Tulare Irrigation District

2020 Agricultural

Water Management Plan

March 2021

Tulare Irrigation District
6826 Avenue 240
Tulare, California 93274

Tulare Irrigation District
2020 Agricultural Water Management Plan

Section 1

USBR Conditional Approval Letter

Letter is forthcoming from the USBR based upon approval.

Section 2

USBR Tulare Irrigation District

Water Management Plan

Tulare Irrigation District
Water Management Plan
2019

March 2021

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Section 1: Description of the District

District Name: *Tulare Irrigation District*

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A. History

The Tulare Irrigation District (District) was organized on September 21, 1889 for the purpose of managing, supplying and delivering water to growers in the Tulare area. The original proposal for the formation of the irrigation district covered 219,000 acres, extending from the Sierra Nevada foothills to Tulare Lake. The District was eventually reduced to 32,500 acres upon establishment of the District. The District continued in this status until January 1948 when the so-called "Kaweah Lands" (approximately 11,000 acres) were annexed. In October of 1948, approximately 31,000 acres, compromising the area served by the Packwood Canal Company were also annexed into the District. Today the District is approximately 68,000 acres in size and serves approximately 200 irrigation customers.

A U.S. Bureau of Reclamation contract was signed in 1950 providing an annual supply of 30,000 acre-feet of Class 1 water, and up to 141,000 acre-feet of Class 2 water from the Friant-Kern Canal.

After the annexations of the "Kaweah" and "Packwood" lands and the commencement of the diversion of the Central Valley Project water, the District proceeded with extensive improvements to the existing canal system, and the extension of the canal system to serve annexed areas. This work consisted of enlarging and/or relocating canals, constructing diversion structures, road crossings, checkgates, siphons, installing pipelines, etc. The majority of this work occurred between 1951 and 1964.

Since the completion of Terminus Dam in 1962, Kaweah River water rights owners have benefited by the regulation of the natural river flows – temporary storage of flood waters, uniform downstream releases, and options on the time and quantity of irrigation diversions.

The Kaweah Delta Water Conservation District (KDWCD) and the Tulare Irrigation District (TID) formed a joint-power authority in 1982 – the Kaweah River Power Authority (KRPA). The KRPA filed for a license to construct a 17MW hydroelectric plant at Terminus Dam and Lake Kaweah. KRPA proceeded with the plant's design and construction, and the plant went on-line in 1992 delivering power to Southern California Edison Company.

The District and KDWCD also have coordinated efforts to enhance the recharge of groundwater within the Kaweah Basin. During high flow times, KDWCD and the District may use the recharge basins within the District for recharge purposes.

After the passage of the Sustainable Groundwater Management (SGMA) Act in 2014, the District, along with the City of Tulare and the City of Visalia in 2015 formed the Mid-Kaweah Groundwater Sustainability Agency to comply with SGMA.

The Tulare Irrigation District is a political subdivision of the State of California – an independent agency operating under the California Water Code. It is governed by a 5-member Board of Directors.

1. *Date district formed:* 1889 *Date of first Reclamation contract*: October 18, 1950
Original size (acres): 72,000 *Current year (last complete calendar year)*: 2019

2. *Current size, population, and irrigated acres*

	2019
Size (acres)	67,909
Population served	0
Irrigated acres	59,022

3. *Water supplies received in current year*

Water Source	*AF*
Federal urban water (Tbl 1)	0
Federal agricultural water (Tbl 1)	91,797
State water (Tbl 1)	0
Other Wholesaler (define) (Tbl 1)	0
Local surface water (Tbl 1)	213,267
Upslope drain water (Tbl 1)	0
District ground water (Tbl 2)	0
Banked water (Tbl 1)	0
Transferred water (Tbl 1)	13,405
Recycled water (Tbl 3)	7,471
Other (define) (Tbl 1)	0
Total	325,940

4. *Annual entitlement under each right and/or contract*

Agriculture AF/Y	*AF*	*Source*	*Contract #*	*Availability period(s)*
Reclamation Ag. Class I	30,000	San Joaquin River	175r-2485D	March 1st – February 28th
Reclamation Ag. Class II	141,000	San Joaquin River	175r-2485D	March 1st – February 28th
Local - Average Amount	83,000	Kaweah River		January - December

5. Anticipated land-use changes

The District surrounds but does not contain the City of Tulare. Growth of the City of Tulare has accounted for exclusions of land from the District due to conversion of farmland to developed City land. The District and the city of Tulare have an agreement that requires the city to pay District tax assessments on any land removed from the District by the City. As the City of Tulare continues to grow into the District, these areas will convert from agriculture to development, and will not be served by the District.

6. Cropping patterns (Agricultural only)

List of current crops (crops with 5% or less of total acreage) can be combined in the 'Other' category.

Original Plan 1993		*Previous Plan 2010*		*Current Plan 2019*	
Crop Name	*Acres*	*Crop Name*	*Acres*	*Crop Name*	*Acres*
Cotton	27,176	Field Corn	22,486	Field Corn	21,422
Field Corn	14,001	Alfalfa	15,346	Wheat	15,158
Alfalfa	11,720	Wheat	18,945	Alfalfa	10,158
Wheat	4,209	Cotton	7,042	Pistachios	8,336
Barley	3,324	Pistachios	4,667	Almonds	7,239
Grapes	1,766	Walnuts	3,038	Cotton	5,203
Walnuts	1,392	Almonds	1,107	Walnuts	5,076
Other Grasses	1,050	Field Peas	1,494	Milo Maize	846
Other (<5%)	2,044	*Other (<5%)*	1,805	*Other (<5%)*	2,328
Total	66,682	*Total*	75,930	*Total*	75,766

(See Planner, Chapter 2, Appendix A for list of crop names)

7. Major irrigation methods (by acreage) (Agricultural only)

Original Plan 1993		*Previous Plan 2010*		*Current Plan 2019*	
Irrigation Method	*Acres*	*Irrigation Method*	*Acres*	*Irrigation Method*	*Acres*
Level Basin	20,645	Level Basin	34,613	Level Basin	26,305
Furrow	45,737	Furrow	36,719	Furrow	32,667
Low Volume-Est..	300	Low Volume Drip	3,773	Low Volume Drip	15,102
		Sprinkler	825	Sprinkler	1,692
Other		*Other*		*Other*	
Total	66,682	*Total*	75,930	*Total*	75,766

(See Planner, Chapter 2, Appendix A for list of irrigation system types)

B. Location and Facilities

See Attachment A for points of delivery, turnouts (internal flow), and outflow (spill) points, conveyance system, storage facilities, operational loss recovery system, District wells and lift pumps, water quality monitoring locations, and groundwater facilities.

1. Incoming flow locations and measurement methods

Location Name	*Physical Location*	*Type of Measurement Device*	*Accuracy*
Main Canal/North Branch Split	SE ¼ of Sec. 17, T 19S, R 25E	Parshall Flume	+/- 6%
Cameron Creek @ Mooney's	NW ¼ of Sec. 18 T 19S R 25E	Parshall Flume	+/- 6%
Packwood Creek below Tagus	NW ¼ of Sec. 15 T 19S R 24E	Rated Section	+/- 6%
Evans Ditch	NE ¼ of Sec. 13 T 19 S R 23E	Parshall Flume	+/- 6%

2. Current year Agricultural Conveyance System

Miles Unlined - Canal	*Miles Lined - Canal*	*Miles Piped*	*Miles - Other*
300 +/-	1/4	30 +/-	

3 Current year Urban Distribution System

Miles AC Pipe	*Miles Steel Pipe*	*Miles Cast Iron Pipe*	*Miles - Other*
N/A			

4. Storage facilities (tanks, reservoirs, regulating reservoirs)

Name	*Type*	*Capacity (AF)*	*Distribution or Spill*
Abercrombie	G.W. Recharge/regulate	80	Distribution
Anderson	G.W. Recharge/regulate	680	Distribution
Cordeniz	G.W. Recharge/regulate	250	Distribution
Creamline	G.W. Recharge/regulate	535	Distribution
Doris	G.W. Recharge/regulate	60	Distribution
Guinn	G.W. Recharge/regulate	675	Distribution
Martin	G.W. Recharge/regulate	160	Distribution
Swall	G.W. Recharge/regulate	725	Distribution
Tagus	G.W. Recharge/regulate	800	Distribution
Watte	G.W. Recharge/regulate	90	Distribution
K.D.W.C.D. # 3	G.W. Recharge/regulate	640	Distribution
K.D.W.C.D. # 6	G.W. Recharge/regulate	665	Distribution
K.D.W.C.D. # 8	G.W. Recharge/regulate	480	Distribution

5. *Description of the agricultural spill recovery system and outflow points*

The District does not have an agricultural spill recovery system in place. The District utilizes terminal spill basins and an extensive Supervisory Control and Data Acquisition (SCADA) system to monitory and control the network of canals. These features allow the system to maintain a balance that reduces the amount of water spilled outside of the District.

6. *Agricultural delivery system operation (check all that apply)*

On-demand	*Scheduled*	*Rotation*	*Other (describe)*
	X		

District deliveries are on Modified Demand system and only available when the District makes water available. District growers must request start times at least 24 hours in advance, and request shut-off times at least 24 hours in advance to allow the District to make the necessary canal adjustments to make deliveries. The District typically makes water available for a spring pre-irrigation during the month of February, and summer irrigation during the months of June through August. These deliveries are dependent on the Districts water supply.

7. *Restrictions on water source(s)*

Source	*Restriction*	*Cause of Restriction*	*Effect on Operations*
US Law	USBR Water	CVPIA PL 102-575	Loss of Water Supply
US Law	USBR Water	San Joaquin River Restoration	Loss of Water Supply

8. *Proposed changes or additions to facilities and operations for the next 5 years*

The District proposes the following facilities and operations improvements:

- **Increase groundwater sinking basin and regulation basin acres (approximately 60 acres).**
- **Increase the number of automated and remote sensing sites within the distribution system (SCADA).**
- **Upgrade distribution system checks and measurement devices as required.**
- **Replacement and improvements to various pump and pipeline systems to increase efficiency and reduce the loss of water due to leaks and pump failures.**
- **Continued development of on-farm recharge programs.**

C. Topography and Soils

1. *Topography of the district and its impact on water operations and management*

   The District is located on the western side of Tulare County and is generally characterized as having fairly flat sloping land. The District generally slopes from northeast to southwest at an average of 6.2 feet per mile. The topography of the District has not had an impact on water operations or water management. Subsidence is present within the District; however the impacts have not fully been documented. Within the next two years, the District will begin tracking subsidence in an attempt to document any impacts in order to develop strategies to maintain flow capacities.

2. *District soil association map (Agricultural only)*
   See Attachment A, District Maps

   A NRCS soil classification maps is provided as Attachment B. Soils in the District are primarily a loam and sandy loam, which are compatible with the crops grown within the District. There are no known soil quality problems.

3. *Agricultural limitations resulting from soil problems (Agricultural only)*

Soil Problem	*Estimated Acres*	*Effect on Water Operations and Management*
Salinity		
High-water table		
High or low infiltration rates		
Other (define)		
Akers- Akers saline-sodic	11,300	No limit Akers. Leaching to maintain low saline-sodic levels for Akers saline-sodic.
Biggriz- Biggriz saline-sodic	29,000	No limitations on Biggriz, crop limitations on Biggriz saline sodic, leaching required.
Crosscreek- Kai	23,700	Duripan effects drainage rate, Kai soils require saline-sodic leaching.
Flamen loam	50	Duripan effects drainage rate.
Gambogy loam	400	Sodicity requires leaching to maintain low sodic levels.
Gambogy loam- Biggriz saline sodic	2,800	Salinity and sodic levels require leaching to keep levels down.

D. Climate

1. *General climate of the district service area*

The District is characterized as having hot and very dry summers, with relatively mild winters. The average annual precipitation is between 10 – 12 inches of rain. The estimated average daytime temperature in the summer months is approximately 95 degrees Fahrenheit- and the average winter temperature is about 40 degrees Fahrenheit. Frost-free days average 340 days per year in the District. Mean wind speed is less than 10 mph prevailing from the northwest. They are no known microclimates in the District.

With the long, hot summers that the District experiences, there is a potential for approximately four feet of evaporation per year, with the majority occurring from April to October. Rainfall in the District primarily occurs during the winter with virtually no rain during the summer. Annual crop use per acre averages several times the amount of average precipitation that the District sees. As a result, crops grown within the District are heavily dependent upon irrigation from surface water deliveries, and groundwater pumping, with water needs only partially satisfied by rainfall.

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*
Avg Precip. (in)	1.66	1.48	1.51	.85	.35	.07	.01	.01	.16	.43	.86	1.35	8.73
Avg Temp.(F)	46.5	51.7	56.1	61.2	68.1	75.3	80.8	79.1	73.9	65.2	54.6	46.8	63.3
Max. Temp.(F)	56.0	62.7	68.1	74.7	82.7	91.2	97.7	96.2	90.3	80.1	67.5	57.0	77.0
Min. Temp(F)	37.0	40.7	43.9	47.6	53.4	59.3	64.0	62.0	57.5	50.3	41.7	36.7	49.5
ETo (in)	1.14	1.77	3.32	4.83	6.76	7.79	8.10	7.26	5.36	3.45	1.75	1.07	52.61

Weather station ID Tulare, CA/Visalia, CA *Data period: Year* 1876 *to Year* 2019

Average wind velocity < 10 mph *Average annual frost-free days:* 340

2. *Impact of microclimates on water management within the service area*

There are no known microclimates located within the District, primarily due to the flat topography of the area.

E. Natural and Cultural Resources

1. *Natural resource areas within the service area*

Name	*Estimated Acres*	*Description*
Open space	0	

2. *Description of district management of these resources in the past or present*

Open space is privately owned and there are no known resource areas.

3. *Recreational and/or cultural resources areas within the service area*

There are no known Recreational or Cultural resources within the District. District land is predominantly privately held land used only for agriculture.

Name	*Estimated Acres*	*Description*
None		

F. Operating Rules and Regulations

1. *Operating rules and regulations*
   See Attachment B, District Rules and Regulations (water related)

   The Rules and Regulations Governing the Distribution of Water in the Tulare Irrigation District is included in Attachment B. Also included in Attachment B is the Tulare Irrigation District – Irrigation Operation Procedures.

2. *Water allocation policy (Agricultural only)*
   See Attachment B, Pages 1 & 4

   In most years the District does not provide an allocation policy for the distribution of surface water. The request for water is taken on a first-come-first-serve basis. As water users go off-line, new services are started. In instances when there is not enough water to distribute equally to all users; the District will prorate the water based upon the water available, total District acreage, and the water users' eligible acreage within the canal system and the District.

3. *Official and actual lead times necessary for water orders and shut-off (Agricultural only)*
   See Attachment B, Page 1

   The District requires 24-hours' notice before the start time requested by the water user. The same 24-hour notice is required before the water user intends to shut off irrigation supplies.

4. *Policies regarding return flows (surface and subsurface drainage from farms) and outflow (Agricultural only)*

   The District does not have any return flows, therefore it does not have any policies concerning return flows.

5. *Policies on water transfers by the district and its customers*

   The District does not have any written policies concerning the transfer of water by the District. In the event of a transfer, the terms and conditions are negotiated between parties and reviewed with the District Board of Directors. All transfers of water are approved by the Board of Directors. The District does not have any customer transfers, because the water user does not have any water rights.

G. Water Measurement, Pricing, and Billing

1. *Agricultural Customers*

a. *Number of farms* 207

b. *Number of delivery points (turnouts and connections)* 622

c. *Number of delivery points serving more than one farm* 4

d. *Number of measured delivery points (meters and measurement devices)* *622*

e. *Percentage of delivered water that was measured at a delivery point* 100%

f. *Delivery point measurement device table (Agricultural only)*

Measurement Type	*Number*	*Accuracy (+/- %)*	*Reading Frequency (Days)*	*Calibration Frequency (Months)*	*Maintenance Frequency (Months)*
Orifices					
Propeller meter	169	3%	Once a day	Every 2 to 5 years	Every 1 or 2 years
Weirs					
Flumes					
Venturi					
Metered gates	453	6%	1 -3 times a day	When requested	When needed / varies
Acoustic doppler					
Other (define)					
Total	622				

2. *Urban Customers*

a. *Total number of connections* 0

b. *Total number of metered connections* 0

c. *Total number of connections not billed by quantity* 0

d. *Percentage of water that was measured at delivery point* 0

e. *Percentage of delivered water that was billed by quantity* 0

f. *Measurement device table*

Meter Size and Type	*Number*	*Accuracy (+/-percentage)*	*Reading Frequency (Days)*	*Calibration Frequency (Months)*	*Maintenance Frequency (Months)*
5/8-3/4"					
1"					
1 ½"					
2"					
3"					
4"					
6"					
8"					
10"					
Compound					
Turbo					
Other (define)					
Total					

3. *Agriculture and Urban Customers*

a. *Current year agriculture and /or urban water charges - including rate structures and billing frequency*

The District currently tracks the volumetric rate of water at each water user's turnout in units of acre-feet. The District had varying rates throughout the 2019 year. From January 1st, 2019 through July 15th, 2019 the charge was $45.00 per acre-foot, except for March. That month was $10.00 per acre-foot. From July 15th, 2019 through December 31st, 2019 the rate was set at $49.00 per acre-foot. There is also an additional $2.50 per acre-foot charge for turnouts served through some of the District pipelines. Also, sometimes the District will allow the local Kaweah River water we bring in to be sold to growers outside of our District boundaries. This is sold at our normal rate plus half. Each water user's monthly volumetric consumption of water is recorded in the District water accounting system and billed to each water user based on volumetric consumption at the turnout.

The District also charges each acre within the District that is not owned by a public agency an annual assessment. These charges are roughly $32.00 +- based on soil classification.

b. *Annual charges collected from customers (2019 year data)*

Fixed Charges			
Charges ($ unit)	*Charge units ($/acre), ($/customer) etc.*	*Units billed during year (acres, customer) etc.*	*$ collected ($ times units)*
$32.00 +-	$32.00 +- / acre	65,129 acres	$2,040,241.70

Volumetric charges			
Charges ($ unit)	*Charge units ($/AF), ($/HCF), etc.*	*Units billed during year (AF, HCF) etc.*	*$ collected ($ times units)*
$45.00	$/AF	83,511.44 AF	$7,491,985.80
$47.50	$/AF	3,380.28 AF	$160,563.34
$67.50	$/AF	654.19 AF	$44,157.84
$10.00	$/AF	12,650.98 AF	$126,509.80
$12.50	$/AF	391.51 AF	$4,893.89
$15.00	$/AF	90.68 AF	$1,360.20
$49.00	$/AF	42,887.58 AF	$2,101,491.42
$51.50	$/AF	1,387.75 AF	$71,469.11
$73.50	$/AF	376.22 AF	$27,652.17

See Attachment D, District Sample Bill

c. *Describe the contractor's record management system*

District ditchtenders record daily water consumption readings at each water user turnout. This information is delivered to the District office where the Watermaster and the Accounting Department input the water use into the water billing software. The software tracks the water usage for each turnout and all turnouts listed for each water user (water users have multiple turnouts throughout the District). At the end of each month a bill is created that is mailed to each water user indicating water usage and payment amounts.

The electronic and paper information created during this process is kept on file for a minimum of 10 years. The electronic system is kept on the District server and is secured and backed up daily.

H. Water Shortage Allocation Policies

1. *Current year water shortage policies or shortage response plan - specifying how reduced water supplies are allocated*
   See Attachment E, District Water Shortage Plan

   See the attached Rules and Regulations and Operating Procedures (Attachment B). During severe drought periods, no water is available and efforts are made to carryover any water to the next year in storage. Water users have the availability of deep wells to meet crop irrigation demands.

   Any time the District is unable to meet irrigation demands, due to water shortage or canal capacity, it will be necessary to prorate available water. The water will be prorated on the basis of water available, total District acreage, and water users' eligible acreage within the canal system and District. If a particular canal or pipeline capacity is not adequate to meet the demand, the prorate will be based upon the water available, the acreage served by the canal or pipeline, and the water user's acreage by the canal or pipeline. All water deliveries otherwise; will be made in sequential receipt of application orders.

2. *Current year policies that address wasteful use of water and enforcement methods*
   See Attachment B, Page 6

I. Evaluate Policies of Regulatory Agencies Affecting the Contractor and Identify Policies that Inhibit Good Water Management

Discuss possible modifications to policies and solutions for improved water management

None Applicable.

Section 2: Inventory of Water Resources

A. Surface Water Supply

1. Surface water supplies in acre feet, imported and originating within the service area, by month (Table 1)
See Section 5, Water Inventory Tables, Table 1

2. Amount of water delivered to the district by each of the district sources for the last 10 years (Table 8)
See Section 5, Water Inventory Tables, Table 8

B. Groundwater Supply

1. Groundwater extracted by the District and delivered, by month (Table 2)
See Section 5, Water Inventory Tables, Table 2

2. Groundwater basin(s) that underlies the service area

Name	*Size (Square Miles)*	*Usable Capacity (AF)*	*Safe Yield (AF/Y)*
Kaweah	Unknown	Est. 3.4 million AF	740,000 AF/Y

3. Map of district-operated wells and managed groundwater recharge areas
See Attachment A, District Map to find Groundwater Facilities

Included, as Attachment A is a District Map that indicates the location of groundwater recharge basins and the district canal network. Recharge capacity is estimated to be approximately 300 cfs/day for all basins and unlined canals within the district.

4. Description of conjunctive use of surface and groundwater

The District maintains an aggressive conjunctive use program to maintain and increase groundwater elevations below the District. This program utilizes all unlined canals estimated to provide 450 acres of recharge basin capacity, as well as over 1,300 acres of recharge basins to provide for recharge of the groundwater table.   In very wet years when there is excess water on the Kaweah River System and the Friant Kern Canal System, the District imports as much water as possible to fill recharge basins and canals. The District has historically maximized excess winter water, which may come free of charge, but also the District has aggressively purchased water during winter months to recharge the groundwater.

This has been an effective and efficient means of recharging the area's groundwater supply, and is one of the primary reasons why the District contracted for Class I and Class II water supply on the Friant Unit of the CVP. Between CVP and local surface water supplies, the District has been able to maintain a relatively steady depth to groundwater in the area with the exception of the drop produced by drought conditions observed recently. Obviously, this success depends on maximizing surface water imports.

5. Groundwater Management Plan
See Attachment F, Groundwater Management Plan

6. *Groundwater Banking Plan*
See Attachment G, Ground Water Banking Plan

The District does not engage in groundwater banking.

C. Other Water Supplies

1. *"Other" water used as part of the water supply*
See Section 5, Water Inventory Tables, Table 3 and Table 8

In 2013, the City of Visalia and the District agreed to a program where the City will deliver tertiary treated waste water to the District. The City of Visalia pursued an upgrade to its wastewater treatment plant (WWTP), which included the ability to treat the water to a tertiary level, allowing it to be used for agricultural irrigation. This agreement covers delivery of tertiary treated water to the District from the City WWTP and the delivery of excess surface water to the City from District supplies.
The Agreement acknowledges that a pipeline needed to be constructed to deliver the water to the District. The District and the City pursued grant funds, receiving $2.8 million from the California Department of Water Resources (DWR) Integrated Regional Water Management Program (IRMWP) funding and approximately $700,000 in USBR funding. The pipeline was completed in 2015 and deliveries of tertiary water to the District began in early 2018.
Under the agreement between the District and the City, the City is obligated to deliver 800 AF per calendar month, and not less than 11,000 AF per year (also not to exceed 13,000 AF). The District is obligated to take the tertiary water and will utilize it for irrigation and incidental percolation (channel losses). For every two acre-feet of tertiary water delivered to the District, the District will return one acre-foot of water to specific recharge facilities identified by the City (the Agreement was developed as a 2:1 exchange).

D. Source Water Quality Monitoring Practices

1. *Potable Water Quality (Urban only)*
See Attachment H – District Annual Potable Water Quality Report

The District does not produce an annual potable water quality report as it does not supply any municipal surface water supplies.

2. *Agricultural water quality concerns: Yes* ____________ *No* ______*X*_____

3. *Description of the agricultural water quality testing program and the role of each participant, including the district, in the program*

The District collects groundwater samples and surface water samples each year from various locations throughout the District. The District targets multiple groundwater wells that are running throughout the District to sample. An effort is made to test different wells on a year-to-year basis, therefore getting a District-wide assessment of water quality. The District strives to resample

groundwater wells every five years to run a comparison analysis. The testing shown in the charts below was performed between July and September of 2019.

4. *Current water quality monitoring programs for surface water by source (Agricultural only)*

Analyses Performed	*Frequency*	*Concentration Range*		*Average*
pH	Annually	6.6 – 7.6	pH units	7.2
EC (Conductivity)	Annually	0.03 – 0.04	ds/m	0.04
TDS	Annually	21 – 30	ppm	26
Boron	Annually	0.01 – 0.01	ppm	0.01
SAR(permeability Na)	Annually	0.1 – 0.4		0.2
SAR/EC Ratio	Annually	3.1 – 11.7		6.0
pHc	Annually	9.5 – 10.1		9.8
Calcium	Annually	1.7 – 4.3	ppm	3.1
Magnesium	Annually	0.2 – 0.7	ppm	0.5
Sodium	Annually	0.6 – 2.3	ppm	1.6
Potassium	Annually	0.4 – 0.7	ppm	0.5
Bicarbonate	Annually	13.8 – 20.0	ppm	17.2
Cloride	Annually	0.2 – 1.3	ppm	0.4
Nitrate - Nitrogen	Annually	0.1 – 0.2	ppm	0.1
Sulfate - Sulfur	Annually	0.6 – 0.9	ppm	0.8

Current water quality monitoring programs for groundwater by source (Agricultural only)

Analyses Performed	*Frequency*	*Concentration Range*		*Average*
pH	Annually	6.6 – 8.2	pH units	7.6
EC (Conductivity)	Annually	0.03 – 0.76	ds/m	0.41
TDS	Annually	21 – 520	ppm	279
Boron	Annually	0.01 – 0.07	ppm	0.04
SAR(permeability Na)	Annually	0.1 – 6.1		2.9
SAR/EC Ratio	Annually	2.6 – 12.6		6.3
pHc	Annually	7.7 – 10.0		8.5
Calcium	Annually	13.8 – 57.2	ppm	32.7
Magnesium	Annually	0.1 – 2.2	ppm	0.9
Sodium	Annually	11.4 – 113.0	ppm	58.4
Potassium	Annually	0.4 – 0.9	ppm	0.6
Bicarbonate	Annually	67.8 – 198.0	ppm	119.3
Chloride	Annually	1.7 – 58.7	ppm	26.1
Nitrate - Nitrogen	Annually	0.1 – 24.0	ppm	9.6
Sulfate-Sulfur	Annually	2.6 – 57.8	ppm	20.7

E. Water Uses within the District

1. Agricultural
See Section 5, Water Inventory Tables, Table 5 - Crop Water Needs

2. Types of irrigation systems used for each crop in current year

Crop name	*Total Acres*	*Level Basin - acres*	*Furrow - acres*	*Sprinkler - acres*	*Low Volume – acres - Drip*	*Multiple methods - acres*
Corn	21,422		21,422			
Wheat	15,158	15,158				
Alfalfa	10,158	10,158				
Pistachios	8,336		500		7,836	
Almonds	7,239		300		6,939	
Cotton	5,203		5,203			
Walnuts	5,076		3,384	1,692		
Milo Maize	846	400	446			
Grapes	473		473			
Dry Beans	417		417			
Native Pasture	375	375				
Cherries	325		175		150	
Oats	214	214				
Blue Berries	148		148			
Persimmons	85		85			
Oranges	81				81	
Nursery	74				74	
Radish	51		51			
Pears, Prunes, Olives	42		20		22	
Pumpkins	20		20			
Lettuce	20		20			
Pomegranates	3		3			
Total	75,766	26,305	32,667	1,692	15,102	

3. Urban use by customer type in current year

Customer Type	*Number of Connections*	*AF*
Single-family	N/A	
Multi-family	N/A	
Commercial	N/A	
Industrial	N/A	
Institutional	N/A	
Landscape irrigation	N/A	
Wholesale	N/A	
Recycled	N/A	
Other (specify)	N/A	
Other (specify)	N/A	
Other (specify)	N/A	
Unaccounted for		
Total		

4. Urban Wastewater Collection/Treatment Systems serving the service area

Treatment Plant	*Treatment Level (1, 2, 3)*	*AF*	*Disposal to / uses*
City of Visalia Water Reclamation Facility	3	7,471	Crops-Wheat, Corn, Alfalfa, Cotton, Walnuts, Pistachios, Milo Maize
	Total	7,471	
Total discharged to ocean and/or saline sink		0	

5. Ground water recharge/management in current year (Table 6)

Recharge Area	*Method of Recharge*	*AF*	*Method of Retrieval*
Abercrombie	Basin Seepage	801	Private Wells
Anderson	Basin Seepage	7,258	Private Wells
Cordeniz	Basin Seepage	143	Private Wells
Creamline	Basin Seepage	17,195	Private Wells
Doris	Basin Seepage	805	Private Wells
Guinn	Basin Seepage	5,863	Private Wells
Martin	Basin Seepage	2,144	Private Wells
Swall	Basin Seepage	9,483	Private Wells
Tagus	Basin Seepage	6,786	Private Wells
Watte	Basin Seepage	1,619	Private Wells
K.D.W.C.D. #3	Basin Seepage	12,115	Private Wells
K.D.W.C.D. #6	Basin Seepage	9,769	Private Wells
K.D.W.C.D. #8	Basin Seepage	6,468	Private Wells
On-Farm Recharge	Intentional Field Seepage	3,028	Private Wells
	Total	83,477	

6a. Transfers and exchanges **into** *the service area in current year (Table 1)*

From Whom	*To Whom*	*AF*	*Use*
Orange Cove ID	Tulare ID	4,000	Ag to Ag
Lindsay-Strathmore ID	Tulare ID	28,292	Ag to Ag
Wutchumna Water Co.	Tulare ID	15,952	Ag to Ag
Tulare Irrigation Co.	Tulare ID	716	Ag to Ag
Foothill Ditch Co.	Tulare ID	1,500	Ag to Ag
Hamilton Ditch Co.	Tulare ID	1,000	Ag to Ag
Cons. Peoples Ditch Co.	Tulare ID	279	Ag to Ag
Lemoncove Ditch Co.	Tulare ID	1,449	Ag to Ag
Kaweah Delta WCD	Tulare ID	2,532	Ag to Ag
Fleming Ditch Co.	Tulare ID	309	Ag to Ag
Persian Ditch Co.	Tulare ID	487	Ag to Ag
Watson Ditch Co.	Tulare ID	892	Ag to Ag

6b. Transfers and exchanges ***out*** *of the service area in current year – (Table 6)*

Not all of the transfers out of the District listed below are included in Table 6 because the information would conflict with the numbers reported in Table 1. Only the transfers to the City of Visalia and to Corcoran ID were included in Table 6 because this water was diverted by the District, then transferred to the City of Visalia and Corcoran ID.

From Whom	*To Whom*	*AF*	*Use*
Tulare ID	City of Visalia	6,478	Ag to GW Recharge
Tulare ID	Corcoran ID	1,559	Ag to Ag
Tulare ID	Wutchumna Water Co.	620	Ag to Ag
Tulare ID	Cons. Peoples Ditch Co.	2,000	Ag to Ag
Tulare ID	Kern-Tulare WD	2,482	Ag to Ag
Tulare ID	Pixley ID	9,235	Ag to Ag
Tulare ID	Arvin-Edison WSD	4,000	Ag to Ag
Tulare ID	Lindsay-Strathmore ID	2,628	Ag to Ag
Tulare ID	Delano-Earlimart ID	13,339	Ag to Ag
Tulare ID	County of Tulare	3,604	Ag to Ag
Tulare ID	Madera ID	2,294	Ag to Ag

7. Trades, wheeling, wet/dry year exchanges, banking or other transactions in current year (Table 6)

From Whom	*To Whom*	*AF*	*Use*
N/A			

8. Other uses of water in current year

Other Uses	*AF*
N/A	
N/A	

F. Outflow from the District (Agricultural only)

See Facilities Map, Attachment A, for the location of surface and subsurface outflow points, outflow measurement points, outflow water-quality testing locations

1. *Surface and subsurface drain/outflow in current year*

The data listed below represents the surface water outflow from the District. The numbers below do not reflect any subsurface drainage due to the fact that the District does not have any subsurface drainage systems.

Outflow Point	*Location Description*	*AF*	*Type of Measurement*	*Accuracy (%)*	*% of Total Outflow*	*Acres Drained*
Section 7	Sec. 7, T. 21 S. R. 23 E.	262	Weir	+- 5%	26%	N/A
Section 9	Sec. 9, T. 21 S. R. 23 E.	489	Weir	+- 5%	48%	N/A
Cameron Creek	Sec. 6, T. 21 S. R. 23 E.	266	Weir	+- 5%	26%	N/A

Outflow Point	*Where the Outflow Goes (Drain, River or Other Location)*	*Type Reuse*
Section 7	Highline Canal / Tulare Lake Bottom	Irrigation/Groundwater Recharge
Section 9	Basin / Tulare Lake Bottom	Irrigation/Groundwater Recharge
Cameron Creek	Corcoran Irrigation District Basin	Groundwater Recharge

2. *Description of the Outflow (surface and subsurface) water quality testing program and the role of each participant in the program*

The information listed in the table below is representative of surface water quality samples taken at each of the District outflow points. The District does not have any subsurface drainage systems, and therefore the data below is only representative of surface water quality. Unfortunately, only one outflow sample was taken in 2019. The sample shown in the chart below was taken on August 18th 2019.

3. Outflow (surface drainage & spill) Quality Testing Program

Analyses Performed	*Frequency*	*Concentration Range*	*Average*	*Reuse limitation?*
pH	Annually	7.6 pH units	7.6	None
EC (Conductivity)	Annually	0.04 ds/m	0.04	None
TDS	Annually	30 ppm	30	None
Boron	Annually	0.01 ppm	0.01	None
SAR(permeability Na)	Annually	0.2	0.2	None
SAR/EC Ratio	Annually	5.2	5.2	None
pHc	Annually	9.5	9.5	None
Calcium	Annually	4.3 ppm	4.3	None
Magnesium	Annually	0.6 ppm	0.6	None
Sodium	Annually	1.9 ppm	1.9	None
Potassium	Annually	0.4 ppm	0.4	None
Bicarbonate	Annually	20 ppm	20	None
Chloride	Annually	0.3 ppm	0.3	None
Nitrate - Nitrogen	Annually	0.1 ppm	0.1	None
Sulfate - Sulfur	Annually	0.8 ppm	0.8	None

Outflow (subsurface drainage) Quality Testing Program

Analyses Performed	*Frequency*	*Concentration Range*	*Average*	*Reuse limitation?*
N/A				

4. *Provide a brief discussion of the District's involvement in Central Valley Regional Water Quality Control Board programs or requirements for remediating or monitoring any contaminants that would significantly degrade water quality in the receiving surface waters.*

The Tulare Irrigation District actively monitors the Kaweah Basin Water Quality Association, which is comprised of water users on the Kaweah River and St. Johns River systems. The Association meets monthly at the offices of the Kaweah Delta Water Conservation District to discuss current water quality issues that face the Southern San Joaquin Valley. The District participates by sending the District Assistant Engineer to the monthly meetings to stay informed on any new or changing water quality issues that may face landowners within the District.

The Coalition has members of its Steering Committee that interact with the Central Valley Regional Water Quality Control Board (Regional Board) and attend the regional and state meetings. Steering Committee members report to the greater group during Association meetings on recent developments and interactions with the Regional Board. Issues that the Association is engaged in include:

- **Diary Monitoring Program**
- **Irrigation Lands Regulatory Program**
- **CV-SALTS**
- **Tulare Lake Basin Plan**
- **Management Plans**

The District Assistant Engineer provides reports back to the District based upon information gathered at Association meetings. The District Assistant Engineer and General Manager also receive emails from the Regional Board by enrolling in the Regional Boards list-serve service.

The District has not identified any contamination issues and therefore has not had any contact with the Regional Board concerning contamination sites or remediation due to contamination.

G. Water Accounting (Inventory)

Quantify Water District Supplies

1. *Surface water supplies, imported and originating within the District, by month (Table 1)*
2. *Ground water extracted by the district, by month (Table 2)*
3. *Effective precipitation by crop (Table 5)*
4. *Estimated annual ground water extracted by non-district parties (Table 2)*
5. *Recycled urban wastewater, by month (Table 3)*
6. *Other supplies, by month (Table 1), (Table 3)*

Quantify Water Used

1. *Agricultural conveyance losses, including seepage, evaporation, and operational spills from canals; (Table 4) and leaks, breaks, and flushing/fire uses in piped systems (Table 4)*
2. *Consumptive use by riparian vegetation (Table 6)*
3. *Applied irrigation water - crop ET, water used for leaching/cultural practices (e.g., frost protection, soil reclamation, etc.) (Table 5)*
4. *Urban water use (N/A)*
5. *Groundwater recharge (Table 6)*
6. *Water exchanges and transfers (Table 1), (Table 6)*
7. *Estimated deep percolation within the District (Table 6)*
8. *Flows to perched water table or saline sink (Table 7)*
9. *Outflow water leaving the district (Table 6)*
10. *Other (Table 6)*

Overall Water Inventory
(Table 6)

Section 3: Best Management Practices (BMPs) for Agricultural Contractors

A. Critical Agricultural BMPs

1. *Measure the volume of water delivered by the district to each turnout with devices that are operated and maintained to a reasonable degree of accuracy, under most conditions, to +/- 6%*

   a. *Number of delivery points (turnouts and connections):* 622

   b. *Number of delivery points serving more than one farm:* 4

   c. *Number of measured delivery points (meters and measurement devices):* 622

   d. *Percentage of water delivered to Contractor that was measured at a delivery point:* 100%

   e. *Total number of delivery points not billed by quantity:* 0%

   f. *Delivery point measurement device table:*

The District measures all turnouts to District water users. Turnout measurement is necessary because the District bills water users based on a volumetric usage of surface water. A majority of measurement devices fall under the submerged orifice calculation. The Bureau of Reclamation's Water Measurement Manual states that submerged orifice turnouts have been calibrated to laboratory accuracy of +/- 3%. However, the District feels that given in-field constrains and flow conditions that the submerged orifice is only accurate to approximately +/- 6% on an instantaneous reading.

The District has also installed on a limited basis propeller meters. These devices are made to deliver reading to an accuracy of +/- 2% under laboratory conditions. The District installs these devices per the manufactures recommendations however due to other constraints feels that the in-field application produces accuracies at approximately +/- 3%. Furthermore, Dr. Daniel Howes, at the Irrigation and Training Research Center (ITRC) at Cal Poly San Luis Obispo found that meter rates can be an accurate measurement in the range of =/- 5 to 7%, if the meter is installed and operated correctly (Accuracy of Round Meter Gates for On-Farm Deliveries, Howes, June 10, 2015).

Measurement Type	*Number*	*Accuracy (+/- %)*	*Reading Frequency (Days)*	*Calibration Frequency (Months)*	*Maintenance Frequency (Months)*
Orifices					
Propeller meter	169	3%	Once a day	Every 2 to 5 years	Every 1 or 2 years
Weirs					
Flumes					
Venturi					
Metered gates	453	6%	1 -3 times a day	When requested	When needed / varies
Acoustic doppler					
Other (define)					
Total	622				

See District Measurement Device Documentation, Attachment C

2. Designate a water conservation coordinator to develop and implement the Plan and develop progress reports

Name: Marco Crenshaw *Title:* Watermaster

Address: 6826 Avenue 240, Tulare, California 93274

Telephone: (559) 686-3425 *E-mail:* mjc@tulareid.org

3. Provide or support the availability of water management services to water users

a. See Attachment I, Notices of District Education Programs and Services Available to Customers

1) On farm irrigation and drainage system evaluations using a mobile lab type assessment

	Total in district	*# surveyed last year*	*# surveyed in current year*	*# projected for next year*	*# projected 2nd yr in future*
Irrigated acres	59,022	0	0	Unknown	Unknown
Number of farms	207	0	0	0-4	0-4

The District supports the availability of on-farm irrigation and drainage system evaluations. This is accomplished by maintaining a list of irrigation educators and professionals that provide these services at the District office. District Staff also make the list available to farmers upon request.

2) Timely field and crop-specific water delivery information to the water users

The District provides water usage reports to water users upon request and water users are encouraged to request data as needed. The District has invested in software that allows the District to better record and report water usage totals. The District has also investigated the potential of software that will make water usage reports available via the District website. The District is phasing in the implementation of new water usage software and anticipates that full integration and website implementation will be completed in the next few years.

b. Real-time and normal irrigation scheduling and crop ET information

The District as a member of the Friant Water Authority receives weekly reports on soil water usage, CIMIS Eto data and crop coefficients. This information is made available to farmers upon request. The District is investigating the potential to make information more readily available via the District website.

c. Surface, ground, and drainage water quantity and quality data provided to water users

The District Watermaster collects daily water measurements throughout the District canal system and daily readings are reported from ditchtenders on individual farm turnouts. This information is available to water users upon request. However, the District does not track groundwater usage, as deep wells are owned by private landowners, and water usage is a private landowner right. However, the District is now a member of the Mid-Kaweah Groundwater Sustainability Agency (MKGSA) and this organization is tasked with achieving groundwater sustainability by 2040. The MKGSA does measure, through satellite imagery and calculation, the groundwater pumping that is taking place within the District. The MKGSA, along with the District is investigating the potential implementation of a groundwater well metering requirement, which is anticipated to be determined in the next five years.

The District collects groundwater and surface water quality samples each year from a selected number of agricultural wells and select surface water locations throughout the District. A general agricultural suitability test is conducted on the samples to determine the levels of constituents that can affect the usability of the water in regards to crop irrigation. The District does not do any sampling or testing required for potable water. At the time of this report there were no water quality problems to report. Approximately 17 groundwater wells and 7 surface water samples are taken each year. About every five years the District attempts to cycle back and resample all of the earlier wells to run a comparison analysis of water quality.

d. Agricultural water management educational programs and materials for farmers, staff, and the public

Program	*Co-Funders (If Any)*	*Yearly Targets*
5th Grade Water Conservation Program (Project – Water Education of Tulare Students)	N/A	750 Students
District Water Efficiency Library	N/A	Open to the public
Online Educational Material	N/A	Variable
Water Education Talks	N/A	Approximately 5 talks per year reaching approximately 300 people

See Attachment I for samples of provided materials and notices

e. other

4. Pricing structure - based at least in part on quantity delivered

Adopt a water pricing structure based on measured quantity delivered.

The District has utilized a volumetric pricing structure for water since the early 1950's. This system is utilized to provide monitoring and control of each irrigation event to each individual water user. The system the District utilizes requires ditchtenders to make daily readings of turnout gates that are receiving irrigation water. This information is then entered into a water accounting program that converts the volume of water used into a billing request. The cost for water within the District is

currently $49.00 per acre foot of water. Monthly invoices are sent to landowners showing the amount of water used and the total cost for the water. A sample bill is included as Attachment D.

5. *Evaluate and improve efficiencies of district pumps*
   Describe the program to evaluate and improve the efficiencies of the contractor's pumps.

   The District provides an inspection of District owned lift pumps on a rotational basis. District lift pumps are tested for efficiency and if determined to need repairs or maintenance they will be removed and the necessary work will be carried out. The District does not own or operate any deep wells that are utilized for irrigation purposes.

	Total in District	*# Surveyed Last Year*	*# Surveyed in Current Year*	*# Projected for Next Year*
Wells	0			
Lift Pumps	11	2	2	2

B. Exemptible BMPs for Agricultural Contractors

(See Planner, Chapter 2, Appendix C for examples of exemptible conditions)

1. *Facilitate alternative land use*

The District does not have any lands that contain or are susceptible to any of the items listed below.

Drainage Characteristic	*Acreage*	*Potential Alternate Uses*
High water table (<5 feet)	0	N/A
Poor drainage	0	N/A
Ground water Selenium concentration > 50 ppb	0	N/A
Poor productivity	0	N/A

Describe how the contractor encourages customers to participate in these programs.

2. *Facilitate use of available recycled urban wastewater that otherwise would not be used beneficially, meets all health and safety criteria, and does not cause harm to crops or soils*

Water users located south of the City of Tulare Waste Water Treatment Plant receive irrigation water from the treatment plant. This arrangement is between the water user and the City of Tulare. The District does not provide any assistance in the ordering or delivery of treated effluent from the City of Tulare Wastewater Treatment Plant.
In 2013, the City of Visalia and the District agreed to a program where the City will deliver tertiary treated waste water to the District. The City of Visalia pursued an upgrade to their wastewater treatment plant (WWTP) and included the ability to treat the water to a tertiary level, allowing it to be used for agricultural irrigation. This agreement covers delivery of tertiary treated water to the District from the City WWTP and the delivery of excess surface water to the City from District supplies.
The Agreement acknowledges that a pipeline needed to be constructed to deliver the water to the District. The District and the City pursued grant funds, receiving $2.8 million from IRMWP funding and approximately $700,000 in USBR funding. The pipeline was completed in 2015 and deliveries of tertiary water to the District began in late 2018.
The City of Visalia is obligated to deliver 800 AF per calendar month, and not less than 11,000 AF per year (also not to exceed 13,000 AF). The District is obligated to take the tertiary water and will utilize it for irrigation and incidental percolation (channel losses). For every two acre-feet of tertiary water delivered to the District, the District will return one acre-foot of water to specific recharge facilities identified by the City (the Agreement was developed as a 2:1 exchange).

Sources of Recycled Urban Waste Water	*AF/Y Available*	*AF/Y Currently Used in District*
City of Tulare Waste Water Treatment Plant	12,000	6,330
City of Visalia Waste Water Treatment Plan	13,000	7,471

3. Facilitate the financing of capital improvements for on-farm irrigation systems

The District continues to seek grant funding from the State of California Department of Water Resources and the United States Bureau of Reclamation for water efficiency improvement projects. Current grant awards have been made to assist the District with facility upgrades, which in turn has helped improve the flexibility of the on-demand system of the District and reduce the amount of water that is spilled outside of the District. The District also supports water efficiency by making available on-farm irrigation and drainage system evaluations, making available a list of water educators and professionals.

From 2008 to 2012, the District received grants from the Natural Resources Conservation District (NRCS) called the Agricultural Water Efficiency Program (AWEP). These grants aimed at providing funds to support on-farm water efficiency projects to individual water users within the District. The District has successfully funded $2,263,885 and accomplished approximately 20 projects within the District. Farmers utilized the funds provided by the NRCS to develop water efficiency projects like micro/drip irrigation or tail water return systems.

Funding source Programs	*How provide assistance*
NRCS AWEP Grant	Provide 50% cost share for on-farm water efficiency projects

4. Incentive pricing
Describe incentive rate structure or other programs and purpose

The District operates as a conjunctive use district, which means that the District provides surface water to water users to meet crop demands, but in many years is unable to meet the entire supply required to cultivate a crop. Therefore, water users are forced to utilize groundwater deep wells to meet the crop demands within the District. The District prices its water supply to be competitive with the ability to pump groundwater utilizing deep wells, therefore providing a cost effective alternative to extracting more groundwater and adding to the overdraft of the underlying basin. Each water user within the District owns and operates a deep well as a part of their farming operations, and can generally pump water for a cost of approximately $50.00 to $75.00 per acre foot of water. If the District were to price water at rates higher than the cost to pump water, water users would simply rely upon their deep wells to meet crop demand. This would cause an excess amount of pumping to increase the overdraft situation that the District faces. For every land owner in the District, regardless of their use of irrigation water or not, there is a flat $32.00 per acre per year assessment.

5. *a) Line or pipe ditches and canals*

This BMP is not applicable to most of the canal system within the District, which will remain unlined by intention. The District maintains an aggressive conjunctive use program to maintain and increase groundwater elevations. This program utilizes all unlined canals, which is estimated to be the equivalent of 450 acres of recharge basin capacity, as well as over 1,300 acres of recharge basins to provide for recharge of the groundwater table. The conversion of these unlined canals to lined canals would adversely impact the District's ability to recharge groundwater and increase the amount of overdraft experienced within the District.

Canal/Lateral (Reach)	*Type of Improvement*	*Number of Miles in Reach*	*Estimated Seepage (AF/Y)*	*Accomplished/ Planned Date*
None				

b) Construct/line regulatory reservoirs

While the District has not constructed any new regulatory reservoirs in the recent past, we have however recently, with the help of the USBR Agricultural Water Conservation and Efficiency Grant No. R12AP20039, upgraded four of our existing regulatory reservoirs with automated release gates. These four reservoirs previously had manual release gates that had to be operated by a ditchtender out in the field.

For three of the reservoirs, #3 Basin, # 6 Basin, and # 8 Basin, the release gates were replaced with SCADA adapted Rubicon Slip Meter Gates which can be controlled remotely. And for the fourth basin, Watte Basin, a new release gate was fabricated and outfitted with a SCADA adapted Rotork actuator which can also be controlled remotely. Also at Watte basin, a new ramp flume is to be constructed for accurate measurement.

The updating of these regulatory reservoirs will increase the District's ability to not only provide steadier downstream service to the farmers' turnouts, but also provide for enhanced water conservation with the District's ability to better regulate the reservoir levels when needed.

The District also continues to search for future sites that can serve as a regulatory or recharge basin. Sites that are considered are reviewed to ensure the site meets the criteria of a regulatory/recharge basin and that the project is cost effective.

Reservoir Name	*Location*	*Describe Improved Operational Flexibility and AF Savings*
#3 Basin	SE ¼, Section 22, T19S, R23E	Steadier downstream service and enhanced regulation of reservoir / AF Saved Unknown
#6 Basin	NW ¼, Section 35, T19S, R23E	Steadier downstream service and enhanced regulation of reservoir / AF Saved Unknown
#8 Basin	SW ¼, Section 10, T20S, R23E	Steadier downstream service and enhanced regulation of reservoir / AF Saved Unknown
Watte Basin	NE ¼, Section 34, T20S, R23E	Steadier downstream service and enhanced regulation of reservoir / AF Saved Unknown

6. Increase flexibility in water ordering by, and delivery to, water users
See Attachment J, contractor 'agricultural water order' form

The District provides surface water to water users based on an on-demand system with a 24-hour notice before delivery and shutoff. Water users are required to place calls to the District Watermaster 24-hours prior to the start of surface water and 24-hours prior to a shutoff of surface water. In some cases the Watermaster is able to start surface water to a water user sooner than 24-hours. The District has also embarked on an aggressive program of installing regulation basins and specific SCADA equipment which allows the Watermaster to make faster changes within the District canal network and deliver water to water users on a quicker timeframe. The SCADA system also allows the canal network to stay closer to a balanced state and deliver a consistent supply of water to the water user. Please see the attached District Map for locations of SCADA Equipment

7. Construct and operate district spill and tailwater recovery systems

The District conducts water operations to prevent the operational spill of water out of the District canal system. When water does spill outside of the District, it is generally during flood release operations from the Kaweah River system, which the District is obligated to pass through its system. During all operations the District owns and operates a system of regulation and recharge basins near the end of all major canals within the District to prevent or minimize the operational spills. The names of these basins are Anderson Basin, Doris Basin, Guinn Basin, and Watte Basin (these basins are shown on the attached Facilities Map). The District also has large basins at the upstream end of the District, which allows the Watermaster to operate these basins as regulation basins. These features allow for the Watermaster to store or release water much closer to the water user and improve water management decisions to reduce the amount of water that is spilled. The District has also installed several new SCADA monitored and controlled sites to assist the Watermaster in balancing the District Canal system and preventing operational spills.

Distribution System Lateral	*Average Annual Spill (AF/Y)*	*Quantity Recovered and reused (AF/Y)*
Section 7	595	0
Section 9	485	0
Doris Basin	639	0
Total	1,720	0

Drainage System Lateral	*Annual Drainage Outflow (AF/Y)*	*Quantity Recovered and reused (AF/Y)*
None	0	0
Total	0	0

8. *Plan to measure outflow*

Total # of outflow (surface) locations/points 3
Total # of outflow (subsurface) locations/points 0
Total # of measured outflow points 3
Percentage of total outflow (volume) measured during report year 100%

Identify locations, prioritize, determine best measurement method/cost, submit funding proposal

Location & Priority	*Estimated cost (in $1,000s)*				
	2019	*2020*	*2021*	*2022*	*2023*
Section 7	0	0	0	0	0
Section 9	0	0	0	0	0
Doris Basin	0	0	0	0	0

9. Optimize conjunctive use of surface and ground water
Describe the potential for increasing conjunctive use of surface and groundwater

The District has historically operated under an aggressive conjunctive use program. This program consists of aggressively pursuing wet year excess water (flood water from the Kaweah River system and Class II water from the Friant Kern Canal System) to provide groundwater recharge benefits to the District. The District utilizes a vast network of unlined canals and 1,300 acres of recharge basins within the District to place excess water and allow it to recharge the groundwater. The District also does not pursue the active lining of canals which are utilized to provide recharge to groundwater as surface water is delivered to water users. Lastly, the District provides a pricing structure for surface water that encourages the use of surface water versus the use of deep wells that pump groundwater.

The District is also actively seeking the acquirement of new recharge basins within the District. In the last several years the District has added approximately 205 acres of new recharge basins in specific locations throughout the District. The District seeks lands that are located in high permeability soils and are located near District canal facilities that will deliver surface water. Given an analysis of these criteria and the cost/benefit of the site, the District can and will pursue the development of any site as a recharge basin.

10. Automate distribution and/or drainage system structures
Identify locations where automation would increase delivery flexibility and reduce spill and losses. Describe program to achieve these benefits and estimate annual water savings

The District began a System Modernization Project in 2007 to install a SCADA monitoring and control system on select canal systems within the District. This project included the installation of several monitoring sites, two level control gates (LOPAC gates), one flow/level control gate (Langemann Gate) and a pump back system out of a reservoir (See attached District Map for a location of SCADA facilities). This project was completed in 2008, at which time the District began evaluating future sites for the inclusion of canal automation and monitoring. Since that time the District has received several grants to install new SCADA sites and has either completed those projects or is in the progress of installing those facilities. The District continues to evaluate new sites to be outfitted with SCADA monitoring and control equipment and based upon a cost/benefit analysis will pursue such projects which are a benefit to the District. With the current upgrades, approximately 200 acre-feet per year may be saved from spilling outside of the District boundaries. Other benefits of our ongoing automation applications are increased flexibility to our growers' deliveries, lower District ditchtender working hours, and increased groundwater recharge capabilities.

11. Facilitate or promote water customer pump testing and evaluation
See Attachment I, Notices of District Education Programs and Services Available to Customers

The District coordinates pump testing between individual water users and Southern California Edison (SCE) or Pacific Gas and Electric (PG&E) upon request. The District advertises this service through the FWUA and monthly newsletters. The District also requests from the utility companies any results of efficiency test performed on pumps within the District for a record of pump efficiencies within the District.

12. *Mapping*

For many years, the District has looked for ways to increase groundwater levels through its conjunctive use program. Whether it be recharge through the District earthen canal system, or through the use of what is now around 1,300 acres of regulation/recharge basins within the service area. Beginning in 2016, the District began to look at ways to supplement these recharge efforts by also looking into ways to work with the District growers to enhance on-farm recharge. We began working with the consultant group Sustainable Conservation on a Groundwater Recharge Assessment Tool (GRAT) to help identify not only which crop ground within the District would be the most beneficial for this application, but also to find out the impacts of this implementation, both on the groundwater table and the financial implications of such applications.

Through this partnership, Sustainable Conservation developed the GRAT tool for the District which incorporates datasets and mapping for our service area. The chart below asks for costs associated with mapping, and the data reflects the minimal cost of utilizing the GRAT tool.

GIS maps	*Estimated cost (in $1,000s)*				
	2019	*2020*	*2021*	*2022*	*2023*
Layer 1 – Distribution system	1	1	1	1	1
Layer 2 – Drainage system					
Suggested layers:					
Layer 3 – Ground water information	1	1	1	1	1
Layer 4 – Soils map	1				
Layer 5 – Natural & cultural resources					
Layer 6 – Problem areas					

C. Provide a 5-Year Budget for Implementing BMPs

1. *Amount actually spent during current year.*

Expenditures do not include maintenance costs or staff hourly costs.

Year 2019 BMP #	*BMP Name*	*Budgeted Expenditure (not including staff time)*	*Staff Hours*
A1	Measurement	$400	5,700
A2	Conservation Staff	$0	40
A3	On-Farm Evaluations / Water Delivery Info	$102,000	75
	Irrigation Scheduling	$0	5
	Water Quality	$900	30
	Agricultural Education Program	$200	15
A4	Quantity Pricing	$0	40
A5	Contractor’s Pumps	$0	10
B1	Alternative Land Use	$0	0
B2	Urban Recycled Water Use	$600	500
B3	Financing On-Farm Improvements	$0	5
B4	Incentive Pricing	$0	0
B5	Line or Pipe Canals/Install Reservoirs	$442,500	120
B6	Increase Delivery Flexibility	$0	0
B7	District Spill/Tailwater Recovery Systems	$0	0
B8	Measure Outflow	$100	200
B9	Optimize Conjunctive Use	$0	0
B10	Automate Canal Structures	See B5 costs above	See B5 above
B11	Customer Pump Testing	$0	0
B12	Mapping	$0	30
	Total	**$546,700**	**6,770**

2. *Projected budget summary for the next year.*

Year 2020 BMP #	*BMP Name*	*Budgeted Expenditure (not including staff time)*	*Staff Hours*
A1	Measurement	$100	850
A2	Conservation Staff	$0	40
A3	On-Farm Evaluations / Water Delivery Info	$2,500	1,000
	Irrigation Scheduling	$0	5
	Water Quality	$450	15
	Agricultural Education Program	$200	15
A4	Quantity Pricing	$0	40
A5	Contractor's Pumps	$0	10
B1	Alternative Land Use	$0	0
B2	Urban Recycled Water Use	$500	500
B3	Financing On-Farm Improvements	$0	5
B4	Incentive Pricing	$0	0
B5	Line or Pipe Canals/Install Reservoirs	$138,000	150
B6	Increase Delivery Flexibility	$0	0
B7	District Spill/Tailwater Recovery Systems	$0	0
B8	Measure Outflow	$40	20
B9	Optimize Conjunctive Use	$0	0
B10	Automate Canal Structures	See B5 costs above	See B5 above
B11	Customer Pump Testing	$0	0
B12	Mapping	$0	30
	Total	**$141,790**	**2,680**

3. *Projected budget summary for 3rd year.*

Year 2021 BMP #	*BMP Name*	*Budgeted Expenditure (not including staff time)*	*Staff Hours*
A1	Measurement	$300	2,800
A2	Conservation Staff	$0	40
A3	On-Farm Evaluations / Water Delivery Info Irrigation Scheduling Water Quality Agricultural Education Program	$2,500 $0 $2,000 $200	2,800 5 35 15
A4	Quantity Pricing	$0	40
A5	Contractor’s Pumps	$0	10
B1	Alternative Land Use	$0	0
B2	Urban Recycled Water Use	$500	500
B3	Financing On-Farm Improvements	$0	5
B4	Incentive Pricing	$0	0
B5	Line or Pipe Canals/Install Reservoirs	$0	0
B6	Increase Delivery Flexibility	$0	0
B7	District Spill/Tailwater Recovery Systems	$0	0
B8	Measure Outflow	$40	20
B9	Optimize Conjunctive Use	$0	0
B10	Automate Canal Structures	$0	0
B11	Customer Pump Testing	$0	0
B12	Mapping	$0	30
	Total	**$5,540**	**6,300**

4. Projected budget summary for 4th year.

Year 2022 BMP #	*BMP Name*	*Budgeted Expenditure (not including staff time)*	*Staff Hours*
A1	Measurement	$300	2,800
A2	Conservation Staff	$0	40
A3	On-Farm Evaluations / Water Delivery Info Irrigation Scheduling Water Quality Agricultural Education Program	$2,500 $0 $450 $200	2,800 5 15 15
A4	Quantity Pricing	$0	40
A5	Contractor's Pumps	$0	10
B1	Alternative Land Use	$0	0
B2	Urban Recycled Water Use	$500	500
B3	Financing On-Farm Improvements	$0	5
B4	Incentive Pricing	$0	0
B5	Line or Pipe Canals/Install Reservoirs	$0	0
B6	Increase Delivery Flexibility	$0	0
B7	District Spill/Tailwater Recovery Systems	$0	0
B8	Measure Outflow	$40	20
B9	Optimize Conjunctive Use	$0	0
B10	Automate Canal Structures	$0	0
B11	Customer Pump Testing	$0	0
B12	Mapping	$0	30
	Total	**$3,990**	**6,280**

4. Projected budget summary for 5th year.

Year 2023 BMP #	*BMP Name*	*Budgeted Expenditure (not including staff time)*	*Staff Hours*
A1	Measurement	$300	2,800
A2	Conservation Staff	$0	40
A3	On-Farm Evaluations / Water Delivery Info Irrigation Scheduling Water Quality Agricultural Education Program	$2,500 $0 $450 $200	2,800 5 15 15
A4	Quantity Pricing	$0	40
A5	Contractor's Pumps	$0	10
B1	Alternative Land Use	$0	0
B2	Urban Recycled Water Use	$500	500
B3	Financing On-Farm Improvements	$0	5
B4	Incentive Pricing	$0	0
B5	Line or Pipe Canals/Install Reservoirs	$0	0
B6	Increase Delivery Flexibility	$0	0
B7	District Spill/Tailwater Recovery Systems	$0	0
B8	Measure Outflow	$40	20
B9	Optimize Conjunctive Use	$0	0
B10	Automate Canal Structures	$0	0
B11	Customer Pump Testing	$0	0
B12	Mapping	$0	30
	Total	**$3,990**	**6,280**

Section 4: Best Management Practices for Urban Contractors

A. Urban BMPs

Not Applicable

Section 5: District Water Inventory Tables

Year of Data	2019	**Enter data year here**

Table 1

Surface Water Supply

2019 Month	**Federal Ag Water** (acre-feet)	**Federal non-Ag Water.** (acre-feet)	**State Water** (acre-feet)	**Local Water (define)** (acre-feet)	**Other Water (define)** (acre-feet)	**Transfers into District** (acre-feet)	**Upslope Drain Water** (acre-feet)	**Total** (acre-feet)
Method	M1			Kaweah Riv. M1		Kaweah/CVP M1		
January	0	0	0	0	0	2,688	0	2,688
February	1,272	0	0	18,258	0	8,344	0	27,874
March	8,187	0	0	22,692	0	12,228	0	43,107
April	38,031	0	0	0	0	2,397	0	40,428
May	6,583	0	0	34,602	0	7,559	0	48,744
June	10,489	0	0	38,184	0	6,264	0	54,937
July	20,261	0	0	26,908	0	13,751	0	60,920
August	6,974	0	0	28,307	0	4,177	0	39,458
September	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	313	0	0	0	313
TOTAL	91,797	0	0	169,264	0	57,408	0	318,469

Table 2

Ground Water Supply

2019 Month	**District Groundwate** (acre-feet)	**Private Agric** *(acre-feet)
Method		E2
January	0	12,000
February	0	12,000
March	0	12,000
April	0	12,000
May	0	12,000
June	0	12,000
July	0	12,000
August	0	12,000
September	0	12,000
October	0	12,000
November	0	12,000
December	0	12,000
TOTAL	0	144,000

*normally estimated

Table 3

Total Water Supply

2019 Month	Surface Water Total (acre-feet)	District Groundwate (acre-feet)	Recycled M&I (acre-feet)	Total District Water Supply (acre-feet)
Method	M1		M1	
January	2,688	0	217	2,905
February	27,874	0	906	28,780
March	43,107	0	738	43,845
April	40,428	0	911	41,339
May	48,744	0	945	49,689
June	54,937	0	653	55,590
July	60,920	0	911	61,831
August	39,458	0	941	40,399
September	0	0	1,051	1,051
October	0	0	198	198
November	0	0	0	0
December	313	0	0	313
TOTAL	318,469	0	7,471	325,940

*Recycled M&I Wastewater is treated urban wastewater that is used for agriculture.

Table 4

Agricultural Distribution System

2019 Canal, Pipeline, Lateral, Reservoir	Length (feet)	Width (feet)	Surface Area (square feet)	Precipitation (acre-feet)	Evaporation (acre-feet)	Spillage (acre-feet)	Seepage (acre-feet)	Total (acre-feet)
Intake Canals	52,800	50	2,640,000	51.6	273.7	0	32,372	(32,594)
In District Canals	1,584,000	25	39,600,000	773.5	4,105.3	0	48,121	(51,453)
Basins	6,922	6,922	47,914,084	935.9	4,967.2	0	0	(4,031)
Section 7	0	0	0	0.0	0.0	262	0	(262)
Section 9	0	0	0	0.0	0.0	489	0	(489)
Cameron Creek	0	0	0	0.0	0.0	266	0	(266)
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
TOTAL				1,760.9	9,346.2	1,017	80,493	(89,095)

Precipitation Worksheet					Evaporation Worksheet				
2019	**inches precip**	**ft precip**	**acres**	**AF/Year**	**2019**	**inches evap**	**ft evap**	**acres**	**AF/YEAR**
Jan	1.27	0.11	60.61	51.57	**Jan**	1.49	0.12	60.61	273.69
Feb	2.66	0.22	909.09	773.48	**Feb**	1.73	0.14	909.09	4,105.30
Mar	1.57	0.13	1,099.96	935.88	**Mar**	3.35	0.28	1,099.96	4,967.22
Apr	0.22	0.02	0.00	0.00	**Apr**	5.48	0.46	0.00	0.00
May	1.47	0.12	0.00	0.00	**May**	5.66	0.47	0.00	0.00
Jun	0.00	0.00	0.00	0.00	**Jun**	8.19	0.68	0.00	0.00
Jul	0.00	0.00	0.00	0.00	**Jul**	8.18	0.68	0.00	0.00
Aug	0.00	0.00	0.00	0.00	**Aug**	7.25	0.60	0.00	0.00
Sept	0.00	0.00	0.00	0.00	**Sept**	5.34	0.45	0.00	0.00
Oct	0.00	0.00	0.00	0.00	**Oct**	3.98	0.33	0.00	0.00
Nov	0.92	0.08	0.00	0.00	**Nov**	2.46	0.21	0.00	0.00
Dec	2.10	0.18	0.00	0.00	**Dec**	1.08	0.09	0.00	0.00
TOTAL	**10.21**	**0.85**	**2069.65**	**1760.93**	**TOTAL**	**54.19**	**4.52**	**2,069.65**	**9,346.21**

Table 5

Crop Water Needs

2019 Crop Name	Area (crop acres)	Crop ET (AF/Ac)	Leaching Requirement (AF/Ac)	Cultural Practices (AF/Ac)	Effective Precipitation (AF/Ac)	Appl. Crop Water Use (acre-feet)
Corn	21,422	2.60	0.0	1.0	0.2	72,835
Wheat	15,158	1.70	0.0	1.0	0.2	37,895
Alfalfa	10,158	4.00	0.0	0.0	0.2	38,600
Pistachios	8,336	3.10	0.0	1.0	0.2	32,510
Almonds	7,239	3.50	0.0	1.0	0.2	31,128
Cotton	5,203	2.90	0.0	1.0	0.2	19,251
Walnuts	5,076	3.80	0.0	1.0	0.2	23,350
Milo Maize	846	2.60	0.0	1.0	0.2	2,876
Grapes	473	2.50	0.0	0.0	0.2	1,088
Dry Beans	417	2.30	0.0	1.0	0.2	1,293
Native Pasture/Grasses	375	1.50	0.0	0.0	0.2	488
Cherries	325	3.00	0.0	1.0	0.2	1,235
Oats	214	1.70	0.0	1.0	0.2	535
Blue Berries	148	2.30	0.0	1.0	0.2	459
Persimmons	85	3.00	0.0	1.0	0.2	323
Oranges	81	3.00	0.0	1.0	0.2	308
Nursery	74	2.50	0.0	0.0	0.2	170
Radish	51	2.40	0.0	1.0	0.2	163
Pears, Prunes, Olives	42	3.50	0.0	1.0	0.2	181
Pumpkins	20	2.40	0.0	1.0	0.2	64
Lettuce	20	1.80	0.0	1.0	0.2	52
Pomegranites	3	2.40	0.0	1.0	0.2	10
	0	0.00	0.0	1.0	0.0	0
Crop Acres	75,766					264,813

Total Irrig. Acres 59,022 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2019 District Water Inventory

Type of Water	Location of Information		
Water Supply	Table 3		325,940
Riparian ET	(Distribution and Drain)	minus	0
Groundwater recharge	(intentional - ponds, injection)	minus	83,477
Seepage	Table 4	minus	80,493
Evaporation - Precipitation	Table 4	minus	7,585
Spillage	Table 4	minus	1,017
Transfers out of District		minus	8,037
Water Available for sale to customers			145,331
Actual Agricultural Water Sales	2019	From District Sales Records	145,331
Private Groundwater	Table 2	plus	144,000
Crop Water Needs	Table 5	minus	264,813
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		24,518
Unaccounted for Water	(calculated)		(0)

Table 7

Influence on Groundwater and Saline Sink

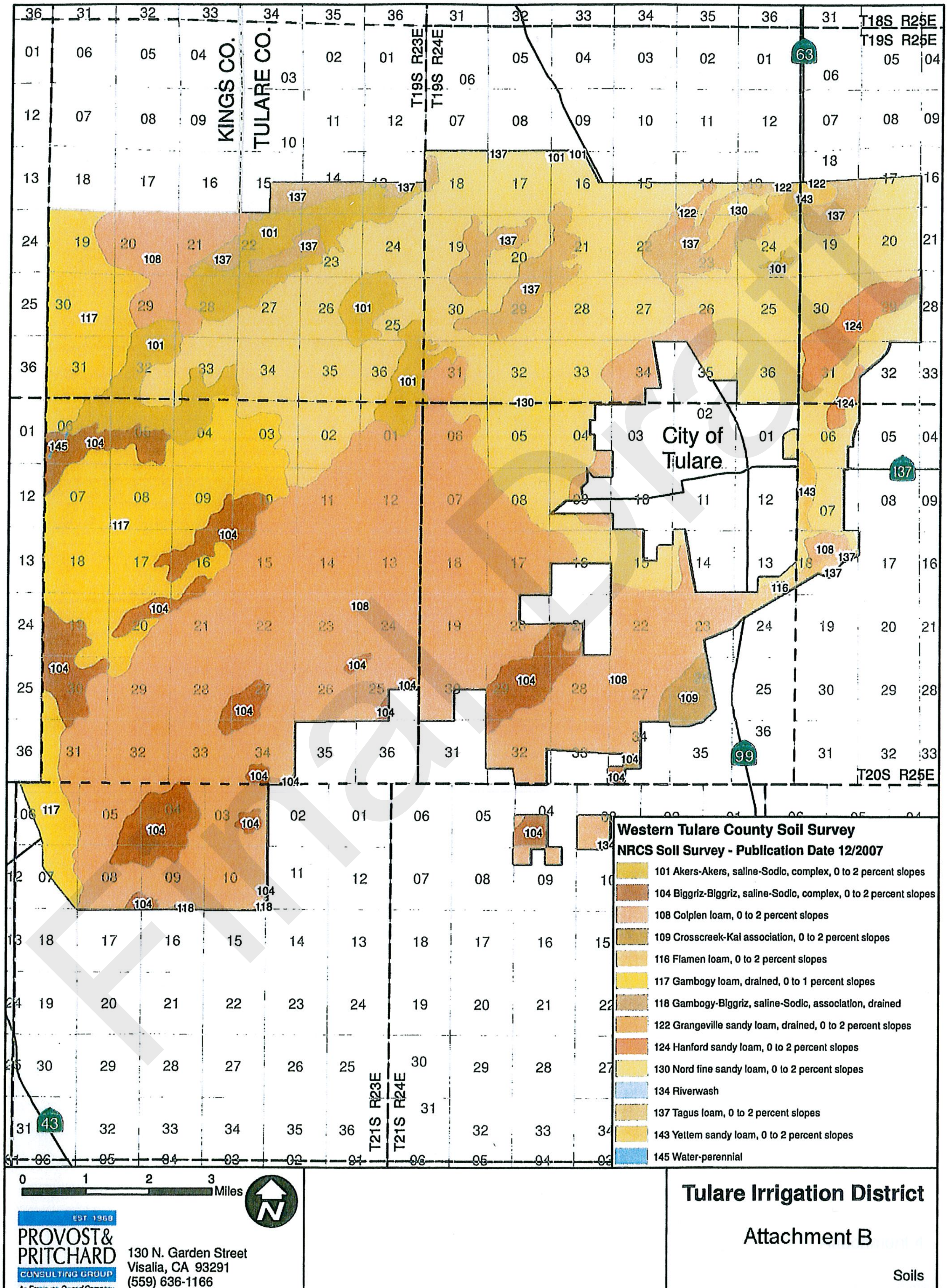
2019	
Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	163,970
Estimated actual change in ground water storage, including natural recharge)	19,970
Irrigated Acres (from Table 5)	75,766
Irrigated acres over a perched water table	0
Irrigated acres draining to a saline sink	0
Portion of percolation from agri seeping to a perched water table	0
Portion of percolation from agri seeping to a saline sink	0
Portion of On-Farm Drain water flowing to a perched water table/saline sink	0
Portion of Dist. Sys. seep/leaks/spills to perched water table/saline sink	0
Total (AF) flowing to a perched water table and saline sink	0

Table 8

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (define) (acre-feet)	Transfers into District (acre-feet)	Upslope Drain Water (acre-feet)	Total (acre-feet)
2010	81,950	0	0	162,115	Recycled	30,072	0	274,137
2011	92,090	0	0	215,147	M&I	30,064	0	337,301
2012	12,086	0	0	37,741	0	0	0	49,827
2013	888	0	0	4,881	0	0	0	5,769
2014	0	0	0	0	0	0	0	0
2015	0	0	0	2,987	0	0	0	2,987
2016	27,543	0	0	56,073	0	8,504	0	92,120
2017	70,592	0	0	295,462	0	30,827	0	396,881
2018	44,510	0	0	41,327	56	17,810	0	103,703
2019	91,797	0	0	169,264	7,471	57,408	0	325,940
Total	421,456	0	0	984,997	7,527	174,685	0	1,588,665
Average	42,146	0	0	98,500	941	17,469	0	158,867

RANGE 23 EAST
RANGE 24 EAST
RANGE 25 EAST
TOWNSHIP 20 SOUTH
TOWNSHIP 20 SOUTH
TOWNSHIP 21 SOUTH
NORTH
SCALE
FEET
0
7,000
14,000
Ave 272
Ave 264
Ave256
Ave 248
Ave 240
Ave 232
Ave 224
Ave 216
Ave 208
Ave 200
Ave 192
Ave 176
Ave 198
Rd 20
Rd 28
Rd 36
Rd 44
Rd 52
Rd 60
Rd 68
Rd 76
Rd 84
Rd 92
Rd 100
Rd 108
Rd 116
Rd 124
Rd 132
Rd 24
Rd 48
Rd 96
Ave 116
TAGUS BASIN
PACKWOOD CREEK
CAMERON CREEK
MAIN CANAL
CREAMLINE BASIN
Ave 256
SWALL BASIN
No. 3 BASIN
GUINN BASIN
No. 6 BASIN
ENTERPRIZE BASIN
MARTIN BASIN
ANERSON NORTH BASIN
ANDERSON SOUTH BASIN
No. 8 BASIN
ABERCROMBIE BASIN
WATTE BASIN
DORIS BASIN
LEGEND
-CANALS AND DITCH
-PIPELINES
- MEASUREMENET LOCATIONS
- DELIVERY TURNOUTS
- SCADA SITES
- AREA PIPELINE WITH PUMPS
- SPILLS OUT OF DISTRICT
- WATER QUALITY TEST LOCATIONS
- EXISTING RECHARGE BASINS
- NEW RECHARGE BASINS
TULARE IRRIGATION DISTRICT
TULARE, CALIFORNIA
ATTACHMENT A
2019
TULARE IRRIGATION DISTRICT
FORMED IN 1889



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Attachment B

Tulare Irrigation District
Irrigation Operation Procedures
2019

Water Rate:

Water users will be notified of rates established by the Board of Directors.

Owners:

1. Any District **property owner** having a delinquent assessment which includes water charges, shall not be eligible to receive District water until such delinquent assessment is paid.

Minimum Charge:

The minimum delivery charge through any turnout will be two (2) acre feet for each irrigation order.

Rules and Regulations:

The following rules and regulations must be observed by all water users to provide adequate service:

1. Water orders shall be placed with the watermaster at the District office **48 hours** in advance. The water user must give the gate number when placing a water order.
2. Orders not accepted by the water user within 12 hours of the requested "turn-on" time will be canceled and must be reordered unless arrangements have been made with the watermaster.
3. Notice shall be given to the District office, during regular office hours, at least 24 hours before the closing of a turnout gate. In the absence of shut-off notification, the water charge will be based on the last gate reading made and the time required to reduce the flow through the District facilities, however, the charge will not exceed 24 hours.
4. Only the ditch tender is authorized to operate T.I.D. canals, laterals, check gates, and points of diversions. It is the farmer's responsibility to open and close and clean turnout gates.
5. In case of an emergency, you are requested to immediately notify the District office, or your ditch tender.

Prorating of Water:

1. Any time the District is unable to meet irrigation demands, due to water shortage or canal capacity, it will be necessary to prorate available water. The water will be prorated on a basis of water available, total District acreage, and the water users' eligible acreage within the canal system and District.
2. If a particular canal or pipeline capacity is not adequate to meet the demand, the prorate will be based upon the water available, acreage served by the canal or pipeline, and the water user's acreage served by the canal or pipeline.
3. All water deliveries otherwise, will be made in sequential receipt of application orders.

Water Measurements:

Any complaint regarding the quantity of water charged shall be brought to the attention of the watermaster or office prior to the 30th day of the month following the date of billing. All charges will be considered as final after that date.

Communications:

Telephone: District Office, 7:00 am to 5:00 pm and after hours messages, 686-3425

Emergency Telephone: 799-9462

Mailing Address: Tulare Irrigation District
P.O. Box 1920
Tulare, CA 93275

RULES

AND

REGULATIONS

GOVERNING

THE DISTRIBUTION OF WATER

IN THE

TULARE

IRRIGATION DISTRICT

Adopted April 25, 1893

Amended July 7, 1953

RULES AND REGULATIONS

Governing The Distribution Of Water In The

TULARE IRRIGATION DISTRICT

Section 22257 of the Water Code of the State of California is, in part, as follows:

"Each district shall establish equitable rules for the distribution and use of water, which shall be printed in convenient form for distribution in the district."

RULE 1

CONTROL OF SYSTEM

The canals and works of the District are under the exclusive management and control of the Superintendent, appointed by the Board of Directors, and no other person, except his employees and assistants, shall have any right to interfere with said canals and works in any manner.

RULE 2

DITCHTENDERS AND OTHER EMPLOYEES

The Superintendent shall employ such ditchtenders and other assistants as may be necessary for the proper operation of the system, and the distribution of the water. Each ditchtender shall have charge of his respective section and shall be responsible to the Superintendent. From the ditchtender's decision an appeal may be made to the Superintendent. From the Action of the Superintendent, appeal may be made to the Board of Directors.

RULE 3

APPORTIONMENT OF WATER

The water will be apportioned to each distributing section by the Superintendent, and in cases of controversy or shortage of water the apportionment shall be made upon the basis of the assessed valuation of the land in each section.

RULE 4

DELIVERY OF WATER

Water will be delivered to the irrigator on demand or by rotation, depending upon the quantity available for distribution.

When delivery is made on demand application must be made to the ditchtender or the district office at least three days before the water is needed. Efforts will be made to make delivery in less than three days, and where possible the delivery will be made within 24 hours. All deliveries will be made in sequence of receipt of application.

When the quantity of water available is insufficient for full service on demand, a rotation schedule will be established. When water is available for irrigation notice will be given to each irrigator as soon as possible to allow preparation to be made to receive the water, which notice will state the approximate time when the run will be commenced, approximate head to be delivered and the time of discontinuance.

RULE 5

CONTINUOUS USE OF WATER

No allowance will be made for failure to use water at night during a regular run. If an irrigator turns the water from his place, it will be considered that the irrigator has completed his irrigation, and service may be discontinued for the current delivery unless cessation of use be due to an emergency and necessary.

RULE 6

IRRIGATION OF EXCESSIVELY HIGH GROUND

The District will not be required to raise water to an excessive height in canals or ditches in order to give service to lands or ditches of unreasonable elevation. Such unreasonable elevation to be determined by the particular conditions wherein such diversions would jeopardize the District ditches and which would interfere with water users service above and below said diversions.

RULE 7

USE OF DELIVERY GATES

Irrigators will receive water only through the delivery gates provided. If it is found that water is taken through cuts in the canal bank, or in any other manner than that provided by the District, the irrigator can be refused further water until all damage caused has been repaired or paid for.

RULE 8

CONTROL OF DIVERTING GATES

The control of all structures on the District's system is under the management of the District, and no water user is allowed to change or interfere with them except by permission, or in case of an emergency, to be reported at once to the District office.

RULE 9

USING WATER OUT OF TURN

Any person who uses water out of his turn and without permission of his ditchtender forfeits his right to water at the next regular irrigation and is also subject to criminal prosecution.

RULE 10

WASTE OF WATER

Persons wasting water on roads or vacant land, or land previously irrigated, either wilfully, carelessly, or on account of defective ditches or inadequately prepared land or who shall flood certain portions of the land to an unreasonable depth or amount in order to properly irrigate other portions will be refused the use of water until such conditions are remedied.

RULE 11

ACCESS TO LAND

The authorized agents of the District shall have free access at all times to lands irrigated from the canal system for the purpose of examining the canals and ditches and the flow of the water therein.

RULE 12

WATER RECEIPTS

Any person to whom water is offered must sign a receipt therefor. If the water is used, the receipt must show upon what kind of crop it was used; and if not used, the receipt must specify the reason.

RULE 13
IN CASE OF BREAKS

When a break or a succession of breaks occur under any distributing section, the person to whom the water is last given while the break is being repaired, will be allowed to finish before the water is taken from him, and shall not claim another irrigation for that run.

RULE 14
PARTY DITCHES

Before water is furnished to any private distributing ditch the land owners receiving the water therefrom must agree upon and sign rules and regulations satisfactory to the Board of Directors, providing for the repair, maintenance, and distribution of water from such ditch, authorizing some one to represent the users in all conferences with the ditchtender, and providing for the apportionment of water, subject to all rules and regulations of the District.

RULE 15
PUMPING RULES

All users pumping water from the canals shall be governed in all respects by the rules and regulations applicable to users under gravity service. The District will not be held resopnsible for any debris which may accumulate in stream flow which may tend to decrease the full operative capacity of pumps or pipelines.

RULE 16
USE OF DISTRICT RIGHT OF WAY

No trees, vines, or alfalfa shall be planted on the right of way of any District canal and all such crops growing on such right of way shall belong absolutely to the District. Permission, however, may be granted by the Board of Directors, under such restriction as they may deem expedient, to raise annual crops thereon.

RULE 17

LIABILITY OF DISTRICT

The District will not be liable for any damage resulting directly or indirectly from any private ditch or the water flowing therein; but its responsibility shall absolutely cease when the water is turned therein according to these rules and regulations.

RULE 18

LIABILITY OF IRRIGATORS

Every consumer of water shall be responsible to the District for all damages caused by his wilful neglect or careless acts, and upon his failure to repair such damage after notification by the ditch-tender, such repairs shall be made at his expense by the District.

RULE 19

LIABILITY OF PERSONS INTERFERING WITH THE REGULATIONS OF WATER OR TAKING WATER OUT OF TURN

Section 592 of the Penal Code of California is as follows:

"WATER-DITCHES, ETC., PENALTY FOR TRESPASS OR INTERFERENCE WITH. Every person who shall, without authority of the owner or managing agent, and with intent to defraud, take water from any canal, ditch, flume or reservoir used for the purpose of holding or conveying water for manufacturing, agricultural, mining, irrigating or generation of power, or domestic uses, or who shall without like authority, raise, lower or otherwise disturb any gate or other appartus thereof, used for the control or measurement of water, or who shall empty or place, or cause to be emptied or placed, into any such canal, ditch, flume or reservoir, any rubbish, filth or obstruction to the free flow of the water, is guilty of a misdemeanor."

Under such statute persons interfering with the regulation of water in the canals and ditches are subject to prosecution.

RULE 20

BUILDING DIVERTING GATES AND WEIRS

No openings shall be made or structures placed in any District canal without the special permission of the Superintendent. All structures in the District canals must be constructed according to requirements of the District, and must be maintained in a condition satisfactory to the Superintendent, and must not be changed without the permission of the Superintendent.

RULE 21

OBSTRUCTIONS ON RIGHT OF WAY

No fences or other obstruction shall be placed across or upon or along any canal bank or right of way belonging to the District without the special permission of the Board of Directors. Whenever such permission shall be granted it shall always be with the distinct understanding that proper openings or passage ways for equipment shall be provided, and that such fence or obstruction must be removed whenever requested by the Superintendent.

RULE 22
ENFORCEMENT OF RULES

Refusal to comply with the requirements hereof, or transgression of any of the foregoing rules and regulations, or any interference with the discharge of the duties of any official, shall be sufficient cause for shutting off the water, and water will not again be furnished until full compliance has been made with all requirements herein set forth.

Attachment C

moving water in new directions
IRRIGATION TRAINING & RESEARCH CENTER
California Polytechnic State University
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Practical Guide for Metergates

by
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September 2014

Background

This document contains brief instructions on the use of special round canal gates called "metergates" for flow measurement. A metergate differs from a traditional canal gate turnout because it has a hole in the top of the pipe attached to a stilling well downstream of the gate so that the downstream water level can be measured.

Metergates have been used since the early 1900's for flow measurement in addition to on-off control. Recent research conducted by the authors at the Irrigation Training and Research Center has shown that the existing tables for "Armco"-type metergates, published after the 1950's, provide good accuracy for flow measurement (if measurements are made correctly).

Armco-type metergates include round gates from Fresno Valve and Casting (101), Waterman (C-10), and X-CAD (model unknown) gates. In order to properly use these gates, a hole (5/8 to 3/4 inch in diameter) must be drilled in the pipe 12 inches downstream of the back face of the gate (or at the top of a corrugation as close to 12 inches as possible). This hole must be attached to a stilling well at least 6 inches in diameter that protrudes up to the elevation of the top of the gate frame.

Figure 1 shows a common metergate design drawing.

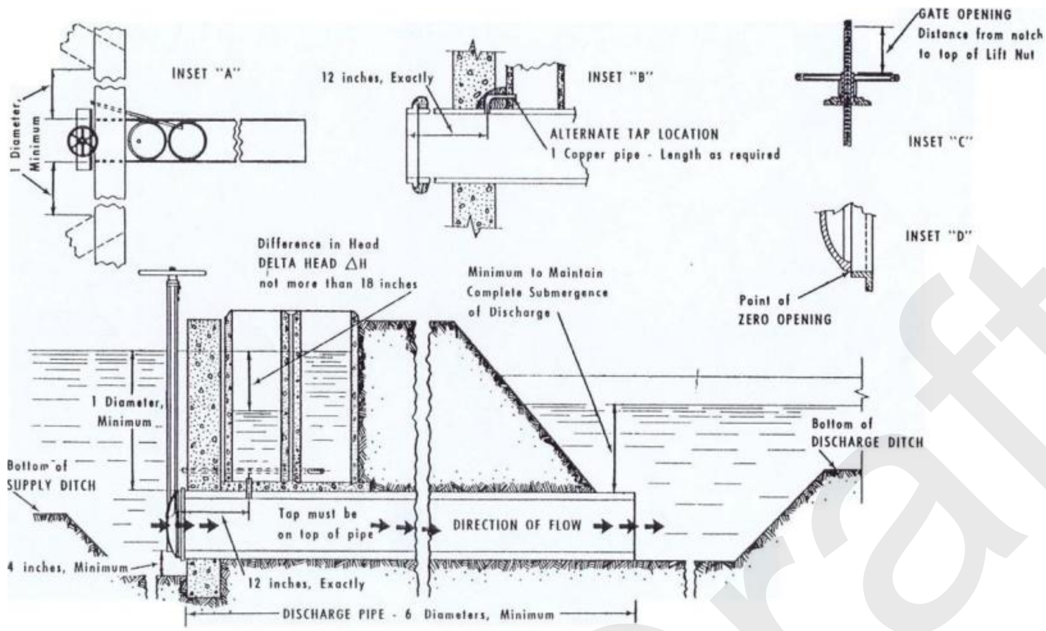

Figure 1. Metergate drawing used by various manufacturers, USBR, etc.

ITRC Research

ITRC evaluated the calibration of a variety of Armco-type round and square gates to determine if published "metergate" calibration tables are accurate. These gates were installed at the ITRC gate calibration facility (**Figure 2**). The gate calibration facility is set up so that the turnout gate is perpendicular to the main supply channel flow, which is typical in field installations.

Figure 2. ITRC gate calibration facility

Summary of ITRC Research Results

1) A high level of accuracy (+/-5%) was found if all of the following conditions are met:
    a. Gate opening range: 20% < Gate Opening < 75%
    b. Upstream submergence > 0.5D (where D is the gate diameter)
    c. Stilling well location was 4" to 12" downstream of the face of the gate
2) The distance downstream of the gate at which the stilling well is located (as long as it is within the 4" to 12" range) does not have a significant effect on the flow rate obtained using the tables **unless** the gate is **open** more than 70-75% (percent of fully open).

3) The preliminary evaluation of tangential supply channel flow velocity did not seem to have a significant impact on the flow through the turnout gates. Supply channel velocities up to 1.9 feet per second (fps) were examined in this evaluation.
4) Higher uncertainty (error) occurred at smaller gate openings.
5) Optimum range of operation for the highest accuracy was an opening between 20% and 75% under most conditions. Smaller gate openings seemed to be more problematic than larger gate openings.
6) One issue that is not discussed here but was apparent was the submergence (water level) in the supply canal above the turnout pipeline. Care should be taken to ensure that the water level upstream of the top of the turnout pipe remains above (0.5 × gate diameter). The USBR standard is (1 × gate diameter).

Correction for Stilling Well 4" from Gate

Standard flow tables are based on a stilling well located 12" downstream of the back of the gate. Stilling well measurements were made at multiple locations downstream of the gate to analyze the effects of stilling well location. It was found that, at gate openings less than 70% open, there was **minimal** impact on the change in head from any stilling well closer than 12" to the gate. Once the gate reached an opening of 70% or greater, the ΔH measurement measured at the closer stilling wells (e.g., at 4") began to vary depending on gate size resulting in more significant error.

On average, at gate openings above 75%, the flow rate for a 4" stilling well was 8%-10% greater than the value shown on a 12" stilling well-based table. This adjustment could be applied in the case where gates must be opened more than 75%.

Practical Details

Figure 3 shows the recommended configuration for a metergate. There are some significant differences between **Figures 1** and **3**. With metergates, "the devil is in the details". These are discussed on the next few pages.

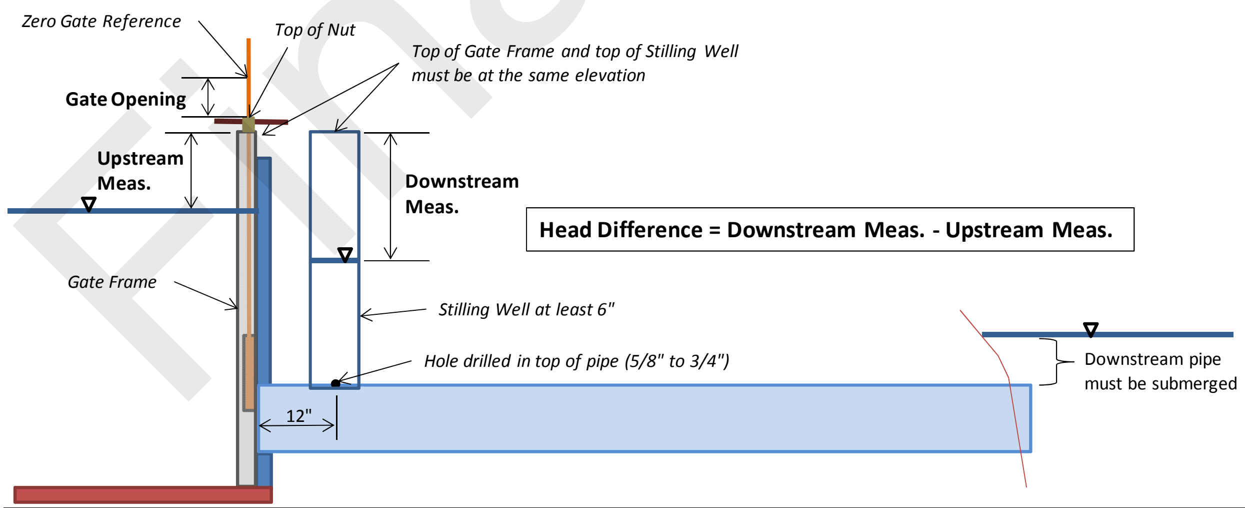

Figure 3. ITRC recommendation for proper metergate installation

Practical Detail #1 – The pipe downstream of the metergate needs to be full. The water level needs to rise to some measurable level in the downstream stilling well.

Practical Detail #2 – Sufficient upstream submergence is needed. The required water level in the canal, <u>above the top of the pipe</u>, must be at least ½ of the gate (or pipe) diameter. In other words, if there is a 12" pipe, the water level in the supply canal needs to be at least 6" above the top of the pipe.

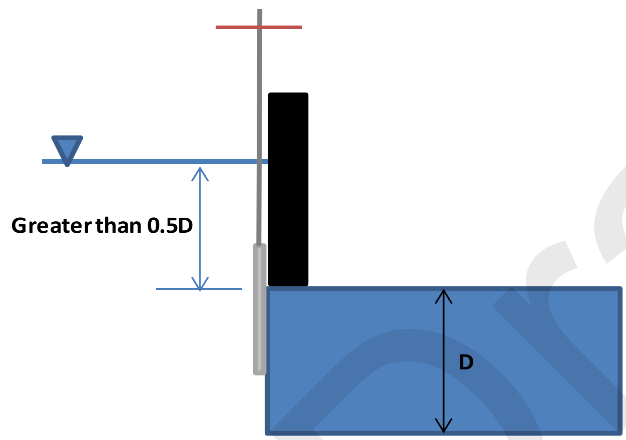

Figure 4. Recommended upstream submergence above the gate to ensure accurate flow measurement

Practical Detail #3 – All of the calibration charts require knowledge of the **<u>gate opening</u>**, as measured by the shaft opening. The "zero" gate opening must be properly determined and marked on the gate shaft. This is not a trivial detail. Specific points are:

1. All measurements of gate opening, as well as the initial marking, must be made after the gate stem has been lifted (opened). This is because there is some "slop" or movement between the shaft and the gate itself.
2. The gate stem will move up some distance before the gate plate itself reaches the bottom of the pipe. The charts depend on knowing the gate <u>opening</u>, not the movement from the gate seating position. The gate must be closed beyond the bottom of the pipe to seal off completely. That sealed position is <u>not</u> the "zero" position.
3. There must be some specific way to measure the shaft position when the bottom of the gate just barely clears the bottom of the pipe – in other words, when there is a "zero opening". This is fairly easy to set and measure if the canal is full. The gate is opened until a narrow strip of paper can be inserted into the crack. **Figure 5** shows photos taken at San Luis Canal Company of a customized tool that is used to detect the actual gate opening, but a similar device can be used to detect the initial "cracking (zero) open" position..

Figure 5. Special tool to detect actual gate opening.

4. The shaft needs to be marked in a clear manner so that operators know where the "zero" opening is for the gate when they open the gate. **Figure 6** shows a properly cut notch. It has a sharp bottom edge that was cut with a grinding wheel so that the bottom of the cut is at the same elevation as the top of the bushing. Notice from the color on the shaft that the shaft can be lowered from this position to properly seat the gate.

   The operator will measure from the bottom of cut to the top of the bushing, when the gate is open, to determine the gate opening. This is always measured after an "uplift" action.

Practical Detail #4 – The stilling well needs to have sufficient diameter to dampen the turbulence, and so that operators can see into it. ITRC recommends a stilling well of 6" – 8" diameter, with an access hole of about 5/8" or 3/4" diameter.

