Fresno Irrigation District
Water Management Plan

Prepared in compliance with 2017 Standard Criteria

Final – (11/5/2020)

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Section I: Description of the District

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A. History

1. *Date district formed:* 1920 *Date of first Reclamation contract*: 1965

Original size (acres): 238,000 *Current year (last complete calendar year)*: 2018

2. Current size, population, and irrigated acres

	2018
Size (acres)	247,691
Population served (urban connections)	0
Irrigated acres (crops)	151,943

3. Water supplies received in current year

Water Source	*AF*
Federal urban water (Tbl 1)	
Federal agricultural water (Tbl 1)	4,113
State water (Tbl 1)	
Other Wholesaler (define) (Tbl 1)	
Local surface water (Tbl 1)	448,221
Upslope drain water (Tbl 1)	
District groundwater (Tbl 2)	1,007
Banked water (Tbl 1)	
Transferred water (Tbl 1)	
Recycled water (Tbl 3)	8,689
Other (define) (Tbl 1)	
Total	462,030

4. Annual entitlement under each right and/or contract

	AF	*Source*	*Contract #*	*Availability period(s)*
Reclamation Urban AF/Y	none			
Reclamation Agriculture AF/Y	75,000	SJR/Friant Class 2	14-06-200-1122D	Non-storable, available after Class 1 water supply
Other AF/Y	Varies	Kings River	SWRCB D-1290	Runoff schedule dependent

5. Anticipated land-use changes. For Ag contractors, also include changes in irrigated acres.

Some irrigated land within Fresno Irrigation District (the District) continues to be lost due to urban expansion and development within the District's boundaries during the past 5 years.

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 (1989)[1]		*Previous Plan (2013)*		*Current Plan (2018)*	
Crop Name	*Acres*	*Crop Name*	*Acres*	*Crop Name*	*Acres*
Grapes	77,194	Grapes (vineyard)	57,828	Grapes (vineyard)	44,622
Pastures	14,353	Almond	25,460	Almond	44,053
Nuts	12,561	Orange/Tangerine	12,896	Orange/Tangerine	13,259
Cotton	11,901	Misc. Vegetables	8,245	Misc. Vegetables	6,713
Deciduous Fruit	10,776	Alfalfa	6,183	Pasture	4,046
Alfalfa	10,207	Pasture	4,725	Alfalfa	4,004
		Corn-Silage	3,547	Corn - Silage	2,694
		Nectarine/Peach	3,072	Nectarine/Peach	2,479
		Oats	2,916	Oat	1,755
		Plum/Prune	1,643	Walnut	1,397
		Sod/Turf	1,173	Sod/Turf	1,065
Other (<5%)	27,212	*Other (<5%)*	5,903	*Other (<5%)*	5,773
Total	164,204	*Total*	133,591	*Total*	131,859

(See Planner, Chapter 3, Addendum D for list of crop names)

[1] "Original Plan" cropping pattern acreage is from the District's Water Conservation Plan dated March 3, 1995, which included crop information for year 1989. The District's Water Conservation Plan approved in 1986 did not include cropping pattern acreage information.

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

Original Plan (1989)[2]		*Previous Plan (2013)*		*Current Plan (2018)*	
Irrigation Method	*Acres*	*Irrigation Method*	*Acres*	*Irrigation Method*	*Acres*
Furrow	177,700	Level Basin	37,983	Level Basin	43,678
Sprinkler	100	Furrow	68,741	Furrow	51,659
Low Volume	4,800	Sprinkler	1,681	Sprinkler	1,437
		Low-volume	25,186	Low-volume	42,150
Other		*Other*		*Other*	
Total	182,600	*Total*	133,591	*Total*	138,924

B. Location and Facilities

See Attachment A for maps containing the following: incoming flow locations, turnouts (internal flow), and outflow (spill) points, conveyance system, storage facilities, operational loss recovery system (same location as District's "outflow (spill) points"), 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*
Fresno Canal	Kings River	Parshall Flume	5%
Gould Canal	Kings River	Parshall Flume	5%
Friant-Kern Canal to Gould Canal	Gould Canal at Friant-Kern Canal	Parshall Flume	5%
Friant-Kern Canal to Enterprise Canal	MacDonough Ave at Enterprise Canal	Parshall Flume	5%

2. Current year Agricultural Conveyance System

Miles Unlined - Canal	*Miles Lined - Canal*	*Miles Piped*	*Miles - Other*
260	52 (primarily sides)	363 (includes culverts)	

3 Current year Urban Distribution System

Miles AC Pipe	*Miles Steel Pipe*	*Miles Cast Iron Pipe*	*Miles - Other*
0	0	0	0

[2] Note: "Original Plan" irrigation methods acreage is from the District's Water Conservation Plan dated March 3, 1995, which included irrigation method information for year 1989. The District's Water Conservation Plan approved in 1986 did not include irrigation method acreage information.

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

Name	*Type*	*Capacity (AF)*	*Distribution or Spill*
Axt	Reservoir/Recharge	115.2	Distribution
Benzler (Clay)	Reservoir/Recharge	16.2	Distribution
Bier	Reservoir/Recharge	55.2	Distribution
Boswell (Jameson)	Reservoir/Recharge	380	Distribution
Cardwell	Reservoir/Recharge	60	Distribution
Chestnut Avenue	Reservoir/Recharge	192	Distribution
Cornell	Reservoir/Recharge	53.6	Distribution
Deadwood	Reservoir/Recharge	20.4	Distribution
Dry Creek Tail	Reservoir/Recharge	480	Distribution
Empire	Reservoir/Recharge	65.3	Distribution
Herndon West	Reservoir/Recharge	24.3	Distribution
Hopps (Haupts)	Reservoir/Recharge	48	Distribution
Houghton Waste (Toste)	Reservoir/Recharge	80	Distribution
Jefferson Ave	Reservoir/Recharge	73.6	Distribution
Johns Inline Reservoir	Reservoir/Recharge	5	Distribution
Kearney Avenue Basin	Reservoir/Recharge	129.6	Distribution
Lambrecht (Goldenrod)	Reservoir/Recharge	309.1	Distribution
Limbaugh	Reservoir/Recharge	64	Distribution
Little Pine Flat	Reservoir/Recharge	64	Distribution
Madera	Reservoir/Recharge	72	Distribution
Nordstrom	Reservoir/Recharge	32	Distribution
North Central	Reservoir/Recharge	139.2	Distribution
Pacheco	Reservoir/Recharge	30.5	Distribution
Pursell	Reservoir/Recharge	25	Distribution
Oleander	Reservoir/Recharge	68	Distribution
Rolinda High (Stiggins)	Reservoir/Recharge	7.2	Distribution
Sandhole Pond (leased)	Reservoir/Recharge	12.6	Distribution
Shubin	Reservoir/Recharge	44	Distribution
South West Basin	Reservoir/Recharge	470	Distribution
Ventura	Reservoir/Recharge	106.25	Distribution
Waldron	Reservoir/Recharge	828.4	Distribution
Westfall (Sportsmen)	Reservoir/Recharge	32	Distribution
Wolf	Reservoir/Recharge	54.6	Distribution
TOTALS		4,157	

The District conveys stormwater to these recharge reservoirs when available for groundwater recharge or banking. Refer to Section II.B.4 for additional details.

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

Spills from the District distribution system are collected in regulating reservoirs and/or groundwater recharge basins with no net loss of water. Water enters back into the system through groundwater wells operated by area water users. The District has the ability to convey spill water to the San Joaquin River through the Biola Spillway, but this spillway is periodically used only to discharge winter storm flows and is not used to spill any water during the irrigation season.

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

Scheduled	*Rotation*	*Other (describe)*
X	X	

The District canal system was acquired from the Fresno Canal and Irrigation Co. in 1921 and was built to serve 1 Cubic Feet per Second (CFS) for 160 acres of stock ownership. By comparison, United States Bureau of Reclamation (USBR) generally designs systems for "demand service" within the Central Valley Project (CVP) with a capacity of 1 CFS for every 80 acres served. Because of the conveyance constraints within the District's distribution system, delivery conveyance is generally operated on a 30-day rotation basis, delivering a basic entitlement of 0.39 AF per acre per month. Approximately 60% of the acreage in the District is on a modified 15-day rotation schedule receiving half the basic allotment twice each month. The District has also adopted rules allowing growers to plan flexible schedules to meet the water needs for their ag operations. By switching the days they take water, growers can alter schedules within their canal systems as long as they do not impact canal operations and other growers. A portion of the District (Area 112, approximately 10% of the District) operates under an arranged demand schedule, which allows further grower flexibility.

A growing number of water users within the District are transitioning from furrow irrigation to drip/micro irrigation systems. These systems generally require a continuous low flow water delivery to the irrigation systems, instead of a standard rotation schedule. To accommodate these water users, the District allows water users to obtain a low flow delivery license as long as impacts to other water users on the District facility can be avoided. Some drip/micro irrigation water users within the District are able to remain on the standard rotation schedule by constructing on-farm reservoirs to store water between District deliveries.

7. Restrictions on water source(s)

Source	*Restriction*	*Cause of Restriction*	*Effect on Operations*
Friant	Class 2 storage restrictions and time of use	CVP Class 2 allocation restrictions	Reduced water supply based on allocation type
Friant & Kings	Reservoir Storage	Storage restrictions, reservoir capacity	Loss of water due to flood criteria
Friant & Kings	Canal System Capacity	Flow Capacity	Requires exceeding capacities or having unmet demands during peak demand periods

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

The District plans to continue to operate the distribution system in a manner similar to how it has been operated for many years. The District recently completed a number of projects to improve operational flexibility and upgrade District facilities utilizing bond proceeds from a $15 million bond. The significant capital and maintenance projects that have occurred recently include canal lining, pipeline projects, control and measurement improvements, automation, regulatory reservoirs, and recharge and banking facilities. Additionally, the District has an extensive SCADA system installed at over 100 sites to monitor, measure, and/or control water deliveries. The District also completed its “3-Year Plan” several years ago, which focused on replacing aging infrastructure as well as continuing to improve operational flexibility. The District will continue to invest in replacing its aging infrastructure to provide continued reliability of its conveyance and delivery system as well as investing in facilities, methods, and instruments to improve operational flexibility and reliability.

Since the fall of 2015, approximately 5.1 miles of pipeline have been replaced at a cost of $5.13 million; about 4.2 miles of open canal replaced with pipeline at a cost of $3.40 million; 9,100 feet of canals concrete-lined at a cost of $3.65 million; and 400 feet of canal lined with high-density polyethylene liner at a cost of $47,000. FID has also invested approximately $4.4 million in purchasing 180 acres of additional properties at 5 locations to construct additional recharge and regulation basins. Additionally, FID will be investing an additional $7.5 million for the construction the basins and infrastructure on those properties.

The District is committed to installing measurement devices and implementing a volumetric pricing component in accordance with SBx7-7. The District continues to work on its measurement evaluation and volumetric tolling study that evaluates measurement alternatives for complying with SBx7-7 regulations as well as a study with California State University Fresno to identify potential options for measurement within FID. The District continues to install a variety of measurement devices to evaluate the feasibility of including same in a measurement program. In order to comply with the State regulations, the District will be considering improvement alternatives to provide additional measurement at the farm-gate turnout level and evaluating the feasibility of those alternatives. Compliance with SBx7-7 requirements will require rate approval by methods specified by Proposition 218 for funding the measurement program and for providing a volumetric pricing component of the District’s billing. Implementation of volumetric pricing will require some system improvements as well as operation and billing changes to allow for water delivery measurement and billing. The District will be updating its SBx7-7 Supplement Report and schedule and will be submitting it to the State of California along with the adopted USBR Water Management Plan.

Additionally, Governor Jerry Brown signed legislation in September 2014 to strengthen local management and monitoring of groundwater basins critical to the state's water needs. The Sustainable Groundwater Management Act (SGMA) required local agencies to form Groundwater Sustainable Agencies (GSA) and adopt groundwater sustainability plans that were tailored to the resources and needs of their communities. The North Kings GSA, consistent with SGMA, developed and adopted a Groundwater Sustainability Plan (GSP) by the legislated deadline of January 31, 2020. The GSP was developed in compliance with the California Department of Water Resources’ Groundwater Sustainability Plan Emergency Regulations. Developed pursuant to Water Code Section 10733.2, the regulations described the components of groundwater sustainability plans, intra-basin coordination agreements, and the methods and criteria to be used by DWR to evaluate those plans and coordination agreements. Under the adopted GSP, the District will be engaging with the GSA to develop projects that will enable the District and GSA to reach the defined measurable objectives by 2040. Much work remains to facilitate the successful implementation of the North Kings GSA’s GSP’s. The District will continue to work with the North Kings GSA to ensure that SGMA is effectively and successfully implemented.

C. Topography and Soils

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

The District slopes gently and uniformly from east to west ranging between Mean Sea Level (MSL) elevations 400 feet to 200 feet, and is bordered by the San Joaquin River on the north side of the District. The 5-feet per mile slope was ideal for development of the gravity flow distribution system throughout the District. The westerly gradient is also responsible for the migration of groundwater under the District from northeast to southwest. Heavy groundwater pumping to the west of the District contributes to the groundwater outflow.

2. District soil association map (Agricultural only)

See Attachment A, District Soils Map

General district soil association summary (Agricultural only)

Soil Association	*Estimated Acres*	*Effect on Water Operations & Management*
Alluvial & Floodplains	11,215	Good percolation and infiltration rates
Young Alluvial	114,960	Subsurface migration
Well drained terraces	74,642	Subsurface migration
Valley basin soils	1,863	Runoff and evaporation losses

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

Soil Problem	*Estimated Acres*	*Effect on Water Operations and Management*
None at this time		

D. Climate

1. General climate of the district service area

Annual precipitation in the District averages more than 10 inches, the majority of which falls during the months of December through March. Summer maximum temperatures frequently exceed 100˚ F and winter temperatures occasionally fall below 32 ˚ F. With a mean annual temperature of 63.8˚ F, the area has an average frost-free growing season over 343 days. The District monitors climate zone in Fresno - San Joaquin Valley. The table summarizes the climate, ET station, data period and average annual frost-free days.

Avg. Precip. and Temp. Source: *NOAA – National Centers for Environmental Information https://www.ncdc.noaa.gov/IPS/lcd/lcd.html?_page=0&state=CA&_target1=Next+%3E*
Station - Fresno Air Terminal [FAT], Jan. 1949 – Dec. 2017

Max/Min Temp. and ETo Source: *https://cimis.water.ca.gov/ - CIMIS, Station 80, Fresno State, Jan. 2018- Dec. 2018*

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*

Avg. Precip.	2.12	1.88	1.80	1.07	.35	.15	.01	.01	.15	.52	1.12	1.65	10.83
Avg. Temp.	46.4	51.4	55.9	61.4	69.1	76.4	82.3	80.5	75.5	65.7	54.2	46.3	63.8
Max. Temp.	61.3	64.6	66.2	75.7	81.3	91.5	98.5	95.2	91	80.7	69.9	57.5	77.8
Min. Temp.	40.7	36.1	42.4	47.8	55	58.8	68.6	62.4	57.3	49	40.1	38.5	49.7
ETo	1.46	2.65	3.4	5.71	7.83	8.98	9.27	8.19	6.26	3.99	2.19	1.14	61.07

Weather station ID Fresno *Data period: Year* 1949 *to Year* 2017[3]

ETo Station ID #80, Fresno State *Average annual frost-free days:* 343

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

The District is unaware of any impacts on crop production from micro-climates within the service area.

E. Natural and Cultural Resources

1. *Natural resource areas within the service area*

Name	*Estimated Acres*	*Description*
Fancher Creek	15.5	Ephemeral stream
Redbank Creek-Dog Creek	22.4	Ephemeral stream
Big Dry Creek	38.3	Ephemeral stream

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

Natural creeks carry rainfall runoff into and through the District and conveyed for groundwater recharge at various locations within the District. Upstream runoff detention is managed by the local flood control district.

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

The District does not deliver water to recreational and/or cultural or wildlife areas under any conveyance agreements.

Name	*Estimated Acres*	*Description*
None operated by District		

F. Operating Rules and Regulations

1. *Operating rules and regulations*

[3] 2018 data is not included in the Average Precipitation and Temperature; 2018 data was not available in the NOAA website. The Average Precipitation and Temperature was accessed through NOAA website on March 25, 2019.

See Attachment B, District Rules and Regulations

2. Water allocation policy (Agricultural only)

See Attachment B, District Rules and Regulations, Rule 5
Summary — Each acre of land provided water service within the District is entitled to a minimum allotment of 0.39 acre-feet per month, deliverable at the rate of 1 CFS, for each 10 acres of land, for a period of 24 hours, twice each month, or 48 hours once per month.

3. Official and actual lead times necessary for water orders and shut-off (Agricultural only)

See Attachment B, District Rules and Regulations, Rules 9 and 10
Summary — At the beginning of each year, the District implements rotation schedules, which sets each landowner's rate of flow, day or days of the month, and duration of his/her irrigations. Unscheduled shutoffs shorter than the required 24 hour notice are acceptable for emergency situations. In areas within the District that operate under an arranged demand schedule, landowners can make requests for water deliveries by providing the District with two to three day advanced notices.

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

See Attachment B, District Rules and Regulations, Rules 29, 30, and 33
Summary — Water users who waste water delivered by the District may be refused further services until such conditions are remedied. Landowner/water user is responsible for damage caused by negligence or careless use of water by landowner/water user. Discharges into canals are not allowed without the written consent of the District. There are no subsurface drainage issues within the District.

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

See Attachment B, District Rules and Regulations, Rules 13 and 14
Summary — As a general rule, District practice is not to transfer water unless that water is surplus to the needs of the District. The District has in the past refused to allow transfers of water by growers out of the District. In-District transfers are allowed between growers per Rules 13 and 14.

G. Water Measurement, Pricing, and Billing

1. Agricultural Customers

Refer to BMP A.1. Information on water measurement for agricultural contractors is completed under BMP A.1 in Section III.

2. Urban Customers

The District is not an urban water supplier.

a. *Total number of connections* ______N/A___

b. *Total number of metered connections*____________

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

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

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

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. Agricultural and Urban Rates

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

The District utilizes a per-acre assessment charge for its billing rate structure in most cases. Each parcel is assessed one of eight different assessment rates, depending on the status of the parcel. The following is a description of each assessment rate in 2018.

- Lift Pump Rate ($53.55): For parcels on land higher in elevation than the District's canal, and the District owns and operates lift pumps to deliver water from the canal to the customer.
- Water Service Rate ($46.38 per acre): For parcels that receive surface water from the District without being required to use a lift pump ("gravity" service). Most of the District's customers are under this rate.
- Pump from Ditch Rate ($40.63 per acre): For parcels on land higher in elevation than the District's canal, and the customer owns and operates his own lift pump to deliver water from the canal to the customer.
- Groundwater Only Rate ($33.45 acre): For parcels that do not receive the District surface water. These parcels rely solely on groundwater supplies from private wells. This assessment rate funds the District projects and operations to protect groundwater resources, including the construction and operation of groundwater recharge and banking facilities.

- Minimum Rate ($12.50 per parcel): A minimum assessment rate for parcels under 1.25 acres. Many of these are large parcels in urban areas.
- Developed Annex Rate ($10.00 per acre plus volumetric charge per acre foot that varies each year): For parcels located within the District's annexed areas just outside the District's boundary, primarily along the District's northeast boundary and near the USBR Friant-Kern Canal, that have the facilities in place to take water from the Friant-Kern Canal. These parcels can only receive USBR Central Valley Project (CVP) water from the District (no Kings River supplies), and only when CVP water is available. Volumetric charges for these annexed areas vary year to year depending on hydrologic year type (lower cost in wetter years, higher cost in dry years). Invoices for volumetric charges are sent monthly. The metered volumetric charge was $150/acre-foot in 2018.
- Undeveloped Annex Rate ($4.50 per acre): For parcels located within the District's annexed areas just outside the District's boundary, primarily along the District's northeast boundary and near the USBR Friant-Kern Canal, that do not have the facilities in place to take water from the Friant-Kern Canal. In general, these parcels are in the annexed areas adjacent to "Developed Annex Rate" parcels, but never had water conveyance facilities constructed.
- Free Water Rate ($4.50 per acre): The term "Free Water" refers to the Freewater County Water District (FCWD) adjacent to the easterly boundary of the District. Over 100 years ago, the construction of what today is the District's Fresno Canal impacted the FCWD's ability to use its main canal to directly receive Kings River water supplies. After a series of legal issues and agreements, this Free Water Rate covers the District's costs to store water in Pine Flat Reservoir on behalf of FCWD and to use the District facilities to deliver water to FCWD's main canal.

Refer to Section III.B.4 for a discussion on the relation between the District's rate structure and incentive pricing.

Annual charges collected from agricultural customers

Fixed Charges (2018)			
Charges ($ unit)	*Charge units $/acre, etc.*	*Units billed during year acres, etc.*	*$ collected ($ times units)*
$53.55	Lift Pump - $/acre	1,095	$58,659.94
$46.38	Water Service - $/acre	183,488	$8,510,166.75
$40.63	Pump From Ditch - $/acre	16,086	$653,574.65
$33.45	Groundwater Only - $/acre	40,225	$1,345,525.71
$12.50	Minimum - $/parcel	6,332	$79,150.00
$10.00	Developed Annex - $/acre	2,934	$29,344.50
$4.50	Undeveloped Annex - $/acre	3,244	$14,598.32
$4.50	Free Water - $/acre	1,823	$8,204.87

Volumetric charges (2018)			
Charges	*Charge units*	*Units billed during year*	*$ collected*

($ unit)	*$/AF, etc.*	*AF, etc.*	*($ times units)*
$150	$/AF	922	$138,300

See Attachment D, District Sample Bills

b. Annual charges collected from urban customers

The District is not an urban water supplier.

Fixed Charges			
Charges ($ unit)	*Charge units ($/meter size) etc.*	*Units billed during year (by meter size) etc.*	*$ collected ($ times units)*
N/A			

Volumetric charges			
Charges ($ unit)	*Charge units ($/HCF), etc.*	*Units billed during year HCF, Kgal, etc.*	*$ collected ($ times units)*
N/A			

c. Describe the contractor's record management system

The District keeps a database for all water diverted through the conveyance system. Daily records are also maintained through the District's SCADA system. Deliveries are scheduled by customer and recorded by the water operations department. The accounting department maintains records of billings and account receivables through the use of the accounting program.

H. Water Shortage Allocation Policies

1. Current year water shortage policies or shortage response plan - specifying how reduced water supplies are allocated

The water delivery season is established by the District's Board of Directors based on the surface water supply available that year. During the water delivery season, the District delivers water according to minimum entitlement requirements under Rule 5 of the District Rules and Regulations. Based on the water supply declared or allocated by the USBR and the Kings River Watermaster, the water delivery season is established to equitably distribute the available water supply. Since the District is a conjunctive use district, individual growers use groundwater to supplement their water needs that are not met by surface water supplies. Canals can be used to transport groundwater, when capacity allows for it.

2. Current year policies that address wasteful use of water and enforcement methods

See Attachment B, Rules 29 and 30, District Rules and Regulations
Water users who waste water delivered by the District may be refused service -until such conditions are remedied.

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

Evaluate policies of agencies that provide the contractor with water. Discuss possible modifications to policies and solutions for improved water management.

One policy change that could help is the ability to store CVP Class 2 water past March in any year as long as flood control operations allow it. Carryover of water is key to many dry season allocations. The San Joaquin River restoration program has reduced the overall available CVP water supply and creates uncertainty of the water supply, and restrictive regulations can result in inefficiencies in managing the water supply. Development and implementation of the re-circulated water program to capture San Joaquin River restoration flows may provide a mechanism for water exchange opportunities for the District. Additionally, water conservation projects are difficult to justify when costs must be capitalized over periods longer than contract terms for water.

Section II: 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

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)*
Kings Groundwater Subbasin	1,530	93,000,000	TBD
		(DWR Bulletin 118 (1961)	

In general, the direction of groundwater flow within the District is to the southwest.

3. Map of district-operated wells and managed groundwater recharge areas

See Attachment A, for District Storage Facilities Map

The District operates wells only at its four groundwater banking facilities. These facilities have allowed the District to greatly expand its conjunctive use capability. During wet years with increased surface water supplies, the District is able to recharge additional water to replenish the groundwater at these facilities. During dry years with reduced surface water supplies, the District can operate the wells at these sites to supplement the District's reduced surface water supplies.

The District also operates many other recharge basins. These waters are allowed to percolate into the underground where private wells in the area can pump the water for irrigation purposes. Seepage from the unlined canals within the District distribution system also contribute to groundwater recharge which benefit conjunctive use with District growers.

4. Description of conjunctive use of surface and groundwater
(Please review Guidebook definition of conjunctive use)

Most water users within the District use a combination of surface water and groundwater. Surface water is used to the extent possible where available, however many crops still require the use of groundwater to meet its evapotranspiration requirements because the surface water supply is not sufficient to meet all water needs. The groundwater in the Kings subbasin is considered to be very high quality and there are no water quality limitations for the use of groundwater for agricultural purposes. The Kings groundwater subbasin is currently in a state of overdraft, and while groundwater levels have dropped significantly over time in portions of the Kings subbasin, the groundwater elevations beneath the District remain fairly high. In 2018, the average depth to groundwater beneath the District was 84.2feet.

As previously noted, the District has constructed four groundwater banking facilities consisting of recharge ponds and recovery wells. The projects are generally located in the western portion of the District. The primary water source for recharge at the projects is local stormwater that can be captured from both the urban and rural areas, or San Joaquin/Kings River floodwater. During wet years (or when there is storm runoff), the District diverts surplus surface water supplies into these recharge ponds to bank groundwater for later use. During dry years when surface water supplies are limited, the District is able to operate its recovery wells at the banking facilities to deliver water via its conveyance system to its growers. This protects the region's groundwater supply by reducing private groundwater pumping and helps create a more reliable water supply for District growers.

5. Groundwater Management Plan

See Attachment E, Fresno Area Regional Groundwater Management Plan

6. Groundwater Banking Plan

The District plans to recharge excess surface water whenever it is available, and groundwater is recovered as required in accordance with the groundwater monitoring program. The source of surface water which can be intentionally recharged would include floodwaters (local stream floodwater, local stormwater, Kings River floodwater, Central Valley Project (CVP) Friant Division Section 215 Water (from the San Joaquin River), CVP Friant Division Class II Water, Recovered Water Account, and Kings River Fisheries Management Program Framework Agreement water.

Waldron, Empire, and Lambrecht Banking Facilities
As the first banking project within the District, the project consists of three banking facilities – Waldron, Empire, and Lambrecht. The Waldron site is the largest site, located on approximately 160 acres in the western area of the District, and is comprised of six recharge cells and four recovery wells. The Lambrecht site is located on approximately 60 acres in the northwestern area of the District, and is comprised of four recharge cells and three recovery wells. The Empire site is located on approximately 32 acres in the western area of the District, and is comprised of two recharge cells and one recovery well.

Overall, the District plans to recharge an average of approximately 11,500 acre-feet (AF) of water annually at these three sites. The District plans to recover up to 90% of the water recharged. On an average annual basis this equates to approximately 10,350 AF being recovered from the aquifer and approximately 1,150 AF (10% of the recharged water) being left in the aquifer to account for losses and help mitigate local impacts due to operations.

Boswell Banking Facility
The site is located on approximately 100 acres located in the southwestern portion of the District, and is comprised of two recharge cells and three recovery wells. Surface water is delivered to this site through the Lower Dry Creek No. 77 Canal (LDC).

Overall, the District plans to recharge an average of approximately 6,000 acre-feet (AF) of water annually at this site. The District plans to recover up to 90% of the water recharged. On an average annual basis this equates to approximately 5,400 AF being recovered from the aquifer and approximately 600 AF (10% of the recharged water) being left in the aquifer to account for losses and help mitigate local impacts due to operations.

C. Other Water Supplies

1. "Other" water used as part of the water supply – Describe supply

See Chapter 5, Water Inventory Tables, Table 1

None.

D. Source Water Quality Monitoring Practices

1. Potable Water Quality (Urban only)

N/A – The District is not an urban water supplier. The water supplied by the District is not in a potable state and the District does not warrant the quality or potability of water supplied.

***2. Agricultural water quality concerns*:** *Yes* ____________ *No* ______X_____
(If yes, describe)

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

The District currently tests the surface water quality at seven locations on a monthly basis during the water delivery season. The water is tested for agricultural suitability. Surface water quality from the CVP is also tested annually by the Friant Water Authority. Groundwater is surveyed at 13 monitoring wells and 10 recovery wells located at the District's groundwater banking facilities twice per year if wells are operational for agricultural suitability, just prior to the start and end of the irrigation season. Groundwater quality is generally not a concern within the District.

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

Analyses Performed	*Frequency*	*Concentration Range*	*Average*
pH	Monthly	6.89 – 8.03	7.4
EC (ds/m)	Monthly	.03 - .21	.1
Ca (meg/L)	Monthly	.12 - .83	0.3
Mg (meg/L)	Monthly	.04 - .51	0.2
Na (meg/L)	Monthly	.07 -.93	0.3
HCO3 (meg/L)	Monthly	0 – 1.28	0.5
SO4 (meg/L)	Monthly	0 - .22	0.1
Cl (meg/L)	Monthly	.14 - .54	0.2
SAR	Monthly	.16 – 1.26	0.5
B (ppm)	Monthly	0 - .01	0.0
NO3-N (ppm)	Monthly	0 – 0.1	0.0

Current water quality monitoring programs for groundwater by source[5] (Agricultural only)

Analyses Performed	*Frequency*	*Concentration Range*	*Average*
Cl (mg/L)	Annually	3.4 - 26	11.6
NO3-N (mg/L)	Annually	0 - 37	11.6
pH	Annually	7.2 – 7.8	7.6
SO4 (mg/L)	Annually	2.8 - 26	10.3
As (µg/L)	Annually	0 – 8.1	3.6
Fe (mg/L)	Annually	0 - .91	0.2
Mg (mg/L)	Annually	5.7 - 17	9.7
Na (mg/L)	Annually	6.1 - 36	16.7
DBCP (µg/L)	Annually	0 - .24	0.1
EDB (µg/L)	Annually	0 - 0	0.0
Gross Alpha (pCi/L)	Annually	2.8 – 38.8	14.3

[4] Surface water range and average concentration were produced from seven sampling locations within the District's delivery system during the irrigation season in 2018.
[5] Ground water range and average concentration values provided are from six groundwater wells near the Boswell Banking Facility in 2018.

E. Water Uses within the District

1. *Agricultural*

See Chapter 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*	*Low Volume acres*	*Sprinkler acres*	*Multiple methods acres*
Grapes (vineyard)	44,622	2,393	35,658	7,596		
Almond	44,053	21,524	2,278	19,210		
Orange/Tangerine	13,259	147	1,905	11,207		
Misc. Vegetables	6,713		6,339	252	78	
Pasture	4,046	3,794			243	
Alfalfa	4,004	3,690	235	40	23	
Corn-Silage	2,694	963	1,658	73		
Nectarine/Peach	2,479	489	1,627	362		
Oats	1,755	1,720			35	
Walnut	1,397	522	239	636		
Sod/Turf	1,065			63	1,000	
Other	5,773					
TOTAL	131,859	43,678	51,659	42,151	1,437	0

Note: Of the 5,773acres in the “Other” crop category 1,063 acres are Livestock/Poultry and assumed to have no irrigation type.

3. *Urban use by customer type in current year*

Not Applicable – Fresno Irrigation District is not an urban contractor.

Customer Type	*Number of Connections*	*AF*
Single-family		
Multi-family		
Commercial		
Industrial		
Institutional		
Landscape irrigation		
Wholesale		
Recycled		
Other (specify)		
Other (specify)		
Other (specify)		
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 Fresno	Secondary	8,689	Percolated to groundwater and reclaimed into Lower Dry Creek Canal & Houghton Canal / Irrigation
City of Clovis	Tertiary	2,002	Fancher Canal / Irrigation
	Total	10,691	
Total discharged to ocean and/or saline sink		0	

5. Groundwater recharge in current year (Table 6)

Recharge Area	*Method of Recharge*	*AF*	*Method of Retrieval*
Canal Seepage	Percolation in Canals	89,644	Private landowner wells
FID Recharge Basins (see District map)	Percolation at Recharge Basins	11,398	Private landowner wells
Banking facilities (see District map)	Percolation at Banking Facilities	30,292	District wells at banking facilities
Flood Control/Urban Basins	Percolation at Recharge Basins	57,601	Private and municipal wells
	Total	188,935	

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

From Whom	*To Whom*	*AF*	*Use*
	Total		

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

From Whom	*To Whom*	*AF*	*Use*
Fresno Irrigation District	Delano - Earlimart Irrigation District	6,957	Irrigation
Fresno Irrigation District	Kern Tulare Water District	10,000	Irrigation
	Total	16,957	

The transfers and exchanges out of the District shown above involved previously developed water supplies from the District's water banking facilities.

7. Wheeling, or other transactions in and out of the district boundaries – (Table 6)

From Whom	*To Whom*	*AF*	*Use*
None			

8. Other uses of water

Other Uses	*AF*
None	

F. Outflow from the District (Agricultural only)

See Facilities Map, Attachment A, for the location of surface and subsurface outflow points, outflow measurement points, and outflow water-quality testing locations. The quantity of water shown below left the boundary of the District but was used for recharge or direct irrigation in the vicinity of the District.

1. Surface and subsurface drain/outflow

Outflow point	*Location description*	*AF 2018*	*Type of measureme*	*Accuracy (%)*	*% of total outflow*	*Acres drained*
A	Peach & Lincoln (Briggs)	1,149	Propeller	2%	13%	N/A
B	Oleander South of South	113	Doppler	1%	2%	N/A
C	Oleander South Branch	197	Doppler	1%	2%	N/A
D	Oleander North Branch	52	Doppler	1%	1%	N/A
E	South Lampee	2,094	Doppler	1%	24%	N/A
F	Adams Waste	2,167	Doppler	1%	25%	N/A
G	Central Waste	64	Doppler	1%	1%	N/A
H	Dry Creek (Tail)[6]	2,882	Flume	5%	33%	N/A
Total		8,708	(1. 9% of total deliveries)			

Outflow point	*Where the outflow goes (drain, river or other location)*	*Type Reuse (if known)*
A	Consolidated I.D. Canal	Recharge and Irrigation (downstream use)
B	Consolidated I.D. Canal	Recharge and Irrigation (downstream use)
C	Consolidated I.D. Canal	Recharge and Irrigation (downstream use)
D	Consolidated I.D. Canal	Recharge and Irrigation (downstream use)
E	Recharge Basin	Groundwater Recharge
F	Recharge Basin	Groundwater Recharge
G	Southwest Banking Facility and James I.D. Canal	Recharge and Irrigation (downstream use)
H	Regulation Basin and James I.D. Canal	Recharge and Irrigation (downstream use)

[6] Most of this water was intentionally routed to the joint FID/James ID Southwest Banking Facility located just outside FID, or was intentionally routed to the James ID Canal.

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

The District does not have an outflow water quality testing program for either surface or subsurface drainage or spills. Regulation basins are located in such a manner that they capture nearly the entire outflow that occurs, and any water reaching these locations is captured for reuse through percolation that recharges the groundwater or is utilized by downstream users that are adjacent to the District. No outflow reaches the San Joaquin River except during heavy rains when storm flows may be discharged by the local flood control district. The District has very few subsurface drainage collection systems that are used to protect neighboring properties from canal or basin seepage. These systems are not included in a water quality testing program.

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

Analyses Performed	*Frequency*	*Concentration Range*	*Average*	*Reuse limitation?*
None				

Outflow (subsurface drainage) Quality Testing Program

Analyses Performed	*Frequency*	*Concentration Range*	*Average*	*Reuse limitation?*
None				

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 District is currently not directly involved in the Central Valley Regional Water Quality Control Board water quality remediation or monitoring programs. However, the District is a member of the Kings River Conservation District (KRCD), and KRCD monitors surface water quality as part of the Kings Basin Irrigated Lands Regulatory Program (ILRP). KRCD has been approved by the RWQCB to serve as a third-party coalition for administering the terms and conditions of the ILRP. The Coalition has been formed to represent landowners and operators irrigating agricultural lands (Members) under the General Order R5-2016-0015.

Districts included in the drainage problem area, as identified in "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley (September 1990)," should also complete Water Inventory Table 7 and Addendum C (include in plan as Attachment J)

G. Water Accounting (Inventory)

Go To Chapter 5 for Agricultural Water Inventory Tables and Instructions.

Go To Chapter 6 for Urban Water Inventory Tables and Instructions.

Section III: 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) 4,093

b. Number of delivery points serving more than one farm 110 (community laterals)

c. Number of measured delivery points (meters and measurement devices) 61

d. Percentage of delivered water that was measured at a delivery point 100% (at headworks)

e. Total number of delivery points not billed by quantity 4,068

f. Delivery point measurement device table

Measurement Type	*Number*	*Accuracy* (+/- %)*	*Reading Frequency (Days)*	*Calibration Frequency (Months)*	*Maintenance Frequency (Months)*
Constant-Head Orifices	8**	7%	1	n/a	n/a
Propeller Meter	55	2%	monthly	36	36
Magnetic Meter	2	1%	monthly	36	36
Metered gates (Type A)	4,024**	3-6%	1	n/a	n/a
Acoustic doppler	4	1%	monthly	n/a	36
Other (define)					
Total	4,093**				

**Documentation verifying the accuracy of measurement devices in 2018 is submitted with Plan and included in Attachment C.*

* See documentation in Attachment C for percent error for various devices as documented in Discharge measurement structures, M.G. Bos, 1989, and the included meter manufacturer documentation.

** Many of the constant-head orifices and Type A metered gates in the District have been damaged and no longer meet the accuracy requirements of SB x7-7. Even if repaired, there is uncertainty as to whether these types of measurement devices would comply with SBx7-7 accuracy requirements if upstream (canal) or downstream (landowner system) water levels fluctuate. As included in the District's SBx7-7 Supplement Report to be submitted to the State of California upon adoption of this USBR Water Management Plan, the District has developed a schedule to bring the District into compliance with SBx7-7 (refer to Section I.B.8). In the last several years, the District has retrofitted or repaired some metered gates as part of its efforts for SBx7-7 compliance, which are included in the 4,024 quantity.

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

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Address: 2907 S. Maple Ave., Fresno, CA 93725

Telephone: (559) 233-7161 *E-mail:* esanchez@fresnoirrigation.com

Provide the job description and minimum qualifications for the water conservation coordinator:

The primary responsibilities of the Water Conservation Coordinator at the District include:

- Preparation of 5-year Water Management Plans and annual updates to the plans.
- Facilitate and implement educational and training programs for growers.
- Collect, compile, and distribute information on soils, climate, and crop water requirements to growers, either directly or through a third party such as the Kings River Conservation District (KRCD).
- Provide technical assistance on irrigation techniques, either directly or through a third party such as KRCD.
- Collaborate with and encourage growers to develop irrigation system projects demonstrating new irrigation methods and technology.
- Assist growers with irrigation scheduling, either directly or through a third party such as KRCD.

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

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

a. *On-Farm Evaluations*

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	152,535	0	0	500	600
Number of farms	unknown	0	0	6	8

The District typically provides information from the Irrigation and Training Research Center (ITRC) at California State Polytechnic University San Luis Obispo to potential farmers who might be interested in on-farm irrigation evaluations. The information is mailed to farmers who primarily use drip/micro-irrigation systems. The District also posts a notice regarding these evaluation services on its website. The ITRC did not conduct any on-farm evaluations in 2018. The District did provide a list of names to the ITRC, however the ITRC did not have the resources or time to perform the tests within the District in 2018. ITRC plans on performing on-farm evaluations in 2019 and 2020 and anticipate increased farmer interest in these programs.

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

The District does not track water past the turnout, but the District requires that the water must stay on the field designated for the turnout delivery. The individual water users are responsible for determining which field the water is used on after it passes through the District turnout if there is more than one field served by the turnout. If only one field is served by the turnout, then all of the information for the water that is delivered through the turnout can be applied to that field. A sample invoice to a water user showing the amount of water used during the month is provided in Attachment D.

Most water users within the District are on a water schedule, where an individual turnout or parcel is scheduled to receive a certain amount of water on certain days (or day) of the month. If a water user's current delivery schedule is not optimal for the user's irrigation practices, the water user can contact the District's Watermaster or the designated Water System Operator (WSO) for their area to develop a potential water schedule change. Short term or one-time schedule changes can also be coordinated through communication with the Watermaster or WSO, and are generally allowable as long as other water users are not negatively impacted. Most coordination between the District and users during the water delivery season involves the District WSO that is operating the District facility supplying water to the user's field.

A growing number of water users within the District are transitioning from furrow irrigation to drip/micro irrigation systems. These systems generally require a continuous low flow of water delivered to the inlet of the irrigation systems. To assist water users in the use of drip/micro system technology, the District allows water users to obtain a low flow delivery agreement from the District as long as impacts to other water users on the District facility can be avoided.

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

The District's website includes a link to KRCD's Ag-Line website[7] where crop water use data is provided for 31 crops as well as providing other useful tools and data. KRCD also publishes the KRCD News newsletter approximately once per year.

Water management meetings have been held by the District or KRCD in the past for water users within the District. Private irrigation consultants are also available to assist growers on a grower-consultant basis to help with crop water use information. Access to CIMIS stations are available through KRCD or the District[8].

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

The water quality information developed by the District is available to all water users and can be requested from the District. Due to high quality water delivered by the District, water quality has not been an issue or concern for District water users.

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

[7] KRCD's website : http://www.krcd.org/water/water_management/agline/

[8] Fresno Irrigation District's website: https://www.fresnoirrigation.com/resources

Program	Co-Funders (If Any)	Yearly Targets
Kings River Water Quality Coalition Newsletter	Kings River Water Quality Coalition / Kings River Conservation District	Annually
KRCD News	Kings River Conservation District	Annually
On-Farm Water Management	California State University Fresno	300 acres
Ag-Line Crop Water Use	Kings River Conservation District	Weekly data
Landowner Meetings	Fresno Irrigation District	As necessary
Waterways Newsletter	Fresno Irrigation District	Semi-Annually
Groundwater Education (online)	Kings Basin Water Authority	On-Going

See Attachment F for samples of provided materials and notices.

The District participates in educational programs through involvement in water safety, water awareness, and water advisory committees that provides newsletters, training and other materials to water users, agencies, schools, staff and the local community. The District also provides training to staff by sending them to training courses provided by the ITRC to help better understand irrigation management and conveyance system operations and management.

e. other

None

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

All CVP water delivered is Class 2 water and pricing is based on both per acre assessments and volumetric charges. The price for CVP water is a factor of the per acre assessment and the supply allotment from the USBR. This amount can vary depending on where in the District a grower farms. Certain areas are charged a percent of the base rate, while others pay whole cost. Volumetric charges for water in excess of the allocated water supply is based on the quantity delivered at the turnout. Total supply divided by the total acres provides the District quantity per acre allocation. The amount available is also a combination of Kings River water and CVP surface water supply from Friant. Areas that currently receive Kings River water pay a per acre assessment.

The District is still evaluating a study report that evaluates delivery point measurement and water tolling alternatives in response to regulations imposed by Senate Bill x7-7. One component of the study is evaluating several pricing structure alternatives that are based on charging customers volumetrically. Thus, the District's pricing structure will likely be modified in the near future for all water delivered.

Refer to Section I.B.8 for a timeline for developing and implementing these rate structure changes as part of the District's SBx7-7 compliance plan.

5. Evaluate and improve efficiencies of district pumps

Describe the program to evaluate and improve the efficiencies of the contractor's pumps.

	Total in district	*# surveyed last year (2017)*	*# surveyed in current year (2018)*	*# projected for next year (2019)*
Wells	11	0	0	0
Lift pumps	5	0	0	0

As a member of the Kings River Conservation District, the District has access to free pump testing services, if necessary. All District wells are located at groundwater banking facilities. Seven of the 11 wells were tested for efficiency in 2009, shortly after they were constructed. In 2012, the remaining three wells were tested at the District's new Boswell Banking Facility. In 2014, the remaining well was tested at the District's Waldron Banking Facility shortly after the well was constructed.

B. Exemptible BMPs for Agricultural Contractors

(See Planner, Chapter 2, Addendum B for examples of exemptible conditions)

1. *Facilitate alternative land use*

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

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

Not Applicable - The District is a conjunctive use district which delivers surface water through gravity-based system and does not have lands affected by shallow groundwater levels or lands with significant problems such as drainage or salinity issues contributed by its current irrigation practices.

2. *Facilitate use of available recycled urban wastewater*

Urban wastewater from the Fresno-Clovis Wastewater Treatment Plant within the District's service area is treated and conveyed to percolation basins to recharge the groundwater basin, as permitted by the Regional Water Quality Control Board. Water percolation to the groundwater is then pumped by water users for agricultural use. Some of this recharged water, by prior agreement, is pumped as groundwater into the District's conveyance system for use by agricultural water users.

Tertiary treated urban wastewater is received by the District from the Clovis Treatment Plant by prior arrangement as permitted by the Regional Water Quality Control Board. This water is placed in the District’s conveyance system for use by agricultural water users.

Sources of Recycled Urban Waste Water	*AF/Y Available*	*AF/Y Currently Used in District*
Fresno-Clovis Wastewater Treatment Plant	Up to 30,000	8,689
Clovis Treatment Plant	Up to 5,000	2,002
Total		11,718

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

Program	*Description*
None	

The District does not provide financing of on-farm capital improvements for private landowners. The District will assist any grower in obtaining grants or low-interest loans from qualified sources such as the Natural Resource Conservation Service (NRCS), State Water Resources Control Board, Bureau of Reclamation, Department of Water Resources or State proposition monies that may be available.

In 2011, the District revised its previous policy on cost sharing to landowners who want to pipe District owned canals. The current policy allows the District to contribute towards projects on a limited basis based on numerous factors such as reducing liability associated with canal seepage and levee breaks.

4. Incentive pricing

Describe incentive rate structure and purpose.

It should be noted that the District has only a USBR Class 2 CVP water contract, water of which is non-storable and intermittent in nature.

In general, District customers receive more District's surface water during wet years than in dry years. Thus, under the District's current rate structure, the effective volumetric cost for District water is lower in wet years (encouraging surface water use) and higher in dry years (encouraging water conservation). Generally, during most years, groundwater use within the District is more expensive due to electrical pumping costs compared to the District surface water.

Incentive pricing, or tiered water pricing, is meant to encourage reduced application of surface water, but is counterproductive for conjunctive use where the District encourages the use of surface water when possible. With the District relying on its conjunctive use methods to maintain groundwater levels, incentive pricing to use less water may come at the expense of increased electrical use and/or depleted groundwater tables. Growers must supplement surface water supplies with their own groundwater pumps, but the District's new banking facility wells can also supply growers with recovered water during dry years. In lieu of groundwater pumping, growers can purchase extra water, such as Section 215 water, when it becomes available. Another option available to each grower is that he can use only pumped groundwater, if it is cheaper, but he must still pay for his allocation or transfer it to another grower. In most cases, pumping groundwater is more expensive than using surface water, therefore, incentive pricing exists to avoid the higher priced water supply. Additionally, since the surface water supply is not enough to fully meet crop evapotranspiration requirements, incentive pricing exists to conserve water to minimize use of the more expensive groundwater.

As previously discussed, the District service area suffers from an average annual overdraft of the groundwater basin so use of available surface water is encouraged within the service area. To the extent this is accomplished, the purpose of having an incentive price program is achieved. Additionally, as part of the measurement method study, the District will consider potential pricing methods to maximize conjunctive use opportunities to encourage growers to use surface water when it is available and conserve the groundwater supply.

As included in the District's SBx7-7 Supplement Report to be submitted to the State of California upon adoption of this USBR Water Management Plan, the District has developed a schedule to bring the District into compliance with SBx7-7, which also includes restructuring water rates and charges (refer to Section I.B.8).

5. a) Line or pipe ditches and canals

Within the District, canals are the single largest District-owned and operated facilities. Canals and ditches are used for conveyance of the surface water supply delivery and recharge facilities for underground storage of water supply. Surface water management help correct overdraft of groundwater within the area. The sustained groundwater levels are evidence that utilization of the conveyance system for recharge is an integral part of the District's conjunctive use program. Some ditches have been lined or piped within the service area, however these generally were done as a result of conversion to urban uses or to improve the movement of water to areas not served before or served poorly from the existing ditches. Some ditches have lined sides to reduce maintenance but the bottom is not lined to promote groundwater recharge. The District will continue to explore areas that need lining for improved water management. The table below includes recently completed projects.

Canal/Lateral (Reach)	*Type of Improvement*[9]	*Number of Miles in Reach*	*Estimated Seepage (AF/Y)*	*Accomplished/ 2018*
Redbanks	Pipe Replacement	0.12	unknown	Completed 2018
Maupin	Pipeline Replacement	0.04	unknown	Completed 2018
Maupin	Pipeline Replacement	0.22	unknown	Completed 2018
Briggs	Canal Lining	.13	unknown	Completed 2018
Briggs	Canal Lining	.10	unknown	Completed 2018
Dry Creek	Pipeline Replacement	.16	unknown	Completed 2018
Malaga Ext	Lining Project	0.23	unknown	Completed 2018
Redbanks	Pipeline Replacement	0.22	unknown	Completed 2018
Victoria Col. W. Br	Pipeline Replacement	0.08	unknown	Completed 2018
McNeil	Slip Line	0.11	unknown	Completed 2018
Gow	Pipe Canal	0.07	unknown	Completed 2018
Thompson #4	Pipeline Replacement	.15	unknown	Completed 2018

b) Construct/line regulatory reservoirs

The District has numerous reservoirs (previously listed) that are used for regulatory control at certain locations within the service area. In addition, the District's groundwater banking facilities also provide regulation reservoir functionality. An extensive SCADA system has been installed throughout the District to monitor water deliveries. This system continues to be expanded on an annual basis. The SCADA system performs well in regulating flows throughout the District's conveyance system and will continue to be expanded in the future.

Reservoir Name	*Location*	*Describe improved operational flexibility and AF savings*
Previously listed		

[9] Pipeline Replacements improvements are performed to improve pipes identified in poor condition, damaged or have leaks and contributing to seepage.

6. Increase flexibility in water ordering by, and delivery to, water users

The District utilizes a rotation schedule for irrigation water delivery. This is due to the canals being undersized and at times requiring turnouts from multiple systems to meet the needs of growers. Pipelines and canal lining have been installed in some areas to facilitate water deliveries to certain locations. The SCADA system was initiated to provide more flexibility in water order time and location. Additionally, growers are allowed to swap dates with others as long as additional conveyance constraints are not created. To the extent possible, the District will continue to provide and increase on-demand flexibility to water users with micro-irrigation systems where possible, primarily adjacent to larger conveyance canals

7. Construct and operate district spill and tailwater recovery systems

The District does not have specific spill recovery systems. Rather, regulation basins within the system are located in areas throughout the District to capture most tailwater any given year. The table below shows where tailwater can leave the District, particularly during periods of heavy rainfall. Most of the time any water reaching these locations is reused through percolation or direct irrigation use. Water that seeps past the boards in a check structure, referred to as “crack water”, is pumped back into the system for reuse. There are no spills to the San Joaquin River during the irrigation season. The local flood control district may discharge storm water into District facilities and the District may route this water to the Biola Spill under extreme storm events.

Distribution System Lateral	*Annual Spill 2018 (AF/Y)*	*Quantity Recovered and reused (AF/Y)*[10]
Peach & Lincoln (Briggs Tail)	1,149	1,149
Oleander South of South (Tail)	133	133
Oleander South Branch (Tail)	197	197
Oleander North Branch (Tail)	52	52
South Lampee	2,064	2,064
Adams Waste	2,167	2,167
Central Waste	64	64
Dry Creek (Tail) (Much is intentional to Southwest Banking Facility or James ID)	2,884	2,884
Total	8,708	8,708

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

[10] Recovered and reused by others outside the District.

8. *Plan to measure outflow.*

Total # of outflow (surface) locations/points 11

Total # of outflow (subsurface) locations/points 0

Total # of measured outflow points 11

Percentage of total outflow (volume) measured during report year 100%

All outflow from the District is currently measured, and includes storm water during heavy rains. Regulation basins are located near the tail end of the District's canal systems to capture most of any year's tailwater. Water is collected for recharge or direct irrigation use. There are no additional plans to modify or add outflow measurement locations.

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

Location & Priority	*Estimated cost (in $1,000s)*				
	Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Nothing additional required					

9. Optimize conjunctive use of surface and groundwater

Describe the potential for increasing conjunctive use of surface and groundwater.

As discussed previously, in addition to recharging the groundwater through the conveyance system, the District has constructed four groundwater banking facilities, which have dramatically increased the conjunctive use of surface and groundwater within the District. In an effort to improve the on-going conjunctive use program, the District has encouraged the following programs:

- Provide incentives for lands to come into water service;
- Assist urban agencies in obtaining surface water supplies;
- Planning and constructing more recharge facilities;
- Planning and constructing groundwater banking facilities;
- Discuss water banking with others outside the immediate area; and
- Encourages on farm recharge during periods when crops are dormant.

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 the annual water savings.

In the recent past, the District bonded for $15 million to perform maintenance and upgrade District facilities. The District has routinely spent a significant amount of money on system improvements. The significant capital and maintenance projects that have occurred throughout the years included canal lining, pipeline projects, control and measurement improvements, automation, telemetry/SCADA sites, regulatory reservoirs, and recharge and banking facilities. The District is continues to implement and focus on replacing aging infrastructure as well as continuing to improve its operational flexibility.

Upon completion of the previously discussed system improvements, all critical sites have had improvements made to its measurement capability within the District, many improvements were made with automation. However, the District will gradually continue to automate its conveyance system, as needed, by increasing the amount of regulation facilities and monitoring sites. SCADA software is used to provide the most efficient automation system throughout the District.

11. Facilitate or promote water customer pump testing and evaluation

See Attachment F, Notices of District Education Programs and Services Available to Customers
The Kings River Conservation District continues to offer pump testing to those that pump groundwater within their district, including those within the District. Funding for some level of pump testing is also available through the Energy Commission and through California State University, Fresno's Center for Irrigation Technology. The District encourages water users to test their pumps on an annual basis and improve the efficiency of their pump units. The District notifies water users of pump testing and evaluation programs and other opportunities through its website and a social media site (Facebook). Energy problems will continue to be an area of concern.

12. *Mapping*

The District has developed an extensive GIS mapping system. Maintenance updates are performed each year as facilities are modified or constructed. The estimated costs below are for maintaining and updating the GIS system that have already been developed.

GIS maps	*Estimated cost*				
	2019	*2020*	*2021*	*2022*	*2023*
Layer 1 – Distribution system	$20,000	$20,000	$20,000	$20,000	$20,000
Layer 2 – Drainage system	$0	$0	$0	$0	$0
Suggested layers:					
Layer 3 – Groundwater information					
Layer 4 – Soils map					
Layer 5 – Natural & cultural resources					
Layer 6 – Problem areas					

C. Provide a 3-Year Budget for Implementing BMPs

1. Projected budget summary for the next year.

Year 2019 or Year 1

BMP #		BMP Name	Budgeted Expenditure (not including staff time)	Staff Hours
A	*1*	Measurement	$122,000	960
	2	Conservation staff	$2,250	50
	3	On-farm evaluation /water delivery info	$90	2
		Irrigation Scheduling	$0	0
		Water quality	$27,000	60
		Agricultural Education Program	$7,000	120
	4	Quantity pricing	$30,000	250
	5	Contractor's pumps	$0	0
B	*1*	Alternative land use	$0	0
	2	Urban recycled water use	$40,000	850
	3	Financing of on-farm improvements	$2,000	10
	4	Incentive pricing	$0	0
	5	Line or pipe canals/install reservoirs	$2,797,500	3,840
	6	Increase delivery flexibility	$500	10
	7	District spill/tailwater recovery systems	$0	0
	8	Measure outflow	$0	0
	9	Optimize conjunctive use	$1,250,000	1,200
	10	Automate canal structures	$195,000	500
	11	Customer pump testing	$0	0
	12	Mapping	$20,000	700
		Total	$4,493,340	8,552

2. Projected budget summary for 2nd year.

Year 2020 or Year 2

BMP #		BMP Name	Budgeted Expenditure[11] (not including staff time)	Staff Hours
A	*1*	Measurement	$170,000	1,840
	2	Conservation staff	$2,250	50
	3	On-farm evaluation /water delivery info	$90	2
		Irrigation Scheduling	$0	0
		Water quality	$15,000	40
		Agricultural Education Program	$5,000	150
	4	Quantity pricing	$30,000	250
	5	Contractor's pumps	$0	0
B	*1*	Alternative land use	$0	0
	2	Urban recycled water use	$40,000	850
	3	Financing of on-farm improvements	$2,000	10
	4	Incentive pricing	$0	0

[11] Some of the budget assigned to "A.1 Measurement" will be used to perform a turnout measurement pilot test, evaluating the District's proposed methods for metering turnouts for compliance with SBx7-7 projected in years 2019-2020.

	5	Line or pipe canals/install reservoirs	$2,453,000	3,100
	6	Increase delivery flexibility	$500	10
	7	District spill/tailwater recovery systems	$0	0
	8	Measure outflow	$0	0
	9	Optimize conjunctive use	$1,250,000	1,200
	10	Automate canal structures	$75,000	222
	11	Customer pump testing	$0	0
	12	Mapping	$20,000	700
		Total	$4,062,840	8,424

3. Projected budget summary for 3rd year.

Year 2021 or Year 3

BMP #		*BMP Name*	*Budgeted Expenditure (not including staff time)*	*Staff Hours*
A	*1*	Measurement	$100,000	1,520
	2	Conservation staff	$2,250	50
	3	On-farm evaluation /water delivery info	$90	2
		Irrigation Scheduling	$0	0
		Water quality	$15,000	40
		Agricultural Education Program	$5,000	150
	4	Quantity pricing	$30,000	250
	5	Contractor’s pumps	$0	0
B	*1*	Alternative land use	$0	0
	2	Urban recycled water use	$40,000	850
	3	Financing of on-farm improvements	$2,000	10
	4	Incentive pricing	$0	0
	5	Line or pipe canals/install reservoirs	$2,091,667	4,608
	6	Increase delivery flexibility	$500	10
	7	District spill/tailwater recovery systems	$0	0
	8	Measure outflow	$0	0
	9	Optimize conjunctive use	$2,999,700	1,000
	10	Automate canal structures	$75,000	222
	11	Customer pump testing	$0	0
	12	Mapping	$20,000	700
		Total	$5,381,207	9,412

Section IV: Best Management Practices for Urban Contractors

Section not applicable because Fresno Irrigation District is not an urban contractor.

A. Urban BMPs

Foundational BMPs

1. Utility Operations Programs
    - 1.1. Operations Practices
        - A.1) Conservation Coordinator
        - A.2) Water waste prevention
        - A.3) Wholesale agency assistance programs
    - 1.2. Water Loss Control
    - 1.3. Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections
    - 1.4. Retail Conservation Pricing

2. Education Programs
    - 2.1. Public Information Programs
    - 2.2. School Education Programs

Programmatic BMPs

3. Residential
    - A.1) Residential assistance program
    - A.2) Landscape water survey
    - A.3) High-efficiency clothes washers (HECWs)
    - A.4) WaterSense Specification (WSS) toilets
    - A.5) WaterSense Specifications for residential development

4. Commercial, Industrial, and Institutional (CII)

5. Landscape

B. Provide a 3-Year Budget for Expenditures and Staff Effort for BMPs

1. Amount actually spent during current year.

Year 2018 BMP #	BMP Name	*Actual Expenditures (not including staff hours)*	*Staff Hours*
1.	*Utilities Operations*		
	1.1 Operations Practices	*$0*	*0*
	1.2 Water Loss Control	*$0*	*0*
	1.3 Metering	*$0*	*0*
	1.4 Retail Conservation Pricing	*$0*	*0*
2.	*Education Programs*		
	2.1 Public Information Programs	*$0*	*0*
	2.2 School Education Programs	*$0*	*0*
3.	*Residential*	*$0*	*0*
4.	*CII*	*$0*	*0*
5.	*Landscape*	*$0*	*0*
	Total	*$0*	*0*

2. Projected budget summary for 2nd year.

Year 2019 BMP #	BMP Name	*Projected Expenditures* (not including staff hours)	Staff Hours
1.	*Utilities Operations*		
	1.1 Operations Practices	*$0*	*0*
	1.2 Water Loss Control	*$0*	*0*
	1.3 Metering	*$0*	*0*
	1.4 Retail Conservation Pricing	*$0*	*0*
2.	*Education Programs*		
	2.1 Public Information Programs	*$0*	*0*
	2.2 School Education Programs	*$0*	*0*
3.	*Residential*	*$0*	*0*
4.	*CII*	*$0*	*0*
5.	*Landscape*	*$0*	*0*
	Total	*$0*	*0*

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

Year 2020 BMP #	BMP Name	*Projected Expenditures* (not including staff hours)	Staff Hours
1.	*Utilities Operations*		
	1.1 Operations Practices	*$0*	*0*
	1.2 Water Loss Control	*$0*	*0*
	1.3 Metering	*$0*	*0*
	1.4 Retail Conservation Pricing	*$0*	*0*
2.	*Education Programs*		
	2.1 Public Information Programs	*$0*	*0*
	2.2 School Education Programs	*$0*	*0*
3.	*Residential*	*$0*	*0*
4.	*CII*	*$0*	*0*
5.	*Landscape*	*$0*	*0*
	Total	*$0*	*0*

Section V: Agriculture Water Inventory Tables

Table 1 – Surface Water Supply
Table 2 – Ground Water Supply
Table 3 – Total Water Supply
Table 4 – Agricultural Distribution System
Table 5 – Crop Water Needs
Table 6 – 2018 District Water Inventory
Table 7 – Influence on Groundwater and Saline Sink
Table 8 – Annual Water Quantities Delivered Under Each Right or Contract

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 (Kings River) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain Water (acre-feet)	Total (acre-feet)
Method								
January	0	0	0	1,337	0	0	0	1,337
February	0	0	0	6,803	0	0	0	6,803
March	0	0	0	9,275	0	0	0	9,275
April	2,034	0	0	58,977	0	0	0	61,011
May	2,079	0	0	88,072	0	0	0	90,151
June		0	0	83,248	0	0	0	83,248
July	0	0	0	70,163	0	0	0	70,163
August	0	0	0	58,635	0	0	0	58,635
September	0	0	0	59,669	0	0	0	59,669
October	0	0	0	6,149	0	0	0	6,149
November	0	0	0	3,138	0	0	0	3,138
December	0	0	0	2,755	0	0	0	2,755
TOTAL	4,113	0	0	448,221	0	0	0	452,334

Table 2

Ground Water Supply

2018 Month	District Groundwate (acre-feet)	Private Agric Groundwate *(acre-feet)
Method		
January	0	0
February	0	0
March	0	0
April	0	1,000
May	0	6,000
June	0	21,000
July	0	25,000
August	1,007	20,000
September	0	3,000
October	0	0
November	0	0
December	0	0
TOTAL	1,007	76,000

* 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 (acre-feet)
Method				
January	1,337	0	0	1,337
February	6,803	0	0	6,803
March	9,275	0	0	9,275
April	61,011	0	0	61,011
May	90,151	0	120	90,271
June	83,248	0	2,105	85,353
July	70,163	0	2,247	72,410
August	58,635	1,007	2,033	61,675
September	59,669	0	2,184	61,853
October	6,149	0	0	6,149
November	3,138	0	0	3,138
December	2,755	0	0	2,755
TOTAL	452,334	1,007	8,689	462,030

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

	2018	Precipitation Worksheet		
	inches precip	ft precip	acres	AF/Year
Jan	1.01	0.08	984.14	851.28
Feb	0.39	0.03	984.14	851.28
Mar	4.67	0.39	984.14	851.28
Apr	0.60	0.05	984.14	851.28
May	0.01	0.00	984.14	851.28
Jun	0.00	0.00	984.14	851.28
Jul	0.00	0.00	984.14	851.28
Aug	0.00	0.00	984.14	851.28
Sept	0.00	0.00	984.14	851.28
Oct	0.61	0.05	984.14	851.28
Nov	2.17	0.18	984.14	851.28
Dec	0.92	0.08	984.14	851.28
TOTAL	**10.38**	**0.87**		

	2018	Evaporation Worksheet	
	inches evap	ft evap	acres
Jan	1.61	0.13	984.14
Feb	2.92	0.24	984.14
Mar	3.74	0.31	984.14
Apr	6.28	0.52	984.14
May	8.61	0.72	984.14
Jun	9.78	0.81	984.14
Jul	10.69	0.89	984.14
Aug	9.01	0.75	984.14
Sept	6.89	0.57	984.14
Oct	4.39	0.37	984.14
Nov	2.41	0.20	984.14
Dec	1.25	0.10	984.14
TOTAL	**67.573**	**5.63**	

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)
Basins (all)	4,786	4,787	22,910,582	455.0	2,961.7	0	0	(2,507)
Canals (all)	1,663,200	12	19,958,400	396.3	2,580.1	8,708	90,467	(101,359)
Pipelines	1,900,800	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			42,868,982	851.3	5,541.8	8,708	90,467	(103,865)

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)
Grapes (Vineyard)	44,622	2.51	0.05	0.3	0.2	116,427
Almond	44,053	3.55	0.05	0.4	0.2	165,419
Orange/Tangerine	13,259	3.03	0.05	0.3	0.2	42,166
Misc Vegetables	6,713	2.38	0.05	0.2	0.2	16,585
Pasture	4,046	3.64	0.05	0.4	0.2	15,609
Alfalfa	4,004	3.64	0.05	0.4	0.2	15,445
Corn - Silage	2,694	2.68	0.05	0.3	0.2	7,548
Nectarine/Peach	2,479	3.35	0.05	0.3	0.2	8,771
Oat	1,755	1.34	0.05	0.1	0.2	2,327
Walnut	1,397	3.64	0.05	0.4	0.2	5,388
Sod/Turf	1,065	4.10	0.05	0.4	0.2	4,642
Other	5,773	3.08	0.05	0.3	0.2	18,693
	0	0.00	0.00	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
	0	0.00	0.0	0.0	0.0	0
Crop Acres	131,859					419,020

Total Irrig. Acres 131,859 (If this number is larger than your known total, it may be due to double cropping)

Table 6

2018 District Water Inventory

Water Supply	Table 3		462,030
Riparian ET	(Distribution and Drain)	minus	11
Groundwater recharge	(intentional - ponds, injection)	minus	11,398
Seepage	Table 4	minus	90,467
Evaporation - Precipitation	Table 4	minus	4,690
Spillage	Table 4	minus	8,708
Transfers out of District		minus	16,957
Water Available for sale to customers			329,799
Actual Agricultural Water Sales 2018	From District Sales Records		343,197
Private Groundwater	Table 2	plus	76,000
Crop Water Needs	Table 5	minus	419,020
Drainwater outflow	(tail and tile, not recycled)	minus	0
Percolation from Agricultural Land	(calculated)		177
Unaccounted for Water	(calculated)		(13,398)

Table 7

Influence on Groundwater and Saline Sink

2018

Agric Land Deep Perc + Seepage + Recharge - Groundwater Pumping = District Influence on	100,858
Estimated actual change in ground water storage, including natural recharge	-24,000
Irrigated Acres (from Table 5)	131,859
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

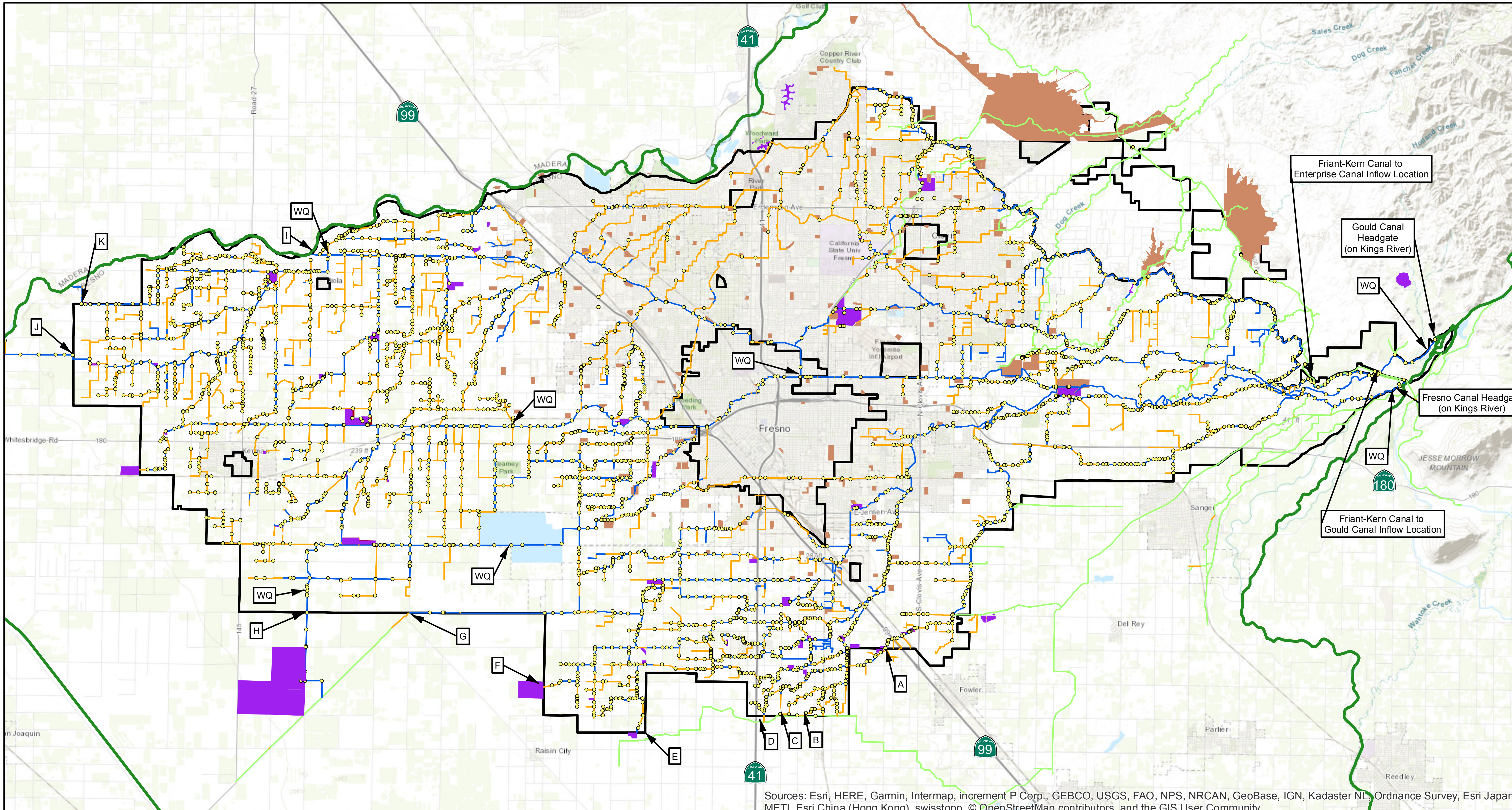
Table 8

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 (Kings River) (acre-feet)	Other Water (acre-feet)	Transfers into District (acre-feet)	Upslope Drain Water (acre-feet)	Total (acre-feet)
2009	3,750	0	0	393,002	0	0	0	396,752
2010	19,232	0	0	503,966	0	0	0	523,198
2011	3,750	0	0	469,406	0	0	0	473,156
2012	0	0	0	361,979	0	23	0	362,002
2013	0	0	0	322,160	0	23	0	322,183
2014	0	0	0	253,682	0	0	0	253,682
2015	0	0	0	117,996	0	0	0	117,996
2016	0	0	0	433,926	0	0	0	433,926
2017	0	0	0	547,846	0	0	0	547,846
2018	4,113	0	0	448,221	0	0	0	452,334
Total	30,845	0	0	3,852,184	0	46	0	3,883,075
Average	3,085	0	0	385,218	0	5	0	388,308

<u>**ATTACHMENT A**</u>

DISTRICT MAPS



FRESNO IRRIGATION DISTRICT

N

0 1 2 3 4 Miles

FID Facilities

- FID Canal
- FID Pipeline
- Creek or Open Canal Owned By Others
- River
- FID Ponds
- FID Groundwater Bank
- Fresno Metropolitan Flood Control District Basin
- FID Boundary
- Turnout
- A Surface Outflow Point
- WQ Surface Water Quality Sampling Location

Fresno Irrigation District

Facilities Map

G:\Reports\FID\Water Management 2019\Facilities Map 20190521.mxd

<u>ATTACHMENT B</u>

DISTRICT RULES AND REGULATIONS

ATTACHMENT B

DISTRICT RULES & REGULATIONS

Rules & Regulations

(Adopted December 23, 1985)

Control and Operation of the Water Distribution System

AUTHORIZATION

Section 22257 of the California Water Code states 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."

