARSS benefits the District’s ability to conserve water supply storage by helping TID staff to determine when and how much flood space will be needed in reservoirs to ensure public safety.

TID has been using this technology since 2013, when the National Aeronautics and Space Administration Jet Propulsion Laboratory (NASA-JPL) began research and development with this technology in the Tuolumne River watershed. Since 2018, when NASA-JPL research concluded, TID has been a leader in developing a cooperative, operational program under DWR for use in several basins throughout the Central and Southern Sierra Nevada. More information is available on TID’s website: https://www.tid.org/about-tid/current-projects/airborne-snow-observatory/.
6.5.1.2 Forecast-Coordinated Operations (F-CO) for the San Joaquin River watershed, and the TID Forecast-Informed Reservoir Operations (FIRO) Program

In 2009, DWR, the National Weather Service California-Nevada River Forecast Center, and the U.S. Army Corps of Engineers initiated the Forecast-Coordinated Operations (F-CO) Program for the San Joaquin River watershed. The F-CO Program allows DWR and other agencies to improve management of flood control pools to reduce peak flood flows downstream through the use of improved watershed and river forecasting and the coordination of releases during flood control operations.

TID’s Forecast-Informed Reservoir Operations (FIRO) program is a reservoir-operations forecasting strategy that TID developed over the decades to strategically manage the District’s surface water supplies and storage capacity at Don Pedro Reservoir. Through FIRO, TID brings together improved hydrologic monitoring, weather forecasting, and water supply forecasting to optimize the balance of flood protection and water supply storage for TID and its customers.

TID has been using this technology in conjunction with ARSS since 2017, providing staff the information needed to optimize reservoir storage in wet and dry years. In wet years, information assembled through FIRO and ARSS allow TID to create space in the reservoir through pre-flood releases to minimize the effects of storms forecasted to hit the area. In dry years, accurate forecasts of weather events and runoff can give TID the confidence to retain water supply storage that may otherwise be released.

Since 2016, TID has utilized grant monies under the F-CO Program to:

- add additional weather stations and improve the technology of existing weather stations throughout the watershed,
- add additional streamflow and reservoir gages and improve the technology of existing gages throughout the watershed,
- improve the technology and efficiency of data sharing among agencies and the public,
- improve runoff forecasting technology, and
- gather refined snowpack data collection through the use of airborne remote sensing for snowpack.

Information gathered through watershed monitoring directly benefits TID’s understanding of watershed runoff and flood characteristics, and of how to conserve this water.

6.5.1.3 Hydrocomp and Hydrologic Modeling of the Tuolumne River Watershed

In 1997, TID implemented a calibrated internal hydrologic model for the Tuolumne River watershed. This model, the Hydrocomp Forecast and Analysis Model (HFAM), was developed by Hydrocomp and provides both deterministic and probabilistic forecast of watershed and reservoir conditions. In recent years, the HFAM model has been used again to study climate change impacts to the Tuolumne River Watershed. The results of this study, published in 2012, are provided earlier in this section. A reservoir operation tool is currently under development to
optimize system requirements based on both value and risk. This tool will further support TID’s preparedness and response to the effects of climate change in the future.

### 6.5.1.4 Weather Generator Model

The purpose of this work is to develop a model that can create ensembles of climate scenarios across the Tuolumne River Basin for evaluating the vulnerability of water systems and the robustness of adaptation strategies under climate change. The proposed work will provide decision makers at TID with a novel scenario generation framework and associated scenario ensemble that is consistent with and advances state-of-the-art climate scenario generation methods being used across California.

As part of this work, TID will experiment with how to incorporate characteristics of atmospheric rivers more directly into the parameterization of the weather generator model. TID will also develop a module that will allow the District to input its own time series of multi-site data for use in the generation of synthetic weather, rather than the baseline climate dataset currently used in the model. The goal of this effort will be to ensure that climate data currently being used by TID in other modeling applications can be generated directly by the weather generator.

### 6.5.1.5 Weather Resources Management Program

Since 1990, TID has had a weather resources management program (WRMP) for precipitation augmentation by use of aerial cloud seeding. This program takes advantage of the orographic glaciogenic precipitation process by introducing ice nuclei to storms with clouds containing super-cooled liquid water, which is water that is below freezing in temperature but remains liquid in form for want of nuclei upon which it can begin to crystalize and then precipitate. The WRMP allows TID to draw more precipitation from storms that otherwise would be less efficient, which helps TID to offset the broadening range of annual meteorological and hydrological conditions.

### 6.5.1.6 Sustainable Groundwater Management Efforts

TID is actively participating in local groundwater initiatives and efforts for compliance with the Sustainable Groundwater Management Act of 2014 (SGMA), including membership in the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA) and development of the Turlock Subbasin Groundwater Sustainability Plan (GSP). Intentional, sustainable groundwater management in the Turlock Subbasin will protect these groundwater resources for TID, its customers, and other beneficial users into the future.

### 6.5.1.7 Tuolumne River Management Plan

Together with the Modesto Irrigation District, TID has developed a comprehensive management plan for the Tuolumne River, covering proposed operations, improvements, and resource protection measures under a new Federal Energy Regulatory Commission (FERC) license for the Don Pedro Project. The goals of this plan balance the needs of the many and varied uses of Tuolumne River water, including agricultural, municipal, recreational, riparian, and environmental users. This plan supports adaptation to climate changes, providing a clear and balanced plan for the sustainable use of available runoff into the future. Additional information is
provided on the Tuolumne River Management Plan Website: http://www.tuolumnerivermanagementplan.com/#environmental-flows.

6.5.2 Summary of Climate Change Mitigation Strategies

Several strategies for mitigating the climate change impacts to agricultural water providers and other water resources entities have been identified. These strategies include those identified as part of the California Water Plan published in 2009 and updated in 2013 and 2018 (DWR, 2010a, 2013, and 2018a), as well as strategies identified as part of the California Climate Adaptation Strategy (CNRA, 2009) and as part of the Sacramento and San Joaquin Basins Study (USBR, 2016b). The District is already implementing many of the strategies applicable to irrigation districts in an appropriate form and level to meet local water management objectives. These strategies will continue to serve the District well as climate change impacts occur.

Resource strategies that are being implemented or could be implemented by the District to adapt to climate change are summarized in Table 6.1.

6.6 ADDITIONAL RESOURCES FOR WATER RESOURCES PLANNING FOR CLIMATE CHANGE

In addition to the study completed by Hydrocomp et al. (2012) that evaluated the potential effects of climate change on the Tuolumne River watershed, much work has been done at the State and regional levels to evaluate the effects and impacts of climate change and to develop strategies to manage available water resources effectively under climate change. The following lists of resources provides additional information describing water resources planning for climate change:

6.6.1 Local and Regional Resources

- Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios. Hydrocomp, Inc.; San Francisco Public Utilities Commission; and Turlock Irrigation District. January 2012. (Hydrocomp et al., 2012)
- San Joaquin Valley Summary Report, Preview. California’s Fourth Climate Change Assessment. 2018. Available at: https://climateassessment.ca.gov/regions/.
### Table 6.1. District Strategies to Mitigate Climate Change Impacts.

<table>
<thead>
<tr>
<th>Source</th>
<th>Strategy</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>California Water Plan (DWR 2010a, 2013, and 2018a)</td>
<td><strong>Reduce water demand</strong></td>
<td>The District is implementing all technically feasible and locally cost-effective EWMPs identified by SBX7-7 to improve water use efficiency in District operations and to encourage on-farm improvements. Additional actions to reduce water demand are considered on an ongoing basis as part of TID’s water management activities.</td>
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<tr>
<td></td>
<td><strong>Improve operational efficiency and transfers</strong></td>
<td>As described above and elsewhere in this AWMP, the District has and continues to implement improvements to increase operational efficiency.</td>
</tr>
<tr>
<td></td>
<td><strong>Increase water supply, including through recharge and sustainable groundwater management</strong></td>
<td>The District has increased its available water supply through conjunctive management of available groundwater supplies, through reuse of drainage water, through improved forecasting of the runoff from the upper watershed, and through other innovative technologies. Irrigators within TID use recycled processing water from Hilmar Cheese and recapture drain water for irrigation. TID also actively forecasts runoff and manages its water supply through the ARSS, F-CO, FIRO, and watershed monitoring programs. Data and tools available through these programs allow TID to better track and understand the amount of water in the upper watershed, informing reservoir operations to optimize the balance of available flood storage and water supply storage. Additionally, TID, in conjunction with MID, has implemented a cloud seeding program to maximize surface water supplies available from Tuolumne River. In the future, the District will seek additional opportunities to increase available water supply, including increased conjunctive management through consideration of opportunities to increase groundwater recharge to increase available groundwater supply to compensate for reduced April through July runoff. As a member of the WTSGSA, TID is also actively engaged in SOMA efforts and is supporting the development of a GSP for the Turlock Subbasin that will be completed in January 2022. Among these efforts, TID staff is responsible for administering grants to support GSP development, development of a Groundwater Recharge Assessment Tool for the Subbasin, the installation of monitoring wells, and creation of a Draft Programmatic Environmental Impact Report for the GSP. Implementation of the GSP will guide sustainable groundwater management in the Turlock Subbasin.</td>
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<tr>
<td></td>
<td><strong>Improve water quality</strong></td>
<td>The District will continue to monitor surface water and groundwater quality as part of its active water quality monitoring program, and the coordination with monitoring programs conducted by others, including: regular ag suitability monitoring at Turlock Lake and spills, sampling and analysis of TID-owned and rented wells, ag suitability monitoring of subsurface drain discharges to the TID distribution system, real-time monitoring of canal and drain spill locations, and monitoring required for TID’s use of aquatic herbicides.</td>
</tr>
<tr>
<td></td>
<td><strong>Practice resource stewardship</strong></td>
<td>The District intrinsically supports the stewardship of agricultural lands within and surrounding its service area through its irrigation operations and resulting groundwater recharge. The District will participate in studies of aquatic life and habitat to better understand potential impacts of climate change. TID also supports stewardship of surface water and groundwater supplies, as evidenced through its comprehensive conjunctive management program, watershed monitoring programs, development of the Tuolumne River Management Plan, and active engagement in GSP development for the Turlock Subbasin, among other efforts.</td>
</tr>
<tr>
<td></td>
<td><strong>Improve flood management</strong></td>
<td>TID actively forecasts runoff and manages flood storage through the ARSS, F-CO, FIRO, and watershed monitoring programs. Data and tools available through these programs allow TID to better track and understand the amount of water in the upper watershed, informing reservoir operations to optimize the balance of available flood storage and water supply storage. The District is required to follow the flood management criteria established by the Army Corps of Engineers at Don Pedro Reservoir. In addition, its irrigation and drainage systems provide a passive system to collect and convey winter runoff. If runoff characteristics change substantially within the District in the future, modifications to the irrigation and/or drainage system to increase capacity or mitigate other impacts will be considered.</td>
</tr>
<tr>
<td></td>
<td><strong>Engage people in water management</strong></td>
<td>TID offers affordable surface water in all years, with a tiered pricing structure that incentivizes surface water use and groundwater recharge in normal years, and water conservation in dry years. As described in Section 7.4.12, TID also offers a variety...</td>
</tr>
</tbody>
</table>
### Source

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support Long-Term and Regional Water Management Planning</td>
<td>The District collects, manages, and reports a wide array of data related to the District’s operations and water management efforts. The District is also actively involved in regional water management planning and SGMA-related water management planning.</td>
</tr>
<tr>
<td>Other strategies</td>
<td>Other strategies include crop idling, irrigated land retirement, and rainfed agriculture. Under severely reduced water supplies, growers could consider these strategies; however, it is anticipated that climate change impacts will be mitigated through the other strategies described.</td>
</tr>
<tr>
<td>California Climate Adaptation Strategy (CNRA 2009)</td>
<td><strong>Aggressively increase water use efficiency</strong>&lt;br&gt;Described above under &quot;Reduced water demand&quot; and &quot;Improve operational efficiency and transfers.&quot;</td>
</tr>
<tr>
<td></td>
<td><strong>Practice and promote integrated flood management</strong>&lt;br&gt;Described above under &quot;Improve flood management.&quot;</td>
</tr>
<tr>
<td></td>
<td><strong>Enhance and sustain ecosystems</strong>&lt;br&gt;Described above under “Practice resource stewardship.”</td>
</tr>
<tr>
<td></td>
<td><strong>Expand water storage and conjunctive management</strong>&lt;br&gt;Described above under &quot;Increase water supply.&quot;</td>
</tr>
<tr>
<td>Fix Delta water supply</td>
<td>Not applicable to the District.</td>
</tr>
<tr>
<td>Preserve, upgrade, and increase monitoring, data analysis, and management</td>
<td>The amount of information and analysis available to support the District's water management is extensive and continues to increase substantially. For example, TID staff monitors the quantity and quality (EC and temperature) of water in the distribution system on a real-time basis to support operations and conjunctive management. TID has also expanded SCADA monitoring and automation of canal structures over time. TID’s water balance analysis is updated on an annual basis to inform near- and long-term water management decisions. TID also conducts extensive monitoring throughout the upper Tuolumne River watershed and implements several innovative programs to forecast runoff and manage reservoir operations, including ARSS, F-CO, FIRO, and HFAM.</td>
</tr>
<tr>
<td>Plan for and adapt to sea level rise</td>
<td>Projections indicate that sea levels could rise by 2 to 5 feet by 2100. Direct impacts on the District are not anticipated.</td>
</tr>
<tr>
<td>Reduce water demand</td>
<td>Described above under “Reduce water demand”.</td>
</tr>
<tr>
<td>Increase water supply</td>
<td>Described above under “Increase water supply, including through recharge and sustainable groundwater management”</td>
</tr>
<tr>
<td>Improve operational efficiency</td>
<td>Described above under “Improve operational efficiency and transfers.” The District has and continues to implement improvements to increase operational efficiency through SCADA monitoring and automation, canal lining and improvements, conjunctive use management, and the many other efforts described as EWMPs in Section 7.</td>
</tr>
<tr>
<td>Improve resource stewardship</td>
<td>Described above under “Practice resource stewardship.”</td>
</tr>
<tr>
<td>Improve institutional flexibility</td>
<td>TID cooperates with Modesto Irrigation District, which co-owns Don Pedro Reservoir with TID, and works with agencies that affect the flexibility with which TID can store and deliver water, including the Federal Energy Regulatory Commission (FERC) and the U.S. Army Corps of Engineers. TID also implements ARSS, FIRO, and watershed monitoring to better track and understand the amount of water in the upper watershed and optimize reservoir operations to balance flood storage and water supply storage.</td>
</tr>
<tr>
<td>Improve data and management</td>
<td>Described above under “Preserve, upgrade, and increase monitoring, data analysis, and management.”</td>
</tr>
</tbody>
</table>
6.6.2 State Resources

- Indicators of Climate Change in California. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. May 2018. (Cal EPA, 2018)
- Cal-Adapt website tools, data, and resources for exploring California’s climate change research and developing adaption plans. Available at https://cal-adapt.org/

6.6.3 Other Resources

• SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water 2016. March 2016. (USBR, 2016a).
• Sacramento and San Joaquin Rivers Basin Study. March 2016. (USBR, 2016b)
7. Efficient Water Management Practices

7.1 INTRODUCTION

This section describes the actions that TID has taken and is planning to take to accomplish improved and more efficient water management. These actions are organized with respect to the Efficient Water Management Practices (EWMPs) described in the California Water Code (CWC) §10608.48. The CWC lists two types of EWMPs: critical EWMPs that are mandatory for all agricultural water suppliers subject to the Code, and conditional EWMPs that are mandatory if found to be technically feasible and locally cost-effective.

The two mandatory, critical EWMPs are (1) measurement of the volume of water delivered to customers with sufficient accuracy for aggregate reporting, and (2) adoption of a pricing structure for water customers based at least in part on the quantity delivered.

TID has implemented the delivery measurement accuracy EWMP by implementing the corrective action plan included in the 2012 AWMP and updated in the 2015 AWMP, which defined corrective actions, a budget, and a schedule to comply with the agricultural water delivery measurement regulations required by California Code of Regulations (CCR) Title 23 §597. The implementation status of the plan is summarized below and described in detail in Appendix F of this 2020 AWMP.

TID has implemented the volumetric pricing EWMP since June 2012, when the TID Board of Directors adopted a volumetric pricing structure to be implemented beginning with the 2013 irrigation season. The volumetric rate structure is described in Section 2 of this AWMP.

TID has also implemented and plans to continue implementing all additional (i.e., conditional) EWMPs that are technically feasible and locally cost-effective. Table 7.1 describes each EWMP and summarizes TID’s implementation status.

7.2 DELIVERY MEASUREMENT ACCURACY (10608.48.B(1))

Status: Implementing

Sidegates are the delivery points through which water is delivered from TID canals and laterals to customers. TID customers are the individual landowners (or land tenants) to whom TID delivers water, served either directly from the TID distribution system or through facilities owned by groups of landowners organized under Improvement Districts (IDs). TID measures water deliveries at the sidegate, where responsibility for water control and management is passed from TID to its customers.

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30“Sidegate” is the term that is used in TID for the “delivery point” defined in 23 CCR§597 as “…the location at which the agricultural water supplier transfers control of delivered water to a customer or group of customers….” (23 CCR §597.2(a)(6))
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### Table 7.1. Summary of Critical and Conditional EWMPs (Water Code Sections 10608.48 b & c)

<table>
<thead>
<tr>
<th>Water Code Reference No.</th>
<th>EWMP Description</th>
<th>Implementation Status</th>
<th>AWMP Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical EWMPs – Mandatory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.b(1)</td>
<td>Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).</td>
<td>Implementing</td>
<td>7.2</td>
</tr>
<tr>
<td>10608.48.b(2)</td>
<td>Adopt a pricing structure for water customers based at least in part on quantity delivered.</td>
<td>Implementing</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>Additional (Conditional) EWMPs – To be Implemented if Locally Cost-Effective and Technically Feasible</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(1)</td>
<td>Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.</td>
<td>Not Technically Feasible</td>
<td>7.4.1</td>
</tr>
<tr>
<td>10608.48.c(2)</td>
<td>Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils</td>
<td>Implementing</td>
<td>7.4.2</td>
</tr>
<tr>
<td>10608.48.c(3)</td>
<td>Facilitate financing of capital improvements for on-farm irrigation systems</td>
<td>Implementing</td>
<td>7.4.3</td>
</tr>
<tr>
<td>10608.48.c(4)</td>
<td>Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.</td>
<td>Implementing</td>
<td>7.4.4</td>
</tr>
<tr>
<td>10608.48.c(5)</td>
<td>Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage</td>
<td>Implementing</td>
<td>7.4.5</td>
</tr>
<tr>
<td>10608.48.c(6)</td>
<td>Increase flexibility in water ordering by, and delivery to, water customers within operational limits</td>
<td>Implementing</td>
<td>7.4.6</td>
</tr>
<tr>
<td>10608.48.c(7)</td>
<td>Construct and operate supplier spill and tailwater recovery systems</td>
<td>Implementing</td>
<td>7.4.7</td>
</tr>
<tr>
<td>10608.48.c(8)</td>
<td>Increase planned conjunctive use of surface water and groundwater within the supplier service area</td>
<td>Implementing</td>
<td>7.4.8</td>
</tr>
<tr>
<td>10608.48.c(9)</td>
<td>Automate canal control structures</td>
<td>Implementing</td>
<td>7.4.9</td>
</tr>
<tr>
<td>Water Code Reference No.</td>
<td>EWMP Description</td>
<td>Implementation Status</td>
<td>AWMP Section</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>10608.48.c(10)</td>
<td>Facilitate or promote customer pump testing and evaluation</td>
<td>Implementing</td>
<td>7.4.10</td>
</tr>
<tr>
<td>10608.48.c(11)</td>
<td>Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.</td>
<td>Implementing</td>
<td>7.4.11</td>
</tr>
<tr>
<td>10608.48.c(12)</td>
<td>Provide for the availability of water management services to water users.</td>
<td>Implementing</td>
<td>7.4.12</td>
</tr>
<tr>
<td>10608.48.c(13)</td>
<td>Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.</td>
<td>Implementing</td>
<td>7.4.13</td>
</tr>
<tr>
<td>10608.48.c(14)</td>
<td>Evaluate and improve the efficiencies of the supplier’s pumps.</td>
<td>Implementing</td>
<td>7.4.14</td>
</tr>
</tbody>
</table>
TID has developed two approaches to comply with California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597) consisting of:

(1) the installation of new permanent measurement devices at 151 sites (including 142 sidegates) to accurately measure deliveries to nearly 73,000 assessed acres, or approximately 47 percent of the District’s service area

(2) the development of calibrated flow rates specific to each sidegate-parcel-irrigation method-requested flow rate combination, which are used to accurately measure deliveries to more than 81,000 assessed acres, covering the remaining 53 percent of the District’s service area.

As of 2019, TID has completed initial calibrations per the corrective action plan for all active sidegates that don’t fall under DWR exemptions. Across both approaches, 100% of the assessed acreage served by active, non-exempted sidegates now receive deliveries through new permanent measurement devices or have calibrated delivery flow rates. Together, these approaches ensure that TID will comply with 23 CCR §597 while minimizing capital and ongoing operation and maintenance costs. TID plans to continue taking additional calibration measurements, as needed, to calibrate new flow requests from customers.

As of 2019, the field-testing accuracy certification of new permanent measurement devices is complete. Only a few remaining actions are needed to complete the field testing and accuracy certification for calibrated delivery flows at the remaining existing sidegates in TID. TID developed a plan for completing these remaining actions in 2020. Unfortunately, the public health guidelines resulting from the COVID-19 pandemic prevented additional field-testing during the 2020 irrigation season. TID staff will work within the bounds of recommended public health guidelines to complete these measurements at the earliest opportunity available.

Appendix F describes TID’s measurement program and the 2020 status of the process in greater detail.

7.2.1 New Permanent Measurement Devices

As of December 2019, new permanent measurement devices have been installed at 142 sidegates, along with six new permanent measurement devices at sites downstream of sidegates, and three new permanent measurement devices at ID pipeline spillage sites. The majority of these new permanent measurement devices are Rubicon SlipMeters and Rubicon FlumeMeters. Both of these devices use Rubicon’s Sonaray measurement technology, and are laboratory certified to ±2.5 percent flow rate accuracy (Judge, 2011). Field tests in California irrigation district conditions found that the Sonaray measurement was within ±2.0 percent of a National Institute of Standards and Technology (NIST) certified magnetic flow meter (Hopkins and Johansen, 2011). To improve the measurement accuracy of delivery volumes, TID trains

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31 Measurement devices downstream of sidegates are used primarily for ensuring that only one customer is irrigating, which allows TID to attribute the measurement at the sidegate to that customer. Due to the complexity of determining the travel time of delivery flows, these devices are not used directly in measurement calculations.
WDOs and irrigators to use the gates, and has made training videos in English and Spanish that are available on the TID web site and YouTube.\(^{32}\)

In most installations, a SlipMeter completely replaces an existing sidegate and will automatically adjust its opening to accurately deliver a desired flow, or maintain a specified gate opening. A few SlipMeters are mounted on frames in front of the existing sidegates. In these cases the sidegates are still manually adjusted to control the delivery flow rate, while the SlipMeter is primarily used as a measurement device. FlumeMeters are also installed in front of existing sidegates, so the FlumeMeter is primarily used as a measurement device. A few FlumeMeters are installed in ID pipeline structure boxes where the ID pipeline branches, and are used to measure flow at the split. Both SlipMeters and FlumeMeters send digital data to TID in real time via TID’s Supervisory Control and Data Acquisition (SCADA) system. TID has completed the installation of new permanent flow measurement devices. TID plans to continue to review delivery measurement accuracy and customer needs. TID has added additional permanent measurement devices based on this review, and may install more permanent flow measurement devices in the future.

7.2.2 Flow Rate Calibration for Existing Sidegates

TID is employing three techniques to develop flow rate calibrations at existing sidegates, depending on conditions at each sidegate.

At existing sidegates with access vents that are not suitably located for delivery flow measurement and calibration using handheld measurement devices, a Rubicon FlumeMeter was temporarily installed and used to develop calibrated delivery flow rates for each sidegate-parcel-irrigation method-requested flow rate combination. These calibrated flow rates are calculated based on the average flow rate observed from the FlumeMeter continuous flow measurements available from SCADA. Once at least one delivery event was measured for all active parcels served by a sidegate, the Rubicon FlumeMeter was moved to another sidegate. In total, TID has used 57 mobile FlumeMeters to develop calibrated delivery flow rates at 550 existing sidegates that serve 1,196 parcels, representing 32,187 assessed acres, or approximately 21 percent of the District.

For sidegates with access vents in suitable locations for delivery flow measurement and calibration using handheld measurement devices, a handheld Hach FH950 electromagnetic flow meter was used to determine calibrated flow rates specific to each sidegate-parcel-irrigation method-requested flow rate combination. The Hach FH950 flow meter provides a “spot” flow rate measurement at a specific point in time using an access vent downstream of a sidegate. Hach FH950 meters were used at 349 sidegates serving 536 parcels that together represent 19,345 assessed acres, or approximately 13 percent of the District.

For parcels with pressurized on-farm systems served by existing sidegates, a handheld Fuji Portaflow ultrasonic flow meter was used to determine calibrated flow rates specific to each sidegate-parcel-irrigation method-requested flow rate combination. The Fuji Portaflow meter

\(^{32}\) [https://www.tid.org/irrigation/irrigation-information/how-to-operate-rubicon-equipped-sidegates/]
also provides a “spot” flow rate measurement at a specific point in time. Fuji Portaflow meters were used at 471 sidegates serving 877 parcels that together represent 29,798 assessed acres, or approximately 19 percent of the District.

### 7.2.3 Use of Calibration Flows in Delivery Records and Billing

To provide growers a consistent basis for planning irrigations during an irrigation season, TID provides growers access to their calibrated flow rates for each of their sidegate-parcel-irrigation method-requested flow rate combinations. Customers are able to access this information either by phone through the Water Call Center or online by accessing their online water accounts. These calibrated delivery flow rates are based on all flow measurements completed prior to the beginning of the current irrigation season. The volume of water delivered during each irrigation event is calculated using these calibrated delivery flow rates and the recorded start and end times of the delivery event.

As future calibration measurements occur, calibrated flows will be updated at the end of each year by incorporating the new measurements into calibrated average flow rate. Growers will be able to access their new calibrated flow rates by phone or online, as described above.

TID has updated their water ordering, delivery, and billing software to use the calibrated flow rates for billing. For billing purposes, TID uses the calibrated flow average from the prior year to provide growers certainty with respect to water costs. For reporting delivery volumes to DWR and for use in the TID water balance, TID updates the calibrated delivery flow rates at the end of each irrigation season and uses these updated values to calculate the measured volume of water delivered in the completed irrigation season. Additional information is given in Appendix F.

### 7.2.4 Certification of Measurement Accuracy

As the initial flow rate calibrations have been completed at all sidegates and the software system changes have been implemented, TID has begun conducting a formal certification of the volumetric measurement accuracy consistent with 23 CCR §597.

To certify the volumetric measurement accuracy of all measurement devices, TID has evaluated both the accuracy of the recorded delivery duration and the accuracy of the flow rate measurement. The accuracy evaluations for both the new permanent measurement devices and the existing measurement devices are described in detail in Appendix F.

The field-testing accuracy certification of new permanent measurement devices is complete. Only a few remaining actions are needed to complete the field testing and accuracy certification for calibrated delivery flows at the remaining existing sidegates in TID. At the end of 2019, TID had developed a plan for completing these tasks in 2020 to validate the accuracy of deliveries to the remaining assessed area in TID (Appendix F, Attachment F.1). Unfortunately, the public health guidelines resulting from the COVID-19 pandemic prevented additional field-testing in 2020. TID staff will work within the bounds of recommended public health guidelines to complete these measurements at the earliest opportunity available. The results of these measurements will be provided and discussed in the next AWMP update.
7.3  VOLUMETRIC PRICING (10608.48.B(2))

**STATUS: IMPLEMENTING**

TID adopted a volumetric pricing structure that has been in effect since the 2013 irrigation season. TID’s current volumetric pricing structure was adopted in 2014 for implementation starting during the 2015 irrigation season, following completion of the Proposition 218 process. A detailed description of the volumetric pricing structure is included in Section 2 of this AWMP.

The volumetric pricing structure consists of separate tiered-pricing structures for normal and dry years, with four water rate tiers in each year type that are defined based on the amount of water delivered per acre. The cost per acre-foot of water delivered increases as growers move from lower to higher tiers, and increases in dry versus normal years. A fixed charge per acre is also included.

TID has also updated the water ordering, delivery, and billing software to use the calibrated flow rates described in Section 7.2 for billing purposes. With this update, TID’s customers are accurately billed for the quantity of water that is delivered.

7.4  ADDITIONAL CONDITIONAL EWMPs

California Water Code (CWC) §10608.48.c requires agricultural water suppliers to implement an additional 14 conditional EWMPs “if the measures are locally cost-effective and technically feasible.” As part of its ongoing water management activities, TID is implementing all of these measures, except one that is not technically feasible, as described in the following sections.

7.4.1 Facilitate Alternative Land Use (10608.48.c(1))

**STATUS: NOT TECHNICALLY FEASIBLE**

Facilitating alternative land use, as envisioned through implementation of this EWMP, is not technically feasible in TID. This EWMP was designed to focus on resolving problems for lands with exceptionally high water duties or lands where irrigation contributes to significant problems, including problem drainage. TID has neither of these conditions within the District boundaries. Furthermore, TID’s rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring (see Section 2.2.4.1).

According to the California Important Farmland Data collected and reported by the Farmland Mapping and Monitoring Program, the majority of farmland within the TID service area is considered to be “prime farmland,” “farmland of statewide importance,” or “farmland of local importance.” These three categories include farmland with suitably high-quality physical and chemical features (e.g. soil quality, moisture supply, slope) to support long-term agriculture and the economy without significant problems (Table 7.2).

Some areas within TID require drainage to sustain maximum agricultural production. Shallow groundwater in these areas is suitable for irrigation and is used as a source of supply by TID and individual growers. Considering these factors, drainage does not pose a significant problem within TID.
Due to the factors described above, this EWMP is not technically feasible in TID, and is not currently being implemented. Should future conditions change such that this is not the case, TID will re-evaluate this EWMP.

Table 7.2. Farmland Classification within TID Boundaries, from the California Farmland Mapping and Monitoring Program, California Important Farmland Data, 2016.

<table>
<thead>
<tr>
<th>Farmland Type¹</th>
<th>Land Type Description</th>
<th>Percent Total Farmland Area within TID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Farmland</td>
<td>Irrigated land with the best combination of physical and chemical features (e.g. soil quality, growing season, and moisture) to support long-term cropping</td>
<td>57%</td>
</tr>
<tr>
<td>Farmland of Statewide Importance</td>
<td>Irrigated land similar to Prime Farmland, with a good combination of physical and chemical features, but with minor shortcomings (e.g., soil type, etc.)</td>
<td>25%</td>
</tr>
<tr>
<td>Farmland of Local Importance</td>
<td>Land of importance to the local agricultural economy as determined by each county's board of supervisors and a local advisory committee</td>
<td>2%</td>
</tr>
<tr>
<td>Unique Farmland</td>
<td>Lesser quality soils used for the production of the state's leading agricultural crops.</td>
<td>16%</td>
</tr>
<tr>
<td>Total Farmland</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

¹ Only includes land types classified as “farmland.” Other land uses ancillary to agriculture (grazing land, confined animal production facilities, and agricultural storage and packing facilities) are not included in this summary.

7.4.2 Facilitate Recycled Water Use (10608.48.c(2))

**Status: Implementing**

TID is implementing this EWMP by facilitating the safe utilization of available recycled water. The District accepts recycled water from municipal and industrial users into its system provided that the dischargers have the appropriate National Pollutant Discharge Elimination System (NPDES) permits, and are able to meet TID-specific requirements.

For 20 years, land in the TID service area has been irrigated using treated wastewater from the Cities of Modesto and Turlock. Land is also irrigated using untreated dairy nutrient water and industrial process water from Hilmar Cheese. The combined average volume of recycled treated wastewater used for irrigation was approximately 5,000 AF per year between 2015 and 2019.

TID assists growers who wish to receive nutrient water by allowing dairies to transport nutrient water through Improvement District (ID) conveyance structures. This recycling of dairy runoff reduces discharge, enables growers to utilize the nutrient water as fertilizer for forage crops, and provides water for irrigation.

Similarly, TID supports the practice of reusing industrial process water from Hilmar Cheese Company by allowing Hilmar Cheese to transport process water through ID conveyance structures. Using the existing ID facilities in this manner enables Hilmar Cheese to recycle the
process water for agricultural use, and provides growers the benefit of water supply year-round, including the non-irrigation season when TID supplied irrigation water isn’t available. This type of reuse has increased over time as the Hilmar Cheese facility has diversified and expanded. Approximately 2,000 AF of process water is recycled per year, on average.

TID endeavors to use recycled treated wastewater where possible to meet non-irrigation needs as well. In May 2010, TID converted the water source for its cooling towers at the Walnut Energy Center in Turlock to tertiary treated wastewater effluent from the City of Turlock. TID has used approximately 1,000 AF per year of effluent, reducing TID’s non-irrigation pumping needs by an equivalent amount.

TID also recovers spillage from the Harding Drain for reuse along Lateral 5½. The Harding Drain is used to transport runoff, drainage from adjacent lands, groundwater accretions, and canal spillage. For the period from 2015 to 2019, an average of 1,200 AF of water per year was reused.

TID has been implementing and will continue to implement locally cost-effective and technically feasible practices consistent with this EWMP. TID continues to work with cities and permitted dischargers within its service area to gain access to recycled water supplies for agricultural needs. In the future, TID will continue to identify and evaluate opportunities for use of recycled water that conform to regulatory and agronomic water quality standards and resource requirements.

7.4.3 Capital Improvements for On-Farm Irrigation Systems (10608.48.c(3))

**Status: Implementing**

TID is implementing the EWMP to facilitate capital improvements for on-farm irrigation systems through a variety of programs described below.

TID has an active financing program to support on-farm capital improvements of irrigation facilities through the formation of new Improvement Districts (IDs), and on-going maintenance and support of existing IDs. IDs are formed to allow groups of growers to pool resources to build, operate and maintain on-farm water distribution systems, subsurface drain systems, deep wells, and micro irrigation systems. There are currently 1,046 IDs that deliver water from the TID canals and laterals to individual growers. IDs own approximately 700 miles of lined irrigation delivery ditches and pipelines, serving 124,000 acres within TID.

TID offers low interest financing to IDs, generally with a 10-year loan term, and offers engineering design and installation oversight for these facilities. In addition, TID provides at-cost maintenance and repair for ID facilities. Financial assistance is further provided to each ID on a short-term basis through TID’s assessment process. Maintenance, electrical charges, and repairs for the year are carried by TID interest-free and billed to ID members in November of each year. ID members have the option of paying the assessment in two installments with no interest or penalties. For very large assessments, TID will work with an ID to establish a multiple-year assessment that distributes the costs over a longer period. Multiple-year assessments are also interest-free and typically last two to three years.
TID has also hired an assistant engineer with a background in agriculture whose primary work assignment is to provide on-farm technical support and design assistance to TID customers. Services include support of micro/drip conversion and on-farm reservoir sizing.

As a member of the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA), TID is actively involved in preparing the Turlock Subbasin Groundwater Sustainability Plan (GSP) that will identify the actions needed to achieve groundwater sustainability. GSP development efforts are ongoing and are on track to result in the adoption and submittal of a SGMA-compliant plan by January 2022. The GSP will identify projects to support groundwater sustainability in the Turlock Subbasin, and may include projects that facilitate on-farm improvements. The complete list of projects is currently being developed, and will be described in future AWMP updates.

TID continually searches for grants on behalf of the District and its customers, including those to support on-farm improvements.

TID has been implementing and will continue to implement this EWMP. In the future, TID will continue to identify and evaluate opportunities to facilitate financial assistance for on-farm capital improvements.

### 7.4.4 Incentive Pricing Structure (10608.48.c(4))

**Status:** Implementing

TID is implementing this EWMP by implementing a tiered, volumetric pricing structure that promotes the following goals identified in the CWC:

1. More efficient water use at the farm level
2. Conjunctive use of groundwater
3. Increased groundwater recharge
4. Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.

As described in Section 2.2.3, TID’s volumetric pricing structure consists of separate tiered-pricing structures for normal and dry years, with four water rate tiers in each year type that are defined based on the amount of water delivered per acre. The cost per acre-foot of water delivered increases as growers move from lower to higher tiers, promoting efficient water use at the farm level (goal 1, above).

TID’s pricing structure also promotes conjunctive use of groundwater, appropriate increases in groundwater recharge, and effective management of all water sources (goals 2, 3, and 4 above) by implementing separate normal year and dry year water rates, with higher rates in dry years. This pricing structure supports the District’s overall conjunctive management strategy through the following mechanisms:

- Encouraging the use of available surface water supplies and groundwater recharge by keeping surface water rates low relative to the cost of groundwater pumping,
- Encouraging conservation of limited surface water supplies in dry years by increasing the cost per acre-foot delivered, and
Implementing the dry year rate structure, enables the District to generate additional revenue to pay for increased groundwater pumping in dry years.

TID has been implementing and will continue to implement this EWMP. In the future, TID will periodically review the volumetric pricing structure and rates with respect to TID’s water management objectives.

### 7.4.5 Lining or Piping of Distribution System and Construction of Regulating Reservoirs (10608.48.c(5))

**Status: Implementing**

TID has implemented this EWMP through:

- lining or pipeline conversion of over 90 percent of its conveyance and distribution system
- maintaining the canal lining through its active gunite and lining maintenance program
- supporting Improvement Districts in their effort to maintain and improve ID-owned water conveyance facilities
- evaluating the installation of regulating reservoirs, and – when locally cost-effective or deemed necessary for other reasons, such as improved customer service – installing regulating reservoirs along its distribution system.

#### 7.4.5.1 Lining or Piping of Distribution System

TID’s conveyance and distribution system (including the Upper Main Canal from La Grange to Turlock Lake) consists of approximately 240 miles of canals, of which 222 miles are fully or partially lined (92%). The remaining areas of unlined canals are primarily in upland clay soils with low seepage rates. The relatively small volume of seepage from the remaining unlined and partially lined canals provides beneficial groundwater recharge as these canals are located near the area to the east of TID where groundwater levels have steadily declined (see Section 4.1.2).