Figure 6. Proper cut in shaft to mark the "zero" opening

Figure 7. Stilling well is located the correct distance downstream of the gate, but is so small that there will be tremendous surging (up/down movement), and operators cannot see the water surface

Practical Detail #5 – The stilling well does not need to be centered over the access hole in the top of the discharge pipe. In general, it is good to have the stilling well close to the gate frame/bulkhead, so that it can be supported.

Practical Detail #6 – Make it easy to measure the difference in head (between the water level in the canal, and the water level in the stilling well). In other words, use the same datum (elevation) for both measurements. **Figure 8** shows a stilling well with the top correctly placed at the same elevation as the gate frame, and with a proper diameter. **The top of the stilling well should be at the same elevation as the top of the gate frame (where the bottom of the nut rests).** Then the upstream measurement should be taken from the top of the gate frame to the water level. The downstream measurement should be taken from the top of the stilling well to the water level. The head difference is the difference between the upstream and downstream water levels.

Figure 8. Stilling well installed on an existing discharge pipe. It is constructed of PVC pipe that is too thin for long life, but it serves as an example of the correct diameter, position, and height.

Figure 9. An old type of dual-stilling well commonly found in Central California irrigation districts. One stilling well was connected to the canal, and the second was directly over the discharge pipe. The idea of measuring down into both stilling wells from the same center point was good, but the top of the stilling well was so close to the ground surface that road maintenance quickly filled these stilling wells with dirt. Also, the side connection between the canal stilling well and the canal itself was too difficult to clean.

Figure 10. This stilling well is properly located, but it has too small a diameter. The operator also needs to know the elevation difference between the top of the stilling well and the gate frame, which requires an extra computation to determine the difference in head across the gate.

Figure 11. Correct height of stilling well to match top of gate frame. However, the diameter is too small. Steel pipe material is good

Figure 12. Large diameter stilling well, with cover to minimize having it fill with dirt from the road. Strong concrete, with the rim of the stilling well at the same elevation as the bulkhead top.

The tables on the next few pages show the key measurements needed to properly use a metergate. The gate opening should be measured from the top of the gate opening nut to a zero gate opening reference. **As mentioned previously, the zero gate opening reference should be marked with a grinder at the gate opening nut on the shaft when the gate is just open enough to breach the bottom of the pipe.**

Metergate Tables

12-inch Gate

Head Difference (feet)	Net Gate Opening (feet)										
	0.17	**0.25**	**0.33**	**0.42**	**0.50**	**0.58**	**0.67**	**0.75**	**0.83**	**0.92**	**1.00**
	Discharge (cfs)										
0.08	0.36	0.53	0.67	0.80	0.93	1.06	1.15	1.27	1.37	1.38	1.40
0.10	0.40	0.58	0.74	0.89	1.03	1.17	1.29	1.41	1.50	1.55	1.57
0.13	0.44	0.63	0.81	0.97	1.12	1.28	1.41	1.54	1.64	1.70	1.73
0.15	0.47	0.68	0.87	1.04	1.21	1.38	1.52	1.66	1.77	1.83	1.86
0.17	0.50	0.73	0.93	1.10	1.29	1.47	1.62	1.77	1.89	1.96	1.99
0.19	0.53	0.78	0.98	1.16	1.36	1.55	1.71	1.87	2.00	2.08	2.12
0.21	0.56	0.82	1.03	1.22	1.43	1.63	1.80	1.97	2.11	2.20	2.23
0.23	0.59	0.85	1.08	1.28	1.49	1.70	1.88	2.06	2.21	2.31	2.34
0.25	0.61	0.88	1.12	1.34	1.55	1.77	1.96	2.14	2.31	2.41	2.45
0.27	0.63	0.91	1.16	1.39	1.61	1.84	2.04	2.22	2.40	2.50	2.55
0.29	0.65	0.94	1.20	1.44	1.67	1.91	2.12	2.30	2.49	2.59	2.65
0.31	0.67	0.97	1.23	1.49	1.73	1.98	2.19	2.38	2.57	2.68	2.74
0.33	0.69	1.00	1.27	1.54	1.79	2.04	2.26	2.46	2.65	2.77	2.83
0.35	0.71	1.03	1.31	1.59	1.85	2.10	2.33	2.54	2.73	2.86	2.92
0.38	0.73	1.06	1.35	1.64	1.90	2.16	2.40	2.62	2.81	2.94	3.01
0.40	0.75	1.09	1.39	1.68	1.95	2.22	2.47	2.69	2.89	3.02	3.10
0.42	0.77	1.12	1.42	1.72	2.00	2.28	2.54	2.76	2.96	3.10	3.19
0.46	0.80	1.17	1.49	1.80	2.10	2.39	2.66	2.89	3.10	3.24	3.34
0.50	0.83	1.22	1.56	1.88	2.19	2.50	2.78	3.02	3.24	3.38	3.48
0.54	0.86	1.27	1.62	1.96	2.28	2.60	2.89	3.14	3.37	3.52	3.62
0.58	0.89	1.31	1.68	2.04	2.36	2.70	3.00	3.26	3.50	3.65	3.76
0.63	0.92	1.35	1.74	2.11	2.44	2.79	3.10	3.38	3.62	3.78	3.89
0.67	0.95	1.39	1.80	2.18	2.52	2.88	3.20	3.49	3.74	3.90	4.02
0.71	0.98	1.43	1.86	2.25	2.60	2.97	3.30	3.60	3.85	4.02	4.14
0.75	1.01	1.47	1.91	2.31	2.68	3.06	3.40	3.70	3.96	4.14	4.26
0.79	1.04	1.51	1.96	2.37	2.75	3.14	3.50	3.80	4.07	4.25	4.38
0.83	1.07	1.55	2.01	2.43	2.82	3.22	3.59	3.90	4.18	4.36	4.49
0.92	1.12	1.63	2.11	2.55	2.96	3.38	3.76	4.09	4.38	4.57	4.70
1.00	1.17	1.70	2.21	2.67	3.10	3.53	3.93	4.27	4.58	4.78	4.92
1.08	1.22	1.77	2.30	2.78	3.22	3.68	4.09	4.45	4.77	4.98	5.12
1.17	1.27	1.84	2.38	2.88	3.34	3.81	4.24	4.61	4.95	5.17	5.31
1.25	1.32	1.90	2.46	2.98	3.46	3.94	4.39	4.77	5.12	5.35	5.49
1.33	1.36	1.96	2.54	3.08	3.57	4.07	4.53	4.93	5.29	5.52	5.67
1.42	1.40	2.02	2.62	3.17	3.68	4.20	4.67	5.08	5.45	5.69	5.85
1.50	1.44	2.08	2.70	3.26	3.79	4.33	4.81	5.23	5.61	5.85	6.02

Metergate Tables

15-inch Gate

Head Difference (feet)	Net Gate Opening (feet)																	
	0.17	**0.21**	**0.25**	**0.29**	**0.33**	**0.38**	**0.42**	**0.46**	**0.50**	**0.58**	**0.67**	**0.75**	**0.83**	**0.92**	**1.00**	**1.08**	**1.17**	**1.25**
	Discharge (cfs)																	
0.08	0.46	0.57	0.66	0.75	0.83	0.91	0.98	1.07	1.14	1.30	1.43	1.58	1.71	1.84	1.94	2.04	2.13	2.18
0.10	0.51	0.62	0.73	0.83	0.92	1.02	1.09	1.19	1.27	1.44	1.59	1.75	1.90	2.05	2.17	2.29	2.38	2.43
0.13	0.55	0.67	0.79	0.91	1.00	1.11	1.19	1.30	1.38	1.57	1.74	1.91	2.08	2.24	2.38	2.51	2.62	2.67
0.15	0.59	0.72	0.85	0.98	1.08	1.19	1.28	1.39	1.49	1.68	1.87	2.06	2.24	2.41	2.57	2.72	2.83	2.90
0.17	0.63	0.77	0.90	1.04	1.15	1.27	1.37	1.48	1.59	1.79	1.99	2.20	2.39	2.58	2.75	2.90	3.03	3.09
0.19	0.67	0.81	0.95	1.10	1.22	1.34	1.45	1.57	1.48	1.89	2.11	2.33	2.54	2.73	2.91	3.07	3.22	3.28
0.21	0.70	0.85	1.00	1.15	1.28	1.41	1.53	1.65	1.76	1.99	2.22	2.45	2.68	2.87	3.07	3.24	3.40	3.46
0.23	0.73	0.89	1.05	1.20	1.33	1.48	1.60	1.73	1.84	2.09	2.33	2.57	2.81	3.01	3.21	3.40	3.57	6.64
0.25	0.76	3.93	1.09	1.25	1.38	1.54	1.67	1.80	1.92	2.18	2.43	2.69	2.93	3.14	3.35	3.54	3.73	3.81
0.27	0.79	0.97	1.13	1.29	1.43	1.60	1.73	1.87	2.00	2.27	2.53	2.80	3.05	3.27	3.49	3.68	3.88	3.97
0.29	0.82	1.00	1.17	1.33	1.48	1.65	1.79	1.94	2.08	2.36	2.63	2.90	3.17	3.39	3.62	3.82	4.01	4.11
0.31	0.85	1.03	1.21	1.37	1.53	1.70	1.85	2.01	2.15	2.44	2.72	3.00	3.28	3.51	3.75	3.96	4.14	4.25
0.33	0.88	1.06	1.25	1.41	1.58	1.75	1.91	2.07	1.22	2.52	2.81	3.10	3.39	3.63	3.87	4.09	4.27	4.39
0.35	0.91	1.09	1.29	1.45	1.63	1.80	1.97	2.13	2.29	2.60	2.90	3.20	3.49	3.74	3.99	4.21	4.40	4.53
0.38	0.93	1.12	1.32	1.49	1.68	1.85	2.03	2.19	2.36	2.68	2.98	3.29	3.59	3.85	4.10	4.33	4.53	4.67
0.40	0.95	1.15	1.35	1.53	1.73	1.90	2.09	2.25	2.42	2.75	3.06	3.38	3.69	3.96	4.21	4.45	4.65	4.80
0.42	0.97	1.18	1.38	1.57	1.77	1.95	2.14	2.31	2.48	2.82	3.14	3.47	3.79	4.06	2.32	4.57	4.77	4.92
0.46	1.01	1.23	1.44	1.64	1.85	2.05	2.24	2.43	2.60	2.96	3.30	3.63	3.97	4.26	4.54	4.79	5.00	5.14
0.50	1.05	1.28	1.50	1.71	1.93	2.14	2.34	2.54	2.72	3.09	3.44	3.79	4.15	4.44	4.74	5.00	5.22	5.36
0.54	1.09	1.33	1.56	1.78	2.01	2.23	2.44	2.64	2.83	3.22	3.58	3.95	4.32	4.62	4.93	5.20	5.43	5.58
0.58	1.13	1.38	1.62	1.85	2.09	2.31	2.53	2.74	2.93	3.34	3.72	4.10	4.48	4.79	5.11	5.40	5.64	5.79
0.63	1.17	1.42	1.68	1.92	2.16	2.39	2.62	2.84	3.03	3.46	2.85	4.25	4.64	4.96	5.29	5.59	5.84	5.99
0.67	1.21	1.46	1.73	1.98	2.23	2.47	2.71	2.93	3.13	3.57	2.98	4.39	4.79	5.13	5.47	5.78	6.03	6.19
0.71	1.24	1.50	1.78	2.04	2.30	2.55	2.79	3.02	3.23	3.68	4.10	4.52	4.93	5.29	5.64	5.95	6.22	6.38
0.75	1.27	1.54	1.83	2.10	2.37	2.62	2.87	3.11	3.33	3.79	4.22	4.65	5.07	5.44	5.80	6.12	6.40	6.56
0.79	1.30	1.58	1.88	2.16	2.43	2.69	2.95	3.19	3.42	3.89	4.34	4.78	5.21	5.59	5.96	6.29	6.58	6.74
0.83	1.33	1.62	1.93	2.22	2.49	2.76	3.03	3.27	3.51	3.99	4.45	4.91	5.35	5.73	6.11	6.46	6.75	6.92
0.92	1.39	1.70	2.03	2.32	2.61	2.90	3.17	3.43	3.68	4.18	4.66	5.14	5.61	6.01	6.41	6.77	7.07	7.26
1.00	1.45	1.78	2.12	2.42	2.73	3.03	3.31	3.59	3.84	4.37	4.87	5.37	5.86	6.29	6.70	7.07	7.39	7.59
1.08	1.50	1.85	2.21	2.52	2.84	3.15	3.45	3.73	4.00	4.55	5.07	5.59	6.10	6.54	6.97	7.36	7.69	7.89
1.17	1.55	1.92	2.29	2.62	2.95	2.37	3.58	3.87	4.15	4.72	5.26	5.80	6.34	6.79	7.24	7.64	7.98	8.19
1.25	1.60	1.99	2.37	2.71	3.05	3.38	3.70	4.01	4.30	4.88	5.44	6.00	6.56	7.03	7.49	7.91	8.26	8.47
1.33	1.65	2.05	2.45	2.80	3.15	3.49	3.82	4.14	4.44	5.04	5.62	6.20	6.77	7.26	7.73	8.17	8.53	8.75
1.42	1.70	2.11	2.52	2.89	3.25	3.60	3.94	4.27	4.57	5.20	5.80	6.39	6.98	7.48	7.97	8.42	8.80	9.02
1.50	1.75	2.17	2.59	2.97	3.34	3.70	4.05	4.39	4.70	5.35	5.96	6.58	7.18	7.69	8.20	8.66	9.05	9.28

Metergate Tables

18-inch Gate

Head Difference (feet)	Net Gate Opening (feet)																				
	0.17	**0.21**	**0.25**	**0.29**	**0.33**	**0.38**	**0.42**	**0.46**	**0.50**	**0.58**	**0.67**	**0.75**	**0.83**	**0.92**	**1.00**	**1.08**	**1.17**	**1.25**	**1.33**	**1.42**	**1.50**
	Discharge (cfs)																				
0.08	0.54	0.66	0.77	0.89	0.99	1.10	1.20	1.30	1.38	1.56	1.73	1.90	2.07	2.25	2.39	2.54	2.71	2.84	2.96	3.07	3.14
0.10	0.60	0.73	0.86	0.98	1.09	1.22	1.32	1.43	1.54	1.73	1.92	2.11	2.30	2.50	2.66	2.84	3.02	3.16	3.31	3.44	3.52
0.13	0.65	0.80	0.94	1.07	1.19	1.33	1.44	1.56	1.67	1.89	2.10	2.30	2.51	2.72	2.89	3.10	3.31	3.47	3.62	3.75	3.85
0.15	0.70	0.86	1.01	1.15	1.28	1.43	1.56	1.68	1.80	2.02	2.26	2.48	2.70	2.92	3.12	3.34	3.56	3.74	3.90	4.05	4.15
0.17	0.75	0.92	1.07	1.22	1.37	1.52	1.66	1.79	1.92	2.16	2.41	2.65	2.88	3.12	3.35	3.55	3.79	3.99	4.17	4.33	4.43
0.19	0.79	0.97	1.13	1.29	1.45	1.60	1.75	1.90	2.03	2.29	2.55	2.81	3.06	3.31	3.54	3.77	4.01	4.21	4.41	4.61	4.70
0.21	0.83	1.02	1.18	1.36	1.52	1.68	1.84	2.00	2.13	2.41	2.69	2.96	3.23	3.49	3.73	3.97	4.21	4.43	4.63	4.84	4.97
0.23	0.87	1.06	1.24	1.42	1.59	1.76	1.93	2.09	2.23	2.52	2.82	3.11	3.39	3.66	3.91	4.16	4.41	4.64	4.85	5.06	5.22
0.25	0.90	1.10	1.29	1.48	1.66	1.84	2.01	2.17	2.32	2.63	2.95	3.25	3.54	3.82	4.08	4.35	4.61	4.84	5.07	5.27	5.44
0.27	0.93	1.15	1.34	1.54	1.72	1.91	2.09	2.26	2.41	2.74	3.07	3.38	3.68	3.97	4.25	4.53	4.79	5.04	5.28	5.49	5.66
0.29	0.96	1.19	1.39	1.59	1.78	1.98	2.17	2.35	2.50	2.85	3.18	3.51	3.82	4.12	4.41	4.70	4.97	5.23	5.47	5.70	5.86
0.31	0.99	1.23	1.43	1.64	1.84	2.05	2.24	1.43	2.59	2.95	3.29	3.63	3.95	4.27	4.56	4.86	5.15	5.41	5.66	5.90	6.06
0.33	1.02	1.27	1.48	1.69	1.90	2.11	2.31	2.51	2.68	3.04	3.40	3.75	4.08	4.41	4.71	5.02	5.32	5.59	5.85	6.09	6.26
0.35	1.05	1.30	1.52	1.74	1.95	2.17	2.38	2.59	2.76	3.14	3.51	3.87	4.21	4.54	4.86	5.18	5.48	5.76	6.04	6.28	6.46
0.38	1.08	1.33	1.56	1.79	2.01	2.23	2.45	2.66	2.84	3.23	3.61	3.98	4.33	4.67	5.00	5.33	5.64	5.93	6.21	6.46	6.65
0.40	1.11	1.37	1.60	1.83	2.07	2.29	2.52	2.73	2.92	3.32	3.71	4.09	4.45	4.81	5.14	5.47	5.80	6.09	6.38	6.64	6.83
0.42	1.14	1.40	1.64	1.88	2.13	2.35	2.59	2.80	2.99	3.40	3.80	4.19	4.56	4.93	5.26	5.61	5.95	6.26	6.55	6.81	7.00
0.46	1.19	1.47	1.72	1.97	2.23	2.46	2.71	2.94	3.14	3.57	3.99	1.40	4.79	5.16	5.52	5.89	6.24	6.56	6.86	7.15	7.35
0.50	1.24	1.53	1.78	2.05	2.33	2.57	2.83	3.07	3.28	3.73	4.17	4.59	5.00	5.40	5.77	6.15	6.51	6.85	7.17	7.46	7.67
0.54	1.28	1.60	1.85	2.13	2.43	2.68	2.95	3.20	3.42	3.88	4.34	4.78	5.21	5.62	6.01	6.41	6.78	7.13	7.46	7.77	7.99
0.58	1.33	1.64	1.92	2.21	2.52	2.78	3.06	3.32	3.55	4.02	4.50	4.96	5.40	5.83	6.24	6.65	7.04	7.40	7.74	8.06	8.29
0.63	1.37	1.68	1.98	2.29	2.61	2.88	3.17	3.44	3.67	4.16	4.66	5.14	5.59	6.04	6.45	6.88	7.28	7.66	8.01	8.35	8.58
0.67	1.41	1.74	2.04	2.37	2.69	2.97	3.27	3.55	3.79	4.30	4.81	5.31	5.77	6.24	6.66	7.10	7.52	7.91	8.28	8.61	8.86
0.71	1.45	1.79	2.10	2.44	2.78	3.06	3.37	3.66	3.91	4.44	4.96	5.47	5.95	6.43	6.86	7.32	7.75	8.15	8.54	8.88	9.13
0.75	1.49	1.84	2.16	2.51	2.86	3.15	3.47	3.76	4.02	4.56	5.10	5.63	6.12	6.61	7.06	7.54	7.98	8.39	8.78	9.14	9.40
0.79	1.54	1.89	2.22	2.58	2.94	3.24	3.57	3.87	4.13	4.69	5.24	5.79	6.30	6.80	7.26	7.74	8.20	8.62	9.02	9.39	9.66
0.83	1.59	1.93	2.28	2.65	3.02	3.32	3.66	3.97	4.24	4.81	5.38	5.94	6.46	6.98	7.46	7.95	8.41	8.85	9.26	9.64	9.91
0.92	1.65	2.03	2.39	2.78	3.16	3.48	3.83	4.16	4.44	5.04	5.64	6.22	6.77	7.31	7.81	8.33	8.82	9.27	9.70	10.10	10.38
1.00	1.71	2.12	2.50	2.90	3.30	3.64	4.00	4.34	4.64	5.26	5.89	6.50	7.07	7.64	8.16	8.70	9.21	9.69	10.13	10.55	10.84
1.08	1.77	2.20	2.60	3.02	3.43	3.79	4.16	4.52	4.83	5.48	6.13	6.76	7.36	7.95	8.50	9.05	9.59	10.09	10.55	10.98	11.28
1.17	1.83	2.28	2.70	3.13	3.56	3.93	4.32	4.69	5.01	5.69	6.36	7.02	7.64	8.25	8.81	9.40	9.95	10.47	10.95	11.40	11.72
1.25	1.89	2.36	2.80	3.24	3.69	4.07	4.48	4.86	5.19	5.89	6.58	7.26	7.91	8.54	9.12	9.72	10.30	10.82	11.32	11.80	12.12
1.33	1.95	2.44	2.89	3.35	3.81	4.20	4.62	5.01	5.36	6.08	6.80	7.50	8.16	8.82	9.42	10.04	10.63	11.18	11.70	12.18	12.52
1.42	2.01	2.52	2.98	3.45	3.93	4.33	4.76	5.16	5.52	6.27	7.01	7.73	8.41	9.09	9.71	10.36	10.96	11.52	12.07	12.56	12.92
1.50	2.07	2.59	3.06	3.55	4.04	4.46	4.90	5.32	5.69	6.45	7.22	7.96	8.66	9.35	10.00	10.65	11.28	11.87	12.42	12.92	13.28

Metergate Tables

24-inch Gate

Head Difference (feet)	Net Gate Opening (feet)																											
	0.17	**0.21**	**0.25**	**0.29**	**0.33**	**0.38**	**0.42**	**0.46**	**0.50**	**0.58**	**0.67**	**0.75**	**0.83**	**0.92**	**1.00**	**1.08**	**1.17**	**1.25**	**1.33**	**1.42**	**1.50**	**1.58**	**1.67**	**1.75**	**1.83**	**1.92**	**2.00**
	Discharge (cfs)																										
0.08	0.70	0.86	1.03	1.18	1.32	1.47	1.60	1.75	1.88	2.12	2.36	2.60	2.83	3.05	3.27	3.48	3.71	3.94	4.14	4.33	4.51	4.68	4.83	4.98	5.11	5.19	5.25
0.10	0.77	0.95	1.13	1.30	1.46	1.63	1.78	1.94	2.09	2.35	2.62	2.89	3.14	3.39	3.64	3.88	4.14	4.38	4.60	4.80	5.00	5.20	5.36	5.53	5.68	5.77	5.85
0.13	0.83	1.04	1.23	1.41	1.59	1.78	1.94	2.11	2.28	2.57	2.85	3.14	3.42	3.71	3.98	4.23	4.52	4.76	5.02	5.23	5.44	5.65	5.84	6.04	6.21	6.31	6.40
0.15	0.89	1.12	1.32	1.52	1.71	1.92	2.09	2.27	2.45	2.77	3.07	3.38	3.69	3.99	4.29	4.56	4.86	5.12	5.40	5.62	5.85	6.07	6.28	6.50	6.68	6.79	6.90
0.17	0.95	1.19	1.40	1.62	1.82	2.04	2.23	2.42	2.61	2.96	3.28	3.61	3.94	4.25	4.58	4.86	5.18	5.45	5.74	5.99	6.24	6.47	6.70	6.93	7.13	7.25	7.37
0.19	1.00	1.26	1.48	1.72	1.93	2.16	2.36	2.56	2.76	3.13	3.48	3.83	4.17	4.50	4.85	5.16	5.49	5.78	6.08	6.35	6.61	6.85	7.10	7.34	7.56	7.69	7.82
0.21	1.05	1.32	1.56	1.81	2.03	2.27	2.48	2.69	2.89	3.29	3.67	4.04	4.40	4.75	5.11	5.44	5.79	6.10	6.41	6.70	6.97	7.22	7.48	7.73	7.96	8.09	8.24
0.23	1.10	1.38	1.63	1.89	2.13	2.37	2.59	2.81	3.02	3.44	3.85	4.24	4.61	7.98	5.36	5.71	6.07	6.40	6.73	7.03	7.31	7.57	7.85	8.10	8.34	8.48	8.64
0.25	1.15	1.44	1.70	1.97	2.22	2.47	2.70	2.93	3.15	3.59	4.02	4.43	4.82	5.20	5.60	5.96	6.34	6.68	7.03	7.34	7.64	7.91	8.20	8.45	8.70	8.84	9.02
0.27	1.20	1.49	1.77	2.04	2.30	2.57	2.80	3.04	3.28	3.74	4.19	4.61	5.02	5.41	5.83	6.21	6.60	6.95	7.31	7.64	7.95	8.23	8.53	8.80	9.06	9.20	9.38
0.29	1.24	1.54	1.83	2.11	2.38	2.66	2.90	3.15	3.40	3.88	4.34	4.78	5.20	5.61	6.04	6.44	6.84	7.21	7.58	7.92	8.25	8.54	8.85	9.13	9.40	9.55	9.74
0.31	1.28	1.59	1.89	2.18	2.46	2.74	3.00	3.26	3.52	4.01	4.49	4.95	5.38	5.81	6.25	6.66	7.08	7.47	7.85	8.20	8.54	8.84	9.16	9.45	9.73	9.88	10.07
0.33	1.32	1.64	1.95	2.25	2.54	2.82	3.10	3.36	3.64	4.14	4.64	5.11	5.56	6.00	6.46	6.88	7.32	7.71	8.11	8.47	8.82	9.13	9.46	9.76	10.04	10.21	10.40
0.35	1.36	1.69	2.01	2.32	2.61	2.90	3.19	3.46	3.75	4.27	4.78	5.27	5.73	6.19	6.66	7.09	7.55	7.95	8.36	8.73	9.09	9.41	9.75	10.06	10.35	10.53	10.73
0.38	1.40	1.74	2.06	2.39	2.68	2.98	3.28	3.56	3.86	4.40	4.92	5.42	5.90	6.37	6.85	7.30	7.76	8.18	8.60	8.99	9.35	9.69	10.03	10.35	10.65	10.83	11.05
0.40	1.44	1.79	2.11	2.45	2.75	3.06	3.37	3.66	3.97	4.52	5.06	5.57	6.06	6.55	7.04	7.50	7.97	8.40	8.84	9.24	9.60	9.95	10.30	10.63	10.94	11.13	11.35
0.42	1.47	1.84	2.16	2.51	2.82	3.14	3.46	3.76	4.07	4.62	5.19	5.72	6.22	6.72	7.23	7.70	8.18	8.62	9.07	9.48	9.85	10.21	10.57	10.91	11.23	11.42	11.65
0.46	1.53	1.92	2.26	2.62	2.95	3.29	3.62	3.94	4.26	4.86	5.44	6.00	6.52	7.04	7.58	8.07	8.58	9.04	9.51	9.94	10.33	10.71	11.10	11.45	11.78	11.98	12.22
0.50	1.59	2.00	2.36	2.73	3.08	3.44	3.78	4.11	4.45	5.07	5.68	6.26	6.81	7.35	7.91	8.43	8.96	9.44	9.93	10.38	10.80	11.19	11.59	11.95	12.30	12.51	12.76
0.54	1.65	2.08	2.45	2.83	3.20	3.58	3.94	4.28	4.64	5.28	5.92	6.52	7.09	7.65	8.24	8.77	9.33	9.83	10.34	10.80	11.24	11.64	12.06	12.44	12.81	13.02	13.28
0.58	1.71	2.15	2.54	2.93	3.32	3.71	4.09	4.44	4.82	5.48	6.14	6.76	7.36	7.95	8.55	9.10	9.68	10.20	10.73	11.21	11.67	12.09	12.52	12.92	13.30	13.52	13.79
0.63	1.77	2.22	2.62	3.03	3.44	3.84	4.23	4.60	4.99	5.68	6.36	7.00	7.62	8.23	8.85	9.43	10.02	10.57	11.11	11.61	12.09	12.52	12.96	13.37	13.78	14.00	14.28
0.67	1.83	2.28	2.70	3.13	3.55	3.97	4.37	4.75	5.15	5.87	6.56	7.23	7.86	8.50	9.13	9.73	10.35	10.92	11.47	11.99	12.48	12.93	13.38	13.80	14.23	14.46	14.74
0.71	1.88	2.34	2.78	3.23	3.66	4.09	4.51	4.90	5.31	6.05	6.76	7.45	8.10	8.76	9.41	10.03	10.67	11.26	11.82	12.35	12.85	13.32	13.79	14.22	14.66	14.90	15.19
0.75	1.93	2.40	2.86	3.32	3.77	4.21	4.64	5.04	5.46	6.22	6.96	7.66	8.34	9.01	9.69	10.33	10.98	11.58	12.17	12.71	13.22	13.71	14.19	14.63	15.08	15.33	15.63
0.79	1.98	2.46	2.94	3.41	3.87	4.33	4.77	5.18	5.61	6.39	7.16	7.87	8.57	9.25	9.96	10.62	11.28	11.89	12.50	13.06	13.58	14.08	14.58	15.03	15.49	15.75	16.07
0.83	2.03	2.52	3.02	3.50	3.97	4.44	4.89	5.31	5.75	6.55	7.34	8.08	8.79	9.49	10.21	10.89	11.58	12.20	12.82	13.40	13.93	14.44	14.95	15.42	15.89	16.15	16.48
0.92	2.12	2.63	3.16	3.67	4.16	4.65	5.12	5.57	6.03	6.86	7.70	8.47	9.21	9.95	10.70	11.41	12.14	12.78	13.44	14.05	14.61	15.13	15.68	16.17	16.65	16.93	17.28
1.00	2.21	2.74	3.30	3.83	4.35	4.86	5.35	5.82	6.30	7.18	8.04	8.85	9.63	10.40	11.19	11.92	12.68	13.35	14.05	14.68	15.28	15.82	16.39	16.90	17.40	17.69	18.05
1.08	2.30	2.85	3.44	3.99	4.53	5.06	5.57	6.06	6.56	7.48	8.37	9.21	10.02	10.83	11.65	12.41	13.20	13.90	14.63	15.28	15.90	16.48	17.06	17.60	18.12	18.42	18.78
1.17	2.38	2.96	3.57	4.14	4.70	5.25	5.78	6.29	6.80	7.76	8.69	9.56	10.40	11.23	12.08	12.88	13.70	14.42	15.18	15.85	16.50	17.10	17.70	18.25	18.80	19.12	19.50
1.25	2.46	3.06	3.69	4.28	4.86	5.43	5.98	6.51	7.04	8.03	8.98	9.90	10.76	11.62	12.50	13.32	14.17	14.92	15.70	16.40	17.07	17.69	18.31	18.90	19.46	19.79	20.20
1.33	2.53	3.16	3.81	4.42	5.02	5.61	6.18	6.73	7.27	8.30	9.29	10.22	11.12	12.01	12.91	13.76	14.64	15.42	16.22	16.94	17.63	18.28	18.92	19.52	20.10	20.45	20.85
1.42	2.60	3.25	3.93	4.56	5.17	5.78	6.37	6.93	7.50	8.55	9.58	10.53	11.47	12.38	13.31	14.19	15.09	15.90	16.71	17.47	18.18	18.84	19.50	20.12	20.71	21.07	21.48
1.50	2.66	3.34	4.04	4.69	5.32	5.95	6.55	7.13	7.72	8.80	9.85	10.83	11.80	12.74	13.70	14.60	15.52	16.37	17.20	17.99	18.70	19.39	20.06	20.70	21.31	21.68	22.10

	ITRC Water Measurement Tables – 18” Armco-Type Gate, Stilling Well Located 12” d/s of Back of Gate [Blue center represents best accuracy range] Net Gate Opening (Inches)																							
ΔH (inches)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	7	8	9	10	11	12	13	14	15	16	17	18
0.5	0.08	0.19	0.29	0.38	0.46	0.54	0.61	0.67	0.74	0.80	0.86	0.92	1.04	1.16	1.29	1.42	1.55	1.68	1.80	1.92	2.02	2.10	2.17	2.21
0.75	0.10	0.23	0.35	0.46	0.56	0.66	0.74	0.82	0.90	0.98	1.05	1.13	1.27	1.42	1.58	1.74	1.90	2.05	2.21	2.35	2.47	2.58	2.66	2.70
1	0.12	0.27	0.40	0.53	0.65	0.76	0.86	0.95	1.04	1.13	1.22	1.30	1.47	1.64	1.82	2.01	2.19	2.37	2.55	2.71	2.85	2.98	3.07	3.12
1.25	0.13	0.30	0.45	0.59	0.73	0.85	0.96	1.06	1.17	1.26	1.36	1.45	1.64	1.84	2.04	2.24	2.45	2.65	2.85	3.03	3.19	3.33	3.43	3.49
1.5	0.15	0.33	0.50	0.65	0.79	0.93	1.05	1.17	1.28	1.38	1.49	1.59	1.80	2.01	2.23	2.46	2.68	2.90	3.12	3.32	3.49	3.64	3.76	3.82
1.75	0.16	0.35	0.53	0.70	0.86	1.00	1.13	1.26	1.38	1.50	1.61	1.72	1.95	2.17	2.41	2.65	2.90	3.14	3.37	3.58	3.77	3.94	4.06	4.13
2	0.17	0.38	0.57	0.75	0.92	1.07	1.21	1.35	1.47	1.60	1.72	1.84	2.08	2.33	2.58	2.84	3.10	3.35	3.60	3.83	4.04	4.21	4.34	4.41
2.25	0.18	0.40	0.61	0.80	0.97	1.14	1.29	1.43	1.56	1.70	1.82	1.95	2.21	2.47	2.73	3.01	3.28	3.56	3.82	4.06	4.28	4.46	4.60	4.68
2.5	0.19	0.42	0.64	0.84	1.03	1.20	1.36	1.51	1.65	1.79	1.92	2.06	2.33	2.60	2.88	3.17	3.46	3.75	4.03	4.28	4.51	4.70	4.85	4.93
2.75	0.20	0.44	0.67	0.88	1.08	1.25	1.42	1.58	1.73	1.87	2.02	2.16	2.44	2.73	3.02	3.33	3.63	3.93	4.22	4.49	4.73	4.93	5.09	5.17
3	0.21	0.46	0.70	0.92	1.12	1.31	1.48	1.65	1.81	1.96	2.11	2.25	2.55	2.85	3.16	3.47	3.79	4.11	4.41	4.69	4.94	5.15	5.32	5.40
3.25	0.22	0.48	0.73	0.96	1.17	1.36	1.55	1.72	1.88	2.04	2.19	2.34	2.65	2.96	3.29	3.62	3.95	4.28	4.59	4.88	5.14	5.36	5.53	5.62
3.5	0.22	0.50	0.76	0.99	1.21	1.42	1.60	1.78	1.95	2.11	2.27	2.43	2.75	3.08	3.41	3.75	4.10	4.44	4.76	5.07	5.34	5.57	5.74	5.84
3.75	0.23	0.52	0.78	1.03	1.26	1.47	1.66	1.84	2.02	2.19	2.35	2.52	2.85	3.18	3.53	3.88	4.24	4.59	4.93	5.25	5.53	5.76	5.94	6.04
4	0.24	0.53	0.81	1.06	1.30	1.51	1.71	1.90	2.09	2.26	2.43	2.60	2.94	3.29	3.65	4.01	4.38	4.74	5.09	5.42	5.71	5.95	6.14	6.24
4.25	0.25	0.55	0.83	1.10	1.34	1.56	1.77	1.96	2.15	2.33	2.51	2.68	3.03	3.39	3.76	4.13	4.51	4.89	5.25	5.58	5.88	6.13	6.33	6.43
4.5	0.25	0.56	0.86	1.13	1.38	1.61	1.82	2.02	2.21	2.40	2.58	2.76	3.12	3.49	3.87	4.25	4.65	5.03	5.40	5.75	6.05	6.31	6.51	6.62
4.75	0.26	0.58	0.88	1.16	1.41	1.65	1.87	2.08	2.27	2.46	2.65	2.83	3.21	3.58	3.97	4.37	4.77	5.17	5.55	5.90	6.22	6.49	6.69	6.80
5	0.27	0.59	0.90	1.19	1.45	1.69	1.92	2.13	2.33	2.53	2.72	2.91	3.29	3.68	4.08	4.48	4.90	5.30	5.69	6.06	6.38	6.65	6.86	6.98
5.5	0.28	0.62	0.95	1.25	1.52	1.77	2.01	2.23	2.45	2.65	2.85	3.05	3.45	3.86	4.27	4.70	5.14	5.56	5.97	6.35	6.69	6.98	7.20	7.32
6	0.29	0.65	0.99	1.30	1.59	1.85	2.10	2.33	2.55	2.77	2.98	3.19	3.60	4.03	4.46	4.91	5.36	5.81	6.24	6.64	6.99	7.29	7.52	7.64
6.5	0.31	0.68	1.03	1.36	1.65	1.93	2.19	2.43	2.66	2.88	3.10	3.32	3.75	4.19	4.65	5.11	5.58	6.05	6.49	6.91	7.28	7.59	7.82	7.95
7	0.32	0.70	1.07	1.41	1.72	2.00	2.27	2.52	2.76	2.99	3.22	3.44	3.89	4.35	4.82	5.31	5.79	6.27	6.74	7.17	7.55	7.87	8.12	8.25
7.5	0.33	0.73	1.11	1.46	1.78	2.07	2.35	2.61	2.86	3.10	3.33	3.56	4.03	4.50	4.99	5.49	6.00	6.50	6.97	7.42	7.81	8.15	8.40	8.54
8	0.34	0.75	1.14	1.50	1.83	2.14	2.42	2.69	2.95	3.20	3.44	3.68	4.16	4.65	5.16	5.67	6.19	6.71	7.20	7.66	8.07	8.42	8.68	8.82
8.5	0.35	0.78	1.18	1.55	1.89	2.21	2.50	2.78	3.04	3.30	3.54	3.79	4.29	4.79	5.31	5.85	6.38	6.91	7.42	7.90	8.32	8.68	8.95	9.09
9	0.36	0.80	1.21	1.60	1.95	2.27	2.57	2.86	3.13	3.39	3.65	3.90	4.41	4.93	5.47	6.02	6.57	7.12	7.64	8.13	8.56	8.93	9.21	9.36
9.5	0.37	0.82	1.25	1.64	2.00	2.33	2.64	2.93	3.21	3.48	3.75	4.01	4.53	5.07	5.62	6.18	6.75	7.31	7.85	8.35	8.80	9.17	9.46	9.61
10	0.38	0.84	1.28	1.68	2.05	2.39	2.71	3.01	3.30	3.57	3.85	4.11	4.65	5.20	5.76	6.34	6.92	7.50	8.05	8.57	9.02	9.41	9.70	9.86
11	0.40	0.88	1.34	1.76	2.15	2.51	2.84	3.16	3.46	3.75	4.03	4.31	4.88	5.45	6.05	6.65	7.26	7.87	8.45	8.98	9.46	9.87	10.18	10.35
12	0.42	0.92	1.40	1.84	2.25	2.62	2.97	3.30	3.61	3.92	4.21	4.51	5.09	5.70	6.31	6.95	7.59	8.22	8.82	9.38	9.89	10.31	10.63	10.81
13	0.43	0.96	1.46	1.92	2.34	2.73	3.09	3.43	3.76	4.08	4.38	4.69	5.30	5.93	6.57	7.23	7.90	8.55	9.18	9.77	10.29	10.73	11.07	11.25
14	0.45	1.00	1.51	1.99	2.43	2.83	3.21	3.56	3.90	4.23	4.55	4.87	5.50	6.15	6.82	7.50	8.19	8.87	9.53	10.14	10.68	11.13	11.48	11.67
15	0.46	1.03	1.57	2.06	2.51	2.93	3.32	3.69	4.04	4.38	4.71	5.04	5.70	6.37	7.06	7.77	8.48	9.19	9.86	10.49	11.05	11.52	11.89	12.08
16	0.48	1.06	1.62	2.13	2.59	3.03	3.43	3.81	4.17	4.52	4.86	5.20	5.88	6.58	7.29	8.02	8.76	9.49	10.19	10.84	11.41	11.90	12.28	12.48
17	0.49	1.10	1.67	2.19	2.67	3.12	3.53	3.93	4.30	4.66	5.01	5.36	6.06	6.78	7.51	8.27	9.03	9.78	10.50	11.17	11.77	12.27	12.65	12.86
18	0.51	1.13	1.72	2.26	2.75	3.21	3.64	4.04	4.42	4.80	5.16	5.52	6.24	6.98	7.73	8.51	9.29	10.06	10.80	11.49	12.11	12.62	13.02	13.23
19	0.52	1.16	1.76	2.32	2.83	3.30	3.74	4.15	4.55	4.93	5.30	5.67	6.41	7.17	7.94	8.74	9.54	10.34	11.10	11.81	12.44	12.97	13.38	13.60
20	0.54	1.19	1.81	2.38	2.90	3.38	3.83	4.26	4.66	5.05	5.44	5.82	6.58	7.35	8.15	8.97	9.79	10.61	11.39	12.11	12.76	13.31	13.72	13.95
21	0.55	1.22	1.85	2.44	2.97	3.47	3.93	4.36	4.78	5.18	5.57	5.96	6.74	7.53	8.35	9.19	10.03	10.87	11.67	12.41	13.08	13.64	14.06	14.30
22	0.56	1.25	1.90	2.49	3.04	3.55	4.02	4.47	4.89	5.30	5.70	6.10	6.90	7.71	8.55	9.41	10.27	11.12	11.94	12.71	13.38	13.96	14.39	14.63
23	0.58	1.28	1.94	2.55	3.11	3.63	4.11	4.57	5.00	5.42	5.83	6.24	7.05	7.88	8.74	9.62	10.50	11.37	12.21	12.99	13.69	14.27	14.72	14.96
24	0.59	1.30	1.98	2.60	3.18	3.71	4.20	4.66	5.11	5.54	5.96	6.37	7.20	8.05	8.93	9.82	10.73	11.62	12.47	13.27	13.98	14.58	15.03	15.28
25	0.60	1.33	2.02	2.66	3.24	3.78	4.29	4.76	5.21	5.65	6.08	6.50	7.35	8.22	9.11	10.03	10.95	11.86	12.73	13.54	14.27	14.88	15.34	15.60
26	0.61	1.36	2.06	2.71	3.31	3.86	4.37	4.86	5.32	5.76	6.20	6.63	7.50	8.38	9.29	10.23	11.17	12.09	12.98	13.81	14.55	15.17	15.65	15.91
27	0.62	1.38	2.10	2.76	3.37	3.93	4.45	4.95	5.42	5.87	6.32	6.76	7.64	8.54	9.47	10.42	11.38	12.32	13.23	14.08	14.83	15.46	15.95	16.21
28	0.63	1.41	2.14	2.81	3.43	4.00	4.54	5.04	5.52	5.98	6.43	6.88	7.78	8.70	9.64	10.61	11.59	12.55	13.47	14.33	15.10	15.75	16.24	16.51
29	0.65	1.43	2.18	2.86	3.49	4.08	4.62	5.13	5.62	6.09	6.55	7.00	7.92	8.85	9.82	10.80	11.79	12.77	13.71	14.59	15.37	16.02	16.53	16.80
30	0.66	1.46	2.21	2.91	3.55	4.14	4.70	5.22	5.71	6.19	6.66	7.12	8.06	9.01	9.98	10.98	11.99	12.99	13.95	14.84	15.63	16.30	16.81	17.09

ITRC Water Measurement Tables -24" Armco-Type Gate, Stilling Well Located 12” d/s of Back of Gate [Blue center represents best accuracy range]

Net Gate Opening (Inches)

ΔH (inches)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.5	0.11	0.25	0.39	0.52	0.64	0.75	0.85	0.95	1.05	1.14	1.23	1.31	1.47	1.63	1.79	1.95	2.11	2.27	2.43	2.59	2.74	2.90	3.04	3.17	3.29	3.40	3.49	3.57	3.62	3.65
0.75	0.14	0.31	0.48	0.63	0.78	0.92	1.04	1.17	1.28	1.39	1.50	1.60	1.80	2.00	2.19	2.39	2.58	2.78	2.97	3.17	3.36	3.55	3.72	3.89	4.03	4.17	4.28	4.37	4.44	4.47
1	0.16	0.36	0.55	0.73	0.90	1.06	1.21	1.35	1.48	1.61	1.73	1.85	2.08	2.31	2.53	2.76	2.98	3.21	3.43	3.66	3.88	4.09	4.30	4.49	4.66	4.81	4.94	5.05	5.12	5.17
1.25	0.18	0.40	0.62	0.82	1.00	1.18	1.35	1.51	1.66	1.80	1.94	2.07	2.33	2.58	2.83	3.08	3.33	3.59	3.84	4.09	4.34	4.58	4.80	5.02	5.21	5.38	5.52	5.64	5.73	5.78
1.5	0.20	0.44	0.67	0.89	1.10	1.29	1.48	1.65	1.81	1.97	2.12	2.27	2.55	2.83	3.10	3.37	3.65	3.93	4.21	4.48	4.75	5.01	5.26	5.49	5.70	5.89	6.05	6.18	6.28	6.33
1.75	0.21	0.48	0.73	0.97	1.19	1.40	1.60	1.78	1.96	2.13	2.29	2.45	2.76	3.05	3.35	3.64	3.94	4.24	4.54	4.84	5.13	5.42	5.68	5.93	6.16	6.36	6.53	6.67	6.78	6.83
2	0.23	0.51	0.78	1.03	1.27	1.50	1.71	1.91	2.09	2.28	2.45	2.62	2.95	3.26	3.58	3.90	4.21	4.54	4.86	5.18	5.49	5.79	6.08	6.34	6.59	6.80	6.99	7.14	7.25	7.31
2.25	0.24	0.54	0.83	1.10	1.35	1.59	1.81	2.02	2.22	2.41	2.60	2.78	3.13	3.46	3.80	4.13	4.47	4.81	5.15	5.49	5.82	6.14	6.45	6.73	6.99	7.21	7.41	7.57	7.69	7.75
2.5	0.26	0.57	0.87	1.15	1.42	1.67	1.91	2.13	2.34	2.54	2.74	2.93	3.29	3.65	4.00	4.36	4.71	5.07	5.43	5.79	6.14	6.47	6.79	7.09	7.36	7.60	7.81	7.98	8.10	8.17
2.75	0.27	0.60	0.91	1.21	1.49	1.75	2.00	2.23	2.46	2.67	2.87	3.07	3.45	3.83	4.20	4.57	4.94	5.32	5.70	6.07	6.44	6.79	7.13	7.44	7.72	7.98	8.19	8.37	8.50	8.57
3	0.28	0.62	0.95	1.26	1.56	1.83	2.09	2.33	2.57	2.79	3.00	3.21	3.61	4.00	4.38	4.77	5.16	5.55	5.95	6.34	6.72	7.09	7.44	7.77	8.07	8.33	8.56	8.74	8.88	8.95
3.25	0.29	0.65	0.99	1.32	1.62	1.91	2.17	2.43	2.67	2.90	3.12	3.34	3.76	4.16	4.56	4.97	5.37	5.78	6.19	6.60	7.00	7.38	7.75	8.09	8.40	8.67	8.91	9.10	9.24	9.31
3.5	0.30	0.67	1.03	1.37	1.68	1.98	2.26	2.52	2.77	3.01	3.24	3.47	3.90	4.32	4.74	5.15	5.58	6.00	6.42	6.85	7.26	7.66	8.04	8.39	8.71	9.00	9.24	9.44	9.59	9.66
3.75	0.31	0.70	1.07	1.41	1.74	2.05	2.34	2.61	2.87	3.12	3.36	3.59	4.03	4.47	4.90	5.34	5.77	6.21	6.65	7.09	7.52	7.93	8.32	8.69	9.02	9.31	9.57	9.77	9.92	10.00
4	0.32	0.72	1.10	1.46	1.80	2.11	2.41	2.69	2.96	3.22	3.47	3.70	4.17	4.62	5.06	5.51	5.96	6.41	6.87	7.32	7.76	8.19	8.59	8.97	9.32	9.62	9.88	10.09	10.25	10.33
4.25	0.33	0.74	1.13	1.51	1.85	2.18	2.49	2.78	3.05	3.32	3.57	3.82	4.29	4.76	5.22	5.68	6.14	6.61	7.08	7.54	8.00	8.44	8.86	9.25	9.60	9.92	10.18	10.40	10.56	10.65
4.5	0.34	0.76	1.17	1.55	1.91	2.24	2.56	2.86	3.14	3.41	3.68	3.93	4.42	4.90	5.37	5.84	6.32	6.80	7.29	7.76	8.23	8.69	9.12	9.52	9.88	10.20	10.48	10.70	10.87	10.96
4.75	0.35	0.78	1.20	1.59	1.96	2.30	2.63	2.94	3.23	3.51	3.78	4.04	4.54	5.03	5.52	6.00	6.50	6.99	7.48	7.98	8.46	8.92	9.37	9.78	10.15	10.48	10.77	11.00	11.17	11.26
5	0.36	0.80	1.23	1.63	2.01	2.36	2.70	3.01	3.31	3.60	3.87	4.14	4.66	5.16	5.66	6.16	6.66	7.17	7.68	8.18	8.68	9.16	9.61	10.03	10.42	10.75	11.05	11.28	11.46	11.55
5.5	0.38	0.84	1.29	1.71	2.11	2.48	2.83	3.16	3.47	3.77	4.06	4.34	4.89	5.41	5.94	6.46	6.99	7.52	8.05	8.58	9.10	9.60	10.08	10.52	10.92	11.28	11.58	11.83	12.02	12.11
6	0.40	0.88	1.35	1.79	2.20	2.59	2.95	3.30	3.63	3.94	4.24	4.54	5.10	5.65	6.20	6.75	7.30	7.86	8.41	8.96	9.51	10.03	10.53	10.99	11.41	11.78	12.10	12.36	12.55	12.65
6.5	0.41	0.92	1.40	1.86	2.29	2.70	3.08	3.43	3.78	4.10	4.42	4.72	5.31	5.89	6.45	7.02	7.60	8.18	8.76	9.33	9.89	10.44	10.96	11.44	11.88	12.26	12.59	12.86	13.06	13.17
7	0.43	0.95	1.46	1.93	2.38	2.80	3.19	3.56	3.92	4.26	4.58	4.90	5.51	6.11	6.70	7.29	7.89	8.49	9.09	9.68	10.27	10.83	11.37	11.87	12.32	12.73	13.07	13.35	13.56	13.67
7.5	0.44	0.98	1.51	2.00	2.46	2.90	3.30	3.69	4.06	4.41	4.74	5.07	5.71	6.32	6.93	7.54	8.16	8.78	9.41	10.02	10.63	11.21	11.77	12.29	12.76	13.17	13.53	13.82	14.03	14.15
8	0.46	1.02	1.56	2.07	2.54	2.99	3.41	3.81	4.19	4.55	4.90	5.24	5.89	6.53	7.16	7.79	8.43	9.07	9.71	10.35	10.98	11.58	12.15	12.69	13.17	13.60	13.97	14.27	14.49	14.61
8.5	0.47	1.05	1.60	2.13	2.62	3.08	3.52	3.93	4.32	4.69	5.05	5.40	6.07	6.73	7.38	8.03	8.69	9.35	10.01	10.67	11.31	11.94	12.53	13.08	13.58	14.02	14.40	14.71	14.94	15.06
9	0.48	1.08	1.65	2.19	2.70	3.17	3.62	4.04	4.44	4.83	5.20	5.56	6.25	6.93	7.59	8.27	8.94	9.62	10.30	10.98	11.64	12.28	12.89	13.46	13.97	14.43	14.82	15.14	15.37	15.50
9.5	0.50	1.11	1.70	2.25	2.77	3.26	3.72	4.15	4.56	4.96	5.34	5.71	6.42	7.11	7.80	8.49	9.19	9.88	10.59	11.28	11.96	12.62	13.25	13.83	14.36	14.82	15.23	15.55	15.79	15.92
10	0.51	1.14	1.74	2.31	2.84	3.34	3.81	4.26	4.68	5.09	5.48	5.86	6.59	7.30	8.01	8.71	9.42	10.14	10.86	11.57	12.27	12.95	13.59	14.19	14.73	15.21	15.62	15.96	16.20	16.34
11	0.54	1.19	1.82	2.42	2.98	3.51	4.00	4.47	4.91	5.34	5.75	6.14	6.91	7.66	8.40	9.14	9.88	10.64	11.39	12.14	12.87	13.58	14.25	14.88	15.45	15.95	16.38	16.73	16.99	17.13
12	0.56	1.24	1.91	2.53	3.11	3.66	4.18	4.67	5.13	5.57	6.00	6.42	7.22	8.00	8.77	9.54	10.32	11.11	11.90	12.68	13.44	14.18	14.89	15.54	16.14	16.66	17.11	17.48	17.75	17.89
13	0.58	1.29	1.98	2.63	3.24	3.81	4.35	4.86	5.34	5.80	6.25	6.68	7.51	8.32	9.13	9.93	10.75	11.56	12.38	13.20	13.99	14.76	15.49	16.17	16.79	17.34	17.81	18.19	18.47	18.63
14	0.60	1.34	2.06	2.73	3.36	3.96	4.51	5.04	5.54	6.02	6.48	6.93	7.80	8.64	9.47	10.31	11.15	12.00	12.85	13.69	14.52	15.32	16.08	16.79	17.43	18.00	18.48	18.88	19.17	19.33
15	0.63	1.39	2.13	2.83	3.48	4.09	4.67	5.22	5.74	6.23	6.71	7.17	8.07	8.94	9.80	10.67	11.54	12.42	13.30	14.17	15.03	15.86	16.64	17.37	18.04	18.63	19.13	19.54	19.85	20.01
16	0.65	1.44	2.20	2.92	3.60	4.23	4.82	5.39	5.92	6.44	6.93	7.41	8.33	9.23	10.13	11.02	11.92	12.83	13.74	14.64	15.52	16.38	17.19	17.94	18.63	19.24	19.76	20.18	20.50	20.66
17	0.67	1.48	2.27	3.01	3.71	4.36	4.97	5.55	6.11	6.63	7.14	7.64	8.59	9.52	10.44	11.36	12.29	13.22	14.16	15.09	16.00	16.88	17.72	18.50	19.20	19.83	20.37	20.80	21.13	21.30
18	0.69	1.52	2.33	3.10	3.81	4.49	5.12	5.72	6.28	6.83	7.35	7.86	8.84	9.79	10.74	11.69	12.64	13.61	14.57	15.53	16.47	17.37	18.23	19.03	19.76	20.41	20.96	21.41	21.74	21.92
19	0.70	1.57	2.40	3.18	3.92	4.61	5.26	5.87	6.46	7.01	7.55	8.07	9.08	10.06	11.03	12.01	12.99	13.98	14.97	15.95	16.92	17.85	18.73	19.55	20.30	20.97	21.53	21.99	22.34	22.52
20	0.72	1.61	2.46	3.27	4.02	4.73	5.39	6.02	6.62	7.20	7.75	8.28	9.32	10.32	11.32	12.32	13.33	14.34	15.36	16.37	17.36	18.31	19.22	20.06	20.83	21.51	22.09	22.56	22.92	23.10
21	0.74	1.65	2.52	3.35	4.12	4.84	5.53	6.17	6.79	7.37	7.94	8.49	9.55	10.58	11.60	12.63	13.66	14.70	15.74	16.77	17.78	18.76	19.69	20.56	21.34	22.04	22.64	23.12	23.48	23.67
22	0.76	1.68	2.58	3.42	4.22	4.96	5.66	6.32	6.95	7.55	8.13	8.69	9.77	10.83	11.87	12.92	13.98	15.04	16.11	17.17	18.20	19.21	20.16	21.04	21.85	22.56	23.17	23.67	24.03	24.23
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24	0.79	1.76	2.70	3.58	4.40	5.18	5.91	6.60	7.26	7.88	8.49	9.07	10.21	11.31	12.40	13.50	14.60	15.71	16.82	17.93	19.01	20.06	21.05	21.98	22.82	23.56	24.20	24.72	25.10	25.31
25	0.81	1.80	2.75	3.65	4.49	5.29	6.03	6.74	7.41	8.05	8.66	9.26	10.42	11.54	12.66	13.78	14.90	16.04	17.17	18.30	19.40	20.47	21.49	22.43	23.29	24.05	24.70	25.23	25.62	25.83
26	0.82	1.83	2.81	3.72	4.58	5.39	6.15	6.87	7.55	8.21	8.83	9.44	10.62	11.77	12.91	14.05	15.20	16.35	17.51	18.66	19.79	20.88	21.91	22.87	23.75	24.52	25.19	25.73	26.13	26.34
27	0.84	1.87	2.86	3.79	4.67	5.49	6.27	7.00	7.70	8.36	9.00	9.62	10.83	11.99	13.15	14.32	15.49	16.66	17.85	19.02	20.17	21.28	22.33	23.31	24.20	24.99	25.67	26.22	26.63	26.84
28	0.85	1.90	2.91	3.86	4.76	5.59	6.38	7.13	7.84	8.51	9.17	9.80	11.02	12.21	13.40	14.58	15.77	16.97	18.17	19.37	20.54	21.67	22.74	23.74	24.65	25.45	26.14	26.70	27.11	27.33
29	0.87	1.93	2.96	3.93	4.84	5.69	6.50	7.25	7.98	8.67	9.33	9.97	11.22	12.43	13.63	14.84	16.05	17.27	18.49	19.71	20.90	22.05	23.14	24.16	25.08	25.90	26.60	27.17	27.59	27.82
30	0.88	1.97	3.01	4.00	4.92	5.79	6.61	7.38	8.11	8.81	9.49	10.14	11.41	12.64	13.87	15.09	16.32	17.57	18.81	20.05	21.26	22.43	23.54	24.57	25.51	26.34	27.06	27.63	28.07	28.29

State Water Resources Control Board

Office of Delta Watermaster

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Linda S. Adams
Acting Secretary for Environmental Protection

Edmund G. Brown Jr.
Governor

TO: Craig M. Wilson, Delta Watermaster
Office of Delta Watermaster

FROM: Nichole S. Baker
Office of Delta Watermaster

DATE: May 31, 2011

SUBJECT: MEASUREMENT OF WATER DIVERSIONS

Background
In November 2009, the California Legislature passed Senate Bill X7 8, requiring monthly records of water diversions on and after January 1, 2012. The new law requires that the measurements of water diversions are made using the best available technologies and best professional practices. These are defined in the law as follows:

> "Best available technologies" means technologies at the highest technically practical level, using flow totaling devices, and if necessary, data loggers and telemetry.
>
> "Best professional practices" means practices attaining and maintaining the accuracy of measurement and reporting devices and methods.

Section 5103 of the California Water Code is amended to read:
> "Each statement shall include all of the following information"

With Section 5103 (e) (1) reading:
"On and after January 1, 2012, monthly records of water diversions. The measurements of the diversion shall be made using best available technologies and best processional practices. Nothing in this paragraph shall be construed to required the implementation of technologies or practices by a person who provides to the board documentation demonstrating that the implementation of those practices is not locally cost effective."

Discussion
When determining the appropriate method of measuring a diversion or measuring device for the application several factors should be taken into consideration, including: accuracy, cost, environment, delivery system, flow range, straight pipe installation requirement and storage, if used.

Accuracy – the majority of measuring devices when installed properly are accurate within ±1% to ±5%. However, in the field, maintaining these accuracies can require considerable expense and/or effort (i.e. maintenance, special construction, recalibration, etc.). By selecting a device that is not appropriate for the site conditions can result in a non-standardize installation and reduced accuracy of ±10%.

Cost – includes the device, associated appurtenances, installation and operation and maintenance. These costs vary based on the measuring device and size.

Environment – if the correct measuring device is not chosen based on the environment, the measuring device can become clogged with organics, resulting in inaccurate readings. This may be the most important factor when selecting a measuring device.

Delivery system – the appropriate type of measuring device may vary depending of the delivery system (pressurized pipe, non-pressurized pipe, and open channel).

Flow range – the accuracy of measuring devices is dependent of the rated flow range.

Straight pipe installation requirement – some water measuring devices require a length of straight pipe prior to (upstream) and after (downstream) the measuring device to eliminate any turbulence caused by a transition fitting (elbow). This distance can be up to 10 times the diameter of the pipe upstream and 5 times the diameter of the pipe downstream. Increasing installation cost if additional pipe is needed.

Storage – the law currently requires the measurement of water diversions. However, the current reporting form for Supplemental Statements of Water Diversion and Use, (and reports of Permittee and Licensee) ask for the amount of water consumptively used post storage. This raises the question if the measurement of water post storage is to be estimated or measured in the same manner as pre-storage.

While we are not able to be prescriptive when asking for measuring devices at the point of diversion we are able to ask for the best available technology. As discussed above the best available technology may vary from diversion to diversion or based on various factors within the state, thus making some devices not locally cost effective.

Also over time technology will change, therefore it is recommended to have diverters select the best available technology while using the best professional practices for their location (i.e. to select the device that best suits the location and diversion configuration).

Overview of Measuring Devices

In general metering devices are available from 2-inches to 72-inches in diameter and are rated for flows ranging from 35 gpm (0.078cfs) to 90,000 gpm (200 cfs); however, devices greater than 12-inches in diameter are considered as large devices and many times require additional time to ship to the site. When a meter is used it will generally be sized one to two sizes smaller than the pipe size. Mechanical registers, calculating both the total and instantaneous flow are generally standard with meters. Flow totaling devices, data loggers and telemetry (SCADA (Supervisory Control and Data Acquisition)) would be a significant additional cost.

In reviewing the Initial Statements received by the Division of Water Rights, Division, the average size of diversions within the legal delta are 12-inches and 14-inches in diameter. Therefore the average measuring devices would range from 8-inches to 12-inches in size.

Pricing

When determining the installed price of a measuring device several factors should be taken into account, including:

1. State sales tax on the equipment (8.25%)
2. Shipping and handling (assume 10%)
3. Installation – contractors generally charge approximately 30% of the equipment cost for installation.
4. Contractor's overhead and profit – 30% can be generally be assumed addition to the base price of the measuring device for projects under $100,000.
5. Mobilization and Demobilization – in addition to the above cost the contractor will charge approximately $3/mile/piece of equipment plus the cost of the crew to travel to and from the site. For small projects this will be negligible.

When adding the above percentages a minimum of 78.25% in addition to the cost of the measuring device for installation. Not including in additional associated apparatuses necessary to install the measuring device. This can include additional straight pipe length, metering boxes, pipe supports, etc.

Please note that for projects larger than $100,000 contractors historically have charged a lower percentage for overhead and profit. Also based on conversations with local agencies the construction market is currently fluctuating daily.

Non-Metering Alternatives

For small and older diversions it may not be cost effective to retrofit the existing infrastructure to install a metering device. Several factors may play into making this decision including:

- The age of the facilities.
- The amount of water that is being diverted and how often is the water being diverted, including over what duration.
- The configuration of the existing diversion.

In cases where the cost of retrofitting the existing surface water diversion to install a metering device out ways the benefits, the use of power consumption of the water diversion pump may be used to calculate the volume of water diverted. For this alternative to work the diverter must have the following information:

- Electricity records that isolate the power consumption of the diversion.
- The efficiency of the pump at the diversion.
- The efficiency of the motor of the pump at the diversion.
- The total dynamic head of the system (suction head + discharge head + head loss).

Recommendation

The State Water Board should:

1. Develop a list of water measuring devices for both pipelines and open channels, which meet both best available technologies and best professional practices. Including:
    a. Propeller meters
    b. Magnetic meters
    c. Acoustic meters
    d. Metergates
    e. Calibrated slide gates
    f. Calibrated sluice gates
2. Invite vendors (of the above devices) and diverters to a workshop.
3. Develop a list of vendors and suppliers to post on the State Water Board, Division of Water Rights website.
4. Provide an option for diverters to propose an equal device or measuring method that meets best available technologies and best professional practices.
5. Require diverters to certify that the devices were installed and maintained per manufacturer's recommendations or American Water Works Association.

6. Update the electronic Supplemental Statement of Water Diversion and Use form to request the following information:
   a. Type of measuring device used.
   b. Make, model and serial number of measuring device and any separate counting units.
   c. Size of diversion.
   d. Average depth of diversion.
   e. Date measuring device was last calibrated.
   f. Any dates during which measuring device was not functioning properly.
   g. Electricity[1], when approved by the Division, where;
      i. $$V = \frac{318{,}600\ (kWh)(P_{eff})(M_{eff})}{TDH}$$

      Where: V = volume of water pumped in gallons;
      318,600 = conversion factor;
      kWh = number of kilowatt-hours for the time period in question; e.g., irrigation season, year or minutes;
      P_{eff} = pump efficiency as a decimal;
      M_{eff} = motor efficiency as a decimal; and
      TDH = total dynamic head of the system in feet.
   h. Electrical records, if measurements is based on power consumption.

[1] Electricity is an acceptable method of measuring diversions in Washington State when approved by the Department of Ecology (http://www.ecy.wa.gov/programs/wr/measuring/measuringhome.html). The following set of criteria is utilized by the State of Washington when determining to approve electricity as an acceptable method:

- If diversion is currently metered
- Age of diversion
- Availablity of power records for diversion
- Amount of diversion

APPENDIX A

Examples: the following examples and prices are for 8-inch and 10-inch measuring devices. The average pipe diameter in the legal delta was found to be 12-inches to 14-inches in size, therefore the approximate measuring device would be one to two sizes smaller. Cut sheets for each type of measuring device is included in Appendix B.

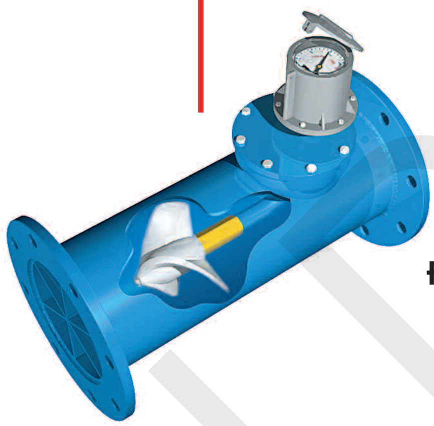
1. Propeller Meters
    - a. McCrometer
        - i. $967 - 8”
        - ii. $1,021 - 10”
        - iii. $1,078 - 12”
    - b. Netafim
        - i. $2,475 - 8”
        - ii. $4,125 - 10”
        - iii. $5,500 - 12”
        - iv. $6,105 - 8” hydrometer (larger sizes available by special order)
2. Magnetic Meters
    - a. Elster
        - i. $1,000/diameter inch
3. Acoustic Meters
    - a. Mace
        - i. $4,200
4. Slide Gates
    - a. Waterman
        - i. $600 to $1,300 - 12” to 14”, does not include automated measuring equipment.

APPENDIX B
CUT SHEETS

PROPELLER METER CUT SHEETS

Propeller Flowmeter Technology

Mc Propeller



For the Real World.

McCROMETER

The Flow Measurement Specialists

Propeller Flowmeters

Long-lasting Stainless Steel Ball Bearings. *Factory lubricated and protected from flow stream.*

Magnetic Coupling System. *Isolates register and drive system from flow and allows unrestricted impeller movement.*

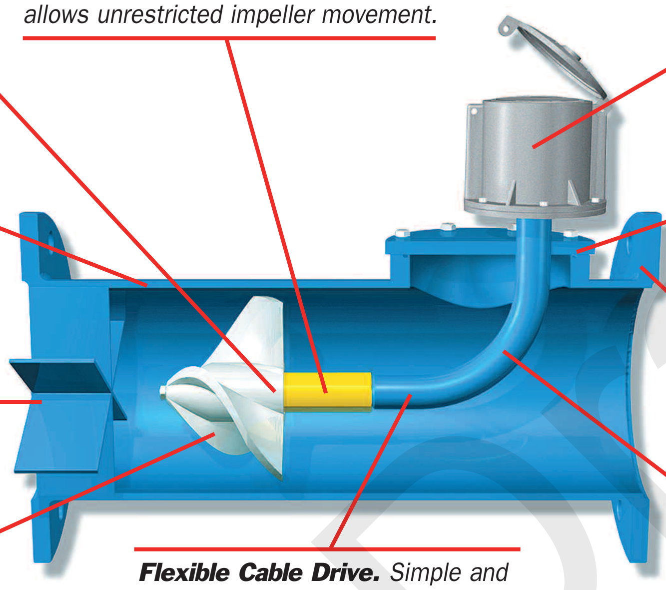
Instantaneous Flowrate Indicator and Totalizer. *Housed in a Die-Cast Aluminum Register Canopy.*

Epoxy-Coated Carbon Steel Body. *All stainless steel construction available.*

Removable Top-Plate Assembly. *Available on many models for easy access during field service or replacement.*

Straightening Vanes. *For optimum flow profiles.*

Wide Variety of End Fittings. *Including threaded, grooved-end, flanged, and weld-on.*



Corrosion-Resistant Impeller. *Made of durable polymer material, factory calibrated to retain accuracy.*

Flexible Cable Drive. *Simple and durable, protected by self-lubricating cable guide.*

Heavy Gauge Stainless Steel Support. *Resists corrosion.*

The Most Proven, Dependable Choice

McCrometer offers a complete line of dependable and economical propeller flowmeters for the widest range of applications—from fire hydrant testing to effluent management to farm irrigation. Designed to operate in real-world environments, these flowmeters can measure turbulent flows and fluids containing debris, suspended solids, and other contaminants with an accuracy superior to other technologies.

McCrometer's Mc Propeller flowmeters offer a simple and efficient design. They are easy to install, use, and maintain. After over 50 years of installations, it's no wonder these economical workhorses remain the number one choice for so many water management applications.

Self-Cleaning, Durable Design

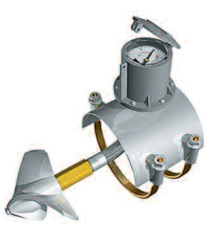
Key to the success of McCrometer's Mc Propeller flowmeters is a self-cleaning design that prevents the build-up of solids. A unique, magnetic coupling system keeps the register

FIRE HYDRANT FLOWMETER M1104

- Lightweight, portable design
- Instantaneous readings

BOLT-ON SADDLE FLOWMETER MO300

- 4″ to 16″ line sizes



LARGE-LINE, BOLT-ON SADDLE FLOWMETER M1400

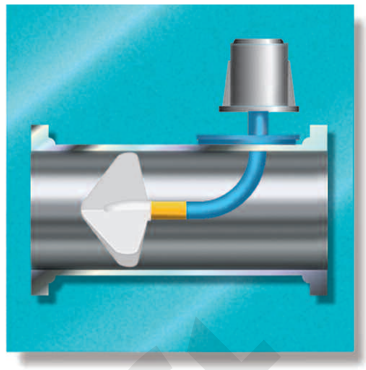
- 18″ to 48″ line sizes

BOLT-ON SADDLE SURFACE WATER FLOWMETER M0300SW

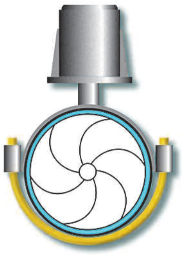
- 4″ to 12″ line sizes

OPEN FLOWMETER M1700

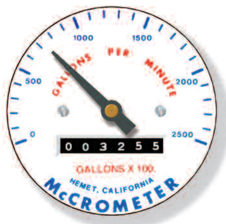
- 10″ to 72″ and larger line sizes



The McCrometer Mc Propeller flowmeter's self-cleaning design uses a flexible drive shaft running within a curved, stainless steel "ell" that makes it easier to shed debris.



The positioning of the impeller directly in the flow stream assures full-flow measurement and greater accuracy.



The McCrometer Propeller flowmeter comes with a standard instantaneous flowrate indicator and straight-reading totalizer. An optional electronic FlowCom register is also available.

six-digit, straight-reading totalizer. They are available in gallons, cubic feet, acre feet, cubic meters and other standard measurements. Both mechanical and electronic registers are available.

Accuracy for Challenging Environments

McCrometer's Mc Propeller flowmeters operate in a wide variety of environments without damage or loss of accuracy. They deliver ±2% of true accuracy and ±.25% repeatability over a flowrange of up to 25 to 1. Whether measuring clean or dirty fluids, McCrometer's Mc Propeller flowmeters excel in measuring turbulent flows, and their built-in versatility makes them ideal for retrofits.

Options to Meet a Wide Range of Needs

McCrometer's Mc Propeller flowmeters come in a variety of standard style configurations—including bolt-on saddle meter, open flow meter, and precision tube—and with a host of options for custom requirements. They offer exceptional sizing flexibility, and can be sized for line diameters of 2″ to 96″ and larger.

MAIN LINE FLOWMETER MW500/MZ500

• 2″ to 24″ or larger line sizes

IRRIGATION-FLANGED FLOWMETER ML100

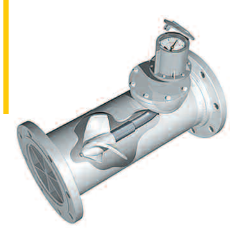
• 6″ to 12″ line sizes

GROOVED AND SMOOTH-END FLOWMETER MG100/MS100

• 2″ to 24″ line sizes

ALL STAINLESS STEEL MAIN LINE FLOWMETER QW500/QZ500

• 2″ to 24″ line sizes



Proven performance.

and drive isolated from the flow while permitting unrestricted movement of the impeller. Free rotation of the impeller also is assured by factory-lubricated, stainless steel bearings.

The high-impact plastic impeller will not flex or otherwise change in dimension. In fact, it maintains its shape and accuracy over the lifetime of the meter. The impeller also is corrosion and erosion resistant, enabling McCrometer's Mc Propeller flowmeters to operate safely in rugged environments.

Easy to Use and Maintain

McCrometer's Mc Propeller flowmeters install easily and require little maintenance. All their components are easily serviced in the field. The register is driven by a flexible steel cable. The register can also be extended topward for easy reading in confined spaces.

Instantaneous Flow Rate Indicator & Straight-Reading Totalizer: Standard

Registers have an instantaneous rate of flow indicator and

THREADED-END FLOWMETER MT100

• 2″ to 6″ line sizes

WELD-ON SADDLE FLOWMETER MW600

• 4″ to 48″ or larger line sizes

RIGHT ANGLE FLOWMETERS MW800/MM800

• 3″ to 24″ line sizes

MAIN LINE FLOWMETER MW900/MG900/MT900

• 2″ to 24″ or larger line sizes
• Smooth, grooved, or threaded ends

FLANGED-END FLOWMETER MF100

• 2″ to 12″ line sizes

Proven performance.

Engineered for Accuracy, Durability, and Economy for...

Municipal Water/Wastewater

and

Agriculture/Turf Irrigation

Potable water

Drip and sprinkler irrigation

Wastewater management

Water well production

Marine system testing

Fire sprinkler testing

Pumping stations

Golf courses and park water management

Truck loading and discharge

Canal laterals

Center pivot systems

McCrometer's Mc Propeller flowmeters measure both flow rate and volume, using turbine technology and a helical shaped impeller. The flowmeter consists of a rotating device, an impeller, positioned in the flow stream. When fluid passes through the meter, it contacts the impeller, causing it to spin. The impeller's rotational velocity is directly proportional to the velocity of the flow. The rotation is translated through a magnetic coupling and flexible drive system to the register. The register automatically calculates the flow rate by multiplying the flow velocity with the cross-sectional area of the meter tube.

The register incorporates an instantaneous flowrate indicator and straight-reading totalizer. The flowrate and total flow may be indicated in virtually any unit of measurement such as U.S. gallons or liters.

McCrometer

Application

Support

At McCrometer, all we make are flowmeters. We have over 50 years of flow measurement experience in municipal, industrial, and agricultural markets.
Our knowledgeable staff can accurately evaluate your flow applications and specify the best metering technology for your specific flow condition. For a free evaluation of your flow application or to find out about our other flowmeter products, contact your McCrometer representative today, or visit our website at **www.mccrometer.com**

Instrumentation Options For Remote Display & Control

McCrometer's Electronic instrumentation is specifically designed for use on all McCrometer Mc Propeller flowmeters, allowing the flow data generated by the flowmeter to be transmitted and incorporated into flow monitoring and control systems. This instrumentation can be ordered along with the flowmeters or retrofitted to any existing McCrometer Mc Propeller flowmeter.

Transmitters

Transmitters can be easily installed on all new or existing McCrometer Mc Propeller flowmeters to provide a variety of signal outputs to flow computers, irrigation controllers, electronic and electromechanical totalizers, chart recorders, Programmable Logic Controllers (PLCs), and computerized data acquisition systems.

Standard signal outputs available:

- Linear 4-20 mA
- Dual forward and reverse 4-20 mA (separate signal for forward and reverse flows)
- Digital 0-12 volt pulse
- Dry Contact Relay
- Open-Collector

Electronic Registers

These battery-powered FlowCom registers come with LCD Rate of Flow and Total Flow displays. They replace the mechanical register and can be mounted directly on the propeller flowmeter or in a remote enclosure. These registers are field programmable and have optional 4-20 mA and pulse outputs.

Flow Computers

Remote mounted microprocessors display both rate of flow and total flow. These flow computers are easily field programmable and can include control features such as high and low alarm set points, control and alarm outputs, relay outputs, RS-485 serial communications ports and 4-20 mA outputs.

Chart Recorders

McCrometer Chart Recorders are remote, microprocessor-based, circular chart recorders for monitoring and permanent recording of flowrate information. They use a thermal printing stylus to draw charts on blank paper. Chart Recorders are available with both 24-hour and 7-day charts. Recorders are also available with 4-20 mA control outputs.

McCROMETER
The Flow Measurement Specialists

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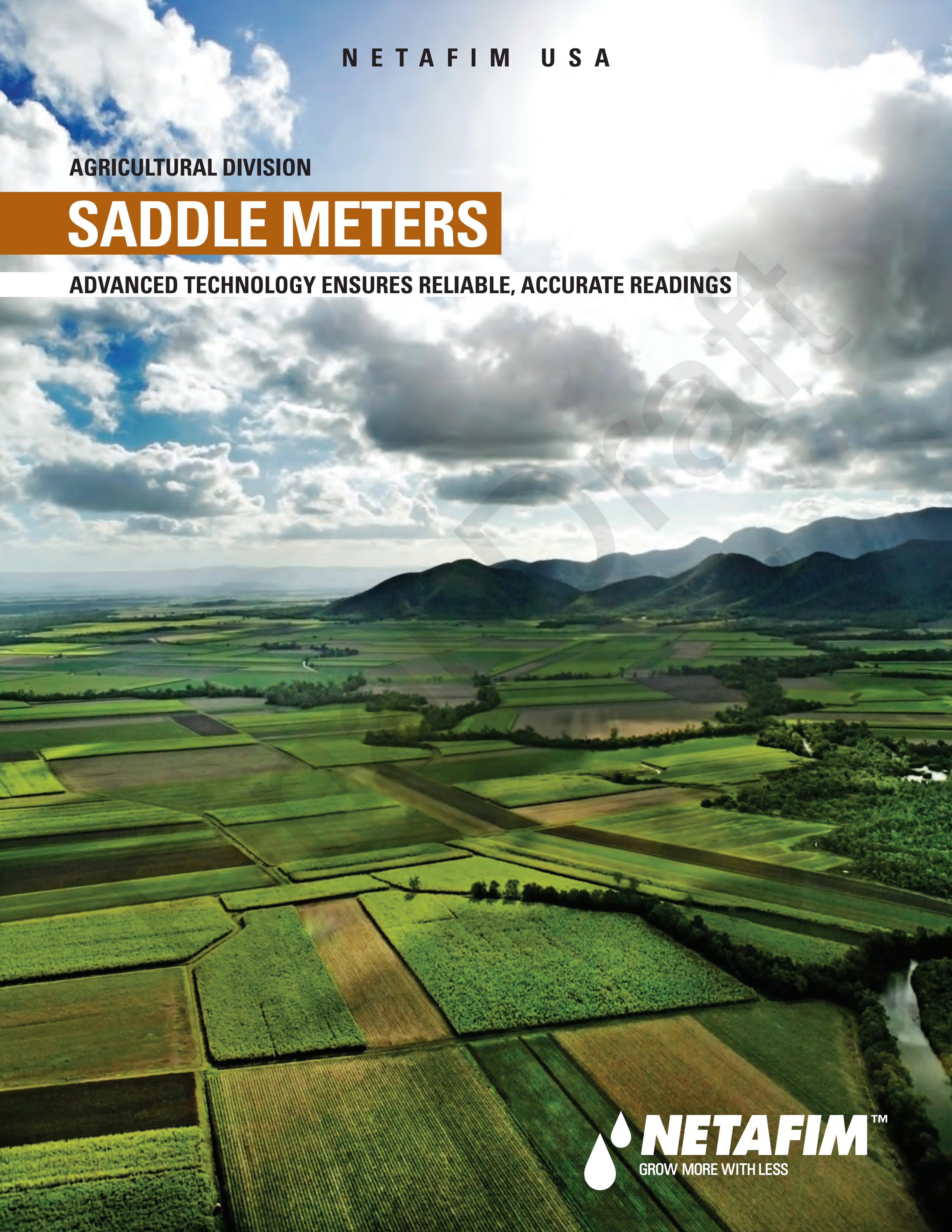
NETAFIM USA

AGRICULTURAL DIVISION

SADDLE METERS

ADVANCED TECHNOLOGY ENSURES RELIABLE, ACCURATE READINGS



NETAFIM™
GROW MORE WITH LESS

IF YOU CAN'T MEASURE IT - YOU CAN'T MANAGE IT

MEASUREMENT IS THE KEY TO EFFECTIVE WATER MANAGEMENT

Every irrigation system - drip/micro, flood, sprinkler or center pivot - needs water and fertilizer delivered at the right time and in the right amounts. Metering is the only way to make sure water and fertilizers are delivered accurately.
High quality Netafim WT-SM Saddle Meters provide the confidence and assurance that the correct amount of water and fertilizer (nutrients) are being delivered to the crop maximizing yields and reducing energy costs.

ADVANCED TECHNOLOGY = RELIABILITY

Netafim's advanced saddle meter technology ensures reliable flow readings without the problems associated with old-style drive trains and speedometer dial indicators. The smooth rotation of the impeller allows accurate measurement of both high and low flows. Performance and reliability you can count on to effectively manage your operation day after day.

THE INDUSTRY'S LONGEST WARRANTY

Netafim stands behind our meters with an unprecedented warranty - the industry's longest - three (3) years. This warranty begins from the date of installation, not the date of sale like other manufacturers.

MORE ACCURATE OVER A WIDE RANGE OF FLOWS

The unique design of a double magnetic transmission allows the meter to handle high loads of sand since only the impeller is in contact with the water.
Repelling magnets enable accurate measurement across a wide range of flow rates, from very high to very low flows, while maintaining high accuracy even after many years of operation.

MORE FEATURES AT NO ADDITIONAL COST

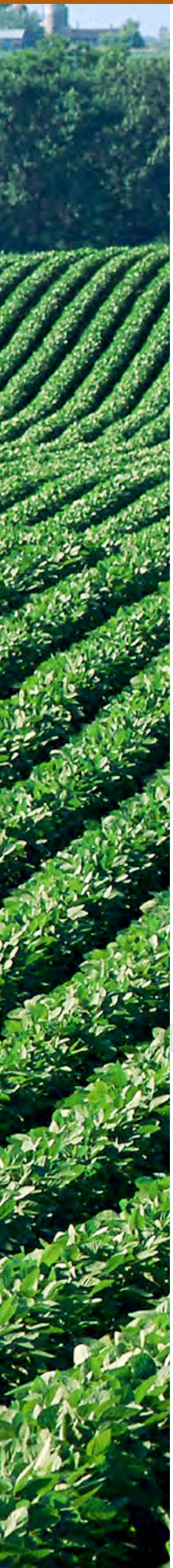
ONLY NETAFIM OFFERS THESE FEATURES

- Accuracy of +/-2% over a wider range of flows (0.7 ft/s up to 13 ft/s) without adding costly overrun bearings
- Corrosion-resistant stainless steel saddle and bearings for long life
- Digital register displays rate of flow and total volume readings without requiring tedious calculations
- Programmable register allows calibration changes for multiple pipe sizes/wall thickness without changing mechanical gears
- Dry pulse output provides reliable communication and integration with Netafim automation products
- Each saddle meter includes a full set of testing documents
- Easy installation and retrofit to existing meters

GET MORE AT NO ADDITIONAL COST

The examples below illustrate product features standard on all Netafim WT-SM Saddle Meters. Because we offer more features than other manufacturer's meters, you save time and money.

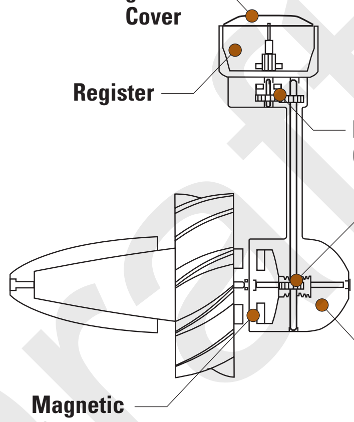
	NETAFIM WT-SM SADDLE METERS	OTHER MANUFACTURER'S SADDLE METERS
Stainless Steel Bearings	✓ Included	Up to $230 Additional
Overrun Bearings	✓ Not Required	Up to $44 Additional
Digital Display	✓ Included	Up to $320 Additional
Dry Pulse Output	✓ Included	Up to $400 Additional
Testing Documents	✓ Included	Up to $145 Additional
Warranty	3 3 Years	1 Year
Shipping Time	2 2 Days	2 + Weeks



OPERATION AND APPLICATION

WT-SM SADDLE METER OPERATION

The double magnetic transmission of the WT-SM Saddle Meter along with repelling magnets ensures accurate measurements. Transmission gears are located in a sealed, dry compartment which has no contact with the water - only the impeller contacts the water. The balanced impeller has an equal load on the front and rear bearings preventing wear and maintaining high accuracy. Injecting fertilizers and chemicals through the system will not damage the non-corrosive components of the saddle meter.



APPLICATIONS

- Agricultural Irrigation
- Wastewater
- Utilities and Industrial Use

AVAILABLE SIZES FOR IPS PIPE

- 6", 8”, 10” and 12”

MPE DIGITAL REGISTERS

Netafim Multi-Purpose Electronic (MPE) Digital Registers combine standard digital register features with dry pulse output capabilities. They clearly display the rate of flow and volume readings in gallons or acre feet. Register data is stored on an internal chip and retrievable if the register is damaged. Additional features include:

- Programmable - accommodates a wide variety of pipe sizes
- Stainless steel/plastic (IP67) encapsulated - guaranteed not to accumulate moisture or fog
- Hermetically sealed and mounted in a dry compartment - no contact with the water
- Interchangeable and easily replaced - only need common tools
- Electrical output - driven by a magnetic coupling that activates a reed switch creating a pulsed output for communicating with control and monitoring equipment
- Lithium batteries included - 10+ years of life
- Tamper-proof register - ideal for water district usage

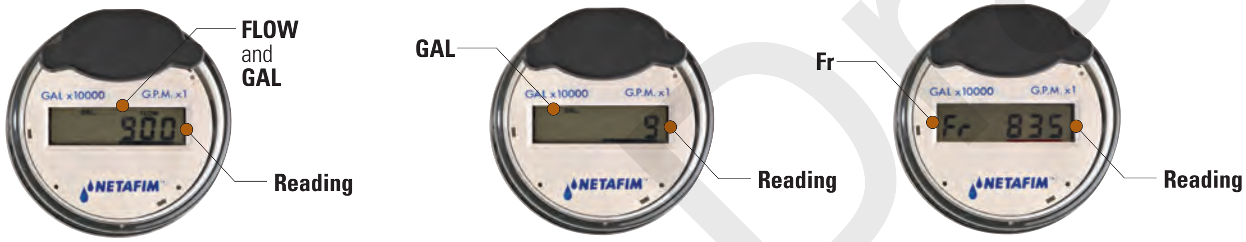
MPE DIGITAL REGISTER
GALLON TOTALIZER

MPE DIGITAL REGISTER
WITH PULSE OUTPUT

The MPE electronic register's LCD screen displays six digits and alternates every 10 seconds between Rate of Flow in Gallons per Minute (GPM) and Total Volume as a whole number and a fractional number in U.S. Gallons (U.S.G.) or Acre Feet.

- **FLOW** and **GAL** are visible on the display - reading for the Rate of Flow in GPM.
- **GAL** is visible on the display - whole number reading for a portion of Total Volume in U.S.G. or Acre Feet.
- **Fr** is visible on the display and the numbers are underlined in red - fractional number reading for a portion of the Total Volume in U.S.G. or Acre Feet.

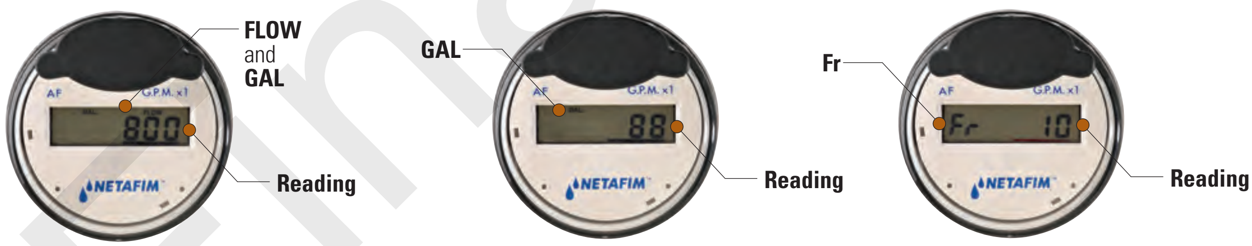
READING THIS GALLON TOTALIZER REGISTER



RATE OF FLOW
Reading: 900
Current Rate of Flow is 900 GPM

CALCULATING TOTAL VOLUME
1st Reading: 9 **2nd Reading:** 835
1st reading + decimal point + 2nd reading: 9.835
Multiplication: 9.835 x 10,000 = 98,350
Current Total Volume is 98,350 U.S.G.

READING THIS ACRE FEET TOTALIZER REGISTER



RATE OF FLOW
Reading: 800
Current Rate of Flow is 800 GPM

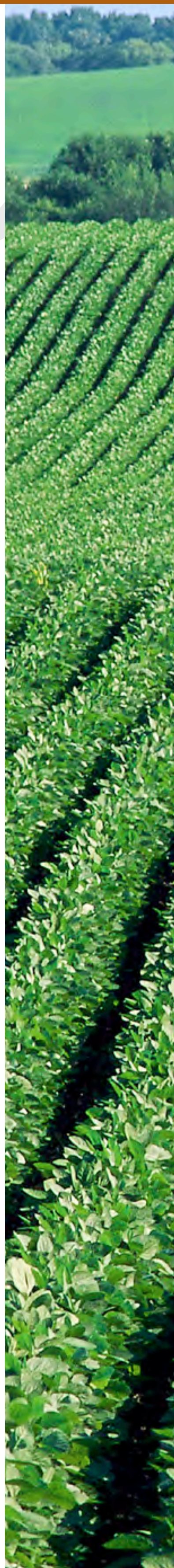
CALCULATING TOTAL VOLUME
1st Reading: 88 **2nd Reading:** 10
1st reading + decimal point + 2nd reading: 88.10
Multiplication: 88.10 x 1 = 88.10
Current Total Volume is 88.10 Acre Feet

MPE DIGITAL REGISTERS

METER SIZES	VOLUME UNITS	PULSE OUPUT
6", 8", 10", 12"	Gallon x 10,000	100 gal/pulse
6", 8"	Acre Feet x 1.00	32.6 gal/pulse
10", 12"	Acre Feet x 1.00	325.9 gal/pulse

ELECTRICAL SPECIFICATIONS

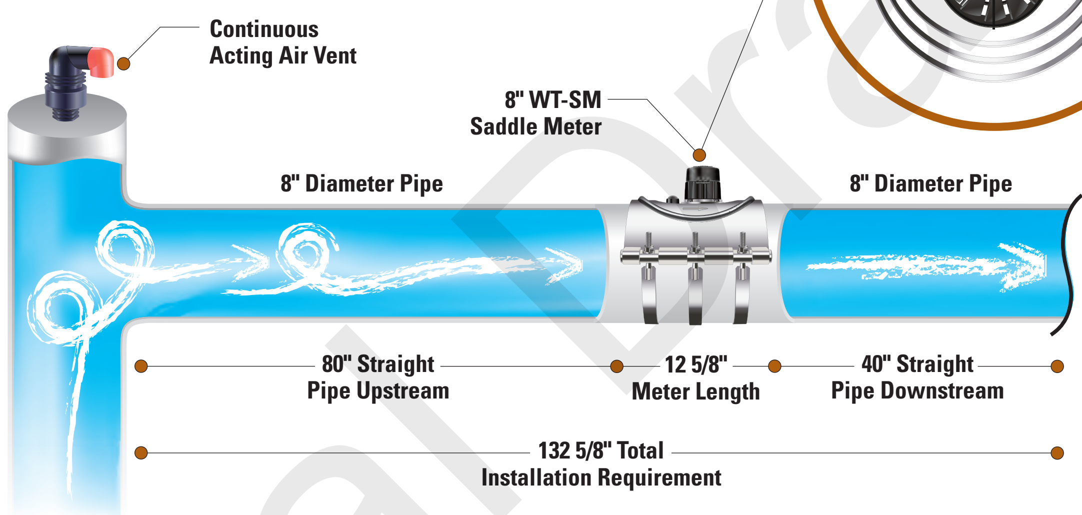
MINIMUM VOLTAGE	3.6VDC
MAXIMUM VOLTAGE	40VDC
MAXIMUM CURRENT	200mA
MAXIMUM DISTANCE (between meter and control board)	65 feet



REQUIREMENTS AND TECHNICAL SPECIFICATIONS

STRAIGHT PIPE REQUIREMENT

When water flows through a pipe, any transition through a fitting, elbow or change in pipe size, causes turbulence in the water. In order to eliminate water turbulence, saddle meters require straight pipe before and after the meter. Straight pipe installation refers to the length of straight pipe needed before (upstream of the saddle meter) and after (downstream of the saddle meter). Saddle meters require 10 x diameter before and 5 x diameter after. (Diameter = Meter Size)



STRAIGHT PIPE INSTALLATION REQUIREMENTS

- Straight pipe installation requirement: 10 x diameter pipe upstream (before the meter) and 5 x diameter pipe downstream (after the meter).
- The saddle meter may be installed in any position. For non-horizontal positions, the flow shall be upwards.
- Prior to installation of meter, the pipeline should be thoroughly flushed.
- Meter must be installed so that the pipe is full of water at all times during metering.
- Recommendation: Continuous Acting Air Vents of proper size and type be installed to eliminate air.

WT-SM SADDLE METERS

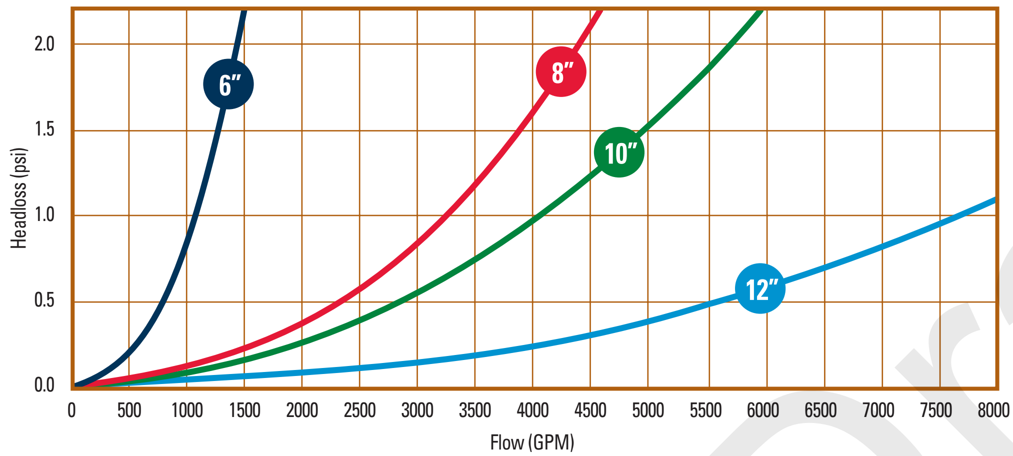
Straight Pipe Installation Requirement - 10 x D and 5 x D

SIZE	UPSTREAM DISTANCE	DOWNSTREAM DISTANCE	METER LENGTH	TOTAL REQUIREMENT
6"	60"	30"	11 3/4"	101 3/4"
8"	80"	40"	12 5/8"	132 5/8"
10"	100"	50"	12 5/8"	162 5/8"
12"	120"	60"	12 5/8"	192 5/8"

SPECIFICATIONS

MAXIMUM WORKING PRESSURE	150 psi
MAXIMUM LIQUID TEMPERATURE	140° F
BODY MATERIAL	Stainless Steel
STANDARDS	AWWA, ISO 4064, EEC

HEADLOSS CHART



FLOW RATE
@ 1.0 psi of Headloss

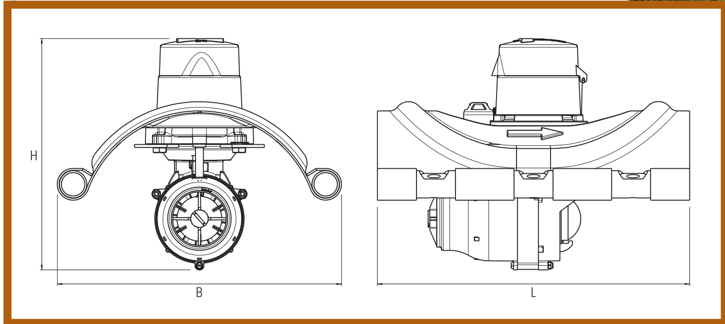
SIZE	GPM
6″	1,056
8″	3,229
10″	4,058
12″	7,711

PERFORMANCE DATA

SIZE	LOWEST FLOW (within ± 5% accuracy)	LOWEST FLOW (within ± 2% accuracy)	NOMINAL FLOW (within ± 2% accuracy)	MAXIMUM FLOW (within ± 2% accuracy)
6″	20 GPM	88 GPM	1,100 GPM	1,805 GPM
8″	33 GPM	132 GPM	1,980 GPM	3,212 GPM
10″	53 GPM	176 GPM	3,300 GPM	6,160 GPM
12″	79 GPM	264 GPM	4,400 GPM	8,800 GPM

DIMENSIONS AND WEIGHT

SIZE	H (Height)	B (Width)	L (Length)	WEIGHT
6″	9 1/2″	10 1/2″	11 3/4″	15.4 lbs.
8″	9 7/16″	11 5/8″	12 5/8″	15.5 lbs.
10″	12 13/32″	13 13/16″	12 5/8″	20.5 lbs.
12″	13 13/32″	15 3/4″	12 5/8″	23.5 lbs.