The Rules and Regulations set forth hereafter have been approved and adopted by the Fresno Irrigation District Board of Directors and are intended to fulfill the requirements of Section 22257 of the California Water Code. Further, these Rules and Regulations cancel and supercede those Fresno Irrigation District Rules and Regulations dated February 21, 1974. Refusal to comply with the requirements of or transgression of the stated Rules and Regulations may result in sanctions, including but not limited to denial of water service, being imposed by the District until full compliance has been made.

Initial distribution of these Rules and Regulations, to individual landowners/water users, shall be at the beginning of the 1986 water season. Copies of the Rules and Regulations shall be available thereafter in the District office.

CONTROL OF THE SYSTEM

Rule 1: All matters relating to the distribution of water and the maintenance of the District's canals, ditches, and conduits shall be under the general supervision of the District Manager acting under the authority and direction of the Board of Directors.

OWNERSHIP OF CANAL SYSTEM

Rule 2: Certain diversion works, canals, and conduits, headgates and other structures owned by the Fresno Irrigation District were acquired by virtue of a deed from the Fresno Canal and Land Corporation to the Fresno Irrigation District dated May 16, 1921, and recorded on May 17, 1921, in Volume 107, page 1, Official Records of Fresno County, California. Others were acquired by prescriptive use, grants, and various forms of conveyance agreements. All are dedicated to public use and are under the exclusive control of the elected Board of Directors acting through the Manager and staff of the District.

DUTY WATERMASTER/DITCHTENDER RESPONSIBILITIES

Rule 3: Ditchtenders will be assigned to operational areas within the District and will have the responsibility of enforcing District rules and directives. The Duty Watermaster will be responsible for the coordination of landowner/water user requests and will communicate those requests to the Ditchtender as they occur. Scheduled water deliveries to landowners/water users will be performed by Ditchtenders under the direction of the Duty Watermaster.

HANDLING OF DISPUTES

Rule 4: When landowners/water users cannot resolve differences or controversies with the Ditchtender, the Team Supervisor or the Duty Watermaster, they are expected to discuss the problem with the Manager prior to asking the Board of Directors for final determination. The Board of Directors reserves the authority to act as the final level of appeal on differences and controversies between landowners/water users and District employees.

WATER ENTITLEMENT

Rule 5: Each acre of land on water service within the District shall be entitled to a monthly minimum allotment of water consisting of .39 acre feet per month, deliverable at the rate of one cubic foot (7 ½ gallons) per second, for each ten acres of water service land for a period of 24 hours twice each month or 48 hours once each month. The District may, if operational conditions warrant, vary the time and flow rate so long as the water user is afforded a reasonable opportunity to utilize his monthly allotment of water.

WATER ENTITLEMENT EXCEPTIONS

Rule 6: Fresno Irrigation District personnel are not authorized nor are they responsible for the division of water for the lands within the Free Water County Water District which has its own separate water entitlement within the Fresno Irrigation District water rights.

Rule 7: At the start of water season each year the Board of Directors will make an allocation of water to those annexed lands that were formally Trimmer Springs, Dry Creek and Round Mountain Districts. Thereafter the water users within those annexed areas may purchase up to said allotment of water by submitting a request and paying for such water in advance. Delivery of such water shall thereafter be subject to the control of the Watermaster or his representative.

Rule 8: From time to time the Board of Directors may authorize entering into contractual agreements with entities or individuals for the delivery of water on other than a rotational basis.

ROTATION SCHEDULES

Rule 9: Rotation schedules which set forth each landowner's rate of flow, day or days of the month, and duration of delivery shall be prepared by the District staff under the direction and supervision of the District Manager. The rotation schedules shall be prepared prior to the beginning of each water season and landowners taking delivery and utilizing water from the District's canals, ditches and conduits shall be informed in writing by the Ditchtender of the delivery dates, length of time, and amount of water allocated to each landowner or group of landowners during each rotation period. The District reserves the right to revise the rotation schedule at any time during the water season.

WATER DELIVERIES

Rule 10: Water deliveries under the rotation schedules shall be made on the basis of continuous and steady use of water during all days and nights, including holidays and Sundays. It shall be incumbent upon the landowner to utilize water during his full allotted time and to relinquish the water at the end of his scheduled time period unless otherwise approved by the Ditchtender. In order to prevent waste of water and prevent breaks, it is mandatory that every water user notify the Duty Watermaster if he must discontinue the diversion of water prior to his scheduled shut off time.

Rule 11: The Ditchtender will make every effort to maintain an adequate flow of water in each lateral system to meet anticipated demands. However, changes in water use due to temperature variation, improper coordination by upstream users during water changes, local runoff from precipitation, spill water from other lateral systems, canal breaks, and other emergencies may cause unavoidable fluctuations and interruptions in flow. It is expected that a water user will notify the Duty Watermaster if water is not available at the time his rotation period begins or if the flow is interfered with during the period. It is also expected that all water users will cooperate with the Duty Watermaster and/or the Ditchtender in determining the cause of the interruption and will, to the extent practical, assist in correcting the problem.

Rule 12: No additional time shall be granted to water users who fail to use the water continuously when available during the allotted time. If a water user fails, neglects, or refuses to use the water during the period assigned to him on the schedule, it shall not be a valid basis for claiming the right to use water at any other subsequent time. However, if such failure to use water is due to circumstances beyond the control of the water user, particularly if caused by the unavailability of water, the District shall endeavor to make up the lost time in so far as it can be done without unreasonably interfering with the scheduled delivery of water to other water users. Any such water user which is unable to divert his full allotment of water shall promptly notify the Duty Watermaster of his desire to divert the remainder of his entitlement.

WATER EXCHANGES AND TRANSFERS

Rule 13: Landowners may be permitted to exchange water delivery dates (water turns), within a ditch service area if authorized by the Watermaster or his designated representative, provided any such exchange does not create an operational problem or unreasonably interfere with the regular rotation schedule.

Rule 14: Landowners may be permitted to transfer water from one parcel to another, provided both parcels are entitled to receive water service and any such transfer will not unreasonably interfere with the regular rotation schedule and will not exceed the safe operating capacity of any canal, ditch or conduit as determined by the Watermaster or his designated representative. Transfer of water entitlements under this rule may be granted for only one water season and must be reapproved for any subsequent water season. Permanent transfers will not be approved. The following criteria regarding landowner status is applicable:

Different Landowners: As a general rule the transfer of water entitlement from one landowner to another landowner whether on the same lateral or on a different lateral must be approved by the Watermaster. However, short term transfers of 30 days or less on the same lateral system may be authorized by the Ditchtender for the particular lateral.

Same Landowner: Transfer of water along the same lateral need only be approved by the Ditchtender if the water entitlement belongs to the same landowner. In cases where a landowner requests to transfer his entitlement to lands served from a different lateral, approval must first be obtained from the Watermaster

DETERMINATION OF SAFE OPERATING LEVELS IN CANALS

Rule 15: It must be recognized that some lands within the District cannot be served by gravity flow and that the irrigation of such lands will necessitate the use of lift pumps. The water level in any District canal, ditch or conduit shall not be raised to an unsafe height for the purpose of providing gravity service to high elevation lands or delivery facilities. The Watermaster or his designated representative shall determine the safe levels to which water may be raised for the purpose of providing gravity service. Diversions which jeopardize the safe operations of District facilities or interfere with service to others shall not be permitted.

PUMPING FROM CANALS

Rule 16: All landowners/water users who pump from canals, ditches or conduits belonging to the District for the purpose of irrigating land that is too high to be served by gravity water shall be governed in all respects by the rules and regulations applicable to land owners and water users under gravity service. The District will not be responsible for any trash or debris which may flow or accumulate in the water or any interference or decrease in the operating capacity of any private pump installations or pipelines. Private pumping facilities must be installed on a stand offset from District facilities. The exact location and tie-in are subject to approval by the District Manager or his designated representative.

SERVICE TO PRIVATE/COMMUNITY LATERALS

Rule 17: All Ditchtenders will provide limited service to water users who receive their deliveries through private/community owned facilities by informing and advising such users of their water days and allotted time for each rotation period.

Rule 18: Water entitlements of landowners/water users who utilize private/community canals, ditches or conduits shall be delivered to the head of these facilities by the Ditchtender. It shall be incumbent on the owners and/or users to control the actions of individuals taking water from private canals, ditches or conduits. The same authority and jurisdiction granted to Ditchtenders in the operation of canals, ditches and conduits owned by the District is not applicable to those that are privately/community owned.

Rule 19: The District will not knowingly, nor is a Ditchtender authorized to, deliver water to a private/community ditch, pipeline, or other conduit that is not reasonably clean, free of leaks, obstructions and has sufficient capacity to carry the flow of water.

Rule 20: Any landowner who desires to sell his prorata share of water on a year-to-year basis or desires to purchase water from another landowner should contact the Assessor-Collector of the District for prior approval and payment. Any water sale may not be finally approved until the Watermaster determines such transaction will not interfere with the regular rotation schedule or exceed the safe operating capacity of any canal or conduit. Water cannot be permanently sold by one landowner to another, nor can it be transferred for use beyond the boundaries of the District, except to those lands which are presently entitled and which are classified as "water-rental" lands. Water entitlement cannot be sold or transferred to lands that have been annexed since September 1963.

REQUESTS FOR WATER SERVICE

Rule 21: Landowners within the District who are not presently receiving water from the District's distribution system, but desire to do so, shall be required to provide the necessary facilities to transport the water from the District's system to their lands. Requests for new water service must be submitted to the District Assessor-Collector. If the request or requests are approved by the Board of Directors during equalization sessions, the District Watermaster will make the necessary arrangements and schedule the delivery of water to the lands to be irrigated.

RIGHTS OF WAY

Rule 22: Rights of way and easements for canals and ditches owned by the District include the land actually occupied by the canal or ditch, and such land on both sides thereof, as is reasonably necessary for the maintenance and operation of such canals and ditches. Widths of easements vary with the size of the canal and other factors. Specifications and standard dimensions for easements may be obtained from the District Engineer. Rights of way and easements for conduits (pipelines) which have been substituted for open canals and ditches owned by the District and which have been acquired either by voluntary agreement with the landowner or by legal process have been recorded in Official Records of Fresno County, California.

ENCROACHMENTS

Rule 23: No trees, vines, shrubs, corrals, fences, buildings, bridges, or any other type of encroachment shall be planted or placed in, on, over or across any District canal, ditch, conduit or the right-of-way therefor except pursuant to specific written authority of the District Manager. Any such encroachment of an unusual or extraordinary nature shall be approved by the Board of Directors. Any unauthorized encroachment may be removed by the District at the expense of the encroacher.

ACCESS TO LANDS

Rule 24: The authorized agents and employees of the District shall have reasonable access at all times to all lands irrigated from the District's distribution system for the purpose of maintaining, operating, or inspecting the canals, ditches, and conduits and the flow of water therein and for the purpose of ascertaining the acreage of crops on lands irrigated or to be irrigated. If the District holds a right-of-way or easement across private land for the operation and maintenance of a canal or other facilities, the law provides that the District shall have certain secondary rights, such as the right to enter upon the property on which the right-of-way or easement is located to make repairs and do such things reasonably necessary for the full exercise of the easement rights.

WELL MEASUREMENTS

Rule 25: If requested, landowners shall be expected to allow District employees to enter upon their property and measure the depth of water in their private wells for the purpose of determining the conditions of the groundwater within the District. Measurements in selected observation wells are made and recorded by District personnel, in furtherance of a well measurement program begun in 1921.

TAMPERING WITH FACILITIES

Rule 26: Landowners or water users who, by opening, closing or otherwise interfering with regulating gates or devices, cause any fluctuations in the flow of water in the District's distribution system or cause any overflows, breaks or damage of any kind, shall be responsible to the District for the expense and damage caused thereby and may be liable to others that may be adversely affected. Where water control devices are regulated in accordance with specific instructions from an authorized District representative or in cases of an emergency nature when immediate adjustment or other corrective action will prevent overflows, breaks, crop loss or other property damage, the person making such adjustments or taking corrective action shall not be deemed to be in violation of this rule. Any such emergency action or adjustments shall be reported forthwith to the Duty Watermaster.

DAMAGING FACILITIES

Rule 27: No person shall make an opening, cut, plow or disc down or otherwise damage or weaken any canal, ditch or conduit owned by the District without written approval of the Manager or his designated representative. Any such approval to open, cut, plow, or disc down or otherwise disturb any District canal, ditch or conduit shall contain requirements for the restoration of such canal, ditch, or conduit to its original condition or better. The District reserves the right to seek restoration and monetary damages as provided by law for any unauthorized damage done to its system.

UNAUTHORIZED INSTALLATION

Rule 28: No delivery gate, pipe, siphon or any other structure or device shall be installed or placed in any canal, ditch or conduit owned by the District without express written permission and must be in strict compliance with plans and specifications approved by the Manager or his designated representative. Any such structure or device installed on a District canal, ditch or conduit without approval may be removed by the District at the expense of the owner.

LANDOWNER/WATER USER RESPONSIBILITIES

Rule 29: Water users who waste water delivered by the District, either willfully, carelessly or on account of defective or inadequate privately owned ditches, conduits, or structures, or because of inadequate preparation of the land for irrigation, may be refused further services until such conditions are remedied. Any waste or other improper use of water shall be reported to the Duty Watermaster who will take appropriate action.

Rule 30: When water is delivered to a landowner/water user he shall be responsible for the water at all times after it leaves any canal, ditch or conduit owned by the District. The District will not be responsible or liable for any damage caused by negligence or careless use of water by any landowner/water user or the result of failure on his part to maintain any ditch, pipeline or other facility for which he is wholly or in part responsible. It is incumbent on all landowners/water users to prevent hazardous conditions, mosquito nuisances, or damage to the property of others.

PERSONAL LIABILITY

Rule 31: Any person entering upon District property or District right-of-way, does so at his own risk and assumes all risks associated therewith and by such action accepts the responsibility for any damage to District or private property resulting therefrom.

TRASH AND DEBRIS

Rule 32: No tires, trash, debris, litter, garbage, prunings, brush, grass, dairy waste, dead animals, herbicides, pesticides, or any other material which is offensive to the senses or injurious to health, or which pollutes or degrades the quality of water or which obstructs the flow of water, shall be placed, emptied, discharged, thrown, or be allowed to slide, flow, wash or be blown into any canal, ditch or conduit belonging to the District. All District employees shall promptly report any violations of this rule to the District's Duty Watermaster who will take appropriate action. The District reserves the right to take appropriate legal action and seek restitution in incidents of this nature.

DISCHARGES INTO CANALS

Rule 33: No person, firm, company, corporation or agency shall be permitted to pump, siphon, or drain surplus irrigation water (tail-water), storm water, waste water, or any other water, including but not limited to well water, into any District canal, ditch, or conduit on a long-term basis without the express written consent of the Board of Directors. A short-term discharge authorization may be issued by the District Manager. Any such written authorization shall include the manner, method, limitations, and terms and provisions for the District's control and regulation of the approved discharge. Any such discharges which result in pollution or contamination of District facilities shall be immediately reported to the Duty Watermaster for appropriate action.

<u>ATTACHMENT C</u>

MEASUREMENT DEVICE DOCUMENTATION

ATTACHMENT C

MEASUREMENT DEVICE DOCUMENTATION

Discharge measurement structures

Third revised edition

Edited by
M.G. Bos

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3.3 Properties and limits of application of structures

3.3.1 General

In Section 3.2 the most common demands made upon discharge measuring or regulating structures are described. In Chapters 4 to 9, the properties and limits of application of each separate structure are given in the sections entitled Description and Limits of application. To aid the design engineer in selecting a suitable structure, we have tabulated the most relevant data.

3.3.2 Tabulation of data

Table 3.1 consists of 18 columns giving data on the following subjects

Column 1 – Name of the standard discharge measuring or regulating device. In brackets is the section number in which the device is discussed. Each section generally consists of sub-sections entitled: Description, Evaluation of discharge, Modular limit, Limits of application.

Column 2 – A three-dimensional sketch of the structure.

Column 3 – Shape of the control section perpendicular to the direction of flow and the related power u to which the head or differential head appears in the head-discharge equation.

Column 4 – Possible function of the structure. If the area of the control section cannot be changed, the structure can only be used to measure discharges; this is indicated by the letter M in the column. If the weir crest can be made movable by use of a gate arrangement as shown in Section 4.2, or if the area of an orifice is variable, the structure can be used to measure and regulate discharges and has the letters MR in the column. The Dethridge and propeller meters can measure a flow rate in m^3/s and totalize the volume in m^3. The discharge can be regulated by a separate gate, which is, however, incorporated in the standard design. These two devices have the letters MRV in the column.

Column 5 – Minimum value of H_1 or Δh in metres or in terms of structural dimensions.

Column 6 – As Column 5, but giving maximum values.

Column 7 – Minimum height of weir crest or invert of orifice above approach channel bottom; in metres or in terms of structural dimensions.

Column 8 – Minimum dimensions of control section; b_c, B_c, w, and D_p.

Column 9 – Range of notch angle θ for triangular control sections.

Column 10 – Minimum discharge (Q_{min}) in $m^3/s \times 10^{-3}$ or l/s of the smallest possible structure of the relevant type, being determined by the minima given in Columns 5, 8, and 9.

Column 11 – Maximum discharge: q in m^2/s, being the discharge per metre crest width if this width is not limited to a maximum value, or Q in m^3/s if both the head (differential) and control section dimensions are limited to a maximum. No maximum discharge value is shown if neither the head (differential) nor the control dimensions are limited by a theoretical maximum. Obviously, in such cases, the discharge is limited because of various practical and constructional reasons.

Column 12 – Value of $\gamma = Q_{max}/Q_{min}$ of the structure. If Q_{max} cannot be calculated directly, the γ-value can usually be determined by substituting the limitations on head (differential) in the head-discharge equation, as shown in Section 3.2.3.

Column 13 – Modular limit H_2/H_1 or required total head loss over the structure. The modular limit is defined as that submergence ratio H_2/H_1 whereby the modular discharge is reduced by 1% due to an increasing tailwater level.

Column 14 – Error in the product C_dC_v or in the coefficient C_e.

Column 15 Maximum value of the sensitivity of the structure times 100, being

$$100\,S = \frac{u}{h_1}\,\Delta h_1\; 100$$

where the minimum absolute value of h_1 is used with the assumption $\Delta h_1 = 0.01$ m. The figures shown give a percentage error in the minimum discharge if an error in the determination of h_1 equal to 0.01 m is made. The actual error Δh obviously depends on the method by which the head is determined.

Column 16 – Classifies the structures as to the ease with which they pass floating and suspended debris.

Column 17 – Classifies the structures as to the ease with which they pass bed-load and suspended load.

Column 18 – Remarks.

3.4 Selecting the structure

Although it is possible to select a suitable structure by using Table 3.1, an engineer may need some assistance in selecting the most appropriate one. To help him in this task, we will try to illustrate the process of selection. To indicate the different stages in this process we shall use differently shaped blocks, with connecting lines between them. A set of blocks convenient for this purpose is defined in Figure 3.7.
All blocks except the terminal block, which has no exit, and logical decision blocks, which have two or more exits, may have any number of entry paths but only one exit path. A test for a logical decision is usually framed as a question to which the answer is 'Yes' or 'No', each exit from the Lozenge block being marked by the appropriate answer.

A block diagram showing the selection process is shown in Figure 3.8. The most important parts of this process are:

- The weighing of the hydraulic properties of the structure against the actual situation or environment in which the structure should function (boundary conditions);
- The period of reflection, being the period during which the engineer tests the type of structure and decides whether it is acceptable.

Both parts of the selection process should preferably be passed through several times to obtain a better understanding of the problem.

To assist the engineer to find the most appropriate type of structure, and thus the

TABLE 3.1. DATA ON VARIOUS STRUCTURES

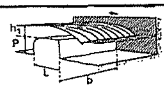
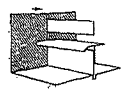
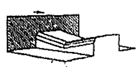
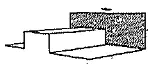
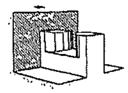
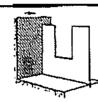
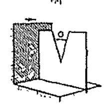
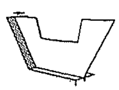
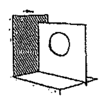
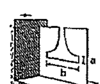
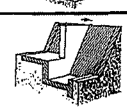
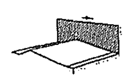
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Name of structure and section number in which structure is described	Sketch of structure	Shape of control section perpendicular to flow and u-value	M = measuring MR = measuring & regulating	H_1 min or Δh min	H_1 max or Δh max	minimum crest height above approach channel bottom p	minimum size of control b or B, w and D_p	range of notch angle θ degrees	Q_{min} m^3/s	Q_{max} in m^3/s or q max in m^2/s	$\gamma = \frac{Q_{max}}{Q_{min}}$	modular limit H_2/H_1 or head loss	error in C_dC_v or C_e (%)	sensitiveness at minimum head % per 0.01 m	debris passing capacity (+ + very good; + good; □ fair; - poor; - - very poor)	sediment passing capacity	Remarks
Round-nose horizontal broad-crested weir (4.1)		rectangular u = 1.5	MR	0.06 m 0.05 L	0.5 L	0.15 m 0.33 H_1	0.30 m H_1 max 0.2 L	-	0.0066 b = 0.30 m	q = 4.7 H_1=2.0 m	35	0.70 to* 0.95	2(21-20 C_d)	25	+	□	* value depends on slope backface and on ratio p_2/H_2
Romijn movable measuring/regulating weir (4.2)		rectangular u = 1.5	MR	0.05 m 0.12 L	0.78 L	0.15 m 0.33 H_1	0.30 m H_1 max	-	0.0057* b=0.30 m	Q=0.860* b=1.50 m	30	0.30	3	30	+	+	* values refer to standard weir with L = 0.60 m
Triangular broad-crested weir (4.3)		(truncated) triangular u=1.7 to 2.5	MR	0.06 m 0.05 L	0.5 L to 0.7 L	0.15 m 0.33 H_1	0.30 m H_1 max 0.2 L	30 to 180	0.0026 at θ=30°	variable	830*	0.80 to 0.95	2(21-20 C_d)	42	+ to □ depending on θ	□	* triangular control 0.05 L≤H_1≤0.7 L
Broad-crested rectangular profile weir (4.4)		rectangular u = 1.5	MR	0.06 m 0.08 L	0.85 L* 1.50 L	0.15 m if 0.4 h_1 if 0.65 h_1	0.30 m h_1 max 0.2 L	-	0.0064	q=5.07 H_1=2.0 m	35* 81	0.66 to 0.38	10F-8 1≤F≤1.24	25	□	□	* depending on weir height p
Faiyum weir (4.5)		rectangular u = 1.6	M	0.06 m 0.08 L	1.6 L	0.15 m	0.05 m $3h_1/A_1$	-	0.0011	q=5.1 H_1=2.0 m	90	0.66*	5	25	□	-	* usually lower
Rectangular sharp-crested weirs (5.1)		rectangular u = 1.5	M or MR	0.07 m 0.03 m	0.60 m 0.5 b 2.4 p	0.30 m 2 h_1 0.10 m 0.5 h_1	0.30 m B-b>4 h_1 0.15 m	-	0.00997 0.00137	q=0.813 variable	24.5 if b≥1.2 m about 30	head loss= H_1 +0.05 m head loss= H_1 +0.05 m	1 1	25 25	- - -	- - - -	Fully contracted weir Full width & partially contracted weirs
V-notch sharp-crested weirs (5.2)		triangular u = 2.5	M M	0.05 m 0.05 m	0.60 m 1.2 p 0.38 m 0.4 p	0.10 m 0.45 m	B_1≥2.5 h_1 B_1≥5.0 h_1	90 25 to 100	0.0008 about 0.0002 if θ=28°4'	Q=0.390 about Q=0.145 if θ=100°	about 500 about 150	head loss ≥ H_1 head loss ≥ H_1	2 1	50 50	- - - -	- - - -	partially contracted fully contracted
Cipoletti weir (5.3)		trapezoidal u = 1.5	MR	0.06 m	0.60 m	0.30 m 2 h_1	b≥0.30 m 0.5 h_1	-	Q=0.0082 b=0.30 m	q=0.864	36.4	head loss H_1+0.05 m	5	25	- -	- -	
Circular weir (5.4)		circular u is variable but ≤ 2.0	M	0.03 m 0.1 d	0.9 d	0.10 m 0.5 d	d≥0.20 m	-	0.00091 d=0.20 m	variable	55.9 if d≥0.30 m	head loss H_1+0.05 m	2	67	- -	- -	
Proportional weir (5.5)		proportional u = 1.0	M	0.03 m 2 a	such that x≤0.005 m	p = 0" or p≥0.15 m	0.15 m	-	0.0058 a=0.006 m b=0.15 m	variable	small,but depends on a-value	head loss H_1+0.05 m	2	33	- -	- - " good if p = 0	a ≥ 0.005 m
Weir sill with rectangular control section (6.1)		rectangular u = 1.5	M	0.09 m 0.75 L	0.90 m 0.5 b	0	0.30 m b≥1.25 b_1	-	0.013 b=0.30 m	q=1.366	32	0.20	5	17	+	+	
V-notch weir sill (6.2)		triangular u = 2.5	M	h_1=0.03m	h_1=1.83 m	0.15 m	-	126°52'* 143°08' 157°22'	0.0005 0.0007 0.0010	Q=25.4** Q=30.6 Q=49.4	50000* 43000 49000	0.30	3	83	□	-	*three notch angles only **depending on A_1-values
Triangular profile two-dimensional weir (6.3)		rectangular u = 1.5	M	0.03 m* steel 0.06 m concrete	3.00 m 3.0 p	0.06 m 0.33 H_1	0.30 m 2 H_1	-	0.0031 h_1=0.03m 0.0088 b=0.30 m h_1=0.06m	q=10.18	1000* or 350	0.75	10 C_v-9	50 or 25	+ +	+	*depends on crest material. Applies to 1-to-5 back face

TABLE 3.1. DATA ON VARIOUS STRUCTURES (cont.)

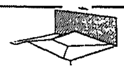
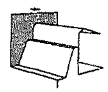
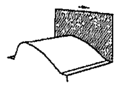
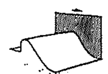
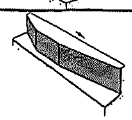
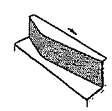
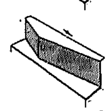
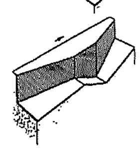
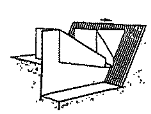
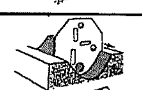
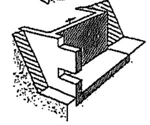
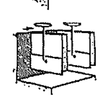
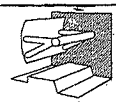
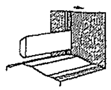
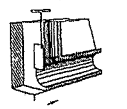
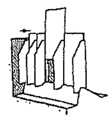
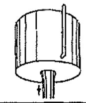
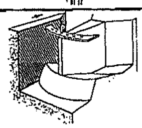
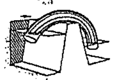
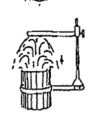
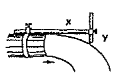
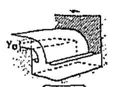
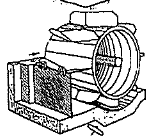
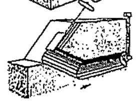
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Name of structure and section number in which structure is described	Sketch of structure	Shape of control section perpendicular to flow and u-value	M = measuring MR = measuring & regulating	H_1 min or Δh min	H_1 max or Δh max	minimum crest height above approach channel bottom p	minimum size of control b or B, w and D_p	range of notch angle θ degrees	Q_{min} m^3/s	Q_{max} in m^3/s or q max in m^2/s	$\gamma = \frac{Q_{max}}{Q_{min}}$	modular limit H_2/H_1 or head loss	error in C_dC_v or C_e (%)	sensitiveness at minimum head % per 0.01 m	debris passing capacity	sediment passing capacity	Remarks
															+ + very good; + good; □ fair; - poor; - - very poor		
Triangular profile flat-vee weir (6.4)		(truncated) triangular u = 1.7 to 2.5	M	0.03 m steel 0.06 m concrete	3.00 m 3.0 p	0.06 m 0.33 H_1	0.30 m 2 H_1	168°34' 174°16'	0.0137 b=0.03 m 0.0275 h_1=0.06 m b=0.30 m	depends on degree of truncation	100,000* h_1≥0.03 m 17,500 h_1≥0.06 m	0.67	10 C_v-8	83 if h_1=0.03 m 42 if h_1=0.06 m	+ +	+	Applies to 1-to-5 back face only. *γ-values decrease if control is more truncated
Butcher's movable standing wave weir (6.5)		rectangular u = 1.6	MR	0.05 m	1.00 m	1.4 $h_1$max	0.30 m 2 h_1	-	0.0077 b=0.30 m	q=2.30	120	0.70	3	32	+	-*	* good if gate arrangement as in Section 4.2
WES-Standard spillway (6.6)		rectangular u = 1.5	M	0.06 m	depends* on h_d 5.0 p	0.15 m 0.2 h_1	0.30 m 2 H_1	-	0.025 b=1.0 m	variable*	about 1000 but depends on h_d-value	0.30	5	25	+ +	+	* minimum pressure on crest limited to -4.0 m water column (see Fig.6.17)
Cylindrical crested weir (6.7)		rectangular u = 1.5	MR	0.06 m 0.1 r	depends* on r 3.0 p	0.15 m 0.33 h_1	0.30 m 2 H_1	-	0.0064 b=0.30 m	variable*	about 750, but depends on ratio H_1/r	0.33	5	25	+ +	+	* minimum pressure on crest limited to -4.0 m water column (see Fig.6.23)
Long-throated flumes (5 basic shapes) (7.1)		rectangular u = 1.5	M	0.06 m 0.1 L for all flumes	1.0 L 1.0 B for all flumes *Note: in general* H_1≤3.0 m	0 but Fr≤0.5 for all flumes	0.30 m*	-	0.0066 b=0.30 m	variable with throat length	35	0.70 to 0.95 depending on downstream transition	2(21-20C_d) for all flumes	25	+ +	+	* for all flumes: at maximum stage: B > 0.30 m B > H_1max B > L/5
		(truncated) triangular u=1.7 to 2.5	M				B≥0.10 m*	30 to 180	0.00098 θ=90°		≤315			28 to 42	+ +	+ +	
		trapezoidal u=1.6 to 2.4	M				B≥0.30 m*	side slope variable**	0.0036 b=0.08 m slope 1:2		≤250			27 to 40	+ +	+ +	**side slope ratio horz : vert. varies between 1:1 to 4:1
		parabolic u = 2.0	M				f ≥0.10 m*	-	0.0027 f=0.10 m		100			33	+ +	+ +	
		(semi)-circular u is variable but ≤ 2.0	M				d ≥ 0.20 m*	-	0.0026 d=0.20 m		100 if d≥0.60 m			≤ 33	+ +	+ +	
Throatless flumes with rounded transition (7.2)		rectangular u = 1.5	M	0.06 m	2.00 m 1.5 R	0	0.20 m H_1 max	-	0.0050 b=0.20 m	q=4.82 H_1=2.00 m	190	about* 0.50	8	25	+ +	+	* if radii of rounding and if downstream transition comply with Section 7.2.2
Throatless flumes with broken plane transition (7.3)		rectangular u = 1.5	M	0.06 m	1.80 m	0	0.305 m only	-	-	-	-	-	-	25	+ +	+	not recommended to be constructed due to lack of data
Parshall flumes (22 types) (7.4)		rectangular u = 1.55	M	0.015 m and 0.03 m	0.21 m to 0.33 m	0 level floor	0.0254 m to 0.0762 m	-	0.00009 to 0.00077	0.0054 to 0.0321	about 55	0.50	3	103 to 52	+ +	+	very small flumes; 1,2, and 3 inch wide
		u = 1.522 to u = 1.607	M	0.03 m, 0.045 m, and 0.076 m	0.45 m to 0.76 m		0.1524 m to 2.438 m	-	0.0015 to 0.0972	0.111 to 3,949	about 75	0.60 and 0.70	3	53 to 21	+ +	+	small flumes; 0.5,0.75, 1.0, 1.5, 2,3 to 8 feet wide
		u = 1.60	M	0.09 m	1.07 m to 1.83 m		3.048 m to 15.24 m	-	0.16 to 0.75 m^3/s	8.28 to 93.04 m^3/s	about 105	0.80	3	18	+ +	+	large flumes; 10 to 50 feet wide
H-flumes (3 types) (7.5)		sloping trapezium u = 2.0 to 2.4	M	0.01 m to 0.04 m	0.11 m to 0.30 m	0	see Figure 7.21	-	0.000012 to 0.00034	0.0003 to 0.0223	about 100	0.25	3	≤240	-		HS-flumes, D=0.4, 0.6, 0.8 and 1.0 ft
				0.01 m to 0.03 m	0.14 m to 1.36 m				0.000031 to 0.0014	0.009 to 2.336	about 750	0.25	3	≤240			H-flumes, D=0.5, 0.75, 1.0, 1.5, 2.0, 2.5, 3.0, and 4.5 ft
				0.03 m	1.06 m and 1.21 m				0.0018 and 0.0020	2.369 and 3.326	about 1500	0.25	3	≤ 80	+		HL-flumes, D=3.5 and 4.0 ft
Circular sharp-edged orifice (8.1)		circular u = 0.5	M	Δh≥0.03 m h_1 ≥ d	-	0.5 d	A ≤ 10 A_1 d ≥ 0.02 m	-	0.00014 d=0.02 m	variable	5.8*	submerged	1	17	- -	- -	*0.03 m ≤ Δh ≤ 1.0 m
Rectangular sharp-edged orifice (8.2)		rectangular u = 0.5	M but MR if suppressed	Δh≥0.03 m y_1≥0.15 m	-	0	b≥0.30 m w≥0.02 m	-	0.0028	variable	5.8*	submerged	2 to 3	17	- -	□ if p=0	*0.03 m ≤Δ h ≤ 1.0 m and A = constant
Constant head orifice (8.3)		rectangular u = 0.5	MR	Δh≡0.06 m y_1 ≥ 2.5 w	Δh=0.06 m	0	usually* b=0.60 m and b=0.75 m	-	0.0086* 0.0107	Q=0.140* Q=0.280	16** 26	submerged, but usually ΔH_t≥0.30 m	≥ 7	8	- -	-	* Two sizes of orifice gates,0.60×0.45 m & 0.75 ×0.60 m are com.used ** If A varies

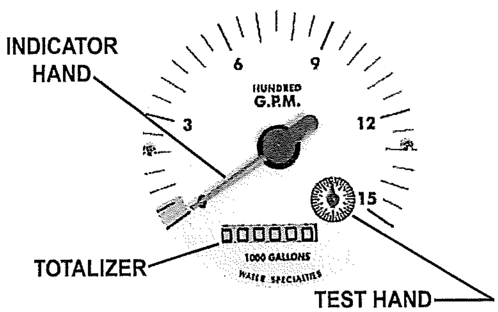
TABLE 3.1. DATA ON VARIOUS STRUCTURES (cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Name of structure and section number in which structure is described	Sketch of structure	Shape of control section perpendicular to flow and u-value	M = measuring MR = measuring & regulating	H_1 min or Δh min	H_1 max or Δh max	minimum crest height above approach channel bottom p	minimum size of control b or B, w and D_p	range of notch angle) degree:	Q_{min} m^3/s	Q_{max} in m^3/s or q max in m^2/s	$\gamma = \frac{Q_{max}}{Q_{min}}$	modular limit H_2/H_1 or head loss	error in C_dC_v or C_e (%)	sensitiveness at minimum head % per 0.01 m	debris passing capacity	sediment passing capacity + + very good; + good; □ fair; - poor; - - very poor	Remarks
Radial or Tainter gate (8.4)		rectangular u = 0.5	MR	$y_1 \geq 0.15$ m $y_1 \geq 1.25$ w $y_1 \geq 0.1$ r	$y_1 < 1.2$ r	0	b≥0.30 m w≥0.02 m	-	0.005 y_1=0.15 m	variable	about* 35	variable	5	8	-	+ +	* If A varies γ is greater if gate is lifted entirely
Crump-de Gruyter adjustable orifice (8.5)		rectangular u = 0.5	MR	0.03 m 1.58 w	0.60 m	0.20 m p = b	b≥0.20 m 0.02 m ≤ w ≤ 0.38 m w≤0.63 h_1	-	0.0088	q=0.742	10	up to* 0.25	3	8	-	-	* If w/h_1 is small
Meter gate (8.6)		Section of circle u=0.5	MR	$h_1 \geq 1.0$ D_p Δh≥0.05 m	Δh≤0.45 m	0.17 D_p	$D_p \geq 0.30$ m w≤0.75 D_p w≥0.02 m	-	0.0076 D_p=0.30 m	Q=2.10 D_p=1.22 m	7 to 45	$h_2 \geq 0.15$ m $\Delta H_t \geq 0.30$ m	3 to 6	8	-	-	Usually 0.20 m ≤ D_p ≤ 1.22 m
Neyrpic modules (8.7)		rectangular u = 0.5	MR	h_d=0.17m h_d=0.28m	$h_d \leq$ P and $h_d \leq 0.35$ P_2	0.16 m 0.26 m	0.05 m 0.05 m	- -	0.0005 0.0010	q=0.100 q=0.200	1* 1	0.60 0.60	5 5	3 1.8	- - - -	□ □	Type X 1 Type XX 2 * Discharge is regulated by opening/closing gates
Danaidean tub (8.8)		circular or rectangular u = 0.5	M	approx. 0.10 m	approx. 5.0 m	-	d≥0.02 m b≥0.02 m	$0^\circ \leq \theta \leq 180^\circ$	0.00027 d=0.02 m h_1=0.10 m	variable	7	h_1+δd*	2	5	- -	□	*δ = contraction coefficient
Divisors (9.1)		rectangular u = 1.5	MR	0.06 m 0.50 r	1.0 p 0.35 P_2 4.0 r	0.15 m 0.33 H_1	0.30 m 2.0 H_1	-	0.0075 b=0.30 m	q=5.69 H_1=2.00 m	30*	0.60	5	25	- -	+	* Other weir profiles are possible
Pipes and small siphons (9.2)		circular u = 0.5	M	0.03 m	1.20 m	1.0 D_p	$D_p \geq 0.015$ m $D_p \geq 0.03$ m	-	0.00006 0.00037	variable	6 6	usually submerged	10 10	17 17	- - - -	- - - -	L > 20 D_p 6 D_p ≤ L ≤ 20 D_p *
Fountain flow from vertical pipe (9.3)		circular u = 1.35 or u = 0.53	M	0.03 m	4.00 m	-	0.025 ≤ D_p D_p ≤ 0.609	-	0.00048 D_p=0.025 m	Q=2.45 D_p=0.609 m	237	pipe must discharge free into the air	15 to 20	50	- -	- -	
Flow from horizontal pipes (9.4)		circular 1.5 < u ≤ 2 u = 1.5 (versus Y)	M M	y_e=0.02m 0.1 D_p $y_e \geq D_p$ Y≥0.025	y_e ≤ 0.56 D_p Y ≤ 0.15 m*	- -	$D_p \geq 0.05$ m 0.05 ≤ D_p ≤ 0.15 m	- -	0.00062 D_p=0.05 m 0.0020 D_p=0.05 m	variable Q=0.100 D_p=0.15 m	42 2.5	pipe must discharge free into the air	3 15	100 20	- - - -	- - - -	Brink depth method Trajectory method; X=0.152, 0.305 and 0.457 m
Brink depth method for rectangular canals (9.5)		rectangular u = 1.5	M	$y_e \geq 0.03$m	-*	p = 0	0.30 m 3 y_c	-	0.0081 b=0.30 m	q=4.82 H_1=2.0 m	about 175	head loss 2.1 H_1	3	25	+	+	y_e/y_c=0.715 * Approach canal length ≥ 12 y_c
Dethridge meters (9.6)		rectangular no u-value	MRV	y_1=0.30m y_1=0.38m	y_1=0.90m y_1=0.90m	- -	0.52 m 0.78 m	- -	0.015 0.040	Q=0.070 Q=0.140	4.6 3.5	head loss ≥ 0.08 m ≥ 0.09 m at y_1 min.	5 5	- -	+ +	+ +	Small meter Large meter
Propeller meters (9.7)		usually circular no u-value	MRV	v > 0.45 m/s	v < 5.0 m/s	-	0.05 m ≤D_p≤ 1.82 m	-	0.00088 D_p=0.05 m	Q=13.0 D_p=1.82 m	10	usually Δh ≥ 0.50 m	5*	-	□	+	* If propeller is maintained frequently

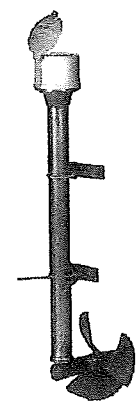
WATER SPECIALTIES
PROPELLER METER™

MODEL OF12

OPEN FLOW METER
SEALED METER MECHANISM - MAGNETIC DRIVE
INDICATOR - TOTALIZER
SIZES 10" thru 72"



TYPICAL 4" DIAL
INDICATOR-TOTALIZER



DESCRIPTION

MODEL OF12 OPEN FLOW METERS are designed for accurate metering of ditch turnouts, reservoir outlets, closed conduits, or other similar installations. The rigid, light weight construction and simple installation allow easy removal for winter storage or transfer to other locations. The upper mounting plate is equipped with a padlock hasp. The lower bracket has suitable guides for easy installation. An optional revolving mounting bracket, with padlock hasp, is also available. The revolving mounting bracket allows the meter assembly to be raised approximately 2 inches permitting the column to be rotated 180 degrees and easily withdrawn. The revolving mounting bracket is ideal when high velocity flow conditions exist.

INSTALLATION can be made to any wall or vertical structure which will center the propeller in the flow measuring area. The meter location must have a controlled flow measuring area and a full flow of liquid for proper accuracy. Fully opened gate valves, fittings, or other obstructions that tend to set up flow disturbances should be a minimum of ten pipe diameters upstream from the meter. Installations with less than ten pipe diameters of straight pipe require straightening vanes. Meters with straightening vanes require at least five pipe diameters upstream and one pipe diameter downstream.

PROPELLER is magnetically coupled with the drive mechanism through the sealed oil filled gearbox. This completely eliminates water entering the meter assembly, as well as the need for any packing gland. The propeller is a conical shaped three bladed propeller, injection molded of thermoplastic material resistant to normal water corrosion and deformity due to high flow velocities.

BEARING is a water lubricated ceramic sleeve and spindle bearing system with a ceramic/stainless steel spindle. Dual ceramic thrust bearings, standard on all meters handle flows in both forward and reverse directions. The bearing design promotes extended periods of maintenance free propeller operation. Bearings within the sealed meter mechanism are shielded precision stainless steel bearings and are factory lubricated for the life of the meter.

INDICATOR-TOTALIZER is mechanically driven by the meter mechanism and features a full 4" diameter, 250 degree sweep dial with a six digit, straight reading type totalizer and sweep test hand. The indicator drive mechanism is temperature compensated so the indicator will be accurate at all points on the dial when operated between 32° and 140° F. The indicator dial can be furnished in GPM, CFS, MGD or any standard liquid measuring units with choice of standard totalizer measuring units. The bonnet, with padlock hasp, is o-ring sealed to the meter head.

CHANGE GEARS may be easily exchanged in the field when changing the dial, or when recalibrating for different pipe sizes. It is not necessary to remove the meter from the line for these changes.

O-RING SEALS are used at all points where seals are required, making the meter mechanism completely immune to any of the corrosive effects of atmospheric moisture or the liquids measured by the meter assembly.

SPECIFICATIONS

ACCURACY Plus or minus 2% of actual flow within the range specified for each meter size.

TEMPERATURE RANGE 140° F Maximum. Consult factory for special construction for higher temperatures.

MINIMUM FLOWS As shown for each meter size and construction are required for accurate registration. See flow chart.
NOTE: Minimum flow will be higher on meters with drop pipe lengths over 6' long.

MAXIMUM FLOWS As shown for each meter size and construction are rated for continuous operation. See flow chart.

INTERMITTENT FLOWS As shown for each meter size are rated for 10% to 15% of the total time the meter is operating. Consult factory for High Velocity construction when intermittent flows are higher than shown on flow chart and/or when longer operating periods are required.

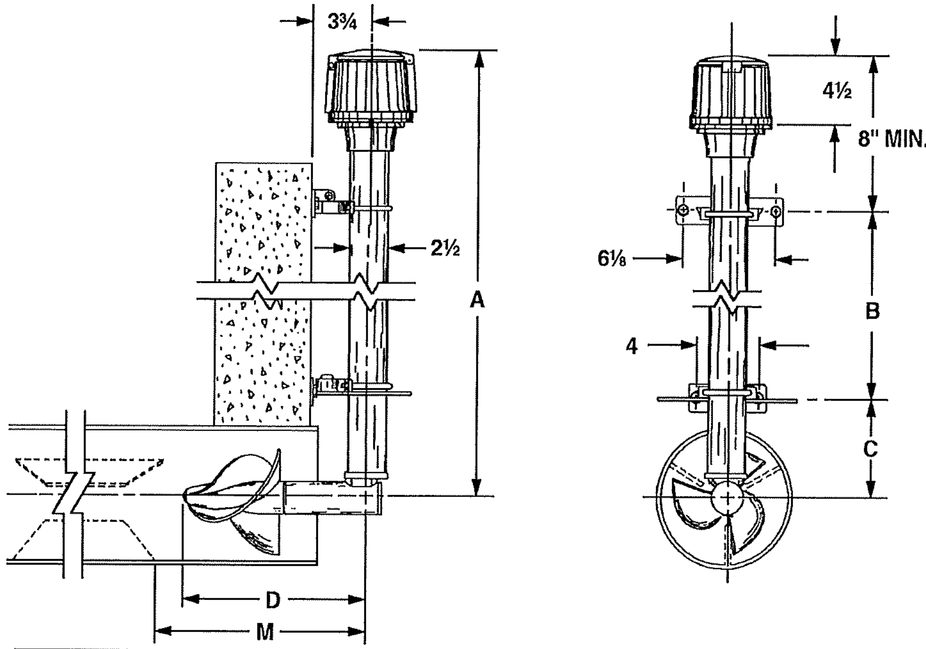
MATERIALS Used in construction are chosen to minimize the corrosive effects of the liquids measured by the meter assembly.
MAGNETS - permanent ceramic type
INTERIOR BEARINGS - shielded stainless steel
PROPELLER BEARING - ceramic sleeve type
PROPELLER SPINDLE - ceramic coated stainless steel
PROPELLER - injection molded thermoplastic
GEARBOX - stainless steel
SEPARATOR - stainless steel
SHAFTS AND BOLTS - stainless steel
DROP PIPE - bronze
METER HEAD - cast bronze
MOUNTING BRACKETS - cast bronze

OPTIONAL EQUIPMENT A wide range of controls and instruments for indicating, totalizing, and recording flow data for each meter. Special constructions and materials are available upon request.

ORDERING INFO Must be specified by the customer and includes:
- "A" dimension (see back of data sheet)
- Pipe I.D.
- Minimum & maximum flow ranges
- Temperature of meter environment
- Indicator scale and units
- Totalizer dial units
- Type of materials and construction,
- Optional equipment desired

MODEL OF12

OPEN FLOW METER
SEALED METER MECHANISM - MAGNETIC DRIVE
INDICATOR-TOTALIZER
SIZES 10" thru 72"



METER & PIPE SIZE	FLOW RANGES, GPM			DIMENSIONS					SHIPPING WEIGHT POUNDS**
	MIN.	MAX.	INT.	A*	B	C	D	M	
10	300	2000	3000				11½	13½	80
12	400	3000	3500				11½	13½	80
14	500	4000	4500				11½	13½	80
16	600	5000	6000				11½	13½	80
18	800	6000	7500				11½	13½	80
20	900	8000	9000				11½	13½	80
24	1000	10000	13500				11½	13½	80
30	1800	15000	21000				11½	13½	80
36	2000	20000	30000				11½	13½	80
42	3000	30000	40000				11½	13½	80
48	5500	35000	50000				11½	13½	80
54	6500	45000	55000				11½	13½	200
60	7500	60000	80000				11½	13½	200
66	8500	75000	95000				11½	13½	200
86	16000	125000	150000				11½	13½	200

* NOTE: Model OF12 meters are equipped with a 6 foot "A" dim. unless otherwise specified. Minimum flow will be higher on meters with drop pipe lengths over 6' long.

** NOTE: Shipping weights are approximate. Actual weight depends upon "A" dim.

McCROMETER
www.mccrometer.com

3255 WEST STETSON AVENUE • HEMET, CALIFORNIA 92545 USA
TEL: 951-652-6811 • FAX: 951-652-3078

SONTEK

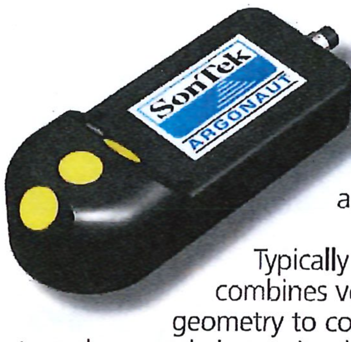
Argonaut-SW®

Shallow Water Flow, Level and Velocity

Argonaut-SW®

Shallow Water Flow, Level and Velocity

Built to Last. Made to Perform.

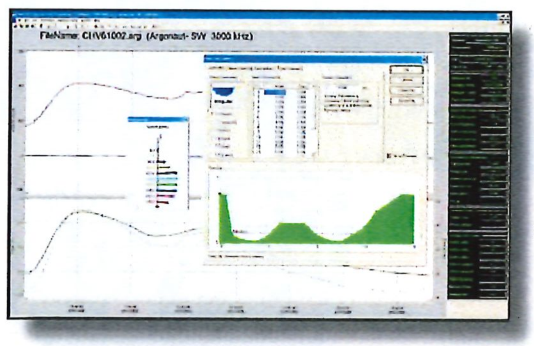


Using SonTek's proven pulsed acoustic Doppler technology, the **Argonaut-SW** is the superior choice for accurate flow measurements in natural streams, man-made channels, and pipes. Because it is a "fast sampling" velocity profiler, the SW accounts for variations in the velocity field to make the most accurate flow measurements possible.

Typically mounted on the bottom of a channel or pipe, the SW combines velocity and water level data with user-supplied channel geometry to compute total flow in real time. Its unique "all-in-one" transducer and electronics design features an internal recorder and requires no top-side processing.

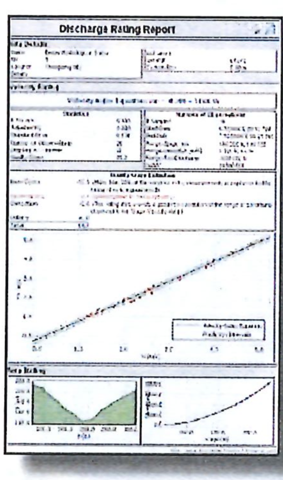
Display. Process. Analyze.

Every Argonaut-SW comes with **ViewArgonaut** - a user-friendly software program for setting up your system and analyzing data. A flow configuration utility makes flow measurement simple!



ViewArgonaut consists of five modules:

- **Diagnostics** - Deployment site survey and diagnostics tool.
- **Recorder** - Extracts data from or erases the Argonaut's internal recorder.
- **Deployment** - Sets up the Argonaut for an Autonomous or SDI-12 deployment.
- **Realtime** - Sets up the Argonaut to collect and display real-time data.
- **Processing** - Lets you play back and manipulate Argonaut data.



Velocity-Indexing is a Snap with FlowPack Software!

One of the main benefits to the Argonaut-SW is its ability to calculate flow using uniquely derived flow equations for individual channels via the velocity-index method. SonTek's optional FlowPack software facilitates velocity-index rating development, making your data reporting process a whole lot friendlier and faster! FlowPack provides a simple method to store flow, velocity, and stage measurements and convert this information into comprehensive reports, helping you make better and more informed decisions.

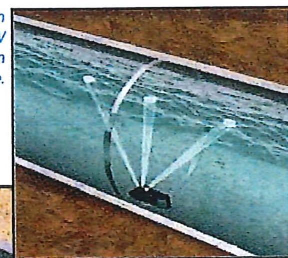
Sound Principles. Good Advice.

Flow
Level
Velocity

Continuous Flow Monitoring Under Complex Conditions

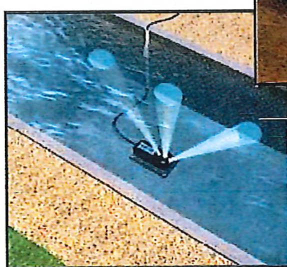
Reversing flow? Rapid changes? Tidal influence? Pumping? Backwater? Under ice? Small, portable and easy to use, the Argonaut-SW is your friend for all these challenging shallow-water conditions. The SW operates in depths from 0.2 to 5.0 meters (0.7 to 16 ft) and automatically adjusts its velocity cell with changing water level while also reporting a velocity profile for subsequent analysis. Just provide power, and the SW can either output data in real time or record data internally for periodic downloads.

Example of an Argonaut-SW installed in an industrial pipe.



Features Include:

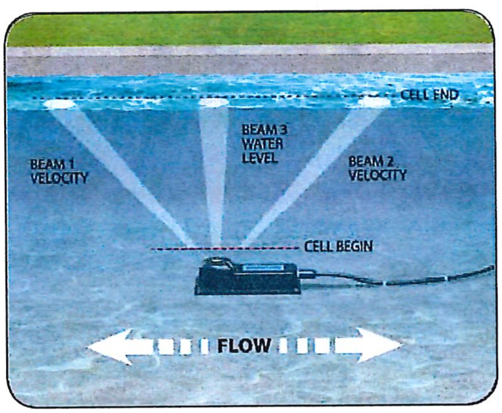
- Unique "all-in-one" design
- Provides 10 cells of velocity profiling
- Internal data recorder
- Real time output (RS 232/422, SDI-12, Modbus, analog)
- External flow display
- Total volume output
- Measures under ice



Example of an Argonaut-SW installed in an irrigation canal.

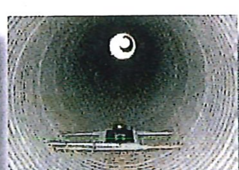
How it Works

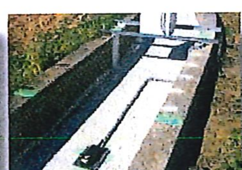
The Argonaut-SW has three acoustic beams. When properly bottom-mounted (usually in a channel), one of these beams points straight up, and the other two point up/down stream at a 45-degree angle. The upward-looking beam measures water level. The two slanted beams measure the water velocity in two dimensions via the acoustic Doppler method.



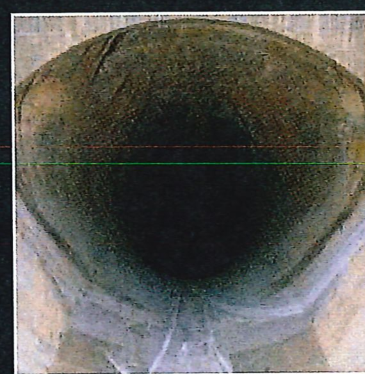
This illustration depicts an Argonaut-SW mounted on the bottom of a shallow irrigation canal, with water flowing in either direction. The SW has the ability to switch to a one beam solution if either of the velocity beams are blocked, and then revert to 2-beam solution when the blockage clears or is cleared.

Profiling water velocity provides a more accurate depiction of flow characteristics, enabling use under conditions where stratification exists. This level and velocity information is then used (together with the geometry of the channel) to compute flow, volume, mean velocity, and area.

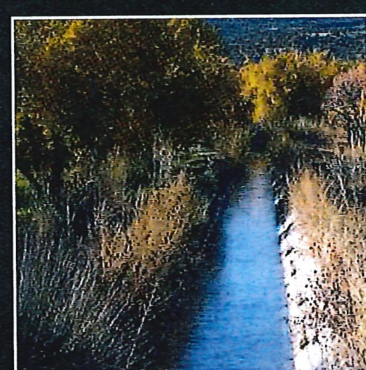




Natural Streams



Pipes and Culverts



Irrigation Canals

SonTek

YSI incorporated

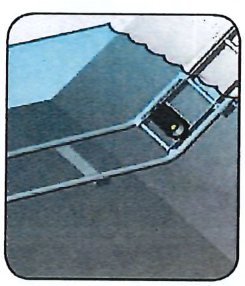
Argonaut-SW

Useful options and accessories make the Argonaut-SW a complete, turn-key solution!

Real-time Flow Display: Provides an easy-to-use interface for monitoring both output data and the system status.

SW Mounting Shoe: This streamlined, hard plastic casing helps deflect sediment in canals, channels and pipes. Also has slots for pipe-ring mounting.

Modbus Interface Module (MIM): Integrate into any Modbus-enabled system using Modbus RS-232 protocol. Acting as an RTU slave device, the MIM stores data in a series of registers so it can be reported to the master unit in real-time.



Sliding Mount: Rail system for easy instrument deployment and retrieval. A modular design allows for multiple length and depth configurations.

Specifications

Standard Features

- 2-D velocity measurement (using 2 acoustic beams) along channel and vertical velocity components
- Water level measurement using vertical acoustic beam
- Automatically adjusts sampling volume location to measure the maximum possible portion of the water column
- RS-232/SDI-12 communication protocol
- Real-time flow calculations using user-supplied channel geometry
- 4 MB recorder capacity (over 50,000 samples)
- Temperature sensor
  - Resolution: ±0.01° C
  - Accuracy: ±0.5° C
- ViewArgonaut Windows 2000/XP/Vista software for instrument setup, data collection, and post processing.
- PDA software (SonUtils and deployment module)
- Multi-cell current profiling
- Mounting plate

Velocity Profiling Range

- Maximum Depth: 5.0m (16ft)
- Minimum Depth: 0.3m (1ft)*

Water Level Measurement

- Minimum Depth:
  - Above transducer: 0.10m (0.3ft)
  - Total water depth: 0.20m (0.6ft)
- Maximum depth: 5.0m (16ft)
- Accuracy: ±0.1% of measured level, ±0.3cm (0.01ft)

Water Velocity

- Range: ±5 m/s (16 ft/s)
- Resolution: 0.1 cm/s (0.003 ft/s)
- Accuracy: ±1% of measured velocity, ±0.5 cm/s (0.015 ft/s)

Optional Features

- FlowPack velocity indexing software
- 4-20 mA and 0-5VDC output modules; possible variables are X velocity, Y velocity, velocity magnitude, temperature, SNR, stage, volume and flow.
- Custom mounting shoe (at left)
- Deployment sliding mount (at left)
- Flow Display (at left)
- Durable plastic shipping case
- RS-422 for cable runs longer than 100m

SonTek/YSI
9940 Summers Ridge Road
San Diego, CA 92121, USA
Tel: +1 (858) 546-8327
Fax: +1 (858) 546-8150
Email: inquiry@sontek.com

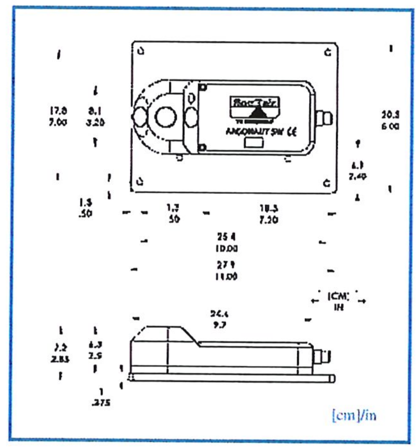
Physical Parameters

- Dimensions: 24.5cm (9.7 in) long by 10cm (4 in) wide by 6.3cm (2.5 in) high
- Weight:
  - In air: 1.2kg (2.6 lb)
  - In water: 0.15kg (0.3 lb)
- Pressure rating: 25m (80 ft)
- Operating temperature: -5°C to 60°C (23°F to 140°F)
- Storage temperature: 10°C to 70° (14° to 158°F

Power Requirements

- Input power: 5-15 VDC
- Power consumption: 500 mW nominal

Can operate in shallower depths down to 0.2m (0.7ft) with performance limitations. Contact SonTek for details.



SonTek/YSI, founded in 1992 and advancing environmental science in over 100 countries, manufactures affordable, reliable acoustic Doppler instruments for water velocity measurement in oceans, rivers, lakes, harbors, estuaries, and laboratories. SonTek/YSI is an employee-owned company.

sontek.com

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 discrete 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 months - 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
Min. 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)
Urethane sensor cable	9mm (D) up to 50m (L) (0.35" (D) up to 164ft (L))
Min. operating depth	40mm (1.57")
Max. operating temperature	60° C (140° F)

DOPPLER INSERT VELOCITY SENSOR

For use in full pipes or partially full pipes (when used in conjunction with an EchoFlo depth sensor)

Patents	US Patent No. D544,803 AUS Patent No. AU 301464 S
Pipe size	0.1 to 2.54m (4" to 100") diameter
Process fitting	2" BSP or 2" NPT
Max. process fitting pressure[1]	1034 kPa (150psi)
Max. operating pressure[2]	253kPa (37psi)
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)
Wetted materials	Nickel plated brass and epoxy
Pipe intrusion area	11.25cm² (1.75 sq.")

*1 The pipe **must be de-pressurized** prior to insertion or removal*

*2 The stream flow may be suitable for Doppler ultrasonic flow measurement in pressures >253kPa (37psi) if it contains **at least** 100 parts per million of suspended solids that are >75 microns in size.*

DOPPLER AREA/VELOCITY SENSOR

ZX SnapStrap mounted, combined velocity and depth sensor for use in partially full pipes or open channels

Pipe size	0.15 to 2.54m (6" to 100") diameter
Max. channel width *	3m (10ft.)
Dimensions	12.5cm (L) x 5cm (W) x 1.6cm (H) 5" (L) x 2" (W) x 0.63" (H)
Wetted materials	PVC, Alumina ceramic and epoxy
Pipe intrusion area	8cm² (1.25 sq.")

DOPPLER VELOCITY SENSOR

ZX SnapStrap mounted, velocity sensor for use in full pipes or open channels (when used in conjunction with a depth sensor)

Pipe size	0.15 to 2.54m (6" to 100") diameter
Max. channel width *	3m (10ft.)
Dimensions	12.5cm (L) x 5cm (W) x 1.6cm (H) 5" (L) x 2" (W) x 0.63" (H)
Wetted materials	PVC and epoxy
Pipe intrusion area	8cm² (1.25 sq.")

** MACE Doppler ultrasonic sensors **will** operate in wider channels, but a reliable stream gauging **must** be performed for best system accuracy.*

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.

DISTRIBUTOR:

Part No. 825-310 Rev. 3.4

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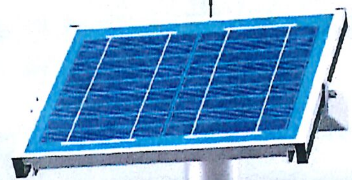
www.maceusa.com

mace
Water Monitoring Solutions

AgriFlo® XCi

SMART PACKAGED MONITORING



Measure agricultural water and wastewater flows plus monitor vital farm operations

Full pipe flow measurement
MACE Insert Velocity Sensor

- ✓ Patented Doppler ultrasonic insert sensor with MASP Technology
- ✓ Easy to install in existing pipework through a 2" ball valve
- ✓ Works great in dirty water and animal waste
- ✓ No moving parts, no blockages, no worries
- ✓ Minimal straight run requirements

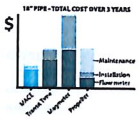
www.macemeters.com

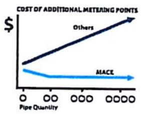
mace
Water Monitoring Solutions

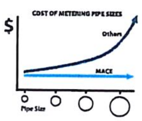
AgriFlo XCi - Smart packaged monitoring

The AgriFlo XCi can be used to monitor vital farm equipment and on-farm sensors. Use the versatility of AgriFlo XCi to monitor inputs as diverse as: irrigation flows; farm wastewater flows; water quality; dam levels; soil moisture; pump and engine management systems.

AgriFlo XCi is easy to install, easy to use and virtually maintenance free. Utilizing state of the art MACE Doppler ultrasonic velocity sensors, AgriFlo has no moving parts and provides minimal obstruction to the flow. MACE Doppler ultrasonic velocity sensors excel in trash laden water and animal waste which means that the meter stays in service longer without time-consuming repairs.







Cost effective flow metering

MACE offers the flexible, true value metering solution. When comparing flow meters, consider the TOTAL COST of the flow meter, installation & ongoing maintenance.

- In similar sized pipes, AgriFlo XCi is significantly cheaper than other comparable high quality solutions.
- AgriFlo XCi is easily installed into existing pipework whether above or below ground - no expensive fittings or re-routing.
- A typical single pipe installation can be completed by two people in under two hours.
- Because AgriFlo XCi has no moving parts and the sensor cannot foul, there are virtually no ongoing maintenance costs.
- Connect up to five flow sensors to a single AgriFlo XCi to reduce your cost per metering point even further. Significant savings for pump stations with more than one pipe.

Ready-to-Go straight out of the box

The MACE AgriFlo XCi includes a data logger, LCD display, solar regulator, battery, multiple cards (application dependent) all in one ruggedized weatherproof enclosure. No more hunting around for bits and pieces. In most cases you can be up and monitoring in just a couple of hours.

Access data remotely with WebComm

- MACE WebComm card for GSM/3G gives remote access to your data
- Card is powered by and housed in the AgriFlo XCi
- Data is pushed from your AgriFlo XCi device to the MACE Data Server where it is available for retrieval on your PC or smartphone
- SMS/Email alert subscription service available

Easily configure with MACE FloCom+

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

MASP TECHNOLOGY

True average velocity measurement

MACE velocity sensors use continuous wave Doppler ultrasound to measure the speed of dirt, bubbles and other particles in the stream flow. *MACE Doppler ultrasonic sensors "see" particles in water just like turning on a flashlight in fog.*

In a full pipe, electromagnetic or mechanical insertion devices "see" a golf ball sized velocity profile and then use complex algorithms to calculate velocity. By contrast, MACE Doppler ultrasonic velocity sensors utilizing MACE Advanced Signal Processing (MASP) technology *"see"* across the entire stream profile to give a true average velocity.

Multiple cards for multiple sensor applications

The AgriFlo XCi (multiple card interface) allows the user to efficiently monitor an array of irrigation flow and vital on-farm sensors. It's a smart packaged monitoring solution that provides remote data access with alerts and alarms. It's also telemetry-ready for effective low cost control and rapid response. Users can install any combination of the MACE cards shown, in the five available card slots.

Choose the right card/s for your application to tailor the AgriFlo to your exact farm requirements now and in the future.

Doppler Card
This card supports one MACE Doppler ultrasonic sensor.

I/O Card
This card supports seven sensor inputs and four control outputs including 4-20mA, voltage and digital.
The card also supplies 12V to power your add-on sensors.