During the winters of 2006-2007 and 2007-2008, TID also lined approximately 4.5 miles of existing earthen canals for operational purposes. The main purpose of this project was to reduce maintenance requirements by preventing erosion, improving the hydraulic efficiency, and reducing aquatic weed growth, with added benefits of seepage reduction. In 2014, TID converted the Lower Stevinson Flume to a pipeline. Additionally, Lateral 1 and Upper Lateral 4 have been converted from open channels to pipelines in some developed areas.

An effective lining maintenance program is necessary to prevent seepage losses from increasing due to cracks as the concrete lining ages. TID has an active gunite and canal lining maintenance program to maintain the effectiveness of the concrete lining. TID inspects canal lining on a regular basis and rates the lining condition by canal reach. Each year, lining condition and reach ratings are reviewed and reaches selected for resurfacing with gunite primarily based on the reach condition. Between 2000 and 2019, TID has resurfaced an average of approximately 340,000 square feet (7.8 acres, 0.012 square miles) of canal lining each year. From time to time, TID has conducted ponding tests to quantify seepage rates in lined reaches to better understand the relationship between the canal reach rating system that is used to select reaches for maintenance, and the underlying soils and seepage of those reaches. The gunite and canal lining
maintenance program helps to maintain hydraulic efficiency, prevent canal failure, and reduce seepage from the lined portions of the distribution system.

A substantial portion of the 700 miles of ID conveyance facilities have been replaced by pipeline systems. Aging or leaking pipelines are actively maintained and are replaced as necessary. TID provides low interest loans for these improvements (see Section 7.4.3).

### 7.4.5.2 Evaluation and Construction of Regulating Reservoirs

In addition to canal lining and pipeline conversion, TID has considered the construction of a number of regulating reservoirs at key locations in the distribution system.

During the 2014-2015 winter season, TID constructed a regulating reservoir, referred to as the Lateral 8 Regulating Reservoir. The reservoir began operations in 2015 with 29 acre-feet of storage. The reservoir is located such that water which would normally be spilled from the Highline Canal or Lateral 8 can instead be routed to the new reservoir. TID expanded the storage capacity to 130 acre-feet in 2016 to allow more water to be captured.

In 2010, reservoirs on the Ceres Main Canal at the headings of Lower Lateral 3 and Lower Lateral 4 were evaluated as part of a phased project aimed at providing increased monitoring and control of the distribution system along with regulating storage to facilitate increased flexibility to growers and reduction of spills. Ultimately, the evaluation of the project including only the benefits to spill reduction resulted in a benefit-cost ratio of 0.23, denoting that local project benefits would provide only about one quarter of the cost required to implement the project at that time.

TID is currently working on a multi-year planning effort to improve irrigation service and modernize infrastructure, referred to as the TID Irrigation Facilities Master Plan (IFMP). The draft IFMP identifies and evaluates a suite of potential modernization projects for the District’s water distribution infrastructure below Turlock Lake, including a variety of projects to construct regulating reservoirs and improve canal conveyance. Projects are being developed with the intent of allowing growers to adopt more efficient and productive on-farm irrigation systems, leading to increased water conservation over time as well as increased farm profitability.

Projects have been conceptualized through input from TID staff at all levels and considering responses from 27 grower interviews that discussed existing and future cropping practices, irrigation systems, and water source preferences. The draft IFMP encompasses more than 50 work products, and will provide a strategic plan for future modernization of the TID system in the coming years.

TID has acquired land at the head of Lower Lateral 3 for the proposed regulating reservoir, has begun designing the new reservoir and has begun preparing an Initial Study in accordance with the California Environmental Quality Act (CEQA). Construction of the regulating reservoir could potentially occur in the future depending on funding.

In addition to constructing and studying new regulating reservoirs, TID has also conducted ponding tests at Turlock Lake as a means of evaluating existing reservoir operations. These tests have provided TID with more information about reservoir recharge to support efficient water management and to support decisions on future operations at Turlock Lake.
As described above, TID has implemented this EWMP in several ways through canal lining, canal maintenance, and evaluation and construction of regulating reservoirs. TID also assists IDs in doing the same. TID will continue these efforts in the future, and will continue planning efforts to modernize the TID system, including the draft IFMP. Additionally, TID will continue to consider the construction of regulating reservoirs to increase distribution system flexibility and reduce operational spillage.

7.4.6 Increased Flexibility to Water Users (10608.48.c(6))

**Status: Implementing**

TID is implementing this EWMP by providing arranged-frequency demand deliveries to its customers. TID has been a pioneer in providing increased flexibility to water users for decades, offering a wide range of flexibility in the frequency and duration of irrigation deliveries.

In TID’s arranged-frequency demand ordering and delivery system, the irrigation frequency (day of irrigation) is arranged between TID and the customer through the water ordering process, the delivery flow rate is requested by the customer with some flexibility, and the delivery duration is controlled by the customer with complete flexibility (growers are allowed to irrigate until finished). On average, between 2011 and 2019 growers received water approximately 50 to 55 hours after they placed an order with the Central Call Center.

TID has also taken several steps to provide increased levels of customer service. Prior to the start of the 2008 irrigation season, TID moved its Central Call Center to the TID Customer Service Department in order to improve customer service in taking water orders. In 2014, TID implemented online ordering and made water use information available online to growers. Growers can plan and manage water use on each parcel by requesting a copy of their water use records when placing a water order or at any other time of the year. At the end of each irrigation season, growers are also mailed a water use statement that details the number of irrigations, the amount of water applied during each irrigation, and total water use for the season. Additionally, TID provides customers with access to real time monitoring of Rubicon SlipMeters and permanent FlumeGates.

TID continues to work to accommodate growers’ evolving needs. Real-time SCADA monitoring of distribution system flows, water levels, and spillage by Water Distribution Operators (WDOs) has allowed TID to improve flexibility to water users while maintaining distribution system efficiency. In recent years, these improvements and efforts have allowed TID to increasingly provide non-standard heads of water (i.e., less than 15 to 20 cfs) to customers who are using micro irrigation systems. In 2014, TID provided tablets to all WDOs and provided real-time access to 397 SCADA sites, including nine miles of Rubicon Total Channel Control (TCC) automation provided by Rubicon SlipMeters and permanent FlumeGates, as well as remote drainage pump controls. Intermediate system flows at several locations are also monitored to better meet customer demands and prevent operational spillage.

During the 2014-2015 winter season, TID constructed a regulating reservoir to improve customer service on Lateral 8. The Lateral 8 Regulating Reservoir, as it is called, provided 29 acre-feet of storage beginning in 2015. The reservoir is located such that water which would normally be spilled from the Highline Canal or Lateral can instead be routed to the new reservoir, allowing
WDOs to provide water with greater flexibility. The reservoir was so successful that TID expanded the storage capacity to 130 acre-feet in 2016 to allow more water to be captured.

In some dry years, TID allows growers to pump groundwater into the canals and then receive a delivery “credit” equal to the volume they supplied at any sidegate that serves their property. This practice supplements the water supply available to downstream users, and allows growers the flexibility to transport water that they pump to any of their fields served by an active sidegate. The District implemented this practice in 2014-2015, and will consider implementing it again in future dry years.

In February 2019, TID completed an Irrigation Delivery Operations Assessment to evaluate the efficiency and flexibility of TID’s irrigation delivery system operations through (1) comparison of system parameters and deliveries between TID and other California irrigation water suppliers, and (2) evaluation of WDOs’ activities and roles in providing high-quality and flexible irrigation deliveries. The assessment found that overall TID ranks high among the water suppliers that were evaluated for their operational efficiency. During peak-season operations, TID’s WDOs provide, on average, the largest number of deliveries and the largest delivery volumes per hour worked among the suppliers that were compared. Observation and surveys of WDOs found that while TID’s policies to provide flexible irrigation deliveries to customers pose operational challenges and complicate delivery scheduling, TID’s WDOs are generally doing a good job of maintaining high operational efficiency.

TID is currently working on a multi-year planning effort to improve irrigation service and modernize infrastructure, referred to as the TID Irrigation Facilities Master Plan (IFMP). As described in the previous section, the draft IFMP identifies and evaluates a suite of potential modernization projects for the District’s water distribution infrastructure, with the goal of maintaining and improving the level of irrigation service provided to its customers. This effort will result in detailed project descriptions and implementation plans for a suite of potential projects to increase operational flexibility, among other benefits, while minimizing operational costs and life cycle costs of TID infrastructure.

TID has implemented numerous measures to increase flexibility in water ordering by, and delivery to, water users within operational limits, and will continue to implement locally cost-effective improvements consistent with this EWMP in the future.

7.4.7 Supplier Spill and Tailwater Recovery Systems (10608.48.c(7))

**STATUS: IMPLEMENTING**

TID is implementing this EWMP in several ways, through:

- interception of spillage from upper laterals and Improvement District pipelines by the District’s canals, allowing water to be utilized to the greatest extent possible for deliveries downstream
- spillage recovery from the Harding Drain
- real time monitoring of distribution system spills
- operation of drainage wells and rented wells to provide a localized source of supply and reduce spillage.
The District’s canal system is configured to intercept spillage from upper laterals, and reuse this water to help meet irrigation demands in the lower laterals (see the District map in Appendix D). Additionally, some long Improvement District pipelines were designed and constructed so they terminate at a TID canal, allowing recovery of undelivered irrigation water to be used for irrigation delivery downstream. This undelivered water generally originates from “fill up” and “run down” water (i.e., water that flows through the pipeline before and after deliveries, as the pipe first fills and then empties).

As described previously in Section 7.4.2, TID also recovers spillage from the Harding Drain for reuse along Lateral 5 ½. The Harding Drain is used to transport runoff, drainage from adjacent lands, groundwater accretions, and canal spillage. For the period from 2015 to 2019, an average of 1,200 AF of water per year was reused. There are also several private, grower-operated systems that recover a mixture of drainage water and operational spills to meet irrigation demands. The extent to which this occurs is not quantified as it occurs at the farm-level, downstream of the TID distribution system.

TID has completed the installation of SCADA monitoring equipment at its spillage sites, and has upgraded these sites with float-operated sensors. The District has a total of 397 SCADA sites that monitor flows system-wide. Sites automatically transmit these data to master radios located at electrical substations, where these data are collected and transmitted over a fiber optic network to TID’s SCADA system. The District has largely accomplished the three main goals of its master SCADA plan:

- Maintain and upgrade the SCADA system to meet current and future needs.
- Create a centralized repository for water records and increase accessibility to SCADA data.
- Expand SCADA capabilities to incorporate cost-effective water operations and water delivery efficiency improvements.

TID has provided its WDOs with tablets to monitor the distribution system in real time, including all spillage sites. These remote monitoring capabilities enhance the ability of WDOs to minimize spillage while operating the distribution system flexibly and efficiently.

The SCADA system also supports spillage control by allowing WDOs to remotely control drainage pumps. Strategic pumping in the western portion of TID allows WDOs to tightly control flows along the downstream end of the distribution system. Under this operating regime, pumping is used to supplement irrigation deliveries low in the system. This reduces the volume of surface water that must be released from Turlock Lake, and reduces the potential volume of spillage that could occur if surface water were used exclusively to satisfy these irrigation demands low in the system. Long travel times from Turlock Lake make it challenging for TID staff to respond to changing irrigation demands in the lower parts of the system while also minimizing operational spillage. Through the SCADA system, the WDOs can turn pumps on and off from their portable tablets, allowing them to respond much more quickly to changes in canal flows, and helping to further reduce spillage.

As described in Section 7.4.5, TID constructed a regulating reservoir, referred to as the Lateral 8 Regulating Reservoir, as part of a pilot installation of Total Channel Control (TCC) on Lateral 8. The reservoir is located such that water which would normally be spilled from the Highline...
Canal or Lateral 8 can instead be routed to the new reservoir. The reservoir began operating in 2015 with 29 acre-feet of storage, and was expanded to 130 acre-feet in 2016. With TCC on Lateral 8, TID is also better able to match supply and demand, and thus provide better service with increased flexibility to customers on Lateral 8 while simultaneously reducing spillage from Lateral 8.

TID has implemented and continues to operate spillage recovery, including spillage prevention measures at levels that are locally cost-effective. TID has also studied regulating reservoirs as an approach to spillage prevention and recovery. To that end, TID is currently considering the purchase of 7 acres at the end of Lower Lateral 2 which would enable a future reservoir and pump back system. Through its draft Irrigation Facilities Master Plan, described in Section 7.4.5, TID is also conducting extensive evaluations of potential modernization projects that would improve system efficiency and reduce spillage. Among these potential projects are several potential reservoirs and a spillage recovery system. TID will continue to evaluate the cost-effectiveness of spillage and tailwater reduction opportunities in the future.

With regard to tailwater, many fields in TID that receive surface water are irrigated with basin check systems that produce no tailwater. Some tailwater is generated on the heavier soils of the northeastern portion of TID; however, the majority of growers in this area have control structures to prevent irrigation tailwater from flowing back into the distribution system. Only a small volume of tailwater generated in the irrigation service area is intercepted by agricultural drains that flow into the distribution system. This water is blended with the water in the canals and delivered as irrigation water to the greatest extent possible. A survey of irrigated lands in 2004 indicated that only a small percentage of lands within TID (approximately 2,700 acres, or less than 2%) generate tailwater that ultimately enters the distribution system. An additional 8,200 acres in TID can also produce tailwater, but this water does not enter the TID distribution system. Tailwater that does not enter the distribution system is available for recovery and reuse by growers within and outside of TID. TID also recovers and reuses tilewater that enters the District’s distribution system. The tilewater is blended with surface water supplies from Don Pedro Reservoir and then utilized to the greatest extent possible for deliveries downstream.

7.4.8 Increase Planned Conjunctive Use (10608.48.c(8))

**STATUS: IMPLEMENTING**

The District is implementing increased planned conjunctive use of surface water and groundwater through a combination of actions as part of the District’s overall conjunctive management strategy. TID’s conjunctive management objectives include: 1) maintaining a sustainable groundwater system through continued use of surface water for deliveries and recharge in normal and wet years, and 2) maintaining water deliveries in dry years through increased groundwater pumping.

On average, groundwater makes up approximately 14 percent of the TID water supply in normal water supply years, and 23 percent of the TID water supply in dry years. As a result, the use and recharge of groundwater supplies are an essential part of TID’s water management program.

Key components of TID’s conjunctive management program include the following:

- Competitive pricing to promote the use of available surface water supplies in all years;
• Higher-cost volumetric pricing in dry years to promote conservation of limited surface water supplies;
• Higher-cost volumetric pricing and higher-cost fixed charge per acre in dry years to provide revenue to operate drainage and rental wells required to pump additional groundwater;
• Direct and in-lieu recharge in wetter years through “replenishment” water sales to adjacent agricultural lands east of TID’s irrigation service area;
• Operation of over 100 drainage wells to increase water supply and reduce spillage in the western service area;
• Utilization of rental wells to supplement available surface water supply, with an increase in the number of rented wells in dry years (up to 100 or more privately-owned wells);
• Use of treated wastewater for cooling at the Walnut Energy Center, as a substitute for groundwater;
• Partnership with the Eastside Water District for groundwater recharge projects;
• Implementation of groundwater monitoring as part of SBx7-6 (California Statewide Groundwater Elevation Monitoring or CASGEM); and
• Development of sophisticated groundwater and surface water models used as planning tools to aid conjunctive management, including a semi-automated water balance documenting surface water and groundwater use within the irrigation service area.
• Active participation in local groundwater management efforts, including the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA)

Many of the key components of TID’s conjunctive management practices are described throughout this AWMP, including Section 4.1.2.2 and Section 3.5, and have not been restated in detail within this section.

TID, as a member of the WTSGSA, anticipates adopting and implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), beginning in 2022. The GSP will identify actions needed to achieve groundwater sustainability in the Turlock Subbasin, providing support for ongoing conjunctive use of surface water and groundwater supplies in the Subbasin.

Two grants have been received to assist with the Subbasin’s SGMA efforts. The first grant is funding a significant portion of the GSP development. The second grant will fund a Groundwater Recharge Assessment Tool for the Subbasin, the installation of monitoring wells, and a Draft Programmatic Environmental Impact Report for the GSP. TID staff are administering these grants on behalf of the GSAs, and are actively engaged in the planning and development of each effort. Both efforts will further aid conjunctive management in the Subbasin and the TID service area.

As described in Section 6, TID actively forecasts runoff and manages its water supply through the Airborne Remote Sensing for Snowpack (ARSS) Program, Forecast-Coordinated Operations (F-CO) and Forecast-Informed Reservoir Operations (FIRO), and watershed monitoring programs. Data and tools available through these programs allow TID to better track and understand the amount of water in the upper watershed, informing reservoir operations to optimize the balance of available flood storage and water supply storage and to support conjunctive management decisions.
TID has also conducted ponding tests at Turlock Lake in recent years as a means of evaluating existing reservoir operations and groundwater recharge. These tests have provided TID with more information about reservoir recharge to support efficient water management and to support decisions on future operations at Turlock Lake.

TID plans to update its water budget in the near future to include the Upper Main Canal and Turlock Lake. The TID water budget has historically been calculated only during the irrigation season for the distribution system and irrigated lands downstream of Turlock Lake, beginning with irrigation releases from Turlock Lake. Adding the Upper Main Canal and Turlock Lake to the water budget will better account for all inflows and outflows of District supplies, including infiltration of surface water to the groundwater system. This information will help TID staff to better quantify groundwater recharge, and will directly support conjunctive management decisions. These future updates are expected to occur within the next five years, and will be included in the next AWMP update.

TID also plans to improve its monitoring and tracking of off-season flows through the system. In the past, TID has not operated the distribution system during the off-season except to pass storm flows, runoff, and drainage water through the service area. Measurement sites in the TID system have been monitored during the off-season primarily to observe changing trends in flow. Also, excess water has been passed through the system in some wet years using drainage outflow locations that are not part of the measured spillage network. As reporting needs change, TID will review its operations at these sites to ensure better accuracy throughout the entire water year. Tracking these flows will help TID to manage this water better and to make use of it locally, supporting conjunctive use.

TID has a long history of leadership and optimization of conjunctive management in the Turlock Subbasin, with the objective to provide a reliable long-term water supply to growers in both normal and dry years. TID has implemented numerous locally cost-effective conjunctive management actions and will continue to evaluate and implement locally cost-effective actions consistent with this EWMP in the future.

7.4.9 Automate Canal Control Structures (10608.48.c(9))

**STATUS: IMPLEMENTING**

TID is implementing this EWMP by:

- installing, operating, and maintaining more than 345 canal control structures that automatically control canal water levels or flows based on operator targets
- monitoring 397 SCADA sites in real time
- ensuring that all structure modifications allow for future automation

TID has utilized automated canal control structures for over one hundred years. In particular, the District’s 66 Meikle\(^{33}\) automatic gates, a type of hydraulic automatic gate believed to be unique to TID, provide water level control at check structures throughout the distribution system.

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\(^{33}\) Named for Mr. Roy V. Meikle, who served the Turlock Irrigation District as chief engineer for over 50 years, beginning in 1912.
(Scobey, 1914) (Figures 7.1 and 7.2). The gates provide excellent water level control across a range of flows and require no external power.

Another “passive” structure utilized by TID to provide automatic control of canal water levels across a wide range of flows is the long crested weir. TID operates 227 long crested weirs throughout its distribution system. The long crested weir provides simple water level control through a triangular or rectangular weir (when viewed from above) that sits within the canal channel. Because of the relatively long crest over which water flows, relatively large fluctuations in flows over the weir result in relatively small fluctuations in the canal water level upstream of the weir. This allows for steady delivery of water to irrigation gates or lateral headings upstream of the weir.

Flap gates developed as a modified version of the Begemann gate by the Irrigation Training and Research Center (ITRC) at California Polytechnic State University, San Luis Obispo are also used at 18 locations within TID’s distribution system. The flap gate provides automated water level control, serving the same function as a Meikle gate or a long crested weir, but with generally lower construction and installation costs. A disadvantage of flap gates is that they require a relatively large drop in water level across their control structures, limiting their applicability at many sites.

The District has also recently been installing Rubicon FlumeGates™ at many canal head gate structures. These automatic drop leaf style gates can be set to control flow rates through them or water levels upstream of the control structure. These devices also have the benefit of reporting flow rates to the District’s SCADA control network and can be remotely operated through the network as well. The District has installed these gates at 31 locations within TID’s distribution system so far, with more planned in the future.

In addition to the automatic control structures described above, TID operates a number of permanent and moveable Rubicon FlumeMeters™ throughout the District’s service area. These gates are primarily used for delivery measurement. Additional Rubicon SlipMeters™ have also been installed to provide automated flow control and improved measurement accuracy for irrigation deliveries. These gates also report water levels through the SCADA system that are available to WDOs on their tablets, providing intermediate canal water level measurement sites where these gates are located throughout the system.
Ongoing implementation of TID’s Irrigation Capital Plan provides for automation and rehabilitation of canal control structures and drop structures as part of normal TID operations.
TID implements an ongoing maintenance program that is designed to ensure these automatic structures continue to operate effectively throughout the irrigation season. Regular canal inspections and coordination between WDOs and other field crews help TID to quickly identify maintenance issues and expedite repairs to ensure the facilities continue to operate as designed, maintaining reliable control of water levels.

In addition to the various automated structures used to operate the distribution system, TID has modernized its operations through the installation of 397 SCADA sites for real time water level and flow monitoring that help to optimize operation of the distribution system. Access to real time flow data allows WDOs to make more precise and timely adjustments to gates and control structures, as needed. Recent SCADA improvements have also provided WDOs the ability to remotely control drainage pumps using their portable tablets. As described in Section 7.4.7, TID plans to upgrade and expand its SCADA and automation opportunities in the future and has developed and is following a SCADA master plan.

TID has implemented and continues to operate a variety of automatic canal control structures that maintain water levels and flows in the distribution system. TID has also implemented a SCADA network that allows real time monitoring of canal levels by WDOs, improving the effectiveness of canal automation. TID will also continue to evaluate other cost-effective canal automation and modernization projects that would improve the ease and flexibility of distribution system operation while maintaining system efficiency.

7.4.10 Facilitate Customer Pump Testing (10608.48.c(10))

STATUS: IMPLEMENTING

TID is implementing this EWMP by conducting a pump testing program in which TID staff provide testing services for private pumps throughout the District’s irrigation and electrical service areas.

As part of the pump testing program, TID trained employees in pump testing methods in 2014. Improvement District pumps and other privately owned pumps have historically been tested once per year when they are rented by TID, or upon request by the owner. TID has obtained portable Fuji flow meters for testing flows in pressurized pipe. These meters are used to test customers’ wells upon request. Two staff members are available for water level testing and 12 WDOs are available for flow testing. The electrical service area includes approximately 40,000 additional cropped acres east of the irrigation service area that are irrigated almost exclusively with groundwater. Pump testing for this area is available through TID’s electric department.

Over the last three to five years, pump testing has been limited as manpower has been redirected to other urgent efforts in support of TID’s delivery measurement accuracy verification and field-testing program (described in Section 7.2 and Appendix F).

TID plans to continue implementing the pump testing program in the future and will continue to evaluate locally cost-effective opportunities to expand the program as part of the District’s overall management of water and electrical resources.
7.4.11 Designate Water Conservation Coordinator (10608.48.c(11))

**STATUS: IMPLEMENTING**

TID is implementing this EWMP by continuing to have a designated Water Conservation Coordinator to develop and implement the AWMP and encourage continued evaluation of efficient water management practices. This position was established in June 1997 and is currently filled by the District’s Water Planning Department Manager.

7.4.12 Provide for Availability of Water Management Services (10608.48.c(12))

**STATUS: IMPLEMENTING**

TID is implementing this EWMP through a variety of actions aimed at providing water management services to its customers. These actions are summarized in Table 7.3 and the sections below.

### Table 7.3. Summary of Water Management Services Provided to Irrigation Customers.

<table>
<thead>
<tr>
<th>Water Management Service Category</th>
<th>TID Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-farm irrigation and drainage system evaluations</td>
<td>Engineering design services for ID facilities</td>
</tr>
<tr>
<td></td>
<td>Private and Improvement District pump testing upon request</td>
</tr>
<tr>
<td>Normal year and real-time irrigation scheduling and crop evapotranspiration information</td>
<td>Installation of CIMIS stations 168 (inactive) and 206 in Denair</td>
</tr>
<tr>
<td></td>
<td>Link on TID web site to weather data from DWR CIMIS program and weather forecasts</td>
</tr>
<tr>
<td>Surface water, groundwater, and drainage water quantity and quality data</td>
<td>Private and Improvement District pump testing upon request</td>
</tr>
<tr>
<td></td>
<td>Water use information by parcel available from TID at any time online, or upon grower’s request, plus all growers receive a year-end water use report</td>
</tr>
<tr>
<td></td>
<td>Information describing suitability of surface water, groundwater, and drain water quality for irrigation upon request</td>
</tr>
<tr>
<td></td>
<td>Real time flows and storage for 6 surface water sites provided on TID website</td>
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<tr>
<td></td>
<td>TID participates in DWR’s CASGEM groundwater level reporting program</td>
</tr>
<tr>
<td></td>
<td>Grower newsletter distributed quarterly</td>
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</tbody>
</table>
7.4.12.1 On-farm Irrigation and Drainage System Evaluations

TID is implementing on-farm irrigation system evaluations by offering pump tests to irrigators and Improvement Districts throughout the District’s irrigation and electrical service areas. As described in Section 7.4.10, TID staff are trained in pump testing methods and provide flow tests upon request. Staff utilize Fuji flow meters for testing flows in pressurized pipes, allowing irrigators owners to verify pump flow rates and application rates through their pressurized irrigation systems.

TID also supports IDs in building, operating, and maintaining on-farm water distribution systems, subsurface drain systems, deep wells, and micro irrigation systems. As described in Section 7.4.3, TID offers low interest financing to IDs, generally with a 10-year loan term, and offers engineering design and installation oversight for irrigation and drainage facilities. In addition, TID provides at-cost maintenance and repair for ID facilities.

7.4.12.2 Normal Year and Real-time Irrigation Scheduling and Crop Evapotranspiration Information

TID provides its customers with information on crop evapotranspiration and other parameters relevant to irrigation scheduling through the District’s CIMIS station and website.

TID has been providing growers with local weather information to support on-farm water management for nearly 20 years. In early 2002, TID installed the California Irrigation Management Information System (CIMIS) Station #168 (Denair). The station was installed in a central location in the TID irrigation service area, providing data for a previously
underrepresented area in the CIMIS network. In April 2009, CIMIS Station #168 (Denair) was relocated approximately two miles to the southeast and assigned a new station number (#206). The station is currently located on an irrigated pasture with adequate fetch to provide reliable reference evapotranspiration estimates.

The station provides area-specific climate and reference evapotranspiration data to growers to allow them to effectively schedule irrigation events based on current and projected crop water usage. TID provides growers with the CIMIS website information and a web link to CIMIS tutorials and station data on the TID website (www.tid.org/irrigation/irrigation-information/cimis). The link to CIMIS on the District’s website is shown in Figure 7.3. The District also provides links to additional weather information including precipitation forecasts on a Weather page on the TID web site (https://www.tid.org/news-and-resources/weather; Figure 7.4).
California Irrigation Management Information System (CIMIS)

The California Irrigation Management Information System (CIMIS), a standardized accounting for water consumed through evapotranspiration by the soil and plants, is designed to help growers develop efficient water budgets and irrigation strategies by providing scheduling information matching the amount of water applied to a crop with needs of the plant.

The California Irrigation Management Information System (CIMIS) is a network of over 145 automated weather stations managed by the California Department of Water Resources. Developed in 1982 by the DWR and the University of California, Davis it was designed to assist irrigators in managing their water resources more efficiently saving water, energy, and money.

The CIMIS stations in this area are:

- #206 Denair
- #148 Merced
- #161 Patterson
- #71 Modesto

For more information about how to use CIMIS, visit the Department of Water Resources CIMIS website.

The Fresno State Center for Irrigation Technology hosts the Waterright website at http://waterright.org providing free irrigation scheduling programs and tutorials that can be used to develop irrigation schedules using CIMIS data. Additionally, the CIMIS site provides links to other irrigation scheduling programs (some of which must be purchased) and resources.

For more information about these programs, please call (209) 883-8386.

Figure 7.3. Link to CIMIS on TID Website.
Figure 7.4. Additional Weather Information on TID Website.
### 7.4.12.3 Surface Water, Groundwater, and Drainage Water Quantity and Quality Data

TID provides water use, water supply and water quality data to its irrigation customers through a variety of resources:

- Water use information is available by parcel from TID at any time online, or upon a grower’s request,
- Water use information is provided by TID to all growers in a year-end water use report
- Real-time flows, water level, and storage are available on the TID website for various sites operated or used by TID (Figure 7.5):
  - Real-time flows, water level, and storage available for six sites via TID’s Water Information Systems by KISTERS (WISKI) web portal (Figure 7.6, available at [http://wiskiweb.tid.org/index.htm](http://wiskiweb.tid.org/index.htm))
  - Current report and link to current flows to the Tuolumne River below La Grange Dam ([https://www.cnrfc.noaa.gov/graphicalRVF.php?id=MDSC1](https://www.cnrfc.noaa.gov/graphicalRVF.php?id=MDSC1))
  - List of seven online telemetry gauges used by TID, with links to each on the USGS National Water Information System website
- Groundwater monitoring is implemented by TID throughout the irrigation service area, a portion of which is reported as part of SBx7-6 (California Statewide Groundwater Elevation Monitoring or CASGEM) (Figure 7.7) Groundwater level data are available to growers upon request.
- Information about groundwater supply wells is provided by TID staff through pump tests. As described in Section 7.4.10, TID staff are trained in pump testing methods and provide flow tests upon request to irrigators and Improvement Districts throughout the District’s irrigation and electrical service areas.
- Upper Tuolumne River watershed collaborative project to implement Forecast Informed Reservoir Operations (FIRO), a reservoir-operations forecasting strategy that is communicated to the TID Board of Directors, and available to the public through the Board process.
- Information describing the suitability of surface water, groundwater, and drain water quality for irrigation is collected by TID staff and is available to growers upon request, as described in Section 4.2:
  - Surface water quality is monitored at Main Canal Drop 1 (effectively representing Turlock Lake supply) and all spill locations twice during each irrigation season
  - Groundwater samples from drainage wells and rented wells have historically been monitored to maintain a good understanding of the quality of groundwater entering the canal system. Samples are collected as needed to confirm the current water quality conditions if there are concerns regarding water quality in a specific area or from a particular well.
  - Groundwater samples are tested by TID during the formation of a pump Improvement District.
  - Subsurface drainage at 32 tile drain discharge locations has historically been sampled and evaluated on a quarterly basis
Canal flows are monitored by multi-parameter water quality sondes at 18 canal and drain spill locations. The sondes measure electrical conductivity (EC) and temperature on a real-time basis, and upload the data into TID’s SCADA system.

Figure 7.5. Links to Real Time Hydrological Conditions on TID Website (https://www.tid.org/irrigation/hydrological-conditions/).
Figure 7.6. Sample Summary of Real Time Hydrological Conditions along Tuolumne River Below La Grange Dam.
7.4.12.4 Agricultural Water Management Educational Programs and Materials for Farmers, Staff, and the Public

TID offers numerous educational materials and programs to farmers, staff, and the public through its website, newsletter, social media, and other sources, as summarized below.

- TID regularly prepares an irrigation newsletter, titled “The Grower,” that is distributed to growers, staff, and the public quarterly (Figure 7.8).
- TID’s “Irrigation Information” webpage provides a wealth of resources and educational materials, all of which are provided in a user-friendly and accessible format (Figure 7.9). Topics and resources accessible on this page include (but are not limited to):
  - Irrigation tips for water conservation
  - Information on Rubicon gates
  - CIMIS weather station data
  - Water measurement educational resources
  - Groundwater management educational resources
  - TID’s most recently adopted AWMP and supporting documents
- TID’s “Irrigation” webpage provides links to educational materials and data from Don Pedro Reservoir, La Grange Dam, Turlock Lake, and other locations in the TID distribution system (see links to data in Section 7.4.12.3, and Figure 7.5).
- TID supports local educators by participating in school assemblies and demonstrations as well as career days, and has created an “Education” webpage that provides education guides and videos to the public.
• TID has developed training videos for staff, irrigators, and growers that provide information on the operation of Rubicon sidegates. These videos are available in English and Spanish on the TID website (https://www.tid.org/irrigation/irrigation-information/how-to-operate-rubicon-equipped-sidegates/).
• TID provides remote data access to staff and growers, providing delivery flows data for sidegates with SlipMeters and permanent FlumeGates.
• TID employs an assistant engineer with a background in agriculture who provides on-farm technical support to growers. Services include support of micro/drip conversion and on-farm reservoir sizing.
• TID has increased its social media presence, developing specific content to keep growers informed of the latest information.
• TID conducts occasional seminars for growers on various water management topics.
Growers Offer Feedback on Communications

In March, TID launched a survey of the District’s irrigation customers to identify how best to communicate and engage with you, the growers in our irrigation service area. The brief, 10-question survey was meant to identify preferred communication methods, satisfaction rates with current District communications, and invite customers to provide additional contact information for future communications. The survey was mailed directly to 5,000 growers and was distributed digitally via email and text messages to over 6,000 contacts.

The preferred method by which to receive TID specific news and information, print responses heavily favored Printed Mail (55.25%) to the next preferred option of Email (20.76%). Digital responses preferred Email (43.93%) with a fairly even split for the next preferred method between Text Message (25.31%) and Printed Mail (24.69%).

Based on the feedback we received and the high number of responses indicating the preference for printed information, TID made the decision to revamp our Grower Newsletter. The new format will allow us to communicate more of the information growers are looking for in a concise format. To address the growing number of irrigation customers who prefer their information in a digital format we will be creating a digital campaign on our social media platforms that pull articles and information from the newsletter. In addition, future issues of the newsletter will offer links and QR codes to additional information on certain topics and issues.

We are hopeful that all of these changes will help bring you the information you need from the District to help you plan the operations of your farm, fields or property.

Figure 7.8. Front Page of December 2020 Issue of “The Grower.”
Figure 7.9. TID Irrigation Information Webpage (https://www.tid.org/irrigation/irrigation-information/).
7.4.13 Evaluate Supplier Policies to Allow More Flexible Deliveries and Storage (10608.48.c(13))

**Status: Implementing**

TID is implementing this EWMP through ongoing partnership with cooperating entities at Don Pedro Reservoir, working together on watershed studies and other efforts, including Forecast-Coordinated Operations (F-CO) and Forecast-Informed Reservoir Operations (FIRO) of the reservoir. Data and tools available through these programs and the Airborne Remote Sensing for Snowpack (ARSS) Program allow TID to better track and understand the amount of water in the upper watershed, informing reservoir operations to optimize the balance of available flood storage and water supply storage. TID also works with applicable regulatory agencies that affect the flexibility with which TID can store and deliver water.

Another example of coordination is TID’s role in the formation and ongoing operation of the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA), an association of local municipal water systems and agencies located in the western portion of the Turlock Subbasin. As a member of the WTSGSA, TID is actively involved in SGMA-implementation efforts and GSP development for the Turlock Subbasin, which may affect the flexibility of water use and storage in the Subbasin. Both the WTSGSA and the East Turlock Subbasin GSA anticipate adopting and implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), beginning in 2022. TID will continue to evaluate opportunities for more flexible deliveries and storage in the future and will pursue those opportunities found to be locally cost-effective.

7.4.14 Evaluate and Improve Efficiencies of Supplier’s Pumps (10608.48.c(14))

**Status: Implementing**

TID is implementing this EWMP by testing and monitoring TID-owned and privately-owned wells that the District rents.

In order to develop and maintain in-house pump testing capabilities, TID trained employees in pump testing methods. Pumps owned by TID are tested as needed to evaluate operational changes and to reliably calculate flows. The test results are used by staff to evaluate repair and replacement options. TID has an ongoing pump capital improvement program designed to maintain the efficiency of TID owned pumps through rehabilitation or replacement when necessary.

Improvement District pumps or other privately owned pumps have historically been tested once per year when they are rented by TID, or upon request by the owner. The pump test information has been utilized by TID to evaluate which pumps to rent and to accurately calculate the amount of water pumped by the District. This information is also provided to the pump owner to assist with maintenance decisions. Fewer pump tests have been conducted over the last three to five years as manpower has been redirected to other urgent efforts in support of TID’s delivery measurement accuracy verification and field-testing program (described in Section 7.2 and Appendix F).
TID has also implemented remote operation capabilities to improve the efficiency of the District’s drainage pumps. WDOs are able to remotely turn on and shut down drainage pumps using portable tablets to prevent operational spillage. This also reduces wear and tear on the pumps, prolonging the pump life and improving efficiency.

TID will continue to implement this program in the future and continue to evaluate locally cost-effective opportunities to expand the program as part of the District’s overall management of water and electrical resources.

7.5 SUMMARY OF EWMP IMPLEMENTATION STATUS

TID has taken many actions to promote efficient and sustainable water management throughout its more than 130-year history. Today, TID continues to review and plan additional measures to accomplish improved and more efficient water management. For purposes of this AWMP, TID’s actions have been organized and are reported with respect to the Efficient Water Management Practices (EWMPs) listed in Water Code §10608.48. A summary of the implementation status of each listed EWMP is provided in Table 7.4.