ORDERING INFORMATION
Required Information: Inside and Outside Pipe Diameter (IPS PIPE ONLY)

SIZE	DIGITAL MPE REGISTER	GALLONS PER PULSE	MINIMUM FLOW (GPM)	MAXIMUM FLOW (GPM)	MODEL NUMBER
6″	Gallons	100	88	1,805	36WTSM6E*.***
	Acre Feet	32.6			36WTSM6EAF*.***
8″	Gallons	100	132	3,212	36WTSM8E*.***
	Acre Feet	32.6			36WTSM8EAF*.***
10″	Gallons	100	176	6,160	36WTSM10E**.***
	Acre Feet	325.9			36WTSM10EAF**.***
12″	Gallons	100	264	8,800	36WTSM12E**.***
	Acre Feet	325.9			36WTSM12EAF**.***

*.*** or **.*** = Specification for inside pipe diameter.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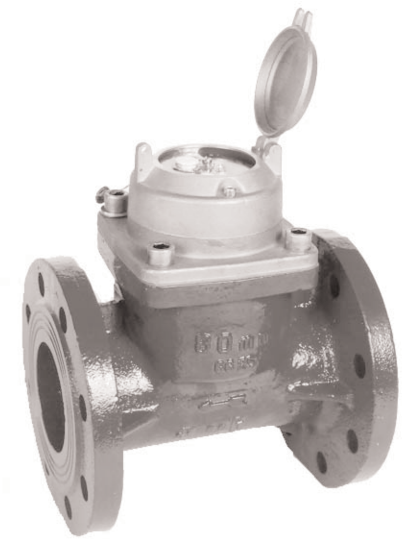
Specification Sheet

R1000 Propeller Meter



Sizes 2" - 10"

Description

Operation. The R1000 Propeller meter line uses a specially designed propeller type turbine that presents a relatively low cross section to the flow. The turbine design, combined with the constant area body cross section, results in a very low pressure drop. The unobtrusive design of the measuring device also means that the R1000 is less susceptible to damage from debris than Woltmann style meters that are often used in irrigation applications. The wide range of meter sizes provides an extended flow range to meet most irrigation metering needs. A single measuring chamber fits all sizes of meter housings.

Installation. The meter may be installed horizontally, vertically, or any orientation in between. The meter shall be installed with the direction of the flow as indicated by the arrow cast in the meter case. Note: The meter must have 10 straight pipe diameters ahead of the meter and 5 straight pipe diameters after to insure proper flow through the meter.

Applications. This meter is for use with cold water up to 120°F (50°C) and working pressures up to 150 psi. The meter will register accurately within the flow ranges listed and at the accuracy listed. Accuracy tests are made prior to shipment so no adjustments need to be made prior to installation.

Construction. The meter consists of a main case, a measuring element, and a magnetically driven register assembly with a brass cover. The main case is cast iron, finished with an epoxy coating both inside and out.

Specifications

Size	2"	3"	4"	6"	8"	10"
Performance						
Min Flow GPM ± 5%	5	14	21	53	88	141
Low Flow GPM ± 2%	20	53	79	198	330	530
Rec Cont Flow GPM ± 2%	132	352	528	1320	2200	3520
Peak Flow GPM ± 2%	308	660	1100	2200	3960	5280
Pressure Loss Peak (psi)	1.7	1.5	0.7	0.4	0.7	0.4
Max Operating Pressure (psi)	150	150	150	150	150	150
Max Operating Temp (°F)	120	120	120	120	120	120
Registration						
Smallest Readable Amt (USG)	10	10	10	10	10	10
Capacity (Billions USG)	10	10	10	10	10	10
Smallest Readable Amt (m^3)	0.005	0.005	0.005	0.005	0.005	0.05
Capacity (Million m^3)	10	10	10	10	10	100
Physical Description						
Laying Length (Inches)	7.875	8.875	9.875	11.75	13.75	17.75
Weight (Lbs.)	24	33	42	66	106	187
Low Seped Reed Pulser						
US Gallons per Pulse	1000	1000	1000	1000	1000	10000
Cubic Meters per Pulse	1	1	1	1	1	10
High Speed Reed Pulser						
US Gallons per Pulse	1	10	10	10	10	100
Cubic Meters per Pulse	10	100	100	100	100	1000

Materials	
Body Case	Epoxy Coated Cast Iron
Top Plate	Brass
Gasket/O-ring	EPDM
Rotor	Plastic
Register	Plastic (Makrolon)
Register Housing	Brass

The register cover includes a drilled boss that can accomodate a padlock to prevent tampering.

Register. The six digit register is available in both USG and metric (cubic meter) registration. The register housing is completely separate from the measuring element, insuring a dry register.

Connections. The propeller meter incorporates round raised-face flanged connections conforming to ANSI specifications. Maximum recommended operating pressure is 150 psi.

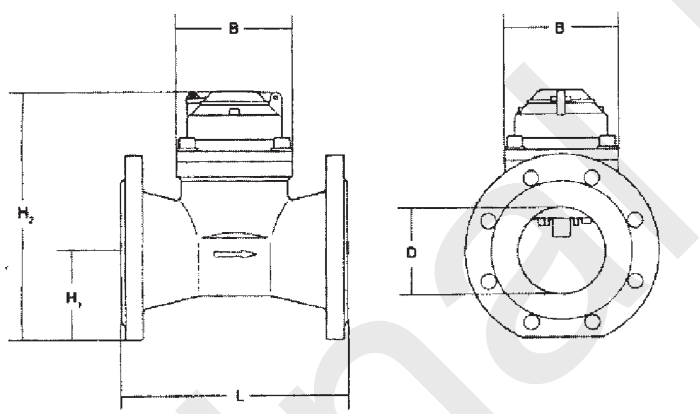
Dimensions in Inches (mm)

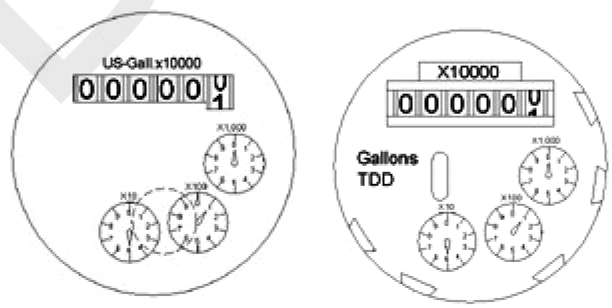
Meter Size	L	B	H_1	H_2
2"	7.875 (200)	5.125 (130)	2.835 (72)	5.125 (130)
3"	8.875 (225)	5.125 (130)	3.750 (95)	9.875 (250)
4"	9.875 (250)	5.125 (130)	4.125 (105)	10.250 (260)
6"	11.750 (300)	5.125 (130)	5.315 (135)	11.375 (290)
8"	13.750 (350)	5.125 (130)	6.300 (160)	12.375 (315)
10"	17.750 (450)	5.125 (130)	7.875 (200)	14.000 (355)

Pulser. **(Low Speed)** An optional reed switch pulser may be ordered with the meter or may be retrofitted at any time. The pulser outputs one pulse per 1000 gallons or one pulse per 1000 liters (one pulse per 10,000 liters for the 10" meter), depending on the registration. The maximum voltage for the pulser is 24 VDC. Maximum current is 100 mA and the internal resistance is 100 Ohms. Approximately 10 feet of cable is supplied with the pulser.

Pulser. (High Speed) (opto-electronic -- PV14) This infrared optical sensor is powered by 12 to 24 VDC, 15/25 mA max. power from an external source, 15 ohm line resistance core. The pulse is provided at a 50/50 open/closed ratio. This is a three-wire system, red wire +12/24 VDC Power, white wire-signal, black wire-ground. The following are the outputs per size:

2"	1 pulse = 1 US Gallon/10 Litres
3"-8"	1 pulse = 10 US Gallon/100 Litres
10"	1 pulse = 100 US Gallon/1000 Litres





The company's policy is one of continuous product improvement and the right is reserved to modify the specifications contained herein without notice. These products have been manufactured with current technology and in accordance with applicable AWWA Standards.

AMCO

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R1000-100/01-03

MAGNETIC METER CUT SHEETS

accuMAG™ Register

Technical Report

THE ACCUMAG ELECTRONIC REGISTER

The Sensus accuMAG Register provides the enhanced features and benefits that are available with the Sensus ICE Register. The register is fully compliant with ANSI/AWWA Encoder Standard C707-10.

The Sensus accuMAG electronic register is available in either a non-submersible (i.e. weatherproof) or a submersible (i.e. waterproof) enclosure. The register may be mounted directly to the meter or remotely. The remote register can be located 30 to 75 feet from the meter. The display contains AMR or Totalization and a high-resolution Resettable Test Totalizer. The accuMAG register features:

- AMR resolution units – fully programmable
- Pulse output units – fully programmable
- Integral resettable accuracy testing feature
- Two electronic outputs – enable links to AMR/AMI systems and SCADA systems at the same time
- Large, easy-to-read LCD
- Standard display shows net totalization or AMR digits and flow rate
- Custody transfer application displays forward (+) and reverse (-) flow totalizer
- Field replaceable batteries

Waterproof enclosure

Remote Non-submersible enclosure

ASCII-BASED PROTOCOL FOR COMPATIBILITY WITH OTHER BRANDS OF READERS

The Sensus accuMAG Register extends the use of the ASCII-based communication protocol first utilized by Sensus in 1984. The meter reading data, which consists of the odometer reading and register ID number, are transmitted in ASCII code, the standard data code used by most of the data communications industry. ASCII encoding methodology requires that a complete reading of a register wheel contain 10 bits of information, which includes a "start, "stop" and a "parity" bit. The parity bit is used as a self-check to insure that the interrogation device has correctly received the data from each wheel.

accuMAG Register Display

Although additional data fields have been incorporated, it can be read by any handheld or AMR reading device that could read ICE or OMNI registers. Now widely considered to be the defacto industry standard, the Sensus 3-wire AMR interface protocol is made available free of charge to other AMR equipment manufacturers, thereby promoting accuMAG register compatibility with present and future AMR networks.

IMPROVED RESOLUTION FOR TESTING AND VISUAL READING

With its eight odometer digits and resettable test totalizer, testing the accuracy of an accuMAG water meter fitted with the electronic register is greatly enhanced. Visual readings in the test mode are more precise by a factor of one hundred, thereby enabling a precise comparison with the volume "standard" of the testing equipment. Decimal points on the dial face are used to separate whole units from fractional measurement units. Following tradition, the meter's unit of measurement, gallons, cubic feet, imperial gallons, or acre feet, is displayed on the register face.

PERMANENT, FACTORY-SET ID NUMBER

The accuMAG electronic register incorporates a unique, never – duplicated identification number that is factory-set into the register's non-volatile electronic memory. The exclusive ID number can be used to identify a particular meter and link it in a utility's billing computer to the customer served by that meter.

UTILITY PROGRAMMABILITY

The Sensus accuMAG electronic register has four data fields that can be programmed by a utility for incorporating and gathering useful information.

One field could be used to identify the register's unit of measurement. Another to identify a reading multiplier. A third, 12-character field could be used to incorporate a unique ID number. And lastly, a 20-character alphanumeric data field could be used to indicate meter size, a customer account number or address, or to identify the utility to protect against inadvertently picking up readings from an adjoining utility's meters.

TWO OR THREE-WIRE REGISTER INTERROGATION TECHNOLOGY

The Sensus accuMAG electronic register can be interrogated in either two-wire mode or three-wire AMR mode, which makes it totally compatible for incorporation into existing systems such as two-wire TouchRead or three-wire RadioRead, or fixed base systems. This feature makes it easy and economical for a utility that starts out with a TouchRead System to easily upgrade to a more-advanced AMR system without having to replace the registers on its meters.

WATERPROOF ENCLOSURE

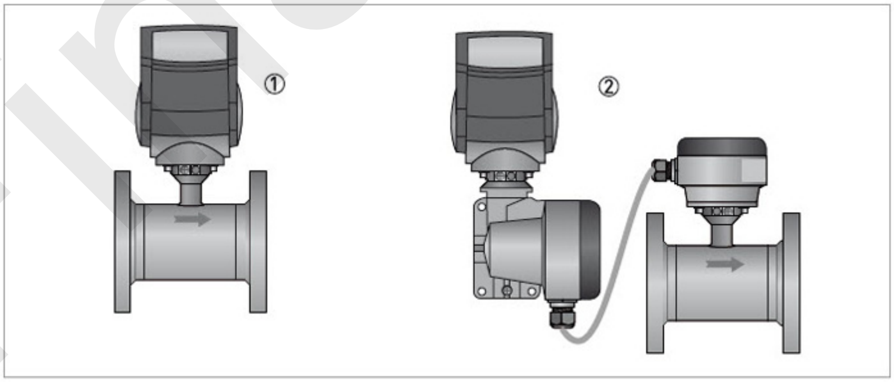
An important requirement for insuring meter reading integrity and accuracy is to protect a register's electronic components from moisture, dirt, sunlight and mechanical damage. This is crucial for meters installed underground in meter boxes and vaults that are subject to flooding, as the potential exists for moisture to pass through a register's cover and damage its electronic components. The accuMAG waterproof electronic register protects the electronic components from moisture in pit sets up to four feet in depth.

PROTECTION OF WIRING CONNECTIONS

Another important requirement for maintaining reading integrity is to insure that wiring connections are protected from moisture, and especially critical for providing long-term operational stability in pit-set environments. To prevent moisture-infiltration, connection components on Sensus accuMAG waterproof electronic registers utilize special waterproof connectors.

DOCUMENTATION

For more detailed accuMAG meter information, please see the Sensus website at www.sensus.com.



① Attached non-submersible
② Remote mounted non-submersible

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elster

evoQ$_4$

Electromagnetic Water Meter

Make every drop count

www.elsteramcowater.com
www.elster-evolution.com

evoQ_4 Electromagnetic water meter

Today's water meters need to be more reliable, accurate and durable with advanced flow technology that has the capability to capture revenue while reducing overall operating costs. The evoQ_4 provides a total solution for commercial water utility metering, by filling the needs of turbines, compounds, single jets and electromagnetic.

With advanced measurement and flow technology, the evoQ4 battery powered mag meter delivers high accuracy through a wide range of flows and varied conditions and applications. Typical accuracy performance ranges from 99.25% to 100.75% (+/- 0.75% error) of true value through the normal flow range.
The meter line can be sized to suit either predominantly high or low flow rates, and is ideal for a wide variety of bulk flow metering applications, such as network monitoring, leakage detection and commercial billing.

Reliable connectivity
With a choice of bi-directional pulse or encoded outputs, the evoQ4 provides dependable connectivity to critical distribution management and billing systems, including AMR and data-logging devices. The evoQ4 is compatible with evolution™ AMI and other AMR/AMI devices.

Accurate measurement
The evoQ4 has a standard, continuous sampling rate of 0.5 second, so you can be confident of accurate and reliable measurement. It also features anticorrosive electrodes to ensure consistently accurate performance throughout its entire life.

Durability
The evoQ4's tough stainless steel construction ensures a long, corrosion-free working life, while its lightweight body makes storage, transportation and installation both simpler and safer.
An IP68 rating provides protection for internal electronics meaning long-term reliability.

Zero maintenance
Designed without moving parts and a 10-year battery life, the evoQ4 is maintenance free, eliminating regular battery change outs and calibration often required with mechanical and electromagnetic meters.

Real-time data
A large, bright and easy-to-read LCD, displays volume and instantaneous flow rate for referrence The evoQ4 also has alarm functions providing real time status, to ensure no loss in measuring continuity.

Easy access
The evoQ4's optional remote display unit provides a clear LCD for simpler access in hard-to-read applications. The unit also includes two pulse outputs for connection to ancillary devices such as AMR or process monitoring devices.

Low pressure loss
An unrestricted flow tube ensures minimal pressure loss, even at the highest flow rates. This means that overall network system pressures can be reduced, lowering energy expendatures, reducing the occurances of burst pipes and extending the useful life of pumping stations.

Simple installation

Installation of the evoQ4 is simple. Just fit and go, no need for grounding rings or programming with a laptop in a vault. The evoQ4 comes in AWWA C701 Class II Turbine meter lay lengths. The flanges are epoxy coated cast iron to reduce weight and prevent corrosion. The 1.5 and 2" comes with an oval flange and the 3" and larger meters come with a round flange. All flanges conform to ANSI B16.1 Class 125 standards.

evoQ4 AL (Alternate Length)

The evoQ4 meter is now available in alternate lengths for 1.5 and 2" meter installations. The lengths are typical of C700, C702 and C712 lay lengths to facilitate direct replacement of mechanical meters without the added expense of makeup spool pieces. Additionaly, these meters feature a shorter height dimension, fitting into tight spaces. The complete suite of output modules is available to provide remote display or AMR / AMI functionality.

evoQ4 FSM (Fire Service Meter)

As an optional feature, the evoQ4 comes with a full FM Standard 1044 approval for use as a fire service instrument. Replace those monstrous mechanical fire service assemblies with an easily fit solid state meter.

System options

1. Display only
Simple, visual read meter only with no output communications. Pulse or encoder output can be easily added through upgrade in-the-field with option 2 or remote and pulse with option 3.

2. Pulse or encoded output meter
As above with the addition of a plug and play pulse or encoder output transmitter for connection to ancillary devices including AMR, data-loggers or remote monitoring system.

3. Meter + remote display
As in option 1 with the addition of a pulse output and remote display unit (pictured right) connected electronically to the meter. The remote display features two pulse output channels.

Display functions

Volume – the net volume of water measured is diplayed.

Flow Rate – If water is flowing in the reverse direction a minus sign is displayed to the left of the value.

Low-Battery – The indicator appears when the battery voltage is low and the meter should be replaced.

No-Water – The indicator blinks when there is an empty pipe condition in the meter.

Comparison mechanical commercial meters

		evoQ_4	AWWA C701 Turbine	AWWA C702 Compound	AWWA C712 Single Jet
1.5″	AL Low Flow (gpm)	1/2	4	N/A	1/2
	Continuous Flow (gpm)	176	80	N/A	50
	High Flow (gpm)	220	160	N/A	10
	Weight	9.5	16	N/A	12
	Lay Length	13	13	N/A	13
	Operating PSI	150	150	N/A	150
	Warranty (years)	5	2	N/A	2
2″	Low Flow (gpm)	1/4	4	1/4	1/2
	Continuous Flow (gpm)	176	100	80	90
	High Flow (gpm)	220	160	160	160
	Weight	11	21*	51*	30*
	Lay Length	10	10	17	17
	Operating PSI	230	150	150	150
	Warranty (years)	5	2	2	2
3″	Low Flow	1/2	8	1/2	1/2
	Continuous Flow	440	350	175	160
	High Flow	550	435	350	320
	Weight	22.5	37*	92*	60*
	Lay Length	12	12	17	17
	Operating PSI	230	150	150	150
	Warranty (years)	5	2	2	2
4″	Low Flow	1.7	15	3/4	3/4
	Continuous Flow	700	650	300	250
	High Flow	880	750	600	500
	Weight	35.5	50*	134*	94*
	Lay Length	14	14	20	20
	Operating PSI	230	150	150	150
	Warranty (years)	5	2	2	2
6″	Low Flow	4	30	1 1/2	1 1/2
	Continuous Flow	1100	1400	675	500
	High Flow	1400	1600	1350	1000
	Weight	55.5	113*	165*	142*
	Lay Length	18	18	24	24
	Operating PSI	230	150	150	150
	Warranty (years)	5	2	2	2
8″	Low Flow	8	50	2	N/A
	Continuous Flow	2770	2400	900	N/A
	High Flow	3500	2800	1600	N/A
	Weight	81.5	177*	523*	N/A
	Lay Length	20	20	34.5	N/A
	Operating PSI	230	150	150	N/A
	Warranty (years)	5	2	2	N/A

* Average Weight of Each Manufacturer's Offering

The evoQ_4 is a single meter that meets the needs of traditional turbine, compound, single jet and mag meters.

Traditional electromagnetic meter comparison

Specifications	evoQ$_4$	Traditional Utility E-Mag
Power Options		
AC Only	No	Yes
AC Battery Back Up	No	Yes
Battery Only	Yes	Some
Battery Life	10 yrs	3 yrs (Maximum)
Reading Sample Rate	0.5 sec	15 sec
Reading Options		
Pulse Output	Yes	Yes
Encoder Output	Yes	Yes
4-20mA	No*	No*
Meter Accuracy		
Typical 4” meter		
Low Flow	1.7 gpm	5.9 gpm
Maximum Flow	880 gpm	704 gpm
Dimensions		
Lay Lengths	AWWA C701	Non-standard 4”
Weight	35.5 lbs	33 lbs
Approvals		
CE	Yes	Yes
NSF61	Yes	Yes
FM	Yes	Yes

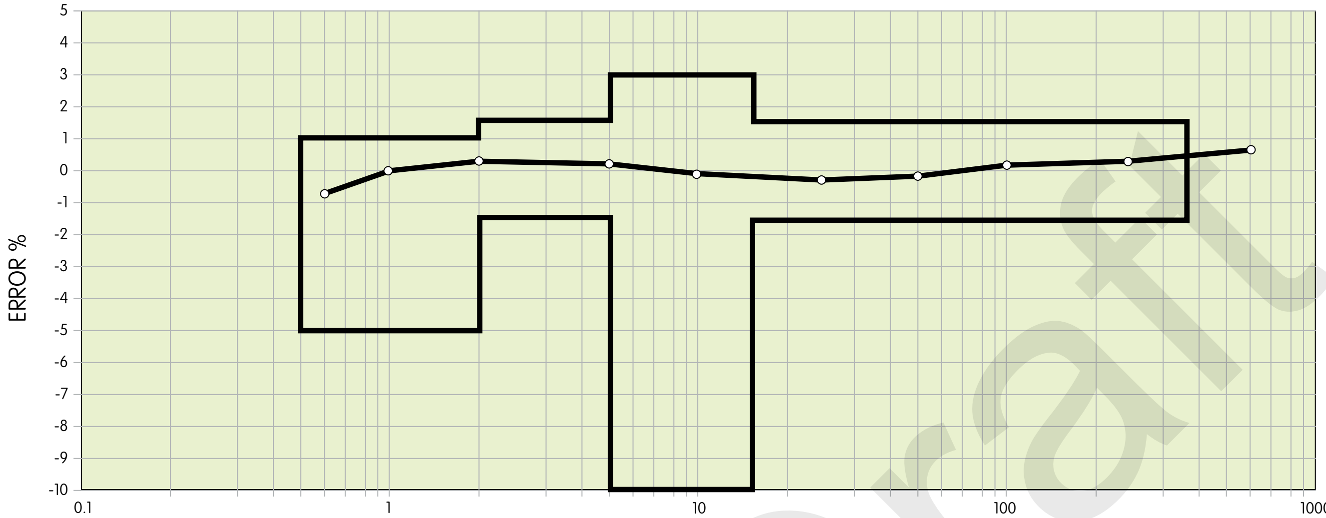
* 4-20mA output can be achieved with a converter

FM
APPROVED

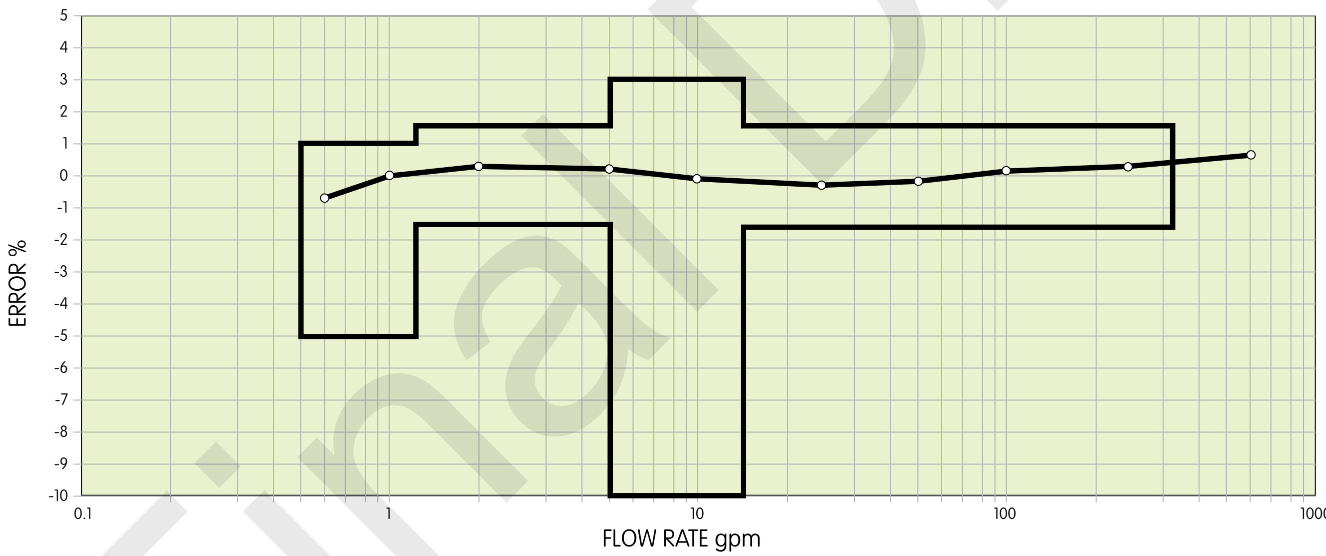
High accuracy measurement

C702 compound accuracy limits

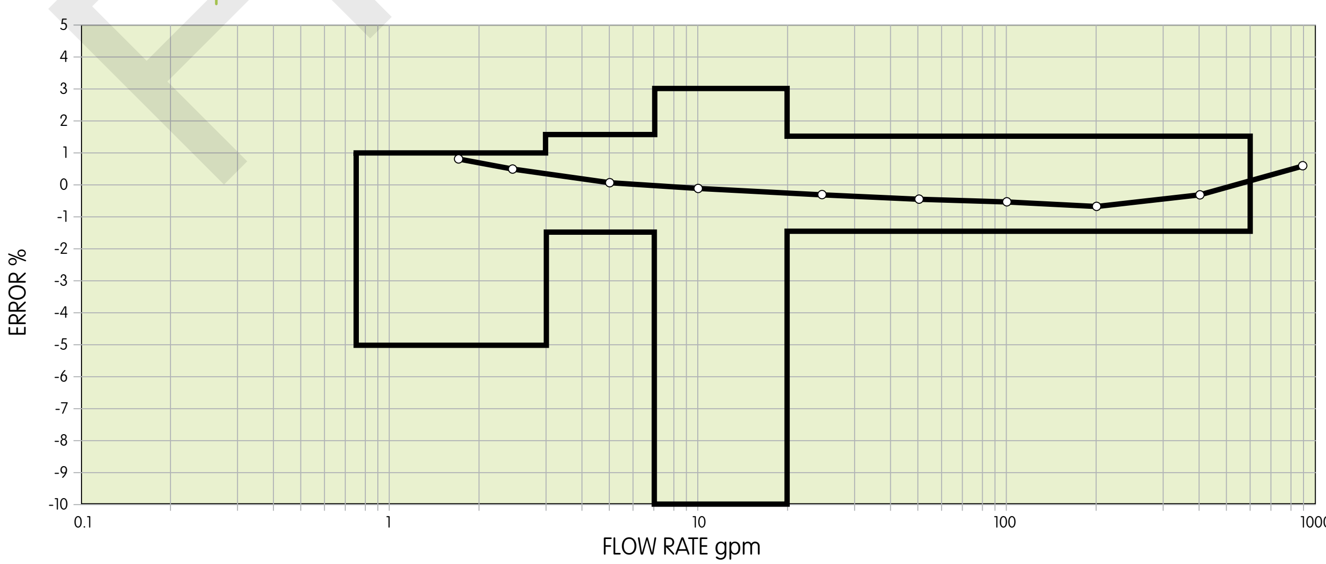
2" evoQ$_4$ vs C702 Accuracy Envelope



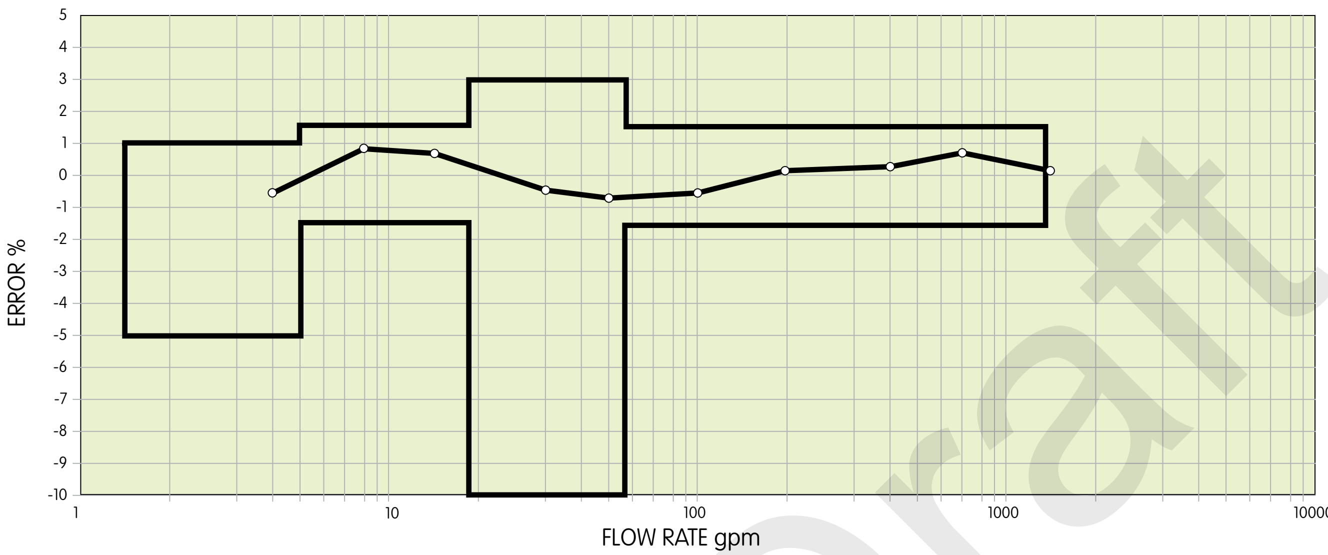
3" evoQ$_4$ C702 Accuracy Envelope



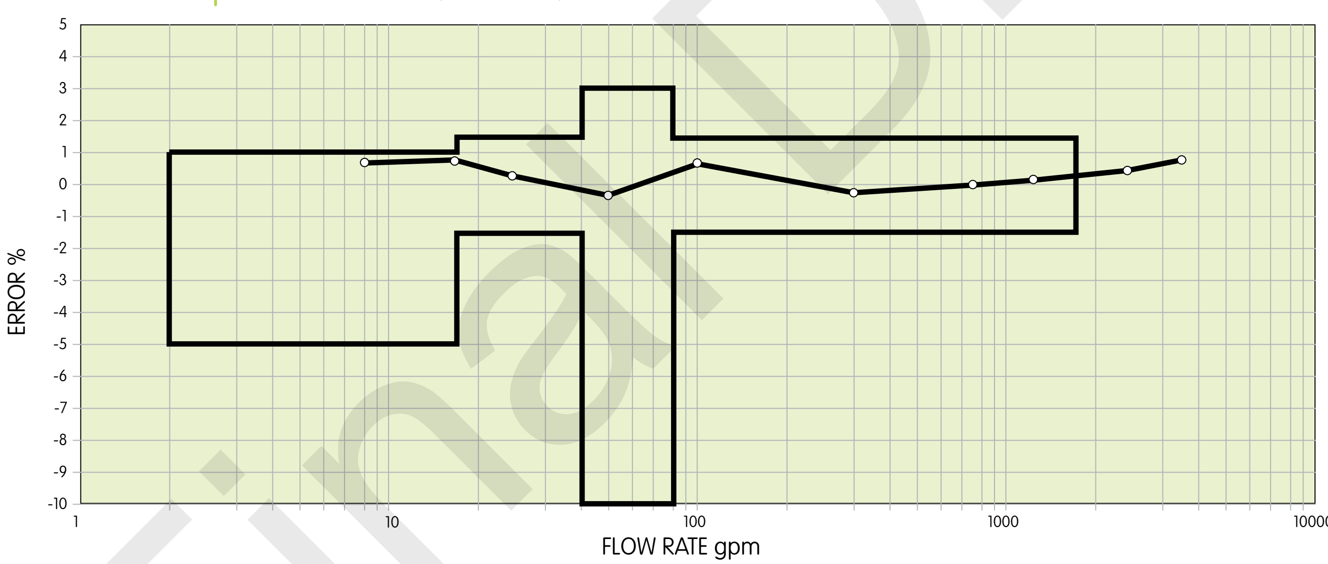
4" evoQ$_4$ C702 Accuracy Envelope



6″ evoQ$_4$ C702 Accuracy Envelope



8″ evoQ$_4$ C702 Accuracy Envelope



evoQ4 pressure loss

Size	Flow Rate (gpm)	Pressure Loss (PSI)
1.5″	220	4.35
2″	220	4.35
3″	550	3.62
4″	880	3.62
6″	1400	2.17
8″	3500	5.80

About Elster AMCO Water, Inc.

Located in Ocala, Florida, Elster AMCO Water is part of Elster, the world's largest metering and smart metering system solution company. Elster AMCO Water is an industry leader in the development and implementation of innovative metering and system solutions and is committed to delivering superior customer service, quality products, solutions and services to the water utility industry.

About Elster Group

Elster has delivered over 1.5 million smart metering devices worldwide with systems located in North America, Central America, Europe, Australia, New Zealand and the Caribbean. Elster smart metering systems allow utilities to implement energy conservation measures, demand response programs, smart grid initiatives, and smart home solutions as well as achieve operational efficiencies resulting in significant value creation across the utility enterprise. Elster has over 7,500 staff and operations in 38 countries, focused in North and South America, Europe, and Asia.

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Lit Ref: evoQ_4-101/03-09

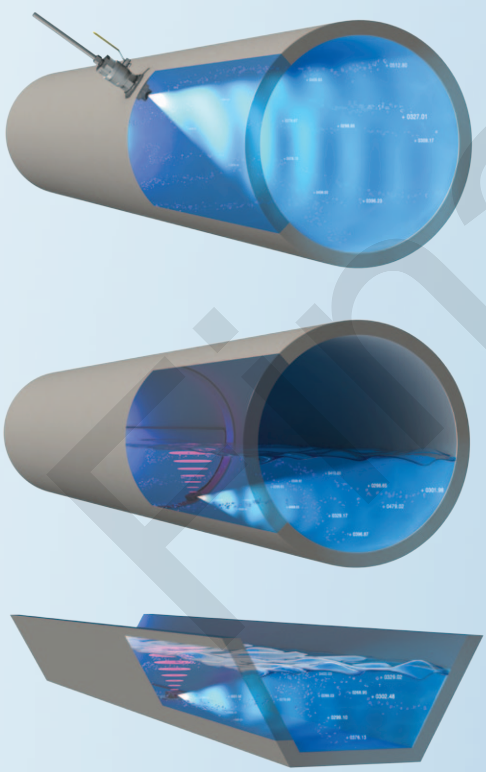
ACOUSTIC METER CUT SHEETS

AgriFlo XCi

DOPPLER ULTRASONIC WATER FLOW METER

Measure Agricultural Flows with MACE Doppler Ultrasonic Technology

in full pipes, partially full pipes
& open channels



www.maceusa.com

mace
Water Monitoring Solutions

Key Benefits

Multiple cards for multiple sensor applications

- 5 card slots allows control of up to 5 MACE Doppler sensors
- Choose cards and sensors for your exact requirements
- Compatible MACE cards:
  - Doppler, FloSI, Pulse I/O, WebComm.

High accuracy with NO moving parts

- Works great in dirty water and animal waste
- No more broken propellers – ever
- No more blocked pipes – ever

Measures flow practically anywhere

- Same insertion sensor will measure in full pipes 0.1 to 2.54m (4" to 100") diameter
- Area/velocity sensor will measure in partially full pipes 0.15 to 2.54m (6" to 100") diameter
- Open channel flow
  - regular cross-sections
  - irregular cross-sections

Low cost of ownership

- Economical to purchase and install
- Single unit with up to 5 Doppler sensors
- No moving parts - virtually maintenance-free
- No pipe blockages - less field maintenance

Versatile straight run requirements

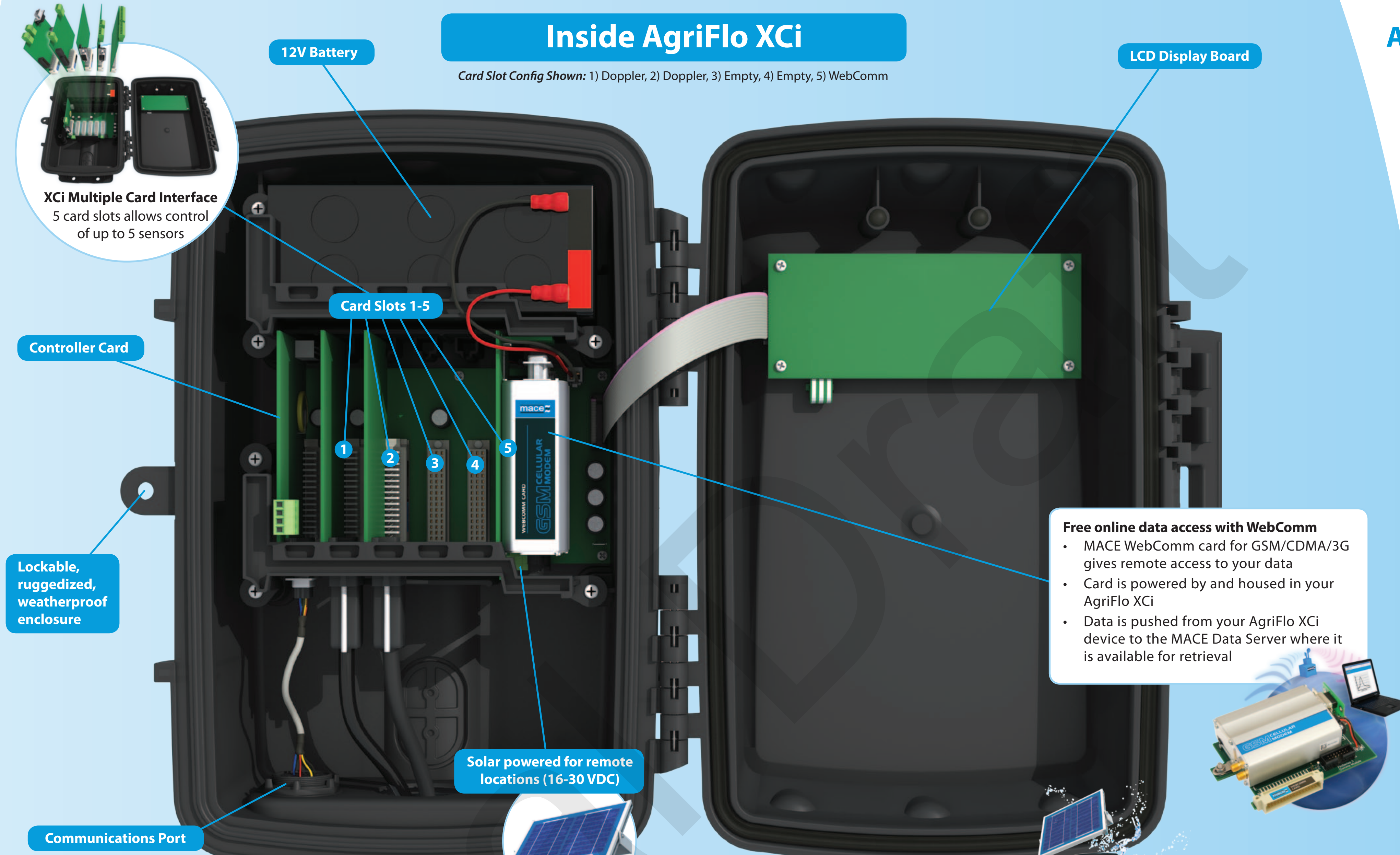
- Only 8 total diameters of straight run
- AgriFlo can "look" upstream or downstream
- Different sensor styles - versatile mounting options

Telemetry ready

- ModBUS
- SDI-12
- GSM/CDMA/3G WebComm card

Inside AgriFlo XCi

Card Slot Config Shown: 1) Doppler, 2) Doppler, 3) Empty, 4) Empty, 5) WebComm



Free online data access with WebComm

- MACE WebComm card for GSM/CDMA/3G gives remote access to your data
- Card is powered by and housed in your AgriFlo XCi
- Data is pushed from your AgriFlo XCi device to the MACE Data Server where it is available for retrieval

Configure with FloCom+ Software

- Free configuration and diagnostic software
- Powerful easy to use Windows® interface
- Painless point 'n' click channel calibration
- No proprietary coding knowledge required

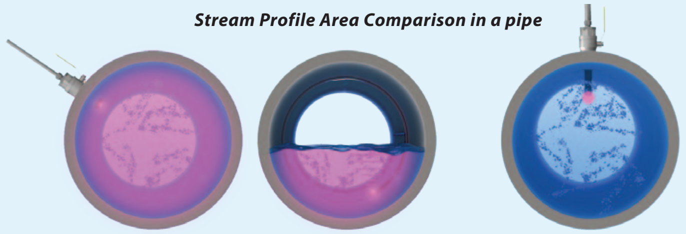
Ready-to-Go straight out of the box

- AgriFlo XCi comes complete with everything you need to get going as quickly as possible
- In most cases, you can be up and monitoring in just a couple of hours.

Total stream profile velocity measurement

In a full pipe, electromagnetic or mechanical insertion devices "see" a golf ball sized velocity profile and then use complex algorithms to calculate velocity. The MACE Doppler insertion sensor utilizes advanced spectrum signal processing to give a true average velocity across the whole stream profile.

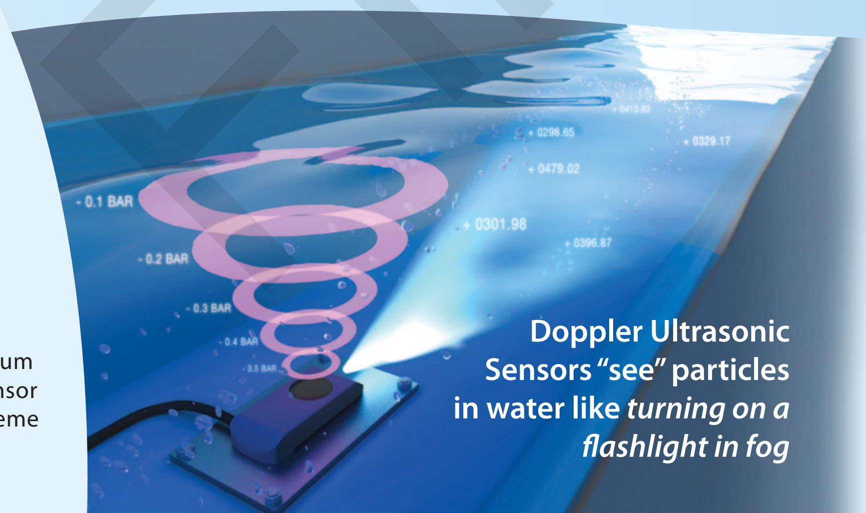
Stream Profile Area Comparison in a pipe



MACE Doppler Velocity Sensors full pipe/partially full pipe

Traditional Insert Sensor in a full pipe

In partially full pipes or open channels, the same advanced spectrum signal processing available with a MACE Doppler area/velocity sensor results in superior average velocity measurements even with extreme turbulence, or reverse flows.



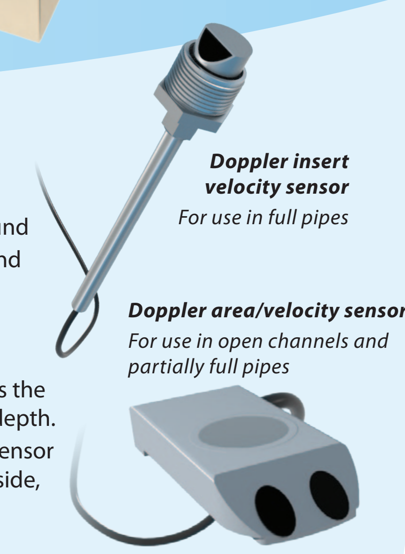
Doppler Ultrasonic Sensors

Velocity

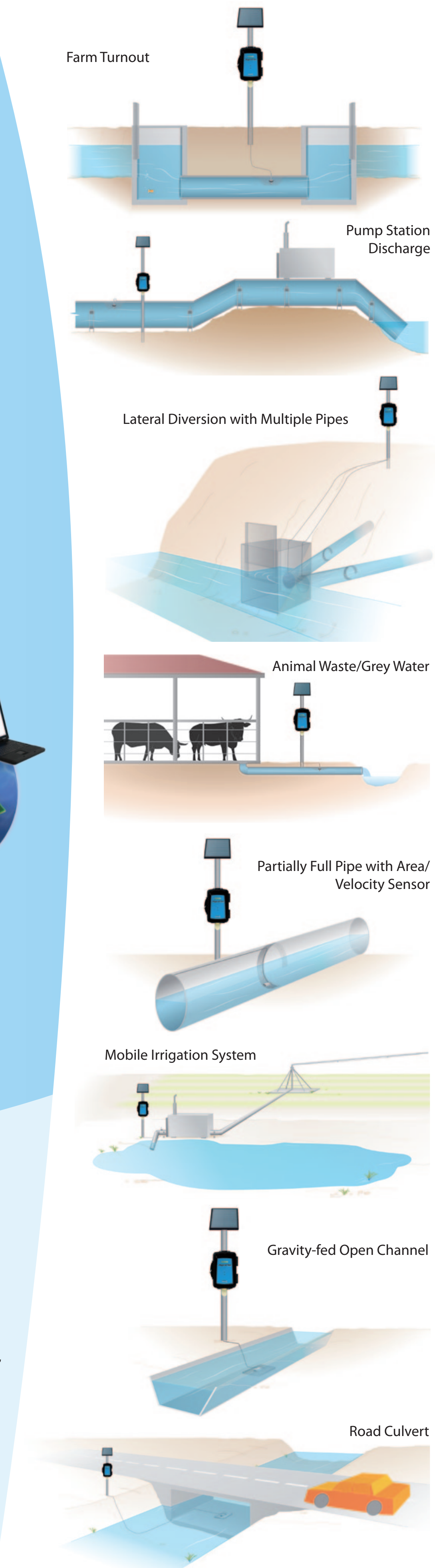
- Measured using continuous wave Doppler ultrasound
- Sound wave measures the speed of dirt, bubbles and other particles across the whole stream profile to calculate a true average velocity.

Integral Depth

- Integral hydrostatic ceramic depth sensor measures the "weight" of the water above it and converts it to a depth.
- Mounting versatility is the key. This style of depth sensor can be mounted on the channel bottom or on the side, away from sand & silt.



Applications for AgriFlo XCi



AgriFlo XCi Specifications

GENERAL

Weight	Approx. 5kg (11lbs)
Dimensions	36.5cm (H) x 26cm (W) x 17cm (D) 14.4" (H) x 10.2" (W) x 6.7" (D)
Enclosure rating	IP66
Enclosure material	UV stabilized polycarbonate
Operating temperature (with internal battery installed)	-15 to +50° C (5 to 122° F)
Operating temperature (with internal battery removed and external power used)	-20 to +65° C (-4 to 150° F)
Backlit display	16 character x 2 line alphanumeric LCD
Program memory	2 Mb flash (sufficient for 600,000 discreet readings)
Power	Internal 12Volt 7.2Ah battery with external solar panel or mains charger
Units of measure	User definable (metric/US)
Application software	FloCom+ PC software for system configuration, data downloading and velocity profile testing. Minimum system requirements - Windows® XP
Factory backup	24 month parts and labour guarantee

DEPTH MEASUREMENT

Method	Ceramic pressure transducer with large flat sensing diaphragm which allows straight, undeflected flow over the sensing area to reduce drawdown effects at high stream velocities and provides for self cleaning with an impervious Alumina ceramic surface.
Full scale range	4m (13ft) above the transducer face
Accuracy	0.2% of full scale at constant temperature in a static stream. 1% of full scale over a stream 5 to 55° C (41 to 130° F)
Resolution	1mm (0.04")
Overrange	60m (200ft) without damage
Minimum operating depth	17mm (0.67")

VELOCITY MEASUREMENT

Method	Submerged Ultrasonic Doppler
Range	±0.025 to ± 8.0 m/s (±0.08 to ± 26ft/s)
Resolution	1mm at 1.0 m/s (0.04" at 3.3ft/s)
Accuracy	±1% up to 3.0 m/s (±1% up to 10ft/s)
PVC sensor cable	9mm (D) up to 50m (L) (0.35" (D) up to 164ft (L))
Minimum operating depth	40mm (1.57")

AgriFlo XCi Compatible Cards [Please refer to the appropriate MACE card specifications brochure for further details]

DOPPLER CARD

This card supports one MACE Doppler insertion sensor or one MACE Doppler area/velocity sensor

FLOSI CARD

This card provides an SDI-12 or ModBus output to interface AgriFlo XCi to SCADA systems or 3rd party data loggers

PULSE I/O (INPUT/OUTPUT) CARD

This card powers (+5VDC or + 12VDC) a single pulsing flow sensor (Eg. MACE RotoFlo) and provides a pulse output. This also allows AgriFlo XCi the ability to sense pulses from non-MACE flow sensors.

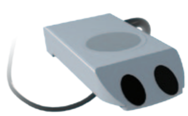
WEBCOMM CARD

This card provides AgriFlo XCi the ability to automatically upload internal logged data to the web-based MACE Data Server via mobile telephone networks.

AgriFlo XCi Compatible Velocity Sensors

DOPPLER INSERT VELOCITY SENSOR

For use in full pipes 0.1 to 2.54m (4" to 100") diameter	
Process fitting	2" BSP or 2" NPT
Shaft dimensions	33cm (L) x 2cm (D) 13" (L) x 0.8" (D)
Head dimensions	4.5cm (D) x 2.5cm (H) 1.8" (D) x 1" (H)
Pipe intrusion area	11.25cm^2 1.75 sq."



DOPPLER AREA/VELOCITY SENSOR (STRAP MOUNT)

For use in partially full pipes 0.15 to 2.54m (6" to 100") diameter	
Dimensions	12.5cm (L) x 5cm (W) x 1.6cm (H) 5" (L) x 2" (W) x 0.63" (H)
Pipe intrusion area	8cm^2 1.25 sq."

DOPPLER VELOCITY SENSOR (STRAP MOUNT)

For use in full pipes 0.15 to 2.54m (6" to 100") diameter	
Dimensions	12.5cm (L) x 5cm (W) x 1.6cm (H) 5" (L) x 2" (W) x 0.63" (H)
Pipe intrusion area	8cm^2 1.25 sq."

Note to end users: These specifications are subject to change at any time without notice. MACE takes no responsibility for the use of these figures. Please consult MACE for the latest specifications before using them in contract submittals or third party quotes etc. MACE reserves the right to change specifications without prior warning. All quoted figures are based on test conditions and are subject to variation due to site conditions.

Part No. 825-310 Rev. 2.0

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mace
Water Monitoring Solutions

Quote

Date	Quote #
5/26/2011	3925

MACE USA LLC
PO BOX 7144
OVERLAND PARK, KS 66207

Name / Address	Ship To

Project

Item	Description	Qty	Total
850-365	MACE FloSeries 3 - AgriFlo XCi	1	2,040.00T
850-328	MACE FloSeries3 - Doppler Velocity Module S/N	1	547.00T
850-112	Sensor - Insert 2 - 4m/s 10mCable - D9 - NPB - NPT	1	1,851.00T
814-017	MACE Solar Panel (for FloSeries 3) 12Volt/5Watt	1	270.00T
850-302	Mounting Kit - FloSeries 3 - device and solar panel	1	92.00T
850-363	MACE FloSeries 3 - USB External Comms Lead	1	144.00T
	Subtotal		4,944.00
Agriculture Discount	Agriculture Discount - 15%		-741.60
	Subtotal		4,202.40

Total $4,202.40

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888-440-4215	888-440-6999	kathy.peterson@maceusa.com	www.maceusa.com

SLIDE GATE CUT SHEETS

TABLE OF CONTENTS

KEY TO WATERMAN SLUICE GATE TERMINOLOGY

(applies to Series 3000 only this section)

PREFIX	SERIES	SUFFIX
Q = Flushbottom Seal	Gate I.D.	f = Standard Flangeback
S = Sluice Gate		ff = Extended Flangeback
C = Circular Opening		NRS = Non-Rising Stem
		Y = Self-Contained Frame
		X = Special Modifications

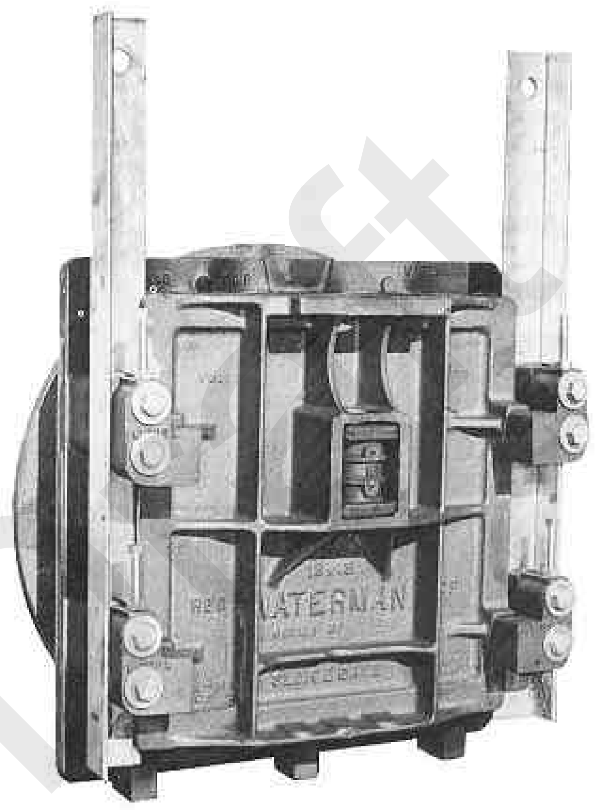
Example: QSC-3000-f-NRS-Y
Flushbottom Sluice Gate with Circular Opening, Standard Flangeback,
Non-Rising Stem, Self-Contained Frame

Note: Canal Gate Models and Terminology are identified on Canal Gate pages.

SERIES 3000 SLUICE GATE

CAST IRON
MEDIUM DUTY

- **Cast Iron Standard Flangeback, Extended Flangeback or Spigotback Frame**
- **Rectangular or Circular Openings**
- **Rectangular, Ribbed Slide for Rising or**
- **Non-Rising Stems**
- **Finished Iron or Bronze Seat Faces**
- **Galvanized or Optional Stainless Steel Structural Guide Rails and Fasteners**
- **Adjustable Side Wedge Assemblies**
- **Optional Adjustable Top and Bottom Wedge Assemblies (for gates wider than 24")**
- **May be Thimble, Wall or Flange Mounted**



SC-3000ff

Waterman Series 3000 Sluice Gates have been designed to give maximum water control service, operating at seating heads up to 50 feet and unseating heads up to 20 feet.

Gates have one-piece cast iron, standard flangeback, extended flangeback or spigotback frames. Slides (covers) have horizontal and vertical ribs, and cast side wedges. Fully adjustable, positive locking wedge blocks force the smoothly machined seats into a practical water tight closure (maximum clearance between faces: .004 inch). Adjustable top and bottom wedges augment the side wedges for unseating heads.

Heavy galvanized structural steel guide angles and bolts are furnished as standard. Stainless steel guides and bolts are optional and recommended for corrosive water conditions.

Bronze seat facings should be specified where the gate will not be operated for long periods of time or where salt water, industrial wastes or sewage will be handled.

APPLICATIONS

- Flood control projects
- Industrial and municipal treatment plants
- Drainage systems
- Reservoirs
- Fish hatcheries
- Canal and irrigation systems

Similar projects where operating conditions will be moderate and first cost is an important factor.

SERIES 3000 SLUICE GATE

FEATURES:

Gates with non-rising stems, flushbottom closures, self-contained frames and special downward opening models are available.

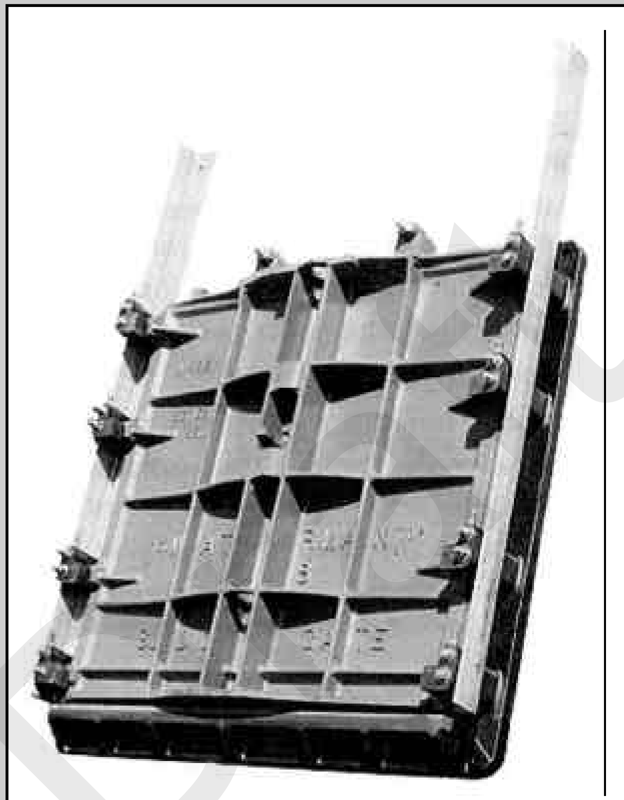
Side wedges are cast integrally with the cover. Wedge blocks are cast ductile iron. They easily adjust and are securely locked in position.

Top and bottom wedges are provided to meet higher unseating heads, are bolted to the frame and slide, and are adjustable.

A cast iron or bronze thrust nut is shipped with each gate and is threaded to fit the stem ordered with the gate. The thrust nut located in a reinforced pocket cast in the slide, is prevented from turning on the stem in rising stem model gates by set screws. (Pins or keys are optional.)

Slides for non-rising stem gates are supplied with a nut pocket located so as to provide a full gate opening without allowing the stem to extend into the waterway. The thrust nut on these units is threaded to receive the gate stem and travels up or down, operating the slide, as the stem is rotated.

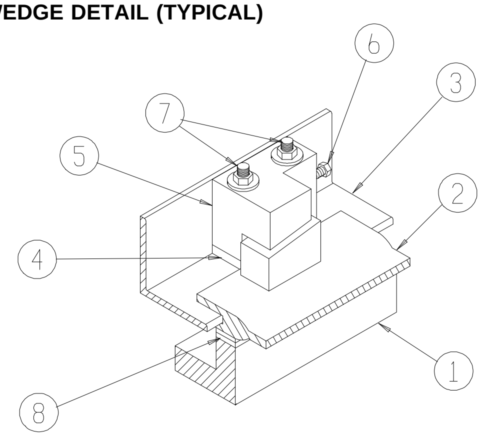
Gates with a self-contained frame (yoke) and lift are available with rising or non-rising stems. Flushbottom seals can be provided (see page 6). Downward opening models, special material combinations and coatings are also available.



QS-3000F
WITH TOP WEDGES AND FLUSHBOTTOM SEAL

SIDE WEDGE DETAIL (TYPICAL)

PARTS LIST	
No.	Name
1	Frame
2	Slide w/Cast-in Wedge
3	Guide Rail
4	Wedge Spacer
5	Adjustable Wedge Blocks
6	Adjusting Screw w/Lock Nut
7	Wedge Bolts
8	Seat Facings



SERIES 3000 SELF-CONTAINED SLUICE GATE

- **Galvanized or Stainless Steel Rails**
- **Rising Stem or Non-rising Stem**

The Series 3000-Y Sluice Gate (Y indicates self-contained frame and yoke) can be furnished with any of the options noted for the standard units and includes extended side rails, a structural steel yoke (headrail), stem, and lift. The thrust of operation is transferred directly to the yoke. Both rising stem (S-3000-RSY) and non-rising stem gates (S-3000 NRS-Y) are available.

Standard units feature galvanized steel structural guide rails and fasteners. Stainless steel may be substituted as an extra cost item. Minimum frame heights for openings are provided unless extended heights are specified.

Self-contained gates with rising stems can be installed where it is impractical to have independently mounted handwheel and pedestal lifts and can project above a headwall to give necessary operating clearance. Stems are cold finished steel with modified acme threads, secured to the slide (cover) with a thrust nut and operated by a cast bronze lift nut with suitable handwheel or geared crank lift. Stainless steel stems are optional.

Self-contained gates with non-rising stems are similar to rising stem units, but have a cast bronze thrust nut threaded to match the stem threads which travel up and down (operating the slide) as the stem is rotated. Non-rising stems are stainless steel unless specified otherwise. The thrust of the stem is transferred directly to the yoke (headrail) through a flange and thrust collar. Ball or roller bearings should not be used at the thrust flange if they will be submerged.

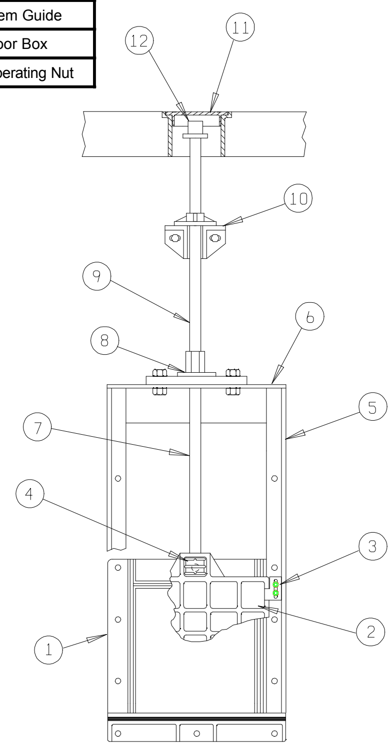
APPLICATION

A non-rising stem gate is used where a standard Series 3000 gate is required, and where it is desirable not to have the stem rise into walk-ways, roads, or other obstructions.

MODEL S-3000-NRS-Y (NON-RISING STEM)

PARTS LIST

No.	Name	No.	Name
1	Frame	7	Stem
2	Cover	8	Lift
3	Wedge	9	Extension Stem
4	Thrust Nut	10	Stem Guide
5	Guide Rail	11	Floor Box
6	Headrail	12	Operating Nut



Typical installation of S-3000-NRS-Y Gate with floor box, stem extension and coupling.

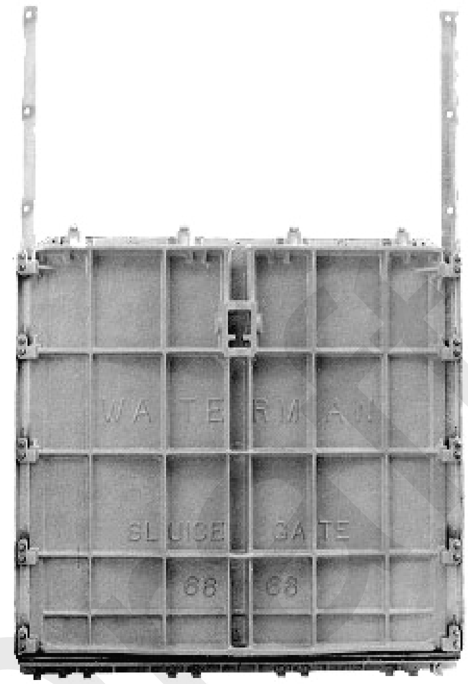
QS-3000 FLUSHBOTTOM SLUICE GATES

- **Maximum Flow**
- **Flushing Action**
- **Complete Drainage**
- **Lowest Invert**
- **Maximum Hydraulic Gradient**
- **Fully Contained Neoprene Bottom Seal**

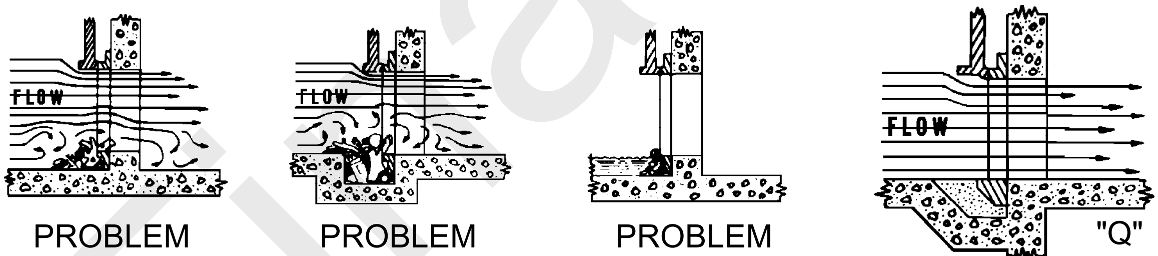
Use anywhere that an unimpeded flow, free of debris, is required. Use for maximum flow and minimum clearances in sewage disposal plants, filtration plants, drainage projects, settling tanks, flood control, distribution systems, etc.

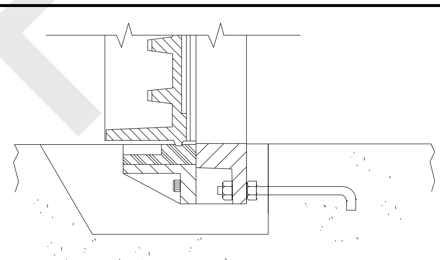
Waterman Series 3000 Cast Iron Sluice Gates in both rising and non-rising stem models are available with flushbottom openings. A neoprene seal confined on three sides in the frame bottom compresses upon contact with the blunt bottom edge of the slide, providing a tight seal. When open, the flat plane across the bottom provides unobstructed high capacity flow and flushing action.

The prefix "Q" indicates a flushbottom seal on your Waterman gate, i.e. - a "QS-3000-f" indicates a rectangular Sluice Gate with a flushbottom seal.



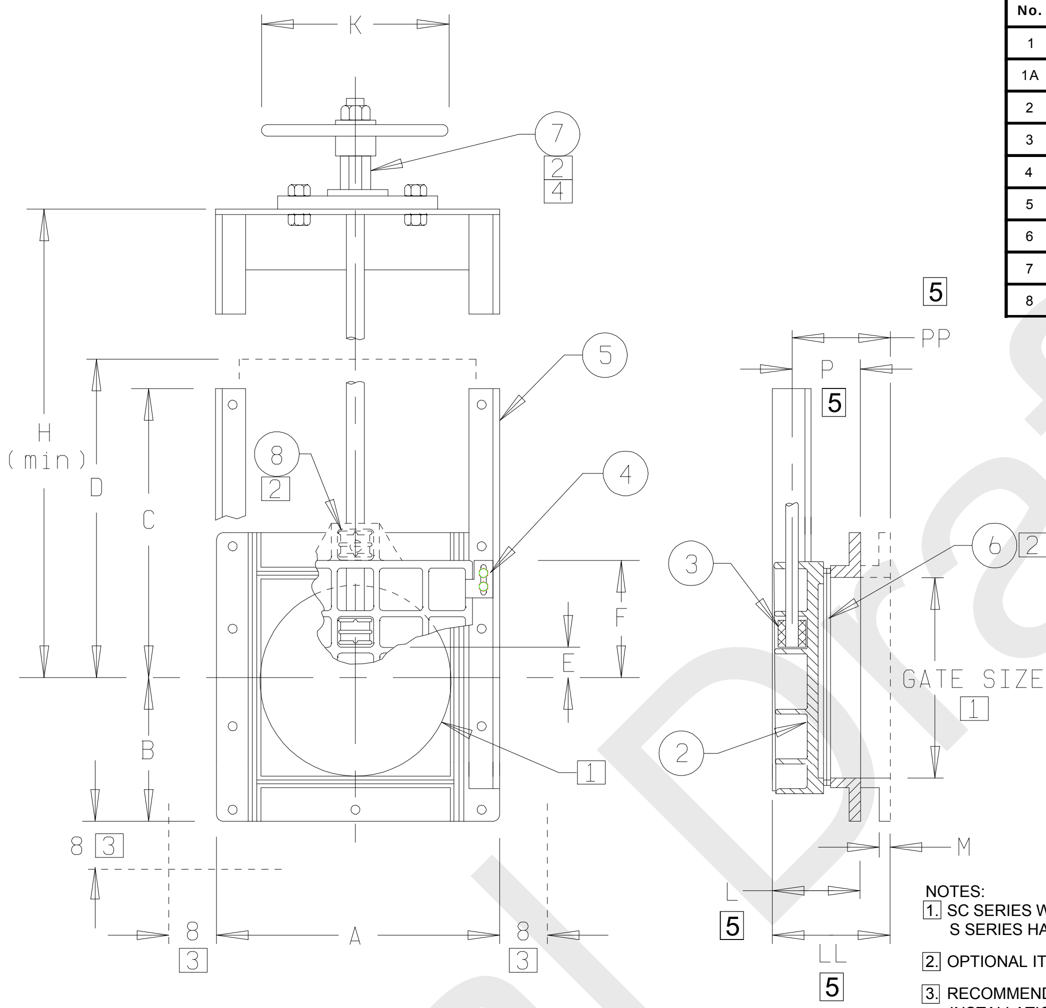
QS-3000F





SECTION THROUGH TYPICAL FLUSHBOTTOM, GATE CLOSED

SERIES 3000 SLUICE GATE



PARTS LIST	
No.	Name
1	Standard Flangeback
1A	Extended Flangeback
2	Cover
3	Thrust Nut
4	Wedge Assembly
5	Guide Rail
6	Bronze Seats (Optional)
7	Self-Contained Frame w/Lift (Optional)
8	Non-Rising Stem (Optional)

NOTES:
1. SC SERIES WITH CIRCULAR OPENING SHOWN; S SERIES HAS SQUARE OPENING
2. OPTIONAL ITEMS
3. RECOMMENDED CLEARANCE TO ALLOW INSTALLATION OF ANCHOR BOLTS.
4. GEARED, CRANK TYPE LIFTS REQUIRED ON 54" AND LARGER GATES.
5. IF GROUT PAD MOUNTING IS USED, ADD GROUT THICKNESS TO DIMENSION.

GATE DIMENSIONS IN INCHES

GATE SIZE	A	B	C	D	E	F	H	J	K	L	M	P	LL	PP
12 X 12	19	9½	18	29	3½	6½	30	4¼	15	8	⅝	5	11	8
14 X 14	20¾	10⅜	21	33	1½	8	34	4¼	15	7½	⅝	4½	10½	7½
15 X 15	20¾	10⅜	21	33½	1½	8	34	4¼	15	7½	⅝	4¼	10½	7½
16 X 16	23¼	11⅝	21	35	2	8½	36	4¼	15	8	¾	5¼	11½	8½
18 X 18	24	12	22	38	6¼	9½	40	6	18	8½	¾	5½	12	9
20 X 20	26¾	13⅜	29	42	1½	12	44	6	18	8½	¾	5½	12	9¼
21 X 21	26¾	13⅜	29	42½	7½	12	44	6	18	8½	¾	5½	12	9¼
24 X 24	30	16	32	47	9	12½	48	6	24	9	¾	5¾	12¾	9½
30 X 30	38	19	37	56	5¾	16½	58	6	24	10	⅞	6	14	10
36 X 36	44	22	42	65	7	20	67	6	30	10	⅞	6¼	14½	10½
42 X 42	50¼	25⅛	45¾	74	8	23	76	NA	NA	11½	1	7	15½	11
48 X 48	57	28½	47¼	83	5½	26	85	NA	NA	12	1	7¾	16	11½
54 X 54	62½	31¼	64	93	15	29½	95	NA	NA	12½	1	7½	16½	11½
60 X 60	69	34½	70½	102	17¼	32	104	NA	NA	12½	1¼	7	16½	11
66 X 66	82	41	83	112	21	35	116	NA	NA	13½	1½	8½	17½	12½
72 X 72	81	40½	83	120	21	38	124	NA	NA	13	1½	8	17	12

NOTE: FOR PRELIMINARY DESIGN PURPOSES ONLY
DO NOT USE FOR INSTALLATION
UNLESS PART OF CERTIFIED & APPROVED SUBMITTAL

Waterman® INDUSTRIES, INC.

TYPICAL SPECIFICATIONS
FOR WATERMAN MODEL S-3000 SLUICE GATE

The sluice gates shall be Waterman Model S-3000 or approved equal.

General
The gates shall be self-contained with yoke and bench stand operators; self-contained with either non-rising stem extension (NRE) or rising stem extensions (RSE); or gates with minimum height frames and separate stem guides and operators, in accordance with requirements of these specifications. Grooves shall be cast on the vertical sides of the cover to match guide angles. The cover shall have horizontal and vertical stiffening ribs to withstand a maximum seating head of 50 feet or specific gate design and configuration shall be noted in gate schedule or as shown on plans.

Frame and Cover
The frame and cover (slide) shall be cast iron with machined seating faces. The frame shall be flatback, spigot back, or flangeback configuration as specified.

Grooves shall be cast on the vertical sides of the cover to match guide angles. The cover shall have horizontal and vertical stiffening ribs to withstand a maximum seating head of 50 feet or unseating head from 5 to 20 feet. For unseating head conditions greater than 5 feet, gates 24 inches wide or wider shall have adjustable bronze top and bottom wedges.

The guide rails and head rails shall be minimum ¼-inch thick galvanized steel, designed and built to withstand the total thrust of the gate slide due to water pressure and wedge action.

There shall be adjustable cast ductile iron wedges located along side of gate as required to insure proper sealing. The wedges, located on the cover shall be integrally cast with the cover. The frame wedges shall be attached to the guide rails with two bolts. The wedges shall have smooth bearing surfaces and shall be adjustable to insure effective contact between gate seating surfaces.

Flushbottom Closure
When a flushbottom closure in specified, a resilient seal shall be attached to the frame so that it is flush with the invert. It shall be supported by a cast iron bracket which shall be bolted to machined pads provided on the frame. The seal shall be held in place by a stainless steel bar which shall be bolted through the seal to the bracket with stainless steel fasteners. The cover (slide) shall be shortened and provided with a smooth, rounded surface along the bottom to depress the seal. When unseating heads are to be acting on a flushbottom gate, top wedges shall be added, but bottom wedges will not be required. Sealing pressure shall be varied by adjusting side and top wedges.

Stem
The stems shall be cold finished steel of suitable length and ample strength for the intended service. The stem diameter shall be capable of withstanding twice the rated out put of the operator at 40 pound pull, and shall be supported such that the l/r ratio for the unsupported part of the stem shall not exceed 200.

When a rising stem extension is used, the stem extension shall be supported such that a rigid installation shall be provided. Stem guides shall be spaced so that the l/r ratio of the stem does not exceed 200.

Operators
Manual operated lifting mechanisms shall be indicated on the plan drawings or specified in the gate schedule. Handwheel type lifts shall have threaded bronze lift nut to match stem. Threads shall be machine cut, acme type. An arrow shall be cast on the handwheel to indicate the direction of rotation to open the gate. A maximum effort of 40 pounds shall be required top operate the gate after it is unseated, based on the maximum specified operating head.

Materials
Frame, Cover (Slide), Handwheel - Cast Iron - ASTM A-126; Class B
Rails and Yoke - Galvanized Structural Steel - ASTM A-36, Galvanized per ASTM-A-123
Stem - Leaded Cold Rolled Steel - CF Steel ASTM A-108 Gr. 12L14
Assembly Hardware and Fasteners - Galvanized per ASTM A-153
Paint - Manufacturer's Standard or as specified.

Optional Items Include:
Bronze Seating Faces
Type 304 or 316 Stainless Steel Rails and Yokes
Stainless Steel (Type 304 or 316) or Brass Stems
Stainless Steel Assembly Hardware
Structural Steel pipe (w/cast iron brackets) NRE & RSE Stem Extensions
Total Galvanizing per ASTM-A-123 (Frame, Cover, Rails, Lift, Etc.)
Special Paint Finish; Coal Tar Epoxy, Polyamide Epoxy, Etc.

C-20
CANAL GATE

- 10 foot Unseated Head
- Rugged Cast Bronze Lift Nut
- Machined Cast Iron Seats, standard
- Rising Stems
- Adjustable Side Wedges
- Sizes 8" - 42" Available

USES:

The Waterman Model C-20 Canal Gate is made to fit the need for a moderate pressure cut-off where both moderate seating and/or low unseating pressures are encountered. Typical uses include installation in treatment plants, flood control projects, irrigation canals and diversion stands.

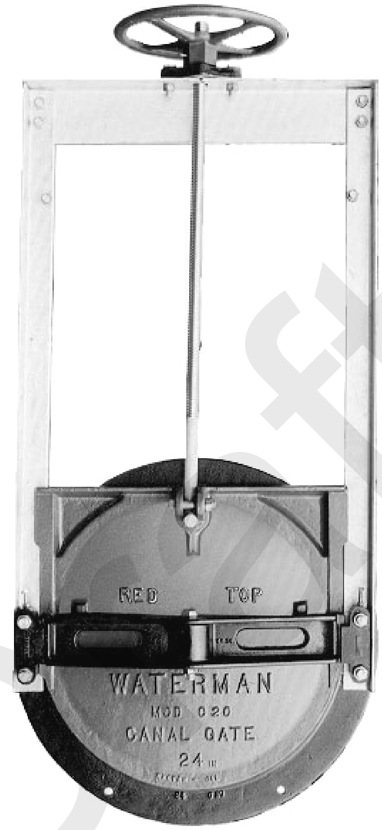
FEATURES:

Flatback gates for headwall mounting, spigotback models for attaching to corrugated metal pipe, or machined flangeback for mounting to pipe flange are available.

The cover, frame ring, adjustable wedges, arch, and handwheel are of cast iron. The lift nut is cast bronze and utilizes rugged acme type threads. The steel stem is secured to the cover by an easily removable pin to permit removal for maintenance. This feature also allows the user to stock standard frame length gates and provide field installation of rising stem extensions, where this is desirable.

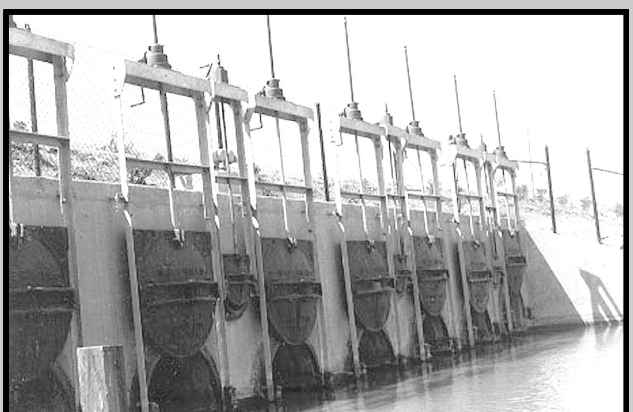
Flatback flanges with 25# or 125# ANSI standard drilling available on special order, but bolt holes must be located on vertical center line.

- Stainless Steel Guide Rails and Stem, optional
- Bronze Seats, optional
- 25# and 125# ANSI drilling, optional
- Total Galvanizing

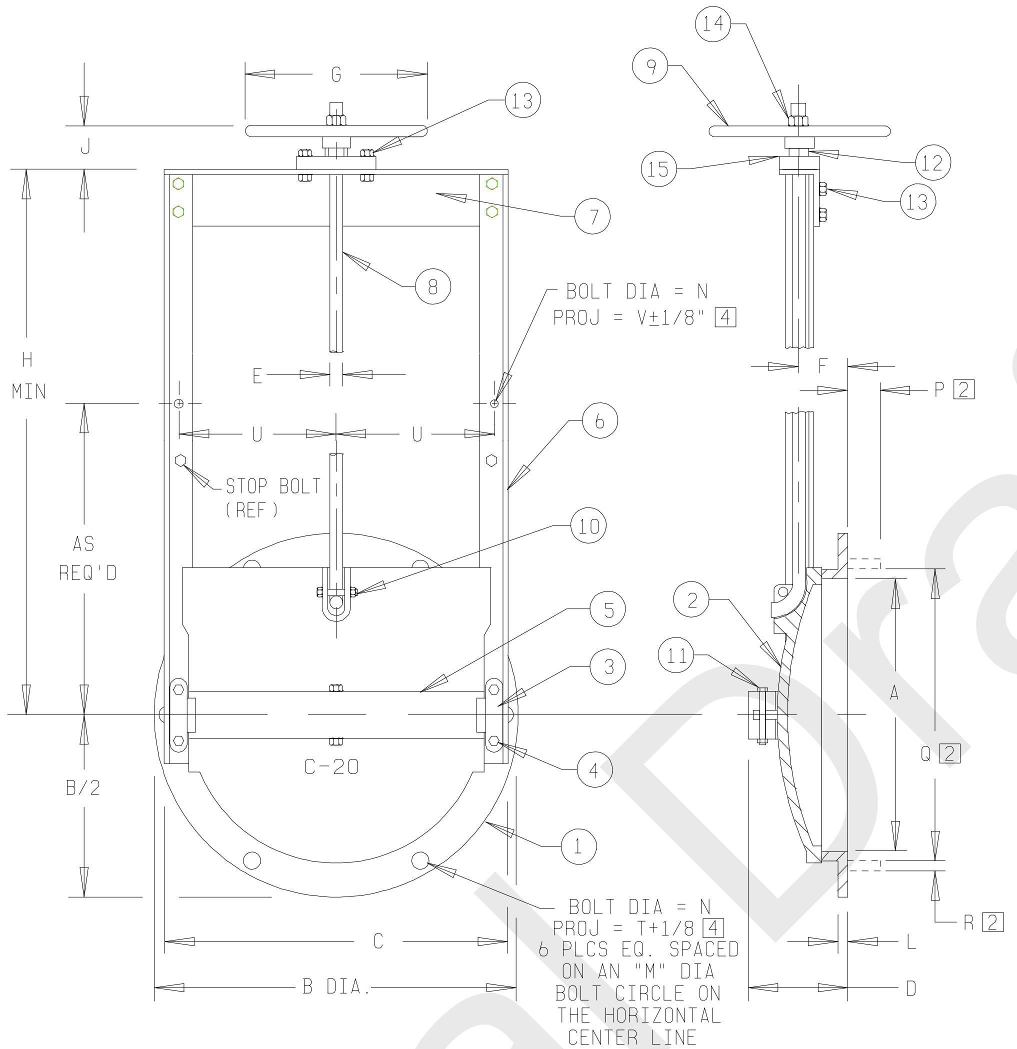


Model C-20f Flatback

RECOMMENDED MAXIMUM SEATING and UNSEATING HEADS		
GATE SIZE	RECOMMENDED MAXIMUM SEATING HEAD	RECOMMENDED MAXIMUM UNSEATING HEAD
8" TO 12"	35 FEET	10 FEET
14" TO 18"	32 FEET	10 FEET
20" TO 24"	26 FEET	10 FEET
30" TO 42"	20 FEET	10 FEET



C-20 CANAL GATE DIMENSIONS



NOTES

1. TYPE 2 lubricated ball bearing lift used on 42" gate.
2. Applies to spigotback gate only. Optional spigot, shown in phantom.
3. Drilling for mounting to 25 or 125 lb. pipe flange available for all gates. Due to gate design, bolt hole location (orientation) is straddle center drilling.
4. Add grout pad thickness to anchor bolt projection.

PARTS LIST	
No.	**Name**
1	FRAME
2	COVER
3	WEDGE (R & L)
4	WEDGE BOLTS
5	ARCH
6	GUIDE RAIL
7	HEAD RAIL
8	STEM
9	HANDWHEEL
10	STEM BOLT
11	ARCH BOLT & NUT
12	LIFT NUT
13	ATCH. HDW.
14	LIMIT NUT (optional)
15	LIFT COLLAR

GATE DIMENSIONS IN INCHES

A	B	C	D	E	F	G	H	J	L	M	N	P 2	Q 2	R 2	T	U	V
8	13½	13⅛	5⅞	⅞	3½	12	24	2⅞	⅝	11⁹⁄₁₆	½	2¼	9	⁵⁄₁₆	1½	5⁹⁄₁₆	3¾
10	16	14½	6	⅞	3½	12	24	2⅞	⅝	14	½	2¼	11	⅜	1½	6⁵⁄₁₆	3¾
12	19	17½	6¹⁄₁₆	⅞	3½	12	30	2⅞	⅝	16¼	½	2¼	13	⅜	1½	7½	3¾
14	21	19⅛	6⅜	⅞	3⅜	12	32	2⅞	⅝	18⅞	½	2¼	15	⅜	1½	8½	3½
15	22½	20⅝	6¾	⅞	3⅜	12	32	2⅞	⅝	20	½	2¼	16	⁷⁄₁₆	1½	9	3½
16	23 ½	21⅛	7⅛	⅞	3⅝	12	32	2⅞	⅝	21	½	2¼	17	⅜	1½	9⁹⁄₁₆	3¾
18	25	24	8⅛	1⅛	4⅜	15	36	4	⅞	23	⅝	2¼	19	⅜	2	10⅞	4½
20	27½	26	8¾	1⅛	4⅜	15	42	4	⅞	25⅛	⅝	2¼	21	⅜	2	11¾	4½
21	28⅛	26¾	9	1⅛	4½	15	42	4	⅞	26¾	⅝	2¼	22	⅜	2	12⅛	4¾
24	32	30¼	9⅜	1⅛	4¼	15	48	4	⅞	30	⅝	2¼	25	⅜	2	13⅞	4½
30	39⅛	36½	10	1½	5⅜	18	60	4½	1	37½	¾	2¼	31	½	1¾	17	4¾
36	46	42½	12	1½	4½	18	70	4½	1	43½	¾	2¼	37	½	2	20	4½
42 1	53	49¾	13½	1½	5⅝	24	84	6	1⅛	49½	¾	2½	43	⅝	2¼	23⅜	5¾

TYPICAL SPECIFICATIONS
FOR WATERMAN MODEL C-20 CANAL GATE

The canal gates shall be Waterman Model C-20 or approved equal.

General
The gates shall be self-contained with yoke and bench stand operators; self-contained with either non-rising stem extension (NRE) or rising stem extensions (RSE); or gates with minimum height frames and separate stem guides and operators, in accordance with requirements of these specifications. Specific gate design and configuration shall be noted in gate schedule or as shown on plans.

Frame and Cover (Slide)
The frame and cover (slide) shall be cast iron with machined seating faces. The frame shall be flatback or spigotback special mounting configuration as specified.

Grooves shall be cast on the vertical sides of the cover to match guide angles. The cover shall be of domed design to withstand a maximum seating head of 20 feet or unseating head of 10 feet.

The guide rails and head rails shall be minimum ¼-inch thick steel, designed and built to withstand the total thrust of the gate slide due to water pressure and wedge action.

There shall be one adjustable cast iron wedge per side, located on the horizontal centerline of the gate. A heavy cast iron arch shall be provided and bolted to the slide. The ends of the arch shall contain integrally cast wedges, which shall wedge in beneath the other half of the wedge system, attached to the guide rails with two bolts. The wedges shall have smooth bearing surfaces and shall be adjustable to insure effective contact between gate seating surfaces.

Stem
The stem shall be cold finished steel of suitable length and ample strength for the intended service. The stem diameter shall be capable of withstanding twice the rated out put of the operator at 40 pound pull, and shall be supported such that the L/r ratio for the unsupported part of the stem shall not exceed 200.

When rising stem extension is used, the stem extension shall be supported such that a rigid installation shall be provided. Stem guides shall be spaced such that the L/r ratio of the stem does not exceed 200.

Operators
Manually operated lifting mechanisms shall be indicated on the plan drawings or in the gate schedule. Handwheel type lifts shall have threaded bronze lift nut to match stem. Threads shall be machine cut, acme type.

An arrow shall be cast on the handwheel to indicate the direction of rotation to open the gate. A maximum effort of 40 pounds shall be required to operate the gate after it is unseated, based on the maximum specified operating head.

Material
Frame, Cover (slide), Handwheel - Cast Iron - ASTM A-126, Class B.
Rails and Yoke - Painted Structural Steel - ASTM A-36.
Stem - Leaded cold rolled steel - ASTM A-108, Gr. 12L14.
Lift Nut - Bronze - ASTM B-584, Alloy 836 or 865.
Assembly Hardware and Fasteners - Galvanized per ASTM A-153.
Paint - Manufacturer's Standard.

Optional Items Include:
Bronze Seating Surfaces
Galvanized Steel Rails and Yokes
Type 304 Stainless Steel Rails and Yokes
Stainless Steel (Type 304 or 316) or Brass Stems
Stainless Steel (Type 304 or 316) Assembly Hardware
Structural Steel Pipe (w/cast iron brackets) NRE & RSE Stem Extensions
Total Galvanizing per ASTM-A-123 (Frame, Cover, Rails, Lift, etc.)
Special Paint Finish; Coal Tar Epoxy, Polyamide Epoxy, etc.

C-10 CANAL GATE

- **Sizes 6" - 72"**
- **Attachments Available for**
  - **CMP**
  - **Concrete Pipe**
  - **Headwall**
  - **Plastic Pipe**
- **Seating Heads to 23 Feet***

This gate is designed for use on canal and pipeline systems which operate at low "heads" and where a moderately priced gate is desired. Typical installations include: farm turnouts, control of industrial wastes, drainage and for tide control.

Construction is of grey iron with an all-bolted steel frame with ¼" minimum thickness. The standard stem is of a special leaded steel which resists corrosion. The stem is operated at the structural frame top by a heavy cast-bronze lift nut and a cast iron handwheel.

Adjustable cast iron wedge blocks, held securely in place by two machine bolts, assure a dependable seating closure with a practical degree of water tightness. The cast iron seats are machined or ground. A solid rim "easy-grip" handwheel is standard.

Optional materials include: bronze seats; stainless steel structural frame and bolts; stainless steel or brass stems; and special epoxy, coal tar or galvanized coatings.

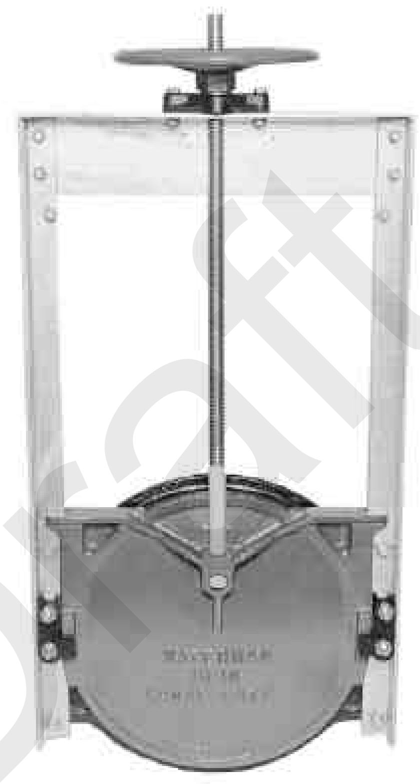
When desired, design variations in stem diameter, pitch and thread rotation are available to match existing equipment. Extended stems, special lifts, oil seals, stem guides and limit nuts are a few of the optional items available for use with these gates.

Frame Types for Various Installation Requirements

F-	Flatback for headwall mounting.
SB-	Spigotback for annular or recor spiral corrugated pipe.
CIP-	For solvent cement mounting onto plastic pipe.
C-	With galvanized steel tapered setting collar for concrete or asbestos cement pipe.
SA-	Spigot for annular corrugated pipe. (special order)
TYPE 4-	For mounting on plastic pipe utilizing special two part epoxy.

(See following pages for more detailed information.)

C-10

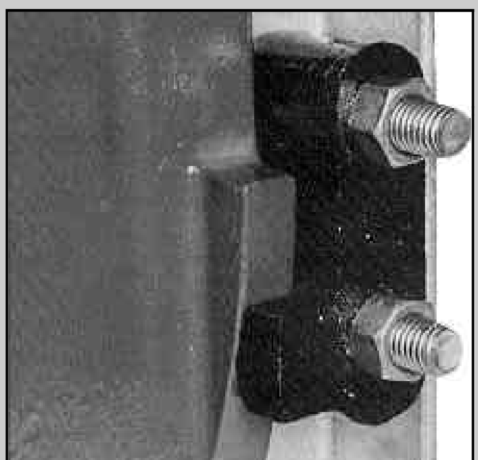


Note: Bronze Lift Nut furnished as standard on all Waterman Canal Gates

*** Recommended Maximum Seating Heads**

6" - 24"	23 Feet
30" - 36"	11 Feet
42" - 48"	9 Feet
54" - 72"	6 Feet

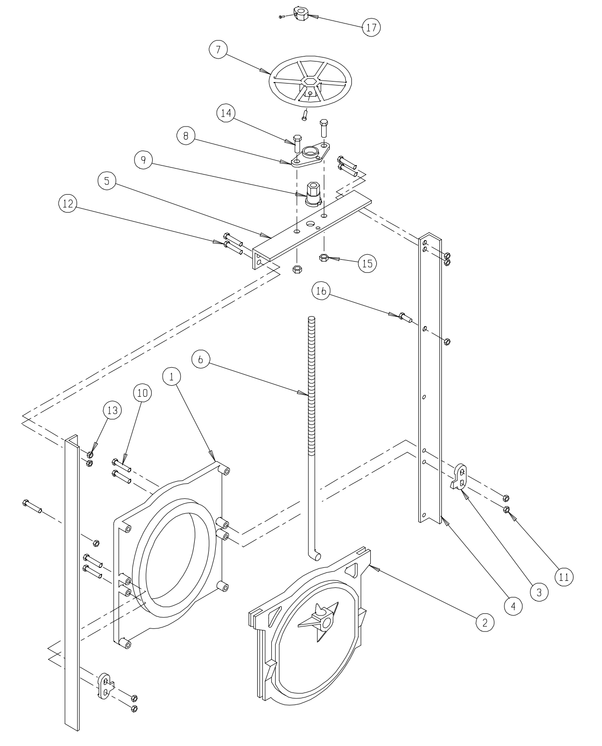
Recommended Maximum Unseating Head - 0



Waterman Model C-10 wedging system offers two point adjustment and larger wedging surfaces for a more positive contact.

Waterman INDUSTRIES, INC.