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

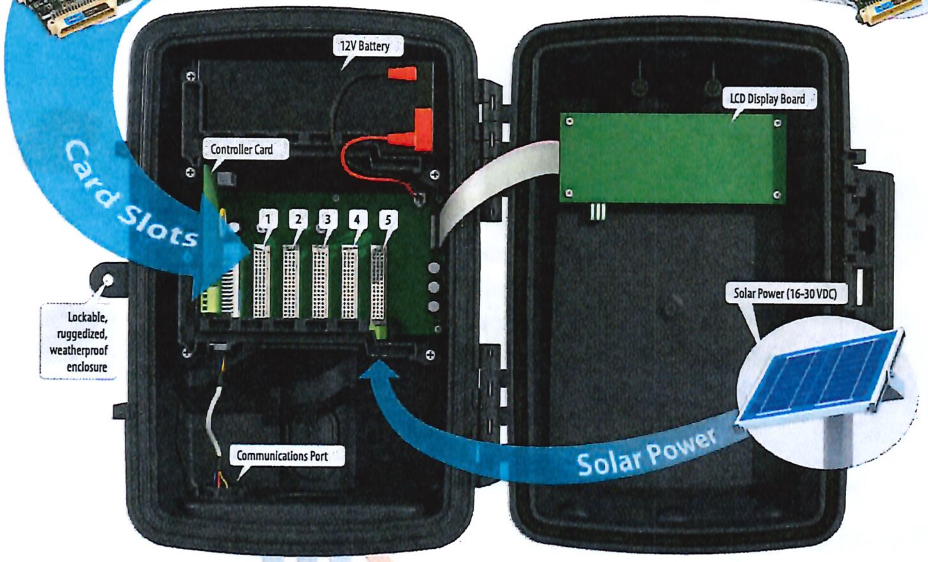
SDI-12 Master Card
This card provides AgriFlo XCi with the ability to control and log SDI-12 sensors.

SCADA

FloSI Card
This card provides an SDI-12 or ModBus output to interface AgriFlo XCi to SCADA systems.

Remote Access

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.



Lockable, ruggedized, weatherproof enclosure

MACE Sensors

Add-on Sensors

Doppler Ultrasonic Insert Velocity Sensor
For use in full pipes or partially full pipes (when used in conjunction with an EchoFlo depth sensor).

Doppler Ultrasonic Velocity Sensor
ZX SnapStrap mounted, velocity sensor for use in full pipes or open channels (when used in conjunction with a depth sensor).

Doppler Ultrasonic Area/Velocity Sensor
ZX SnapStrap mounted, combined velocity and depth sensor for use in partially full pipes or open channels.

Add-on Sensors
AgriFlo XCi can be configured to monitor a diverse range of farm sensors and devices.
For example:
- Pumps/engines (RPM, pressure, temperature)
- Electromagnetic sensor for ground water
- EC/pH/rainfall sensors
- Pond/dam/tank level measurement

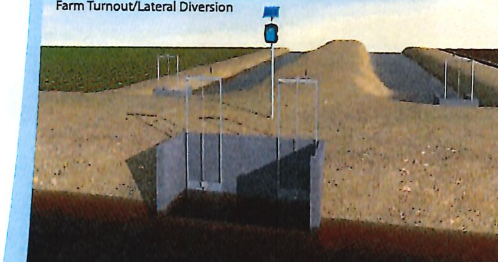
Solutions using AgriFlo XCi

River Pump Station

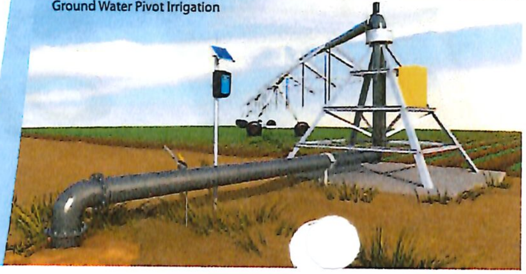
Flume/Weir

Dairy Waste

Farm Turnout/Lateral Diversion

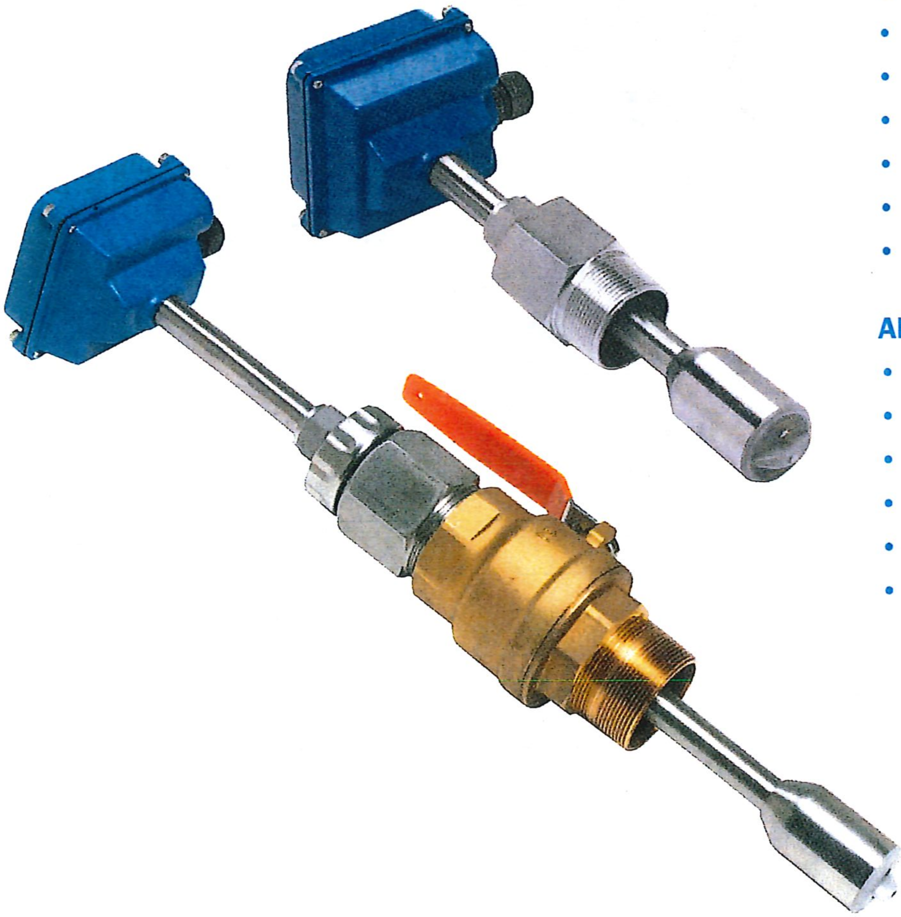


Ground Water Pivot Irrigation



EX100/200-SERIES
Insertion Electromagnetic Flow Sensor

ISO 9001:2008 CERTIFIED COMPANY



FEATURES

- No moving parts
- Durable
- Adjustable depth
- Hot-tap available
- Brass or stainless steel
- Immersibility available
- Reverse flow output available

APPLICATIONS

- 3"- 48" pipe (up to 72" optional)
- Clean or "dirty" liquids
- Conductive liquids
- Municipal
- Industrial
- Irrigation

GENERAL INFORMATION

The complete lack of moving parts of the **EX100/200-Series** insertion flow sensor is the source of its reliability. Brass and stainless steel models withstand a variety of temperature, pressure, and chemical conditions. The EX-Series has no rotor to stop turning in dirty water and there are no bearings to wear out. Like all magmeters, when used in chemical injection applications, these meters should be installed upstream of the chemical line (or far enough downstream to allow complete mixing of fluids before the meter).

A rapidly reversing magnetic field is produced in the lower housing. As the fluid moves through this field, a voltage is generated that is measured and translated into a frequency signal proportional to flow rate. This square wave signal can be sent directly to a PLC or other control or can be converted using any of the Seametrics family of indicators and converters.

A modular system of electronics can be attached directly to the flow sensor or remotely mounted. The Seametrics FT420 provides full indication of rate and total, plus 4-20 mA output. The AO55 provides blind 4-20 mA output, and the DL76 is a battery-powered data logger.

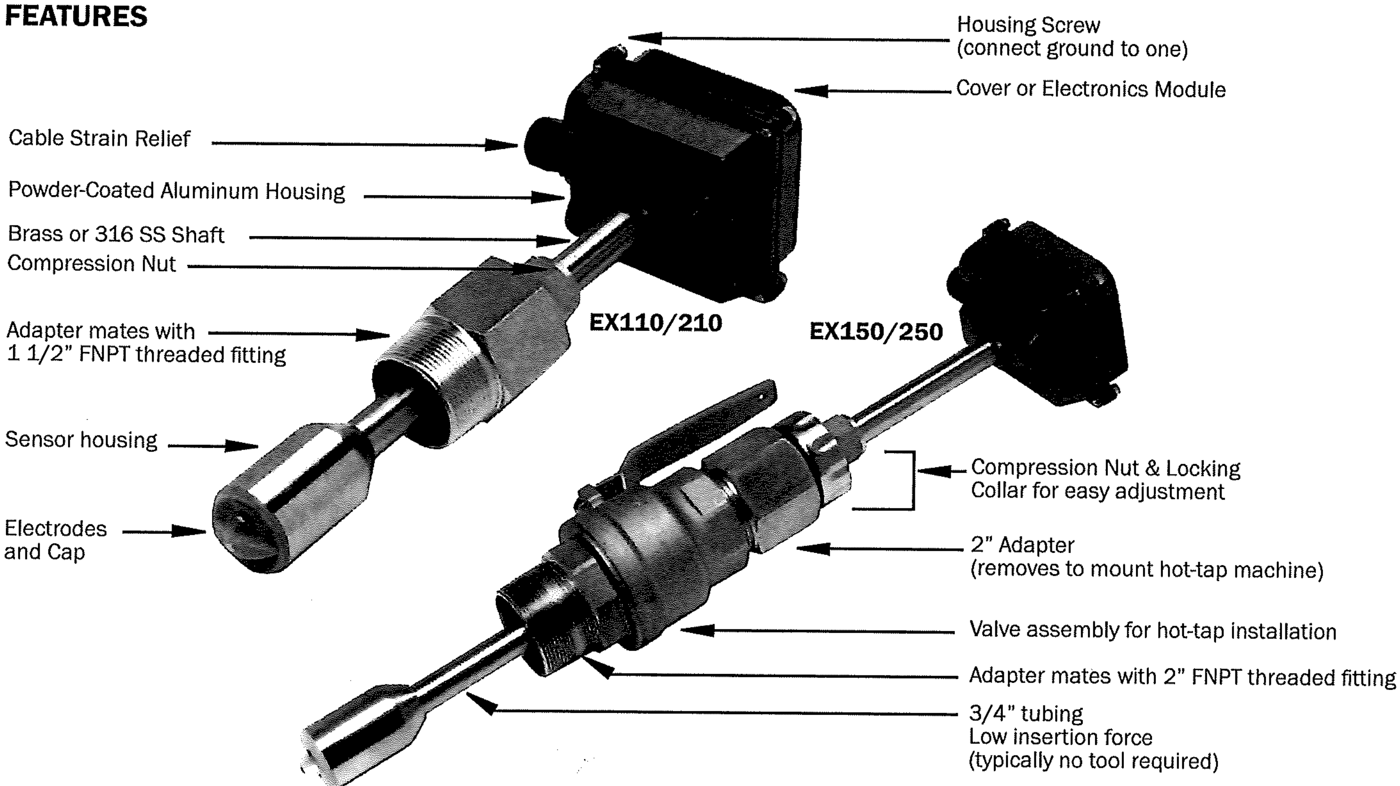
Adapters mate with standard 1-1/2" (110/210) or 2" (150/250) FNPT threaded fittings such as saddles and weldolets which may be purchased either locally or from Seametrics. The EX150 and 250 include an isolation valve, allowing hot-tap installation, or installation and removal under pressure; a bronze ball valve is standard, with a 316 stainless steel valve option if needed.

Reverse flow output and immersibility are optional.

Seametrics

EX100/200-SERIES
Insertion Electromagnetic Flow Sensor

FEATURES

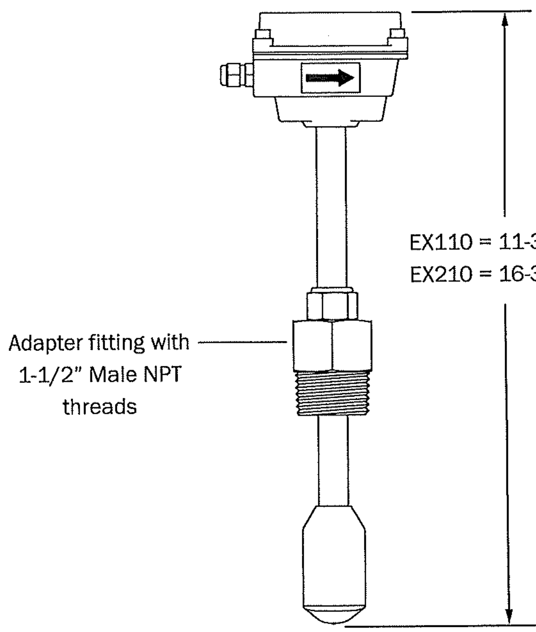


SPECIFICATIONS*

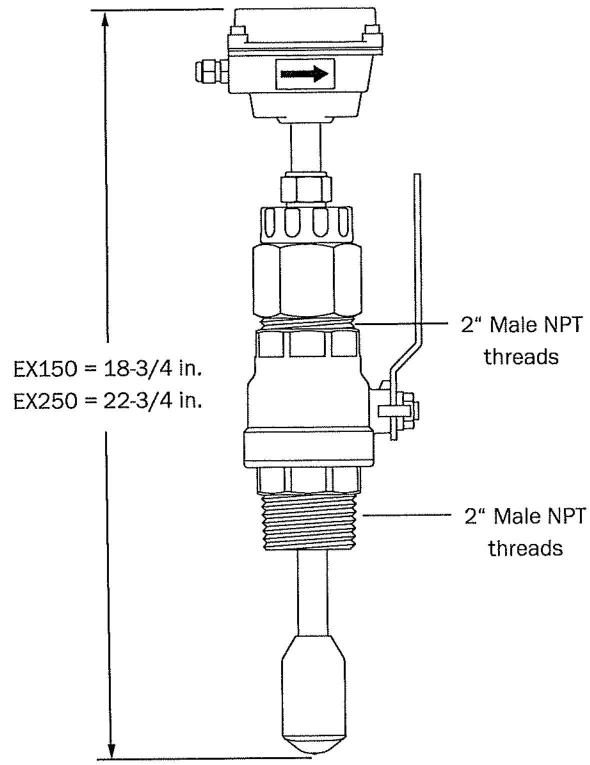
Pipe Sizes		3" to 48" (up to 72" optional)	
Materials	**Shaft/Fitting**	316 SS or Brass	
	Electrodes	Hastelloy	
	Electrode Cap	PVDF	
	Housing	Cast powder-coated aluminum	
	Valve Assembly (115/215 Only)	Bronze (stainless optional) with bronze ball valve	
	O-Ring (115/215 Only)	EPDM	
Power	**Full Power**	12-25 Vdc, 250 mA	
	Low Power	12-25 Vdc, 40 mA average with 250 mA peaks	
Flow Range		0.28 to 20 ft/sec (0.08 - 6.09 m/sec)	
Fitting Size Required		**EX110/210**	**EX150/250**
		1-1/2" FNPT	2" FNPT
Temperature	**Ambient**	0° to 160° F (-17° to 72° C)	
	Fluid	32° to 200° F (0° to 93° C)	
Pressure		200 psi (13.8 bar)	
Minimum Conductivity		20 microSiemens/cm	
Calibration Accuracy		+/- 1% of full scale	
Output		Square wave pulse, opto isolated, 550 Hz @ 20 ft/sec 6 mA max, 30 Vdc forward flow standard; reverse flow optional	
Empty Pipe Detection		Software, defaults to zero flow	

**Specifications subject to change • Please consult our website for current data (www.seametrics.com).*

DIMENSIONS

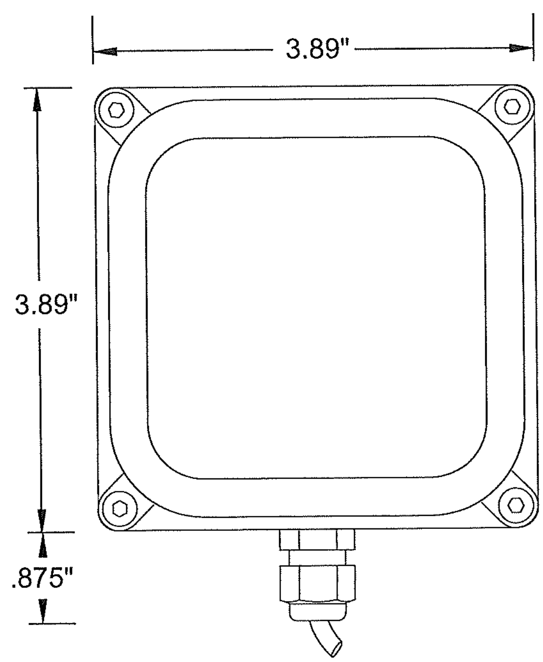


EX110 and EX210



EX150 and EX250

Flow Range (GPM)		
Nominal Pipe Size	**Min. Flow**	**Max. Flow**
3	6	440
4	11	783
6	25	1,762
8	44	3,133
10	69	4,895
12	99	7,050
14	134	9,596
16	175	12,533
18	222	15,863
20	274	19,584
24	395	28,200
30	617	44,064
36	888	63,452
48	1,580	112,804



EX100/200-SERIES
Insertion Electromagnetic Flow Sensor

HOW TO ORDER

Sensor Only

Description	Size	Sensor Material	Options (110/210)	Options (150/250)
Sensor Only.	3" – 10" pipe = **EX110** 10" – 40" pipe = **EX210** **Hot Tap** 3" – 10" pipe = **EX150** 10" – 40" pipe = **EX250**	PVC = **P** Brass = **B** 316 Stainless = **S**	Brass Adapter Fitting 2" NPT = **-02** SS Adapter Fitting 2" NPT = **-02** Reverse Flow Output = **-15** Brass Adapter 1 ½" BSP = **-23** SS Adapter 1 ½" BSP = **-24** Old Style Adapter 1 ½" NPT = **-35** Immersible = **-40** Low Power = **-50** 12" Extension (210/250 Series Only) = **-72**	316 SS Valve Assembly = **-08** No Valve Assembly = **-09** 316 SS Valve Assembly = **-08** Reverse Flow Output = **-15** Immersible = **-40** Low Power = **-50** 12" Extension (210/350 Series Only) = **-72**

FT420 Mounted on Sensor

Description	Size	Sensor Material	Options (111/211)	Options (151/251)
Rate & total indicator with pulse & 4-20 mA output, externally powered (FT420) mounted on the sensor.	3" – 10" pipe = **EX111** 10" – 40" pipe = **EX211** **Hot Tap** 3" – 10" pipe = **EX151** 10" – 40" pipe = **EX251**	PVC = **P** Brass = **B** 316 Stainless = **S**	Brass Adapter Fitting 2" NPT = **-02** SS Adapter Fitting 2" NPT = **-02** Reverse Flow Output = **-15** Brass Adapter 1 ½" BSP = **-23** SS Adapter 1 ½" BSP = **-24** Tamper Evident Kit = **-32** Old Style Adapter 1 ½" NPT = **-35** Immersible = **-40** Low Power = **-50** Non-resettable Total = **-64** 12" Extension (210/250 Series Only) = **-72** Dual Relay Output = **-98** Hinged Display Cover = **-126**	316 SS Valve Assembly = **-08** No Valve Assembly = **-09** Reverse Flow Output = **-15** Tamper Evident Kit = **-32** Immersible = **-40** Non-resettable Total = **-64** 12" Extension (210/350 Series Only) = **-72** Dual Relay Output = **-98** Hinged Display Cover = **-126**

A055 Mounted on Sensor

Description	Size	Sensor Material	Options (112/212)	Options (152/252)
Blind 4-20 mA analog transmitter (A055) mounted on the sensor.	3" – 10" pipe = **EX112** 10" – 40" pipe = **EX212** **Hot Tap** 3" – 10" pipe = **EX152** 10" – 40" pipe = **EX252**	PVC = **P** Brass = **B** 316 Stainless = **S**	Brass Adapter Fitting 2" NPT = **-02** SS Adapter Fitting 2" NPT = **-02** Standard Power, LMI 4-pin Connector = **-06** Reverse Flow Output = **-15** Brass Adapter 1 ½" BSP = **-23** SS Adapter 1 ½" BSP = **-24** Old Style Adapter 1 ½" NPT = **-35** Immersible = **-40** Low Power = **-50** 12" Extension (210/250 Series Only) = **-72** Roytronics Series-A 5-Pin Connector = **-106**	Standard Power, LMI 4-pin Connector = **-06** 316 SS Valve Assembly = **-08** No Valve Assembly = **-09** Reverse Flow Output = **-15** Immersible = **-40** Low Power = **-50** 12" Extension (210/350 Series Only) = **-72** Roytronics Series-A 5-Pin Connector = **-106**

DL76 Mounted on Sensor

Description	Size	Sensor Material	Options (116/216)	Options (156/256)
Data logger (DL76) mounted on the sensor.	3" – 10" pipe = **EX116** 10" – 40" pipe = **EX216** **Hot Tap** 3" – 10" pipe = **EX156** 10" – 40" pipe = **EX256**	PVC = **P** Brass = **B** 316 Stainless = **S**	Brass Adapter Fitting 2" NPT = **-02** SS Adapter Fitting 2" NPT = **-02** Reverse Flow Output = **-15** Brass Adapter 1 ½" BSP = **-23** SS Adapter 1 ½" BSP = **-24** Tamper Evident Kit = **-32** Old Style Adapter 1 ½" NPT = **-35** Immersible = **-40** Low Power = **-50** 12" Extension (210/250 Series Only) = **-72**	316 SS Valve Assembly = **-08** No Valve Assembly = **-09** Reverse Flow Output = **-15** Tamper Evident Kit = **-32** Immersible = **-40** Low Power = **-50** 12" Extension (210/350 Series Only) = **-72**

PD10 Mounted on Sensor

Description	Size	Sensor Material	Options (118/218)	Options (158/258)
Pulse Divider (PD10) mounted on the sensor.	3" – 10" pipe = **EX118** 10" – 40" pipe = **EX218** **Hot Tap** 3" – 10" pipe = **EX158** 10" – 40" pipe = **EX258**	PVC = **P** Brass = **B** 316 Stainless = **S**	Brass Adapter Fitting 2" NPT = **-02** SS Adapter Fitting 2" NPT = **-02** LMI Pump 4-pin Connector = **-06** Reverse Flow Output = **-15** Brass Adapter 1 ½" BSP = **-23** SS Adapter 1 ½" BSP = **-24** Old Style Adapter 1 ½" NPT = **-35** 10 Ft. Cable for LMI Connector = **-37** Immersible = **-40** Low Power = **-50** 12" Extension (210/250 Series Only) = **-72** Roytronics Series-A 5-Pin Connector = **-106**	LMI Pump 4-pin Connector = **-06** 316 SS Valve Assembly = **-08** No Valve Assembly = **-09** Reverse Flow Output = **-15** 10 Ft. Cable for LMI Connector = **-37** Immersible = **-40** Low Power = **-50** 12" Extension (210/350 Series Only) = **-72** Roytronics Series-A 5-Pin Connector = **-106**

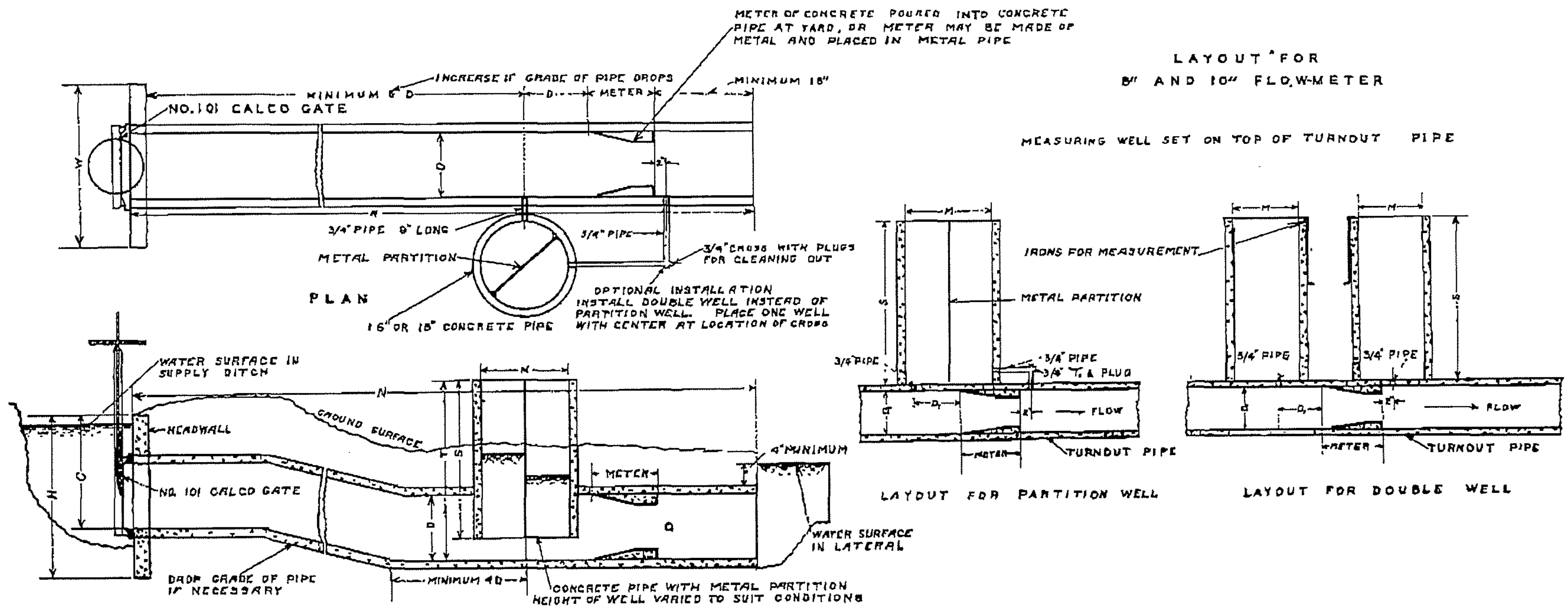
*Total Units must be specified at time of order **Requires appropriate fitting.

METHODS AND DEVICES USED IN THE MEASUREMENT AND REGULATION OF FLOW TO SERVICE DITCHES, TOGETHER WITH TABLES FOR FIELD USE

FRESNO IRRIGATION DISTRICT
FRESNO, CALIFORNIA

1928

ABBREVIATED EDITION
PAGES 26 TO 39 INC.



SECTION ALONG CENTER LINE
SCALE 1" = 12"

TABLE SHOWING MINIMUM DIMENSIONS

SIZE OF TURNOUT D	H	W	C	N	M	S	T
8"	2'-6"	2'-0"	1'-10"	12'-6"	16"	2'-6"	2'-9"
10"	2'-6"	2'-0"	1'-10"	12'-6"	16"	2'-6"	2'-9"
12"	2'-6"	2'-6"	1'-10"	12'-6"	16"	2'-6"	2'-9"
14"	2'-6"	2'-6"	2'-0"	12'-6"	16"	2'-6"	2'-9"
16"	2'-9"	2'-9"	2'-1"	12'-6"	16"	3'-0"	3'-3"
18"	3'-0"	3'-0"	2'-4"	15'-0"	16"	3'-0"	3'-3"
20"	3'-2"	3'-0"	2'-5"	17'-6"	16"	3'-0"	3'-6"
24"	3'-2"	3'-0"	2'-7"	17'-6"	1'-6"	5'-0"	3'-6"

DIMENSIONS H, W AND C ARE FOR CONCRETE HEAD-WALLS 3" THICK, PRECAST IN YARD. WHERE WALLS ARE POURED IN PLACE, THESE DIMENSIONS ARE INCREASED.

FRESNO IRRIGATION DISTRICT

STANDARD CANAL TURNOUT
WITH
CALIBRATED FLOW METER
MEASURING DEVICE

JULY 1928

FIGURE 11

TURNOUT WITH CALIBRATED FLOW METER MEASURING DEVICE

(9) This device, the general plans of which are shown on Figure 11, makes use of the difference between the static pressures taken off at two points, in the outlet pipe, between which there is a change in cross-section of the pipe and therefore a change in velocity. As indicated in the drawings this change in cross-section in concrete turnout pipes is accomplished by casting the modified section in the standard joints of concrete pipe. The particular form of this modification was chosen to facilitate the process of casting. It is observed that the device involves the principle of the Venturi meter and in the development of the device valuable ideas were obtained from the Research Report on Fluid Meters by the American Society of Mechanical Engineers. In our work this device is designated as a flow meter. In addition to those shown in Figure 11 the essential details of construction, installation and calibrating are as follows:

(10) The flow meters are cast into joints of concrete pipe by the use of metal forms which are well oiled before being set and which are removed from 12 to 18 hours after pouring. The concrete used is one part cement to 1½ parts of sand and 1½ parts of pea gravel. The fresh concrete is kept moist for a period of ten days and each joint is inspected carefully to see that there are no faults in pouring and that the setting of the concrete is as nearly perfect as possible. Since the accuracy of the device depends somewhat upon the relationship of the diameters of the regular pipe section and the restricted section, these diameters are very carefully measured for each individual flow meter. This requires the measurement of a standard joint of pipe to be installed immediately above the flow meter section and also the measurement of the finished flow meter section. These joints are numbered and placed in pairs, with the proper record kept, so that in their utilization these data are available.

The head to be utilized in determining the flow through this device is the difference in the static pressure taken from the center of the pipe a distance of one diameter above the flow meter section and that taken at a point 2" below the end of the restricted section. Provisions for securing these data are made, as shown in the drawings, by the placing of a concrete pipe vertically, at the side or on top of the outlet pipe, and dividing it into two compartments by a vertical partition. The space on one side of this partition is connected to the measuring point above the meter and that on the other side to the measuring point below the restricted section. The pipes forming this connection are usually ¾" galvanized and take out at the center of the pipe, on the side, for turnouts 12" to 24" diameter and at the center of the pipe on top for the 8" and 10" diameter turnouts.

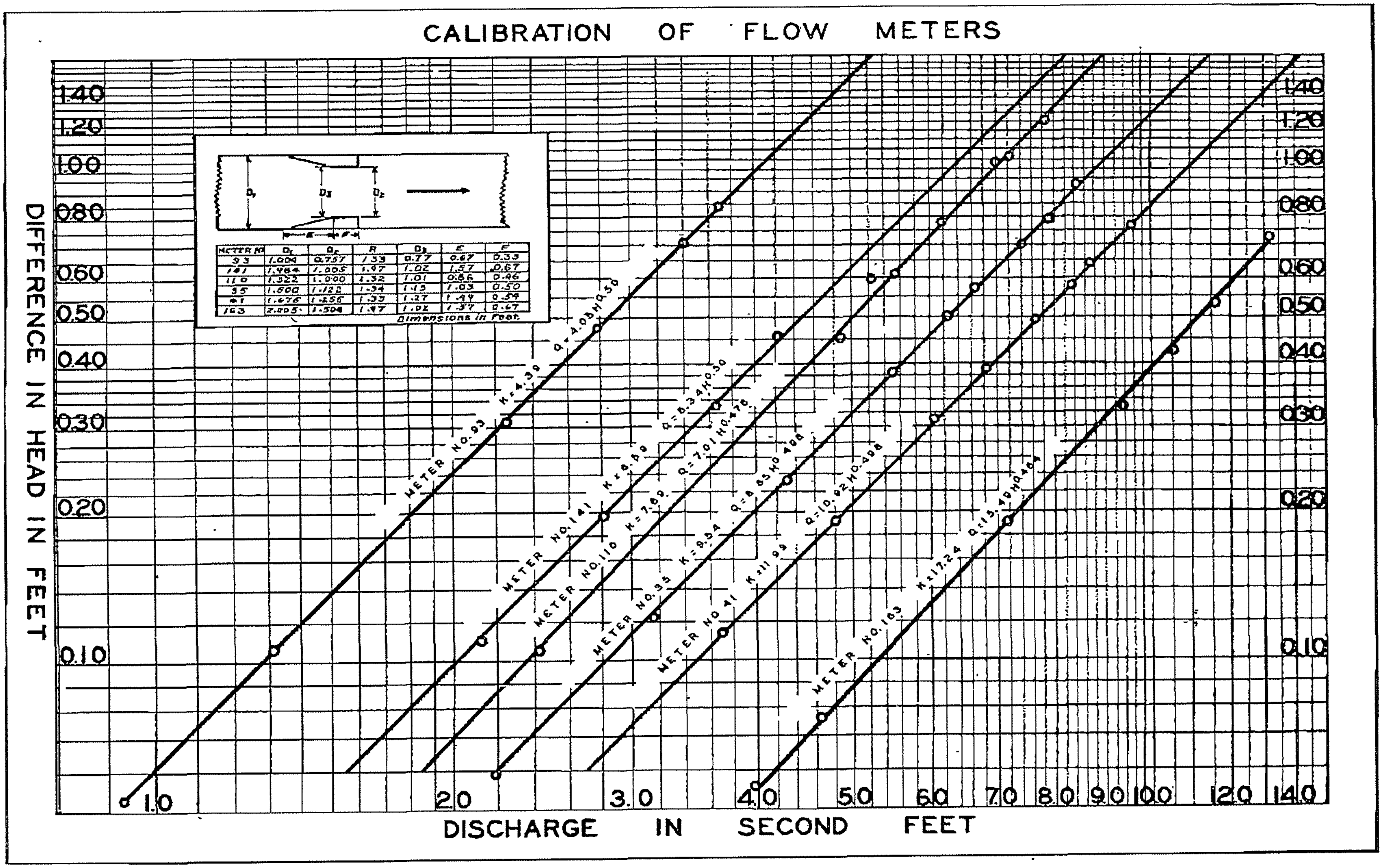
Before any of the meters are taken out of the storage yard the diameters of the standard and restricted sections, respectively designated as D_1 and D_2, are very carefully measured, in order to provide the data for determining the constants and other necessary data connected with the tests. The essential theoretical features involved are as follows: If Q be the theoretical volume flowing through the meter with a difference in head h, and if A_1 be the area of the section at D_1 and R be the ratio of D_1 to D_2 the necessary mathematical processes show that

$$Q = \frac{A_1\sqrt{2gh}}{\sqrt{R^4-1}}$$

If T be substituted for $\dfrac{\sqrt{2g}}{\sqrt{R^4-1}}$

then $Q = A_1 T\sqrt{h}$. If K be substituted for $A_1 T$ we have $Q = K\sqrt{h}$. The coefficient K in this equation is constant for any particular meter and is thus utilized as indicated on Figures 12, 13, and 14.

(11) This device was tested as described in paragraph 5, for determination of discharge as related to differences in head h. The data are plotted to logarithmic scale on Figures 12, 13 and 14. From the resulting data and straight lines through the points of this plotting the discharges under the conditions set forth were computed. The results of these computations are given in Tables VIII, IX and X on pages 29, 31, 33.



METER No	D1	D2	R	D3	E	F
93	1.004	0.757	1.33	0.77	0.67	0.33
141	1.464	1.005	1.47	1.02	1.57	0.67
110	1.322	1.000	1.32	1.01	0.86	0.46
35	1.600	1.122	1.34	1.15	1.03	0.50
41	1.676	1.256	1.33	1.27	1.49	0.59
163	2.005	1.504	1.47	1.02	1.37	0.67

Dimensions in Feet.

FIGURE 12

TABLE VIII—DISCHARGE DATA

For Flow Meter Measuring Device for Values of R from 1.30 to 1.40

Head (Ft.)	4.2	4.4	4.6	7.4	7.6	7.8	9.4	9.6	9.8	11.6	11.8	12.0	17.0	17.2	17.4	Head (Ft.)
	VALUE OF K — Second Feet															
0.02	0.6	0.6	0.6	1.1	1.1	1.1	1.3	1.3	1.3	1.5	1.5	1.6	2.5	2.5	2.5	0.02
0.04	0.8	0.8	0.9	1.5	1.5	1.5	1.8	1.8	1.8	2.1	2.1	2.2	3.4	3.5	3.5	0.04
0.06	1.0	1.0	1.0	1.8	1.8	1.9	2.2	2.2	2.3	2.6	2.7	2.7	4.1	4.2	4.2	0.06
0.08	1.1	1.2	1.2	2.0	2.1	2.2	2.5	2.5	2.6	3.0	3.1	3.1	4.7	4.8	4.8	0.08
0.10	1.2	1.3	1.3	2.3	2.3	2.4	2.8	2.8	2.9	3.4	3.4	3.5	5.2	5.3	5.4	0.10
0.12	1.3	1.4	1.5	2.5	2.5	2.6	3.1	3.1	3.2	3.7	3.8	3.8	5.7	5.8	5.8	0.12
0.14	1.5	1.5	1.6	2.7	2.7	2.8	3.3	3.4	3.4	4.0	4.1	4.1	6.1	6.2	6.3	0.14
0.16	1.6	1.6	1.7	2.8	2.9	3.0	3.5	3.6	3.7	4.3	4.3	4.4	6.5	6.6	6.7	0.16
0.18	1.6	1.7	1.8	3.0	3.1	3.2	3.7	3.8	3.9	4.6	4.6	4.7	6.9	7.0	7.1	0.18
0.20	1.7	1.8	1.9	3.1	3.2	3.3	3.9	4.0	4.1	4.8	4.9	4.9	7.3	7.3	7.4	0.20
0.22	1.8	1.9	2.0	3.3	3.4	3.5	4.1	4.2	4.3	5.0	5.1	5.2	7.6	7.7	7.8	0.22
0.24	1.9	2.0	2.1	3.4	3.5	3.6	4.3	4.4	4.5	5.2	5.3	5.4	7.9	8.0	8.1	0.24
0.26	2.0	2.1	2.2	3.6	3.7	3.8	4.5	4.6	4.7	5.4	5.5	5.6	8.2	8.3	8.4	0.26
0.28	2.0	2.2	2.2	3.7	3.7	3.9	4.7	4.8	4.9	5.6	5.7	5.8	8.5	8.6	8.7	0.28
0.30	2.1	2.2	2.3	3.8	3.9	4.0	4.8	4.9	5.0	5.8	5.9	6.0	8.8	8.9	9.0	0.30
0.32	2.2	2.3	2.4	3.9	4.1	4.2	5.0	5.1	5.2	6.0	6.1	6.2	9.0	9.1	9.2	0.32
0.34	2.3	2.4	2.5	4.1	4.2	4.3	5.1	5.2	5.3	6.2	6.3	6.4	9.3	9.4	9.5	0.34
0.36	2.3	2.4	2.5	4.2	4.3	4.4	5.3	5.4	5.5	6.4	6.5	6.6	9.5	9.7	9.8	0.36
0.38	2.4	2.5	2.6	4.3	4.4	4.5	5.4	5.5	5.6	6.6	6.7	6.8	9.8	9.9	10.0	0.38
0.40	2.5	2.6	2.7	4.4	4.5	4.6	5.5	5.6	5.8	6.7	6.8	7.0	10.0	10.1	10.2	0.40
0.42	2.5	2.6	2.8	4.5	4.6	4.7	5.7	5.8	5.9	6.9	7.0	7.1	10.3	10.4	10.5	0.42
0.44	2.6	2.7	2.8	4.6	4.7	4.8	5.8	5.9	6.1	7.1	7.2	7.3	10.5	10.6	10.7	0.44
0.46	2.6	2.8	2.9	4.7	4.8	4.9	5.9	6.1	6.2	7.2	7.3	7.5	10.8	10.9	11.1	0.46
0.48	2.7	2.8	2.9	4.8	4.9	5.1	6.1	6.2	6.3	7.4	7.5	7.6	11.0	11.1	11.2	0.48
0.50	2.7	2.9	3.0	4.9	5.0	5.1	6.2	6.3	6.5	7.5	7.7	7.8	11.2	11.3	11.4	0.50
0.55	2.9	3.0	3.2	5.1	5.2	5.4	6.5	6.6	6.8	7.9	8.0	8.2	11.7	11.8	11.9	0.55
0.60	3.0	3.1	3.3	5.3	5.5	5.6	6.8	6.9	7.1	8.2	8.4	8.5	12.2	12.3	12.4	0.60
0.65	3.1	3.3	3.4	5.5	5.7	5.8	7.1	7.2	7.4	8.6	8.7	8.9	12.6	12.7	12.9	0.65
0.70	3.2	3.4	3.6	5.7	5.9	6.0	7.3	7.5	7.6	8.9	9.1	9.2	13.0	13.2	13.3	0.70
0.75	3.4	3.5	3.7	5.9	6.1	6.2	7.6	7.7	7.9	9.2	9.4	9.5	13.4	13.6	13.8	0.75
0.80	3.5	3.6	3.8	6.1	6.3	6.4	7.8	8.0	8.1	9.5	9.7	9.9	13.9	14.0	14.2	0.80
0.85	3.6	3.7	3.9	6.3	6.5	6.6	8.0	8.2	8.4	9.8	10.0	10.1	14.1	14.4	14.6	0.85
0.90	3.7	3.8	4.0	6.4	6.6	6.8	8.3	8.5	8.7	10.1	10.2	10.4	14.6	14.8	15.0	0.90
0.95	3.8	3.9	4.1	6.6	6.8	7.0	8.5	8.7	8.9	10.4	10.5	10.7	15.0	15.2	15.3	0.95
1.00	3.9	4.1	4.3	6.8	7.0	7.1	8.7	8.9	9.1	10.6	10.8	11.0	15.4	15.5	15.7	1.00
1.05	4.0	4.2	4.4	6.9	7.1	7.3	8.9	9.1	9.3	10.9	11.1	11.3	15.7	15.9	16.0	1.05
1.10	4.1	4.3	4.5	7.1	7.3	7.5	9.2	9.3	9.5	11.1	11.3	11.5	16.0	16.2	16.4	1.10
1.15	4.2	4.4	4.6	7.2	7.4	7.6	9.4	9.6	9.8	11.4	11.6	11.8	16.4	16.6	16.7	1.15
1.20	4.2	4.4	4.7	7.4	7.6	7.8	9.6	9.8	10.0	11.6	11.8	12.0	16.7	16.9	17.1	1.20
1.25	4.3	4.5	4.8	7.5	7.7	7.9	9.8	9.9	10.2	11.9	12.1	12.3	17.0	17.2	17.4	1.25
1.30	4.4	4.6	4.9	7.7	7.9	8.1	9.9	10.1	10.4	12.1	12.3	12.5	17.3	17.5	17.7	1.30
1.35	4.5	4.7	4.9	7.8	8.0	8.2	10.1	10.4	10.6	12.3	12.5	12.7	17.6	17.8	18.0	1.35
1.40	4.6	4.8	5.0	7.9	8.2	8.4	10.3	10.6	10.8	12.5	12.7	13.0	18.0	18.2	18.4	1.40
1.45	4.7	4.9	5.1	8.1	8.3	8.5	10.5	10.7	11.0	12.8	13.0	13.2	18.3	18.5	18.7	1.45
1.50	4.7	5.0	5.2	8.2	8.5	8.7	10.7	10.9	11.2	13.0	13.2	13.4	18.6	18.8	19.0	1.50

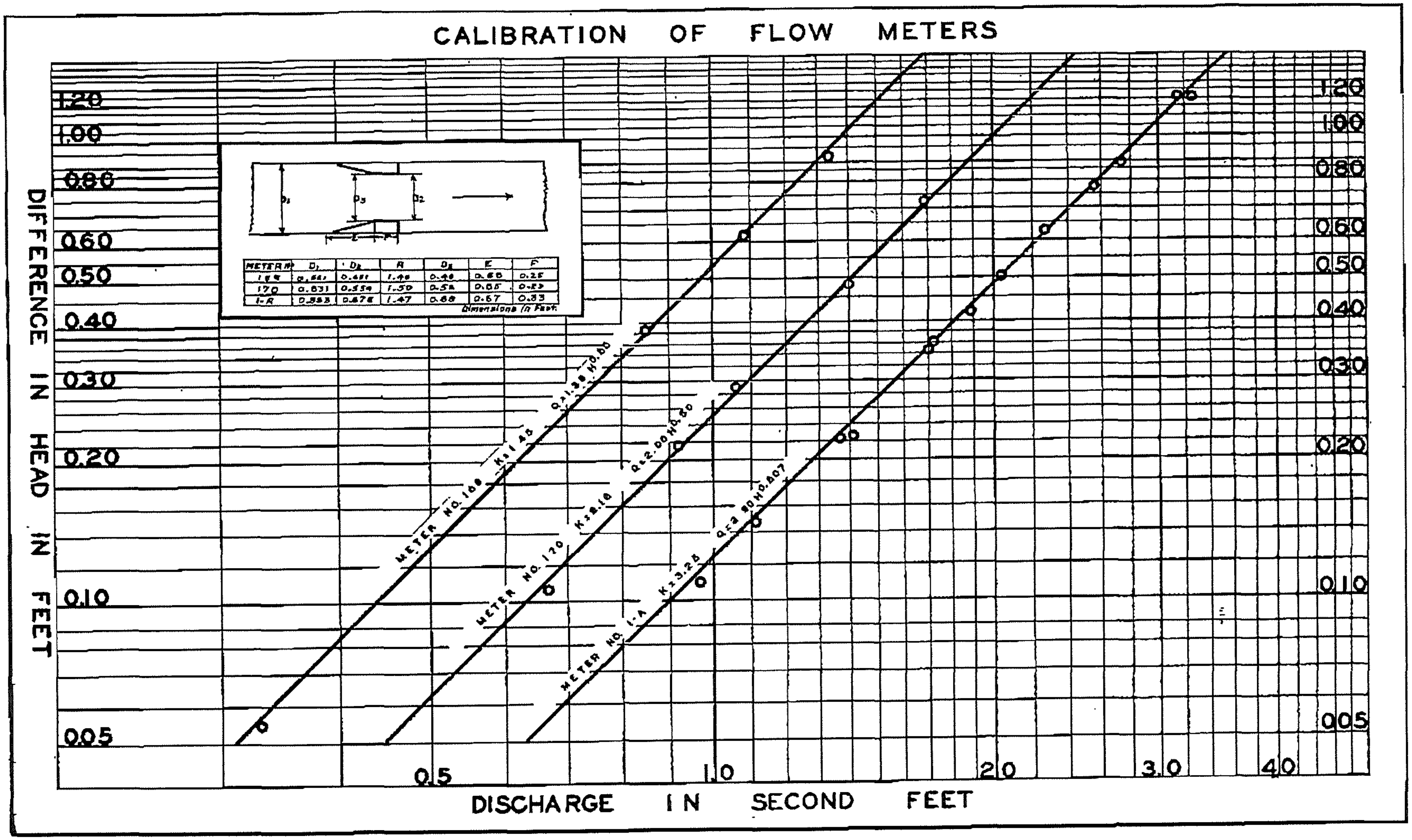

CALIBRATION OF FLOW METERS
DIFFERENCE IN HEAD IN FEET
DISCHARGE IN SECOND FEET
1.20
1.00
0.80
0.60
0.50
0.40
0.30
0.20
0.10
0.05
0.5
1.0
2.0
3.0
4.0
Dimensions in Feet

FIGURE 13

TABLE IX—DISCHARGE DATA

For Flow Meter Measuring Device for Values of R from 1.47 to 1.52

Head (Ft.)	VALUE OF K																	Head (Ft.)
	3.0	3.2	3.4	4.2	4.4	4.6	5.4	5.6	5.8	7.0	7.2	7.4	8.6	8.8	9.0	12.5	13.0	
	Discharge in Second Feet																	
0.02	0.4	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.9	1.0	1.0	1.1	1.1	1.2	1.6	1.6	0.02
0.04	0.5	0.6	0.6	0.8	0.8	0.9	1.0	1.0	1.0	1.3	1.4	1.4	1.6	1.6	1.6	2.2	2.3	0.04
0.06	0.6	0.7	0.7	1.0	1.0	1.0	1.2	1.2	1.3	1.6	1.6	1.7	1.9	1.9	2.0	2.6	2.8	0.06
0.08	0.7	0.8	0.8	1.1	1.2	1.2	1.4	1.4	1.5	1.8	1.9	1.9	2.2	2.2	2.3	3.1	3.4	0.08
0.10	0.8	0.9	0.9	1.2	1.3	1.4	1.5	1.6	1.6	2.1	2.1	2.2	2.4	2.5	2.6	3.5	3.6	0.10
0.12	0.9	1.0	1.0	1.3	1.4	1.5	1.6	1.7	1.8	2.2	2.3	2.4	2.7	2.7	2.8	3.8	4.0	0.12
0.14	1.0	1.1	1.1	1.5	1.5	1.6	1.8	1.8	1.9	2.4	2.5	2.6	2.9	2.9	3.0	4.1	4.3	0.14
0.16	1.1	1.1	1.2	1.6	1.6	1.7	1.9	2.0	2.0	2.6	2.7	2.7	3.1	3.1	3.2	4.4	4.6	0.16
0.18	1.1	1.2	1.3	1.6	1.7	1.8	2.0	2.1	2.2	2.7	2.8	2.9	3.3	3.3	3.4	4.7	4.8	0.18
0.20	1.2	1.3	1.4	1.7	1.8	1.9	2.1	2.2	2.3	2.9	3.0	3.0	3.4	3.5	3.6	4.9	5.1	0.20
0.22	1.2	1.3	1.4	1.8	1.9	2.0	2.2	2.3	2.4	3.0	3.1	3.2	3.6	3.7	3.7	5.1	5.3	0.22
0.24	1.3	1.4	1.5	1.9	2.0	2.1	2.3	2.4	2.5	3.1	3.2	3.3	3.7	3.8	3.9	5.4	5.6	0.24
0.26	1.4	1.4	1.5	2.0	2.1	2.2	2.4	2.5	2.6	3.3	3.4	3.5	3.9	4.0	4.1	5.6	5.9	0.26
0.28	1.4	1.5	1.6	2.0	2.1	2.3	2.5	2.6	2.7	3.4	3.5	3.6	4.0	4.1	4.2	5.8	6.0	0.28
0.30	1.4	1.6	1.6	2.1	2.2	2.3	2.6	2.7	2.8	3.5	3.6	3.7	4.2	4.3	4.4	6.0	6.2	0.30
0.32	1.5	1.6	1.7	2.2	2.3	2.4	2.6	2.8	2.9	3.6	3.7	3.8	4.3	4.4	4.5	6.2	6.4	0.32
0.34	1.5	1.7	1.7	2.3	2.4	2.5	2.7	2.8	2.9	3.7	3.8	3.9	4.4	4.5	4.6	6.4	6.6	0.34
0.36	1.6	1.7	1.8	2.3	2.4	2.6	2.8	2.9	3.0	3.8	3.9	4.0	4.5	4.6	4.8	6.6	6.8	0.36
0.38	1.6	1.7	1.9	2.4	2.5	2.6	2.9	3.0	3.1	3.9	4.0	4.1	4.7	4.8	4.9	6.7	7.0	0.38
0.40	1.7	1.8	1.9	2.4	2.6	2.7	3.0	3.1	3.2	4.0	4.1	4.2	4.8	4.9	5.0	6.9	7.2	0.40
0.42	1.7	1.8	1.9	2.5	2.6	2.8	3.0	3.1	3.4	4.1	4.2	4.3	4.9	5.0	5.1	7.0	7.3	0.42
0.44	1.8	1.9	2.0	2.6	2.7	2.8	3.1	3.2	3.4	4.2	4.3	4.4	5.0	5.1	5.2	7.2	7.5	0.44
0.46	1.8	1.9	2.0	2.6	2.8	2.9	3.2	3.3	3.4	4.3	4.4	4.5	5.1	5.2	5.4	7.4	7.7	0.46
0.48	1.8	2.0	2.1	2.7	2.8	2.9	3.2	3.4	3.5	4.4	4.5	4.6	5.2	5.3	5.5	7.5	7.8	0.48
0.50	1.9	2.0	2.1	2.8	2.9	3.0	3.3	3.5	3.6	4.5	4.6	4.7	5.3	5.5	5.6	7.7	8.0	0.50
0.55	2.0	2.1	2.2	2.9	3.0	3.2	3.5	3.6	3.7	4.7	4.8	5.0	5.6	5.7	5.8	8.1	8.4	0.55
0.60	2.1	2.2	2.3	3.0	3.2	3.3	3.6	3.8	3.9	4.9	5.0	5.2	5.8	6.0	6.1	8.4	8.8	0.60
0.65	2.2	2.3	2.4	3.1	3.3	3.4	3.8	3.9	4.1	5.1	5.2	5.4	6.0	6.2	6.3	8.8	9.1	0.65
0.70	2.2	2.4	2.5	3.2	3.4	3.6	3.9	4.1	4.2	5.3	5.4	5.6	6.3	6.4	6.6	9.1	9.4	0.70
0.75	2.3	2.5	2.6	3.4	3.5	3.7	4.1	4.2	4.4	5.4	5.6	5.8	6.5	6.6	6.8	9.4	9.8	0.75
0.80	2.4	2.5	2.7	3.5	3.6	3.8	4.2	4.4	4.5	5.6	5.8	5.9	6.7	6.8	7.0	9.7	10.1	0.80
0.85	2.5	2.6	2.8	3.6	3.8	3.9	4.3	4.5	4.6	5.8	6.0	6.1	6.9	7.0	7.2	10.0	10.4	0.85
0.90	2.5	2.7	2.9	3.7	3.9	4.0	4.4	4.6	4.8	6.0	6.1	6.3	7.1	7.3	7.4	10.3	10.7	0.90
0.95	2.6	2.8	3.0	3.8	4.0	4.1	4.6	4.7	4.9	6.1	6.3	6.4	7.3	7.5	7.6	10.6	11.0	0.95
1.00	2.7	2.9	3.0	3.9	4.1	4.2	4.7	4.9	5.0	6.3	6.4	6.6	7.5	7.6	7.8	10.8	11.2	1.00
1.05	2.7	2.9	3.1	4.0	4.2	4.4	4.8	5.0	5.1	6.4	6.6	6.8	7.7	7.8	8.0	11.1	11.5	1.05
1.10	2.8	3.0	3.2	4.1	4.3	4.5	4.9	5.1	5.3	6.6	6.8	6.9	7.8	8.0	8.2	11.4	11.8	1.10
1.15	2.9	3.1	3.2	4.2	4.4	4.6	5.0	5.2	5.4	6.7	6.9	7.1	8.0	8.2	8.4	11.6	12.1	1.15
1.20	2.9	3.1	3.3	4.3	4.4	4.7	5.1	5.3	5.5	6.8	7.0	7.2	8.2	8.4	8.6	11.9	12.3	1.20
1.25	3.0	3.2	3.4	4.3	4.5	4.8	5.2	5.4	5.6	7.0	7.2	7.4	8.3	8.5	8.7	12.1	12.6	1.25
1.30	3.0	3.2	3.5	4.4	4.6	4.8	5.3	5.5	5.7	7.1	7.3	7.5	8.5	8.7	8.9	12.3	12.8	1.30
1.35	3.1	3.3	3.5	4.5	4.7	4.9	5.4	5.6	5.8	7.2	7.4	7.6	8.7	8.9	9.1	12.5	13.0	1.35
1.40	3.2	3.4	3.6	4.6	4.8	5.0	5.5	5.7	5.9	7.4	7.6	7.8	8.8	9.0	9.2	12.8	13.3	1.40
1.45	3.2	3.4	3.6	4.7	4.9	5.1	5.6	5.8	6.0	7.5	7.7	7.9	9.0	9.2	9.4	13.0	13.5	1.45
1.50	3.3	3.5	3.7	4.8	5.0	5.2	5.7	5.9	6.1	7.6	7.8	8.0	9.1	9.3	9.5	13.2	13.8	1.50

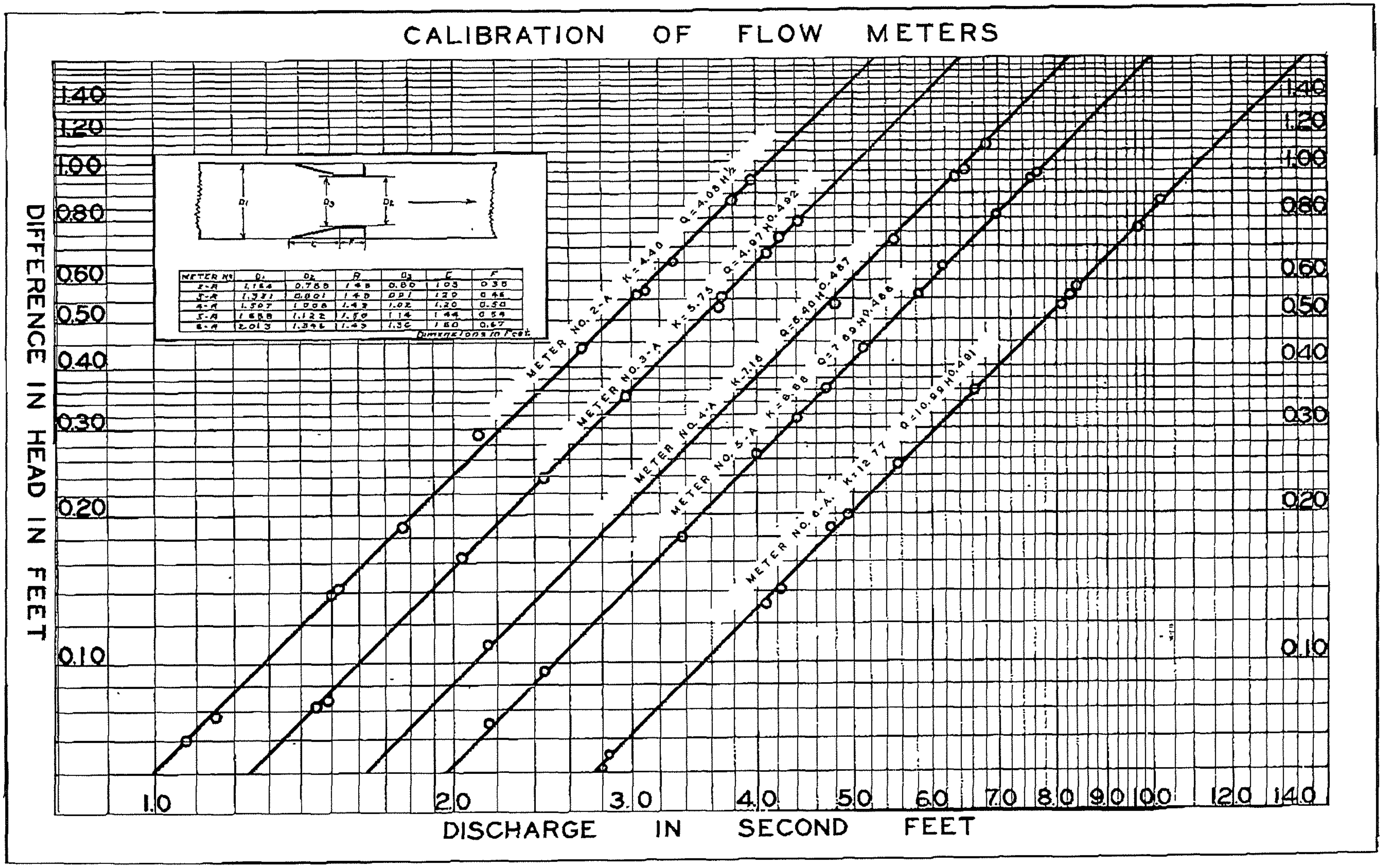

CALIBRATION OF FLOW METERS
DIFFERENCE IN HEAD IN FEET
DISCHARGE IN SECOND FEET
METER NO. 2-A K=4.40 Q=4.08H½
METER NO. 3-A K=5.75 Q=4.97H0.492
METER NO. 4-A K=7.16 Q=6.40H0.487
METER NO. 5-A K=8.88 Q=7.69H0.488
METER NO. 6-A. K=12.77 Q=10.99H0.491
Dimensions in Feet

FIGURE 14

TABLE X—DISCHARGE DATA

For Flow Meter Measuring Device for Values of R from 1.47 to 1.52 and 1.97 to 2.02

Head (Ft.)	VALUE OF "K"								
	1.2	1.4	1.6	2.0	2.2	2.4	6.4	6.6	6.8
	R lies between 1.47 and 1.52						R lies between 1.97 and 2.02		
	Discharge in Second Feet								
0.02	0.2	0.2	0.2	0.3	0.3	0.3	0.9	0.9	0.9
0.04	0.2	0.3	0.3	0.4	0.4	0.4	1.2	1.3	1.3
0.06	0.3	0.3	0.4	0.5	0.5	0.5	1.5	1.6	1.6
0.08	0.3	0.4	0.4	0.5	0.6	0.6	1.7	1.8	1.9
0.10	0.4	0.4	0.5	0.6	0.6	0.7	1.9	2.0	2.1
0.12	0.4	0.5	0.5	0.6	0.7	0.8	2.1	2.2	2.3
0.14	0.4	0.5	0.6	0.7	0.8	0.8	2.3	2.4	2.5
0.16	0.5	0.5	0.6	0.7	0.8	0.9	2.5	2.5	2.6
0.18	0.5	0.6	0.6	0.8	0.9	0.9	2.6	2.7	2.8
0.20	0.5	0.6	0.7	0.8	0.9	1.0	2.7	2.8	2.9
0.22	0.5	0.6	0.7	0.9	0.9	1.0	2.9	3.0	3.1
0.24	0.6	0.6	0.7	0.9	1.0	1.1	3.0	3.1	3.2
0.26	0.6	0.7	0.8	0.9	1.0	1.1	3.1	3.2	3.3
0.28	0.6	0.7	0.8	1.0	1.1	1.2	3.3	3.4	3.5
0.30	0.6	0.7	0.8	1.0	1.1	1.2	3.4	3.5	3.6
0.32	0.6	0.8	0.9	1.0	1.2	1.3	3.5	3.6	3.7
0.34	0.7	0.8	0.9	1.1	1.2	1.3	3.6	3.7	3.8
0.36	0.7	0.8	0.9	1.1	1.2	1.3	3.7	3.8	3.9
0.38	0.7	0.8	0.9	1.1	1.3	1.4	3.8	3.9	4.0
0.40	0.7	0.8	1.0	1.2	1.3	1.4	3.9	4.0	4.1
0.42	0.7	0.9	1.0	1.2	1.3	1.4	4.0	4.1	4.2
0.44	0.8	0.9	1.0	1.2	1.3	1.5	4.1	4.2	4.3
0.46	0.8	0.9	1.0	1.3	1.4	1.5	4.2	4.3	4.4
0.48	0.8	0.9	1.1	1.3	1.4	1.5	4.3	4.4	4.5
0.50	0.8	0.9	1.1	1.3	1.4	1.6	4.4	4.5	4.6
0.55	0.8	1.0	1.1	1.4	1.5	1.6	4.6	4.7	4.9
0.60	0.9	1.0	1.2	1.4	1.6	1.7	4.8	4.9	5.1
0.65	0.9	1.1	1.2	1.5	1.6	1.8	5.0	5.1	5.3
0.70	1.0	1.1	1.3	1.5	1.7	1.9	5.2	5.3	5.5
0.75	1.0	1.2	1.3	1.6	1.8	1.9	5.3	5.5	5.7
0.80	1.0	1.2	1.4	1.6	1.8	2.0	5.5	5.7	5.9
0.85	1.0	1.2	1.4	1.7	1.9	2.1	5.7	5.8	6.0
0.90	1.1	1.3	1.4	1.8	1.9	2.1	5.9	6.0	6.2
0.95	1.1	1.3	1.5	1.8	2.0	2.2	6.0	6.2	6.4
1.00	1.1	1.3	1.5	1.8	2.0	2.2	6.2	6.4	6.5
1.05	1.2	1.4	1.6	1.9	2.1	2.3	6.3	6.5	6.7
1.10	1.2	1.4	1.6	1.9	2.1	2.3	6.4	6.7	6.9
1.15	1.2	1.4	1.6	2.0	2.2	2.4	6.6	6.8	7.0
1.20	1.2	1.5	1.7	2.0	2.2	2.4	6.7	7.0	7.2
1.25	1.3	1.5	1.7	2.1	2.3	2.5	6.9	7.1	7.3
1.30	1.3	1.5	1.7	2.1	2.3	2.5	7.0	7.2	7.5
1.35	1.3	1.5	1.8	2.1	2.4	2.6	7.2	7.4	7.6
1.40	1.3	1.6	1.8	2.2	2.4	2.6	7.3	7.5	7.8
1.45	1.4	1.6	1.8	2.2	2.5	2.7	7.4	7.7	7.9
1.50	1.4	1.6	1.9	2.3	2.5	2.7	7.5	7.8	8.0

To facilitate the use of these tables there is placed on top of the observation well of each of these meters a brass tag on which is shown the number of the meter, the constant K and the diameter ratio R. It will be observed that the tables are made to conform to these factors so that the observer only needs to read the difference in head in the observation well and observe the values of R and K on the number tag to enable him to take the discharge directly from the table.

If the limits and conditions of these tests be observed our investigations indicate that the device will give dependable results within the limits of accuracy that are necessary for the normal and prevailing conditions in canal service outlets.

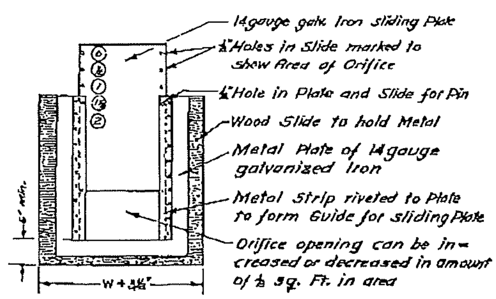
Variable Submerged Orifice

(12) The variable submerged orifice has been in use in the District for a number of years. It involves the ordinary principle of the orifice and is adaptable to the smaller deliveries to farm ditches and at the heads of some of the smaller main laterals. The general plan of the device as used in this District is shown on Figure 15. As noted in the drawing the orifice is usually placed above the turnout gate and the orifice and slide to regulate the opening are built of galvanized sheet metal. The structure involves no unusual difficulties in construction but is more expensive than either the calibrated gate device or the flow meter.

A number of tests were made of this device at the calibrating station and the results of these have been worked out as indicated in Table XI on page 36.

Supplemental Data and Suggestions

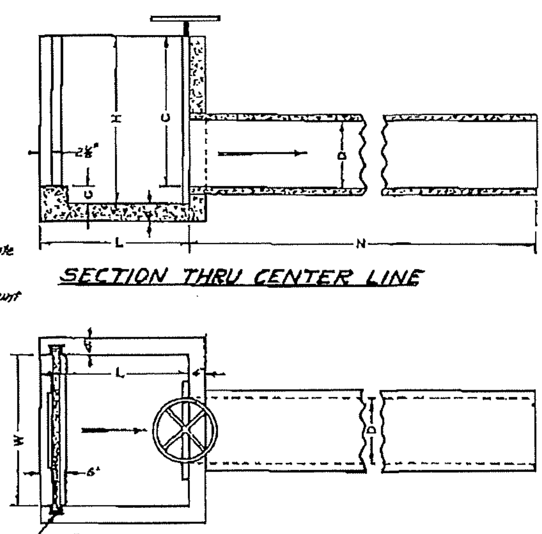
(13) In the discussion of the flow meter it is observed that the factor T which is utilized in the data is substituted for $\dfrac{\sqrt{2g}}{\sqrt{R^4-1}}$ where R is the ratio between the diameters D_1 and D_2 of the meter. The computations for this value of T involved considerable work and there is appended to this report, as Table XII, page 37, the computed values of T for different values of R. This table is utilized in computing the values of K to be placed on the tags which are attached to all flow meters to facilitate operation.



DETAIL OF VARIABLE ORIFICE

TABLE OF MINIMUM DIMENSIONS

D	H	W	C	N	G	L
8"	2'-4"	2'-0"	2'-0"		4"	2'-0"
10"	2'-4"	2'-6"	2'-0"		4"	2'-0"
12"	2'-10"	2'-6"	2'-6"	AS REQUIRED	4"	2'-6"
14"	2'-10"	3'-0"	2'-6"		4"	2'-6"
16"	3'-4"	3'-0"	3'-0"		4"	3'-0"
18"	3'-0"	3'-6"	3'-6"		4"	3'-6"
20"	4'-3"	3'-6"	3'-9"		4"	3'-6"
24"	4'-6"	4'-0"	4'-3"		4"	4'-0"



SECTION THRU CENTER LINE

PLAN

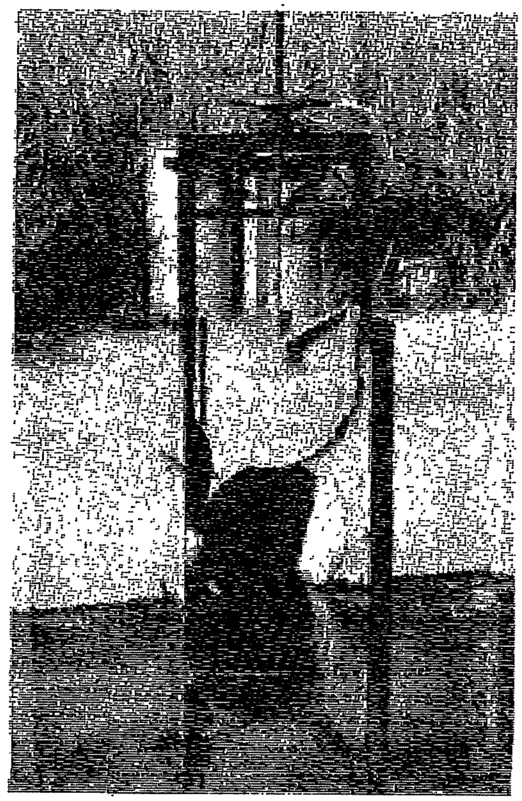
FRESNO IRRIGATION DISTRICT
STANDARD CANAL TURNOUT
WITH VARIABLE SUBMERGED
ORIFICE MEASURING DEVICE
JULY 1929

FIGURE 15

Another factor involved in the considerations is the loss of head that occurs in the operation of these devices. In order that this factor may be available in the use of these data there is given in Table XIII, page 38, the data for the calibrated gate device and in Table XIV, page 38, the data for the flow meter device.

(14) In the utilization of these devices it is necessary that the conditions of use provide the fundamental hydraulic elements involved in the tests. The calibrated gate device and flow meter device are not necessarily equally adaptable to all cases. For instance analysis of a particular situation may indicate that in an attempt to use the calibrated gate device a negative pressure would be developed in the measuring well below the gate. The condition may be more readily satisfied by a flow meter device. An effort has been made, in the work, to utilize available facilities and pertinent hydraulic principles, together with more or less comprehensive field tests to develop some practical means of equitably distributing the District's water supply to the small neighborhood ditches.