TID and its staff has long been active in, and affiliated with, organizations supporting excellence in water management, including the Association of California Water Agencies (ACWA), the California Farm Water Coalition (CFWC), the United States Committee for Irrigation and Drainage (USCID), the Irrigation Technology and Research Center (ITRC), the American Society of Civil Engineers (ASCE), the California Irrigation Institute (CII), the California Municipal Utilities Association (CMUA) and others. One of the benefits that TID’s active participation in these organizations brings is continuing exposure to water management innovations through conferences, trainings, and networking with water management professionals. Additionally, TID occasionally sends staff to water management trainings to enhance skill sets and increase basic understanding of efficient water management. TID will continue its engagement in the water management community, supporting water management advancements in the District, throughout California, and beyond.
<table>
<thead>
<tr>
<th>Water Code Reference No.</th>
<th>EWMP</th>
<th>Implemented Activities (pre-2015 and ongoing)</th>
<th>Updates Since Last AWMP (2015-2020)</th>
<th>Planned Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical EWMPs</strong></td>
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<tr>
<td>10608.48.b(1)</td>
<td>Measure deliveries with sufficient accuracy</td>
<td>Initiated delivery measurement accuracy improvement program under a corrective action plan for SBx7-7 compliance: <em>Installed new permanent measurement devices with laboratory-certified flow rate accuracy at 142 sidegates serving roughly half the irrigated acreage in TID</em> <em>Developed calibrated flow rates at remaining sidegates for each specific combination of sidegate-parcel-irrigation method-requested flow rate: o Temporarily installed 57 mobile Rubicon FlumeMeters at 550 sidegates that serve 1,196 parcels (representing approximately 21 percent of TID) o Used Hach FH850 meters to determine parcel-specific calibrated flow rates at 349 sidegates serving 536 parcels (approximately 13 percent of TID) o Used Fuji Portaflow meters to determine parcel-specific calibrated flow rates at 471 sidegates serving 877 parcels (approximately 19 percent of TID)</em></td>
<td>• Completed initial corrective action plan goals, providing direct measurements or calibrated delivery flow rates to 100% of the assessed acreage served by active, non-exempted sidegates <em>Updated water ordering, delivery, and billing software to use the measured and calibrated flow rates for billing.</em></td>
<td>• Complete the last remaining actions needed for formal certification of the volumetric measurement accuracy of existing measurement devices, consistent with 23 CCR §597: o Verify accuracy of existing measurement devices that have not yet been field-tested and certified <em>Continue using the measured and calibrated flow rates for billing.</em> <em>Continue using the measured and calibrated flow rates to calculate the measured volume of water delivered for reporting to DWR.</em> *Conducted formal certification of the volumetric measurement accuracy consistent with 23 CCR §597: o Verified accuracy of new permanent measurement devices o Verified accuracy of existing measurement devices (progress delayed due to operational challenges associated with COVID-19)</td>
</tr>
<tr>
<td>10608.48.b(2)</td>
<td>Adopt a water pricing structure based in part on quantity delivered</td>
<td>Tiered pricing structure based on volume of water delivered (in effect since 2013; current rate structure in effect since 2015 after completion of the Proposition 218 process) <em>Continued using tiered volumetric pricing structure in effect since 2015</em> <em>Updated water ordering, delivery, and billing software to use the measured and calibrated flow rates (described under 10608.48.b(1)) for billing.</em></td>
<td>Continue implementing a tiered volumetric pricing structure, although the price will likely change over time.</td>
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<tr>
<td><strong>Conditional EWMPs</strong></td>
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<tr>
<td>10608.48.c(1)</td>
<td>Facilitate alternative land use (lands with exceptionally high water duties, or lands that contribute to significant problems, e.g. drainage)</td>
<td>Not Technically Feasible (not an issue in TID – lands with exceptionally high water duties or significant problems do not exist in TID’s service area; Irrigation Rules prohibit wasteful use, precluding exceptional water duties or significant problems)</td>
<td>No change (Not Technically Feasible)</td>
<td>No change (Not Technically Feasible)</td>
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<tr>
<td>10608.48.c(2)</td>
<td>Facilitate recycled water use</td>
<td>Dairy nutrient water and industrial process water from Hilmar Cheese is recycled and applied to TID irrigated lands <em>Treated M&amp;I water is recycled and applied to TID irrigated lands</em> <em>Spillage recovery and tilewater/tailwater flow into canals, where this water is available for reuse downstream</em> <em>Active spillage recovery from Harding Drain</em> <em>Tertiary treated effluent from City of Turlock used for cooling at TID’s Walnut Energy Center</em></td>
<td>Continued existing use of recycled water within TID service area, as listed in the previous column. *Continued support of SRWA’s Regional Surface Water Supply Project, which will eventually provide “offset” water to TID from recycled or stored groundwater supplies to offset a portion of the surface water supplies from TID</td>
<td>Continue existing use of recycled water within TID. *Continue working with cities and qualifying permitted dischargers to gain access to recycled water supplies.</td>
</tr>
<tr>
<td>10608.48.c(3)</td>
<td>Facilitate financing of capital improvements for on-farm irrigation systems</td>
<td>TID has an active financing program for IDs, which support on-farm capital improvements (low interest financing, 10-yr loan term) <em>Offers engineering design and construction oversight for ID irrigation facilities</em> <em>Offers at-cost maintenance and repair of ID irrigation facilities (assessment process)</em> <em>Pursues grant funding to assist growers with on-farm improvements (WaterSMART, etc.)</em></td>
<td>Continued offering existing programs and services, as listed in the previous column. <em>Continued searching for grant funding</em> *Actively involved in ongoing development of Turlock Subbasin GSP, which could include projects that facilitate on-farm improvements that encourage continued use of surface water (list of projects is currently being developed)</td>
<td>Continue offering existing programs and services. <em>Continue searching for grant funding</em> *Upon completion of GSP, there may be GSP projects that facilitate on-farm improvements that encourage continued use of surface water (list of projects is currently under development)</td>
</tr>
<tr>
<td>EWMP Code</td>
<td>Implemented Activities (pre-2015 and ongoing)</td>
<td>Updates Since Last AWMP (2015-2020)</td>
<td>Planned Activities</td>
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<tr>
<td>10608.48.c(4)</td>
<td>Tiered pricing structure promotes (A), (B), (C), and (F). Rates are higher with higher water use, promoting efficiency (A). Normal/dry year rates help to manage water by adjusting rates to reflect current water conditions (F) and by supporting TID’s conjunctive management strategy (B). Lower rates in normal years encourage recharge (C).</td>
<td>Continued using tiered volumetric pricing structure, as listed in the previous column.</td>
<td>Continue implementing a tiered volumetric pricing structure, although the price will likely change over time.</td>
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<tr>
<td>10608.48.c(5)</td>
<td>Lining/Pipelines: Lined or converted to pipelines in 92 percent of the distribution system downstream of La Grange Diversion Dam (222 miles out of ~240 miles). o In 2006-2008, lined ~4.5 miles of earthen canals o In 2014, converted the Lower Stevens Flume to a pipeline o Lateral 1 and Upper Lateral 4 have been converted from open channels to pipelines in some developed areas. Active gunite and lining maintenance program (~340,000 square feet of canal lining resurfaced each year (7.8 acres, or 0.012 square miles)). Ponding tests conducted to quantify seepage rates in lined reaches. Substantial portion of the 700 miles of ID conveyance facilities have been replaced by pipeline systems, with maintenance and replacement of aging or leaking pipes as needed. Regulating Reservoirs: In 2015, TID completed the Lateral 8 Regulating Reservoir integrated with TCC on Lateral 8. Feasibility studies of reservoirs on the Ceres Main Canal.</td>
<td>Continued gunite and lining maintenance program (~340,000 square feet of canal lining resurfaced each year (7.8 acres, or 0.012 square miles)). Expanded storage capacity of Lateral 8 Regulating Reservoir to 130 acre-feet in 2016 to allow more water to be regulated. Worked on Draft Irrigation Facilities Master Plan (IFMP), which will identify, evaluate, rank, and create implementation strategies for potential distribution system modernization projects, including a variety of projects to potentially construct regulating reservoirs and improve canal conveyance.</td>
<td>Continue gunite and lining maintenance program. Continue ponding tests, as needed, to quantify seepage rates in canal reaches to improve and monitor the effectiveness of the lining maintenance program. Potentially pursue select TID system modernization projects to be proposed under Draft IFMP (in progress), including regulating reservoir construction projects. Upon completion of GSP, there could be other GSP modernization projects that work in combination or in concert with other TID projects, including the Draft IFMP projects. Complete design of the new reservoir. Obtain CEQA clearance to construct the new reservoir. Potentially construct reservoir, depending on funding.</td>
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<tr>
<td>10608.48.c(6)</td>
<td>Increase flexibility in water ordering by, and delivery to, water customers. TID offers arranged-frequency demand deliveries (arranged day; requested delivery flow rate; duration is controlled by customer). Improvements to customer service o Central Call Center moved to Customer Service Department (2008) o Online ordering and online water use information (since 2014).</td>
<td>Expanded customers’ ability to request and receive non-standard delivery flows to serve drip and microirrigation systems (standard flood head is 15 cfs). Continued offering existing benefits to customers: o arranged-frequency demand deliveries o online ordering and online water use information o annual water use statement o access to real-time monitoring data.</td>
<td>Continue offering existing benefits to customers: o arranged-frequency demand deliveries o online ordering and online water use information o annual water use statement o access to real-time monitoring data.</td>
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</table>
### EWMP Reference No. 10608.48.c(7)

#### Construct and operate supplier spill and tailwater recovery systems

- **TID canals passively intercept spillage from the upper laterals allowing water to be utilized to the greatest extent possible for deliveries downstream.**
- **TID system intercepts undelivered irrigation water from ID pipelines.**
- **TID system recovers and reuses tilewater and tailwater that re-enter the system.**
- **Spillage is actively recovered from Harding Drain.**
- **Lateral 8 Regulating Reservoir and TCC project regulates excess flows and reduces spillage from Lateral 8.**
- **WDOs use tablets and computers in the field to access real-time SCADA data at spillage sites and other locations in the system, allowing better control over the system to reduce spillage.**
- **Operation of drainage wells (many of which are remotely-operable) and rented wells provide a localized source of supply to match demand and reduce spillage.**
- **Created and implemented SCADA Master Plan, which has helped to reduce spillage through increased mobile data access, remote operation and monitoring of irrigation control structures, and improved system redundancy.**

### EWMP Reference No. 10608.48.c(8)

#### Increase planned conjunctive use of surface water and groundwater within the supplier service area

- **TID implements a comprehensive conjunctive management program in its regular operations.**
- **TID has a series of pre- and post-1914 water rights that provide secure surface water supplies.**
- **In dry years, TID operates drainage wells and rents privately-owned wells to increase water supply.**
- **Tiered pricing structure in normal and dry years.**
  - Affordable pricing to promote the use of available surface water supplies in all years
  - Lower volumetric prices in normal years to incentivize surface water use and recharge
  - Higher volumetric prices and fixed charges in dry years to promote water conservation and to provide revenue to

### Updates Since Last AWMP (2015-2020)

- **Continued operating and installing SCADA equipment to improve operational flexibility.**
- **Completed Irrigation Delivery Operations Assessment in 2019 to evaluate the efficiency and flexibility of TID’s irrigation delivery system operation.**
  - Compared parameters related to system flexibility, efficiency, and deliveries between TID and other California irrigation water suppliers.
  - Evaluated WDO’s activities and roles in providing high-quality and flexible irrigation deliveries.
- **Worked on Draft IFMP, creating a strategic plan and cost estimates for modernizing the TID system and infrastructure.** These projects are conceptualized and designed with the goal of improving service levels, including delivery flexibility and consistency, to TID’s customers.
- **In 2015, allowed growers to pump groundwater into canals in exchange for a delivery “credit” of equal volume.**

### Planned Activities

- **In some dry years, allow growers to pump into canals for a delivery “credit” of equal volume.**
- **Continue pursuing distribution system infrastructure improvements.**
- **Potentially pursue select TID system modernization projects proposed under Draft IFMP (in progress).**

### Water Code Section 10706.24.2.g(8)

#### Increase planned conjunctive use of surface water and groundwater within the supplier service area

- **TID implements a comprehensive conjunctive management program in its regular operations.**
- **TID has a series of pre- and post-1914 water rights that provide secure surface water supplies.**
- **In dry years, TID operates drainage wells and rents privately-owned wells to increase water supply.**
- **Tiered pricing structure in normal and dry years.**
  - Affordable pricing to promote the use of available surface water supplies in all years
  - Lower volumetric prices in normal years to incentivize surface water use and recharge
  - Higher volumetric prices and fixed charges in dry years to promote water conservation and to provide revenue to

### Updates Since Last AWMP (2015-2020)

- **Continued conjunctive management program.**
- **Enhanced conjunctive management by modifying operations to pump even less in normal and wetter years to further increase the use of available surface water and allow for in-lieu groundwater recharge, with lower rented pumping on average in the last five years as compared to the historical past.**
- **Continued remote operation of drainage wells to carefully control pumping and increase groundwater recharge.**
- **Active participation in local groundwater entities and initiatives, including SGMA efforts.**
- **Active engagement in the development of a groundwater recharge assessment tool for the Turlock Subbasin.**
- **Conducted ponding tests at Turlock Lake as a means of evaluating existing reservoir operations, providing information about reservoir recharge to**

### Planned Activities

- **Enhance conjunctive management program and related practices.**
- **As a member of the West Turlock Subbasin GSA, adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), with plans to achieve groundwater sustainability by 2042.**
- **Continue and expand groundwater and surface water monitoring under SGMA.**
- **Continue engagement in the development of a groundwater recharge assessment tool for the Turlock Subbasin.**
- **Continue active runoff forecasting and surface water supply management through the ARSS, F-CO, FIRO, and watershed monitoring programs.**
### SECTION SEVEN

**Water Code Reference No.**

<table>
<thead>
<tr>
<th>EWMP</th>
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</table>
| 10608.48.c(9) | **Automate canal control structures**
- TID operates more than 345 automatic canal control structures, including 66 Meikle automatic gates, 227 long-crested weirs, flap gates (18 locations), Rubicon FlumeGates™ (31 locations), and other structures.
- TID has been installing Rubicon FlumeGates at many canal headgate structures, with SCADA integration and remote operability.
- Created and implemented SCADA Master Plan, and now operates 397 SCADA sites, providing control and/or real-time flow and water level information throughout the canals, including at lateral headgates.
- All structure modifications are designed to allow for future modifications.
- Lateral 8 Regulating Reservoir and Total Channel Control (TCC) implemented on Lateral 8 beginning in 2015, allowing near-full automated control of flows along Lateral 8.
- TID conducts a pump testing program and provides testing services for private pumps upon request throughout the District’s irrigation and electrical service areas.
- TID historically tested rented pumps once per year.
- TID uses portable flow meters to test customer wells. Two staff members are available for water level testing and twelve WDOs plus additional staff are available for flow testing.
- TID trained employees in pump testing methods.
- Continued pump testing program for District-owned and rented pumps, and offering pump testing services for private pumps upon request (fewer tests over last 3-5 years as manpower has been redirected to delivery measurement accuracy field-testing efforts).
| Support efficient water management and to support decisions on future operations at Turlock Lake.
- Continued active runoff forecasting and surface water supply management through the ARSS, F-CO, FIRO, and watershed monitoring programs.
- Updated water budget to include the Upper Main Canal and Turlock Lake, supporting better accounting for all inflows/outflows, including recharge.
- Improve monitoring and tracking of off-season flows through the system, supporting better management of this water and the District’s ability to make use of this water locally. |
| 10608.48.c(10) | **Facilitate or promote customer pump testing and evaluation**
- TID has been installing Rubicon FlumeGates at many canal headgate structures, with SCADA integration and remote operability.
- Created and implemented SCADA Master Plan, and now operates 397 SCADA sites, providing control and/or real-time flow and water level information throughout the canals, including at lateral headgates.
- All structure modifications are designed to allow for future modifications.
- Lateral 8 Regulating Reservoir and Total Channel Control (TCC) implemented on Lateral 8 beginning in 2015, allowing near-full automated control of flows along Lateral 8.
- TID conducts a pump testing program and provides testing services for private pumps upon request throughout the District’s irrigation and electrical service areas.
- TID historically tested rented pumps once per year.
- TID uses portable flow meters to test customer wells. Two staff members are available for water level testing and twelve WDOs plus additional staff are available for flow testing.
- TID trained employees in pump testing methods.
- Continued pump testing program for District-owned and rented pumps, and offering pump testing services for private pumps upon request (fewer tests over last 3-5 years as manpower has been redirected to delivery measurement accuracy field-testing efforts).
| Continue appointing Water Conservation Coordinator |
| 10608.48.c(11) | **Designate a water conservation coordinator**
- Water Conservation Coordinator position established in 1997.
- Position is currently filled by the District’s Water Planning Department Manager.
| Continue appointing Water Conservation Coordinator |
| 10608.48.c(12) | **Provide for the availability of water management services to water users.**
- On-farm irrigation and drainage system evaluations:
  - TID provides services to build, operate, and maintain improvement district (ID) facilities, including on-farm distribution and irrigation facilities, subsurface drains, and deep wells.
  - TID staff provide testing upon request for pump flow rates and application rates through pressurized irrigation systems using Fuji flow meters.
  - Normal Year and Real-time Irrigation Scheduling and Crop Evapotranspiration Information:
    - TID installed CIMIS stations #168 (now inactive) and #168 at Denair in 2002 and 2009.
    - TID provides growers with CIMIS website information, tutorials, and data through links on the TID irrigation information web page.
    - Continued offering on-farm irrigation and drainage system services upon request:
      - Engineering services for ID facilities, including on-farm distribution and irrigation facilities, subsurface drains, and deep wells.
      - Pump flow rate testing and irrigation system application rate testing.
      - Continued offering irrigation scheduling and crop evapotranspiration information (links to CIMIS information, weather, and precipitation forecasts on TID website).
      - Continued offering on-farm irrigation and drainage system services upon request:
        - Water use information online, upon request, and in annual water use report.
        - Real-time flows, water level, and storage data available online.
  - On-farm irrigation and drainage system evaluations:
  - TID provides services to build, operate, and maintain improvement district (ID) facilities, including on-farm distribution and irrigation facilities, subsurface drains, and deep wells.
  - TID staff provide testing upon request for pump flow rates and application rates through pressurized irrigation systems using Fuji flow meters.
  - Normal Year and Real-time Irrigation Scheduling and Crop Evapotranspiration Information:
    - TID installed CIMIS stations #168 (now inactive) and #168 at Denair in 2002 and 2009.
    - TID provides growers with CIMIS website information, tutorials, and data through links on the TID irrigation information web page.
    - Continued offering on-farm irrigation and drainage system services upon request:
      - Engineering services for ID facilities, including on-farm distribution and irrigation facilities, subsurface drains, and deep wells.
      - Pump flow rate testing and irrigation system application rate testing.
      - Continued offering irrigation scheduling and crop evapotranspiration information (links to CIMIS information, weather, and precipitation forecasts on TID website).
      - Continued offering on-farm irrigation and drainage system services upon request:
        - Water use information online, upon request, and in annual water use report.
        - Real-time flows, water level, and storage data available online.
| Continue offering existing on-farm irrigation and drainage system services upon request.
- Continue offering existing irrigation scheduling and crop evapotranspiration information.
- Continue monitoring and offering surface water, groundwater, and drainage water quantity and quality data to growers:
  - Continue SGMA-related public outreach and involvement.
  - Adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP).
  - Continue and expand groundwater and surface water monitoring under SGMA.
### Implemented Activities (pre-2015 and ongoing)

- TID provides growers with weather and precipitation forecasts on the TID weather web page
- Surface water, groundwater, and drainage water quantity and quality data:
  - Parcel water use information available at any time online, or upon a grower’s request
  - Water use information provided to all growers in year-end water use report
- Real time flows, water level, and storage are available on the TID website for various sites operated or used by TID:
  - Real-time flows, water level, and storage available for six sites via TID’s WISKI web portal
  - Current report and link to current flows to the Tuolumne River below La Grange Dam available on TID website
  - Links to seven online telemetry gauges used by TID and reported by USGS NWIS are available through the TID website
- CASGEM groundwater monitoring implemented by TID
- Information about groundwater supply wells provided by TID staff
- Upper Tuolumne River watershed collaborative project to implement Forecast Informed Reservoir Operations (FIRO), a reservoir-operations forecasting strategy that is communicated to the TID Board of Directors, and available to the public through the Board process
- Suitability of surface water, groundwater, and drain water quality for irrigation is tested by TID staff and available to growers upon request:
  - Surface water monitored at Main Canal Drop 1 (Turlock Lake supply) and all spill locations twice during each irrigation season
  - Groundwater samples from drainage wells and rented wells monitored as needed, upon request, and during the formation of a pump Improvement District.
  - Subsurface drainage at 32 tile drain discharge sites historically evaluated on a quarterly basis
  - Canal flows monitored by multi-parameter water quality sondes at 18 canal and drain locations, recording EC and temperature and upload the data to TID’s SCADA system.

### Updates Since Last AWMP (2015-2020)

- Pump tests conducted for groundwater supply wells
- Continued CASGEM groundwater monitoring, and plans for SGMA groundwater monitoring
- Continued and formalized FIRO forecasting
- Continued monitoring suitability of surface water, groundwater, and drain water quality for irrigation (monitoring less frequent in recent years because of other operational efforts underway in TID)
- Continued providing agricultural water management educational programs and materials to growers, staff, and the public:
  - Prepared and distributed “The Grower” irrigation newsletter
  - Maintained and updated the “Irrigation Information” and “Education” webpages with resources and educational materials
  - Maintained and updated the “Irrigation” webpage with links to educational materials and water data
  - Continued targeted social media messaging
  - Continued supporting local educators by participating in school assemblies, demonstrations, and career days
  - Continued providing remote data access to staff and growers from SlipMeters and FlumeGates.
  - Began shifting away from annual grower meetings, and moving toward direct emails and expanded use of new virtual communications mediums (social media, etc.) to enhance grower engagement.

### Planned Activities

- Continue providing agricultural water management educational programs and materials to growers, staff, and the public
- Continue targeted social media messaging
## Implemented Activities (pre-2015 and ongoing)

- TID has developed training videos for staff, irrigators, and growers that provide information on the operation of Rubicon sidegates. These videos are available in English and Spanish on the TID website.
- TID provides remote data access to staff and growers, providing delivery flows data for sidegates with SlipMeters and permanent FlameGates.
- TID employs an assistant engineer with a background in agriculture who provides on-farm technical support. Services include support of micro/drip conversion and on-farm reservoir sizing.
- TID conducted annual grower meetings.
- TID conducts occasional seminars for growers on various water management topics.

## Updates Since Last AWMP (2015-2020)

- Continued partnership with cooperating agencies and applicable regulatory agencies that have the potential to impact the District's flexibility in delivery and storage.
- Continued implementation of ARSS, F-CO, FIRO, and watershed monitoring to better track and understand the amount of water in the upper watershed and optimize reservoir operations to balance flood storage and water supply storage.
- Active participation in local groundwater entities and initiatives, including SGMA efforts.
- As a member of the West Turlock Subbasin GSA, adopt and begin implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), with plans to achieve groundwater sustainability by 2042.

## Planned Activities

- Continue partnership with cooperating agencies and applicable regulatory agencies.
- Continue implementation of ARSS, F-CO, FIRO, and watershed monitoring.
- Continue participation in local groundwater entities and initiatives, including SGMA efforts.
- Continue to provide remote operation capabilities to WDOs.
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7.6 EVALUATION OF WATER USE EFFICIENCY IMPROVEMENTS

CWC §10608.48(d) requires that AWMPs include:

... a report on which efficient water management practices have been implemented and are planned to be implemented, an estimate of the water use efficiency improvements that have occurred since the last report, and an estimate of the water use efficiency improvements estimated to occur five and 10 years in the future.

A description of which EWMPs have been implemented has been provided in the sections above. This section provides an evaluation of EWMP implementation and an estimate of water use efficiency (WUE) improvements that have occurred in the past and are expected to occur in the future.

As described elsewhere in this document, TID has, over time, effectively implemented a variety of EWMPs designed to: develop and maintain reliable surface water and groundwater supplies; prevent or reduce system losses; promote the efficient use of water; seek alternative sources of supply; and maximize the flexibility with which the District can deliver and store water. The value of evaluating WUE improvements (and EWMP implementation in general), from TID’s perspective, is to identify what the benefits of EWMP implementation are and to identify those additional actions that hold the potential to improve TID’s ability to provide customers with a reliable water supply.

First and foremost among the issues that must be considered in any evaluation of the benefits of EWMP implementation and WUE improvements is how any proposed actions may impact the water balance, and overall water supply availability (Davenport and Hagan, 1982; Keller, et al., 1996; Burt, et al., 2008; Clemmens, et al., 2008; Canessa, et al., 2011). For example, flows to deep percolation and seepage that could be considered losses in some settings are critical to maintain the long-term sustainability of the underlying groundwater basin. Reduced seepage or on-farm WUE improvements could be considered beneficial in some areas, but would adversely impact local groundwater recharge. Similarly, spillage and tailwater are also recoverable flows. These flows are already being recovered locally, or have the potential to be put to beneficial use downstream. The only distribution system or on-farm losses that are not recoverable within TID, the underlying groundwater basin, or the San Joaquin River Basin as a whole are canal and reservoir water surface evaporation and evaporation from irrigation application. These components represent a small portion of TID’s water supply, resulting in a high water management fraction ranging from 98 to 99 percent (Table 5.6). An implication of this is that very little water can be made available through water conservation in TID to increase the State’s overall water supply.

An essential first step in evaluating EWMP implementation and WUE improvements is a comprehensive, quantitative, multi-year water balance (see Section 5). The quantitative understanding of the water balance flow paths enables identification of targeted flow paths for TID water management objectives and WUE improvements, along with improved understanding of the beneficial impacts and consequential effects of EWMP implementation at varying spatial and temporal scales. The water balance enables evaluation of potential changes in flow path quantities and timing for any given change in water management.
Even where comprehensive, multi-year water balances have been developed, evaluating water balance impacts and WUE improvements is not a trivial task. Issues of spatial and temporal scale and the relatively small changes in annual flow path volumes (relative to year to year variation in water diversions and use) that result from most water management improvements coupled with the inaccuracies inherent in even the best water measurement greatly complicate the evaluation of WUE improvements. Additionally, the implications of recoverable and nonrecoverable losses at varying scales complicate the evaluation of WUE improvements, and consequential, potentially unintended consequences must be considered (Burns et al. 2000, AWMC 2004).

Given the aforementioned complexities inherent in evaluating WUE improvements and the extremely limited potential for increase to the State’s overall water supply, TID has developed a qualitative assessment of past WUE improvements and those expected to occur five and ten years in the future. The qualitative magnitude is expressed as None, Limited, Modest, or Substantial in order of increasing relative magnitude for each EWMP. Past WUE improvements are estimated relative to no historical implementation and relative to the time of the last plan (adopted in November 2015). Future WUE improvements are estimated for five years in the future (2025) relative to 2020 and for ten years in the future (2030) relative to 2020. The result of this evaluation is provided in Table 7.5.

TID will continue to seek out and implement water management actions that meet its overall water management objectives and result in WUE improvements. TID staff regularly attend water management conferences and evaluate technological advances in the context of TID’s water management objectives and regional setting. The continuing review of water management within TID, coupled with exploration of innovative opportunities to improve water management will continue to result in future water management innovations and additional WUE improvements.
Table 7.5. Evaluation of Relative Magnitude of Past and Future WUE Improvements by EWMP.

<table>
<thead>
<tr>
<th>Water Code Reference No.</th>
<th>EWMP</th>
<th>Implementation Status</th>
<th>Marginal WUE Improvements&lt;sup&gt;1,2&lt;/sup&gt;</th>
<th>Past Relative to No Historical Implementation&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Since Last AWMP&lt;sup&gt;4&lt;/sup&gt;</th>
<th>5 Years in Future&lt;sup&gt;5&lt;/sup&gt;</th>
<th>10 Years in Future&lt;sup&gt;5&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>10608.48.b</td>
<td>(1)</td>
<td>Measure the volume of water delivered to customers with sufficient accuracy</td>
<td>Being Implemented</td>
<td>No Direct WUE Improvements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.b</td>
<td>(2)</td>
<td>Adopt a pricing structure based at least in part on quantity delivered</td>
<td>Being Implemented</td>
<td>Limited</td>
<td>Limited</td>
<td>Limited to Modest, Depending on Changes to Pricing Structure</td>
<td></td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(1)</td>
<td>Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage</td>
<td>Not Technically Feasible</td>
<td>Not Applicable to TID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(2)</td>
<td>Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils</td>
<td>Being Implemented</td>
<td>Modest (approx. 5,000 to 6,200 AF total annually)</td>
<td>None</td>
<td>None</td>
<td>None to Limited, Depending on Future Opportunities (Timing and Availability)</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(3)</td>
<td>Facilitate financing of capital improvements for on-farm irrigation systems</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>None</td>
<td>None</td>
<td>None to Modest, Depending on Future Needs</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(4)</td>
<td>Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>None</td>
<td>Limited, Depending on Change In Pricing Structure</td>
<td></td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(5)</td>
<td>Expand lined or piped portions of the distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage</td>
<td>Being Implemented</td>
<td>Substantial (Limited Reduction in Irrecoverable Losses)</td>
<td>None</td>
<td>None</td>
<td>Modest</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(6)</td>
<td>Increase flexibility in water ordering by, and delivery to, water customers within operational limits</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>Limited</td>
<td>Limited</td>
<td>Modest</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(7)</td>
<td>Construct and operate supplier spill and tailwater recovery systems</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>Limited</td>
<td>Limited</td>
<td>Modest</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(8)</td>
<td>Increase planned conjunctive use of surface water and groundwater within the supplier service area</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>Limited</td>
<td>Limited</td>
<td>Modest</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(9)</td>
<td>Automate canal control structures</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>Limited</td>
<td>Limited</td>
<td>Modest</td>
</tr>
<tr>
<td>10608.48.c</td>
<td>(10)</td>
<td>Facilitate or promote customer pump testing and evaluation</td>
<td>Being Implemented</td>
<td>Modest</td>
<td>None</td>
<td>(Limited Energy Conservation)</td>
<td>None</td>
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<tr>
<td>10608.48.c</td>
<td>(11)</td>
<td>Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report</td>
<td>Being Implemented</td>
<td>The activities of the Water Conservation Coordinator and other TID staff to achieve WUE improvements through implementation of the EWMPs are described individually by EWMP.</td>
<td></td>
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<tr>
<td>10608.48.c</td>
<td>(12)</td>
<td>Provide for the availability of water management services to water users</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>Limited</td>
<td>Limited</td>
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<tr>
<td>10608.48.c</td>
<td>(13)</td>
<td>Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>Modest</td>
<td>Modest</td>
<td></td>
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<tr>
<td>10608.48.c</td>
<td>(14)</td>
<td>Evaluate and improve the efficiencies of the supplier’s pumps</td>
<td>Being Implemented</td>
<td>Substantial</td>
<td>None</td>
<td>(Limited Energy Conservation)</td>
<td>None</td>
</tr>
</tbody>
</table>

<sup>1</sup> As noted herein and throughout this analysis, reductions in losses that result in WUE improvements at the farm or district scale do not result in WUE improvements at the basin scale, except in the case of evaporation reduction. All losses to seepage, spillage, tailwater, and deep percolation are recoverable within TID or by downgradient water users within the basin.

<sup>2</sup> In most cases, quantitative estimates of improvements are not available. Rather, qualitative estimates are provided as follows, in increasing relative magnitude: None, Limited, Modest, and Substantial.

<sup>3</sup> WUE Improvements occurring in recent years relative to if they were not being implemented.

<sup>4</sup> WUE Improvements occurring in recent years relative to the level of implementation at time of last AWMP (2015).

<sup>5</sup> WUE Improvements expected in 2025 (five years in the future) and 2030 (ten years in the future), relative to level of implementation in recent years.
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8. References


TID Website Information Regarding Draft AWMP

Updates to the TID AWMP are communicated to the public through the TID website:

https://www.tid.org/irrigation/irrigation-information/ag-water-management-plan/
### Table A.1. TID Agricultural Water Management Plan – Outreach/Distribution List

<table>
<thead>
<tr>
<th>Agency/Entity¹</th>
<th>Department</th>
<th>Mailing Street Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Letter Notice #1</th>
<th>Letter Notice #2</th>
<th>Draft Plan</th>
<th>Plan, via TID Website</th>
<th>Submittal (Method)</th>
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<tbody>
<tr>
<td>Stanislaus County</td>
<td>Environmental Resources Dept</td>
<td>3800 Cornucopia Way, Ste C</td>
<td>Modesto</td>
<td>CA</td>
<td>95358-9494</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Merced County</td>
<td>Environmental Health Dept</td>
<td>260 E 15th St</td>
<td>Merced</td>
<td>CA</td>
<td>95341-6216</td>
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<td>City of Turlock</td>
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<td>156 S. Broadway, Ste 270</td>
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<td>95380-5461</td>
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<td>Modesto</td>
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<td>95354-0642</td>
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<td>95386-0199</td>
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<td>Monterey Tract CSD</td>
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<td>CA</td>
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<td>Eastside WD</td>
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<td>731 East Yosemite Ave, Ste B #147</td>
<td>Merced</td>
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<td>Ballico-Cortez WD</td>
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## PUBLIC OUTREACH AND RESOLUTION ADOPTING PLAN

<table>
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<tr>
<th>Agency/Entity 1</th>
<th>Department</th>
<th>Mailing Street Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
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<th>Letter Notice #2</th>
<th>Draft Plan</th>
<th>Plan, via TID Website</th>
<th>Submittal (Method)</th>
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<td>Turlock</td>
<td>CA</td>
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1 Acronyms:
CSD = Community Services District
CWD = County Water District
GSA = Groundwater Sustainability Agency
LAFCO = Local Agency Formation Commission
WD = Water District
Sample Notice of Intent Letter to Local Public Agencies

December 22, 2020

Walter Ward  
Stanislaus County  
Environmental Resources Dept  
3800 Cornucopia Way, Ste C  
Modesto, CA 95358-9494

Dear Walter Ward,

RE: Notice of Intent to Adopt Update to Agricultural Water Management Plan (Turlock Irrigation District)

California law requires Agricultural Water Management Plans to be updated by April 1, 2021. The Turlock Irrigation District’s current Agricultural Water Management Plan (AWMP) was adopted on November 10, 2015 and evaluates water use within the District and applicable management practices to make the best use of available resources. A copy of the 2015 plan is available on TID’s website (a link is provided below).

TID is in the process of preparing an update of the plan to comply with these requirements and intends to adopt the updated 2020 AWMP in 2021. Prior to adopting an updated plan, the draft will be available for review and public comment. An electronic copy of the draft 2020 plan will be posted on TID’s website. A hearing is anticipated in March 2021. Following the public hearing, the TID Board of Directors will consider comments received, and may choose to consider adopting the plan on the day of the hearing.

Comments may be submitted via email to dcmontalbano@tid.org or via US Mail to:  
Debbie Montalbano  
Turlock Irrigation District  
P.O. Box 949  
Turlock, CA 95381-0949

Please refer to our website (https://www.tid.org/irrigation/irrigation-information/ag-water-management-plan/) to review the District’s 2015 AWMP, and/or the draft 2020 plan when it becomes available in February.

Should you have any questions regarding this process, please do not hesitate to contact Debbie Montalbano at (209) 883-8428, or dcmontalbano@tid.org.

Sincerely,

Michael Cooke  
Director of Water Resources and Regulatory Affairs
Sample Public Hearing Notice Letter to Local Public Agencies

(to be included in final AWMP)
Public Hearing Notice

(to be included in final AWMP)
APPENDIX A
PUBLIC OUTREACH AND RESOLUTION ADOPTING PLAN

Copy of Hearing Notice – Turlock Journal

(to be included in final AWMP)
Resolution Adopting AWMP

(to be included in final AWMP)
Appendix B

TURLOCK GROUNDWATER BASIN GROUNDWATER MANAGEMENT PLAN
TURLOCK GROUNDWATER BASIN

Groundwater Management Plan

Prepared for.

Turlock Irrigation District
333 East Canal Drive/P.O. Box 949
Turlock, CA 95381

March 18, 2008

Prepared by.

Turlock Groundwater Basin Association
APPENDIX B

The Turlock Groundwater Basin Groundwater Management Plan can be found on the TID website at:

https://issuu.com/turlockirrigationdistrict/docs/groundwater_management_plan?e=15635682/51560707
Appendix C

EXAMPLE NEWSLETTER
Growers Offer Feedback on Communications

In March, TID launched a survey of the District’s irrigation customers to identify how best to communicate and engage with you, the growers in our irrigation service area. The brief, 10-question survey was meant to identify preferred communication methods, satisfaction rates with current District communications, and invite customers to provide additional contact information for future communications. The survey was mailed directly to 5,000 growers and was distributed digitally via email and text messages to over 6,000 contacts.

The preferred method by which to receive TID specific news and information, print responses heavily favored Printed Mail (55.25%) to the next preferred option of Email (20.76%). Digital responses preferred Email (43.93%) with a fairly even split for the next preferred method between Text Message (25.31%) and Printed Mail (24.69%)

Based on the feedback we received and the high number of responses indicating the preference for printed information, TID made the decision to revamp our Grower Newsletter. The new format will allow us to communicate more of the information growers are looking for in a concise format. To address the growing number of irrigation customers who prefer their information in a digital format we will be creating a digital campaign on our social media platforms that pull articles and information from the newsletter. In addition, future issues of the newsletter will offer links and QR codes to additional information on certain topics and issues.

We are hopeful that all of these changes will help bring you the information you need from the District to help you plan the operations of your farm, fields or property.
Important Off-Season Notices

ANNOUNCEMENTS

Water Use Statement Due-Date: December 31, 2020

2nd Installment for Fixed Water Charge: December 20, 2020

1st Installment for 2021 Assessments: December 20, 2020

Last Day for Water Transfers: December 20, 2020

TID has an O.F.F.E.R for You

The TID O.F.F.E.R. (On-Farm Flow Efficiency Recommendation) program will send members of our Civil Engineering and Water Distribution departments to your property to evaluate your specific irrigation situation and help you identify potential opportunities to increase your overall efficiency. Simply email offerprogram@tid.org and a TID staff member will begin your contact-free evaluation.

Growers intending to use TID canals and laterals or Improvement District facilities for irrigation purposes during the off-season must contact the Water Distribution Department (209-883-8356) to coordinate such use. Regular maintenance and repairs are often conducted to canals and laterals during the off-season and any use of TID infrastructure must be pre-approved.

Irrigation Rule 2.3.1:
Growers shall not plant or place trees, vines, shrubs fences or any other type of encroachment in, on, or over any District or Improvement District conduit or District right-of-way unless the District has given specific written approval for such encroachment. Please contact TID prior to placing encroachment in the District's right-of-way. If you are unsure of what area constitutes the District's right of way, TID can come on property, identify and mark the area, often at no cost to the grower. For more information, please contact Tristan Higgins at tshiggins@tid.org or (209) 883-8670.

TID Wraps 2020 Irrigation Season

The TID Hydrology department forecasted a drier than usual season.