C-10 CANAL GATE PARTS



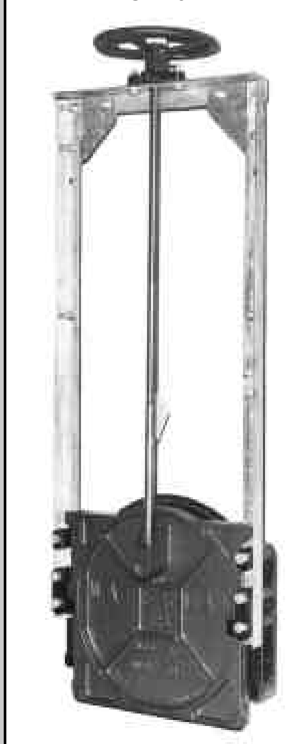
PARTS LIST		
No.	**Name**	**Qty.**
1	Frame	1
2	Cover	1
3	Wedge (R&L)	2
4	Guide Rail (R&L)	2
5	Headrail	1
6	Stem	1
7	Handwheel	1
8	Thrust Collar	1
9	Lift Nut	1
10	Wedge Bolt	4
11	Wedge Nut	4
12	Frame Bolt	4
13	Frame Nut	4
14	Collar Bolt	2
15	Collar Nut	2
16	Stop Bolt & Nut	1
17	Limit Nut (optional) *	1

* With set screw

CL-10 CANAL GATE

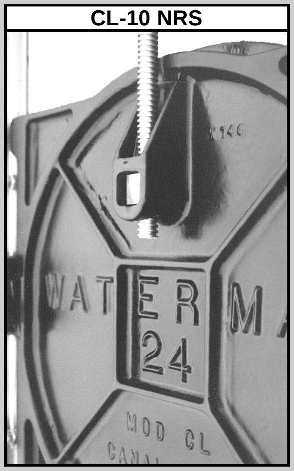
Waterman CL-10 Canal Gates are identical to our model C-10 Gates with the exception of the cast iron cover (slide) which is of a flat plate type construction with ribs reinforcing its face, to withstand the maximum heads as noted for our C-10 gates. This gate cover also features a square bottom design, which allows a more open "clog-free" flow at points of initial opening. The seat being only slightly raised above the cover plate surface helps prevent trash from collecting behind the cover which can cause difficulty in operation.

CL-10



Flat , Square Bottom Cover

CL-10 NRS



Available with threaded thrust nut for true NRS application. All parts are interchangeable with our Standard C-10 gate. Available in a variety of sizes.

C-10 CANAL GATE

NOTES

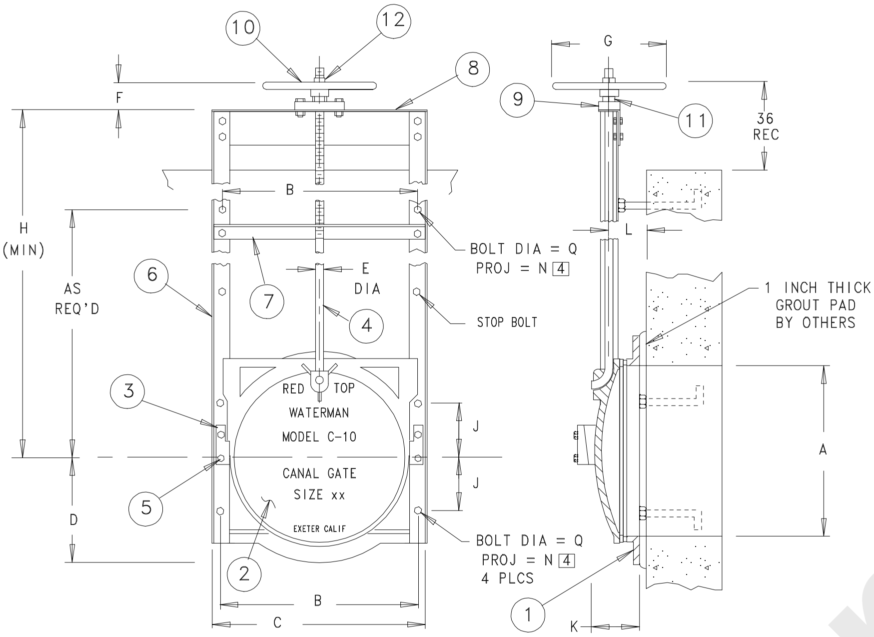
1. TYPE 2 lubricated ball bearing lift used on 48" and larger gates.

2. Applies to spigotback gate only. Optional spigot, shown in separate detail.

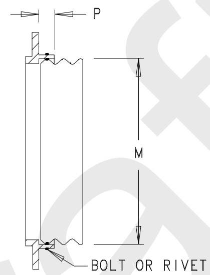
3. All dimensions are also applicable for model CL-10 & CM-10 when available.

4. Add grout pad thickness to anchor bolt projection.

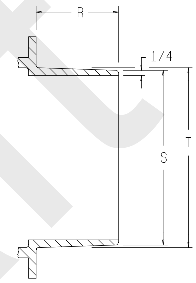
5. Type 3E 2:1 lift used, mounted to dual headrail.



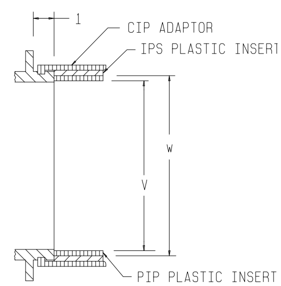
Wall Mounted Flatback Frame



Corrugated Pipe Attached to Spigotback Frame



Type 4 Spigot Frame



CIP Frame

PARTS LIST		
No.	Name	Qty.
1	Frame	1
2	Cover	1
3	Wedge (Right & Left)	1 ea.
4	Stem	1
5	Wedge Bolts	4
6	Guide Rail	2
7	Stem Support	A/R
8	Head Rail	1
9	Lift Collar	1
10	Handwheel	1
11	Lift Nut	1
12	Limit Nut	1

A	B	C	D	E	F	G	H	J	K	L	M 2	N	P 2	Q	R	S	T	V	W
6	8	9⅞	4	⅞	2⅞	10	24	3	3½	2⅝	7	3½	2¼	½	-	-	-	6.160	6.645
8	10	12	4⅞	⅞	2⅞	10	24	3	3¾	2½	9	3½	2¼	½	4	7¹³⁄₁₆	8	8.180	8.645
10	12	13⅞	6	⅞	2⅞	10	24	3½	3¾	2½	11	3½	2¼	½	3⅞	9⅞	10	10.220	10.770
12	14	15⅞	7	⅞	2⅞	10	24	4	3½	3	13	4	2¼	½	4	11⅞	12	12.270	12.780
14	16	17⅞	8	⅞	2⅞	10	27	4¾	3¾	3¼	15	4	2¼	½	-	-	-	-	-
15	17	18⅞	8⅞	⅞	2⅞	10	30	5	4½	3½	16	4	2⅛	½	4	14⅞	15	-	-
16	18¾	20⅝	9⅞	⅞	2⅞	10	32	5½	4½	3½	17	4½	2¼	⅝	-	-	-	-	-
18	21	22⅞	10½	1	3⅛	12	34	6	4½	4¼	19	4½	2¼	⅝	4	17¹³⁄₁₆	18	-	-
20	23¼	25⅛	11¾	1	3⅛	12	38	7	4¾	4	21	4½	2¼	⅝	-	-	-	-	-
21	24	25⅞	12⁵⁄₁₆	1	3⅛	12	40	7	4¾	4	22	4½	2¼	⅝	-	-	-	-	-
24	27¼	29⅛	13⅞	1	3⅛	12	44	8	5¾	4⅛	25	4½	2¼	⅝	-	-	-	-	-
30	33¾	36⅛	17⅜	1⅛	4	15	54	10	6	4½	31	6	2¼	¾	-	-	-	-	-
36	39¾	42⅛	20½	1⅛	4	15	62	12	6¼	5⅜	37	6	2⅛	¾	-	-	-	-	-
42	45¾	48⅜	23⅝	1½	5	18	84	14	7	6	43	6	2½	¾	-	-	-	-	-
48	51¾	54⅜	26¾	1½	6	24 1	90	16	7⅜	6⅛	49⅛	6	2½	¾	-	-	-	-	-
54	58½	61½	30	2	6	30 1	100	18	7⅞	6½	55⅛	7	3	1	-	-	-	-	-
60	65	68	34	2	6	30 1	102	20	8⅛	7⅛	61⅛	8	3¼	1	-	-	-	-	-
72	77½	80¼	41	2	13	5	121	25½	10⅝	8¾	73¼	8	3⅜	1	-	-	-	-	-

GATE DIMENSIONS IN INCHES

Waterman® INDUSTRIES, INC.

TYPICAL SPECIFICATIONS
FOR WATERMAN MODEL C-10 CANAL GATE

General
The gates shall be self-contained with yoke mounted bench stand operators with rising stem, or self-contained with either non-rising stem extension (NRE) or rising stem extension (RSE), or with separate stem guides and operators, in accordance with the requirements of these specifications. Specific gate design and configuration shall be as noted in gate schedule or shown on plans.

Frame and Cover (Slide)
The frame and cover (slide) shall be cast iron with machined seating faces. Seating surfaces of both frame and cover shall be assembled so that maximum clearance between seating faces shall be .004 when in fully closed and wedged position. The frame shall be flatback or spigotback, or other special mounting configuration as specified herein or shown on plans.

Grooves shall be cast on the vertical sides of the cover to match guide angles. The cover shall be of domed design to withstand maximum seating head as specified following:

Gate Size	Max. Seating Head (Ft.)
6" - 24"	23
30" - 36"	11
42" - 48"	9
54" - 72"	6

The guide rails and head rails shall be minimum ¼-inch thick structural steel, designed and built to withstand the total thrust of the gate slide due to water pressure and wedge action.

There shall be one adjustable cast iron wedge per side, located on the horizontal centerline of the gate. The cover wedge shall be integrally cast with the cover, while the other half of the wedging system shall be attached to the guide rail with two bolts. The wedges shall have smooth bearing surfaces and shall be adjustable to insure effective contact between gate seating surfaces.

Stem
The stem shall be cold finished steel of suitable length and ample strength for the intended service. The stem diameter shall be capable of withstanding twice the rated output of the operator at 40 pound pull, and shall be supported such that the L/r ratio for the unsupported part of the stem shall not exceed 200.

When rising stem extension is used, the stem extension shall be supported such that a rigid installation shall be provided. Stem guides shall be spaced that the L/r ratio of the stem does not exceed 200.

Operators
Manual operated lifting mechanisms shall be as indicated on the plan drawings or in the gate schedule. Handwheel type lifts shall have threaded bronze lift nut to match stem. Threads shall be machine cut, acme type, and right hand unless otherwise specified.

An arrow shall be cast on the handwheel to indicate the direction of rotation to open the gate. A maximum effort of 40 pounds shall be required to operate the gate after it is unseated, based on the maximum specified head.
The canal gates shall be Waterman Model C-10 or approved equal.

Materials
Frame, Cover (Slide), Handwheel - Cast Iron - ASTM A=126; Class B
Rails and Yoke - Structural Steel - ASTM 1-36
Stem - Leaded Cold Rolled Steel - ASTM A-108, Type 12L14
Lift Nut - Bronze - ASTM B-584, Alloy 844 or 865
Assembly Hardware and Fasteners - Galvanized per ASTM A-153
Paint - Manufacturer's Standard

Optional Items Include:
Galvanized Steel or 304 or 316 Stainless Steel Rails and Yoke
Type 304 or 316 Stainless Steel or Brass Stems
Stainless Steel Assembly Hardware
Structural Steel Pipe (w/cast iron brackets) NRE and RSE
Stem Extensions
Total Galvanizing per ASTM A-123 (Frame, Cover, Rails, Lift, Etc.)
Special Paint Finish: Coal Tar Epoxy, Polyamide Epoxy, Etc.

FC-10 CAST IRON COMBINATION DRAINAGE AND CANAL GATE

FC-10

- **Sizes 16" - 60"**

The Waterman Model FC-10 Combination Drainage and Canal Gate combines our Models F-10 Drainage Gate and C-10 Canal Gate in one convenient unit. When the unit is closed, the flap functions as an automatic drainage gate, permitting outflow and stopping backflow. The gate can be raised with the handwheel or other suitable lift to permit backflow when desired.

This gate can be installed in locations suitable for the Model F-10 and C-10 Gates, and has the same operating characteristics and limitations.

The gate is normally furnished with a self-contained frame and handwheel lift. Special short frames with optional lifts and extensions are available as well as the standard options used on our F-10 and C-10 Gates, such as stainless rails, bronze links, bolts and bushings, etc.

These gates are ideal for use in tidal basins, drainage, and certain industrial and water district applications where automatic control is usually desired, but where manual control is needed occasionally.

For more detailed information refer to the Drainage Gate Section of this catalog.

AFC-331 FABRICATED ALUMINUM COMBINATION DRAINAGE AND CANAL GATE

AFC-331

- Sizes 12" through 84"
- A corrosion-resistant rust-proof combination canal and automatic drainage gate.
- Prevents electrolysis associated with cast iron gates to aluminum pipe connections.
- J-Bulb neoprene adjustable seats provide excellent sealing against return flow.
- Frame, cover, retainer ring, hinge arm, and pivot lug are of aluminum alloy 6061-T6. Gate hardware is stainless steel.
- Heavy duty construction.
- Seating heads to 30 feet.

CM-10 CANAL GATE

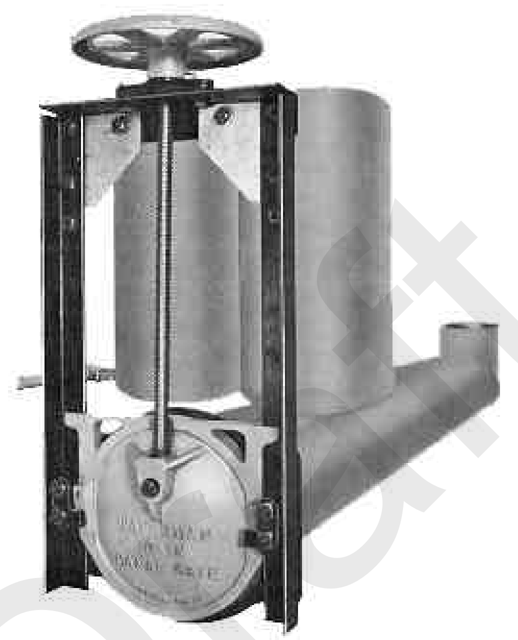
METER GATE INSTALLATIONS

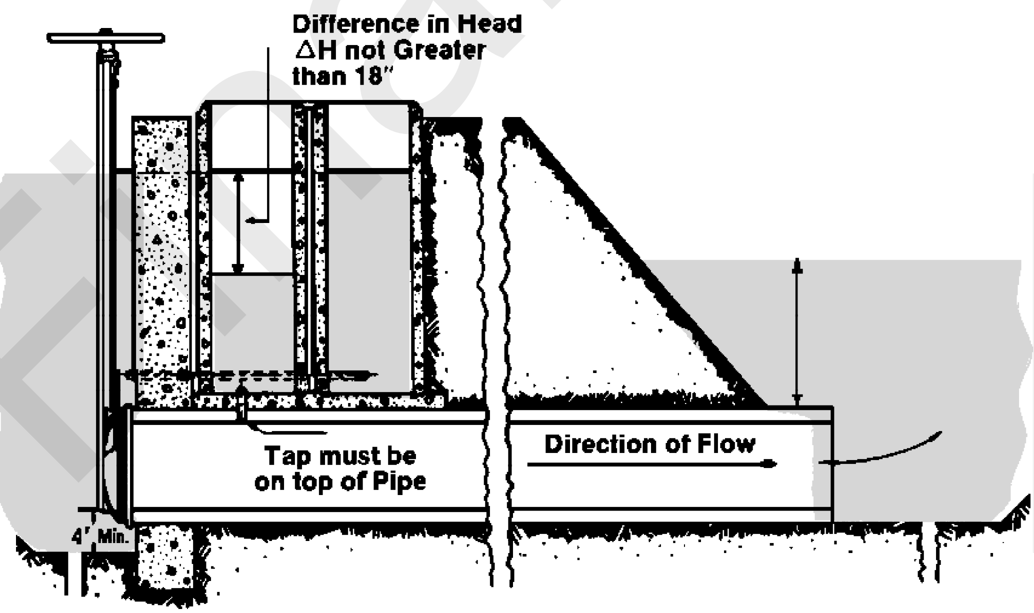
The time tested WATERMAN RED TOP CANAL GATE (Model CM-10) can be furnished with calibration tables, enabling the user to install it in standard meter gate installations. A typical installation is shown below and should be duplicated as accurately as possible to assure measurements compatible with conditions under which these calibrations have been made. Standard setting demensions and design have been maintained to assure interchangeability with systems already in operation.

This gate is available in various mounting configurations (see frame types). Standard and special frame lengths are available. Our rising stem extensions and other standard options are available as on our regular Model C-10 gates.

Complete installation and technical data can be found in our bulletin "Waterman Data Book, CM-10 Canal Gate."

CM-10





RED TOP

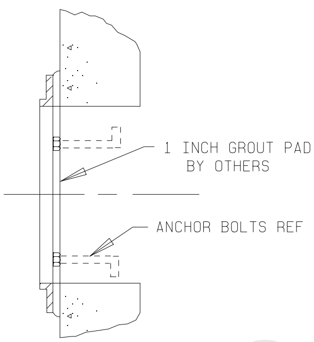
CANAL GATE FRAME TYPES

FOR C-10,CL-10, FC-10 AND CM-10 GATES

The Waterman C-10 gate and its variations can be furnished to suit many installation requirements. These include:

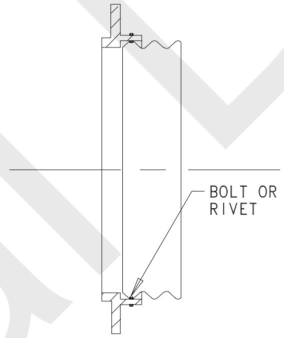
- “F” flatback for headwall mounting with anchor bolts
- “SB” spigotback for attaching to annular or spiral corrugated metal pipe
- “SA” spigotback for annular corrugated metal pipe
- “C” galvanized steel tapered setting collar for installation on concrete pipe
- “CIP” for quick, easy, rugged mounting onto plastic pipe using standard PVC solvent cement
- “Type 4” for mounting gate to plastic pipe utilizing two part epoxy

“F” FLATBACK



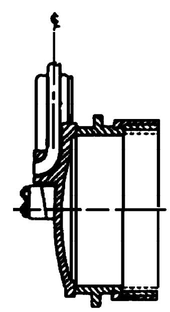
HEADWALL MOUNTED

“SB” SPIGOTBACK



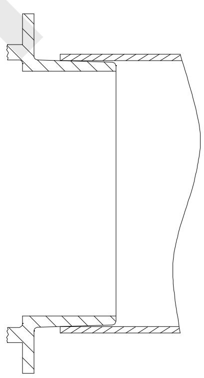
FOR ANNULAR OR SPIRAL CORRUGATED PIPE

“CIP” PLASTIC PIPE



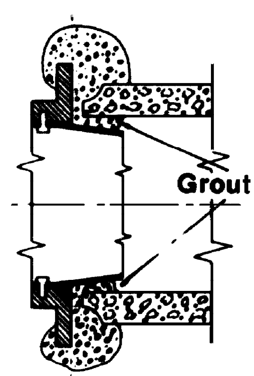
HEAVY DUTY FEMALE SPIGOT FOR SOLVENT CEMENT BONDING ONTO OUTSIDE OF PLASTIC PIPE.

“TYPE 4” FRAME



MALE SPIGOT FOR MOUNTING GATE TO PLASTIC PIPE I.D. UTILIZING TWO PART EPOXY.

“C” TAPER SETTING COLLAR



WITH GALVANIZED STEEL TAPER SETTING COLLAR FOR CONCRETE PIPE OR ASBESTOS CEMENT.

INDUSTRIES, INC.

RED TOP

C-10 TYPE 4

CANAL GATE

The Waterman C-10 Canal Gate with Type 4 frame is designed for direct bonding onto PVC plastic pipe utilizing a two part epoxy cement such as IPS.

The frame is quick and easy to install, simply apply epoxy to the special spigot and push into I.D. of low head pipe. It is recommended that additional headrail for frame support be provided to reduce stress on the plastic pipe, particularly on extended frames. This can be accomplished with the use of anchor bolts.

C-10 Type 4

RED TOP C-10 CIP

WITH CIP FRAME

The Waterman C-10 Canal Gate with CIP frame is designed for direct solvent cement bonding onto PVC plastic pipe. The need for costly, high labor two-part epoxy cement is eliminated, as use of standard PVC cement is recommended.

The CIP is a rugged, long-lasting, patented frame that is quick and easy to install. It is recommended that additional headrail or frame support be provided to reduce stress on the plastic pipe, particularly on extended frames. This can be accomplished with the use of anchor bolts.

The CIP frame, along with the other frame types on this page, is an example of Waterman's leadership is design and response to water control needs.

C-10 CIP

MODEL CL-11 “SAHARA”™ LEAK-RESISTANT CAST IRON CANAL GATE

- **Tapered Slide for Low Friction Leak-Resistant Closure**
- **Seating and Unseating Heads to 10 Feet**
- **Spigotback for CMP or Flatback for Wall Mounting**
- **Exclusive Flat Bottom Slide and O-Ring Seat**

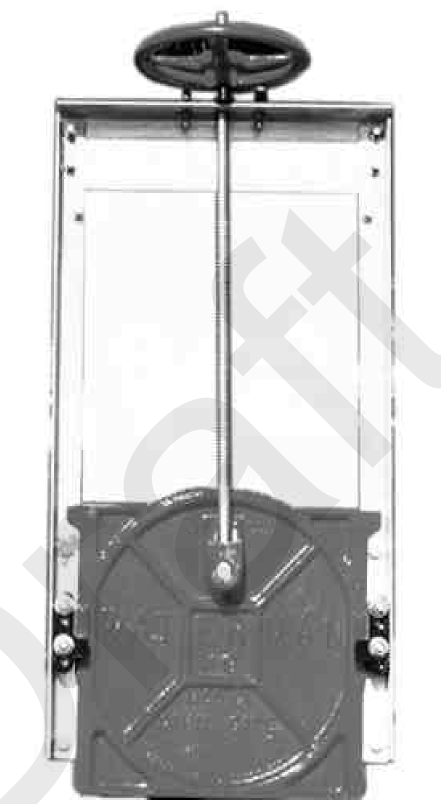
The CL-11 “SAHARA” ™ leak-resistant canal gate is designed to fill the need for a canal gate that prevents water loss to the delivery systems of water conscience irrigation districts. The slide is machined on a taper to allow full travel without wearing on the neoprene seat ring. Testing has produced no wear on the seal after 5000 cycles while still maintaining a leak-resistant seal. Options are the same for the CL-11 as for the C-10.

Standard Materials:

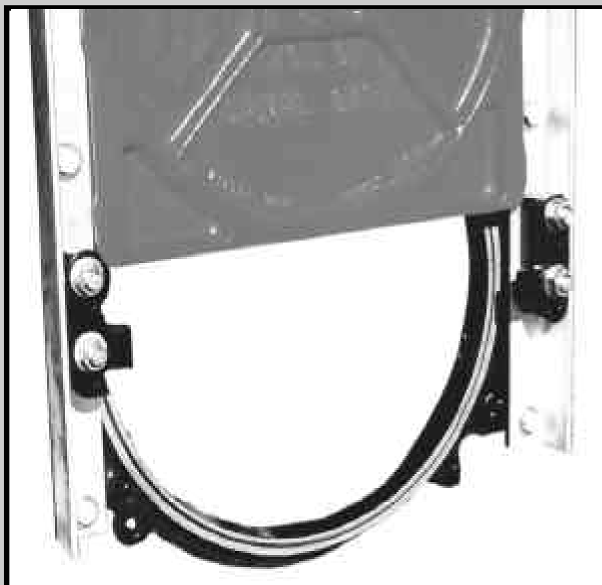
- Rugged galvanized or painted ASTM A-36 Steel Guide Rails and Head Rails
- ASTM A-36 Steel Stem
- A-126 Cast Iron Frame, Cover and Wedges
- Bronze Lift Nut w/Cast Iron Handwheel
- Seat Seal - Neoprene

Available with:

- Flatback Frame
- Spigotback Frame
- Type 4 Frame
- CIP Frame
- All C-10 Options



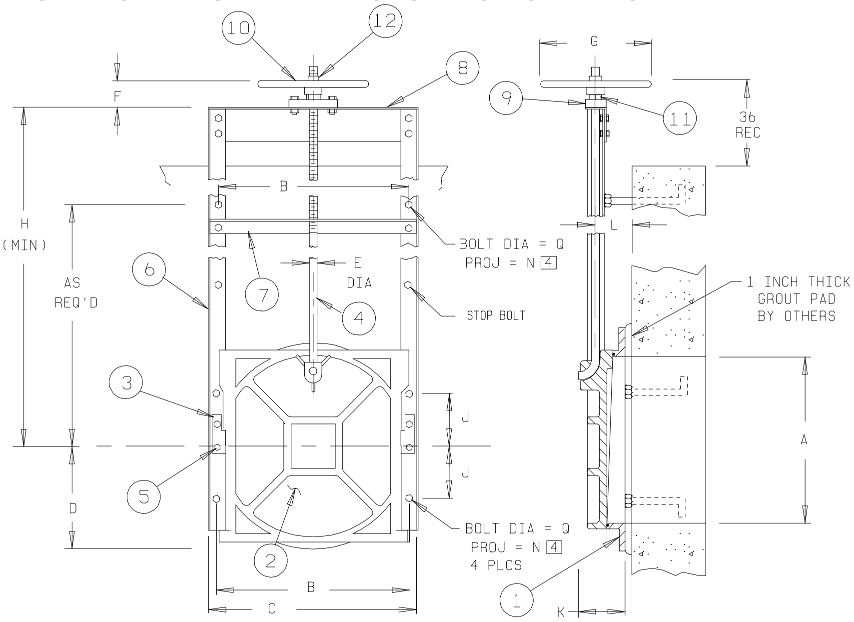
Leak-Resistant
CL-11 "SAHARA"™ Canal Gate



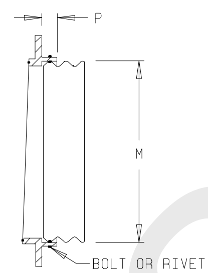
Neoprene Seat for Tight Seal

MODEL CL-11 "SAHARA"™ CAST IRON CANAL GATE

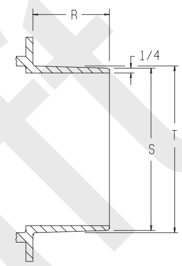
NOTES
1. TYPE 2 lubricated ball bearing lift used on 48" and larger gates.
2. Applies to spigotback gate only. Optional spigot, shown in separate detail.
3. Add grout pad thickness to anchor bolt projection.
4. Type 3E 2:1 lift used, mounted to dual headrail.



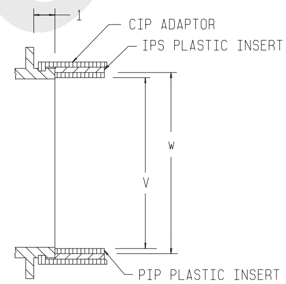
Headwall Mounted Flatback Frame



Corrugated Pipe Attached to Spigotback Frame



Type 4 Spigot



CIP

PARTS LIST		
No.	**Name**	**Qty.**
1	Frame	1
2	Cover	1
3	Wedge (R&L)	1 ea.
4	Stem	1
5	Wedge Bolts	4
6	Guide Rail	2
7	Stem Support	A/R
8	Headrail	1
9	Lift Collar	1
10	Handwheel	1
11	Lift Nut	1
12	Limit Nut	1

A	B	C	D	E	F	G	H	J	K	L	M 2	N	P 2	Q	R	S	T	V	W
6	8	9⅞	4	⅞	2⅞	10	24	3	3½	2⅝	7	3½	2	½	-	-	-	6.160	6.645
8	10	12	4⅞	⅞	2⅞	10	24	3	3¾	2½	9	3½	2	½	4	7 13/16	8	8.180	8.645
10	12	13⅞	6	⅞	2⅞	10	24	3½	3¾	2½	11	3½	2	½	3⅞	9⅞	10	10.220	10.770
12	14	15⅞	7	⅞	2⅞	10	24	4	3½	3	13	4	2	½	4	11⅞	12	12.270	12.780
14	16	17⅞	8	⅞	2⅞	10	27½	4¾	3¾	3¼	15	4	2	½	-	-	-	-	-
15	17	18⅞	8⅞	⅞	2⅞	10	30	5	4½	3½	16	4	2⅛	½	4	14⅞	15	-	-
16	18¾	20⅝	9⅞	⅞	2⅞	10	32	5½	4½	3½	17	4½	2	⅝	-	-	-	-	-
18	21	22⅞	10½	1	3⅛	12	34	6	4½	4¼	19	4½	2	⅝	4	17 13/16	18	-	-
20	23¼	25⅛	11¾	1	3⅛	12	38	7	4¾	4	21	4½	2	⅝	-	-	-	-	-
21	24	25⅞	12 5/16	1	3⅛	12	40	7	4¾	4	22	4½	2	⅝	-	-	-	-	-
24	27¼	29⅛	13⅞	1	3⅛	12	44	8	5¾	4⅛	25	4½	2	⅝	-	-	-	-	-

GATE DIMENSIONS IN INCHES

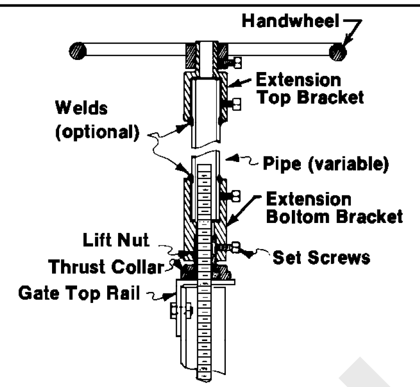
STEM EXTENSIONS

(USE WITH C-10, CL-11 AND C-20 MODELS)

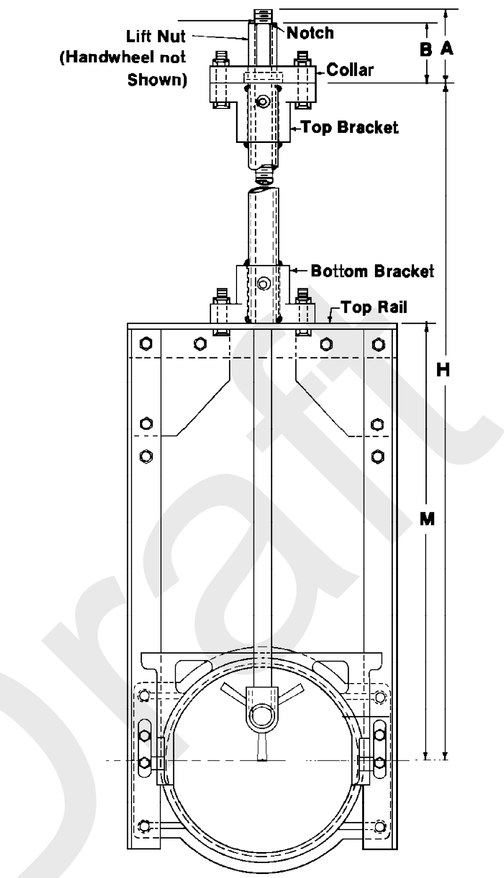
RISING STEM EXTENSIONS (RSE)

Waterman Rising-Stem Extensions are factory installed to the height ("H") required. They provide a rising stem and handwheel, keeping threads and lifts above the water level and allowing the amount of gate opening to be readily determined. Cast iron brackets, fastened to the top and bottom of standard galvanized steel pipe, are secured to the frame headrail and mount to the standard handwheel and stem hardware.

The stem extends through the entire length of pipe. With the addition of oil seals, these rising stem extension can be used where weather conditions require that the stem operate in oil to prevent freezing.



NON-RISING STEM EXTENSION



RISING STEM EXTENSION

NON-RISING STEM EXTENSIONS

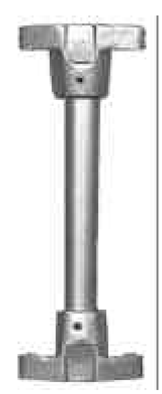
(USE WITH C-10, CL-11 AND C-20 MODELS)

Waterman Non-Rising Stem Extensions are an accessory to Waterman stock gates. They are used to position the gate handwheel at convenient and non-changing operating elevations. This eliminates the problem of gate stems protruding into traffic areas or walkways.

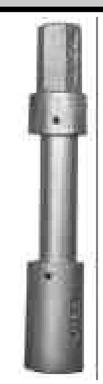
The use of Waterman Non-Rising Stem Extensions also eliminates the expense and inconvenience of ordering gate frames of special dimensions to meet different operating height conditions.

The extensions are readily installed in the field. The upper and lower brackets are joined by a section of standard galvanized steel pipe (normally not furnished) by means of threads, set screws, pins or welds. The length of the pipe determines the elevation of the handwheel. Waterman Stem Guides, such as Eye Bolt, NRS-K, SK-1, SK-2, K-1 and K-2 Series, are recommended to secure the handwheel location.

Complete units are available from the factory when desired.
6" - 24" gates require 1¼" pipe
30" - 36" gates require 1½" pipe
42" - 48" gates require 2" pipe
These extensions may also be adapted to C-20 gates and Series R slide gates.



RSE EXTENSION



NRE EXTENSION

Gate Size	A	B	M	H
6	3⅞	2⅞	24	VARIABLE AS REQUIRED
8	3⅞	2⅞	24	
10	3⅞	2⅞	24	
12	3⅞	2⅞	24	
14	3⅞	2⅞	27½	
15	3⅞	2⅞	30	
16	3⅞	2⅞	32	
18	4⅛	3⅛	34	
20	4⅛	3⅛	38	
21	4⅛	3⅛	40	
24	4⅛	3⅛	44	
30	5	4	54	
36	5	4	62	
42	6	5	84	
48	7	6	90	
54	7	6	100	
60	7	6	102	
72	*	*	121	

All dimensions in inches and apply to C-10 Series gates.
* Special fabricated design for geared type lift.

Waterman INDUSTRIES, INC.

P-30ff PRESSURE SLIDE GATE

- **MEDIUM DUTY**
- **CORROSION RESISTANT TRIM**
- **FLANGEBACK**

This Waterman Model P-30ff Red Top Pressure Slide Gate features a circular opening, circular flangeback frame and is provided with bronze seat faces and stem, and stainless steel assembly hardware for Sluice Gate type applications in water treatment facilities.

It is an economical gate, ideally suited for effluent ponding installations, pumping stations, and distributing boxes.

This gate is a product of many years of field, as well as manufacturing experience, and is of particularly sturdy construction. It has a powerful center wedge closing action, but is always easily opened. A bronze non-rising stem is standard and features rugged modified acme threads. Seat faces are iron (bronze optional). Guide rails on 6" - 14" are cast iron. Guide rails on 16" and larger are stainless steel. Frame, cover and arch are high strength cast iron.

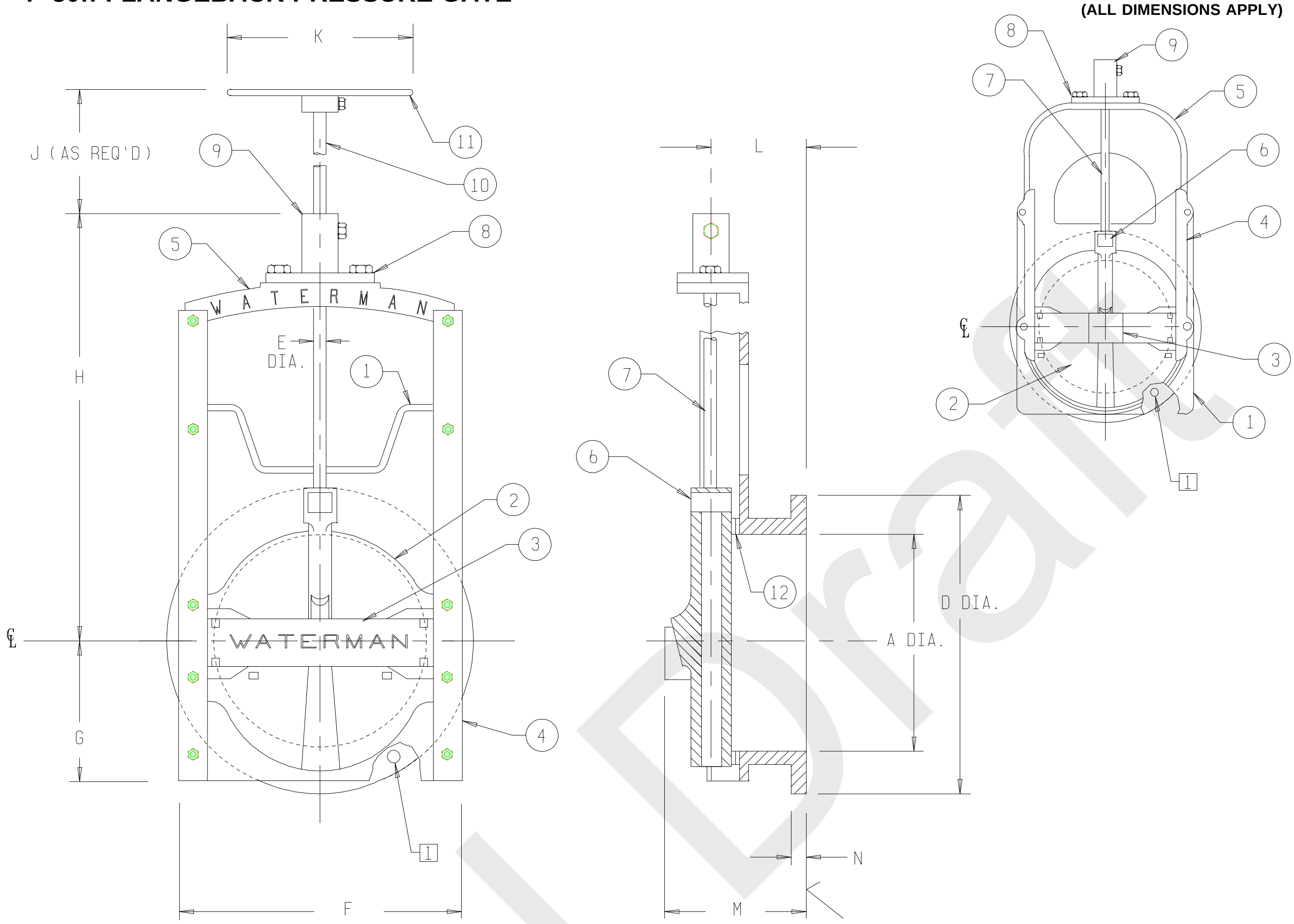
Used in water control applications where a rugged but economical circular opening gate is required, such as small reservoirs, distribution boxes, ponding areas and pumping stations where fluid and operating conditions are only moderately severe and continuous throttling action is not anticipated.

FEATURES:
- Circular opening cast iron slide gate
- For **60 foot** seating (face) pressure and **10 foot** unseating (back) pressure.
- Circular flangeback mounting with 125 lb. ANSI straddle center drilling standard. 25 lb. ANSI drilling optional
- Non-rising bronze stem standard. (Rising stainless steel stem, optional).
- Optional bronze seat faces
- Center-point wedge action
- Stainless steel assembly hardware.

P-30ff

P-30ff FLANGEBACK PRESSURE GATE

CAST ON YOKE
SIZE 6" - 14" ONLY
(ALL DIMENSIONS APPLY)



NOTES:

1. 125# drilling standard; "P" dia. holes, "S" places eq. spaced, straddle centerline on "BC" dia. bolt circle, uses "R" NC bolts.

2. Gate capacity:
   Max. seating head 60 Ft.
   Max. unseating head 10 Ft.

3. Standard gate with non-rising stem.

4. All assembly hardware 300 series stainless steel.

GATE DIMENSIONS IN INCHES

A	BC	D	E	F	G	H	K	L	M	N	P	R	S
6	9½	11	⅞	10	5½	14	10	5¼	7¼	1	⅞	¾	8
8	11¾	13½	⅞	11⅛	5½	17⅝	10	4½	7	⅞	⅞	¾	8
10	14¼	16	⅞	13⅜	6½	20⅞	10	4½	7	⅞	1	⅞	12
12	17	19	⅞	15⅝	8	24⅛	12	4½	7½	1	1	⅞	12
14	18¾	21	⅞	18	9	26	12	4½	8	1⅛	1⅛	1	12
16	21¼	23½	1	20⅝	10½	30¼	12	4½	8	1⅛	1⅛	1	16
18	22¾	25	1	22¾	11½	33¾	15	5	8½	1¼	1¼	1⅛	16
20	25	27½	1⅛	25	12½	40	15	5	9	1¼	1¼	1⅛	20
24	29½	32	1½	29¾	14½	48½	18	6¾	10½	1½	1⅜	1¼	20

PARTS LIST

No.	Name
1	Frame- Cast Iron
2	Cover - Cast Iron
3	Arch - Cast Iron
4	Rails - 304 Stn. Stl. (Cast Iron thru 14")
5	Yoke - Cast Iron (cast on thru 14")
6	Thrust Nut - Bronze
7	Stem - Bronze
8	Collar - Cast Iron
9	Stem Ext. Brkt. - Cast Iron
10	Ext. Stem - Mat'l. as req'd.
11	Handwheel - Cast Iron
12	Bronze Seat - Optional

TYPICAL SPECIFICATIONS
FOR WATERMAN MODEL P-30ff PRESSURE SLIDE GATE

The pressure slide gates shall be Waterman Model P-30ff or approved equal.

General
The gates shall be self-contained with yoke, benchstand operators, and non-rising stems (rising stem optional). Specific gate design and configuration shall be noted in gate schedule or as shown on plans.

Frame and Cover (Slide)
The frame and cover (slide) shall be cast iron with machined (bronze optional) seating faces. The frame shall be flatback or flangeback with 125 lb. drilling (25 lb. optional), while the cover shall be of domed design to withstand maximum seating head of 60 feet, or unseating head of 10 feet.

A cast iron (on 14" and smaller, stainless steel on 16" and larger) guide rail shall be mounted to the frame to form a guide slot for flat vertical sides of cover and arch. The guide rail and headpiece, whether it be separate or integrally cast with frame, shall be designed to withstand the total thrust of the gate slide due to water pressure and wedging action.

A heavy duty cast iron arch, pivoting about a center positioned cast iron wedge located on the cover, shall be provided to uniformly distribute wedging action over the entire seating surface. Predetermined stops on the frame shall stop the arch at the lowermost portion of gate travel, while allowing the cover to continue and wedge against the arch, forcing the seating surfaces together.

Stem
The stem shall be bronze (optional stainless steel) of suitable length and ample strength for the intended service. Any potion of the stem subject to thrust force, shall be capable of withstanding twice the rated output of the operator at 40 pound pull, and shall be supported such that a L/r ratio for the unsupported part of the stem shall not exceed 200.

When rising stem is used, the stem extension shall be supported with stem guide such that a rigid installation shall be provided. Stem guides shall be so spaced, that the L/r ratio of the stem does not exceed 200.

Operators
On a standard gate with non-rising stem, the screw head is mounted on top of the headrail, and includes a handwheel (2" square nut optional) located above the gate as shown on the plans.

On a rising stem gate, manually operated lifting mechanisms shall be as indicated on the plan drawings or in the gate schedule. Handwheel type lifts shall have threaded bronze lift nuts to match the stem. Threads shall be machine cut, acme type, and left hand.

An arrow shall be cast on the handwheel to indicate the direction of rotation to open the gate. A maximum effort of 40 pounds shall be required to operate the gate after it is unseated, based on the maximum specified operating head.

Material
Frame, Cover (slide), Handwheel, Yoke and Rails (14" and smaller), Screwhead - Cast Iron - ASTM A-126, Class B
Rails (16" and larger) Stainless Steel - A-276, Type 304
Stem and Lift Nut - Free Cutting Brass - Alloy 360
Assembly Hardware and Fasteners - Stainless Steel ASTM F-593 and 594
Paint - Manufacturer's Standard

Other Optional Items Include
Galvanized Steel Rails - ASTM A-36 Galvanized per A-123
Stainless Steel (Type 304) Stems
Galvanized Assembly Hardware
Special Paint Finish: Coal Tar Epoxy, Polyamide Epoxy, etc.

ITRC
moving water in new directions

Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	045-33-18
Supply Canal/Lat.	S-4
Date	3/27/2017
Start/Stop time	11am-5pm
Turnout Type	Metergate

Gate manufacturer	Waterman
Round or square gate?	Round
Gate frame width outside to outside (ft)	2.00
Gate frame width bolts center to center (ft)	1.83
Center of stilling well to back of gate frame (ft)	1.20
Bottom of gate to u/s invert (ft)	0.04
Total length of discharge pipe (ft)	15.00
Edge of frame to nearest wall (ft)	1.00
Upstream WL reference point description	Canal Concrete Headwall
Downstream WL reference point description	Canal Concrete Headwall
Reference point offset (ft)	0

Exposed stem height at gate zero (ft)	0.13	Estimated error of existing mark	+/- ⅛"
Existing gate zero mark on stem?	Yes	Zero reference marked by ITRC?	No

	Low Flow		Medium Flow		High Flow	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	3.01	3.01	3.01	3.03	3.04	3.01
Downstream water measurement (ft)	3.74	3.75	3.74	3.70	3.74	3.76
Exposed stem height (ft)	0.44		0.48		0.52	
Difference in head (ft)	0.74		0.70		0.73	
Net gate opening (ft)	0.32		0.36		0.40	
Target flow rate (CFS)	2.40		2.70		3.00	

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	2.56		2.76		2.97	
2	2.55		2.70		2.94	
3	2.53		2.71		2.95	
4	2.52		2.69		2.98	
5	2.53		2.64		2.98	
6	2.41		2.60		2.94	
7	2.47		2.59		2.93	
8	2.42		2.65		2.98	
9	2.42		2.60		2.99	
10	2.37		2.62		3.05	
11	2.36		2.63		3.06	
12	2.35		2.65		3.07	
13	2.35		2.61		3.06	
14	2.37		2.65		3.10	
15	2.40		2.66		3.11	
16	2.42		2.71		3.11	
17	2.43		2.65		3.10	
18	2.46		2.65		3.11	
19	2.49		2.70		3.11	
20	2.51		2.74		3.08	

Estimation of average	U/S	1.0	Estimate of water level variability during	U/S	0.01
submergence (ft)	D/S	0.5	during irrigation(ft)	D/S	0.01

Funding provided by USBR-MPR

Turnout Description

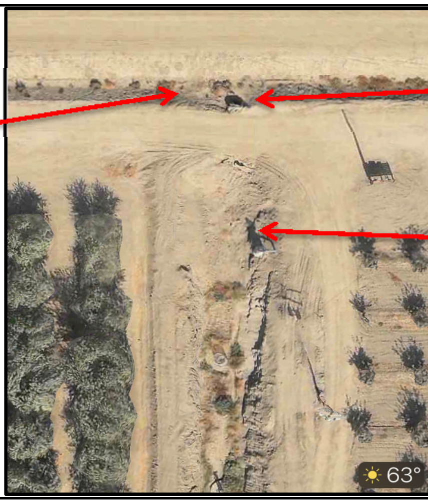
District ID	Tulare ID
Turnout ID	045-33-18
Turnout Type	Metergate
Date Evaluated	3/27/2017

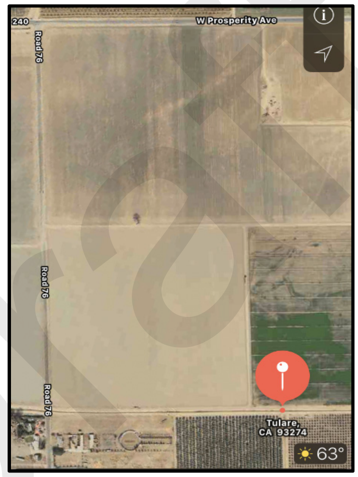
Labeled aerial photos

Pump Discharge

Meter Gate

Pump D/S Suction





Turnout photos

Testing Notes:

Stilling well was full of mud, port was dug out
On medium flow test, resevoir lowered during test ~.05ft, discovered after
16" flow meter not operational

Funding provided by USBR-MPR

moving water in new directions

Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	045-33-18
Supply Canal/Lat.	S-4
Date	3/27/2017
Start/Stop time	11am-5pm

Gate Manufacturer	Waterman
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.13

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	0.44	0.48	0.52
Net gate opening (ft)	0.32	0.36	0.40
Difference in head (ft)	0.74	0.73	0.73
Target flow rate (CFS)	2.40	2.70	3.00

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	2.45	N/A	2.66	N/A	3.03	N/A
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	2.45	N/A	2.66	N/A	3.03	N/A
Flow rate from Table (CFS)	2.77		2.98		3.30	
Absolute Error (%)	13.26	N/A	12.03	N/A	8.92	N/A
Avg. instantaneous flow rate error (%)	11.40					

Reference Table: 18" ITRC Metergate Reference Table

ITRC Water Measurement Tables - 18" Armco-Type Gate, Stilling Well Located 12" d/s of Back of Gate [Blue center represents best accuracy range]

Net Gate Opening (feet)

ΔH (feet)	0.042	0.08	0.13	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.25
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.04	0.07	0.16	0.25	0.35	0.44	0.52	0.61	0.68	0.75	0.81	0.87	0.93	1.05	1.17	1.29	1.40	1.54	1.67	1.81	1.95	2.05
0.06	0.08	0.20	0.31	0.43	0.54	0.64	0.74	0.84	0.92	1.00	1.07	1.14	1.29	1.43	1.58	1.72	1.88	2.05	2.22	2.39	2.51
0.08	0.10	0.23	0.36	0.50	0.62	0.74	0.86	0.96	1.06	1.15	1.24	1.31	1.49	1.65	1.82	1.98	2.18	2.36	2.57	2.76	2.90
0.10	0.11	0.25	0.40	0.56	0.70	0.83	0.96	1.08	1.19	1.29	1.38	1.47	1.67	1.85	2.04	2.22	2.43	2.64	2.87	3.09	3.24
0.13	0.12	0.28	0.44	0.61	0.76	0.91	1.05	1.18	1.30	1.41	1.51	1.61	1.83	2.03	2.23	2.43	2.66	2.89	3.14	3.38	3.55
0.15	0.13	0.30	0.48	0.66	0.82	0.98	1.13	1.28	1.40	1.52	1.63	1.73	1.97	2.19	2.41	2.62	2.88	3.12	3.39	3.65	3.84
0.17	0.14	0.32	0.51	0.70	0.88	1.05	1.21	1.36	1.50	1.63	1.75	1.85	2.11	2.34	2.58	2.80	3.08	3.34	3.63	3.90	4.10
0.19	0.15	0.34	0.54	0.75	0.93	1.11	1.28	1.45	1.59	1.73	1.85	1.97	2.24	2.48	2.74	2.97	3.26	3.54	3.85	4.14	4.35
0.21	0.15	0.36	0.57	0.79	0.98	1.17	1.35	1.52	1.68	1.82	1.95	2.07	2.36	2.62	2.88	3.13	3.44	3.74	4.06	4.36	4.58
0.23	0.16	0.37	0.60	0.82	1.03	1.23	1.42	1.60	1.76	1.91	2.05	2.17	2.47	2.74	3.02	3.29	3.61	3.92	4.25	4.58	4.81
0.25	0.17	0.39	0.62	0.86	1.08	1.28	1.48	1.67	1.84	2.00	2.14	2.27	2.58	2.87	3.16	3.43	3.77	4.09	4.44	4.78	5.02
0.27	0.17	0.41	0.65	0.90	1.12	1.34	1.54	1.74	1.91	2.08	2.23	2.36	2.69	2.98	3.29	3.57	3.92	4.26	4.62	4.98	5.23
0.29	0.18	0.42	0.67	0.93	1.16	1.39	1.60	1.80	1.99	2.16	2.31	2.45	2.79	3.10	3.41	3.71	4.07	4.42	4.80	5.16	5.42
0.31	0.19	0.44	0.70	0.96	1.20	1.44	1.66	1.87	2.06	2.23	2.39	2.54	2.89	3.20	3.53	3.84	4.21	4.57	4.97	5.35	5.62
0.33	0.19	0.45	0.72	0.99	1.24	1.48	1.71	1.93	2.12	2.30	2.47	2.62	2.98	3.31	3.65	3.96	4.35	4.72	5.13	5.52	5.80
0.35	0.20	0.46	0.74	1.02	1.28	1.53	1.76	1.99	2.19	2.38	2.55	2.70	3.07	3.41	3.76	4.09	4.48	4.87	5.29	5.69	5.98
0.38	0.21	0.48	0.76	1.05	1.32	1.57	1.82	2.05	2.25	2.44	2.62	2.78	3.16	3.51	3.87	4.20	4.61	5.01	5.44	5.86	6.15
0.40	0.21	0.49	0.78	1.08	1.36	1.62	1.87	2.10	2.31	2.51	2.69	2.86	3.25	3.61	3.98	4.32	4.74	5.15	5.59	6.02	6.32
0.42	0.22	0.50	0.81	1.11	1.39	1.66	1.91	2.16	2.37	2.58	2.76	2.93	3.33	3.70	4.08	4.43	4.86	5.28	5.74	6.17	6.48
0.46	0.23	0.53	0.84	1.17	1.46	1.74	2.01	2.26	2.49	2.70	2.90	3.08	3.50	3.88	4.28	4.65	5.10	5.54	6.02	6.47	6.80
0.50	0.24	0.55	0.88	1.22	1.52	1.82	2.10	2.36	2.60	2.82	3.03	3.21	3.65	4.05	4.47	4.85	5.33	5.79	6.28	6.76	7.10
0.54	0.25	0.57	0.92	1.27	1.59	1.89	2.18	2.46	2.71	2.94	3.15	3.34	3.80	4.22	4.65	5.05	5.55	6.02	6.54	7.04	7.39
0.58	0.26	0.60	0.95	1.31	1.65	1.96	2.26	2.55	2.81	3.05	3.27	3.47	3.94	4.38	4.83	5.24	5.75	6.25	6.79	7.30	7.67
0.63	0.26	0.62	0.99	1.36	1.70	2.03	2.34	2.64	2.91	3.16	3.38	3.59	4.08	4.53	5.00	5.43	5.96	6.47	7.02	7.56	7.94
0.67	0.27	0.64	1.02	1.41	1.76	2.10	2.42	2.73	3.00	3.26	3.49	3.71	4.22	4.68	5.16	5.61	6.15	6.68	7.25	7.81	8.20
0.71	0.28	0.66	1.05	1.45	1.81	2.16	2.50	2.81	3.10	3.36	3.60	3.82	4.35	4.82	5.32	5.78	6.34	6.89	7.48	8.05	8.45
0.75	0.29	0.68	1.08	1.49	1.87	2.23	2.57	2.89	3.19	3.46	3.71	3.93	4.47	4.96	5.47	5.95	6.53	7.09	7.70	8.28	8.70
0.79	0.30	0.69	1.11	1.53	1.92	2.29	2.64	2.97	3.27	3.55	3.81	4.04	4.59	5.10	5.62	6.11	6.70	7.28	7.91	8.51	8.94
0.83	0.31	0.71	1.14	1.57	1.97	2.35	2.71	3.05	3.36	3.64	3.91	4.15	4.71	5.23	5.77	6.27	6.88	7.47	8.11	8.73	9.17
0.92	0.32	0.75	1.19	1.65	2.06	2.46	2.84	3.20	3.52	3.82	4.10	4.35	4.94	5.49	6.05	6.57	7.21	7.83	8.51	9.15	9.62
1.00	0.34	0.78	1.25	1.72	2.15	2.57	2.97	3.34	3.68	3.99	4.28	4.54	5.16	5.73	6.32	6.86	7.53	8.18	8.89	9.56	10.04
1.08	0.35	0.81	1.30	1.79	2.24	2.67	3.09	3.48	3.83	4.15	4.45	4.73	5.37	5.96	6.58	7.15	7.84	8.52	9.25	9.95	10.45
1.17	0.36	0.84	1.35	1.86	2.33	2.78	3.20	3.61	3.97	4.31	4.62	4.91	5.58	6.19	6.83	7.41	8.14	8.84	9.60	10.33	10.85
1.25	0.37	0.87	1.39	1.92	2.41	2.87	3.32	3.73	4.11	4.46	4.78	5.08	5.77	6.41	7.06	7.68	8.42	9.15	9.93	10.69	11.23
1.33	0.39	0.90	1.44	1.99	2.49	2.97	3.42	3.86	4.25	4.61	4.94	5.25	5.96	6.62	7.30	7.93	8.70	9.45	10.26	11.04	11.60
1.42	0.40	0.93	1.49	2.05	2.56	3.06	3.53	3.98	4.38	4.75	5.09	5.41	6.15	6.82	7.52	8.17	8.97	9.74	10.58	11.38	11.96

Funding provided by USBR-MPR

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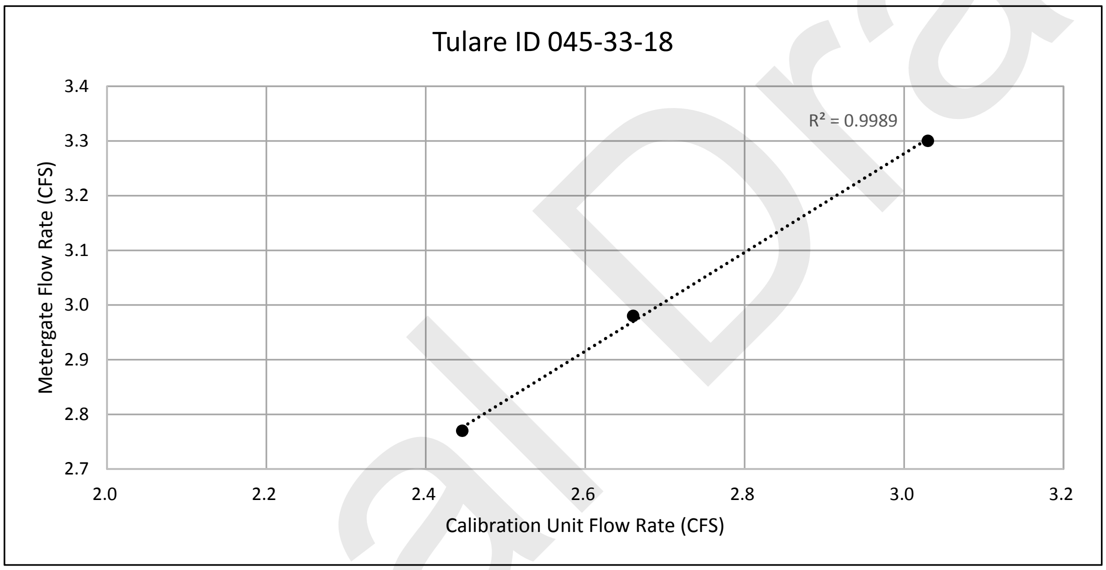
Flow Calibration Report

District ID	Tulare ID
Turnout ID	045-33-18
Type	Metergate
Size(in)	18

Calibration Date: 3/27/2017

Metergate discharge table source: 18" ITRC Metergate Reference Table



Tested By: Austin Jones, Dylan Goodwin, Sean McCoy

This flow verification was performed with the USBR funded, Irrigation Turnout Calibration Unit. The farm ditch downstream of the turnout was dammed up, and water was delivered to the ditch through the turnout. The calibration unit pump was used to return water to the supply lateral/canal while measuring the pump flow rate.

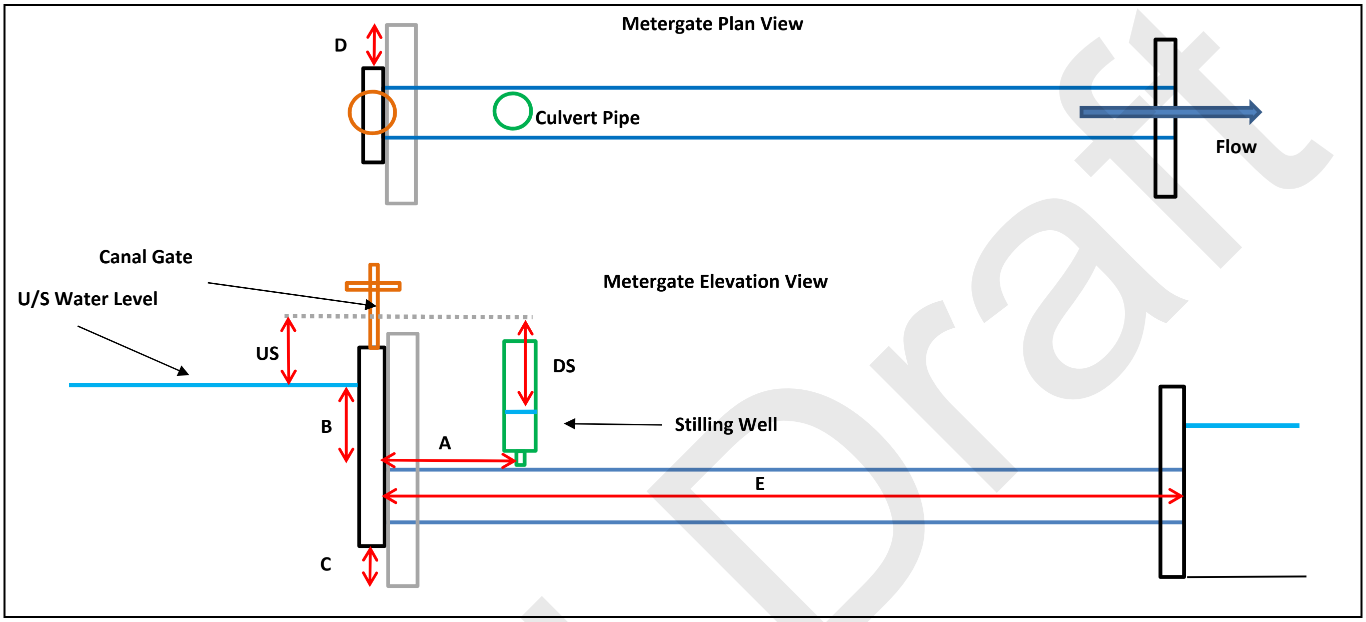
Notes:
The average absolute instantaneous flow rate error is 11.4% which is one component of volumetric accuracy.

Funding provided by USBR-MPR

Existing Turnout Conditions

District ID: Tulare ID
Turnout ID: 045-33-18
Type: Metergate

Calibration Date: 3/27/2017



Gate Diameter (in): 18

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.20	1.00		0.20
B, ft	1.00	>0.75		0.50
C, ft	0.04		>0.33	0.29
D, ft	1.00		>1.5	0.50
E, ft	15.0		>9	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	0.75	5/8 to 1		
Ratio of diameters (stilling well to port)	10:0.75	10 : 1		
Range of gate opening during test (%)	21% to 26%	20% to 75%		

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	045-30-21
Supply Canal/Lat.	S-4
Date	3/28/2017
Start/Stop time	7:30am-Noon
Turnout Type	Metergate

Gate manufacturer	Armco
Round or square gate?	Round
Gate frame width outside to outside (ft)	2.14
Gate frame width bolts center to center (ft)	1.95
Center of stilling well to back of gate frame (ft)	1.2
Bottom of gate to u/s invert (ft)	0.8
Total length of discharge pipe (ft)	10
Edge of frame to nearest wall (ft)	1
Upstream WL reference point description	Concrete Headwall
Downstream WL reference point description	N/A
Reference point offset (ft)	N/A

Exposed stem height at gate zero (ft)	0.18	Estimated error of existing mark	+/- ⅛"
Existing gate zero mark on stem?	Yes	Zero reference marked by ITRC?	No

	Low Flow		Medium Flow		High Flow	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	3.07	3.07	3.07	3.07	3.08	3.08
Downstream water measurement (ft)	N/A	N/A	N/A	N/A	N/A	N/A
Exposed stem height (ft)	0.32		0.34		0.39	
Difference in head (ft)	N/A		N/A		N/A	
Net gate opening (ft)	0.14		0.16		0.21	
Target flow rate (CFS)	2.3		2.6		3	

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	2.29		2.61		3.03	
2	2.30		2.60		2.97	
3	2.30		2.59		3.00	
4	2.30		2.59		2.95	
5	2.31		2.59		2.93	
6	2.33		2.61		3.08	
7	2.32		2.62		2.90	
8	2.33		2.63		2.83	
9	2.32		2.63		2.77	
10	2.34		2.62		2.77	
11	2.32		2.61		2.83	
12	2.31		2.61		2.83	
13	2.30		2.61		2.85	
14	2.31		2.63		2.84	
15	2.31		2.61		2.88	
16	2.30		2.61		2.83	
17	2.30		2.62		2.82	
18	2.29		2.62		2.97	
19	2.30		2.62		3.04	
20	2.28		2.62		3.02	

Estimation of average	U/S	3.0	Estimate of water level variability during	U/S	0.01
submergence (ft)	D/S	1.5	during irrigation(ft)	D/S	0.01

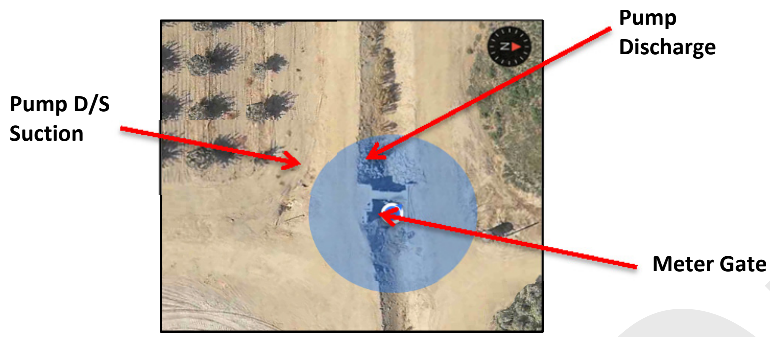
Funding provided by USBR-MPR

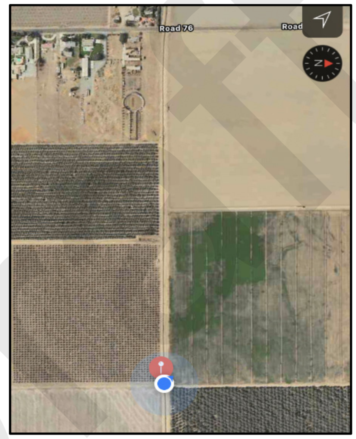
ITRC
moving water in new directions

Turnout Description

District ID	Tulare ID
Turnout ID	045-30-21
Turnout Type	Metergate
Date Evaluated	3/28/2017

Labeled aerial photos





Turnout photos

Testing Notes:
- Stilling well clogged beyond use
- No d/s reference point available
- Were instructed to measure at target stem heights
- 16" Flow meter not operational

Funding provided by USBR-MPR

ITRC

moving water in new directions

Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	045-30-21
Supply Canal/Lat.	S-4
Date	3/28/2017
Start/Stop time	7:30am-Noon

Gate Manufacturer	Armco
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.18

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	0.32	0.34	0.39
Net gate opening (ft)	0.14	0.16	0.21
Difference in head (ft)	N/A	N/A	N/A
Target flow rate (CFS)	2.3	2.6	3

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	2.31	N/A	2.61	N/A	2.91	N/A
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	2.31	N/A	2.61	N/A	2.91	N/A
Flow rate from Table (CFS)	N/A		N/A		N/A	
Absolute Error (%)	N/A	N/A	N/A	N/A	N/A	N/A
Avg. instantaneous flow rate error (%)	N/A					

Summary Flow Table			
Net Gate Opening (ft)	0.14	0.16	0.21
Flow (CFS) with an upstream water level 3.07 ft below the top of the concrete gate headwall with a static (unknown) water level downstream	2.31	2.61	2.91

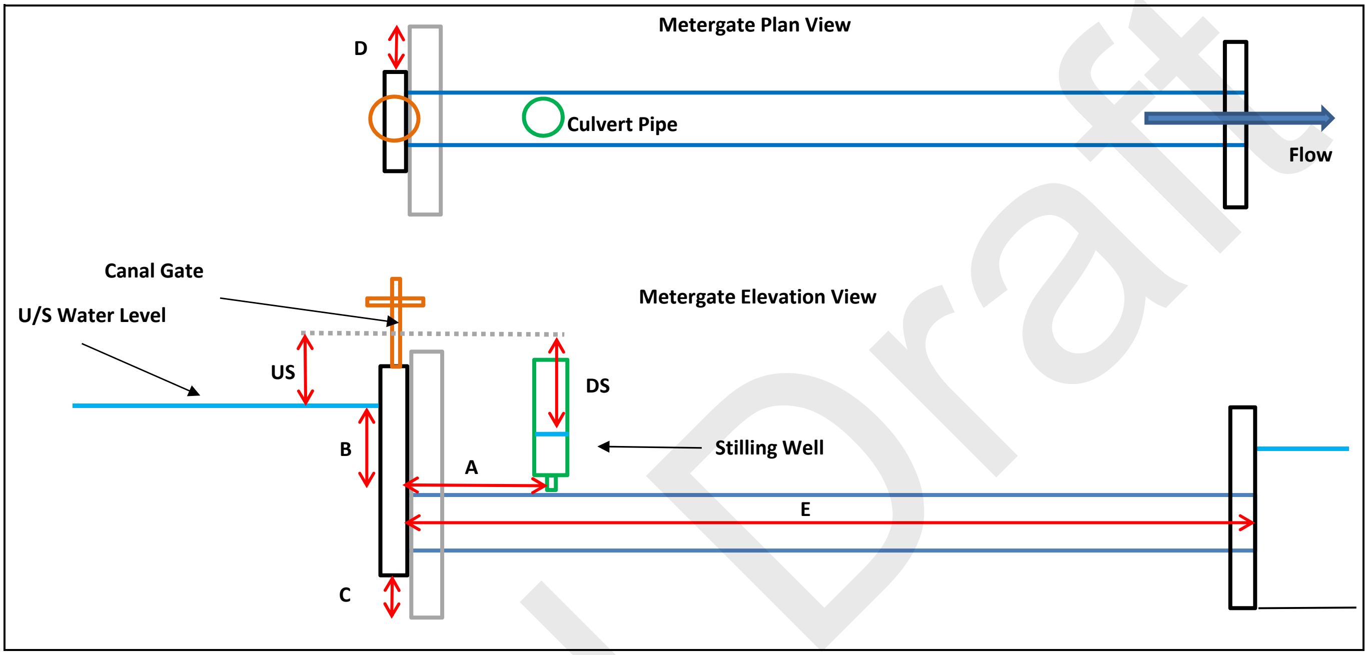
Funding provided by USBR-MPR

moving water in new directions

Existing Turnout Conditions

District ID: Tulare ID
Turnout ID: 045-30-21
Type: Metergate

Calibration Date: 3/28/2017



Gate Diameter (in): 18

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.20	1.00		0.20
B, ft	3.00	>0.75		-
C, ft	0.80		>0.33	-
D, ft	1.00		>1.5	0.50
E, ft	10.0		>9	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	N/A	5/8 to 1		
Ratio of diameters (stilling well to port)	N/A	10 : 1		
Range of gate opening during test (%)	7% to 16%	20% to 75%		Small openings at low flows

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	9325-20-18
Supply Canal/Lat.	#6 Ditch
Date	3/28/2017
Start/Stop time	1:00pm to 6:00pm
Turnout Type	Metergate

Gate manufacturer	Fresno Valve
Round or square gate?	Round
Gate frame width outside to outside (ft)	1.9
Gate frame width bolts center to center (ft)	1.71
Center of stilling well to back of gate frame (ft)	1.4
Bottom of gate to u/s invert (ft)	N/A
Total length of discharge pipe (ft)	30
Edge of frame to nearest wall (ft)	1
Upstream WL reference point description	Concrete Headwall
Downstream WL reference point description	Top of Standpipe
Reference point offset (ft)	5.41

Exposed stem height at gate zero (ft)	0.30	Estimated error of existing mark	0.5"
Existing gate zero mark on stem?	Yes	Zero reference marked by ITRC?	No

	Low Flow		Medium Flow		High Flow	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	3.71	3.71	3.70	3.70	N/A	
Downstream water measurement (ft)	9.10	9.10	9.23	9.23	N/A	
Exposed stem height (ft)	1.84		1.90		N/A	
Difference in head (ft)	5.39		5.53		N/A	
Net gate opening (ft)	1.54		1.60		N/A	
Target flow rate (CFS)	2.5		3			

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	2.57	2.49	3.16			
2	2.62	2.54	3.39			
3	2.66	2.62	2.85			
4	2.68	2.65	2.97			
5	2.64	2.61	2.82			
6	2.60	2.49	2.92			
7	2.65	2.48	3.00			
8	2.61	2.48	3.02			
9	2.54	2.52	2.99			
10	2.60	2.51	2.95			
11	2.62	2.46	2.93			
12	2.60	2.50	2.91			
13	2.61	2.50	2.90			
14	2.54	2.54	3.15			
15	2.52	2.50	2.93			
16	2.57	2.42	2.87			
17	2.56	2.55	2.90			
18	2.53	2.56	2.90			
19	2.43	2.63	2.88			
20	2.49	2.60	2.94			

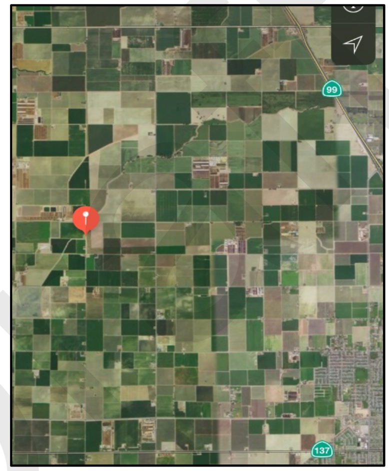
Estimation of average	U/S	3.5	Estimate of water level variability during	U/S	0.10
submergence (ft)	D/S	3.0	during irrigation(ft)	D/S	0.10

Funding provided by USBR-MPR

Turnout Description

District ID	Tulare ID
Turnout ID	9325-20-18
Turnout Type	Metergate
Date Evaluated	3/28/2017

Labeled aerial photos



Turnout photos

Testing Notes:

Could not get bottom of gate to u/s invert measurement due to rebar cage on gate
Could not use stilling well due to accumulation of mud, used nearby standpipe to get head diff. across gate and pipe
Found level reference point (top of standpipe) using Tulare ID's GNSS equipment
16" magmeter not operational for medium flow test

Funding provided by USBR-MPR

ITRC
moving water in new directions

Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	9325-20-18
Supply Canal/Lat.	#6 Ditch
Date	3/28/2017
Start/Stop time	1:00pm to 6:00pm

Gate Manufacturer	Fresno Valve
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.30

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	1.84	1.90	N/A
Net gate opening (ft)	1.54	1.60	N/A
Difference in head (ft)	0.16	0.12	N/A
Target flow rate (CFS)	2.5	3.0	N/A

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	2.58	2.53	2.97	N/A	N/A	N/A
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	2.58	2.53	2.97	N/A	N/A	N/A
Flow rate from Table (CFS)	4.30		3.70		N/A	
Absolute Error (%)	66.54	69.84	24.59	N/A	N/A	N/A
Avg. instantaneous flow rate error (%)	53.66					

Reference Table: 18" ITRC Flow Measurement Table

ITRC Water Measurement Tables – 18" Armco-Type Gate, Stilling Well Located 12" d/s of Back of Gate [Blue center represents best accuracy range]

Net Gate Opening (feet)

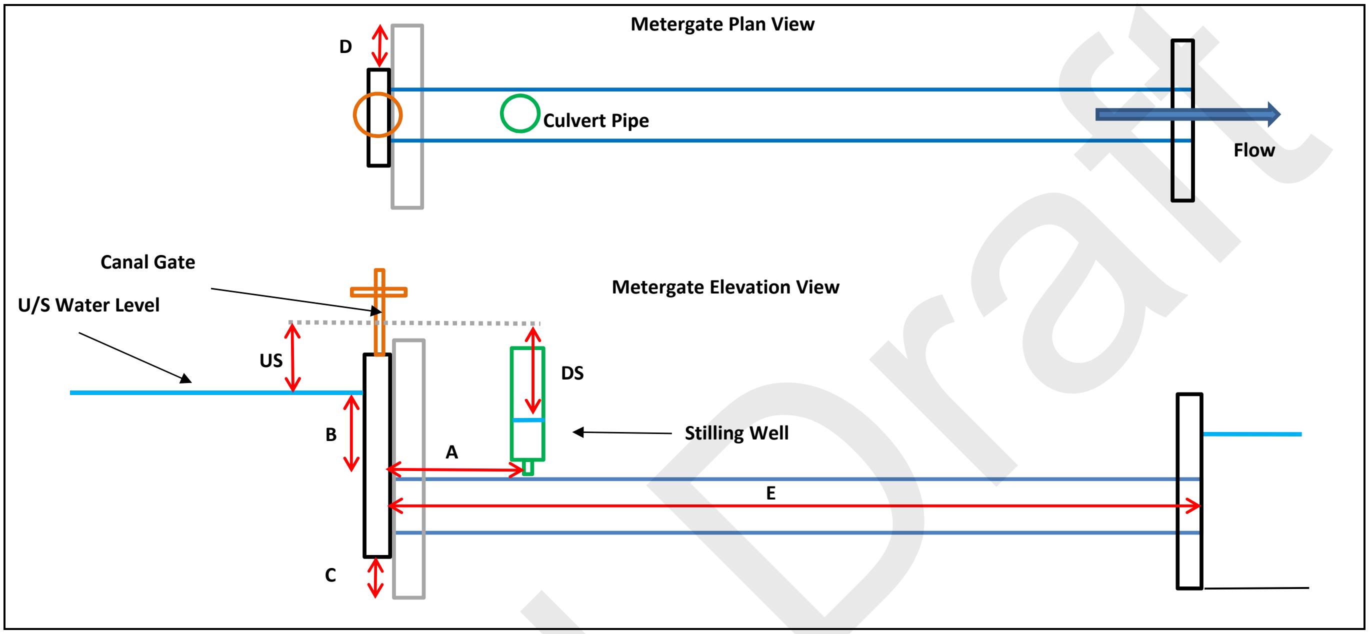
ΔH (feet)	0.042	0.08	0.13	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.25	1.33	1.42	1.50
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.04	0.07	0.16	0.25	0.35	0.44	0.52	0.61	0.68	0.75	0.81	0.87	0.93	1.05	1.17	1.29	1.40	1.54	1.67	1.81	1.95	2.05	2.14	2.17	2.17
0.06	0.08	0.20	0.31	0.43	0.54	0.64	0.74	0.84	0.92	1.00	1.07	1.14	1.29	1.43	1.58	1.72	1.88	2.05	2.22	2.39	2.51	2.62	2.66	2.66
0.08	0.10	0.23	0.36	0.50	0.62	0.74	0.86	0.96	1.06	1.15	1.24	1.31	1.49	1.65	1.82	1.98	2.18	2.36	2.57	2.76	2.90	3.02	3.07	3.07
0.10	0.11	0.25	0.40	0.56	0.70	0.83	0.96	1.08	1.19	1.29	1.38	1.47	1.67	1.85	2.04	2.22	2.43	2.64	2.87	3.09	3.24	3.38	3.43	3.43
0.13	0.12	0.28	0.44	0.61	0.76	0.91	1.05	1.18	1.30	1.41	1.51	1.61	1.83	2.03	2.23	2.43	2.66	2.89	3.14	3.38	3.55	3.70	3.76	3.76
0.15	0.13	0.30	0.48	0.66	0.82	0.98	1.13	1.28	1.40	1.52	1.63	1.73	1.97	2.19	2.41	2.62	2.88	3.12	3.39	3.65	3.84	4.00	4.06	4.06
0.17	0.14	0.32	0.51	0.70	0.88	1.05	1.21	1.36	1.50	1.63	1.75	1.85	2.11	2.34	2.58	2.80	3.08	3.34	3.63	3.90	4.10	4.27	4.34	4.34
0.19	0.15	0.34	0.54	0.75	0.93	1.11	1.28	1.45	1.59	1.73	1.85	1.97	2.24	2.48	2.74	2.97	3.26	3.54	3.85	4.14	4.35	4.53	4.60	4.61
0.21	0.15	0.36	0.57	0.79	0.98	1.17	1.35	1.52	1.68	1.82	1.95	2.07	2.36	2.62	2.88	3.13	3.44	3.74	4.06	4.36	4.58	4.78	4.85	4.85

Funding provided by USBR-MPR

Existing Turnout Conditions

District ID: Tulare ID
Turnout ID: 9325-20-18
Type: Metergate

Calibration Date: 3/28/2017



Gate Diameter (in): 18

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.40	1.00		0.40
B, ft	3.50	>0.75		-
C, ft	N/A		>0.33	-
D, ft	1.00		>1.5	0.50
E, ft	30.0		>9	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	N/A	5/8 to 1		
Ratio of diameters (stilling well to port)	N/A	10 : 1		
Range of gate opening during test (%)	95% to 99%	20% to 75%		

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

ITRC
moving water in new directions

Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	032-2-15
Supply Canal/Lat.	#6 Ditch
Date	3/29/2017
Start/Stop time	7:30am - 1:00pm
Turnout Type	Metergate

Gate manufacturer	Unknown
Round or square gate?	Round
Gate frame width outside to outside (ft)	1.67
Gate frame width bolts center to center (ft)	1.5
Center of stilling well to back of gate frame (ft)	1
Bottom of gate to u/s invert (ft)	0.09
Total length of discharge pipe (ft)	28
Edge of frame to nearest wall (ft)	1.5

Upstream WL reference point description	Concrete Headwall
Downstream WL reference point description	Concrete Headwall
Reference point offset (ft)	0

Exposed stem height at gate zero (ft)	0.23	Estimated error of existing mark	+/- ⅛"
Existing gate zero mark on stem?	Yes	Zero reference marked by ITRC?	No

	Low Flow		Medium Flow		High Flow	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	1.73	1.73	1.73	1.73	1.73	1.73
Downstream water measurement (ft)	1.95	1.95	1.79	1.79	1.82	1.82
Exposed stem height (ft)	0.52		0.65		0.66	
Difference in head (ft)	0.22		0.06		0.09	
Net gate opening (ft)	0.29		0.42		0.43	
Target flow rate (CFS)	2.2		2.7		3	

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	2.25	2.48	2.69	2.80	3.12	3.33
2	2.26	2.50	2.68	2.90	3.09	3.30
3	2.26	2.49	2.70	2.90	3.08	3.23
4	2.26	2.50	2.69	2.90	3.08	3.21
5	2.25	2.47	2.70	2.96	3.07	3.18
6	2.27	2.36	2.71	2.97	3.04	3.13
7	2.25	2.32	2.70	2.98	3.05	3.10
8	2.26	2.41	2.73	2.94	3.05	3.06
9	2.23	2.44	2.72	2.83	3.05	3.03
10	2.22	2.40	2.71	2.83	3.07	3.04
11	2.23	2.49	2.71	2.75	3.08	3.07
12	2.21	2.53	2.72	2.75	3.06	3.13
13	2.22	2.56	2.71	2.65	3.05	3.18
14	2.21	2.45	2.69	2.52	3.05	3.14
15	2.20	2.37	2.68	2.60	3.00	3.12
16	2.21	2.40	2.67	2.73	2.99	3.19
17	2.22	2.47	2.68	2.78	2.99	3.15
18	2.22	2.45	2.67	2.84	2.99	3.17
19	2.21	2.46	2.69	2.90	3.02	3.23
20	2.20	2.49	2.69	2.88	3.02	3.34

Estimation of average	U/S	3.0	Estimate of water level variability during	U/S	0.01
submergence (ft)	D/S	2.2	during irrigation(ft)	D/S	0.02

Funding provided by USBR-MPR

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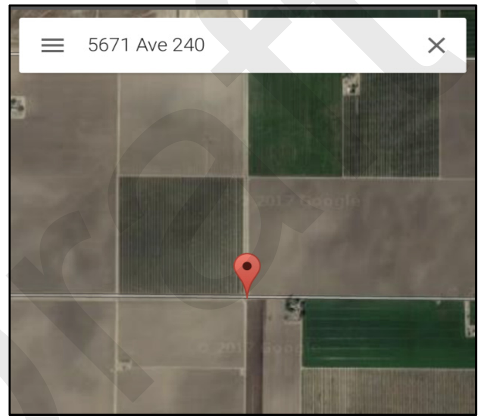
Turnout Description

District ID	Tulare ID
Turnout ID	032-2-15
Turnout Type	Metergate
Date Evaluated	3/29/2017

Labeled aerial photos



Turnout photos

Testing Notes:

Head diff. at medium flow was not on table

Stilling well not operational/accurate

Funding provided by USBR-MPR

ITRC
moving water in new directions

Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	032-2-15
Supply Canal/Lat.	#6 Ditch
Date	3/29/2017
Start/Stop time	7:30am - 1:00pm

Gate Manufacturer	Unknown
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.23

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	0.52	0.65	0.66
Net gate opening (ft)	0.29	0.42	0.43
Difference in head (ft)	0.22	0.06	0.09
Target flow rate (CFS)	2.2	2.7	3

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	2.23	2.45	2.70	2.82	3.05	3.17
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	2.23	2.45	2.70	2.82	3.05	3.17
Flow rate from Table (CFS)	1.17		N/A		1.05	
Absolute Error (%)	47.59	52.26	N/A	N/A	65.53	66.85
Avg. instantaneous flow rate error (%)	58.1					

Reference Table: 15" ITRC Metergate Reference Table

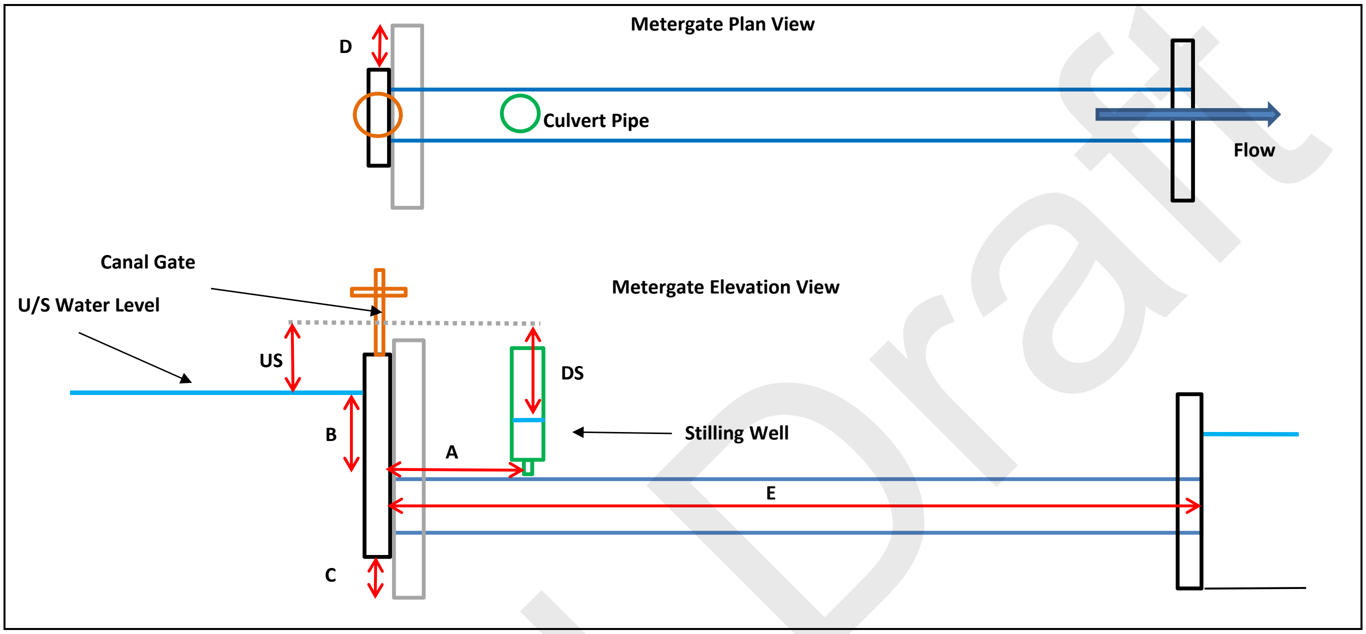
Head Difference (feet)	Net Gate Opening (feet)												
	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.58	0.67	0.75	0.83
	3	4	5	6	7	8	9	10	11	12	13	14	15
0.08	0.46	0.57	0.66	0.75	0.83	0.91	0.98	1.07	1.14	1.30	1.43	1.58	1.71
0.10	0.51	0.62	0.73	0.83	0.92	1.02	1.09	1.19	1.27	1.44	1.59	1.75	1.90
0.13	0.55	0.67	0.79	0.91	1.00	1.11	1.19	1.30	1.38	1.57	1.74	1.91	2.08
0.15	0.59	0.72	0.85	0.98	1.08	1.19	1.28	1.39	1.49	1.68	1.87	2.06	2.24
0.17	0.63	0.77	0.90	1.04	1.15	1.27	1.37	1.48	1.59	1.79	1.99	2.20	2.39
0.19	0.67	0.81	0.95	1.10	1.22	1.34	1.45	1.57	1.48	1.89	2.11	2.33	2.54
0.21	0.70	0.85	1.00	1.15	1.28	1.41	1.53	1.65	1.76	1.99	2.22	2.45	2.68
0.23	0.73	0.89	1.05	1.20	1.33	1.48	1.60	1.73	1.84	2.09	2.33	2.57	2.81
0.25	0.76	3.93	1.09	1.25	1.38	1.54	1.67	1.80	1.92	2.18	2.43	2.69	2.93
0.27	0.79	0.97	1.13	1.29	1.43	1.60	1.73	1.87	2.00	2.27	2.53	2.80	3.05
0.29	0.82	1.00	1.17	1.33	1.48	1.65	1.79	1.94	2.08	2.36	2.63	2.90	3.17

Funding provided by USBR-MPR

Existing Turnout Conditions

District ID: Tulare ID
Turnout ID: 032-2-15
Type: Metergate

Calibration Date: 3/29/2017



Gate Diameter (in): 15

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.00	1.00		0.00
B, ft	3.00	>0.63		-
C, ft	0.09		>0.33	0.24
D, ft	1.50		>1.25	-
E, ft	28.0		>7.5	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	N/A	5/8 to 1		
Ratio of diameters (stilling well to port)	N/A	10 : 1		
Range of gate opening during test (%)	23% to 45%	20% to 75%		

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

ITRC
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Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	033-8-18
Supply Canal/Lat.	Packwood Ditch
Date	3/29/2017
Start/Stop time	1:00pm - 6:00pm
Turnout Type	Metergate

Gate manufacturer	Waterman
Round or square gate?	Round
Gate frame width outside to outside (ft)	1.93
Gate frame width bolts center to center (ft)	1.75
Center of stilling well to back of gate frame (ft)	1.5
Bottom of gate to u/s invert (ft)	0.13
Total length of discharge pipe (ft)	38
Edge of frame to nearest wall (ft)	1

Upstream WL reference point description	Stilling Well
Downstream WL reference point description	Stilling Well
Reference point offset (ft)	0

Exposed stem height at gate zero (ft)	0.24	Estimated error of existing mark	2"
Existing gate zero mark on stem?	Yes	Zero reference marked by ITRC?	No

	Low Flow		Medium Flow		High Flow	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	1.79	1.79	1.76	1.76	1.77	1.77
Downstream water measurement (ft)	3.14	3.14	2.99	2.99	2.75	2.75
Exposed stem height (ft)	0.41		0.46		0.53	
Difference in head (ft)	1.35		1.23		0.98	
Net gate opening (ft)	0.17		0.22		0.29	
Target flow rate (CFS)	2.2		2.7		3	

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	2.11	2.17	2.64	2.67	3.05	3.12
2	2.11	2.21	2.65	2.68	3.04	3.09
3	2.12	2.16	2.62	2.71	3.04	3.11
4	2.13	2.13	2.63	2.71	3.05	3.20
5	2.12	2.06	2.63	2.82	3.05	3.16
6	2.11	2.06	2.63	2.83	3.05	3.14
7	2.09	2.09	2.61	2.82	3.03	3.14
8	2.11	2.06	2.63	2.78	3.03	3.11
9	2.12	2.07	2.64	2.76	3.03	3.09
10	2.11	2.05	2.63	2.76	3.04	3.04
11	2.10	2.10	2.64	2.73	3.03	3.03
12	2.10	2.18	2.65	2.71	3.04	3.06
13	2.10	2.23	2.66	2.66	3.03	3.13
14	2.10	2.18	2.65	2.63	3.03	3.16
15	2.09	2.19	2.64	2.65	3.04	3.18
16	2.07	2.16	2.62	2.67	3.03	3.19
17	2.06	2.18	2.61	2.72	3.04	3.15
18	2.02	2.17	2.61	2.72	3.04	3.14
19	2.03	2.15	2.60	2.70	3.05	3.11
20	2.02	2.12	2.60	2.66	3.05	3.14

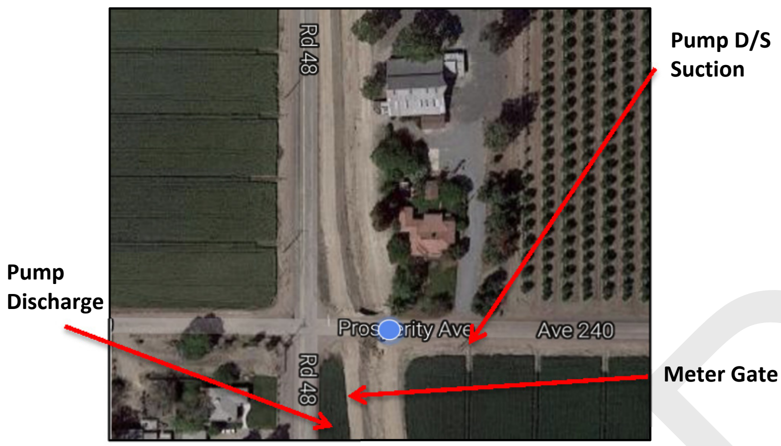
Estimation of average	U/S	2.0	Estimate of water level variability during	U/S	0.01
submergence (ft)	D/S	2.5	during irrigation(ft)	D/S	0.03

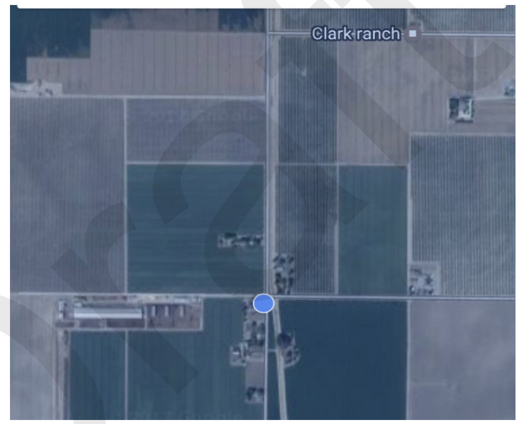
Funding provided by USBR-MPR

Turnout Description

District ID	Tulare ID
Turnout ID	033-8-18
Turnout Type	Metergate
Date Evaluated	3/29/2017

Labeled aerial photos





Turnout photos

Testing Notes:

Funding provided by USBR-MPR

moving water in new directions

Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	033-8-18
Supply Canal/Lat.	Packwood Ditch
Date	3/29/2017
Start/Stop time	1:00pm - 6:00pm

Gate Manufacturer	Waterman
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.24

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	0.41	0.46	0.53
Net gate opening (ft)	0.17	0.22	0.29
Difference in head (ft)	1.35	1.23	0.98
Target flow rate (CFS)	2.20	2.70	3.00

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	2.09	2.14	2.63	2.72	3.04	3.12
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	2.09	2.14	2.63	2.72	3.04	3.12
Flow rate from Table (CFS)	2.04		2.52		2.92	
Absolute Error (%)	2.35	4.53	4.14	7.33	3.93	6.52
Avg. instantaneous flow rate error (%)	4.80					

Reference Table: 18" ITRC Metergate Reference Table

ITRC Water Measurement Tables – 18" Armco-Type Gate, Stilling Well Located 12" d/s of Back of Gate [Blue center represents best accuracy range]

Net Gate Opening (feet)

ΔH (feet)	0.042	0.08	0.13	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.25
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.04	0.07	0.16	0.25	0.35	0.44	0.52	0.61	0.68	0.75	0.81	0.87	0.93	1.05	1.17	1.29	1.40	1.54	1.67	1.81	1.95	2.05
0.06	0.08	0.20	0.31	0.43	0.54	0.64	0.74	0.84	0.92	1.00	1.07	1.14	1.29	1.43	1.58	1.72	1.88	2.05	2.22	2.39	2.51
0.08	0.10	0.23	0.36	0.50	0.62	0.74	0.86	0.96	1.06	1.15	1.24	1.31	1.49	1.65	1.82	1.98	2.18	2.36	2.57	2.76	2.90
0.10	0.11	0.25	0.40	0.56	0.70	0.83	0.96	1.08	1.19	1.29	1.38	1.47	1.67	1.85	2.04	2.22	2.43	2.64	2.87	3.09	3.24
0.13	0.12	0.28	0.44	0.61	0.76	0.91	1.05	1.18	1.30	1.41	1.51	1.61	1.83	2.03	2.23	2.43	2.66	2.89	3.14	3.38	3.55
0.15	0.13	0.30	0.48	0.66	0.82	0.98	1.13	1.28	1.40	1.52	1.63	1.73	1.97	2.19	2.41	2.62	2.88	3.12	3.39	3.65	3.84
0.17	0.14	0.32	0.51	0.70	0.88	1.05	1.21	1.36	1.50	1.63	1.75	1.85	2.11	2.34	2.58	2.80	3.08	3.34	3.63	3.90	4.10
0.19	0.15	0.34	0.54	0.75	0.93	1.11	1.28	1.45	1.59	1.73	1.85	1.97	2.24	2.48	2.74	2.97	3.26	3.54	3.85	4.14	4.35
0.21	0.15	0.36	0.57	0.79	0.98	1.17	1.35	1.52	1.68	1.82	1.95	2.07	2.36	2.62	2.88	3.13	3.44	3.74	4.06	4.36	4.58
0.23	0.16	0.37	0.60	0.82	1.03	1.23	1.42	1.60	1.76	1.91	2.05	2.17	2.47	2.74	3.02	3.29	3.61	3.92	4.25	4.58	4.81
0.25	0.17	0.39	0.62	0.86	1.08	1.28	1.48	1.67	1.84	2.00	2.14	2.27	2.58	2.87	3.16	3.43	3.77	4.09	4.44	4.78	5.02
0.27	0.17	0.41	0.65	0.90	1.12	1.34	1.54	1.74	1.91	2.08	2.23	2.36	2.69	2.98	3.29	3.57	3.92	4.26	4.62	4.98	5.23
0.29	0.18	0.42	0.67	0.93	1.16	1.39	1.60	1.80	1.99	2.16	2.31	2.45	2.79	3.10	3.41	3.71	4.07	4.42	4.80	5.16	5.42
0.31	0.19	0.44	0.70	0.96	1.20	1.44	1.66	1.87	2.06	2.23	2.39	2.54	2.89	3.20	3.53	3.84	4.21	4.57	4.97	5.35	5.62
0.33	0.19	0.45	0.72	0.99	1.24	1.48	1.71	1.93	2.12	2.30	2.47	2.62	2.98	3.31	3.65	3.96	4.35	4.72	5.13	5.52	5.80
0.35	0.20	0.46	0.74	1.02	1.28	1.53	1.76	1.99	2.19	2.38	2.55	2.70	3.07	3.41	3.76	4.09	4.48	4.87	5.29	5.69	5.98
0.38	0.21	0.48	0.76	1.05	1.32	1.57	1.82	2.05	2.25	2.44	2.62	2.78	3.16	3.51	3.87	4.20	4.61	5.01	5.44	5.86	6.15
0.40	0.21	0.49	0.78	1.08	1.36	1.62	1.87	2.10	2.31	2.51	2.69	2.86	3.25	3.61	3.98	4.32	4.74	5.15	5.59	6.02	6.32
0.42	0.22	0.50	0.81	1.11	1.39	1.66	1.91	2.16	2.37	2.58	2.76	2.93	3.33	3.70	4.08	4.43	4.86	5.28	5.74	6.17	6.48
0.46	0.23	0.53	0.84	1.17	1.46	1.74	2.01	2.26	2.49	2.70	2.90	3.08	3.50	3.88	4.28	4.65	5.10	5.54	6.02	6.47	6.80
0.50	0.24	0.55	0.88	1.22	1.52	1.82	2.10	2.36	2.60	2.82	3.03	3.21	3.65	4.05	4.47	4.85	5.33	5.79	6.28	6.76	7.10
0.54	0.25	0.57	0.92	1.27	1.59	1.89	2.18	2.46	2.71	2.94	3.15	3.34	3.80	4.22	4.65	5.05	5.55	6.02	6.54	7.04	7.39
0.58	0.26	0.60	0.95	1.31	1.65	1.96	2.26	2.55	2.81	3.05	3.27	3.47	3.94	4.38	4.83	5.24	5.75	6.25	6.79	7.30	7.67
0.63	0.26	0.62	0.99	1.36	1.70	2.03	2.34	2.64	2.91	3.16	3.38	3.59	4.08	4.53	5.00	5.43	5.96	6.47	7.02	7.56	7.94
0.67	0.27	0.64	1.02	1.41	1.76	2.10	2.42	2.73	3.00	3.26	3.49	3.71	4.22	4.68	5.16	5.61	6.15	6.68	7.25	7.81	8.20
0.71	0.28	0.66	1.05	1.45	1.81	2.16	2.50	2.81	3.10	3.36	3.60	3.82	4.35	4.82	5.32	5.78	6.34	6.89	7.48	8.05	8.45
0.75	0.29	0.68	1.08	1.49	1.87	2.23	2.57	2.89	3.19	3.46	3.71	3.93	4.47	4.96	5.47	5.95	6.53	7.09	7.70	8.28	8.70
0.79	0.30	0.69	1.11	1.53	1.92	2.29	2.64	2.97	3.27	3.55	3.81	4.04	4.59	5.10	5.62	6.11	6.70	7.28	7.91	8.51	8.94
0.83	0.31	0.71	1.14	1.57	1.97	2.35	2.71	3.05	3.36	3.64	3.91	4.15	4.71	5.23	5.77	6.27	6.88	7.47	8.11	8.73	9.17
0.92	0.32	0.75	1.19	1.65	2.06	2.46	2.84	3.20	3.52	3.82	4.10	4.35	4.94	5.49	6.05	6.57	7.21	7.83	8.51	9.15	9.62
1.00	0.34	0.78	1.25	1.72	2.15	2.57	2.97	3.34	3.68	3.99	4.28	4.54	5.16	5.73	6.32	6.86	7.53	8.18	8.89	9.56	10.04
1.08	0.35	0.81	1.30	1.79	2.24	2.67	3.09	3.48	3.83	4.15	4.45	4.73	5.37	5.96	6.58	7.15	7.84	8.52	9.25	9.95	10.45
1.17	0.36	0.84	1.35	1.86	2.33	2.78	3.20	3.61	3.97	4.31	4.62	4.91	5.58	6.19	6.83	7.41	8.14	8.84	9.60	10.33	10.85
1.25	0.37	0.87	1.39	1.92	2.41	2.87	3.32	3.73	4.11	4.46	4.78	5.08	5.77	6.41	7.06	7.68	8.42	9.15	9.93	10.69	11.23
1.33	0.39	0.90	1.44	1.99	2.49	2.97	3.42	3.86	4.25	4.61	4.94	5.25	5.96	6.62	7.30	7.93	8.70	9.45	10.26	11.04	11.60
1.42	0.40	0.93	1.49	2.05	2.56	3.06	3.53	3.98	4.38	4.75	5.09	5.41	6.15	6.82	7.52	8.17	8.97	9.74	10.58	11.38	11.96

Funding provided by USBR-MPR

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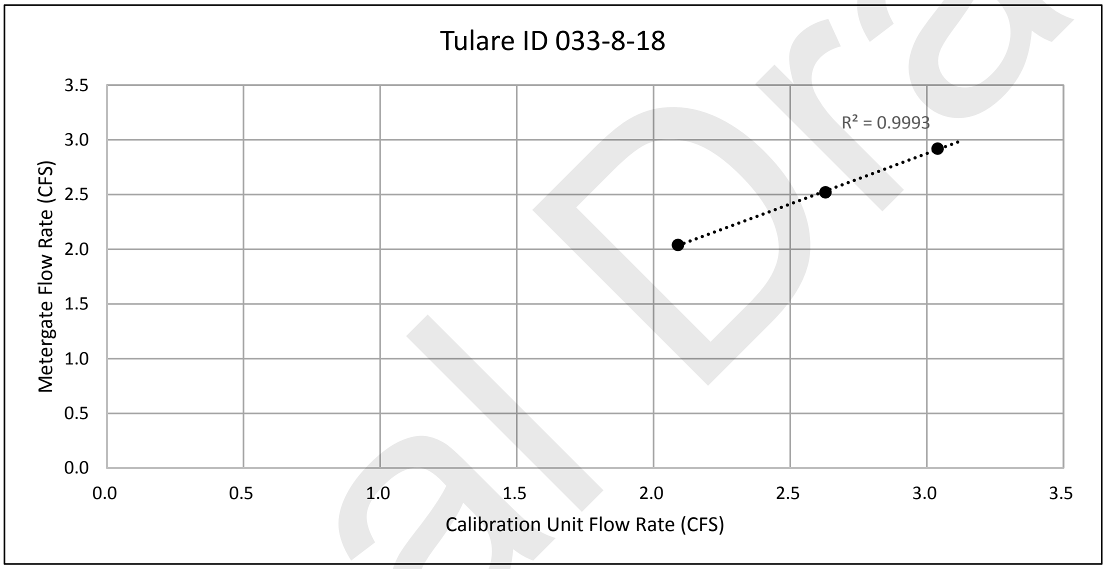
Flow Calibration Report

District ID	Tulare ID
Turnout ID	033-8-18
Type	Metergate
Size(in)	18

Calibration Date: 3/29/2017

Metergate discharge table source: 18" ITRC Metergate Reference Table



Tested By: Austin Jones, Dylan Goodwin, Sean McCoy

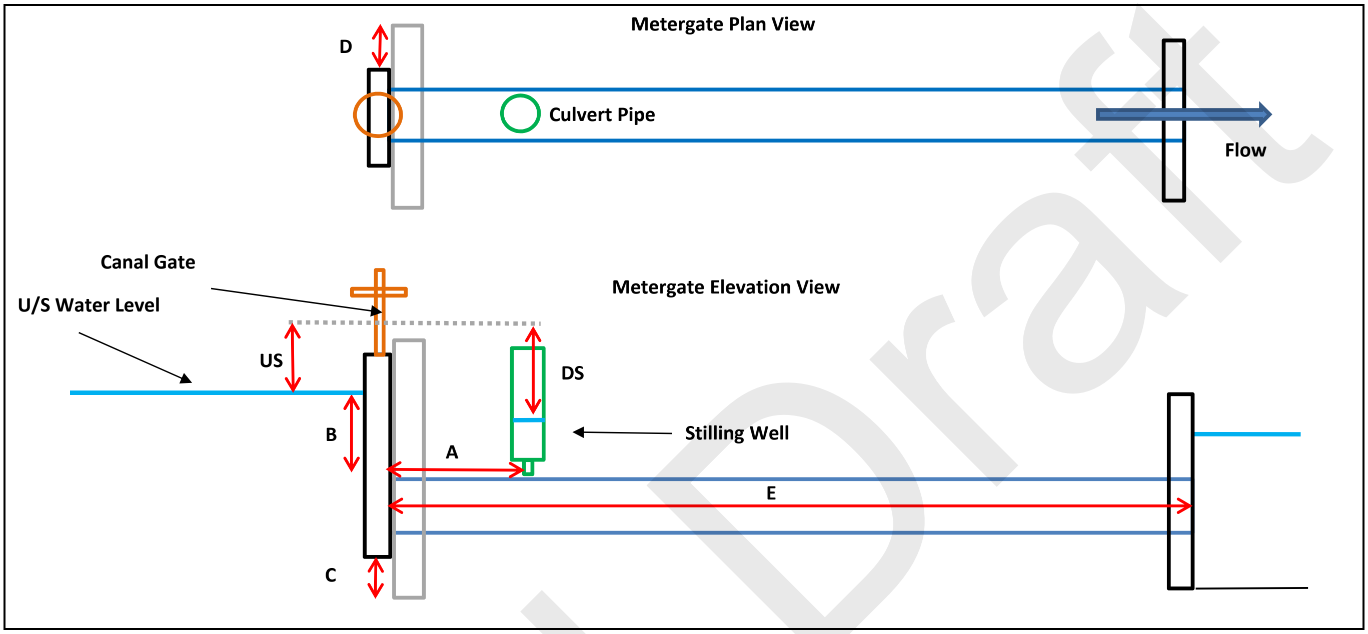
This flow verification was performed with the USBR funded, Irrigation Turnout Calibration Unit. The farm ditch downstream of the turnout was dammed up, and water was delivered to the ditch through the turnout. The calibration unit pump was used to return water to the supply lateral/canal while measuring the pump flow rate.