A check of results in actual field use has been made to a limited extent and thus far the resulting data are satisfactory. More accurate and comprehensive data in this regard are contemplated.



20" Calco Slide Headgate Used as Standard Measuring Device.

Tables of Discharge and Pertinent Operation Factors for Flow Meter Turnouts as Determined in Calibrations and Tests by Fresno Irrigation District

	Values of R	*Values of K*
Table VIII	1.30 to 1.40	4.2 to 17.4
Table IX	1.47 to 1.52	3.0 to 13.0
Table X	1.47 to 1.52	1.2 to 2.4
and	1.97 to 2.02	6.4 to 6.8

***Example of Use of Tables*:**

Required to determine the discharge through a flow meter turnout, on the number tag of which, the value of R is given as 1.33 and K is 11.6 and the difference in the elevation of the water surfaces in the pressure wells of the measuring device is 0.55 feet.

Answer: Table VIII includes the value of $R = 1.33$. Under the value of $K = 11.6$ in the eleventh column of the table and opposite 0.55 in the first column of the table the result is 7.9 sec. ft.

TABLE XI.

Discharge in Second Feet for Adjustable Rectangular Submerged Orifice

Head (Ft.)	AREAS IN SQUARE FEET 0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
	Second Feet							
0.02	0.4	0.7	1.1	1.4	1.8	2.2	2.6	2.9
0.04	0.5	1.0	1.5	2.0	2.6	3.1	3.6	4.1
0.06	0.7	1.3	1.9	2.5	3.1	3.8	4.4	5.0
0.08	0.8	1.5	2.2	2.9	3.6	4.4	5.1	5.8
0.10	0.9	1.6	2.4	3.2	4.0	4.9	5.7	6.5
0.12	0.9	1.8	2.6	3.5	4.4	5.4	6.2	7.1
0.14	1.0	1.9	2.9	3.8	4.8	5.8	6.8	7.7
0.16	1.1	2.1	3.1	4.1	5.1	6.2	7.2	8.2
0.18	1.1	2.2	3.2	4.3	5.4	6.6	7.7	8.7
0.20	1.2	2.3	3.4	4.5	5.7	6.9	8.1	9.2
0.22	1.3	2.4	3.6	4.7	6.0	7.3	8.5	9.7
0.24	1.3	2.5	3.7	5.0	6.2	7.6	8.8	10.1
0.26	1.4	2.6	3.9	5.2	6.5	7.9	9.2	10.5
0.28	1.4	2.7	4.0	5.4	6.7	8.2	9.5	10.9
0.30	1.5	2.8	4.2	5.6	7.0	8.5	9.9	11.3
0.32	1.5	2.9	4.3	5.7	7.2	8.7	10.2	11.7
0.34	1.6	3.0	4.5	5.9	7.4	9.0	10.5	12.0
0.36	1.6	3.1	4.6	6.1	7.7	9.3	10.8	12.4
0.38	1.7	3.2	4.7	6.2	7.9	9.5	11.1	12.7
0.40	1.7	3.3	4.8	6.4	8.1	9.8	11.4	13.0
0.42	1.8	3.4	4.9	6.6	8.3	10.0	11.7	13.4
0.44	1.8	3.5	5.1	6.7	8.5	10.3	12.0	13.7
0.46	1.8	3.5	5.2	6.9	8.6	10.5	12.1	14.0
0.48	1.9	3.6	5.3	7.0	8.8	10.7	12.5	14.3
0.50	1.9	3.7	5.4	7.2	9.0	10.9	12.8	14.6
0.55	2.0	3.9	5.7	7.5	9.5	11.5	13.4	15.3
0.60	2.1	4.0	5.9	7.8	9.9	12.0	14.0	16.0
0.65	2.2	4.2	6.2	8.2	10.3	12.5	14.5	16.6
0.70	2.3	4.3	6.4	8.5	10.7	12.9	15.1	17.3
0.75	2.3	4.5	6.6	8.8	11.0	13.4	15.6	17.9
0.80	2.4	4.6	6.8	9.1	11.4	13.8	16.1	18.4
0.85	2.5	4.8	7.0	9.3	11.8	14.2	16.6	19.0
0.90	2.6	4.9	7.2	9.6	12.1	14.7	17.1	19.6
0.95	2.6	5.1	7.4	9.9	12.4	15.1	17.6	20.1
1.00	2.7	5.2	7.6	10.1	12.8	15.5	18.0	20.6

TABLE XII.

Calibrated Flow Meter Device Table for Values of "T" for Given Values of "R"

R	00	001	.002	.003	004.	.005	.006	.007	.008	.009
					Values of T					
1.30	5.89	5.88	5.86	5.85	5.84	5.82	5.81	5.80	5.78	5.77
1.31	5.76	5.74	5.73	5.72	5.71	5.69	5.68	5.67	5.65	5.64
1.32	5.63	5.61	5.60	5.59	5.57	5.56	5.55	5.54	5.52	5.51
1.33	5.50	5.49	5.47	5.46	5.45	5.44	5.42	5.41	5.40	5.39
1.34	5.37	5.36	5.35	5.34	5.33	5.32	5.30	5.29	5.28	5.27
1.35	5.26	5.25	5.24	5.23	5.22	5.20	5.19	5.18	5.17	5.16
1.46	4.26	4.25	4.24	4.24	4.23	4.22	4.21	4.20	4.20	4.19
1.47	4.18	4.17	4.17	4.16	4.15	4.14	4.14	4.13	4.12	4.12
1.48	4.11	4.10	4.10	4.09	4.08	4.08	4.07	4.06	4.06	4.05
1.49	4.04	4.04	4.03	4.02	4.02	4.01	4.00	4.00	3.99	3.98
1.50	3.98	3.97	3.96	3.96	3.95	3.94	3.94	3.93	3.92	3.92
1.51	3.91	3.91	3.90	3.89	3.89	3.88	3.87	3.87	3.86	3.86
1.52	3.85	3.85	3.84	3.83	3.83	3.82	3.81	3.81	3.80	3.80
1.53	3.79	3.78	3.78	3.77	3.77	3.76	3.75	3.75	3.74	3.74
1.96	2.16	2.16	2.16	2.16	2.15	2.15	2.15	2.15	2.14	2.14
1.97	2.14	2.14	2.13	2.13	2.13	2.13	2.13	2.12	2.12	2.12
1.98	2.12	2.11	2.11	2.11	2.11	2.10	2.10	2.10	2.10	2.10
1.99	2.09	2.09	2.09	2.09	2.08	2.08	2.08	2.08	2.08	2.07
2.00	2.07	2.07	2.07	2.06	2.06	2.06	2.06	2.05	2.05	2.05

TABLE XIII

Calibrated Gate Turnouts. Total Loss of Head in Turnout for Given Quantities of Flow

Size of Turnout (Inches)	Second Feet											
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
	Total Loss of Head in Feet											
8	0.15	0.35	0.50	0.90								
10	0.10	0.15	0.30	0.50								
12	0.05	0.10	0.20	0.30	0.45	0.60	0.80	1.00	1.20	1.75	2.40	3.10
14	0.05	0.05	0.10	0.15	0.25	0.30	0.40	0.50	0.65	0.95	1.30	1.65
16		0.05	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.50	0.70	0.90
18				0.05	0.10	0.10	0.15	0.15	0.20	0.30	0.40	0.50
20				0.05	0.05	0.05	0.10	0.10	0.10	0.15	0.25	0.30
24										0.05	0.05	0.10

This table is for use in field to determine minimum size of turnout and applies only with gate wide open.

TABLE XIV.

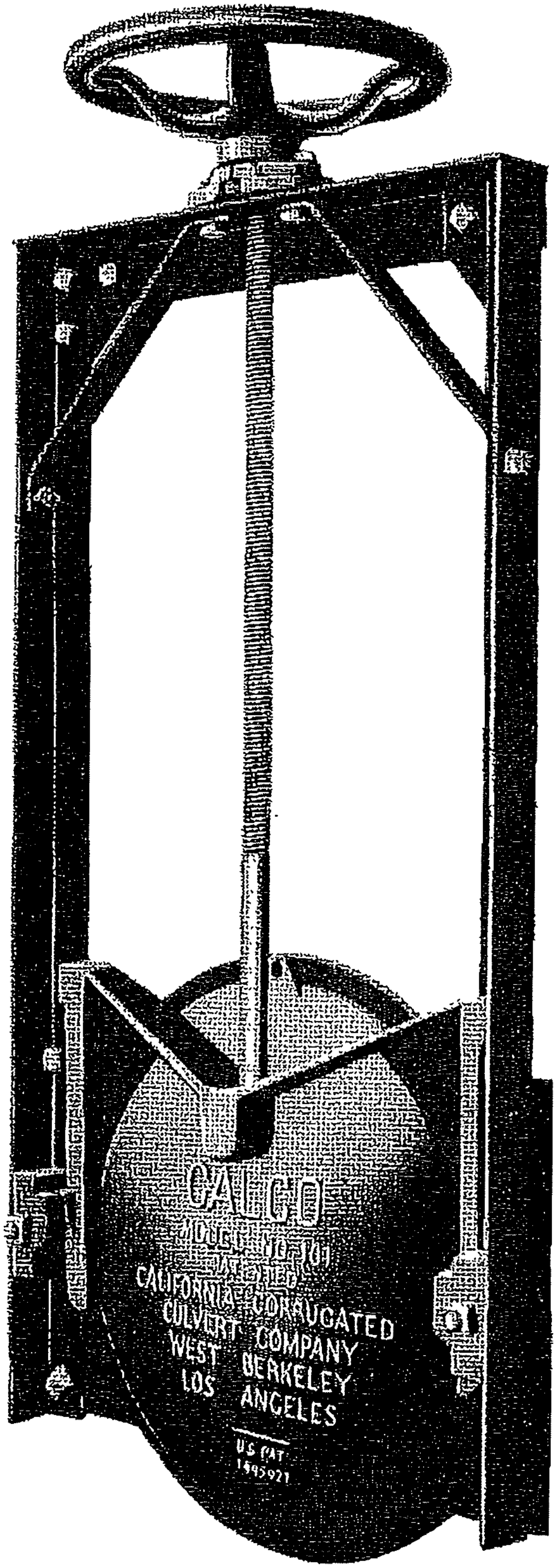
Calibrated Flow-Meter. Loss in Head to Pass Given Quantities of Water.

WHEN R IS APPROXIMATELY 1.50

Size of Turnout (Inches)	Second Feet																	
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.0	10.0	11.0	12.0
	Total Loss in Head in Feet																	
12	0.11	0.23	0.40	0.62	0.93	1.28	1.66	2.10										
14	0.05	0.13	0.22	0.33	0.48	0.66	0.89	1.14	1.40	1.68								
16	0.04	0.08	0.14	0.22	0.31	0.42	0.55	0.70	0.87	1.05	1.25	1.46	1.66					
18	0.02	0.05	0.10	0.15	0.22	0.29	0.38	0.48	0.59	0.70	0.83	0.96	1.09	1.37	1.66	1.96		
20			0.06	0.08	0.12	0.16	0.22	0.28	0.36	0.44	0.53	0.62	0.72	0.93	1.16	1.38	1.63	1.88
24			0.04	0.05	0.06	0.08	0.11	0.13	0.17	0.21	0.26	0.30	0.35	0.47	0.62	0.76	0.92	1.08

WHEN R IS APPROXIMATELY 1.33

Size of Turnout (Inches)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.0	10.0	11.0	12.0
12	0.07	0.16	0.27	0.43	0.62	0.87	1.16											
16	0.03	0.06	0.09	0.13	0.18	0.24	0.31	0.41	0.52	0.64	0.77	0.91	1.05					
18	0.01	0.02	0.05	0.08	0.12	0.16	0.22	0.28	0.35	0.42	0.50	0.58	0.66	0.84	1.20			
20		0.01	0.03	0.04	0.07	0.10	0.13	0.16	0.21	0.24	0.30	0.35	0.41	0.55	0.70	0.87	1.04	
24					0.03	0.04	0.06	0.07	0.09	0.11	0.13	0.16	0.19	0.25	0.33	0.42	0.51	0.62


CALCO
CALIFORNIA CORRUGATED
CULVERT COMPANY
WEST BERKELEY
LOS ANGELES

WATER MEASUREMENT TABLES

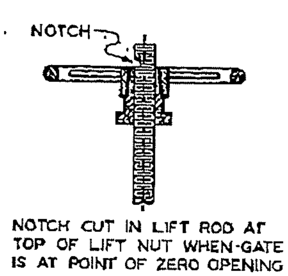
FOR THE ARMCO METERGATE

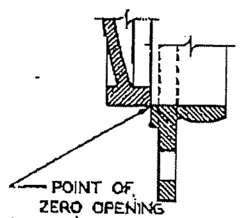
NOTE:

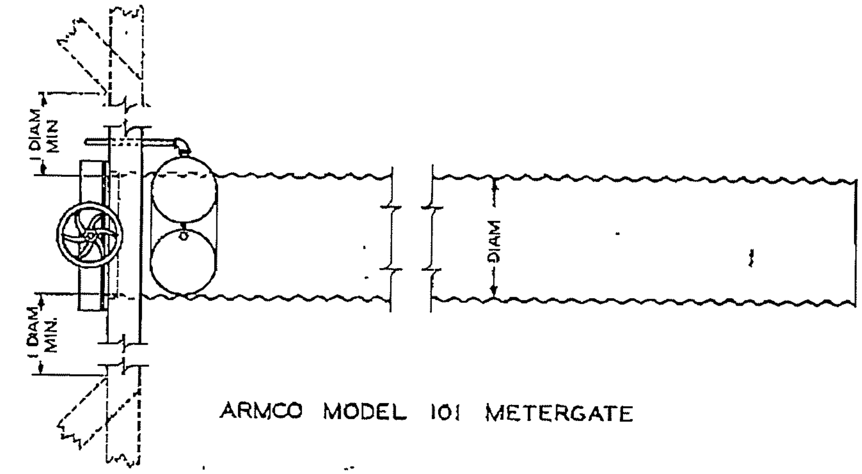
In 1927 the Fresno Irrigation District recognized the need and advantages of having a gate that would both control and measure water with a minimum loss of head.

This district conducted calibration tests on the Armco Model 101 Gate. In 1928 discharge tables derived from this data were published in a booklet titled "Methods and Devices used in the Measurement and Regulation of Flow to Service Ditches, Together with Tables for Field Use." These tables enabled users of the gate to rapidly measure water within the limits of the accuracy of the test and testing facilities available at that time.

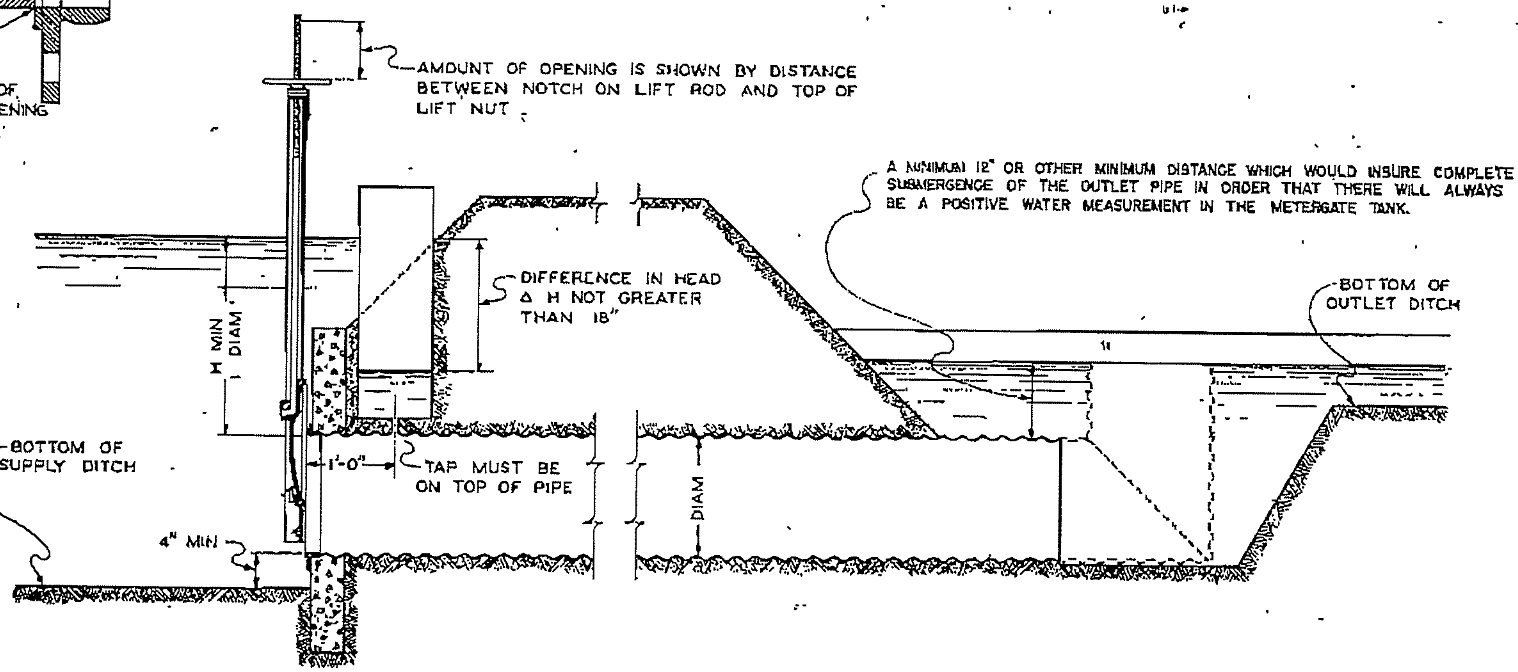
Further studies on the Armco Model 101 Gate were made in 1950 by the U. S. Bureau of Reclamation, primarily to determine the limitations of its use. Colorado A & M College cooperated with the Bureau in this work by calibrating additional gates and preparing calibration curves and discharge tables for all sizes of Armco Meter Gates. The results, even with the better laboratory testing equipment available, required only a slight modification of the original tables to meet today's exacting standards of water measurement. The modified tables are printed in this booklet.







ARMCO MODEL 101 METERGATE



INSTALLATION OF ARMCO METERGATE WITH CORRUGATED PIPE

TABLE I — DISCHARGE DATA — 8" ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches												
	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8
	Discharge in Cubic Feet per Second												
1	0.27	0.32	0.38	0.42	0.46	0.51	0.55	0.57	0.59	0.61	0.62	0.63	0.64
1¼	.30	.36	.42	.46	.51	.56	.60	.63	.65	.68	.70	.71	.71
1½	.32	.39	.46	.50	.56	.61	.67	.69	.72	.75	.77	.78	.78
1¾	.35	.42	.49	.54	.60	.66	.72	.75	.78	.81	.83	.84	.85
2	.37	.44	.52	.58	.64	.70	.76	.80	.83	.86	.89	.90	.91
2¼	.39	.46	.54	.61	.67	.74	.80	.84	.88	.92	.94	.96	.97
2½	.41	.49	.57	.64	.70	.77	.85	.89	.93	.96	1.00	1.01	1.02
2¾	.42	.51	.60	.66	.74	.81	.88	.93	.97	1.01	1.04	1.06	1.07
3	.44	.53	.62	.69	.76	.84	.92	.97	1.02	1.06	1.09	1.11	1.12
3¼	.46	.55	.64	.72	.79	.87	.95	1.01	1.06	1.10	1.13	1.15	1.16
3½	.47	.57	.67	.74	.82	.90	.99	1.05	1.10	1.14	1.18	1.20	1.21
3¾	.49	.59	.69	.77	.85	.93	1.02	1.08	1.14	1.18	1.22	1.24	1.26
4	.50	.60	.71	.79	.88	.96	1.05	1.12	1.18	1.22	1.26	1.28	1.30
4¼	.52	.62	.73	.82	.90	.99	1.08	1.15	1.22	1.26	1.30	1.33	1.34
4½	.53	.64	.75	.84	.92	1.02	1.11	1.19	1.25	1.30	1.34	1.37	1.38
4¾	.54	.65	.76	.86	.95	1.04	1.14	1.22	1.29	1.34	1.38	1.41	1.42
5	.56	.67	.78	.88	.97	1.07	1.17	1.25	1.32	1.37	1.42	1.44	1.46
5½	.58	.70	.81	.91	1.01	1.12	1.22	1.31	1.38	1.44	1.49	1.52	1.54
6	.60	.72	.84	.95	1.06	1.17	1.27	1.36	1.44	1.50	1.55	1.58	1.60
6½	.62	.75	.87	.99	1.10	1.22	1.32	1.42	1.50	1.56	1.61	1.65	1.67
7	.64	.77	.90	1.03	1.15	1.26	1.37	1.47	1.55	1.62	1.67	1.71	1.74
7½	.66	.80	.94	1.06	1.19	1.31	1.42	1.53	1.61	1.68	1.73	1.77	1.80
8	.68	.82	.96	1.10	1.22	1.35	1.47	1.58	1.66	1.73	1.79	1.83	1.86
8½	.70	.85	1.00	1.13	1.26	1.39	1.52	1.62	1.71	1.78	1.84	1.88	1.92
9	.72	.87	1.02	1.16	1.30	1.43	1.56	1.67	1.76	1.84	1.89	1.94	1.97
9½	.74	.90	1.05	1.19	1.33	1.47	1.60	1.72	1.81	1.89	1.94	1.99	2.02
10	.76	.92	1.08	1.22	1.37	1.51	1.64	1.76	1.85	1.94	1.99	2.04	2.08
11	.79	.96	1.13	1.28	1.44	1.58	1.72	1.85	1.94	2.03	2.09	2.14	2.18
12	.83	1.01	1.18	1.34	1.50	1.66	1.80	1.93	2.03	2.12	2.18	2.24	2.27
13	.86	1.05	1.23	1.40	1.56	1.72	1.87	2.01	2.12	2.21	2.28	2.33	2.37
14	.89	1.09	1.28	1.45	1.62	1.79	1.94	2.08	2.20	2.29	2.36	2.42	2.46
15	.92	1.13	1.32	1.50	1.68	1.85	2.01	2.16	2.27	2.37	2.44	2.50	2.54
16	.95	1.16	1.37	1.55	1.73	1.91	2.08	2.23	2.35	2.45	2.52	2.58	2.62
17	.98	1.20	1.41	1.60	1.78	1.97	2.14	2.30	2.42	2.52	2.60	2.66	2.71
18	1.01	1.23	1.45	1.64	1.84	2.03	2.20	2.36	2.49	2.60	2.68	2.74	2.79

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE II — DISCHARGE DATA — 10″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches												
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10
	Discharge in Cubic Feet per Second												
1	0.31	0.39	0.45	0.51	0.56	0.62	0.67	0.72	0.77	0.86	0.93	0.97	0.99
1¼	.34	.43	.50	.56	.62	.69	.75	.80	.86	.96	1.03	1.07	1.10
1½	.37	.47	.54	.61	.68	.75	.81	.87	.94	1.05	1.12	1.17	1.20
1¾	.40	.50	.58	.65	.73	.80	.87	.94	1.01	1.12	1.21	1.27	1.30
2	.43	.53	.62	.69	.78	.85	.93	.99	1.08	1.19	1.29	1.36	1.39
2¼	.46	.56	.65	.73	.82	.89	.98	1.04	1.14	1.26	1.37	1.45	1.48
2½	.49	.59	.68	.77	.86	.93	1.03	1.09	1.20	1.33	1.45	1.53	1.57
2¾	.52	.62	.71	.81	.90	.97	1.08	1.14	1.25	1.39	1.52	1.60	1.65
3	.54	.64	.74	.84	.94	1.01	1.12	1.19	1.30	1.45	1.59	1.67	1.72
3¼	.56	.66	.77	.87	.98	1.05	1.16	1.24	1.35	1.51	1.66	1.74	1.78
3½	.58	.68	.80	.90	1.01	1.09	1.20	1.29	1.40	1.57	1.72	1.80	1.84
3¾	.60	.70	.83	.93	1.04	1.13	1.24	1.34	1.45	1.62	1.78	1.86	1.90
4	.62	.72	.86	.96	1.07	1.17	1.28	1.39	1.50	1.67	1.84	1.92	1.96
4¼	.64	.74	.88	.99	1.10	1.21	1.32	1.43	1.55	1.72	1.89	1.98	2.02
4½	.66	.76	.90	1.02	1.13	1.25	1.36	1.47	1.59	1.77	1.94	2.04	2.08
4¾	.68	.78	.92	1.05	1.16	1.29	1.40	1.51	1.63	1.82	1.99	2.10	2.14
5	.70	.80	.94	1.08	1.19	1.32	1.44	1.55	1.67	1.87	2.04	2.16	2.20
5½	.73	.84	.98	1.13	1.25	1.38	1.51	1.63	1.75	1.96	2.14	2.26	2.32
6	.75	.88	1.02	1.18	1.30	1.44	1.58	1.70	1.83	2.05	2.24	2.36	2.44
6½	.77	.91	1.06	1.22	1.35	1.50	1.64	1.77	1.91	2.14	2.34	2.46	2.55
7	.79	.94	1.10	1.26	1.40	1.56	1.70	1.84	1.98	2.22	2.42	2.56	2.64
7½	.81	.97	1.14	1.30	1.45	1.61	1.76	1.90	2.05	2.30	2.50	2.65	2.73
8	.83	1.00	1.18	1.34	1.50	1.66	1.82	1.96	2.12	2.37	2.58	2.74	2.82
8½	.85	1.03	1.22	1.38	1.55	1.71	1.87	2.02	2.18	2.44	2.66	2.82	2.91
9	.87	1.06	1.26	1.42	1.60	1.76	1.92	2.08	2.24	2.51	2.74	2.90	3.00
9½	.89	1.09	1.30	1.46	1.64	1.81	1.97	2.14	2.30	2.58	2.82	2.98	3.09
10	.91	1.12	1.33	1.50	1.68	1.86	2.02	2.20	2.36	2.65	2.90	3.06	3.17
11	.95	1.17	1.39	1.57	1.76	1.95	2.12	2.30	2.48	2.78	3.04	3.21	3.32
12	.99	1.22	1.45	1.64	1.84	2.04	2.22	2.40	2.59	2.90	3.17	3.36	3.47
13	1.03	1.27	1.51	1.71	1.92	2.12	2.31	2.50	2.70	3.02	3.30	3.50	3.62
14	1.07	1.32	1.56	1.78	1.99	2.20	2.40	2.60	2.80	3.14	3.42	3.62	3.76
15	1.11	1.37	1.61	1.84	2.06	2.28	2.48	2.69	2.90	3.24	3.54	3.74	3.88
16	1.15	1.42	1.66	1.90	2.12	2.36	2.56	2.78	2.99	3.34	3.66	3.86	4.00
17	1.19	1.46	1.71	1.96	2.18	2.43	2.64	2.86	3.08	3.44	3.77	3.98	4.12
18	1.23	1.50	1.76	2.02	2.24	2.50	2.72	2.94	3.17	3.54	3.88	4.10	4.24

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE III — DISCHARGE DATA — 12" ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches — 2	2½	3	3½	4	4½	5	5½	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
1¼	.40	.51	.58	.67	.74	.82	.89	.95	1.03	1.17	1.29	1.41	1.50	1.55	1.57
1½	.44	.55	.63	.73	.81	.89	.97	1.04	1.12	1.28	1.41	1.54	1.64	1.70	1.73
1¾	.47	.59	.68	.78	.87	.95	1.04	1.12	1.21	1.38	1.52	1.66	1.77	1.83	1.86
2	.50	.63	.73	.83	.93	1.01	1.10	1.19	1.29	1.47	1.62	1.77	1.89	1.96	1.99
2¼	.53	.67	.78	.88	.98	1.07	1.16	1.26	1.36	1.55	1.71	1.87	2.00	2.08	2.12
2½	.56	.70	.82	.92	1.03	1.13	1.22	1.32	1.43	1.63	1.80	1.97	2.11	2.20	2.23
2¾	.59	.73	.85	.96	1.08	1.18	1.28	1.38	1.49	1.70	1.88	2.06	2.21	2.31	2.34
3	.61	.76	.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
3¼	.63	.79	.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
3½	.65	.82	.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
3¾	.67	.84	.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	.69	.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
4¼	.71	.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
4½	.73	.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
4¾	.75	.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	.77	.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
5½	.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	.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
6½	.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	.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
7½	.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	.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
8½	.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
9½	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

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE IV — DISCHARGE DATA — 14″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches																
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14
	Discharge in Cubic Feet per Second																
1	0.44	0.53	0.62	0.70	0.78	0.86	0.93	1.01	1.07	1.21	1.35	1.49	1.60	1.72	1.81	1.87	1.91
1¼	.49	.59	.68	.77	.86	.95	1.03	1.12	1.19	1.34	1.50	1.65	1.78	1.91	2.01	2.08	2.12
1½	.53	.64	.74	.84	.94	1.03	1.12	1.22	1.30	1.46	1.64	1.80	1.95	2.09	2.20	2.29	2.33
1¾	.57	.69	.79	.91	1.01	1.10	1.21	1.31	1.40	1.57	1.77	1.94	2.09	2.25	2.38	2.47	2.53
2	.60	.73	.84	.96	1.07	1.17	1.28	1.39	1.49	1.67	1.88	2.07	2.23	2.41	2.54	2.65	2.71
2¼	.63	.77	.89	1.01	1.13	1.24	1.35	1.47	1.57	1.77	1.98	2.19	2.37	2.55	2.69	2.82	2.88
2½	.66	.81	.94	1.06	1.19	1.31	1.42	1.54	1.65	1.87	2.08	2.31	2.50	2.68	2.83	2.98	3.03
2¾	.69	.85	.98	1.11	1.24	1.37	1.49	1.61	1.73	1.96	2.18	2.42	2.62	2.81	2.96	3.13	3.18
3	.72	.88	1.02	1.16	1.29	1.43	1.55	1.68	1.81	2.05	2.28	2.53	2.73	2.93	3.09	3.27	3.33
3¼	.75	.91	1.06	1.20	1.34	1.48	1.61	1.75	1.89	2.13	2.37	2.63	2.84	3.05	3.22	3.39	3.47
3½	.78	.94	1.10	1.24	1.39	1.53	1.67	1.82	1.96	2.21	2.46	2.73	2.95	3.16	3.34	3.50	3.60
3¾	.81	.97	1.14	1.28	1.44	1.58	1.73	1.88	2.03	2.29	2.55	2.82	3.05	3.27	3.46	3.61	3.73
4	.83	1.00	1.18	1.32	1.49	1.63	1.79	1.94	2.10	2.36	2.63	2.91	3.15	3.38	3.57	3.72	3.86
4¼	.85	1.03	1.21	1.36	1.53	1.68	1.84	2.00	2.16	2.43	2.71	3.00	3.25	3.49	3.68	3.83	3.98
4½	.87	1.06	1.24	1.40	1.57	1.73	1.89	2.06	2.22	2.51	2.79	3.09	3.35	3.59	3.79	3.94	4.10
4¾	.89	1.09	1.27	1.44	1.61	1.78	1.94	2.12	2.28	2.58	2.87	3.18	3.44	3.69	3.89	4.05	4.21
5	.91	1.12	1.30	1.48	1.65	1.83	1.99	2.18	2.34	2.65	2.95	3.26	3.53	3.79	3.99	4.16	4.31
5½	.95	1.17	1.36	1.55	1.73	1.92	2.09	2.28	2.46	2.77	3.09	3.42	3.70	3.97	4.19	4.36	4.51
6	.99	1.21	1.41	1.62	1.81	2.00	2.19	2.38	2.57	2.89	3.23	3.57	3.86	4.15	4.37	4.55	4.70
6½	1.03	1.25	1.46	1.68	1.88	2.08	2.28	2.48	2.67	3.01	3.36	3.72	4.02	4.32	4.55	4.74	4.89
7	1.07	1.29	1.51	1.74	1.95	2.16	2.36	2.57	2.77	3.12	3.48	3.86	4.17	4.48	4.72	4.92	5.08
7½	1.11	1.33	1.56	1.80	2.02	2.24	2.44	2.66	2.87	3.23	3.60	3.99	4.32	4.63	4.89	5.09	5.26
8	1.15	1.37	1.61	1.86	2.09	2.31	2.52	2.75	2.96	3.34	3.72	4.12	4.46	4.78	5.05	5.25	5.43
8½	1.18	1.41	1.66	1.92	2.16	2.38	2.60	2.84	3.05	3.44	3.84	4.25	4.60	4.93	5.20	5.41	5.59
9	1.21	1.45	1.71	1.98	2.22	2.45	2.68	2.92	3.14	3.54	3.95	4.37	4.73	5.07	5.35	5.57	5.75
9½	1.24	1.49	1.76	2.03	2.28	2.52	2.75	3.00	3.23	3.64	4.06	4.49	4.86	5.21	5.50	5.72	5.91
10	1.27	1.53	1.81	2.08	2.34	2.59	2.82	3.08	3.31	3.74	4.16	4.61	4.99	5.35	5.64	5.87	6.07
11	1.32	1.61	1.90	2.18	2.45	2.71	2.96	3.23	3.48	3.92	4.36	4.83	5.22	5.61	5.92	6.16	6.36
12	1.37	1.68	1.98	2.28	2.56	2.83	3.09	3.37	3.65	4.09	4.56	5.05	5.45	5.86	6.19	6.44	6.65
13	1.42	1.75	2.06	2.37	2.66	2.95	3.22	3.51	3.79	4.26	4.75	5.26	5.68	6.10	6.44	6.70	6.92
14	1.47	1.81	2.14	2.46	2.76	3.06	3.34	3.64	3.92	4.42	4.92	5.46	5.90	6.33	6.68	6.95	7.18
15	1.52	1.87	2.21	2.55	2.86	3.17	3.46	3.77	4.05	4.58	5.09	5.65	6.10	6.55	6.91	7.20	7.43
16	1.57	1.93	2.28	2.63	2.96	3.27	3.57	3.89	4.18	4.73	5.26	5.83	6.80	6.77	7.14	7.44	7.68
17	1.62	1.99	2.35	2.71	3.05	3.37	3.68	4.01	4.31	4.87	5.43	6.01	6.50	6.98	7.36	7.67	7.92
18	1.66	2.05	2.42	2.79	3.14	3.47	3.79	4.13	4.44	5.01	5.59	6.19	6.69	7.19	7.57	7.89	8.15

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE V — DISCHARGE DATA — 15″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches																	
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14	15
	Discharge in Cubic Feet per Second																	
1	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
1¼	.51	.62	.73	.83	.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
1½	.55	.67	.79	.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
1¾	.59	.72	.85	.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	2.88	2.90
2	.63	.77	.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
2¼	.67	.81	.95	1.10	1.22	1.34	1.45	1.57	1.68	1.89	2.11	2.33	2.54	2.73	2.91	3.07	3.22	3.28
2½	.70	.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
2¾	.73	.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	3.64
3	.76	.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
3¼	.79	.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
3½	.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
3¾	.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
4	.88	1.06	1.25	1.41	1.58	1.75	1.91	2.07	2.22	2.52	2.81	3.10	3.39	3.63	3.87	4.09	4.27	4.39
4¼	.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
4½	.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
4¾	.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
5	.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	4.32	4.57	4.77	4.92
5½	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
6	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
6½	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
7	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
7½	1.17	1.42	1.68	1.92	2.16	2.39	2.62	2.84	3.03	3.46	3.85	4.25	4.64	4.96	5.29	5.59	5.84	5.99
8	1.21	1.46	1.73	1.98	2.23	2.47	2.71	2.93	3.13	3.57	3.98	4.39	4.79	5.13	5.47	5.78	6.03	6.19
8½	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
9	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
9½	1.30	1.58	1.88	2.16	2.48	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
10	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
11	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
12	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
13	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
14	1.55	1.92	2.29	2.62	2.95	3.27	3.58	3.87	4.15	4.72	5.26	5.80	6.34	6.79	7.24	7.64	7.98	8.19
15	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
16	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
17	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
18	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

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE VI — DISCHARGE DATA — 16″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches																		
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14	15	16
	Discharge in Cubic Feet per Second																		
1	0.49	0.59	0.70	0.79	0.89	0.97	1.05	1.14	1.22	1.37	1.53	1.68	1.83	1.96	2.10	2.24	2.35	2.43	2.47
1¼	.55	.66	.77	.88	.98	1.08	1.16	1.27	1.36	1.52	1.70	1.87	2.04	2.19	2.34	2.50	2.63	2.72	2.78
1½	.59	.72	.84	.96	1.07	1.18	1.27	1.39	1.48	1.66	1.86	2.04	2.22	2.39	2.56	2.74	2.89	2.98	3.05
1¾	.63	.77	.90	1.03	1.15	1.27	1.37	1.49	1.59	1.79	1.99	2.20	2.40	2.57	2.76	2.96	3.12	3.23	3.31
2	.67	.82	.96	1.10	1.23	1.35	1.46	1.59	1.69	1.91	2.12	2.34	2.56	2.74	2.94	3.16	3.31	3.46	3.54
2¼	.71	.86	1.02	1.16	1.30	1.43	1.54	1.68	1.79	2.02	2.25	2.48	2.71	2.91	3.11	3.33	3.50	3.66	3.75
2½	.75	.90	1.07	1.21	1.36	1.50	1.62	1.76	1.89	2.13	2.37	2.61	2.85	3.08	3.28	3.50	3.68	3.85	3.95
2¾	.78	.94	1.12	1.26	1.42	1.57	1.69	1.84	1.98	2.23	2.49	2.74	2.99	3.23	3.44	3.67	3.86	4.03	4.14
3	.81	.98	1.16	1.31	1.48	1.64	1.76	1.92	2.06	2.33	2.60	2.86	3.12	3.37	3.59	3.83	4.04	4.20	4.33
3¼	.84	1.02	1.20	1.36	1.54	1.70	1.84	2.00	2.14	2.43	2.71	2.98	3.25	3.51	3.74	3.99	4.20	4.37	4.51
3½	.87	1.06	1.24	1.41	1.59	1.75	1.91	2.08	2.22	2.52	2.81	3.09	3.37	3.64	3.88	4.14	4.36	4.53	4.69
3¾	.90	1.09	1.28	1.46	1.64	1.81	1.98	2.15	2.30	2.61	2.91	3.20	2.49	3.77	4.02	4.28	4.52	4.69	4.86
4	.93	1.12	1.32	1.51	1.69	1.87	2.05	2.22	2.38	2.69	3.00	3.31	3.61	3.89	4.15	4.42	4.67	4.85	5.02
4¼	.96	1.15	1.36	1.56	1.74	1.93	2.11	2.29	2.45	2.77	3.09	3.41	3.72	4.01	4.28	4.56	4.81	5.00	5.18
4½	.99	1.18	1.40	1.61	1.79	1.99	2.17	2.36	2.52	2.85	3.18	3.51	3.83	4.13	4.40	4.69	4.95	5.15	5.32
4¾	1.02	1.21	1.44	1.65	1.84	2.04	2.23	2.42	2.59	2.93	3.27	3.61	3.94	4.24	4.52	4.82	5.09	5.29	5.46
5	1.04	1.24	1.48	1.69	1.89	2.09	2.29	2.48	2.66	3.01	3.36	3.70	4.04	4.35	4.64	4.95	5.22	5.43	5.59
5½	1.08	1.30	1.55	1.76	1.98	2.19	2.40	2.60	2.79	3.16	3.52	3.88	4.24	4.56	4.87	5.19	5.47	5.69	5.85
6	1.12	1.36	1.61	1.83	2.07	2.28	2.50	2.71	2.91	3.30	3.68	4.05	4.42	4.76	5.08	5.42	5.71	5.94	6.10
6½	1.16	1.41	1.67	1.90	2.15	2.37	2.60	2.82	3.03	3.43	3.83	4.21	4.60	4.96	5.29	5.64	5.95	6.18	6.35
7	1.20	1.46	1.73	1.97	2.23	2.46	2.70	2.93	3.14	3.56	3.97	4.37	4.77	5.15	5.49	5.85	6.18	6.41	6.59
7½	1.24	1.51	1.79	2.04	2.31	2.55	2.80	3.04	3.25	3.69	4.11	4.53	4.94	5.33	5.68	6.06	6.39	6.64	6.82
8	1.28	1.56	1.85	2.11	2.39	2.63	2.89	3.14	3.36	3.81	4.25	4.68	5.11	5.50	5.87	6.26	6.60	6.86	7.05
8½	1.31	1.60	1.90	2.18	2.46	2.71	2.98	3.24	3.46	3.93	4.38	4.82	5.26	5.67	6.05	6.45	6.81	7.07	7.27
9	1.34	1.64	1.95	2.24	2.53	2.79	3.07	3.33	3.56	4.04	4.51	4.96	5.41	5.83	6.23	6.64	7.01	7.27	7.48
9½	1.37	1.68	2.00	2.30	2.60	2.87	3.15	3.42	3.66	4.15	4.63	5.10	5.56	5.99	6.40	6.83	7.20	7.47	7.68
10	1.40	1.72	2.05	2.36	2.67	2.95	3.23	3.51	3.75	4.26	4.75	5.23	5.71	6.15	6.56	7.00	7.39	7.67	7.88
11	1.46	1.80	2.15	2.48	2.80	3.09	3.39	3.68	3.93	4.46	4.98	5.48	5.98	6.45	6.88	7.34	7.74	8.04	8.26
12	1.52	1.88	2.25	2.59	2.92	3.23	3.54	3.84	4.11	4.66	5.20	5.73	6.25	6.74	7.19	7.66	8.09	8.40	8.63
13	1.58	1.96	2.34	2.69	3.04	3.36	3.68	4.00	4.28	4.85	5.41	5.96	6.50	7.01	7.48	7.98	8.41	8.74	8.98
14	1.64	2.04	2.43	2.79	3.15	3.49	3.82	4.15	4.44	5.03	5.61	6.19	6.75	7.28	7.76	8.27	8.73	9.07	9.32
15	1.70	2.11	2.51	2.89	3.26	3.61	3.96	4.29	4.60	5.21	5.81	6.40	6.99	7.54	8.04	8.56	9.04	9.39	9.65
16	1.76	2.18	2.59	2.99	3.37	3.73	4.09	4.43	4.75	5.38	6.00	6.61	7.22	7.79	8.30	8.85	9.34	9.70	9.96
17	1.81	2.25	2.67	3.08	3.48	3.84	4.22	4.57	4.90	5.55	6.19	6.82	7.44	8.03	8.56	9.13	9.63	10.00	10.27
18	1.86	2.31	2.75	3.16	3.58	3.95	4.34	4.70	5.04	5.71	6.37	7.01	7.65	8.25	8.80	9.39	9.90	10.28	10.56

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE VII — DISCHARGE DATA — 18" ARMCO METERGATE MODEL No. 101

Head in In's.	Net Gate Opening in Inches																				
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14	15	16	17	18
	Discharge in Cubic Feet per Second																				
1	0.54	0.66	0.77	0.89	0.99	1.10	1.20	1.30	1.38	1.56	1.78	1.90	2.07	2.25	2.39	2.54	2.71	2.84	2.96	3.07	3.14
1¼	.60	.73	.86	.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
1½	.65	.80	.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
1¾	.70	.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
2	.75	.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
2¼	.79	.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
2½	.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
2¾	.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
3	.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
3¼	.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
3½	.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	5.28	5.47	5.70	5.86
3¾	.99	1.23	1.43	1.64	1.84	2.05	2.24	2.43	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
4	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
4¼	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
4½	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
4¾	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
5	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
5½	1.19	1.47	1.72	1.97	2.23	2.46	2.71	2.94	3.14	3.57	3.99	4.40	4.79	5.16	5.52	5.89	6.24	6.56	6.86	7.15	7.35
6	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
6½	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
7	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
7½	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
8	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
8½	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
9	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
9½	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
10	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
11	1.65	2.08	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
12	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
13	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
14	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
15	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
16	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
17	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
18	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

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE VIII — DISCHARGE DATA — 20" ARMCO METERGATE MODEL No. 101

Head in In's.	Net Gate Opening in Inches: 2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Discharge in Cubic Feet per Second																						
1	0.58	0.73	0.86	0.96	1.10	1.21	1.32	1.43	1.54	1.75	1.92	2.12	2.29	2.48	2.66	2.84	3.01	3.16	3.31	3.44	3.57	3.68	3.71
1¼	.66	.81	.96	1.09	1.23	1.35	1.48	1.60	1.72	1.95	2.16	2.37	2.56	2.77	2.98	3.18	3.37	3.54	3.71	3.86	4.01	4.14	4.19
1½	.72	.88	1.04	1.18	1.35	1.47	1.61	1.74	1.88	2.12	2.35	2.58	2.79	3.03	3.25	3.47	3.69	3.88	4.06	4.23	4.39	4.52	4.61
1¾	.77	.95	1.11	1.27	1.44	1.58	1.72	1.87	2.02	2.27	2.52	2.77	3.00	3.26	3.50	3.73	3.95	4.18	4.36	4.55	4.71	4.86	4.97
2	.82	1.01	1.18	1.36	1.53	1.68	1.83	1.99	2.15	2.42	2.69	2.95	3.21	3.48	3.73	3.97	4.20	4.46	4.66	4.85	5.02	5.20	5.31
2¼	.87	1.07	1.25	1.44	1.62	1.78	1.94	2.11	2.27	2.56	2.86	3.13	3.42	3.69	3.96	4.21	4.45	4.72	4.95	5.15	5.33	5.53	5.65
2½	.91	1.12	1.31	1.51	1.70	1.87	2.04	2.21	2.38	2.70	3.02	3.31	3.62	3.89	4.18	4.45	4.70	4.97	5.21	5.43	5.63	5.83	5.95
2¾	.95	1.17	1.37	1.58	1.78	1.96	2.13	2.31	2.49	2.84	3.16	3.49	3.80	4.08	4.39	4.66	4.95	5.21	5.46	5.70	5.91	6.13	6.24
3	.99	1.22	1.43	1.65	1.85	2.04	2.22	2.41	2.60	2.96	3.30	3.64	3.96	4.26	4.58	4.86	5.16	5.44	5.70	5.95	6.17	6.41	6.52
3¼	1.03	1.27	1.49	1.71	1.92	2.12	2.31	2.51	2.71	3.08	3.44	3.79	4.12	4.44	4.77	5.06	5.37	5.66	5.94	6.20	6.43	6.68	6.80
3½	1.07	1.31	1.54	1.77	1.99	2.19	2.40	2.61	2.82	3.20	3.56	3.93	4.28	4.60	4.95	5.25	5.57	5.88	6.16	6.43	6.67	6.92	7.08
3¾	1.10	1.35	1.59	1.83	2.06	2.26	2.49	2.70	2.92	3.31	3.68	4.07	4.43	4.76	5.13	5.44	5.77	6.09	6.38	6.65	6.90	7.15	7.32
4	1.13	1.39	1.64	1.88	2.12	2.33	2.57	2.79	3.02	3.42	3.80	4.20	4.57	4.92	5.29	5.62	5.96	6.29	6.58	6.87	7.12	7.38	7.56
4¼	1.16	1.43	1.69	1.93	2.18	2.40	2.65	2.88	3.12	3.52	3.92	4.33	4.71	5.07	5.45	5.79	6.14	6.48	6.78	7.08	7.34	7.61	7.79
4½	1.19	1.47	1.73	1.98	2.24	2.47	2.73	2.96	3.21	3.62	4.04	4.46	4.85	5.22	5.61	5.96	6.32	6.67	6.98	7.29	7.56	7.84	8.02
4¾	1.22	1.51	1.77	2.03	2.30	2.54	2.80	3.04	3.29	3.72	4.16	4.58	4.99	5.36	5.76	6.13	6.50	6.85	7.18	7.50	7.77	8.05	8.25
5	1.25	1.55	1.81	2.08	2.36	2.61	2.87	3.12	3.37	3.82	4.26	4.70	5.12	5.50	5.91	6.29	6.66	7.03	7.36	7.69	7.97	8.26	8.46
5½	1.31	1.61	1.89	2.18	2.48	2.74	3.02	3.28	3.53	4.01	4.47	4.93	5.36	5.77	6.20	6.59	6.98	7.37	7.72	8.06	8.36	8.66	8.87
6	1.37	1.67	1.97	2.28	2.59	2.86	3.15	3.42	3.69	4.19	4.67	5.15	5.60	6.04	6.48	6.89	7.30	7.70	8.06	8.41	8.73	9.05	9.26
6½	1.42	1.73	2.05	2.38	2.69	2.98	3.28	3.56	3.85	4.36	4.86	5.37	5.84	6.28	6.76	7.17	7.60	8.02	8.40	8.76	9.10	9.44	9.65
7	1.47	1.79	2.12	2.47	2.79	3.09	3.40	3.70	3.99	4.53	5.05	5.57	6.06	6.51	7.01	7.45	7.89	8.32	8.72	9.10	9.43	9.78	10.02
7½	1.52	1.85	2.19	2.56	2.89	3.20	3.52	3.82	4.13	4.68	5.22	5.76	6.26	6.74	7.25	7.70	8.16	8.61	9.02	9.42	9.76	10.12	10.37
8	1.57	1.91	2.26	2.65	2.98	3.30	3.63	3.94	4.26	4.83	5.39	5.95	6.46	6.96	7.48	7.95	8.43	8.88	9.31	9.72	10.08	10.44	10.70
8½	1.61	1.97	2.33	2.73	3.07	3.40	3.74	4.06	4.39	4.98	5.55	6.13	6.66	7.17	7.70	8.19	8.69	9.15	9.60	10.01	10.40	10.76	11.03
9	1.65	2.02	2.40	2.80	3.16	3.50	3.85	4.18	4.52	5.13	5.71	6.31	6.86	7.38	7.92	8.43	8.95	9.42	9.88	10.30	10.70	11.08	11.34
9½	1.69	2.07	2.47	2.87	3.25	3.60	3.96	4.30	4.65	5.27	5.87	6.49	7.06	7.59	8.14	8.67	9.20	9.69	10.15	10.59	11.00	11.40	11.65
10	1.73	2.12	2.54	2.94	3.34	3.70	4.07	4.42	4.77	5.41	6.03	6.65	7.25	7.79	8.36	8.90	9.44	9.95	10.41	10.88	11.28	11.69	11.96
11	1.81	2.22	2.67	3.08	3.50	3.87	4.28	4.63	5.00	5.67	6.31	6.97	7.60	8.16	8.76	9.32	9.88	10.42	10.91	11.44	11.82	12.24	12.53
12	1.88	2.32	2.79	3.22	3.66	4.04	4.47	4.84	5.22	5.92	6.59	7.29	7.93	8.53	9.16	9.74	10.32	10.89	11.41	11.93	12.34	12.79	13.10
13	1.95	2.42	2.91	3.36	3.81	4.21	4.64	5.04	5.44	6.17	6.87	7.60	8.26	8.88	9.55	10.13	10.76	11.33	11.88	12.40	12.86	13.32	13.65
14	2.02	2.52	3.02	3.49	3.95	4.38	4.81	5.23	5.64	6.40	7.13	7.89	8.57	9.21	9.90	10.52	11.16	11.77	12.32	12.87	13.33	13.82	14.17
15	2.08	2.61	3.12	3.61	4.09	4.53	4.97	5.41	5.84	6.62	7.38	8.15	8.86	9.53	10.24	10.88	11.53	12.18	12.74	13.30	13.80	14.30	14.65
16	2.14	2.70	3.22	3.73	4.22	4.67	5.18	5.58	6.03	6.84	7.62	8.41	9.15	9.85	10.58	11.23	11.90	12.56	13.16	13.72	14.25	14.78	15.13
17	2.20	2.78	3.32	3.84	4.35	4.81	5.29	5.75	6.22	7.05	7.85	8.67	9.43	10.15	10.90	11.58	12.27	12.94	13.58	14.14	14.69	15.24	15.59
18	2.26	2.86	3.41	3.95	4.47	4.95	5.45	5.92	6.40	7.25	8.08	8.93	9.70	10.44	11.22	11.92	12.64	13.32	13.98	14.56	15.11	15.68	16.05

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE IX — DISCHARGE DATA — 21″ ARMCO METERGATE MODEL No. 101

Head in In's.	Net Gate Opening in Inches																							
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Discharge in Cubic Feet per Second																							
1	0.62	0.77	0.91	1.04	1.16	1.28	1.41	1.53	1.63	1.85	2.07	2.27	2.46	2.63	2.83	3.01	3.21	3.38	3.56	3.73	3.87	3.98	4.08	4.16
1¼	.68	.85	1.00	1.15	1.29	1.42	1.56	1.70	1.81	2.05	2.30	2.51	2.73	2.93	3.14	3.34	3.58	3.76	3.97	4.14	4.29	4.42	4.54	4.62
1½	.74	.93	1.09	1.25	1.40	1.55	1.70	1.85	1.97	2.24	2.50	2.74	2.98	3.19	3.43	3.66	3.91	4.10	4.32	4.51	4.69	4.82	4.98	5.07
1¾	.80	1.00	1.18	1.35	1.51	1.67	1.83	1.99	2.13	2.41	2.68	2.95	3.20	3.44	3.69	3.95	4.19	4.40	4.67	4.87	5.05	5.21	5.38	5.49
2	.85	1.06	1.26	1.44	1.61	1.78	1.95	2.12	2.27	2.57	2.86	3.15	3.40	3.67	3.94	4.21	4.46	4.70	4.99	5.20	5.39	5.57	5.76	5.89
2¼	.90	1.12	1.33	1.52	1.70	1.88	2.07	2.25	2.40	2.72	3.02	3.33	3.60	3.90	4.19	4.46	4.72	4.99	5.27	5.50	5.69	5.90	6.09	6.24
2½	.95	1.18	1.40	1.60	1.79	1.98	2.18	2.36	2.52	2.86	3.18	3.51	3.80	4.11	4.41	4.70	4.98	5.26	5.53	5.77	5.99	6.19	6.39	6.56
2¾	.99	1.28	1.46	1.67	1.87	2.07	2.28	2.47	2.63	2.99	3.34	3.68	3.98	4.31	4.62	4.93	5.22	5.51	5.78	6.04	6.27	6.48	6.69	6.88
3	1.03	1.28	1.52	1.74	1.95	2.16	2.37	2.57	2.74	3.12	3.49	3.84	4.15	4.50	4.83	5.15	5.45	5.76	6.02	6.30	6.55	6.76	6.99	7.19
3¼	1.07	1.33	1.57	1.81	2.03	2.24	2.46	2.66	2.85	3.25	3.63	4.00	4.32	4.68	5.03	5.36	5.67	5.99	6.26	6.56	6.82	7.04	7.27	7.49
3½	1.11	1.38	1.62	1.87	2.10	2.32	2.55	2.75	2.96	3.37	3.76	4.15	4.49	4.86	5.22	5.56	5.88	6.21	6.50	6.81	7.07	7.30	7.54	7.76
3¾	1.15	1.42	1.67	1.93	2.17	2.39	2.63	2.84	3.07	3.49	3.90	4.30	4.65	5.03	5.40	5.76	6.09	6.43	6.73	7.05	7.32	7.56	7.81	8.01
4	1.18	1.46	1.72	1.99	2.23	2.46	2.71	2.93	3.17	3.60	4.03	4.44	4.80	5.20	5.58	5.95	6.29	6.65	6.95	7.28	7.56	7.81	8.06	8.26
4¼	1.21	1.50	1.77	2.05	2.29	2.53	2.79	3.02	3.27	3.71	4.15	4.58	4.95	5.36	5.75	6.13	6.49	6.86	7.16	7.50	7.80	8.05	8.31	8.51
4½	1.24	1.54	1.82	2.11	2.35	2.60	2.87	3.11	3.36	3.82	4.27	4.71	5.09	5.51	5.92	6.31	6.68	7.06	7.37	7.72	8.02	8.29	8.55	8.76
4¾	1.27	1.58	1.87	2.16	2.41	2.67	2.95	3.20	3.45	3.92	4.39	4.84	5.23	5.66	6.08	6.49	6.86	7.25	7.57	7.93	8.24	8.51	8.79	9.00
5	1.30	1.62	1.92	2.21	2.47	2.74	3.03	3.28	3.54	4.02	4.50	4.96	5.36	5.81	6.24	6.65	7.04	7.44	7.77	8.14	8.46	8.73	9.02	9.23
5½	1.36	1.70	2.01	2.31	2.59	2.88	3.17	3.44	3.71	4.22	4.72	5.20	5.62	6.09	6.54	6.97	7.38	7.80	8.15	8.53	8.87	9.17	9.45	9.68
6	1.42	1.78	2.10	2.40	2.71	3.01	3.31	3.59	3.88	4.41	4.93	5.43	5.87	6.36	6.83	7.29	7.71	8.15	8.51	8.91	9.26	9.57	9.88	10.11
6½	1.47	1.84	2.17	2.49	2.82	3.13	3.45	3.78	4.04	4.59	5.13	5.66	6.11	6.62	7.11	7.58	8.02	8.48	8.86	9.28	9.64	9.95	10.27	10.52
7	1.52	1.90	2.24	2.58	2.92	3.25	3.58	3.87	4.19	4.76	5.32	5.87	6.35	6.87	7.38	7.87	8.32	8.80	9.20	9.63	10.00	10.33	10.66	10.92
7½	1.57	1.96	2.31	2.67	3.02	3.36	3.71	4.01	4.33	4.93	5.51	6.08	6.57	7.11	7.64	8.15	8.62	9.10	9.51	9.96	10.35	10.70	11.03	11.30
8	1.62	2.02	2.38	2.76	3.12	3.47	3.83	4.15	4.47	5.10	5.70	6.28	6.79	7.35	7.89	8.41	8.90	9.40	9.82	10.28	10.70	11.05	11.40	11.66
8½	1.67	2.08	2.45	2.85	3.22	3.58	3.94	4.28	4.61	5.25	5.88	6.48	7.00	7.57	8.13	8.67	9.17	9.70	10.12	10.60	11.02	11.39	11.75	12.02
9	1.72	2.14	2.52	2.93	3.31	3.68	4.05	4.41	4.75	5.40	6.04	6.66	7.21	7.79	8.36	8.92	9.44	9.98	10.42	10.90	11.34	11.72	12.10	12.38
9½	1.76	2.19	2.59	3.01	3.40	3.78	4.16	4.53	4.88	5.55	6.20	6.84	7.41	8.01	8.59	9.16	9.70	10.26	10.72	11.20	11.66	12.05	12.44	12.72
10	1.80	2.24	2.66	3.09	3.49	3.88	4.27	4.64	5.01	5.70	6.37	7.02	7.60	8.22	8.82	9.40	9.96	10.53	11.00	11.50	11.97	12.36	12.76	13.04
11	1.88	2.34	2.79	3.24	3.66	4.07	4.48	4.86	5.25	5.97	6.67	7.36	7.96	8.61	9.25	9.85	10.43	11.03	11.52	12.06	12.54	12.95	13.37	13.68
12	1.96	2.44	2.92	3.38	3.83	4.25	4.69	5.08	5.49	6.24	6.97	7.69	8.31	9.00	9.66	10.30	10.90	11.52	12.03	12.60	13.10	13.53	13.97	14.30
13	2.04	2.54	3.04	3.52	3.99	4.42	4.88	5.29	5.70	6.49	7.26	8.00	8.65	9.37	10.06	10.72	11.34	11.99	12.52	13.11	13.63	14.08	14.54	14.88
14	2.11	2.63	3.15	3.65	4.14	4.59	5.06	5.49	5.92	6.74	7.54	8.31	8.99	9.73	10.45	11.12	11.78	12.45	13.00	13.61	14.16	14.62	15.10	15.45
15	2.18	2.72	3.26	3.78	4.28	4.75	5.23	5.68	6.13	6.97	7.80	8.60	9.29	10.07	10.81	11.51	12.18	12.88	13.45	14.10	14.65	15.18	15.62	16.00
16	2.25	2.81	3.37	3.90	4.42	4.91	5.40	5.87	6.33	7.20	8.05	8.88	9.59	10.40	11.16	11.90	12.58	13.30	13.90	14.55	15.13	15.63	16.13	16.52
17	2.31	2.90	3.47	4.02	4.56	5.06	5.57	6.05	6.52	7.48	8.30	9.15	9.89	10.71	11.50	12.26	12.98	13.72	14.33	15.00	15.60	16.10	16.63	17.02
18	2.37	2.98	3.57	4.14	4.69	5.21	5.74	6.22	6.71	7.64	8.54	9.41	10.18	11.02	11.82	12.60	13.35	14.12	14.74	15.43	16.04	16.57	17.10	17.50

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE X — DISCHARGE DATA — 24″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches												
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10
	Discharge in Cubic Feet per Second												
1	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
1¼	.77	.95	1.13	1.30	1.46	1.63	1.78	1.94	2.09	2.35	2.62	2.89	3.14
1½	.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
1¾	.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
2	.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
2¼	1.00	1.26	1.48	1.72	1.93	2.16	2.36	2.56	2.76	3.18	3.48	3.83	4.17
2½	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
2¾	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
3	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
3¼	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
3½	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
3¾	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
4	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
4¼	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
4½	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
4¾	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
5	1.47	1.84	2.16	2.51	2.82	3.14	3.46	3.76	4.07	4.64	5.19	5.72	6.22
5½	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
6	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
6½	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	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
7½	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	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
8½	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
9	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
9½	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
10	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
11	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
12	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
13	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
14	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
15	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
16	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
17	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
18	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

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE X — DISCHARGE DATA — 24″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches													
	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Discharge in Cubic Feet per Second													
1	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
1¼	3.39	3.64	3.88	4.14	4.38	4.60	4.80	5.00	5.20	5.36	5.53	5.63	5.77	5.85
1½	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
1¾	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
2	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
2¼	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
2½	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
2¾	4.98	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
3	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
3¼	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
3½	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
3¾	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
4	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
4¼	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
4½	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
4¾	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
5	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
5½	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
6	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
6½	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
7	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
7½	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
8	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
8½	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
9	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
9½	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
10	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
11	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
12	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
13	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
14	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
15	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
16	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
17	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
18	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

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XI — DISCHARGE DATA — 30″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches: 2	2½	3	3½	4	4½	5	5½	6	7	8	9	10
	Discharge in Cubic Feet per Second												
1	0.84	1.05	1.25	1.45	1.63	1.84	2.00	2.20	2.34	2.69	3.03	3.35	3.64
1¼	.93	1.17	1.39	1.62	1.82	2.04	2.23	2.45	2.61	2.99	3.36	3.71	4.04
1½	1.01	1.27	1.52	1.76	1.97	2.22	2.48	2.66	2.85	3.25	3.63	4.05	4.41
1¾	1.08	1.37	1.63	1.89	2.12	2.39	2.62	2.87	3.06	3.50	3.88	4.37	4.73
2	1.16	1.46	1.74	2.02	2.27	2.54	2.80	3.05	3.27	3.73	4.13	4.64	5.03
2¼	1.23	1.55	1.85	2.14	2.40	2.69	2.96	3.22	3.46	3.95	4.38	4.90	5.33
2½	1.30	1.63	1.94	2.25	2.52	2.84	3.11	3.38	3.63	4.15	4.63	5.15	5.61
2¾	1.36	1.70	2.03	2.35	2.64	2.98	3.25	3.53	3.80	4.34	4.86	5.40	5.89
3	1.41	1.77	2.11	2.45	2.75	3.11	3.38	3.67	3.95	4.53	5.08	5.64	6.16
3¼	1.46	1.84	2.19	2.55	2.86	3.22	3.50	3.81	4.10	4.71	5.29	5.87	6.41
3½	1.51	1.90	2.27	2.64	2.96	3.33	3.62	3.94	4.25	4.88	5.49	6.09	6.65
3¾	1.56	1.96	2.35	2.72	3.06	3.43	3.74	4.07	4.40	5.05	5.68	6.30	6.88
4	1.61	2.02	2.42	2.80	3.15	3.53	3.85	4.20	4.54	5.21	5.86	6.51	7.10
4¼	1.65	2.08	2.49	2.88	3.24	3.63	3.96	4.33	4.68	5.38	6.04	6.71	7.32
4½	1.69	2.14	2.56	2.96	3.33	3.73	4.07	4.45	4.82	5.54	6.22	6.91	7.54
4¾	1.73	2.20	2.62	3.04	3.42	3.82	4.18	4.57	4.95	5.69	6.39	7.10	7.75
5	1.77	2.25	2.68	3.11	3.50	3.91	4.29	4.69	5.08	5.84	6.56	7.29	7.95
5½	1.85	2.35	2.80	3.25	3.66	4.09	4.50	4.92	5.33	6.12	6.88	7.64	8.34
6	1.93	2.45	2.92	3.39	3.82	4.27	4.70	5.14	5.56	6.39	7.19	7.98	8.70
6½	2.01	2.55	3.04	3.53	3.97	4.44	4.89	5.35	5.79	6.65	7.48	8.31	9.06
7	2.09	2.64	3.15	3.64	4.13	4.61	5.07	5.55	6.01	6.90	7.76	8.62	9.40
7½	2.16	2.72	3.25	3.76	4.27	4.77	5.25	5.75	6.21	7.15	8.03	8.92	9.74
8	2.23	2.80	3.34	3.88	4.41	4.92	5.42	5.94	6.42	7.38	8.30	9.21	10.06
8½	2.30	2.88	3.43	3.99	4.54	5.07	5.59	6.12	6.61	7.60	8.55	9.49	10.36
9	2.36	2.96	3.52	4.10	4.67	5.22	5.75	6.30	6.81	7.82	8.80	9.76	10.66
9½	2.42	3.04	3.61	4.21	4.80	5.36	5.91	6.47	7.00	8.04	9.04	10.03	10.95
10	2.48	3.12	3.70	4.32	4.93	5.50	6.06	6.64	7.18	8.26	9.28	10.30	11.24
11	2.59	3.27	3.88	4.53	5.17	5.78	6.36	6.96	7.53	8.66	9.73	10.80	11.78
12	2.70	3.40	4.05	4.74	5.40	6.04	6.64	7.27	7.86	9.04	10.16	11.28	12.31
13	2.81	3.52	4.21	4.93	5.62	6.28	6.91	7.57	8.19	9.40	10.57	11.74	12.82
14	2.91	3.64	4.37	5.11	5.84	6.51	7.17	7.86	8.49	9.76	10.97	12.18	13.30
15	3.01	3.76	4.52	5.29	6.04	6.74	7.42	8.13	8.79	10.10	11.37	12.62	13.76
16	3.11	3.88	4.67	5.47	6.24	6.96	7.66	8.40	9.08	10.43	11.74	13.03	14.22
17	3.20	3.99	4.81	5.64	6.43	7.18	7.90	8.66	9.36	10.76	12.10	13.43	14.65
18	3.28	4.10	4.95	5.79	6.61	7.39	8.13	8.91	9.63	11.06	12.43	13.81	15.08

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XI — DISCHARGE DATA — 30" ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches												
	11	12	13	14	15	16	18	20	22	24	26	28	30
	Discharge in Cubic Feet per Second												
1	3.92	4.20	4.48	4.75	5.03	5.28	5.84	6.34	6.76	7.10	7.46	7.70	7.86
1¼	4.36	4.67	4.99	5.30	5.61	5.89	6.49	7.04	7.51	7.90	8.31	8.58	8.77
1½	4.75	5.11	5.46	5.80	6.12	6.46	7.08	7.67	8.19	8.65	9.07	9.40	9.59
1¾	5.11	5.49	5.86	6.22	6.57	6.94	7.60	8.25	8.81	9.29	9.72	10.15	10.32
2	5.45	5.86	6.26	6.63	7.02	7.41	8.11	8.78	9.40	9.91	10.34	10.88	11.04
2¼	5.78	6.21	6.64	7.04	7.45	7.86	8.61	9.31	9.94	10.48	10.94	11.56	11.74
2½	6.09	6.55	7.00	7.41	7.85	8.29	9.07	9.81	10.48	11.03	11.52	12.16	12.40
2¾	6.39	6.87	7.34	7.78	8.23	8.69	9.51	10.28	10.98	11.56	12.08	12.68	13.00
3	6.68	7.17	7.67	8.13	8.60	9.08	9.94	10.75	11.47	12.07	12.62	13.18	13.55
3¼	6.95	7.46	7.98	8.46	8.95	9.45	10.34	11.20	11.95	12.57	13.15	13.68	14.05
3½	7.21	7.75	8.28	8.78	9.29	9.81	10.74	11.62	12.40	13.06	13.65	14.18	14.52
3¾	7.47	8.02	8.57	9.09	9.62	10.14	11.12	12.03	12.83	13.50	14.12	14.67	14.98
4	7.71	8.28	8.85	9.38	9.93	10.47	11.48	12.42	13.25	13.94	14.58	15.15	15.44
4¼	7.95	8.54	9.12	9.67	10.23	10.80	11.83	12.80	13.66	14.37	15.03	15.61	15.90
4½	8.18	8.79	9.39	9.95	10.53	11.12	12.17	13.17	14.06	14.80	15.47	16.07	16.36
4¾	8.40	9.03	9.65	10.23	10.82	11.43	12.51	13.54	14.45	15.20	15.90	16.52	16.82
5	8.62	9.26	9.90	10.50	11.11	11.73	12.84	13.90	14.83	15.60	16.32	16.95	17.26
5½	9.05	9.72	10.38	11.02	11.65	12.30	13.47	14.57	15.56	16.36	17.10	17.77	18.10
6	9.45	10.14	10.84	11.50	12.16	12.83	14.06	15.20	16.23	17.08	17.85	18.55	18.90
6½	9.84	10.56	11.29	11.96	12.66	13.36	14.63	15.83	16.90	17.77	18.58	19.30	19.65
7	10.20	10.96	11.72	12.42	13.14	13.87	15.19	16.43	17.53	18.45	19.30	20.04	20.40
7½	10.56	11.35	12.13	12.85	13.60	14.36	15.72	17.00	18.15	19.10	19.97	20.74	21.12
8	10.90	11.72	12.52	13.27	14.04	14.83	16.23	17.56	18.73	19.72	20.62	21.42	21.82
8½	11.23	12.08	12.91	13.68	14.47	15.29	16.78	18.10	19.30	20.32	21.26	22.08	22.52
9	11.56	12.44	13.28	14.07	14.90	15.74	17.21	18.62	19.87	20.91	21.87	22.72	23.17
9½	11.89	12.79	13.64	14.46	15.30	16.15	17.68	19.14	20.42	21.49	22.47	23.34	23.80
10	12.20	13.12	14.00	14.85	15.70	16.60	18.15	19.65	20.95	22.06	23.06	23.95	24.40
11	12.79	13.74	14.69	15.57	16.47	17.40	19.03	20.60	21.96	23.13	24.20	25.12	25.58
12	13.36	14.35	15.33	16.26	17.20	18.16	19.88	21.50	22.95	24.15	25.25	26.23	26.72
13	13.90	14.94	15.96	16.93	17.90	18.90	20.70	22.40	23.90	25.15	26.28	27.30	27.80
14	14.43	15.50	16.56	17.56	18.57	19.60	21.48	23.23	24.80	26.10	27.28	28.32	28.85
15	14.93	16.04	17.14	18.18	19.23	20.30	22.23	24.05	25.66	27.00	28.23	29.32	29.86
16	15.42	16.57	17.70	18.77	19.86	20.97	22.95	24.84	26.50	27.87	29.15	30.30	30.84
17	15.90	17.08	18.26	19.36	20.48	21.62	23.66	25.60	27.32	28.73	30.06	31.25	31.80
18	16.36	17.57	18.78	19.90	21.05	22.25	24.34	26.34	28.10	29.56	30.92	32.15	32.70