To see how the year wrapped up, please go to: www.TID.org/grower

DAIRY FAN REBATE

$100/HP PER FAN

To learn more or to apply visit: TID.org/dairy or call (209) 883-8432

WATER CALL CENTER

Open 7 days a week during irrigation season from 7 a.m. to 5 p.m.
(209) 883-8456

CONTACT US

Pam Lancaster
pmlancaster@TID.org
(209) 883-8356

March 2021 C-4 Turlock Irrigation District Public Review Draft Agricultural Water Management Plan
Appendix D
DISTRICT MAPS
Figure 1: Area Map Turlock Irrigation District

M.J.N 10/13/09

APPENDIX D
DISTRICT MAPS

March 2021
Public Review Draft
D-3
Turlock Irrigation District
Agricultural Water Management Plan
Figure 2: Map of the Turlock Irrigation District

Legend:
- **TID Canal**
- **Canal Spill Location**
- **Rented Well**
- **TID Drainage Well**
- **TID Irrigation Service Boundary**

March 2021  
Turlock Irrigation District  
Agricultural Water Management Plan
Appendix E

TURLOCK IRRIGATION DISTRICT IRRIGATION RULES
The Turlock Irrigation District Irrigation Rules can be found online at:
Appendix F
AGRICULTURAL WATER MEASUREMENT REGULATION DOCUMENTATION
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Appendix F: Agricultural Water Measurement Regulation Documentation
For Turlock Irrigation District

By
Davids Engineering, Inc.

December 2020
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1.0 Introduction

The Turlock Irrigation District (TID or District) recognizes the need for accurate farm delivery measurements and uniform standards and procedures for measuring and recording farm water deliveries in order to: (1) provide cost-effective service to customers, and (2) generate improved operational records for planning and analysis. This appendix documents TID’s compliance with the regulations requiring a specified level of delivery measurement accuracy that were incorporated into California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597) in July 2012.

1.1 BACKGROUND

Field investigations conducted by TID between 2002 and 2012 indicated that TID’s measurement devices, referred to as sidegates, and associated measurement methods that were in place in 2012 were generally adequate for the aforementioned purposes, but that not all sidegates would satisfy the new accuracy standards required by 23 CCR §597. Thus, per regulation 23 CCR §597, TID developed a corrective action plan with a budget and schedule to achieve compliance by December 31, 2015. This plan for compliant agricultural water measurement and accuracy certification is described in Appendix F of TID’s 2012 Agricultural Water Management Plan (AWMP) and was updated in Appendix F of TID’s 2015 AWMP.

1.2 SUMMARY OF EFFORTS THROUGH 2020

Between 2013 and 2019, TID spent $10.5 million to (1) install 151 new measurement devices to accurately measure deliveries to nearly 3,000 parcels covering about half of the District’s assessed service area, and (2) develop calibrated flow rates for more than 3,000 existing sidegate-parcel combinations that cover the remaining assessed service area. These calibrated flow rates have been developed and certified to provide greater delivery accuracy through TID’s Delivery Measurement Program.

In 2016, following review of flow measurement data collected between 2012 and 2015, TID determined that it was necessary to also calibrate flow rates based on the irrigation method and requested flow rate. These parameters were subsequently added to the sidegate-parcel calibration combinations, resulting in a unique calibrated flow rate for each sidegate-parcel-irrigation method-requested flow rate combination. These changes to the Delivery Measurement Program have improved the measurement accuracy for the wide range of delivery flows that TID provides to its customers and significantly increased the number of calibration flow measurements necessary. Between 2016 and 2019, TID spent between $280,000 and $1.5 million each year on delivery flow calibration efforts. Additionally, TID has modified its custom ordering and delivery measurement recording software to improve its functionality for recording accurate delivery measurement volumes.

District-wide, there are about nine hundred parcels served by multiple sidegates, so there are approximately 3,900 sidegate-parcel combinations, and many irrigation methods and requested flow rate combinations that must all be calibrated. As of 2019, TID has completed initial calibrations per the corrective action plan for all active sidegates that don’t fall under DWR exemptions. In total, across all field testing methodologies, 100% of the assessed acreage served by the non-exempted active sidegates now receive calibrated delivery flow rates. TID
plans to continue taking additional calibration measurements, as needed, to calibrate new flow requests from customers.

By the end of 2019, TID had verified through field-testing that the accuracy requirements were being met in accordance with 23 CCR §597 for deliveries made to approximately 86% of the assessed area within TID (Table F1.1). These include deliveries measured by:

- All new measurement devices (i.e., permanent Rubicon SlipMeters and FlumeMeters, serving 47% of the total assessed area in TID)
- Approximately 73% of existing measurement devices (i.e., sidegates), with calibrated flow rates developed and validated by field-testing (serving the remaining assessed area in TID)

At the end of 2019, TID had developed a plan for completing field-testing of existing measurement devices in 2020 to validate the accuracy of deliveries to the remaining assessed area in TID (Attachment F.1). Unfortunately, the public health guidelines resulting from the COVID-19 pandemic prevented additional field-testing in 2020. TID staff will work within the bounds of recommended public health guidelines to complete these measurements at the earliest opportunity available. The results of these measurements will be provided and discussed in the next AWMP update.

Table F1.1. Delivery Measurement Accuracy Validation Results by Device Type.

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<th>Device Type/Calibration Method</th>
<th>Assessed Area Served</th>
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<td>Percent Total District Area</td>
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<td>New Device—Continuous Flow Measurement Device**</td>
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<td>Existing Device (sidegate)—Parcel Specific Average Flow Rate**</td>
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<tr>
<th></th>
<th>Percent Total District Area</th>
<th>Acres**</th>
<th>Approx. Percent Area Served by Devices Meeting Accuracy Requirement*</th>
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<td>154,306</td>
<td>86%</td>
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*Per 23 CCR §597.4(b), if at least 75% of the field-testing random sample meets the accuracy requirements of 23 CCR §597.3(a) when combining the accuracies of delivery flow and delivery duration measurements, the entire area served by that device type is considered to meet the accuracy requirements.

**Some parcels measured by new devices also irrigate with drip/micro methods and are also included in the existing device sidegate and assessed area totals.

34 In accordance with 23 CCR § 597.4, TID conducted an initial certification of all devices, and conducted field-testing and field-inspection for random samples of measurement devices. Per 23 CCR § 597.4(b)(2), if at least 75% of the random sample met the accuracy requirements pursuant to §597.3(a), all devices of that given device type were considered to meet the accuracy requirements of 23 CCR §597.
2.0 Compliance Requirements (23 CCR §597.1)

Briefly summarized, 23 CCR §597 requires agricultural water suppliers that provide water to 25,000 irrigated acres or more to measure the volume of water delivered to customers according to specific accuracy standards on or before July 31, 2012 (23 CCR §597.1(a)). The accuracy of existing measurement devices must be certified within ±12 percent by volume (23 CCR §597.3(a)(1)). The accuracy of new or replacement measurement devices must be certified within ±5 percent by volume in the laboratory if using a laboratory certification, or ±10 percent by volume in the field if using a non-laboratory certification (23 CCR §597.3(a)(2)). The regulation further includes specific requirements for certifying and documenting the accuracy of existing and new measurement devices (23 CCR §597.4). Additionally, suppliers subject to the regulation are required to report certain information in their AWMP (23 CCR §597.4(e)).

TID serves more than 25,000 irrigated acres and is therefore subject to these regulations. TID has elected to use a non-laboratory (field-testing) certification approach for all new and existing measurement devices District-wide. Field-testing measurements were performed between August 2016 and October 2019 by staff trained in the use of state-of-the-art flow measurement devices, including the Rubicon SlipMeter, the Rubicon FlumeMeter, the Hach FH950 electromagnetic flow meter, and the Fuji Portaflow ultrasonic flow meter measurement devices. The Rubicon SlipMeter and FlumeMeter provide continuous flow rate measurements at the sidegate, while the Hach FH950 and Fuji Portaflow flow meters provide “spot” flow rate measurements at a point in time through an access vent downstream of a sidegate or booster pump downstream of a sidegate. For sidegates measured using meters that report flow rate, TID calculates the delivery volume as the measured delivery duration multiplied by the flow rate. TID’s accuracy certification procedure accounts for the accuracy of both these values when computing the overall measurement device accuracy. Best professional practices were used for all field-testing measurements. Initial certification of device accuracy was completed by field-testing a random and statistically representative sample of the existing measurement devices and new measurement devices after installation in the field.

Sections 4 through 6 of this appendix document the best professional practices and protocols used for field-testing, field-inspection, and analysis of all new and existing measurement devices. The procedures and associated results are also documented in a TID report approved by an engineer.

3.0 Completed Corrective Actions (23 CCR §597.4(e)(4))

To comply with 23 CCR §597, TID implemented the corrective action plan (or plan) described in Appendix F of TID’s 2012 AWMP and updated in Appendix F of TID’s 2015 AWMP. As described in the plan, TID installed new permanent measurement devices at 151 sites, including 142 sidegates, six sites downstream of sidegates\(^{35}\), and three ID pipeline spillage sites. In 2019, 138 of the sidegates equipped with new measurement devices were actively used to irrigate nearly 73,000 assessed acres, nearly half of the District assessed service area. For the remaining

\(^{35}\) Measurement devices downstream of sidegates are used primarily for ensuring that only one customer is irrigating, which allows TID to attribute the measurement at the sidegate to that customer. Due to the complexity of determining the travel time of delivery flows, these devices are not used directly in measurement calculations.
active sidegates not replaced with new permanent measurement devices, TID has used portable measurement devices to develop calibrated flow rates that provide accurate deliveries for virtually all of the sidegate-parcel-irrigation method-requested flow rate combinations at existing sidegates. Calibrated flow rates for existing sidegates have been determined by TID staff and Water Distribution Operators (WDOs) trained to use the Rubicon FlumeMeter, the Hach FH950 electromagnetic flow meter, and the Fuji Portaflow ultrasonic flow meter measurement devices.

Currently, TID uses the following measurement devices throughout the District:

- Rubicon SlipMeters™
- Rubicon FlumeMeters™
- SonTek-IQ® Series Meters
- Hach FH950 electromagnetic flow meters
- Fuji Portaflow ultrasonic flow meters
- Permanent magnetic meters (mounted on booster pump systems)
- FlowLine™ down looker (in ID structures)

This section describes TID’s delivery facilities, the status of the corrective actions to date, a plan for recalibrating flows for parcels with changes to on-farm facilities, and a plan for integrating accurate delivery measurements into TID’s volumetric billing process.

### 3.1 TID DELIVERY FACILITIES OVERVIEW

#### 3.1.1 Irrigation Deliveries

Sidegates are the delivery points through which water is delivered from TID canals and laterals to customers. TID customers are the individual landowners (or land tenants) to whom TID delivers water. Customers are served either directly from the TID distribution system (Figure F3.1) or through facilities owned by groups of landowners organized under Improvement Districts (IDs). TID measures water deliveries at the sidegate, where responsibility for water control and management is passed from TID to its customers.

The predominant on-farm irrigation method in the TID service area is basin-check flood irrigation. The standard basin-check flood irrigation delivery rate (or “flood head”) is 15 cubic feet per second (cfs) or 20 cfs, depending on the on-farm or system capacity. Customers typically receive a full standard flood head, or more, unless the conveyance or on-farm system (open ditch or pipeline) lacks sufficient capacity. Growers are responsible for (1) controlling the destination of their delivery head while irrigating, and (2) passing the delivery head to the next grower, as instructed by the TID WDO. Customers on large pipelines with new measurement...
devices are also able to order a specific requested flow rate as long as it is compatible with irradiation facilities and TID operations.

Water deliveries to parcels typically occur on a rotational schedule, with one parcel taking the full “head” of water delivered through the TID sidegate at a given time. The “head” of water is passed from parcel to parcel by growers, while the delivery duration varies according to parcel size and other factors. In a few cases, sidegates have the capacity for two heads and the heads are divided at a point below the sidegate. In these IDs, additional permanent FlumeMeters or SonTek-IQ meters have been installed at the point the heads are divided to identify which growers are taking water.

![Figure F3.1. TID Distribution System.](image)

### 3.1.2 Measurement Devices and Methodologies

As described previously, sidegates are the delivery points through which water is delivered from the TID system to customers. Sidegates are operated for measurement by consistently setting the sidegate opening to deliver a standard flood head, based on the sidegate size and the difference between the water levels upstream and downstream of the sidegate. Historically, sidegate-specific gate openings were developed so that the majority of parcels received at least a standard flood head (flow rate), as determined by flow measurements made by trained TID employees using portable electromagnetic flow meters. The sidegate openings are based on specific upstream water levels that are intended to, and generally do, remain steady during canal and lateral operations. The sidegate-specific openings were compiled and provided to WDOs tasked with delivering the water. In the future, TID also plans to provide this information to growers so
they can verify that sidegates openings are correct, and that they are receiving a standard flood head.

Using TID’s sidegates to measure delivery volumes at the parcel level (different from delivering a minimum flow rate) is complicated by two main factors:

- Downstream hydraulic conditions on sidegates can vary appreciably among parcels as the head is rotated and, relatively infrequently, even within individual parcels as irrigation “sets” are changed, resulting in flow rate fluctuations.
- Vent pipes are not always suitably located for observing downstream water levels and for conducting flow verification. In some cases, such as sidegates that discharge into pipelines, access to vent pipes is limited or impossible.

Two additional factors also present challenges to using TID’s sidegates to measure delivery volumes at the parcel-level:

- Thirty-four sidegates supply ID pipelines that spill into other TID laterals, IDs, or drains.
- About 900 parcels can be supplied water by more than one sidegate.

TID’s corrective action plan addressed the two main factors affecting delivery volume measurement at the parcel level for both flood heads and for drip and micro system booster pumps. TID installed new permanent measurement devices that are not affected by downstream conditions at 138 sidegates. These devices are installed at sidegates that together deliver water to nearly half of the assessed service area (Table F3.1). For the remaining active existing sidegates not replaced, TID developed specific calibrated average flow rates under standard hydraulic conditions (i.e. upstream water level in canal or lateral and sidegate opening) for each sidegate-parcel-irrigation method-requested flow rate combination in the District. This approach allows for accurate delivery measurement using existing measurement devices by accounting for varying downstream conditions at each parcel. TID has inventoried parcels that irrigate with booster pumps and has also developed calibrated flow rates for these parcels.

TID also delivers water to about 600 gardenhead parcels (hobby farms) that are each five acres or less, irrigate on a pre-set rotational group schedule and grow small pastures, lawns, ornamentals, or produce for self-consumption. These parcels are not subject to the regulation according to DWR’s response to comments on the regulation37.

### 3.2 INSTALLATION OF NEW PERMANENT MEASUREMENT DEVICES

TID currently has real time measurement data for nearly 73,000 assessed acres using permanent measurement devices installed at 142 sidegates. The majority of these new permanent measurement devices are Rubicon SlipMeters and Rubicon FlumeMeters. Both of these new gates use Rubicon’s Sonaray measurement technology, and are laboratory certified to ±2.5 percent flow rate accuracy (Judge, 2011). Field tests in California irrigation district conditions found that the Sonaray measurement was within ±2.0 percent of an NIST certified magnetic flow

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37 Based on DWR’s Final Statement of Reasons dated 5/31/12, response number G24.
meter (Hopkins and Johansen, 2011). To improve the measurement accuracy of delivery volumes, TID trains WDOs and irrigators to use the gates, and has made training videos in English and Spanish that are available on the TID web site and YouTube.\(^{38}\)

In most installations, a SlipMeter completely replaces an existing sidegate and will automatically adjust its opening to accurately deliver a desired flow rate. The SlipMeter can also be set to maintain a specified gate opening. A few SlipMeters are mounted on frames in front of the existing sidegates. In these cases the sidegates are still manually adjusted to control the delivery flow rate, while the SlipMeter is primarily used as a measurement device. FlumeMeters are also installed in front of existing sidegates. A few FlumeMeters are installed in ID pipeline structure boxes where the ID pipeline branches, and are used to measure flow at the split. Both SlipMeters and FlumeMeters send digital data to TID in real time via TID’s Supervisory Control and Data Acquisition (SCADA) system. TID has completed the installation of new permanent flow measurement devices. TID plans to continue to review delivery measurement accuracy and customer needs. TID has added additional permanent measurement devices based on this review, and may install more permanent flow measurement devices in the future.

Table F3.1. Summary of Corrective Actions and Associated Certification Approaches and Accuracy Standards for Flood Deliveries at TID Sidegates.

<table>
<thead>
<tr>
<th>Corrective Action</th>
<th>Delivery Measurement Certification Approach</th>
<th>Accuracy Required (23 CCR §597.3(a))</th>
<th>Number of Sidegates</th>
<th>Assessed Area Served, acres</th>
<th>Assessed Area Served, Percent of Total District Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Device--Continuous Flow Measurement Device*</td>
<td>Laboratory Certification of Flow Rate; Field Certification of Duration</td>
<td>+/- 10%</td>
<td>142</td>
<td>72,977</td>
<td>47%</td>
</tr>
<tr>
<td>Existing Device (sidegate)--Parcel Specific Average Flow Rate*</td>
<td>Field Certification</td>
<td>+/- 12%</td>
<td>1,195</td>
<td>81,329</td>
<td>53%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,333</td>
<td>154,306</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Some parcels measured by new devices also irrigate with drip/micro methods and are also included in the existing device sidegate and assessed area totals.

### 3.3 FLOW RATE CALIBRATION FOR EXISTING SIDEGATES

At existing sidegates with access vents that are not suitably located for delivery flow measurement and calibration using handheld measurement devices, a Rubicon FlumeMeter was

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\(^{38}\) [https://www.tid.org/irrigation/irrigation-information/how-to-operate-rubicon-equipped-sidegates/]
temporarily installed and used to develop calibrated delivery flow rates for each sidegate-parcel-irrigation method-requested flow rate combination. These calibrated flow rates are calculated based on the average flow rate observed from the FlumeMeter continuous flow measurements available from SCADA. Once at least one delivery event was measured for all active parcels served by a sidegate, the Rubicon FlumeMeter was moved to another sidegate. In total, TID has used 57 mobile FlumeMeters to develop calibrated delivery flow rates at 550 existing sidegates that serve 1,196 parcels, representing 32,187 assessed acres, or approximately 21 percent of the District (Table F3.2).

For sidegates with access vents in suitable locations for delivery flow measurement and calibration using handheld measurement devices, a handheld Hach FH950 electromagnetic flow meter was used to determine calibrated flow rates specific to each sidegate-parcel-irrigation method-requested flow rate combination. The Hach FH950 flow meter provides a “spot” flow rate measurement at a specific point in time using an access vent downstream of a sidegate. Hach FH950 meters were used at 349 sidegates serving 536 parcels that together represent 19,345 assessed acres, or approximately 13 percent of the District (Table F3.2).

For parcels with pressurized on-farm systems served by existing sidegates, a handheld Fuji Portaflow ultrasonic flow meter was used to determine calibrated flow rates specific to each sidegate-parcel-irrigation method-requested flow rate combination. The Fuji Portaflow meter also provides a “spot” flow rate measurement at a specific point in time. Fuji Portaflow meters were used at 471 sidegates serving 877 parcels that together represent 29,798 assessed acres, or approximately 19 percent of the District (Table F3.2).

See Section 5.3 of this appendix for additional details on the flow rate calibration process for existing sidegates. Across all field testing methodologies, 100% of the assessed acreage served by existing active sidegates now receive calibrated delivery flow rates. The flow rate calibration for existing sidegates is virtually complete. However, when irrigation methods or requested flow rates change at each sidegate-parcel combination, the new sidegate-parcel-irrigation method-requested flow rate combination requires a new calibrated flow rate. Thus, there will likely always be some flow rate calibration being conducted.

Figure F3.2 shows the parcels in TID that have calibrated flow rates and indicates that about 15 parcels, less than one percent, still do not have calibrated flow rates for various reasons described below. Some parcels are only irrigated one to two times per year, providing insufficient opportunities for calibration. Two parcels do not have access vents installed, although one is coming out of production, according to the owner. Deliveries to one parcel were historically ordered on a different sidegate, so TID did not have accurate records to plan for vent installation. TID planned to install the vent in 2020, but was unable to do so because of the public health guidelines resulting from the COVID-19 pandemic. One parcel was measured for calibration, but TID later found that the measurement was incorrect. TID planned to measure deliveries to this parcel again in 2020, but was prevented from successfully completing this effort due to the public health guidelines resulting from COVID-19. Four parcels are irrigated using a shared system, so in the past TID has had problems isolating the parcels individually. TID also planned to identify irrigations to each parcel in 2020 by gathering additional information from the customer, though these efforts were again hindered by the public health guidelines due to COVID-19. Deliveries to the last parcel serve multiple ponds. Calibration measurements have presented difficulty because the pipe to the second pond is never full. TID is working to resolve
APPENDIX F AGRICULTURAL WATER MEASUREMENT REGULATION DOCUMENTATION

March 2021 F-9 Turlock Irrigation District
Public Review Draft

Agricultural Water Management Plan

this issue. TID plans to complete the efforts it was unable to accomplish in 2020 due to COVID-19 at the next available opportunity. Updates to these efforts will be discussed in the next AWMP update.

Table F3.2. Summary of Flow Rate Calibration Method and Parcels with Calibrated Flow Rates Completed at Existing Sidegates in TID.

<table>
<thead>
<tr>
<th>Existing Sidegate Flow Rate Calibration Method</th>
<th>Number of Sidegates</th>
<th>Number of Parcels</th>
<th>Assessed Area, acres</th>
<th>Number of Parcels Calibrated</th>
<th>Assessed Area by Parcels Calibrated, acres</th>
<th>Assessed Area by Parcels Calibrated, %</th>
<th>Total by Sidegate Assessed Area Served by Parcels Calibrated, %</th>
<th>Total District Area Assessed Area Served by Parcels Calibrated, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary Continuous Flow Measurement Device (Rubicon FlumeMeter)</td>
<td>550</td>
<td>1,196</td>
<td>32,187</td>
<td>1,196</td>
<td>32,187</td>
<td>100%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Spot Electromagnetic Flow Meter (Hach FH950)</td>
<td>349</td>
<td>536</td>
<td>19,345</td>
<td>536</td>
<td>19,345</td>
<td>100%</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>Flood Subtotals</td>
<td>899</td>
<td>1,732</td>
<td>51,531</td>
<td>1,732</td>
<td>51,531</td>
<td>100%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>Spot Ultrasonic Flow Meter (Fuji Portaflow)</td>
<td>471</td>
<td>877</td>
<td>29,798</td>
<td>877</td>
<td>29,798</td>
<td>100%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>Exempt--Non-Agriculture (Gardenheads)**</td>
<td>-</td>
<td>593</td>
<td>926</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong>*</td>
<td>1,370</td>
<td>2,609</td>
<td>81,329</td>
<td>2,609</td>
<td>81,329</td>
<td>100%</td>
<td>53%</td>
<td></td>
</tr>
</tbody>
</table>

* Total number of sidegates and parcels exceeds those reported for existing devices (Table 3.1) because many parcels that pump also take a few flood deliveries and are thus included in both totals. Totals exclude exempt gardenhead parcels.
**Number of parcels and area based on TID delivery records in 2019, area is included in the area of the other existing sidegate flow rate calibration methods.
Figure F3.2. Map of Parcels with Completed Calibrated Delivery Flow Rate Measurements.
3.4 PLAN, SCHEDULE AND BUDGET FOR COMPLETION

In its plans for additional flow measurements, TID will prioritize the sidegates in the random samples found to have a flow rate accuracy that is outside of the acceptable range to meet SBx7-7 requirements. These measurements will be collected to improve the accuracy of the average flow rate used as the calibrated flow rate for the *sidegate-parcel-irrigation method-requested flow rate* combination. The annual projected budget for additional flow measurements, operations and maintenance (O&M) activities, and capital replacement after 2020 is $200,000 per year.

Unfortunately, the public health guidelines resulting from the COVID-19 pandemic affected the planned schedule for completing these additional flow measurements. TID staff will work within the bounds of recommended public health guidelines to complete these measurements at the earliest opportunity available. The results of these measurements will be provided and discussed in the next AWMP update.

3.5 USE OF CALIBRATION FLOWS WITH DELIVERY RECORDS AND BILLING

To provide growers a consistent basis for planning irrigations during an irrigation season, TID provides growers access to their calibrated flow rates for each of their *sidegate-parcel-irrigation method-requested flow rate* combinations. Customers are able to access this information either by phone through the Water Call Center or online by accessing their online water accounts (*Figure F3.3*). These calibrated delivery flow rates are developed following the procedure described in Section 6 of this appendix, and are based on all flow measurements completed prior to the beginning of the current irrigation season. The volume of water delivered during each irrigation event is calculated using these calibrated delivery flow rates and the recorded start and end times of the delivery event.

As calibrations continue into the future, growers will be able to access their new calibrated flow rates by phone or online, as described above. These new calibrated flow rates will account for updates to average delivery flow rates based on additional flow measurements conducted during the prior irrigation season.

TID has updated their water ordering, delivery, and billing software to use the calibrated flow rates for billing. For reporting delivery volumes to DWR and for use in the TID water balance, TID updates the calibrated delivery flow rates at the end of each irrigation season and uses these updated values to calculate the measured volume of water delivered in the completed irrigation season.
Figure F3.3. Online Water Account Screen Shot
3.6 PLAN FOR CALIBRATING FLOW RATES FOR NEW OR INACTIVE PARCELS

When TID receives a delivery request for a new sidegate-parcel-irrigation method-requested flow rate combination, TID will develop a calibrated delivery flow rate for this combination by measuring the flow rate during one of the first irrigation events. The new combination will be calibrated using the same methods used to calibrate flows at existing sidegates, typically using the mobile Hach FH950 meter, Rubicon FlumeMeter, or the Fuji Portaflow meter for parcels that use a pump. Each calibrated delivery flow rate is tracked by TID as a unique “Flow ID” corresponding to a single sidegate-parcel-irrigation method-requested flow rate combination. Until the actual calibration can be performed, TID will assign a parcel without a calibrated delivery flow rate an initial flow rate based on similar irrigation method – requested flow rate combinations.

4.0 Best Professional Practices (23 CCR §597.4(e)(2 and 3))

As described previously, sidegates are the delivery points through which water is delivered from the TID system to customers. Sidegates are operated for measurement by setting the sidegate opening to deliver a standard flood head (15 or 20 cfs) or another specific requested delivery flow rate, based on the sidegate size, the difference between the water levels upstream and downstream of the sidegate, and – since implementing the corrective action plan – conditions specific to each unique sidegate-parcel-irrigation method-requested flow rate combination.

Historically, sidegate-specific gate openings were set so that most parcels received at least a standard flood head, as determined by flow measurements made by trained TID employees using portable electromagnetic velocity meters. The sidegate-specific gate openings were based on specific upstream water levels that are intended to, and generally do, remain relatively steady during typical canal and lateral operations. The sidegate-specific openings were compiled and provided to WDOs tasked with delivering the water.

Currently, sidegate gate openings are precisely set to deliver the flow rate requested by the customer. For sidegates equipped with new measurement devices (Rubicon SlipMeters and FlumeMeters), the sidegate opening is guided by the Rubicon Sonaray measurement technology, providing the requested flow rate within ±2.5 accuracy (Judge, 2011). For existing sidegates, the sidegate is opened to provide the calibrated delivery flow rate developed for each specific sidegate-parcel-irrigation method-requested flow rate combination (Sections 5 and 6 of this appendix).

TID has implemented a modified irrigation water ordering, delivery, and billing system. For sidegates with new, permanent water measurement devices, this system will determine delivery volumes based on the average measured flow rates of irrigation events from the previous season.
and delivery durations reported by WDOs. For each distinct sidegate delivery event, the WDOs evaluate TID’s SCADA records to identify and record the durations of delivery events.

For existing sidegates, this system will determine delivery volumes based on the calibrated flow rates from the previous season specific to each sidegate-parcel-irrigation method-requested flow rate combination and the delivery durations recorded by WDOs.

4.1 COLLECTION OF DELIVERY MEASUREMENT DATA

TID collects water measurement data from 392 SCADA sites that collect upstream water levels, gate openings, and measured flows at regular intervals. These SCADA sites include all of the new permanent measurement devices installed at 138 active sidegates in 2019 as well as 17 additional locations and all of the 57 temporary, mobile FlumeMeter measurement devices. TID also collects water measurement data from TID-owned drainage wells, tile drain systems that discharge water into TID laterals, and spill sites at the end of TID laterals and canals. The SCADA data is regularly transferred into a SCADA Historian (PI) for storage, analysis and reporting of historic data.

TID also collects spot flow rate measurements with the Hach FH950 magnetic Velocimeter and Fuji Portaflow transit time flow meter. The detailed data collected by these devices are stored in Excel and text files. Average flows from each measurement are calculated and stored in TID’s TXDB database.

4.2 FREQUENCY OF MEASUREMENTS

TID collects SCADA data at regular 5-minute intervals. Spot flow rate measurements are collected when growers ask for validation measurements of flows and at other times as needed. Start and end dates and times are collected and recorded by WDOs for each water delivery event.

4.3 METHOD FOR DETERMINING IRRIGATED ACRES

TID maintains a database of irrigated parcels that receive water deliveries. The assessed area of these parcels is included in the database and is adjusted downward six percent to estimate irrigated acres for the water balance, based on prior analysis of the average proportion of each parcel that is irrigated.

4.4 QUALITY CONTROL AND QUALITY ASSURANCE PROCEDURES

TID regularly reviews all water measurement data collected through TID’s daily PI Data report and internal validation process. Growers are billed for the water volume delivered, and will

39 If it is determined that the customer was overbilled, TID adjusts the flow rate to the current year average. TID also has six sites that are billed according to the actual volume of water recorded by the permanent measurement device.

40 A “distinct sidegate delivery event” is defined as the duration between a start time (i.e. change from 0 cfs to desired delivery amount) and end time (i.e. change from desired delivery amount to 0 cfs) without any intermediate zero flows.
likely contact TID if there is an error in the reported water volume delivered. If an error is found, TID staff promptly correct the error.

Additionally, water data collected by TID is used in a District-wide water balance. Prior to using this data in the water balance, the data is reviewed for out-of-range values and other possible errors. When assembled in the water balance, the data is again checked to ensure the highest possible data quality.

4.5 CONVERSION OF FLOW RATE TO VOLUME

Flow rates are converted to volume delivered by multiplying by the duration of the delivery. TID records delivery start and end dates and times in the ordering, delivery and billing software and calculates delivery duration from these values that are entered by WDOs based on information received from growers for parcels irrigated from existing gates. For new, permanent measurement devices, the WDOs obtain the start and end dates and times from SCADA and enter them into the ordering, delivery and billing system. TID has implemented a modified irrigation water ordering, delivery, and billing system that:

1. Uses SCADA reported measured flows and WDO recorded durations confirmed by SCADA delivery durations from the new, permanent measurement devices,
2. Uses calibrated flow rates specific to each sidegate-parcel-irrigation method-requested flow rate combination, and WDO recorded durations for existing sidegates,
3. Tracks water to the sidegate if it is delivered to parcels that can be served by multiple sidegates, and
4. Allows WDOs to adjust delivery volumes in the interest of fairness for the relatively rare situations when delivery service does not meet TID service standards.

5.0 Field Testing Methodology (23 CCR §597.4(b))

5.1 OVERVIEW

As described previously, TID installed new, permanent measurement devices at 142 sidegates, of which 138 were active in 2019. For the remaining existing sidegates, TID developed calibrated flow rates for each downstream parcel receiving deliveries that are specific to each sidegate-parcel-irrigation method-requested flow rate combination.

To certify the volumetric measurement accuracy of all measurement devices, the accuracy of the recorded delivery duration and the accuracy of the flow rate measurement must both be considered.

5.1.1 Accuracy Evaluation for New Measurement Devices

For new, permanent measurement devices, the actual duration is based on the start and end times of deliveries to individual downstream parcels that are recorded directly in TID’s SCADA system. Measured duration is based on the start and end times of deliveries to individual downstream parcels that are calculated by TID’s WDOs from review of the SCADA data, and that are then entered into TID’s TXDB water order and delivery records database (TXDB). For these devices, the duration accuracy was determined through comparison between the measured
durations calculated from WDO start and end times recorded in the TXDB and the actual durations calculated from SCADA field-reported start and end times to determine duration accuracy. The sample of actual durations calculated from SCADA field-reported start and end times was limited to single parcel delivery events so that there would be sufficient confidence that the SCADA start and end times were associated with the delivery event in question.

The new, permanent measurement devices have laboratory certified flow rate measurement accuracies of ±2.5 percent.

5.1.2 Accuracy Evaluation for Existing Measurement Devices

For existing measurement devices, duration accuracy is based on an analysis of permanent devices in 2015 similar to the analysis described in Section 5.1.1 of this appendix. During 2015, the method of determining beginning and ending times to enter into the TXDB was the same for new measurement devices with SCADA records as it was for existing devices without SCADA records.

Historically, measured duration was based on the start and end times of deliveries to individual downstream parcels that were reported by irrigators to TID’s WDOs for entry into TID’s TXDB database. The actual duration is defined based on the start and end times of deliveries to individual downstream parcels that are recorded directly in TID’s SCADA system. During the 2015 analysis, the duration accuracy was similarly determined through comparison between measured durations and actual durations calculated from SCADA field-reported start and end times for single parcel delivery events. This analysis is described in the TID 2015 AWMP Appendix F, and resulted in an estimated duration accuracy of 7.6 percent.

For existing devices, flow rate measurement accuracy was field tested by making an additional measurement of the flow rate to a parcel after the calibration process for that parcel was complete. This additional actual flow measurement was compared to the calibrated (measured) average flow rate (comprised of the measured flows, not including the additional actual flow measurement) for the randomly selected parcels. Methodologies of random sample selection, new permanent measurement device duration accuracy field testing, and existing device flow rate accuracy field testing are described in the following sections.

5.2 RANDOM SAMPLE SELECTION

TID irrigated parcels range in size from less than five acres to 640 acres. Although the majority of parcels are less than 20 acres, the larger parcels account for the majority of the area (Figures F5.1 and F5.2). With this wide range in parcel areas, and the large number of small parcels, a simple random selection of measurement devices would over-emphasize the importance of deliveries to small parcels. Thus, the importance of each parcel was weighted according to its area using the probability-proportional-to-size (PPS) sampling method recommended by Burt and Geer (2012). Additionally, on any given day, only a subset of parcels were irrigating and thus available for a validation measurement, requiring the use of opportunity sampling also described in Burt and Geer (2012). On any given day, parcels were selected for validation measurements by sorting all parcels that have not already been field tested that are irrigating that day according to the random selection number assigned through the PPS sampling method.
A parcel master list containing all parcels capable of receiving water from TID was provided to Davids Engineering. This list was divided into two lists, one for each device type: (1) new measurement devices, and (2) existing sidegates. For each device type, the PPS sampling methodology established a random selection number for each delivery event, or “Flow ID,” corresponding to a specific sidegate-parcel-irrigation method-requested flow rate combination.
This number was used to develop a random sample of 100 delivery events for each device type according to the process below:

1. Flow IDs corresponding to each device type (new measurement device or existing measurement device) were divided into separate lists, and inactive Flow IDs were removed from each list.
2. Each Flow ID was listed in an arbitrary order and assigned a unique “acre range” equal to the irrigated acreages of that Flow ID. The acre range value was used to provide area-weighting for random selection. This assignment provides a probability of random selection of each Flow ID that is proportional to area.
   a. All Flow IDs one acre or less are assigned one value (an “acre range” of one, e.g. an “acre range” range of 124-124).
   b. All other Flow IDs were assigned an “acre range” beginning after the previous parcel’s upper range value plus the Flow ID parcel’s acreage (e.g., if a parcel has 20 acres and the previous parcel’s acre range spanned from 39-92 acres, the parcel’s acre range is 93-112).
   c. A “total acre population” of 1-62,290 was developed (i.e., the first parcel’s acre range began at one acre, and the last parcel’s acre range ended at 62,290 acres).
3. Each acre in the total acre population was assigned a random number used to select a random sample. These acre values were then sorted by their assigned random numbers in ascending order.
4. Each Flow ID was identified for each acre randomly selected in step 3, resulting in a list of randomly selected Flow IDs. Flow IDs are included on the list one time for each acre (i.e., a Flow ID will be listed as many times as the number of acres it contains).
5. Duplicate Flow ID appearances were removed from the list of randomly selected Flow IDs list, retaining only the first occurrence of a Flow ID (ordered by the random number value, from lowest to highest).
6. A random validation selection number was assigned to each Flow ID in the list prepared in step 5, which was then sorted in ascending order to prepare a randomly ordered list of Flow IDs to evaluate.
7. A final, ordered validation list of Flow IDs was developed by matching the random validation selection number assigned in step 6 to its Flow ID in the original list. This list was finally sorted in ascending order by the validation selection number.

This procedure resulted in a randomly ordered list of all Flow IDs for each device type. The random sample of 100 Flow IDs was then identified by evaluating each Flow ID, in ascending order by validation selection number, and identifying whether key criteria were met (e.g. single delivery events; criteria described in the next section). The first 100 Flow IDs to meet these criteria comprised the random sample that was evaluated.

5.3 NEW PERMANENT MEASUREMENT DEVICES

5.3.1 Flow Rate Accuracy

The flow rate accuracy of the new permanent measurement devices (i.e. Rubicon FlumeMeters and SlipMeters) is laboratory certified to be 2.5 percent by the gate manufacturer (Judge, 2011). Field tests in California irrigation district conditions found that the Sonaray measurement was
within ±2.0 percent of an NIST certified magnetic flow meter (Hopkins and Johansen, 2011). Figure F5.3 shows a typical SlipMeter installation at TID.

5.3.2 Duration Accuracy

The law of the propagation of uncertainty, and Burt and Geer (2012) describe a method to compute the resulting accuracy for volumetric measurement given known, or estimated accuracies of the various components of the volumetric calculation. Following this method, given the 2.5 percent accuracy of the flow rate, and the required 10 percent accuracy for field testing validation of new devices (23 CCR §597), the required accuracy of the duration measurement can be calculated as 9.7 percent (i.e. \((0.12 - 0.025^2)^{0.5} = 0.097\) or 9.7 percent).

Figure F5.4 shows an example of the single deliveries used in the field tests used to evaluate duration measurement accuracy. These events are defined as a delivery to a single parcel as indicated in the TXDB delivery record with no other deliveries at the sidegate within a 12 hour window preceding and following the recorded delivery. Events on parcels with the following characteristics were not included in the sample:

1. Parcels on sidegates which can spill to other IDs or TID laterals, and
2. Parcels known to receive water deliveries from more than one sidegate.