Notes:
The average absolute instantaneous flow rate error is 4.8% which is one component of volumetric accuracy.

Funding provided by USBR-MPR

Existing Turnout Conditions

District ID	Tulare ID	Calibration Date:	3/29/2017
Turnout ID	033-8-18		
Type	Metergate		



Gate Diameter (in): 18

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.50	1.00		0.50
B, ft	2.00	>0.75		-
C, ft	0.13		>0.33	0.20
D, ft	1.00		>1.5	0.50
E, ft	38.0		>9	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	N/A	5/8 to 1		
Ratio of diameters (stilling well to port)	N/A	10 : 1		
Range of gate opening during test (%)	11% to 19%	20% to 75%		Small openings at low flows

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

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Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	0314-6-18
Supply Canal/Lat.	Cameron Creek
Date	3/30/2017
Start/Stop time	7:30-11am
Turnout Type	Metergate

Gate manufacturer	Fresno Valve
Round or square gate?	Round
Gate frame width outside to outside (ft)	1.92
Gate frame width bolts center to center (ft)	1.73

Center of stilling well to back of gate frame (ft)	1.35
Bottom of gate to u/s invert (ft)	0.9
Total length of discharge pipe (ft)	25
Edge of frame to nearest wall (ft)	1.5

Upstream WL reference point description	Stilling Well
Downstream WL reference point description	Stilling Well
Reference point offset (ft)	0

Exposed stem height at gate zero (ft)	0.15	Estimated error of existing mark	N/A
Existing gate zero mark on stem?	No	Zero reference marked by ITRC?	No

	Test #1		Test #2		Test #3	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	2.53	2.53	2.53	2.53	2.53	2.53
Downstream water measurement (ft)	3.45	3.45	3.27	3.27	3.17	3.17
Exposed stem height (ft)	0.65		0.74		0.79	
Difference in head (ft)	0.92		0.74		0.64	
Net gate opening (ft)	0.50		0.59		0.64	
Target Flow Rate (cfs)	4.5		4.5		4.5	

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	4.43	4.44	4.43	4.44	4.43	4.44
2	4.61	4.39	4.61	4.39	4.61	4.39
3	4.35	4.52	4.35	4.52	4.35	4.52
4	4.36.	4.51	4.36.	4.51	4.36.	4.51
5	4.29	4.45	4.29	4.45	4.29	4.45
6	4.21	4.49	4.21	4.49	4.21	4.49
7	4.29	4.41	4.29	4.41	4.29	4.41
8	4.21	4.39	4.21	4.39	4.21	4.39
9	4.29	4.33	4.29	4.33	4.29	4.33
10	4.45	4.30	4.45	4.30	4.45	4.30
11	4.62	4.36	4.62	4.36	4.62	4.36
12	4.49	4.42	4.49	4.42	4.49	4.42
13	4.48	4.49	4.48	4.49	4.48	4.49
14	4.29	4.46	4.29	4.46	4.29	4.46
15	4.37	4.43	4.37	4.43	4.37	4.43
16	4.25	4.43	4.25	4.43	4.25	4.43
17	4.30	4.41	4.30	4.41	4.30	4.41
18	4.32	4.43	4.32	4.43	4.32	4.43
19	4.42	4.45	4.42	4.45	4.42	4.45
20	4.40	4.52	4.40	4.52	4.40	4.52

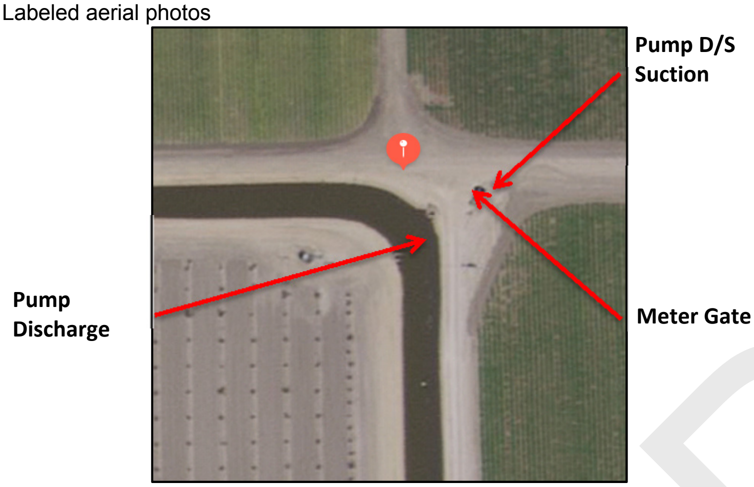
Estimation of average	U/S	3.5	Estimate of water level variability during	U/S	0.01
submergence (ft)	D/S	2.5	during irrigation(ft)	D/S	0.03

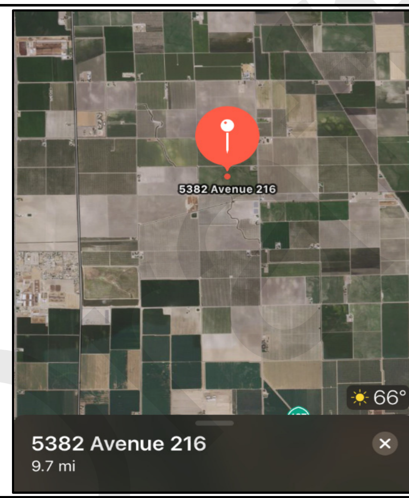
Funding provided by USBR-MPR

Turnout Description

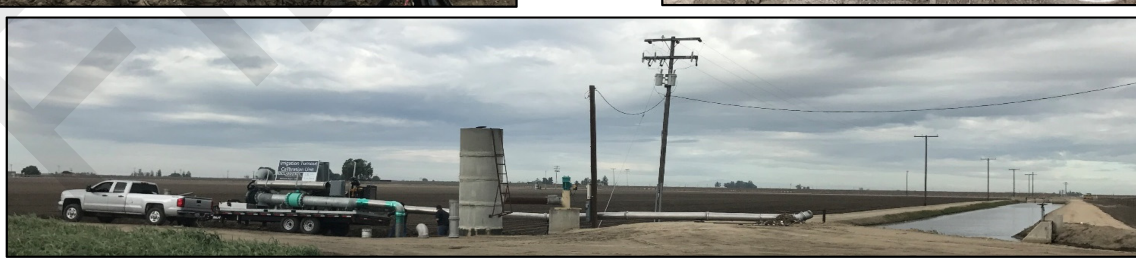
District ID	Tulare ID
Turnout ID	0314-6-18
Turnout Type	Metergate
Date Evaluated	3/30/2017

Labeled aerial photos





Turnout photos



Testing Notes:

Gravity irrigation system not operational, used pump system instead.
Pump can output only one flow rate with one alfalfa valve open

Funding provided by USBR-MPR

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Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	0314-6-18
Supply Canal/Lat.	Cameron Creek
Date	3/30/2017
Start/Stop time	7:30-11am

Gate Manufacturer	Fresno Valve
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.15

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	0.65	0.74	0.79
Net gate opening (ft)	0.50	0.59	0.64
Difference in head (ft)	0.92	0.74	0.64
Target flow rate (CFS)	N/A	N/A	N/A

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	4.37	4.43	4.37	4.43	4.37	4.43
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	4.37	4.43	4.37	4.43	4.37	4.43
Flow rate from Table (CFS)	4.36		4.48		4.44	
Absolute Error (%)	0.26	1.59	2.49	1.11	1.57	0.21
Avg. instantaneous flow rate error (%)	1.21					

Reference Table: 18" ITRC Metergate Reference Table

ITRC Water Measurement Tables - 18" Armco-Type Gate, Stilling Well Located 12" d/s of Back of Gate [Blue center represents best accuracy range]

ΔH (feet) \ Net Gate Opening (feet)	0.042	0.08	0.13	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.25
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.04	0.07	0.16	0.25	0.35	0.44	0.52	0.61	0.68	0.75	0.81	0.87	0.93	1.05	1.17	1.29	1.40	1.54	1.67	1.81	1.95	2.05
0.06	0.08	0.20	0.31	0.43	0.54	0.64	0.74	0.84	0.92	1.00	1.07	1.14	1.29	1.43	1.58	1.72	1.88	2.05	2.22	2.39	2.51
0.08	0.10	0.23	0.36	0.50	0.62	0.74	0.86	0.96	1.06	1.15	1.24	1.31	1.49	1.65	1.82	1.98	2.18	2.36	2.57	2.76	2.90
0.10	0.11	0.25	0.40	0.56	0.70	0.83	0.96	1.08	1.19	1.29	1.38	1.47	1.67	1.85	2.04	2.22	2.43	2.64	2.87	3.09	3.24
0.13	0.12	0.28	0.44	0.61	0.76	0.91	1.05	1.18	1.30	1.41	1.51	1.61	1.83	2.03	2.23	2.43	2.66	2.89	3.14	3.38	3.55
0.15	0.13	0.30	0.48	0.66	0.82	0.98	1.13	1.28	1.40	1.52	1.63	1.73	1.97	2.19	2.41	2.62	2.88	3.12	3.39	3.65	3.84
0.17	0.14	0.32	0.51	0.70	0.88	1.05	1.21	1.36	1.50	1.63	1.75	1.85	2.11	2.34	2.58	2.80	3.08	3.34	3.63	3.90	4.10
0.19	0.15	0.34	0.54	0.75	0.93	1.11	1.28	1.45	1.59	1.73	1.85	1.97	2.24	2.48	2.74	2.97	3.26	3.54	3.85	4.14	4.35
0.21	0.15	0.36	0.57	0.79	0.98	1.17	1.35	1.52	1.68	1.82	1.95	2.07	2.36	2.62	2.88	3.13	3.44	3.74	4.06	4.36	4.58
0.23	0.16	0.37	0.60	0.82	1.03	1.23	1.42	1.60	1.76	1.91	2.05	2.17	2.47	2.74	3.02	3.29	3.61	3.92	4.25	4.58	4.81
0.25	0.17	0.39	0.62	0.86	1.08	1.28	1.48	1.67	1.84	2.00	2.14	2.27	2.58	2.87	3.16	3.43	3.77	4.09	4.44	4.78	5.02
0.27	0.17	0.41	0.65	0.90	1.12	1.34	1.54	1.74	1.91	2.08	2.23	2.36	2.69	2.98	3.29	3.57	3.92	4.26	4.62	4.98	5.23
0.29	0.18	0.42	0.67	0.93	1.16	1.39	1.60	1.80	1.99	2.16	2.31	2.45	2.79	3.10	3.41	3.71	4.07	4.42	4.80	5.16	5.42
0.31	0.19	0.44	0.70	0.96	1.20	1.44	1.66	1.87	2.06	2.23	2.39	2.54	2.89	3.20	3.53	3.84	4.21	4.57	4.97	5.35	5.62
0.33	0.19	0.45	0.72	0.99	1.24	1.48	1.71	1.93	2.12	2.30	2.47	2.62	2.98	3.31	3.65	3.96	4.35	4.72	5.13	5.52	5.80
0.35	0.20	0.46	0.74	1.02	1.28	1.53	1.76	1.99	2.19	2.38	2.55	2.70	3.07	3.41	3.76	4.09	4.48	4.87	5.29	5.69	5.98
0.38	0.21	0.48	0.76	1.05	1.32	1.57	1.82	2.05	2.25	2.44	2.62	2.78	3.16	3.51	3.87	4.20	4.61	5.01	5.44	5.86	6.15
0.40	0.21	0.49	0.78	1.08	1.36	1.62	1.87	2.10	2.31	2.51	2.69	2.86	3.25	3.61	3.98	4.32	4.74	5.15	5.59	6.02	6.32
0.42	0.22	0.50	0.81	1.11	1.39	1.66	1.91	2.16	2.37	2.58	2.76	2.93	3.33	3.70	4.08	4.43	4.86	5.28	5.74	6.17	6.48
0.46	0.23	0.53	0.84	1.17	1.46	1.74	2.01	2.26	2.49	2.70	2.90	3.08	3.50	3.88	4.28	4.65	5.10	5.54	6.02	6.47	6.80
0.50	0.24	0.55	0.88	1.22	1.52	1.82	2.10	2.36	2.60	2.82	3.03	3.21	3.65	4.05	4.47	4.85	5.33	5.79	6.28	6.76	7.10
0.54	0.25	0.57	0.92	1.27	1.59	1.89	2.18	2.46	2.71	2.94	3.15	3.34	3.80	4.22	4.65	5.05	5.55	6.02	6.54	7.04	7.39
0.58	0.26	0.60	0.95	1.31	1.65	1.96	2.26	2.55	2.81	3.05	3.27	3.47	3.94	4.38	4.83	5.24	5.75	6.25	6.79	7.30	7.67
0.63	0.26	0.62	0.99	1.36	1.70	2.03	2.34	2.64	2.91	3.16	3.38	3.59	4.08	4.53	5.00	5.43	5.96	6.47	7.02	7.56	7.94
0.67	0.27	0.64	1.02	1.41	1.76	2.10	2.42	2.73	3.00	3.26	3.49	3.71	4.22	4.68	5.16	5.61	6.15	6.68	7.25	7.81	8.20
0.71	0.28	0.66	1.05	1.45	1.81	2.16	2.50	2.81	3.10	3.36	3.60	3.82	4.35	4.82	5.32	5.78	6.34	6.89	7.48	8.05	8.45
0.75	0.29	0.68	1.08	1.49	1.87	2.23	2.57	2.89	3.19	3.46	3.71	3.93	4.47	4.96	5.47	5.95	6.53	7.09	7.70	8.28	8.70
0.79	0.30	0.69	1.11	1.53	1.92	2.29	2.64	2.97	3.27	3.55	3.81	4.04	4.50	5.10	5.62	6.11	6.70	7.28	7.91	8.51	8.94
0.83	0.31	0.71	1.14	1.57	1.97	2.35	2.71	3.05	3.36	3.64	3.91	4.15	4.71	5.23	5.77	6.27	6.88	7.47	8.11	8.73	9.17
0.92	0.32	0.75	1.19	1.65	2.06	2.46	2.84	3.20	3.52	3.82	4.10	4.35	4.94	5.49	6.05	6.57	7.21	7.83	8.51	9.15	9.62
1.00	0.34	0.78	1.25	1.72	2.15	2.57	2.97	3.34	3.68	3.99	4.28	4.54	5.16	5.73	6.32	6.86	7.53	8.18	8.89	9.56	10.04

Funding provided by USBR-MPR

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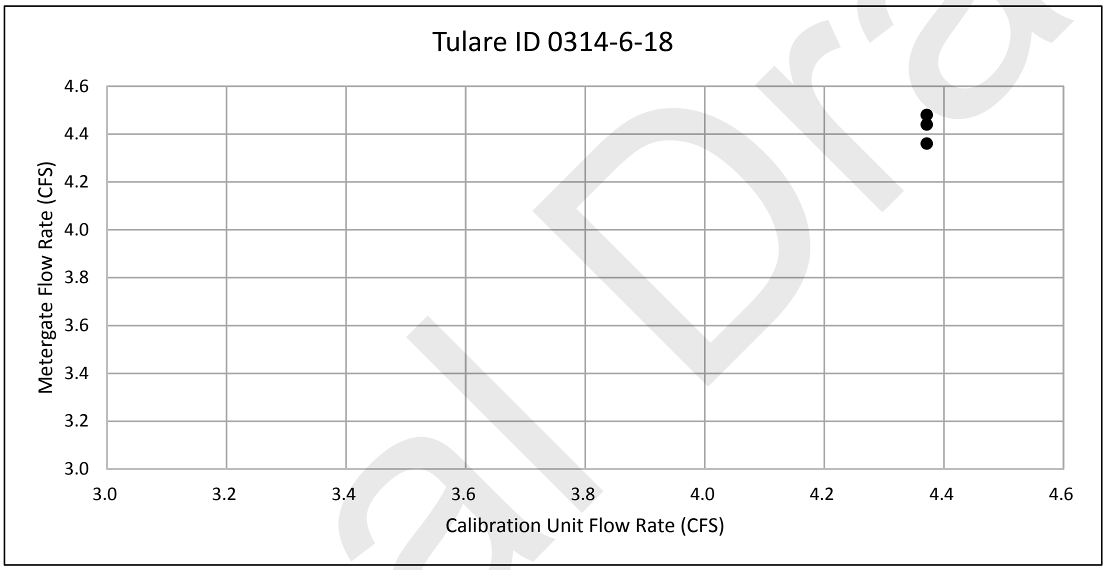
Flow Calibration Report

District ID	Tulare ID
Turnout ID	0314-6-18
Type	Metergate
Size(in)	18

Calibration Date: 3/30/2017

Metergate discharge table source: 18" ITRC Metergate Reference Table



Tested By: Austin Jones, Dylan Goodwin, Sean McCoy

This flow verification was performed with the USBR funded, Irrigation Turnout Calibration Unit. The farm ditch downstream of the turnout was dammed up, and water was delivered to the ditch through the turnout. The calibration unit pump was used to return water to the supply lateral/canal while measuring the pump flow rate.

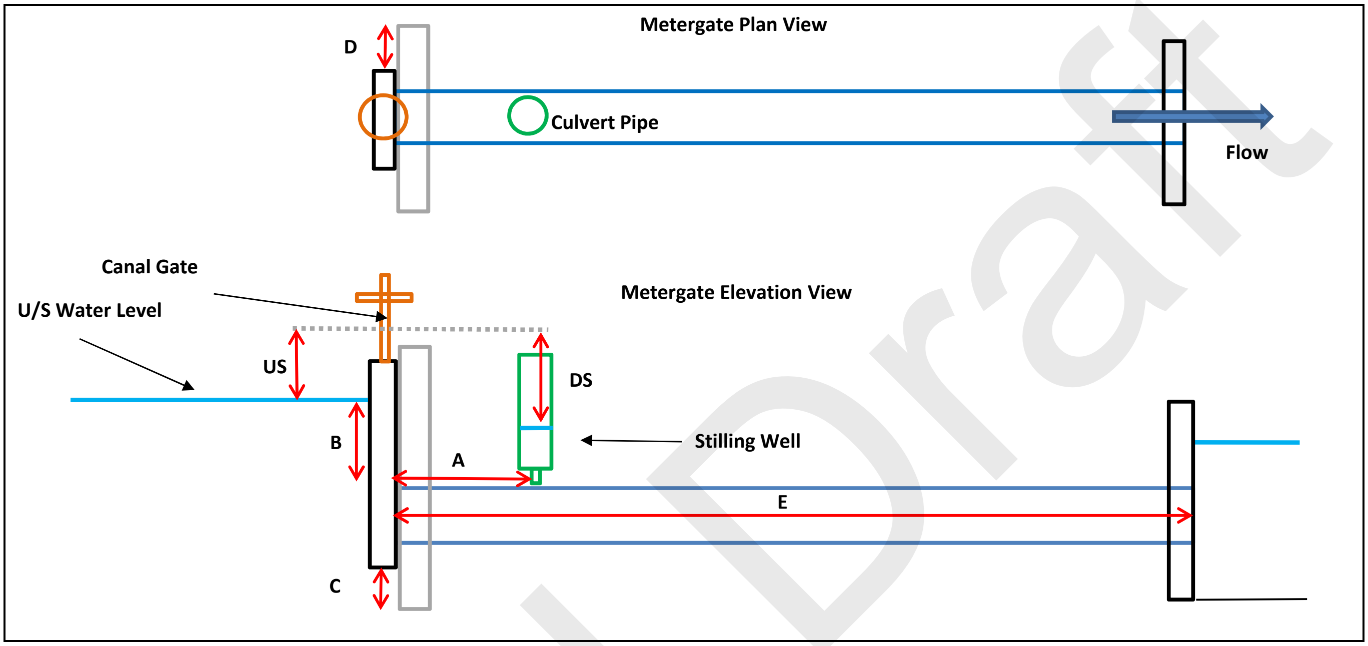
Notes:
The average absolute instantaneous flow rate error is 1.2% which is one component of volumetric accuracy.

Funding provided by USBR-MPR

Existing Turnout Conditions

District ID: Tulare ID
Turnout ID: 0314-6-18
Type: Metergate

Calibration Date: 3/30/2017



Gate Diameter (in): 18

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.35	1.00		0.35
B, ft	3.50	>0.75		-
C, ft	0.90		>0.33	-
D, ft	1.50		>1.5	-
E, ft	25.0		>9	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	N/A	5/8 to 1		
Ratio of diameters (stilling well to port)	N/A	10 : 1		
Range of gate opening during test (%)	33% to 43%	20% to 75%		

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

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Irrigation Turnout Calibration

District ID	Tulare ID
Turnout ID	0311-17-18
Supply Canal/Lat.	Rockyford Canal
Date	3/30/2017
Start/Stop time	1:00pm to 3:00pm
Turnout Type	Metergate

Gate manufacturer	Unknown
Round or square gate?	Round
Gate frame width outside to outside (ft)	1.9
Gate frame width bolts center to center (ft)	1.71
Center of stilling well to back of gate frame (ft)	1.35
Bottom of gate to u/s invert (ft)	1.1
Total length of discharge pipe (ft)	20
Edge of frame to nearest wall (ft)	0.75

Upstream WL reference point description	Headwall/Ground
Downstream WL reference point description	Headwall/Ground
Reference point offset (ft)	0

Exposed stem height at gate zero (ft)	0.38	Estimated error of existing mark	N/A
Existing gate zero mark on stem?	No	Zero reference marked by ITRC?	No

	Low Flow		Medium Flow		High Flow	
	Start	*End*	*Start*	*End*	*Start*	*End*
Upstream water measurement (ft)	2.10	2.10	2.10	2.10	2.10	2.10
Downstream water measurement (ft)	2.66	2.66	2.86	2.86	3.53	3.53
Exposed stem height (ft)	0.79		0.79		0.86	
Difference in head (ft)	0.56		0.76		1.43	
Net gate opening (ft)	0.41		0.41		0.48	
Target flow rate (CFS)	2.2		2.6		4.2	

Data Point	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
1	2.22	2.12	2.57	2.72	4.39	4.30
2	2.22	2.14	2.55	2.67	4.27	4.40
3	2.23	2.15	2.56	2.80	4.25	4.37
4	2.21	2.19	2.58	2.73	4.26	4.31
5	2.20	2.20	2.59	2.66	4.31	4.44
6	2.22	2.22	2.60	2.71	4.30	4.68
7	2.21	2.25	2.59	2.77	4.27	4.68
8	2.29	2.30	2.61	2.78	4.29	4.12
9	2.16	2.33	2.66	2.74	4.31	4.11
10	2.14	2.23	2.64	2.81	4.29	4.32
11	2.14	2.17	2.64	2.77	4.28	4.26
12	2.16	2.16	2.62	2.76	4.26	4.22
13	2.14	2.11	2.62	2.86	4.25	4.16
14	2.16	2.15	2.59	2.78	4.24	4.23
15	2.20	2.13	2.56	2.74	4.25	4.25
16	2.20	2.05	2.56	2.79	4.18	4.17
17	2.20	2.10	2.59	2.86	4.22	4.35
18	2.20	2.09	2.58	2.78	4.24	4.35
19	2.20	2.12	2.58	2.74	4.28	4.44
20	2.22	2.20	2.59	2.73	4.28	4.58

Estimation of average	U/S	3.0	Estimate of water level variability during	U/S	0.01
submergence (ft)	D/S	5.5	during irrigation(ft)	D/S	0.01

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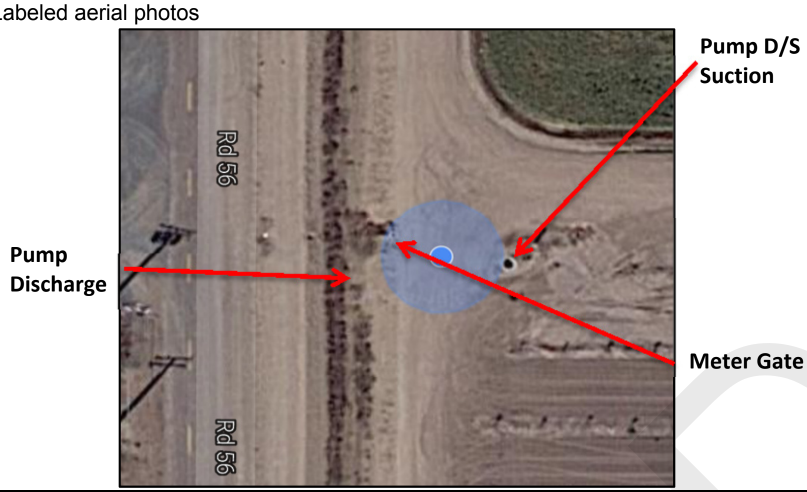
Turnout Description

District ID	Tulare ID
Turnout ID	0311-17-18
Turnout Type	Metergate
Date Evaluated	3/30/2017

Labeled aerial photos



Turnout photos

Testing Notes:

Instructed to test higher than normal flow rates
Stilling well plugged with mud, functional but likely not accurate

Funding provided by USBR-MPR

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Irrigation Turnout Calibration - Metergate Summary

District ID	Tulare ID
Turnout ID	0311-17-18
Supply Canal/Lat.	Rockyford Canal
Date	3/30/2017
Start/Stop time	1:00pm to 3:00pm

Gate Manufacturer	Unknown
Gate Type	Metergate
Exposed stem height at gate zero (ft)	0.38

	Low Flow	Medium Flow	High Flow
Exposed stem height (ft)	0.79	0.79	0.86
Net gate opening (ft)	0.41	0.41	0.48
Difference in head (ft)	0.56	0.76	1.43
Target flow rate (CFS)	2.2	2.6	4.2

	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)	12" Magmeter Flow Rate (CFS)	16" Magmeter Flow Rate (CFS)
Avg. calibration unit flow rate (CFS)	2.20	2.17	2.59	2.76	4.27	4.34
Leaks (CFS)	0	0	0	0	0	0
Adjusted calibration flow rate (CFS)	2.20	2.17	2.59	2.76	4.27	4.34
Flow rate from Table (CFS)	2.95		3.44		5.28	
Absolute Error (%)	34.37	35.94	32.60	24.64	23.66	21.76
Avg. instantaneous flow rate error (%)	28.83					

Reference Table: 18" ITRC Metergate Reference Table

ITRC Water Measurement Tables – 18" Armco-Type Gate, Stilling Well Located 12" d/s of Back of Gate [Blue center represents best accuracy range]

ΔH (feet)	Net Gate Opening (feet)																				
	0.042	0.08	0.13	0.17	0.21	0.25	0.29	0.33	0.38	0.42	0.46	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.25
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.04	0.07	0.16	0.25	0.35	0.44	0.52	0.61	0.68	0.75	0.81	0.87	0.93	1.05	1.17	1.29	1.40	1.54	1.67	1.81	1.95	2.05
0.06	0.08	0.20	0.31	0.43	0.54	0.64	0.74	0.84	0.92	1.00	1.07	1.14	1.29	1.43	1.58	1.72	1.88	2.05	2.22	2.39	2.51
0.08	0.10	0.23	0.36	0.50	0.62	0.74	0.86	0.96	1.06	1.15	1.24	1.31	1.49	1.65	1.82	1.98	2.18	2.36	2.57	2.76	2.90
0.10	0.11	0.25	0.40	0.56	0.70	0.83	0.96	1.08	1.19	1.29	1.38	1.47	1.67	1.85	2.04	2.22	2.43	2.64	2.87	3.09	3.24
0.13	0.12	0.28	0.44	0.61	0.76	0.91	1.05	1.18	1.30	1.41	1.51	1.61	1.83	2.03	2.23	2.43	2.66	2.89	3.14	3.38	3.55
0.15	0.13	0.30	0.48	0.66	0.82	0.98	1.13	1.28	1.40	1.52	1.63	1.73	1.97	2.19	2.41	2.62	2.88	3.12	3.39	3.65	3.84
0.17	0.14	0.32	0.51	0.70	0.88	1.05	1.21	1.36	1.50	1.63	1.75	1.85	2.11	2.34	2.58	2.80	3.08	3.34	3.63	3.90	4.10
0.19	0.15	0.34	0.54	0.75	0.93	1.11	1.28	1.45	1.59	1.73	1.85	1.97	2.24	2.48	2.74	2.97	3.26	3.54	3.85	4.14	4.35
0.21	0.15	0.36	0.57	0.79	0.98	1.17	1.35	1.52	1.68	1.82	1.95	2.07	2.36	2.62	2.88	3.13	3.44	3.74	4.06	4.36	4.58
0.23	0.16	0.37	0.60	0.82	1.03	1.23	1.42	1.60	1.76	1.91	2.05	2.17	2.47	2.74	3.02	3.29	3.61	3.92	4.25	4.58	4.81
0.25	0.17	0.39	0.62	0.86	1.08	1.28	1.48	1.67	1.84	2.00	2.14	2.27	2.58	2.87	3.16	3.43	3.77	4.09	4.44	4.78	5.02
0.27	0.17	0.41	0.65	0.90	1.12	1.34	1.54	1.74	1.91	2.08	2.23	2.36	2.69	2.98	3.29	3.57	3.92	4.26	4.62	4.98	5.23
0.29	0.18	0.42	0.67	0.93	1.16	1.39	1.60	1.80	1.99	2.16	2.31	2.45	2.79	3.10	3.41	3.71	4.07	4.42	4.80	5.16	5.42
0.31	0.19	0.44	0.70	0.96	1.20	1.44	1.66	1.87	2.06	2.23	2.39	2.54	2.89	3.20	3.53	3.84	4.21	4.57	4.97	5.35	5.62
0.33	0.19	0.45	0.72	0.99	1.24	1.48	1.71	1.93	2.12	2.30	2.47	2.62	2.98	3.31	3.65	3.96	4.35	4.72	5.13	5.52	5.80
0.35	0.20	0.46	0.74	1.02	1.28	1.53	1.76	1.99	2.19	2.38	2.55	2.70	3.07	3.41	3.76	4.09	4.48	4.87	5.29	5.69	5.98
0.38	0.21	0.48	0.76	1.05	1.32	1.57	1.82	2.05	2.25	2.44	2.62	2.78	3.16	3.51	3.87	4.20	4.61	5.01	5.44	5.86	6.15
0.40	0.21	0.49	0.78	1.08	1.36	1.62	1.87	2.10	2.31	2.51	2.69	2.86	3.25	3.61	3.98	4.32	4.74	5.15	5.59	6.02	6.32
0.42	0.22	0.50	0.81	1.11	1.39	1.66	1.91	2.16	2.37	2.58	2.76	2.93	3.33	3.70	4.08	4.43	4.86	5.28	5.74	6.17	6.48
0.46	0.23	0.53	0.84	1.17	1.46	1.74	2.01	2.26	2.49	2.70	2.90	3.08	3.50	3.88	4.28	4.65	5.10	5.54	6.02	6.47	6.80
0.50	0.24	0.55	0.88	1.22	1.52	1.82	2.10	2.36	2.60	2.82	3.03	3.21	3.65	4.05	4.47	4.85	5.33	5.79	6.28	6.76	7.10
0.54	0.25	0.57	0.92	1.27	1.59	1.89	2.18	2.46	2.71	2.94	3.15	3.34	3.80	4.22	4.65	5.05	5.55	6.02	6.54	7.04	7.39
0.58	0.26	0.60	0.95	1.31	1.65	1.96	2.26	2.55	2.81	3.05	3.27	3.47	3.94	4.38	4.83	5.24	5.75	6.25	6.79	7.30	7.67
0.63	0.26	0.62	0.99	1.36	1.70	2.03	2.34	2.64	2.91	3.16	3.38	3.59	4.08	4.53	5.00	5.43	5.96	6.47	7.02	7.56	7.94
0.67	0.27	0.64	1.02	1.41	1.76	2.10	2.42	2.73	3.00	3.26	3.49	3.71	4.22	4.68	5.16	5.61	6.15	6.68	7.25	7.81	8.20
0.71	0.28	0.66	1.05	1.45	1.81	2.16	2.50	2.81	3.10	3.36	3.60	3.82	4.35	4.82	5.32	5.78	6.34	6.89	7.48	8.05	8.45
0.75	0.29	0.68	1.08	1.49	1.87	2.23	2.57	2.89	3.19	3.46	3.71	3.93	4.47	4.96	5.47	5.95	6.53	7.09	7.70	8.28	8.70
0.79	0.30	0.69	1.11	1.53	1.92	2.29	2.64	2.97	3.27	3.55	3.81	4.04	4.59	5.10	5.62	6.11	6.70	7.28	7.91	8.51	8.94
0.83	0.31	0.71	1.14	1.57	1.97	2.35	2.71	3.05	3.36	3.64	3.91	4.15	4.71	5.23	5.77	6.27	6.88	7.47	8.11	8.73	9.17
0.92	0.32	0.75	1.19	1.65	2.06	2.46	2.84	3.20	3.52	3.82	4.10	4.35	4.94	5.49	6.05	6.57	7.21	7.83	8.51	9.15	9.62
1.00	0.34	0.78	1.25	1.72	2.15	2.57	2.97	3.34	3.68	3.99	4.28	4.54	5.16	5.73	6.32	6.86	7.53	8.18	8.89	9.56	10.04
1.08	0.35	0.81	1.30	1.79	2.24	2.67	3.09	3.48	3.83	4.15	4.45	4.73	5.37	5.96	6.58	7.15	7.84	8.52	9.25	9.95	10.45
1.17	0.36	0.84	1.35	1.86	2.33	2.78	3.20	3.61	3.97	4.31	4.62	4.91	5.58	6.19	6.83	7.41	8.14	8.84	9.60	10.33	10.85
1.25	0.37	0.87	1.39	1.92	2.41	2.87	3.32	3.73	4.11	4.46	4.78	5.08	5.77	6.41	7.06	7.68	8.42	9.15	9.93	10.69	11.23
1.33	0.39	0.90	1.44	1.99	2.49	2.97	3.42	3.86	4.25	4.61	4.94	5.25	5.96	6.62	7.30	7.93	8.70	9.45	10.26	11.04	11.60
1.42	0.40	0.93	1.49	2.05	2.56	3.06	3.53	3.98	4.38	4.75	5.09	5.41	6.15	6.82	7.52	8.17	8.97	9.74	10.58	11.38	11.96

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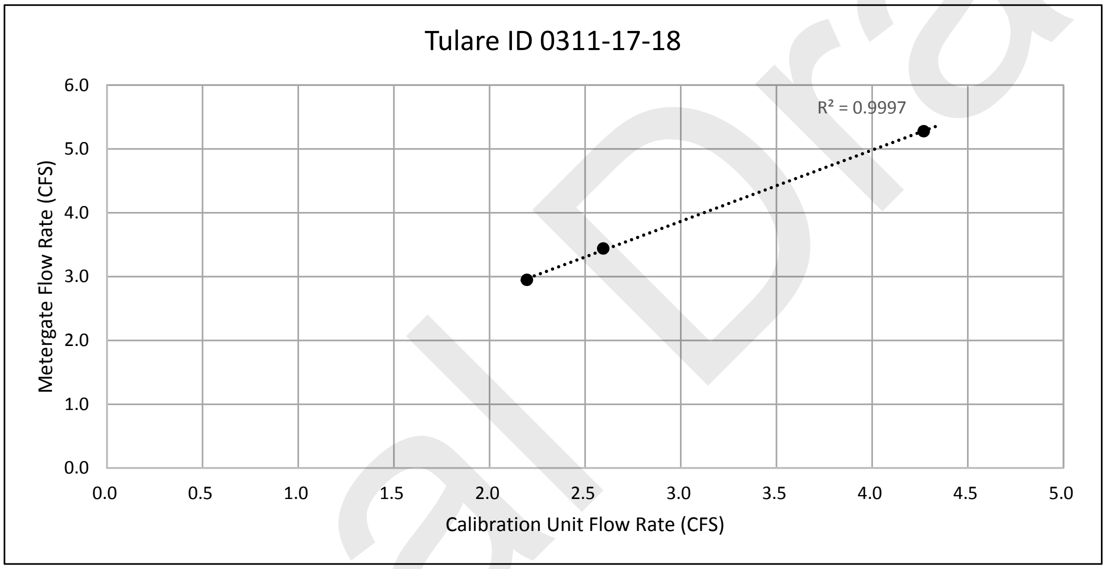
Flow Calibration Report

District ID	Tulare ID
Turnout ID	0311-17-18
Type	Metergate
Size(in)	18

Calibration Date: 3/30/2017

Metergate discharge table source: 18" ITRC Metergate Reference Table



Tested By: Austin Jones, Dylan Goodwin, Sean McCoy

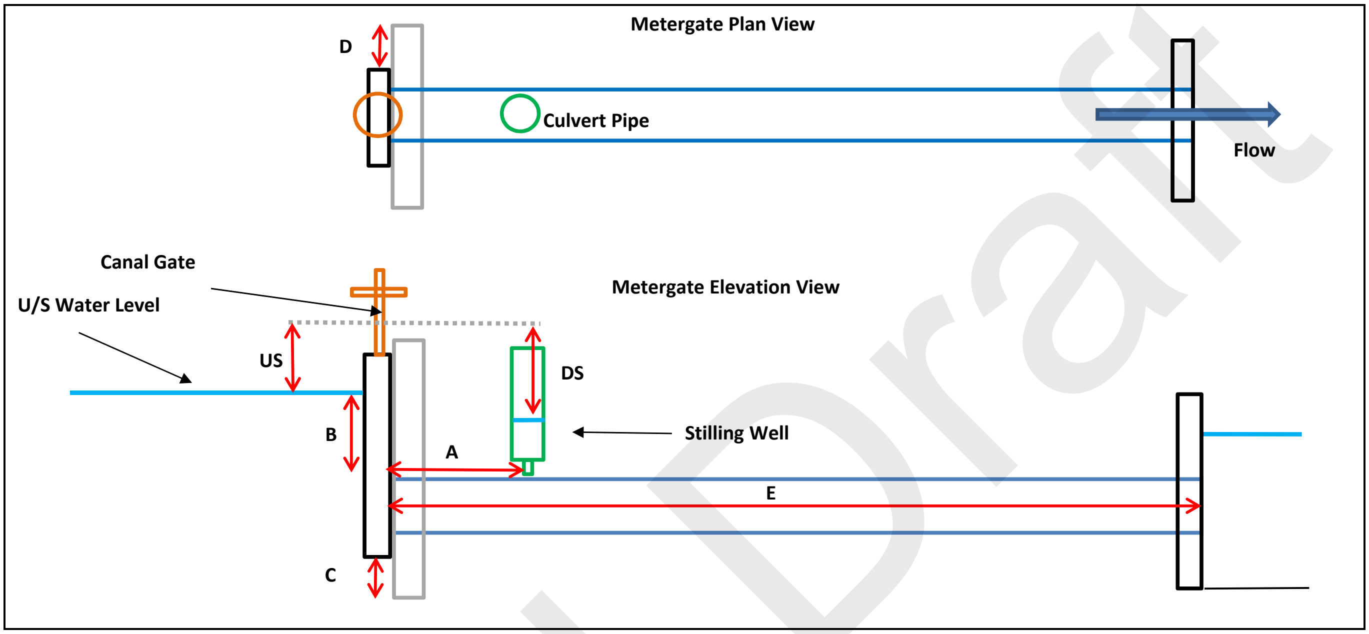
This flow verification was performed with the USBR funded, Irrigation Turnout Calibration Unit. The farm ditch downstream of the turnout was dammed up, and water was delivered to the ditch through the turnout. The calibration unit pump was used to return water to the supply lateral/canal while measuring the pump flow rate.

Notes:
The average absolute instantaneous flow rate error is 28.8% which is one component of volumetric accuracy.

Funding provided by USBR-MPR

Existing Turnout Conditions

District ID	Tulare ID	Calibration Date:	3/30/2017
Turnout ID	0311-17-18		
Type	Metergate		



Gate Diameter (in): 18

Measurement ID	As-built dimension or condition	ITRC recommendation	Armco/USBR recommendation	As-built difference from ITRC / Armco standards
A, ft	1.35	1.00		0.35
B, ft	3.00	>0.75		-
C, ft	1.10		>0.33	-
D, ft	0.75		>1.5	0.75
E, ft	20.0		>9	-
Estimated effective stilling well diameter, inches	10	6 to 10		
Estimated stilling well port diameter, inches	N/A	5/8 to 1		
Ratio of diameters (stilling well to port)	N/A	10 : 1		
Range of gate opening during test (%)	27% to 32%	20% to 75%		

Error Source
Some Contribution
Significant Contribution

Funding provided by USBR-MPR

Attachment D

TULARE IRRIGATION DISTRICT
PO Box 1920
TULARE, CA 93275-1920
(559) 686-3425

STATEMENT

Billing Month:	June
Statement Period:	6/1/19 - 6/30/19
Beginning Balance:	$10,254.33
Current Charges:	$3,934.97
Account No.:	[redacted]
Page:	1 of 1

Bill To:

[redacted]

Amount Due: $ 3,934.97
Remit Stub with Total Amount Due

Current charges due 7/30/2019. 1% interest applies to unpaid balances after due date.

IMPORTANT NOTICE
Any Water Sales and Sales of Service accounts with an upaid balance as of November 01, 2019, will be added to the first installment of the landowners' 2020 Assessment.

If you have any questions or comments, contact our office (559) 686-3425.

Date	Description				Amount
6/1/2019	Beginning Balance				$10,254.33
6/10/19	Payment				($5,417.45)
6/28/19	Payment				($4,836.88)
6/30/19	June Irrigation Billing				
Turnout	**Start Date**	**Ending Date**	**AcFt**	**Rate**	
9426-3	6/24/2019	6/28/2019	15.91	$47.50	$755.72
9427-9	6/14/2019	6/19/2019	20.17		
	6/30/2019	6/30/2019	2.96		
			23.13	$45.00	$1,040.85
9431-13	6/14/2019	6/19/2019	47.52	$45.00	$2,138.40
					$3,934.97
				Amount Due:	$3,934.97

Please pay from this statement, invoice will not follow.

Attachment E

The District does not have a water shortage policy or plan. Please see Attachment C, Rules and Regulations.

Attachment F

GROUNDWATER MANAGEMENT PLAN

TULARE IRRIGATION DISTRICT

TULARE IRRIGATION DISTRICT
FORMED IN 1889

SEPTEMBER 2010

PREPARED BY:

PROVOST AND PRITCHARD
CONSULTING GROUP

EST. 1968
PROVOST&
PRITCHARD
CONSULTING GROUP
An Employee Owned Company

REGISTERED PROFESSIONAL ENGINEER
DENNIS RAY MILLS
No. 67,478
Civil
STATE OF CALIFORNIA

Dennis Ray Mills

Date: 9/2/10

TABLE OF CONTENTS

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Appendices

List of Abbreviations

AB	Assembly Bill
ACWA	Association of California Water Agencies
AF	Acre-feet
AWEP	Agricultural Water Enhancement Project
bgs	below ground surface
CVP	Central Valley Project
DBCP	dibromochloropropane
DWR	Department of Water Resources
EPA	Environmental Protection Agency
ET	evapotranspiration
F	Fahrenheit
FKC	Friant-Kern Canal
FWA	Friant Water Authority
FWUA	Friant Water Users Authority
GAC	Groundwater Advisory Committee
GMP	Groundwater Management Plan
GPM	gallons per minute
GPS	Global Positioning System
ID	Irrigation District
IRWMP	Integrated Regional Water Management Plan
KDWCD	Kaweah Delta Water Conservation District
KSJRA	Kaweah and St. Johns River Association
MOU	Memorandum of Understanding
NRCS	Natural Resources Conservation Service
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SOR	Systems Optimization Review
TID	Tulare Irrigation District
TDS	total dissolved solids
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WHPA	Wellhead protection area
WRI	Water Resources Investigation of the Kaweah Delta Water Conservation District

1 – INTRODUCTION

This Groundwater Management Plan (GMP or Plan) is an update of a Plan that was adopted by the Tulare Irrigation District in October 1992. The original Plan was prepared in accordance with the requirements prescribed in Assembly Bill No. 255 (California Water Code Section 10750 et seq.).

This GMP is a revision that satisfies the new requirements for GMPs created by the September 2002 California State Senate Bill No. 1938, which amended Sections 10753 and 10795 of the California Water Code. This Plan also addresses recommended components for a Groundwater Management Plan described in Appendix C of Department of Water Resources Bulletin 118 (2003 Update). **Table 1.1** shows the required and recommended components (See Section 1.4).

This plan outlines the framework for TID's groundwater management efforts. General categories that are addressed include a description of the District's geology and hydrogeology, basin management objectives, stakeholder involvement, groundwater monitoring, groundwater resources protection, groundwater sustainability, groundwater operations, and groundwater planning and management. Within these categories, specific groundwater management elements are described including existing activities and planned actions to expand and improve groundwater management.

1.1 - Area Covered by Groundwater Management Plan

This GMP covers the entire area served by TID, which includes about 72,000 acres (see **Attachment 1**). TID also owns and operates some facilities outside of their service area boundaries, and has determined that adjacent areas could impact their groundwater resources. As a result, the GMP discusses the physiography, geology, hydrogeology and groundwater issues in neighboring lands. Specifically, a 'Buffer Zone' has been defined (see **Attachment 8**), which is bounded by several hydrologic features (i.e. rivers and creeks). Groundwater investigations and studies suggest that groundwater management activities in this buffer zone influence the groundwater in TID. The buffer zone primarily covers lands in the Kaweah Delta Water Conservation District, but also includes several other water agencies and municipalities. TID can manage groundwater in these water agencies if they give TID permission to do so.

The KDWCD is a regional water management agency covering 340,000 acres, including all of TID. KDWCD also has a GMP, and recognizing their common interests and overlapping areas, TID and KDWCD signed a MOU regarding groundwater management in areas the two plans overlap, as well as adjacent zones and facility areas. TID interprets these 'adjacent zones and facilities areas' as the Buffer Zone lands within KDWCD. This agreement is informally called the 'Overlap MOU'. In the MOU, KDWCD and TID agreed to allow both agencies to manage groundwater in the overlap areas and adjacent zones, unless there is a disagreement, in which case TID will have sole authority to manage groundwater in TID and the City of Tulare, but not in the buffer zone lands of KDWCD. If necessary in the future, TID may seek permission from other agencies in the buffer zone to manage their groundwater according to this GMP.

1.2 - Background Information on Tulare Irrigation District

Below is a brief description of the origin, physiography, geology, water supplies and facilities of the District.

History

TID is a political subdivision of the State of California – an independent agency operating under the California Water Code. TID is a conjunctive use district, formed in 1889 for the purpose of managing, supplying and delivering water to growers within TID. The District has conjunctively utilized Kaweah River waters and groundwater since at least the early 1940's. TID's original water service contract with the USBR was signed in 1950 for water delivery from the Friant Unit of the CVP. This imported contract supply was also designed around TID's conjunctive use capabilities. The contract includes a large quantity of Class 2 entitlement, a supplemental supply made available by USBR largely for groundwater recharge within the Friant Unit service area.

Geography

TID is located in western Tulare County on the eastern part of the San Joaquin Valley, about 20 miles west of the Sierra Nevada foothills, approximately 50 miles southeast of the City of Fresno and approximately 65 miles northwest of the City of Bakersfield (see **Attachment 1** for a vicinity map). The District surrounds, but does not contain, the City of Tulare. State Highways 63, 99 and 137 traverse the District. Adjacent agricultural water agencies include Corcoran Irrigation District, Kaweah Delta Water Conservation District, Kings County Water District, Consolidated Peoples Ditch Company, and Farmers Ditch Company. Refer to **Attachment 2a** for a map of neighboring surface water delivery districts, **Attachment 2b** for a map of neighboring municipal water delivery districts, and **Attachment 3** for a map of neighboring ditch and irrigation companies. The District covers about 77,000 acres (120.3 square miles). The topography slopes generally from northeast to southwest at an average of 6.2 feet per mile.

Climate

The District is characterized as having hot and very dry summers, with relatively mild winters. Average annual precipitation and temperature are 10.15 inches and 63° F, respectively. With the long, hot summers that normally occur in the valley, there is a potential for about five feet of evaporation per year, with the majority occurring from April through October. Rainfall in the District occurs primarily in the winter months, with virtually no rainfall in the summer months. Annual crop use per acre averages several times the amount of average precipitation. As a result, agricultural crops grown within the District are heavily dependent upon irrigation from surface water deliveries and groundwater pumping, with water needs only partially satisfied by rainfall.

Soils and Agronomy

Refer to **Attachment 4** for a NRCS soils map of TID. Soils in the district are primarily loam and sandy loam. About 59,000 acres, or 77% of the total District area, is cropped. The major crops include corn, alfalfa, cotton, pistachios and wheat; with a total of over 20 different crops grown (2009 data). According to the District's most recent Water Management Plan, the irrigation methods include drip and micro (4%), gravity (96%), and sprinkler (<1%). The combined average irrigation efficiency is estimated to be between 75 and 85%.

Geology

TID is located in the Kaweah Groundwater Sub-basin (see **Attachment 5**). The geological sequences of permeable, water bearing sediments within TID, from youngest to oldest, are: Topsoil, Young Alluvium and the Kern River Series. Recent standing groundwater levels average about 135 feet bgs. TID cooperates with the USBR in monitoring groundwater levels. The number of groundwater wells within the District is unknown as they are private facilities owned and controlled by landowners. Refer to Section 2 for more details on the geology in TID.

Water Demands

The agricultural demand within the District was estimated to be approximately 221,500 AF/year in the District's 2002 Agricultural Water Management Plan. However, in recent years, the District has experienced a significant shift in cropped acreage away from cotton and towards crops that support the dairy industry. These plantings are more often double cropped and so the average annual water demand within the District may be increasing.

Groundwater Supply

The District does not operate any groundwater wells and therefore does not supply groundwater to District landowners. Each individual landowner must provide his own well(s) to sustain irrigation during periods when the District is not diverting surface water into its system. See **Attachment 6** for a map of private wells in the District that are monitored by TID. It has previously been estimated that TID growers pump approximately 100,000 AF/year (CH2MHill, 2000), on average, from private groundwater wells to supplement District supplies. The District tracks depths to groundwater in the area through a network of private irrigation wells shown on **Attachment 6**.

Surface Water Supplies

The District's average annual surface water supply from 1988 to 2008 was approximately 163,400 AF, from water rights on Kaweah River and Friant Unit entitlement imported from the San Joaquin River. TID's Kaweah rights yield is, on average, about 75,000 AF annually. TID has a CVP Friant Unit water supply contract for up to 30,000 AF of Class 1 water and up to 141,000 AF of Class 2 water annually. In addition, the District enters into annual contracts for Section 215 water (surplus CVP water).

Facilities

The vast majority of the District's distribution system consists of unlined earthen channels with reinforced concrete control structures and road crossings. Collectively, the District owns and operates approximately 300 miles of earthen canals and ditches. The District also owns approximately 30 miles of pipeline. The District's distribution system begins in the Friant-Kern Canal. Diversions into the distribution system are also utilized further downstream from the St. Johns River and Lower Kaweah River. There are a few other channels (Cameron and Packwood Creeks) that flow from the Kaweah River that terminate in or near the District. Once the Main Intake Canal reaches the District boundary, it bifurcates into the Main Canal, which extends southwesterly to serve a major portion of the District and the North Branch Canal which serves the northwesterly portion of the District. The District's distribution system is currently built out and can deliver surface water to the vast majority of the landowners. The District has approximately 968 farm service turnouts. Additionally, the District maintains and operates 11 regulation and recharge basins covering approximately 1,110 acres. The recharge basins and canals in the District are shown on **Attachment 7**. Although the District owns a few production wells, it does not use them for groundwater extraction to supplement its surface water supplies.

1.3 - Goals and Objectives of Groundwater Management Plan

This GMP documents the existing groundwater management efforts in TID and planned efforts to improve groundwater management. The purpose of the GMP is to help TID meet the following objectives:

1. Address potential changes in local hydrology brought about by surface water losses (i.e. San Joaquin River Restoration), urban development and drought.
2. Preclude surface water or groundwater exports that would reduce the long-term reliability of groundwater.
3. Coordinate groundwater management efforts between regional water users.
4. Maintain local management of the groundwater resources.
5. Implement a groundwater-monitoring program to provide an "early warning" system to future problems.
6. Stabilize groundwater levels in order to minimize pumping costs and energy use, and provide groundwater reserves for use in droughts.

7. Develop groundwater storage facilities to reduce stress on local groundwater reserves during droughts.
8. Maximize the use of all surface water sources, including available flood water, for beneficial use and groundwater recharge, and thus reduce stress on groundwater resources.
9. Increase knowledge of the local geology and hydrogeology to better understand threats to groundwater quality and quantity.
10. Minimize future land subsidence caused by groundwater pumping through in-lieu groundwater recharge, and wise and conservative use of pumped groundwater.
11. Prevent groundwater degradation by protecting groundwater quality, importing clean surface water, and preventing intrusion of poor quality groundwater from neighboring areas.

In addition, the District will take a proactive role in the legislative process. TID will participate in development of sound legislation concerning groundwater management if it becomes necessary. TID will also take an active role in opposing any legislation that is detrimental to local groundwater management efforts, or prevents the local management of groundwater. In furtherance of this effort, District staff are active in the Groundwater Committee of ACWA, in which groundwater legislation and implementation strategies are regularly discussed.

1.4 - Statutory Authority for Groundwater Management

The District, under the authority of AB 255 passed by the state legislature in 1991, adopted a groundwater management plan in 1992. The District was one of the first in the state to adopt such a plan and groundwater management program. The District, like others in the San Joaquin Valley, felt it best to adopt a plan locally as a means to demonstrate its commitment to local conjunctive use management and embrace the authorities afforded therein to further that commitment. AB 255 essentially empowered districts with the authorities of groundwater replenishment districts. These powers include the ability to impose charges and levy taxes for the purposes of acquiring and recharging surface water.

Under subsequent legislation, namely AB 3030 which passed in 1992, Kaweah Delta WCD also adopted a groundwater management plan in 1995. The KDWCD's Plan was regional in extent and overlaps the service area of TID and twelve other water agencies. The newer legislation provided for many of the same authorities and powers as did AB 255; however, one additional management power was the ability to regulate (reduce) groundwater pumping should other measures first prove inadequate to address overdraft issues.

The authorities in AB255 and AB3030 remained unchanged with the amendments to the law provided by 2002 California Senate Bill 1938 (SB 1938), which also identified new requirements for GMPs. The GMP represents an updated version, and includes the additional components listed in California SB 1938.

The powers granted to an agency adopting a Groundwater Management Plan include:

1. The District may take any actions needed to replenish the groundwater within the District, including buying and selling water, delivering water in-lieu of groundwater pumping, and spreading water for recharge.

2. The District has the authority to limit or suspend groundwater extractions, but only if they determine through study and investigation that groundwater replenishment programs, or other alternative sources of water supply, have proved insufficient or infeasible to lessen the demand for groundwater.

3. The District may take actions needed to protect or prevent interference with water, water quality, or water rights within the District.

4. The District may take any actions necessary to put water under its control to beneficial use.

5. Using water quality goals, the District may take any action needed to preserve the water within the District for beneficial uses. These actions include preventing contaminants from entering District groundwater supplies, removing contaminants, locating and characterizing contaminants within the District, identifying parties responsible for contamination of groundwater, and performing studies relative to the listed water quality goals.

6. The District may enter into agreements with other local agencies or private parties to manage mutual groundwater supplies, including those existing in overlapping areas.

7. The District may levy and collect general groundwater replenishment assessments, as well as water extraction fees based on the amount of groundwater extracted from the aquifer. However, these fees must be "ratified" by a majority vote in an election, according to the election rules applicable to the District.

8. The District may sue to recover the amount of District expenditures for protection of groundwater quality protection from parties responsible for the contamination.

9. The District is granted additional powers of a Replenishment District, which allows it to:
   a) Acquire and operate facilities, waters and rights needed to replenish

the groundwater supplies.

b) Store water in groundwater basins, acquire water rights, import water into the District, and conserve water.
c) Participate in legal proceedings as required to defend water rights, and water supplies, and to prevent unlawful exportation of water from the District.
d) Under certain conditions, to exercise the right of eminent domain.
e) Act jointly with other entities in order to economically perform required activities.
f) Carry out investigations required to implement programs.
g) Fix rates for water for replenishment purposes.
h) Fix the terms and conditions of contracts for use of surface water in-lieu of groundwater.

The District's overall strategy in using these powers is to limit their control over private groundwater facilities, and, through a combination of grower education, water conservation efforts, groundwater recharge, and groundwater banking, to reduce the rate of groundwater level decline, and, if possible, stabilize groundwater levels to help ensure that groundwater resources are sustainable and economically accessible.

1.5 - Groundwater Management Plan Components

This GMP includes the required and voluntary components for a GMP as identified in California Water Code Section 10753, et. seq. This Plan is also consistent with the recommended elements for a GMP as identified in DWR Bulletin 118 (2003), Appendix C. **Table 1.1** identifies the appropriate section of the GMP where each component is addressed.

Table 1.1 - Location of Groundwater Management Plan Components

Description		Plan Section(s)
California Water Code Mandatory Requirements (10750 *et seq.*)		
1.	Documentation of public involvement	1.6, Appendix A
2.	Groundwater basin management objectives	1.3, 3
3.	Monitoring and management of groundwater elevations, groundwater quality, land subsidence, and surface water	5
4.	Plan to involve other agencies located in the groundwater basin	4.3
5.	Monitoring protocols	5.3
6.	Map of groundwater basin and agencies overlying the basin	Att. 2,3 and 5
California Water Code Voluntary Components (10750 *et seq.*)		
7.	Control of saline water intrusion	6.3
8.	Identification and management of wellhead protection areas and recharge areas	6.2, 7.2
9.	Regulation of the migration of contaminated groundwater	6.3, 6.4
10.	Administration of well abandonment and well destruction program	6.1
11.	Mitigation of overdraft conditions	7.1, 7.2
12.	Replenishment of groundwater extracted by water users	7.2
13.	Monitoring of groundwater levels and storage	5.1, 9.3
14.	Facilitating conjunctive use operations	7.3
15.	Identification of well construction policies	8.1
16.	Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	6.4, 7, 8.2
17.	Development of relationships with state and federal regulatory agencies	4.2, 4.3
18.	Review of land use plans and coordination with land use planning agencies	9.1
Additional Components Recommended by DWR (App. C of Bulletin 118)		
19.	Advisory committee of stakeholders	4.1
20.	Description of the area to be managed under the Plan	1.1, 1.2, 2
21.	Descriptions of actions to meet management objectives and how they will improve water reliability	4 - 9
22.	Periodic groundwater reports	9.3
23.	Periodic re-evaluation of Groundwater Management Plan	9.5

1.6 - Adoption of Plan

Refer to **Appendix A** for documentation on the adoption of the GMP and the public process that was followed.

Public Participation in Plan Development
The public was invited to participate in the development of the updated GMP through newspaper notices and public hearings. The City of Visalia, City of Tulare and Kaweah Delta Water Conservation District were also sent copies of the Draft GMP for their review and comments.

Groundwater Advisory Committee
A Groundwater Advisory Committee was formed comprising the District Manager, District Engineer and TID Board of Directors. The TID Board of Directors is comprised of local farmers and represents the local community. They are familiar with the local and regional water issues and are best suited to serve as the primary voice on the GAC. The general public was informed of the GMP update through a series of public notices and meetings.

Public Notice of Intention to Update the Groundwater Management Plan
As required by the California Water Code, a public hearing was duly noticed consistent with Code §10753.2(a) and held on August 11, 2009, to discuss updating TID's existing GMP. No public comments beyond those offered by the GAC were received at this meeting.

Resolution of Intention to Update the Groundwater Management Plan
TID adopted a Resolution of Intention to Update the Groundwater Management Plan on August 11, 2009. This resolution was then published on July 27 and August 3, 2009 consistent with Code §10753.2(a).

Resolution of Intention to Adopt the Updated Groundwater Management Plan
TID adopted a Resolution of Intention to Adopt the Groundwater Management Plan on May 11, 2010, consistent with Code §10753.2(a).

Resolution Adopting the Updated Groundwater Management Plan
TID adopted a Resolution to Adopt the Updated Groundwater Management Plan on September 14, 2010. This resolution was then published on September 23, 2010 and September 30, 2010 consistent with Code §10753.2(a).

1.7 - Kaweah Delta Water Conservation District Groundwater Management Plan
TID is a cooperating agency in the KDWCD GMP, which was updated in November 2006. KDWCD's original plan was prepared in 1995 in accordance with the requirements prescribed in Assembly Bill No. 3030. The 2006 Plan was revised to satisfy the new requirements for GMPs created by the September 2002 Senate Bill No. 1938. Refer to Section 4.2 for more information on KDWCD and **Attachment 8** for a map showing the border of KDWCD in relation to TID.

The Plan officially recognizes stakeholders through the execution of a MOU. The purpose of the MOU is to document the interests and responsibilities of participants. The MOU also promotes the sharing of information, the development of a course of action, and the resolving of differences that may arise regarding the Plan. Since the Plan's inception in 1995, thirteen stakeholders have signed the MOU. A list of the stakeholders is provided in Section 4.2 – Relationships with Other Agencies.

In 1996, TID and KDWCD executed an additional MOU referred to as the "Overlap MOU" for the purpose of coordinating the implementation of their respective Plans (see **Appendix B**). From the District's perspective, the two principle features of the MOU as stated therein are that (1) each agency will coordinate its groundwater management activities in the overlap area with the other, and (2) should there be unresolved disputes, TID's plan will govern within its prescribed area, including the City of Tulare.

The two groundwater management plans share common goals and themes. This GMP focuses on groundwater issues unique to TID and its surrounding area, while the KDWCD GMP focuses on regional groundwater issues. TID considers both GMPs important resources in their groundwater management program. While the KDWCD and several other agencies within the Kaweah sub-basin currently maintain individual GMP's, TID will continue to maintain and implement its own Plan given its historic and leading role in the basin of importing large quantities of surface water from the Friant Unit, a practice that has and will serve as one of the most significant measures in combating local and regional overdraft.

2 - GEOLOGY AND HYDROGEOLOGY

This section discusses the geology and hydrogeology of TID and the surrounding area. The purpose of this section is to provide general background information on the local hydrogeology that will aid in selecting and implementing groundwater management programs. Most of the information on the local geology was derived from reports prepared by USBR (February, March 1949), and Fugro West (2007). Regional geologic information is documented in Bertoldi et al (1991), Page (1986), and Croft (1968).

The following sections include technical discussions on the District's groundwater. These are intended to provide geologists, engineers, and water managers a greater understanding of the area's stratigraphy, groundwater conditions, and hydrogeologic parameters. The content of this chapter requires a basic understanding of some geologic principles and terminology. Less technical discussions on groundwater management programs can be found in Sections 3-9.

2.1 - Regional Geology

The District is located entirely within the confines of the San Joaquin Valley. The San Joaquin Valley is a large asymmetric structural trough that has been receiving sediments from the Sierra-Nevada Mountains to the east and from the Coast Ranges to the west. In the area of TID, these sediments and corresponding structures control the direction of groundwater flow and the quality of groundwater available to wells. In general, TID is underlain by (oldest to youngest) basement rocks, unconsolidated deposits, and topsoil.

Groundwater Basin

TID is located in the Tulare Lake Hydrologic Region, which covers 10.9 million acres (17,000 square miles) and includes all of Kings and Tulare Counties and most of Fresno and Kern Counties. The Tulare Lake Hydrologic Region has 12 distinct groundwater basins and 7 sub-basins. TID is located in the Kaweah sub-basin of the San Joaquin Valley Groundwater Basin (**Attachment 5**). The San Joaquin Valley Groundwater Basin is surrounded on the west by the Coast Range, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada Mountains and on the north by the Sacramento-San Joaquin Delta and Sacramento Valley. General information on the San Joaquin Valley Basin and Kaweah sub-basin can be found in the California Department of Water Resources Groundwater Bulletin (2003 update).

The Kaweah sub-basin lies between the Kings Groundwater sub-basin on the north, the Tule Groundwater sub-basin on the south, the crystalline bedrock of the Sierra Nevada foothills on the east and the Tulare Lake sub-basin on the west. The Kaweah sub-basin boundaries are similar to those for the KDWCD. Major rivers and streams in the sub-basin include the Lower Kaweah and St. Johns Rivers. The Kaweah River is considered a primary surface water source for groundwater recharge to the area. In the 1980 California Groundwater Bulletin 118 (DWR, 1980), DWR classified the Kaweah sub-basin as being critically overdrafted. This designation was not re-evaluated by DWR when Bulletin 118 was updated in 2003. (However, recent analysis by Fugro (2007) still shows the basin to be in a state of overdraft). DWR has assigned the sub-basin a 'Type B' groundwater budget, which means that enough data are available to estimate the groundwater extraction to meet the local water needs, but not enough data is available to characterize the groundwater budget.

According to DWR (2003), well yields in the Kaweah sub-basin are 1,000 to 2,000 gpm, with a maximum of 2,500 gpm. The total dissolved solids in the groundwater ranges from 35-580 mg/L with an average of 189 mg/L.

Previous Studies
In December 2003, Fugro West, Inc. prepared a report for KDWCD entitled "*Water Resources Investigation of the Kaweah Delta Water Conservation District*". The report was revised in July 2007. The purpose of the study was to conduct a detailed geologic and hydrogeologic analysis to evaluate and assess the safe yield within the District. The overall purpose of the study was to provide the District, overlying water purveyors, and Tulare County planning agencies with foundational data to help plan future water supply projects. Although the investigation does not address specific planning or water management issues, it provides a foundation for agencies to continue and to optimize their water resource planning efforts. The results of the study are discussed throughout this GMP.

The KDWCD was divided into 5 separate Hydrologic Units for the study (see **Attachment 9**). TID is located in Hydrologic Unit No. 5, which essentially covers the District, as well as the City of Tulare and a small overlapping portion of the Elk Bayou Ditch Company. Hydrologic Unit No. 5 covers 81,500 acres in comparison to TID which covers 77,000 acres. For general purposes, these two areas are assumed to be the same. The most important results from the study include detailed figures for hydrologic balance parameters, and an estimated safe yield for Hydrologic Unit No. 5.

2.2 - Physiography of the District
The San Joaquin Valley, which is the southerly part of the great Central Valley of California, extends from the Sacramento-San Joaquin Delta area on the north about 250 miles to the Tehachapi Mountains on the south. In the vicinity of the District, it is approximately 65 miles wide. The Valley is bordered on the east by the Sierra Nevada Mountains, which range in elevation from about 1,000 feet or less to more than 14,000 feet above sea level. The Coast Range Mountains, which borders the Valley on the west, rises to about 6,000 feet above sea level.

The southern end of the San Joaquin Valley, also known as the Tulare Basin, is a closed feature, with water flowing out of the basin only in extreme wet periods. Tributary streams drain to depressions, the largest of which is Tulare Lake bed located to the west of the District's boundary. The Kings River, Kaweah River, Tule River, White River, Deer Creek, Lewis Creek and Poso Creek, and, on occasion, the Kern River, discharge into Tulare Lake at times when flows exceed the capacity of foothill reservoirs and of the irrigation and recharge diversion systems.

Water level fluctuations in the Tulare Lake waters have been common, and it is reasonable to assume that the process has been taking place for many centuries. During years of heavy precipitation and run-off, before levees were constructed, large volumes of water accumulated in Tulare Lake, and as the relief is very low, the area of the lake fluctuated widely with slight changes in depth of water. Through the years, very little water has escaped from the lake by overflow; most has evaporated or been absorbed by the sands and silts of the lake bottom. Dissolved salts brought in by tributary streams have, in this way, been concentrated. Currently, much less water accumulates in the Lake from runoff due to the construction of several dams and numerous irrigation diversions, and much of the land in the Lakebed is now cropped.

2.3 - Stratigraphy

The following discussion focuses on significant hydrogeologic units that could have an impact on the groundwater resources within the District. Stratigraphy in the District is documented in several reports. The description below is based primarily on the information provided in *Technical Studies in Support of the Factual Report – Tulare Irrigation District* (USBR, February 1949). The generalized stratigraphic sequence of the District includes topsoil, a water bearing series and a non-water bearing series.

Topsoil

Soils in the District are generally favorable for irrigated agriculture with regards to depth, texture and freedom from gravel, stones, or hardpan. According to the Natural Resources Conservation Service Soil Survey for Western Tulare County (2007), most of the District is comprised of loam or sandy loam. The primary soil types include Colpien loam, Nord fine sandy loam, and Gambogy loam. According to the TID Factual Report (March 1949), about 80 percent of the District's land is affected by varying concentrations of alkali, which has resulted from former high water table conditions.

Water Bearing Series

The water-bearing series consists of alluvial fans and lake beds of late Tertiary and Quaternary geologic age which form the groundwater reservoir of the District and adjacent areas. They consist generally of the Delano beds, the Kern River formation, and Young Alluvium. For the purpose of this study, the Kern River Series has been divided into the lower "Kern River formation", and an upper portion, the "Delano beds".

Clay beds apparently formed in relatively still lakes are included within the latter. The water-bearing sediments form a huge wedge, thickest near the western edge of the San Joaquin Valley and thinnest along the mountain front to the east.

Kern River Series. The Kern River formation, in this discussion, includes all known or suspected local sediments older than the Delano beds. Sediments of the Kern River Formation crop out south of Tule River where they disappear northerly beneath the Delano beds. Aquifers in this formation presumably contribute water to the deeper wells. The lithology is similar to the Delano Beds described below.

The Delano Beds consist of fluvial sands, silts, sandy clays, and clays, in part lacustrine, with a few thin lenses of gravel. They crop out east of the District in the area of Lindsay. The sands are generally arkosic, angular to subangular, friable to loose, poorly sorted, and of various shades of reddish-brown, tan and gray.

Young Alluvium. This material forms the fans, floodplains, and channels of the present streams. It resembles the Delano beds, but being younger is not so deeply weathered.

Soils developed in Young Alluvium are generally open and porous, but on the outer fringes of the fans of Tule and Kaweah Rivers and in interfan areas between distributaries of the Kaweah Branch, dense sub soils correspond to areas formerly having a high water table and restricted surface drainage.

Younger alluvium consists of gravelly sand, silty sand, silt, and clay deposited along stream channels and laterally away from the channels in the westerly portion of the District. Younger alluvium is relatively thin locally, reaching a maximum depth below ground surface of perhaps 100 feet. The Young Alluvium is generally above the water table and does not constitute a major water-bearing unit.

Soils developed on the Young Alluvium do not show multiple soil horizons (layers) and are generally free of underlying clay subsoil or hardpan. Because percolation rates through the Young Alluvium are moderate to high, this deposit serves as a permeable conveyance system for recharge to underlying water-bearing materials.

Clay Layers. The westerly two-thirds of the District is largely underlain by the so-called Corcoran Clay or E-Clay, which separates a generally unconfined aquifer system above and a confined aquifer system below. Irrigation wells in the District's area are generally perforated in both systems.

Although as many as six laterally continuous clay zones have locally been defined in the southern San Joaquin Valley, only the most prominent of these E-Clay zones known as the E-Clay (or Corcoran Clay member) is found within the District. The E-Clay is one of the largest confining bodies in the area and underlies about 1,000 square miles of the San Joaquin Valley. The beds were deposited in a lake that occupied the San Joaquin Valley trough and which varied from 10 to 40 miles in width and was more than 200 miles in length (Davis et al., 1957).

The E-Clay extends from Tulare Lake Bed to U.S. Highway 99 and is vertically bifurcated near Goshen. It is about 140 feet thick near Corcoran and the average thickness is about 75 feet. The deposits near the City of Corcoran are probably the thickest section in the San Joaquin Valley. The Corcoran Clay is generally used to differentiate between a lower confined aquifer and an upper unconfined aquifer west of its eastern extent.

As mapped by Page (1986), the E-Clay (or Corcoran Clay) underlies the majority of the District. Pages' mapping extends the eastern limit of the Corcoran Clay in the vicinity of the plan area from earlier studies by Davis et. al. (1957), and Croft (1968). Later mapping of the Corcoran Clay by R. S. Brown (1981) of the California Department of Water Resources, is in large part similar to Pages (1986) mapping, and as such his description is used here. All of the sources consulted for this study agree that the Corcoran Clay dips and thickens southwest beneath the District. The depth to the top is questionable in the northeast portion of the plan area, but appears to be between 200 to 300 feet deep there, dipping to depths of 400 feet beneath the southwest part of the District. While information on thickness is incomplete in the District, it does show that the Corcoran Clay thickens from about 20 feet thick in the northeast to about 40 feet thick in the southwest portion of the District, and locally maybe as much as 60 feet thick.

Alluvial Fans. TID is located on the recent and still growing alluvial fan of the Kaweah and St. Johns Rivers. The Tule River alluvial fan approaches to about two miles southeast of the District. The alluvial fan slopes generally southwesterly at 7 to 8 feet per mile in the northeastern half of the district. Land classification studies show the soils in this area to be generally light-textured. The southwestern half of the District slopes southwesterly about 5 feet per mile, with prevailingly medium-textured soils. Change in slope and in soil texture reflects the change from the active portion of the fan to the outer, largely inactive, portion.

The Kaweah alluvial fan was built by deposition from Kaweah River and its distributaries. Original slopes of the fan were gentle, and deposition was sufficiently slow to allow deep weathering and break down of coarser materials. The aquifers are lenticular (composed of lenses) in character and are separated from each other by less permeable deposits, permitting a slow, steady migration of ground water from sand lens to sand lens.

Basement Complex (Non-water bearing series)
The non-water bearing series is the Basement Complex, which crops out throughout the mountains and foothills, 10 miles or so east of the District. The Basement Complex consists of ancient sedimentary and volcanic rocks, now greatly metamorphosed, and of the granitic rocks which intrude them. These were involved in the late Jurassic deformation and form a unit that underlies the valley fill at varying depths—probably not less than 5,300 feet below TID. The Basement Complex is relatively impervious and inhibits groundwater recharge. Streams flowing through the Basement Complex lose little or none of their original flow by influent seepage. In the District the basement is assumed to be deep enough to have no significant effect on ground-water supply and conditions.

2.4 - Aquifer Characteristics

In TID, aquifers occur in unconfined, semi-confined, and confined states. Water levels in an unconfined aquifer system coincide with the top of the zone of saturation, where hydrostatic pressure is equal to atmospheric pressure. Seasonal water level variations in such systems are typically subdued. In confined or artesian aquifers, water bearing materials are completely saturated and are overlain by confining materials of low permeability, such as clay and fine silt, and water within the aquifer is under hydrostatic pressure. The hydrostatic head, or pressure, in such an aquifer is reflected by the height above the confining stratum to which water will rise in a well drilled into the aquifer.

Because the alluvial and continental deposits in the District are characteristically heterogeneous in composition, containing individual strata of low permeability that generally exhibit little or no continuity, most aquifer systems are, in fact, semi-confined, becoming increasingly confined with depth. Such aquifers respond to pressure changes over short periods of time, however hydrostatic heads reach equilibrium with unconfined water tables only over extended periods of static, non-pumping conditions.

Specific Yield
Specific yield is defined as the volume of water that will drain by gravity from sediments within a designated storage unit if the regional water table were lowered. Conversely, it is also defined as the volume of water to re-saturate the deposits after they are drained (as long as the sediments do not collapse i.e., subsidence).

Average estimated specific yield of sediments underlying TID is 10 percent (USBR, February 1949). This figure was derived from studies of 477 water wells, in which the material evaluated was, in most cases, between 20 and 70 feet below the surface (USBR, February 1949). The specific yield of the ground water reservoir was estimated by segregating sediments recorded in driller's water well logs into the following classifications:

Table 2.1 – Specific Yield of Various Sediments

Sediment	Relative Permeability	Specific Yield
Clay and silt	Impermeable	2.9%
Very find sand, silt and clay	Relatively impermeable	4.2%
Fine sandy silt	Poor permeability	5.8%
Sandy silt, slightly cemented sand	Relatively permeable	7.5%
Medium and fine sand	Permeable	24.2%
Gravel and coarse sand	Very permeable	34.8%

Note that the estimated specific yield of 10% is for a zone (20 to 70 feet depth) that has been mostly dewatered. Average groundwater depths in TID were approximately 135 feet in Fall of 2009.

Fugro (2007) also estimated specific yield for the entire KDCWD area. Considered in an overall picture, the contours of equal specific yield percentage in the Kaweah area follow a fairly uniform pattern. High percentages are centered around the present main channel of Kaweah River. Decreasing percentages are found north into the Ivanhoe area and as the topographic low in the interfan area between the Kaweah and Tule Rivers is approached. These details can be seen on a specific yield map (Fugro, 2007, Plate 23). The map shows a specific yield of 10 percent in most of TID and slightly lower specific yield in the northern part of District. The extreme southwest corner of TID is higher, with some areas having an estimated 13% specific yield. The specific yields were estimated for depths from 0 to 200 feet below ground surface.

Transmissivity

Transmissivity data for the TID area from available literature is sparse. A study by Davis et al., (1964) summarized numerous specific capacity values from Pacific Gas & Electric pump tests performed across the San Joaquin Valley. Using data from field tests in the TID area, they calculated specific capacities ranging from 42 to 60 gpm per foot. Driscoll (1986) provides an approximate relationship between specific capacity data and transmissivitiy. Using this method, transmissivity values for the District and immediately surrounding areas range from 63,000 to 90,000 gpd/ft. These values of specific capacity and transmissivity are probably valid for the unconfined aquifer, as at the time of the report most wells drilled in the area were most likely completed above the E-Clay.

Wells Yields and Depths

Usable groundwater in the District occurs both above and below the Corcoran Clay, and many water wells perforate zones both above and below the E-Clay. These wells allow significant amounts of inter-aquifer flow between the upper unconfined aquifer and lower confined aquifer, thereby equalizing piezometric (head) differences.

According to USBR (February, 1949), pump tests gave no indication of any particularly favorable pumping areas in the District from the viewpoint of specific capacity or yield. Well yields throughout the district averaged approximately 700 gallons per minute and specific capacity averaged 55 gallons per minute per foot of drawdown. However, this data is over 50 years old and conditions and well construction methods have changed substantially over time.

The California DWR (2003) states that well yields in the Kaweah groundwater sub-basin range from 1,000 to 2,000 gpm, with a maximum of 2,500 gpm.

The City of Tulare Urban Water Management Plan includes attributes for 30 City production wells (Table 3-2 in Urban Water Management Plan). The well depths range from 200 to 780 feet, and capacities range from 230 to 1,500 gpm.

<u>Safe Yield</u>

The safe or perennial yield of a groundwater basin is typically defined as the volume of groundwater that can be pumped year after year without producing an undesirable result. Any withdrawal in excess of safe yield is considered overdraft. The "undesirable results" mentioned in the definition are recognized to include not only the depletion of groundwater reserves, but also deterioration in water quality, unreasonable and uneconomic pumping lifts, creation of conflicts in water rights, land subsidence, and depletion of stream flow by induced infiltration. It should also be recognized that the concepts of safe yield and overdraft imply conditions of water supply and use over a long-term period.

The supplemental supply to be furnished from the Friant-Kern Canal was intended to maintain water levels approximating those during 1921-1946, or during a similar cycle of normal runoff. Therefore, with full utilization of the surface water supplies, then groundwater pumping should match the safe yield. However, several factors have contributed to the current condition of overdraft, including: 1) Planting of high water use crops; 2) Double cropping; 3) Dairy development; 4) Urban development and attendant pumping and land use impacts; 5) High groundwater pumping in neighboring areas; and 6) Endangered species issues that result in less surface water diversions to water agencies in the region. In addition, the San Joaquin River Restoration project will reduce TID's surface water deliveries and create a greater disparity between groundwater pumping and the safe yield.

Fugro provided a 'Practical Rate of Withdrawal' for Hydrologic Unit No. 5 (Table 78), which is considered to be the estimated safe yield. This value ranges from 126,000 to 141,000 AF/year for Hydrologic Unit No. 5. Fugro (2007) estimated that the overdraft in the KDWCD ranges from 21,700 to 36,000 AF/year, and the overdraft in Hydrologic Unit No. 5, which is roughly equivalent to the TID service area, is 6,800 AF/year. Within

KDWCD, the greatest overdraft is occurring west of TID, which includes distinctive pumping depressions according to groundwater contour maps.

Groundwater Storage
The area of the District is 72,000 acres and the average specific yield is about 10 percent. With an assumed average groundwater depth of about 135 feet, there is 8.9 million AF of storage capacity between the groundwater table and a depth of 20 feet below the ground surface.

Groundwater Flow
In general, a characteristic regional northeast to southwest pattern of groundwater flow occurred during the 1980's and 1990's. Areas of pumpage depressions are persistently present north of Corcoran, west of Visalia, and northwest of Exeter. Groundwater also flows into TID from the Tule River area into the southern portion of TID. Fugro (2007) estimated groundwater inflow and outflow in Hydrologic Unit No. 5 to average 22,200 AF/year and 16,200 AF/year, respectively, between 1981 and 1999. This equates to a net groundwater inflow of 22,200 – 16,200 = 6,000 AF/year.

Recharge
The estimated specific yield and soil permeabilities resulting from land classification studies indicate that conditions in TID favor artificial water spreading (USBR, February 1949). The northeast quarter of the District is the most suitable for this purpose and the southwest quarter is fairly suitable. The northwest and southeast quarters are generally unfavorable, although there are some areas of moderate permeability in each. The Young Alluvium that overlies all of the TID varies widely in porosity and texture. This variation is noticeable, particularly in the small interfan areas between the natural distributaries of the Kaweah River.

Regionally, most of the KDWCD is underlain by soils with "moderate" rates of water infiltration. Geologically, these correspond to areas of Holocene alluvium. Areas of slow infiltration are also common; these areas correspond to areas of Pleistocene alluvium. Scattered pockets of high infiltration soils appear to be associated with stream channels and associated deposits.

2.5 - Groundwater Levels

In the early 1900's, groundwater levels were high in TID and many wells experienced artesian flow. Since the early 1950's, the District has observed declining groundwater levels and the Kaweah sub-basin has been identified by the DWR as a sub-basin subject to critical conditions of overdraft. Critical conditions of overdraft are defined as a groundwater basin in which continuation of present practices would probably result in significant adverse overdraft-related environmental, social or economic impacts.

Throughout the years the KDWCD has accomplished various studies that examined groundwater supplies. The most recent study, "*The Water Resources Investigation of the Kaweah Delta Water Conservation District*", was completed in 2003 and updated in 2007. The study once again confirmed the Basin was in a state of overdraft. The study was a comprehensive review of the elements required to determine safe yield for the aquifers within the District. The final conclusion was that annual groundwater supplies in KDWCD were insufficient for water demands not met by surface water in the range of 20,000 to 36,000 AF annually.

TID has been monitoring groundwater levels within and adjacent to its service area since the 1940's. This is accomplished through groundwater level measurements taken in the late fall and early spring. This data is provided to USBR as part of that agency's assessment of groundwater trends within the Friant Unit service area. The KDWCD also measures depths to groundwater basin-wide. Based on historical water level readings by these and other entities, there is an overall trend of declining groundwater levels within the Sub basin. It is important to note that the Basin does have the ability to respond to positive conditions and this is demonstrated during years of above-average precipitation when the decline has been periodically interrupted by short-term groundwater recovery, as a result of reduced groundwater pumping and increased surface water imports. The most severe water level declines within the Basin from 1950 to 2000 occurred in the extreme western end, which is westerly of TID.

The groundwater levels (elevation and depth) in TID and the KDWCD are shown on **Attachments 10** and **11**. Between 1950 and 2000, groundwater levels fluctuated seasonally and according to climatic conditions. Fugro (2007, Plate 30) shows 18 hydrographs for wells throughout TID. Almost all of the hydrographs show a precipitous drop in groundwater levels from 1987 to 1995, a 7-year drought. The water level drops ranged from 50 to 120 feet, with most wells seeing about an 80-foot drop in water levels. From 1995 to 2000 the hydrographs show that water levels recovered and in some cases were slightly higher than in 1950.

USBR (February 1949) notes that TID may lose water by groundwater outflow in years when they take large quantities of Friant Unit CVP Class 2 water. They suggest that this could be avoided by recharging or using some of the water in areas outside of TID. TID is doing this through their various water sales and transfer agreements, discussed in Sections 4.2 and Chapter 7.

2.6 - Land Subsidence

According to Ireland et al. (1984), land subsidence from 1926 to 1970 in the KDWCD has likely been no more than several feet and restricted to the extreme west side of the KDWCD. Subsequent work by Swanson (1998) indicates that with the availability of new surface water supplies in the San Joaquin Valley in about 1970, rates of subsidence were substantially reduced. From 1925 to 1995, such subsidence occurred only in drought years and in local areas where historic low water levels were exceeded.