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XII — DISCHARGE DATA — 36″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening In Inches													
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11
	Discharge in Cubic Feet per Second													
1	0.96	1.22	1.47	1.71	1.94	2.16	2.41	2.61	2.82	3.24	3.67	4.05	4.42	4.77
1¼	1.07	1.35	1.62	1.89	2.15	2.41	2.69	2.90	3.12	3.59	4.07	4.50	4.91	5.31
1½	1.17	1.47	1.77	2.06	2.34	2.63	2.94	3.16	3.40	3.92	4.43	4.93	5.36	5.79
1¾	1.26	1.59	1.92	2.22	2.53	2.84	3.18	3.42	3.67	4.24	4.77	5.32	5.79	6.25
2	1.34	1.70	2.05	2.36	2.69	3.04	3.39	3.66	3.92	4.53	5.08	5.68	6.18	6.66
2¼	1.42	1.80	2.17	2.50	2.85	3.21	3.58	3.87	4.14	4.79	5.38	6.00	6.52	7.04
2½	1.50	1.89	2.28	2.63	3.00	3.37	3.76	4.07	4.35	5.04	5.65	6.30	6.85	7.42
2¾	1.57	1.98	2.39	2.76	3.14	3.52	3.93	4.26	4.55	5.28	5.91	6.60	7.18	7.79
3	1.63	2.06	2.49	2.88	3.28	3.67	4.10	4.45	4.75	5.50	6.17	6.89	7.50	8.13
3¼	1.69	2.14	2.59	3.00	3.41	3.82	4.27	4.63	4.95	5.72	6.42	7.17	7.81	8.46
3½	1.75	2.21	2.68	3.11	3.53	3.95	4.42	4.79	5.13	5.93	6.66	7.44	8.10	8.78
3¾	1.81	2.28	2.76	3.22	3.65	4.08	4.56	4.95	5.31	6.14	6.90	7.70	8.39	9.09
4	1.86	2.35	2.84	3.31	3.76	4.20	4.68	5.11	5.49	6.34	7.13	7.95	8.66	9.38
4¼	1.91	2.42	2.92	3.40	3.86	4.32	4.81	5.27	5.66	6.54	7.35	8.20	8.93	9.67
4½	1.96	2.49	3.00	3.49	3.96	4.44	4.94	5.42	5.82	6.73	7.56	8.44	9.19	9.95
4¾	2.01	2.56	3.08	3.58	4.06	4.56	5.07	5.57	5.98	6.92	7.77	8.67	9.45	10.22
5	2.06	2.62	3.16	3.67	4.16	4.68	5.19	5.72	6.14	7.10	7.97	8.89	9.70	10.49
5½	2.16	2.74	3.31	3.84	4.36	4.90	5.43	6.00	6.43	7.44	8.36	9.33	10.17	11.00
6	2.26	2.86	3.45	4.00	4.55	5.11	5.67	6.26	6.71	7.77	8.73	9.73	10.61	11.50
6½	2.35	2.98	3.59	4.16	4.72	5.32	5.91	6.52	6.99	8.09	9.09	10.13	11.04	11.97
7	2.44	3.09	3.72	4.31	4.89	5.52	6.14	6.76	7.25	8.39	9.43	10.51	11.46	12.41
7½	2.53	3.19	3.85	4.45	5.06	5.72	6.36	7.00	7.51	8.69	9.76	10.89	11.87	12.85
8	2.61	3.29	3.97	4.59	5.23	5.91	6.57	7.23	7.76	8.97	10.09	11.24	12.26	13.28
8½	2.69	3.38	4.08	4.72	5.39	6.09	6.77	7.45	8.00	9.25	10.40	11.59	12.63	13.68
9	2.76	3.47	4.19	4.85	5.55	6.27	6.97	7.66	8.23	9.52	10.70	11.93	13.00	14.08
9½	2.83	3.56	4.30	4.98	5.70	6.44	7.16	7.87	8.45	9.78	11.00	12.26	13.37	14.47
10	2.90	3.65	4.41	5.11	5.85	6.61	7.35	8.07	8.67	10.03	11.28	12.58	13.71	14.83
11	3.04	3.82	4.60	5.36	6.13	6.92	7.70	8.46	9.10	10.52	11.82	13.18	14.37	15.55
12	3.16	3.98	4.79	5.61	6.40	7.28	8.05	8.85	9.51	10.99	12.35	13.78	15.01	16.25
13	3.28	4.14	4.98	5.85	6.67	7.52	8.39	9.22	9.89	11.44	12.85	14.35	15.62	16.93
14	3.39	4.29	5.16	6.06	6.91	7.81	8.70	9.56	10.26	11.88	13.33	14.88	16.21	17.58
15	3.50	4.43	5.34	6.27	7.15	8.08	9.00	9.89	10.62	12.30	13.80	15.40	16.78	18.19
16	3.61	4.56	5 51	6.48	7.39	8.34	9.29	10.22	10.98	12.69	14.27	15.90	17.33	18.78
17	3.72	4.69	5.68	6.68	7.62	8.60	9.58	10.54	11.32	13.08	14.70	16.39	17.86	19.34
18	3.82	4.82	5.85	6.87	7.84	8.85	9.86	10.84	11.64	13.45	15.12	16.88	18.39	19.89

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XII — DISCHARGE DATA — 36" ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches														
	12	13	14	15	16	18	20	22	24	26	28	30	32	34	36
	Discharge in Cubic Feet per Second														
1	5.10	5.47	5.83	6.13	6.50	7.12	7.86	8.43	8.92	9.37	9.84	10.10	10.35	10.56	10.74
1¼	5.67	6.10	6.49	6.82	7.22	7.87	8.67	9.30	9.88	10.38	10.89	11.20	11.50	11.74	11.92
1½	6.20	6.68	7.08	7.44	7.89	8.59	9.44	10.14	10.81	11.33	11.86	12.24	12.57	12.84	13.02
1¾	6.70	7.20	7.63	8.04	8.52	9.28	10.17	10.95	11.65	12.25	12.80	13.24	13.60	13.91	14.09
2	7.17	7.67	8.13	8.60	9.10	9.95	10.87	11.71	12.43	13.09	13.67	14.16	14.54	14.87	15.05
2¼	7.61	8.12	8.62	9.12	9.65	10.57	11.52	12.42	13.18	13.86	14.47	15.00	15.39	15.74	15.95
2½	8.02	8.56	9.09	9.61	10.18	11.13	12.16	13.10	13.88	14.60	15.21	15.76	16.17	16.54	16.78
2¾	8.42	8.98	9.54	10.07	10.68	11.68	12.76	13.73	14.55	15.31	15.93	16.50	16.94	17.34	17.60
3	8.79	9.37	9.95	10.52	11.15	12.20	13.31	14.35	15.20	16.00	16.64	17.23	17.68	18.10	18.38
3¼	9.15	9.76	10.35	10.96	11.60	12.70	13.86	14.95	15.83	16.66	17.33	17.94	18.40	18.85	19.14
3½	9.49	10.12	10.74	11.37	12.04	13.18	14.37	15.50	16.42	17.28	17.98	18.61	19.08	19.54	19.85
3¾	9.82	10.48	11.11	11.77	12.46	13.63	14.89	16.04	16.99	17.89	18.60	19.27	19.74	20.23	20.55
4	10.14	10.83	11.48	12.15	12.87	14.08	15.37	16.56	17.55	18.46	19.20	19.90	20.40	20.89	21.25
4¼	10.45	11.16	11.83	12.52	13.27	14.51	15.84	17.08	18.10	19.03	19.80	20.50	21.05	21.53	21.90
4½	10.76	11.49	12.18	12.89	13.66	14.94	16.31	17.57	18.61	19.60	20.38	21.10	21.65	22.17	22.55
4¾	11.06	11.80	12.52	13.25	14.04	15.35	16.76	18.05	19.13	20.15	20.95	21.68	22.25	22.80	23.20
5	11.34	12.10	12.85	13.60	14.40	15.75	17.20	18.53	19.64	20.65	21.50	22.25	22.80	23.40	23.80
5½	11.90	12.70	13.47	14.25	15.10	16.52	18.03	19.43	20.60	21.65	22.55	23.35	23.90	24.50	24.90
6	12.42	13.26	14.07	14.88	15.77	17.25	18.82	20.28	21.50	22.62	23.55	24.39	24.95	25.60	26.00
6½	12.93	13.80	14.64	15.50	16.41	17.97	19.60	21.13	22.40	23.56	24.50	25.39	26.00	26.65	27.10
7	13.42	14.32	15.20	16.09	17.03	18.64	20.35	21.94	23.25	24.44	25.43	26.33	27.00	27.67	28.15
7½	13.90	14.83	15.74	16.67	17.64	19.30	21.08	22.72	24.08	25.30	26.34	27.25	27.95	28.65	29.15
8	14.35	15.32	16.25	17.20	18.21	19.92	21.75	23.45	24.84	26.13	27.20	28.13	28.85	29.55	30.10
8½	14.79	15.79	16.74	17.72	18.77	20.54	22.42	24.15	25.60	26.95	28.05	29.00	29.75	30.45	31.00
9	15.21	16.25	17.23	18.28	19.31	21.15	23.07	24.85	26.33	27.73	28.85	29.84	30.62	31.35	31.88
9½	15.63	16.68	17.70	18.73	19.84	21.72	23.70	25.55	27.05	28.47	29.63	30.65	31.45	32.20	32.75
10	16.03	17.10	18.17	19.21	20.35	22.27	24.30	26.20	27.75	29.20	30.40	31.45	32.25	33.05	33.60
11	16.81	17.93	19.05	20.14	21.33	23.35	25.47	27.45	29.10	30.60	31.85	32.95	33.80	34.65	35.20
12	17.58	18.74	19.90	21.05	22.30	24.40	26.62	28.70	30.40	32.00	33.30	34.45	35.35	36.20	36.80
13	18.30	19.53	20.72	21.92	23.22	25.40	27.75	29.87	31.65	33.32	34.65	35.85	36.80	37.68	38.30
14	18.99	20.25	21.50	22.75	24.10	26.35	28.80	31.00	32.85	34.60	35.98	37.20	38.18	39.10	39.75
15	19.64	20.95	22.24	23.54	24.93	27.30	29.80	32.10	34.00	35.80	37.25	38.50	39.50	40.45	41.15
16	20.29	21.65	22.98	24.30	25.75	28.20	30.75	33.15	35.10	36.95	38.45	39.80	40.80	41.80	42.50
17	20.92	22.32	23.69	25.05	26.55	29.03	31.70	34.15	36.20	38.10	39.60	41.10	42.05	43.10	43.80
18	21.54	22.97	24.36	25.78	27.33	29.85	32.63	35.15	37.25	39.20	40.75	42.30	43.25	44.35	45.10

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XIII — DISCHARGE DATA — 42″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches												
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10
	Discharge in Cubic Feet per Second												
1	1.08	1.38	1.67	1.95	2.24	2.51	2.79	3.06	3.31	3.82	4.32	4.74	5.19
1¼	1.21	1.54	1.88	2.19	2.51	2.81	3.12	3.43	3.72	4.28	4.84	5.31	5.81
1½	1.33	1.68	2.05	2.38	2.74	3.05	3.40	3.74	4.04	4.65	5.26	5.81	6.35
1¾	1.43	1.81	2.20	2.56	2.96	3.29	3.65	4.02	4.34	4.99	5.65	6.24	6.85
2	1.52	1.93	2.34	2.73	3.15	3.52	3.90	4.28	4.64	5.32	6.02	6.65	7.31
2¼	1.60	2.04	2.48	2.89	3.33	3.74	4.13	4.53	4.92	5.65	6.37	7.03	7.74
2½	1.68	2.14	2.60	3.05	3.50	3.92	4.34	4.76	5.19	5.95	6.70	7.41	8.15
2¾	1.76	2.24	2.72	3.19	3.65	4.10	4.55	4.99	5.42	6.21	7.02	7.77	8.55
3	1.84	2.33	2.84	3.33	3.80	4.28	4.75	5.19	5.65	6.46	7.33	8.11	8.93
3¼	1.92	2.42	2.96	3.47	3.95	4.46	4.93	5.37	5.86	6.71	7.63	8.45	9.30
3½	1.98	2.51	3.08	3.60	4.10	4.64	5.09	5.55	6.06	6.96	7.92	8.76	9.64
3¾	2.04	2.60	3.19	3.72	4.25	4.81	5.25	5.73	6.26	7.21	8.20	9.07	9.98
4	2.10	2.68	3.30	3.83	4.40	4.97	5.41	5.91	6.46	7.45	8.47	9.36	10.30
4¼	2.16	2.76	3.41	3.94	4.54	5.12	5.57	6.09	6.66	7.68	8.73	9.65	10.62
4½	2.22	2.84	3.51	4.05	4.67	5.26	5.73	6.27	6.86	7.90	8.98	9.94	10.93
4¾	2.29	2.92	3.60	4.16	4.79	5.39	5.89	6.45	7.05	8.12	9.23	10.21	11.23
5	2.35	3.00	3.68	4.27	4.90	5.51	6.04	6.62	7.23	8.33	9.47	10.47	11.53
5½	2.47	3.14	3.84	4.46	5.11	5.74	6.33	6.94	7.59	8.74	9.94	10.98	12.08
6	2.57	3.28	3.99	4.65	5.31	5.96	6.61	7.24	7.92	9.12	10.37	11.47	12.62
6½	2.67	3.41	4.14	4.83	5.50	6.18	6.88	7.53	8.24	9.49	10.80	11.93	13.13
7	2.77	3.54	4.29	5.00	5.69	6.40	7.14	7.82	8.55	9.85	11.20	12.38	13.63
7½	2.87	3.66	4.44	5.16	5.88	6.62	7.39	8.10	8.85	10.20	11.60	12.83	14.12
8	2.96	3.78	4.59	5.31	6.07	6.84	7.63	8.36	9.15	10.53	11.98	13.25	14.57
8½	3.05	3.88	4.72	5.46	6.26	7.05	7.87	8.62	9.43	10.85	12.35	13.65	15.02
9	3.13	3.98	4.85	5.61	6.44	7.26	8.10	8.87	9.70	11.17	12.70	14.04	15.45
9½	3.21	4.08	4.97	5.76	6.62	7.45	8.32	9.11	9.97	11.48	13.05	14.43	15.88
10	3.29	4.17	5.09	5.91	6.79	7.65	8.54	9.35	10.22	11.78	13.40	14.82	16.30
11	3.43	4.35	5.31	6.20	7.12	8.02	8.95	9.80	10.72	12.35	14.05	15.53	17.10
12	3.57	4.53	5.52	6.48	7.44	8.38	9.35	10.23	11.20	12.90	14.67	16.22	17.85
13	3.71	4.70	5.73	6.74	7.74	8.72	9.73	10.66	11.66	13.42	15.27	16.90	18.57
14	3.85	4.87	5.93	7.00	8.04	9.05	10.10	11.06	12.10	13.93	15.85	17.52	19.27
15	3.99	5.04	6.13	7.24	8.31	9.37	10.45	11.44	12.52	14.42	16.40	18.13	19.95
16	4.13	5.21	6.34	7.48	8.59	9.67	10.80	11.82	12.93	14.90	16.94	18.73	20.60
17	4.26	5.37	6.53	7.71	8.85	9.97	11.13	12.19	13.33	15.35	17.47	19.30	21.24
18	4.36	5.51	6.71	7.94	9.11	10.26	11.45	12.53	13.72	15.80	17.96	19.87	21.85

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XIII — DISCHARGE DATA — 42" ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches												
	11	12	14	16	18	20	22	24	28	32	36	40	42
	Discharge in Cubic Feet per Second												
1	5.65	6.05	6.88	7.70	8.48	9.20	9.97	10.63	11.90	12.88	13.38	13.96	14.22
1¼	6.31	6.79	7.75	8.64	9.50	10.30	11.13	11.93	13.30	14.38	15.03	15.65	15.96
1½	6.90	7.41	8.44	9.38	10.32	11.20	12.13	13.03	14.55	15.68	16.40	17.15	17.42
1¾	7.42	7.96	9.06	10.10	11.13	12.08	13.08	14.05	15.65	16.88	17.67	18.38	18.75
2	7.92	8.50	9.67	10.80	11.92	12.93	13.98	15.02	16.68	17.98	18.87	19.58	19.95
2¼	8.40	9.03	10.26	11.47	12.65	13.73	14.85	15.93	17.66	19.03	20.00	20.73	21.10
2½	8.85	9.52	10.81	12.10	13.33	14.47	15.67	16.80	18.60	20.03	21.10	21.83	22.18
2¾	9.29	9.99	11.33	12.70	13.98	15.18	16.45	17.63	19.50	20.99	22.14	22.88	23.18
3	9.69	10.48	11.82	13.27	14.60	15.86	17.18	18.42	20.35	21.90	23.11	23.88	24.15
3¼	10.08	10.86	12.30	13.80	15.20	16.50	17.88	19.17	21.20	22.78	24.05	24.85	25.10
3½	10.47	11.27	12.77	14.32	15.78	17.13	18.56	19.90	22.00	23.65	24.96	25.80	26.02
3¾	10.88	11.66	13.22	14.82	16.32	17.73	19.20	20.60	22.77	24.50	25.84	26.70	26.92
4	11.18	12.03	13.66	15.30	16.85	18.30	19.83	21.28	23.50	25.30	26.66	27.55	27.82
4¼	11.53	12.40	14.08	15.77	17.37	18.86	20.44	21.93	24.23	26.06	27.48	28.40	28.70
4½	11.87	12.77	14.48	16.23	17.88	19.41	21.03	22.55	24.95	26.80	28.30	29.25	29.55
4¾	12.20	13.13	14.88	16.67	18.38	19.95	21.60	23.15	25.66	27.53	29.10	30.05	30.37
5	12.52	13.47	15.26	17.10	18.86	20.47	22.16	23.74	26.32	28.25	29.85	30.80	31.15
5½	13.12	14.12	16.00	17.93	19.78	21.46	23.23	24.90	27.60	29.64	31.30	32.30	32.64
6	13.70	14.74	16.72	18.73	20.65	22.40	24.26	26.00	28.80	30.97	32.70	33.74	34.10
6½	14.26	15.35	17.40	19.50	21.48	23.32	25.26	27.08	29.97	32.25	34.00	35.12	35.50
7	14.80	15.94	18.05	20.24	22.28	24.20	26.22	28.12	31.10	33.45	35.30	36.46	36.80
7½	15.32	16.50	18.68	20.96	23.06	25.06	27.14	29.10	32.20	34.60	36.54	37.74	38.10
8	15.82	17.03	19.29	21.65	23.82	25.90	28.03	30.04	33.26	35.74	37.74	39.00	39.35
8½	16.30	17.55	19.88	22.30	24.56	26.70	28.90	30.94	34.30	36.83	38.90	40.20	40.60
9	16.77	18.05	20.46	22.94	25.28	27.46	29.76	31.84	35.30	37.90	40.00	41.35	41.75
9½	17.24	18.54	21.03	23.58	25.98	28.22	30.60	32.72	36.25	38.95	41.10	42.50	42.90
10	17.70	19.02	21.60	24.20	26.66	28.98	31.40	33.58	37.20	39.95	42.15	43.60	44.00
11	18.56	19.96	22.63	25.38	27.95	30.38	32.90	35.23	39.00	41.90	44.20	45.70	46.10
12	19.38	20.85	23.63	26.50	29.20	31.68	34.35	36.80	40.73	43.80	46.18	47.70	48.15
13	20.16	21.70	24.60	27.60	30.40	32.93	35.74	38.30	42.40	45.60	48.08	49.65	50.15
14	20.91	22.52	25.55	28.64	31.54	34.18	37.10	39.75	44.00	47.30	49.90	51.60	52.10
15	21.64	23.30	26.44	29.64	32.64	35.38	38.40	41.15	45.55	48.95	51.65	53.40	53.90
16	22.36	24.08	27.30	30.60	33.70	36.55	39.65	42.50	47.05	50.55	53.35	55.20	55.70
17	23.06	24.84	28.14	31.54	34.75	37.70	40.90	43.80	48.50	52.10	55.00	56.85	57.40
18	23.72	25.55	28.95	32.46	35.80	38.80	42.10	45.10	49.90	53.60	56.60	58.50	59.05

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

TABLE XIV — DISCHARGE DATA — 48″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening Inches														
	2	2½	3	3½	4	4½	5	5½	6	7	8	9	10	11	12
	Discharge in Cubic Feet per Second														
1	1.19	1.51	1.85	2.21	2.52	2.84	3.15	3.45	3.75	4.34	4.93	5.48	6.05	6.56	7.12
1¼	1.32	1.69	2.06	2.47	2.80	3.16	3.50	3.83	4.18	4.84	5.48	6.11	6.73	7.30	7.88
1½	1.48	1.87	2.25	2.70	3.06	3.44	3.83	4.19	4.55	5.29	5.98	6.67	7.33	7.96	8.58
1¾	1.54	2.00	2.43	2.91	3.29	3.70	4.13	4.50	4.90	5.70	6.44	7.20	7.90	8.55	9.25
2	1.65	2.12	2.59	3.10	3.52	3.95	4.40	4.80	5.24	6.09	6.90	7.66	8.43	9.08	9.89
2¼	1.75	2.24	2.74	3.29	3.72	4.20	4.66	5.08	5.56	6.46	7.32	8.12	8.95	9.61	10.49
2½	1.84	2.36	2.89	3.47	3.92	4.42	4.92	5.36	5.87	6.80	7.70	8.56	9.44	10.12	11.05
2¾	1.93	2.48	3.02	3.63	4.11	4.64	5.16	5.62	6.14	7.14	8.05	8.97	9.90	10.62	11.60
3	2.01	2.59	3.15	3.79	4.29	4.85	5.39	5.86	6.40	7.46	8.40	9.37	10.33	11.10	12.11
3¼	2.09	2.69	3.27	3.94	4.45	5.05	5.60	6.10	6.66	7.75	8.75	9.76	10.76	11.55	12.60
3½	2.17	2.79	3.39	4.08	4.61	5.23	5.81	6.33	6.89	8.02	9.10	10.13	11.18	11.98	13.08
3¾	2.24	2.88	3.51	4.22	4.77	5.40	6.02	6.56	7.12	8.29	9.42	10.49	11.56	12.40	13.53
4	2.31	2.97	3.63	4.36	4.92	5.56	6.22	6.79	7.35	8.56	9.73	10.83	11.94	12.81	13.98
4¼	2.38	3.06	3.74	4.49	5.07	5.71	6.40	7.00	7.58	8.82	10.03	11.17	12.31	13.20	14.41
4½	2.44	3.15	3.84	4.62	5.20	5.87	6.58	7.19	7.81	9.08	10.32	11.49	12.66	13.59	14.88
4¾	2.51	3.24	3.94	4.74	5.33	6.01	6.76	7.36	8.03	9.34	10.61	11.80	13.00	13.96	15.23
5	2.57	3.32	4.05	4.85	5.46	6.18	6.93	7.55	8.23	9.58	10.88	12.10	13.34	14.32	15.62
5½	2.68	3.47	4.23	5.07	5.73	6.48	7.24	7.92	8.63	10.04	11.40	12.70	14.00	15.01	16.40
6	2.79	3.62	4.41	5.29	5.97	6.75	7.55	8.28	9.01	10.49	11.90	13.26	14.61	15.70	17.13
6½	2.90	3.76	4.59	5.51	6.20	7.02	7.86	8.62	9.38	10.93	12.40	13.81	15.20	16.32	17.83
7	3.00	3.90	4.76	5.72	6.43	7.28	8.16	8.95	9.74	11.32	12.87	14.32	15.78	16.93	18.50
7½	3.10	4.04	4.92	5.92	6.66	7.54	8.54	9.25	10.09	11.72	13.32	14.82	16.34	17.53	19.14
8	3.20	4.16	5.08	6.10	6.88	7.79	8.73	9.55	10.41	12.11	13.75	15.31	16.88	18.13	19.77
8½	3.30	4.28	5.22	6.27	7.10	8.02	9.00	9.85	10.73	12.48	14.18	15.79	17.40	18.67	20.38
9	3.40	4.40	5.37	6.44	7.30	8.25	9.26	10.13	11.04	12.85	14.60	16.24	17.90	19.21	20.97
9½	3.49	4.52	5.52	6.61	7.50	8.48	9.51	10.41	11.35	13.20	15.00	16.68	18.39	19.78	21.56
10	3.58	4.63	5.67	6.77	7.69	8.70	9.76	10.69	11.64	13.53	15.38	17.11	18.87	20.24	22.11
11	3.74	4.85	5.94	7.10	8.05	9.13	10.23	11.20	12.20	14.19	16.13	17.95	19.79	21.23	23.19
12	3.90	5.06	6.20	7.42	8.41	9.53	10.70	11.71	12.76	14.84	16.85	18.77	20.68	22.19	24.22
13	4.05	5.26	6.43	7.72	8.75	9.92	11.12	12.19	13.30	15.42	17.53	19.51	21.52	23.08	25.20
14	4.20	5.46	6.66	8.01	9.08	10.30	11.54	12.64	13.78	16.01	18.20	20.25	22.33	23.96	26.16
15	4.35	5.65	6.89	8.29	9.40	10.65	11.95	13.10	14.26	16.58	18.84	20.96	23.13	24.80	27.08
16	4.50	5.83	7.10	8.56	9.70	11.00	12.34	13.52	14.72	17.11	19.45	21.64	23.87	25.61	27.95
17	4.63	6.01	7.31	8.82	10.00	11.34	12.72	13.93	15.18	17.64	20.05	22.31	24.60	26.40	28.81
18	4.76	6.18	7.52	9.08	10.30	11.67	13.10	14.33	15.61	18.17	20.64	22.97	25.32	27.18	29.66

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

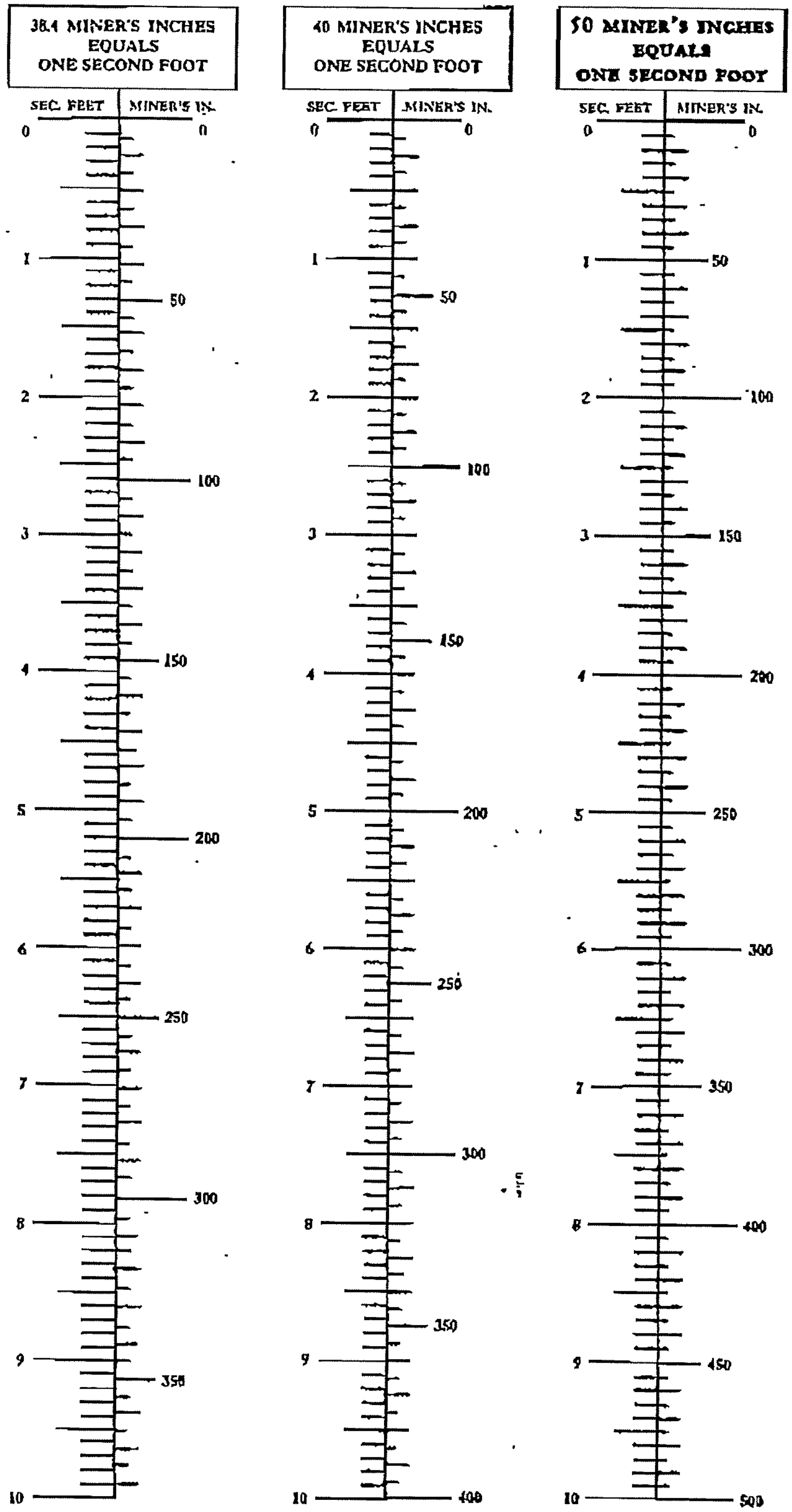
TABLE XIV — DISCHARGE DATA — 48″ ARMCO METERGATE MODEL No. 101

Head in Inches	Net Gate Opening in Inches													
	14	16	18	20	22	24	26	28	30	34	38	42	46	48
	Discharge in Cubic Feet per Second													
1	8.06	9.00	9.88	10.78	11.73	12.46	13.23	13.92	14.72	15.82	17.00	17.20	17.67	17.78
1¼	8.98	10.00	10.94	12.00	12.98	13.81	14.70	15.55	16.32	17.57	18.75	19.10	19.59	19.78
1½	9.79	10.91	11.98	13.14	14.22	15.16	16.12	17.05	17.85	19.20	20.30	21.00	21.48	21.68
1¾	10.57	11.79	12.92	14.20	15.34	16.37	17.42	18.42	19.23	20.72	21.84	22.63	23.24	23.38
2	11.28	12.60	13.82	15.18	16.42	17.50	18.63	19.70	20.60	22.10	23.33	24.15	24.78	24.98
2¼	11.98	13.37	14.67	16.10	17.40	18.57	19.76	20.89	21.83	23.40	24.67	25.60	26.21	26.36
2½	12.63	14.10	15.47	16.96	18.34	19.57	20.85	22.02	23.05	24.65	26.00	26.95	27.63	27.74
2¾	13.24	14.78	16.21	17.80	19.23	20.52	21.85	23.10	24.15	25.87	27.28	28.30	29.00	29.12
3	13.83	15.43	16.93	18.60	20.10	21.42	22.82	24.13	25.20	27.02	28.50	29.65	30.35	30.50
3¼	14.40	16.06	17.62	19.34	20.95	22.30	23.77	25.18	26.25	28.14	29.67	30.90	31.53	31.66
3½	14.92	16.67	18.29	20.07	21.71	23.15	24.67	26.09	27.25	29.20	30.80	32.07	32.69	32.81
3¾	15.44	17.26	18.93	20.79	22.45	23.96	25.52	26.98	28.18	30.20	31.85	33.17	33.85	33.93
4	15.94	17.82	19.57	21.47	23.19	24.75	26.36	27.85	29.10	31.20	32.90	34.27	34.98	35.05
4¼	16.44	18.37	20.16	22.13	23.92	25.52	27.18	28.70	30.00	32.20	33.93	35.32	36.05	36.17
4½	16.92	18.90	20.74	22.78	24.62	26.25	27.95	29.53	30.87	33.11	34.90	36.36	37.06	37.20
4¾	17.40	19.41	21.31	23.39	25.30	26.97	28.71	30.34	31.72	34.01	35.88	37.34	38.07	38.20
5	17.88	19.91	21.85	23.99	25.95	27.65	29.45	31.14	32.57	34.88	36.80	38.30	39.08	39.20
5½	18.73	20.90	22.93	25.19	27.21	29.01	30.88	32.65	34.15	36.60	38.57	40.20	41.00	41.16
6	19.54	21.83	23.96	26.29	28.42	30.32	32.25	34.10	35.67	38.20	40.30	41.97	42.78	42.98
6½	20.35	22.72	24.94	27.38	29.60	31.55	33.60	35.50	37.10	39.75	41.95	43.68	44.55	44.70
7	21.10	23.58	25.85	28.40	30.70	32.78	34.87	36.85	38.50	41.30	43.52	45.32	46.23	46.42
7½	21.85	24.40	26.76	29.38	31.80	33.90	36.10	38.13	39.85	42.74	45.05	46.90	47.85	48.05
8	22.60	25.20	27.65	30.33	32.80	35.01	37.23	39.40	41.15	44.17	46.50	48.46	49.43	49.62
8½	23.30	26.00	28.51	31.27	33.80	36.10	38.40	40.65	42.40	45.50	47.95	49.95	50.96	51.17
9	23.95	26.75	29.34	32.19	34.80	37.15	39.55	41.80	43.65	46.80	49.35	51.40	52.48	52.64
9½	24.60	27.47	30.13	33.07	35.75	38.15	40.65	42.91	44.83	48.05	50.70	52.80	53.89	54.10
10	25.22	28.18	30.90	33.93	36.65	39.15	41.67	44.02	46.00	49.29	52.00	54.19	55.26	55.48
11	26.46	29.53	32.41	35.60	38.45	41.10	43.70	46.20	48.30	51.70	54.60	56.83	58.00	58.20
12	27.65	30.86	33.84	37.15	40.20	42.90	45.60	48.25	50.45	54.10	57.00	59.40	60.55	60.75
13	28.75	32.12	35.24	38.65	41.80	44.68	47.50	50.20	52.50	56.25	59.30	61.79	63.00	63.24
14	29.85	33.35	36.60	40.15	43.40	46.35	49.32	52.15	54.50	58.40	61.53	64.15	65.40	65.65
15	30.95	34.50	37.90	41.60	44.95	47.95	51.00	54.00	56.40	60.40	63.70	66.36	67.65	67.98
16	31.95	35.65	39.10	42.95	46.40	49.50	52.68	55.70	58.20	62.40	65.80	68.50	69.85	70.15
17	32.90	36.75	40.30	44.25	47.80	51.00	54.35	57.40	60.00	64.40	67.85	70.63	72.10	72.37
18	33.84	37.80	41.50	45.55	49.20	52.50	55.85	59.03	61.70	66.20	69.80	72.67	74.10	74.48

Data derived from Tests by U. S. Bureau of Reclamation and Colorado A & M College.

CONVERSION TABLE

CUBIC FEET PER SECOND TO MINER'S INCHES



CONVERSION TABLE

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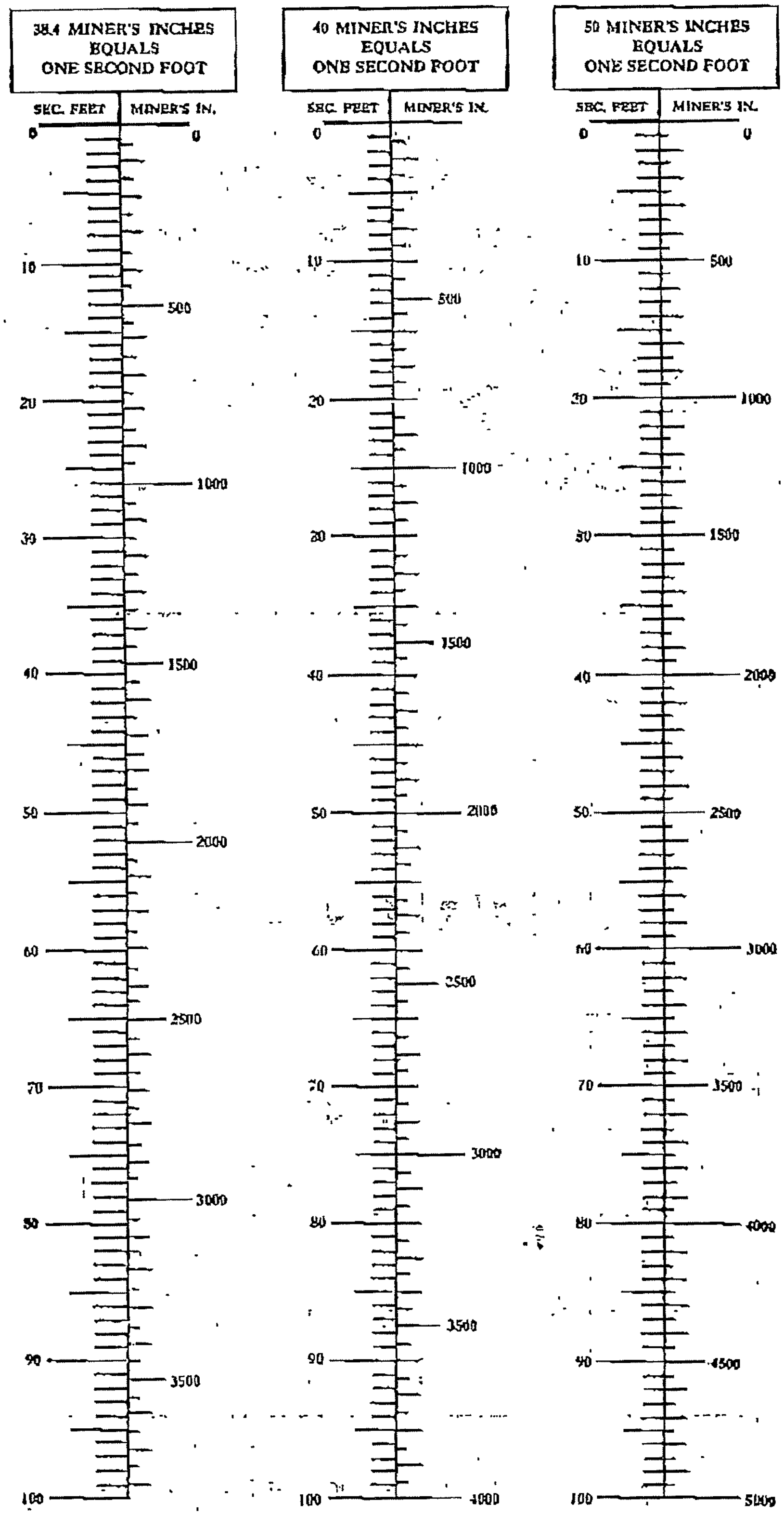
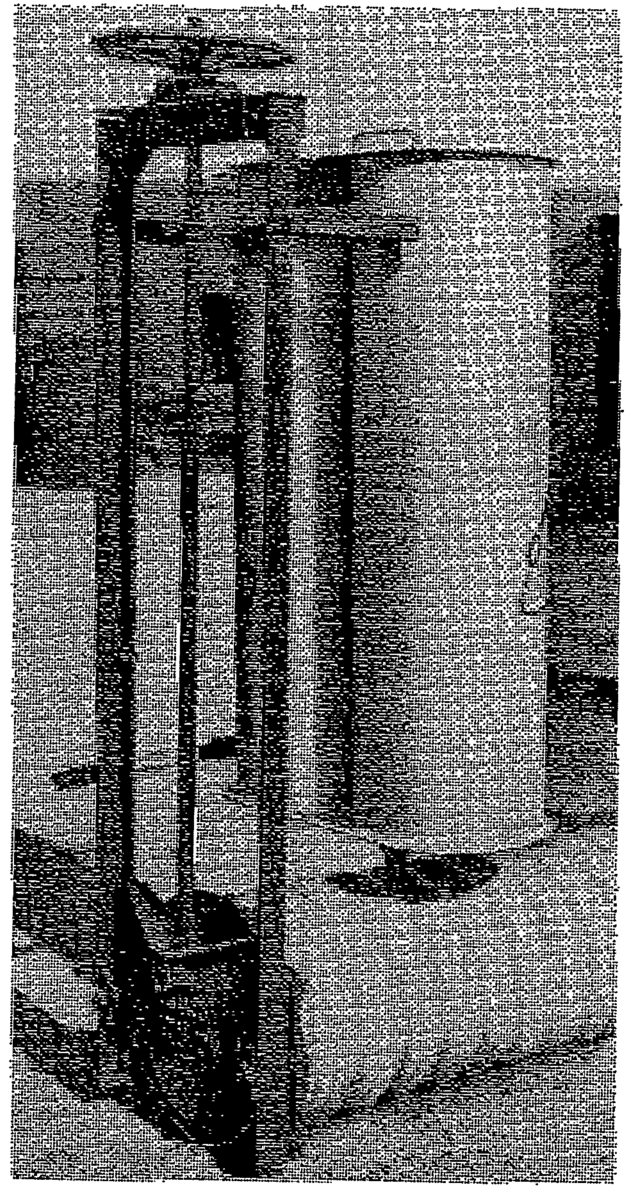


E-497

INCHES AND FRACTIONS
EXPRESSED IN DECIMALS OF A FOOT

Inches	Fractions of Inches			
	0	¼	½	¾
0	.00	.02	.04	.06
1	.08	.10	.12	.15
2	.17	.19	.21	.23
3	.25	.27	.29	.31
4	.33	.35	.38	.40
5	.42	.44	.46	.48
6	.50	.52	.54	.56
7	.58	.60	.62	.65
8	.67	.69	.71	.73
9	.75	.77	.79	.81
10	.83	.85	.88	.90
11	.92	.94	.96	.98
12	1.00	—	—	—



ARMCO*

ARMCO DRAINAGE & METAL PRODUCTS, INC.

Calco Division

Berkeley 10 | Los Angeles 22

<u>ATTACHMENT D</u>

DISTRICT SAMPLE BILLS

FRESNO IRRIGATION DISTRICT

STATEMENT OF CHARGES
FOR SERVICES AND ASSESSMENTS

Make Check Payable To:

FRESNO IRRIGATION DISTRICT
ASSESSMENTS
2907 S MAPLE AVE FRESNO CA 93725-2208
PHONE (559) 233-7161 · www.fresnoirrigation.com

PARCEL NUMBER
308 052 10

ASSESSED TO:

[redacted]

ASSESSMENT			
1ST INSTALLMENT	2ND INSTALLMENT	TOTAL	
$118.21	$78.81	$197.02	
YEAR	NUMBER OF ACRES	RELATIVE VALUE PER ACRE	TOTAL RELATIVE VALUE
2018	5.89	$33.45	$197.02

BILLING ADDRESS	DESCRIPTION
[redacted]	[redacted]

PARCEL NUMBER
[redacted]

FRESNO IRRIGATION DISTRICT

STATEMENT OF CHARGES
FOR SERVICES AND ASSESSMENTS

2

PLEASE WRITE YOUR PARCEL NUMBER ON YOUR CHECK

IF PAID BY JUNE 20 ▼ PAY THIS AMOUNT

BILLING ADDRESS			
[redacted]	5% PENALTY + $10 COST IF PAID AFTER JUNE 20	2ND INSTALLMENT	$78.81
		THE SECOND INSTALLMENT CANNOT BE PAID BEFORE THE FIRST INSTALLMENT	

PARCEL NUMBER
[redacted]

FRESNO IRRIGATION DISTRICT

STATEMENT OF CHARGES
FOR SERVICES AND ASSESSMENTS

1

PLEASE WRITE YOUR PARCEL NUMBER ON YOUR CHECK

IF PAID BY DEC 20 ▼ PAY THIS AMOUNT

BILLING ADDRESS			
[redacted]	10% PENALTY IF PAID AFTER DECEMBER 20	1ST INSTALLMENT	$118.21
		TO PAY TOTAL AMOUNT DUE, RETURN BOTH STUBS WITH PAYMENT OF: $197.02 BY: 12/20/2017	

Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725
Phone: (559)233-7161

INVOICE

Billed To:
BEE SWEET CITRUS, INC

416 E SOUTH AVE
FOWLER, CA 93625

DATE: 3/6/2018
INVOICE #: 05709

DUE DATE: 4/5/2018

CUSTOMER ACCOUNT # : 1006

ITEM DESCRIPTION	UNITS	PRICE	AMOUNT
WATER SALES - ANNEX	7.88	75.00	591.00
TOTAL THIS INVOICE			591.00

FEBRUARY 2018 USAGE

REMIT TO:
Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Please reference the invoice number on your check. Thank you!

Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725
Phone: (559)233-7161

INVOICE

Billed To:
UNITED CALIFORNIA CITRUS WEST

19716 E TRIMMER SPRINGS RD
SANGER, CA 93657

DATE: 5/8/2018
INVOICE #: 05755

DUE DATE: 6/7/2018

CUSTOMER ACCOUNT # : 1062

ITEM DESCRIPTION	UNITS	PRICE	AMOUNT
WATER SALES - ANNEX - MARCH	0.10	300.00	30.00
WATER SALES - ANNEX - APRIL	6.20	75.00	465.00
TOTAL THIS INVOICE			495.00

MARCH & APRIL 2018 USAGE

REMIT TO:
Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Please reference the invoice number on your check. Thank you!

Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725
Phone: (559)233-7161

INVOICE

Billed To:
BEE SWEET CITRUS, INC

416 E SOUTH AVE
FOWLER, CA 93625

DATE: 6/13/2018
INVOICE #: 05791

DUE DATE: 7/13/2018

CUSTOMER ACCOUNT # : 1006

ITEM DESCRIPTION	UNITS	PRICE	AMOUNT
WATER SALES - ANNEX	28.85	150.00	4,327.50
TOTAL THIS INVOICE			4,327.50

MAY 11, 2018 - MAY 31, 2018 USAGE

REMIT TO:
Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

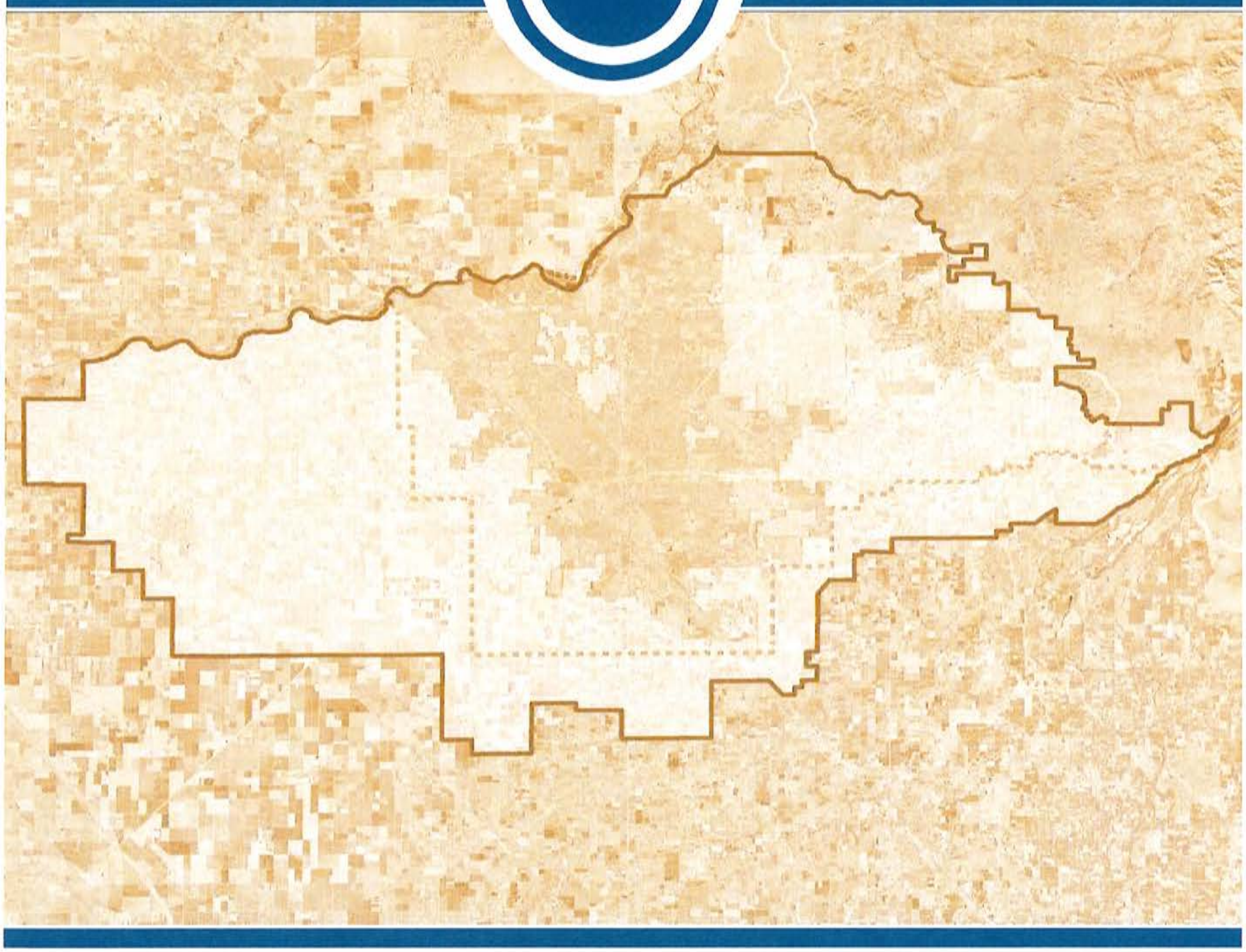
Please reference the invoice number on your check. Thank you!

<u>ATTACHMENT E</u>

GROUNDWATER MANAGEMENT PLAN

December 2006

Fresno Area Regional Groundwater Management Plan



• *Fresno Irrigation District* • *City of Clovis* • *Fresno Metropolitan Flood Control District* •
• *County of Fresno* • *City of Fresno* • *City of Kerman* • *Bakman Water Company* •
• *Garfield Water District* • *Malaga County Water District* • *Pinedale County Water District* •

The Fresno Area Regional
Groundwater Management Plan

Adopted by:	On:
Fresno Irrigation District	01/25/2006
City of Clovis	02/13/2006
Bakman Water Company	03/13/2006
County of Fresno	07/18/2006
City of Fresno	04/18/2006
Pinedale County Water District	09/20/2006
Fresno Metropolitan Flood Control District	02/08/2006
City of Kerman	03/01/2006
Malaga County Water District	02/14/2006
Garfield Water District	11/01/2006

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B- Resolutions to Adopt Plan
C - Memorandum of Understanding
D - Glossary

LIST OF ABBREVIATIONS

AB	Assembly Bill
AF	Acre-feet
CSA	Community Service Area
CVP	Central Valley Project
DBCP	Dibromo-Chloropropane
DHS	Department of Health Services
DWR	Department of Water Resources
EDB	Ethylene Dibromide
EHS	Environmental Health System
EPA	Environmental Protection Agency
FCEHD	Fresno County Environmental Health Department
FID	Fresno Irrigation District
FMFCD	Fresno Metropolitan Flood Control District
GAC	Granulated Activated Carbon
GMP	Groundwater Management Plan
HSA	Hydrologic Study Area
ISI	Integrated Storage Investigations
MCWD	Malaga County Water District
MG	Million Gallons
MGD	Million Gallons Per Day
MOU	Memorandum of Understanding
MTBE	Methyl Tertiary-Butyl Ether
NPDES	National Pollution Discharge Elimination System
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SWTP	Surface Water Treatment Plant
TAC	Technical Advisory Committee
TCE	Trichloroethylene
TCP	Trichloropropane
VOC	Volatile Organic Chemicals or Volatile Organic Compounds
WWD	Waterworks District
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant

1 - INTRODUCTION

This Groundwater Management Plan (GMP or Plan) is a collaborative effort among nine public agencies and one private water company in the Fresno-Clovis metropolitan and surrounding area. The Plan documents a regional approach toward groundwater management, while still addressing individual goals and issues for each of the participants. The Plan satisfies the new requirements for Groundwater Management Plans created by the September 2002 California State Senate Bill No. 1938, which amended Sections 10753 and 10795 of the California Water Code. The Plan also addresses recommended components for a Groundwater Management Plan described in Appendix C of Department of Water Resources Bulletin 118 (2003 Update).

1.1 - Background Information on Regional Group

Background

The desire to develop and adopt a regional groundwater management plan for this region came from an effort to involve local stakeholders in development of a groundwater management plan for the Fresno Irrigation District (FID). In 2004, FID intended to update its groundwater management plan to meet SB 1938 requirements and DWR recommendations. In an effort to solicit comment from stakeholders, FID held a public hearing on July 7, 2004, to notify the public of FID's intent to modify its plan. The notice invited landowners and interested parties to make comment at the meeting and participate on a technical advisory committee. No public comments were received at the hearing. FID adopted a Resolution of Intent to Modify its Groundwater Management Plan on July 7, 2004.

A Technical Advisory Committee (TAC) was formed to provide input during preparation of the Plan. The TAC was comprised of local agency representatives and landowners. The first meeting of the TAC was held on November 18, 2004. A review of the new Water Code requirements was provided, as well as the initial expectations of the TAC. At this initial meeting, some of the agency representatives noted that they planned to prepare their own groundwater management plan and some expressed interest in developing a regional plan. It was decided to conduct another meeting with representatives of agencies that have overlapping boundaries with FID to determine the interest of other local stakeholders to participate in a cooperative or regional plan. This meeting was held on January 27, 2005. The meeting addressed the need for an updated plan, the new requirements in the Water Code, the benefits of a regional plan, and discussions on how to proceed with a regional groundwater management plan. From this meeting, it was determined that there was enough interest in developing a regional plan. The attendees at the meeting identified four major reasons for developing a regional plan:

- Cooperative groundwater management efforts
- Cost savings with preparing a regional plan and annual groundwater reports
- Inclusion of smaller agencies
- Regional funding opportunities

Cooperative Effort
Interested parties continued to meet to develop a Memorandum of Understanding (MOU) for preparation of the regional plan. The MOU was drafted and reviewed by each of the agencies, and monthly meetings with the agency representatives and landowners were held. The MOU was presented before each agency's governing body for discussion and public comment. The MOU was then adopted by each of the agencies. A copy of the signed MOU is included in Appendix B.

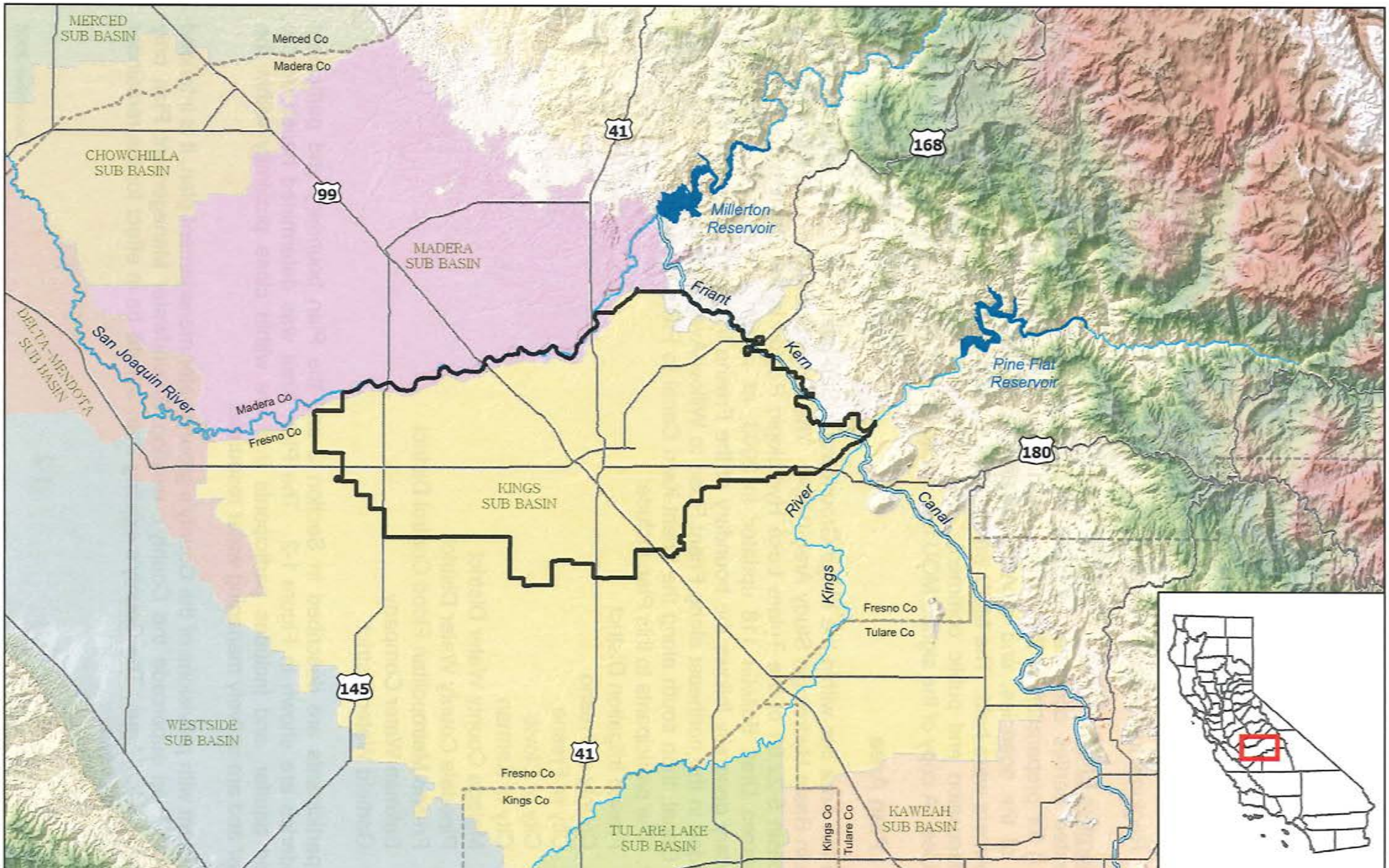
1.2 - Plan Area

The Plan Area lies within the Kings Groundwater Sub-basin, which lies within the San Joaquin Basin Hydrologic Study Area (HSA). The Kings Sub-basin is also identified as sub-basin 5-22.08 of the Tulare Lake Hydrologic Region in the Department of Water Resources Draft Bulletin 118 updated in 2003, as shown in Figure 1-1. The Plan boundary generally follows the boundary of the Fresno Irrigation District, however it is extended in the northeast along Friant Road to Willow Avenue, then east to the Friant-Kern Canal, then south along the Friant-Kern Canal to FID's boundary near the Kings River. The participants to this Plan include:

- Fresno Irrigation District
- County of Fresno
- City of Fresno
- City of Clovis
- City of Kerman
- Malaga County Water District
- Pinedale County Water District
- Fresno Metropolitan Flood Control District
- Bakman Water Company
- Garfield Water District

The participants are described in Section 2 and the Plan boundary and participant boundaries are shown in Figure 1-2. The Plan Area was determined based on the shared aquifer, and includes participants that are within close proximity within the aquifer and are actively managing water resources.

Consistent with provisions of the County's groundwater management plan, it is intended that this Plan supercede the County's existing Groundwater Management Plan only within the Plan Area. The County's existing Plan will still be in effect for the remainder of the County area.



PROVOST& PRITCHARD ENGINEERING GROUP
286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700

Figure 1-1

Groundwater Basin Map

Fresno-Area Regional Groundwater Management Plan

December, 20 tington\gis\Clients\FresnoID_1038\10380505\GMP_Vicinity.mxd

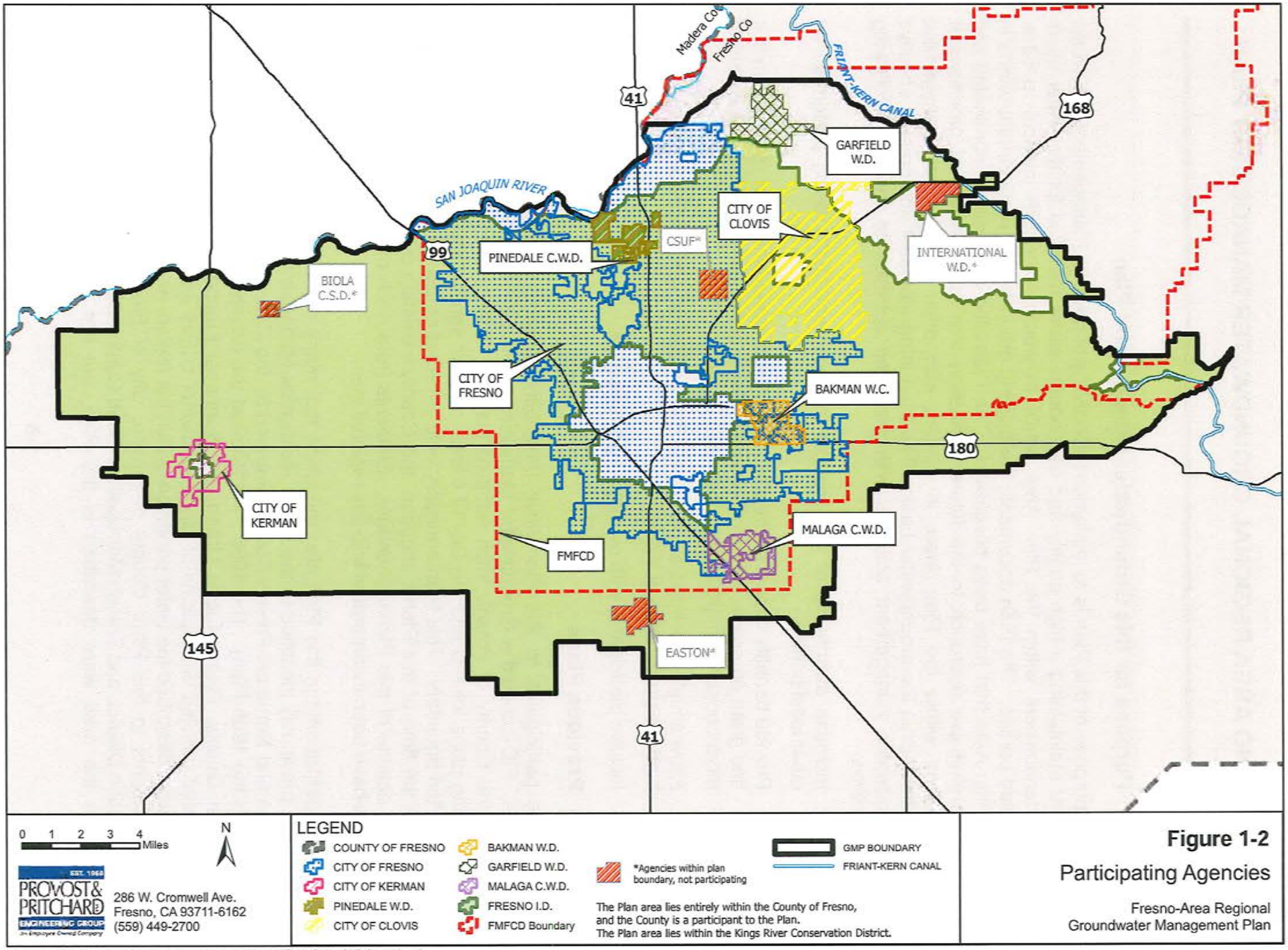


Figure 1-2

Participating Agencies

Fresno-Area Regional Groundwater Management Plan

December, 2005 \\hunlington\gis\Clients\FresnoID_1038\10380505\FresnoRegionGMP_figure1-2.mxd

1.3 - Purpose for this Groundwater Management Plan

The purpose of this Plan is to implement effective groundwater management that works toward maintaining a high quality and dependable water resource for the water users and landowners within the Plan Area, while minimizing negative impacts to other affected parties. The Plan documents the existing groundwater management efforts in the Plan Area that have been successful. The Plan also develops a coordinated and comprehensive approach to the future evaluation and management of groundwater resources within the Plan Area, in concert with other groundwater management activities within the groundwater basin. The Plan integrates past and present effective groundwater management activities with proposed activities to meet the following objectives:

1. Increase awareness of groundwater management efforts being performed by other local parties.
2. Provide benefits of cost savings for preparation, opportunities for regional funding and grant programs, inclusion of smaller local agencies, and the development of more cooperative groundwater efforts.
3. Allow smaller agencies to participate that otherwise would not have been able to fund the preparation of a GMP.
4. Include participants with overlapping boundaries.

1.4 - Previous Plans

Three participants to this Plan have previously adopted Groundwater Management Plans. FID adopted a Groundwater Management Plan in 1995, and the City of Clovis and the County of Fresno each adopted plans in 1997. This Plan supercedes the existing plans for FID and the City of Clovis, as their service areas are included within the Plan boundary. This Plan boundary only covers a portion of the County of Fresno, so at the time of this Plan's adoption, the County's existing plan will still apply to the area outside of this Plan's boundary. Elements from each of the previously adopted plans have been incorporated into this regional plan.

The participants in this Plan also recognize that many of the components of this Plan were previously identified in the Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County prepared by the County of Fresno in 1986 (herein called the 1986 Plan). The 1986 Plan followed the Interim Best Management Plan for Water Quality, Fresno-Clovis Urban and Northeast Fresno County. The 1986 Plan included detailed descriptions of the groundwater quality and quantity conditions within the area, described the water purveyors within the region, and included five of the same participants to this Plan: County of Fresno, City of Fresno, City of Clovis, Fresno Irrigation District, and Fresno Metropolitan Flood Control District. Other water purveyors within the area were described in the Plan, but not included as participants for implementation. The plan area of the 1986 Plan was smaller than the area described in this Plan. The 1986 Plan includes surface water related objectives that are included in this Plan. Many of the activities of the 1986 Plan are still viable and have become a part of on-going operations for the five agencies involved. However, the committees formed to implement the activities proposed in the 1986 Plan have not actively met for many years, and there is a need to review and update the groundwater related activities described in that plan. This Plan is intended to be a continuation of the groundwater related objectives of the 1986 Plan, which included:

1. Preserve and enhance the existing quality of the area's groundwater.
2. Preserve untreated groundwater as the primary source of domestic water.
3. Maximize the available water supply, including conjunctive use of surface water and groundwater.
4. Conserve the water resource for long-term beneficial use and assure an adequate supply for the future.
5. Manage water resources to the extent necessary to ensure reasonable, beneficial, and continued use of the resource.

1.5 - Statutory Authority for Groundwater Management

The California legislature recognized that local groundwater management is preferable to State or Federal groundwater controls, and passed Assembly Bill 255 (AB 255) in 1989. AB 255 was the first statewide legislation allowing local water agencies to prepare and adopt groundwater management plans for their jurisdictions. California Assembly Bill No. 3030 (AB 3030), which became law on January 1, 1993, superceded AB 255, and authorized local agencies that are within groundwater basins, as defined in California Department of Water Resources (DWR) Bulletin 118, to prepare and adopt groundwater management plans. Each of the public agency participants to this Plan meets the requirements of a "local agency", as defined within Section 10752 of the Water Code.

Agencies adopting a Plan are authorized to enter into agreements with other local agencies or private parties to manage mutual groundwater supplies, including those existing in overlapping areas, as necessary to implement the Plan. Bakman Water Company has been an active participant in the development of this Plan, and has entered into the Memorandum of Understanding for its development and implementation.

1.6 - Groundwater Management Plan Components

This Plan includes the required and recommended components for a Groundwater Management Plan as identified in California Water Code Section 10753, et. seq. This Plan is also consistent with the recommended elements for a Groundwater Management Plan as identified in DWR Bulletin 118 (2003), Appendix C. Table 1-1 identifies the location within this document where each of the components 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	Appendix A, 1.1, 1.7
2. Groundwater basin management objectives	1.3, 4
3. Monitoring and management of groundwater elevations, groundwater quality, land subsidence and surface water	6
4. Plan to involve other agencies located in the groundwater basin	5.3
5. Monitoring protocols	6.3
6. Map of groundwater basin and agencies overlying the basin	Figure 1-1, 1-2
California Water Code Voluntary Components (10750 *et seq.*)	
7. Control of saline water intrusion	7.4
8. Identification and management of wellhead protection areas and recharge areas	7.3, 8.1
9. Regulation of the migration of contaminated groundwater	7.4, 7.5, 8.5
10. Administration of well abandonment and well destruction program	7.1
11. Mitigation of conditions of overdraft	8
12. Replenishment of groundwater extracted by water producers	8.1
13. Monitoring of groundwater levels and storage	6.1
14. Facilitating conjunctive use operations	8.4
15. Identification of well construction policies	7.2
16. Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.	7.5, 8.1, 8.2, 8.4, 8.5, 8.6
17. Development of relationships with state and federal regulatory agencies	5.2, 5.3
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	1.1, 5.1
20. Description of the area to be managed under the Plan	1.2, 2, 3
21. Descriptions of actions to meet management objectives and how they will improve water reliability	4 - 9
22. Periodic groundwater reports	9.2
23. Periodic re-evaluation of Groundwater Management Plan	9.4

1.7 - Adoption of Plan

Public Notice of Intention to Modify/Prepare a Regional Groundwater Management Plan
As required by the California Water Code, a public hearing was duly noticed on July 26, 2005 and August 2, 2005 consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss adoption and implementation of the regional Plan. No public comments were received at this meeting.