Figure F5.3. Rubicon SlipMeter used for New Permanent Flow Measurement Device; Installed on TID Upper Lateral 3 at Sidegate 2-9. Hach FH950 used to Develop Sidegate-parcel Specific Flow Rate Calibrations for Adjacent Sidegate 2-8.
For the example in **Figure F5.4**, the duration analysis was conducted as follows:

1. The “actual” delivery duration was identified from SCADA records as the difference between the SCADA start time and SCADA end time (27 hours 26 minutes)
2. The “measured” delivery duration was identified from TXDB data as the difference between the TXDB start time and TXDB end time (27 hours 0 minutes)

The percent duration difference was calculated as the “measured” duration minus the “actual” duration, divided by the “actual” duration (-1.5%)

As described earlier the customer invoicing software changes include features to allow accurate tracking of duration on parcels known to receive water deliveries from more than one sidegate.

![Figure F5.4. Example of Single Delivery used for New Measurement Site Duration Accuracy Analysis.](image)

Additional quality control measures described below were applied to exclude delivery events with the following characteristics:

1. Delivery event less than or equal to 3 hours: durations are being reported by growers to WDOs and deliveries less than 3 hours require an absolute accuracy of around 9 to 10 minutes (10 percent of 180 is 18 minutes or 9 minutes on start time and 9 minutes on end time) given field conditions and manual start and stop of irrigations it is unreasonable to expect a better absolute accuracy than 10 minutes
2. Delivery events with less than four SCADA records per hour—something was assumed wrong with the SCADA record.\textsuperscript{41}
3. Manual review finds that this is not a single event
4. Manual review finds the delivery event is not to a single parcel
5. Adjusted durations where warranted in the following situations:
   a. Spill sheet records spill water given to farmer—TXDB start and end times were adjusted to include the spill record
   b. Well documented need to slowly fill pipe due to high O&M costs, SCADA duration was adjusted to not include fill time in duration

Failed events were graphically reviewed to verify the reason for failure. For each event excluded for one of the reasons listed above, the random delivery event with the next lowest random selection number was reviewed and either used or excluded depending on whether it met the quality control measures described above. This continued until the number of randomly selected parcels reached 100.

5.4 EXISTING SIDEGATES

5.4.1 Flow Rate Accuracy

Parcel specific flow rates for existing sidegates were developed in one of three ways. At existing sidegates without access vents in suitable locations for measurement, a Rubicon FlumeMeter was temporarily installed (see Figure F5.5 for details), and the continuous record of flow rate was used to develop average flow rates for each parcel. Once at least one delivery event was measured for all the actively irrigating parcels served by a sidegate, the Rubicon FlumeMeter was moved to another sidegate.

\textsuperscript{41} SCADA measurements are collected at regular 5-minute intervals, so if less than four measurements are available per hour, this means that only 33.3\% of SCADA measurements are in the record.
FlumeMeters were chosen to develop calibrated flow rates for 1,196 parcels representing 32,187 assessed acres, or approximately 21 percent of the District (Table F3.1). For existing sidegates with access vents in suitable locations for measurement, a Hach FH950 magnetic Velocimeter was chosen to determine calibrated flow rates. Hach FH950 meters were used for 536 parcels representing 19,345 assessed acres, or approximately 13 percent of the District. For parcels with pressurized on-farm systems served by existing sidegates, a Fuji Portaflow was chosen to determine calibrated flow rates. Fuji Portaflow meters were used for 877 parcels representing 29,798 assessed acres, or approximately 19 percent of the District.

**Flow Ratings at Existing Sidegates Without Suitable Vent Access**

At existing sidegates without access vents in suitable locations for measurement, the following steps were taken to develop calibrated flow rates, and to perform verification measurements:

1. Rubicon FlumeMeters measure flow rate with Rubicon’s Sonaray measurement technology, and are laboratory certified to ±2.5 percent flow rate accuracy.
2. FlumeMeter data was recorded in the TID SCADA system at regular five to 15 minute intervals.
3. WDO start and end times (determined from review of SCADA data) were used to determine individual delivery events.
4. A time weighted average flow rate was developed for all delivery events by multiplying each flow rate by the duration and dividing by the total duration.
   a. Generally, this average flow rate is nearly equivalent to simply averaging the flow rate values.
5. Flow values less than half of the ordered flow rate were assumed to be data transmission errors and were excluded from the average.
6. Sidegates with FlumeMeters were not visited during delivery events.
7. The average flows for delivery events with the same requested flow in the TXDB are averaged to become the calibrated average flow.
8. The average flow for the last event with the same ordered flow as the calibrated events (for parcels with more than one event) is not included in the average and used as the validation event.
9. The average flow rate for validation measurement is calculated using the same methodology as the average flow rate for the calibrated flows.
10. Similar to the new, permanent slip meters, parcels used in the validation analysis must be on side gates that:
    a. Do not spill back to another ID or TID lateral, and
    b. Do not take water from more than one sidegate.
    c. Deliveries that lasted three hours or less are not included as validation events.

Flow Ratings at Existing Sidegates With Suitable Vent Access

For existing sidegates with access vents in suitable locations for measurement, the following steps were taken by trained WDOs to develop parcel specific flow rates, and to perform verification measurements:

1. WDOs collected comprehensive information about upstream and downstream conditions at the sidegate during the calibration/verification measurement.
2. A specialized rod, Figure F5.6, was used to determine pipe diameter.
3. The location and pipe diameter information was recorded on the field notes and entered into the Hach FH950.
4. Hach FH950 magnetic Velocimeters were used to measure average water velocity in the pipe.
5. Hach FH950 combines area and velocity data to provide a flow rate. The Hach data file was stored onto an SD card, and the flow rate was written on the field notes.
6. The SD card was returned to the office where the data was offloaded, quality controlled, and entered into TID’s TXDB database.

Figure F5.6 shows the pipe diameter measurement device, and Figure F5.7 shows the Hach FH950 magnetic Velocimeter.
Figure F5.6. Pipe Diameter Measurement Device.

Figure F5.7. Hach FH950 Magnetic Velocimeter with Measurement Access Vent Pipe in the Background.
Flow Ratings at Existing Sidegates for Parcels with Pressurized On-farm Systems

For parcels with pressurized on-farm systems served by existing sidegates, the following steps were taken by trained WDOs to develop parcel specific flow rates, and to perform verification measurements:

1. The pipe diameter was measured with a special pipe diameter tape manufactured by Pipeman Products.
2. The pipe thickness was measured with Check Line Ultrasonic Wall Thickness Gauge Model #TI-25S pipe thickness transducer.
3. The pipe material, pipe diameter, and pipe thickness was recorded on the actual pipe at the rating point and entered into the Fuji Portaflow transit-time flow meter.
4. The Fuji Portaflow transducers were installed in a two pass “v” arrangement (Figure F5.8), and the flow rate data was recorded every 10 seconds for a period of 5 minutes onto an SD card, and the flow rate was written on the field notes.
5. The SD card was returned to the office where the data was offloaded, quality controlled, and entered into TID’s TXDB database.

Figure F5.8 shows a typical Fuji Portaflow calibration/verification measurement.
The velocity and transit-time flow meter measurements are spot measurements at one point in time with a single measurement representing the flow rate for the entire delivery. In all cases, the flow rate accuracy of the existing sidegates for a particular sidegate-parcel-irrigation method-requested flow rate combination is determined by comparing the average of all calibration measurements (i.e. measured flow rate) to a subsequent verification measurement (i.e. actual flow rate). Failed events were graphically reviewed to verify the reason for failure.

5.4.2 Duration Accuracy

For existing devices, the duration accuracy was assumed to be 7.6%, the same as determined by the analysis at the new, permanent measurement devices in 2015, as discussed in Section 5.1.2 of this appendix.

6.0 Field Testing Results (23 CCR §597.4(b))

6.1 OVERVIEW

TID elected to use a field testing certification approach. Field-testing measurements performed between June 1 and September 4, 2019 by staff trained in the use of state-of-the-art flow measurement devices, including the Rubicon FlumeMeter, Hach FH950, and Fuji Portaflow measurement devices are included in this report. Best professional practices were used for all field-testing measurements.

6.2 SELECTION OF A REPRESENTATIVE RANDOM SAMPLE RESULTS

Figure F6.1 illustrates that the PPS methodology used selected predominately larger parcels as was intended. The blue bars represent the percent of the full population by numbers of parcels found within the various parcel acreage bins listed on the x-axis. The orange bars represent the percent of the 100 parcels randomly selected by numbers of parcels found within the various parcel acreage bins listed on the x-axis.

Figure F6.2 shows that the distribution of parcels by area in the sample more closely matches the distribution in the full population, the intended result of the PPS methodology. The blue bars represent the percent of the full population by acreage of parcels found within the various parcel acreage bins listed on the x-axis. The orange bars represent the percent of the 100 parcels randomly selected by acreage found within the various parcel acreage bins listed on the x-axis. It can be seen in this case, that the blue and orange bars are more or less evenly distributed among the various parcel acreage bins listed on the x-axis.
**Figure F6.1.** Comparison of Parcel Area Distribution between the Total Number of Parcels in TID (Blue Bars) and the Number of Parcels in the Samples Randomly Selected by PPS Methodology (Orange Bars).

**Figure F6.2.** Comparison of Parcel Area Distribution between the Total Area of Parcels with Flow Measurement by Existing Measurement Devices (Blue Bars) and the Area of Parcels in a 100-Parcel Sample Randomly Selected by PPS Methodology (Orange Bars).
6.3 VOLUMETRIC ACCURACY CALCULATION RESULTS

6.3.1 New Permanent Measurement Devices

TID completed field tests on a random sample of 100 delivery events to 100 parcels to evaluate duration measurement accuracy. Table 6.1 provides a summary of the duration field testing results. Since the new measurement devices have a laboratory-certified flow measurement accuracy of ±2.5 percent, the duration measurement accuracy must be less than ±9.7 percent to ensure the volumetric measurement accuracy was within the ±10 percent required by 23 CCR §597 for field testing of new devices (i.e. \((0.12^2 - 0.025^2)^{0.5} = 0.097\) or 9.7 percent). The newly installed measurement gates meet the 23 CCR §597 accuracy standards, with 96 of the 100 verification measurements having duration accuracies less than or equal to ±9.7 percent. Per 23 CCR §597.4(b), if at least 75% of the field-testing random sample meets the volumetric accuracy requirements of 23 CCR §597.3(a), the entire area served by that device type is considered to meet the accuracy requirements.

As described in Section 5 of this appendix, each of the selected 100 events was manually reviewed and 15 were eliminated because of spillage that occurred related to the event and seven were eliminated due to not being a single event. Each of the 22 events eliminated was replaced by the next random event so that the end total was 100 events. The average absolute value of the percent difference between the measured and the actual durations for the 96 parcels that passed the accuracy requirement was 1.6 percent. When combined with the flow rate measurement accuracy of 2.5 percent, this yields an average absolute volumetric measurement accuracy of 3.0 percent.

The average absolute percent difference between the measured and the actual durations for all 100 new permanent measurement devices tested was 3.5 percent. When combined with the laboratory-certified flow measurement accuracy of ±2.5 percent, this yields an average absolute volumetric measurement accuracy of 4.3 percent – less than the ±10 percent required by 23 CCR §597.

6.3.2 Existing Sidegates

TID also completed field tests on a random sample of delivery events to parcels served by existing sidegates with parcel-specific calibrated flow ratings using one of the three calibration methods described above. Table F6.2 provides a summary of the flow rate field testing results. The same methodology used for measuring the delivery duration at the new measurement devices (described above) was also used for measuring the delivery duration at existing measurement devices. For this reason, the duration accuracy for existing devices was assumed to be 7.6%, the same as determined by the delivery duration analysis for new, permanent measurement device in 2015, as discussed in Section 5.1.2 of this appendix. This duration accuracy was also used to calculate the required flow rate accuracy for the existing measurement devices. To ensure the volumetric measurement accuracy of existing devices was within the ±12 percent required by 23 CCR §597 for field testing, the resulting flow rate measurement accuracy needed to be less than ±9.3 percent (i.e. \((0.12^2 - 0.076^2)^{0.5} = 0.093\) or 9.3 percent). The majority of existing measurement devices (i.e. sidegates) meet the standard, with 73 percent having flow accuracies less than or equal to ±9.3 percent. The average absolute percent difference between the measured and the actual flow rate for the parcels that pass the accuracy requirement was 3.0 percent.
percent. When combined with the duration measurement accuracy of 7.6 percent, this yields an average absolute volumetric measurement accuracy of 8.2 percent.

The average absolute percent difference between the measured and the actual flow rate for all existing measurement devices tested was 8.4 percent, which when combined with the duration measurement accuracy of 7.6 percent yields an average absolute volumetric measurement accuracy of 11.3 percent. It is important to note that even though approximately 27% of the field tests did not pass the accuracy requirements, the average absolute value volumetric measurement accuracy across all tests is less than the ±12 percent required by 23 CCR §597.

6.3.3 All Measurement Devices
The average absolute volumetric accuracy across all field-tested was found to be approximately 8.6 percent. This includes the average absolute accuracy of all field-tested new measurement devices – 4.3 percent – and the average absolute accuracy of all field-tested existing measurement devices – 11.3 percent.

7.0 Corrective Actions (23 CCR §597.4(d)(2))
As of 2019, TID has finished initial calibrations per the corrective action plan for active sidegates that don’t fall under DWR exemptions. In total, across all field testing methodologies, 100% of the assessed acreage served by the non-exempted active sidegates now receive calibrated delivery flow rates. TID plans to continue taking additional calibration measurements, as needed, to serve new flow requests from customers.

By the end of 2019, TID had verified through field-testing that the accuracy requirements were being met in accordance with 23 CCR §597 for deliveries to 85% of the assessed area within TID. The remaining corrective actions that TID plans to complete are described below by device type.

7.1 NEW PERMANENT MEASUREMENT DEVICES
All of the sampled events passed the accuracy criteria, so no corrective actions are necessary.

7.2 EXISTING SIDE Gates
TID plans to correct the sidegate-parcel-irrigation method-requested flow rate combination calibrated flow rates that were outside of the required 9.3 percent accuracy by collecting additional spot flow measurements for those sidegate-parcel-irrigation method-requested flow rate combinations. The calibrated flow rate will then be updated to include the additional flow measurement data.
### Table F6.1. Field Testing Results for New Measurement Devices.

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Total Assessed Area Served, acres</th>
<th>Duration</th>
<th>Flow Rate</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Device--Continuous Flow Measurement Device</td>
<td>72,977</td>
<td>96%*</td>
<td>1.6%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

*Per 23 CCR §597.4(b), if at least 75% of the field-testing random sample meets the accuracy requirements of 23 CCR §597.3(a) when combining the accuracies of delivery flow and delivery duration measurements, the entire area served by that device type is considered to meet the accuracy requirements.

### Table F6.2. Field Testing Results for Existing Measurement Devices.

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Total Assessed Area Served, acres</th>
<th>Duration</th>
<th>Flow Rate</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Device (Sidegate)--Parcel Specific Average Flow Rate</td>
<td>81,329</td>
<td>7.6%</td>
<td>73%</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

*Per 23 CCR §597.4(b), if at least 75% of the field-testing random sample meets the accuracy requirements of 23 CCR §597.3(a) when combining the accuracies of delivery flow and delivery duration measurements, the entire area served by that device type is considered to meet the accuracy requirements.

**For existing devices, the weighted average is calculated across field tests conducted with the three different calibration methods described.
At the end of 2019, TID had developed a plan for completing field-testing of existing measurement devices in 2020 to validate the accuracy of deliveries to the remaining assessed area in TID (Attachment F.1). Unfortunately, the public health guidelines resulting from the COVID-19 pandemic prevented additional field-testing in 2020. TID staff will work within the bounds of recommended public health guidelines to complete these measurements at the earliest opportunity available. The results of these measurements will be provided and discussed in the next AWMP update.

8.0 References

Burt, C. and E. Geer. 2012. SBx7 Flow Rate Measurement Compliance for Agricultural Irrigation Districts. ITRC. California Polytechnic State University, San Luis Obispo, California.


The following field-testing plan was prepared by TID staff in 2019 in anticipation of completing the accuracy certification of measurement devices during the 2020 season. Unfortunately, public health guidelines resulting from the COVID-19 pandemic prevented additional field-testing in 2020. TID staff will work within the bounds of recommended public health guidelines to complete these measurements according to the plan described below at the earliest opportunity available. The results of these measurements will be provided and discussed in the next AWMP update.

FIELD-TESTING OF EXISTING MEASUREMENT DEVICES IN 2020

- Early March: Confirm the field-testing plan.
- Early July: Develop random sample of FlowIDs (i.e., sidegate-parcel-irrigation method-requested flow rate combinations) for field-testing.
- Early August through Late September: TID will conduct field-testing of the FlowIDs in the random sample. Once complete, TID will provide field-testing results for analysis.
- November 15: Prepare draft report for review.
- Late November through Early December: Review and revise draft report.
- December 31: Complete final report.
Appendix G

TURLOCK IRRIGATION DISTRICT DROUGHT MANAGEMENT PLAN
Introduction

Since its formation in 1887, TID has faced variability in surface water supplies due to drought, leading to the development of TID’s current water shortage allocation policies. These policies have been developed in response to the 1976-1977 drought, the most severe two-year drought in TID, and to the 1987-1992 and 2012-2016 droughts, the most severe and longest droughts in California’s recorded history. Given the recent impacts and severity of the 2012-2016 drought, this drought is considered to be the archetypal drought for planning purposes in TID. A key aspect of TID’s drought management policy is to plan for carryover storage in Don Pedro Reservoir and to plan for strategic, conjunctive management of surface water and groundwater supplies for a period of forecasted consecutive dry years. Prudent water supply planning requires TID to consider that the first dry year encountered may be the first year in a series of dry years, similar to the 1976-1977, 1987-1992, or 2012-2016 periods.

On April 1, 2015 Governor Brown issued Executive Order B-29-15, mandating agricultural water suppliers to include a detailed Drought Management Plan (DMP) describing actions and measures taken to manage water demand during drought in their 2015 Agricultural Water Management Plan (AWMP) update. In response to the Governor’s Executive Order, TID developed a detailed description of existing policies and extraordinary actions undertaken in response to drought conditions. Three years later, Assembly Bill 1668 (AB 1668) was passed on May 31, 2018. AB 1668 amended the California Water Code (CWC) and requirements for AWMPs, providing more detail on the specific requirements of a Drought Plan, or DMP (CWC 10826.2). This DMP builds upon TID’s long-standing shortage allocation policies and describes drought resiliency planning actions undertaken to prepare for drought, along with a broad range of actions undertaken during drought to manage available water supplies and to meet customer demands to the maximum extent possible.

The 2020 DMP includes all components that are required by CWC 10826.2 and that are recommended by DWR in its 2020 AWMP Guidebook (DWR 2020). Additionally, the 2020 DMP reflects on the impacts of the 2012-2016 drought.

The DMP describes TID’s drought resilience and drought response planning efforts, organized under the following categories:

- Drought resilience planning
  - Determination of water supply availability and drought severity
  - Potential vulnerability to drought
  - Drought resilience opportunities and constraints, specifically:
    - Availability of new technology or information
    - Availability of additional water supplies
    - Other planned actions

- Drought response planning
  - Policies and processes for water shortage declaration and water shortage allocation and implementation
  - Operational modifications to increase efficiency
  - Methods and procedures for triggering and enforcing water shortage response actions
Drought Resilience Planning (§10826.2(a))

This section describes actions and activities undertaken by TID to prepare for drought and effectively manage and mitigate the effects of surface water shortage. It includes the determination of water supply availability and drought severity, identification and analyses of potential vulnerability to drought, and opportunities and constraints for improving drought resiliency planning.

DETERMINATION OF WATER SUPPLY AVAILABILITY AND DROUGHT SEVERITY (§10826.2(A)(1))

Monitoring hydrologic conditions to assess available water supply is at the core of TID’s drought management strategy. TID actively monitors forecasted precipitation and snow, accumulated precipitation and snow, runoff, reservoir storage, groundwater levels, availability of rented pumps, and instream flows. Key programs that TID implements to monitor and forecast water supply availability are described in Section 6 of the AWMP, and include:

- Airborne Remote Sensing for Snowpack (ARSS) Program
- Forecast-Coordinated Operations (F-CO) for the San Joaquin River watershed, and the TID Forecast-Informed Reservoir Operations (FIRO) Program
- Hydrologic Modeling of the Tuolumne River Watershed using the Hydrocomp Forecast and Analysis Model (HFAM)

Additional information sources include DWR snow surveys and other streamflow and groundwater level measurements. These data are incorporated into the District’s models to forecast operations and inform decisions related to water supply availability. Real time flows, water levels, and storage data are also available on the TID website for various sites operated or used by TID (see Section 7.4.12.3 of the 2020 AWMP).

Water reports describing hydrologic conditions are prepared by staff and reported to the Board of Directors at each Board meeting. Sample reports presented on 01/07/2020, 03/17/2020, 05/19/2020, and 11/17/2020 are provided in Attachment G.1.

In addition to monitoring water supply availability, TID reviews current and forecasted drought conditions on a local and regional scale. TID also has access to drought planning and mitigation strategies from a variety of sources, including the United States Drought Monitor, Western Regional Climate Center, DWR, and USBR. These resources improve TID’s understanding of projected drought conditions, and help the District to improve its drought planning and response efforts.

Each year, the Board of Directors determines the amount of water available to growers for purchase that year (termed “available water”), and the fee schedule to be used that year (e.g. normal or dry year). Table G.1 shows the available water and year type in recent years, as
determined by the TID Board. These determinations are made based on the information described above, specifically: the projected runoff (including the possibility of the occurrence of consecutive dry years), the desired carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps.

Table G.1. Recent Historical TID Available Water.

<table>
<thead>
<tr>
<th>Year</th>
<th>Available Water (inches)¹</th>
<th>Year Type (Fee Schedule Used)</th>
<th>Percent of Full Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>48</td>
<td>Normal</td>
<td>100%</td>
</tr>
<tr>
<td>2012</td>
<td>40</td>
<td>Dry</td>
<td>83%</td>
</tr>
<tr>
<td>2013</td>
<td>34</td>
<td>Dry</td>
<td>71%</td>
</tr>
<tr>
<td>2014</td>
<td>20</td>
<td>Dry</td>
<td>42%</td>
</tr>
<tr>
<td>2015</td>
<td>18</td>
<td>Dry</td>
<td>38%</td>
</tr>
<tr>
<td>2016</td>
<td>36</td>
<td>Dry</td>
<td>75%</td>
</tr>
<tr>
<td>2017</td>
<td>48</td>
<td>Normal</td>
<td>100%</td>
</tr>
<tr>
<td>2018</td>
<td>48</td>
<td>Normal</td>
<td>100%</td>
</tr>
<tr>
<td>2019</td>
<td>48</td>
<td>Normal</td>
<td>100%</td>
</tr>
</tbody>
</table>

¹ Depth of water in inches available equally to each acre of land. In 2011-2012, this was termed the “allotment.”

POTENTIAL VULNERABILITY TO DROUGHT (§10826.2(A)(2))

Generally, TID water supplies have been sufficient in all but the driest years due to its conjunctive management of surface water and groundwater supplies and drought management actions. At least 48 inches of available water have been available to TID customers in more than half of all years since 1991 (Figures G.1 and G.2). In the remaining years, an average of nearly 33 inches of water (68 percent of full supply) was available to growers each year.
APPENDIX G
TURLOCK IRRIGATION DISTRICT DROUGHT MANAGEMENT PLAN

Figure G.1. Annual Available Water in TID, with Normal and Dry Year Averages.

Figure G.2. Distribution of Annual Available Water in TID (1991-2019).

TID has reliable access to surface water supplies from the Tuolumne River. The District diverts surface water from the Tuolumne River under a series of pre- and post-1914 flow and storage water rights recognized by the State of California. While TID's surface water supply depends upon annual hydrologic and reservoir storage conditions, the hydrologic variance between years is somewhat mitigated by storage capacity at the Don Pedro Reservoir, which has an overall
capacity of 2,030,000 AF. TID has access to 68.46 percent of the reservoir’s available storage above the minimum operating pool. As described in Section 4.1.1 of the 2020 AWMP, surface water accounts for about 60 to 90 percent of TID’s total water supply in a given year.

As described above and in Section 7.4.12.3 of the 2020 AWMP, TID tracks real-time flows, water levels, and storage in the District, and utilizes these in conjunction with other data to implement Forecast Informed Reservoir Operations (FIRO) and forecast water supply from the upper Tuolumne River watershed. TID also implements an Airborne Remote Sensing for Snowpack (ARSS) Program, using data and tools to precisely map and quantify the water content of snow in the Upper Tuolumne River Watershed. TID’s forecasting tools are used to efficiently and strategically manage the District’s surface water supplies, and thereby protect TID’s growers from potential vulnerabilities to future drought conditions.

TID supplements surface water releases by pumping groundwater from drainage wells and rented wells. Drainage wells owned by TID are used to lower groundwater levels in localized, high groundwater areas and to supplement other irrigation water supplies. Rented wells are owned by private parties or Improvement Districts, and are rented by TID to supplement irrigation supplies, particularly in drier years when surface water supplies are limited. Together, these wells are used to support TID’s conjunctive management practices, supplementing reduced surface water supplies in dry years. These two additional supply sources reduce TID’s potential vulnerability to drought.

Between 2015-2019, approximately 66,000 combined acres of pasture, alfalfa, corn, and grain were grown in TID each year to support the area’s extensive dairy and livestock operations. While irrigation of these crops is important to support local dairy and livestock operations, these crops are more adaptable to reduced or variable water supplies than permanent crops. In recent years, the acreage of permanent crops (primarily almonds) has been increasing due to their demand and profitability. If this trend continues, it could present a new potential vulnerability to drought within the District.

DROUGHT RESILIENCE OPPORTUNITIES AND CONSTRAINTS: AVAILABILITY OF NEW TECHNOLOGY OR INFORMATION (§10826.2(A)(3)(A))

TID has prioritized implementation of new technology and improvements in data collection throughout the District for many decades. In recent years, TID has also made substantial, long-term improvements to distribution system infrastructure and operational practices that have increased operational efficiency and improved TID’s drought resilience. Several highlights of TID’s activities are described below and in Section 7 of the 2020 AWMP:

- TID began installing and implementing its SCADA system in 1997. As of 2020, TID has implemented and upgraded SCADA monitoring equipment at 397 sites throughout the District. These sites monitor distribution system flows, water levels, gate openings, pumping, and spillage at regular intervals.
- In 2014, TID provided tablets to all Water Distribution Operators (WDOs), allowing them to remotely access SCADA data and operational information. Real-time access to SCADA data has helped WDOs improve the flexibility of deliveries to water users while maintaining distribution system efficiency and reducing spillage.
TID implemented remote-control capabilities for drainage pumps, allowing WDOs to quickly monitor and operate pumps in response to real-time canal flows, further reducing spillage.

During the 2014-2015 winter season, TID constructed a regulating reservoir and installed Total Channel Control (TCC) on Lateral 8. The reservoir storage capacity was expanded to 130 AF near the Highline Spill, providing storage for water that would have previously been spilled. With TCC on Lateral 8, TID is better able to match supply and demand, and thus provide better service with increased flexibility to customers on Lateral 8 while simultaneously reducing spillage.

As of December 2020, TID has installed 151 new, permanent Rubicon flow measurement devices at sidegates, sites downstream of sidegates, and ID pipeline spillage sites throughout the District.

TID installed the California Irrigation Management Information System (CIMIS) Weather Station #168 (Denair) in 2002, which was relocated and assigned a new station number (#206) in 2009. TID provides growers access to the CIMIS data on its website along with other weather information and forecasts (see Section 7.4.12.2 of 2020 AWMP).

TID actively monitors water supply data and forecasts, and provides the following information to growers (see Section 7.4.12.3 of the 2020 AWMP):

- Real-time flows, water levels, and available storage for six sites via TID’s Water Information Systems by KISTERS (WISKI) web portal (available at http://wiskiweb.tid.org/index.htm)
- Current weather reports and Tuolumne River flows below La Grange Dam (https://www.cnrfc.noaa.gov/graphicalRVF.php?id=MDSC1)
- List of seven online telemetry gauges used by TID, with links to each on the USGS National Water Information System website
- Groundwater monitoring implemented by TID as part of SBx7-6 (California Statewide Groundwater Elevation Monitoring or CASGEM)
- Results of the upper Tuolumne River watershed collaborative project to implement Forecast Informed Reservoir Operations (FIRO), a reservoir-operations forecasting strategy that is communicated to the TID Board of Directors, and available to the public through the Board process

TID staff are administering two grants on behalf of the Turlock Subbasin Groundwater Sustainability Agencies (GSAs), and are actively engaged in the planning and development of each effort. The first grant is funding a significant portion of the Groundwater Sustainability Plan (GSP) development. The second grant will fund a Groundwater Recharge Assessment Tool for the Subbasin, the installation of monitoring wells, and a Draft Programmatic Environmental Impact Report for the GSP. Both efforts will further aid conjunctive management in the Subbasin and the TID service area.

TID is currently working on a multi-year planning effort to improve irrigation service and modernize infrastructure, referred to as the TID Irrigation Facilities Master Plan (IFMP). The draft IFMP identifies and evaluates a suite of potential modernization projects for the District’s water distribution infrastructure, with the goal of maintaining and improving the level of irrigation service provided to its customers. This effort will benefit TID’s future drought resilience through potential projects to increase operational efficiency and
flexibility, while minimizing system losses, operational costs, and life cycle costs of TID infrastructure.

TID plans to continue implementing new technologies to improve drought resiliency and operational efficiency and is continually exploring new technologies and information to achieve these ends. The largest impediment to implementing new technologies and disseminating information is cost, which can be restrictive to implementation in some cases. TID staff continually pursue grant funding to support these important efforts.

DROUGHT RESILIENCE OPPORTUNITIES AND CONSTRAINTS: AVAILABILITY OF ADDITIONAL WATER SUPPLIES (§10826.2(A)(3)(B))

As described previously, TID’s water supplies have generally been sufficient in all but the driest years through conjunctive management of surface water and groundwater supplies combined with drought management actions. TID has historically increased groundwater pumping to deal with drought conditions, but has limited pumping to areas which do not risk negatively impacting nearby water users.

TID considers potential water transfers from other entities on a case-by-case basis; however, availability of transfers is limited and, even if available, costly. As described in Section 4.1.3 of the 2020 AWMP, TID actively utilizes available recycled water and drainage water to supplement primary water supplies. Between 2015-2019, an average of 14,000 AF of other supplies were used in TID each year.

In addition, TID is collaborating with the Modesto Irrigation District on an active cloud seeding program to help to increase available surface water supplies. TID will continue to evaluate the program, taking advantage of technological advances and/or increased cloud seeding opportunities to enable the Districts to maximize the water supply benefits of the program.

DROUGHT RESILIENCE OPPORTUNITIES AND CONSTRAINTS: OTHER PLANNED ACTIONS (§10826.2(A)(3)(C))

The District plans to continue evaluating opportunities to reduce potential vulnerability to drought. As opportunities are identified, planning efforts will incorporate feasibility studies, scoping, and implementation timelines for feasible opportunities.

As described in Section 7.4.8 of the 2020 AWMP, TID has long implemented a robust conjunctive management program. TID’s conjunctive management objectives support drought resiliency by: 1) maintaining a sustainable groundwater system through continued use of surface water for deliveries and recharge in normal and wet years, and 2) maintaining water deliveries in dry years through increased groundwater pumping.

As a member of the West Turlock Subbasin GSA, TID anticipates adopting and implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP), beginning in 2022. The GSP will identify actions needed to achieve groundwater sustainability in the Turlock Subbasin, providing

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42 Other water supplies include treated wastewater, spill recovery, and tailwater, tilewater, and runoff that flow to TID canals.
support for ongoing conjunctive use of surface water and groundwater supplies in the subbasin and improving drought resilience in the future.

A Groundwater Recharge Assessment Tool is being developed as part of the GSP work by the GSA. The Tool can be used to help optimize recharge and conjunctive use opportunities.

One additional action to promote drought resilience, which has been implemented in the past and which TID continues to implement, is encouragement of on-farm water stewardship to support drought resilience. Specific actions taken by TID include:

- Education and Outreach to Growers
- Enforcement of TID Rules and Regulations
- Volumetric Pricing, and Increased Cost per Unit of Water Delivered in Dry Years
- Reduction of Available Water in Dry Years
- Reduction in Season Length in Dry Years

These actions are described in the 2020 AWMP, and summarized below.

Education and Outreach to Growers

TID regularly provides educational resources and conducts outreach activities to support efficient water management by its irrigation customers (see Section 7.4.12 of the 2020 AWMP). During drought, TID increases these efforts to further encourage on-farm water conservation and to keep growers informed of any changes that are made to TID policies and practices to manage limited water supplies. The TID website offers resources and educational information in its “Irrigation Information” and “News & Resources” sections. In addition to public notices, press releases, news, and educational materials, TID offers a wealth of strategies to improve irrigation efficiency and drought resilience. Sample resources that TID has provided to the public and to growers are listed below and provided as attachments to this DMP.

**TID General Resources (Attachment G.2)**

- TID Water Conservation FAQ's
- TID Drought Resolution, adopted by TID Board of Directors on Feb. 25, 2014
- TID Water Management page
- TID Groundwater Management page
- TID Irrigation Tips page
- TID Water Measurement page
- TID Water Measurement Project Presentation
- “The Grower” newsletter (sample from August 2016)

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Appendix G
Turlock Irrigation District Drought Management Plan

Grower Resources (Attachment G.3)

- Drought Strategies for Orchards
- Strategies for Farming in a Drought
- University of California Drought Management page
- How NRCS Can Help

Enforcement of TID Rules and Regulations

TID’s Irrigation Rules (Appendix E of the 2020 AWMP) require that all water be applied efficiently and be used in a reasonable and beneficial manner. During an irrigation delivery, the irrigator is responsible for the water at all times after it leaves the TID distribution system (Rules 4.1.3 and 4.1.4). Irrigators who waste water intentionally or as a result of carelessness, improper field preparation, or neglected facility maintenance may be refused TID water until the cause of the waste is remedied (Rule 4.2.2).

Additional information about specific rules, enforcement actions, and appeals processes are described in Section 2.2.4.2 of the 2020 AWMP, and in the section below titled “Methods and Procedures for Triggering and Enforcing Water Shortage Response Actions (§10826.2(B)(2)).”

Volumetric Pricing, and Increased Cost per Unit of Water Delivered in Dry Years

Beginning in 2013, TID implemented a new water rate structure that charges customers based, in part, on the volume of water delivered (see Section 7.3 of the 2020 AWMP). In reduced supply years, the Board of Directors has the discretion to implement a dry year rate schedule, increasing the cost per acre-foot delivered, based on consideration of certain factors and staff recommendations. Each schedule includes a fixed per-acre cost in addition to volumetric water charges.

The 2020 water rate structure is as follows:

- Normal Year
  - Fixed Charge: $60 per acre
  - Volumetric Charge
    - Tier 1: $2 per acre-foot, up to 2 acre-feet
    - Tier 2: $3 per acre-foot, up to 2 acre-feet (total water over 2 and up to 4 acre-feet)
    - Tier 3: $15 per acre-foot, up to 1 acre-foot (total water over 4 and up to 5 acre-feet)
    - Tier 4: $20 per acre-foot, additional available (total water above 5 acre-feet, if available)

- Dry Year
  - Fixed Charge: $68 per acre
  - Volumetric Charge
    - Tier 1: $2 per acre-foot, up to 1 acre-foot
Total irrigation rates as a function of usage are illustrated in Figure G.3. As indicated, during dry years the cost for a given volume increases, with the aim of encouraging on-farm conservation and other grower decisions to reduce demand.

**Figure G.3. TID Normal and Dry Year Irrigation Rates as a Function of Usage.**

*Fixed charge (charge at 0 acre-feet) is a function of acreage. Volumetric charges (all charges for farm deliveries above 0 acre-feet) are a function of usage. This figure shows fixed charges for a one-acre parcel.*

**Reduction of Available Water in Dry Years**

As described previously, the District’s Board of Directors considers and reviews staff recommendations to determine the annual water availability for growers, expressed as water available per acre, up to 48 inches. In dry years when water supply is reduced, less than 48 inches is available. Reducing available water supplies directly reduces customer demand, as described in the section “Policies and Processes for Water Shortage Declaration and Water Shortage Allocation and Implementation (§10826.2(B)(1)),” below. During the 2012-2016 drought, available surface water supplies ranged from 38 percent to 83 percent of full supply, with an average availability of 62 percent of full supply. Some growers responded to the reduction in available water by switching to drought resistant sorghum. In 2014, a new crop
code for sorghum was added to TID’s crop tracking system at the request of TID’s Call Center in response to growers increasingly reporting their crop as sorghum.

**Reduction in Season Length in Dry Years**

The District’s Board of Directors determines the irrigation season start and end dates considering grower preferences and staff recommendations. In dry (reduced water supply) years, the season start and end dates are often adjusted to reduce the season length. In 2014 and 2015, the irrigation seasons were 182 days each, the two shortest seasons in the last 29 years (1991-2019) with 33 fewer days than the average season length (215 days) over that period.

**Drought Response Planning (§10826.2(b))**

This section describes actions and activities undertaken by TID in response to drought to address surface water shortage. It includes discussion of the policies and processes for declaring water shortage and implementing water shortage allocations (also described in Section 2.2.4 of the 2020 AWMP), the methods and procedures for the enforcement or appeal of triggered shortage responses, the methods and procedures for monitoring and evaluating the drought management plan, the communication protocols and procedures used by TID during drought, and the potential financial impacts of drought and proposed measures to overcome those impacts.

**POLICIES AND PROCESSES FOR WATER SHORTAGE DECLARATION AND WATER SHORTAGE ALLOCATION AND IMPLEMENTATION (§10826.2(B)(1))**

The District’s water shortage allocation policies are described in Section 2.2.4 of the 2020 AWMP. Each year, the District’s Board of Directors determines the annual “available water” – the amount of water per acre available to growers for purchase – based on staff recommendations. Staff create these recommendations by developing and reviewing runoff projections and projected carryover storage and by considering past operations, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps.

In dry years when water supply is reduced, less than 48 inches per acre is available to growers. In establishing the available water in a dry year, the District evaluates water supplies as if it is the first dry year of a multiple year dry cycle. The recent 2012-2016 drought is used as the “drought of record” for planning purposes. Other significant dry periods are also considered, including 1976-1977 and 1987-1992. During the 2012-2016 drought, available water ranged from a maximum of 40 inches in 2012 (83 percent of a full supply year) to 18 inches in 2015 (38 percent of a full supply year), as indicated in Table G.1. Since 2012, TID has implemented a tiered, volumetric pricing structure to comply with SBx7-7 water pricing requirements. The pricing structure is an increasing block rate structure (combined with a fixed charge) with two different fee schedules, one for “normal” water years and one for “dry” years. As shown in Figure G.3 of this appendix and in Section 2.2.3 of the 2020 AWMP, the “dry” year fee schedule is set at a higher rate to encourage conservation and to help recover the additional pumping costs incurred in dry years.