Ireland (1984) indicates land subsidence of up to 4 to 5 feet in the southern and western portion of the Kaweah sub-basin.

2.7 - Groundwater Quality

Groundwater quality in TID is known only from limited testing. However, the chemical quality of both surface water and groundwater in the District is generally excellent for irrigation, and satisfactory for municipal and industrial use, although there may be some localized problems. The quality of groundwater is expected to remain satisfactory in view of the excellent quality of the replenishment water. The quality of runoff from the Kaweah River and San Joaquin River, which furnishes most ground and surface supply to the District, is very good to excellent quality.

Generally, water is considered suitable for agriculture if the total dissolved solids (TDS) is less than 700 mg/L (Cherry, 1979). According to DWR (2003), TDS in the Kaweah Groundwater sub-basin averages 189 mg/L with a range from 35 to 580 mg/L.

The TID Factual Report (USBR, March 1949) mentions deep brackish water zones within the District. The reports states that they may not be extensive, but should not be ignored, and caution should be used when deep well drilling (greater than 650 feet) is being considered.

The City of Tulare 2008 Consumer Confidence Report also includes information on the local groundwater quality. Between 2006 and 2008 the City did not have any water quality violations. Ranges in water quality parameters included the following:

- Total dissolved solids: 86-220 ppm
- Specific conductance: 130-340 uS/cm
- Arsenic: 2.1-10 ppb

3 - BASIN MANAGEMENT OBJECTIVES

The District's Basin Management Objectives are listed below:

1. **Stabilize Groundwater Levels.** Stabilize average long-term groundwater levels to prevent the loss of groundwater reserves, and prevent the need for well deepening or the installation of new wells. This would be achieved through a combination of water conservation measures, direct groundwater recharge, in-lieu groundwater recharge (importing surface water) and groundwater banking.

2. **Increase Groundwater in Storage.** Increase groundwater storage through the development of groundwater banking projects in areas that have geologic conditions conducive to groundwater recharge and recovery.

3. **Prevent Further Land Subsidence.** Prevent further land subsidence that can cause a reduction in groundwater storage space and damage water delivery infrastructure through efficient use of groundwater supplies and full utilization of surface supplies.

4. **Prevent Groundwater Degradation.** Prevent groundwater degradation by protecting groundwater through proper well construction and abandonment, proper use of agricultural amendments, importing clean high quality surface water, and preventing intrusion of poor quality groundwater from neighboring areas.

5. **Maintain Good Groundwater Quality for Agricultural Irrigation.** Maintain suitable groundwater quality for agricultural irrigation according to published guidelines for crops grown in the District.

6. **Increase Knowledge of Local Geology and Hydrogeology.** Increase knowledge of the local geology and hydrogeology through technical studies, subsurface investigations, water quality testing, water level monitoring, and land subsidence monitoring. Gain a better understanding of regional groundwater quality, groundwater overdraft, and groundwater flow conditions. Seek funding for these investigations through State and Federal grant programs.

7. **Solidify District's Claim to Local Groundwater Management.** Solidify the District's position and authority as the manager of the local groundwater, provide better representation for the District growers on groundwater issues, and develop

a relationship with the State that fosters local assistance and decision-making to assist in promulgating state goals and objectives.

Existing Activities

- All existing and on-going activities described in Sections 4-9 will be maintained, unless stated otherwise. (In Sections 4-9 the Existing Activities are not repeated under Planned Actions, even though they will be continued in the future).

Planned Actions

- All new policies and projects described in Sections 4-9 will be pursued, but their implementation will be subject to available funding and staff time.
- Manage local groundwater resources with an emphasis on meeting the GMPs Basin Management Objectives.

4 - STAKEHOLDER INVOLVEMENT

4.1 - Groundwater Advisory Committee

A Groundwater Advisory Committee (GAC) was formed in 2009 to assist with the development of this GMP. The GAC is comprised of the District Manager, District Engineer and TID Board of Directors. The TID Board of Directors is comprised of local farmers and represents the local community. They are familiar with the local and regional water issues and are best suited to serve as the primary voice on the GAC. However, no members of the general public have presently expressed any interest in serving on the GAC, although with an indication of interest in the future public members may be added by the Board. The GAC offered several useful and insightful comments that were incorporated into this GMP. The GAC will also monitor and evaluate the technical progress made in achieving the goals of this GMP.

Existing Activities

Assisted with the development of this GMP.

Planned Actions

The Committee will attempt to hold special groundwater sessions at regular Board meetings once each year, or more frequently if deemed appropriate, and said Committee will have the following responsibilities:

- Review trends in groundwater levels and available information on groundwater quality.
- Evaluate the effectiveness of current groundwater management policies, programs and facilities.
- Discuss the need for new groundwater supply/enhancement facilities.
- Determine the sufficiency of revenue sources to fund the District's conjunctive use operations.
- Educate landowners on groundwater management issues.
- Assess the overall progress in implementing the programs outlined in the GMP.
- Recommend updates or amendments to the GMP.
- Identify regional and multi-party groundwater projects.
- Review and comment on the Annual Groundwater Report.
- If needed, form special committees or task forces to undertake special groundwater management tasks.

4.2 - Relationships with Other Agencies

The District is located in the Kaweah groundwater sub-basin, which extends beyond many political boundaries and includes other municipalities, irrigation districts, water districts, private water companies, and individual water users (see **Attachments 2 and 3**). This emphasizes the importance of inter-agency cooperation, and the District has historically made efforts to work conjunctively with many other water management agencies.

Below is a list of some agencies that the District has and is working with in managing the local groundwater:

- Kaweah Delta Water Conservation District
- Consolidated Peoples Ditch Company/Farmers Ditch Company
- Member Units of the Friant Water Authority
- Friant Water Users Authority
- United States Bureau of Reclamation
- California Department of Water Resources
- Association of California Water Agencies
- City of Tulare
- City of Visalia
- Southern San Joaquin Valley Water Quality Coalition
- County of Tulare
- Kaweah River Basin IRWMP
- Tulare County

A description of each agency and their role in managing groundwater within TID is provided below.

Kaweah Delta Water Conservation District

The Kaweah Delta Water Conservation District was formed in 1927 under provisions of the Water Conservation District Act of 1927 for the purpose of conserving and storing waters of the Kaweah River and for conserving and protecting the underground waters of the Kaweah Delta. The District includes lands in both Tulare County and Kings County (see **Attachment 8**). The total area of the District is approximately 340,000 acres.

KDWCD's Plan Area contains multiple local agencies that provide various types of water services. Those local agencies have been included as stakeholders through the execution of a (MOU). Signatories to this stakeholder MOU are as listed below:

- California Water Service Company
- City of Farmersville
- City of Lindsay
- City of Tulare
- City of Visalia
- City of Woodlake
- Consolidated Peoples Ditch Company
- Kings County Water District

- Lakeside Ditch Company
- Lakeside Irrigation Water District
- St. Johns Water District
- Stone Coral Irrigation District
- Ivanhoe Irrigation District

TID also prepared a special MOU (the "Overlap MOU") with KDWCD regarding groundwater management in areas where their two GMPs overlap (see **Appendix B**). TID has cooperated with the KDWCD on many projects, including the KDWCD GMP (see Section 1.6), KDWCD Numerical Groundwater Model (see Section 9.2), and the Kaweah River Basin IRWMP (in process). TID also meets with KDWCD on a regular basis to discuss their respective groundwater management objectives as called for in the MOU.. TID has worked with KDWCD on numerous occasions to maximize the importation of surplus CVP water into the Kaweah sub-basin.

<u>Ditch Companies</u>
TID developed an exchange agreement with Consolidated Peoples and Farmers Ditch Companies which provides for delivery of imported water thereto in exchange for Kaweah water in storage in Lake Kaweah. Such exchanges are planned at times when more diversion capacity for imported CVP water is needed beyond what TID may have available. This practice in accordance with the agreement allows for the maximization of imported surface supplies into the basin.

<u>Member Units of the Friant Water Authority</u>
The Friant Water Authority is a joint powers authority comprised of 22 member districts located in Fresno, Tulare, and Kern Counties. In addition to its primary mission of operating and maintaining the Friant-Kern Canal, FWA also addresses various water supply, financial, legislative, legal and other policy issues on behalf of its members. As a member of FWA, TID is often involved in water management projects which involve transfer and exchange arrangements with other FWA members. TID's goal in such arrangements is to increase the net deliveries of imported water into the District.

<u>Friant Water Users Authority</u>
The Friant Water Users Authority is a joint powers authority that has member districts in Madera, Fresno, Tulare, and Kern Counties. The FWUA is staffed by employees of the Friant Water Authority under an agreement between the two organizations. FWUA is maintained to work on projects and legal matters that preceded the formation of the Friant Water Authority. The FWUA is further charged in working with USBR and others in advancing the needs of its members with respect to maximizing the availability of CVP water deliveries to the Friant Service area, much of which is in a state of overdraft.

USBR/DWR

TID currently participates in the Semi-annual Groundwater Measurement Program administered by the USBR. This program requires TID to take water level measurements from specified wells two times a year and share the data with USBR. USBR then shares this data with the DWR. TID has also historically applied for and received grants from the DWR and USBR that fund water management studies and construction of water infrastructure.

Association of California Water Agencies

TID is an active member of the Association of California Water Agencies. ACWA fosters cooperation among all interest groups concerned with stewardship of the State's water resources. TID staff attends the ACWA semi-annual meetings, selected committee meetings, and benefits from the educational and informational services that ACWA offers.

City of Tulare

In May 2005, the District and the City of Tulare renewed a long-standing agreement which provides for the City's use of certain District-owned canal and ditch facilities for disposing of storm drainage, payments by the City in-lieu of District assessments, a process to develop joint policies related to impacts of new urban development on District facilities, and also to consider and enter into various joint projects of mutual benefit. The outcome of this agreement was evaluating various joint projects and the eventual development of a water importation agreement to maximize groundwater levels in and around the City. The "City Groundwater Augmentation Program" was developed by the City/District Joint Operations Committee in early 2006. This program outlines the basis for District/City cooperation, the groundwater recharge locations, the water sources, fee collection mechanisms, and the fund accounting to carry out programs purposes. The District prepares an annual report for the City to document the accomplishments of the program in accordance with the agreement.

City of Visalia

TID is holding discussions with the City of Visalia on groundwater recharge projects and the use of City wastewater effluent for crop irrigation in exchange for an expansion of TID's conjunctive use operations in ways to benefit the City.

Southern San Joaquin Valley Water Quality Coalition

TID is a member of the Southern San Joaquin Valley Water Quality Coalition (Coalition) through their association with the Kaweah and St. Johns River Association. The Coalition encompasses the entire Tulare Lake Basin (4.4 million acres) and is comprised of four sub watershed groups (Kings, Kaweah, Tule and Kern). TID is a member of the Kaweah River sub watershed group. The Coalition is organized under a MOU, adopted in 2002, to jointly and cooperatively address water quality issues. The

Coalition monitors surface water (irrigation and storm water) and prepares annual reports.

Tulare County
TID stays apprised of water issues with the County of Tulare through the Tulare County Water Commission. The Water Commission serves as an advisory body to the Tulare County Board of Supervisors. The Commission is made up of local water experts including engineers, water district managers, elected officials and community activists. The Commission meets monthly to discuss regional water issues. TID is indirectly represented through a member belonging to KDWCD. TID staff is actively engaged in the Water Resources Committee of the Water Commission.

Kaweah River Basin IRWMP
TID is a member of the Integrated Regional Water Management Plan for the Kaweah River Basin. The IRWMP is a collaborative process among a number of public entities, non-profit groups and other stakeholders to identify, formulate and advocate surface and groundwater projects for the region. TID intends to coordinate its proposed groundwater management projects within this overall effort to seek grant and loan funds from DWR.

Existing Activities

- On-going agreements, cooperative programs and projects with other agencies as mentioned above.
- Continued involvement in the development of the Kaweah Groundwater Basin Integrated Regional Water Management Plan that is being led by Kaweah Delta Water Conservation District.

Planned Actions

- Implement multi-agency projects identified in the Kaweah River Basin IRWMP that will benefit TID and the region's groundwater resources.
- Implement projects funded as part of the Water Management Goal of the San Joaquin River Restoration Settlement. These are expected to include groundwater recharge projects with 50% funding provided by the Federal government.

4.3 - Plan to Involve the Public and Other Agencies

The District is already involved with many neighboring and regional agencies on groundwater management projects. Nevertheless, TID is always interested in building new relationships with other agencies that share the same groundwater basins. TID will also strive to involve the public in groundwater management decisions. Additional cooperative relationships can be achieved through the sharing of data, inter-agency committees, interagency meetings, memorandums of understandings, formal agreements, and collaborations on groundwater projects.

Existing Activities

- Conducted public hearings to discuss the content of this GMP prior to its adoption.

Planned Actions

- Hold annual Groundwater Advisory Committee meetings that are open to the public.
- Provide copies of the annual groundwater reports to the public at their request. Notify the public of the availability of the annual reports on the TID website and District newsletter.
- Publish information on groundwater management accomplishments on the TID website and quarterly newsletter.

5 - MONITORING PROGRAM

Optimal use of the groundwater resource is dependent on obtaining good basic data respecting both geology and hydrology. The purpose of this element of the Program is to characterize the conditions within the groundwater basin, both to document the accomplishments of the Management Program and to identify and implement specific programs, as needed, to reflect changing conditions in the basin.

This section discusses monitoring of groundwater levels, groundwater quality, land surface subsidence, and surface water. Monitoring is considered critical to future management decisions, and the District's monitoring program is intended to:

1. Provide warning of potential future problems.
2. Use data gathered to generate information for water resources evaluations.
3. Develop meaningful long-term trends in groundwater characteristics.
4. Provide data comparable from place to place in the District.

5.1 - Groundwater Level Monitoring

The District began routinely measuring groundwater levels in the late 1940's. The District now measures groundwater levels in about 100 wells each spring and fall. **Attachment 6** illustrates the location of private wells that are monitored by TID. **Attachment 12** includes a list of attributes for these wells. TID plans to collect more detailed well attribute information (such as well depth, screened interval, type of well, precise coordinates, etc.) in the future, if landowners are willing to share the data with the District. Pending the availability of grant funding, TID plans to install dedicated piezometer wells to better determine depth to groundwater in both the unconfined and confined (below the E-Clay) zones.

Groundwater Level Data

TID maintains the groundwater level data in a spreadsheet database. Electronic data is available as far back as the 1940's in some wells. Occasionally, TID has used the data to generate groundwater contour maps. TID plans to prepare annual groundwater reports documenting groundwater levels, groundwater contour maps, well hydrographs, and change in groundwater storage. Refer to Section 9.3 for more detail on these reports. An annual report is currently being prepared as referenced in Section 4.2 for submittal to the City of Tulare to document localized groundwater recharge accomplishments.

Sharing of Groundwater Level Data

TID currently participates in the Semi-annual Groundwater Measurement Program administered by the USBR. This program requires TID to take water level measurements from specified wells two times a year and share the data with USBR. In compliance with SB7X-6, the District intends to comply with state requirements to furnish groundwater level data to DWR under the provisions prescribed therein.

KDWCD Monitoring

KDWCD performs groundwater level monitoring on a regional scale. KDWCD has an extensive monitoring network that was initially established in the 1950's. This network has been maintained and improved in a continuing effort to provide reliable information for annual and long-term assessment of groundwater conditions. The KDWCD prepares semi-annual maps of groundwater depth, groundwater elevations, and annual change in groundwater depth. This data is useful to TID for assessing groundwater inflow and outflow, and assessing the health of regional groundwater supplies. The groundwater contour maps use a lower density well network than TID uses, and therefore TID still sees value in generating their own groundwater contour maps.

Existing Activities

- Measurement of groundwater levels each spring and fall.
- Review regional groundwater contour maps and hydrographs prepared by KDWCD each year.

Planned Actions

- Periodically review the monitoring network to determine if it provides sufficient aerial coverage to evaluate groundwater levels.
- Protect wells in monitoring program from being abandoned.
- Encourage landowners and developers to convert unused wells to monitoring wells. Inform them through the District website and newsletter that their abandoned well could be useful to TID.
- Install data loggers in a select number of wells to collect groundwater level data more frequently than twice a year.
- Collect more detailed information on the attributes of each monitoring well.
- Determine the perforated interval for each monitoring well so the groundwater level in confined and unconfined aquifers can be differentiated.
- Prepare annual groundwater reports, which will include detailed evaluations of groundwater level trends and estimated changes in groundwater storage (see Section 9.3).
- Maintain at least the same number of wells in the monitoring network by constructing monitoring wells, or adding new private wells to the network, when existing wells are taken out of the monitoring network due to lack of landowner cooperation or well failure.
- Coordinate data collection with the City of Tulare to better integrate trends in depths to water under the City boundaries and outer agricultural areas.
- Seek grant funds to install dedicated monitoring wells, including nested wells that measure groundwater levels above and below the Corcoran Clay.

- Convert groundwater well data and associated contouring efforts from a computer-aided drafting process to a Geographic Information System process.

5.2 - Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect of groundwater management in TID. Groundwater monitoring efforts serve the following purposes:

1) Spatially characterize water quality according to soils, geology (above and below the Corcoran Clay), surface water quality, and land use.
2) Establish a baseline for future monitoring.
3) Work with the City of Tulare with respect to its assessment of water quality for potable use purposes and its abilities in meeting federal and state requirements.
4) Compare constituent levels at a specific well over time (i.e. years and decades).
5) Determine the extent of groundwater quality problems in specific areas.
6) Identify groundwater quality protection and enhancement needs.
7) Determine water treatment needs.
8) Identify impacts of recharge and banking projects on water quality.
9) Identify suitable crop types that are compatible with the water characteristics.
10) Monitor the migration of contaminant plumes.

The District has only performed limited groundwater quality monitoring in the past, and has relied on private landowners and other agencies for groundwater quality data. As there are very few water quality concerns in the District, this approach has generally provided adequate information to monitor and manage the groundwater quality. Furthermore, the groundwater quality in TID has generally been of good quality for irrigation, so extensive monitoring does not appear to be necessary. A discussion on groundwater quality monitoring by the District, landowners, and other agencies is provided below.

TID Monitoring

TID currently collects groundwater samples each year on about five agricultural wells. The landowners have given TID permission to collect samples and review the test results, but have requested that the information be kept confidential. An effort is made to sample different wells on a year-to-year basis and resample the same wells after 5 years for a comparison analysis. In addition, the District will begin to measure electrical conductivity in a larger number of wells each year to serve as a general long-term indicator of groundwater quality. If TID develops a groundwater bank in the future, they may perform detailed monitoring in the vicinity of the bank.

Landowner Monitoring

Many landowners test the water quality of their domestic and irrigation wells on a regular basis. Some landowners will provide the test results to TID, however, the results are proprietary, and the landowners typically ask that TID use the data for their information only and not release it to the general public.

Other Agency Monitoring
Numerous other agencies play important roles in the monitoring and maintenance of groundwater quality. These agencies include the Regional Water Quality Control Board, state and federal Environmental Protection Agency, Department of Toxic Substances Control, Tulare County Environmental Health Department, USGS, State Water Resources Control Board, City of Tulare, and neighboring irrigation and water districts. TID makes an effort to collect and review pertinent water quality data published by these agencies. The Tulare County Environmental Health Department is currently developing a Groundwater Data Management System, which will help to consolidate much of the data into a single database.

Existing Activities

- Test the groundwater quality in a select number of agricultural wells each year.
- Regularly collect new water quality information from other agencies and review it to identify any impending groundwater quality problems from an agricultural standpoint.

Planned Actions

- Protect wells in monitoring program from being abandoned.
- Measure electrical conductivity at all monitoring wells every five years in conjunction with groundwater management plan updates.
- Assess the adequacy of the groundwater quality monitoring network annually.
- Install dedicated nested monitoring wells, with the ability to sample groundwater above and below the Corcoran Clay.

5.3 - Groundwater Monitoring Protocols

Monitoring protocols are necessary to ensure consistency in monitoring efforts and are required for monitoring evaluations to be valid. Consistency should be reflected in factors such as location of sample points, sampling procedures, testing procedures, and the time of year when the samples were taken. Without such common ground, comparisons between reports must be carefully considered and used with considerable caution. Consequently, uniform data gathering procedures are practiced by the District. The District has developed new water level and water quality monitoring protocols, which can be found in **Appendix C**. These protocols will be cross-referenced against any monitoring guidelines promulgated by DWR as called for in SB7X-6.

Existing Activities

None

Planned Actions

- Use the District's new protocols when performing groundwater level and groundwater quality monitoring.
- Perform annual calibration of water level sounder devices or confirmation of tape measurement elevation reference points.

5.4 - Surface Water Monitoring

Several minor surface streams pass through TID including Cameron Creek, Packwood Creek and Deep Creek. TID also uses surface water from sources that originate and flow through other areas, namely the San Joaquin River and Kaweah River. Detailed monitoring of these water supplies is performed by other agencies.

San Joaquin River. San Joaquin River Water is stored in Millerton Lake and impounded behind Friant Dam. The USBR operates Friant Dam and monitors water releases, reservoir levels, and water quality. San Joaquin River Water is made available to TID from the Friant-Kern Canal, which is operated by the FWA. FWA monitors flow rates in the Friant-Kern Canal, diversions to TID and others, and canal water quality.

Kaweah River. Kaweah River water is monitored by the Kaweah & St. Johns River Association. The KSJRA monitors river flows, river stage, deliveries to TID, and water quality.

Due to the efforts of these other agencies, TID has not had a need to monitor the quality of their surface water sources. However, TID regularly reviews the data and monitoring reports prepared by FWA, USBR and the KSJRA with the primary goals of understanding the long-term hydrology and water availability, and monitoring changes in water quality that could affect crop irrigation or groundwater quality.

Existing Activities

- Regularly review hydrologic and water quality data for the San Joaquin and Kaweah Rivers.
- Cooperate with the Southern San Joaquin Valley Water Quality Coalition in monitoring surface waters.

Planned Actions

- Monitor changes to surface water quality that could directly affect groundwater quality.

5.5 - Land Surface Subsidence Monitoring

Subsidence in the San Joaquin Valley has been characterized as the largest human alteration of the earth's surface. The reason behind this statement comes from inelastic land surface subsidence that has occurred principally from aquifer-system compaction.

The lowering of groundwater levels through sustained groundwater overdraft causes this type of subsidence. The impact to groundwater from such subsidence is the reduction in available aquifer storage capacity caused by the compaction of soil void space that retains groundwater. Studies performed by the DWR and the USGS have identified an area of subsidence in the western portion of the District that correlates with the Corcoran Clay. The magnitude of subsidence within this portion of the District was on the order of four feet for a study period extending from 1926 to 1970 (USGS Professional Paper 437-H).

In addition, Lofgren and Klausing (1969) reported that:

> *"Intensive pumping of groundwater has caused more than 800 square miles of irrigable land to subside in the Tulare-Wasco area. In the southeastern part of the Tulare-Wasco area [in the Tulare ID area], subsidence was arrested in the late fifties, when water levels recovered as much as 130 feet in response to reduced pumping and increased recharge resulting from importation of water through the Friant-Kern Canal."*

Studies performed since these findings have revealed a dramatic decrease in the rate of subsidence. It is likely that some of the land subsidence has been arrested with the importation of large volumes of surface water since the 1950's.

A return to higher groundwater pumping rates could result in land subsidence across a broad area, result in aquifer compaction and irrecoverable loss of storage capacity, and cause adverse effects to surface features such as canals, flood control systems, and water supply pipelines which rely on gravity flow.

Currently, land subsidence does not appear to be a major problem in TID. TID staff and landowners have not observed any obvious signs of subsidence to irrigation facilities and structures. However, as access to surface water rights are reduced and demand from groundwater grows commensurately, there is a real threat of a return to major land subsidence. If subsidence is occurring, then some unstoppable residual subsidence will continue to occur for several years. Lands within the District will be observed for land subsidence, and, if land subsidence becomes a problem, this Plan will be amended to include preventative and mitigative measures.

Existing Activities
None

Planned Actions

- Periodic resurvey of control points, local benchmarks, water control structures and wells to check for land subsidence. The control points and local benchmarks will be checked relative to High Precision Geodetic Network benchmarks.
- Participate in any regional efforts to monitor and evaluate land subsidence.
- Pursue funding to construct and operate an extensometer within the District boundary.
- Educate local growers on the potential for land subsidence and visual indicators of possible subsidence.
- Review published information by others such as the DWR, USBR and CalTrans on local subsidence findings.

6 - GROUNDWATER RESOURCES PROTECTION

6.1 - Well Abandonment

Proper destruction of abandoned wells is necessary to protect groundwater resources and public safety. Abandoned or improperly destroyed wells can result in contamination from surface sources, or undesired mixing of water of different chemical qualities from different strata. This is especially important in TID because part of the District has a confined aquifer, and there may be some isolated perched aquifers.

The administration of a well construction, abandonment and destruction program has been delegated to the counties by the state legislature. Many counties have adopted a permitting program consistent with Department of Water Resources Bulletin 74-81 for well construction, abandonment, and destruction.

The County of Tulare has adopted a Well Ordinance that addresses well destruction and establishes requirements for destroying or abandoning wells. The ordinance has provisions which stipulate that impairment of the quality of water within the well or groundwater encountered by the well is not allowed. Those wells that are defective require correction of the defective conditions or destruction of the well. In all cases, the primary responsibility for remedying defective or abandoned wells falls on the landowner and in those cases of non-compliance, the County has the authority to take necessary action to abate unsatisfactory conditions.

The District will properly abandon their own wells when they are no longer useful. In addition, the District will encourage landowners and developers to properly abandon their own wells, or preferably, convert unusable wells to monitor wells so that they can become a part of the District's groundwater monitoring program.

Before abandoned wells are converted to monitoring wells they will be evaluated for suitability, including their condition, depth, peroration interval, etc.

Existing Activities

None

Planned Actions

- When no longer in use, destroy any District owned wells according to County and State standards.
- Educate landowners, through the District website and newsletter, on well abandonment standards, and that abandoned wells could be useful to TID as monitoring wells.
- When possible, convert unusable production wells to monitoring wells.

- Meet with the County of Tulare to discuss a partnership whereby TID would be informed of any landowner that has filed a permit to abandon a well, so TID can ask them if the well can be converted into a monitoring well.

6.2 - Wellhead Protection

Need for Wellhead Protection

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the well head. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential to any wellhead protection program are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

Furthermore, since wells can be a direct conduit to the aquifer, they must be properly destroyed and abandoned or they will provide an unimpaired route for pollutants to enter the groundwater, particularly if pumping equipment is removed from the well and the casing is left uncapped. Well Abandonment is discussed in Section 6.1.

In the past, wells were commonly contaminated from chemigation systems that allowed the chemicals to flow back into the pump column. This potential contamination can be reduced by installing a check valve on all piping systems that include a chemigation system.

Wellhead Protection Policy

Any wells constructed by the District will be designed and constructed in accordance with DWR Bulletins 74-81 and 74-90 and Tulare County standards. In addition, the District will encourage landowners to follow the same standards for privately owned wells. The DWR bulletins and County standards provide specifications for the following:

- Methods for sealing the well from intrusion of surface contaminants.
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism.
- Site grading to assure drainage is away from the well head.
- Set-back requirements from known pollution sources.

Wellhead Protection Area

As defined in the Federal Safe Drinking Water Act Amendments of 1986, a wellhead protection area is "the surface and subsurface area surrounding a water well or well field supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field." The WHPA may also be the recharge area that provides the water to a well or well field. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on geology, pumping rates, and well construction. Private agricultural wells are randomly and fairly closely spaced throughout the District. The District encourages growers to treat land within 200 feet of any well as a wellhead protection area.

Existing Activities
None

Planned Actions
- Provide wellhead protection on all newly constructed TID wells according to County and State standards.
- Through landowner education efforts (newsletters, website, meetings, etc.) encourage local growers to incorporate proper wellhead protection into all new wells, and retrofit old wells with proper wellhead protection.

6.3 - Saline Water Intrusion

Salt accumulation in surface water and groundwater in the Central Valley is a natural process inherent to lands with semi-arid to arid climates, enclosed basins, or reduced or impeded drainage. Salt accumulation in surface water and groundwater can impact and eventually eliminate most beneficial uses. Salt accumulation can be exacerbated by a wide variety of human activities including irrigation, importation of surface water, application of fertilizer (including manure and biosolids) and pesticides, land disposal of wastes including those from food processing facilities, wineries, municipal wastewater treatment plants, discharge of urban storm water runoff, and use of recycled wastewater. Groundwater inflow of saline water is also a problem in some regions of the Central Valley.

Currently, there are no known saline groundwater problems in TID. The District will review available water quality data on a periodic basis. Should saline intrusion become a problem in the future, a GMP amendment will be prepared to address the issue. Currently, the District strives to prevent the importation of saline surface waters that could ultimately degrade the groundwater. When alternative water sources are available for importation, the District considers not only the cost but also the quality, including salinity, of the water. The District will evaluate all possible alternatives, and, when practical and feasible, select water sources with low levels of salinity that will not substantially degrade their soils or groundwater.

Existing Activities
- Review available water quality data to identify areas with the potential for saline water intrusion.

Planned Actions

- Map and track the progression of any saline water bodies in the District which may be identified in the future.

6.4 - Migration of Contaminated Groundwater

Groundwater contamination can be human induced or caused by naturally occurring processes and chemicals. Human induced sources of groundwater contamination can include irrigation, confined animal facilities, improper application of agricultural chemicals, septic tanks, industrial sources, storm water runoff, and disposal sites.

The groundwater quality in TID has been good for agricultural irrigation. However, there are areas of concern in TID and in neighboring agencies. These areas include dairies, milk processing plants, Medford Field Airport, and the City of Tulare Wastewater Treatment Plant. The District will continue to review groundwater quality data from other sources and remain cognizant of the possibility of contaminated groundwater migration into TID. However, the management and remediation of contaminant plumes generally falls under the responsibility of other agencies such as the Tulare County Environmental Health Department, California Regional Water Quality Control Board, California Environmental Protection Agency and the U.S. Environmental Protection Agency. The degree to which each agency participates depends on the nature and magnitude of the problem.

Existing Activities

- Regularly review data and reports from regulatory agencies on contaminant plumes to provide warning of potential future problems.

Planned Actions

- Seek to locate recharge basins next to areas with water quality problems to blend water supplies and create a hydraulic barrier to impede movement of contaminant plumes.
- Collect and consolidate maps from other agencies identifying the contaminant plumes in the District.
- If necessary, alter groundwater pumping patterns to change the hydraulic gradient and reduce contaminant migration, or reduce the pumping of contaminated groundwater.

6.5 - Groundwater Quality Protection

The District's surface water supplies cannot fully support the crop demand within the District, and therefore some groundwater will always be necessary. The groundwater, however, will have limited or no use if it has poor quality. Therefore, protecting the quality of the groundwater is a cardinal component of this GMP. Groundwater quality can be protected through proper use of pesticides, herbicides and fertilizers, storm water quality management, septic system management, and water vulnerability planning and management. Some of these tasks are the responsibility of cities and communities, but TID will support their efforts whenever possible.

Existing Activities

- Cooperate with water quality monitoring as a member of the Southern San Joaquin Valley Water Quality Coalition.
- Discussions with the County of Tulare on water quality issues that are identified by the County within the District or in the area.
- Review of information made public by the County of Tulare Water Commission.
- Educate growers on the proper use of pesticides, herbicides and fertilizers in the District newsletter.

Planned Actions

- Seek funding to improve security at TID water facilities (i.e. wells, recharge basins, etc.) and reduce the potential for contamination from acts of vandalism or terrorism.
- Follow State and Tulare County well construction standards for wellhead protection to protect groundwater quality.

7 - GROUNDWATER SUSTAINABILITY

On average, groundwater comprises about 25-50% of the water used in TID, but can comprise up to 100% of water supplies in an extreme drought. During years with low surface water allocations, groundwater is essential to prevent the loss of permanent crops and agricultural businesses. Groundwater is the most dependable water supply for the District's growers and the local domestic water users. Therefore, preserving the sustainability of groundwater is essential for the economic well being of the District and its growers.

A decline in groundwater levels reduces groundwater reserves, increases pumping lifts, and could require deepening or abandonment of wells. Therefore, maintaining stable groundwater levels is a high priority for TID.

7.1 - Issues Impacting Groundwater Sustainability

Issues of concern for groundwater sustainability in TID are discussed below:

San Joaquin River Settlement. Friant Division CVP supplies have been recently curtailed due to the Settlement Agreement of Natural Resources Defense Council v. Rodgers on the San Joaquin River. Based on the Agreement, Friant Division water contractors will be impacted by about 200,000 AF per year. One estimate shows that deliveries to TID would be reduced by an average of 1,800 AF/year of Class I water and 12,600 AF/year of Class II water and 4,300 AF/year of surplus water on the system (Section 215). However, total losses could be as high as 32,000 AF/year in some years. This would represent about 20% of the District's average surface water supplies. Interim releases to the river began in 2009, with full restoration flows potentially beginning in 2014. TID has a goal of fully recovering the lost contract supplies, primarily through conservation and groundwater conjunctive-use recharge projects, as well as Water Management Goal provisions as called for in the Settlement.

Surface Storage. Millerton Lake provides the primary surface storage element for the Friant Unit of the CVP. The District is capable of storing some of its allocated CVP entitlement behind Friant Dam at Millerton Lake, but this storage is subject to the flood operations criteria of the facility and the management of USBR, and TID can only store water for a limited period. In addition, Millerton Lake lacks sufficient carry-over storage capacity to balance the wet and dry year needs for conservation storage. Similarly, Lake Kaweah, which stores Kaweah River water behind Terminus Dam, has similar limitations and could benefit from expanded storage.

Delta Pumping Restrictions. Due to problems with the California Delta smelt, there have been incremental reductions over time in export pumping allowed from the Delta, which is affecting numerous water users throughout the San Joaquin Valley. Cross

Valley Canal water users in the area of TID may be impacted. This loss of surface water is being offset in part by increased groundwater pumping from the common groundwater basin. The first priority for Delta exports is to meet the demands of the lower San Joaquin River Exchange Contractors (EC). These entities receive Delta export supplies in trade for their river water right supplies to be dedicated to the Friant system as delivered from Millerton Lake. Should the Delta exchange supply be limited, USBR will likely call on Millerton water to meet the EC demands. This has never happened in the 60 plus years of Friant operations; however, with the Delta export constraints that currently in place, there is a chance that the Friant contractors could loose some of their imported supplies, which will result in further adverse impacts to groundwater conditions as the lost surface supply will likely be offset by increased pumping.

Drought and Groundwater Level Declines. Depths to groundwater within the District have continued to increase over the last several years. Not being deep enough to reach lowered water levels, many local wells have gone dry over the last two years. With another year or more of drought, more wells can be expected to go dry in the future. Additional conservation and groundwater recharge projects are essential to maintain the District's groundwater resources so that they are as reliable as possible during times of drought and reduced surface water availability.

Cropping Patterns. In recent years, the District has experienced a significant shift in cropped acreage. Plantings are more often double cropped than in the past so the general understanding is that the average annual agricultural demand within the District has been increasing.

Population Growth. The San Joaquin Valley is one of the fastest growing regions in California. Although TID primarily provides agricultural water, significant population growth will increase water demands and tensions over limited water supplies in the region.

System Optimization Review Study. To address water supply sustainability, in 2009 TID sought funding to perform a System Optimization Review study. Funding was awarded by the USBR in August 2009. The SOR Study will evaluate: (1) the District's historic surface diversion versus the District's currently-available supplies, (2) the existing capacity of the District's surface water source diversion and end user delivery system, (3) the District's historic and current agricultural demands, (4) the estimated amount of agricultural and municipal groundwater pumped versus the estimated safe yield, (5) potential groundwater recharge or banking projects near the District's delivery system and (6) new projects or programs to address specific limiting issues identified through the SOR through preliminary design, estimated yield and project cost estimates. The SOR will also develop a strategic plan to address the pressing issues the District faces of the next several years. The overall goal of the SOR is to address the aforementioned issues regarding water supply sustainability in TID, and develop a plan and vision for the future to address these problems.

7.2 - Overdraft Mitigation

Groundwater overdraft has been a concern since the early 1900's, and was one of the reasons the District sought a CVP contract for surface water. The District's groundwater levels are sensitive to drought conditions and significant declines have been observed during prolonged droughts. Moreover, the District is concerned that reductions in surface water supplies as a result of the San Joaquin River Restoration plan may lead to greater groundwater overdraft.

Groundwater recharge can help reduce overdraft and is discussed in Section 7.3. The following groundwater management practices and policies are also followed to help reduce groundwater overdraft:

Limitations on Pumping

The California Water Code gives local agencies with an adopted GMP the power to limit or suspend groundwater extractions. However, such limits can only be implemented if the District determines through study and investigation that groundwater replenishment programs, or other alternative sources of water supply, have proved insufficient or infeasible to lessen impacts to groundwater. In the unlikely event that it becomes necessary to reduce groundwater extractions, the District intends to accomplish such reductions under a voluntary program, which would include suitable incentives to compensate users for reducing their groundwater pumping. Generally, only as a last resort will the District restrict or interfere with any landowner or water user exercising a valid property right to pump and utilize groundwater.

Limitations on the Exportation of Water Supplies

The District generally does not support groundwater pumping for export out of the District unless it involves a transfer or exchange of water that will not reduce the total water supply available to the District. In addition, the District usually opposes surface water transfers that are accompanied with increased groundwater pumping used to replace the transferred surface water. Exceptions could apply to growers that own land on both the TID border and just outside of the border, since they will be using the groundwater in the vicinity of TID and in the same groundwater basin. Other groundwater exports will be reviewed on a case-by-case basis and will be permitted if they are approved by the Board of Directors. Under some circumstances, an exchange involving a net loss in water may be considered. This could occur, for instance, if TID exchanges poor quality water for good quality water, or if TID exchanges floodwater for dry year water.

The KSJRA has also adopted a policy that forbids the exportation of groundwater that results in a net loss to KSJRA's total water supplies. The KSJRA Board of Directors has the authority to institute any measures proposed to prevent such net loss in the furtherance of this policy.

Water Transfers
Under certain conditions (for example, during wet years), the District has facilities that transfer/convey surface water to other San Joaquin Valley areas. Conversely, the District has been the recipient of wet-year water from neighboring areas. Water exchanges, in various forms, are also a part of the District's conjunctive use portfolio. Groundwater benefits can accrue to the District through such arrangements.

In critically-dry years, the District has had insufficient surface water supplies available to make efficient delivery thereof for irrigation because of excessive seepage losses. Arrangements have been made in recent critically-dry years, through exchange agreements, to deliver this water to other agencies (primarily other Friant contractors) for their immediate use. In exchange, the District may be paid back in additional water, generally during "normal" years, historically at ratios of up to four to one, i.e., the District receives four acre-feet for every acre-foot so exchanged. The District may also be paid back monetarily, an such additional funds are placed in a groundwater replenishment reserve funds and are later used to purchase water in wet years at a reduced cost. These transfers benefit both parties and in particular provide significant volumes of water, either directly or indirectly, for direct or in-lieu recharge within TID.

Economic Inducements
The District recognizes that management of water supplies should reflect water conservation and the protection of groundwater resources. The District currently provides an indirect economic inducement by establishing water rates high enough to promote water conservation yet low enough to compete with groundwater pumping costs. This pricing system encourages the use of surface water to meet irrigation demands when available, thereby preserving the underlying groundwater resource.

In addition, the Code provides those agencies with an adopted GMP the ability to tax or otherwise place fees or assessments to cover the cost of groundwater management activities or for groundwater extractions. However, such taxing ability cannot be imposed unless brought to a landowner vote. Like extraction restrictions, this step is to be considered only as a last resort in the overall management of groundwater in the District.

Existing Activities

- Restrict groundwater exports from the District.

- Set surface water sale rates to remain competitive with groundwater pumping costs.
- Continued development of the McKay Point Reservoir Project to provide off-stream storage for surplus river system water to provide the District with additional in-lieu recharge capabilities.

Planned Actions

- Develop a water marketing plan to sell surplus waters to other water agencies and entities within the same groundwater basin. The program will outline the basis for evaluating the effectiveness of the District's existing water marketing commitments in light of other available opportunities.
- Periodically, such as every 5 years, perform a hydrologic balance to estimate the amount of groundwater overdraft, if any.
- Evaluate annual groundwater contour maps for evidence of pumping well interference from neighboring agencies.
- Establish groundwater banking goals (total storage capacity and annual recovery capacity) as part of a Systems Optimization Review (SOR) study.
- Distribute awarded Drought Relief grant funds from USBR to growers within the District for groundwater well projects.

7.3 - Groundwater Replenishment

Replenishment of groundwater underlying the District occurs both naturally and through deliberate, controlled means (artificial). The various forms of groundwater replenishment in TID are discussed below:

Groundwater Inflow to District Area. In general, a characteristic regional northeast to southwest pattern of groundwater flow occurred during the 1980's and 1990's. Areas of pumpage depressions are persistently present north of Corcoran, west of Visalia, and northwest of Exeter. Groundwater also flows into TID from the Tule River area into the southern portion of TID. Fugro (2007) estimated groundwater inflow and outflow in Hydrologic Unit No. 5 to average 22,200 AF/year and 16,200 AF/year, respectively, during the period 1981 through 1999. This equates to a net groundwater inflow of 22,200 – 16,200 = 6,000 AF/year.

Deep percolation from precipitation. The WRI Report (Fugro, 2007) estimates that deep percolation from precipitation in TID averages about 20,600 AF/year (0.3 feet/acre).

Artificial recharge. The District operates 11 groundwater recharge basins located throughout the District. These basins are show on **Attachment 7** and listed in **Table 7.1** below.

Table 7.1 - Groundwater Recharge Basins

Basin Name	T, R and Sec	Area (acres)
Abercrombie	20 24 23	20
Anderson	20 23 6	167
Creamline	19 25 20	153
Doris	21 23 6	21
Enterprise	19 24 29	20
Guinn	19 23 30	162
Tagus	19 24 15	120
Watte	20 23 34	19
KDWCD #3	19 23 22	155
KDWCD #6	19 23 35	155
KDWCD #8	20 23 10	118
	Total	1,110

The WRI Report (2007) estimated recharge basin deliveries in TID to range from 0 to 141,000 AF/year, with an average of 30,000 AF/year. TID also has an agreement to allow KDWCD to recharge water in these basins when they are not being used by TID.

The individual recharge capacities in each basin are currently unknown. The District is in the process of implementing a program to measure inflows and infiltration rates to determine the rates of recharge.

Groundwater banking. TID does not currently operate groundwater banks in their service area. Although the purpose of groundwater banks is to store and later recover water, groundwater banking can result in some long-term groundwater replenishment. Water that is recovered from groundwater banks serves as in-lieu groundwater recharge, by providing a dry-year water supply that would normally be obtained from groundwater. Also, groundwater banking agreements often require that a portion of the banked water, e.g. 10%, be left in the aquifer as a payment to the banking agency (i.e. TID) to account for unavoidable losses and groundwater migration. In addition, often some water that is banked is for various reasons never recovered.

The City of Tulare and the District jointly developed a "City Groundwater Augmentation Program" in early 2006. This program was developed through the understanding that the City of Tulare depends on groundwater resources for all its municipal supplies and wanted to assist the District to bring as much surplus surface water into the area as possible. The mutual goal in this endeavor is to make the shared groundwater resources as reliable as possible. Generally the program sets up an arrangement for the

City to fund surplus water procurement by the District that is conveyed to recharge facilities in areas beneficial to the City's groundwater recovery wells.

In an outgrowth of the joint program, the District and the City of Tulare entered into an agreement in 2007 providing for the joint purchase of property known as the "Plum Property," for the purpose of developing such property for groundwater, recharge and surface water regulation. This purchase agreement between the two entities establishes joint rights in the Plum Property and the mutual intent to develop the property into a water recharge/regulation facility. After execution of the agreement the property was successfully purchased. The 154 acre project will include three basins and associated control structures. The project will allow for a long-term average recharge of about 3,700 AF/year.

In May 2008 the City of Tulare and TID signed an agreement regarding the delivery of water to groundwater banking facilities (**Appendix D**). In this agreement the parties determined where recharge would occur under their on-going program, to continue the joint operations committee which evaluates projects of mutual benefit, and evaluate the development of additional groundwater recharge facilities. The agreement also provides guidelines for determining the average annual quantity of water delivered by TID to the City. This quantity was initially 10,000 AF/year, but will vary depending on the area of the City, City groundwater pumping, and the cost of imported surplus water supplies available to the District. The delivery of TID water to City basins will directly benefit City wells, and indirectly benefit TID by reducing stress on the local groundwater supply.

In-lieu deliveries. The District views in-lieu deliveries as a practical and effective means of groundwater replenishment. In-lieu deliveries, also called indirect deliveries, involve the delivery of surface water to landowners and water users who would otherwise have pumped groundwater, thus leaving water in the aquifer for future use. With the diversion of around 100,000 AF of surface water annually which is sold to District water users (CH2MHill, 2000), TID is performing a significant amount of in-lieu recharge.

TID plays a significant role in importing water and providing in-lieu deliveries in the area, primarily because TID has extensive water rights that they attempt to fully utilize each year. In comparison, other districts in the area have less surface water rights, and must rely more on groundwater to meet their irrigation water needs.

Streambed infiltration. Three creeks flow into TID, namely Cameron Creek, Packwood Creek and Deep Creek. These creeks operate more as irrigation conveyance facilities than natural creeks and have, in certain reaches, each been modified and realigned over the years. Little to no seepage from natural creek flow occurs. There is some seepage from storm water inflows which are directed under agreements into such creeks. Seepage from irrigation flows is discussed below under 'Seepage from distribution facilities'.

Deep percolation from irrigation. Deep percolation occurs when some of the water applied for irrigation percolates beyond the crop root zone and accumulates in the aquifer. The extent of deep percolation varies with the irrigation method, irrigation efficiency, and antecedent moisture condition. The WRI Report (2007) estimated that deep percolation from irrigation in TID averages 44,400 AF/year.

Seepage from distribution facilities. Collectively, the District owns and operates approximately 300 miles of earthen canal and approximately 30 miles of pipeline. The unlined canals cover approximately 450 acres. The average transport loss through the District's system is estimated to be 60,000 to 70,000 AF per year. This is a large percentage of the District's average available surface water supply; however, this "loss" provides recharge to the common underground basin supply both up-gradient of and within the District, from which TID water users later pump for on-farm irrigation. This loss averages about 40 percent of total diversions and consists of a 10 percent loss largely in the unlined canals and ditches providing service to TID water users. The District has worked with regional partners to be financially reimbursed in part for these losses as they are considered significant groundwater recharge through the region.

Existing Activities

- Groundwater recharge in eleven existing recharge basins.
- Construction of new multi-purpose basin behind the new TID office location.
- Construction of a new multi-purpose basin at Mooney's Grove in cooperation with Tulare County.
- Feasibility evaluation of a potential groundwater banking project with several other Kaweah River districts at Rancho de Kaweah.
- Allow KDWCD to use TID recharge facilities when they are available.
- Measure the volume of water delivered to groundwater recharge basins.
- Periodically remove sediment and rip the soils in recharge basins to maintain infiltration rates.
- Maintain existing unlined canals in an unlined condition in those locations where it is determined that canal seepage is a significant source of recharge and does not create detrimental side effects.
- Regular meetings with the City of Tulare regarding the City Groundwater Augmentation Program, the joint Plum Basin project, and other on-going cooperative efforts.
- Discussions with the City of Visalia on scenarios where recharge can be facilitated in the local creeks in above average water years.

- Evaluate potential arrangements and projects with existing and potential partners to cooperatively improve groundwater recharge within the District.
- Continue practice of acknowledging seepage through Main Intake Canal as a benefit to the regional area in return for financial reimbursement from KDWCD.
- Apply for grants or participate in grant applications in conjunction with partners to construct new groundwater monitoring wells within the District and the surrounding area.
- Apply for grants or participate in grant applications with partners to improve the operation of groundwater recharge basins or the development of new basins.
- Work with regional partners (both Kaweah River water rights holders and Friant Unit CVP) to acquire available excess surface waters to recharge within the District boundaries when recharge capacity in the District's basins is available.

Planned Actions

- Procure lands for more groundwater recharge basins when property is available and is affordable to the District at market value.
- Investigate the feasibility of constructing additional recharge basin capacity on the western end of the District.
- Monitor the rates of infiltration in basins, natural channels and ditches, and, when feasible use the facility that offers the greatest recharge rate in order to maximize recharge potential.
- Produce a Five Year Strategic Plan for TID that addresses water policy, surface water supply, groundwater resources, groundwater banking, water exchanges, District staffing, and establishes short-term and long-term water management goals.
- Evaluate potential groundwater banking opportunities for the District and for others to improve groundwater conditions within the District.
- Work cooperatively to minimize development on lands that are favorable for artificial recharge.
- Develop and maintain an inventory of sites in the District that are suitable for recharge.
- Estimate the infiltration rate in each basin by monitoring inflows, outflows and water levels.

7.4 - Conjunctive Use of Water Resources

Conjunctive use of water is defined as the coordinated use of both subsurface and surface water sources so that the combination will result in optimum water supplies. Groundwater management in California is rooted in the conjunctive use of surface and groundwater resources. In this regard, the District has two primary sources of surface water supply; local Kaweah River water through water right holdings and imported CVP water (originating in Millerton Lake on the San Joaquin River) under a long-term contract with the USBR. Also, the District has short-term and year-to-year arrangements to secure additional CVP and Kaweah River supplies. Kaweah River waters and groundwater have been conjunctively utilized within the District since the early 1900s. In 1950, the District integrated CVP water into its conjunctive use operations. Necessarily, the District operates an extensive system of conveyance, distribution and recharge facilities throughout its service area to make use of the surface supplies as available.

The District's conjunctive use program includes surface water delivery in lieu of groundwater pumping, groundwater recharge, and, when practical, transfers to neighboring areas sharing a common groundwater supply. These are discussed below:

Surface Water Deliveries. The District delivers surface water to District growers through an extensive distribution system. The surface water is a form of in-lieu groundwater recharge, since it reduces the volume of groundwater pumped. TID strives to keep surface water rates low enough that growers choose to fully utilize surface water supplies before resorting to groundwater. Historically, TID has provided, on average, 50% of its surface water directly to District growers.

Groundwater Recharge. TID performs direct groundwater recharge in eleven recharge basins, and through seepage in earthen canals that are left unlined because of their recharge benefit. The amount of recharge varies each year with the availability of water. Having significant recharge capacity is important so that large volumes of water can be captured in wet years to recharge and later extracted by water users in dry years. Refer to Section 7.3 for more details on the Districts recharge facilities. TID desires to construct more recharge facilities and potentially some groundwater banking facilities in the future.

Water Transfers to Agencies within the Same Groundwater Basin. TID sometimes ends up with small amounts of water that cannot be beneficially delivered to growers given the seepage losses in the long delivery system to the District. Also in very wet years the District will have supplies in excess of agricultural demand within the District and available storage behind local reservoirs. With these water supplies TID regularly performs water transfers and exchanges with other water agencies. TID strives to keep any exported or excess water in their region so it benefits the local groundwater supply and groundwater migration out of the District. TID also selects local exchange partners because it can benefit the local economy. The priority of water transfer partners include: 1) neighboring agencies; 2) agencies in the same groundwater sub-basin, 3) agencies within Friant Unit service area; and 4) agencies in the Central Valley.

Existing Activities

- Support and facilitate the delivery of imported water supplies to neighboring agencies for the purposes of reducing groundwater migration out of the District.

- Work with all appropriate public agencies, private organizations, and individuals within and outside of the Plan area to protect existing surface water rights and supplies.
- Participation in Friant Water Authority water supply and managers meetings to facilitate the cooperative operation and efficient use of available resources within the Friant Unit CVP system.
- Participation in KDWCD water supply and board of directors meetings and KSJRA meetings to facilitate the cooperative operation and efficient use of available resources on the Kaweah and St. Johns rivers system.
- Explore additional partnerships with other districts and water supply entities to optimize the collective water assets of each for basin-wide benefits.
- Maintenance and operation of approximately 300 miles of earthen channel to deliver water throughout the District to sustain TID's ability to divert large quantities of water when available, particularly on short notice.

Planned Actions

- Support the development of new surface storage and other water supply projects that would permit the participants to better utilize surface water supplies.
- Investigate additional groundwater banking projects and facilities.
- Investigate additional groundwater recharge facilities and potential partner affiliations.

7.5 - Water Conservation and Education

The District considers water conservation and education important aspects of their overall groundwater management efforts. The District's Rules and Regulations (**Appendix E**) state the following in Rule 10: Waste of Water:

> *"Persons wasting water on roads or vacant land, or land previously irrigated, either willfully, carelessly, or on account of defective ditches or inadequately prepared land or who shall flood certain portions of the land to an unreasonable depth or amount in order to properly irrigate other portions will be refused the use of water until such conditions are remedied."*

In fact, most District growers use water in a responsible and efficient manner. Many of the District's growers conserve water through the use of highly efficient drip, micro-jet, and micro-sprinkler irrigation system technology. In addition, all water deliveries are measured and billed on a volumetric basis. Therefore, all customers have an incentive to minimize water usage. Despite all these water conservation achievements, TID still provides on-going water conservation education to its growers.

Since about 1993 the District has been submitting an annual Water Conservation Plan with associated updates to USBR in accordance with provisions of the Reclamation

Reform Act and CVP Improvement Act. This plan sets forth water efficiency targets and objectives and documents the District's progress towards their implementation. This plan has been accepted by the Agricultural Water Management Council, a DWR agency established to foster voluntary agricultural water conservation at the district level. The District is a member of the Council and participates in its meetings and workshops.

Existing Activities

- Monthly water statements include water use information for each customer. In addition, the District maintains historic water use by turnout. This data is available to water users on request as it could be beneficial in making on-farm water management decisions.
- The District participates in the KDWCD WRI Study and its updates to analyze the region's water balance and document changing conditions over time.
- The District is conducting a System Optimization Review of District operations, which will identify potential areas for water conservation.
- The District publishes a quarterly newsletter to, among other things, help educate local growers on important issues such as water conservation and water quality protection, as well as several informational articles on recently declining groundwater levels within the District.
- The District volunteers with local grade school classes making presentations on water resources and the importance of water conservation.
- The District is a member of the Association of California Water Agencies.
- The District is a member of the Agricultural Water Management Council.
- The District is positioned to administer up to $4 million in Natural Resources Conservation Service grant funding for the implementation of on-farm water use efficiency projects which should aid in reducing groundwater demands from TID growers.

Planned Actions

- Continue to educate growers on water conservation measures.
- Distribution of awarded Agricultural Water Enhancement Program grant funds from NRCS for on-farm water conservation projects within the District.

7.6 - Water Recycling

TID has held discussions with the cities of Tulare and Visalia on using municipal wastewater effluent for crop irrigation. According to the WRI Report (Fugro, 2007), the City of Tulare generated, on average, 3,900 AF/year of wastewater return flow between 1981 and 1999. The water is currently sent to evaporation ponds. Some farmers adjacent to the ponds use a portion of the water for crop irrigation, but none is delivered directly into the TID distribution system. The water is currently treated using a secondary level treatment process. TID would like to divert the water to its distribution system, but are reluctant to unless the water has received tertiary level treatment (disinfection) due to concerns about contaminating edible crops and due to the required permitting involved in the arrangement. TID is also exploring a proposal to take delivery of wastewater effluent from the City of Visalia, but that water is likewise treated only to a secondary level. The City of Visalia would have the opportunity to improve treatment as part of a planned treatment plant expansion and is taking steps to implement tertiary treatment as part of its operations. In exchange for receipt of such treated water, TID is considering an expansion of its conjunctive use operations into areas up gradient of the City to enhance groundwater recharge in these areas.

Existing Activities

- Discussions with the Cities of Tulare and Visalia regarding the use of wastewater effluent for irrigation in TID.
  - Continued discussions with the City of Visalia regarding a potential water exchange agreement for tertiary treated waste water after the City's wastewater treatment expansion is completed.

Planned Actions

- Remain cognizant of opportunities to purchase recycled water from other local industrial facilities and municipalities.

8 - GROUNDWATER OPERATIONS

8.1 - Well Construction Policies

The District does not currently own any monitoring wells, but has recently acquired two irrigation wells on the jointly-owned Plum Basin property which are not connected to the District's conveyance system. The District may construct monitoring wells in the near future as part of a phased implementation of a dedicated groundwater monitoring well/piezometer network..

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. DWR Bulletins 74-81 and 74-90 provide useful guidelines for the construction of groundwater wells. Proper wellhead protection is essential to ensure that contaminants do not inadvertently enter a well. Well construction policies that are intended to ensure proper wellhead protection are discussed in Section 6.2 – Wellhead Protection.

In addition, the District will follow the quality assurance procedures listed below when contracting for the construction of new District wells. Landowners are also encouraged to follow these procedures when constructing private wells:

1. Well construction will be performed under contract by a licensed and experienced well driller, in accordance with specifications prepared by a licensed engineer or geologist, and reviewed by legal counsel.
2. A licensed engineer or geologist will oversee construction of the wells.
3. A licensed land surveyor in the State of California will oversee a survey of any newly constructed wells to determine locations for mapping and groundwater depth purposes.

Existing Activities

- Educate landowners on the existing Tulare County well ordinance and State guidelines.

Planned Actions

- Construct wells according to DWR Bulletin 74-81 and 74-90, and Tulare County standards.
- Construct wells using qualified and licensed contractors, engineers, geologists and land surveyors.

8.2 - Operation of Facilities

Groundwater facilities in TID include production wells, monitoring wells, recharge basins, and the distribution system (see **Attachment 6 and 7**). The operation of each of these is discussed below.

Production Wells. The District does not currently own any production wells, but has recently acquired two irrigation wells on the Plum Basin property which are not connected to the District's conveyance system. All other production wells in the District are currently owned by private landowners or the City of Tulare, who are responsible for constructing, operating, maintaining and abandoning the wells.

Monitoring Wells. TID does not currently own any dedicated monitoring wells. Instead, the District has historically used private agricultural wells to monitor groundwater levels. Currently, the monitoring network includes about 100 wells. Groundwater levels are monitored each spring and fall. TID may construct dedicated monitoring wells in the future to fill gaps in their network, and monitor proposed groundwater banking and recharge facilities. TID would also like to construct nested monitoring wells to measure groundwater levels in the different aquifers.

Recharge Basins. TID currently operates eleven groundwater recharge basins. The basins are for the most part owned by KDWCD; however, by agreement TID maintains them. Regular inspection and maintenance of these basins is important to ensure they function properly and maintain good recharge rates.

Distribution System. TID's distribution system is sufficiently built out to cover the entire District service area and does not appear to need any significant expansion. As a result, TID can provide surface water to all parts of the District. Most of the canals in TID are unlined and seepage from the canals recharges the groundwater. TID generally plans to leave these canals unlined. TID has an agreement with KDWCD to be compensated for the imported water that seeps in the upstream diversion channels easterly of the District, and thus TID has no plans to line these upstream diversion channels.

Existing Activities

- Maintenance of recharge facilities including de-vegetation, discing, deep ripping, and de-silting, as necessary to improve recharge potential.
- Leave earthen canals unlined so they can be used for groundwater recharge.
- Expansion of SCADA system for better management and operation of basin facilities when water is being conveyed thereto.

Planned Actions

- When practical and beneficial, develop groundwater recharge facilities as multi-functional facilities that also serve other purposes such as urban storm water runoff, environmental enhancement, aesthetics, and groundwater banking.
- Investigate partnership with local wildlife groups to see if common goals can be pursued through shared resources in efforts to develop additional recharge areas.

9 - GROUNDWATER PLANNING AND MANAGEMENT

9.1 - Land Use Planning

The intent of this Plan is not to dictate land-use planning policies, but rather to establish some land-use planning goals that can aid in protecting and preserving groundwater resources. TID does not have direct land-use planning authority. However, TID does have the opportunity to comment on environmental documents for land-use related activities and proposed developments as well as proposed Tulare County General Plans and updates. TID will attempt to work cooperatively with other agencies to minimize adverse impacts to groundwater supplies and quality as a result of proposed land-use changes. Some specific land-use planning goals include: (1) preserving areas with high groundwater recharge potential for recharge activities; (2) protecting areas sensitive to groundwater contamination; (3) requiring hydrogeologic investigations, water master plans, and proven and sustainable water supplies for all new developments; and (4) requiring appropriate mitigation for any adverse impacts that land use changes have on groundwater resources.

Existing Activities

- Notify residents and agencies of TID projects that have the potential to impact groundwater within their sphere of influence.
- When appropriate, comment on environmental documents and land-use plans that have the potential to impact groundwater.
- Provide input on City of Visalia, City of Tulare, and County of Tulare General Plans, particularly on issues that impact groundwater resources.
- Stay informed of changes to the City of Tulare's Sphere of Influence, annexations and de-annexations.

Planned Actions

None

9.2 - Numerical Groundwater Model

In 2005, utilizing a cooperative grant from the State Department of Water Resources, the KDWCD developed a groundwater model to calculate future changes in groundwater conditions that could occur based upon major influences such as changes in population growth, water supply and distribution. The model is able to calculate quantifiable changes to groundwater levels and flow conditions. This analytical tool can be applied to assess how existing and proposed groundwater management actions, changes in cultural practices, or changes in hydrologic conditions may influence groundwater sustainability. The knowledge gained from the model will be applied in the development and evaluation of new and existing programs. The expected result will be the progression of programs and policies that will efficiently use available resources to affect the most beneficial influence to groundwater supplies.

Existing Activities

- Remain abreast of the uses of the groundwater model by local partners for planning purposes and KDWCD's efforts to periodically update the model and it's analysis of the region's groundwater.

Planned Actions

- When appropriate, use the numerical groundwater model to evaluate proposed projects and changes to current groundwater operations, and determine their net impact on groundwater conditions.

9.3 - Groundwater Reports

The District has a goal to prepare groundwater reports every year to document groundwater levels, available groundwater storage, historical trends, and other important groundwater related topics. As a supplement to such reports, TID intends to more explicitly document and disseminate its annual accomplishments in the area of conjunctive use operations and accompanying benefits to the regional groundwater supply. This information will be used to forecast future problems, plan future groundwater projects, and develop new groundwater policies. The annual report will cover the prior calendar year and will be completed each year by April 30th. See **Attachment 13** for a report outline.

Existing Activities

- TID prepares an Agricultural Water Management Plan every five years for the United States Bureau of Reclamation as a requirement to maintain their Central Valley Project water supply. The Water Management Plan focuses on surface water but includes sections on groundwater usage and groundwater projects.
- TID provides crop and groundwater level information to KDWCD for periodic evaluations of groundwater conditions and groundwater reports.
- TID prepares and provides the city of Tulare an annual report documenting its groundwater recharge operations of immediate benefit to the City groundwater supply. The report is prepared in accordance with a groundwater augmentation agreement executed by both agencies in 2008.

Planned Actions

Prepare an annual Groundwater Report that will include the following:

1. Groundwater level data.
2. Groundwater contour maps and groundwater flow directions.
3. Groundwater storage estimates.

4. Evaluation of one-year and five-year historical trends in groundwater levels, contours, and storage, and perceived reasons for any changes.
5. Estimates of deliveries to recharge basins.
6. Estimates of groundwater pumpage by private agricultural well owners based on estimated crop demand minus surface water deliveries.
7. Documentation of groundwater pumpage for municipal supply by the City of Tulare and other local mutual water companies.
8. Summary of important groundwater management actions.
9. Discussion on whether management actions are meeting the associated objectives.
10. Summary of proposed management actions for the future.
11. Summary of groundwater related actions taken by other regional groups.
12. Recommendations for changes in the content or format of the annual report.
13. Recommendations for updates to the GMP.

9.4 - Plan Implementation

Implementation of this updated GMP is expected to result in significant amounts of new knowledge and an achievable improvement in groundwater management in TID. **Attachment 14** includes an implementation schedule for this GMP from 2010-2016. The schedule does not include existing activities that will be continued. TID will maintain all existing programs unless stated otherwise in this GMP. In addition, the schedule does not include proposed actions that are new policies or guidelines, which will be implemented on a continuous basis. Rather, the schedule only includes new tasks and projects.

9.5 - Plan Re-evaluation

The GAC will be responsible for monitoring the progress in implementing the GMP objectives. Refer to Section 4.1 for more information on the membership, policies, and procedures of the Committee. The Committee will attempt to meet at least once a year to review and evaluate groundwater conditions as well as evaluate the effectiveness of the GMP. As new policies, practices, and ordinances become necessary or desirable to enhance the management of the District's groundwater supply, this Plan will be amended as necessary.

Existing Activities

None

Planned Actions

- Update the GMP at least every five years through a formal public process, or more frequently if a sufficient quantity of revisions, updates and additions have been identified.

- Evaluate the effectiveness of the GMP and need for an update at the annual Groundwater Advisory Committee meetings.
- Document recommendations for improving or updating the GMP in each annual Groundwater Report.

9.6 - Dispute Resolution

Groundwater disputes will probably require input from the District General Manager, and possibly an engineering consultant and District Counsel. In resolving these disputes several factors will be considered such as a landowner's right to extract groundwater, beneficial use of water resources, and, if applicable, restrictions on export of groundwater.

Groundwater disputes in TID can fall into three general categories: 1) Landowner versus Landowner; 2) TID versus Landowner; and 3) TID versus another agency.

Landowner versus Landowner

Disputes between landowners are not the responsibility of TID, however, when asked to, TID may choose to help resolve disputes as an impartial mediator. Such efforts are intended to maintain amicable relationships among landowners, educate landowners on groundwater management goals and policies, and avoid a court process which may lead to adjudication.

TID versus Landowner

Disputes with landowners are generally resolved using the general process outlined in the District's Rules and Regulations (**Appendix E**). These state the following under Rule 2: Ditchtenders and Other Employees:

> "*Each ditchtender shall have charge of his respective section and shall be responsible to the Superintendent. From the ditchtender's decision an appeal may be made to the Superintendent. From the Action of the Superintendent, appeal may be made to the Board of Directors*"

The District's current Rules and Regulations deal primarily with surface water; however, in furtherance of this GMP and the authorities contained therein, new rules may be promulgated which could lead to disputes related to groundwater extraction fees, pumping restrictions, and other groundwater issues involving landowners.

TID versus Another Agency

When TID faces a dispute with another agency the dispute will be resolved through the TID Board of Directors. If necessary, the District General Manager may also use legal counsel, technical staff, or technical consultants to assist in addressing any disputes.

If a dispute arises between TID and KDWCD or another district within KDWCD, then it will be handled according to the MOU between TID and KDWCD (**Appendix B**). The MOU discusses coordination of efforts, management of the overlap area, and dispute resolution procedures.

Existing Activities

- Resolve disputes through the District's general dispute resolution procedures.

Planned Actions

- Discuss issues of concern at the annual GAC meetings in an effort to prevent future disputes.

9.7 - Program Funding and Fees

Several alternatives are available to TID for funding groundwater projects, and are described below:

Water Replenishment Fees

Under AB255 and AB3030, local agencies have the authority to limit groundwater extractions and implement water replenishment fees based upon the amount of water extracted (extraction based fees must first be approved by majority vote of impacted landowners). Inherent in these powers is the authority to implement metering of private wells. These are considered measures of last resort and TID will make any and all efforts to ensure the private, non-metered use of groundwater by the local growers. However, if at some point the State were to take steps to initiate regulation or control over groundwater extractions, or if a legal adjudication of the basin pumping rights were to occur, then these fees may be unavoidable.

Capital Improvement Fees

The District has the authority to finance capital improvement projects and collect repayment charges from the benefited parties. This process would require a favorable vote from the constituency, and is considered a realistic alternative for large capital projects, such as groundwater recharge or banking projects.

Grants and Loans

The District will pursue available grants and low-interest loans from the DWR as well as other state and federal agencies like the Bureau of Reclamation. The District realizes that funding from state and federal agencies for groundwater projects will be partially based on their progress in implementing this GMP. Established programs from which grant funding has and may be sought in the future include the USBR Challenge Grant program, Part III funding from the San Joaquin River Settlement Act and the state's IRWMP program.

Other Revenue Sources

Groundwater projects can also be financed through water user fees and assessments that are collected regularly from all District landowners.

Exiting Activities

- Regularly research grant and loan opportunities from the state and federal government and apply for these opportunities when they appear advantageous to the District.
- On-going negotiations with the Bureau of Reclamation to convert its contract from a 9(e) to a 9(d) contract. This would require advance repayment of the District's remaining capital obligations. To raise this capital the District would likely sell bonds, which necessitate modifications to the existing assessments. The District would likely modify assessments by switching the facility repayment costs from water charges to land based assessments in an effort to reduce the interest rate associated with the necessary bond financing.

Planned Actions

- Identify beneficial groundwater projects that become economically feasible when costs are shared among two or more participants.
- Share information on funding opportunities with other agencies that may be potential partners in multi-agency groundwater projects.

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21. Swanson, A. A., *Land Subsidence in the San Joaquin Valley, updated to 1995*, 1998.

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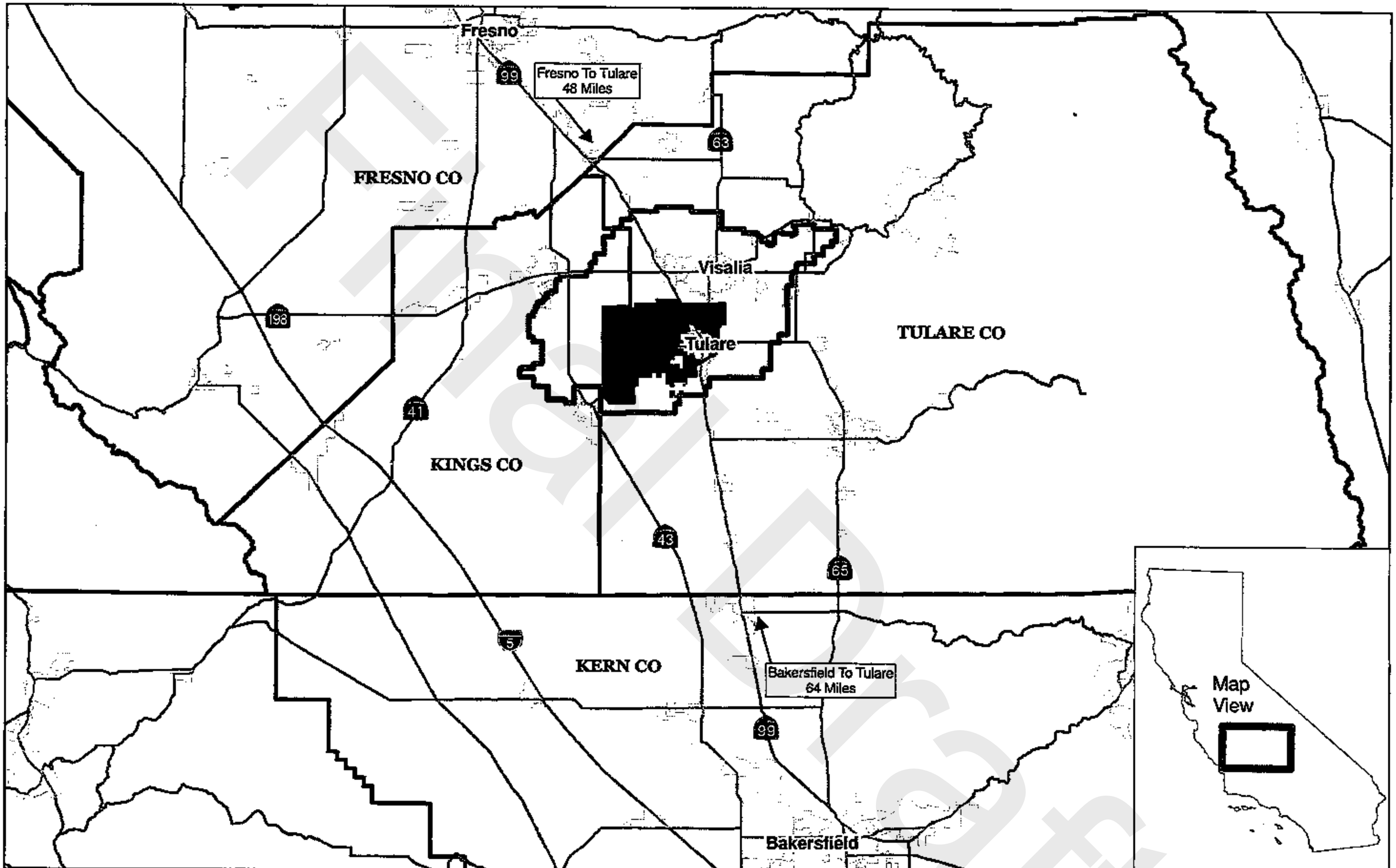
TULARE IRRIGATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

ATTACHMENTS



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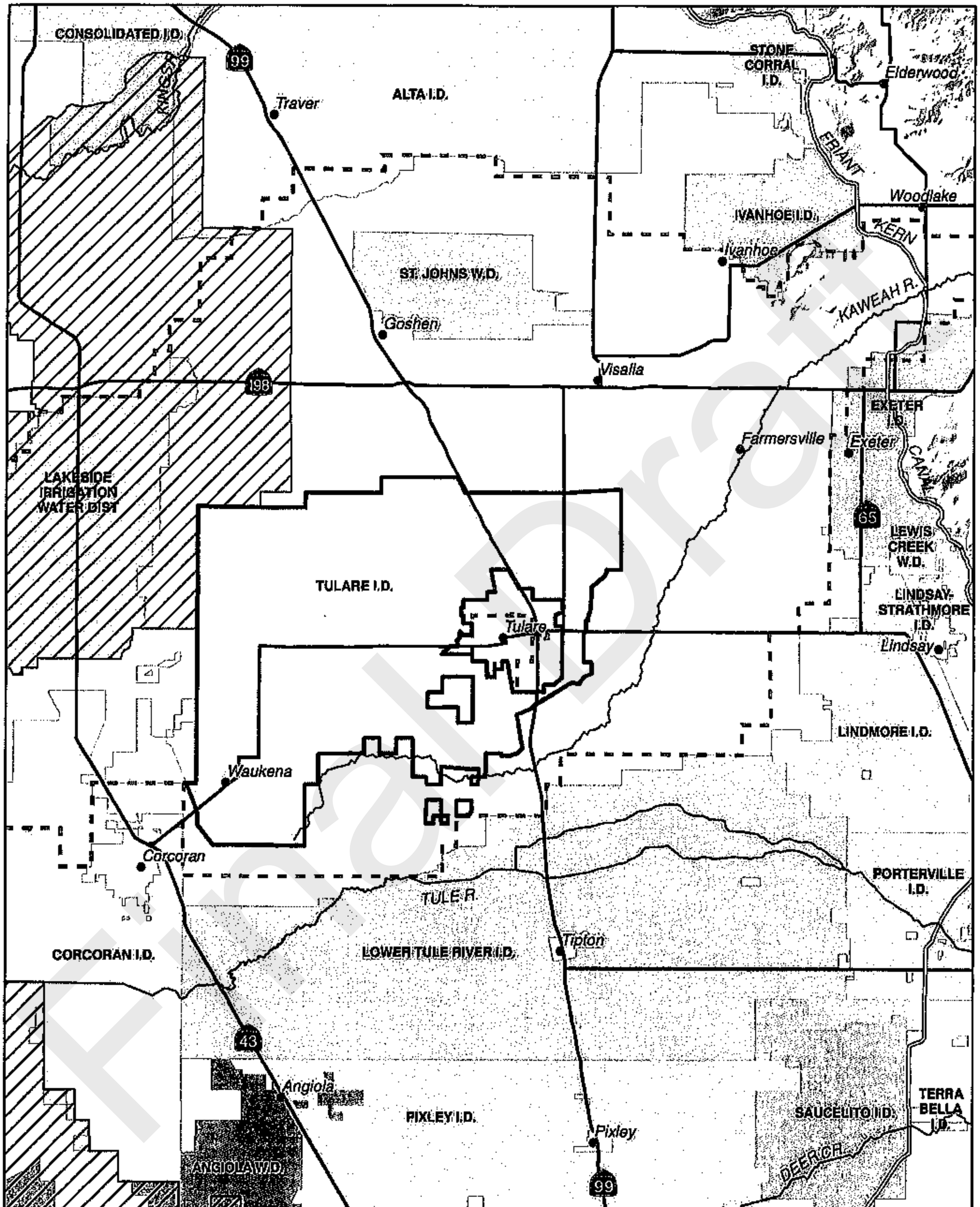
Tulare Irrigation District

Attachment 1

Vicinity Map

11/24/2009 \\goose\vs[_clients\Clients\Tulare ID-1248\124809V1-Update Groundwater Management Plan\GIS\Map\Attachment1_Vicinity.mxd



0 1 2 3 4 Miles

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Legend

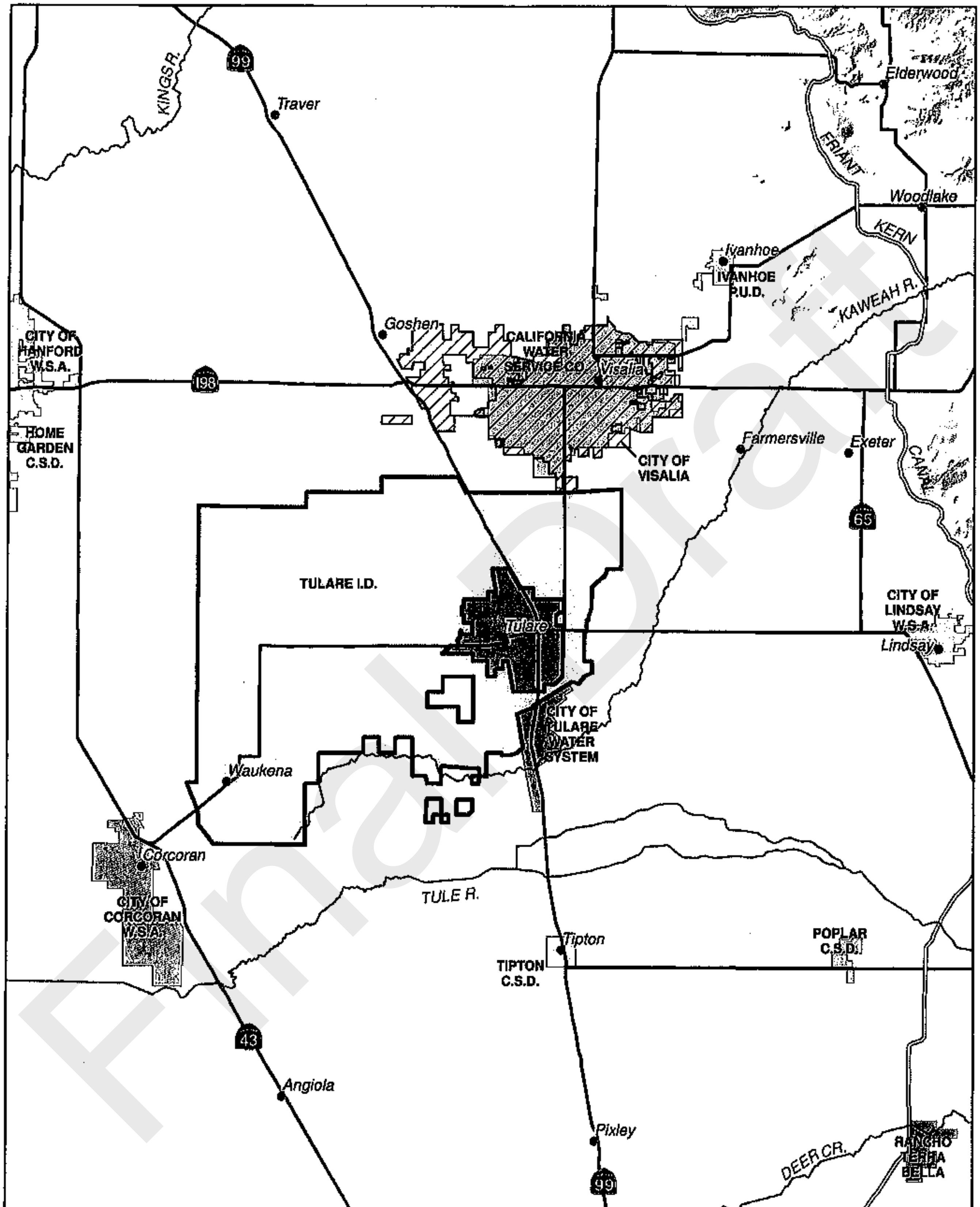
- KAWEAH DELTA W.C.D.
- KINGS COUNTY W.D.
- TULARE LAKE BASIN W.S.D.

Tulare Irrigation District

Attachment 2a

Neighboring Surface Water Delivery Districts

12/3/2009 \\goose\wsl_clients\Clients\Tulare ID-1248\124809V1-Update Groundwater Management Plan\GIS\Map\Attachment2a_WaterAgencies.mxd



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Tulare Irrigation District

Attachment 2b

Neighboring Municipal Water Delivery Districts

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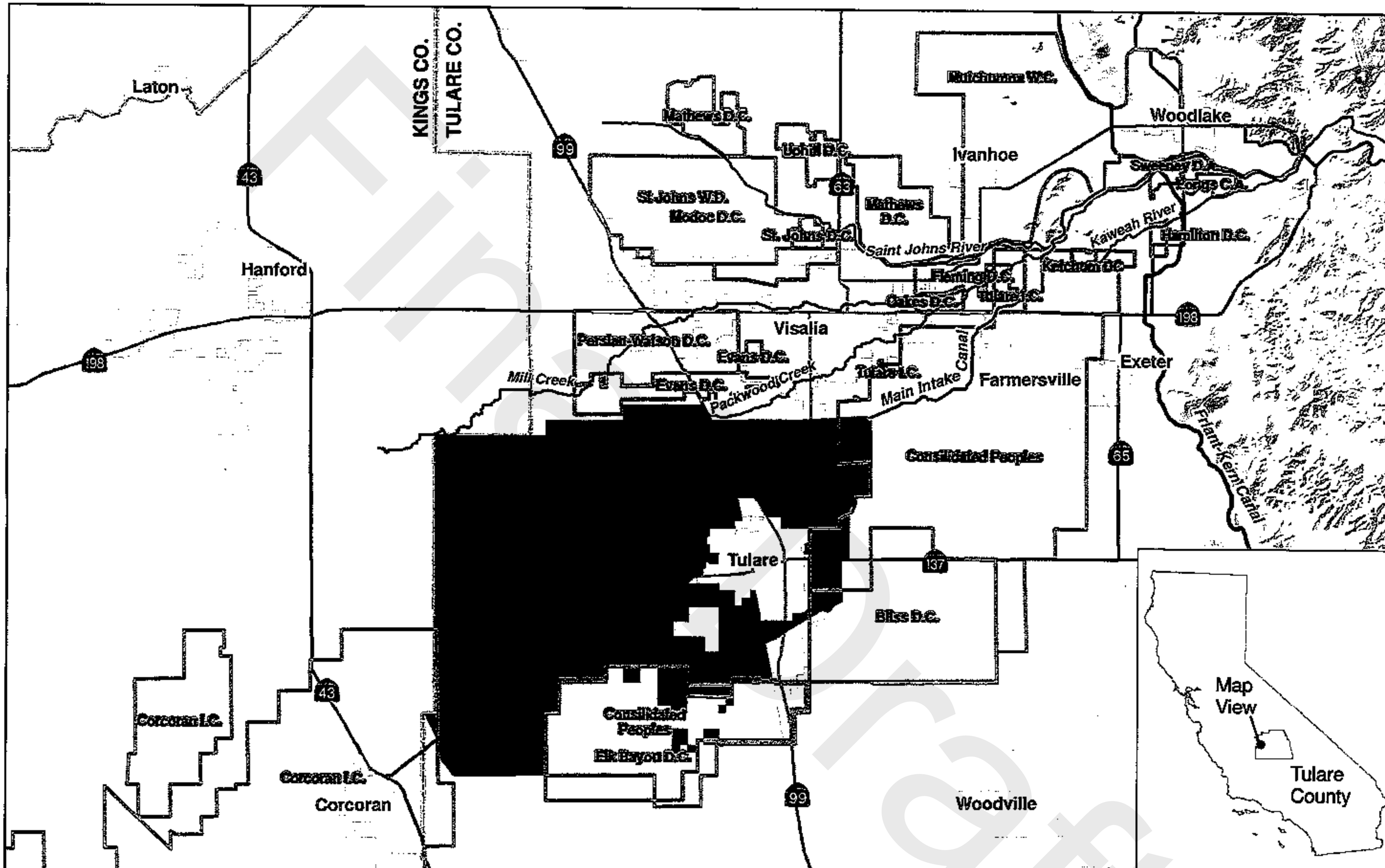

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Legend

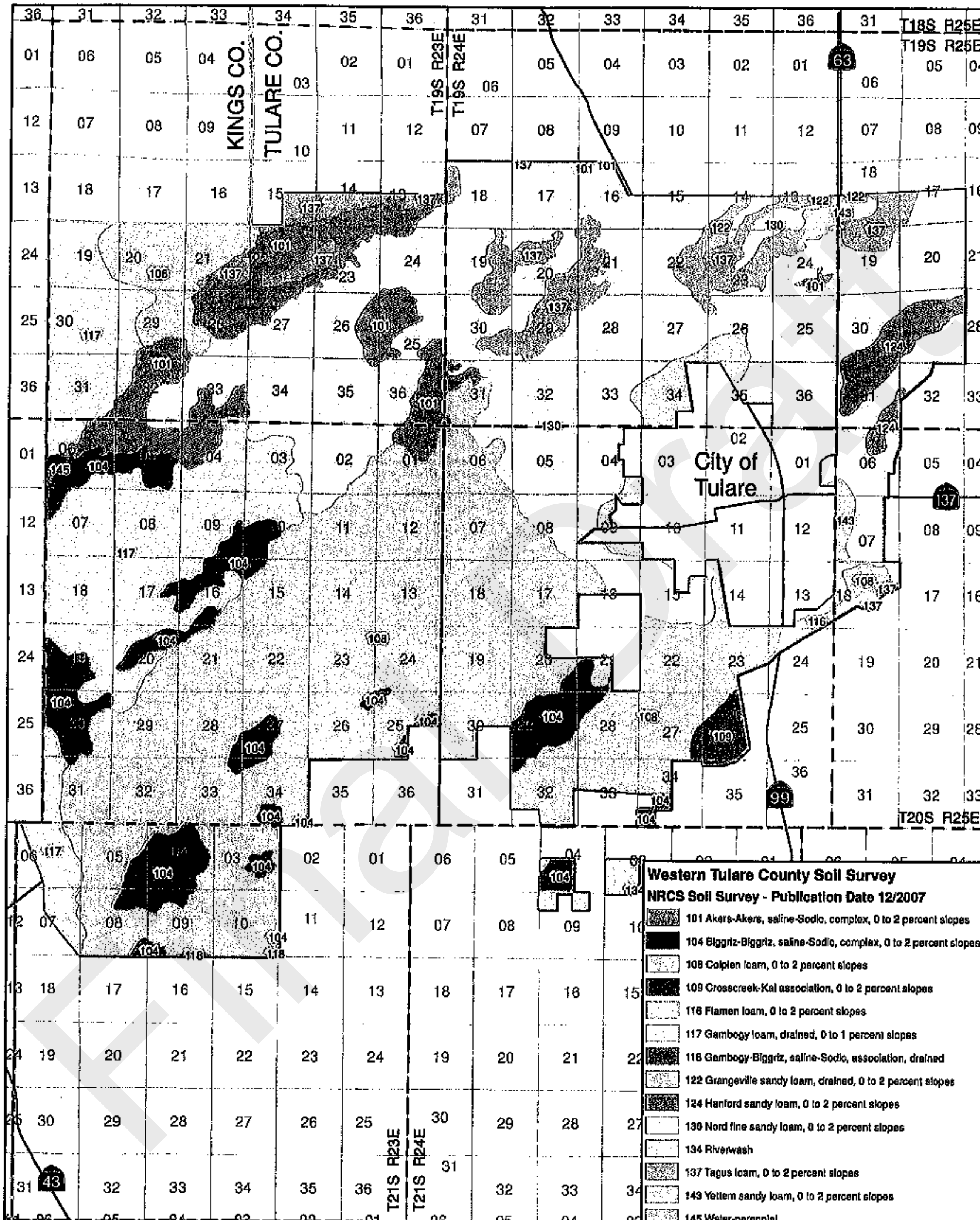
Tulare ID	City
Main Intake Canal	County
Ditch Companies	Major Road

Tulare Irrigation District

Attachment 3

Neighboring Ditch and Irrigation Companies

11/30/2009 \\goose\vst_clients\Clients\Tulare ID-1248\124809V1-Update Groundwater Management Plan\GIS\Map\Attachment3_DitchCompanies.mxd



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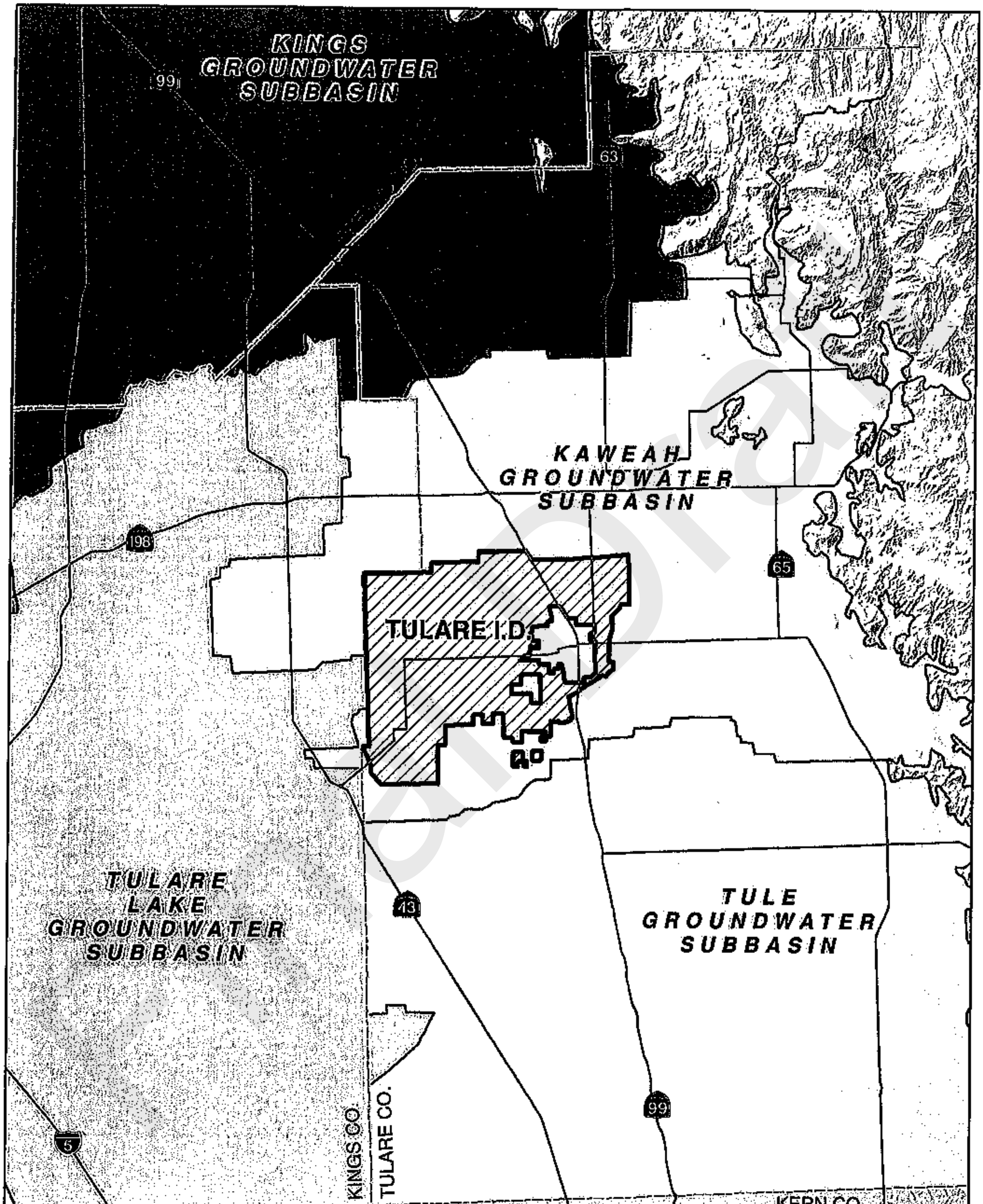
Tulare Irrigation District

Attachment 4

Soils



0 2 4 6 8 Miles

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Groundwater Sub Basin
DWR 118-80 (GIS Oct 2000)

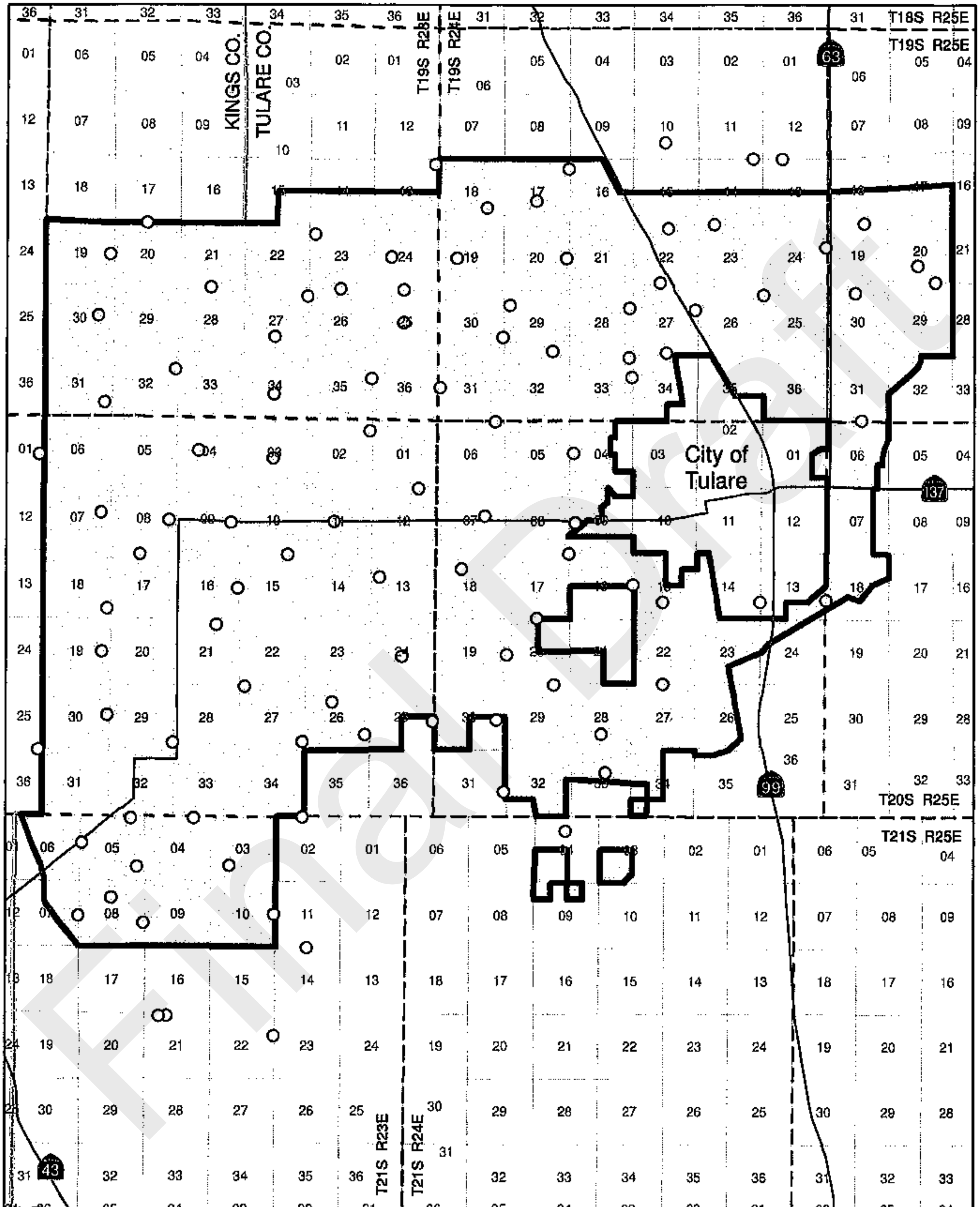
- KAWEAH
- KERN COUNTY
- KINGS
- TULARE LAKE
- TULE