Resolution of Intention to Modify/Prepare a Regional Groundwater Management Plan
Each agency adopted a Resolution for Intention to Modify/Prepare the Fresno-Area Regional Groundwater Management Plan. A copy of each agency's resolution is included in Appendix A. This resolution was then published on December 20, 2005 and December 27, 2005 consistent with California Water Code Section 10753.2(a).

Public Participation in Plan Development
The public was invited to participate in the development of the updated Groundwater Management Plan through the newspaper notices and the public hearing. The draft regional plan was then prepared with input from a Technical Advisory Committee (TAC). The Technical Advisory Committee includes landowners and representatives from each party participating in the plan. In October 2005, the Technical Advisory Committee included:

- Dale Stanton, Assistant General Manager, Fresno Irrigation District
- Bill Stretch, District Engineer, Fresno Irrigation District
- Lon Martin, Water Division Manager, City of Fresno
- Brock Buche, Water Division, City of Fresno
- Lisa Koehn, Assistant Utilities Director, City of Clovis
- Alan Weaver, Public Works Director, County of Fresno
- Phil Desatoff, Geologist, County of Fresno
- Jerry Lakeman, Fresno Metropolitan Flood Control District
- Alan Jacobsen, Public Works Director, City of Kerman
- Tim Bakman, Bakman Water Company
- Russ Holcomb, General Manager, Malaga County Water District
- John Garcia, General Manager, Pinedale County Water District
- Richard Carstens, Landowner
- Chris Palmer, Landowner

Following the public hearing regarding the intent to prepare and adopt the Plan, the Garfield Water District (Garfield) expressed an interest in participating in the Plan. The TAC and participants agreed to Garfield's participation. Garfield provided a Letter of Intent to Participate in the plan, and Exhibit 2 of the MOU was updated to included Garfield, as shown in Appendix C. Garfield held a public hearing on December 8, 2005 regarding intent to participate in the Plan. The meeting was publicly noticed on

November 26, 2005. Garfield's Board of Directors adopted the Resolution of Intent to Prepare and Adopt the Fresno-Area Groundwater Plan on December 8, 2005.

Public Notice of Intention to Adopt a Regional Groundwater Management Plan
As required by the California Water Code, a public hearing was duly noticed on January 10, 2006 and January 17, 2006, consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss adoption and implementation of the regional Plan.

Resolution Adopting the Regional Groundwater Management Plan
Each agency adopted a Resolution for Adoption of the Fresno-Area Regional Groundwater Management Plan. A copy of each agency's resolution is included in Appendix B. A listing of the date of adoption by each agency is shown below.

Adopted by:	On:
Fresno Irrigation District	01/25/2006
City of Clovis	02/13/2006
Bakman Water Company	03/13/2006
County of Fresno	07/18/2006
City of Fresno	04/18/2006
Pinedale County Water District	09/20/2006
Fresno Metropolitan Flood Control District	02/08/2006
City of Kerman	03/01/2006
Malaga County Water District	02/14/2006
Garfield Water District	11/01/2006

Public Notice of Resolutions Adopting the Regional Groundwater Management Plan
Notice of the resolutions adopting the Fresno-Area Regional Groundwater management Plan was published on November 24, 2006 and December 1, 2006 consistent with California Water Code Section 10753.2(a).

2 - PARTICIPANT INFORMATION

Nine public agencies and one private water company in the Fresno-Clovis metropolitan and surrounding area have collaborated to develop this Plan. The Plan Area covers 455 square miles and is located entirely within Fresno County. The total population in the Plan Area in 2000 was approximately 600,000, according to recent census data. Refer to Figure 1-2 for a map showing the Plan Area boundary and the location of each participant. Table 2-1 summarizes the background information on each of the Plan participants. Figure 2-1 shows the major surface water facilities in the Plan Area, including canals, pipelines, streams, and flood control basins. Following is a brief description of each participant including information regarding the history, demographics, water supply, water quality, and facilities of each.

2.1 - Fresno Irrigation District

The Fresno Irrigation District (FID or District) is a public irrigation district formed pursuant to the California Irrigation District Law (Division 11 of the California Water Code). The District was formed in 1920 as the successor to the privately owned Fresno Canal and Land Company. The District is a local agency responsible for delivery of surface water to lands within the District, and management of groundwater in accordance with this adopted Groundwater Management Plan.

FID is located in the geographical center of Fresno County and extends from the San Joaquin River in the north, south to near the City of Fowler, and roughly from the Friant-Kern Canal to about five miles west of the City of Kerman, as shown in Figure 1-2. The District service area is approximately 245,000 acres (about 380 square miles) and includes the Fresno/Clovis metropolitan area near its center. The District now operates approximately 680 miles of canals and pipelines. Water delivery is provided to approximately 190,000 acres, although this number has been decreasing in recent years as a result of urban expansion.

Potable water is used within the District boundary for municipal, industrial and agricultural purposes. The District delivers approximately 500,000 acre-feet (average annual) of water from the Kings River and Central Valley Project water through the Friant-Kern Canal. Most of this water is delivered to agriculture, although an increasing share of the District's water supply is used for groundwater recharge in the urban area. In 2004, FID began delivery of surface water to surface water treatment facilities operated by the City of Fresno and the City of Clovis. In addition to surface water deliveries, a significant amount of groundwater pumping occurs in the District to meet urban and agricultural demands.

The agricultural lands in the District remain predominantly permanent crops, however the rapid growth of urban development is changing the land use in the Fresno/Clovis metropolitan area. About 150,000 acres (or 60%) of the District remains as farmed agricultural land. Vineyards make up the largest category of farmland at nearly 30% of the total District acreage. Almonds and citrus are other significant categories. Nearly 30% of the District is now urban, with the remaining 10% of land area classified as rural residential.

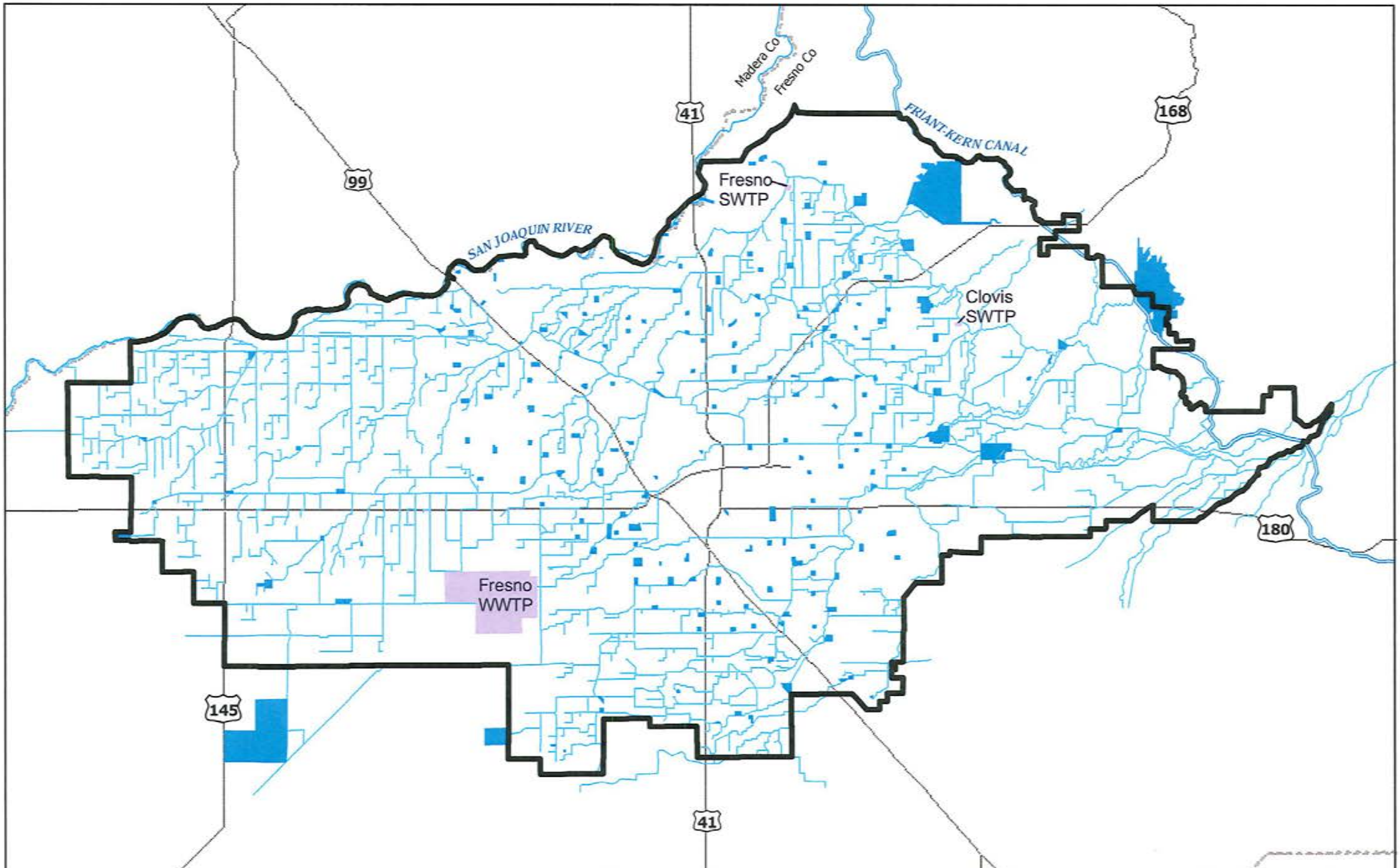
2.2 - Fresno County

Fresno County was established in 1856 and covers 6,016 square miles extending from the Sierra Nevada mountains to the west side of the San Joaquin Valley. The County population was 824,000 in 2000. The area covered in this Plan (455 square miles) lies entirely within Fresno County. Hence, only a portion of Fresno County is addressed in this Plan, although it is generally the most densely populated area in the County.

Fresno County supplies potable water to communities in the Plan Area through six Community Service Areas (CSAs) and one Waterworks District (WWD). The CSAs and WWD have 14 active wells; one of the CSAs is connected to the City of Fresno water system. County staff monitors groundwater levels and groundwater quality in cooperation with CSA and WWD staff. In rural areas, water is supplied from private domestic wells and sewerage is handled almost exclusively with septic systems. Constituents of concern in Fresno County include nitrates, DBCP, radionuclides, and EDB.

Along the eastern border of the Plan Area, groundwater is limited to fractured zones deep within the underlying bedrock. Locating sustainable groundwater supplies in these areas has been problematic in recent years.

Though dated, significant information on the groundwater in Fresno County can be found in the *Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County*, prepared in 1986 by Fresno County.



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Wastewater Treatment Plant

GWMP BOUNDARY

FMFCD Basins and FID Ponds

Water Facilities (Canals, Pipelins and Streams)

Figure 2-1

Surface Water Facilities

Fresno-Area Regional
Groundwater Management Plan

December, 2006 \\huntington\gis\Clients\FresnoID_1038\10380505\GMP_Facilities.mxd

2.3 - City of Fresno

The City of Fresno was founded in 1885 and had a population in 2003 of 457,000. The total area of the City is 102.5 square miles, but the City only serves water to 87.2 square miles. The City of Fresno serves customers located within the city limits, as well as in some unincorporated areas (county islands). The City of Fresno has and continues to be one of the fastest growing cities in California.

The City of Fresno supplies water to residential, commercial, industrial and landscape irrigation customers. The City does not provide water for any agricultural purposes. In 2005, the City had 120,399 connections, and 14% of the connections were measured. Since water is metered for all of the large water users, 33% of total water deliveries are measured.

The City of Fresno's primary source of water is groundwater from the Fresno Sole Source Aquifer, a large underground aquifer. The City of Fresno's domestic water system is somewhat unique for a water system of its size. Prior to beginning a new 30 million gallons per day (MGD) surface water treatment plant (SWTP) in 2004, the Fresno water system was one of the largest water systems in the United States relying solely on pumped groundwater as its only source of potable water. The total water pumped from Fresno's 250 wells exceeded 54 billion gallons (166,000 AF) in 2003.

The City of Fresno also has two surface water supplies: 60,000 AF of CVP water from the Friant system (San Joaquin River) and more than 100,000 AF (average annual) from the Kings River through a contract with FID. Since the mid-1960's surface water from these rivers has been imported to the City of Fresno via FID canals and placed into groundwater recharge basins. In cooperation with FID and FMFCD, the City of Fresno currently diverts more than 40,000 acre-feet of surface water per year to more than 70 basins throughout the Plan Area for the purposes of groundwater recharge. More than 40,000 AF was recharged during the 2005 irrigation season. Surface water is now also conveyed to the City's new SWTP located in northeast Fresno.

The City of Fresno measures water levels on a quarterly basis and performs water quality testing according to Department of Health Service (DHS) requirements. Eight major contaminant plumes are present in Fresno, and they are being addressed by the responsible parties through assessment and remediation, and some are in advanced stages of mitigation. The inorganic plume contaminants include chloride, nitrate, arsenic, and chromium. Organic plume contaminants include petroleum hydrocarbons and methyl tertiary-butyl ether (MTBE), chlorinated volatile organic chemicals (VOCs), Dibromo-Chloropropane (DBCP) and other pesticides, and trichloropropane (TCP). The City currently has 32 active municipal wells that are treated for DBCP or TCE.

For more information on groundwater in the City of Fresno refer to the City of Fresno Water Conservation Plan (2005), the Fresno Metropolitan Water Resources Management Plan (1992), and the Fresno Municipal Code, Chapter 14, Water Regulations.

2.4 - City of Clovis

The City of Clovis (Clovis) is located in eastern Fresno County, just east of the City of Fresno. Clovis was incorporated in 1912 and now covers an area of 19.76 square miles. The population of Clovis in 2005 was 86,215. Clovis also delivers domestic water to the unincorporated area known as Tarpey Village, which in 2005 has a population of 3,957.

In 2004, groundwater pumping in Clovis was about 7,500 MG (23,000 AF). Clovis has 36 active wells; other wells have been abandoned due to low yields, sanding, or contamination problems. Some wells have facilities for granulated activated carbon (GAC) treatment. Clovis monitors groundwater quality according to DHS requirements, and monitors groundwater levels semi-annually.

Clovis lies on the eastern side of a large cone of depression that underlies the Fresno-Clovis Metropolitan area. In 1997, groundwater overdraft was estimated to be 2,500 AF/year. This amount has increased due to rapid urban growth and a corresponding increase in groundwater demand. Clovis performs intentional groundwater recharge using Kings River water derived from entitlements through FID. The annual surface water entitlement for Clovis currently is over 20,000 AF in an average year. Recharge is performed in single purpose recharge basins owned by Clovis, dual-purpose storm drainage basins owned by the Fresno Metropolitan Flood Control District (FMFCD), and local channels including Dry Creek, Redbank Creek, and Dog Creek. More than 9,000 acre-feet of surface water is currently recharged annually.

In 2004, Clovis also constructed and placed into operation a 15 MGD capacity surface water treatment plant. The plant is providing treated surface water to the easterly portion of Clovis. Clovis, in cooperation with FID, also has areas where surface water from FID's canal system is directly delivered to areas of large landscaping such as cemeteries, schools and parks.

For additional information on the groundwater resources in Clovis refer to the following reports prepared by Provost and Pritchard Engineering Group: *City of Clovis Groundwater Recharge Investigation Report* (1997) and *Groundwater Monitoring and Recharge Investigation Project* (2003).

2.5 - City of Kerman

The City of Kerman (Kerman) is located in central Fresno County, near the western edge of the Plan Area. Kerman was incorporated in 1946 and had a population of 11,500 in 2004. Kerman occupies 2.5 square miles and the surrounding area is predominantly an agricultural community.

Kerman serves urban water to residential (2,104), commercial (307) and industrial (7) connections. All of Kerman's water supplies come from locally pumped groundwater and the City does not have the water rights for any surface supplies. In 2004, Kerman pumped a total of 988 million gallons (3,030 AF) of groundwater. Kerman has four active wells and one well on standby. The construction of two new wells is planned for 2006. Planned improvements will be capable of meeting projected water demands through 2011. Kerman is also developing a groundwater recharge partnership with FID. The program would place combination flood control/recharge basins close to FID conveyance facilities.

Groundwater is available to Kerman from a deep aquifer, beneath the Corcoran Clay, and a shallow aquifer above the Corcoran Clay. The shallow aquifer sometimes has high levels of uranium. Kerman is experiencing accelerated urban growth and expects new developments to rapidly increase water demands. As a result, Kerman is investigating surface water supplies, or the use of water from the shallow aquifer for landscaping, as alternatives for meeting the growing demand.

For more information on Kerman's water supplies and facilities refer to the *City of Kerman Capital Improvement Plan* prepared by Yamabe and Horn in 2004.

2.6 - Malaga County Water District

Malaga County Water District (Malaga or District) is a water and wastewater utility district covering 2.3 square miles just south of the City of Fresno. Malaga began delivering water in 1965 and now serves a residential population of about 1,300 from 224 residential connections and 220 industrial/commercial connections. Residential development in Malaga is nearly complete; existing zoning and readily available land allow for continued commercial and industrial development. All new industrial and commercial enterprises will be required to connect to the District water system.

Since 1982 the demand for water has generally been increasing. Malaga depends entirely upon groundwater to meets its water needs, and, in 2003, District wells supplied 602 million gallons (1,848 AF). However, there is no pumping data available for the many private wells in the area. Malaga is currently in discussions with neighboring agencies to participate in groundwater recharge projects to replenish the groundwater supplies.

Malaga has three active wells and two that have been removed from service due to a variety of contamination problems, including nitrates and DBCP's. Malaga also operates a wastewater treatment plant (WWTP) with a capacity of 1.2 MGD. Effluent from the WWTP is delivered to percolation ponds. If necessary, tertiary treated overflow is discharged into FID's Central Canal.

Additional information on Malaga's facilities, water usage, and groundwater quality can be found in the *2004 Malaga County Water District Water Supply Report* prepared by Provost and Pritchard Engineering Group.

2.7 - Pinedale County Water District

Pinedale County Water District (PCWD or Pinedale) was formed in 1954 and presently delivers water to approximately 2,400 residential and 550 commercial customers. Pinedale covers 1.7 square miles and is located in the north central portion of the Plan Area, with portions of the district in the City of Fresno and unincorporated Fresno County. Some areas in Pinedale remain undeveloped, and consequently water demands are expected to increase as the lands are occupied.

Pinedale has five active wells, but typically only needs to operate three to meet current water demands. Some other wells in Pinedale are no longer used due to TCE contamination. No treatment or chlorination is presently performed on a regular basis on any of the pumped groundwater. Pinedale monitors groundwater quality according to DHS requirements. Pinedale does not presently monitor groundwater levels.

Pinedale also collects sewage and delivers it to the Fresno sewerage system, except for an area in the northwest portion of the district where sewerage is collected by the Pinedale Public Utilities District. About 20 residential units in the eastern portion of Pinedale are still on underground septic systems.

2.8 - Fresno Metropolitan Flood Control District

The Fresno Metropolitan Flood Control District (FMFCD) was founded in 1956 to provide flood control, local storm drainage management, water conservation, and recreational services in the Fresno-Clovis Area. The district is located in the north-central portion of Fresno County between the San Joaquin and Kings Rivers. FMFCD is authorized to control storm waters within an urban area and rural foothill watersheds of approximately 400 square miles, known as the Fresno County Stream Group. About 270 square miles of the service area lies within the area covered by this Groundwater Management Plan.

The FMFCD currently has three reservoirs, five regional flood control detention basins planned, and 163 local basins constructed or in planning. The principal method of disposal of stormwater in the area is groundwater recharge at all of these basins.

FMFCD monitors water deliveries to flood control/recharge basins and tests the chemical composition of sediments that collect in basins. FMFCD does not presently monitor groundwater levels or groundwater quality.

FMFCD is the lead agency for stormwater quality management and has primary responsibility for implementing a Stormwater Quality Management Program developed jointly with the City of Clovis, City of Fresno, County of Fresno, and California State University at Fresno. FMFCD has been involved with the Nationwide Urban Runoff Program (NURP) project, in conjunction with the Environmental Protection Agency (EPA). The goal of the program was to determine the extent to which urban runoff contributes to water quality problems and evaluate various management practices.

FMFCD maintains as its first operational priority the protection of people and property from flood damage. However the FMFCD also aims to conserve water by (1) retaining storm water runoff in basins to facilitate storm water percolation; and (2) cooperating with the Cities of Fresno and Clovis to direct imported surface water entitlements to District facilities for percolation.

For more information on FMFCD refer to the *FMFCD District Services Plan* prepared in 2004.

2.9 - Bakman Water Company

Bakman Water Company (Bakman) is a privately owned utility that has provided water service to the Fresno area since 1948. Bakman delivers water to approximately 1,800 connections serving 10,000 customers. Bakman's service area covers 1,660 acres within the southeastern portion of the City of Fresno and parts of unincorporated Fresno County.

Bakman is currently negotiating a contract with FID for a surface water allotment. Bakman does not have any other contract for surface water to be treated and delivered to its customers, and therefore delivers pumped groundwater to its customers. Bakman pumped a total of 1,270 MG (3,900 AF) of water in 2003. Water is served to residential and commercial customers. Bakman currently has ten active wells, three standby wells, and three inactive wells. Numerous private wells are found in the Bakman service area. However, new developments are required to connect to the Bakman water system.

Water quality concerns in Bakman include nitrate contamination from food processing industries and DBCP. Due to these water quality concerns, three wells have been classified as "standby wells" in accordance with Department of Health Services (DHS) standards. Blending and GAC treatments are working at other wells to reduce nitrate and DBCP concentrations within Bakman's boundary. All wells are plumbed and wired to allow for emergency chlorination.

In 1991, Bakman signed an agreement with FID to fund groundwater recharge projects in FID through an annual payment. In addition, Bakman is presently pursuing groundwater recharge projects within its boundaries.

2.10 - Garfield Water District

Garfield Water District (Garfield) delivers surface water for agricultural uses to approximately 1,300 of the 1,750 acres within the District. Garfield recently entered into a Long-Term Renewal Contract with the United States for Project Water Service from the Friant Division. The contract is for 3,500 acre-feet of Class 1 water. Water deliveries to Garfield are made from a turnout on the Friant-Kern Canal, and metered delivery is made to the growers via a pipelined system. The predominant crops in Garfield are grapes, almonds, citrus, olives and stone fruits.

Garfield does not own nor operate any wells. All groundwater within Garfield is pumped from privately owned wells.

2.11 - Surrounding Area

Although not Plan participants, the neighboring water agencies shown in Figure 2-2 will be kept apprised of groundwater projects and policies that may impact them. Lands to the south and west of the Plan Area are particularly important since they are downgradient and located in the same groundwater sub-basin. Lands to the north share less hydrologic connection due to the partial hydraulic barrier created by the San Joaquin River.

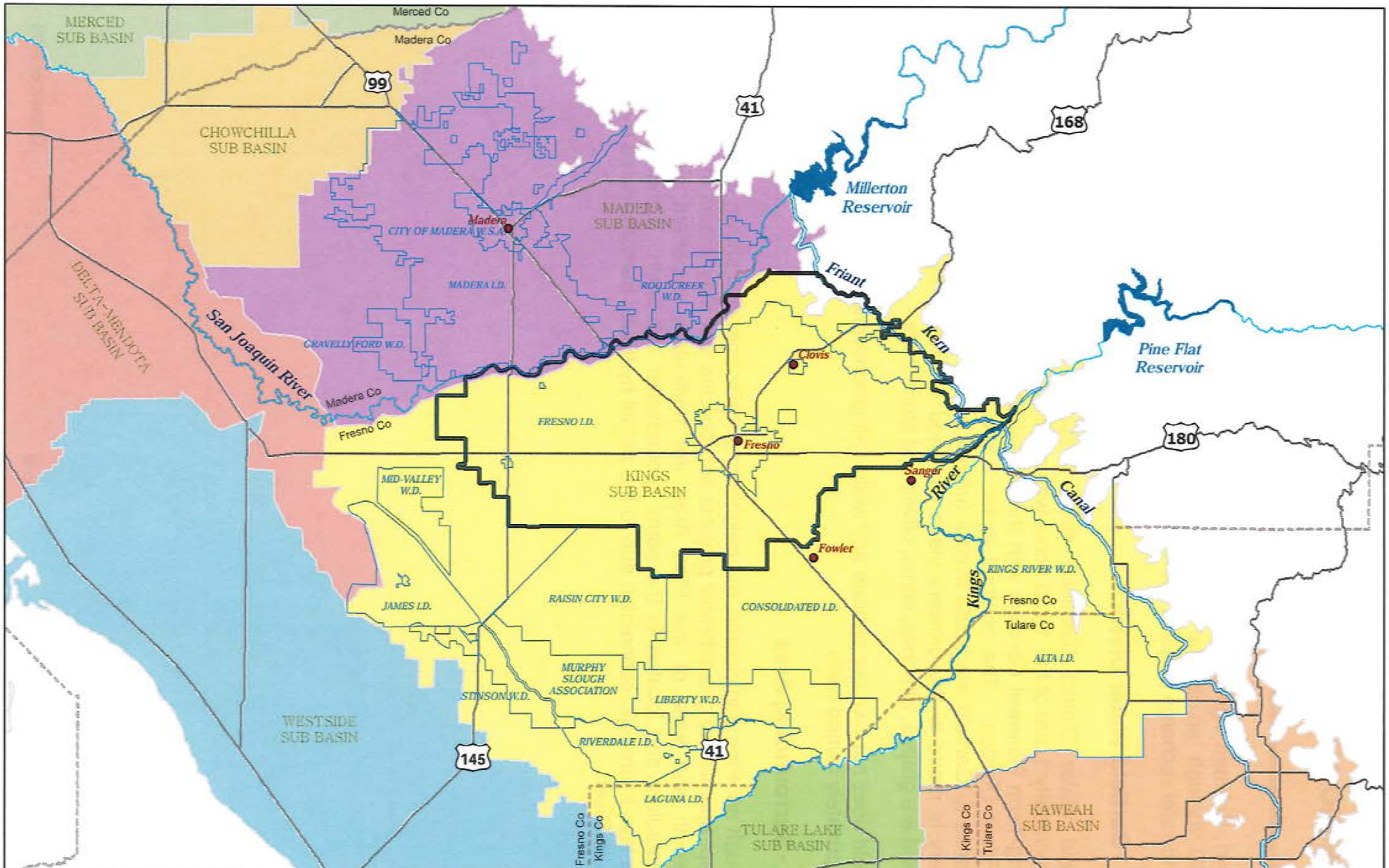

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Figure 2-2

Neighboring Agency Map

Fresno-Area Regional
Groundwater Management Plan

December, 2 ...\gis\Clients\FresnoID_1038\10380505\GMP_SurrAgencies.mxd

TABLE 2-1

FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN
SUMMARY OF PARTICIPANTS

Description	Fresno Irrigation District	Fresno County	City of Fresno	City of Clovis	City of Kerman	Malaga County Water District	Pinedale County Water District	Fresno Metro. Flood Control District	Bakman Water Company
Address	2907 South Maple, Fresno, CA, 93725	2220 Tulare St, 7th Floor, Fresno, CA 93721	1910 East University Ave., Fresno, CA 93703-2988	155 N. Sunnyside Ave. Clovis, CA 93611	850 S. Madera, Kerman, CA 93630	3580 S. Frank St., Fresno, CA 93725	480 W. Birch Avenue, Pinedale, CA 93650	5469 E. Olive Avenue, Fresno, CA 93727	PO Box 7965, Fresno, CA, 93747
Website	www.fresnoirrigation .com	www.co.fresno.ca.us	www.ci.fresno.ca.us	www.ci.clovis.ca.us	-	-	-	www.fresnofloodcontrol .org	www.bakmanwater.com
Gross Area (square miles)	387	6,016 (455 within Plan area)	103	19.8	2.5	2.3	1.7	400 (__ within Plan area)	2.4
Formation Date	1920	1856	1885	1912	1946	1965	1954	1956	1948
Population Served (1)			466,200	90,000	11,500	1,300			10,000
Water Users	Agriculture, Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban
Production Wells (2)	0	14	250	36	4	3	5	0	11
Groundwater Pumping - Volume (year)	0		54,000 MG (2003)	7,500 MG (2004)	990 MG (2004)	600 MG (2003)		None	1,270 MG (2003)
Primary Constituents of Concern		Nitrates, DBCP, radionuclides, EDB	Nitrate, arsenic, petro hydrocarbons, VOCs, DBCP, TCP	DBCP, nitrates, TCP	Uranium	Nitrate, DBCP	TCE	Various urban runoff contaminants	Nitrate, DBCP
Groundwater Level Monitoring Program	Y	Y	Y	Y	Y	Y	N	N	Y
Groundwater Quality Monitoring Program	N	Y	Y	Y	Y	Y	Y	Y (monitors storm water quality)	Y

(1) The 'Population Served' is the approximate population that the agency shown is provided.

(2) Only includes active wells owned and operated by the participant. Does not include private wells in the participant's area.

3 - GEOLOGY AND HYDROGEOLOGY OF THE FRESNO AREA

This section provides a brief summary of the geology, hydrogeology, and groundwater conditions in the Plan Area. For additional details refer to the reports listed in Section 10 - References.

3.1 - Geology

The largest geomorphic features in the Plan Area are two high fans deposited by the San Joaquin River and Kings River. A compound alluvial fan of intermittent streams between the two rivers also extends southwesterly from the northeast portion of the Plan Area. Unconsolidated alluvial deposits comprised of layers of cobbles, gravel, sand, silt and clay comprise the aquifer. Highly permeable, course-grained deposits of the ancestral San Joaquin and Kings Rivers underlie most of the area. These deposits comprise Quaternary age alluvium and the underlying Quaternary-Tertiary Continental deposits. These deposits are present above a depth of 350 to 400 feet below land surface and are tapped by most large-capacity wells in the area.
The Tertiary-Quaternary age continental deposits are composed mainly of the fine-grained sands, silts, and clays with some lenses of coarse-grained deposits. The thickness ranges from a feather edge in the east to more than 1,300 feet in the west. These deposits generally yield less groundwater to wells compared to the overlying more permeable deposits.

3.2 - Hydrogeologic Characteristics

<u>Groundwater Basin</u>
The Plan Area lies within the Kings Groundwater Sub-basin, which is located within the San Joaquin Basin Hydrologic Study Area (HSA). The Kings Sub-basin is also identified as sub-basin 5-22.08 of the Tulare Lake Hydrologic Region in the DWR Bulletin 118 updated in 2003. The Kings Sub-basin extends from the Sierra Nevada foothills on the east to the San Joaquin Valley trough on the west, and from the San Joaquin River on the north to roughly the Fresno County line on the south. Refer to Figure 1-1 for the location of each participant in relation to the Kings Sub-basin. The Kings sub-basin has been identified as critically overdrafted, as identified in DWR Bulletin 118-80.

<u>Aquifer Characteristics</u>
Most of the aquifer underlying the Plan Area is generally unconfined but may be semi-confined in some locations due to localized, fine-grained, low permeability layers. For much of the Plan Area there are no extensive low permeability units to isolate deep aquifers from shallow aquifers. At the west edge of the Plan Area, near the City of Kerman, there is an area underlain by the Corcoran Clay.

Groundwater Levels

Groundwater levels in the Plan Area range from about 10 feet to 400 feet below the ground surface. A large cone of depression under the Fresno/Clovis metropolitan area has developed. Figure 3-1 is a chart illustrating the decline in average water level in the Plan Area in recent years. Figure 3-2 shows hydrographs of selected wells within the Plan Area, showing the decline in groundwater levels for wells in the Fresno/Clovis metropolitan area since the 1950's. There is also a mound that has formed in the area of the Fresno-Clovis Regional Wastewater Treatment Facility located south and west of the City of Fresno.

Groundwater Movement

Historically, groundwater moved from northeast to southwest. More recently, the heavy municipal and agricultural pumping in the area has influenced the natural groundwater flow. The pumping cone of depression has caused the southwesterly flows to decrease and flows are generally deflected into the urban area. Figure 3-3 shows recent groundwater levels within the Plan Area.

Transmissivity

The ability of an aquifer to transmit groundwater is measured by its transmissivity. Transmissivity is defined as the quantity of groundwater that would move through a one-foot-wide section of the total thickness of the aquifer under a unit hydraulic gradient. Transmissivity in the Plan Area is spatially distributed with the highest transmissivity in the northwest. Well yields are higher in the northwestern and southwestern portions of the Plan Area. The well yields in the northeast are limited because a thinner aquifer is present above bedrock.

Specific Yield

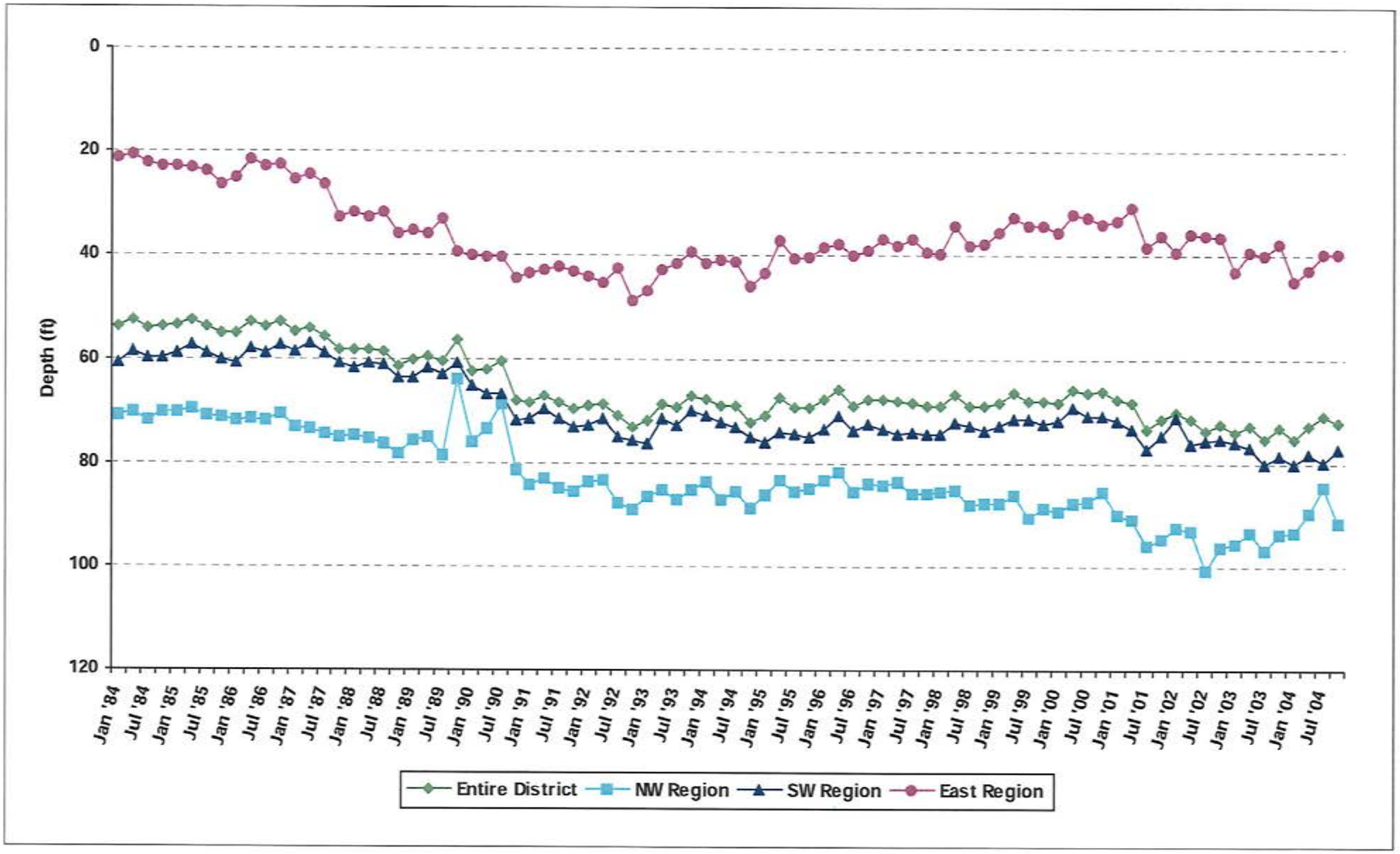
The ability of an aquifer to store groundwater is measured by its specific yield. Specific yield is defined as the quantity of groundwater that could be extracted from a unit volume of aquifer per unit decline in water level. The specific yield of an aquifer is important for evaluating the response of an aquifer to pumping. For example, if the specific yield is known, analysis of well hydrographs can be used to monitor the quantity of groundwater in storage in the reservoir. Estimates of specific yield of the older alluvium range from 0.15 to 0.20. Average values for the underlying continental deposits are estimated to range from 0.07 to 0.12.

Groundwater Development

The most favorable subsurface geologic conditions for the future development of groundwater are in the northwest Fresno area. Subsurface geologic conditions limit groundwater development in the northeast because of shallow bedrock north and northeast of Clovis and the predominance of fine-grained deposits at depth beneath these areas.

Fresno Irrigation District Regional Quarterly Weighted Average Depth To Groundwater

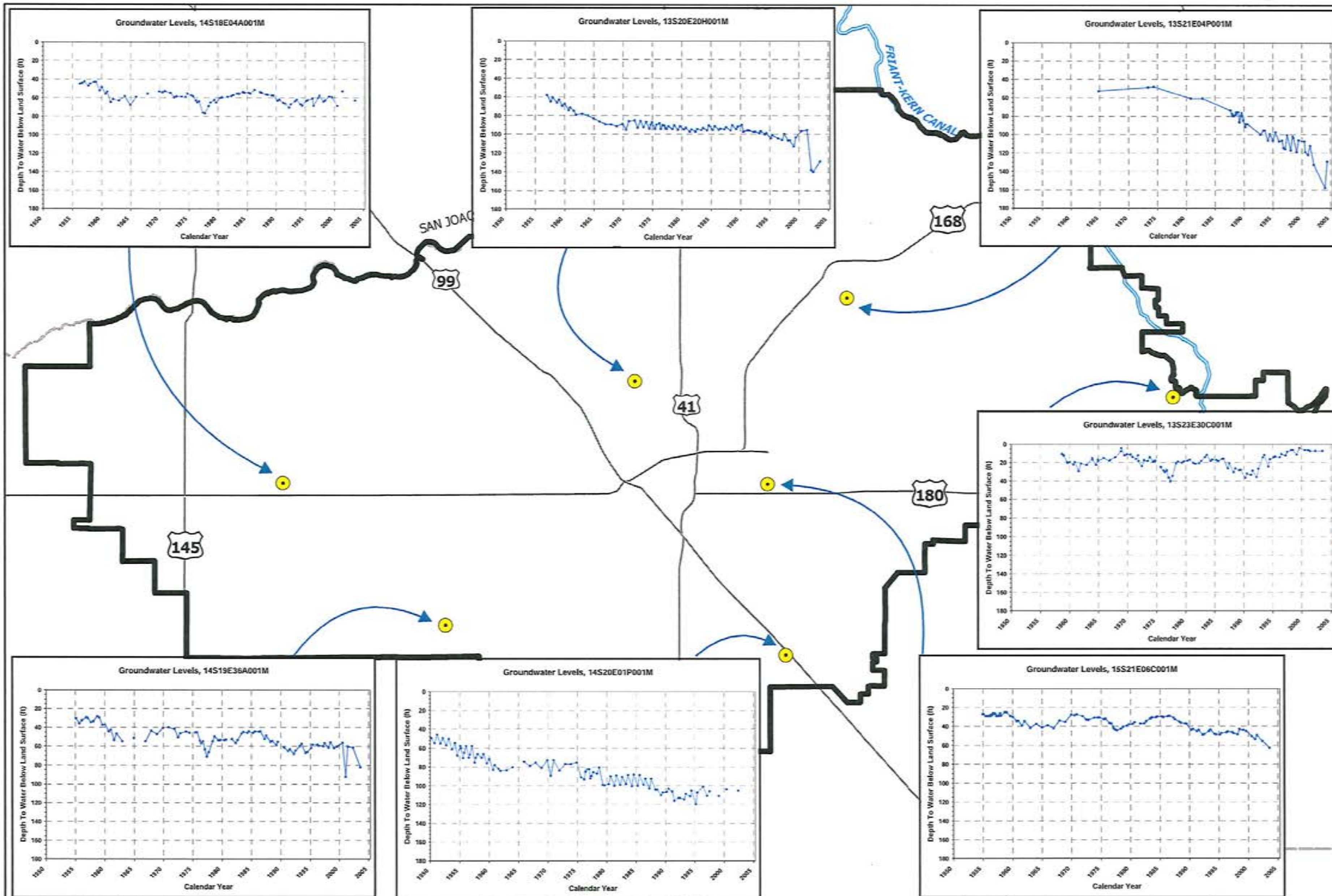
1/1/1984 To 10/1/2004



Printed On: 11/11/2005

*NW Region is north of Belmont Ave, west of Fowler Ave
*SW Region is south of Belmont Ave, west of Fowler Ave
*East Region is east of Fowler Ave

Figure 3-1

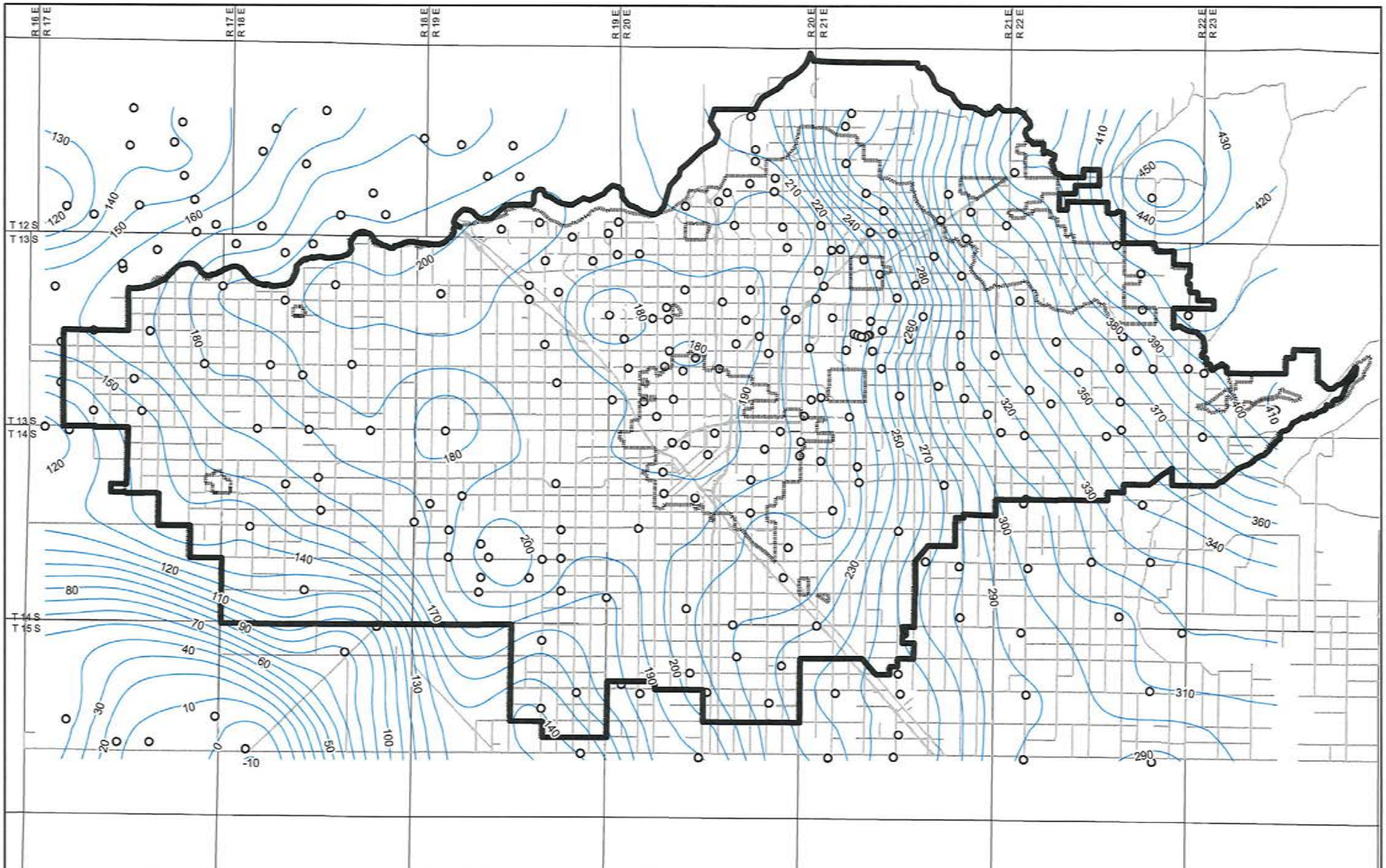


PROVOST & PRITCHARD ENGINEERING GROUP
286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700

Figure 3-2

Well Hydrographs

Fresno-Area Regional
Groundwater Management Plan



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January 2005 Water Surface Elevation
10 Foot Lines of Equal Elevation

Figure 3-3

FID Annual Groundwater Report
Water Surface Elevation Contours

Fresno-Area Regional
Groundwater Management Plan

December, 20 ington\gis\Clients\FresnoID_1038\10380505\GMP_Contours.mxd

Intentional Recharge

Subsurface geologic conditions are favorable for intentional recharge basins beneath the much of the Plan Area. Conditions are less favorable beneath part of the northeast portions of the Plan Area because of the restricting layers above the water table.

Substantial operational information on average infiltration rates is available from stormwater management basins managed by the Fresno Metropolitan Flood Control District. Typical infiltration rates range from about one-third to one-half foot per day. Much of this water is observed to move laterally in highly permeable deposits.

3.3 - Groundwater Conditions within the Plan Area

A combination of surface water supplies and groundwater pumping are used to satisfy the water demands of the area. In agricultural areas, the difference between surface deliveries and the agricultural crop requirements is met by supplemental groundwater pumping almost exclusively by private individual landowners. For many years, all municipal and industrial demands were met entirely from groundwater pumping. However, both the City of Clovis and City of Fresno have recently begun operation of surface water treatment plants.

The Plan participants have long recognized the importance of preserving and maximizing groundwater supplies within its boundaries. Some participants have actively facilitated groundwater recharge and groundwater banking, and have engaged in indirect or "in lieu' recharge programs by delivering surplus surface water whenever possible to minimize groundwater extractions.

Water level measurements taken within the Plan Area show a continued downward trend in the groundwater elevations.

Some areas within the Plan Area's service area suffer from groundwater quality degradation, particularly where the groundwater is used as a potable water supply. Some areas have identified "plumes" of contamination resulting from discharges of industrial or agricultural contaminants, and in some instances groundwater quality has been degraded to below that required by applicable regulatory standards. While most groundwater within the Plan Area is still of acceptable quality, these contamination plumes could spread if not properly managed and controlled.

3.4 - Historic Groundwater Monitoring Programs

Several groundwater studies of the Plan Area have been performed since 1930. These studies are conveniently summarized in the *Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County* (1986) prepared in a cooperative effort by the County of Fresno, the Cities of Clovis and Fresno, the Fresno Irrigation

District, and the Fresno Metropolitan Flood Control District. Most of these studies focused on water quality with the remainder focusing on groundwater levels and storage. Geologic and hydrogeologic information for the Plan Area is described in the U.S.G.S. Open File Report, *Geology, Hydrogeology & Water Quality in the Fresno Area, California* (Page & LeBlanc, 1969).

Groundwater Levels

A groundwater-level monitoring program was developed when FID was formed in 1920. The program included monthly and quarterly measurement of wells within FID. As more farmers installed wells, FID began to use additional wells for measuring water levels. The water level measurement program has been maintained since 1920 and covers the vast majority of the Plan Area. FID began to store and organize water level data in a database in 1995, and has prepared annual Groundwater Reports for many years.

In the early 1970's the DWR completed a study of the aquifer underlying FID to determine the specific yields and available storage in the aquifer by township and range. FID has incorporated this information into its quarterly groundwater reports so that changes in storage are calculated.

Groundwater Quality

Extensive groundwater-quality testing has been performed by various agencies in the Plan Area. Since the 1960's, testing for general chemical, trace mineral, and inorganic substances has been routinely performed on a large number of the community wells located in the Fresno/Clovis metropolitan area.

The available water quality data is voluminous and therefore is not presented in this Plan. The reader is referred to specific Plan participants if they seek water quality data.

In the *Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County* (1986) water quality was evaluated through research and assimilation of all available data, and the collection and analyses of water samples where additional data was needed. Documentary evidence of water quality held by the California Department of Health Services (DHS), Regional Water Quality Control Board (RWQCB), Department of Water Resources (DWR), Fresno County Health Departments Environmental Health System (EHS), and other agencies and municipalities were examined along with a historical review of pertinent literature. In addition, data developed from water quality hydrographs were grouped and evaluated in the report. Since 1986, a vast quantity of additional water quality data has been collected by the aforementioned agencies and the Plan participants.

Land Subsidence and Groundwater Impacts on Surface Water Flow and Quality

The Plan participants have not historically monitored land subsidence and groundwater impacts on surface water flow and quality. Refer to sections 6.4 and 6.5 for more information on these topics, respectively.

4 - REGIONAL GROUNDWATER MANAGEMENT OBJECTIVES

The Plan Area is, and will continue to be, dependent on groundwater as a significant water supply source. The Plan objectives have been developed to monitor, protect and sustain groundwater within the region. These objectives of the Fresno-Area Regional Groundwater Management Plan include:

1. Preserve and enhance the existing quality of the area's groundwater.
2. Correct the overdraft and stabilize groundwater levels at the highest practical beneficial levels.
3. Preserve untreated groundwater as the primary source of domestic water.
4. Maximize the available water supply, including conjunctive use of surface water and groundwater.
5. Conserve the water resource for long-term beneficial use and to assure an adequate supply for the future.
6. Manage groundwater resources to the extent necessary to ensure reasonable, beneficial, and continued use of the resource.
7. Monitor groundwater quality and quantity to provide the requisite information for establishing groundwater policies, goals, and recommended actions.
8. Improve coordination and consistency amongst agencies responsible for the monitoring and management of groundwater in the Plan Area.

The proposed actions identified within each of the sections of this Plan are intended to help accomplish these Plan objectives.

5 - STAKEHOLDER INVOLVEMENT

5.1 - Advisory Committee of Stakeholders

The Technical Advisory Committee (TAC) was formed to guide the development and implementation of this Plan. The TAC includes landowners and representatives from each party participating in the plan. In October 2005, the TAC members include:

- Dale Stanton, Assistant General Manager, Fresno Irrigation District
- Bill Stretch, District Engineer, Fresno Irrigation District
- Lon Martin, Water Division Manager, City of Fresno
- Brock Buche, Water Division, City of Fresno
- Lisa Koehn, Assistant Public Utilities Director, City of Clovis
- Alan Weaver, Public Works Director, County of Fresno
- Phil Desatoff, Geologist, County of Fresno
- Jerry Lakeman, Fresno Metropolitan Flood Control District
- Alan Jacobsen, Public Works Director, City of Kerman
- Tim Bakman, Bakman Water Company
- Russ Holcomb, General Manager, Malaga County Water District
- John Garcia, General Manager, Pinedale County Water District
- Richard Carstens, Landowner in Fresno Irrigation District
- Chris Palmer, Landowner in Fresno Irrigation District

The TAC ensures representation from a broad spectrum of interests including public agencies, private utilities, local landowners, agricultural water purveyors, urban water purveyors, and special districts.

Planned Activities

A TAC will meet semi-annually or more frequently if deemed appropriate. The Committee will have the following responsibilities:

- Review trends in groundwater levels and groundwater quality;
- Evaluate the effectiveness of current groundwater management policies and facilities;
- Discuss the need for new groundwater management policies and procedures;
- Discuss the need for new groundwater supply/enhancement facilities;
- Evaluate the progress of on-going groundwater related projects;
- Assess the overall progress in implementing the programs outlined in the Groundwater Management Plan;
- Recommend updates or amendments to the Groundwater Management Plan;
- Identify regional and multi-party groundwater projects;
- Identify and share information on funding opportunities for groundwater projects;
- Share new ideas and methods for managing groundwater;

- Update Plan participants on the efforts of other regional groups; and
- Review and comment on the Annual Groundwater Report.

5.2 - Relationships with Other Agencies

The participants have been and continue to be involved in many programs, studies and committees that include groundwater related items in this Plan as part of their focus or charge. The Participants will continue to be involved in these efforts. A summary of some of these efforts is included here.

1986 Water Resources Management Plan

As described in the 1986 Water Resources Management Plan (1986 Plan), the Fresno Irrigation District (FID), City of Fresno (Fresno), the City of Clovis (Clovis), the County of Fresno (County), and the Fresno Metropolitan Flood Control District (FMFCD) have partnered in a cooperative effort to develop and implement a comprehensive surface and groundwater management program consistent with the Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County. The 1986 Plan, prepared with a grant from the Environmental Protection Agency (EPA) under Section 205j of the Clean Water Act, is a water quality and quantity project to plan for the preservation and enhancement of the area water supply.

Fresno/Clovis Area Recharge Program

The five agencies have entered into a Master Agreement for management of water quality and quantity for the area. The main thrust of the program involves using the FID's delivery system to deliver portions of the Fresno and Clovis water allocations to certain FMFCD basins for recharge during the summer when the basins are not needed to control urban storm runoff. Fresno and Clovis both own and operate significant recharge facilities to which a portion of the cities' water allocations is also delivered using the FID's system. This program also contains elements designed to protect the quality of groundwater in the area.

Integrated Storage Investigation Program

Other basin wide groundwater management efforts include a Memorandum of Understanding (MOU) with the Department of Water Resources entered into on May 24, 2001, as part of the Integrated Storage Investigation (ISI) program. The MOU between DWR, the Kings River Conservation District, Alta Irrigation District, Consolidated Irrigation District and Fresno Irrigation District, formed a cooperative effort amongst the agencies to review and investigate groundwater conjunctive use efforts on the Upper Kings Basin. During the formation of this program, the Kings Basin Advisory Panel was formed to include the basin stakeholders. The primary goal of the Basin Advisory Panel is "to stabilize groundwater in the Upper Kings Basin by halting, and ultimately reversing, the current overdraft of the groundwater aquifer."

Upper Kings Water Forum
Several of the participants to this Plan are actively involved with the Upper Kings Water Forum. Specifically, the City of Fresno, City of Clovis, County of Fresno, and FID have been involved. Representatives from FID serve on the Upper Kings Forum Planning and Steering Committee. The purpose of the forum has been to develop an Integrated Regional Water Management Plan with assistance from State funding. The forum has also sought funding for construction, or implementation, projects within the region, including projects for the City of Clovis and FID. This Fresno-Area Regional Groundwater Management Plan will be incorporated into the Upper Kings Forum Integrated Regional Water Management Plan.

Water and Groundwater Associations
All of the plan participants are active in the groundwater community. Table 5-1 is a matrix illustrating the many water and groundwater related organizations that each participant belongs to. Many participants hold memberships in similar organizations, which increase opportunities for groundwater management coordination and the sharing of ideas.

Planned Activities

- Continue involvement with existing regional programs including the Fresno/Clovis Area Recharge Program, Integrated Storage Investigation Program, and Upper Kings Water Forum.
- Participate in newly formed regional groups that would complement this Plan.

5.3 - Plan to Involve the Public and Non-Participating Agencies

Water purveyors that are within the Plan boundary, but are not participating, include:

- Biola Community Service District
- Easton Community Service District
- International Water District

Each of these member agencies was invited to be a participating agency to the Plan, but could not financially participate. A copy of the draft Plan was sent directly to these agencies for review and comment. The Plan participants would welcome the participation of these and other agencies in the Plan Area, and they will have the opportunity to join the Plan in the future.

Input from neighboring agencies and interested parties was also solicited during this Plan's preparation.

Existing Activities

- Conducted public workshops regarding the Plan prior to adoption.
- Solicited input from neighboring agencies including Biola Community Service District, Easton Community Service District and International Water District.

Planned Activities

- Allow for agencies within the Plan Area to be incorporated into the Plan.
- Publish annual groundwater reports for distribution to stakeholders and interested parties. Notify the public of the availability of the annual report for their review on websites and newsletters.
- Publish information on the accomplishment of the regional group on websites and newsletters.

TABLE 5-1

FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN
MEMBERSHIPS IN WATER-RELATED ORGANIZATIONS

Organization	Fresno Irrigation District	County of Fresno	City of Fresno	City of Clovis	City of Kerman	Malaga County Water District	Pinedale County Water District	Fresno Metro. Flood Control District	Bakman Water Company
Agricultural Water Management Council	●								
American Public Works Association		●	●	●	●			●	
American Water Works Association			●	●	●				
Association of California Water Agencies	●		●			●	●	●	
Association of Metropolitan Water Agencies	●	●	●	●		●	●	●	●
California Rural Water Association					●				
California Storm Water Quality Association								●	
California Urban Water Conservation Council			●			●			
California Water Awareness Campaign			●	●	●			●	●
Central Valley Project Association			●						
Central Valley Water Awareness Committee	●	●	●	●		●		●	●
Central Valley Water Education Center	●	●	●	●					
Fresno-Area Groundwater Management Group	●	●	●	●	●	●	●	●	●
Fresno County Water Advisory Committee				●					●
Fresno/Clovis Area Recharge Program	●		●	●				●	
Kings River Water Association	●								
National Association of Flood and Stormwater Management Agencies								●	
Waldron Pond Group	●			●					
Water Education Foundation			●	●				●	●

6 - MONITORING PROGRAM

A groundwater level and quality monitoring program is a critical component for documenting and evaluating groundwater conditions within the Plan Area. There is a need for a coordinated and consistent level and quality data collection method within the Plan Area as there is not currently a complete groundwater data management system for the Plan Area. The County of Fresno has planned to develop a database management system, but insufficient funding has delayed its development. The cooperative effort through this Plan will help spread some of the financial burden to multiple agencies. The program shall include groundwater level, quality monitoring, as well as any indication of land subsidence. To ensure the integrity and consistency of the data, protocols for collecting and reporting the data are needed, and must be implemented by each agency. The proposed monitoring program is intended to:

1. Provide warning of potential future problems.
2. Use data gathered to generate information for water resources evaluation.
3. Develop meaningful long-term trends in groundwater characteristics.
4. Provide data comparable from place to place in the plan area.
5. Better characterize the quality of well water in the plan area.

6.1 - Groundwater Level Monitoring

Many of the participants routinely perform groundwater level and quality monitoring in accordance with agency standards and State regulations for water purveyors, however the frequency and method for monitoring varies by participant. FID currently collects well water level readings within most of the Plan Area, but the system only includes a few wells in some areas and has very little water quality information. FID developed a groundwater-monitoring program, when it was formed in 1920, to quantify changes in groundwater depth within the District. FID currently collects water level measurements each quarter, and also compiles water level data that is collected yearly from other agencies. Each agency's water-level measuring-program was established separately and the data are managed separately, but FID compiles all the data into a single database. Other agencies from which FID receives groundwater level data include:

- City of Fresno
- City of Clovis
- Consolidated Irrigation District
- Madera Irrigation District
- James Irrigation District
- Malaga County Water District
- California Department of Water Resources

The County of Fresno no longer collects groundwater level data outside of its CSAs or WWDs. Some of the water purveyors, such as Kerman and the City of Fresno, have a water level measurement device in many wells connected to their SCADA systems. Other water purveyors such as Pinedale County Water District do not routinely record groundwater levels. FID and the City of Clovis monitor wells near their recharge facilities. The City of Fresno has several triple completion monitor wells near existing well sites that are monitored, however there are no monitor wells in or around recharge basin facilities that are used to evaluate groundwater recharge effects. A map of the domestic production and monitor wells that are frequently monitored for water level is included as Figure 6-1.

Existing Activities

- Individual monitoring by some participants with limited data sharing.
- Encourage landowners and developers to convert unused wells to monitor wells.

Planned Actions

- Develop a groundwater level monitoring program for the entire Plan Area. This will be accomplished by performing an inventory of monitoring efforts, finding gaps in the data, and adding wells to monitor in gap areas. Well driller's reports or monitored wells will be compared to identify each well's perforation depth.
- Decide on months for water level measurements to be taken so they are consistent for all parties.
- Survey the elevations for all wellheads and use a common survey datum.
- Protect wells in monitoring program from being abandoned.
- Develop Groundwater Database in accordance with 1986 Water Resources Master Plan and Fresno County Ordinance.
- Develop and use standard forms by all participants.
- Develop program for sharing data.

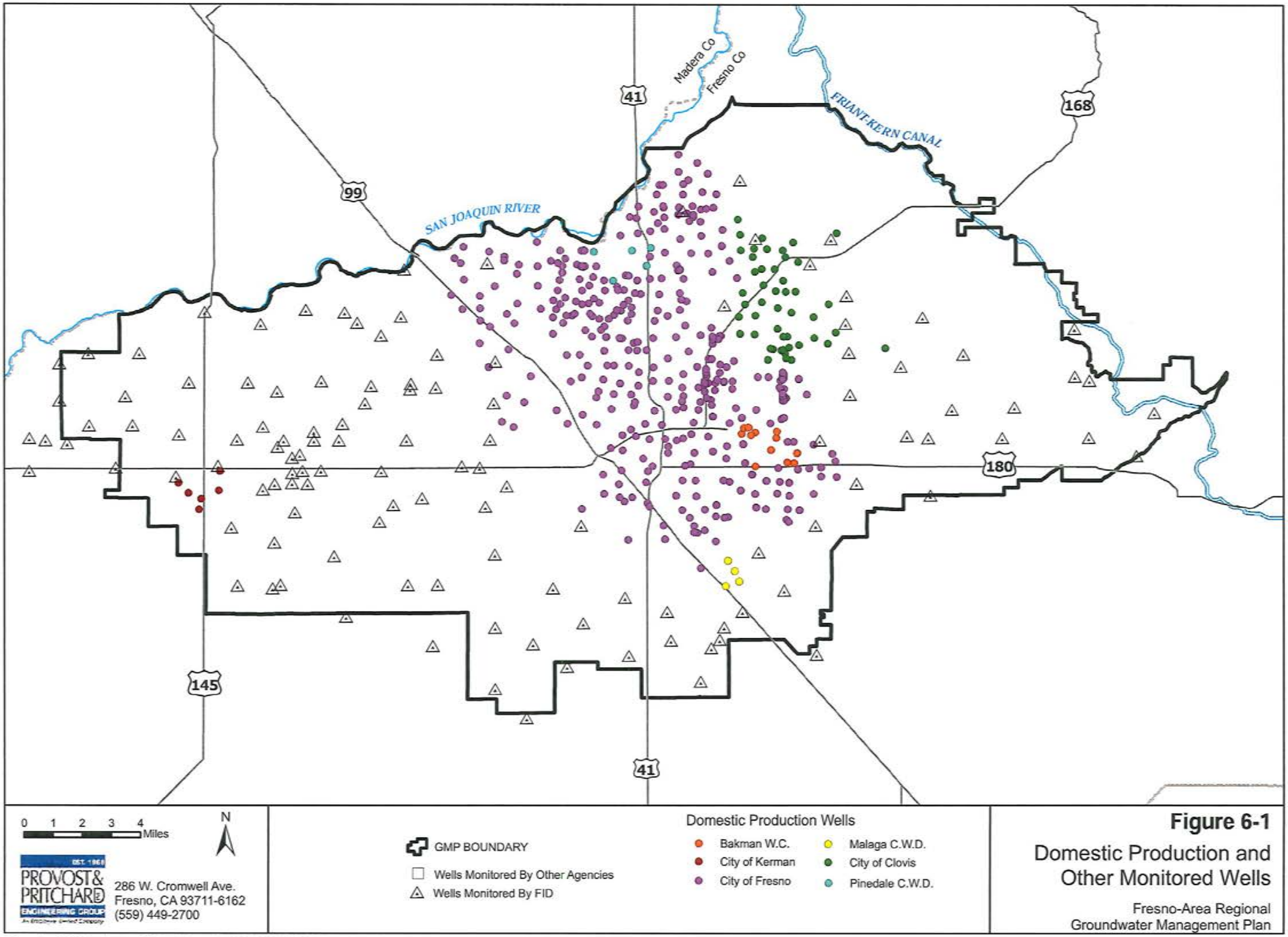

Figure 6-1
Domestic Production and Other Monitored Wells

Fresno-Area Regional Groundwater Management Plan

December, 2005 \\huntington\gis\Clients\FresnoID_1038\10380505\GMP_DomProdWells.mxd

6.2 - Groundwater Quality Monitoring

Groundwater within the Plan Area is generally of good quality, however there are some specific areas of concern. Primary contaminants within these areas of concern are nitrates, Dibromo-Chloropropane (DBCP), and TCE. The domestic water purveyors within the Plan Area perform routine water quality monitoring as required by the State Department of Health Services. The requirements for testing are based on the size of the community system. Additional testing is performed at individual sites for specific constituents of concern. Additional water quality testing is needed to update various plumes that have been identified within the area. In addition, there are many locations within the Plan Area where little to no water quality monitoring is performed. Outside of the boundaries of the domestic water purveyors, the County of Fresno will perform basic water quality monitoring for individual wells, however, the City of Fresno recently completed a study of nitrate in wells in the southeast portion of the Plan Area. The City of Fresno has also recently studied nitrate in wells near the Wastewater Treatment Facility.

The following contaminant plumes are found within the City of Fresno's borders:

- Purity Oil plume
- Fresno landfill
- TCE Pinedale groundwater site
- FMC plume
- Salt Plume
- THAN plume
- Old Hammer Field plume
- Weir Floway plume

Most of the groundwater contaminants in the Fresno area are being addressed by responsible parties through assessment and remediation, and some are in advanced stages of mitigation. The responsible parties of many of the point source contaminants (i.e. hydrocarbons and VOCs) are working with state (Regional Water quality Control Board, Department of Toxic Substances Control) and local (FCEHD) agencies to remediate the contaminants. Area wide contaminants are being addressed via wellhead treatment (DBCP) and plans are underway to address others, such as nitrate.

The groundwater quality beneath portions of the City of Fresno is compromised by a number of inorganic and organic chemical contaminants. The inorganic contaminants include chloride, nitrate, arsenic, manganese and chromium. Organic contaminants include petroleum hydrocarbons and MTBE, volatile organic compounds (VOCs), DBCP and other pesticides, and trichloropropane (TCP). The sources of these contaminants are primarily anthropogenic and include industrial facilities, fuel storage and dispensing sites, agricultural applications, septic systems, and food processing facilities.

Management of these plumes is a key issue that the City of Fresno has historically focused on and will continue to address.

The Fresno Irrigation District does not have specific water quality requirements since they only supply agricultural water. However, they are cognizant of recommended water requirements for crops and use these as guidelines when evaluating water quality.

Existing Activities

- Routine water quality monitoring and reporting by domestic water purveyors as required by DHS.
- County offers free water quality testing to individual landowners outside of a community system. This data is either not retained or not readily available.
- Monitor sediment in recharge/flood control basins according to FMFCD's Standard Operating Procedures for Monitoring, Maintaining and Disposal of Stormwater Basin Sediment.

Planned Actions

- Develop a coordinated monitoring program by methods similar to groundwater level monitoring evaluation; inventory existing efforts, find gaps in data monitoring, then add wells to monitor in gap areas. Critical to this effort will be an understanding of perforation intervals within each well to identify the depth of the various constituents of concern.
- Protect wells in monitoring program from being abandoned.
- Develop program for sharing data to participants.
- Improve access to County individual water quality testing information.
- Prepare groundwater quality maps on a periodic basis with the aid of a qualified hydrogeologist.

6.3 - Monitoring Protocols

Monitoring protocols are necessary to ensure consistency in monitoring efforts and consistency is required for monitoring evaluations to be valid. Consistency should be reflected in factors such as location and reference elevation at sample points, sampling procedures, testing procedures, time of year and frequency of sample collection. Without such common ground, comparisons between and among reports must be carefully considered. Consequently, more uniform data gathering procedures are proposed in order to increase the reliability of analyses. Specific protocols for water level and water quality monitoring are discussed below.

General protocols that will be used for the groundwater level-measuring program include:

- Perform all water level measurements in as short a period as possible.

- Perform year-to-year measurements at the same time of the year.
- Document the measurement reference point for each well as well as the measuring device and calibration date for the measuring device.
- Document the date and time of each measurement.
- Test each well twice, or more if needed, until consistent results are obtained.
- If there is reason to suspect groundwater contamination, water level measuring equipment will be decontaminated, and in general, measurements will proceed from the least to the most contaminated wells. Also use standardized decontamination procedures.
- Landowners will be contacted for permission to access their property prior to any fieldwork.

The water-quality monitoring protocols may include the following for existing and future monitoring efforts:

- Adequate pumping time prior to sample collection with documentation of stabilized parameters.
- Proper sample containers, preservatives, and holding times.
- Secure chain-of-custody procedures.
- Testing will only be performed at accredited, state-certified laboratories that use proper quality control and quality assurance procedures.
- All samples will be given a quality assurance code, which represents the relative confidence in the water sample.
- Some testing will include spiked, duplicate and field-blank samples for comparison to genuine samples.
- Proper handling procedures (e.g. placing the containers in an ice chest immediately after collection).
- Documentation of all protocols and procedures that are used.
- Uniform time of year for sampling (during periods of both minimal pumping in the winter and heavy pumping in July and August).
- Document the name, contact information, and qualifications of the individuals taking measurements.
- Landowners will be contacted for permission to access their property prior to any fieldwork.

These protocols, and any new protocols that are adopted, will be documented in future Annual Groundwater Reports.

Existing Activities

- Annual calibration of water level measurement transmitters by some agencies
- Use of well sounder for measurement.
- Conduct water quality testing in accordance with DHS and EPA requirements and testing procedures.

Planned Actions

- Collect and compare monitoring protocols from all of the Plan participants. Develop standard regional protocols for water level and water quality monitoring.
- Develop standardized form for collection of data.