Historically, growers who paid the District’s water charge were provided with access to the same amount of available water, regardless of crop type. The current rate schedule is designed to act
in a similar manner. Payment of the fixed charge provides growers with access to purchase the amount of water available that year, regardless of crop type. This benefits the District’s users because a large proportion of the field crops in this region are grown in conjunction with local dairy operations which have a year-round water demand, not unlike orchard crops in the area.

**OPERATIONAL MODIFICATIONS TO INCREASE EFFICIENCY**

During drought, TID modifies operations through a combination of strategies to increase operational efficiency with the primary goal of reducing operational spillage from TID canals and laterals.

During dry years, WDOs increase efforts to reduce spillage by monitoring spillage more closely, by making more frequent adjustments to water level control structures and lateral headings, and by using pumps to more precisely match supply with demand.

In all but extreme drought years, TID increases groundwater pumping to supplement surface water supplies in the canal system, providing increased flexibility for WDOs to more precisely match water supply to customer demands and further reduce spills. This use of pumps, particularly in the lower distribution system (i.e. west of the Ceres Main Canal), allows WDOs to more rapidly adjust canal flows to match demand and reduce spills that result from irrigation head changes and varying delivery amounts that can cause fluctuations in canal flows. This strategic use of groundwater supplies enables the District to maximize surface water supplies, reserving surface water in Don Pedro Reservoir that would otherwise have spilled and making it available for delivery later in the season or in subsequent dry years.

During the 1987-1992 drought, these actions resulted in a substantial decrease in operational spills. TID has continued to rely on these extraordinary operational practices in subsequent drought years. Notably, during the dry period of 2007-2009 operational spills were decreased to an average of less than five percent of total supply. Similarly, during the onset of the recent 2012-2016 drought, operational spills decreased each year to less than five percent of total supply in 2014-2015.

Another operational strategy employed by TID to increase operational efficiency in drought years is to modify targeted water levels in Turlock Lake. By operating the Lake at reduced water levels during drought, losses are reduced. In 2015, TID operated Turlock Lake at approximately 50 percent capacity to reduce seepage and evaporation.

TID’s internal water transfer policies additionally allow growers to transfer water between parcels that they own or rent. This program enables growers to maximize available supplies for use in meeting crop water requirements and is facilitated by TID WDOs, who convey the transferred water through the TID distribution system as needed.

Together, these operational modifications allow TID and its customers to effectively respond to drought while minimizing the potential impacts on available water supplies and demand.
METHODS AND PROCEDURES FOR TRIGGERING AND ENFORCING WATER SHORTAGE RESPONSE ACTIONS (§10826.2(B)(2))

TID does not rely on mechanistic, pre-determined triggers to implement drought management actions. Rather, the Board of Directors considers data that it receives on an ongoing basis as well as recommendations from TID staff based on assessment of current and projected water supply conditions on an annual basis to set an annual available water amount. Based on Board decisions influenced by the amount of water available each year, water policies are modified and drought management actions are implemented and adjusted as needed. This approach to managing water supplies and demands during shortages allows TID flexibility to maximize the long term reliability, quality, and affordability of irrigation water supplies.

TID enforces its Irrigation Rules (Appendix E of the 2020 AWMP) in all years to ensure that all water is applied efficiently and is used in a reasonable and beneficial manner. The section “Enforcement of TID Rules and Regulations” above describes specific rules and enforcement actions that prevent wasteful or improper use of water in all years.

In the face of drought, TID increases enforcement of water regulations to prevent unauthorized use of water. Landowner or irrigator failure or refusal to comply with the TID rules and regulations may lead to suspension of water delivery until the issue is resolved (Rule 10.1). The Water Distribution Department Manager is authorized to issue a Notice and Order or oral or written warning to any irrigator or landowner in violation of TID regulations (Rule 10.2.1). The landowner or irrigator has 10 calendar days from the service date of the Notice and Order to file a written appeal to the General Manager or Board of Directors, depending on type of notice, after which all rights to a hearing are waived (Rule 10.2.2). Water deliveries may be terminated immediately in certain circumstances (Section 10.3). These circumstances and the appeal process are described in detail in the TID Irrigation Rules in Part I, Section 10 (Appendix E).

Once an order or decision has become final, the irrigator or landowner has seven calendar days to commence corrective action or repair and must pursue the action with sufficient diligence to meet the time established for compliance (Rule 10.5.4). When the landowner or irrigator returns to full compliance with all regulations, the individual will resume eligibility to receive water deliveries.

During the 2012-2016 drought, the TID Board of Directors adopted the following penalties for unauthorized use of water:

- First offense - $1,000 fine and water taken will be billed at the highest tier amount.
- Second offense - Potential loss of water on all parcels owned or rented for the remainder of the season.

MONITORING AND EVALUATION OF THE DROUGHT MANAGEMENT PLAN (§10826.2(B)(3))

Continuous monitoring of hydrologic conditions, water supply, water deliveries, operational efficiency and other metrics is an important part of TID’s water management in any year, but especially in times of drought. TID continually monitors changes in water supply availability and drought severity, allowing the District to adapt and align its water management efforts per
the Drought Management Plan to best distribute and manage available water resources for the mutual benefit of lands within the District’s service area boundaries. TID’s water reports (Attachment G.1), extensive SCADA network, array of reservoir and flow monitoring sites, and implementation of models to forecast water supply from the upper Tuolumne River watershed are just a few of the many resources TID uses to proactively monitor drought resilience and response efforts.

Review of these metrics following a period of drought allows TID to evaluate the cumulative impacts of drought and the overall effectiveness of the DMP over consecutive dry years. Analyses of past drought periods also provide opportunities to revise the DMP and improve drought management within the District moving forward. To this end, the “Evaluation of 2012-2016 Drought” section below includes a review of the most recent drought, its effects in TID, and the overall effectiveness of the DMP during the 2012-2016 drought.

COMMUNICATION PROTOCOLS AND PROCEDURES (§10826.2(B)(4))

This section describes communication protocols and procedures within TID as well as broader communication and collaboration efforts with regional stakeholders during times of drought.

Communication Protocols and Procedures within TID

TID strives to have clear communication protocols and procedures with landowners and customers within the District and recognizes the importance of this, especially in times of drought. Typically, informational materials are made available through multiple channels of communication. TID communicates through the District website; delivers announcements and notices through physical mail, email, and targeted social media; and posts announcements at the TID office.

Communication materials are made available to irrigation customers at the front office and on the TID website. Special announcements, public notices, and press releases from the Board of Directors are also made available on the TID website (https://www.tid.org/news-and-resources/public-notices/; https://www.tid.org/news-and-resources/press-releases/). Examples of TID’s communication during the 2012-2016 drought are included in Attachments G.2 and G.3. TID also supplies growers with up-to-date weather information and forecasts through its “Weather” web page (https://www.tid.org/news-and-resources/weather/).

Finally, TID office staff and WDOs are available during business hours to answer questions related to water supply availability or drought management from landowners and customers.

Coordination and Collaboration with Regional and Statewide Entities

Extensive coordination and collaboration with others is a vital component of TID operations. The District reports data to the California Energy Commission, the California Department of Water Resources, and other governmental entities, as necessary. TID also partners with cooperating entities at Don Pedro Reservoir on watershed studies and other efforts surrounding Tuolumne River water supply and demand, including instream flows, snowpack, agricultural and urban demand, climate change, and other considerations. TID also works with applicable regulatory agencies that affect the flexibility with which TID can store and deliver water.
One example of such coordination is TID’s role in the formation and ongoing operation of the West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA), an association of local municipal water systems and agencies located in the western portion of the Turlock Subbasin. As a member of the WTSGSA, TID is actively involved in subbasin-wide SGMA-implementation efforts. Both the WTSGSA and the East Turlock Subbasin GSA anticipate adopting and implementing the Turlock Subbasin Groundwater Sustainability Plan (GSP) beginning in 2022.

Additionally, the District meets with local cities and counties regarding groundwater resources, water conservation and recycling projects, and public education and outreach.

**POTENTIAL FINANCIAL IMPACTS OF DROUGHT AND PROPOSED DISTRICT MANAGEMENT MEASURES (§10826.2(B)(5))**

Increased expenditures during times of drought result from increased public outreach activities and increased groundwater pumping costs. District staff members spend significantly more time providing irrigation customer service and outreach to the public through increased targeted social media communication, “The Grower” newsletter, outreach programs, and drought workshops. The District has also historically operated rented pumps and drainage pumps to help supply water deliveries, especially in dry years.

The increased expenditures to implement drought management actions are mitigated by reducing expenditures and focus on capital improvements and maintenance. This places more emphasis on system operations and on-farm water stewardship during times of drought.

TID also increases revenue during drought years through its tiered water rate structure. In dry years, TID increases the fixed (per-acre) charge for all customers and increases the volumetric charges at a higher rate per unit of water use.

Finally, TID periodically reviews the financial status of the District and potential impacts of drought to identify opportunities to improve the financial resiliency of the District during periods of drought.

**Evaluation of the 2012-2016 Drought**

The following sections describe the impacts of the 2012-2016 drought on water supply and water demand in TID. Water supply and demand in 2011 are also provided for comparison with a normal, full-supply year preceding the drought period.

This discussion also examines the effectiveness of TID’s past drought resilience and drought response efforts, identifies lessons learned from the drought, and provides context for planning future actions.

**DROUGHT IMPACTS ON WATER SUPPLY**

TID’s water supplies in 2011-2016 are discussed to illustrate the effect of actions taken by TID and its customers to manage available water supplies during drought. The years 2012-2016 represent a historic, multi-year drought, while 2011 represents a normal year with full supply. All sources of supply identified in the AWMP water budget are summarized below, including
Turlock Lake releases, District pumping (both rented pumping and drainage pumping), private pumping, and other supply sources (tilewater drainage, tailwater runoff, precipitation runoff, recycled treated wastewater, and spillage recovery).

The total releases from Turlock Lake (including both irrigation season and off-season releases) generally decreased each year during the drought, except in 2016 (Figure G.4). In 2011, the total annual releases from Turlock Lake exceeded 588,000 acre-feet. In 2012 and 2013, releases were around 470,000 acre-feet, more than 100,000 acre-feet lower than the total releases in 2011 but higher than the 1991-2019 dry year average of about 439,000 acre-feet. In 2014 and 2015, Turlock Lake releases were reduced to around 300,000 acre-feet, the lowest volumes in the 1991-2019 water budget period. However, in 2016 the releases from Turlock Lake increased again to nearly 400,000 acre-feet.

Total District pumping – the combined total drainage and rented pumping by TID – increased from 68,000 acre-feet in 2011 to over 110,000 acre-feet in 2012 and 2013, the first two years of the drought (Figure G.5). The total District pumping decreased in 2014 to about 88,000 acre-feet, and decreased again in 2015 to about 56,000 acre-feet as TID reduced pumping in certain areas to reduce the potential impacts on local groundwater levels. The total pumping then increased again to 75,000 acre-feet in 2016, the final year of the drought period.

The total private pumping in the TID service area was lowest in 2011, the last full supply year before the drought, and only increased slightly in 2012 and 2013 (Figure G.6). In response to reduced District pumping, private pumping increased to over 103,000 acre-feet in 2014 and over 125,000 acre-feet in 2015. As TID’s surface water and groundwater supplies increased in 2016, pumping decreased to just over 60,000 acre-feet. The increase in private pumping in 2014-2015 is partly attributed to TID’s practice in certain dry years that allows growers to pump groundwater into the canals and then receive a delivery “credit” equal to the volume they supplied at any sidegate that serves their property. This practice supplements the water supply available to downstream users, and allows growers the flexibility to transport water that they pump to any of their fields served by an active sidegate. In the 2014-2015 water budgets, the volume of private pumping used in this practice is included in the total private pumping volume, since the same volume that is pumped is also delivered for irrigation.
Figure G.4. Daily Cumulative Turlock Lake Releases, 2011-2016.

Figure G.5. Monthly Cumulative District Pumping, 2011-2016.
Figure G.6. Monthly Cumulative Private Pumping, 2011-2016.*

*In 2014-2015, TID allowed growers to pump groundwater into the canals and receive a delivery “credit” equal to the volume they supplied. This volume is included in the private pumping volumes and water receipts in 2014-2015. In future water budgets, TID will consider separately accounting and reporting the volume of private pumping used in this practice.

Other sources of water supply available to TID customers include tilewater drainage, tailwater runoff, precipitation runoff into canals, spillage recovery, and recycled treated wastewater. These combined other water supplies were greatest in 2011, the last full supply year, and decreased more than 30 percent to less than 12,000 acre-feet in 2014 and 2015 (Figure G.7). As available water supplies provided by the District decreased during drought periods, other recycled water supplies that originated from these supplies, namely spillage, and flood irrigation, likewise decreased. In 2016, other water supplies increased again to nearly 15,000 acre-feet as available water and District water supplies increased.

The total water supply encompasses all surface water and groundwater that is potentially available for delivery and use in the District service area, including all releases from Turlock Lake, District pumping, private pumping, and other supplies. Altogether, the total water supply was greatest in 2011, at nearly 700,000 acre-feet, and lowest in 2015, at approximately 480,000 acre-feet (Figure G.8). The total supply in TID in 2012-2013 only varied from total supply available in 2011 by 10-12 percent (70,000 to 80,000 acre-feet), indicating that TID’s drought planning and response efforts are successful in weathering short droughts. However, by the third and fourth years of the drought in 2014 and 2015, reductions in surface water supply were compounded by reductions in TID groundwater production while private pumping increased. In 2016, the fifth year of the drought, both Turlock Lake releases and District pumping increased, while private pumping decreased.
Figure G.7. Monthly Cumulative Other Supply, 2011-2016.

Figure G.8. Monthly Cumulative Total Supply, 2011-2016.
DROUGHT IMPACTS ON WATER DEMAND

Water demand in the TID service area from 2011-2016 is discussed to illustrate the effect of actions taken by TID and its customers to manage water use during drought. The years 2012-2016 represent a historic, multi-year drought, while the year 2011 represents a normal year with full supply. Overall demand is based on several parameters:

- monthly farm deliveries (as quantified through the TID water balance), a measure of farm surface water demand
- reference evapotranspiration (ET₀), a measure of atmospheric water demand
- crop evapotranspiration of applied water (ETₕₐₜ), a measure of agricultural consumptive water demand.

The total volume of farm deliveries by TID were similar in 2011, 2012, and 2013, with approximately 490,000 acre-feet delivered each year (Figure G.9). The similarity in total delivery volumes between 2011 and the first two years of drought highlights that TID’s drought planning efforts are successful in weathering short droughts. In the third and fourth years of the drought, the annual volumes of TID farm deliveries were reduced by 25-40 percent from the volume in 2011, as TID’s Board limited the water available to growers to just 20 inches and 18 inches per acre, respectively. In 2014 and 2015, approximately 364,000 acre-feet and 295,000 acre-feet were delivered, respectively. In 2016, the total farm deliveries increased to just over 400,000 acre-feet as TID’s water supplies increased and the amount of available water also increased to 36 inches per acre. Notably, total deliveries decreased from pre-drought levels to a lesser extent than did total supplies. This was due primarily to increased efforts to improve water use efficiency, namely reduction in spillage and increases in on-farm irrigation efficiency.

Figure G.9. Monthly Cumulative TID Farm Deliveries, 2011-2016.
Daily cumulative atmospheric water demand, $E_{To}$, for 2011-2016 is shown in Figure G.10. Total $E_{To}$, as measured at the Denair and Denair II CIMIS stations, was essentially the same in 2011 and 2012, at 51.0 and 51.9 inches, respectively. Total $E_{To}$ during 2013-2016 was between 55.5 and 57.1 inches each year, about 10 percent higher on average than in 2011 and 2012.

The total volume of agricultural consumptive water demand, $ET_{aw}$, in the TID service area was lowest during 2011, the last full supply year, totaling nearly 280,000 acre-feet. Agricultural $ET_{aw}$ increased to between approximately 318,000 acre-feet and 365,000 acre-feet in during the 2012-2016 drought, driven by increased $E_{To}$ and shifts in agriculture toward higher-demand permanent crops such as orchards (Figure G.11).

![Figure G.10. Daily Cumulative $E_{To}$, 2011-2016.](image)
EFFECTIVENESS OF TID DROUGHT PLANNING EFFORTS IN 2012-2016

The evaluation of drought impacts on TID’s water supply and water demand generally indicates that TID’s ongoing drought planning efforts are highly effective in response to shorter droughts, and generally support growers in weathering and recovering from potential impacts of longer droughts when District supplies are limited.

In 2012-2013, the total water supply in the TID system was reduced by 10-12 percent compared to 2011 (Figure G.8) – the last full supply year preceding the 2012-2016 drought – yet TID was able to supply nearly the same total volume of farm deliveries to growers as in 2011 (Figure G.9). Reductions in surface water supply during 2012-2013 were partly offset by increased District pumping, consistent with the District’s overall conjunctive management strategy. The effects of the supply reductions on growers were also mitigated by enhanced system and operational efficiency on the part of TID’s WDOs. Consequently, private pumping volumes increased only slightly in 2012-2013 (Figure G.6), suggesting that growers’ irrigation needs were largely satisfied by TID during the early drought period.

As the drought continued into 2014-2015, TID reduced both surface water releases and groundwater pumping to prevent undesirable effects on local groundwater levels in the subbasin. As a result, total supplies in the TID system were reduced by 25-30 percent compared to 2011. Likewise, TID’s Board of Directors restricted the amount of available water to 20 inches and 18 inches per acre in 2014 and 2015, respectively, resulting in a 25-40 percent reduction in farm
deliveries compared to 2011 (Figure G.9). While the reduced deliveries contributed to substantial increases in private pumping in 2015 (Figure G.6), the groundwater available to growers was also buffered by years of conjunctive management and recharge in TID.

As TID’s total supplies recovered somewhat in 2016, the total volume of farm deliveries made by TID also increased while private pumping decreased. These shifts suggest that although the severe drought and restricted water supplies in 2015 pushed growers to pump more groundwater for irrigation, the availability and affordability of TID’s supplies, even at the higher rates charged during dry years, strongly incentivize conjunctive management.

Cropping and ET\text{aw} volumes in TID also suggest that TID’s drought planning efforts are effective in sustaining crop and livestock production even in the midst of drought. TID supplies water to large areas of permanent crops and pasture, alfalfa, and grain crops that support local dairies, all of which requires a steady annual water supply. Despite the large decreases in total water supply between 2013 and 2014-2015 (Figure G.8), the volume of total agricultural ET\text{aw} in TID decreased by only about 1 to 5 percent (5,000 to 18,000 acre-feet) from the total ET\text{aw} in 2013. This is likely attributable in part to increases in on-farm water use efficiency, enhanced grower outreach and education, and increased distribution system efficiency.

These findings indicate TID’s drought planning efforts are highly effective in response to shorter droughts, and are generally supportive of managing the impacts of longer droughts on crop production when District supplies are limited.

Key practices and policies that were especially critical to TID’s drought resilience and drought response in 2012-2016 include, but are not limited to:

- **Conjunctive management in all years.** TID practices conjunctive management of surface water and groundwater supplies in all years, supplementing surface water releases when needed by strategically pumping groundwater from drainage wells and rented wells selected based on need, location, cost, and water quality. During normal years, TID incentivizes the use of available surface water supplies (described below), thereby supporting groundwater recharge. During dry years, TID increases groundwater pumping, as supplies allow, to balance available surface water supplies with carryover storage requirements. TID also utilizes supplemental groundwater pumping to help conserve water by reducing canal spillage. This is done by purposely releasing less surface water than is needed for irrigation into the head of each canal, and pumping groundwater into the lower sections of a canal to make up the difference. Conjunctive management of available surface water and groundwater supplies, particularly shallow groundwater, provides greater flexibility to system operators to meet irrigation demand, while reducing distribution system spillage.

- **Affordable irrigation water rates, and tiered volumetric pricing set based on water supply availability (since 2013).** For many years, TID has offered irrigation water to its customers at affordable rates that encourage growers to use available surface water in lieu of pumping groundwater. In normal years, TID allows growers up to 48 inches of “available water” per acre. Much of the surface water applied in TID recharges the groundwater system, supporting groundwater sustainability. Water recharged into the groundwater system for storage can then be pumped in dry years to supplement reduced surface water supplies, supporting crop production even in drought. In TID’s four-tiered
increasing block rate pricing structure, water is less expensive during normal years and more expensive during dry years, encouraging water conservation and generating additional revenue to cover costs associated with the pumping needed to supplement reduced surface water supplies.

- **Reduction of Available Water and Season Length in Dry Years.** As described previously, TID’s Board of Directors determines the annual water availability for growers each year. The “available water” determination is made considering staff recommendations and available data regarding water supplies, runoff and carryover storage projections, availability of rented pumps, and instream flow requirements. During dry years and periods of drought, the amount of water available to the growers is progressively reduced, as needed, to balance available supplies with carryover storage requirements. The irrigation season length was also reduced in 2014 and 2015 to reduce consumption and distribution system losses of drought-limited water supplies.

**References**

Attachment G.1. Water Reports Presented at TID Board Meetings

Water Reports presented to the TID Board of Directors can be found online at: https://www.tid.org/about-tid/board-of-directors/tid-board-meetings/.

Water Reports are posted online under the dates they were presented, together with the agenda, minutes, Board meeting video, and other resources or reports that were presented.
Attachment G.2. TID General Resources Available During the 2012-2016 Drought

- TID Water Conservation FAQ's
- TID Drought Resolution, adopted by TID Board of Directors on Feb. 25, 2014
- TID Water Management page
- TID Groundwater Management page
- TID Irrigation Tips page
- TID Water Measurement page
- TID Water Measurement Project Presentation
- “The Grower” Newsletter (sample from August 2016, at the end of the 2012-2016 drought)

(PDFs to be added in final AWMP)
Water Conservation FAQ

- **What is TID doing to help the City of Turlock achieve its water conservation goals?**

TID doesn’t provide water to the City of Turlock for municipal uses but, we’re doing our part to conserve and help the city and region achieve the water conservation goals set by the state.

For example; TID has stopped watering the grass areas around our Canal Drive and Broadway offices and, once the purchase of the Palm Street Operations Complex is complete, TID will re-landscape the entire complex with drought tolerant landscaping. TID is also installing a demonstration landscape in front of the Canal Drive Office and will include information on the plants and techniques used so residents can install similar landscaping at their home or business.

- **Why is agriculture not being cut back like urban water users are?**

Agriculture has been at the forefront of water restrictions for the past 4 years. The last wet rainy season was in 2011 and since then, growers have seen their available water shrink with the supply. Growers in the TID have been reduced by 62% in 2015. This is on top of a 58% reduction in availability in 2014. Reductions also occurred in 2013 and 2012.

- **What has TID done to be more efficient?**

TID has taken a number of steps to improve efficiency and maximize the amount of water available for our growers. The following is a partial list -

- TID is operating Turlock Lake around 50% of capacity in order to reduce seepage and evaporation.
- TID is piloting several water efficiency projects including:
  - A regulating reservoir in Hilmar to capture water that would otherwise be spilled into the river unused.
  - A system of automated gates on the Lateral 8 canal which are used to automatically control the amount of water in the canal, minimizing spillage and increasing efficiency.
- TID is in the second year of a multi-year project to install automated gates and meters at the point of delivery to the growers throughout the District. This will significantly increase its ability to measure the water delivered.
- This year, TID more than doubled irrigation water rates which will encourage conservation.
• What are the penalties for the unauthorized use of water?

TID’s Board of Directors adopted the following penalties for unauthorized use of water as part of the 2015 Irrigation Season Rules.

- 1st offense - $1,000 fine and water taken will be billed at the highest tier amount.
- 2nd offense- Potential loss of water for the remainder of the season.

• How do I report unauthorized water use?

TID has a tip line to report water theft and tipsters can remain anonymous (209) 883-8359 (Monday - Friday, 8 a.m. to 4:30 p.m.)

• I’ve heard Agriculture uses 80% of the water in California. Is that true?

There is some confusion about the amount of water used by agriculture in California and it comes in part from the way the Department of Water Resources (DWR) previously reported usage numbers.

Beginning in 2007, the DWR began including urban, agricultural and environmental mandates in their water accounting system. Under this new system, agriculture accounts for 40.9% of water used and urban residents 8.9%. According to the California Department of Water Resources the environment receives 50.2% of California water – nearly 40-million acre-feet – to manage wetlands, meet Delta, stream and river flows.
RESOLUTION NO. 2014 - 8

RESOLUTION PROCLAIMING TURLOCK IRRIGATION DISTRICT
IN A DROUGHT STATE OF OPERATION

WHEREAS, Governor Brown proclaimed California to be in a drought state of emergency on January 17, 2014; and

WHEREAS, Turlock Irrigation District is on pace to have experienced the three driest consecutive water years in the history of record keeping come this September; and

WHEREAS, the full natural flow of the Tuolumne River thus far in the 2014 Water Year is less than 10 percent of the historical average; and

WHEREAS, the amount of available water in Don Pedro Reservoir represents a volume that is among the lowest in TID’s history of distributing irrigation water; and

WHEREAS, the drought has negatively impacted TID hydroelectric generation capabilities and recreational opportunities at Don Pedro Reservoir; and

WHEREAS, the TID Board of Directors plans to set an amount of available water to customers for the 2014 Irrigation Season that amounts to a significant reduction compared to past irrigation seasons.

NOW, THEREFORE BE IT HEREBY RESOLVED by the Board of Directors of the Turlock Irrigation District that TID is experiencing an unprecedented drought with potentially alarming effects on its customers.

BE IT FURTHER RESOLVED that:

1. TID will continue to be a good steward of water, which includes delivering water as efficiently as possible, limiting operational spills that exit the TID distribution system, and continuing environmental stewardship efforts, among other actions.

2. TID will balance its responsibilities to maximize the near-term and long-term best interests of its irrigation and electric customers.

3. TID will assist the Don Pedro Recreation Agency to take measures to reduce the impact of drought conditions to water based recreation on and around Don Pedro Reservoir.

4. Staff is directed to develop and implement strategies to conserve water in 2014 and beyond.

5. TID will continue to strategically utilize its conjunctive use program of planned groundwater recharge in wet years and managed pumping in dry years.
6. Staff is directed to strictly enforce the existing Irrigation Rules. Customers are responsible for knowing and complying with the Irrigation Rules, and staff will assist customers with any questions of interpretation.

7. TID will strive to inform and assist irrigation customers to the best of staff’s ability and with measured flexibility, while fully acknowledging the constraints of the drought.

Moved by Director Fernandes, seconded by Director Santos, that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes: Directors Fernandes, Santos, Frantz, Alamo, Macedo
Noes: Directors None
Absent: Directors None

The President declared the resolution adopted.

I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 25th day of February, 2014.

[Signature]
Executive Secretary to the Board of Directors of the Turlock Irrigation District
Water Management

Proper management of the District’s water is critical to ensuring a stable and reliable supply for irrigation customers, especially in dry years. The District works cooperatively with other local agencies to promote long-term sustainability of this precious resource. Proper planning as well as efficient use of water benefits both the local urban and agricultural communities.

Groundwater Management

Groundwater within the District is supplied by the Turlock Groundwater Basin, which is a subunit of the larger San Joaquin Valley Groundwater Basin. The District utilizes a combination of surface water and groundwater to supply irrigation water to its growers.

Agricultural Water Management Plan

TID’s Agricultural Water Management Plan (AWMP) evaluates water use within the District and applicable management practices to make the best use of available resources.

Volumetric Water Measurement

Water metering equipment is currently being installed throughout Turlock Irrigation District. This project is related to the Water Conservation Act of 2009, also known as SBx7-7.

California Irrigation Management Information System

The California Irrigation Management Information System (CIMIS) is designed to help growers develop efficient water budgets and irrigation strategies. CIMIS is a standardized way of accounting for water consumed through evapotranspiration (ET) by the soil and plants.
Groundwater Management

As the only source of groundwater recharge in the basin, TID has lead the efforts toward sustainable groundwater.

Resources

- Groundwater Fact Sheet
- Groundwater Management Plan
- Agriculture Water Management Plan
- West Turlock Subbasin Fact Sheet

Conjunctive Use: balancing surface water and groundwater

We utilize a combination of surface and groundwater to supply our growers. Growers utilizing flood irrigation contribute to the replenishment of the groundwater supply by allowing water to soak into the ground where a portion of it eventually reaches underground aquifers. In normal and wetter years, surface water makes up the bulk of the supply with groundwater being drawn upon to a lesser extent. In those years, growers using flood irrigation are net groundwater rechargers, providing more water to the aquifer than is pumped out. In dry years, this stored groundwater can be utilized to help meet irrigation demand that cannot be supplied by surface water alone. This practice of utilizing surface and ground water to meet local requirements is known as conjunctive use.

The District's conjunctive use strategy is vital to maintaining a stable water supply. Deep percolation of surface water past the root zone is the primary method of groundwater recharge in the Turlock Groundwater Basin. This stored water then becomes part of the District's water supply in dry years as well as being the sole source of drinking and municipal water for Turlock, Ceres, Hilmar, Hickman, Hughson, Deming, Delhi, Kays, Ballo, and rural residences in the Turlock Groundwater Basin. Agricultural areas extending from the eastern boundary of TID to the Sierra Nevada foothills also rely exclusively upon groundwater for irrigation needs.

Our use of groundwater also plays an important role in water conservation. TID-owned and -rented pumps (distributed throughout the District) not only provide an additional source of water, they are used to help control flow fluctuations in the canal system. This helps TID Water Distribution Operators conserve water by reducing spills at the end of the canal system.

Groundwater Leadership

We’ve long been a leader in the management of local groundwater resources developing a model to predict the behavior of the underground aquifer under a variety of conditions over twenty-five years ago and since that time, we’ve continued to update and improve it. The model has proved to be a useful tool for evaluating the potential future impacts of land use changes, the sustainability of groundwater supplies, and drought planning efforts.

We’ve also taken an active role in local groundwater management and planning through our long-standing program of monitoring groundwater levels inside our boundaries, and cooperating with other state and local entities to monitor the larger basin area. We were the first local entity to adopt a Groundwater Management Plan in 1993, and are a member of the Turlock Groundwater Basin Association (TGBA), collaborating on groundwater issues since 1995. The TGBA developed basin-wide Groundwater Management Plans in 1997 and January 2008. The TID Board of Directors adopted the latest Groundwater Management Plan on March 18, 2008.
The Sustainable Groundwater Management Act (SGMA)

The Sustainable Groundwater Management Act (SGMA) was signed into law by Governor Brown on September 16, 2014 and became effective on January 1, 2015 enabling local agencies to manage groundwater so long as specific actions are taken and timelines met.

SGMA required local agencies form a Groundwater Sustainability Agency (GSA) or multiple GSAs, covering the entire Turlock Subbasin by June 30, 2017. GSAs are required to develop and implement a Groundwater Sustainability Plan (GSP) or plans to achieve sustainability and prevent “undesirable results.” This plan must be completed by 2022 and sustainability achieved by 2042. Under SGMA, failure to comply with any of these requirements may lead to state intervention in which case the State Water Resources Control Board (SWRCB) would require reporting, charge fees and may create interim management plans until such time that local agencies are able to take over.

Two GSAs formed within the Turlock Subbasin in 2017.

1. The West Turlock Subbasin Groundwater Sustainability Agency (WTGSA) which is encompassed nearly completely by the TID service territory and includes the cities of Turlock, Ceres, Hughson, Modesto and local water districts as well as the counties of Stanislaus and Merced, TID, and several other public water agencies.

2. The East Turlock Subbasin Groundwater Sustainability Agency (ETGSA) which is made up of the white area east of TID. The boundary separating the two GSAs is generally the Turlock Irrigation District’s eastern irrigation service area boundary.

For more information on SGMA compliance within the Turlock Subbasin, please visit turlockgroundwater.org.
Irrigation Tips

Tips and strategies to help our growers use water more efficiently.

Irrigation Tips

The tips below are designed to help growers reduce both tailwater drainage and the amount of deep percolation that contributes to high water tables and localized drainage problems. Most TID growers produce no tailwater. While these Irrigation tips are mainly intended for growers on the west side of the District who have access to area ditches or use tile drainage systems, all growers can benefit during a drought.

Following these tips may lead to changes in the layout of the checks in your fields and cultural practices for growing field crops. Improved irrigation also saves on fertilizer costs because less of the expensive nutrients are leached out of the soil with deep percolation of the unused irrigation water that passes the crop roots. A grower making these changes must reach a balance between field layouts based on production and labor needs and the goal to reduce tailwater and drainage percolation losses.

Water Saving Strategies to Reduce Drainage from Flood Irrigation

The key to reducing tailwater drainage and deep percolation is to irrigate very fast and control how long the water is on the field. Good irrigation practices can result in overall irrigation efficiencies of 75 percent. These irrigation strategies were developed with the U.C. Cooperative Extension during the 1987 to 1992 drought and they still apply to today’s practices.

- **Reduce check size to irrigate as fast as possible, thus minimizing the volume of tailwater**
  - Smaller or narrower checks irrigate better.
  - For example: sandy soils use 1 acre checks 55 to 55 feet wide by 700 to 600 feet long; loamy soils use 1.5 to 2 acre checks 80 to 90 feet wide by 800 to 1000 feet long.
  - On existing large checks, install a weir in the center to make 2 narrow checks.

- **Preparation of the field is critical to achieve a uniform flow of water across the check**
  - A high uniformity of irrigation means all parts of the field have the same amount of water for the same time. This also reduces deep percolation losses.
  - Laser level to insure cross slope is flat and check slope is uniform.
  - A narrow check with normal slope of 1/10 percent irrigates more uniformly across the check than a wider check with a steeper slope of 2/10 percent.

- **Practice “cutback irrigation” by turning off the water before it reaches the end of the check**
  - This will reduce pending, deep percolation losses, and tailwater volume. Cutback irrigation works because the water on the upper portion of the check will continue to flow down the check after the shutoff and irrigate the remainder of the check.
  - Change shutoff times during season to match how soil dries between irrigations. Midseason cultivation will also change the shutoff time.
  - Shut off times will vary throughout the season. The first irrigation may require a shutoff when the water reaches 10 percent of the distance down the check.
  - By the third irrigation this shutoff time may be reduced to only 70 percent of the distance down the check.
Schedule irrigations to match crop needs and soil water-holding characteristics

- To reduce drainage volume, how long you irrigate is just as important as how often
- On sandy loam soils 1.25 inches of applied water fills 1 foot of soil; on sandy soil 1 inch of water fills 1 foot of soil
- The plants can only utilize 50 percent to 60 percent of the water applied to the soil
- Understanding the crop rooting depth which varies with the stage of growth, can save water
- The highest deep percolation losses occur early in the growth season for annual field crops when the roots are not well developed
  - For example, the depths of corn roots are typically 3 feet during the peak stage of crop growth meaning each irrigation should require 3 inches on a sandy soil. But, since the irrigation efficiency is 75 percent, the total amount of water needed to reach the entire root zone is 4 inches, or 25 percent more than and be used by the crop.
  - For winter oats the rooting depth in May is typically 18 inches while alfalfa roots can reach 5 feet

How often to irrigate is based on how fast the plant uses the water in the soil

- Use crop water use or evapotranspiration (ET) information will help determine how much water is taken from the soil between irrigations.
- A typical corn crop uses .27 inches of water per day at peak growth in early August
  - On sandy soil with 3 foot roots, there is about 60 percent of the 3 inches of water in the soil or 1.8 inches of water available for the plant between irrigations
  - To keep the soil moisture at the optimum level for best yields, irrigate every 7 days
- For the same crop and soil in June, the corn uses only .13 inches per day and irrigations could be 13 days apart
- Because crop ET varies seasonally, use the current year ET values to schedule irrigations
- The local CIMIS site is Denair #168

Each field is different

- To obtain optimum yield, irrigation practices need to be tailored to specific situations
- Your local Farm Advisor can be of assistance in developing these practices

Receive Notifications from TID Alert

TID Alert – get emergency messages straight to your inbox or cell phone. Click here to learn more.

The Grower Customer Newsletter

Read The Grower newsletter for irrigation customers for up-to-date information about the irrigation season, best practices, notices and topics affecting growers. Click here for the latest issue.
Lateral 8 Total Channel Control Project
The Lateral 8 TCC Project is a high-tech water management system.

Water Measurement
Since 2013 TID has deployed several different types of water metering devices in response to the Water Conservation Act of 2009, also known as SBx7-7. In simple terms, this law requires all agricultural water suppliers serving more than 25,000 acres to measure customers within a specific volumetric accuracy range.

SBx7-7
The law defines the accuracy requirements based on the type of device measuring a parcel’s flow. The only way to measure by volume per the State’s requirements was to make a significant investment in new metering equipment and modify the way our customers order water. Many of you have probably noticed the requirement to order on every sidegate opened. This is directly related to SBx7-7. The District has also modified the way it tracks and accounts for water in an effort to comply.

Prior to deploying these meters, TID’s delivery/measurement facilities were adequate based on the historical allotment system. The new volumetric billing and accuracy requirements of the law meant we could no longer use the allotment system or report usage from historical measurements. This triggered a Corrective Action Plan process specified by the California Department of Water Resources (DWR). The implementation of this Plan resulted in the meters you see in our system today. TID’s goal is to rate every active parcel/sidegate combination receiving water in an effort to comply with SBx7-7. Details of the original Corrective Action Plan from 2012 are outlined in Appendix F of TID’s Agricultural Water Management Plan available here.

Some plan specific has changed over time but the overall accuracy requirements of the law still applies. Updating of the current plan is scheduled for completion in 2020.

Volumetric Accuracy vs. Flow Accuracy
There is a very important distinction between volumetric accuracy and flow accuracy as it applies to a gravity system such as ours. On gravity deliveries, it is virtually impossible for the flow delivered through a standard sidegate to remain exactly the same throughout an entire irrigation. This ever-changing flow can be created by many variables/changes in conditions. The list below does not show all of the conditions affecting flow but it does describe the most common variables for every gravity/surface water delivery in our system.