Tulare Irrigation District

Attachment 5

Groundwater Sub Basins

11/24/2009 \\goose\wl_clients\Clients\Tulare ID-1248\124809V1-Update Groundwater Management Plan\GIS\Map\Attachment5_GWBasins.mxd



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Legend

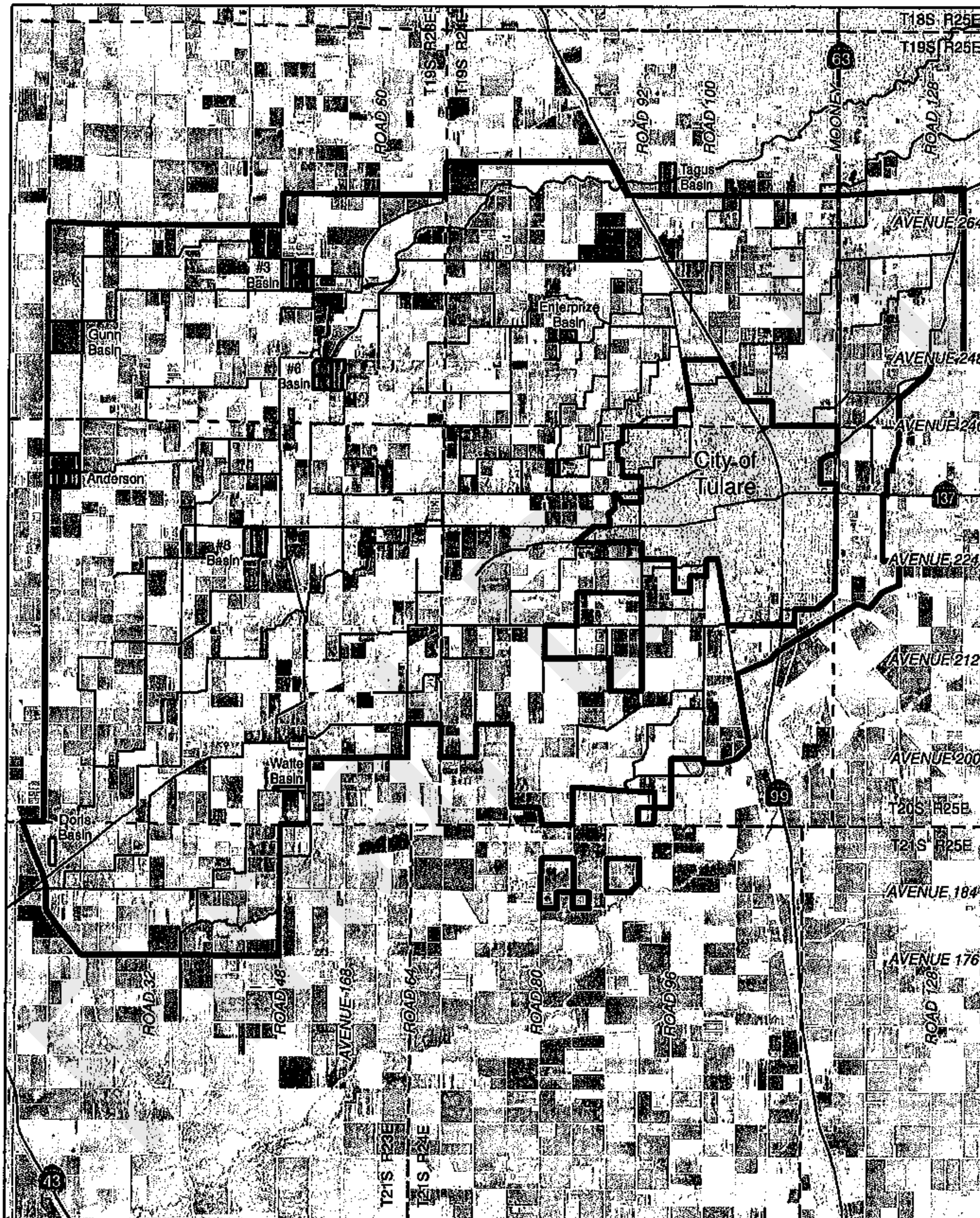
Wells
Tulare ID
County
Township / Range

Tulare Irrigation District

Attachment 6

Wells

11/30/2009 \\goose\vsl_clients\Clients\Tulare ID-1248\124809V1-Update Groundwater Management Plan\GIS\Map\Attachment6_Wells.mxd



0 1 2 3 Miles

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Legend

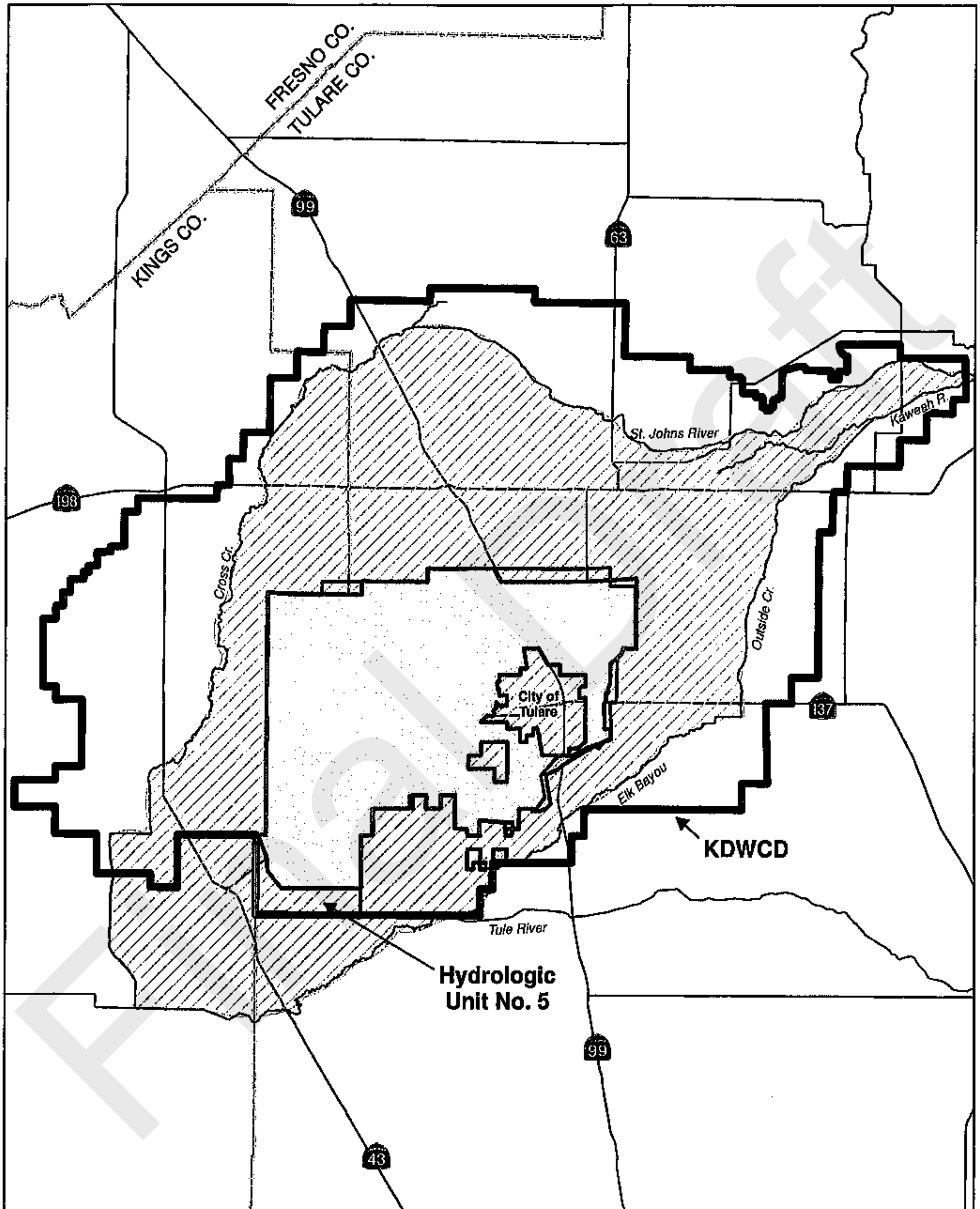
- Ditch / Stream
- Recharge Basin
- Tulare ID
- County
- Township / Range

Tulare Irrigation District

Attachment 7

Conveyance Facilities and Recharge Basins

11/24/2009 \\goose\wsi_clients\Clients\Tulare ID-1246\124809V1-Update Groundwater Management Plan\GIS\Map\Attachment7_Facilities.mxd



0 2 4 6 Miles

Legend

- Tulare ID
- Kaweah Delta WCD
- County
- Hydrologic Unit 5 (Water Resources Investigation 2007)
- Groundwater Management Plan Buffer Zone

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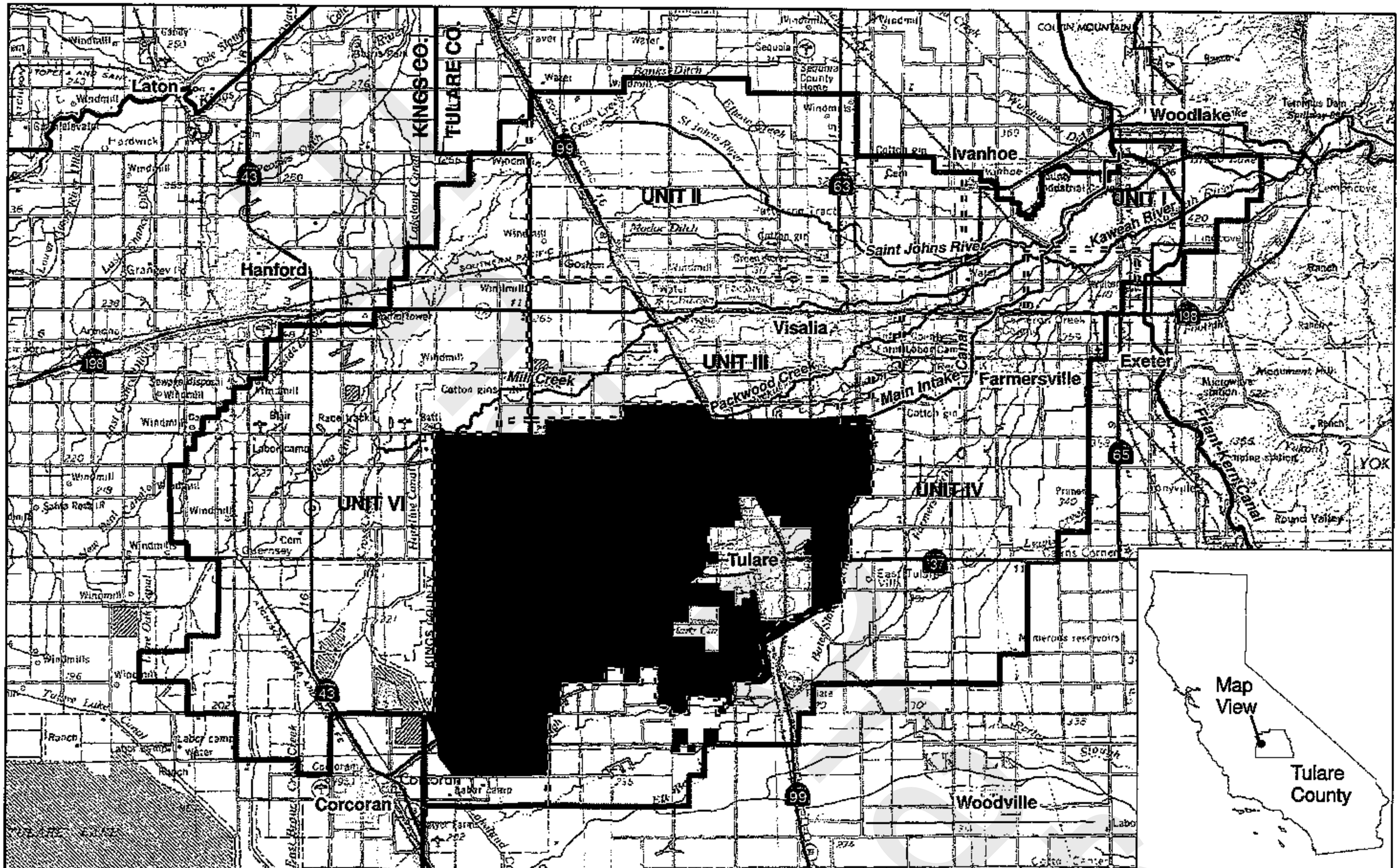
Tulare Irrigation Distrtict

Attachment 8

Water Management Boundaries



0 1 2 3 4 5
Miles

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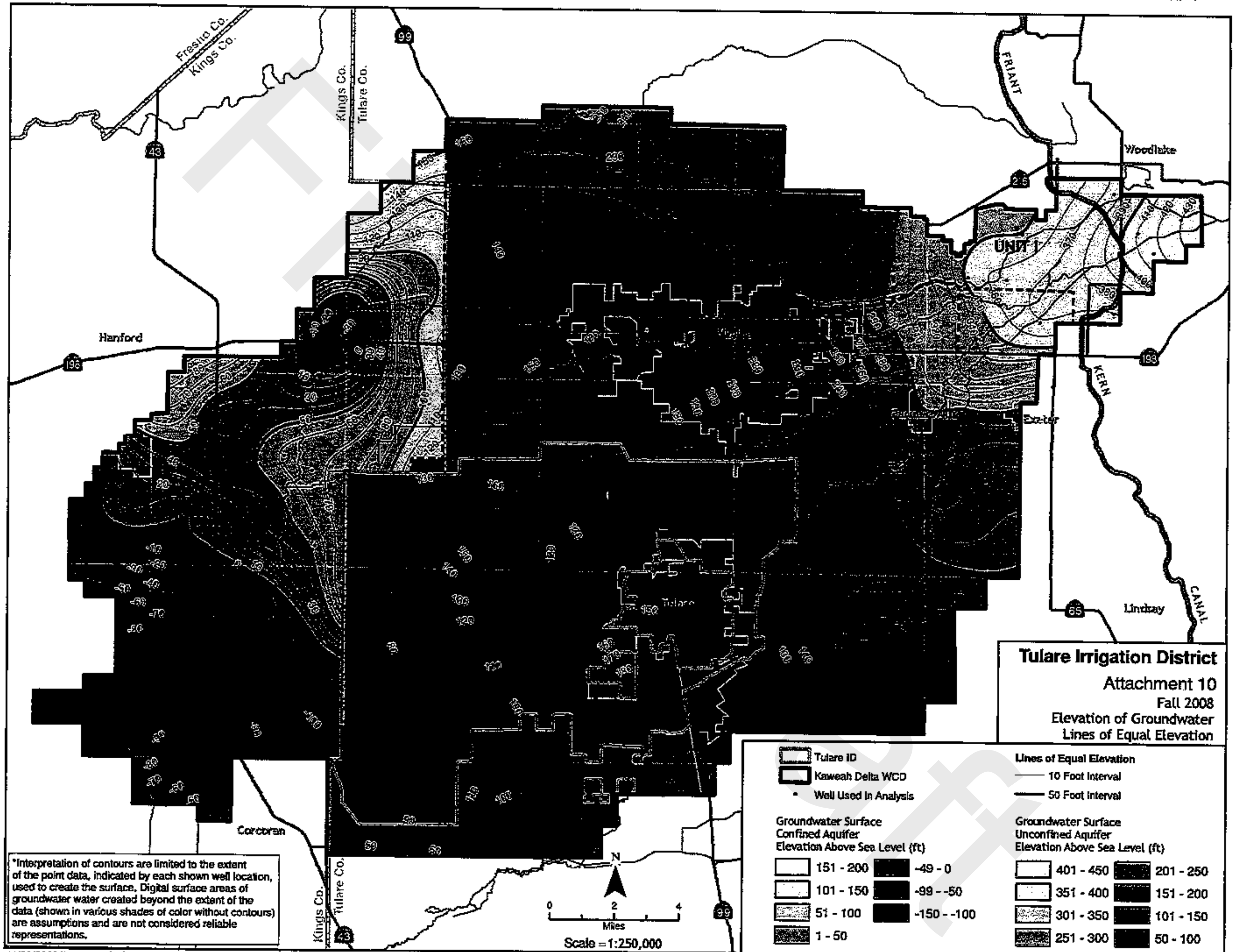
Legend

- Tulare ID
- Main Intake Canal
- Kaweah Delta WCD
- KDWCD Hydrologic Unit
- City
- County
- Major Road

Tulare Irrigation District

Attachment 9

Regional Hydrologic Units



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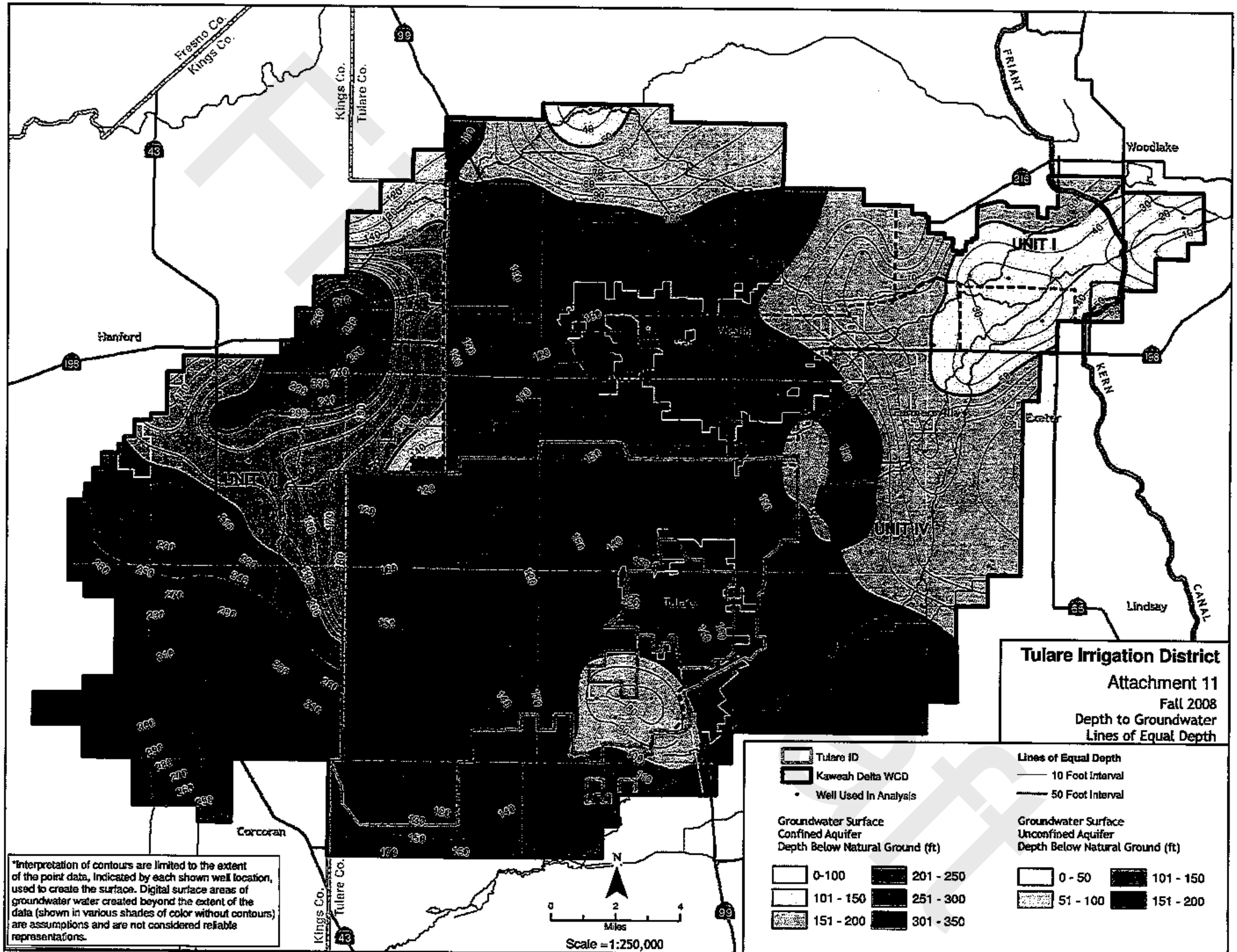

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Attachement 12 - Table of Well Attributes

Well ID	Township	Range	Section	Tract and Squence	Owner
192313 A03	19 S	23 E	13	A03	Nichols
192319 H01	19 S	23 E	19	H01	Te Velde
192320 C01	19 S	23 E	20	C01	Te Velde
192321 P01	19 S	23 E	21	P01	Westra
192323 D01	19 S	23 E	23	D01	Pacheco
192324 L01	19 S	23 E	24	L01	Fisher
192325 C01	19 S	23 E	25	C01	Mederos
192325 L02	19 S	23 E	25	L02	Gist
192326 B01	19 S	23 E	26	B01	Pacheco
192327 A01	19 S	23 E	27	A01	Bebereia
192327 P01	19 S	23 E	27	P01	Pires
192330 H02	19 S	23 E	30	H02	Te Velde
192331 R01	19 S	23 E	31	R01	Hildebrand
192332 H01	19 S	23 E	32	H01	Lemstra
192334 L01	19 S	23 E	34	L01	Bassett
192335 H01	19 S	23 E	35	H01	Mendonca
192410 G01	19 S	24 E	10	G01	Gordon
192413 C02	19 S	24 E	13	C02	Out of District
192414 A01	19 S	24 E	14	A01	Blain
192417 A01	19 S	24 E	17	A01	Pacheco
192417 N01	19 S	24 E	17	N01	Hamstra
192418 R01	19 S	24 E	18	R01	Hamstra
192419 L01	19 S	24 E	19	L01	Goeman
192420 J01	19 S	24 E	20	J01	Darthelemy
192422 C02	19 S	24 E	22	C02	Nunes
192422 P01	19 S	24 E	22	P01	Royal Farms
192423 D01	19 S	24 E	23	D01	Goins
192424 A03	19 S	24 E	24	A03	Visser
192425 D01	19 S	24 E	25	D01	Thomas
192427 H01	19 S	24 E	27	H01	Thomas
192427 Q01	19 S	24 E	27	Q01	K.D. Gin
192428 H01	19 S	24 E	28	H01	Gist
192429 D01	19 S	24 E	29	D01	Bertao
192429 R01	19 S	24 E	29	R01	Stuhaan
192430 J01	19 S	24 E	30	J01	De Campos
192431 E01	19 S	24 E	31	E01	Oak Valley School
192433 A02	19 S	24 E	33	A02	Fisher
192433 H01	19 S	24 E	33	H01	Fisher
192436 R01	19 S	24 E	36	R01	Lagomarsino
192519 B01	19 S	25 E	19	B01	Rodgers
192520 P01	19 S	25 E	20	P01	Serpa
192529 B01	19 S	25 E	29	B01	Gerawan
192530 C01	19 S	25 E	30	C01	Gerawan
202201 H01	20 S	22 E	1	H01	Out of District
202225 R01	20 S	22 E	25	R01	Out of District
202302 H01	20 S	23 E	2	H01	Hillman

Well ID	Township		Range		Section	Tract and Squence	Owner
202303 L01	20	S	23	E	3	L01	Clark
202304 F01	20	S	23	E	4	F01	Fagundes
202307 H03	20	S	23	E	7	H03	Anderson
202308 H01	20	S	23	E	8	H01	Monteiro
202309 J02	20	S	23	E	9	J02	J.R. Simplot Co.
202311 L01	20	S	23	E	11	L01	Watte
202312 A01	20	S	23	E	12	A01	Kotsier
202313 E02	20	S	23	E	13	E02	Almeida
202315 A01	20	S	23	E	15	A01	Watte
202316 J01	20	S	23	E	16	J01	Terra Linda
202317 C01	20	S	23	E	17	C01	Quinn
202318 R01	20	S	23	E	18	R01	Monteiro
202319 J01	20	S	23	E	19	J01	Harmon
202321 B01	20	S	23	E	21	B01	Watte
202324 L01	20	S	23	E	24	L01	Heiskell
202325 J02	20	S	23	E	25	J02	Jones
202326 C01	20	S	23	E	26	C01	Mederos
202326 R01	20	S	23	E	26	R01	Smith
202327 D01	20	S	23	E	27	D01	VandeVelde
202327 R01	20	S	23	E	27	R01	Watte
202329 J02	20	S	23	E	29	J02	Souza
202330 R01	20	S	23	E	30	R01	Quinn
202404 E01	20	S	24	E	4	E01	Junio
202406 A01	20	S	24	E	6	A01	Royal Crest
202407 G01	20	S	24	E	7	G01	Clarklind
202409 M01	20	S	24	E	9	M01	Soults
202414 R01	20	S	24	E	14	R01	Souza
202415 P01	20	S	24	E	15	P01	Clarklind
202416 H01	20	S	24	E	16	H01	Catron
202417 A02	20	S	24	E	17	A02	Texeira
202417 P01	20	S	24	E	17	P01	Faria
202418 F01	20	S	24	E	18	F01	Koetsier
202420 M02	20	S	24	E	20	M02	Clarklind
202427 C01	20	S	24	E	27	C01	Mello
202428 L01	20	S	24	E	28	L01	Eddy
202429 B01	20	S	24	E	29	B01	Mello
202430 J02	20	S	24	E	30	J02	Silveira
202431 R01	20	S	24	E	31	R01	Cardosa
202433 C01	20	S	24	E	33	C01	Hamilton
202506 C01	20	S	25	E	6	C01	Lagomarsino
202518 M01	20	S	25	E	18	M01	Uchita
212302 C01	21	S	23	E	2	C01	Wilbur
212303 N01	21	S	23	E	3	N01	Martin
212304 A01	21	S	23	E	4	A01	Ribeiro
212305 A02	21	S	23	E	5	A02	Cunha
212305 E02	21	S	23	E	5	E02	Valov

Well ID	Township		Range		Section	Tract and Squence	Owner
212305 R01	21	S	23	E	5	R01	Nunes
212307 H01	21	S	23	E	7	H01	Curti
212308 F02	21	S	23	E	8	F02	Valov
212308 R01	21	S	23	E	8	R01	Curti
212310 J02	21	S	23	E	10	J02	Leyendekker
212314 C01	21	S	23	E	14	C01	Torrez
212321 C03	21	S	23	E	21	C03	Salyer
212404 F01	21	S	24	E	4	F01	Bowles

TULARE IRRIGATION DISTRICT

2010 ANNUAL GROUNDWATER REPORT

Table Of Contents

Tulare Irrigation District
Groundwater Management Plan
Implementation Schedule

Task No.	Task[1]	2009				2010				2011				2012				2013				2014			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Groundwater Advisory Committee meetings																								
2	Prepare Annual Groundwater Reports																								
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13	Update Groundwater Management Plan																								

Notes:
1 - Only proposed new projects are shown in this schedule. Existing and on-going projects are not shown. Also, new policies and guidelines that will be implemented on a continuous basis are not shown.
2 - Implementation of these projects will depend on the results of current feasibility studies and the availability of funding to construct them.

TULARE IRRIGATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX A - PUBLIC PARTICIPATION IN PLAN ADOPTION

TULARE IRRIGATION DISTRICT

RESOLUTION NO. 09-12

WHEREAS, the Tulare Irrigation District adopted a Groundwater Management Plan in 1992 in accordance with Assembly Bill 255; and

WHEREAS, the California Water Code permits the adoption and implementation of Groundwater Management Plans to encourage authorized local agencies to manage groundwater resources within their service areas; and

WHEREAS, updating the District's Groundwater Management Plan is in furtherance of and consistent with the District's goals and objectives and will be in the best interests of the District's landowners and water users; and

WHEREAS, a public hearing was held on August 11, 2009, to discuss updating the Groundwater Management Plan;

NOW, THEREFORE, BE IT RESOLVED, by the Board of Directors that it is the intention of the District to update their Groundwater Management Plan in accordance with Senate Bill No. 1938, that this resolution shall be deemed a resolution of intention in accordance with California Water Code § 10753.2, and that the Board hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

THE FOREGOING RESOLUTION WAS PASSED AND ADOPTED at a regular meeting of the Board of the Tulare Irrigation District held on this 11th day of August, 2009, by the following vote:

Ayes: Directors Bixler, Martin, Rogers and Thomas

Noes: None

Abstain: None

Absent: Director Borges

ATTEST:

David G. Bixler

David G. Bixler, President

TULARE IRRIGATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX B - MEMORANDUM OF UNDERSTANDING BETWEEN KAWEAH DELTA WATER CONSERVATION DISTRICT AND TULARE IRRIGATION DISTRICT

MEMORANDUM OF UNDERSTANDING
BETWEEN
KAWEAH DELTA WATER CONSERVATION DISTRICT
AND
TULARE IRRIGATION DISTRICT

ARTICLE I - AGREEMENT

The articles and provisions contained herein constitute a bilateral and binding agreement by and between KAWEAH DELTA WATER CONSERVATION DISTRICT (hereinafter "Kaweah Delta") and TULARE IRRIGATION DISTRICT (hereinafter "Tulare").

ARTICLE II - RECOGNITION

Tulare developed a Groundwater Management Plan (hereinafter "The Tulare Plan") in 1992 with input from the City of Tulare located within the exterior boundaries of the district. Kaweah Delta has developed a Groundwater Management Plan (hereinafter "the Kaweah Delta Plan") the plan area of which overlaps the entire area of the Tulare Plan (hereinafter "the Overlap Area") and additionally overlaps Tulare facilities outside of the Tulare boundary. (Namely a buffer zone adjacent to the perimeter boundary and additionally areas along its main intake canal facility from Tulare non-tributary source water supply.)

ARTICLE III - PURPOSE

It is the purpose of this Memorandum of Understanding, entered into willingly by the districts, to document the interests and obligations of the districts with respect only to the Overlap Area of the two plans. It is also hoped that this Memorandum of Understanding will promote and provide a means to establish an orderly process to share information, develop a course of action and resolve any misunderstandings or differences that may arise regarding both plans.

ARTICLE IV - COORDINATION

There shall be an annual coordinating meeting (hereinafter "the meeting") between the districts. Kaweah Delta shall give notice to Tulare thirty (30) days prior to the date of the meeting to discuss the manner in which the plans are being implemented and other items relating to the plans. If there are concerns or questions regarding the plans, each district shall transmit its concerns in writing seven (7) days prior to the meeting.

ARTICLE V - MANAGEMENT OF OVERLAP AREA

Subject to the provisions of this Agreement, Tulare Irrigation District and Kaweah Delta Water Conservation District will allow each District to manage both their respective groundwater and their respective tributary and non-tributary source groundwater pursuant to their own Groundwater Management Plans in all areas overlapped by both Districts and adjacent zones and facilities areas.

The districts agree to meet as necessary to attempt to resolve any disputes developed from implementation of their respective plans within the Overlap Area. If differences cannot be resolved acceptable to both districts, Kaweah Delta will immediately cease to manage the Kaweah Delta Plan in any area inside the boundaries of Tulare. Additionally, Tulare will immediately cease to manage The Tulare Plan in any area outside its boundaries, provided such area is also within the boundaries of Kaweah Delta, except the area within the City of Tulare, which will continue to be subject to The Tulare Plan. Thereafter, this Agreement shall be deemed terminated.

ARTICLE VI - TERM

The initial term of this Agreement shall commence on the date hereof and continue for five (5) years, and shall continue from year to year thereafter unless terminated by written notice given at least one year prior to such termination, or as stated in Article V due to a lack of conflict resolution.

This Memorandum of Understanding is made and entered into this 29th day of April, 1996.

KAWEAH DELTA WATER CONSERVATION DISTRICT	TULARE IRRIGATION DISTRICT
By	By
Title Chairman	Title President
By	By
Title Secretary	Title General Manager

DLR\Agrmnts\KDWCDTID\4.3.96

TULARE IRRIGATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX C – GROUNDWATER MONITORING PROTOCOLS

GROUNDWATER MONITORING PROTOCOLS

GENERAL SCOPE

The purpose of this document is to insure that the sampling and analytical methods are adequately documented and appropriate for the project scope and purpose by individuals responsible for implementing the monitoring program. Examples of all required forms are presented at the end of this section.

In general, measurements of the static water level will be taken from the top of each casing, and then the monitoring wells will be purged and sampled. A detailed description of these procedures follows.

EQUIPMENT USED DURING SAMPLING

Water level sounding equipment and field meter probes (pH, dissolved oxygen, conductivity, temperature, and turbidity) will be thoroughly rinsed with deionized/distilled water before and after each reading. All field meters will be calibrated according to manufacturer's guidelines and specifications before and after every day of field use.

The monitoring wells will be equipped with a dedicated sampling well pump or sampling activities will utilize disposable bailing equipment. All non-dedicated sampling equipment (in contact with sample) shall be thoroughly cleaned prior to each sampling event to prevent cross-contamination between samples and to ensure accurate representation of analytes of interest in each sample. All sample containers and sampling equipment shall be sterilized and transported to the field under conditions to preserve its sterility. Personnel performing decontamination shall wear gloves, eye-protection, and such other safety equipment as needed. The analytical laboratory as part of their agreement shall provide all sample containers, container preparation services, preservatives, and field blanks.

EQUIPMENT DECONTAMINATION PROCEDURES

All equipment that comes into contact with potentially contaminated water will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment. The following, to be carried out in sequence, is the recommended procedure.

- Non-phosphate detergent and tap water wash, using a brush if necessary;
- Tap water rinse; and
- Deionized/distilled water rinse.

WATER LEVEL MEASUREMENT PROCEDURES

Water levels will be measured in wells that have the least amount of known contamination first. Wells with known or suspected contamination will be measured last.

If wellheads are accessible, all wells will be sounded for depth to water from top of casing and total well depth prior to purging. An electronic sounder, accurate to the nearest +/- 0.01-ft, will be used to measure depth to water in each well. When using an electronic sounder, the probe is lowered down the casing to the top of the water column, the graduated markings on the probe wire or tape are used to measure the depth to water from the surveyed point on the rim of the well casing. Total well depth will be sounded from the surveyed top of casing by lowering the weighted probe to the bottom of the well. The weighted probe will sink into silt, if present, at the bottom of the well screen. Total well depths will be measured by lowering the weighted probe to the bottom of the well and recording the depth to the nearest 0.1-ft. Depth to water and total well depth will be recorded on a Monitoring Well Purging and Sampling Record as presented at the end of this section.

WELL PURGING

The wells will be sampled no sooner than 48 hours after well development. All wells will be purged prior to sampling. If the well casing volume is known, a minimum of three casing volumes of water will be purged using the dedicated well pump, if present, or a bailer, hand pump, or submersible pump depending on the diameter and configuration of the well. When a submersible pump is used for purging, clean flexible Teflon tubes will be used for groundwater extraction. Pumps will be placed 2 to 3 ft from the bottom of the well to permit reasonable draw down while preventing cascading conditions.

Water will be collected into a measured bucket to record the purge volume. Casing volumes will be calculated based on total well depth, standing water level, and casing diameter. One casing volume will be calculated as $\mathbf{V = \pi r^2 h\ 7.48}$ where **V** is the volume of one well casing of water in gallons ($1ft^3 = 7.48$ gallons); $\pi = 3.14$; **r** is the radius of the inner well casing (in ft); and **h** is the total height of the water column in the well (in ft).

It is most important to obtain a representative sample from the well. Stable water quality parameter field measurements (temperature, pH, and specific conductivity [EC]) indicate representative sampling is obtainable. Water quality is considered stable if for three consecutive readings:

- Temperature range is no more than +1/C;
- pH varies by no more than 0.2 pH units; and
- EC readings are within 10% of the average.

If the well casing volume is known, measurements will be taken before the start of purging, in the middle of purging, and at the end of purging each casing volume. If the well casing volume is NOT known, measurements will be taken every 2.5 minutes after flow starts. If water quality parameters are not stable after 5 casing volumes or 30 minutes, purging will cease, which will be noted in the field notes, and ground water samples will be taken. The depth to water, water quality field measurements, and purge volumes will be recorded on a Monitoring Well Purging and Sampling Record as presented at the end of this section.

If a well dewaters during purging and three casing volumes are not purged, that well will be allowed to recharge up to 80% of the static water column and dewatered once more. After water levels have recharged to 80% of the static water column, groundwater samples will be collected.

WATER LEVEL MEASUREMENT AND WELL PURGING RECORDS

During the collection of each sample, the following information will be recorded on a Monitoring Well Purging and Sampling Record as presented at the end of this section:

- Well identification;
- Sampler's name(s);
- Date and time of sample collection;
- Designation of sample as composite or grab, if applicable;
- Type of sampling equipment used;
- Field instrument readings and calibration;
- Field observations and details related to analysis or integrity of samples (e.g., conditions in nearby waterways, weather conditions, noticeable odors, colors, etc.);
- Preliminary sample descriptions (e.g., clear with strong ammonia-like odor);
- Time of arrival/entry on site and time of site departure; and
- Deviations from sampling plans.

PURGED WATER DISPOSAL

Purged and excess groundwater collected for sample container filling may be disposed on site or in the sampling area by dispersing onto the ground, or at the owner's direction.

ANALYTICAL METHODS AND REPORTING LIMITS

Requested analytes are provided in the following table. Reporting limits are laboratory specific based on the type of equipment each laboratory uses. Analytical methods and holding times are listed by analyte below.

Analyte	Standard Method	EPA Method	Holding Time
PH	4500H-B	150.1	24 hours
EC	2510B	120.1	28 days
Alkalinity	2320B	310.1	14 days
Ammonium	4500NH4	350.1	28 days
Bicarbonate	2320B	310.1	14 days
Carbonate	2320B	310.1	14 days
Chloride	4500Cl	300.0	28 days
Iron	3120B	200.7	6 months
Magnesium	3120B	200.7	6 months
Manganese	3120B	200.7	6 months
Nitrate as N	4500NO3	353.2; 300.0	48 hours
Nitrite as N	4500NO2	353.2; 300.0	48 hours
Phosphorus	4500P	365	28 days
Potassium	3120B	200.7	6 months
Sodium	3120B	200.7	6 months
Sulfate	4500SO4	300.0	28 days
TDS	2540C	160.1	7 days
TKN	4500-NH3	351	28 days

SAMPLE CONTAINERS AND PRESERVATIVES

Sample containers are generally available directly from the laboratory. All containers will be one-liter polyethylene, precleaned, and analyte specific. Groundwater samples for TKN and ammonia will be collected in containers containing H_2SO_4 as a preservative. The remaining samples need not be preserved. If a preservative is present, the bottle will be capped and lightly shaken to mix in the preservative. Samples from each location that require the same preservative may be placed in the same bottle if being analyzed by the same laboratory. Samples to be analyzed for dissolved metals must be filtered prior to preservation and analysis.

SAMPLING PROCEDURES

Water samples will be collected from each well and placed into laboratory prepared containers, sealed with tight fitting caps, labeled, and stored in a cool ice chest. Water used for field measurements of temperature, pH, and EC shall not be used as sample water. The following are the recommended sample collection procedures:

- Rinse the tubing with one liter of sample prior to sample collection;
- If no preservative is present, rinse sample bottles three times with a small amount of sample;
- Collect sample directly into the sample bottle;
- Allow sample containers to be open for the shortest time possible to prevent contamination;
- Do not touch the inside of bottles, lids, or tubes. Hold the bottle lid with the inside facing down to prevent contaminating the inside of the lid;
- Allow the sample water to flow into the bottle from above;
- Close bottle tightly,
- Samples will be chilled to 4 C^0 immediately upon collection; and
- Transport samples to the lab as soon as possible.

At each sampling location, all bottles designated for a particular analysis will be filled sequentially before bottles designated for the next analysis are filled. If a duplicate sample is to be collected at this location, all bottles designated for a particular analysis will be filled sequentially before bottles for another analysis are filled.

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. Every sample, including samples collected from a single location but going to separate laboratories, will be pre-assigned an identifiable, unique sample number. The following is an example sample label:

Sample #:	**Well ID:**
Analytes:	**Date:**
Collected by:	**Time:**

It will be possible to identify each unique sample by recording the following information on the Monitoring Well Purging and Sampling Record:

- Sample identification numbers and any explanatory codes;
- Sample date and time;
- Lot numbers of the sample containers;
- Chain-of-custody form numbers;
- Shipping arrangements (overnight air bill number); and
- Name(s) of recipient laboratory (ies).

CHAIN-OF-CUSTODY

A chain-of-custody (COC) record will be completed and accompany all sample shipments for each laboratory and each shipment. If multiple coolers are sent to a single laboratory on a single day, COCs will be completed and sent with the samples for each cooler. Generally, the laboratory will supply blank COCs. An example COC is included at the end of this section.

The COC will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. The sampling team leader or designee will sign the COC in the "relinquished by" box and note date, time, and air bill number.

SAMPLE HANDLING AND TRANSPORT

The following outlines the packaging procedures for sample delivery to a California Certified Environmental Laboratory Accreditation Program (ELAP) laboratory:

- Pack ice in zip-locked, double plastic bags. Seal the drain plug of the cooler with tape to prevent melting ice from leaking out;
- Line the bottom of the cooler with bubble wrap to prevent breakage during shipment;
- Check screw caps for tightness;
- Seal all container tops with tape;
- Secure sample labels onto the containers with clear tape;
- Wrap all glass sample containers in bubble wrap to prevent breakage;
- Seal all sample containers in heavy-duty plastic zip-lock bags with the sample numbers written on the outside of the bags with indelible ink;
- Place samples in a sturdy cooler(s) lined with a large plastic trash bag. Enclose the appropriate COC(s) in a zip-lock plastic bag affixed to the underside of the cooler lid;
- Fill empty space in the cooler with bubble wrap or Styrofoam peanuts

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CONSULTING GROUP
An Employee Owned Company

Monitoring Well Purging and Sampling Record

Client: ____________________ Date: ________
Project Name: ____________________ County: ________
Project Address: ____________________
Project Manager: ________ Job No: ________ Phase(s): ________
Regulatory Contact: ________ Telephone: ________
Sample Containers: ________ Air Temp (F): ________
Preservatives: ________ Precipitation: ________
Instrumentation: ________ Wind (dir/speed): ________
Date Last Calibrated/By: ________ Sampler Signature: ________

Well Number						
Well Elevation (ft)						
Well Diameter (in)						
Slotted Interval (ft)						
DTW (ft)						
GW Elevation (ft)						
Sounding Depth (ft)						
Well Volumes (gal)						
Notes:						
Well Volume Purged (1st)						
Time						
Temp (C°)						
pH						
EC						
Volume Removed (gal)						
Well Volume Purged (2nd)						
Time						
Temp (C°)						
pH						
EC						
Volume Removed (gal)						
Well Volume Purged (3rd)						
Time						
Temp (C°)						
pH						
EC						
Volume Removed (gal)						
Sample Depth (ft)						
Sample Time						

Equipment used:

Remarks:

2" Well Volume = 0.163 x height of water column   4" Well Volume = 0.653 x height of water column

TULARE IRRIGATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX D – GROUNDWATER RECHARGE AGREEMENT WITH THE CITY OF TULARE

AGREEMENT REGARDING DELIVERY OF WATER TO CERTAIN GROUNDWATER RECHARGE FACILITIES

THIS AGREEMENT is made and entered into this 6th day of May, 2008, by and between TULARE IRRIGATION DISTRICT, an Irrigation District organized and existing pursuant to the laws of the State of California (hereinafter referred to as "District"), and the CITY OF TULARE, a Municipal Corporation of the State of California (hereinafter referred to as "City").

WITNESSETH

A. WHEREAS, District is a public entity engaged in the importation and delivery of water for irrigation purposes to landowners within the District; and

B. WHEREAS, City and District entered into an Agreement dated May 10, 2005 (the "Master Agreement"), which provides for the use by City of certain canal and ditch facilities owned and controlled by District for the purpose of disposing of storm drainage; payments by City in lieu of District assessments; an agreement to develop joint policies related to impacts of new urban development on District facilities; and an agreement to consider and enter into various joint projects; and

C. WHEREAS, City has determined that it is in City's interest to acquire water from District and to deliver such water to groundwater recharge basins in locations that will provide a groundwater recharge benefit to areas that serve City; and

D. WHEREAS, in addition to purchasing water, City has the need to acquire basins to which such water can be delivered; and

E. WHEREAS, City and District have entered into an agreement dated December 4, 2007, ("Joint Purchase Agreement") providing for the joint purchase of property located at the corner of Road 132 and Avenue 256, known as the "Plum Property", for the purpose developing such property to a groundwater recharge basin. The Joint Purchase Agreement establishes joint rights in the Plum Property. After execution of the Joint Purchase Agreement, the property has been acquired as envisioned; and

F. WHEREAS, the Joint Purchase Agreement obligates the parties to negotiate and enter into a subsequent agreement providing for the purchase of water by City and the delivery of such water to various City, District and joint City-District facilities; and

G. WHEREAS, the parties now desire to set forth their agreement regarding the obligation of District to deliver water to various facilities, and the obligation of the City to pay the costs of such delivered water.

NOW THEREFORE, the parties hereto covenant and agree as follows:

1. **Definitions.** The following terms, when appearing as capitalized terms elsewhere in this Agreement, shall have the following meanings:

"Agreed Facilities" shall mean all of those facilities described in Exhibit A attached hereto. City may identify in the future any City-owned property it believes would be beneficial to receive water pursuant to this Agreement, and with the consent of District, such facility shall be added to the Agreed Facilities list, subject the District maintaining its discretion for determining the timing and amount of water to be delivered to such City facilities.

"Average Annual Quantity" shall initially mean approximately 10,000 a.f., such amount to be increased proportionally if adjustments to City's jurisdictional boundaries consistent with the Master Agreement results in more land being included within City boundaries or if the City increases its groundwater extractions from City-owned wells. Said Average Annual Quantity is to be annually derived in accordance with a formula as defined in Exhibit B attached hereto.

"Credited Water Balance" is defined as the amount of water, in acre feet, calculated by determining the total cumulative water delivered by District during the five year period immediately preceding the date of calculation, and subtracting from that amount the sum of the Average Annual Quantity for each of the previous five years or the number of years this Agreement has been in effect, whichever is less. By way of example only and not by limitation, assuming 55,000 acre feet have been delivered to the Agreed Facilities during the past five years, and assuming that the Average Annual Quantity in effect through the past five years is 10,000 acre feet, the Credited Water Balance would be equal to: 55,000 a.f. – (10,000 a.f. * 5); or 55,000 a.f. – 50,000 a.f.; or +5,000 a.f.

2. **Obligation to Deliver Water.** District hereby agrees to deliver on an annual basis a certain average quantity of water, defined above as the Average Annual Quantity, to the facilities defined above as the Agreed Facilities. District shall be responsible for determining, with the advice and consent of City, the manner and location of the water to be delivered, and shall not be

required to deliver all or any percentage of the water to be delivered to any particular basin, including the basin to be constructed by City and District jointly on the Plum Property. District shall endeavor to ensure that the Credited Water Balance, as annually reported pursuant to the provisions of paragraph 3 below, remains greater than or equal to zero. The purpose of the Credited Water Balance calculation is ensure that a total of 10,000 acre-feet of water is delivered on a rolling five year average annual basis, recognizing that water conditions will allow for more water to be delivered in some years and less in other years. The Credited Water calculation and accounting is not intended to establish a "water bank" or in any other way establish a right to the amount of water calculated through the Credited Water accounting system.

3. Accounting for Delivered Water. District shall, by October 31st each year, document and provide an annual summary of the water deliveries made pursuant the Water Purchase Agreement, and shall endeavor to document estimates of groundwater recharge benefits that resulted from or are anticipated to result from such water deliveries. As part of such annual summary, District shall calculate the Credited Water Balance according to the formula defined above.

4. Timing of Water Deliveries. Water deliveries shall occur only during those times when water is available to District for delivery, and can be recharged into the Agreed Facilities. To the extent that District makes deliveries to any of the Agreed Facilities that are under the City's control ("City's Facilities"), District shall provide an anticipated schedule of such deliveries and flow rate with reasonable advance notice to City for approval, and District shall not cause water to flow into any such City's Facilities without City's consent.

5. Water Charges. City shall pay a unit water delivery charge associated with such delivered water that is equal to the water charge paid by District for its Central Valley Project Class 2 contract supply. Such payment shall be made annually and shall be based on the then-current Average Annual Quantity.

6. Water Source & Quality. District reserves the right to determine the source of the water from which deliveries will be made to satisfy this Agreement. District does not guarantee the quality of water delivered pursuant to this Agreement; District agrees that such water shall be of a similar quality to water District delivers to other users from the Friant-Kern Canal or the Kaweah River.

7. District's Obligations Contingent Upon Continuation of US-District Contract, Etc. District's obligations to deliver water to the Agreed Facilities pursuant to this Agreement are contingent upon, and subject to, the continuing existence of (i) a contract between the United States government (or agency thereof) and District for the provision of water from the Central Valley Project via the Friant-Kern Canal, or (ii) a contract or entitlement otherwise affording District sufficient water to meet its obligations pursuant to Section 5.

8. Term. The Water Purchase Agreement shall be in effect for as long as the City and District continue to abide by the terms of the Master Agreement.

9. Representations and Warranties of Authority. Each party represents to all other parties that such party has the full power and authority to enter into this Agreement, that the execution and delivery thereof will not violate any agreement to which such party is a party or by which such party is bound, and that this Agreement, as executed and delivered, constitutes a valid and binding obligation of such party, enforceable in accordance with its terms. The corporate, partnership, and association signatories to this Agreement expressly warrant that they have been authorized by their respective company, partnership, or association entities to execute this Agreement and to bind them to the terms and provisions hereof. Any public agency signatory to this Agreement represents and warrants that the Agreement is executed in compliance with a resolution of the governing entity of the public agency, duly adopted by the governing entity and transcribed in full in the minutes of the governing entity. Any individual signing this Agreement on behalf of a public agency represents that she/he has full authority to do so.

10. Duty to Cooperate. Each party shall cooperate so as to facilitate the other party's efforts to carry out its obligations under this Agreement.

11. Successors and Transferees. The obligations and benefits of this Agreement do not run with the land, and are personal to the City and the District and are not assignable or transferable.

12. Entire Agreement. This Agreement constitutes the entire agreement between the parties, and it is expressly understood and agreed that the Agreement has been freely and voluntarily entered into by the parties with the advice of counsel, who have explained the legal effect of this Agreement. The terms of this Agreement are contractual and not mere recitals. The parties further acknowledge that no warranties, representations or inducements not contained in this Agreement have been made on any subject in connection with this Agreement, and that they have not been induced to execute this Agreement by reason of non-disclosure or suppression of any fact. This Agreement may not be altered, modified or otherwise changed in any respect except by writing, duly executed by the parties or their authorized representatives. This Agreement is fully integrated.

13. Construction. The parties acknowledge that each party and its counsel have reviewed and revised this Agreement and that no rule of construction to the effect that any ambiguities are to be resolved against the drafting party shall be employed in the interpretation of this Agreement.

14. Severability. In the event any of the terms, conditions or covenants contained in this Agreement is held to be invalid, any such invalidity shall not affect any other terms, conditions or covenants contained herein which shall remain in full force and effect.

15. Governing Law. California law shall govern the interpretation and enforcement of this Agreement.

16. Remedies. Any motion or other action by the parties to enforce this Agreement shall be filed or otherwise brought and adjudicated in the Tulare County Superior Court. The Tulare County Superior Court shall maintain and reserve jurisdiction of this action for the purpose of enforcing the terms of this Agreement as a judgment or order of the Court. Nothing in this paragraph shall be interpreted in a manner to preclude whatever rights the parties may have to appeal rulings of the Tulare County Superior Court. The parties otherwise retain the full range of legal and equitable remedies to enforce the terms of this Agreement, including injunctive relief and specific performance, to ensure the parties comply with their commitments under this Agreement. In any action to enforce this Agreement, each party shall be responsible for its own attorneys' fees and costs. The parties shall meet and confer and attempt to resolve their differences informally before commencing any action to enforce this Agreement.

17. Further Assurances. In addition to the documents and instruments to be delivered as herein provided, each of the parties shall, from time to time at the request of the other parties, execute and deliver to the other parties such other instruments of transfer, conveyance and assignment and shall take such other action as may be required to more effectively carry out the terms of this Agreement.

18. Time of the Essence. Time is expressly declared to be of the essence of this Agreement and of every provision hereof in which time is an element.

19. Captions. Paragraph titles or captions contained herein are inserted as a matter of convenience and for reference, and in no way define, limit, extend or describe the scope of this Agreement or any provision thereof.

20. Notices. Where required by this Agreement, notice shall be provided by regular mail or overnight delivery, and shall be considered made when deposited in U.S. or express mail.

21. Counterparts. The parties may execute this agreement in counterparts. The counterparts, if any, constitute a single agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement to be effective as of the date and year last below written.

CITY OF TULARE "CITY"	TULARE IRRIGATION DISTRICT "DISTRICT"
By: ______________ 5-7-08	By: ______________ 6-10-2008
Darrel L. Pyle — Date City Manager	David G. Bixler — Date President, Board of Directors
Attested	
By: ______________ 5/7/08	By: J. Paul Hendrix 6/11/08
Chief Deputy City Clerk — Date	J. Paul Hendrix — Date General Manager
Approved as to form and content.	*Approved as to form and content.*
By: ______________ 5/7/08	By: ______________ 6/11/08
S.L. Kabot — Date City Attorney	Alex M. Peltzer — Date District Counsel

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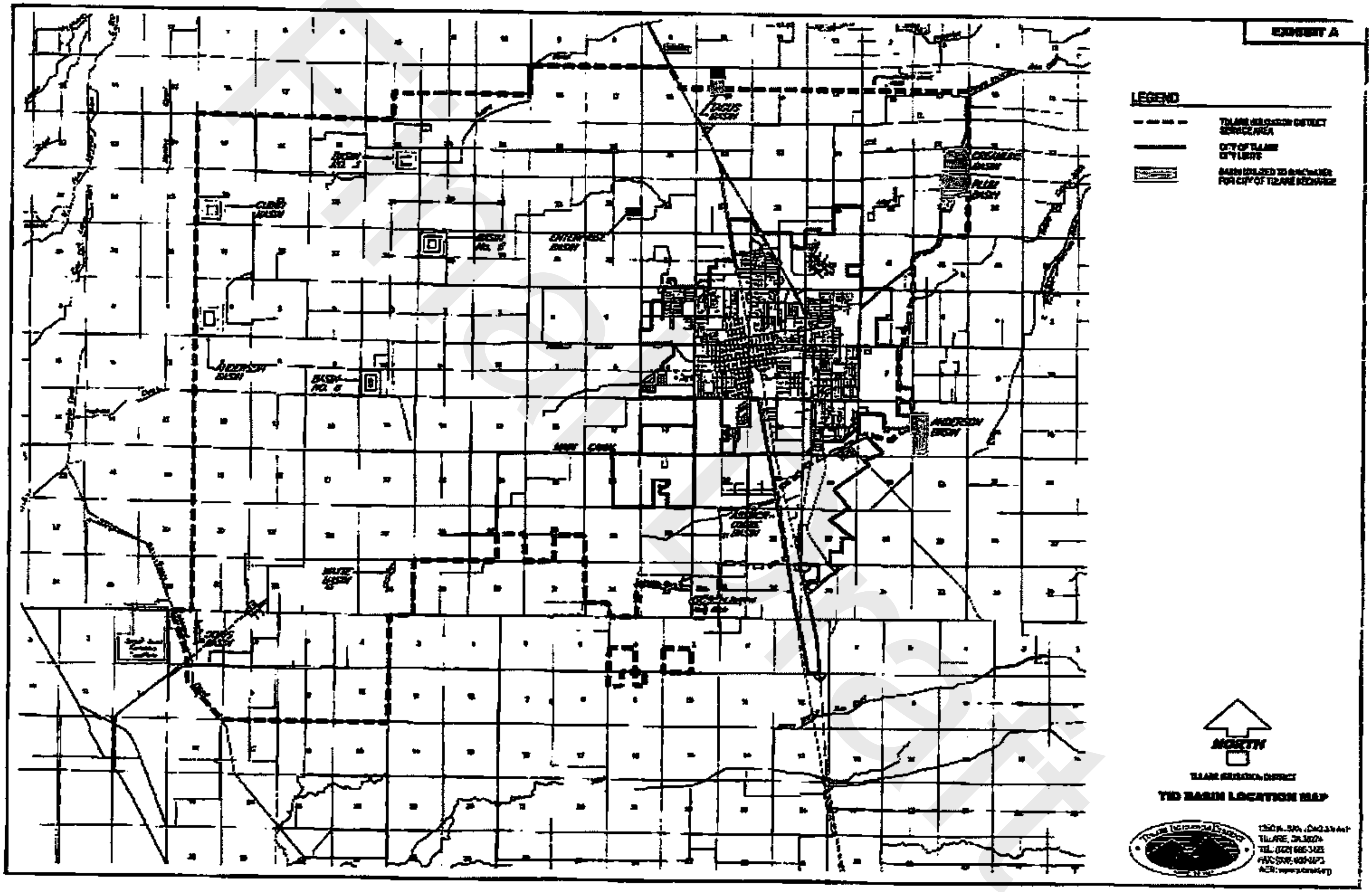

EXHIBIT A
LEGEND
NORTH
TID BASIN LOCATION MAP

Exhibit B
Calculation of Average Annual Quantity

For the purposes of the Agreement, the following parameters will apply:

Avg. surface water supply to TID water users: 60%[1]

Groundwater overdraft in Tulare region: 7,000 AF[2]

City annual groundwater pumping: City Use

District area: TID A

City area: City A

City share of total area: City A ÷ (TID A + City A)

Based on the foregoing parameters, the Average Annual Quantity shall be computed as follows:

Average Annual Quantity = 60% X City Use + (City A/(TID A+City A) X 7,000)

Example for 2007: 60% X 18,870 AF + (18.78 sq. mi./ (104.04 sq. mi. + 18.78 sq. mi.)X 7,000 AF) = 12,392 AF

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(1) Based on long-term TID surface water deliveries and crop water usage
(2) Per KDWCD "Water Resources Investigation Report" - April 2005

TULARE IRRIGATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

APPENDIX E – RULES AND REGULATIONS GOVERNING DISTRIBUTION OF WATER IN THE TULARE IRRIGATION DISTRICT

RULES

AND

REGULATIONS

GOVERNING

THE DISTRIBUTION OF WATER

IN THE

[illegible]

IRRIGATION DISTRICT

[illegible]

[illegible]

RULES AND REGULATIONS
Governing The Distribution Of Water In The
TULARE IRRIGATION DISTRICT

Section 22257 of the Water Code of the State of California is, in part, as follows:

"Each district shall establish equitable rules for the distribution and use of water, which shall be printed in convenient form for distribution in the district."

RULE 1
CONTROL OF SYSTEM

The canals and works of the District are under the exclusive management and control of the Superintendent, appointed by the Board of Directors, and no other person, except his employees and assistants, shall have any right to interfere with said canals and works in any manner.

RULE 2
DITCHTENDERS AND OTHER EMPLOYEES

The Superintendent shall employ such ditchtenders and other assistants as may be necessary for the proper operation of the system, and the distribution of the water. Each ditchtender shall have charge of his respective section and shall be responsible to the Superintendent. From the ditchtender's decision an appeal may be made to the Superintendent. From the Action of the Superintendent, appeal may be made to the Board of Directors.

RULE 3
APPORTIONMENT OF WATER

The water will be apportioned to each distributing section by the Superintendent, and in cases of controversy or shortage of water the apportionment shall be made upon the basis of the assessed valuation of the land in each section.

RULE 4
DELIVERY OF WATER

Water will be delivered to the irrigator on demand or by rotation, depending upon the quantity available for distribution.

When delivery is made on demand application must be made to the ditchtender or the district office at least three days before the water is needed. Efforts will be made to make delivery in less than three days, and where possible the delivery will be made within 24 hours. All deliveries will be made in sequence of receipt of application.

When the quantity of water available is insufficient for full service on demand, a rotation schedule will be established. When water is available for irrigation notice will be given to each irrigator as soon as possible to allow preparation to be made to receive the water, which notice will state the approximate time when the run will be commenced, approximate head to be delivered and the time of discontinuance.

RULE 5
CONTINUOUS USE OF WATER

No allowance will be made for failure to use water at night during a regular run. If an irrigator turns the water from his place, it will be considered that the irrigator has completed his irrigation, and service may be discontinued for the current delivery unless cessation of use be due to an emergency and necessary.

RULE 6
IRRIGATION OF EXCESSIVELY HIGH GROUND

The District will not be required to raise water to an excessive height in canals or ditches in order to give service to lands or ditches of unreasonable elevation. Such unreasonable elevation to be determined by the particular conditions wherein such diversions would jeopardize the District ditches and which would interfere with water users service above and below said diversions.

RULE 7
USE OF DELIVERY GATES

Irrigators will receive water only through the delivery gates provided. If it is found that water is taken through cuts in the canal bank, or in any other manner than that provided by the District, the irrigator can be refused further water until all damage caused has been repaired or paid for.

RULE 8
CONTROL OF DIVERTING GATES

The control of all structures on the District's system is under the management of the District, and no water user is allowed to change or interfere with them except by permission, or in case of an emergency, to be reported at once to the District office.

RULE 9

USING WATER OUT OF TURN

Any person who uses water out of his turn and without permission of his ditchtender forfeits his right to water at the next regular irrigation and is also subject to criminal prosecution.

RULE 10

WASTE OF WATER

Persons wasting water on roads or vacant land, or land previously irrigated, either willfully, carelessly, or on account of defective ditches or inadequately prepared land or who shall flood certain portions of the land to an unreasonable depth or amount in order to properly irrigate other portions will be refused the use of water until such conditions are remedied.

RULE 11

ACCESS TO LAND

The authorized agents of the District shall have free access at all times to lands irrigated from the canal system for the purpose of examining the canals and ditches and the flow of the water therein.

RULE 12

WATER RECEIPTS

Any person to whom water is offered must sign a receipt therefor. If the water is used, the receipt must show upon what kind of crop it was used; and if not used, the receipt must specify the reason.

RULE 13
IN CASE OF BREAKS

When a break or a succession of breaks occur under any distributing section, the person to whom the water is last given while the break is being repaired, will be allowed to finish before the water is taken from him, and shall not claim another irrigation for that run.

RULE 14
PARTY DITCHES

Before water is furnished to any private distributing ditch the land owners receiving the water therefrom must agree upon and sign rules and regulations satisfactory to the Board of Directors, providing for the repair, maintenance, and distribution of water from such ditch, authorizing some one to represent the users in all conferences with the ditchtender, and providing for the apportionment of water, subject to all rules and regulations of the District.

RULE 15
PUMPING RULES

All users pumping water from the canals shall be governed in all respects by the rules and regulations applicable to users under gravity service. The District will not be held resopnsible for any debris which may accumulate in stream flow which may tend to decrease the full operative capacity of pumps or pipelines.

RULE 16
USE OF DISTRICT RIGHT OF WAY

No trees, vines, or alfalfa shall be planted on the right of way of any District canal and all such crops growing on such right of way shall belong absolutely to the District. Permission, however, may be granted by the Board of Directors, under such restriction as they may deem expedient, to raise annual crops thereon.

RULE 17

LIABILITY OF DISTRICT

The District will not be liable for any damage resulting directly or indirectly from any private ditch or the water flowing therein; but its responsibility shall absolutely cease when the water is turned therein according to these rules and regulations.

RULE 18

LIABILITY OF IRRIGATORS

Every consumer of water shall be responsible to the District for all damages caused by his wilful neglect or careless acts, and upon his failure to repair such damage after notification by the ditchtender, such repairs shall be made at his expense by the District.

RULE 19

LIABILITY OF PERSONS INTERFERING WITH THE REGULATIONS OF WATER OR TAKING WATER OUT OF TURN

Section 592 of the Penal Code of California is as follows:

"WATER-DITCHES, ETC., PENALTY FOR TRESPASS OR INTERFERENCE WITH. Every person who shall, without authority of the owner or managing agent, and with intent to defraud, take water from any canal, ditch, flume or reservoir used for the purpose of holding or conveying water for manufacturing, agricultural, mining, irrigating or generation of power, or domestic uses, or who shall without like authority, raise, lower or otherwise disturb any gate or other appartus thereof, used for the control or measurement of water, or who shall empty or place, or cause to be emptied or placed, into any such canal, ditch, flume or reservoir, any rubbish, filth or obstruction to the free flow of the water, is guilty of a misdemeanor."

Under such statute persons interfering with the regulation of water in the canals and ditches are subject to prosecution.

RULE 20

BUILDING DIVERTING GATES AND WEIRS

No openings shall be made or structures placed in any District canal without the special permission of the Superintendent. All structures in the District canals must be constructed according to requirements of the District, and must be maintained in a condition satisfactory to the Superintendent, and must not be changed without the permission of the Superintendent.

RULE 21

OBSTRUCTIONS ON RIGHT OF WAY

No fences or other obstruction shall be placed across or upon or along any canal bank or right of way belonging to the District without the special permission of the Board of Directors. Whenever such permission shall be granted it shall always be with the distinct understanding that proper openings or passage ways for equipment shall be provided, and that such fence or obstruction must be removed whenever requested by the Superintendent.

RULE 22
ENFORCEMENT OF RULES

Refusal to comply with the requirements hereof, or transgression of any of the foregoing rules and regulations, or any interference with the discharge of the duties of any official, shall be sufficient cause for shutting off the water, and water will not again be furnished until full compliance has been made with all requirements herein set forth.

Attachment G

The District does not have a Groundwater Banking Plan. For groundwater operations and plans please see Attachment F – Groundwater Management Plan

Attachment H

The District does not produce an annual potable water quality report as it does not supply any municipal surface water supplies.

Attachment I

The District supports the availability of on-farm irrigation and drainage system evaluations. This is accomplished by maintaining a list of irrigation educators and professionals that provide these services at the District office, as well as on the District Website under the "Grower Resources" tab, and can making the list available to farmers upon request.

Examples of these are:

Cal Poly ITRC

California Agricultural Technology Institute

California Farm Water Coalition

Fresno State Wateright

University of California (UC) Integrated Pest Management Program (IPM)

US Bureau of Reclamation California-Great Basin Watershare

Water Education Foundation

Agriculture Water Use Efficiency CDFA-DWR Grants

USDA Natural Resources Conservation Service (NRCS)

Attachment J

The District does not have a Water Order form. Water user orders are taken over the phone and documented in an order book.

Section 3

Attachment A

Attachment A

Legal Certification and Apportionment Required for Water Measurement – Lack of Legal Access to Farm-Gate

The Tulare Irrigation District (District) currently measures surface water flows within the District canal system at critical distribution points along with individual farm-gate turnouts. The District possesses various forms of easements, some in fee, to secure its canal system rights of way. Water deliveries to individual landowners are tracked on a volumetric basis and billed according to the amount of water used per month. Therefore, the District does not intend to provide aggregated farm-gate delivery values.

Documentation Requirement:

1. Certification for lack of legal access by the water supplier legal counsel (CCR §597.3(b(1)(A)).
   NOT APPLICABLE
   The District has access to all farm-gate turnouts to measure daily irrigation water usage.

2. Documentation on apportionment of volume of water delivered to customers (CCR §597.3(b(2)(C)).
   NOT APPLICABLE
   The District does not apportion water to landowners; however the District does track individual landowner consumption on a daily basis and charges landowners based upon an individual monthly volumetric rate of use.

Section 4

Attachment B

Attachment B

Engineer Certification and Apportionment Required for Water Measurement – Technically Infeasible

The Tulare Irrigation District (District) currently measures surface water irrigation supplies to landowners at the farm-gate turnout to each individual landowner. Each irrigation delivery to a landowner is measured through a flow measurement device that is utilized to bill the landowner for a volumetric rate of use on a monthly basis.

Documentation Requirement:

1. Engineer determination that accuracy standards of CCR §597.3(a) cannot be met at the farm-gate CCR §597.3(b)(1)(B) and CCR §597.3(b)(2)(B). NOT APPLICABLE
   The District currently measures each irrigation delivery at the individual landowner farm-gate turnout; therefore there is no need for the required engineering determination that said accuracy standards cannot be met.

2. Documentation on apportionment of volume of water delivered to customers as described above (Guidebook section 5.1 A.2) (CCR §597.3(b(2)(C)). NOT APPLICABLE
   The District does not deliver water on an apportionment basis, however the volumetric rate of usage by each individual landowner is determined through the daily measurement of flows through the individual farm-gate turnout.

Section 5

Attachment C

Attachment C

Description of Water Measurement Best Professional Practices

The Tulare Irrigation District (District) has historically measured irrigation deliveries to landowners at each individual farm-gate turnout and based the billings to landowners on the volume of water delivered. In order to accomplish this level of water measurement the District has utilized a system of water orders, delivery and billings that has been in place since about 1960.

District Background

The District serves surface water to approximately 68,000 irrigated acres through the utilization of approximately 300 miles of earthen canals and approximately 30 miles of pipeline. Water is delivered to landowners through approximately 622 farm-gate turnouts serving 207 customers. Each farm-gate turnout is equipped with a flow measurement device. The three main flow measurement devices utilized include:

- Meter Gate Installation (453 turnouts) (See Appendix B for a typical Meter Gate Installation)
- Propeller Meter Installation (166 turnouts)
- Mace Meter Doppler Flow Measurement (3 turnouts)

The District utilizes an established set of standards called the *Rules and Regulations Governing the Distribution of Water in the Tulare Irrigation District* to govern the request and delivery of irrigation water to landowners. The notable rules and regulations pertaining to water measurement are:

- Landowner must contact the District office or ditchtender three days before water is needed. The District makes all attempts to deliver the water within 24 hours.
- Landowners can only receive irrigation water through turnouts provided by the District.
- The District controls and maintains all structures including turnouts to deliver water to the landowner.
- District staff shall have free access at all times to irrigated lands to examine District canals and ditches and the overall flow of water therein.

The above rules assist the District in operating and maintaining an efficient water delivery and measurement system. Landowners are required to contact the District to order water ahead of their needs. The District logs and meets the requests for water deliveries based upon the order in which the request was taken. All water orders are taken by the District Watermaster, who in turn determines which order may be satisfied based on canal system flows and projected near-term changes there-to. Once these determinations have been made by the Watermaster, he relays the orders to the Ditchtenders who are able to coordinate the daily start times and stop times for turnouts. Ditchtenders open and shut farm-gate turnouts along with providing daily readings of flow metering devices. The District has implemented a digital flow logging system whereby each Ditchtender is given an electronic device that allows them to enter flow readings into an Apple iPod Touch (Data Collector) loaded with a custom application that interfaces with the District billing system. When the Ditchtender comes into the office for daily meetings the electronic devices are able to remotely upload information to the District water billing software, which is called STORM Water Accounting and Management Software. STORM tracks daily irrigation water usage by utilizing the readings taken from Ditchtenders and, on a monthly basis, generates an invoice for irrigation water specific to each landowner. Included in Appendix C is a typical monthly billing that is representative of what a landowner receives from the District.

Best Management Practices

Collection of Water Measurement Data

The District relies upon daily readings taken by Ditchtenders to record the necessary data required to determine volumetric water deliveries to landowners. Ditchtenders are required to record the beginning date and time and the stop date and time of each irrigation run at each individual farm-gate turnout. If a landowner must stop and restart his/her irrigation the Ditchtender must coordinate this with the landowner and record such data. By recording the start, stop and potential interruption dates and times, the Ditchtender is able to establish the run period (hours) that the landowner is utilizing water.

Depending on the type of water meter that is utilized at each farm-gate turnout the Ditchtender will also be required to record the daily measurement parameters. For each device the following is recorded:

- Meter Gate – Ditchtenders will start a landowner by opening his/her farm-gate turnout and note the "start" time and date on their Data Collector . The Ditchtender will not take a flow reading immediately, however will return 20-30 minutes later and take a "start" reading. The Ditchtender will record the head conditions upstream of the farm-gate turnout, downstream of the farm-gate turnout and the gate position and input these variables into the Data Collector. While the landowner is running, which averages approximately 4-5 days per irrigation, the Ditchtender will inspect the farm-gate turnout at minimum once a day and record the date, time, head upstream and downstream of the farm-gate turnout, and gate position in the Data Collector. When the irrigation has completed the Ditchtender is notified by the landowner or the Watermaster and the Ditchtender will close the farm-gate turnout and record the date and time in the Data Collector. All information that is collected is converted from input variables into the volumetric rate of use. Each day as the Ditchtender visits the office to attend meetings, held by the Watermaster, the information that is logged in the Data Collector is uploaded to a dedicated server in the District office that houses STORM.
- Propeller Meter - Ditchtenders will start a landowner by opening his/her farm-gate turnout gate and noting the "start" time and date on their Data Collector. The Ditchtender will also note the meter reading at the time of "start." The Ditchtender then inspects the farm-gate turnout and takes a date, time and meter reading once a day until the landowner has completed his/her irrigation. Once complete the Ditchtender closes the farm-gate turnout and records the stop time and date in the Data Collector. All information that is collected is converted from input variables into a volumetric rate of use. Each day as the Ditchtender attends office meetings, held by the Watermaster, the information that is logged in the Data Collector is uploaded to a dedicated server in the District office that houses STORM.
- Mace Meter - Ditchtenders will start a landowner by opening his/her turnout gate and noting the "start" time and date on their Data Collector. The Ditchtender will also note the meter reading at the time of "start." The Ditchtender then inspects the farm-gate turnout and takes a date, time and meter reading once a day until the landowner has completed his/her irrigation. Once complete the Ditchtender closes the farm-gate turnout and records the stop time and date in the Data Collector. All information that is collected is converted from input variables into a volumetric rate of use each day when the Ditchtender attends office meetings, held by the Watermaster, the information that is

logged in the Data Collector is uploaded to a dedicated server in the District office that houses STORM.

Frequency of Reading

The District has a long-established policy of reading canal levels, meter gates and flow meters once a day. The District employs 7 ditchtenders to control and monitor flows within its conveyance system and to deliver irrigation water to the previously-cited 535 farm-gate turnouts. Each Ditchtender manages a separate portion of the District's 67,000-acre service area called "irrigation runs."

The District has long-determined that its practice of daily instantaneous meter readings is adequate to capture volumetric deliveries over a 24-hour period. This information is brought to the daily Watermaster meetings and turnout measurement data is fed into STORM as previous described. Supporting this approach is a study conducted by the Irrigation Training & Research Center at the California Polytechnic State University, San Luis Obispo, which evaluated the accuracy impact of reading flow rates once per day versus more frequently. The report, which was titled SBx7 Flow Rate Measurement Compliance for Agricultural Irrigation Districts, found that for districts such as Tulare Irrigation District, which can operate to serve approximately 10 farm irrigation cycles per season, the estimate of annual volumetric error due to fluctuations in canal water levels is approximately +/- 0.5%. This represents a fairly small incremental error that could only be reduced by investing a great deal of money and time to increase the frequency of flow readings to more closely capture any fluctuations in the canal levels.

Method for Determining Irrigated Acres

The District has historically maintained a detailed crop survey that allows the District to determine the irrigated acreage in the District. Each year the District conducts two visual crop surveys throughout the District to identify crops that are being grown. District employees log each parcel and field within the District and regress the information into a database and map to reflect the acreages of each crop within the District. A sample of the information is provided as Appendix A.

Quality Control and Quality Assurance Plan

The District currently utilizes multiple levels of quality control and assurance measures to assure the reliability of data and calculations utilized to determine the volumetric rate of water delivered to a farmer is accurate. Measures implemented include:

- Ditchtenders are trained by the Watermaster prior to being deployed into the Water Department. Often an employee will shadow a veteran Ditchtender prior to being utilized as a full-time Ditchtender. The principles of water measurement along with the critical components required to take an accurate reading are reviewed with the employee prior to any duty as a Ditchtender.
- Readings that are taken by Ditchtenders in the field are entered into electronic recording devices and uploaded to the District water billing software called STORM. The District had historically utilized hand-written records that were delivered to the office and inputted into computers for billing purposes. The Data Collectors utilized today allow the District to minimize the potential for errors in interpreting hand-written notes and mistyped values in the computer system.
- Once the information is uploaded into STORM the Watermaster reviews the daily water deliveries to ensure conformity between what is being ordered by landowners and what is being delivered.
- Each month when bills are printed, another verification that water deliveries are in conformance with what is ordered and what is delivered is made before billings are sent out to landowners.
- The last level of quality assurance resides with the landowner, who can request that the District audit their billing to ensure that the appropriate amount of water is being delivered and billed.

Section 6

Attachment D

Attachment D

Documentation of Water Measurement Conversion to Volume

The District utilizes different methods for measuring volumetric flow rates delivered to landowners, therefore this document shall discuss each calculation of volumetric flow rate separately.

Meter Gate Measurements

A majority of the District turnouts are measured through a Meter Gate for flow measurement. A diagram of the method for measurement is provided in Appendix B. In taking this measurement, the gate opening is determined by measuring the height of the gate stem above the gate wheel and the change in hydraulic head across the meter gate is determined by measuring the height of water in the upstream stilling well and the downstream stilling well (collectively called the meter gate parameters). Meter gate parameters and the standard discharge rating tables are used to determine the instantaneous flow rate in cubic feet per second (CFS). The rating table included as Appendix D is a sample of the typical rating table that is utilized to determine the instantaneous flow rate.

Once the farm-gate turnout is opened the Ditchtender records the time and date of the "start" on a hand-held digital device (Apple Touch device that has a special application that works with the District billing system STORM). Measurements are taken every 24-hours and each reading that is taken by the Ditchtender records the date, time and meter gate parameters. When the farmer has completed with his/her irrigation the Ditchtender records the "stop" date and time.

The STORM billing system that the District utilizes takes the individual recordings and multiplies the instantaneous flow reading, which is in units of cubic feet per second, by the time period between readings and a conversion constant. The equation utilized is:

$$\text{Volume} = \text{flow} \times \text{time} \times 1.9837$$

Volume is in acre-feet/day

Flow is in cubic feet per second

Time is in hours

Propeller Meters / Mace Meters

A limited number of farm-gate turnouts within the District are equipped with Propeller Meters or Mace meters that utilize the flow across a propeller or sensor to calculate the flow and volumetric rate of water. Typically these meters will read in cubic feet per second on an instantaneous basis and totalize flow in acre-feet. On a limited number of meters the readout will have flow in gallons per minute and totalize in gallons. In these instances the District uses unit conversions to yield cubic feet per second and acre-feet. In order for the District to determine the volumetric rate delivered to farmers Ditchtenders will read the totalizing meter reading when the irrigation begins, in increments of 24-hours thereafter, and when the irrigation stops. The volumetric rate utilized to bill the landowner is:

$$\text{Volume} = \text{Start Meter Reading} - \text{Stop Meter Reading}$$

Section 7

Attachment E

Attachment E

Device Corrective Action Plan

The Tulare Irrigation District (District) has a long history of measuring individual farm-gate deliveries to each landowner and the utilization of volumetric billing rates to each landowner. The District has a contract with the United States Bureau of Reclamation for a water supply from the Friant Unit of the Central Valley Project and, as such, complies with the water delivery and measurement requirements as originally established in the Reclamation Reform Act of 1982 and its water management plan criteria. The District typically utilizes a meter gate installation to take readings on a daily basis. A meter gate allows the District to measure the upstream water level (head) conditions and the downstream water level conditions, and with the gate position the District can determine the instantaneous flow rate through the canal gate. A discussion of the methods used in determining the volumetric rate of deliveries can be found in Attachment C.

The District is aware of the the SB 7x-7 regulations and associated implementation timetable. However, given the very dry year combined with the delayed release of the Agricultural Water Measurement Regulations (Regulations) passed in July 2012, the District has been unable to perform the initial Accuracy Certification per the Regulations. Although the District has been unable the complete this feature the District is proposing to implement an Agricultural Water Measurement Master Plan (Master Plan), which will contain details on the initial certification of existing water measurement devices and any corrective actions that will need to be taken. The Master Plan will also contain a Schedule, Budget and Finance Plan to accomplish the tasks set forth in the Master Plan. The Master Plan is attached in Appendix E.

Section 8

District Crop Survey

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

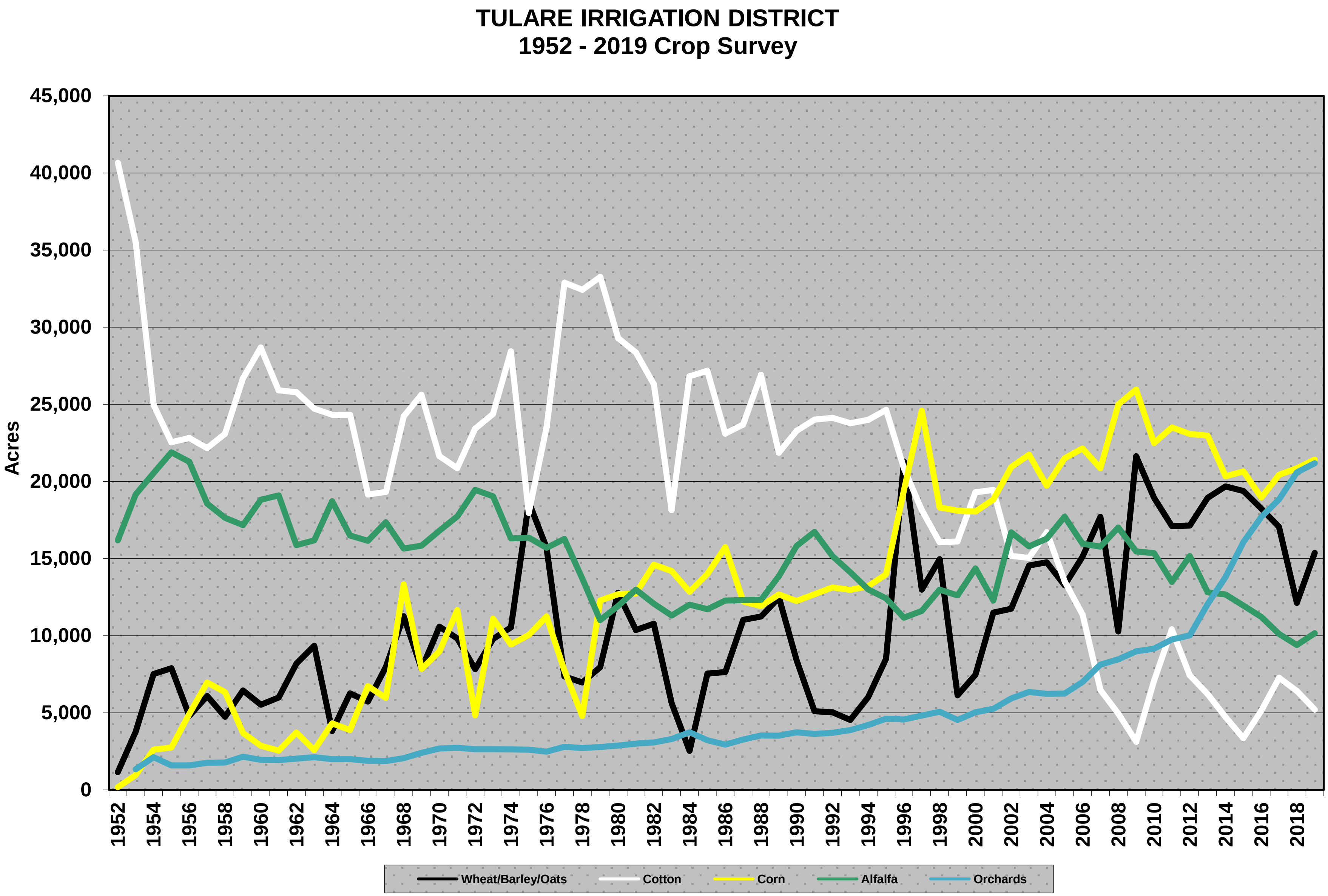
Crop	Acres	Price	Unit	Yield
Mixed Grasses	7			
Native Pasture	368			
Alfalfa	10,158			
Milo Maize				
Field Corn	5,664			
Wheat	15,158			
Oats	214			
Dry Beans	369			
Field Peas				
Pumpkins	20			
Radish	51			
Blue Berries	148			
Lettuce	20			
Cherries	325			
Olives	20			
Peaches				
Pears	10			
Prunes	12			
Persimmons	85			
Pomegranites	3			
Oranges	81			
Grapes	473			
	0			
	0			
Cotton	5,185			
Fallow	0			
Idle Crop Land	691			
Almonds	7,239			
Walnuts	5,076			
Pistachios	8,336			
Nursery	10			
Commercial	781			
Farmstead	3,308			
Wast & Misc.	307			
Residential	1,125			
Non-Ag Land	2,665			
Total	67,909	0	0	0

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Round)

Crop	Acres	Price	Unit	Yield
Sudan Grass				
Alfalfa				
Milo Maize	846			
Field Corn	15,758			
Dry Beans	48			
Pistachios				
Cotton	18			
Nursery	64			
2nd. Totals	16,734			


TULARE IRRIGATION DISTRICT
1952 - 2019 Crop Survey
Acres
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Wheat/Barley/Oats
Cotton
Corn
Alfalfa
Orchards

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 23 E.

Section

Crop	13	14	15	19	20	21	22	23	24	25	Total
Alfalfa	82			180	78	221			168	208	937
Field Corn	126	230	77					85	90		608
Wheat	40	44	78	498	246	300		266	67	48	1,587
Dry Beans											0
Tomatoes											0
Cotton	6					18		107	101	111	343
Idle Crop Land											0
Almonds										40	40
Walnuts										211	211
Pistachios	32				284		310		179		805
Comercial											0
Farmstead	6	35			18	2	156	157	9	2	385
Waste & Misc											0
Residential					3	11		1			15
Non-Ag Land	17	2		1	5	15	156	14	28		238
Section Totals	309	311	155	679	634	567	622	630	642	620	5169

Comments: 5169

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 23 E.

Section

Crop	26	27	28	29	30	31	32	33	34	35	Total
Native Pasture		9									9
Alfalfa	128	298	79	120	169			140	153	56	1,143
Field Corn	113		79	198		35			89	74	588
Wheat	106	122	393	160	152		304	40	65	40	1,382
Oats							104				104
Dry Beans	63										63
Cherries		15				40					55
Olives											0
Wine Grapes											0
Cotton	35							40		73	148
No Crop											0
Idle Crop Land	13										13
Almonds					167	330	80	314	223	215	1,329
Walnuts	43	70						76			189
Pistachios	63	72				246			79		460
Commercial								1			1
Farmstead	46	24	65	138		4	129	16			422
Wast & Misc.	2		3		6	1	6		1		19
Residential	3	11	2			3	1	5	11	6	42
Non-Ag Land	22	3			131	10	13	7	21	172	379
Section Totals	637	624	621	616	625	669	637	639	642	636	6346

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 23 E.

Section

Crop	36										Total
Alfalfa											0
Field Corn	78										78
Wheat	120										120
Dry Beans											0
Onions											0
Cotton	261										261
Almonds	74										74
Pistachios	72										72
Farmstead	18										18
Wast & Misc.	6										6
Residential	1										1
Section Totals	630	0	0	0	0	0	0	0	0	0	630

Comments: 630

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 24 E.

Section

Crop	13	14	15	16	17	18	19	20	21	22	Total
Alfalfa				125	328	138	299	383	198		1,471
Field Corn				217	227	206			158	44	852
Wheat	129	41		94	90	299	179	189	40	151	1,212
Dry Beans											0
Pumpkins	20										20
Cherries			38	20							58
Table Grapes										93	93
Cotton										57	57
Idle Crop Land										21	21
Almonds	94	156									250
Walnuts	20	108	57					39	238	204	666
Pistachios			96								96
Nursery											0
Commercial			25	3				1		3	32
Farmstead	20	4	2	23			138		1	1	189
Wast & Misc.			4	6			8	1		10	29
Residential	36	5	2			4	3	8	1	7	66
Non-Ag Land		5		28	5	7	29	28	9	51	162
Section Totals	319	319	224	516	650	654	656	649	645	642	5274

Comments:

5274

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 24 E.

Section

Crop	23	24	25	26	27	28	29	30	31	32	Total
Native Pasture		11			36		31		8	10	96
Alfalfa					54		93	196	234	146	723
Milo Maize											0
Field Corn	25		80		38						143
Wheat	406	64	138	322	18	67	133	331	109	140	1,728
Oats											0
Dry Beans											0
Bush Berries			9								9
Persimmons		22									22
Table Grapes		105			16						121
Wine Grapes											0
Cotton		36			65						101
Fallow											0
Idle Crop Land				25			76				101
Almonds		64				79			189	209	541
Walnuts	115	254	148	150	254	443	77	75		88	1,604
Pistachios	15			87		13	40		45		200
Nursery		10									10
Commercial			39	13	67	13					132
Farmstead	56	26	5	22		4	81	27	18	22	261
Wast & Misc.		1	8	1	6	1	6	1	4		28
Residential	11	16	13	3	11	12	19	2	1	12	100
Non-Ag Land	11	27	41	16	45	4	83	11	31	6	275

Section Totals	639	636	481	639	610	636	639	643	639	633	6195

Comments: 6195

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 24 E.

Section

Crop	33	34	35	36							Total
Native Pasture	36	80									116
Alfalfa											0
Field Corn	83										83
Wheat	39										39
Oats											0
Cherries	6										6
Cotton											0
Fallow											0
Idle Crop Land		38	139								177
Almonds	167	42									209
Walnuts	138	76	19								233
Pistachios	46	21									67
Nursery											0
Commercial		25	102								127
Farmstead	6	4	2								12
Wast & Misc.	4										4
Residential	50	33	2								85
Non-Ag Land	30	62	12								104
Section Totals	605	381	276	0	0	0	0	0	0	0	1262

Comments: 1262

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 19 S. Range: 25 E.

Section

Crop	17	18	19	20	29	30	31	32			Total
Mixed Grasses							7				7
Native Pasture		34				30	18				82
Alfalfa			79				225				304
Field Corn			79	38							117
Wheat				36		215	242				493
Oats			38								38
Cotton											0
Bush Berries								40			40
Olives			20								20
Plums											0
Pears					10						10
Prunes					12						12
Persimmons			49		14						63
Pomegranates						3					3
Oranges	7					74					81
Table Grapes			175					84			259
Raisin Grapes											0
Fallow											0
Idle Crop Land	9			5	20						34
Pecans											0
Walnuts	262	179	80	380	431	189	26				1,547
Pistachios											0
Nursery											0

Commercial		181	17	5	6	13					222
Farmstead	2		5	6		59	50				122
Wast & Misc.			1	5			7				13
Residential	15	42	39	6	4	20	4	2			132
Non-Ag Land	12	7	23	155	161	17	12	2			389
Section Totals	307	443	605	636	658	620	591	128	0	0	3988

Comments: 3,988

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	1	2	3	4	5	6	7	8	9	10	Total
Native Pasture				10							10
Alfalfa		29	118	41	301	90	70		185		834
Field Corn	80	30			350				100		560
Wheat		97	89			240	229	121	310	25	1,111
Oats											0
Dry Beans											0
Cauliflower											0
Lettuce											0
Onions											0
Cherries						40				7	47
Cotton	311	140						80			531
Idle Crop Land			22								22
Almonds	246	231	310	471				213			1,471
Pistachios		114	97	71		120	338	180		341	1,261
Commercial									21	15	36
Farmstead	8	10	26	53	8		24	42	18	63	252
Wast & Misc.			2	19			5			1	27
Residential	7	9	5					9	9	62	101
Non-Ag Land	14	13	8	2	9	194	20	5	6	150	421
Section Totals	666	673	677	667	668	684	686	650	649	664	6684

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	11	12	13	14	15	16	17	18	19	20	Total
Native Pasture											0
Alfalfa		20	39			80				305	444
Milo Maize											0
Field Corn		130	101								231
Wheat	123	247		81		145	336	528	559	282	2,301
Dry Beans											0
Onions											0
Cherries			115		6						121
Cotton			154	160			116				430
Idle Crop Land											0
Almonds	153		38	309	58	193					751
Walnuts			59								59
Pistachios	337	105	107	80	552	112	152	65			1,510
Commercial			13			74					87
Farmstead	17	114	6	15	16	2		59	77	35	341
Wast & Misc.	3					15			10		28
Residential	6	8	5	2	3	2	13		2	2	43
Non-Ag Land	10	18	1	5	16	17	19	9	17	2	114
Section Totals	649	642	638	652	651	640	636	661	665	626	6460

Comments: 6460

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	21	22	23	24	25	26	27	28	29	30	Total
Native Pasture						14					14
Alfalfa	52	125	94		90		197	141	17	232	948
Field Corn	40	40	12	86		166	28				372
Wheat	151		91	144	115		30	134	200	323	1,188
Oats									35		35
Dry Beans				93	58						151
Lettuce				20							20
Cherries		28									28
Cotton	75	116	86	148	198	111					734
Idle Crop Land						3					3
Almonds	148	115	152				201	152	283		1,051
Walnuts											0
Pistachios	153	189	178	86		313	139	152		39	1,249
Farmstead	10	10	10	34	3	11	19	22	71	52	242
Wast & Misc.				6	1	9	1	9		4	30
Residential	7	8	13	6	4	5	2	12	1	3	61
Non-Ag Land	8	8	8	19	14	6	11	15	15	6	110
Section Totals	644	639	644	642	483	638	628	637	622	659	6236

Comments: 6236

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	31	32	33	34							Total
Native Pasture											0
Alfalfa	51	157	307	80							595
Milo Maize											0
Field Corn	51	135	155	140							481
Wheat	234	122	121	257							521
Cotton				119							119
Lettuce											0
Idle Crop Land											0
Almonds	55										55
Pistachios	236	50	29								315
Farmstead	16	98	7	4							125
Wast & Misc.		12	3	3							18
Residential	8	22	1	2							33
Non-Ag Land	7	20	12	21							60
Section Totals	658	616	635	626	0	0	0	0	0	0	2322

Comments: 2322

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 24 E.

Section

Crop	1	2	3	4	5	6	7	8	9	12	Total
Native Pasture					33						33
Alfalfa					80	80	75				235
Field Corn						114	235				349
Wheat					68	77	80	63			288
Dry Beans								55			55
Cotton				92				223			315
Idle Crop Land					6						6
Almonds				53	111			155	128		447
Walnuts					200	153					353
Pistachios					54	208	228	78	12		580
Nursery											0
Commercial						5	15	12	4		36
Farmstead					41	14	34	15	6		110
Wast & Misc.					7	1		1			9
Residential				11	33	8	5	7	64		128
Non-Ag Land				12	20	22	11	27	7		99
Section Totals	0	0	0	168	653	682	683	636	221	0	3043

Comments: 3043

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 24 E.

Section

Crop	13	14	15	16	17	18	19	20	21	22	Total
Native Pasture			8								8
Alfalfa					206	113	89				408
Field Corn					76	176		101			353
Wheat		141	109			251	425			45	971
Oats			37								37
Dry Beans					38	62					100
Cherries				10							10
Raisin Grapes											0
Cotton			156	190	121	45		131		55	698
Idle Crop Land		6		4						85	95
Almonds			69	80	38					182	369
Pistachios				31	123		35	73	56	151	469
Commercial		6	3		8					14	31
Farmstead					4	8	104		6	2	124
Wast & Misc.		1				1	2				4
Residential			9	4	3	6	7	6	7	80	122
Non-Ag Land		1			21	20	30	11	1	10	94
Section Totals	0	155	391	319	638	682	692	322	70	624	3893

Comments: 3893

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 24 E.

Section

Crop	23	26	27	28	29	30	32	33	34		Total
Alfalfa			7	147	160	92		69			475
Field Corn			182	237		82		73			574
Wheat			31		188	89			37		345
Dry Beans											0
Radish					51						51
Cotton	51	362	180	157	239	134		8	73		1,204
Idle Crop Land	196										196
Almonds			42			30	342		40		454
Walnuts			122	76							198
Pistachios						60	186	131	79		456
Commercial	33										33
Farmstead	18	14	16	5		34		8	5		100
Wast & Misc.	5	1			2		6	2	5		21
Residential	50		28						3		81
Non-Ag Land	27	6	34	4	2		3	3			79
Section Totals	380	383	642	626	642	521	537	294	242	0	4267

Comments: 4267

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 20 S. Range: 25 E.

Section

Crop	6	7	18								Total
Field Corn											0
Wheat											0
Oats											0
Bush Berries	99										99
Strawberries											0
Peaches											0
Plums											0
Table Grapes											0
Cotton			116								116
Idle Crop Land			7								7
Almonds	40										40
Walnuts			16								16
Commercial			39								39
Farmstead			5								5
Wast & Misc.	5		2								7
Residential	65		2								67
Non-Ag Land	4		4								8
Section Totals	213	0	191	0	0	0	0	0	0	0	404

Comments: 404

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 21 S. Range: 23 E.