6.4 - Land Surface Subsidence Monitoring

No information is available on historic land subsidence in the area. The area may have experienced land subsidence in the early 1900's when it was prevalent in the San Joaquin valley. However, no significant land subsidence is known to have occurred in the last 50 years as a result of land development, water resources development, groundwater pumping, or oil drilling. Lands within the Plan Area will be observed for land subsidence, and, if land subsidence becomes a problem, this Plan will be amended to include preventive and mitigative measures for land subsidence. A Global Position System (GPS) control network has been established throughout the Plan Area. This control network consists of more than twenty control points that are tied to the High Precision Grid Network (HPGN), and the vertical datum is North American Vertical Datum 1988 (NAVD 88). This control network can be utilized to survey existing local benchmarks to monitor subsidence.

Existing Activities

- Established GPS Control Network throughout the Plan Area.

Planned Actions

- Periodic resurvey of control points and local benchmarks for land subsidence.

6.5 - Surface Water Monitoring

Within the Plan Area, large areas of agriculture lands that formerly were irrigated with surface water have been urbanized. Much of these urbanized lands rely solely on groundwater for water supply. Surface water is delivered to the outlying agricultural area, stormwater and recharge basins, and some landscaped areas. While a portion of the historically delivered surface water is routed to recharge basins, it was not until 2004, that the cities of Fresno and Clovis were able to utilize surface water through newly constructed surface water treatment facilities. The location of surface water deliveries within the Plan Area has had an impact on groundwater levels as shown in Figure 3-2. FID maintains daily surface water delivery records, and compares surface water delivered within its boundary to groundwater level changes.

Surface water flows can impact groundwater levels and groundwater quality if the two water sources are hydrologically connected. In addition, pumping may also affect nearby surface water rights if the surface supplies are hydrologically connected to the groundwater. Much of the east-side stream flow water enters into the FID canal system for delivery to FMFCD and FID basins. FMFCD monitors surface water flows in portions of its boundary.

Changes to surface water quality can also affect groundwater quality by changing the quality of water that seeps from a stream. FID has not performed any water quality monitoring of stream flows entering FID. The water quality of the streams is monitored by other agencies and has historically been found to be of good quality. Between 85% and 90% of the water recharged in the FID is imported water. When importing water for recharge, the FID considers not just the cost but also the quality of the water to be recharged. The Participants will likewise be cognizant of water quality issues on streams in the Plan Area and address water quality issues if they arise.

Existing Activities

- FID reports surface water delivered within Plan Area and compares to groundwater level changes in annual report.
- Monitoring of surface water quality at Fresno and Clovis Surface Water Treatment Plants, as well as along conveyance system to Plants.
- Monitor quality of reclaimed water pumped to FID Canals from wells at the Wastewater Plant.

Planned Actions

- Continue monitoring of surface water deliveries within Plan Area.
- Prepare updated water budget for the City of Fresno and Clovis.
- Prepare water budget for the Plan Area based on annual monitoring program.

7 - GROUNDWATER RESOURCES PROTECTION

7.1 - Well Destruction

Proper destruction of abandoned wells is necessary to protect groundwater resources and public safety. Improperly destroyed wells can provide a conduit for surface or near-surface contaminants to reach the groundwater. In addition, undesired mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

The administration of a well construction, abandonment and destruction program has been delegated to the Counties by the State legislature. Accordingly, Fresno County has adopted a permitting program consistent with DWR Bulletin 74-81 for well abandonment and destruction. The City of Fresno also has a permit program for well destruction.

The Participants have and will continue to properly destroy any of their wells that are no longer utilized, and will enforce proper well destruction procedures for all private wells. In addition, the Participants will encourage landowners and developers to convert unusable wells to monitor wells, rather than destroy them, so that they can become a part of the Participants' groundwater monitoring program.

Existing Activities

- The Plan participants destroy wells according to City of Fresno, Fresno County or State of California standards.
- Clovis and Fresno require no longer used residential wells within the City to be properly destroyed.

Planned Actions

- Improve enforcement and consistency of well destruction policies; currently wells are not usually destroyed until the land is sold or the land use changes.
- Identify and map the locations of wells requiring proper destruction in the Plan Area.
- Maintain records on all well destruction performed in the Plan Area.

7.2 - Well Construction Policies

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. Fresno County has adopted a well construction permitting program consistent with Department of Water Resources Bulletin 74-81 to assure proper construction of groundwater wells within the County. Other Plan participants have adopted similar permitting programs and standards.

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 7.3 – Wellhead Protection.

Some participants construct monitor wells to monitor water levels and water quality. Proper construction of monitor wells is essential to ensure their reliability and longevity. Important items to consider for a properly drilled monitor well include (1) method of drilling, (2) casing type and diameter, (3) perforations or well screen, (4) gravel pack, (5) annular seal, and (6) well development. As a general rule, monitor wells should be placed immediately upgradient and downgradient of a waste discharge site. After the monitor well is developed an aquifer test is recommended. Care should be taken to drill monitor wells deep enough so they won't go dry during summer months or drought periods; however, they should not be drilled so deep as to make monitoring of the shallowest strata difficult. Historical water level fluctuations should be examined to determine the magnitude of fluctuations to be expected in the future.

Existing Activities

- Wells are constructed according to State of California standards and may be further modified to meet site-specific requirements to accommodate a unique geologic setting in the local area.
- Records are maintained for all new wells drilled in the Plan Area.

Planned Actions

- Share well construction results in a 'Lessons Learned' format from water wells constructed in the Plan Area to share experiences among the Plan participants, and prevent common and recurring mistakes.

7.3 - 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 wellhead. 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.

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 7.1.

Wellhead Protection Guidelines

Wells constructed by the Participants will be designed and constructed in accordance with DWR Bulletin 74-81. In addition, the Participants will encourage landowners to follow the same standard for privately owned wells. DWR Bulletin 74-81 provides specifications pertaining to wellhead protection, including:

- 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 wellhead.
- Setback 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." Wells are randomly spaced throughout the whole Plan Area. Therefore, the entire Plan Area is treated as a wellhead protection area.

Existing Activities

- Wellhead protection is performed according to DWR guidelines.

Planned Actions

- Identify and properly modify all public wells lacking adequate wellhead protection.

7.4 - Saline Water Intrusion

Saline water intrusion is not currently an identified problem in the Plan Area. The Plan Area is not located within or near large saline water bodies such as the ocean, saline inland lakes, or the saline deep aquifer on the Westside of the San Joaquin Valley. In addition, the Participants strive to prevent the importation of saline surface waters that could ultimately degrade the groundwater. When alternative water sources are available for importation, the Participants consider not only the cost but also the quality, including salinity, of the water. The Participants will monitor water quality in a manner that provides management information about salinity in the area. Should saline intrusion become a problem in the future, a Plan amendment will be prepared.

Existing Activities

- None

Planned Actions

- See Groundwater Quality Monitoring Program.

7.5 - Migration of Contaminated Groundwater

Groundwater contamination can be human induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairies, pesticide applications, septic tanks, industrial sources, stormwater runoff, and disposal sites. Groundwater within the Plan Area is generally of excellent quality for agricultural use. However, serious water quality problems in the southern and eastern portions of the Plan Area occur due to high concentrations of nitrate and DBCP. The presence of DBCP is primarily due to former pesticide application to the surrounding farmland.

The City of Fresno Nitrate Management Plan project, nearing completion, has yielded 20 to 30 viable projects of various types including blending, intentional recharge, removal of nitrate sources, treatment for nitrate reduction, and exchange of high nitrate water with lower nitrate surface water that can be used for recharge. All of these projects will be compared, ranked for effectiveness, and placed into service as appropriate over the next several years.

Information on existing contaminant plumes is voluminous, particularly for those plumes that have been assessed and are in various stages of remediation. Therefore, information on the plumes is not provided here.

Existing Activities

- Regularly review data and reports from regulatory agencies on contaminant plumes to provide warning of potential future problems.
- Report groundwater contamination to the appropriate regulatory agencies, including the Regional Water Quality Control Board and Department of Toxic Substances Control.

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.
- Update maps for all contaminant plumes in the Plan Area.
- Implement some of the viable projects identified in the City of Fresno Nitrate Management Plan to control and reduce nitrate levels in the groundwater.

7.6 - Groundwater Quality Protection

The Fresno groundwater basin has been designated as a Sole Source Aquifer as authorized by Section 14246 of the Federal Safe Drinking Water Act of 1974. The designation, made by EPA in 1978, means the Fresno metropolitan area is dependent on a single source of groundwater and that source must be protected from potential contamination. This designation emphasizes the importance of protecting groundwater quality in the Plan Area. Groundwater comprises the majority of water used in the Plan Area; consequently pollution prevention is a cardinal component of this GMP. Groundwater quality can be protected through stormwater quality management, septic system management, and water vulnerability planning and management, as discussed below.

Stormwater Quality Management Program

The Fresno Nationwide Urban Runoff Program project was conducted between 1981 and 1983 in conjunction with the US EPA's national effort. The results indicated that runoff contains significant levels of many contaminants, including most of the heavy metals and some organic compounds. Most stormwater in the Plan Area is delivered to flood control/recharge basins where it can percolate to the groundwater or accumulate in the vadose zone. Hence, stormwater quality management is essential to protecting the quality of the local groundwater.

In compliance with the federal Clean Water Act and storm water permit regulations, the FMFCD, County of Fresno, City of Fresno, City of Clovis, and California State University at Fresno, developed a Stormwater Quality Management Program. The program is documented in the *Fresno-Clovis Storm Water Quality Management Plan*, prepared in February 1999. As owner and operator of the storm water drainage system serving the metropolitan area, the FMFCD has primary responsibility for implementing this mandated program. The program includes pollution prevention and control practices for drainage system planning, design, construction, and maintenance. The program also includes public education programs; commercial, industrial and new development storm water quality control practices; monitoring to assess storm water impacts; and ordinances to enforce storm water quality controls.

Septic Systems

Septic systems have been identified as a major contributor to high nitrate levels in the local groundwater. Septic systems are still present in rural areas and some urban neighborhoods within the Plan Area. The Plan participants generally do not permit septic systems to be installed in urban areas, and specific rules and regulations must be followed for septic systems installed in rural areas. The gradual decommissioning of septic systems in urban areas is a principal goal for the Plan participants.

Water Vulnerability

The local aquifer can be contaminated through intentional acts such as vandalism and terrorism. As a result, the Plan participants have adopted numerous strategies to prevent intentional contamination such as security cameras, fencing, and frequent water quality testing for contaminants.

Some plan participants have also prepared Vulnerability Assessments and Emergency Response Plans in compliance with the 2002 Bioterrorism Act. The Bioterrorism Act requires communities serving water to more than 3,300 persons to:

1. Conduct a Vulnerability Assessment.
2. Certify and submit a copy of the Vulnerability Assessment to the EPA Administrator.
3. Prepare or revise an Emergency Response Plan based on the results of the vulnerability assessment.
4. Certify to the EPA Administrator, within 6 months of completing the assessment, that an Emergency Response Plan has been completed or updated.

Existing Activities

- A Stormwater Quality Protection Program is being implemented by FMFCD, Fresno, Clovis and the County of Fresno to reduce the volume of stormwater pollutants that reach the groundwater.
- Runoff-borne pollutants are trapped in flood control/recharge basin sediments for subsequent removal. All new basins are constructed in accord with FMFCD design standards that facilitate pollutant entrapment and management.
- Plan participants that are required to have prepared Vulnerability Assessments and Emergency Response Plans will keep these documents updated.
- The County of Fresno enforces rules and regulations for newly installed septic systems to reduce the incidence of nitrate contamination in the groundwater.

Planned Actions

- Plan participants will seek funding to sewer areas still served with septic tanks, when practical.
- Plan participants will seek funds to improve security at their water facilities and reduce the potential for contamination from acts of vandalism or terrorism.
- Plan participants will make use of available tools, such as View Fresno, the City of Fresno's online facility and geographic program, to strictly enforce rules and regulations regarding permits for new septic systems in locations where there is an existing sewer collection system in close proximity.

8 - GROUNDWATER SUSTAINABILITY

The region is dependant on sustaining the long-term available groundwater in the Plan Area, as it is critical to the livelihood and economy of the area. The actions described within this section are intended to maintain or increase the volume of groundwater that is stored within the Plan Area. Water conservation, groundwater recharge, surface water treatment for domestic delivery, and water recycling are some of the efforts that are used within the area to mitigate the groundwater overdraft and replenish the groundwater supply.

Historic groundwater pumping within the urban area has developed a large cone of depression within the Plan Area. At the present time, groundwater replenishment efforts within the Plan Area do not offset the combined effect of groundwater extractions and subsurface outflow. The result is that the groundwater overdraft within just the FID boundary has been estimated to be approximately 20,000 acre-feet annually (FID GMP Supporting Documents, 1995). The overdraft within the Plan Area is believed to be even greater. This overdraft is evidenced by falling groundwater levels, and manifested by increasing costs of groundwater pumping, some groundwater degradation, and the undesirable migration of contaminant plumes. It is the specific goal of the Plan to correct the overdraft and to stabilize groundwater levels at the highest practical beneficial levels.

The Plan participants view groundwater usage tolls as a last resort for reducing groundwater pumping and reducing overdraft. The participants strive to ensure the unrestricted, non-export related, private use of groundwater within the Plan Area. The Plan participants believe that proper management, conservation and education programs will help to stabilize groundwater levels and preclude the need for groundwater usage fees.

8.1 - Groundwater Recharge

Substantial portions of the groundwater basin underlying the Plan Area are subject to conditions of critical overdraft as designated by the California DWR in Bulletin 118-80. Drinking water supplies and much of the agricultural water supply in the Plan Area are currently dependent on groundwater and, as a result, the groundwater resource has been stressed. Groundwater is a renewable resource through its proper management. Groundwater recharge is a viable method of renewing groundwater consumed. Recharge of surface water through the soils to the groundwater reservoir is also an economical alternative to replacing the existing groundwater supply system with a surface water supply system requiring treatment, storage, and delivery facilities.

Stabilization and recovery of the aquifer are the goals of groundwater replenishment and will result in (1) decreasing the pumping lifts and thereby decreasing the energy needed for pumping; (2) preventing expenditures for deepening wells; and (3) preventing the premature abandonment of wells which would be necessitated by the lowering of the water table.

Groundwater recharge efforts within the Plan Area primarily involve using FID's delivery system to deliver portions of the Fresno and Clovis water allocations to specific FMFCD basins for recharge during the summer when the basins are not needed to control urban storm runoff. FMFCD owns and operates these basins. Not all basins are used for groundwater recharge, as some have been, or will be, converted to recreational facilities such as parks or athletic fields. Within the City of Fresno, the City Water Division and Parks and Recreation Division have developed a recommended designation for the proposed use of each basin during the non-storm season. FMFCD refers to this designation as each basin's secondary use designation. The designations include recharge, recreation, or dual use. The dual use designation is used for basins that have been developed for recreation, but also have a significant area of the basin remaining for recharge. The City's recommendation was considered and approved by FMFCD's Board of Directors. As new storm water basin locations are identified by FMFCD, the City makes a recommended designation for that basin, and it is then presented to FMFCD's Board of Directors for final determination. Recharge capability is an important consideration when making these designations.

To maintain needed groundwater recharge at these basin sites, it is important to preserve the recharge capability provided by the basin sites designated for recharge.

Although some basins are designated as recreation or dual use facilities, they are not developed as a recreational facility for many years because of a lack of funding or the basins not being fully excavated. This interim period can last several years. In some situations, these basins have been utilized for recharge during the interim period before it is converted to a recreational facility. Once a basin is fully developed as a recreational facility, it is no longer utilized for recharge.

Fresno and Clovis both own and operate significant recharge facilities, to which a portion of the cities' water allocations is also delivered using FID's system.

Some areas in the United States, including Arizona and some parts of California, are performing aquifer storage and recovery through wells. In these programs, surface water (often treated) is directly injected to the groundwater aquifer through existing wells during available periods when the well is not needed for extraction, then the recharged water is later extracted from that same well. Although this type of groundwater storage and recovery is not known to be occurring within the Plan Area, there may be application for such a program within certain portions of the Plan Area.

Existing Activities

- Increase groundwater recharge capabilities within the Plan Area.
- Periodically remove sediment and rip the soils in recharge basins to maintain recharge rates.
- Maintain irrigation canals in an unlined or open bottom condition in those locations where it is determined that canal seepage is a significant source of recharge and does not create detrimental side effects.
- Work cooperatively to minimize development on lands that are favorable for artificial recharge.
- Without compromising flood protection, maximize retention and detention periods for stormwater runoff to maximize percolation to groundwater.
- Measure the volume of water delivered to groundwater recharge basins.
- Use FMFCD basins that are designated for recreational use as recharge basins prior to its conversion to a recreational facility.

Planned Activities

- Investigate the feasibility of groundwater recharge using flood control basins in the vicinity of Bakman Water Company.
- Seek funding to investigate the feasibility of groundwater recharge facilities in western Clovis.
- Construct additional interties between conveyance facilities and flood control basins to facilitate groundwater recharge.
- Develop and maintain an inventory of sites in the region that are suitable for recharge.
- Install flowmeters on all unmetered turnouts to recharge basins in FID.
- Prepare a water budget for the Plan Area to estimate total groundwater pumping, intentional recharge, deep percolation, groundwater inflow and outflow, change in groundwater storage, and, ultimately, the safe yield of the local aquifer.
- Investigate feasibility of aquifer storage and recovery within the Plan Area.
- Investigate feasibility of increasing use of surface water for landscape areas.
- Consider recharge capability of FMFCD basins when considering the secondary use designation for that basin.
- Seek to minimize reduction of groundwater recharge capabilities caused by the conversion of basins already designated for recharge purposes to recreational uses by increasing awareness or impacts of lost recharge capability, promoting alternative considerations, and pursuing replacement recharge capability when necessary.

8.2 - Water Conservation and Education

The Plan participants will at all times encourage effective water conservation measures, including residential and on-farm water saving technologies which produce a true savings of water. Plan participants intend to investigate possible incentive programs that might be made available to landowners and water users to enhance the efficient use of water within the Plan Area. The participants have always been, and will continue to be, committed to efficiently managing water supplies so as to maximize the beneficial use of surface water while enhancing and preserving the groundwater resources to meet the balance of the water needs of the landowners and water users within the Plan Area. The participants will also participate in cooperative conservation efforts with other agencies and private parties.

Existing Activities

The Plan participants practice a variety of measures to educate the public and encourage water conservation. Some of these measures include:

- Watering restrictions on certain days and certain times of the day.
- Educational and informational programs through mailings, newsletters, websites, radio and television commercials, newspaper advertisements and pamphlets.
- Designated water conservation coordinator to enforce conservation measures, assess fines for water wasting, and perform water audits.
- Rebates for low water use fixtures.
- Require new developments to include water conservation fixtures and technology.
- Involvement in organizations that promote water education and water conservation such as the California Water Awareness Campaign, California Water Education Center, and the Water Education Foundation.
- Require new developments to use water conserving technologies, methods, and practices.
- Some participants use water meters and tiered water pricing to encourage conservation through cost savings to the consumer.
- In compliance with AB 2572, the City of Fresno has developed a water meter installation program and schedule. Meter installations will begin about 2008 and are planned for completion in 2013.

Planned Activities

- Share information among the Plan participants on methods that have been successful in conserving water.
- Secure funds to perform metering studies and install water meters at unmetered residential, commercial, and industrial connections.
- Bakman to implement plan to install meters on new development and existing services by 2025.

8.3 - Groundwater Use Limitations

The California Water Code gives certain participants the power to limit or suspend groundwater extractions. However, such limits will only be implemented if the participants determine through study and investigation that groundwater replenishment programs or other alternative sources of water supply have proved insufficient or infeasible to lessen groundwater demand. In the unlikely event that it becomes necessary to reduce groundwater extractions, the participants intend to accomplish such reductions under a voluntary program, which will include suitable incentives to compensate users for reducing their groundwater pumping. The participants will not attempt to restrict or otherwise interfere with any landowner or water user exercising a valid right to pump and utilize groundwater.

County of Fresno Ordinance No. 00-013 regulates groundwater extractions and requires permits for transferring groundwater outside of the County. The Participants generally do not support groundwater pumping for export out of the Plan Area unless it involves a transfer or exchange of water that will not negatively impact the water supply available to the Plan Area.

Pumping Well Interference from Adjacent Properties

One cause of overdraft within the Plan Area is pumping by adjacent landowners, primarily to the south and west of the Plan Area. This occurs when water users in an area pump groundwater and the extraction well's capture zone entrains groundwater from a neighboring entity.

Most of the pumping by adjacent landowners is not offset by groundwater replenishment, which results in the lowering of groundwater levels. That, in turn, causes a subsurface outflow of groundwater from the Plan Area. Previous estimates place the combined subsurface outflow to the south and west as much as 80,000 acre-feet annually.

The Participants intend to encourage efforts to secure supplemental surface water supplies for these areas outside of the Plan Area that have insufficient surface water supplies. The Participants have and will continue to consider entering into cooperative agreements with water users and/or appropriate agencies located outside the Plan Area's boundaries but within or adjacent to the Kings sub-basin. Such cooperative agreements may implement voluntary programs and/or may provide for other actions acceptable to the participants and the affected water users/agencies. However, in no event will the participants attempt to unilaterally impose limits on the lawful extraction and use of groundwater outside its boundaries, and nothing in this section is intended to confer powers on the participants to act within the boundaries of another agency in contravention of the Water Code.

Existing Activities

- Some agencies do not permit individual wells to be drilled in their service area, and all new development must be connected to the agency's water system.
- Restrictions on groundwater exporting.

Planned Activities

- Encourage efforts to secure supplemental surface water supplies for these areas outside of the Plan Area that have insufficient surface water supplies.

8.4 - Conjunctive Use of Water Resources

Conjunctive use of water is defined as the coordinated use of both underground and surface water sources so that the combination will result in optimum benefits. The members believe that they will continue to be water short for the foreseeable future. Conjunctive use is one method to provide more water to users while conserving groundwater resources.

The Cities of Fresno and Clovis have constructed water treatment plants for treating their surface water entitlements. This will ultimately result in a reduction in groundwater pumping within the Plan Area and should slow declining groundwater levels. The Plan Participants support these efforts and will continue to encourage other local agencies to maximize use of their surface waters to conserve groundwater resources.

Groundwater banking is the process of recharging excess surface water into the aquifer, storing the water in the aquifer for a period of time, then extracting the recharged water for delivery. This process allows surface water supplies to be extended, as available surface water can be captured, stored, and then delivered during periods of higher demand. The Plan participants will limit extraction to a percentage of the banked water such that benefits are derived for all parties involved, including adjacent landowners. In addition, banking and subsequent extraction of the banked water shall, to the extent possible, occur in close proximity to each other unless the affected parties agree otherwise, and there will be no adverse impact on the local groundwater supply. FID is developing the Waldron Banking Facility located near Kerman, and is also considering an additional banking facility in the southern portion of FID.

Direct delivery of surface water from the canal system to areas of large landscaping, such as cemeteries, golf courses, schools and parks, is another example of a conjunctive use program. Untreated surface water is filtered and then pumped into the landscape irrigation system at these sites. Certain regulations and limitations for the use of untreated surface water apply, but it is permissible. The direct delivery reduces the amount of groundwater needed, and can be less expensive than delivering surface water treated to drinking water standards. Within the Plan Area, only one school site, one park and one cemetery are known to currently be utilizing surface water for irrigation. The large irrigated turf locations are a primary concern, however there are also other locations in the western United States, including California, that are providing direct delivery of surface water for landscaping irrigation at residences. This is not being performed within the Plan Area, but is being considered.

Existing Activities

- Pending development of Waldron Banking Facility.
- Delivery of surface water for landscaping to a few areas of large irrigated turf.

Planned Activities

- Encourage and assist landowners and water users in the transfer of water into the Plan Area, which will have the effect of causing "in lieu" recharge.
- Pursue the acquisition of new water supplies should they become available at affordable costs.
- Support the development of new surface storage and water supply projects that would permit the participants to better utilize surface water supplies.
- Expand conveyance systems to provide surface water to additional land.
- Wherever appropriate and practical, encourage groundwater conservation through the use of available surface irrigation water for non-agricultural purposes.
- Encourage those municipal water agencies that have not already done so to contract for available surface water.
- 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.
- Seek opportunities to increase conservation storage through groundwater banking programs or off-stream storage to help balance full contract supply years with drought years.
- Construct additional surface water treatment plant capacity for the Cities of Fresno and Clovis.
- Investigate additional groundwater banking facilities.
- Investigate and encourage use of surface water for irrigation of large irrigated turf such as schools, golf courses, cemeteries and parks.

8.5 - Wastewater Reclamation and Recycling

The recycling or reclamation of treated wastewater will extend the overall water supply within the Plan Area. The Regional Water Quality Control Board regulates the use of recycled water based on the treatment method of treatment facilities. While wastewater treatment methods are outside the scope of this plan, the overall water supply of the Plan Area is extended by the reuse of this water.

Wastewater within the City of Fresno is currently piped to the Fresno-Clovis Regional Wastewater Treatment Facility, as shown in Figure 2-1. This facility provides secondary level treatment, and nearly all of the effluent is sent to percolation ponds at the facility. A portion of the water is then reclaimed through a series of reclamation wells, and delivered to FID facilities for on-farm irrigation. The water reclaimed is metered, and the amount delivered is approximately 26,000 acre-feet per year.

Malaga County Water District and the City of Kerman also operate smaller wastewater treatment facilities. The City of Kerman currently delivers tertiary treated wastewater from its facility to neighboring agricultural lands for irrigation. There are other smaller wastewater treatment facilities that are distributing treated wastewater for landscape and irrigation purposes.

The City of Clovis is planning construction of a WWTF in the northeast portion of the Plan Area. The City is also planning to construct distribution facilities for delivering tertiary treated water from this facility to irrigate large landscape areas, including parks, local street and Caltrans right of way landscaping, and agricultural irrigation at California State University Fresno.

Existing Activities

- Delivery of reclaimed water at the Fresno-Clovis Regional WWTF.
- Direct application of effluent for irrigation at the Kerman WWTF.

Planned Activities

- Explore opportunities to optimize reuse of reclaimed water from the Fresno-Clovis Regional Wastewater Treatment Facility.
- Institute water recycling program planned for reuse of wastewater at the proposed Clovis wastewater treatment facility.
- Encourage higher level treatment facilities to facilitate less restricted use of recycled water.
- Encourage new developments to incorporate dual water systems. The secondary water system would use recycled water or groundwater of marginal quality for landscape irrigation.

8.6 - Operation of Facilities

The construction and proper operation of groundwater management facilities is an important facet of this plan. New facilities are needed to keep pace with increased water demands and the desire for improved management.

The participants have a number of opportunities to further improve and enhance the water and groundwater supplies of its landowners and neighbors. The participants will continue to evaluate potential projects that would involve the construction and operation of additional groundwater management facilities. Additional groundwater management facilities can provide needed flexibility and thus allow more optimal management of the groundwater.

Lastly, the members strive to provide the best facilities for delivery of surface water supplies, since they are used conjunctively with groundwater. The members realize that the success of conjunctive-use programs is often contingent on the quality of surface water and conveyance systems.

Existing Activities

- Policy to keep canals unlined where practical to allow for groundwater recharge.
- Cooperative use of stormwater facilities for groundwater recharge.
- Frequent maintenance of recharge ponds to maintain higher infiltration rates.

Planned Activities

- Maintain and upgrade conveyance facilities for capacity and stability.
- Improve canal maintenance procedures to eliminate or reduce canal downtime for deliveries to surface water treatment facilities.

9 - GROUNDWATER PLANNING AND MANAGEMENT

9.1 - Plan Implementation

The Participants have executed a Memorandum of Understanding (MOU) to facilitate the implementation of this Plan. This Plan and associated agreement, serve as a mechanism for cooperative efforts amongst the participants and other agencies within the region. Many of the activities described in the Plan target specific locations within the Plan Area, and therefore may involve only one or a few of the participants. Although certain activities may only involve some participants, the TAC meetings will serve as the primary forum for coordination of cooperative efforts. The annual report will also summarize all related activities within the Plan Area. Implementation of this Plan is expected to result in significant amounts of new knowledge and an achievable improvement in groundwater management in the basin. The participants also recognize that implementing the GMP is in the best interest of their water users. The participants plan to continue all of the 'Existing Activities' listed throughout this Plan. Implementation of each of these tasks would be beneficial to the Plan participants, but will be contingent on available staff time and funding.

Planned Activities

- Implement the Planned Activities described in the Plan.
- TAC to meet semi-annually to discuss regional groundwater management. Comments on the content and value of the GMP will be solicited at each meeting.
- Prepare Annual Reports and Reevaluate the Plan as described herein.

9.2 - Groundwater Reports

The Participants will prepare groundwater reports every year to document groundwater levels, available groundwater storage, historical trends, groundwater quality, and progress on groundwater projects. This information will be used to forecast future problems, plan future groundwater projects, and develop new groundwater policies.

Existing Activities

- Several agencies prepare reports (i.e. water supply reports, water master plans, water conservation plans, urban water management plans, etc.) that document groundwater conditions. These reports will continue to be prepared for use in assessing groundwater conditions within individual agencies.

Planned Activities

- Prepare Fresno Area Regional Groundwater Management Plan Annual Report and include information on all of the Plan participants. Plan will likely include:
  - Groundwater level data
  - Groundwater contour maps
  - Groundwater storage calculations (using specific yield values for each township and range)
  - Evaluation of one-year and five-year historical trends in groundwater levels, contours, and storage, and perceived reasons for any changes
  - Estimation of deliveries to recharge basins
  - Summary of important groundwater management actions during the period covered by the report
  - Discussion on whether management actions are meeting the management objectives
  - Summary of proposed management actions for the future
  - Summary of actions taken to coordinate with other water management, land-use and government agencies
  - Summary of groundwater related actions taken by other regional groups
  - Recommendations for changes in the content or format of the annual report
  - Recommendations for updates to the GMP

- The annual report will cover the prior calendar year and will be completed each year by May 31st.

9.3 - Plan Re-evaluation

Most of the strategies that make up this Plan are established policies, procedures, and ordinances. The goal of this document is to codify them for purposes of identifying an overall management program. Implementation of the various components of the Plan will continue on an on-going basis. As new policies, practices, or ordinances become necessary or desirable to enhance groundwater management, this Plan will be amended as necessary.

The Technical Advisory Committee (TAC) will be responsible for monitoring the progress of the GMP objectives. Refer to Section 5.1 for more information on the membership, policies, and procedures of the TAC. The TAC will attempt to meet twice each year to review and evaluate groundwater conditions as well as evaluate the effectiveness of the GMP.

Planned Activities

- The TAC will meet semi-annually to discuss regional groundwater management. Comments on the content and value of the GMP will be solicited at each meeting.

- Recommendations for modifying, updating, or expanding the GMP will be recorded annually in the Plan Group's Annual Groundwater Report.
- The GMP will be revised through a formal public process every five years, or earlier if a sufficient quantity of revisions, updates, and additions have been identified.

9.4 - 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. Some of the Plan participants have direct land-use planning authority while others do not. However, all of the participants have the opportunity to comment on environmental documents for land-use related activities. The Plan participants 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. A map showing the extent of the general urbanization within the Plan Area is included as Figure 9-1.

Existing Activities

- Notify residents and agencies of 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.

Planned Activities

- Determine ways to improve communication between County, Cities and other Private/Public agencies regarding landuse changes that may have an impact on groundwater.

9.5 - Dispute Resolution

Each participant has their own mechanisms for dispute resolution related to groundwater issues. These may include procedures for filing complaints and appeals to a manager, board, or committee. The Plan participants recognize the importance of groundwater as their primary water source and will work diligently to resolve any groundwater disputes according to their internal rules and regulations.

This regional GMP will provide a forum for the participants to discuss groundwater related disputes and identify possible solutions. In addition, it is envisioned that the regional coordination, improved communication, and multi-party projects that develop as part of this Plan will help to reduce future conflicts among the participants.

Planned Activities

- Discuss issues of concern at semi-annual TAC meeting. Provide recommendations for resolution if appropriate.

9.6 - Program Funding and Fees

Funding individual activities described in this Plan will be provided for in each agency's individual budget. Funding of the Plan preparation and annual report are included in the MOU for implementation. The Plan participants have a variety of options for funding groundwater projects as discussed below.

Water Replenishment Fees
Included in the authority granted to local agencies under the California Water Code were the powers 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 the members will make any and all efforts to ensure the private, non-metered use of groundwater by their water users.

Capital Improvement Fees
Some participants have 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 approving the repayment fees prior to implementation, and is considered a realistic alternative for large capital projects to improve groundwater facilities.

Grants
Some participants have successfully acquired funding from the DWR and other public agencies for projects that are consistent with the goals of their Groundwater Management Plan. The participants will continue to pursue available grants and low-interest loans from the DWR as well as other state and federal agencies.

Other Revenue Sources
Groundwater projects are also financed through a variety of water user fees, property taxes, sales taxes, fine payments, and development impact fees.

Cost Sharing Agreement
Costs for GMP updates, annual groundwater reports, and other projects involving all of the Plan participants will be distributed according to an accepted cost-sharing agreement that is documented in the MOU.

Planned Activities

- Share information on funding opportunities for groundwater related projects.
- Identify beneficial groundwater projects that become economically feasible when costs are shared among two or more participants.

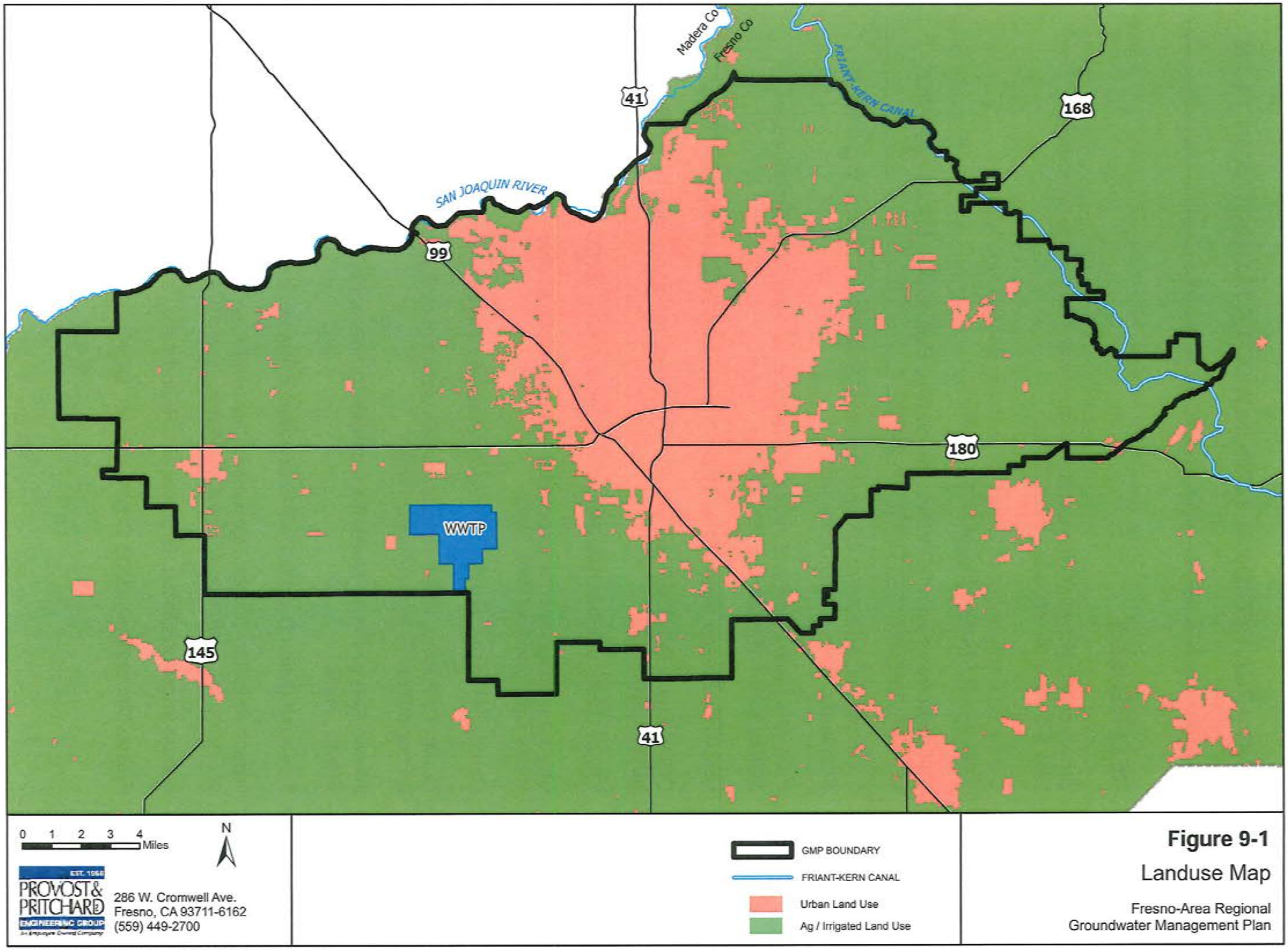

Figure 9-1

Landuse Map

Fresno-Area Regional
Groundwater Management Plan

December, 2005 \\huntington\gis\Clients\FresnoID_1038\10380500\GMP_Landuse.mxd

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20. Provost and Pritchard Engineering Group, *Groundwater Monitoring and Recharge Investigation Project for the City of Clovis*, 2003.

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22. Provost and Pritchard Engineering Group, *Supporting Documents for Fresno Irrigation District Groundwater Management Plan*, 1993.

23. Provost and Pritchard Engineering Group, *Waldron Banking Facility Proposition 13 Groundwater Storage Grant Application for Fresno Irrigation District*, 2003.

24. Thomson West, *California Water Code, 2003 Desktop Edition, Chapter 3 – Groundwater Management Plans*, 2003.

25. United States Department of Agriculture, *A Geologic Approach to Artificial Recharge Site Selection in the Fresno-Clovis Area*, 1980.

26. United States Geologic Survey, *Groundwater Reconnaissance in the Fresno Northeast Area, Open File Report 75-315*, 1975.

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FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

APPENDIX A

PUBLIC PARTICIPATION IN PLAN ADOPTION

RESOLUTION NO. 2005-09

RESOLUTION OF THE BOARD OF DIRECTORS OF THE FRESNO IRRIGATION DISTRICT

FOR INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions; and

WHEREAS, the District's Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Fresno Irrigation District; and

WHEREAS, a public hearing was held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan.

NOW, THEREFORE, BE IT RESOLVED, by the Board of Directors of the Fresno Irrigation District as follows:

The foregoing findings are true and correct:

1. It is the intention of the Fresno Irrigation District to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;

2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;

3. After such a plan has been prepared, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;

4. That the officers of the Fresno Irrigation District are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

5. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the Board of Directors of the Fresno Irrigation District that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The General Manager of the Fresno Irrigation District is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Fresno Irrigation District on August 10, 2005.

Jacob C Andresen

Jacob C. Andresen, President

CERTIFICATE OF SECRETARY

I, GARY SERRATO, Secretary of the Fresno Irrigation District hereby certify that the Board of Directors at a regular meeting on August 10, 2005 adopted the foregoing Resolution by the following roll call vote:

	Aye	Nay	Absent	Abstain
President Andresen	✓			
Vice-President Boswell	✓			
Director Niederfrank	✓			
Director Balls	✓			
Director Neely	✓			

Gary R. Serrato

Gary R. Serrato, Secretary

RESOLUTION NO. 05-140

A RESOLUTION OF INTENTION OF THE COUNCIL OF THE CITY OF CLOVIS, CALIFORNIA, TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the City of Clovis adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on November 17, 1997; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions; and

WHEREAS, the City of Clovis desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Clovis City Council believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Clovis City Council believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the City of Clovis.

NOW, THEREFORE, BE IT RESOLVED by the Clovis City Council as follows:

1. It is the intention of the City of Clovis to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the Fresno Irrigation District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;
3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;
4. That the officers of the City of Clovis are authorized and directed to publish this resolution of intention to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;
5. That the Clovis City Council hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

BE IT RESOLVED by the City Council of the City of Clovis that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The Director of Public Utilities of the City of Clovis is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

* * * * *

The foregoing resolution was introduced and adopted at a regular meeting of the City Council of the City of Clovis held on September 6, 2005 by the following vote, to wit:

AYES: Councilmembers Armstrong, Ashbeck, Flores, Whalen, Mayor Magsig

NOES: None

ABSENT: None

ABSTAIN: None

DATED: September 6, 2005

Mayor

City Clerk

BAKMAN WATER COMPANY

TELEPHONE (559) 255-0324 • P.O. BOX 7965 • 5105 E BELMONT • FRESNO, CA 93747

MINUTES OF THE SPECIAL MEETING OF THE BOARD OF DIRECTORS OF BAKMAN WATER COMPANY, A CALIFORNIA CORPORATION.

A special meeting of the Board of Directors of the Bakman Water Company was held at the Bakman Water Co. office located at 5105 E. Belmont Ave, Fresno, California.

Date: July 8, 2005 **Time**: 9:00am

Officers present were Richard Tim Bakman, Virginia Bakman, and Dottie Patton.

On July 8, 2005, a special meeting was called to discuss the possibility of being a part of **Memorandum of Understanding** regarding The Fresno Area Regional Groundwater Management Plan.

Purpose This MOU is intended to promote and to provide a means to establish an orderly process to share information, develop courses of action, and to resolve any issues with respect to the cooperative development of the groundwater management plan and with respect to the administration of the groundwater management plan. Administration will include coordination of data received from each party, public noticing, meetings and annual reporting as described herein. This MOU memorializes the interests, intent and responsibilities of the parties with respect to the adoption of a groundwater management plan consistent with the provisions of the California Water Code to provide for collection of data and the development of a plan for the management of groundwater resources within the jurisdictions of the parties hereto.

Payment of Costs Each of the parties hereto shall contribute to the cost of updating the groundwater management plan in accordance with the obligations specified in Exhibit "2" attached hereto. Additionally, any ongoing fees or costs incurred in the administration of the plan (as administration is defined and limited in Section 1 of this MOU) or of this Memorandum of Understanding will be shared by the parties in accordance with percentages identified in Exhibit "2".

The following being all of the directors of Bakman Water Company, hereby consent to and agree to be a part of the **Memorandum of Understanding** regarding The Fresno Area Regional Groundwater Management Plan.

Richard Tim Bakman Water

Virginia A. Bakman

Dottie Patton, Secretary/Treasurer

bakman enterprises

RESOLUTION NO. 2005-386

A RESOLUTION OF THE COUNCIL OF THE CITY OF FRESNO, CALIFORNIA, FOR INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the City of Fresno desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

Adopted 9/20/05
Approved
Effective

2005-386

WHEREAS, the Council believes that groundwater can best be managed, as in the past, by *local agencies in coordination with owners of lands overlying the groundwater basin; and*

WHEREAS, the Council believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the City of Fresno.

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of Fresno as follows:

The foregoing findings are true and correct:

1. It is the intention of the City of Fresno to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;
3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;
4. That the officers of the City of Fresno are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;
5. That the Council hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

BE IT FURTHER RESOLVED that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

BE IT FURTHER RESOLVED that the Director of the Department of Public Utilities is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

* * * * * * * * * * * * * * *

STATE OF CALIFORNIA)
COUNTY OF FRESNO) ss.
CITY OF FRESNO)

I, REBECCA E. KLISCH, City Clerk of the City of Fresno, certify that the foregoing resolution was adopted by the Council of the City of Fresno, at a regular meeting held on the 20th day of September, 2005.

AYES : Boyajian, Calhoun, Duncan, Perea, Sterling, Westerlund, Dages
NOES : None
ABSENT : None
ABSTAIN : None

REBECCA E. KLISCH
City Clerk

BY: Rebecca E Klisch
Deputy

APPROVED AS TO FORM:
CITY ATTORNEY'S OFFICE

BY: ____________________
Chief Assistant City Attorney

RESOLUTION NO. 05-___

RESOLUTION OF THE OF THE BOARD OF DIRECTORS OF THE PINEDALE COUNTY WATER DISTRICT

FOR INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the Pinedale County Water District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Pinedale County Water District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. It is the intention of the Pinedale County Water District to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;

2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;

3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;

4. That the officers of Pinedale County Water District are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

5. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the Board of Directors of the Pinedale County Water District that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The General Manager of the Pinedale County Water District is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Pinedale County Water District on 10/5, 2005.

John Garcia

(General Manager)

CERTIFICATION

I, Esther Schwandt, as Clerk to the Board of Directors of the Fresno Metropolitan Flood Control District, do hereby certify the foregoing to be a full, true and correct copy of **Resolution No. 2005-473** adopted by the Board of Directors on **August 24, 2005**, the original of which is on file at the District office.

In witness whereof, I have hereunto set my hand and affixed the Seal of the Fresno Metropolitan Flood Control District.

Esther Schwandt

Esther Schwandt
Clerk to the Board

October 10, 2005
Date

Original document bears our embossment

RESOLUTION NO. 2005-473

BEFORE THE BOARD OF DIRECTORS OF THE FRESNO METROPOLITAN FLOOD CONTROL DISTRICT

RESOLUTION OF INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions; and

WHEREAS, the Fresno Metropolitan Flood Control District, "District", desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. It is the intention of the District to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the Fresno Irrigation District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;
3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;

4. That the officers of District are authorized and directed to publish this resolution of intention to update the Fresno Irrigation District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;
5. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the Board of Directors of the District that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The General Manager-Secretary of the District is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

PASSED AND ADOPTED this 24th day of August 2005 by the following vote to wit:

AYES:	Franco, Spina, Marcus, Groom, Welton, Williams and Rastegar
NOES:	None
ABSTAIN:	None
ABSENT:	None

RESOLUTION NO. 05-54

***RESOLUTION OF THE CITY COUNCIL OF THE CITY OF KERMAN APPROVING* ENTERING INTO MEMORANDUM OF UNDERSTANDING (MOU) WITH FRESNO IRRIGATION DISTRICT (FID) AND OTHER AGENCIES AND WATER COMPANIES ON GROUNDWATER MANAGEMENT PLAN (GWMP) FOR KERMAN**

WHEREAS. the City Council of the City of Kerman ("Kerman") as the legislative body of the City, has authorized the negotiation of a Memorandum of Understanding (MOU) with Fresno Irrigation District ("District"), the City of Fresno ("Fresno"), the City of Clovis ("Clovis"), the Fresno Metropolitan Flood Control District ("Metropolitan"), the Bakman Water Company ("Company"), the City of Kerman ("Kerman"), the County of Fresno ("County"), the Malaga County Water District ("Malaga"), and the Pinedale County Water District ("Pinedale") to provide a means to promote an orderly process to share information, develop courses of action, and to resolve any issues with respect to the cooperative development and administration of the groundwater management plan; and

WHEREAS, the attached Memorandum of Understanding (MOU), Exhibit "A" memorialize. the interests, intent and responsibilities of the parties with respect to the adoption of the groundwater management plan consistent with the provisions of the California Water Code; and

WHEREAS, conditions of the MOU are as outlined therein under Conditions and Covenants 1 through 12.

NOW, THEREFORE, BE IT RESOLVED THAT THE CITY COUNCIL OF THE CITY OF KERMAN RESOLVES THAT the City Manager is authorized to sign the Memorandum of Understanding regarding The Fresno Area Regional Groundwater Management Plan and the City Clerk is to attest.

The foregoing resolution was introduced at a regular meeting of the City Council of the City of Kerman held on the 6th day of July, 2005, and passed at said meeting by the following vote:

AYES:	Cromartie, Rodriguez, Sidhu, Stockwell
NOES:	None
ABSENT:	Moore
ABSTAIN:	None

////

The foregoing resolution is hereby approved.

ATTEST:

MAYOR, CITY OF KERMAN

CITY CLERK, CITY OF KERMAN

CITY CLERK'S CERTIFICATE

EDITH M. FORSSTROM does hereby certify as follows:

That she is the City Clerk of the City of Kerman and that the foregoing Resolution, being Resolution No. 05-54 was passed at a regular meeting of the City Council of the City of Kerman held on the 6th day of July, 2005 and she further certifies that the foregoing is a true and correct copy of said Resolution No. 05-54 so adopted.

Edith M Forsstrom

EDITH M. FORSSTROM, City Clerk

RESOLUTION NO. 05-08-23

RESOLUTION OF THE BOARD OF DIRECTORS OF THE MALAGA COUNTY WATER DISTRICT

FOR INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the Malaga County Water District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Malaga County Water District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. It is the intention of the Malaga County Water District to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;

2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;

3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;

4. That the officers of Malaga County Water District are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

5. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the Board of Directors of the Malaga County Water District that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The General Manager of the Malaga County Water District is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of the Malaga County Water District on August 23, 2005.

RHolcomb

Russ Holcomb
General Manager

RESOLUTION NO. 05-1201

RESOLUTION OF THE BOARD OF DIRECTORS OF THE GARFIELD WATER DISTRICT

FOR INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Garfield Water District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, the Garfield Water District has agreed to the terms of the Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within its jurisdiction; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District and Bakman Water Company desire to have the Garfield Water District participate in the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on December 8, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Garfield Water District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. It is the intention of the Garfield Water District to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;

2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;

3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;

4. That the officers of Garfield Water District are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

5. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the Board of Directors of the Garfield Water District that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The Secretary of the Garfield Water District is hereby authorized and directed to prepare the necessary data, make investigations. sign, and file such application with the California Department of Water Resources.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Garfield Water District on December 8, 2005.

Katherine B. Alves

Secretary

office, 2917 East Shepherd Avenue, Clovis, California. Opportunity for public questions and input will be provided at the hearing.

In compliance with Water Code Section 10753.4 (b), landowners and other interested parties who wish to participate in updating the groundwater management plan, may do so by attending the hearing and indicating their interest or by submitting a written letter to Gary Serrato, Secretary, Fresno Irrigation District, 2907 S. Maple Avenue, Fresno, California 93725.

/s/ Katherine Alves

November 21, 2005 Secretary

(PUB: November 26, 2005)

November 26, 2005

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated NOVEMBER 26, 2005

Cathy Hamilton

FPROOFAD

PROVOST & PRICHARD

ATTN: MICHAEL TAYLOR

286 W CROMWELL AVE

FRESNO , CA 937116162

PROOF OF PUBLICATION

COUNTY OF FRESNO
STATE OF CALIFORNIA

EXHIBIT A.

PUBLIC NOTICE

#104099

NOTICE OF ADOPTION OF RESOLUTION FOR INTENTION TO ADOPT THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, Bakman Water Company, City of Kerman, County of Fresno, Malaga County Water District, Pinedale County Water District and Garfield Water District should adopt a resolution of intention to adopt a Fresno Area Regional Groundwater Management Plan to be in compliance with California Senate Bill No. 1938. This regional groundwater management plan will replace the existing groundwater management plans adopted by the Fresno Irrigation District and the City of Clovis. This regional groundwater management plan will also replace the County of Fresno's existing groundwater management plan for the portion of the county within the plan area.

The resolution adopted by each party reads as follows:

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District . Bakman Water Company and Garfield Water District have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the (party) desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the (party's governing body) believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the (party's governing body) believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the (party).

BE IT RESOLVED, by the (party's governing body) as follows:

The foregoing findings are true and correct:

1. It is the intention of the (party) to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with

The undersigned states:

McClatchy Newspapers in and on all dates herein stated was a corporation, and the owner and publisher of The Fresno Bee.

The Fresno Bee is a daily newspaper of general circulation now published, and on all-the-dates herein stated was published in the City of Fresno, County of Fresno, and has been adjudged a newspaper of general circulation by the Superior Court of the County of Fresno, State of California, under the date of November 22, 1994, Action No. 520058-9.

The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

12/20 . 12/27/05

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated DECEMBER 27, 2005

Aiko [signature]

PROVOST & PRICHARD

ATTN: MICHAEL TAYLOR

286 W CROMWELL AVE

FRESNO , CA 937116162

PROOF OF PUBLICATION

COUNTY OF FRESNO
STATE OF CALIFORNIA

EXHIBIT A.

PUBLIC NOTICE

#173824

NOTICE OF HEARING ON INTENTION TO ADOPT THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that at 4:30 pm on the 10th day of August, 2005, at the office of the Fresno Irrigation District at 2907 S. Maple Avenue, Fresno, California, a public hearing will be held to discuss whether or not the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, Bakman Water Company, City of Kerman, County of Fresno, Malaga County Water District and Pinedale County Water District should adopt a resolution of intention to adopt a Fresno Area Regional Groundwater Management Plan to be in compliance with California Senate Bill No. 1938. This regional groundwater management plan will replace the existing groundwater management plans adopted by the Fresno Irrigation District and the City of Clovis. This regional groundwater management plan will also replace the County of Fresno's existing groundwater management plan for the portion of the county within the plan area.

Part 2.75 of Division 6 of 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.

Landowners within these agency boundaries and other interested parties are invited to attend the hearing. Copies of the proposed resolution and other relevant written materials will be available for review by the public at the hearing or may be obtained in advance at the District Office, 2907 S. Maple Avenue, Fresno, California 93725. Opportunity for public questions & input will be provided at the hearing.

In compliance with Water Code 10753.4 (b), landowners and other interested parties who wish to participate in updating the groundwater management plan, including becoming a member of a technical advisory committee, may do so by attending the hearing and indicating their interest or by submitting a written letter to Gary Serrato, Secretary, Fresno Irrigation District, 2907 S. Maple Avenue, Fresno, California 93725.

July 21, 2005

/s/ Gary Serrato
General Manager

(PUB: July 26, August 2, 2005)

FPROC

The undersigned states:

McClatchy Newspapers in and on all dates herein stated was a corporation, and the owner and publisher of The Fresno Bee.

The Fresno Bee is a daily newspaper of general circulation now published, and on all-the-dates herein stated was published in the City of Fresno, County of Fresno, and has been adjudged a newspaper of general circulation by the Superior Court of the County of Fresno, State of California, under the date of November 22, 1994, Action No. 520058-9.

The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

July 26, 2005;
August 2, 2005

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated AUGUST 2, 2005

Cathy Aguilera

EXHIBIT A.

PUBLIC NOTICE

#104099

NOTICE OF ADOPTION OF RESOLUTION FOR INTENTION TO ADOPT THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, Bakman Water Company, City of Kerman, County of Fresno, Malaga County Water District, Pinedale County Water District and Garfield Water District should adopt a resolution of intention to adopt a Fresno Area Regional Groundwater Management Plan to be in compliance with California Senate Bill No. 1938. This regional groundwater management plan will replace the existing groundwater management plans adopted by the Fresno Irrigation District and the City of Clovis. This regional groundwater management plan will also replace the County of Fresno's existing groundwater management plan for the portion of the county within the plan area.

The resolution adopted by each party reads as follows:

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District , Bakman Water Company and Garfield Water District have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions,

WHEREAS, the (party) desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the (party's governing body) believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the (party's governing body) believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the (party),

BE IT RESOLVED, by the (party's governing body) as follows:

The foregoing findings are true and correct:

1. It is the intention of the (party) to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;
3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;
4. That the officers of (party) are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;
5. That the (party's governing body) hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the (party's governing body) of the (party) that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938.

The of the (party) is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

The resolutions were adopted on the following dates: Fresno Irrigation District on 8/10/2005, City of Clovis on 9/6/2005, Bakman Water Company on 7/8/2005, County of Fresno on 10/11/2005, City of Fresno on 9/20/2005, Pinedale County Water District on 10/5/2005, Fresno Metropolitan Flood Control District on 8/24/2005, City of Kerman on 7/6/2005, Malaga County Water District on 8/23/2005, and Garfield Water District on 12/8/2005.

(PUB: December 20,27, 2005)

PROVOST & PRICHARD

ATTN: MICHAEL TAYLOR

286 W CROMWELL AVE

FRESNO , CA 937116162

PROOF OF PUBLICATION

COUNTY OF FRESNO
STATE OF CALIFORNIA

EXHIBIT A.

PUBLIC NOTICE

#47015

NOTICE OF HEARING ON INTENTION TO ADOPT THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that at five o'clock on the 25th day of January, 2006, at the office of the Fresno Irrigation District at 2907 S. Maple Avenue, Fresno, California, a public hearing will be held to discuss whether or not the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, Bakman Water Company, City of Kerman, County of Fresno, Malaga County Water District, Pinedale County Water District, and Garfield Water District should adopt a resolution of intention to adopt a Fresno Area Regional Groundwater Management Plan to be in compliance with California Senate Bill No. 1938. This regional groundwater management plan will replace the existing groundwater management plans adopted by the Fresno Irrigation District and the City of Clovis. This regional groundwater management plan will also replace the County of Fresno's existing groundwater management plan for the portion of the county within the plan area.

Part 2.75 of Division 6 of 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. The Plan includes the required sections for groundwater management plan, as cited in Section 10753 of the California Water Code and Department of Water Resources recommendations as indicated in DWR Bulletin 118, Appendix C. A Technical Advisory Committee of agency representatives and landowners has provided input for the development of the Plan. The Plan includes regional groundwater management objectives, and a listing of existing and planned groundwater management actions to accomplish these objectives.

Landowners within these agency boundaries and other interested parties are invited to attend the hearing. Copies of the proposed resolution and other relevant written materials will be available for review by the public at the hearing or may be obtained in advance at the District Office, 2907 S. Maple Avenue, Fresno, California 93725. Opportunity for public questions & input will be provided at the hearing.

In compliance with Water Code Section 10753.4 (b), landowners and other interested parties who wish to participate in updating the groundwater management plan, including becoming a member of a technical advisory committee, may do so by attending the hearing and indicating their interest or by submitting a written letter to Gary Serrato, Secretary, Fresno Irrigation District, 2907 S. Maple Avenue, Fresno, California 93725.

January 5, 2006

/s/ Gary Serrato
General Manager

(PUB: January 10,17, 2006)

The undersigned states:

McClatchy Newspapers in and on all dates herein stated was a corporation, and the owner and publisher of The Fresno Bee.

The Fresno Bee is a daily newspaper of general circulation now published, and on all-the-dates herein stated was published in the City of Fresno, County of Fresno, and has been adjudged a newspaper of general circulation by the Superior Court of the County of Fresno, State of California, under the date of November 22, 1994, Action No. 520058-9.

The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

January 10, 17, 2006

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated JANUARY 17, 2006

Cathy Aguilera

FPROOFAD

PROVOST & PRICHARD

ATTN: MICHAEL TAYLOR

286 W CROMWELL AVE

FRESNO , CA 937116162

PROOF OF PUBLICATION

COUNTY OF FRESNO
STATE OF CALIFORNIA

EXHIBIT A.

PUBLIC NOTICE

#167234

NOTICE OF ADOPTION OF RESOLUTION FOR INTENTION TO ADOPT THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, Bakman Water Company, City of Kerman, County of Fresno, Malaga County Water District, Pinedale County Water District and Garfield Water District should adopt a resolution of intention to adopt a Fresno Area Regional Groundwater Management Plan to be in compliance with California Senate Bill No. 1938. This regional groundwater management plan will replace the existing groundwater management plans adopted by the Fresno Irrigation District and the City of Clovis. This regional groundwater management plan will also replace the County of Fresno's existing groundwater management plan for the portion of the county within the plan area.

The resolution adopted by each party reads as follows:

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District , Bakman Water Company and Garfield Water District have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the (party) desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the (party's governing body) believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the (party's governing body) believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the (party).

BE IT RESOLVED, by the (party's governing body) as follows:
The foregoing findings are true and correct:

1. It is the intention of the (party) to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;
3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5. et seq. to determine whether to adopt the plan;

The undersigned states:

McClatchy Newspapers in and on all dates herein stated was a corporation, and the owner and publisher of The Fresno Bee.

The Fresno Bee is a daily newspaper of general circulation now published, and on all-the-dates herein stated was published in the City of Fresno, County of Fresno, and has been adjudged a newspaper of general circulation by the Superior Court of the County of Fresno, State of California, under the date of November 22, 1994, Action No. 520058-9.

The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

November 24, December 1, 2006

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated DECEMBER 1,2006

Cathy Hamilton

EXHIBIT A.

PUBLIC NOTICE

#167234

NOTICE OF ADOPTION OF RESOLUTION FOR INTENTION TO ADOPT THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, Bakman Water Company, City of Kerman, County of Fresno, Malaga County Water District, Pinedale County Water District and Garfield Water District should adopt a resolution of intention to adopt a Fresno Area Regional Groundwater Management Plan to be in compliance with California Senate Bill No. 1938. This regional groundwater management plan will replace the existing groundwater management plans adopted by the Fresno Irrigation District and the City of Clovis. This regional groundwater management plan will also replace the County of Fresno's existing groundwater management plan for the portion of the county within the plan area.

The resolution adopted by each party reads as follows:

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District , Bakman Water Company and Garfield Water District have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the (party) desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the (party's governing body) believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the (party's governing body) believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the (party),

BE IT RESOLVED, by the (party's governing body) as follows:

The foregoing findings are true and correct:

1. It is the intention of the (party) to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with Part 2.75 of Division 6 of the California Water Code, and the District's consultant is hereby authorized and directed to draft such a plan;
2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;
3. After such a plan has been prepared in accordance with all applicable law, including but not limited to the California Environmental Quality Act, a second public hearing will be conducted in accordance with the California Water Code Section 10753.5, et seq. to determine whether to adopt the plan;
4. That the officers of (party) are authorized and directed to publish this resolution of intention to update the District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;
5. That the (party's governing body) hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the (party's governing body) of the (party) that the Fresno-Area Regional Groundwater Management Plan be developed to be in compliance with California Senate Bill No. 1938

The (agency authorized representative) of the (party) is hereby authorized and directed to prepare the necessary data, make investigations, sign, and file such application with the California Department of Water Resources.

The resolutions were adopted on the following dates: Fresno Irrigation District on 1/25/06, City of Clovis on 2/13/06, Bakman Water Company on 3/13/06, County of Fresno on 7/18/06, City of Fresno on 4/18/06; Pinedale County Water District on 9/20/06, Fresno Metropolitan Flood Control District on 2/8/06, City of Kerman on 3/1/06, Malaga County Water District on 2/14/06, and Garfield Water District on 11/1/06.

(PUB: November 24, December 1, 2006)

FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

APPENDIX B

RESOLUTIONS TO ADOPT PLAN

RESOLUTION NO. 2006-03

RESOLUTION OF THE BOARD OF DIRECTORS OF THE FRESNO IRRIGATION DISTRICT

ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the Fresno Irrigation District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors of the Fresno Irrigation District adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on August 10, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Fresno Irrigation District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. That the Board of Directors of the Fresno Irrigation District does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this resolution.

2. That the officers of Fresno Irrigation District are authorized and directed to publish this resolution of adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

3. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Fresno Irrigation District on January 25, 2006.

Jacob C. Andresen

Jacob C. Andresen, President

CERTIFICATE OF SECRETARY

I hereby certify that I am the Secretary of the Fresno Irrigation District and that the foregoing Resolution was duly adopted by the Board of Directors of said District at the Special Meeting duly held in Fresno, California on January 25, 2006, at which meeting a quorum of said Board of Directors was at all times present and acting.

IN WITNESS WHEREOF, I have hereunto set my hand and seal of said District this 25th day of January, 2006.

Gary R. Serrato

Gary R. Serrato, Secretary

	Aye	Nay	Absent	Abstain
President Andresen	✓			
Vice-President Boswell	✓			
Director Niederfrank	✓			
Director Balls	✓			
Director Neely	✓			

RESOLUTION NO. 06-37

A RESOLUTION OF THE COUNCIL OF THE CITY OF CLOVIS ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the City of Clovis adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on November 17, 1997; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions; and

WHEREAS, the City of Clovis desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the City Council of the City of Clovis adopted a Resolution of Intention to Adopt the Fresno-Area Regional Groundwater Management Plan on September 6, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Clovis City Council believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Clovis City Council believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the City of Clovis,

BE IT RESOLVED, by the Clovis City Council as follows:

The foregoing findings are true and correct:

1. That the Council of the City of Clovis does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this resolution.

2. That the officers of the City of Clovis are authorized and directed to publish this resolution of adoption of the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

3. That the Clovis City Council hereby authorizes the Public Utilities Director to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

* * * * * *

The foregoing resolution was introduced and adopted at a regular meeting of the City Council of the City of Clovis held on February 13, 2006, by the following vote, to wit:

AYES: Councilmembers Armstrong, Ashbeck, Flores, Whalen

NOES: None

ABSENT: Mayor Magsig

ABSTAIN: None

DATED: February 13, 2006

CITY OF CLOVIS ★ INCORPORATED FEBRUARY 27 1912 ★

Mayor

City Clerk

CLERK'S CERTIFICATE

I, Diana Stice, Deputy City Clerk of the City of Clovis do hereby certify that the attached is a true and correct copy of Resolution 06-37 dated February 13, 2006 as it appears in the Office of the City Clerk.

IN WITNESS WHEREOF, I hereunto set my hand and affix the seal of the City of Clovis on February 22, 2006.

Diana Stice

Diana Stice, Deputy City Clerk

RESOLUTION NO. 06-01

RESOLUTION OF THE BOARD OF DIRECTORS OF THE BAKMAN WATER COMPANY

ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the Bakman Water Company desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors of the Bakman Water Company adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on August 10, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Bakman Water Company,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. That the Board of Directors of the Bakman Water Company does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this resolution.

2. That the officers of Bakman Water Company are authorized and directed to publish this resolution of adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

3. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Bakman Water Company on March 13, 2006.

President

BAKMAN WATER COMPANY

TELEPHONE (559) 255-0324 • P.O. BOX 7965 • 5105 E. BELMONT • FRESNO, CA 93747

MINUTES OF THE SPECIAL MEETING OF THE BOARD OF DIRECTORS OF BAKMAN WATER COMPANY, A CALIFORNIA CORPORATION.

A special meeting of the Board of Directors of the Bakman Water Company was held at the Bakman Water Co. office located at 5105 E. Belmont Ave, Fresno, California.

Date: March 13, 2006 **Time**: 9:00am

Officers present were Richard Tim Bakman, Virginia Bakman, and Dottie Patton.

On March 13, 2005, a special meeting was called to discuss the possibility of adopting the **Fresno-Area Regional Groundwater Management Plan**

The following being all of the directors of Bakman Water Company, hereby PASSED AND ADOPTED the **Fresno-Area Regional Groundwater Management Plan** on March 13, 2006.

Richard Tim Bakman

Virginia A. Bakman

Dottie Patton

Dottie Patton, Secretary/Treasurer

bakman enterprises

RESOLUTION NO. 06-464

RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF FRESNO

ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the Board of Supervisors desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Supervisors of the County of Fresno adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on October 11, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Supervisors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Supervisors believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the County of Fresno,

BE IT RESOLVED, by the Board of Supervisors as follows:

The foregoing findings are true and correct:

1. That the Board of Supervisors of the County of Fresno do hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this resolution.

2. That the officers of County of Fresno are authorized and directed to publish this resolution of adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

3. That the Board of Supervisors 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 was passed and adopted by the following vote of the Board of Supervisors of the County of Fresno this 18th day of July, 2006, to-wit:

AYES: Supervisors Anderson, Case, Perea, Waterston, Larson

NOES: None

ABSENT: None

CHAIRMAN, Board of Supervisors

ATTEST:

BERNICE E. SEIDEL, Clerk
Board of Supervisors

By ______ Deputy

Agenda #5

Resolution #06-464

CERTIFICATE OF DELIVERY OF DOCUMENT

I am employed by the County of Fresno as a Deputy Clerk of the Board of Supervisors. On July 18, 2006, I delivered a copy of Resolution No. 06-464 to the Chairman of the Fresno County Board of Supervisors.

Javier Flores, Deputy Clerk

RESOLUTION NO. 2006-146

A RESOLUTION OF THE COUNCIL OF THE CITY OF FRESNO, CALIFORNIA, ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the City of Fresno desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Council of the City of Fresno adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on September 20, 2005; and

Adopted 4/18/06
Approved 4/18/06
Effective 4/18/06

2006-146

Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

4. That the Council hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

****

STATE OF CALIFORNIA)
COUNTY OF FRESNO) ss.
CITY OF FRESNO)

I, REBECCA E. KLISCH, City Clerk of the City of Fresno, certify that the foregoing resolution was adopted by the Council of the City of Fresno, at a regular meeting held on the 18th day of April, 2006.

AYES	:	Boyajian, Calhoun, Dages, Perea, Sterling, Westerlund, Duncan
NOES	:	None
ABSENT	:	None
ABSTAIN	:	None

REBECCA E. KLISCH
City Clerk

BY: Rebecca E. Klisch
~~Deputy~~

APPROVED AS TO FORM:
CITY ATTORNEY'S OFFICE

BY: ______________
Deputy City Attorney

JCH:ns [37684ns/jch] – 4/10/06

RECD OCT 16 2006

RESOLUTION NO. 7 OF 2006
PINEDALE COUNTY WATER DISTRICT
FRESNO COUNTY, CALIFORNIA

RESOLUTION ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, a groundwater management plan consistent with the provisions of California Water Code Section 10750, et seq, was adopted on August 12, 1996, and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions, and

WHEREAS, the Pinedale County Water District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et.seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2 (a), and held on August 10, 2005 to discuss whether or not to adopt a resolution of intention to draft a groundwater management plan for the purpose of establishing a groundwater management program; and

WHEREAS, after the hearing, the Pinedale County Water District adopted a Resolution of Intention to draft a ground water management plan in accord with the provisions of California Water Code Section 10753.2(b), and

WHEREAS, the Pinedale County Water District, after its adoption of said Resolution of Intention, caused said Resolution of Intention to be published pursuant to Section 6066 of the Government Code, and

WHEREAS, a Working Draft of the Fresno Area Regional Groundwater Management was prepared on behalf of the parties to the aforementioned Memorandum of Understanding, and

WHEREAS, a public hearing was duly noticed and heard pursuant to the provisions of Water Code Section 10753.5, and

WHEREAS, the Board of Directors believes that groundwater can best be managed by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interest of its constituents and water users and can help meet the projected long-term water needs of the Pinedale County Water District.

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. That the Board of Directors of the Pinedale County Water District does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this Resolution.