These items are normally outside of TID’s control because they exist on private property or are not within our right-of-way
- Mowing from one check to another on your property
- Mowing closer to or farther away from the canal within your pipeline or ditch
- Different elevations of checks within your parcel...sometimes a 1’ difference in ground elevation causes flow variability
- Changing conditions of your property such as floating for harvest, pre-irrigation on ripped ground, heavy weeds, mature crops etc.
- Different stem heights or valve sizes of your own field valves/gates
- Not opening the same number of valves/gates in each of your checks
- The existence of structure boxes, road siphons, debris etc. within the section of line you use while irrigating
- Utilizing any kind of pump that discharges directly into your pipe/ditch
These items are normally within TID’s control because they are within our canal right-of-way

- Any water elevation change within our canal
- Any change in stem opening at the canal sidegate
- A plugged grate or debris in front of your sidegate

How does this variability affect flow accuracy and volumetric accuracy?

The variability requires us to take multiple measurements during different periods of your irrigation so we can average all of the flows together and compute a single average flow rate for your parcel/sidegate combination. The example in this graph illustrates this variability. The graph shows an entire irrigation on a single parcel measured by a Rubicon FlumeMeter™. The flow steps you see on the graph (yellow line) are from the irrigator switching checks on their parcel and the steps up and down illustrate how changing conditions on a parcel can affect flow delivered at the canal. This is why it’s necessary to take multiple readings on the same parcel to compute an accurate flow. After all, accurate volumetric calibrations are the purpose of the program.

Meter Types and Measurement Strategy

These constantly changing conditions coupled with delivering large gravity flood heads along with smaller micro/drip heads means we need to use the appropriate meter for a particular delivery type. Depending on the delivery, we have five types of meters in the following quantities:

- Rubicon SlipMeters™ – 121 permanent sites
- Rubicon FlumeMeters™ – 78 meters, 57 are mobile & 21 are permanent
- Hach® Velocity Meters – 8 hand-held mobile meters
- SonTek-IQ™ Series Meters – 4 permanent & 1 hand-held mobile
- 11 permanent magnetic meters mounted on booster pump systems
- Fuji Transit Time Meters – 12 mobile meters for pumped/booster deliveries
- FlowLine™ downlooker – 2 in ID structures

With over 1,400 active sidegates in our system, installing permanent flowmeters at each site would be extremely expensive resulting in much higher water rates for our growers. For that reason, we only installed permanent meters on sidegates serving more than 250 acres with a few exceptions depending on location and canal operations. The remaining sidegates would be measured by mobile Rubicon FlumeMeters™, Hach® velocity meters, Fuji transit time meters, SonTek-IQ™ Series Meters, Seametrics or McCrometer mag meters and FlowLine™ downlookers. We are able to have permanent real time measurement data on more than 74,000 acres after installing meters in only 155 locations. The remaining 75,000 acres would be measured by the other mobile meters. Utilizing this strategy, we are able to volumetrically measure over 1,400 sidegates serving more than 147,000 acres by purchasing only 236 meters overall.

Rubicon SlipMeter™

The Rubicon SlipMeter™ is a fully automated gate that can be operated in flow mode or gate position mode. Flow mode allows the gate to automatically open or close itself to deliver an ordered flow as long as there is enough water in the canal and the pipeline/ditch capacity will allow it. When the Rubicon SlipMeter™ is in gate position mode it operates just like a standard sidegate by opening to a requested height in inches. Data is sent back to TID in real time allowing WDOs and water managers to see what is happening in the field almost instantly from their PCs or mobile tablets. Click here to see a sample of the data.

Customers served by permanent meters have the ability to see their actual flow while they irrigate by logging into their TID online water account. Contact the irrigation Call Center at 883-6456 for details on how to find your flow. You can also learn how to operate Rubicon SlipMeters™ by contacting your WDO or by watching our short how-to-videos by clicking here.

Rubicon FlumeMeter™ Rotations

Rubicon FlumeMeters™ are rotated from gate to gate and require no interaction from the customer. They are simply just a meter sending flow and canal elevation back to TID in real time. Once all active parcels being served by a specific sidegate are measured, the meter will be moved to a different site and the process will be repeated. By using this rotation method, we will be able to measure over 32,000 acres with only 57 mobile Rubicon FlumeMeters™.

Click here to see a Rubicon FlumeMeter™ installed on a sidegate.
**Sprinkler Systems and Pumps**

In most cases, irrigators utilizing any type of drip, micro or solid-set sprinkler irrigation systems will be measured by portable hand-held meters while some will be rated by Rubicon SlipMeters™ and Rubicon FlumeMeters™. When this project was first developed, the District planned to install magnetic meters along with full scada/radio equipment at all 400 known systems within TID. To verify cost and feasibility, we performed an inventory of every system and installed measuring equipment at ten sites. The inventory found more than 500 systems and the test sites verified it would cost us more than $4,000,000 to install meters & scada District wide. The inventory also found that most systems had two sources of water. One was TID canal water & the other was groundwater. After taking all of this into consideration, it didn’t make sense to spend over $4,000,000 while having the potential of billing a customer for their own pumped groundwater.

**Fuji Transit Time Meter**

The Fuji transit time meter was chosen as the alternative measurement device for pumped deliveries. They are extremely accurate and have a laboratory certified accuracy of ±1.0 percent. Fuji meters are easy to use and most ratings can be completed from start to finish in 15 minutes. Measurements are performed by trained WDOs at a significant savings when compared to the original plan of installing meters and scada/communications equipment at over 500 locations. We can measure virtually every system in the District with only four of these meters over a period spanning two seasons.

[Click here](#) to see a Fuji Transit Meter in use.

**Other Forms of Flood Measurement**

On pipelines and ditches not receiving a Rubicon FlumeMeter™ or a Rubicon SlipMeter™, TID will use a portable hand-held meter manufactured by Hach® (pronounced Hawk) to rate their flows. Trained members of our Water Distribution Department will measure these deliveries by placing the sensor inside the vent pipe or within an open ditch during multiple irrigations to determine an accurate average flow. [Click here](#) for a photo of a Hach® Meter.

SonTek-IQ® Series Meters will be permanently installed inside designated pipelines and open ditches. This type of permanent meter will be less obvious to irrigators because the hardware is not visible at a slidegate. SonTek-IQ® Series Meters will be installed in a location upstream of all field valves so all parcels can be measured. If irrigators notice a pole with a communications antenna installed near a pipeline or ditch, one of these permanent SonTek-IQ® Series Meters is likely being used. [Click here](#) to see a photo of an installed SonTek-IQ® Series Meter.

**Billing**

Prior to the start of the 2019 Irrigation season, Information will be provided to all active parcels comparing their historical volumetric usage with their new volumetric usage. This information will also include a comparison in dollars to help you understand how this new flow change can potentially affect your operations. Some flows will decrease, some will increase and others will see no change at all.

For additional information about water billing, [visit TID's Water Rates page](#) or call the District's irrigation Department at 209-883-8356.
Key Points of the Water Conservation Act of 2009

- Designed to improve water management & conservation statewide
- Law includes both Ag & Urban Agencies
- Ag water suppliers providing water to more than 25,000 acres had to comply by 7/31/12
- Ag portion requires:
  - Measurement, accounting & reporting
  - “Volumetric” pricing structure that encourages conservation
  - Water Management Plan that evaluates and reports measurement, pricing & other water conservation practices to the Department of Water Resources
  - Existing devices = +/- 12% accurate by volume
  - New devices = +/- 5% by volume (Must be lab certified)
  - All parcels to be measured by volume and to within a specified accuracy as of 7/31/12
  - Common thread with the law is measurements by volume at a specific “delivery point”. The “delivery point” is the canal side gate because that’s where the District transfers responsibility of the water over to its customers
What did this 2009 legislation mean to TID?

- The DWR was given the task of creating a measurement regulation
  - The regulation requires measurement accuracy to make volumetric pricing possible
  - Part of the regulation requires us to report aggregate farm-gate deliveries on a quarterly basis

- Since we could not comply by 7/31/2012, the law required us to devise an “Ag Water Measurement Corrective Action Plan”

- Per the law, this plan has to be in place by 12/31/2015

- The plan is available to the public by visiting our website. Go to: tid.com/AWMP & see “Appendix F” for specifics

- Our system was designed to reliably deliver water…now it must do this to a specific efficiency as well

- **Bottom line:** We have to start measuring & billing deliveries to each parcel by volume
Customer Outreach

- New dedicated webpage has been created on our website addressing what customers are seeing in the field
- “How To” videos in English, Spanish & Portuguese will be posted on our website
- Important information will be mailed to customers receiving slip meters
- WDOs and office staff will train customers how to operate the new gates
- Grower Newsletters
Methods of Measurement TID Has Tried…

The District has tested many different methods to measure flood deliveries over the last 4 years:

- Marsh McBirney
- Mace Meter
- ISCO Meter
- Sontek
- Rubicon
Some Parcels Will Be Checked Using Portable Flow Meters

- Can accommodate various measurement conditions
- Marsh McBirney cannot measure partial full pipes
- Sonteks can measure partial pipes and open ditches
- Approximately 550 parcels will be measured this way
Rubicon Slip Meters & Flume Meters

What’s the difference??
A Flume Meter is the frame & meter box that slides in front of existing side gates.

These are considered to be mobile and will not change the way you irrigate.

Irrigator continues to operate existing side gate.

Meter resides at side gate for 4-5 weeks to capture all parcels. Meter is then moved to another side gate.

District wide, there will be 50 Flume Meters measuring over 1984 parcels throughout the District.
Rubicon Slip Meter

- Replaces your existing side gate and will change the way you irrigate
- Irrigator enters flow rate and the Slip Meter delivers that flow rate as long as there’s enough water in the canal
- Irrigator can also enter a stem height and the gate will remain at that height regardless of flow
- Installation is permanent
- Live data will be transmitted to the District’s SCADA system
- 2900 parcels will be served by Slip Meters = 51% of total TID irrigated acres
Installation Progress

**Flume Meter Sites**

- So far there are 231 offset frames installed on 21 canals
- 45 frames left to install before the 2014 season begins

**Slip Meter Sites**

- So far there are 29 Slip Meters installed on 12 canals
- 38 left to install before the 2014 season begins
2013-2014 Installation Progress Map

Legend:
- **Sontek - Installed**
- **Sontek - Not Installed**
- **Frame - Installed**
- **Frame - Not Installed**
- **Slip Meter - Installed**
- **Slip Meter - Not Installed**

SBx7-7 Installation Progress 2/26/14
What About Booster Pump Systems?
By law, these systems also must be measured

- 400 sites have been planned for the project
- An inventory identifying important dimensions of each system is being performed by District staff
- Existing metered systems will be rated by a mobile sonic meter to verify accuracy of +/-12% by volume
- TID plans to have these systems connected via radio to our SCADA software
- TID will install the appropriate mag meters on existing sites that do not meet the accuracy requirements of the law
Vandalism & Security

- All Rubicon sites are remotely monitored and alarmed 24 hours per day
- Remote surveillance on each site will electronically notify staff immediately if there are issues
- Rank Security will get specific locations of sites to perform more frequent patrols
- Many security measures have been implemented on every site
How will this project affect the farmers?

- The goal is to affect farmers as little as possible but we understand there will be a learning curve.

- Our WDOs and office staff will train customers on how these meters operate and we will be as responsive as possible when concerns are raised.

- In the interest of fairness, the District does not intend to bill from these meters until all parcels have been rated which will take at least 2 years.

- Measurements during the 2014 and 2015 seasons will help the District identify where the water is going and will be used as a baseline for future operations.
Re-cap of Measurement Project

✓ TID was required by law to measure volumetrically and within a specific accuracy by 7/31/12

✓ TID couldn’t comply by 7/31/12 on ALL gates…law requires us to have corrective action plan in place by 12/31/15

✓ The accuracy & volumetric requirements for every site meant we could not use our existing sidegates alone as measuring devices

✓ 50 Flume Meters & 125 Slip Meters will be in use during the 2015 season

✓ A projected 400 booster pump sites will be metered before the 2016 season
TID Extends Irrigation Season to Benefit Growers

In an effort to accommodate growers with varying needs, Turlock Irrigation District has adjusted the end of the irrigation season from October 19 to November 2, 2016.

This additional time will allow growers to apply a final irrigation after harvest.

According to the UC Davis Drought Management Website, almonds in early harvest districts, and especially early varieties, can benefit from a final late irrigation due to more of the high water use season remaining post-harvest. This late irrigation can help to reduce stress, especially in times of deficit irrigation. (For details and the full article, visit ucanmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies).

The TID Board of Directors, in setting the 2016 Irrigation Season and the amount of available water, authorized staff to make adjustments to the start and end dates of the season based on customer needs. In speaking with customers and monitoring water usage patterns throughout the District, the TID staff made the season adjustment.

The final day to place water orders has also been extended by two weeks to Sunday, October 30.

Although the season has been extended by two weeks, there is no increase in the amount of available water. That amount remains at 36 inches per acre as set forth by the original board action at the beginning of the Irrigation Season.

If you have any questions regarding the new dates or any other issue relating to irrigation, call the Water Call Center at (209) 883-8456 or contact your WDO.

TID uses a combination of surface and groundwater to supply growers. This strategy, known as conjunctive use, is vital to maintaining a stable water supply.

TID encourages all growers to use the available surface water from TID in order to minimize pumping. After four years of drought, using surface water will help the groundwater levels so we can continue to use it when needed.

ONLINE ORDERING REMINDER - When ordering water online, you will always receive a confirmation e-mail from TID if your online order was successfully placed. If you do not receive one of these e-mails within minutes of placing the order, go back and place the order again or call (209) 883-8456 for assistance.
Lateral 8 Expansion Highlights Water Saving Efforts

The expansion of the Lateral 8 Regulating Reservoir has been completed on time and under budget, utilizing TID staff.

The Lateral 8 Regulating Reservoir Expansion project, coupled with the existing Lateral 8 Total Channel Control project, has increased TID water savings and improved customer service for irrigators downstream. The potential water savings, based on historic records, is estimated to be 9,000 acre-feet in an average year. Due to its size, the new reservoir has the ability to provide entire irrigations in addition to fluctuation control. The reservoir allows TID to maintain more constant irrigation flows and shorter wait times below the reservoir.

The reservoir works in concert with the Lateral 8 Total Channel Control system to capture operational water fluctuations in the Highline Canal and stores the water in the basin until it reaches a usable amount. These operational fluctuations would otherwise be lost to the Merced River as operational spill. The reservoir is capable of storing 130 acre-feet of water.

In the wake of increasing water demands and regulatory requirements, the Lateral 8 Regulating Reservoir and

Lateral 8 Total Channel Control projects are just two examples of the proactive steps that TID is taking to effectively manage our water resources. The District continues to examine the feasibility of these water savings projects throughout our canal system.

Lateral 8 Regulating Reservoir By The Numbers:
- 25.5 acre footprint
- 130 acre-feet storage capacity
- 4 distribution pumps - 1 intake and 3 discharge
- Primarily gravity fed from the Highline Canal
- Pumped discharges to Lateral 7 and Lateral 8
- 11,983 acres served downstream

SED and its Harmful Effects Looming From State Board

The State of California is reportedly close to releasing the long anticipated Substitute Environmental Document (SED) which is being developed for Phase 1 of the Bay Delta Water Quality Control Plan. This proposal, which disregards the water rights of local irrigation districts, would force TID to dedicate significant additional water releases from Don Pedro into the Tuolumne River from February 1 to June 30 annually for fish and wildlife beneficial uses and salinity control.

This proposal could lead to what the State has described as "Significant but unavoidable impacts" to the region’s economy and way of life. Those impacts include, farm-gate revenue losses, labor income losses, potential reductions in property values and lost jobs, just to name a few.

A reliable supply of surface water brings value to the community, including community sustainability, ag production, ag processing, ag-related business, economic base, groundwater recharge and affordable water. For example, the Don Pedro Project supports approximately $4.109 billion in output, $734.8 million in labor income, and 18,900 jobs. (2014 Socioeconomic Study)

While we support the State Water Resources Control Board's objectives for better water quality in the Delta and a healthy salmon fishery, we don't agree that increased river flows are the sole solution or that the San Joaquin River tributaries should be responsible for fixing California's water problems.

Our region has never faced a challenge of this proportion. This water grab has the potential to impact our region's way of life today and for future generations. We'll eventually ask you to make your voices heard by joining us in opposition to the State's attempt to take away your water. Please check our website at tid.org/SED for updates and ways to get involved.
SBx7-7 Measurements Still Being Conducted

In an ongoing effort to comply with the provisions of the California State Law known as SBx7-7, TID employees will be conducting measurement audits of equipment to ensure its accuracy. You might notice TID personnel or contractors taking these measurement audits during your irrigation.

TID contractors should be driving vehicles with door placards indicating they are authorized contractors for TID. If you have any questions or concerns about this work, please contact the Water Call center at (209) 883-8456 or your WDO.

Reminder for Customers Using Multiple Side-gates and Parcels

- Any time a side-gate is opened it must have an order placed for that specific side-gate every time it's used. Each parcel needs an order every time as well.
- Example: If a parcel uses 3 side-gates to irrigate, there must be 3 orders placed every time on that parcel. Each order would be for the specific side-gate opened and the parcel it serves.

2017 Billing Reminder

At the end of the 2015 Irrigation Season you will receive a letter showing the following information:
- Your historical billing amount (water)
- The amount of water you used in 2016
- The amount you have typically been paying
- The amount you would have paid based on the new measurements

A few rule reminders to ensure efficient operations

From time to time, it is important for the District to remind growers and others working near District canals and facilities regarding a few selected rules set forth in TID's Irrigation Rules.

TID's Irrigation Rules exist pursuant to Water Code Section 22257 to ensure the orderly, efficient, and equitable distribution, use and conservation of water resources of the District.

While it may seem that some of these rules are more serious than others, they are designed to allow the District to continue to meet the needs of all growers that rely on District irrigation water.

Irrigation Rule 2.4.1 states: "No diverting gates, weirs, structures, or pump intakes shall be constructed or placed in any District conduit until an application in writing has been made to the TID Board of Directors and permission granted therefore." Growers are not allowed to place structures in TID canals, facilities, easements or rights-of-way without written permission.

The District endeavors to deliver irrigation water in a flexible, timely manner consistent with the physical and operational limits of the delivery system facilities. But in order to do this, TID needs to be able to conduct water distribution operations and maintenance in a manner free of obstructions.

A full copy of TID's Irrigation Rules is available online at tid.org/water/Irrigation.

Water Distribution Operators also have copies available for growers.

TID thanks you for your continued compliance.

SB 854 and You

SB 854 affects the way TID awards all public works projects, including every contractor and subcontractor performing work. This includes work performed by customers utilizing District funds for reimbursement.

If you’re contracting for work to be performed on your property and then requesting reimbursement from TID, you must comply with the provisions of SB 854 to receive reimbursement. For details about SB 854, visit tid.org/SB854.

Calling all growers: important off-season notices

- Growers planning to convert to drip/micro/sprinkler irrigation (i.e., land conversion), need to contact TID prior to performing any work so TID can verify a non-standard head can be delivered. Systems installed without prior approval may be denied water if the configuration is not compatible with the District’s infrastructure and operations. Please keep in mind that this type of conversion can negatively impact groundwater recharge in your area.

- Growers intending to use TID canals and laterals or Improvement District facilities for irrigation purposes during the off-season must contact the Water Distribution Department (883-8356) to coordinate the use.

- Growers shall not plant or place trees, vines, shrubs, fences, or any other type of encroachment in, on, or over any District or Improvement district conduit or any District right-of-way unless the District has given specific written approval for such encroachment (Irrigation Rule 2.3.1). Please contact TID prior to placing encroachments in the District’s rights-of-way. If in doubt, TID can also help to identify and mark the right-of-way, often at no cost to the grower.
ONLINE ORDERING REMINDER -

When ordering water online, you will always receive a confirmation e-mail from TID if your online order was successfully placed.

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Water Statistics

Don Pedro Elevation on 8-1-2016  780.0 feet
Don Pedro Elevation on 8-1-2015  681.7 feet
Average total outflow from Don Pedro 4-1 to 8-1-2016  1,952 cfs
Average flow to TID canal 4-1 to 8-1-2016  1,161 cfs

Visit tid.org/drought for drought resources, water reports and updates
Visit tid.org/weather for up-to-the-minute forecasts
Attachment G.3. Grower Resources Available During the 2012-2016 Drought

- Drought Strategies for Orchards
- Strategies for Farming in a Drought
- University of California Drought Management page
- How NRCS Can Help

(PDFs to be added in final AWMP)
Drought Strategies for Orchards
How best to manage it and what to expect

Roger Duncan
Pomology & Viticulture Advisor
University of California Cooperative Extension
Stanislaus County

*Many slides borrowed from Ken Shackle, UC Davis
David Doll, UCCE Merced
Calculating Water Use by Evapotranspiration (ET)

- $\text{Et}_{\text{crop}} = \text{Et}_o \times K_c$
- $\text{Et}_o =$ reference ET (based on grass)
  - Can obtain from CIMIS

- $K_c =$ crop coefficient.
  - Is a ratio of tree water use compared to grass
  - Varies through the season
  - Different crops have different $K_c$
## Modesto - San Joaquin Valley - Station 71

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<th>Min Air Temp (°F)</th>
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# Calculating Water Use with ET

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<th>ETc</th>
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Past and present Almond Kc values and ETc estimates

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<th>Total ETc (in / period)</th>
<th>Etc Gal/tree/day*</th>
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<td><strong>48-56”</strong></td>
<td><strong>~48”</strong></td>
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* 16 x 21 tree spacing
Canopy cover dictates water needs

Orchards with 80% shaded area will use about 56” of water
About 35% shaded area uses about 25” of water
<table>
<thead>
<tr>
<th>DATE</th>
<th>Almond Kc Values</th>
<th>Average ETc (in / period)</th>
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</table>
MID & TID customers are limited to 24 inches of water in 2014, roughly half of the full irrigation requirement.
• With only half of the desired water available, trees **will** stress.

• We can only determine when and how much

• Timing of stress will affect the current and the following year’s yields
What is the best way to allocate a limited amount of water?

- 1993-1996 study (Goldhamer et al, 2006), Southern SJV, mature orchard
- 3’ root zone, 7.5” average rainfall during study (no pre-irrigation)
- 3 levels of irrigation deficit (34”, 28”, 23”) (80%, 67%, 55%)
- Control (100% Etc = 42”)
- 3 patterns of deficit irrigation
  - “A” – Deficit focused mostly in early season – full irrigation at end
  - “B” – Deficit focused at end of season – no irrigation after mid August
  - “C” – Deficit spread throughout the season
"B" pattern: Some deficit early, most deficit post-harvest

23” → 28” → 34”

(Goldhamer et al., 2006)
“C” pattern: Equal irrigation deficit all season

(Control = 100% season long, about 42")
(Target about 34")
(Target about 28")
(Target about 23")

(March, April, May, June, July, August, September, October, November)

(Goldhamer et al., 2006)
Average Kernel Yield (lbs/ac) 1993-1996

Seasonal Applied Irrigation (inches)

Black = 23”  Red = 28”  Blue = 34”
A = early deficit  B = late deficit  C = even deficit

(100% ETc CONTROL)
**Average Kernel Yield (lbs/ac) 1993-1996**

*An even deficit* over the season always gave the best result

- Black = 23”
- Red = 28”
- Blue = 34”

A = early deficit
B = late deficit
C = even deficit

(100% ETc CONTROL)

(Goldhamer et al., 2006)
Spread Pain Through the Season

- Full ET is about 48”
- MID & TID customers get half of that in 2014
- If you normally run your microsprinkler irrigation system 20 hours twice each week in June & July, run it for 10 hours twice each week
- If you flood irrigate, spread irrigations evenly
Almond Flower Bud Initiation

Almond Flower Bud Differentiation
Double Sigmoid Growth Curve of Stone Fruit

- Stage 1 – Sensitive to drought but too early for severe stress
- Stage 2 – Seed development. Most tolerant of stress. Earliest onset of pit tip hardening
- Stage 3 – 80% of fresh weight; due to cell expansion. Very sensitive to drought
## Estimating Water Application of 24” Total

<table>
<thead>
<tr>
<th>DATE</th>
<th>ETc (in / period)</th>
<th>Water application with only 24”</th>
<th>50% Etc Gal/tree/day*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 1-15</td>
<td>0.74</td>
<td>0.37</td>
<td>5.1</td>
</tr>
<tr>
<td>Mar 15-31</td>
<td>1.05</td>
<td>0.53</td>
<td>7.3</td>
</tr>
<tr>
<td>Apr 1-15</td>
<td>1.79</td>
<td>0.90</td>
<td>12.4</td>
</tr>
<tr>
<td>Apr 16-30</td>
<td>1.95</td>
<td>0.98</td>
<td>13.6</td>
</tr>
<tr>
<td>May 1-15</td>
<td>2.70</td>
<td>1.35</td>
<td>18.8</td>
</tr>
<tr>
<td>May 16-31</td>
<td>2.93</td>
<td>1.47</td>
<td>20.4</td>
</tr>
<tr>
<td>June 1-15</td>
<td>4.04</td>
<td>2.02</td>
<td>28.1</td>
</tr>
<tr>
<td>June 16-30</td>
<td>4.13</td>
<td>2.07</td>
<td>28.8</td>
</tr>
<tr>
<td>July 1-15</td>
<td>4.80</td>
<td>2.40</td>
<td>33.5</td>
</tr>
<tr>
<td>July 16-31</td>
<td>4.80</td>
<td>2.40</td>
<td>33.5</td>
</tr>
<tr>
<td>Aug 1-15</td>
<td>4.17</td>
<td>2.09</td>
<td>29.1</td>
</tr>
<tr>
<td>Aug 16-31</td>
<td>4.17</td>
<td>2.09</td>
<td>29.1</td>
</tr>
<tr>
<td>Sept 1-15</td>
<td>3.00</td>
<td>1.50</td>
<td>21.8</td>
</tr>
<tr>
<td>Sept 16-30</td>
<td>3.00</td>
<td>1.50</td>
<td>21.0</td>
</tr>
<tr>
<td>Oct 1-15</td>
<td>1.77</td>
<td>0.89</td>
<td>12.4</td>
</tr>
<tr>
<td>Oct 16-31</td>
<td>1.64</td>
<td>0.82</td>
<td>11.4</td>
</tr>
<tr>
<td>Nov 1-15</td>
<td>0.62</td>
<td>0.31</td>
<td>4.3</td>
</tr>
<tr>
<td><strong>Total ETc</strong></td>
<td><strong>~48”</strong></td>
<td><strong>24”</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Gal/tree/day based on 16’ x 21’ spacing

Gal/tree/day = ETc (in/day) x ft² x 0.622
A small amount of irrigation (3.6") spread evenly over the season resulted in more use of deep water than did no irrigation.
Control tree
- 9.8 bars
SWP

July 21, 2009
July 21, 2009

- 0” tree

- 39 bars SWP
Yield: The biggest reduction occurred in the year following the stress (i.e. carryover effect)

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield (pounds kernels /acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 (CONTROL)</td>
<td>30.8</td>
</tr>
<tr>
<td>2010</td>
<td>7.2</td>
</tr>
<tr>
<td>2011</td>
<td>3.6</td>
</tr>
<tr>
<td>2012</td>
<td>0</td>
</tr>
</tbody>
</table>


Mature Orchard near Firebaugh, 2003-2012

- 2009: Severe Curtailment on West side, 12" of applied water
- 2010: Full ETc was applied
- 2011: Full ETc was applied, near normal production
- 2012: Full ETc was applied, normal production

David Doll; UCCE Merced

Mature Orchard near Firebaugh, 2003-2012

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Mature Orchard near Firebaugh, 2003-2012

2009: Severe Curtailment on West side, 12” of applied water

2010: Full ETc was applied

2011: Full ETc was applied, near normal production

2012: Full ETc was applied, normal production


David Doll; UCCE Merced
Pressure chamber method for measuring water stress

Like measuring the “blood pressure” of the plant
Stem Water Potential (SWP)
Resources to help with the pressure chamber

For Almond

<table>
<thead>
<tr>
<th>SWP range (bars)</th>
<th>Stress level</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5 to -10</td>
<td>Minimal</td>
</tr>
<tr>
<td>-10 to -16</td>
<td>Mild</td>
</tr>
<tr>
<td>-16 to -24</td>
<td>Moderate</td>
</tr>
<tr>
<td>-24 to -30</td>
<td>Severe</td>
</tr>
<tr>
<td>-60</td>
<td>(complete defoliation)</td>
</tr>
</tbody>
</table>

(For other crops)

### TENTATIVE GUIDELINES FOR INTERPRETING PRESSURE CHAMBER READINGS (MIDDAY STEM WATER POTENTIAL-SWP) IN WALNUT, ALMOND, AND DRIED PLUM. UPDATED MAY 2007.

Alban Fulton and Richard Buchner, UCCE Farm Advisors, Tehama County, Joe Grant, Farm Advisor, San Joaquin County, Terry Pitchard, Bruce Lampine, Larry Schwartz, Extension Specialists, UC Davis, and Ken Shackell, Professor UC Davis.

<table>
<thead>
<tr>
<th>Pressure Chamber Reading (bars)</th>
<th>WALNUT</th>
<th>ALMOND</th>
<th>PLUMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to -2.0</td>
<td>Not commonly observed</td>
<td>Not commonly observed</td>
<td>Not commonly observed</td>
</tr>
<tr>
<td>-2.0 to -4.0</td>
<td>Fully imbibed; low stress, commonly observed when orchards are irrigated according to estimates of real-time evapotranpiration (ETc), long term root and tree health may be a concern, especially on California Black walnut.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-4.0 to -6.0</td>
<td>Low to mild stress, high rate of shoot growth evident, suggested levels from late April and mid-June when nut setting is complete.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-6.0 to -8.0</td>
<td>Mild to moderate stress, shoot growth in non-bearing and bearing trees has been observed to decline. These levels do not appear to affect kernel development.</td>
<td>Low stress, indicator of fully irrigated conditions; ideal conditions for shoot growth. Suggest maintaining these levels from leaf out through mid-June.</td>
<td></td>
</tr>
<tr>
<td>-8.0 to -10.0</td>
<td>Moderate to high stress, shoot growth in non-bearing trees may stop, not setting may be reduced in bearing trees and bud development for next season may be negatively affected.</td>
<td>Low stress, common from March to mid April under fully irrigated conditions. Ideal for maximum shoot growth.</td>
<td></td>
</tr>
<tr>
<td>-10.0 to -12.0</td>
<td>High stress, temporary wilting of leaves has been observed. New shoot growth may be stunted or absent and some defoliation may be evident. Nut size likely to be reduced.</td>
<td>Mild to moderate stress, these levels of stress may be appropriate during the phase of growth just before the onset of hull split (late June).</td>
<td></td>
</tr>
<tr>
<td>-12.0 to -14.0</td>
<td>Severe stress, levels of stress, moderate to severe defoliation should be avoided.</td>
<td>Suggested levels in late April through mid-June. Low stress levels enabling shoot growth and fruit setting.</td>
<td></td>
</tr>
<tr>
<td>-14.0 to -16.0</td>
<td>Severe defoliation, trees are likely dying</td>
<td>Suggested mild stress levels of stress during late June and July. Shoot growth slowed but fruit setting unaffected.</td>
<td></td>
</tr>
<tr>
<td>-16.0 to -20.0</td>
<td>Crop stress levels in English walnut not observed at these levels.</td>
<td>Suggested high stress levels of stress during late June and July. Moderate stress acceptable in September.</td>
<td></td>
</tr>
<tr>
<td>-20.0 to -30</td>
<td>High stress, willling observed, some defoliation</td>
<td>Moderate to high stress levels. Most commonly observed after harvest. Generally intolerable during any stage of bloom or fruit growth. Most appropriately managed with post-harvest irrigation</td>
<td></td>
</tr>
<tr>
<td>Less than -30</td>
<td>Extensive defoliation has been observed</td>
<td>High stress, extensive defoliation</td>
<td></td>
</tr>
</tbody>
</table>

*These guidelines are tentative and subject to change as research and development with the pressure chamber and midday stem water potential progresses. This table should not be duplicated without prior consent by the authors.*
Resources to help with the pressure chamber

New ‘baseline’ website:
Resources to help with the pressure chamber

New ‘baseline’ website:
Strategies to reduce water loss and improve distribution uniformity in flood irrigated orchards
Irrigation distribution uniformity (DU) in surface irrigation is determined by soil infiltration rate, flow down the check and set duration.

\[
DU (\%) = 100 \times \frac{\text{"low quarter" infiltration}}{\text{Average field infiltration}}
\]

Possible stress
N leaching, water logging

Stressed plant growth
Too little water

Rootzone Depth (m)

Deep percolation – lost water & N fertilizer

Infiltration @ 6 hrs
Infiltration @ 12 hrs
Infiltration @ 18 hrs
Infiltration @ 24 hrs

Head
Tail – no leaching
Causes of micro irrigation non-uniformity: algae, slime, debris plugging hose screens and/or emitters.

Trash from pipe break after repair and system restart.

Thin coating of algae. No system chlorination.
Causes of micro irrigation non-uniformity: chemical precipitates clogging drippers or altering flow rates. Check fertilizer mixes, gypsum injection, maybe use acid.

Microsprinklers may show precipitation but rarely lose flow.
Saving water: some general recommendations

1) Control weeds.

2) Maintain irrigation system and try to improve uniformity.

3) No evidence that heavy pruning or kaolin/whitewash sprays do any economic good to mitigate drought conditions.

4) Mild to moderate stress at the start of hull split is a good idea to speed up hull split and reduce hull rot.

5) Use a pressure chamber to identify areas of severe stress and adjust your irrigation approach before these areas become a problem.

6) Expect a reduced kernel size this year, and reduced bloom and set next year.
Thanks for funding and/or cooperation from:

Almond Board of California
USDA-SCRI
Nickels Estate

Thanks to Ken Shackle, David Doll, Bruce Lampinen, & Allan Fulton for sharing slides
Thank you for your attention.

Roger Duncan
209-525-6800
raduncan@ucdavis.edu
cestanislaus.ucdavis.edu
Farming in a Drought

Strategies

Joe Mullinax
Denele Analytical Inc.
Direct Strategies for Forage Crops

Planting Options

- Corn
- Sudan/Sorghum
- Alfalfa
**Corn NEL under Drought Conditions**

Statewide Total Average Energy for corn silage is down for the past year

<table>
<thead>
<tr>
<th>Drought Extent</th>
<th>Hanford</th>
<th>Turlock</th>
<th>Woodland</th>
</tr>
</thead>
<tbody>
<tr>
<td>More</td>
<td></td>
<td>Slight</td>
<td>Less</td>
</tr>
<tr>
<td>2013 Corn NE/LAC Mcal/Lb</td>
<td>.65</td>
<td>.71</td>
<td>.72</td>
</tr>
</tbody>
</table>
Effects of Cutting Water on Yields and Energy

- Max Yield High Energy
- Max Yield Low Energy
- Harvest
- Planting
- Silk
- Tassle

Corn
Effects of Cutting Water on Energy

Sorghum

- Planting
- Heading
- Harvest

Yield

Energy

90
95
100
105
Cutting Strategies
Sorghum/Sudan

**Two Full Cuttings**

- 1st Cutting
- 2nd Cutting
- 3rd Cutting

**Sacrifice First and Second Cutting**

- 1st Cutting
- 2nd Cutting
- 3rd Cutting

- No Pre-Irrigation
- Frost Danger

Sacrifice First and Second Cutting

- Frost Danger
Cutting Strategies
Alfalfa

Sacrifice Cuttings

1st Cuttings

3rd & 4th Cutting

Last Cuttings

Deficit Through Season

1st Cutting

Last Cutting

Low yields at all cuttings

Salt Mitigation
Mitigating Factors That Influence Irrigation Strategies

• Sodium Levels
  – Salt Dome
  – Leaching
  – Leaf Burn

• Nitrate levels

Irrigation Suitability 3 Year average

<table>
<thead>
<tr>
<th></th>
<th>PPM – NO3-N</th>
<th>Lb/Acre/in</th>
<th>Lb/Acre/ft</th>
<th>Lb/3 Acre/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-2013-2014</td>
<td>41</td>
<td>9.26</td>
<td>111.48</td>
<td>336.36</td>
</tr>
<tr>
<td>2010-2011-2012</td>
<td>23</td>
<td>5.21</td>
<td>52.64</td>
<td>187.56</td>
</tr>
</tbody>
</table>
Mitigating Factors in Dry Years
ZN – B – CU - MN

Boron

ppm

2010  2011  2012  2013
Any Questions?
Introduction

When there is insufficient irrigation water to meet the water demands of a crop, the available irrigation water must be applied in the most efficient manner possible.

There are available strategies for maximizing irrigation water efficiency.

Agriculture

- Deficit irrigation strategies may be available to make the best use of limited water supplies. Click here for [Crop Irrigation Strategies](http://ucmanageddrought.ucdavis.edu/) for almonds, pistachios, stone fruit, walnuts, alfalfa, olives, winegrapes, corn, and processing tomatoes.

- Quality [Irrigation Scheduling](http://ucmanageddrought.ucdavis.edu/) can be critical to efficient irrigation water use. Evapotranspiration (ET) irrigation scheduling, soil moisture monitoring, and plant-based irrigation scheduling are all discussed.

For further California drought information, experts, and resources, please visit the [California Institute for Water Resources drought pages](http://ucmanageddrought.ucdavis.edu/).
What does NRCS do?
How can we help?

Diana Waller
District Conservationist
28 May 2014
USDA NRCS  Who Are We?