Section

Crop	3	4	5	6	7	8	9	10	17	18	Total
Native Pasture											0
Alfalfa	118	420			99	235	341	150		238	1,601
Field Corn	60	35				78		102			275
Wheat	337	158	86	87	194	281	190	368	131		1,832
Pomegranates											0
Lettuce											0
Cotton			56								56
Fallow											0
Idle Crop Land			27	2							29
Almonds							81				81
Pistachios	89		360	308		39					796
Commercial			5								5
Farmstead	12	14	54	39	149	6	26				300
Wast & Misc.			17	2	25	3	1		16		64
Residential	4	2	27	2		1	1	1			38
Non-Ag Land	6	5	4	32	50	6	10	20			133
Section Totals	626	634	636	472	517	649	650	641	147	238	5210

Comments: 5210

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (1st Rnd)

Township: 21 S. Range: 24 E.

Section

Crop	3	4	9								Total
Alfalfa			40								40
Field Corn											0
Wheat			40								40
Cotton	72										72
Almonds	77										77
Farmstead											0
Wast & Misc.											0
Residential	10										10
Non-Ag Land											0
Section Totals	159	0	80	0	0	0	0	0	0	0	239

Comments: 239

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 23 E.

Section

Crop	13	14	15	19	20	21	22	23	24	25	Total
Milo Maize					170						170
Field Corn	40	44	78	498	76	300		266	67	127	1,496
Dry Beans											0
Section Totals	40	44	78	498	246	300	0	266	67	127	1666

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 23 E.

Section

Crop	26	27	28	29	30	31	32	33	34	35	Total
Milo Maize											0
Field Corn	217	181	393	160	152		408	40	113	40	1,704
Cotton								18			18
Section Totals	217	181	393	160	152	0	408	58	113	40	1722

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 23 E.

Section

Crop	36										Total
cotton											0
Field Corn	40										40
Section Totals	40	0	0	0	0	0	0	0	0	0	40

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 24 E.

Section

Crop	13	14	15	16	17	18	19	20	21	22	Total
Alfalfa											0
Milo Maize											0
Field Corn	129	41		94	90	299	275	189	40	151	1,308
Dry Beans											0
Walnuts											0
Section Totals	129	41	0	94	90	299	275	189	40	151	1308

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 24 E.

Section

Crop	23	24	25	26	27	28	29	30	31	32	Total
Alfalfa											
Sudan Grass											
Milo Maize				39	56						95
Field Corn	406		138	263			133	331	109	140	1,520
Dry Beans											
Cotton											
Nursery		64									
Section Totals	406	64	138	302	56	0	133	331	109	140	1679

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 24 E.

Section

Crop	33	34	35	36							Total
Milo Maize											
Field Corn	39										
Section Totals	39	0	0	0	0	0	0	0	0	0	39

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 19 S. Range: 25 E.

Section

Crop	17	18	19	20	29	30	31	32			Total
Alfalfa											
Milo Maize											
Field Corn				36		215	242				493
Section Totals	0	0	0	36	0	215	242	0	0	0	493

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	1	2	3	4	5	6	7	8	9	10	Total
Sudan Grass											
Alfalfa											
Mialo Maize						40					40
Field Corn		97	89		350	200	229	121	258	25	1,369
Dry Beans											
Cotton											
Almonds											
Section Totals	0	97	89	0	350	240	229	121	258	25	1409

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	11	12	13	14	15	16	17	18	19	20	Total
Sudan Grass											
Alfalfa											
Milo Maize											
Field Corn	123	199		81		145	336	528	559	282	2,253
Dry Beans		48									48
Cotton											
Almonds											
Section Totals	123	247	0	81	0	145	336	528	559	282	2301

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	21	22	23	24	25	26	27	28	29	30	Total
Alfalfa											
Milo Maize										230	230
Field Corn	151		91	144	115		58	134	235	323	1,251
Dry Beans											
Cotton											
Section Totals	151	0	91	144	115	0	58	134	235	553	1481

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 23 E.

Section

Crop	31	32	33	34							Total
Alfalfa											0
Milo Maize				140							140
Field Corn	234	122	121	257							734
Dry Beans											0
Cotton											0
Section Totals	234	122	121	397	0	0	0	0	0	0	874

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 24 E.

Section

Crop	1	2	3	4	5	6	7	8	9	12	Total
Sudan Grass											
Alfalfa											
Milo Maize											
Field Corn					68	77	155	63			363
Bry Beans											
Cotton											
Section Totals	0	0	0	0	68	77	155	63	0	0	363

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 24 E.

Section

Crop	13	14	15	16	17	18	19	20	21	22	Total
Sudan Grass											
Milo Maize		141	30								171
Field Corn			79			251	425			45	800
Dry Beans											
Cotton											
Section Totals	0	141	109	0	0	251	425	0	0	45	971

Comments:

2019 Crop Survey Report

Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 24 E.

Section

Crop	23	26	27	28	29	30	32	33	34		Total
Milo Maize											0
Field Corn			31		239	89			37		396
Dry Beans											0
Cotton											0
Section Totals	0	0	31	0	239	89	0	0	37	0	396

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 20 S. Range: 25 E.

Section

Crop	6	7	18								Total
Alfalfa											
Field Corn											
Cotton											
Section Totals	0	0	0	0	0	0	0	0	0	0	0

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 21 S. Range: 23 E.

Section

Crop	3	4	5	6	7	8	9	10	17	18	Total
Alfalfa	67										
Milo Maize											
Field Corn	270	281	86	87	194	281	190	368	131		1,888
Cotton											
Section Totals	337	281	86	87	194	281	190	368	131	0	1955

Comments:

2019 Crop Survey Report
Form One, Acreage
Field Statistics

DISTRICT: Tulare Irrigation District (2nd Rnd)

Township: 21 S. Range: 24 E.

Section

Crop	3	4	9								Total
Field Corn			40								40
Section Totals	0	0	40	0	0	0	0	0	0	0	40

Comments:

Section 9

Typical Meter Gate Installation

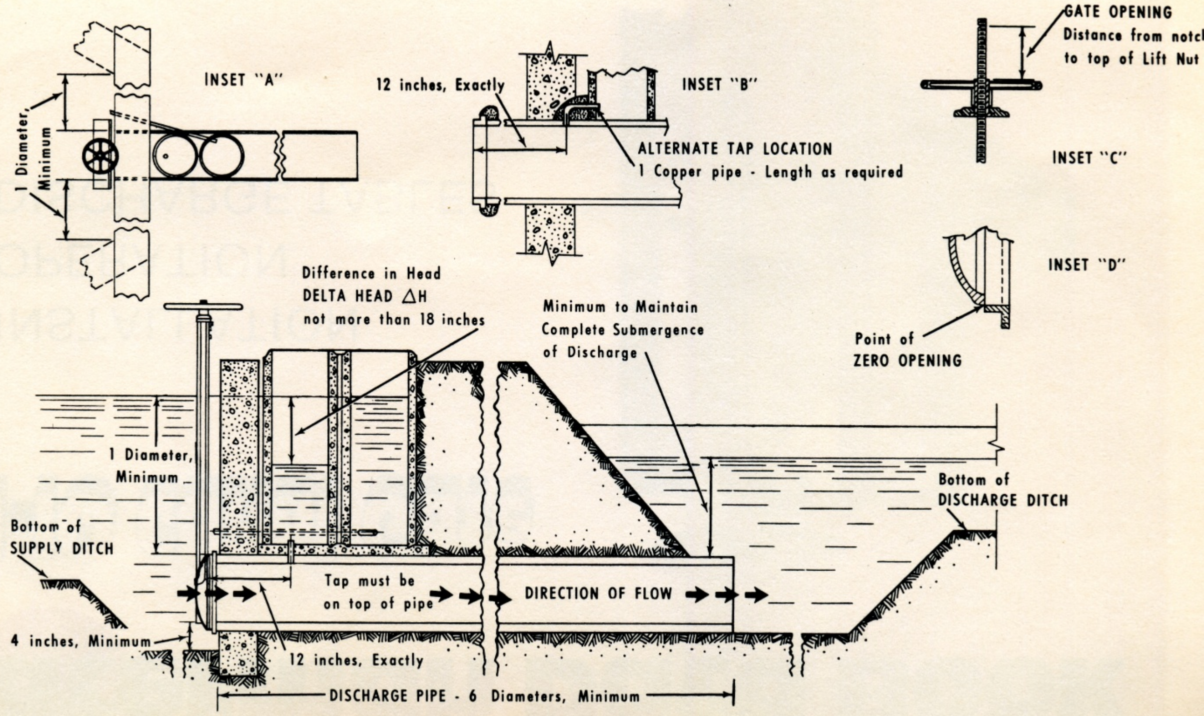


Figure 1. Installation Diagram

INSTALLATION. (See figure 1.)

MEASUREMENTS AND CONDITIONS. Install WATERMAN MODEL CM-10 CANAL GATE as diagramed in figure 1. Calibrations in this book have been made to these measurements and conditions, and any variation in the installation must be considered in the use of the calibrations. Standard settings and dimensions have been maintained to permit the immediate interchangeability with systems already in operation.

FIRST TAP. The tap to the first well, usually 3/4-inch diameter brass pipe, must be located exactly 12 inches from the face of the gate seat, and must be on the top centerline of the pipe. On corrugated metal pipe, the tap must be on the outside diameter of the crown, protrude to the average diameter, and be finished off smoothly on a horizontal plane with filler cement. Where the headwall thickness is 12 inches or greater, or where other conditions make a direct connection impracticable, the tap may be connected by a smooth bend as shown in Inset B.

SECOND TAP. The tap to the upstream stilling well can be made by normal plumbing practice. To facilitate measurements the taps of the metering wells should be level and the same height.

MINIMUM DISTANCES. Maintain the minimum distances as shown. Obstructions, such as log or trash stops, should not be placed immediately in front of the gate opening.

DISCHARGE PIPE. The discharge pipe should not be less than six diameters in length.

WATER LEVEL. Both inlet and outlet ends of the pipe must be submerged at all times. A minimum submergence of 12 inches is recommended. This may be insured on the outlet end by using a 90° elbow set with its discharge end straight up.

GATE OPENING. After the gate has been installed, raise the gate to the point of "zero opening", as shown in Inset C. At this point, file a notch in the gate stem to mark the top of the gate nut. Thereafter the gate opening can always be determined by measuring the distance from this notch to the top of the gate nut. (See figure 2.)

Section 10

Sample Water Bill

TULARE IRRIGATION DISTRICT
PO Box 1920
TULARE, CA 93275-1920
(559) 686-3425

STATEMENT

Billing Month:	June
Statement Period:	6/1/11 - 6/30/11
Beginning Balance:	$12,176.50
Current Charges:	$21,849.75
Account No.:	
Page:	1 of 2

Bill To:

Amount Due: $ 21,849.75
Remit Stub with Total Amount Due

Current charges due 5/31/2012. 1% interest applies to unpaid balances after due date.

IMPORTANT NOTICE
Any Water Sales and Sales of Service accounts with an upaid balance as of October 2011, will be added to the firs installment of the landowners' 2012 Assessment.

If you have any questions or comments, contact our office (559) 686-3425.

Date	**Description**				**Amount**
6/1/2011	**Beginning Balance**				**$12,176.50**
6/21/11	**water payment**				**($12,176.50)**
6/30/11	**June Water Deliveries**				
Turnout	**Start Date**	**Ending Date**	**AcFt**	**Rate**	
0314-11	6/19/2011	6/26/2011	65.30	$25.00	$1,632.50
0314-6	6/19/2011	6/26/2011	39.90	$25.00	$997.50
0315-19	6/16/2011	6/29/2011	92.20	$25.00	$2,305.00
0315-3	6/17/2011	6/30/2011	143.60	$25.00	$3,590.00
0316-5	6/13/2011	6/19/2011	40.80	$25.00	$1,020.00
032-11	6/12/2011	6/16/2011	22.30		
	6/26/2011	6/29/2011	17.60		
			39.90	$27.50	$1,097.25
0321-7	6/14/2011	6/29/2011	147.30	$25.00	$3,682.50
0327-28	6/17/2011	6/21/2011	53.10	$25.00	$1,327.50
048-22	6/7/2011	6/9/2011	14.40		
	6/21/2011	6/25/2011	30.10		
			44.50	$25.00	$1,112.50
049-49	6/13/2011	6/22/2011	74.20	$25.00	$1,855.00
9413-11	6/29/2011	6/30/2011	15.90	$25.00	$397.50
9414-2	6/28/2011	6/30/2011	27.80	$25.00	$695.00
9414-35	6/27/2011	6/30/2011	20.90	$25.00	$522.50
9414-36	6/27/2011	6/30/2011	57.50	$25.00	$1,437.50
9426-10	6/28/2011	6/30/2011	7.10	$25.00	$177.50
					$21,849.75

Section 11

Typical Meter Gate Chart

TABLE III DISCHARGE DATA 12" ARMCO METERGATE MODEL NO. 101

Head in Inches	Net Gate Opening in Inches														
	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	7	8	9	10	11	12
	Discharge in Cubic Feet per Second														
1	0.36	0.46	0.53	0.60	0.67	0.74	0.80	0.86	0.93	1.06	1.16	1.27	1.35	1.38	1.40
1 1/4	0.40	0.51	0.58	0.67	0.74	0.82	0.89	0.95	1.03	1.17	1.29	1.41	1.50	1.55	1.57
1 1/2	0.44	0.55	0.63	0.73	0.81	0.89	0.97	1.04	1.12	1.28	1.41	1.54	1.64	1.70	1.73
1 3/4	0.47	0.59	0.68	0.78	0.87	0.95	1.04	1.12	1.21	1.38	1.52	1.66	1.77	1.83	1.86
2	0.50	0.63	0.73	0.83	0.93	1.01	1.10	1.19	1.29	1.47	1.62	1.77	1.89	1.96	1.99
2 1/4	0.53	0.67	0.78	0.88	0.98	1.07	1.16	1.26	1.36	1.55	1.71	1.87	2.00	2.08	2.12
2 1/2	0.56	0.70	0.82	0.92	1.03	1.13	1.22	1.32	1.43	1.63	1.80	1.97	2.11	2.20	2.23
2 3/4	0.59	0.73	0.85	0.96	1.08	1.18	1.28	1.38	1.49	1.70	1.88	2.06	2.21	2.31	2.34
3	0.61	0.76	0.88	1.00	1.12	1.23	1.34	1.44	1.55	1.77	1.96	2.14	2.31	2.41	2.45
3 1/4	0.63	0.79	0.91	1.04	1.16	1.28	1.39	1.50	1.61	1.84	2.04	2.22	2.40	2.50	2.55
3 1/2	0.65	0.82	0.94	1.08	1.20	1.33	1.44	1.56	1.67	1.91	2.12	2.30	2.49	2.59	2.65
3 3/4	0.67	0.84	0.97	1.11	1.23	1.38	1.49	1.61	1.73	1.98	2.19	2.38	2.57	2.68	2.74
4	0.69	0.86	1.00	1.14	1.27	1.42	1.54	1.66	1.79	2.04	2.26	2.46	2.65	2.77	2.83
4 1/4	0.71	0.89	1.03	1.17	1.31	1.46	1.59	1.71	1.85	2.10	2.33	2.54	2.73	2.86	2.92
4 1/2	0.73	0.92	1.06	1.20	1.35	1.50	1.64	1.76	1.90	2.16	2.40	2.62	2.81	2.94	3.01
4 3/4	0.75	0.94	1.09	1.23	1.39	1.54	1.68	1.81	1.95	2.22	2.47	2.69	2.89	3.02	3.10
5	0.77	0.96	1.12	1.26	1.42	1.58	1.72	1.86	2.00	2.28	2.54	2.76	2.96	3.10	3.19
5 1/2	0.80	1.00	1.17	1.32	1.49	1.66	1.80	1.95	2.10	2.39	2.66	2.89	3.10	3.24	3.34
6	0.83	1.04	1.22	1.38	1.56	1.73	1.88	2.04	2.19	2.50	2.78	3.02	3.24	3.38	3.48
6 1/2	0.86	1.08	1.27	1.44	1.62	1.80	1.96	2.12	2.28	2.60	2.89	3.14	3.37	3.52	3.62
7	0.89	1.12	1.31	1.49	1.68	1.87	2.04	2.20	2.36	2.70	3.00	3.26	3.50	3.65	3.76
7 1/2	0.92	1.16	1.35	1.54	1.74	1.93	2.11	2.28	2.44	2.79	3.10	3.38	3.62	3.78	3.89
8	0.95	1.20	1.39	1.59	1.80	1.99	2.18	2.35	2.52	2.88	3.20	3.49	3.74	3.90	4.02
8 1/2	0.98	1.24	1.43	1.64	1.86	2.05	2.25	2.42	2.60	2.97	3.30	3.60	3.85	4.02	4.14
9	1.01	1.27	1.47	1.69	1.91	2.11	2.31	2.49	2.68	3.06	3.40	3.70	3.96	4.14	4.26
9 1/2	1.04	1.30	1.51	1.74	1.96	2.17	2.37	2.56	2.75	3.14	3.50	3.80	4.07	4.25	4.38
10	1.07	1.33	1.55	1.79	2.01	2.23	2.43	2.63	2.82	3.22	3.59	3.90	4.18	4.36	4.49
11	1.12	1.39	1.63	1.87	2.11	2.34	2.55	2.76	2.96	3.38	3.76	4.09	4.38	4.57	4.70
12	1.17	1.45	1.70	1.95	2.21	2.44	2.67	2.88	3.10	3.53	3.93	4.27	4.58	4.78	4.92
13	1.22	1.51	1.77	2.03	2.30	2.54	2.78	3.00	3.22	3.68	4.09	4.45	4.77	4.98	5.12
14	1.27	1.57	1.84	2.11	2.38	2.64	2.88	3.11	3.34	3.81	4.24	4.61	4.95	5.17	5.31
15	1.32	1.62	1.90	2.19	2.46	2.73	2.98	3.22	3.46	3.94	4.39	4.77	5.12	5.35	5.49
16	1.36	1.67	1.96	2.26	2.54	2.82	3.08	3.33	3.57	4.07	4.53	4.93	5.29	5.52	5.67
17	1.40	1.72	2.02	2.33	2.62	2.91	3.17	3.43	3.68	4.20	4.67	5.08	5.45	5.69	5.85
18	1.44	1.77	2.08	2.39	2.70	2.99	3.26	3.53	3.79	4.33	4.81	5.23	5.61	5.85	6.02

Section 12

Agricultural Water Measurement Master Plan

Tulare Irrigation District

SB 7x-7

Agricultural Water Measurement Master Plan

(Updated December 2015)

Tulare Irrigation District Background

The Tulare Irrigation District (District) was organized on September 21, 1889 as one of the very early irrigation districts in California. For several decades the District operated to deliver surface water supplies from its Kaweah River water rights to landowners and farmers within the District. In 1950 the District signed a contract with the United States Bureau of Reclamation for 30,000 acre-feet of Class 1 and 141,000 of Class 2 water from the Friant Unit of the Central Valley Project. The District averages approximately 180,000 acre-feet of surface water diversions to District landowners in their requirement to meet irrigation demand on approximately 67,202 acres of irrigated agriculture. The District serves approximately 230 family farms with irrigation water.

To meet the irrigation demands of landowners, the District utilizes approximately 300 miles of earthen canals and approximately 30 miles of pipelines. The District also operates approximately 1,250 acres of groundwater recharge basins. Each landowner within the District receives surface water from the District through an individual farm-gate turnout. The District equips each farm-gate turnout with a Meter Gate, which allows the District to measure the instantaneous flow through each farm-gate turnout, which is utilized to determine the volumetric rate of use and bill based upon the volume of water used.

Water Measurement Background

The District utilizes a network of canals and pipelines to deliver water to each landowner within the District. Along each canal or pipeline are farm-gate turnouts that include a canal gate (referred to in this plan as a Meter Gate), which allows the District to control the delivery of irrigation water and measure the instantaneous rate of delivery to each parcel. When landowners request delivery of irrigation water the District Watermaster determines when the landowner can begin his/her irrigation based upon the supply and demand of surface water and the capacity of the canal system. Once the Watermaster has determined the start time for the landowner an order is placed with the Ditchtender that monitors the area where the landowner requested irrigation service. The Ditchtender then coordinates with the landowner and the Meter Gate is opened. The date, time and flow is recorded when the irrigation begins. The Ditchtender will then return approximately every 24-hours to take another flow reading at the Meter Gate, and again the date, time and flow are recorded. The Ditchtender will continue to return to the turnout and read the Meter Gate until the landowner indicates that they have completed their irrigation, at which time the Meter Gate is closed and the date and time is recorded.

All information that is taken is recorded on hand-held devices, which is an Apple iPod Touch that has a custom application that is integrated with the District billing software, STORM Water Accounting and Management Software (Billing Software). The information that is collected in the field by Ditchtenders is brought back to the office and uploaded to the Billing Software which calculates the volumetric water use by multiplying the flow rate by the time between readings. Landowners are then billed on a monthly basis for volumetric water usage.

Meter Gate Operation

The District currently utilizes 535 irrigation farm-gate turnouts to deliver water to District landowners. Each of these turnouts includes a typical Meter Gate (ARMCO gate or Waterman C-10 canal gate). A limited number of turnouts are utilized in concert with a low-head lift pump, which pumps water from the canal onto a landowner's field. In many of these circumstances the landowners have installed a propeller meter downstream of the pump to measure instantaneous flow and totalize the amount of water used (in gallons or acre-feet). The majority of Meter Gates used by the District do not have a downstream measuring device and include an upstream and downstream head pressure measurement to calculate the flow through the Meter Gate. Please reference Figure 1 for a typical Meter Gate Installation.

The Meter Gates installed in the District are at the upstream end of a smooth concrete, PVC or corrugated metal pipeline. Stilling wells are installed such that an upstream head (h_1) and downstream head (h_2) can be determined. The difference between the two readings is considered the effective operating head across the gate (often referenced as $\triangle h$). The position of the gate is also determined by measuring the amount of gate stem that is above the gate hand wheel (minus the zero gate position, which is field marked on the stem of the gate). Discharge or flow (cubic feet per second, cfs) is then obtained by utilizing a rating table that has been determined for each size and style of gate. See Figure 2 for a sample ARMCO Gate Discharge Table that is used to determine flow through a Meter Gates that are installed within the District.

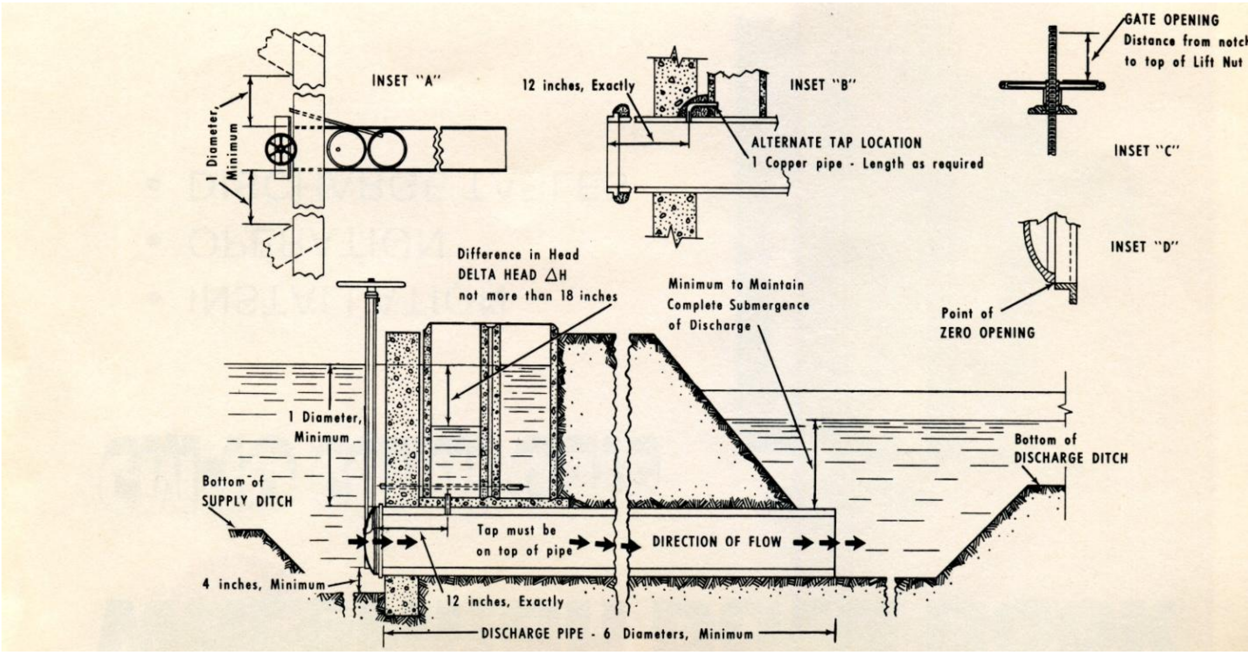


Figure 1. Typical Tulare Irrigation District Meter Gate Installation

TABLE III DISCHARGE DATA 12" ARMCO METERGATE MODEL NO. 101

Head in Inches	Net Gate Opening in Inches														
	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	7	8	9	10	11	12
	Discharge in Cubic Feet per Second														
1	0.36	0.46	0.53	0.60	0.67	0.74	0.80	0.86	0.93	1.06	1.16	1.27	1.35	1.38	1.40
1 1/4	0.40	0.51	0.58	0.67	0.74	0.82	0.89	0.95	1.03	1.17	1.29	1.41	1.50	1.55	1.57
1 1/2	0.44	0.55	0.63	0.73	0.81	0.89	0.97	1.04	1.12	1.28	1.41	1.54	1.64	1.70	1.73
1 3/4	0.47	0.59	0.68	0.78	0.87	0.95	1.04	1.12	1.21	1.38	1.52	1.66	1.77	1.83	1.86
2	0.50	0.63	0.73	0.83	0.93	1.01	1.10	1.19	1.29	1.47	1.62	1.77	1.89	1.96	1.99
2 1/4	0.53	0.67	0.78	0.88	0.98	1.07	1.16	1.26	1.36	1.55	1.71	1.87	2.00	2.08	2.12
2 1/2	0.56	0.70	0.82	0.92	1.03	1.13	1.22	1.32	1.43	1.63	1.80	1.97	2.11	2.20	2.23
2 3/4	0.59	0.73	0.85	0.96	1.08	1.18	1.28	1.38	1.49	1.70	1.88	2.06	2.21	2.31	2.34
3	0.61	0.76	0.88	1.00	1.12	1.23	1.34	1.44	1.55	1.77	1.96	2.14	2.31	2.41	2.45
3 1/4	0.63	0.79	0.91	1.04	1.16	1.28	1.39	1.50	1.61	1.84	2.04	2.22	2.40	2.50	2.55
3 1/2	0.65	0.82	0.94	1.08	1.20	1.33	1.44	1.56	1.67	1.91	2.12	2.30	2.49	2.59	2.65
3 3/4	0.67	0.84	0.97	1.11	1.23	1.38	1.49	1.61	1.73	1.98	2.19	2.38	2.57	2.68	2.74
4	0.69	0.86	1.00	1.14	1.27	1.42	1.54	1.66	1.79	2.04	2.26	2.46	2.65	2.77	2.83
4 1/4	0.71	0.89	1.03	1.17	1.31	1.46	1.59	1.71	1.85	2.10	2.33	2.54	2.73	2.86	2.92
4 1/2	0.73	0.92	1.06	1.20	1.35	1.50	1.64	1.76	1.90	2.16	2.40	2.62	2.81	2.94	3.01
4 3/4	0.75	0.94	1.09	1.23	1.39	1.54	1.68	1.81	1.95	2.22	2.47	2.69	2.89	3.02	3.10
5	0.77	0.96	1.12	1.26	1.42	1.58	1.72	1.86	2.00	2.28	2.54	2.76	2.96	3.10	3.19
5 1/2	0.80	1.00	1.17	1.32	1.49	1.66	1.80	1.95	2.10	2.39	2.66	2.89	3.10	3.24	3.34
6	0.83	1.04	1.22	1.38	1.56	1.73	1.88	2.04	2.19	2.50	2.78	3.02	3.24	3.38	3.48
6 1/2	0.86	1.08	1.27	1.44	1.62	1.80	1.96	2.12	2.28	2.60	2.89	3.14	3.37	3.52	3.62
7	0.89	1.12	1.31	1.49	1.68	1.87	2.04	2.20	2.36	2.70	3.00	3.26	3.50	3.65	3.76
7 1/2	0.92	1.16	1.35	1.54	1.74	1.93	2.11	2.28	2.44	2.79	3.10	3.38	3.62	3.78	3.89
8	0.95	1.20	1.39	1.59	1.80	1.99	2.18	2.35	2.52	2.88	3.20	3.49	3.74	3.90	4.02
8 1/2	0.98	1.24	1.43	1.64	1.86	2.05	2.25	2.42	2.60	2.97	3.30	3.60	3.85	4.02	4.14
9	1.01	1.27	1.47	1.69	1.91	2.11	2.31	2.49	2.68	3.06	3.40	3.70	3.96	4.14	4.26
9 1/2	1.04	1.30	1.51	1.74	1.96	2.17	2.37	2.56	2.75	3.14	3.50	3.80	4.07	4.25	4.38
10	1.07	1.33	1.55	1.79	2.01	2.23	2.43	2.63	2.82	3.22	3.59	3.90	4.18	4.36	4.49
11	1.12	1.39	1.63	1.87	2.11	2.34	2.55	2.76	2.96	3.38	3.76	4.09	4.38	4.57	4.70
12	1.17	1.45	1.70	1.95	2.21	2.44	2.67	2.88	3.10	3.53	3.93	4.27	4.58	4.78	4.92
13	1.22	1.51	1.77	2.03	2.30	2.54	2.78	3.00	3.22	3.68	4.09	4.45	4.77	4.98	5.12
14	1.27	1.57	1.84	2.11	2.38	2.64	2.88	3.11	3.34	3.81	4.24	4.61	4.95	5.17	5.31
15	1.32	1.62	1.90	2.19	2.46	2.73	2.98	3.22	3.46	3.94	4.39	4.77	5.12	5.35	5.49
16	1.36	1.67	1.96	2.26	2.54	2.82	3.08	3.33	3.57	4.07	4.53	4.93	5.29	5.52	5.67
17	1.40	1.72	2.02	2.33	2.62	2.91	3.17	3.43	3.68	4.20	4.67	5.08	5.45	5.69	5.85
18	1.44	1.77	2.08	2.39	2.70	2.99	3.26	3.53	3.79	4.33	4.81	5.23	5.61	5.85	6.02

Figure 2. Typical Waterman Gate Discharge Table

Example:

The Ditchtender reads the upstream head at 12” and the downstream head at 16”. This means that the effective operating head across the gate or the $\triangle h$ is 4”. The Ditchtender also reads the gate position by tape measuring the distance from the top of the hand wheel to the zero-mark at 6”. The Meter Gate is an 12” ARMCO Model No. 101 canal gate. Utilizing the chart provided in Figure 2, the instantaneous flow is 1.79 CFS. If the landowner ran for 24 hours, the District would record a total volumetric usage of 3.55 acre-feet and the landowner would be billed based on this value. A sample bill is included in Appendix C (Section 10) of the 2015 Agricultural Water Management Plan.

Method of Certification

Since the adoption of the 2012 Agricultural Water Management by the District, the State of California experienced consecutive years of drought conditions. The District subsequently did not delivery any irrigation water supplies from late 2012 through 2014. Without the ability to deliver water the original meter certification plan was unable to be accomplished. However, during that period experts within the water measurement profession have conducted studies and the findings have allowed the District to modify the approach that will be taken by the District with the adoption of the 2015 Agricultural Water Management Plan.

Existing Meter Gate Certification

In September 2014 the Irrigation Training and Research Center located at the California Polytechnic State University, San Luis Obispo (ITRC) published a report called the “Practical Guide for Metergates” which is attached to this report as Attachment A. This report was a summary of finding for tests that were conducted on typical meter gates that are utilized within the District. The ITRC tested various Armco-type meter gates to reaffirm previous meter accuracy estimates. Gates were installed within the ITRC calibration facility and simulated the flow pattern that is typically experienced in canal operations (perpendicular to the main supply channel flow).

The study found that meter gates that are installed and operated in a specific manner could yield a high level of accuracy of +/-5% given specific conditions were present. The conditions required by Cal Poly to achieve +/- 5% accuracy and those which the District proposes to verify are:

- Gate operates between 20% and 75% of the gate opening

- Upstream submergence of greater than 50% of the gate diameter
- Stilling wells are installed 4” to 12” downstream of the face of the meter gate

The District also intends to verify that the following conditions are established to ensure a consistent and accurate reading during water measurement operations:

- The “zero” gate opening must be marked on the gate stem
- Stilling wells are sized between 6” and 8” in diameter to dampen static water readings
- Water levels upstream and downstream are read based upon a fixed benchmark

The District Engineer will train key staff to inspect gates along each canal and certify each of the components listed above. Records of each gate inspection shall be retained and any failure to meet the above criteria shall be noted.

Meter Field Inspection

The District is in the process of inspecting all 535 farm-gate turnouts to ensure that the installation of each facility conforms to the recommended and accepted practices that yield the highest accuracy possible. The District is utilizing the criteria established by the Cal Poly ITRC, *Practical Guide for Metergates* and outlined above. The results of the inspections will be provided in the Meter Certification Report.

Critical features to would include, but are not limited to:

- Gate operates between 20% and 75% of the gate opening
- Upstream submergence of greater than 50% of the gate diameter
- Stilling wells are installed 4” to 12” downstream of the face of the meter gate
- The “zero” gate opening must be marked on the gate stem
- Stilling wells are sized between 6” and 8” in diameter to dampen static water readings
- Water levels upstream and downstream are read based upon a fixed benchmark

Sample Size and Determination

The District currently utilizes 535 irrigation farm gate turnouts, which include the installation and use of a Meter Gates to deliver water to landowners. To meet the standards for certification under the field inspection alternative, the District is prepared to inspect all 535 farm-gate turnouts to ensure certification.

Staff

The certification process shall be overseen by the District Engineer, Aaron Fukuda who is a Professional Engineer (P.E. 65295) in the State of California. The District Engineer shall also be assisted by the District Engineering Technician and other Ditchtenders who have experience in water measurement and shall be trained by the District Engineer in the verification process. The final Meter Certification Report shall be prepared and certified by the District Engineer.

Schedule

Due to the recent water year conditions, the District has been unable to implement the Initial Certification of existing water measurement devices within the District. Accordingly, the District proposes to conduct the Initial Certification process starting January 2016 and continuing until all gates have been inspected. The following schedule is provided as a best attempt to outline the process the District will follow, however as each Task is accomplished the Schedule along with the Budget may be modified to reflect findings and accomplishments at each Task:

Task No.	Activity	Date
1	Initial Certification (Field Inspection/Field Testing)	Start Jan. 2016
2	Meter Certification Report Preparation	Jan 2017 – March 2017
3	Meter Certification Report – Final	May 2017 (Board Mtg.)
4	Phase 1 - Meter Corrective Action	Jun 2017 – Dec.2017
5	Optional – Second Round Certification (As Required)	Jan. 2018 – April 2018
6	Phase 2 – Meter Corrective Action	Sept. 2018 – Dec 2018
7	Phase 3 – Meter Corrective Action	Jan. 2019 – March 2019
8	Phase 4 – Meter Corrective Action	April 2019 – June 2019
9	Phase 5 – Meter Corrective Action	Sept. 2019 – Nov 2019

Variability in the schedule may come at the following Tasks:

- If the Meter Certification Report (Task 3) finds that the existing meters are within a +/-12% accuracy range the Certification Process will conclude that the District has met all regulations and will continue to measure and bill according to volumetric usage.
- If the Meter Certification Report (Task 3) finds that the existing meters do not read within a +/-12% accuracy range the total number of turnouts that reads outside of this accuracy shall be determined. If more than 25% of the turnouts read greater than a +/-12% accuracy the District shall conduct a second round of Meter Certifications (Task 5).
- Any of the tasks may be impacted by weather and/or surface water deliveries that will make access to inspection impossible.

Results (Meter Certification Report)

Once the District has completed the testing or inspection of the Meter Gates identified by the Plan a Meter Certification Report will be created. The report will be prepared by the District Engineer and the District Engineering Technician, with final approval and certification coming from the District Board of Directors and the District Engineer respectively. Included in the Report will be the following information:

- Description of Certification Process (including devices and field testing conducted)
- Results of the Certification Process
- Discussion of Future Certification Requirements
- Recommended Meter Modifications (Device Correction Plan)
- Schedule for Meter Modifications
- Budget for Meter Modifications

Device Correction Plan

The Device Correction Plan will be established using the results discovered from the Initial Certification (Task 1). During the certification the District will determine the ability of the existing meters to be modified or calibrated to achieve an accuracy of +/-12%. The District will establish a process to adjust existing meters to meet the accuracy requirements set forth.

If it is determined that the existing meters that are utilized to measure irrigation deliveries within the District cannot meet the +/-12% requirement and cannot be modified to achieve such, the District will strive to identify and create a Water Measurement Replacement Program (Replacement Program). The Replacement program will identify the types of measurement devices to be implemented, the schedule for implementation and the cost to carry out the Replacement Program. If this is required Tasks 4, 6, 7, 8, and 9 will involve the replacement of meters rather than the modification of existing meters.

Budget

The District has estimated the maximum cost to reach compliance at approximately $817,000 based upon its current understanding of the law. An Engineers Estimate (Budget) is included below. This maximum budget reflects the conservative assumption that all of the District's 50-plus meters will need either replacement or some form of repair. Based on staff's knowledge of the canal system and associated farm-gate turnout configurations, the certification protocol should result in significantly fewer number of turnouts in need of alteration. The Budget set forth in this document is subject to changed based upon the findings and necessity to perform meter modifications.

Tulare Irrigation District

Meter Certification and Modification Budget

Engineer's Estimate

Task No.	Description	Quantity	Unit	Unit Price	Total
1	**Initial Certification**				
1a	District Engineer	200	Hours	$75	$15,000
1b	Engineering Technician	300	Hours	$35	$10,500
				Subtotal	*$25,500*
2	**Meter Certification Report Preparation**				
2a	District Engineer	75	Hours	$75	$5,625
2b	Engineering Technician	50	Hours	$35	$1,750
				Subtotal	*$7,375*
3	**Meter Certification Report - Final**				

3a	District Engineer	24	Hours	$75	$1,800
3b	Engineering Technician	24	Hours	$35	$840
				Subtotal	*$2,640*
4	**Phase 1 Meter Corrective Action**				
4a	Meter Modification	100	Each	$2,000	$200,000
4b	District Engineer	200	Hours	$75	$15,000
	Engineering Technician	300	Hours	$35	$10,500
				Subtotal	*$225,500*
5	**Optional - Second Round Certification**				
5a	Rubicon FlumeMeter	1	Each	$8,000	$8,000
5b	Rubicon Mounting Brackets	53	Each	$1,000	$53,000
5c	District Engineer	100	Hours	$75	$7,500
5d	Engineering Technician	150	Hours	$35	$5,250
5e	Boom Truck	100	Hours	$20	$2,000
				Subtotal	*$75,750*
6	**Phase 2 Meter Corrective Action**				
6a	Meter Modification	50	Each	$2,000	$100,000
6b	District Engineer	100	Hours	$75	$7,500
6c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
7	**Phase 3 Meter Corrective Action**				
7a	Meter Modification	50	Each	$2,000	$100,000
7b	District Engineer	100	Hours	$75	$7,500
7c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
8	**Phase 4 Meter Corrective Action**				
8a	Meter Modification	50	Each	$2,000	$100,000
8b	District Engineer	100	Hours	$75	$7,500
8c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
9	**Phase 5 Meter Corrective Action**				
9a	Meter Modification	50	Each	$2,000	$100,000
9b	District Engineer	100	Hours	$75	$7,500
9c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
10	**2015 Agricultural Water Management Plan**				

10a	District Manager	16	Hours	$115	$1,840
10b	District Engineer	200	Hours	$75	$15,000
10c	District Watermaster	200	Hours	$45	$9,000
10d	Engineering Technician	100	Hours	$35	$3,500
				Subtotal	*$29,340*
				Total	**$817,105**

Financing

The District is currently expecting to utilize its Infrastructure Rehabilitation Reserve Funds and the ability to seek grants from the Department of Water Resources to achieve the requirements of this Plan. As this Plan is being implemented the District Engineer will be providing financial updates to the District Board of Directors including an initial cost/benefit analysis to determine the feasibility of carrying out the Device Correction Plan. If the District is unable to find suitable existing funds, it shall seek other sources of funding as needed.

ATTACHMENT A

Section 13

District Drought Management Plan

Tulare Irrigation District

Drought Management Plan

INTRODUCTION

PURPOSE OF PLAN

The Tulare Irrigation District (District) has historically experienced drought conditions whereby the annual precipitation is significantly below the region's recorded average, and surface water supplies are severely diminished. In some cases the District has experienced drought conditions that have been so severe that surface water supplies have been too low to convey base flows to system turnouts without excessive seepage losses. The District has experienced six of those years, three of which have occurred since 2012 to 2015. The four consecutive years of drought conditions caused the Governor of California to issue Executive Order B-29-15[1] which required the District to create and adopt the Tulare Irrigation District Drought Management Plan (Drought Plan). The objective of the Drought Plan is to establish the protocols of determining drought conditions, how to manage District water operations and its surface water supplies during a drought, and how to prepare for future droughts.

AGRICULTURAL WATER MANAGEMENT PLANNING & DROUGHT MANAGMENT PLANNING

As an irrigation district within the state of California that serves surface water to an area greater than 25,000 acres, the District has developed an Agricultural Water Management Plan (AWMP) to comply with the California Water Code. The first plan was submitted to the California Department of Water Resources (DWR) in December 2012 and was subsequently approved by DWR. On January 17, 2014, in response to the recent drought conditions, Governor Brown declared a State of Emergency. State agencies were directed to assist those throughout the state with addressing drought concerns. On April 1, 2015, as drought conditions continued to persist, the Governor issued Executive Order B-29-15. Under the Executive Order the Governor directed agricultural water suppliers that supply water to more than 25,000 acres to create detailed drought management plans.

Drought management plans are intended to detail how a water supplier prepares for drought conditions and manages water supplies during a drought. The plan, once developed, becomes part of the DWR required

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[1] Executive Order B-29-15 (April 1, 2015) http://gov.ca.gov/docs/4.1.15_Executive_Order.pdf

AWMP. At each successive update of the AWMP the agency can revisit the practices and adjust the drought management as needed.

DROUGHT AND WATER MANAGEMENT TOOLS

Provided below is a list of resources that provide drought related guidance:

- **Tulare Irrigation District Website** - The District provides notices to landowners regarding District activities including water conditions and drought declarations. More information can be found at http://www.tulareid.org/.
- **DWR Drought Conditions** - To determine the current water conditions in the State and/or regions visit http://www.water.ca.gov/waterconditions/.
- **DWR Water Use Efficiency** – The DWR Water Use Efficiency division makes available technical expertise, provides information on the CIMIS weather station network, carries out demonstration projects and data analysis to increase water use efficiency, and provides water users with loans and grants to achieve water use efficiency projects. More information can be found at http://www.water.ca.gov/wateruseefficiency/.
- **U.S. Bureau of Reclamation Drought Response Program** - The USBR provides federal water contractors and other water agencies with a broad view of drought conditions in the western United States. The agency also provides technical assistance, grants and loans, and expertise in drought management planning. More information can be found at http://www.usbr.gov/drought/.
- **USDA Disaster and Drought Information** – The USDA provides services and programs aimed at helping agricultural producers and communities in dealing with the impacts of a drought. More information can be found at http://www.usda.gov/wps/portal/usda/usdahome?navid=DISASTER_ASSISTANCE.

PLAN ELEMENTS

HYDROLOGIC CONDITIONS OF DROUGHT

The District typically utilizes two seasonal periods during the year to establish the anticipated water year conditions, thereby projecting the drought conditions and resulting irrigation supply availability. These periods are (a) the winter recharge assessment and (b) the summer irrigation declaration.

The District uses several forecasting tools to determine the surface water allocations:

1. California Cooperative Snow Surveys, Bulletin 120 report that is produced between February and May of each year, in particular for the Kaweah River watershed.
2. United States Bureau of Reclamation forecasting on the San Joaquin River watershed along with allocation determinations. These forecasts are delivered to the District on a monthly basis.
3. Snow sensor readings that are available for public access on the San Joaquin and Kaweah watersheds and available via the internet.

The District tracks the winter rainfall and snowfall via the sources cited above. The first surface water projection for the District is typically provided to the Board of Directors at its March Board meeting. The projection is initially formulated by the District Watermaster using the information that is obtained through the winter. This first forecast will typically use the February Bulletin 120 Snow Survey to estimate runoff in the Kaweah and San Joaquin watersheds and give the Board an idea of what type of surface water runoff will be available and the resulting entitlement allocations to the District. The Board reviews this recommendation then provides guidance to the Watermaster regarding upcoming irrigation delivery periods. Generally the Board will determine that the water year is trending towards dry, average or wet with the first water supply projection in hand. This will help guide the District in its decision making until the second projection is made. The Board however can issue a Drought Stage declaration during this first period if supply forecasts justify that decision.

As the year progresses the next critical point is the availability of the April Bulletin 120 Snow Survey results. This information, along with other snow sensor readings and USBR allocations for Friant Unit supplies, are delivered to the Board in May of each year. At this time the Board will determine the type and extent of summer irrigation run that will take place and/or establish the Drought Stage for implementation. If there is a sufficient supply of surface water (generally in average and wet years), the District Board will use the projection to establish an irrigation delivery period. However, if the water year projection is sufficiently dry, the Board can either establish Drought Stage in order to implement a water allocation process or cancel any previously-scheduled summer irrigation run.

DETERMINATION OF WATER ALLOCATIONS

During periods where the District surface water supplies are limited, allocations to landowners are estimated by the Watermaster and approved by the Board. The guidelines that are used to estimate the allocations are as follows:

1. Upon establishing that the District will encounter an irrigation run whereby surface water supplies will be curtailed, the Watermaster shall use available water supply forecasts to determine the estimated amount of water that is available for distribution to landowners during the irrigation season (typically June to September).

2. The Watermaster shall determine the net amount of water that is available for delivery to turnouts, which accounts for losses within the District distribution system.
3. Utilizing previous year crop surveys the Watermaster shall determine the likely cropped acreage for the upcoming year.
4. The Watermaster, with Board approval, shall allocate the water over a determined period of time. A Drought Proration Start Date and Finish Date shall be established.
5. Based on the Start Date and Finish Date the Watermaster can allocate the available water on a per-acre allocation by utilizing the following equation:

$$Water\ Allocation = \frac{Available\ Net\ Water\ Supply\ (Acre\ Feet)}{Estimate\ Cropped\ Acreage\ (acres)}$$

Allocation determinations will be sent to landowners via our website, email lists and individual mailers sent to addresses on file with the District.

OPERATIONAL ADJUSTMENTS

During drought conditions the District adjusts its delivery of surface water by operating in what is termed "Conservative" mode. During conservative mode the District delivers water only through channels that are required to deliver water to turnouts and minimizes the use of canals and ditches that are not needed. The District also targets channels that have lower losses and avoids those that have higher losses such as Packwood Creek and Cameron Creek.

The District also utilizes recharge/regulation basins differently during Conservative mode. When in Conservative mode the District will either bypass recharge/regulation basins or only utilize cells within the basin that are maximized for regulation and not for recharge. These cells are often compacted and have little to no losses through the system. Outside of Conservative mode, all basin cells are kept full or near full, and basins are thereby used for both flow regulation and for infiltration recharge.

DEMAND MANAGEMENT POLICIES

The District does not participate in the cropping decisions made by landowners on an annual basis. However, the District does participate in two different programs that have demand management influences: 1) on-farm water efficiency projects and 2) on-farm recharge programs.

The District has participated for several years with the Natural Resources Conservation Service (NRCS) to promote and fund on-farm water efficiency projects. These projects have included such practices as drip irrigation, micro sprinkler irrigation, canal to pipeline conversions and tailwater return systems. Each of these on-farm practices lower the surface water demands of the District.

The other program that is being developed and tested within the District is an on-farm surface water recharge program. This aims to promote the application of surplus water during winter months to various crops in excess of crop demand to achieve groundwater recharge, while not causing any harm to crops. In this way the District not only meets winter irrigation needs but also reduces the amount of water that is required in the future by virtue of pre-irrigation applications. More lengthy surplus deliveries also ultimately provide direct percolation to the underlying aquifer system.

ALTERNATIVE WATER SUPPLIES

The District has historically participated in water exchanges to support the conjunctive-use operations strived for by the District. The District typically delivers dry-year water to an exchange partner in return for a larger amount of wet-year water. The ratios that are typically negotiated, based upon individual terms, range from 2:1 to 4:1. The wet-year water is utilized to meet crop demands when it is possible, but a majority of the water is utilized for groundwater recharge activities. When the District experiences drought conditions or the lack of surface water, landowners can then turn to groundwater to help meet their crop demands, making use of the previously-stored recharge water.

The District has also recently entered into agreement with the City of Visalia to take delivery of tertiary-treated wastewater from the City's wastewater treatment plant. The City is currently in the process of completing an upgrade to their wastewater treatment plant that will produce tertiary-treated water that essentially meets the requirements of Title 22, and can be delivered to irrigate crops without any restrictions. This arrangement will add approximately 11,000 acre-feet of water annually to the District's supply for delivery within its northwestern quadrant.

The backstop supply source, usually as a last resort for many landowners, is groundwater. In wetter years the District can meet most of the irrigation demands of the crops within the District. When surface water supplies fall short of the crop demands, farmers will then turn to the use of groundwater wells that are situated on each ranch or parcel.

STAGES OF ACTION

During the course of the water year the District will make projections of the water conditions as discussed in the section – Hydrologic Conditions of Drought. In the event water supplies fall within specific conditions as listed blow, the Board shall adopt the following stages:

<u>Stage 1 – Water Alert</u>

During a Stage 1 drought condition the District experiences supplies that are slightly restricted. This would be in years were the initial forecast is approximately 65% of the April to July runoff. Stage 1 is designed to bring public awareness to possible surface water shortages to the District and the surrounding area.

At the beginning of a dry year, the District has no certainty as to whether conditions will persist further into drought territory. Therefore, the District can establish a Stage 1 Water Alert, which would request voluntary water reduction measures by landowners to prepare for deepening drought conditions. District staff will implement and outreach program to educate landowners regarding the status of District surface water supplies and any estimation of water shortages that may be expected.

Actions to be implemented during Stage 1 Water Alert include:

1. During late winter and early spring the Watermaster will be monitoring rainfall totals and reservoir levels to estimate the potential irrigation supply for the year. This supply number will be presented to the Board on a monthly basis.
2. When the Board makes a determination that the District is in a Stage 1 Water Alert status, staff shall alert all water users via the District website, email lists and notification letters.
3. Water notices sent shall indicate the Stage 1 Water Alert status and request that voluntary water savings measures be taken. Recommended water savings measures shall be included for landowners to utilize.

<u>Stage 2 Water Supply Limitations</u>

The District shall implement a Stage 2 Water Supply Limitation if the Watermaster and the Board determines that water supply conditions are anticipated to be drier than the Stage 1 forecast and that further restrictions on surface water supply are likely. During this stage of water supply shortage the District will experience limited surface water allocations and must determine a likely allocation to landowners based upon the Determination of Water Allocations Section as previously described herein.

Actions to be implemented during a Stage 2 Water Supply Limitation:

1. The Watermaster shall determine a Water Allocation per the details listed in the Determination of Water Allocations Section.
2. The Board shall approve the Water Allocation.
3. Landowners shall be notified of the Water Allocation. Notification shall come in the form of email notification, website notification and letter notification.
4. District staff shall carry out the irrigation run by limiting the surface water deliveries to landowners based upon the Water Allocation.

Stage 3 No Surface Water Irrigation Supplies

The District shall establish a Stage 3 No Surface Water Irrigation Supply when the District is not allocated sufficient surface water supplies from the Friant-Kern Canal or the Kaweah Riverto establish and maintain an irrigation run of reasonable duration. Due to prior water exchange agreements and/or limited to no allocation from either of the District's surface water supply sources, the Board can approve a cancellation of any previously-scheduled irrigation run period.

Notification to landowners shall take place by posting notices on the District website, sending emails to current email lists and sending notifications via individual mailers.

COORDINATION AND COLLABORATION

The District has many long-standing relationships with local agencies that have been successful in implementing projects and fostering water management programs within the area. The District has enjoyed financial support from the City of Tulare since the inception of the District; however, a formally recognized relationship began in the late 1940's. During this period the District agreed to accept storm water runoff from the City into the District distribution system. In return the City would continue to pay the land assessment charges to the District as land was annexed into the City. In later years the relationship blossomed into a groundwater recharge program, whereby the two entities co-venture on recharge projects and the District utilizes these projects to provide groundwater recharge nearby the City's municipal well field.

The District has also developed a working relationship with the City of Visalia. That City has partnered with the District to exchange tertiary-treated wastewater for surface water recharge upgradient from the City's municipal well fields. Several District channels also traverse through the City and the District has worked to utilize these water courses for groundwater recharge for the benefit of the City.

The District is also a member of the Kaweah Integrated Regional Water Management Planning group. This group meets regularly to coordinate water management policies and projects.

Most recently, the District has formed a Groundwater Sustainability Agency (GSA) with the aforementioned cities in order to comply with the sustainability requirements of the Sustainable Groundwater Management Act (SGMA). The three partners, bound together by a joint powers agreement, intend to jointly pursue supply-side groundwater management programs as well as extraction strategies which will help sustain the groundwater supplies beneath the region. These programs and strategies will soon be embodied in a Groundwater Sustainability Plan (GSP), and coordinated with other such plans emerging within the Kaweah Sub-Basin.

REVENUES AND EXPENDITURES

During years that the District delivers surface water, on average approximately half of the revenues needed to operate the District come from water sales and the other half comes from land assessments. Over the years, the District has balanced the sales rate for surface water to be competitive with the pumping of groundwater. This provides a cost mechanism to incentivize landowners to utilize surface water over groundwater when it is available. The District has been able to establish a reserve account, which was primarily established through revenues generated through the Districts participation in a hydroelectric power plant at Terminus Dam, water sales to landowners, water sales to outside entities, and contributions from the City of Tulare agreement. This reserve account is utilized to purchase surplus water when available in wet years for groundwater recharge purposes.

During drought years, such as during 2012-2015, the District endeavors to minimize budget expenses to offset the lack of water-sale and power generation revenues. The District has also been creative and utilized staff to accomplish projects for neighboring agencies that can offset some labor and equipment costs. Lastly, the District also has worked on grant-funded water management projects and facilities, whereby the grants cover approximately half of the labor, materials and equipment used on the project.

LONG TERM DROUGHT MANAGEMENT PROGRAM

This Drought Management Plan addresses water management during periods that fall under drought conditions. This section of the Drought Management Plan shall document and establish the activities that take place during non-drought periods that have a subsequent impact on periods that are dominated by drought conditions. Throughout the District there are a number of ongoing activities related to drought management; however, they may not take place within any given drought year.

WATER MANAGEMENT ACTIVITIES

The District operates as a conjunctive-use district whereby surface water supplies are utilized to meet grower demands, and in years where surface water supplies are in shortage, growers can use groundwater to meet crop demands. In high precipitation years (wet years) with attendant surplus supplies, the District utilizes its surface water distribution system and an array of groundwater recharge basins to replenish the underlying groundwater aquifer system that is depended upon during drought years. The District has access to approximately 1,250 acres of recharge basins and over 300 miles of canals to conduct recharge activities.

The District has two surface water supply sources that are utilized by growers. The first supply is a local surface water supply from pre-1914 appropriative rights on the Kaweah River, which supplies are regulated within Lake Kaweah. The second supply is imported from the Central Valley Project from Millerton Lake on the San Joaquin River, which is secured by a Class 1 and Class 2 supply contract with USBR. Together the District averages a surface water supply of approximately 180,000 AF per year. The District can experience years where zero surface water is supplied and also experience years where up to 350,000 AF is diverted for both water sale deliveries and groundwater recharge. This variable nature in surface water supplies is buffered by the conjunctive use of groundwater.

To sustain its conjunctive operations, the District has implemented several different long-term drought management strategies that center around the conjunctive-use of surface water and groundwater. The list of facilities and management programs outlined below includes the recently-implemented strategies that are taking place within the District:

- An effort to increase the number of recharge basins located within the District that are located on highly permeable soils and hydraulically connected to aquifers that are used by District landowners. Over the last 7 years the District has acquired and/or is in the process of developing approximately 220 acres of recharge basins with potential recharge capacity of 110 AF per day.
- The District has also initiated a basin maintenance program in the existing recharge basins to maintain and ideally increase the infiltration capacity at each basin. This program is being furthered by a study that is taking place that will deliver a report that helps identify best management practices for basin maintenance such that the District can increase its recharge capacity and maintain a high infiltration rate over time.
- The District has sought surface water exchanges with other irrigation districts that increase the amount of water delivered to the District in wet years for groundwater recharge and in return the District delivers its limited supply of firm water in dry years to partner districts. These leveraged exchanges have netted the District exchanges upwards of 4:1.
- The District has reached agreement with the City of Visalia to utilize wastewater that is treated to a tertiary level for delivery within the District for agricultural proposes. This will supply water to specific regions (northwest quadrant) of the District on a continual basis, including in drought years. The infrastructure to utilize this water has been installed and the City of Visalia is in the process of upgrading their wastewater treatment plant to a tertiary level. The City of Visalia and District hope to be utilizing tertiary treated water to meet grower demands within the District within the next 2 years. The District-City agreement will enable the District to import upwards of 6,000 AF on average of additional CVP water into the Kaweah Sub-Basin for mutual groundwater benefits.
- The District has begun discussion with the City of Tulare to also utilize wastewater from their treatment plant, when their plant achieves a tertiary level of treatment.

Section 14

Water Budget Summary

Water Budget Summary (AF)

Water Accounting	2015	2016	2017	2018	2019
Water Supplies[1]	2,987	92,120	396,881	103,703	325,940
Water Uses/Demands[1]	268,782	263,625	276,793	264,615	264,813
Net Water Balance	-265,795	-171,505	120,088	-160,912	61,127

Notes:
[1] Values are provided in attached tables (based on annual data gathered to provide to the USBR)

Year of Data	2015	Enter data year here

Table 1

Surface Water Supply

2015 Month	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
Method	M1			Kaweah Riv. M1		Kaweah/CVP M1		
January	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	2,987	0	0	0	2,987
TOTAL	0	0	0	2,987	0	0	0	2,987

Table 2

Ground Water Supply

2015 Month	District Groundwate (acre-feet)	Private Agric *(acre-feet)
Method		E2
January	0	24,000
February	0	24,000
March	0	24,000
April	0	24,000
May	0	24,000
June	0	24,000
July	0	24,000
August	0	24,000
September	0	24,000
October	0	24,000
November	0	24,000
December	0	24,000
TOTAL	0	288,000

*normally estimated

Table 3

Total Water Supply

2015 Month	Surface Water Total (acre-feet)	District Groundwate (acre-feet)	Recycled M&I (acre-feet)	Total District Water Supply (acre-feet)
Method	M1		M1	
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	2,987	0	0	2,987
TOTAL	2,987	0	0	2,987

*Recycled M&I Wastewater is treated urban wastewater that is used for agriculture.

Precipitation Worksheet					Evaporation Worksheet			
2015	inches precip	ft precip	acres	AF/Year	2015	inches evap	ft evap	acres
Jan	0.00	0.00	60.61	5.25	Jan	0.00	0.00	60.61
Feb	0.00	0.00	909.09	78.79	Feb	0.00	0.00	909.09
Mar	0.00	0.00	1,099.96	95.33	Mar	0.00	0.00	1,099.96
Apr	0.00	0.00	0.00	0.00	Apr	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	May	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	Jun	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	Aug	0.00	0.00	0.00
Sept	0.00	0.00	0.00	0.00	Sept	0.00	0.00	0.00
Oct	0.00	0.00	0.00	0.00	Oct	0.00	0.00	0.00
Nov	0.00	0.00	0.00	0.00	Nov	0.00	0.00	0.00
Dec	1.04	0.09	0.00	0.00	Dec	1.11	0.09	0.00
TOTAL	**1.04**	**0.09**	**2069.65**	**179.37**	**TOTAL**	**1.11**	**0.09**	**2,069.65**

Table 4

Agricultural Distribution System

2015 Canal, Pipeline, Lateral, Reservoir	Length (feet)	Width (feet)	Surface Area (square feet)	Precipitation (acre-feet)	Evaporation (acre-feet)	Spillage (acre-feet)	Seepage (acre-feet)	Total (acre-feet)
Intake Canals	52,800	50	2,640,000	5.3	5.6	0	197	(197)
In District Canals	1,584,000	25	39,600,000	78.8	84.1	0	1,724	(1,729)
Basins	6,922	6,922	47,914,084	95.3	101.8	0	0	(6)
Section 7	0	0	0	0.0	0.0	0	0	0
Section 9	0	0	0	0.0	0.0	0	0	0
Cameron Creek	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
TOTAL				179.4	191.5	0	1,921	(1,933)

Table 5

Crop Water Needs

2015 Crop Name	Area (crop acres)	Crop ET (AF/Ac)	Leaching Requiremen (AF/Ac)	Cultural Practices (AF/Ac)	Effective Precipitatio (AF/Ac)	Appl. Crop Water Use (acre-feet)
Corn	20,648	2.60	0.0	1.0	0.1	72,887
Wheat	19,293	1.70	0.0	1.0	0.1	50,741
Alfalfa	11,951	4.00	0.0	0.0	0.1	46,967
Pistachios	7,026	3.10	0.0	1.0	0.1	28,315
Walnuts	4,654	3.80	0.0	1.0	0.1	22,013
Almonds	3,866	3.50	0.0	1.0	0.1	17,126
Cotton	3,352	2.90	0.0	1.0	0.1	12,838
Milo Maize	2,110	2.60	0.0	1.0	0.1	7,448
Field Peas	1,495	2.30	0.0	1.0	0.1	4,829
Native Pasture/Grasses	667	1.50	0.0	0.0	0.1	954
Grapes	552	2.50	0.0	0.0	0.1	1,341
Cherries	354	3.00	0.0	1.0	0.1	1,391
Nursery	143	2.50	0.0	0.0	0.1	347
Blue Berries	139	3.00	0.0	1.0	0.1	546
Persimmons	97	1.70	0.0	1.0	0.1	255
Oats	78	1.80	0.0	1.0	0.1	213
Lettuce	55	3.00	0.0	1.0	0.1	216
Oranges	46	3.50	0.0	1.0	0.1	204
Olives	20	3.50	0.0	1.0	0.1	89
Pears	10	2.40	0.0	1.0	0.1	33
Cauliflower/Pomegran	8	2.40	0.0	1.0	0.1	27
		0.00	0.0	0.0	0.0	0
		0.00	0.0	0.0	0.0	0
Crop Acres	76,564					268,782

Total Irrig. Acres 60,059 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2015 District Water Inventory

Type of Water	Location of Information		
Water Supply	Table 3		2,987
Riparian ET	(Distribution and Drain)	minus	0
Groundwater recharge	intentional - ponds, injection	minus	1,006
Seepage	Table 4	minus	1,921
Evaporation - Precipitation	Table 4	minus	12
Spillage	Table 4	minus	0
Transfers out of District		minus	0
Water Available for sale to customers			48
Actual Agricultural Water Sales	2015	From District Sales Records	48
Private Groundwater	Table 2	plus	288,000
Crop Water Needs	Table 5	minus	268,782
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		19,266
Unaccounted for Water	(calculated)		(0)

Table 7

Influence on Groundwater and Saline Sink

2015	
Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	2,927
Estimated actual change in ground water storage, including natural recharge)	-265,807
Irrigated Acres (from Table 5)	76,564
Irrigated acres over a perched water table	0
Irrigated acres draining to a saline sink	0
Portion of percolation from agri seeping to a perched water table	0
Portion of percolation from agri seeping to a saline sink	0
Portion of On-Farm Drain water flowing to a perched water table/saline sink	0
Portion of Dist. Sys. seep/leaks/spills to perched water table/saline sink	0
Total (AF) flowing to a perched water table and saline sink	0

Table 8

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
2006	28,199	0	0	45,682	0	0	0	73,881
2007	213,811	0	0	169,188	0	0	0	382,999
2008	131,291	0	0	170,849	0	0	0	302,140
2009	18,838	0	0	28,639	0	0	0	47,477
2010	81,950	0	0	162,115	0	30,072	0	274,137
2011	92,090	0	0	215,147	0	30,064	0	337,301
2012	12,086	0	0	37,741	0	0	0	49,827
2013	888	0	0	4,881	0	0	0	5,769
2014	0	0	0	0	0	0	0	0
2015	0	0	0	2,987	0	0	0	2,987
Total	579,153	0	0	837,229	0	60,136	0	1,476,518
Average	57,915	0	0	83,723	0	6,014	0	147,652

Year of Data	2016	Enter data year here

Table 1

Surface Water Supply

2016 Month	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
Method	M1			Kaweah Riv. M1		Kaweah/CVP M1		
January	0	0	0	3,191	0	0	0	3,191
February	0	0	0	4,350	0	0	0	4,350
March	1,796	0	0	988	0	0	0	2,784
April	14,542	0	0	4,173	0	7,897	0	26,612
May	0	0	0	0	0	0	0	0
June	4,330	0	0	16,084	0	0	0	20,414
July	6,875	0	0	25,894	0	607	0	33,376
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	1,393	0	0	0	1,393
TOTAL	27,543	0	0	56,073	0	8,504	0	92,120

Table 2

Ground Water Supply

2016 Month	District Groundwate (acre-feet)	Private Agric *(acre-feet)
Method		E2
January	0	20,000
February	0	20,000
March	0	20,000
April	0	20,000
May	0	20,000
June	0	20,000
July	0	20,000
August	0	20,000
September	0	20,000
October	0	20,000
November	0	20,000
December	0	20,000
TOTAL	0	240,000

*normally estimated

Table 3

Total Water Supply

2016 Month	Surface Water Total (acre-feet)	District Groundwate (acre-feet)	Recycled M&I (acre-feet)	Total District Water Supply (acre-feet)
Method	M1		M1	
January	3,191	0	0	3,191
February	4,350	0	0	4,350
March	2,784	0	0	2,784
April	26,612	0	0	26,612
May	0	0	0	0
June	20,414	0	0	20,414
July	33,376	0	0	33,376
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	1,393	0	0	1,393
TOTAL	92,120	0	0	92,120

*Recycled M&I Wastewater is treated urban wastewater that is used for agriculture.

Precipitation Worksheet					Evaporation Worksheet			
2016	inches precip	ft precip	acres	AF/Year	2016	inches evap	ft evap	acres
Jan	2.14	0.18	60.61	33.74	Jan	0.96	0.08	60.61
Feb	1.04	0.09	909.09	506.06	Feb	2.30	0.19	909.09
Mar	1.33	0.11	1,099.96	612.31	Mar	3.64	0.30	1,099.96
Apr	0.48	0.04	0.00	0.00	Apr	5.33	0.44	0.00
May		0.00	0.00	0.00	May		0.00	0.00
Jun		0.00	0.00	0.00	Jun	8.17	0.68	0.00
Jul		0.00	0.00	0.00	Jul	8.75	0.73	0.00
Aug		0.00	0.00	0.00	Aug		0.00	0.00
Sept		0.00	0.00	0.00	Sept		0.00	0.00
Oct		0.00	0.00	0.00	Oct		0.00	0.00
Nov		0.00	0.00	0.00	Nov		0.00	0.00
Dec	1.69	0.14	0.00	0.00	Dec	1.15	0.10	0.00
TOTAL	**6.68**	**0.56**	**2069.65**	**1152.11**	**TOTAL**	**30.3**	**2.53**	**2,069.65**

Table 4

Agricultural Distribution System

2016 Canal, Pipeline, Lateral, Reservoir	Length (feet)	Width (feet)	Surface Area (square feet)	Precipitation (acre-feet)	Evaporation (acre-feet)	Spillage (acre-feet)	Seepage (acre-feet)	Total (acre-feet)
Intake Canals	52,800	50	2,640,000	33.7	153.0	0	1,775	(1,895)
In District Canals	1,584,000	25	39,600,000	506.1	2,295.5	0	15,978	(17,767)
Basins	6,922	6,922	47,914,084	612.3	2,777.4	0	0	(2,165)
Section 7	0	0	0	0.0	0.0	71	0	(71)
Section 9	0	0	0	0.0	0.0	28	0	(28)
Cameron Creek	0	0	0	0.0	0.0	40	0	(40)
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
TOTAL				1,152.1	5,225.9	139	17,753	(21,966)

Table 5

Crop Water Needs

2016 Crop Name	**Area** (crop acres)	**Crop ET** (AF/Ac)	**Leaching Requiremen** (AF/Ac)	**Cultural Practices** (AF/Ac)	**Effective Precipitatio** (AF/Ac)	**Appl. Crop Water Use** (acre-feet)
Corn	18,961	2.60	0.0	1.0	0.2	65,226
Wheat	18,151	1.70	0.0	1.0	0.2	46,104
Alfalfa	11,206	4.00	0.0	0.0	0.2	43,031
Pistachios	7,766	3.10	0.0	1.0	0.2	30,598
Cotton	5,119	2.90	0.0	1.0	0.2	19,145
Walnuts	4,852	3.80	0.0	1.0	0.2	22,513
Almonds	4,832	3.50	0.0	1.0	0.2	20,971
Field Peas	2,179	2.30	0.0	1.0	0.2	6,842
Milo Maize	1,303	2.60	0.0	1.0	0.2	4,482
Grapes	542	2.50	0.0	0.0	0.2	1,268
Native Pasture	400	1.50	0.0	0.0	0.2	536
Cherries	325	3.00	0.0	1.0	0.2	1,248
Blue Berries	148	2.30	0.0	1.0	0.2	465
Nursery	96	2.50	0.0	0.0	0.2	225
Persimmons	85	3.00	0.0	1.0	0.2	326
Oats	84	1.70	0.0	1.0	0.2	213
Oranges	49	3.00	0.0	1.0	0.2	188
Olives	20	3.50	0.0	1.0	0.2	87
Plums	17	3.50	0.0	1.0	0.2	74
Pears	12	3.50	0.0	1.0	0.2	52
Lettuce	8	1.80	0.0	1.0	0.2	21
Cauliflower / Pomegra	3	2.40	0.0	1.0	0.2	10
	0	0.00	0.0	0.0	0.0	0
Crop Acres	76,158					263,625

Total Irrig. Acres 60,029 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2016 District Water Inventory

Type of Water	Location of Information		
Water Supply	Table 3		92,120
Riparian ET	(Distribution and Drain)	minus	0
Groundwater recharge	intentional - ponds, injection	minus	21,683
Seepage	Table 4	minus	17,753
Evaporation - Precipitation	Table 4	minus	4,074
Spillage	Table 4	minus	139
Transfers out of District		minus	836
Water Available for sale to customers			47,635
Actual Agricultural Water Sales	2016	From District Sales Records	47,635
Private Groundwater	Table 2	plus	240,000
Crop Water Needs	Table 5	minus	263,625
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		24,010
Unaccounted for Water	(calculated)		(0)

Table 7

Influence on Groundwater and Saline Sink

2016	
Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	39,436
Estimated actual change in ground water storage, including natural recharge)	-176,554
Irrigated Acres (from Table 5)	76,158
Irrigated acres over a perched water table	0
Irrigated acres draining to a saline sink	0
Portion of percolation from agri seeping to a perched water table	0
Portion of percolation from agri seeping to a saline sink	0
Portion of On-Farm Drain water flowing to a perched water table/saline sink	0
Portion of Dist. Sys. seep/leaks/spills to perched water table/saline sink	0
Total (AF) flowing to a perched water table and saline sink	0

Table 8

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
2007	213,811	0	0	169,188	0	0	0	382,999
2008	131,291	0	0	170,849	0	0	0	302,140
2009	18,838	0	0	28,639	0	0	0	47,477
2010	81,950	0	0	162,115	0	30,072	0	274,137
2011	92,090	0	0	215,147	0	30,064	0	337,301
2012	12,086	0	0	37,741	0	0	0	49,827
2013	888	0	0	4,881	0	0	0	5,769
2014	0	0	0	0	0	0	0	0
2015	0	0	0	2,987	0	0	0	2,987
2016	27,543	0	0	56,073	0	8,504	0	92,120
Total	578,497	0	0	847,620	0	68,640	0	1,494,757
Average	57,850	0	0	84,762	0	6,864	0	149,476

Year of Data | 2017 | **Enter data year here**

Table 1

Surface Water Supply

2017 Month	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
Method	M1			Kaweah Riv. M1		Kaweah/CVP M1		
January	0	0	0	32,870	0	0	0	32,870
February	0	0	0	33,029	0	0	0	33,029
March	0	0	0	45,184	0	0	0	45,184
April	11,055	0	0	34,665	0	0	0	45,720
May	11,300	0	0	41,006	0	0	0	52,306
June	21,054	0	0	39,626	0	0	0	60,680
July	25,405	0	0	35,343	0	0	0	60,748
August	0	0	0	25,821	0	23,183	0	49,004
September	1,778	0	0	1,882	0	7,644	0	11,304
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	6,036	0	0	0	6,036
TOTAL	70,592	0	0	295,462	0	30,827	0	396,881

Table 2

Ground Water Supply

2017 Month	District Groundwate (acre-feet)	Private Agric *(acre-feet)
Method		E2
January	0	10,000
February	0	10,000
March	0	10,000
April	0	10,000
May	0	10,000
June	0	10,000
July	0	10,000
August	0	10,000
September	0	10,000
October	0	10,000
November	0	10,000
December	0	10,000
TOTAL	0	120,000

*normally estimated

Table 3

Total Water Supply

2017 Month	Surface Water Total (acre-feet)	District Groundwate (acre-feet)	Recycled M&I (acre-feet)	Total District Water Supply (acre-feet)
Method	M1		M1	
January	32,870	0	0	32,870
February	33,029	0	0	33,029
March	45,184	0	0	45,184
April	45,720	0	0	45,720
May	52,306	0	0	52,306
June	60,680	0	0	60,680
July	60,748	0	0	60,748
August	49,004	0	0	49,004
September	11,304	0	0	11,304
October	0	0	0	0
November	0	0	0	0
December	6,036	0	0	6,036
TOTAL	396,881	0	0	396,881

*Recycled M&I Wastewater is treated urban wastewater that is used for agriculture.

Precipitation Worksheet					Evaporation Worksheet			
2017	inches precip	ft precip	acres	AF/Year	2017	inches evap	ft evap	acres
Jan	3.76	0.31	60.61	47.68	**Jan**	1.03	0.09	60.61
Feb	3.08	0.26	909.09	715.15	**Feb**	1.42	0.12	909.09
Mar	1.18	0.10	1,099.96	865.30	**Mar**	3.52	0.29	1,099.96
Apr	0.76	0.06	0.00	0.00	**Apr**	5.10	0.43	0.00
May	0.43	0.04	0.00	0.00	**May**	6.89	0.57	0.00
Jun	0.07	0.01	0.00	0.00	**Jun**	8.04	0.67	0.00
Jul		0.00	0.00	0.00	**Jul**	8.22	0.69	0.00
Aug		0.00	0.00	0.00	**Aug**	6.90	0.58	0.00
Sept	0.05	0.00	0.00	0.00	**Sept**	5.03	0.42	0.00
Oct		0.00	0.00	0.00	**Oct**		0.00	0.00
Nov		0.00	0.00	0.00	**Nov**		0.00	0.00
Dec	0.11	0.01	0.00	0.00	**Dec**	1.49	0.12	0.00
TOTAL	**9.44**	**0.79**	**2069.65**	**1628.13**	**TOTAL**	**47.64**	**3.97**	**2,069.65**

Table 4

Agricultural Distribution System

2017 Canal, Pipeline, Lateral, Reservoir	Length (feet)	Width (feet)	Surface Area (square feet)	Precipitation (acre-feet)	Evaporation (acre-feet)	Spillage (acre-feet)	Seepage (acre-feet)	Total (acre-feet)
Intake Canals	52,800	50	2,640,000	47.7	240.6	0	27,968	(28,161)
In District Canals	1,584,000	25	39,600,000	715.2	3,609.1	0	41,951	(44,845)
Basins	6,922	6,922	47,914,084	865.3	4,366.8	0	0	(3,502)
Section 7	0	0	0	0.0	0.0	177	0	(177)
Section 9	0	0	0	0.0	0.0	288	0	(288)
Cameron Creek	0	0	0	0.0	0.0	122	0	(122)
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
TOTAL				1,628.1	8,216.5	587	69,919	(77,094)

Table 5

Crop Water Needs

2017 Crop Name	Area (crop acres)	Crop ET (AF/Ac)	Leaching Requiremen (AF/Ac)	Cultural Practices (AF/Ac)	Effective Precipitatio (AF/Ac)	Appl. Crop Water Use (acre-feet)
Corn	20,423	2.60	0.0	1.0	0.1	72,706
Wheat	16,913	1.70	0.0	1.0	0.1	44,989
Alfalfa	10,114	4.00	0.0	0.0	0.1	40,051
Pistachios	7,790	3.10	0.0	1.0	0.1	31,627
Cotton	7,271	2.90	0.0	1.0	0.1	28,066
Almonds	5,586	3.50	0.0	1.0	0.1	24,914
Walnuts	4,944	3.80	0.0	1.0	0.1	23,533
Milo Maize	843	2.60	0.0	1.0	0.1	3,001
Dry Beans	761	2.30	0.0	1.0	0.1	2,481
Grapes	542	2.50	0.0	0.0	0.1	1,333
Native Pasture	400	1.50	0.0	0.0	0.1	584
Cherries	325	3.00	0.0	1.0	0.1	1,287
Blue Berries	148	2.30	0.0	1.0	0.1	482
Oats	143	1.70	0.0	1.0	0.1	380
Nursery	96	2.50	0.0	0.0	0.1	236
Persimmons	85	3.00	0.0	1.0	0.1	337
Pumpkins/Radish/Pom	73	2.40	0.0	1.0	0.1	245
Oranges	49	3.00	0.0	1.0	0.1	194
Lettuce	46	1.80	0.0	1.0	0.1	127
Olives	20	3.50	0.0	1.0	0.1	89
Plums	17	3.50	0.0	1.0	0.1	76
Pears	12	3.50	0.0	1.0	0.1	54
	0	0.00	0.0	0.0	0.0	0
Crop Acres	76,601					276,793

Total Irrig. Acres 60,069 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2017 District Water Inventory

Type of Water	Location of Information		
Water Supply	Table 3		396,881
Riparian ET	(Distribution and Drain)	minus	0
Groundwater recharge	intentional - ponds, injection	minus	119,327
Seepage	Table 4	minus	69,919
Evaporation - Precipitation	Table 4	minus	6,588
Spillage	Table 4	minus	587
Transfers out of District		minus	22,046
Water Available for sale to customers			178,414
Actual Agricultural Water Sales	2017	From District Sales Records	178,414
Private Groundwater	Table 2	plus	120,000
Crop Water Needs	Table 5	minus	276,793
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		21,621
Unaccounted for Water	(calculated)		(0)

Table 7

Influence on Groundwater and Saline Sink

2017	
Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	189,246
Estimated actual change in ground water storage, including natural recharge)	90,867
Irrigated Acres (from Table 5)	76,601
Irrigated acres over a perched water table	0
Irrigated acres draining to a saline sink	0
Portion of percolation from agri seeping to a perched water table	0
Portion of percolation from agri seeping to a saline sink	0
Portion of On-Farm Drain water flowing to a perched water table/saline sink	0
Portion of Dist. Sys. seep/leaks/spills to perched water table/saline sink	0
Total (AF) flowing to a perched water table and saline sink	0

Table 8

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
2008	131,291	0	0	170,849	0	0	0	302,140
2009	18,838	0	0	28,639	0	0	0	47,477
2010	81,950	0	0	162,115	0	30,072	0	274,137
2011	92,090	0	0	215,147	0	30,064	0	337,301
2012	12,086	0	0	37,741	0	0	0	49,827
2013	888	0	0	4,881	0	0	0	5,769
2014	0	0	0	0	0	0	0	0
2015	0	0	0	2,987	0	0	0	2,987
2016	27,543	0	0	56,073	0	8,504	0	92,120
2017	70,592	0	0	295,462	0	30,827	0	396,881
Total	435,278	0	0	973,894	0	99,467	0	1,508,639
Average	43,528	0	0	97,389	0	9,947	0	150,864

Year of Data	2018	Enter data year here

Table 1

Surface Water Supply

2018 Month	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
Method	M1			Kaweah Riv. M1	Recycled M1	Kaweah/CVP M1		
January	0	0	0	0	0	0	0	0
February	16,307	0	0	0	0	0	0	16,307
March	0	0	0	0	0	0	0	0
April	15,589	0	0	0	0	5,320	0	20,909
May	204	0	0	0	0	12,490	0	12,694
June	8,348	0	0	26,889	0	0	0	35,237
July	4,062	0	0	14,438	0	0	0	18,500
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0
November	0	0	0	0	56	0	0	56
December	0	0	0	0	0	0	0	0
TOTAL	44,510	0	0	41,327	56	17,810	0	103,703

Table 2

Ground Water Supply

2018 Month	District Groundwate (acre-feet)	Private Agric *(acre-feet)
Method		E2
January	0	19,000
February	0	19,000
March	0	19,000
April	0	19,000
May	0	19,000
June	0	19,000
July	0	19,000
August	0	19,000
September	0	19,000
October	0	19,000
November	0	19,000
December	0	19,000
TOTAL	0	228,000

*normally estimated

Table 3

Total Water Supply

2018 Month	Surface Water Total (acre-feet)	District Groundwate (acre-feet)	Recycled M&I (acre-feet)	Total District Water Supply (acre-feet)
Method	M1		M1	
January	0	0	0	0
February	16,307	0	0	16,307
March	0	0	0	0
April	20,909	0	0	20,909
May	12,694	0	0	12,694
June	35,237	0	0	35,237
July	18,500	0	0	18,500
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	56	56
December	0	0	0	0
TOTAL	103,647	0	56	103,703

*Recycled M&I Wastewater is treated urban wastewater that is used for agriculture.

Precipitation Worksheet				
2018	inches precip	ft precip	acres	AF/Year
Jan		0.00	60.61	3.89
Feb	0.40	0.03	909.09	58.33
Mar		0.00	1,099.96	70.58
Apr	0.37	0.03	0.00	0.00
May	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00
Aug		0.00	0.00	0.00
Sept		0.00	0.00	0.00
Oct		0.00	0.00	0.00
Nov		0.00	0.00	0.00
Dec		0.00	0.00	0.00
TOTAL	**0.77**	**0.06**	**2069.65**	**132.80**

Evaporation Worksheet			
2018	inches evap	ft evap	acres
Jan		0.00	60.61
Feb	2.42	0.20	909.09
Mar		0.00	1,099.96
Apr	5.30	0.44	0.00
May	7.00	0.58	0.00
Jun	8.14	0.68	0.00
Jul	8.03	0.67	0.00
Aug		0.00	0.00
Sept		0.00	0.00
Oct		0.00	0.00
Nov		0.00	0.00
Dec		0.00	0.00
TOTAL	**30.89**	**2.57**	**2,069.65**

Table 4

Agricultural Distribution System

2018 Canal, Pipeline, Lateral, Reservoir	Length (feet)	Width (feet)	Surface Area (square feet)	Precipitation (acre-feet)	Evaporation (acre-feet)	Spillage (acre-feet)	Seepage (acre-feet)	Total (acre-feet)
Intake Canals	52,800	50	2,640,000	3.9	156.0	0	1,390	(1,542)
In District Canals	1,584,000	25	39,600,000	58.3	2,340.2	0	12,511	(14,793)
Basins	6,922	6,922	47,914,084	70.6	2,831.5	0	0	(2,761)
Section 7	0	0	0	0.0	0.0	49	0	(49)
Section 9	0	0	0	0.0	0.0	0	0	0
Cameron Creek	0	0	0	0.0	0.0	43	0	(43)
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
TOTAL				132.8	5,327.6	92	13,901	(19,188)

Table 5

Crop Water Needs

2018 Crop Name	Area (crop acres)	Crop ET (AF/Ac)	Leaching Requiremen (AF/Ac)	Cultural Practices (AF/Ac)	Effective Precipitatio (AF/Ac)	Appl. Crop Water Use (acre-feet)
Corn	20,848	2.60	0.0	1.0	0.2	70,883
Wheat	12,048	1.70	0.0	1.0	0.2	30,120
Alfalfa	9,395	4.00	0.0	0.0	0.2	35,701
Pistachios	7,901	3.10	0.0	1.0	0.2	30,814
Almonds	6,635	3.50	0.0	1.0	0.2	28,531
Cotton	6,408	2.90	0.0	1.0	0.2	23,710
Walnuts	5,532	3.80	0.0	1.0	0.2	25,447
Milo Maize	3,981	2.60	0.0	1.0	0.2	13,535
Native Pasture/Grasses	751	1.50	0.0	0.0	0.2	976
Grapes	473	2.50	0.0	0.0	0.2	1,088
Cherries	325	3.00	0.0	1.0	0.2	1,235
Dry Beans	241	2.30	0.0	1.0	0.2	747
Blue Berries	148	2.30	0.0	1.0	0.2	459
Nursery	96	2.50	0.0	0.0	0.2	221
Persimmons	85	3.00	0.0	1.0	0.2	323
Lettuce	70	1.80	0.0	1.0	0.2	182
Oats	69	1.70	0.0	1.0	0.2	173
Oranges	49	3.00	0.0	1.0	0.2	186
Pumpkin/Radishe/Pom	23	2.40	0.0	1.0	0.2	74
Olives	20	3.50	0.0	1.0	0.2	86
Prunes	12	3.50	0.0	1.0	0.2	52
Pears	10	3.50	0.0	1.0	0.2	43
Peaches	7	3.40	0.0	1.0	0.0	31
Crop Acres	75,127					264,615

Total Irrig. Acres 59,361 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2018 District Water Inventory

Type of Water	Location of Information		
Water Supply	Table 3		103,703
Riparian ET	(Distribution and Drain)	minus	0
Groundwater recharge	intentional - ponds, injection	minus	25,766
Seepage	Table 4	minus	13,901
Evaporation - Precipitation	Table 4	minus	5,195
Spillage	Table 4	minus	92
Transfers out of District		minus	2,728
Water Available for sale to customers			56,021
Actual Agricultural Water Sales	2018	From District Sales Records	56,021
Private Groundwater	Table 2	plus	228,000
Crop Water Needs	Table 5	minus	264,615
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		19,406
Unaccounted for Water	(calculated)		0

Table 7

Influence on Groundwater and Saline Sink

2018	
Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	39,667
Estimated actual change in ground water storage, including natural recharge)	-168,927
Irrigated Acres (from Table 5)	75,127
Irrigated acres over a perched water table	0
Irrigated acres draining to a saline sink	0
Portion of percolation from agri seeping to a perched water table	0
Portion of percolation from agri seeping to a saline sink	0
Portion of On-Farm Drain water flowing to a perched water table/saline sink	0
Portion of Dist. Sys. seep/leaks/spills to perched water table/saline sink	0
Total (AF) flowing to a perched water table and saline sink	0

Table 8

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
2009	18,838	0	0	28,639	0	0	0	47,477
2010	81,950	0	0	162,115	0	30,072	0	274,137
2011	92,090	0	0	215,147	0	30,064	0	337,301
2012	12,086	0	0	37,741	0	0	0	49,827
2013	888	0	0	4,881	0	0	0	5,769
2014	0	0	0	0	0	0	0	0
2015	0	0	0	2,987	0	0	0	2,987
2016	27,543	0	0	56,073	0	8,504	0	92,120
2017	70,592	0	0	295,462	0	30,827	0	396,881
2018	44,510	0	0	41,327	0	17,810	0	103,647
Total	348,497	0	0	844,372	0	117,277	0	1,310,146
Average	34,850	0	0	84,437	0	11,728	0	131,015

Year of Data	2019	Enter data year here

Table 1

Surface Water Supply

2019 Month	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
Method	M1			Kaweah Riv. M1		Kaweah/CVP M1		
January	0	0	0	0	0	2,688	0	2,688
February	1,272	0	0	18,258	0	8,344	0	27,874
March	8,187	0	0	22,692	0	12,228	0	43,107
April	38,031	0	0	0	0	2,397	0	40,428
May	6,583	0	0	34,602	0	7,559	0	48,744
June	10,489	0	0	38,184	0	6,264	0	54,937
July	20,261	0	0	26,908	0	13,751	0	60,920
August	6,974	0	0	28,307	0	4,177	0	39,458
September	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	313	0	0	0	313
TOTAL	91,797	0	0	169,264	0	57,408	0	318,469

Table 2

Ground Water Supply

2019 Month	District Groundwate (acre-feet)	Private Agric *(acre-feet)
Method		E2
January	0	12,000
February	0	12,000
March	0	12,000
April	0	12,000
May	0	12,000
June	0	12,000
July	0	12,000
August	0	12,000
September	0	12,000
October	0	12,000
November	0	12,000
December	0	12,000
TOTAL	0	144,000

*normally estimated

Table 3

Total Water Supply

2019 Month	Surface Water Total (acre-feet)	District Groundwate (acre-feet)	Recycled M&I (acre-feet)	Total District Water Supply (acre-feet)
Method	M1		M1	
January	2,688	0	217	2,905
February	27,874	0	906	28,780
March	43,107	0	738	43,845
April	40,428	0	911	41,339
May	48,744	0	945	49,689
June	54,937	0	653	55,590
July	60,920	0	911	61,831
August	39,458	0	941	40,399
September	0	0	1,051	1,051
October	0	0	198	198
November	0	0	0	0
December	313	0	0	313
TOTAL	318,469	0	7,471	325,940

*Recycled M&I Wastewater is treated urban wastewater that is used for agriculture.

Precipitation Worksheet					Evaporation Worksheet			
2019	inches precip	ft precip	acres	AF/Year	2019	inches evap	ft evap	acres
Jan	1.27	0.11	60.61	51.57	**Jan**	1.49	0.12	60.61
Feb	2.66	0.22	909.09	773.48	**Feb**	1.73	0.14	909.09
Mar	1.57	0.13	1,099.96	935.88	**Mar**	3.35	0.28	1,099.96
Apr	0.22	0.02	0.00	0.00	**Apr**	5.48	0.46	0.00
May	1.47	0.12	0.00	0.00	**May**	5.66	0.47	0.00
Jun	0.00	0.00	0.00	0.00	**Jun**	8.19	0.68	0.00
Jul	0.00	0.00	0.00	0.00	**Jul**	8.18	0.68	0.00
Aug	0.00	0.00	0.00	0.00	**Aug**	7.25	0.60	0.00
Sept	0.00	0.00	0.00	0.00	**Sept**	5.34	0.45	0.00
Oct	0.00	0.00	0.00	0.00	**Oct**	3.98	0.33	0.00
Nov	0.92	0.08	0.00	0.00	**Nov**	2.46	0.21	0.00
Dec	2.10	0.18	0.00	0.00	**Dec**	1.08	0.09	0.00
TOTAL	**10.21**	**0.85**	**2069.65**	**1760.93**	**TOTAL**	**54.19**	**4.52**	**2,069.65**

Table 4

Agricultural Distribution System

2019 Canal, Pipeline, Lateral, Reservoir	Length (feet)	Width (feet)	Surface Area (square feet)	Precipitation (acre-feet)	Evaporation (acre-feet)	Spillage (acre-feet)	Seepage (acre-feet)	Total (acre-feet)
Intake Canals	52,800	50	2,640,000	51.6	273.7	0	32,372	(32,594)
In District Canals	1,584,000	25	39,600,000	773.5	4,105.3	0	48,121	(51,453)
Basins	6,922	6,922	47,914,084	935.9	4,967.2	0	0	(4,031)
Section 7	0	0	0	0.0	0.0	262	0	(262)
Section 9	0	0	0	0.0	0.0	489	0	(489)
Cameron Creek	0	0	0	0.0	0.0	266	0	(266)
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
	0	0	0	0.0	0.0	0	0	0
TOTAL				1,760.9	9,346.2	1,017	80,493	(89,095)

Table 5

Crop Water Needs

2019 Crop Name	Area (crop acres)	Crop ET (AF/Ac)	Leaching Requiremen (AF/Ac)	Cultural Practices (AF/Ac)	Effective Precipitatio (AF/Ac)	Appl. Crop Water Use (acre-feet)
Corn	21,422	2.60	0.0	1.0	0.2	72,835
Wheat	15,158	1.70	0.0	1.0	0.2	37,895
Alfalfa	10,158	4.00	0.0	0.0	0.2	38,600
Pistachios	8,336	3.10	0.0	1.0	0.2	32,510
Almonds	7,239	3.50	0.0	1.0	0.2	31,128
Cotton	5,203	2.90	0.0	1.0	0.2	19,251
Walnuts	5,076	3.80	0.0	1.0	0.2	23,350
Milo Maize	846	2.60	0.0	1.0	0.2	2,876
Grapes	473	2.50	0.0	0.0	0.2	1,088
Dry Beans	417	2.30	0.0	1.0	0.2	1,293
Native Pasture/Grasses	375	1.50	0.0	0.0	0.2	488
Cherries	325	3.00	0.0	1.0	0.2	1,235
Oats	214	1.70	0.0	1.0	0.2	535
Blue Berries	148	2.30	0.0	1.0	0.2	459
Persimmons	85	3.00	0.0	1.0	0.2	323
Oranges	81	3.00	0.0	1.0	0.2	308
Nursery	74	2.50	0.0	0.0	0.2	170
Radish	51	2.40	0.0	1.0	0.2	163
Pears, Prunes, Olives	42	3.50	0.0	1.0	0.2	181
Pumpkins	20	2.40	0.0	1.0	0.2	64
Lettuce	20	1.80	0.0	1.0	0.2	52
Pomegranites	3	2.40	0.0	1.0	0.2	10
	0	0.00	0.0	1.0	0.0	0
Crop Acres	75,766					264,813

Total Irrig. Acres 59,022 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2019 District Water Inventory

Type of Water	Location of Information		
Water Supply	Table 3		325,940
Riparian ET	(Distribution and Drain)	minus	0
Groundwater recharge	intentional - ponds, injection	minus	83,477
Seepage	Table 4	minus	80,493
Evaporation - Precipitation	Table 4	minus	7,585
Spillage	Table 4	minus	1,017
Transfers out of District		minus	8,037
Water Available for sale to customers			145,331
Actual Agricultural Water Sales	2019	From District Sales Records	145,331
Private Groundwater	Table 2	plus	144,000
Crop Water Needs	Table 5	minus	264,813
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		24,518
Unaccounted for Water	(calculated)		(0)

Table 7

Influence on Groundwater and Saline Sink

2019	
Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	163,970
Estimated actual change in ground water storage, including natural recharge)	19,970
Irrigated Acres (from Table 5)	75,766
Irrigated acres over a perched water table	0
Irrigated acres draining to a saline sink	0
Portion of percolation from agri seeping to a perched water table	0
Portion of percolation from agri seeping to a saline sink	0
Portion of On-Farm Drain water flowing to a perched water table/saline sink	0
Portion of Dist. Sys. seep/leaks/spills to perched water table/saline sink	0
Total (AF) flowing to a perched water table and saline sink	0

Table 8

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Ag Water (acre-feet)	Federal non-Ag Water. (acre-feet)	State Water (acre-feet)	Local Water (define) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain (acre-feet)	Total (acre-feet)
2010	81,950	0	0	162,115	Recycled	30,072	0	274,137
2011	92,090	0	0	215,147	M&I	30,064	0	337,301
2012	12,086	0	0	37,741	0	0	0	49,827
2013	888	0	0	4,881	0	0	0	5,769
2014	0	0	0	0	0	0	0	0
2015	0	0	0	2,987	0	0	0	2,987
2016	27,543	0	0	56,073	0	8,504	0	92,120
2017	70,592	0	0	295,462	0	30,827	0	396,881
2018	44,510	0	0	41,327	56	17,810	0	103,703
2019	91,797	0	0	169,264	7,471	57,408	0	325,940
Total	421,456	0	0	984,997	7,527	174,685	0	1,588,665
Average	42,146	0	0	98,500	941	17,469	0	158,867