- United States Department of Agriculture (Federal)
- Natural Resources Conservation Service
  - Implement Conservation Title Funding Programs
  - Provide Technical Assistance to Farmers and Ranchers
  - Responsible for Soil Surveys on Private Lands
  - Conduct the National Resource Inventory on Private Lands
- Non-Regulatory, Voluntary
- Most Counties Have a Local Office
- Helping People Help The Land
USDA NRCS & Partnership

- Locally-led conservation through local work groups
  - Comprised of stakeholders from local, state and federal government along with private land operators (farmers) and non-government agencies (everybody)
  - Primary stakeholders are farmers and ranchers (foresters)
  - Local, State, Federal Government (RCDs & others)
  - Non-Governmental Organizations (NGOs)

- Resource Conservation Districts (RCDs)
  RCDs are a board of volunteer farmers (and others) that live and work in their areas of influence

- We can leverage funding and resources with other agencies
Technical Assistance

- Conservation planning
- Management Workshops (IWM, NM, IPM)
- Engineering feasibility
- Access to technical specialists (Geologists, Biologists, Agronomists, Soil Scientists, Archeologists, etc.)
- Non-regulatory assistance, protected by the Privacy Act
Resource Inventory

- Soil surveys & soils information
- Topographic & watershed maps
- National wetland inventory
- Historical aerial photography
- Species occurrences
First Step – Your Conservation Plan

- Request Assistance Year-Round
- Identify Your Goals & Resource Concerns
- Planners and Engineering Staff Develop Alternative Practices to Meet Your Goals
- You Decide On Your Approach → May Be Submitted for Funding Consideration Under a Our Funding Programs
Cost-Share Incentives Programs

- Many projects on farmland, forestland, and rangeland have environmental benefits
- Our programs aim to share the cost of doing these projects
- Public benefits = public funding available
- Emergency resource protection (ex. drought)
NRCS Programs

Environmental Quality Incentives Program (EQIP)

Conservation Stewardship Program (CSP)
Environmental Quality Incentives Program (EQIP)

- Cost-share incentive to adopt environmentally beneficial projects
- Applications accepted year-round with periodic funding ‘cut-off’ dates
- Contracts must be finalized before a project is begun
- Competitive! Selection is based on resource benefits as outlined in funding pool
Air Quality

Project examples include:

- Tub grinding removed orchards
- Dust control on unpaved roads
- NOx emissions from diesel engines
- VOC reductions through precision technology
Water Quality/Quantity

Project examples include:
- Micro-irrigation systems
- Irrigation system evaluations
- Irrigation water management
- Nutrient management
- Concrete stacking pads for silage/manure
- Irrigation/manure transfer pipelines
- Tailwater re-use systems
- Ditch Lining
- Flow meters
- Irrigation Reservoirs, Sediment Basins
- And More!
Soil Quality/Soil Erosion

Project examples include:

- Cover crops
- Reduced tillage/no-till
- Nutrient management
- Irrigation improvements
- Erosion mitigation plans
- Prescribed grazing

Highly Erodible Land Treatment*

*Drought/Flood Resiliency
Plants and Animals

Project examples include:
- Wildlife-
  • Pollinator plantings
  • Riparian plantings
  • Fish screens on existing river intakes
    *Many wildlife projects require permits*
- Rangeland/Pasture-
  • Stock watering systems
  • Spring development
  • Grazing management
  • Noxious weed management
  • Cross-fencing
Eligibility Requirements

- Must **Produce an Agricultural Product** on the Land
- Must be **Owner or Operator** of the Land
- Average **Adjusted Gross Income Maximum is $900,000**
- Contracts Limited to **$300,000**
- $450,000 maximum over Farm Bill period
- Highly Erodible Land/Wetland Compliance
- Contracts typically 2 years in length (or less)
- **Irrigation History (2/5 years)** for Irrigation Improvements
- Special Rates for Historically Underserved Groups, Beginning Farmers & Limited Resource Farmers
- Veteran's Preference for Beginning Farmers that have served.
Agricultural Conservation Easement Program

- New with the 2014 Farm Bill - rolled together many of our previous easement programs
- Agricultural Land Easements – just development rights
- Wetland Reserve Easements – agricultural and development rights
Questions???

Local Office:
USDA - NRCS
Modesto Service Center
3800 Cornucopia Way Suite E
Modesto, CA 95358
(209)491-9320 x 3

California NRCS Website:
http://www.nrcs.usda.gov/wps/portal/nrcs/site/ca/home/
Appendix H

HYDROGEOLOGICAL CHARACTERIZATION OF THE EASTERN TURLOCK SUBBASIN
The Hydrogeological Characterization of the Eastern Turlock Subbasin report is available online at:

http://www.esjgroundwater.org/
Appendix I

DWR WATER BUDGET REPORTING TABLES
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This appendix provides the water year water budget tables required by DWR as part of the 2020 AWMP submittal package.

As described in Section 5.5 of the 2020 AWMP, TID has historically calculated and presented the irrigation season water budget for agricultural water management planning efforts. Accounting for water during the irrigation season provides a clearer depiction of agricultural and irrigation practices by growers, and the TID operations that support those practices.

Water year summaries have historically not been reported for several reasons. First, irrigation seasons in TID typically begin in March and may extend into October or November, straddling two water years (defined as October 1 – September 30). Water year reporting thus cuts irrigation seasons into multiple reporting years. Second, the off-season winter months have historically been excluded from TID’s AWMP water budgets because TID does not generally operate the distribution system or supply deliveries outside of the irrigation season. Flows during the off-season primarily include drainage, unmeasured stormwater intercepted by TID’s canals, and precipitation inflows and outflows that are not a function of agricultural operations in TID.

However, to fulfill the updated AWMP requirements pursuant to AB 1668, TID has calculated a boundary water balance on a water year basis (October 1 – September 30) for the TID service area.

The water year water budget tables for TID are provided below in Table I-1 (Inflows) and Table I-2 (Outflows). Additional details regarding the required inflow and outflow components are given in Tables I-3 and I-4, respectively. These detailed tables describe all boundary flow paths in the TID water budget that comprise the inflow and outflow components required by DWR.

A schematic of the TID boundary water budget is provided in Figure I-1, identifying the TID water budget boundary flows and their relationship to the DWR-required inflow and outflow components.

Because the TID irrigation season straddles two water years nearly every year, all flow paths differ slightly between the irrigation season water budgets reported in Section 5 of the AWMP and in the tables below. Apart from this underlying difference, other key differences in flow paths between the irrigation season and water year are described in Table I-5. Off-season inflows and outflows are mainly attributed to winter precipitation, storm flows, other system inflows (including runoff and nuisance water from cities in the TID service area), and unmeasured drainage.44 Perennial crops also continue to uptake residual soil moisture during the off-season that was applied through irrigation during the irrigation season. To balance the water budget during the off-season, the following closure terms were calculated outside of the irrigation season:

44 In the past, TID has not operated the distribution system during the off-season except to pass storm flows, runoff, and drainage water through the service area. Measurement sites in the TID system have been monitored during the off-season primarily to observe changing trends in flow. Excess water has been passed through the system in some wet years using drainage outflow locations that are not part of the measured spillage network. Moving forward, TID will review its operations at these sites to ensure better accuracy throughout the entire water year.
The volumes of the off-season closure terms are small relative to the entire District service area. For example, the off-season Irrigated Lands applied water balance closure “change in root zone storage of applied water” is equivalent to approximately 2 inches of soil moisture depletion, on average, over the entire off-season. The off-season Distribution System closure “Off-Season Unmeasured System Outflows” is equivalent to approximately 2% of the total outflows from the system, and is well within the uncertainty of other measured inflows and outflows.

**Figure I-1. TID Boundary Water Budget Schematic, with TID Boundary Flows and Required DWR Inflow and Outflow Components.**

*Effective precipitation is equal to ET of precipitation, which is accounted as an outflow from the TID water budget. To balance the TID water budget, Effective Precipitation and Additional Precipitation (Total Precipitation minus Effective Precipitation) are both shown in this schematic.*
### Table I-1. Water Budget Inflows (DWR Table V-1).

<table>
<thead>
<tr>
<th>Inflow Components</th>
<th>AWMP Location for Supporting Calculations</th>
<th>Volume Quantification Method</th>
<th>Percent Uncertainty</th>
<th>Uncertainty Quantification Method</th>
<th>Volume (AF/water year) 2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Precipitation(^3)</td>
<td>5.3.3.1; 5.3.3.2.2</td>
<td>Modeled</td>
<td>10%</td>
<td>Modeled</td>
<td>57,057</td>
<td>90,564</td>
<td>106,002</td>
<td>66,856</td>
<td>98,091</td>
</tr>
<tr>
<td>Water Supplier Surface Water Diversions(^4)</td>
<td>5.3.1.1</td>
<td>Measured</td>
<td>3%</td>
<td>Measured</td>
<td>289,004</td>
<td>367,401</td>
<td>488,994</td>
<td>513,451</td>
<td>479,092</td>
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<tr>
<td>Water Supplier Groundwater Pumping</td>
<td>5.3.1.2</td>
<td>Calculated</td>
<td>20%</td>
<td>Estimated</td>
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<td>73,435</td>
<td>34,738</td>
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<td>Private Pumping</td>
<td>5.3.1.3</td>
<td>Calculated</td>
<td>20%</td>
<td>Estimated</td>
<td>131,458</td>
<td>65,887</td>
<td>44,504</td>
<td>78,107</td>
<td>38,082</td>
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<td>Other - Treated Wastewater</td>
<td>5.3.1.4</td>
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<td>10%</td>
<td>Estimated</td>
<td>7,443</td>
<td>8,149</td>
<td>4,897</td>
<td>5,013</td>
<td>4,913</td>
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<tr>
<td>Other - Spillage Recovery</td>
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<td>Calculated</td>
<td>20%</td>
<td>Estimated</td>
<td>999</td>
<td>633</td>
<td>1,374</td>
<td>2,024</td>
<td>1,252</td>
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<tr>
<td>Other - Off-Season System Inflows</td>
<td>Appendix I</td>
<td>Measured</td>
<td>20%</td>
<td>Estimated</td>
<td>1,572</td>
<td>2,595</td>
<td>7,326</td>
<td>846</td>
<td>4,501</td>
</tr>
<tr>
<td>Other - Additional Precipitation (Total Precipitation minus Effective Precipitation)(^3)</td>
<td>5.3.2; 5.3.3.2.2</td>
<td>Measured</td>
<td>20%</td>
<td>Estimated</td>
<td>42,850</td>
<td>69,389</td>
<td>111,507</td>
<td>37,573</td>
<td>63,420</td>
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<tr>
<td><strong>Total Inflows</strong>(^5)</td>
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<td><strong>598,230</strong></td>
<td><strong>678,050</strong></td>
<td><strong>799,340</strong></td>
<td><strong>744,730</strong></td>
<td><strong>730,590</strong></td>
</tr>
</tbody>
</table>

1. Details about all TID water budget flow paths included in each Inflow Component are provided in Table I-3.
2. For required Inflow Components that include multiple TID water budget flow paths, the quantification methods and uncertainty represent the typical methods and uncertainties among all flow paths represented. Details on each TID water budget flow path are provided in Table I-3.
3. Effective precipitation is equivalent to ET of Precipitation, which is accounted as an outflow from the TID water budget. To account for all inflows, the additional precipitation (total precipitation minus effective precipitation) has also been added as an “Other” Inflow Component.
4. The TID water budget has historically been calculated for the distribution system and irrigated lands downstream of Turlock Lake, beginning with irrigation releases from Turlock Lake. As reporting needs change and use of the TID water budget evolves, TID is planning to update the water budget to include the Upper Main Canal and Turlock Lake. Following these future updates, surface water inflows to the TID water budget will be revised to surface water releases from Don Pedro Reservoir. These updates are expected to occur within the next five years, and will be included in the next AWMP update.
5. Total volumes rounded to 10 AF.
Table I-2. Water Budget Outflows (DWR Table V-2).

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<tr>
<th>Outflow Components¹</th>
<th>AWMP Location for Supporting Calculations</th>
<th>Volume Quantification Method²</th>
<th>Percent Uncertainty²</th>
<th>Uncertainty Quantification Method²</th>
<th>Volume (AF/water year)</th>
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<td></td>
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<td></td>
<td>2019</td>
</tr>
<tr>
<td>Evapotranspiration (Crop Consumptive Use)³</td>
<td>5.3.3.1; 5.3.3.2</td>
<td>Modeled</td>
<td>10%</td>
<td>Modeled</td>
<td>433,537</td>
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<td>437,626</td>
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<td>Surface Outflows</td>
<td>5.3.1.4; 5.3.1.5; 5.3.3.1</td>
<td>Measured</td>
<td>9%</td>
<td>Measured</td>
<td>24,821</td>
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<td>86,409</td>
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<td>Deep Percolation⁴</td>
<td>5.3.3.1, 5.3.4, 5.3.1.5</td>
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<td>Calculated</td>
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<td>236,348</td>
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<td>Other - Evaporation</td>
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<td>Estimated</td>
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<td>1,579</td>
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<tr>
<td>Other - Tilewater (to Rivers)</td>
<td>5.3.1.4</td>
<td>Calculated</td>
<td>7%</td>
<td>Estimated</td>
<td>1,558</td>
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<td>1,879</td>
</tr>
<tr>
<td>Other – Change in Root Zone Storage (Precipitation and Off-Season Applied Water)</td>
<td>5.3.3.1; 5.3.3.2.2</td>
<td>Calculated</td>
<td>20%</td>
<td>Calculated</td>
<td>-38,489</td>
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<td>-42,932</td>
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<tr>
<td>Other – Off-Season Unmeasured System Outflows</td>
<td>Appendix I</td>
<td>Calculated</td>
<td>19%</td>
<td>Estimated</td>
<td>11,200</td>
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<td>3,738</td>
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<td>9,679</td>
</tr>
<tr>
<td><strong>Total Outflows⁵</strong></td>
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<td>598,230</td>
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<td>678,050</td>
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<td>799,340</td>
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<td>730,590</td>
</tr>
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</table>

¹ Details about all TID water budget flow paths included in each Outflow Component are provided in Table I-4.

² For required Outflow Components that include multiple TID water budget flow paths, the quantification methods and uncertainty represent the typical methods and uncertainties among all flow paths represented. Details on each TID water budget flow path are provided in Table I-4.

³ Evapotranspiration includes ET of Applied Water (crop consumptive use of applied water) and ET of Precipitation (equivalent to effective precipitation, an inflow component).

⁴ The TID water budget has historically been calculated for the distribution system and irrigated lands downstream of Turlock Lake, excluding infiltration of surface water (seepage) from the Upper Main Canal and Turlock Lake. As reporting needs change and use of the TID water budget evolves, TID is planning to update the water budget to include the Upper Main Canal and Turlock Lake. Following these future updates, seepage from the Upper Main Canal and Turlock Lake will be added to the TID water budget. These updates are expected to occur within the next five years, and will be included in the next AWMP update.

⁵ Total volumes rounded to 10 AF.
Table I-3. Water Budget Inflows - Detail.

<table>
<thead>
<tr>
<th>Inflow Components¹</th>
<th>TID Water Budget Flow Paths</th>
<th>AWMP Location for Supporting Calculations</th>
<th>Volume Quantification Method</th>
<th>Percent Uncertainty (Irrigation Season / Off-Season)²</th>
<th>Uncertainty Quantification Method</th>
<th>Volume (AF/water year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
<td>Modeled</td>
<td>2015</td>
</tr>
<tr>
<td>Effective Precipitation</td>
<td></td>
<td>ET of Precipitation</td>
<td>5.3.3.1, 5.3.3.2.2</td>
<td>Modeled</td>
<td>10%</td>
<td>57,057</td>
</tr>
<tr>
<td>Water Supplier Inflows</td>
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<td></td>
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</tr>
<tr>
<td>Surface Inflow</td>
<td>Irrigation Releases from Turlock Lake³</td>
<td>Measured</td>
<td>5.3.1.1</td>
<td>Measured</td>
<td>3%</td>
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<td>Groundwater Pumping</td>
<td>Drainage Pumping</td>
<td>Calculated</td>
<td>5.3.1.2</td>
<td>Estimated</td>
<td>20%</td>
<td>30,599</td>
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<td>Rented Pumping</td>
<td>Calculated</td>
<td>5.3.1.2</td>
<td>Estimated</td>
<td>20%</td>
<td>37,445</td>
</tr>
<tr>
<td>Private Inflows</td>
<td>Private Pumping</td>
<td>Calculated</td>
<td>5.3.1.3</td>
<td>Estimated</td>
<td>20%</td>
<td>131,458</td>
</tr>
<tr>
<td>Other Inflows</td>
<td>Treated Wastewater</td>
<td>Measured</td>
<td>5.3.1.4</td>
<td>Estimated</td>
<td>10%</td>
<td>7,443</td>
</tr>
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<td></td>
<td>Spill Recovery</td>
<td>Calculated</td>
<td>5.3.1.4</td>
<td>Estimated</td>
<td>20%</td>
<td>999</td>
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<tr>
<td></td>
<td>Additional Precipitation</td>
<td>(Total Precipitation minus Effective Precipitation)</td>
<td>5.3.2; 5.3.3.2.2</td>
<td>Estimated</td>
<td>20%</td>
<td>42,850</td>
</tr>
<tr>
<td></td>
<td>Other - Off-Season System Inflows</td>
<td>Measured</td>
<td>Appendix I</td>
<td>Estimated</td>
<td>N/A / 20%</td>
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<tr>
<td>Total Inflows⁴</td>
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<td>598,230</td>
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</tbody>
</table>

¹ The TID water budget has historically been calculated for the distribution system and irrigated lands downstream of Turlock Lake, beginning with irrigation releases from Turlock Lake. As reporting needs change and use of the TID water budget evolves, TID is planning to update the water budget to include the Upper Main Canal and Turlock Lake. Following these updates, surface water inflows to the TID water budget will be revised to surface water releases from Don Pedro Reservoir. These future updates are expected to occur within the next five years, and will be included in the next AWMP update.

² The listed percent uncertainty is for the entire water year unless two percentages are given.

³ Total volumes rounded to 10 AF.
### Table I-4. Water Budget Outflows – Detail

<table>
<thead>
<tr>
<th>Outflow Components ¹</th>
<th>TID Water Budget Flow Paths</th>
<th>AWMP Location for Supporting Calculations</th>
<th>Volume Quantification Method</th>
<th>Percent Uncertainty (Irrigation Season / Off-Season) ²</th>
<th>Uncertainty Quantification Method</th>
<th>Volume (AF/water year) 2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evapotranspiration (Crop Consumptive Use)</strong></td>
<td></td>
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<td>ET of Applied Water</td>
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<td>ET of Precipitation</td>
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<td>Modeled</td>
<td>10%</td>
<td>Modeled</td>
<td>57,057</td>
<td>90,564</td>
<td>106,002</td>
<td>66,856</td>
<td>98,091</td>
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<td><strong>Surface Outflows</strong></td>
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<td>Modeled</td>
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<td>Estimated</td>
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<td>Runoff of Precipitation (to Rivers)</td>
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<td>3%</td>
<td>Modeled</td>
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<td>Calculated</td>
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<td>Modeled</td>
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<td>Calculated</td>
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<td>32,127</td>
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<td>42,889</td>
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<td><strong>Other</strong></td>
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<td></td>
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<tr>
<td>Evaporation</td>
<td>5.3.1.5</td>
<td>Calculated</td>
<td>30% / 60%</td>
<td>Estimated</td>
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<td>1,510</td>
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<td>1,662</td>
<td>1,579</td>
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<td>Tilewater (to Rivers)</td>
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<td>Estimated</td>
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<td>1,218</td>
<td>2,002</td>
<td>1,585</td>
<td>1,879</td>
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</tr>
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<td>Change in Root Zone Storage of Precipitation</td>
<td>5.3.3.1; 5.3.3.2.2</td>
<td>Modeled</td>
<td>30%</td>
<td>Modeled</td>
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<td>Off-Season Change in Root Zone Storage of Applied Water</td>
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<td>-21,843</td>
<td>-30,717</td>
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<tr>
<td>Off-Season Unmeasured System Outflows</td>
<td>Appendix I</td>
<td>Calculated</td>
<td>19%</td>
<td>Calculated</td>
<td>11,200</td>
<td>2,753</td>
<td>21,360</td>
<td>3,738</td>
<td>9,679</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. The TID water budget has historically been calculated for the distribution system and irrigated lands downstream of Turlock Lake, excluding infiltration of surface water (seepage) from the Upper Main Canal and Turlock Lake. As reporting needs change and use of the TID water budget evolves, TID is planning to update the water budget to include the Upper Main Canal and Turlock Lake. Following these future updates, seepage from the Upper Main Canal and Turlock Lake will be added to the TID water budget. These updates are expected to occur within the next five years, and will be included in the next AWMP update.

2. The listed percent uncertainty is for the entire water year unless two percentages are given.

3. Total volumes rounded to 10 AF.
Table I-5. Differences between Flow Paths in Irrigation Season and Water Year Water Budgets (Aside from Irrigation Season Continuance into October).

<table>
<thead>
<tr>
<th>Accounting Center</th>
<th>Flow Path Type</th>
<th>Flow Path</th>
<th>Difference Between Irrigation Season and Water Year Water Budget (Aside from Irrigation Season Continuance into October)</th>
<th>Reason for Difference (Aside from Irrigation Season Continuance into October)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Irrigation Releases from Turlock Lake</td>
<td>Yes</td>
<td>Storm flow releases during off-season; releases reported shortly before irrigation season begins.</td>
</tr>
<tr>
<td>Distribution System</td>
<td></td>
<td>Drainage Pumping</td>
<td>Yes</td>
<td>Off-season reported drainage pumping (to manage groundwater levels, etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rented Pumping</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tilewater (to Canals)</td>
<td>Yes</td>
<td>Off-season recorded drainage from fields.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tailwater (to Canals)</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spill Recovery</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Runoff of Precipitation (to Canals)</td>
<td>Yes</td>
<td>Off-season precipitation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-Season System Inflows</td>
<td>Yes</td>
<td>Off-season system inflows (creeks, nuisance water from cities, etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Farm Deliveries</td>
<td>No</td>
<td>Spillage of storm flows and drainage during off-season; spillage reported shortly after irrigation season ends.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Canal Spillage</td>
<td>Yes</td>
<td>Spillage during the off-season is estimated based on average seepage rates by soil type, and estimated canal wetted areas during the off-season (fraction of total system wetted area, based on the volume of monthly system inflows compared to average inflows in Jun-Aug).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seepage</td>
<td>Yes</td>
<td>Seepage during the off-season is estimated based on average seepage rates by soil type, and estimated canal wetted areas during the off-season (fraction of total system wetted area, based on the volume of monthly system inflows compared to average inflows in Jun-Aug).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaporation</td>
<td>Yes</td>
<td>Evaporation during the off-season is estimated based on ET₉₀, a water surface evaporation coefficient, and the estimated canal water surface area (fraction of total system area, based on the volume of monthly system inflows compared to average inflows in Jun-Aug).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-Season Unmeasured System Outflows</td>
<td>Yes</td>
<td>Off-season Distribution System water budget closure. Unquantified other outflows when TID is not operating the distribution system for irrigation. (unmeasured drainage and uncertainty in off-season system inflows/outflows)</td>
</tr>
<tr>
<td>Irrigated Lands</td>
<td></td>
<td>Farm Deliveries</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Private Pumping</td>
<td>Yes</td>
<td>Off-season reported private pumping (pre-irrigation and final irrigation before and after the irrigation season; irrigation of winter crops)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treated Wastewater</td>
<td>Yes</td>
<td>Off-season reported deliveries of treated wastewater.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precipitation</td>
<td>Yes</td>
<td>Off-season precipitation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ET of Applied Water (ET₉₀)</td>
<td>Yes</td>
<td>ET₉₀ continues during the off-season as plants continue to uptake residual soil moisture that was applied during the irrigation season.</td>
</tr>
<tr>
<td>Accounting Center Flow Path Type</td>
<td>Flow Path</td>
<td>Difference Between Irrigation Season and Water Year Water Budget (Aside from Irrigation Season Continuance into October)</td>
<td>Reason for Difference (Aside from Irrigation Season Continuance into October)</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
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<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Tailwater (to Canals)</td>
<td>No</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tailwater (to Rivers)</td>
<td>No</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilewater (to Canals)</td>
<td>Yes</td>
<td>Off-season recorded drainage from fields.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilewater (to Rivers)</td>
<td>Yes</td>
<td>Off-season recorded drainage from fields.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Percolation of Applied Water</td>
<td>No</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET of Precipitation (ET&lt;sub&gt;p&lt;/sub&gt;)</td>
<td>Yes</td>
<td>Off-season precipitation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Percolation of Precipitation</td>
<td>Yes</td>
<td>Off-season precipitation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Runoff of Precipitation</td>
<td>Yes</td>
<td>Off-season precipitation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Root Zone Storage</td>
<td>Yes</td>
<td>Off-season precipitation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Root Zone Storage of Applied Water</td>
<td>Yes</td>
<td>Off-season Irrigated Lands water budget closure. Residual soil moisture of applied water that is consumed by crops after the irrigation season ends.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MEMORANDUM

TO: Board of Directors
DATE: February 1, 2021

PREPARED BY: Michael Cooke
RE: United States Fish and Wildlife Service:
   Pilot Project MOU

Action Requested
Adoption of a Resolution authorizing the General Manager to execute a Pilot Project Memorandum of Understanding between U.S. Fish and Wildlife Service, Turlock Irrigation District, Modesto Irrigation District, and the City and County of San Francisco Public Utilities Commission for Implementation of a Pilot Project to Improve Habitat on the Lower Tuolumne River.

Discussion
The attached Pilot Project Memorandum of Understanding (“MOU”) between Turlock Irrigation District, Modesto Irrigation District (collectively “Districts”), the City and County of San Francisco Public Utilities Commission (“SFPUC”), and the United States Fish and Wildlife Service (“Service”) (collectively “Parties”) outlines the intention of the Parties for cooperation and funding, general implementation guidelines, and other matters related to habitat improvement work on the Tuolumne River prior to issuance of a new license for the Don Pedro Project, Federal Energy Regulatory Commission (“FERC”) No. 2299 and an original license for the La Grange Project, FERC No. 14581 (collectively “the Projects”).

The Parties have worked together during the FERC relicensing process to develop mutually-acceptable license conditions and habitat improvement projects that will support positive outcomes for Tuolumne River fisheries and natural resources while meeting the instream flow, water supply and flood control requirements of the Districts and SFPUC. The Service submitted modified license conditions and habitat improvement projects to FERC in a letter dated October 1, 2018 that had been agreed to amongst the Parties. Additionally, the Districts presented detailed descriptions of specific Tuolumne River habitat improvement projects to FERC in a letter dated August 15, 2019. The Parties desire to move forward with cooperative selection and implementation of one or more habitat improvement projects in advance of FERC’s issuance of licenses for the Projects.

TID and its partners on the Tuolumne River have long been proponents of projects that provide immediate benefit to the Tuolumne River. This MOU memorializes TID’s commitment such early implementation projects.

Presenter
Signature/Date:

Dept. Manager
Signature/Date:

Director of Water Resources
Signature/Date:
Michael Cooke
2/2/21

General Manager/COO
Signature/Date:
2/4/2021
RESOLUTION NO. 2021 -  

RESOLUTION AUTHORIZING THE GENERAL MANAGER TO EXECUTE A PILOT PROJECT MEMORANDUM OF UNDERSTANDING BETWEEN U.S. FISH AND WILDLIFE SERVICE, TURLOCK IRRIGATION DISTRICT, MODESTO IRRIGATION DISTRICT, AND THE CITY AND COUNTY OF SAN FRANCISCO PUBLIC UTILITIES COMMISSION FOR IMPLEMENTATION OF A PILOT PROJECT TO IMPROVE HABITAT ON THE LOWER TUOLUMNE RIVER  

WHEREAS, the attached Pilot Project Memorandum of Understanding (“MOU”) between Turlock Irrigation District, Modesto Irrigation District (collectively “Districts”), the City and County of San Francisco Public Utilities Commission (“SFPUC”), and the United States Fish and Wildlife Service (“Service”) (collectively “Parties”) outlines the intention of the Parties for cooperation and funding, general implementation guidelines, and other matters related to habitat improvement work on the Tuolumne River prior to issuance of a new license for the Don Pedro Project, Federal Energy Regulatory Commission (“FERC”) No. 2299 and an original license for the La Grange Project, FERC No. 14581 (collectively “the Projects”); and  

WHEREAS, the Parties have worked together during the FERC relicensing process to develop mutually acceptable license conditions and habitat improvement projects that will support positive outcomes for Tuolumne River fisheries and natural resources while meeting the instream flow, water supply and flood control requirements of the Districts and SFPUC; and  

WHEREAS, the Service submitted modified license conditions and habitat-improvement projects to FERC in a letter dated October 1, 2018 that had been agreed to amongst the Parties; and  

WHEREAS, the Districts presented detailed descriptions of specific Tuolumne River habitat improvement projects to FERC in a letter dated August 15, 2019; and  

WHEREAS, the Parties desire to move forward with cooperative selection and implementation of one or more habitat improvement projects in advance of FERC’s issuance of licenses for the Projects; and  

WHEREAS, TID and its partners on the Tuolumne River have long been proponents of projects that provide immediate benefit to the Tuolumne River, and this MOU memorializes TID’s commitment such early implementation projects.  

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Turlock Irrigation District does hereby authorize the General Manager to execute a Pilot Project Memorandum of Understanding between U.S. Fish and Wildlife Service, Turlock Irrigation District, Modesto Irrigation District, and the City and County of San Francisco Public Utilities Commission for Implementation of a Pilot Project to Improve Habitat on the Lower Tuolumne River.  

Moved by Director , seconded by Director , that the foregoing resolution be adopted.
Upon roll call the following vote was had:

Ayes: Directors  
Noes: Directors  
Absent: Directors  

The President declared the resolution _______.

I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 9th day of February, 2021.

__________________________________  
Executive Secretary to the Board of Directors of the Turlock Irrigation District
PILOT PROJECT MEMORANDUM OF UNDERSTANDING
BETWEEN
U.S. Fish and Wildlife Service, Turlock Irrigation District, Modesto Irrigation District, and the City and County of San Francisco
FOR
Implementation of a Pilot Project to Improve Habitat on the Lower Tuolumne River

PURPOSE

This Pilot Project Memorandum of Understanding (“MOU”) between Turlock Irrigation District, Modesto Irrigation District (collectively “Districts”), the City and County of San Francisco Public Utilities Commission (“SFPUC”), and the United States Fish and Wildlife Service (“Service”) (collectively “Parties”) outlines the intention of the Parties for cooperation and funding, general implementation guidelines, and other matters related to habitat improvement work on the Tuolumne River prior to issuance of a new license for the Don Pedro Project, Federal Energy Regulatory Commission (“FERC”) No. 2299 and an original license for the La Grange Project, FERC No. 14581 (collectively “the Projects”).

BACKGROUND

The Parties have worked together during the FERC relicensing process to develop mutually-acceptable license conditions and habitat improvement projects that will support positive outcomes for Tuolumne River fisheries and natural resources while meeting the instream flow, water supply and flood control requirements of the Districts and SFPUC. The Service submitted modified license conditions and habitat-improvement projects to FERC in a letter dated October 1, 2018 that had been agreed to amongst the Parties. Additionally, the Districts presented detailed descriptions of specific Tuolumne River habitat improvement projects to FERC in a letter dated August 15, 2019. The Parties desire to move forward with cooperative selection and implementation of one or more habitat improvement projects in advance of FERC’s issuance of licenses for the Projects.

AUTHORITY

The Service has authority to enter into this MOU pursuant to Fish and Wildlife Coordination Act, 16 U.S.C. 661, the Fish and Wildlife Act of 1956, 16 U.S.C 742a et seq., and the Federal Power Act, 16 U.S.C. 791, et seq.

COOPERATION OF THE PARTIES

The Parties anticipate working together in good faith to select, define, and implement habitat improvement work on the Tuolumne River in advance of FERC’s issuance of new licenses for the Projects. This MOU reflects each Party’s mutual interests to communicate with each other as the primary means of resolving any disagreements which may arise during such cooperative implementation. While the Parties share an intent to extend their cooperation through the duration of new FERC licenses for the Projects, this MOU addresses and is limited to cooperation in planning potential habitat improvement projects that may be implemented in advance of FERC’s new license orders.
SPECIFIC PROVISIONS

A. Cooperative Approach - The Parties agree to collaborate in developing and implementing habitat improvement projects that reflect their shared interests in the Tuolumne River, consistent with the instream flow, water supply, flood control, recreation and other benefits of the Projects. To the extent disagreements arise during the planning or implementation phases of any proposed habitat improvement project, the Parties agree to attempt to resolve any disagreements and to make best efforts to work cooperatively towards consensus. Provided that the Parties have made reasonable attempts to resolve any disagreement that may arise during the planning phase of a proposed habitat improvement project, lack of agreement during the planning phase of any such proposed project will cause that proposed project to be set aside for possible future funding and implementation after new licenses are issued by FERC.

B. Pilot Project(s) – The Parties intend to cooperate in selecting and developing habitat improvement project(s) to advance under the terms and duration of this MOU, including efforts to plan, design, implement, and construct specific in-channel, riparian, and/or floodplain improvements in the Tuolumne River that benefit native salmonid species, with the first priority being the uppermost 25 miles of the lower Tuolumne River. Types of habitat-improvement projects that may be advanced may include spawning habitat improvements, floodplain habitat improvements, riparian restoration, improved connectivity between river channel and adjacent floodplains, slough development, improvements to in-channel structural complexity, and woody material installation and replacement. Each potential habitat improvement project will include specific monitoring and reporting procedures developed through this cooperative process.

C. Funding - The Districts will establish an interest-bearing account to fund any habitat improvement project(s) that may be voluntarily undertaken prior to issuance of a FERC license. The Districts and SFPUC have conceptually proposed to provide $4,000,000 in capital contributions\(^1\) to fund this account, pending and subject to future consideration and approval by their respective governing bodies. If the governing bodies of the Districts and SFPUC elect, in their sole discretion, to fund any habitat improvement project using this proposed funding, the Districts intend to be responsible for dispersing funds from the account, and for executing and implementing contracts for design, permitting, construction, monitoring, and reporting related to the improvement projects. Unless specifically authorized, USFWS participants shall not have a vote on proposals that the USFWS submits or implements, nor on projects that affect USFWS, nor shall USFWS provide specific direction to the Districts or SFPUC regarding funding decisions under this MOU.

GENERAL PROVISIONS

A. Nature of this MOU: This MOU in no way: (i) impairs any Party from continuing its own planning or project implementation; (ii) limits a Party from exercising its statutory or regulatory authority in any matter; (iii) infers that a Party’s governing body or management will act in any particular manner on a project; or (iv) gives any of the Parties any authority over matters within the jurisdiction of any other Party. This MOU is a statement of mutual intention, and it is not intended to be legally binding. Without limiting the foregoing, nothing in this MOU creates any legal rights, obligations, benefits, or trust responsibilities, substantive or procedural, enforceable at law or in equity, by a Party against any other Party, a Party’s officers, or any person.

B. Environmental Review: This MOU memorializes the intent of the Parties to cooperate in advancing pilot projects that the Parties may choose to plan, design, implement, or construct in the future

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1 Capital cost includes planning, design, permitting and construction services necessary to bring the project to fruition.
prior to the issuance of FERC licenses for the Projects. These pilot projects could result in physical changes to the environment, and may require the Parties to prepare environmental documents in accordance with the California Environmental Quality Act (“CEQA”) and/or other applicable law prior to determining whether to proceed with any of the pilot projects. Accordingly, and notwithstanding any provision of this MOU to the contrary, nothing in this MOU commits the Parties to approve or carry out any pilot project that is subject to CEQA. The Parties’ decisions to approve any of these pilot projects are subject to the requirement that the Parties shall have completed any required environmental review prior to approving a proposed pilot project. In considering any proposed pilot project, the Parties retain absolute discretion to: (1) make such modifications to any of the proposed pilot projects as may be necessary to mitigate significant environmental impacts; (2) select feasible alternatives to the proposed pilot projects that avoid significant adverse impacts; (3) require the implementation of specific measures to mitigate the significant adverse environmental impacts as part of the decision to approve the pilot projects; (4) balance the benefits of the proposed pilot projects against any significant environmental impacts before taking final actions to approve the proposed pilot projects if such significant impacts cannot otherwise be avoided; or (5) determine not to proceed with the proposed pilot projects.

C. Effective date and term of MOU: Execution of this MOU by all Parties will commemorate the intent of the Parties to discuss and collaborate on potential habitat improvement projects. This MOU will remain in effect until FERC’s issuance, and the Districts’ acceptance, of new and original licenses for the Projects, unless terminated.

D. Amendments, Including Addition of Parties: Modifications or amendments to the terms of this MOU shall be in writing and executed by all Parties. Parties may be added to the MOU by concurrence of all the Parties and amendment of this MOU.

E. Relationship of Parties: Execution of this MOU does not create a new legal entity with a separate existence from the individual Parties. This MOU does not create an “advisory committee” as that term is defined in the Federal Advisory Committee Act, as amended (Pub. L. 92-463), however the Parties agree to comply with the Federal Advisory Committee Act to the extent necessary. This MOU also does not result in the joint exercise of powers as set forth in California Government Code section 6500 et seq. This MOU neither expands nor is in derogation of those powers and authorities vested in the Parties, or any of them, by applicable laws, statutes, regulations, or Executive Orders, nor does it modify or supersede any other applicable interagency agreements existing as of the date of this MOU.

F. Funding and Availability of Funds: Funding by the Districts and SFPUC is subject to final funding being approved for each project by the governing bodies of TID, MID, and SFPUC, respectively. Nothing in this MOU is intended or shall be construed to authorize or require the obligation, appropriation, reprogramming, or expenditure of any funds by any Party as permitted by applicable law. As required by the Anti-Deficiency Act, 31 U.S.C. 1341, 1342, and 1517, all commitments made by Federal signatories to this MOU are subject to the availability of appropriated funds and budget priorities. Any funding commitment or services, if pursued, will be handled in accordance with applicable laws, regulations, and procedures.

G. Modification of MOU: This MOU may only be modified by the written mutual agreement of the Parties, duly signed by their authorized representatives.

H. Termination: This MOU may be terminated at will by any Party with 60 days of written notice.

I. This MOU in no way restricts the Parties from participating in similar activities or arrangements with other public or private agencies, organizations, or individuals.
J. Nothing in this MOU may be interpreted to imply that the United States, Department of the Interior, or Fish and Wildlife Service endorses any product, service or policy of TID, MID and SFPUC. Parties will not take any action or make any statement that suggests or implies such an endorsement. Any press releases on projects implemented to this MOU will be circulated amongst the parties in advance of issuance.

K. Information shared with the Fish and Wildlife Service will be subject to federal law, including the Freedom of Information Act.

L. Nothing in this MOU obligates the Department of the Interior, FWS or the United States to spend funds on any particular project or purpose, even if funds are available.

SIGNATURES

United States Fish & Wildlife Service

______________________________
By Date

Turlock Irrigation District

______________________________
By Date

Modesto Irrigation District

______________________________
By Date
City and County of San Francisco
Public Utilities Commission

____________________________________  
By  Date

____________________________________


MOTION CANCELING THE TURLOCK IRRIGATION DISTRICT
REGULAR BOARD MEETING OF FEBRUARY 16, 2021

 Moved by Director , seconded by Director , that the regular meeting of the Board of Directors of the Turlock Irrigation District scheduled for February 16, 2021, be canceled.

 The President declared the motion________.

 I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a motion duly adopted at a regular meeting of said Board of Directors held the 9th day of February, 2021.

 ______________________________
 Executive Secretary to the Board of Directors of the Turlock Irrigation District