2. That the Board of Directors of the Pinedale County Water District hereby authorizes its Officers to execute all documents and to take any other action necessary or advisable to carry out the purposes of this Resolution.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of the Pinedale County Water District this 20th day of September 2006 by the following vote:

AYES : RICHARD BURRILL, NICOLE COOPER, EDWARD HIGGASON, DAVID RODRIGUEZ, DELTES COOPER

NOES : NONE

ABSENT : NONE

S/ RICHARD BURRILL
RICHARD BURRILL, President of the Board of Directors of Pinedale County Water District.

S/ PAM EINSEL
PAM EINSEL, Secretary of the Pinedale County Water District

Eugene L. Adams
ATTORNEY AT LAW
3554 W. Magill Ave
Fresno, CA 93711-0815
(559) 485-4611

SECRETARY'S CERTIFICATE

I, PAM EINSEL, Secretary of the Pinedale County Water District, do hereby certify that the foregoing is a full, true and correct copy of a Resolution duly adopted at a regular meeting of the Board of Directors of said Pinedale County Water District, duly and legally held at the regular meeting place thereof on the 20th day of September, 2006, of which meeting all of the members of said Board had due notice and at which a majority thereof were present; that at said meeting, said Resolution was introduced by Director EDWARD HIGGASON and read in full and was, thereupon, on motion of Director EDWARD HIGGASON, seconded by Director DAVID RODRIGUEZ and adopted by the following vote:

AYES :	RICHARD BURRILL, EDWARD HIGGASON DAVID RODRIGUEZ, DELTES COOPER, NICOLE COOPER
NOES :	NONE
ABSENT:	NONE

That I have carefully compared the same with the original minutes of said meeting on file in my office and that said Resolution is a full, true and correct copy of the original Resolution adopted at said meeting and entered in said minutes. That said Resolution has not been amended, modified or rescinded since the date of its adoption and the same is now in full force and effect

WITNESS MY HAND and the Seal of said District this 6th day of October, 2006.

Pam Einsel

PAM EINSEL, Secretary of the
Pinedale County Water District

EUGENE L. ADAMS
ATTORNEY AT LAW
3551 W Magill Ave
Fresno, CA 93711-0815
(559) 485-1611

RESOLUTION NO. 2006-490

BEFORE THE BOARD OF DIRECTORS OF THE FRESNO METROPOLITAN FLOOD CONTROL DISTRICT

RESOLUTION ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a Groundwater Management Plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions; and

WHEREAS, the Fresno Metropolitan Flood Control District desires to adopt a Groundwater Management Plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors of the Fresno Metropolitan Flood Control District adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on August 24, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Fresno Metropolitan Flood Control District; and

BE IT RESOLVED, by the Fresno Metropolitan Flood Control District as follows: The foregoing findings are true and correct:

1. That the Board of Directors of the Fresno Metropolitan Flood Control District does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this Resolution.
2. That the officers of the Fresno Metropolitan Flood Control District are authorized and directed to publish this resolution of adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;
3. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

PASSED AND ADOPTED by the Board of Directors of the District this 8th day of February 2006 by the following vote, to wit:

AYES:	Directors Franco, Welton, Spina, Groom, Williams and Rastegar
NOES:	None
ABSENT:	Director Marcus
ABSTAIN:	None

RESOLUTION NO. 06-17

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF KERMAN

ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the City Council of the City of Kerman desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the of the City Council of the City of Kerman adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on August 10, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the City Council of the City of Kerman believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the City Council of the City of Kerman believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the City of Kerman.

BE IT RESOLVED, by the City Council of the City of Kerman as follows:

The foregoing findings are true and correct:

1. That the City Council of the City of Kerman does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this resolution.

2. That the officers of City Council of the City of Kerman are authorized and directed to publish this resolution of adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

3. That the City Council of the City of Kerman hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

PASSED AND ADOPTED at a regular meeting of the City Council of the City of Kerman on the 1st day of March, 2006.

L. Renée Holdcroft

CITY CLERK, CITY OF KERMAN

The foregoing resolution was adopted at a regular meeting of the City Council of the City of Kerman on the 1st day of March, 2006, and passed at said meeting by the following vote:

AYES: Cromartie, Rodriguez, Sidhu, Stockwell

NOES: None

ABSENT: None

ABSTAIN: Council Member Moore

The foregoing resolution is hereby approved.

Ken Moore

MAYOR, CITY OF KERMAN

ATTEST:

L. Renée Holdcroft

CITY CLERK, CITY OF KERMAN

CITY CLERK
RESOLUTION CERTIFICATION

I, L. RENEE HOLDCROFT, do hereby certify as follows:

That I am the City Clerk of the City of Kerman and that the foregoing document, being Resolution No. 06-17, was passed at a regular meeting of the City Council of the City of Kerman held on the 1st day of March, 20 06 and I further certify that the foregoing is a true and correct copy of the document so adopted.

6-1-06
DATE

L. Renee Holdcroft
L. RENEE HOLDCROFT
City Clerk

RESOLUTION NO. 02-14-06 (B)

RESOLUTION OF THE BOARD OF DIRECTORS OF THE MALAGA COUNTY WATER DISTRICT

ADOPTING THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the District adopted a groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

WHEREAS, the Malaga County Water District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on August 10, 2005 to discuss the intent to prepare the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors of the Malaga County Water District adopted a Resolution of Intent to Prepare the Fresno-Area Regional Groundwater Management Plan on August 10, 2005; and

WHEREAS, the public was invited to participate in the development of the Fresno-Area Regional Groundwater Management and a Technical Advisory Committee comprised of landowners and participant representatives was formed and met regularly to develop the Plan; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on January 25, 2006 to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the adoption of the Fresno-Area Regional Groundwater Management Plan is in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Malaga County Water District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. That the Board of Directors of the Malaga County Water District does hereby adopt the Fresno-Area Regional Groundwater Management Plan as submitted on the date of this resolution.

2. That the officers of the Malaga County Water District are authorized and directed to publish this resolution of adopt the Fresno-Area Regional Groundwater Management Plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request;

3. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Malaga County Water District on February 14, 2006.

RHolcomb

Russ Holcomb
General Manager

RESOLUTION No. 06-1101

RESOLUTION OF THE BOARD OF DIRECTORS OF THE GARFIELD WATER DISTRICT

FOR INTENTION TO ADOPT THE FRESNO-AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, Part 2.75 of Division 6 of 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, the Fresno Irrigation District, City of Fresno, City of Clovis, Fresno Metropolitan Flood Control District, County of Fresno, City of Kerman, Malaga County Water District, Pinedale County Water District, Garfield Water District and Bakman Water Company have entered into a Memorandum of Understanding to cooperate and participate in the development of the Fresno-Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions within their respective jurisdictions; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions; and

WHEREAS, the Garfield Water District desires to adopt a groundwater management plan that is consistent with recent amendments to the provisions of the California Water Code Section 10750 et seq.; and

WHEREAS, a public hearing was duly noticed consistent with California Water Code Section 10753.2(a), and held on March 1, 2006, to discuss the adoption and implementation of the Fresno-Area Regional Groundwater Management Plan; and

WHEREAS, the Board of Directors believes that groundwater can best be managed, as in the past, by local agencies in coordination with owners of lands overlying the groundwater basin; and

WHEREAS, the Board of Directors believes the updating and adoption of a new groundwater management plan will be in the best interests of its constituents and water users and can help meet the projected long-term water needs of the Garfield Water District,

BE IT RESOLVED, by the Board of Directors as follows:

The foregoing findings are true and correct:

1. It is the intention of the Garfield Water District to adopt the Fresno-Area Regional Groundwater Management Plan in accordance with part 2.75 of Division 6 of the California Water Code, and the District's engineer is hereby authorized to represent the Garfield Water District in any joint management proceedings;

2. That this resolution shall be deemed a resolution of intention in accordance with California Water Code Section 10753.2;

3. That the plan has been prepared in accordance with all applicable laws, including, but not limited to the California Environmental Quality Act, and a public hearing has been conducted in accordance with the California Water Code Section 10753.5 et seq. to determine whether to adopt the plan;

4. That the officers of Garfield Water District have published a resolution of intention to update the Garfield Water District's groundwater management plan in accordance with the provisions of California Water Code Section 10753.3 and to provide interested persons with a copy of this resolution upon written request; and

5. That the Board of Directors hereby authorizes its officers to execute all documents and take any other action necessary or advisable to carry out the purposes of this resolution.

RESOLVED by the Board of Directors of the Garfield Water District that the Fresno-Area Regional Groundwater Management Plan be deemed to be in compliance with California Senate Bill No. 1938.

PASSED AND ADOPTED at a regular meeting of the Board of Directors of Garfield Water District on November 1, 2006.

Katherine B. Alves

Katherine Alves, Secretary

SECRETARY'S CERTIFICATE

I, KATHERINE ALVES, the undersigned do hereby certify:

That I am the duly elected and acting Secretary of the GARFIELD WATER DISTRICT and that the foregoing Resolution was adopted on the 1st day of November, 2006.

Katherine B. Alves

Katherine Alves, Secretary

FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

APPENDIX C

MEMORANDUM OF UNDERSTANDING

AGT. # 05-510

MEMORANDUM OF UNDERSTANDING

REGARDING

THE FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

This Memorandum of Understanding ("MOU") is entered into on this 11th day of October, 2005 by and between the FRESNO IRRIGATION DISTRICT ("District"), the CITY OF FRESNO ("Fresno"), the CITY OF CLOVIS ("Clovis"), the FRESNO METROPOLITAN FLOOD CONTROL DISTRICT ("Metropolitan"), the BAKMAN WATER COMPANY ("Company"), the CITY OF KERMAN ("Kerman"), the COUNTY OF FRESNO ("County"), the MALAGA COUNTY WATER DISTRICT ("Malaga"), and the PINEDALE COUNTY WATER DISTRICT ("Pinedale").

RECITALS

WHEREAS, the District adopted a regional groundwater management plan consistent with the provisions of the California Water Code Section 10750 et. seq. on August 12, 1996; and

WHEREAS, the District desires to update its groundwater management plan to make it consistent with recent amendments to the provisions of the California Water Code Section 10750 et. seq.; and

WHEREAS, other parties that are within the boundary of the District wish to enter into this Memorandum of Understanding, so that the parties may cooperate and participate in the cost-efficient development of a regional groundwater management plan for the planning and monitoring activities for groundwater conditions within their respective jurisdictions; and

WHEREAS, the District desires to incorporate the concerns and conditions of the other parties to this Memorandum of Understanding into its updated regional groundwater management plan so that the plan may provide a more comprehensive view and approach toward groundwater within the jurisdictional territory of the parties as identified, more or less, on the map included as Exhibit "1", attached hereto; and

WHEREAS, each of the parties has the authority pursuant to law and their local governing authorities to enter into this cooperative effort to study and plan for the management of groundwater conditions within their respective jurisdictions.

NOW THEREFORE, BE IT RESOLVED, in consideration of the promises contained herein the parties hereto agree upon the following covenants and conditions:

1. Purpose. This MOU is intended to promote and to provide a means to establish an orderly process to share information, develop courses of

action, and to resolve any issues with respect to the cooperative development of the regional groundwater management plan and with respect to the administration of the regional groundwater management plan. Administration will include coordination of data received from each party, public noticing, meetings and annual reporting as described herein. This MOU memorializes the interests, intent and responsibilities of the parties with respect to the adoption of a regional groundwater management plan consistent with the provisions of the California Water Code to provide for collection of data and the development of a plan for the management of groundwater resources within the jurisdictions of the parties hereto.

2. District's Responsibility. The District shall review and revise its groundwater management plan consistent with the current requirements of the California Water Code and the intentions of the parties hereto. The plan will be based upon the existing groundwater management plan of the District and shall incorporate new provisions required by recent changes in California law. The plan will be updated to include necessary revisions to incorporate the jurisdictions of the parties other than the District into the plan, so that the resulting document will satisfy the requirement of the Water Code that each of the parties has prepared a groundwater management plan. The District intends to complete the update of the regional groundwater management plan by December 2005.

3. Payment of Costs. Each of the parties hereto shall contribute to the cost of updating the groundwater management plan in accordance with the obligations specified in Exhibit "2" attached hereto. Additionally, any ongoing fees or costs incurred in the administration of the plan (as administration is defined and limited in Section 1 of this MOU) or of this Memorandum of Understanding will be shared by the parties in accordance with the percentages identified in Exhibit "2".

4. Coordination and Meetings. There shall be an annual coordination meeting between the parties. The District shall provide notice to the parties to this Memorandum of Understanding of the date and time of the meeting and submit a proposed agenda for such meeting. Each of the parties hereto agrees to provide a representative to participate in each of the annual meetings held during the effective dates of the regional groundwater management plan. The meeting may be held more often than annually if the parties hereto agree that more frequent meetings are necessary.

5. Data Provision. The parties to this agreement shall provide water quantity and water quality data for the purposes of preparing an annual report for public and state dissemination. The purpose of such data will be to evaluate the effectiveness of the implementation of the regional groundwater management plan by the parties. The parties hereto may employ consultants or contractors to assist in the preparation of the annual report which costs shall be shared according to the percentages specified in Exhibit "2". Preparation of the first annual report is estimated at 10% of the total Exhibit "2" fees to be shared at the same percentages as identified in Exhibit "2".

6. Membership. Any party to this Memorandum of Understanding may terminate their participation in the Memorandum of Understanding by providing ninety (90) days written notice to the District. Such member shall be responsible for their proportionate share of any costs incurred in administration of the Memorandum of Understanding through the effective date of their termination. Additionally, by agreement of all of the parties hereto, additional parties may be permitted to become participants in the Memorandum of Understanding and the regional groundwater management plan and will be required to pay their proportionate share of costs. Upon the termination of any member's participation or the addition of any additional member, the parties to the Memorandum of Understanding will revise the percentages for cost sharing purposes contained in Exhibit "2" appropriately. Participation in this MOU does not obligate parties to contribute to construction or implementation of groundwater related projects, unless mutually agreed upon.

7. Lead Agency. The District shall be the lead agency for contracting services associated with the development and implementation of the regional groundwater management plan. To the extent the District wishes to receive reimbursement for costs it incurs in addition to those costs identified on Exhibit "2", it shall obtain the prior written approval of each party. Promptly upon incurring approved costs, the District shall submit invoices according to the percentages contained in Exhibit "2" to each of the parties hereto for payment. The parties hereto shall remit payment of their appropriate portion of any such costs and expenses to the District within thirty (30) days of receipt of an invoice. Each party's share of contribution for preparation of the updated regional groundwater management plan as specified in Exhibit "2" shall be paid prior to the initiation of work to update the plan.

8. Budgets. The District shall prepare a proposed annual budget for consideration of the parties hereto at the annual meeting. The budget shall estimate the expenses and costs to be incurred with development of the updated regional groundwater management plan and any subsequent administration and implementation of the plan.

9. Amendments. This Memorandum of Understanding may be amended only by the express written consent of all of the parties hereto.

10. Severability. If any part of this agreement is found to be in conflict with applicable laws, such part shall be inoperative, null and void and so far as it is in conflict with said law that the remainder of the agreement shall remain in full force and effect.

11. Counterparts. This agreement may be executed in counterparts by the parties.

12. Governing Law and Venue. Any disputes or claims arising in connection with, or out of the implementation of this agreement shall be governed by the law of the State of California.

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: Gary R. Serrato

CITY OF CLOVIS

By: ____________________________

BAKMAN WATER COMPANY

By: ____________________________

COUNTY OF FRESNO

By: ____________________________

CITY OF FRESNO

By: ____________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: __________________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: __________________________

PINEDALE COUNTY
WATER DISTRICT

By: ________________________

FRESNO METROPOLITAN
FLOOD CONTROL DISTRICT

By: ________________________

CITY OF KERMAN

By: ________________________

MALAGA COUNTY WATER
DISTRICT

By: ________________________

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: ____________________________

CITY OF CLOVIS

By: ____________________________

BAKMAN WATER COMPANY

By: ____________________________

COUNTY OF FRESNO

By: ____________________________

CITY OF FRESNO

By: ____________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ____________________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: ____________________________

PINEDALE COUNTY
WATER DISTRICT

By: ____________________________

FRESNO METROPOLITAN
FLOOD CONTROL DISTRICT

By: ____________________________

CITY OF KERMAN

By: ____________________________

MALAGA COUNTY WATER
DISTRICT

By: ____________________________

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: ______________________________

CITY OF CLOVIS

By: ______________________________

BAKMAN WATER COMPANY

By: W. Dottie Patton

COUNTY OF FRESNO

By: ______________________________

CITY OF FRESNO

By: ______________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ______________________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: ______________________________

PINEDALE COUNTY
WATER DISTRICT

By: ______________________________

FRESNO METROPOLITAN
FLOOD CONTROL DISTRICT

By: ______________________________

CITY OF KERMAN

By: ______________________________

MALAGA COUNTY WATER
DISTRICT

By: ______________________________

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: ____________________________

PINEDALE COUNTY
WATER DISTRICT

By: ____________________________

CITY OF CLOVIS

By: ____________________________

FRESNO METROPOLITAN
FLOOD CONTROL DISTRICT

By: ____________________________

BAKMAN WATER COMPANY

By: ____________________________

CITY OF KERMAN

By: ____________________________

COUNTY OF FRESNO

By: ____________________________

MALAGA COUNTY WATER
DISTRICT

By: ____________________________

CITY OF FRESNO

By: ____________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ____________________________
~~Deputy~~ Chief Ast.

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: Elvira Sommerville
Deputy (8/9/05)

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: ____________________________

PINEDALE COUNTY
WATER DISTRICT

By: John Garcia

CITY OF CLOVIS

By: ____________________________

FRESNO METROPOLITAN
FLOOD CONTROL DISTRICT

By: ____________________________

BAKMAN WATER COMPANY

By: ____________________________

CITY OF KERMAN

By: ____________________________

COUNTY OF FRESNO

By: ____________________________

MALAGA COUNTY WATER
DISTRICT

By: ____________________________

CITY OF FRESNO

By: ____________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ____________________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: ____________________________

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: ______________________

PINEDALE COUNTY WATER DISTRICT

By: ______________________

CITY OF CLOVIS

By: ______________________

FRESNO METROPOLITAN FLOOD CONTROL DISTRICT

By: Bob Van Wyk

BAKMAN WATER COMPANY

By: ______________________

CITY OF KERMAN

By: ______________________

COUNTY OF FRESNO

By: ______________________

MALAGA COUNTY WATER DISTRICT

By: ______________________

CITY OF FRESNO

By: ______________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ______________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: ______________________

Executed on this ______ day of ___________, 2005.

FRESNO IRRIGATION DISTRICT

By: ___________________________

PINEDALE COUNTY
WATER DISTRICT

By: ___________________________

CITY OF CLOVIS

By: ___________________________

FRESNO METROPOLITAN
FLOOD CONTROL DISTRICT

By: ___________________________

BAKMAN WATER COMPANY

By: ___________________________

CITY OF KERMAN

By: [signature]
Attest: [signature]
City Clerk

COUNTY OF FRESNO

By: ___________________________

MALAGA COUNTY WATER
DISTRICT

By: ___________________________

CITY OF FRESNO

By: ___________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ___________________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: ___________________________

Executed on this ______ day of ____________, 2005.

FRESNO IRRIGATION DISTRICT

By: ____________________________

PINEDALE COUNTY WATER DISTRICT

By: ____________________________

CITY OF CLOVIS

By: ____________________________

FRESNO METROPOLITAN FLOOD CONTROL DISTRICT

By: ____________________________

BAKMAN WATER COMPANY

By: ____________________________

CITY OF KERMAN

By: ____________________________

COUNTY OF FRESNO

By: ____________________________

MALAGA COUNTY WATER DISTRICT

By: Holcomb

CITY OF FRESNO

By: ____________________________

APPROVED AS TO FORM:

HILDA CANTU MONTOY
City of Fresno Attorney

By: ____________________________
Deputy

ATTEST

REBECCA E. KLISCH
City of Fresno Clerk

By: ____________________________

REVIEWED AND RECOMMENDED FOR APPROVAL

By: *[signature]*
Alan Weaver, Director
Department of Public Works and Planning

APPROVED AS TO ACCOUNTING FORM

By: *[signature]*
Vicki Crow, Auditor-Controller/Treasurer-Tax Collector

APPROVED AS TO LEGAL FORM
Dennis Marshall, County Counsel

By: Susan F. Coberly
Deputy

Fund: 0001
Subclass: 10000
Org Number: 436000300
Account: 7010
Project No.:

COUNTY OF FRESNO

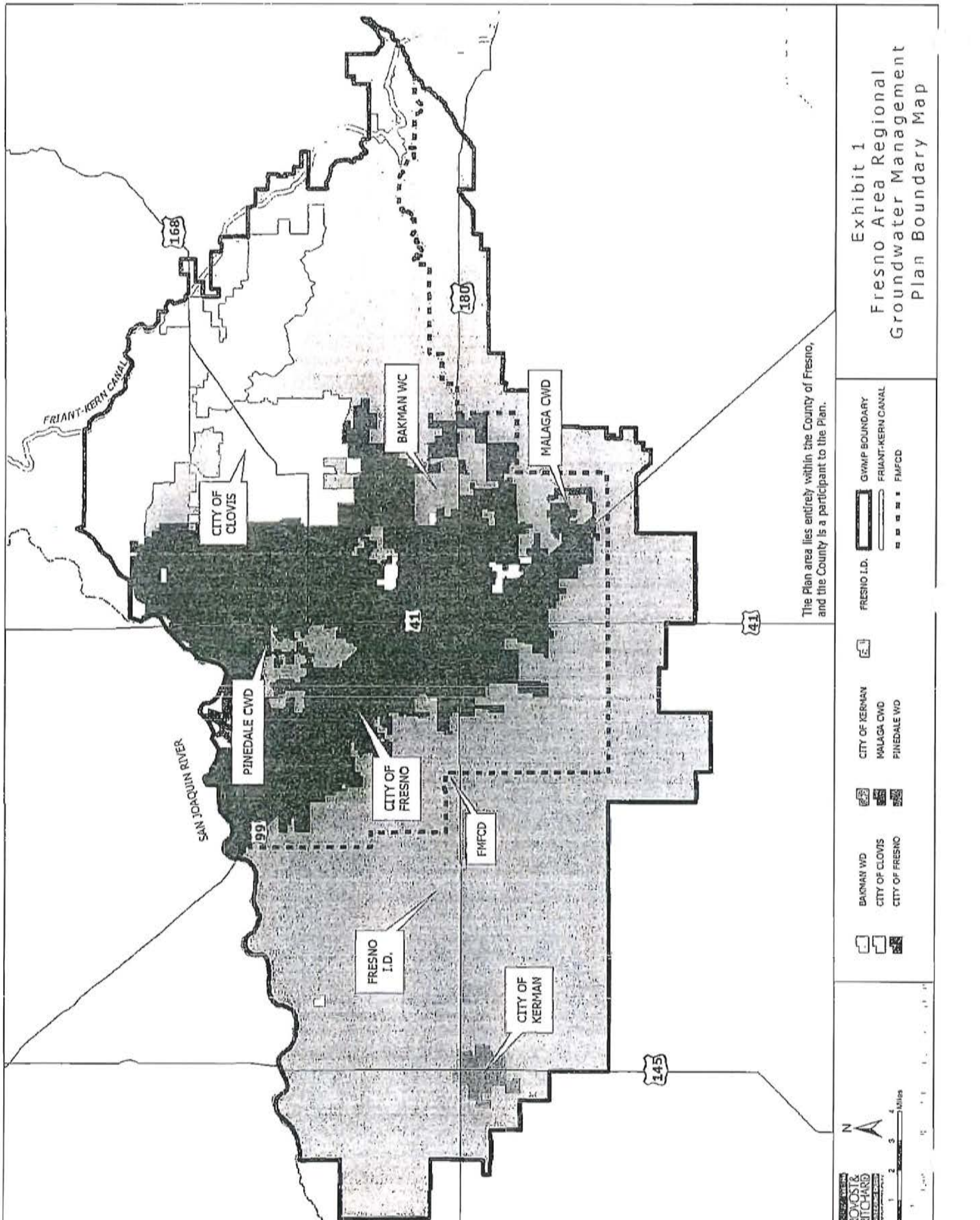
[signature]
Judith G. Case
CHAIRMAN, Board of Supervisors

OCT 11 2005

ATTEST:

[signature]
Bernice E. Seidel, Clerk
Board of Supervisors

EXHIBIT "1"



FRIANT-KERN CANAL
168
180
CITY OF CLOVIS
BAKMAN WC
MALAGA CWD
41
PINEDALE CWD
SAN JOAQUIN RIVER
CITY OF FRESNO
99
FMFCD
FRESNO I.D.
CITY OF KERMAN
145
The Plan area lies entirely within the County of Fresno, and the County is a participant to the Plan.
BAKMAN WD
CITY OF CLOVIS
CITY OF FRESNO
CITY OF KERMAN
MALAGA CWD
PINEDALE WD
FRESNO I.D.
GWMP BOUNDARY
FRIANT-KERN CANAL
FMFCD
PROVOST & PRITCHARD
N
Miles
Exhibit 1
Fresno Area Regional
Groundwater Management
Plan Boundary Map

EXHIBIT 2

Agency	Cost Share	Percent Total
Fresno Irrigation District	$25,000	23.81%
City of Fresno	$30,000	28.57%
City of Clovis	$20,000	19.05%
Fresno Metropolitan Flood Control District	$7,500	7.14%
Bakman Water Company	$5,000	4.76%
City of Kerman	$5,000	4.76%
County of Fresno	$5,000	4.76%
Malaga County Water District	$5,000	4.76%
Pinedale County Water District	$2,500	2.38%
Total Estimated GW Mgmt. Plan Cost	**$105,000**	**100%**[1]

[1] Rounded

NOTE: Estimate does not include agency staff time, legal fees or required newspaper notices. Estimate includes consultant work only as required to prepare the Regional Groundwater Management Plan in compliance with SB 1938.

GARFIELD WATER DISTRICT

Mailing Address
P. O. Box 337
Clovis, CA 93613
Phone (559) 299-1120

Office Location
1990 Shaw, Suite A
Clovis, CA 93613
Fax (559) 299-3304

November 2, 2005

Mr. Dale Stanton, P.E.
Fresno Irrigation District
2907 So. Maple Avenue
Fresno, CA 93725

RE: LETTER OF INTENT TO PARTICIPATE IN THE FRESNO AREA REGIONAL GMP

Dear Mr. Stanton:

The Garfield Water District (District) desires to cooperate and participate in the development of the Fresno Area Regional Groundwater Management Plan for the planning and monitoring activities of groundwater conditions in the area. The District hereby arees to the terms of the Memorandum of Understanding (MOU) regarding the Fresno Area Regional Groundwater Management Plan, attached hereto. In accordance with the recommendation of the Technical advisory Committee responsible for the Plan development, the District will make an initial contribution of two thousand five hundred dollars ($2,500.00) to assist in the preparation of the Plan. A revised cost share and percentage total described in Exhibit 2 of the MOU is attached.

The District will duly notice and conduct a public hearing for intent to participate in preparation of the Plan in accordance with California Water Code requirements. Pending comments received during the hearing, the District Board of Directors intends to adopt a resolution of intent to participate in the preparation of the Plan. Following the acceptance of this letter, completion of the public hearing and adoption of the resolution, the District will participate in Plan development and all processes involved with the Plan's anticipated adoption.

Thank you for the opportunity to participate in this Plan.

Respectfully,

GARFIELD WATER DISTRICT

COPY

Preside[nt]

Attachments

FRESNO AREA REGIONAL GROUNDWATER MANAGEMENT PLAN

APPENDIX D

GLOSSARY

GLOSSARY

Acre-Foot: A quantity or volume of water covering one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons.

Alluvium: A stratified bed of sand, gravel, silt, and clay deposited by flowing water.

Aquifer: A geologic formation that stores and transmits water and yields significant quantities of water to wells and springs.

Confined Aquifer: A water bearing subsurface stratum that is bounded above and below by formations of impermeable, or relatively impermeable, soil or rock.

Conjunctive Operation: The operation of a groundwater basin in combination with a surface water storage and conveyance system. Water is stored in the groundwater basin for later use by intentionally recharging the basin during periods of above-average water supply.

Deep Percolation: The percolation of surface water through the ground and beyond the lower limit of the root zone of plants into a groundwater aquifer.

Ecology: The study of the interrelationships of living organisms to one another and to their surroundings.

Ecosystem: Recognizable, relatively homogeneous units, including the organisms they contain, their environment, and all the interactions among them.

Effluent: Waste water or other liquid, partially or completely treated or in its natural state, flowing from a treatment plant.

Environment: The sum of all external influences and conditions affecting the life and development of an organism or ecological community; the total social and cultural conditions.

Evapotranspiration Of Applied Water (ETAW): The portion of the total evapotranspiration which is provided by irrigation.

Groundwater: Water that occurs beneath the land surface and completely fills all pore spaces of the alluvium, soil, or rock formation in which it is situated.

Groundwater Banking: The importation and storage of a new water supply in a groundwater aquifer for subsequent extraction of a fraction thereof for use by designated beneficiaries. The fraction of the water stored (i.e. banked) in the underground that may be withdrawn is a function of the groundwater mitigation

GLOSSARY

required. Approval, oversight, mitigation and accounting for groundwater banking shall be the responsibility of the local agency whose AB 3030 plan governs. Agreement of the impacted local water service agencies shall also be obtained.

Groundwater Basin: A groundwater reservoir, defined by all the overlying land surface and the underlying aquifers that contain the water stored in the reservoir. In some cases, the boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.

Groundwater Mining: The withdrawal of water from an aquifer in excess of recharge over time. If continued, the underground supply would eventually be exhausted or the water table could drop below economically feasible pumping lifts.

Groundwater Mitigation: An action or activity designed to compensate for the actual or expected negative impact caused by groundwater pumping by appropriators and/or groundwater bankers. Mitigation shall include making provisions for sufficient recharge to offset the effects of all extractions, subsurface outflow and other unrecoverable losses attributable to the appropriation or banking activity. Mitigation may be incorporated into a conjunctive operation of a groundwater basin or subarea thereof with the consent of the agency or agencies responsible for the conjunctive management of such basin or subarea.

Groundwater Overdraft: The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average.

Groundwater Recharge: Increases in groundwater storage by natural conditions or by human activity.

Groundwater Reservoir: An aquifer or an aquifer system in which groundwater is stored.

Groundwater Storage Capacity: The space or voids contained in a given volume of deposits. Under optimum conditions, the usable groundwater storage capacity is the volume of water that can, within specified economic limitations, be alternately extracted and replaced in the reservoir.

Groundwater Table: The upper surface of the zone of saturation (all pores of subsoil filled with water), except where the surface is formed by an impermeable body.

GLOSSARY

Hardpan: A layer of nearly impermeable soil beneath a more permeable soil, formed by natural chemical cementing of the soil particles.

Hydrologic Balance: An accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period.

Hydrologic Basin: The complete drainage area upstream from a given point on a stream.

In-Lieu Groundwater Recharge: A method of replenishing a groundwater resource by delivering an alternate surface supply to agricultural or urban users instead of pumping groundwater, thus leaving water in the underground for future use. Deliveries of surface water to parks, golf courses and freeway landscaping are examples of urban in-lieu recharge.

Intentional Recharge: The addition of surface water to a groundwater reservoir by human activity, such as putting surface water into spreading basins.

Irrecoverable Losses: The water lost to a salt sink or lost by evaporation or evapotranspiration from a conveyance facility, drainage canal, or in fringe areas.

Irrigation Efficiency: The efficiency of water application. Computed by dividing evapotranspiration of applied water by applied water and converting the result to a percentage. Efficiency can be computed at three levels: farm, district, or basin. Applied water may exclude water that percolates to groundwater for subsequent reuse.

Irrigation Return Flow: Applied water that is not transpired, evaporated, or deep percolated into a groundwater basin but that returns to a surface water supply.

Land Subsidence: The lowering of the natural land surface in response to: earth movements; lowering of fluid pressure (or lowering of groundwater level); removal of underlying supporting materials by mining or solution of solids, either artificially or from natural causes; compaction caused by wetting (hydrocompaction); oxidation of organic matter in soils; or added load on the land surface.

Leaching: The flushing of salts from the soil by the downward percolation of applied water.

GLOSSARY

Leaching Requirement: The incremental water necessary to prevent harmful salt accumulations in the soil. LR = ETAW X LF DU100 (1-LF) where LF is the leaching fraction.

Mean Annual Runoff: The average value of annual runoff amounts calculated for a selected period of record for a specified area.

Milligrams Per Liter (mg/L): The weight in milligrams of any substance dissolved in one liter of liquid. Nearly the same as parts per million.

Moisture Stress: A condition of physiological stress in a plant caused by a lack of water.

Natural Flow: The flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modifications in land use.

Net Water Demand: The amount of water needed in a water service area to meet all requirements. It is the sum of evapotranspiration of applied water (ETAW) in an area, the irrecoverable losses from the distribution system, and the outflow leaving the service area.

New Water Supply: A surface water supply which has not historically been imported or brought under control and put to beneficial use by recharge of the groundwater or by direct use. New water would include, but not be limited to:

a. Fresno Stream Group water.
b. C.V.P. Class II water not historically diverted (i.e. obligation water subject to spill from Friant Dam).
c. Kings River flood releases from Pine Flat Dam and divertable under existing license conditions and applicable agreements.
d. Fresno County's C.V.P. Cross Valley Supply.
e. Any other water purchased, exchanged, developed or otherwise acquired that did not constitute a part of the historic water supply for the area in question.
f. City of Fresno's C.V.P. Class I Supply. While this is an existing supply, it can be redirected to portions of the City outside of the District, at any time and at the City's sole discretion, and therefore has all the characteristics of new water.

Nonpoint Source: Waste water discharge other than from point sources. (See Point Source).

GLOSSARY

Perched Groundwater: Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater with which it is not hydrostatically connected.

Percolation: The downward movement of water through the soil or alluvium to the groundwater table.

Permeability: The capability of soil or other geologic formation to transmit water.

Point Source: A specific site from which waste or polluted water is discharged into a water body, the source of which can be identified. See also Nonpoint source.

Pollution (of water): The alteration of the physical, chemical, or biological properties of water by the introduction of any substance into water that adversely affects any beneficial use of water.

Recharge Basin: A surface facility, often a large pond, used to increase the infiltration of surface water into a groundwater basin.

Reclaimed Waste Water: Waste water that becomes suitable for a specific beneficial use as a result of treatment.

Return Flow: The portion of withdrawn water not consumed by evapotranspiration or system losses which returns to its source or to another body of water.

Reuse: The additional use of previously used water.

Riparian: of, or on the banks of, a stream or other body of water.

Riparian Vegetation: Vegetation growing on the banks of a stream or other body of water.

Runoff: The surface flow of water from an area; the total volume of surface flow during a specified time.

Safe Yield: The maximum quantity of water that can be withdrawn from a groundwater basin over a long period of time without developing a condition of overdraft. Sometimes referred to as sustained yield.

Salinity: General, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids), electrical conductivity, or osmotic pressure. Where sea water is known to be the major source of salt,

GLOSSARY

salinity is often used to refer to the concentration of chlorides in the water. See also Total Dissolved Solids.

Secondary Treatment: In waste water treatment, the biological process of reducing suspended, colloidal, and dissolved organic matter in effluent from primary treatment systems. Secondary treatment is usually carried out through the use of trickling filters or by the activated sludge process.

Seepage: The gradual movement of a fluid into, through, or from a porous medium.

Service Area: The geographical land area served by a distribution system of a water agency.

Streamflow: The rate of water flow past a specified point in a channel.

Surface Supply: Water supply from streams, lakes and reservoirs.

Tail Water: Applied irrigation water that runs off the end of a field. Tail water is not necessarily lost; it can be collected and reused on the same or adjacent fields.

Tertiary Treatment: In sewage, the additional treatment of effluent beyond that of secondary treatment to obtain a very high quality of effluent.

Total Dissolved Solids: A quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter. Abbreviation: TDS. See also Salinity.

Transpiration: The process in which plant tissues give off water vapor to the atmosphere as an essential physiological process.

Waste Water: The water remaining after use, liquid waste, or drainage from a community, industry, or institution.

Water Conservation: As used in this report, water conservation is the reduction in depletion. This reduction includes the reduction of the evapotranspiration of applied water and irrecoverable losses to salt sinks.

Waste Water Reclamation: The planned reuse of waste water for specific beneficial purposes.

Water Demand Schedule: A time distribution of the demand for prescribed quantities of water for specified purposes. It is usually a monthly tabulation of

GLOSSARY

the total quantity of water that a particular water user intends to use during a specified year.

Water Quality: Used to describe the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose.

Water Reclamation: The treatment of water of impaired quality, including brackish water, waste water, and sea water to produce a water of suitable quality for the intended use.

Water Right: A legally protected right to take possession of water occurring in a natural water way and to divert that water for beneficial use.

Water Year: A continuous 12-month period for which hydrologic records are compiled and summarized. In California, it begins on October 1.

ATTACHMENT F

NOTICES OF DISTRICT EDUCATION PROGRAMS & SERVICES AVAILABLE TO CONSTUMERS

ATTACHMENT F

NOTICES OF DISTRICT EDUCATION PROGRAMS & SERVICES

AVAILABLE TO COSTUMERS

FRESNO IRRIGATION DISTRICT

WATERWAYS

Published for Fresno Irrigation District Water Users *March 2018*

Storm Helps But Short Season Looms

Rain and snow, largely absent this winter, made a big and helpful return to begin March but much more is needed to avoid a return to drought-curtailed surface water supplies during 2018.

Big Water Year Yields Great Value To District

Last year's generous yields of rain and snow created tremendous benefits to Fresno Irrigation District water users and demonstrated why capturing excess run-off is so important in sustaining ground-water. *(Please see related story below.)*

The Fresno Irrigation District was able to divert 600,000 acre-feet of water

(Continued on Page 4)

The winter's first major storm swept into the valley and Sierra Nevada March 1 in marked contrast to earlier events of limited intensity that generated little rain and discouraging amounts of snow.

How the water season will end up will be determined by late winter and spring precipitation yet to fall, but the autumn and early winter months were a complete contrast to 2017's near record water year.

Bill Stretch, FID Assistant General Manager, said the District saved significant carryover storage from last year. *(Please see related story at left)*. "The carryover will help us in making deliveries," he said. District directors will determine when FID's 2018 water run will begin and how long it may last.

(Continued on Page 3)

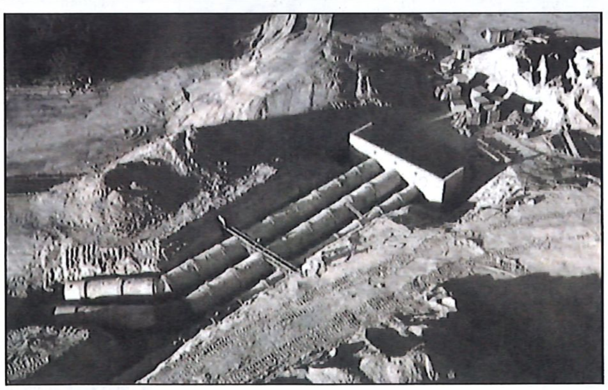
Sustainable Groundwater Act Compliance Continuing

North Kings GSA Steers Plan Efforts

All-out efforts remain on track to frame plans under which compliance will be achieved with California's Sustainable Groundwater Management Act (SGMA).

The North Kings Groundwater Sustainability Agency (GSA), of which the Fresno Irrigation District is a member, continues to frame plans for implementing SGMA.

(Continued on Page 4)



Capturing as much floodwater as possible when it is available is a crucial part of SGMA compliance. These facilities built over the past few months are part of a joint project by the Fresno and James irrigation districts. *(Details and another photo on Page 2.)*

GROWER MEETINGS

Surface Supply, Groundwater Are Main Topics

Three meetings with growers have been scheduled for late March to discuss Fresno Irrigation District's activities and issues.

Topping the agenda will be this winter's return to drought conditions and a much shorter surface water delivery season than normal.

Groundwater will be another important topic. FID leaders will provide updates on implementation of the Sustainable Groundwater Management Act and the plan currently being developed.

All grower meetings are to begin at 8:30 a.m.

They will take place:

- **Friday, March 23 — Easton area,** CPDES Hall, 172 West Jefferson Avenue, Fresno.
- **Tuesday, March 27 — Clovis area,** City Hall, Council Chambers, 1033 Fifth Street, Clovis.
- **Thursday, March 29 — Kerman area,** Kerman Community Center, 15101 West Kearney Boulevard, Kerman.

FID Fights Kern Water Grab Bid

An all-out effort is being mounted by the Fresno Irrigation District, many other Kings River agencies, and three counties seeking to block a south valley district from being able to export Kings floodwater to Kern County.

The Wasco-based Semitropic Water Storage District is seeking such water, upon which the Kings River has been counting as

(Continued on Page 3)

High Speed Rail Impacts FID's Canals

California's High Speed Rail routing and system have been a major political and legal controversy as valley residents have watched Fresno area construction take place, but for the Fresno Irrigation District the project has had significant effects.

Twenty FID facilities, including 25 separate crossings, are involved in High Speed Rail construction now occurring in Fresno County. The rail passenger line is intended to eventually link the San Francisco and Los Angeles areas.

FID's staff has devoted an enormous amount of time and effort over the past few years to meeting with various California High Speed Rail Authority consultants and staffs. The District has reached reimbursement and task order agreements.

High Speed Rail projects include crossings of the Dry Creek, Herndon, Fresno Colony, Central and North Central canals that have either been started or are scheduled to begin later this year. Other crossings are being built or are planned across FID pipelines.

South of Fresno, extensive High Speed Rail right-of-way development is also under way. FID's staff has been working closely with a contractor to ensure all improvements comply with District standards.

This project phase has been accompanied by District groundwater recharge benefits. The contractor has deepened two FID ponds — Ventura and Pursell — and may do the same with Oleander Pond by this summer. Fill material mined from the ponds is being used in construction.

High Speed Rail Authority officials are working with impacted growers on a case-by-case basis to maintain irrigation service. FID facilities relocation in the area may begin after the 2018 irrigation season.

District Completes Numerous Improvements

New Recharge Project Finished Near Kerman

Another major Fresno Irrigation District groundwater recharge facility has been built, this one with the help of a neighboring district.

The Southwest Groundwater Recharge Project was constructed jointly by FID and the San Joaquin-based James Irrigation District. It is one of numerous improvement projects that has been completed.

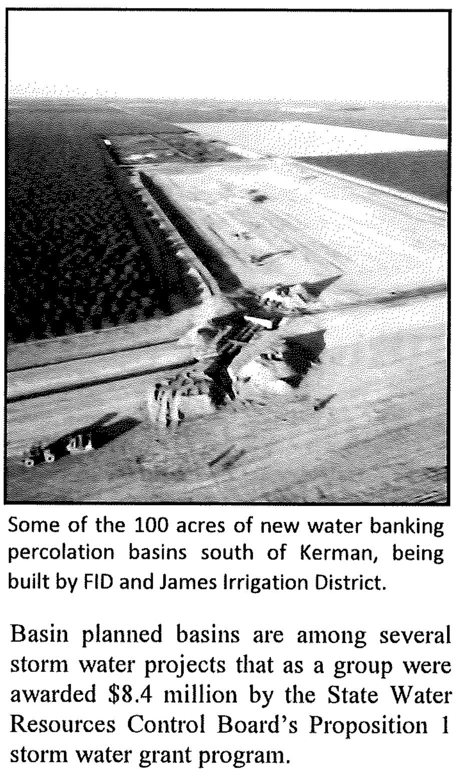
The project was awarded a $3.4 million Department of Water Resources Proposition 84 Integrated Regional Water Management grant as well as a $1 million U.S. Bureau of Reclamation Water Smart grant.

The Southwest Project is located six miles south of Kerman in an area upon which FID has a historical flood right and basin. It is intended to help halt and ultimately reverse a major groundwater overdraft problem in an area west of Raisin City by percolating unused regional floodwater.

Improved in the project were the final three miles of the Lower Dry Creek Canal's channel. A 100-acre groundwater banking site was constructed. FID expects the project to provide an annual average supply of some 5,500 acre-feet.

Three other projects are being planned and designed in the Easton area to improve groundwater supply sustainability.

In partnership with the Fresno Metropolitan Flood Control District, the Central Basin planned basins are among several storm water projects that as a group were awarded $8.4 million by the State Water Resources Control Board's Proposition 1 storm water grant program.



Some of the 100 acres of new water banking percolation basins south of Kerman, being built by FID and James Irrigation District.

FID's groundwater recharge program will consist of a total of 90 acres or recharge basins at three locations and is estimated to provide annual recharge of 2,700 acre-feet.

Other projects completed or in progress by FID staff and/or FID contractors:

CANALS PIPED

- 1,600 feet of canal piped with 21-inch PVC pipe (Anthony No. 399); 1,450 feet of canal piped with 24-inch PVC pipe (Kennedy #2 No. 366).

PIPELINES REPLACED OR SLIP-LINED

- 1,230 feet of 20-inch concrete pipe replaced with 21-inch PVC pipe (Malaga Extension No. 431); 650 feet of 30-inch concrete pipe slip-lined with 24-inch high-density polyethylene (HDPE) pipe (McNeil No. 240).

CANAL LINING

- 400 feet of canal lined with 60 mil high-density polyethylene (HDPE) lining (Briggs No. 7); 870 feet of earthen bottom canal lined on bottom and sides with concrete (Dry Creek No. 75).

WATER LEVEL CONTROL

- Installation of two Langemann Gates (Lower Dry Creek No. 77, Thompson Extension No. 91).

DRAINAGE LINE

- 1,090 feet of 6-inch PVC pipe installed to route seepage water (Enterprise No. 109).

GATE AUTOMATION

- Automate bypass gate at canal head (Dry Creek No. 75).

ALL-WEATHER ROAD

- Three miles of canal bank 15 feet wide were covered using over 700 tons of Class 2 aggregate base (Gould No. 97).

DREDGING

- Five miles of canal were dredged of over 12,000 cubic yards of sediment, removed by a contractor (Lower Dry Creek No. 77).

Urbanization/Development Improvements

CANALS PIPED

- 400 feet of canal piped with 60-inch rubber gasket reinforced concrete pipe (RGRCP) (Bullard No. 124); 770 feet of canal piped with 48-inch RGRCP (Jefferson No. 112).

PIPELINES REPLACED

- 380 feet of 36-inch cast-in-place concrete pipe replaced with 30-inch RGRCP (Clovis No. 115).

CONTROL STRUCTURE

- Check structure constructed as part of new turnout project for Basin NN (Lower Dry Creek No. 77).
- Bridges and culverts expanded by agencies.

Temperance Flat Project Is Advancing

A project aimed at developing the San Joaquin Valley's first new above-ground water storage project in decades is continuing to gain traction.

Temperance Flat Dam and Reservoir would be constructed on the San Joaquin River, upstream from Friant Dam. The new dam would actually be located in the upper end of Millerton Lake.

Fresno Irrigation District officials have much interest in the project, which has the potential to capture much of the San Joaquin River floodwater that is now routinely lost to flood releases from Friant Dam.

The new storage would amount to 1.3 million acre-feet, nearly twice the size of the Central Valley Project's Millerton Lake. It would help provide water supplies needed in many parts of the valley, including water that will be required to make groundwater sustainable as is now required by state law.

FID has been involved in Temperance Flat studies and discussions for decades and has stayed close to activities of the lead agency, the San Joaquin Valley Water Infrastructure Authority (SJVWIA). FID has a contract for up to 75,000 acre-feet of Friant Division-CVP Class 2 water from the San Joaquin River.

The SJVWIA has applied for more than $1 billion in state Water Supply Infrastructure Program funding from Proposition 1 state bond funds passed by voters in 2014.

DRY WINTER

(Continued from Page 1)

Central and southern Sierra Nevada precipitation this winter had been tracking near or slightly below what was observed during the 2014-15 water year when the Kings River recorded its all-time record minimum low total for unimpaired natural runoff (as if there were no dams). That year's total was just over 361,000 acre-feet, a little more than half of what FID delivered or banked in last year's much-above-normal water year.

KERN WATER PLAN

(Continued from Page 1)

the long-term water source and solution for compliance with the new Sustainable Groundwater Management Act (SGMA).

"There are very good reasons why the Fresno Irrigation District is solidly opposed to what this water district in Kern County is trying to do," said Gary Serrato, FID General Manager.

Also opposed are other Kings River agencies, including the Kings River Water Association and Kings River Conservation District, plus the counties of Fresno, Kings and Tulare. "All of us are lined up against Semitropic," said Serrato.

From a water rights standpoint, it is simple — the State Water Resources Control Board decades ago declared the Kings River to be "fully appropriated."

"That means what it says," said Serrato. "All Kings River water has been spoken for and the State of California agrees."

What Semitropic has proposed is rediverting floodwater the Kings River's water agencies are not currently able to use in the biggest water years because not all planned Kings River floodwater-use projects have yet been constructed.

"This floodwater is what all of us on the Kings River are counting on to use to make our region's groundwater sustainable in compliance with SGMA," Serrato said.

Semitropic's purpose is to take this fairly rare and currently surplus floodwater and turn it south through new canals and a 30,000 acre-foot reservoir it wants to build in the old Tulare Lake bed near Kettleman City.

From there, the water would be pumped into the nearby California Aqueduct and conveyed to Semitropic's existing water bank in northwestern Kern County as well as other locations throughout Kern County.

Retrieved groundwater could then be used in Kern County or even be conveyed to water agencies in most parts of Southern California.

Instead of permitting this water to be discharged out the Kings River's North Fork system to the San Joaquin River, Semitropic wants to redivert it down the Kings' South Fork — a much smaller channel — to reach Tulare Lake. Semitropic has provided no plans on how this operation, maintenance and costs would work or be managed.

"What these people want to do is remove water from our counties of origin and essentially be able to send it to Kern County and probably Southern California," said Serrato. "We are going to fight it all the way."

Meanwhile, Semitropic is pursuing $452 million of the $2.7 billion in state Proposition 1 bond revenue under the Water Storage Investment Program (WSIP). The California Water Commission and its staff are currently considering 11 applications to receive funding.

Earlier this year, many FID and Kings River officials, along with central San Joaquin Valley business and civic leaders, appeared before the Water Commission to object strongly to Semi-tropic's application.

FID, Neighboring Districts Counter Grab With Filing

The Fresno, Consolidated, and Alta irrigation districts have countered Semitropic Water Storage District with their own Kings River water filing.

The three districts made their filing with the State Water Resources Control Board.

It requests that the State Board uphold its long-standing decision that the Kings River's waters are fully appropriated to cement their Kings River floodwater uses.

However, should the State Board acquiesce to a filing by Semitropic that the Kings has water available, FID, CID, and AID request that their claims to Kings floodwater use be recognized.

WATERWAYS
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GROUNDWATER PLANS ADVANCE

(Continued from Page 1)

North Kings is a joint powers authority. Along with FID, the GSA includes the Garfield and International water districts; Biola Community Services District; the cities of Fresno, Clovis and Kerman; Fresno County; Bakman Water Company; and Fresno Metropolitan Flood Control District. The website's address is *www.northkingsgsa.org.*

Its organization was completed a year ago in response to SGMA, state legislation that became law in 2014 in response to California's drought and over-reliance upon groundwater.

Local control was assigned by the state to local GSAs such as North Kings. The state recognizes the best controls and uses of water supplies for sustaining groundwater will be designed, implemented and managed locally.

A North Kings groundwater sustainability plan now under development must be completed before the legislated deadline of January 31, 2020.

Regulations developed by the California Department of Water Resources under SGMA describe components required in groundwater sustainability plans as well as intra-basin coordination agreements with the six other Kings Sub-Basin GSAs.

Methods and criteria to be used by DWR to evaluate plans and coordination agreements are also defined. Within the Kings Sub-Basin, it is recognized that major storms resulting in high runoff will have to be relied upon to make the region's aquifer sustainable and provide groundwater needed for conjunctive use when and where surface water is not available.

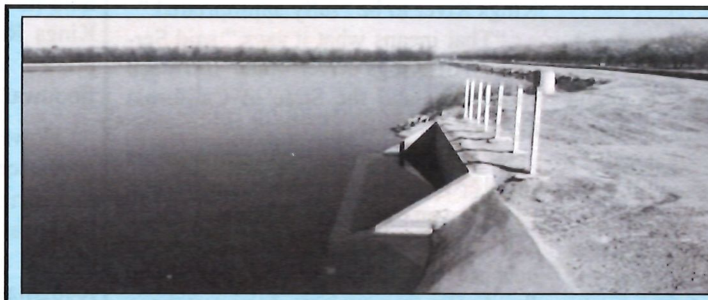
"Through its various surface water resources and several decades of proactive groundwater recharge activities, this portion of the Kings Basin has not experienced significant overdraft conditions experienced elsewhere in the basin," the North Kings GSA says.

"Drought and other challenges, however, have contributed to a gradual decline in overall groundwater conditions."

The North Kings GSA sustainability plan is to address all of the various related issues.

The agency's website provides additional details about the North Kings GSA and its organization. It includes notices of meetings and members of the Board of Directors.

Please see the 'SGMA Update' insert in this *Waterways* issue



FID's Waldron Banking Facility with water from 2016-17.

Big Water Year Shows Need To Capture Runoff

(Continued from Page 1)

in 2016-17 as a result of the longest-ever Fresno Irrigation District water delivery season.

"The level of groundwater rose an average of some three feet across the district and even more in some localities, said Bill Stretch, FID Assistant General Manager. "Extensive water banking and recharge percolation were a significant part of the gain." So was seepage from unlined canals and surface water irrigation into the aquifer. Other gains were achieved by simply not having to rely nearly so much on pumping.

"Last year's storms and runoff demonstrated why we on the Kings River need to capture every available drop of floodwater," Stretch said. "These periodic high flows are really the only tool to make groundwater supplies sustainable as SGMA requires."

The Kings River's calculated full natural flow in 2016-17 was 4,096,865 acre-feet, which ranks third on the Kings River's all-time list. By contrast, the five previous drought years produced a grand total of 3,668,942 acre-feet, the driest such period on record. Groundwater levels in the Kings sub-basin plunged during the five-year span.

FREQUENTLY ASKED QUESTIONS

These are included in an insert in this *Waterways* issue. They provide information on the SGMA legislation and how it may affect growers.

Member of the North Kings Groundwater Sustainability Agency

Insert to the FRESNO IRRIGATION DISTRICT *WATERWAYS* ■ *March 2018*

SGMA Update

Answering Your Groundwater Act Questions

For nearly a century, North Kings GSA members have put great importance on leveraging surface water and groundwater supplies to improve water supply reliability in the region.

The Fresno Irrigation District has a mission statement that includes protecting groundwater resources. FID has invested greatly in that effort.

This has resulted in the development of thousands of acres of groundwater recharge ponds and groundwater banking facilities, in which surplus surface water supplies from the Kings River, federal Central Valley Project-Friant Division, and local streams and runoff (including storm water and floodwater) are captured and utilized to replenish the groundwater aquifer during wet years.

The Cities of Fresno and Clovis have partnered with the Fresno Metropolitan Flood Control District (FMFCD) to utilize existing urban storm basins during the summer and fall months for the sole purpose of recharging surface water supplies.

During a year such as 2017, the North Kings GSA region recharged more than 130,000 acre-feet of water that would have otherwise left the region.

The North Kings GSA will continue to develop projects as we move down the road to groundwater sustainability.

◊

This special FID *Waterways* insert presents updated information and answers frequently asked questions related to the state's new Sustainable Groundwater Management Act (SGMA) that FID and its partnering agencies in the North Kings GSA are working hard to implement.

Sharing Water Resources

Will the North Kings GSA need to share water with its GSA neighbors or within?

The North Kings GSA is not required under SGMA to send some of its water resources to other areas within the Kings Subbasin that do not have enough water to achieve sustainability. Further, SGMA does not require the North Kings GSA to "redistribute" water within the NKGSA from areas with surface water supplies to areas that do not have surface water supplies.

SGMA's Costs

How much is SGMA going to cost growers?

The Groundwater Sustainability Plan (GSP) currently being developed will determine what should be required for the NKGSA to achieve groundwater sustainability by 2040. This may include policies, projects, and programs. Until the GSP is developed, costs are unknown, as well as the types of mecha-nisms for collecting fees (assessments, volumetric extraction costs, etc.). However, with local control, we anticipate SGMA-related fees within North Kings GSA will be significantly less than what the Water Board would charge extractors under State Water Resources Control Board control.

Local Control

What happens if the locals fail?

If local agencies (including Fresno County) and participants fail to bring North Kings GSA and the Kings Subbasin into groundwater sustainability by the statutory milestones and 2040 deadline, the State Water Resources Control Board (Water Board) could step in and regulate groundwater use in our area to achieve sustainability. If this should happen, the Water Board has developed a fee schedule that it would use for every groundwater extraction point (well). Currently, base fees would be $300 per well per year, $10 to $40 per acre-foot of groundwater extracted depending on whether the well is metered or if the basin has a "probationary" status, and $100 per well per year for

(Continued on next page)

Projects

Is the State going to pay for the projects we need for SGMA?

As long as the implementation of SGMA remains under local control, the State will not fund the projects and programs necessary to achieve groundwater sustainability. Costs for these will need to be locally funded by groundwater stakeholders.

Even under State Water Board control, the stakeholders within the North Kings GSA or Kings Subbasin will likely need to fund any projects or program costs that the State determines to be required.

LOCAL CONTROL

(Continued from previous page)

"de minimus" extractors that pump two acre-feet per year or less. On top of these fees, the Water Board would also charge extractors for the cost of the State to develop its own groundwater sustainability plan.

Groundwater and Surface Water Rights

Can my water be taken away?

SGMA itself does not affect groundwater or surface water rights. Local policies and programs such as land use planning may put restrictions on how water can be utilized in various lands.

Land Use Approvals

Will I need approval to change crops or plant a new field?

A goal of the North Kings GSA will be not to affect existing land use, but instead to ensure future development is compatible with the path leading to groundwater sustainability. Farmers are encouraged to continue to make responsible decisions and consider water requirements when determining whether to change crops or develop a new field.

Pumping Restrictions and Land Fallowing

Is someone going to limit how much groundwater I can pump? Will I be required to fallow all or part of my land?

In the North Kings GSA, it is anticipated that neither involuntary restrictions on groundwater pumping nor involuntary land fallowing will be required as long as there is local cooperation among stakeholders, new water supply projects are constructed, and smart, effective water and land use policies are in effect.

Stakeholder Involvement

How do I have a say in the process?

It is crucial that all stakeholders be involved in the SGMA process early on. Every groundwater extractor is a stakeholder who most likely will be affected by SGMA. That includes farmers, municipal and rural residential users, and those in disadvantaged communities. Stakeholders can get involved by participating in North Kings GSA's Advisory Committee and Board of Directors meetings.

Get Involved

The North Kings GSA highly encourages all stakeholders to get involved now in the groundwater sustainability plan (GSP) development process.

Do not wait to be told what the policies, projects and programs require after the GSP is finalized and being implemented. Now is the time to get involved. Start by joining the GSA's mailing list by going to *www.northkingsgsa.org*

North Kings Groundwater Sustainability Agency (GSA) members include the Fresno Irrigation District, the County of Fresno, the City of Fresno, the City of Clovis, the City of Kerman, Biola Community Services District, Garfield Water District, International Water District, Bakman Water Company and the Fresno Metropolitan Flood Control District. The 312,000 - acre North Kings GSA is one of seven GSAs that make up the 979,000 - acre Kings Basin.

***Visit the FID website at* www.fresnoirrigation.com *and North Kings GSA website at* www.northkingsgsa.org**

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AgLine

Crop Water Use

The AgLine information system provides crop water use information for the Kings River service area. Information provided for each crop includes:

- Crop water use for the past 7 days
- Predicted water use for the next 7 days
- Total crop water use season to date

These numbers, updated weekly, can be used to assist growers in irrigation management decisions. AgLine includes crop water use data for 31 cropping cases. To find information on a specific crop, locate the crop on the table below and click on one of the two general categories at the top of the table.

Field and Row Crop Water Use	Tree and Vine Water Use
Alfalfa	Early Almonds
April Beans	Late Almonds
May Beans	Citrus
June Beans	Olives
Corn	Grapes, Single Wire
Early April Cotton	Grapes, 4 ft Crossarm
Mid April Cotton	Kiwis
Early May Cotton	Pistachios
Grain	Apples, Pears, Persimmons
April Melons	Plums, Apricots
May Melons	Low Chilling Stone Fruit
June Melons	Later Variety Stone Fruit, Cherries
July Melons	Early Walnuts
Pasture Grass	Late Walnuts
Safflower	
March Tomatoes	
April Tomatoes	

Origin of AgLine Data

AgLine's crop water use data is derived from the California Irrigation Management Information System (CIMIS) station located in Parlier. The CIMIS station provides "reference evapotranspiration" (ETo) with grass as the reference crop.

Given the weather conditions, Grass Reference ETo approximates the amount of water used by healthy, well-maintained grass. Each week, the **Grass Reference ETo** data is downloaded and entered into a spreadsheet.

The water use for each crop (ETc) is calculated by multiplying the ETo by the crop coefficient (Kc) according to the following formula

$$ETc = ETo * Kc$$

Kc values are factors that correlate the ETo to each crop. Kc varies by crop type, time of year, and cultural practices. Values used by AgLine have been adjusted to match crop water use and grower practices in the Kings River service area.

For more information about crop curves or how reference evapotranspiration is obtained, please visit the CIMIS website at **www.cimis.water.ca.gov**.

Powdery Mildew Index

Information about the Powdery Mildew Index can be obtained from **www.calagquest.com**.

4886 East Jensen Avenue
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- HOME
- ABOUT APEP
  - Eligibility
  - Other Efficiency Programs
  - Contact APEP
- PUMP TESTING
  - How to Get a Pump Test
  - Technical Advisory
  - Pump Testers
  - Becoming a Pump Tester
- INCENTIVE REBATES

The Advanced Pumping Efficiency Program (APEP) is an educational and incentive program intended to improve overall pumping efficiency and encourage energy conservation in California.

IMPORTANT! There are major changes to APEP Policies and Procedures regarding project eligibility and calculation of incentives that become effective January 1, 2018. Applications received on or after January 1, 2018, will be processed with the new Policies and Procedures.

An acceptable application package consists of:
1. the signed and completed (as much as possible) application form
2. a copy of at least the pre-project pump efficiency test

The changes are summarized in the table below but please read the APEP Policies and Procedures Manual for a complete explanation. If you have any questions regarding your project's eligibility or the estimated

Search ...

Events Calendar

Quick Links

- Fact Sheet
- Policies/Procedure Manual
- Technical Advisory
- Pump Testers
- Application Procedure

Center for Irrigation Technology
California State University, Fresno
5370 North Chestnut Ave M/S OF18
Fresno, CA 93740
Phone: 559.278.2066

- Application Procedure
- EDUCATION/EVENTS
  - Four Key Points
  - Seminars/Mobile Education
  - Wateright
  - E-Learning Module
- PUBLICATIONS/RESOURCES
  - APEP Literature
  - Videos
  - Links

incentive that might be available, please call the APEP main office at 800 845-6038.

APEP Policy Component	Old Policy	New Policy
NEW!!! Pre-Project Pump Test OPE Cutoffs for Eligibility (there will be cutoffs developed for natural gas-powered pumps at a later time)	None - Pump must be operational.	From the pre-project pump efficiency test (applies to submersible pumps also): Low OPE Cutoffs (ineligible below these) For Ag (including irrigation/water districts): 30% For Muni (including golf courses/cemeteries/athletic fields): 40% High OPE Cutoffs (ineligible above these) For Ag: 55% For Muni: 65% Note that regardless of what the pre-project pump test indicates the pump must still be operational at the time of the retrofit.
Energy Savings Calculation	If pre-project OPE is calculated and below 50% then a deemed 25% of Annual Energy Use is credited. Otherwise the actual improvement in OPE (or kWh/AF as applicable) is applied against the Annual Energy Use.	Actual improvement in OPE (or kWh/AF as applicable) applied against the Annual Energy Use. There is a cap on energy savings of 30% of Annual Energy Use.
Incentive Calculation Performance Metric	OPE unless OPE is not calculated on either or both of the pre-/post-project pump tests, then use kWh/AF.	OPE, unless not calculated using a measured Pumping Water Level or if Total Dynamic Head on the pre-/post-project tests vary by more than +/- 10%- then kWh/AF will be used.
Definition of "Annual Energy Use" as Used for Calculation of Incentive	Generally the energy use in the calendar year previous to the project year - except read full statement in APEP Policies and Procedures	Whenever possible it will be the average of the three calendar years prior to the project year. If a new account or change in ownership along with a change in crop or irrigation system it may be a shorter period - refer to full statement in new APEP Policies and Procedures.
Application Assistance Fee	Currently $300 for signed applications dated after 1/31/2017	50% of the incentive capped at $300 (e.g. incentive = $400, AA Fee = $200; incentive = $1,000, AA Fee = $300)
Pump Efficiency Testing for pumps controlled by VFDs - APEP Pump Testers only	No requirements	Pump should be tested at 100% speed when possible, VFD frequency must be noted in the Notes section whenever possible

Pacific Gas and Electric Company (PG&E) is funding APEP through 2019 using Public Purpose Programs Funds under the auspices of the California Public Utilities Commission (CPUC). The Center for Irrigation Technology (CIT) at California State University, Fresno administers the program.

From 2002 through 2017 CIT has operated APEP with funding from the CPUC and provided California water pumpers with approximately:

- 2,875 pump retrofit / repair rebates
- $13,350,000 in incentive rebates for those projects
- 158,220,000 kilowatt-hours in net, first-year electrical energy savings
- 238,000 therms in net, first-year natural gas energy savings
- 49,925 subsidized pump efficiency tests ($11,000,000 in subsidies)
- 272 educational seminars

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FRESNO IRRIGATION DISTRICT

CA DWR AGRICULTURAL WATER MANAGEMENT PLAN

NOVEMBER 2020

DROUGHT MANAGEMENT PLAN

As Required Under Executive Order B-29-15

FRESNO IRRIGATION DISTRICT

DROUGHT MANAGEMENT PLAN

ADDITIONAL DOCUMENTATION AS REQUIRED BY
STATE OF CALIFORNIA EXECUTIVE ORDER B-29-15
TO ACCOMPANY
FRESNO IRRIGATION DISTRICT'S WATER MANAGEMENT PLAN
PREPARED FOR THE U.S. BUREAU OF RECLAMATION
IN COMPLIANCE WITH 2011 STANDARD CRITERIA

SUBMITTED TO:
CALIFORNIA DEPARTMENT OF WATER RESOURCES
DIVISION OF STATEWIDE INTEGRATED WATER MANAGEMENT
WATER USE AND EFFICIENCY BRANCH

FEBRUARY 17, 2016

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1 – Fresno Irrigation District Rules and Regulations

1 – INTRODUCTION / BACKGROUND

Purpose of Drought Management Plan

Governor Brown issued Executive Order B-29-15 (Executive Order) on April 1, 2015, directing agricultural water suppliers to include a detailed drought management plan that describes the actions and measures the supplier will take to manage water demand during drought. The Drought Management Plan is to also detail how water suppliers prepare for droughts and manage water supplies and allocations during drought conditions. This document is intended to serve as this additional documentation that Fresno Irrigation District (FID or District) must include with the United States Bureau of Reclamation (USBR) water management plan and submit to the California Department of Water Resources (DWR) to document compliance with specified requirements of this Executive Order.

As a USBR Central Valley Project contractor, the District is required by the USBR to prepare a water management plan (WMP) in accordance with criteria established by USBR, typically on a 5-year schedule. Most recently, the USBR accepted a District 5-year updated WMP in compliance with the 2011 Standard Criteria on February 1, 2016. The District also prepares annual updates each year in compliance with USBR criteria.

Senate Bill X7-7 (SBx7-7), the Water Conservation Act of 2009, mandated water conservation and measurement and reporting activities for certain agricultural water suppliers, including the preparation of water management plans in 2012, 2015 and every five years thereafter. The provisions of SBx7-7 were incorporated in the California Water Code, and Water Code §10828 allows agricultural water suppliers subject to the USBR CVPIA/RRA water management/conservation plan process to submit their USBR plan along with additional documentation to the California Department of Water Resources (DWR) to comply with SBx7-7. DWR will accept USBR water management plans that have been accepted as adequate by the USBR to satisfy the SBx7-7 requirement for preparation of an Agricultural Water Management Plan (AWMP). The District also prepared a Supplementary Report to accompany the USBR water management plan to document the additional information required by DWR as part of SBx7-7. With the recent Executive Order, a Drought Management Plan must also accompany the USBR water management plan and Supplementary Report when submitted to the DWR as part of the AWMP.

The Executive Order mandates that “agricultural water suppliers that supply water to more than 25,000 acres shall include in their required 2015 Agricultural Water Management Plans a detailed drought management plan that describes the actions and measures the supplier will take to manage water demand during drought”. Since the District will ultimately satisfy the requirements of SBx7-7 for submitting an Agricultural Water Management Plan to the DWR by submitting the water management plan (accepted by the USBR on February 1, 2016) and the SBx7-7 Supplement Report, this Drought Management Plan was prepared to be included with the submittal to the DWR to satisfy Executive Order B-29-15.

District Background

FID is a public irrigation district located in Fresno County in the geographic center of the San Joaquin Valley. The District is primarily agricultural, but includes the growing metropolitan area of the cities of Fresno and Clovis. The District was formed in 1920 under the California Irrigation Districts Act as successor to the privately owned Fresno Canal and Irrigation Company. The District comprises approximately 247,600 gross acres, with approximately 152,500 acres currently able to receive irrigation water from the District.

In a typical year, FID diverts approximately 500,000 acre-feet of water and delivers most of that to agricultural users, although a portion of the water supply is used for groundwater recharge and for use at surface water treatment facilities owned by the cities of Fresno and Clovis. The District does not supply any urban water. The primary water source for the District is Kings River water, but the District also has a contract with the U.S. Bureau of Reclamation (USBR) for 75,000 acre-feet (AF) of Class 2 water allocations from the Friant Division of the Central Valley Project (CVP), which is received in above normal water years up to the contract amount. The District water supply can be highly variable, ranging from less than 250,000 AF in drier years to over 600,000 AF in wetter years. The District typically delivers irrigation water during the months of April through August, but in water short years the irrigation delivery season may be much shorter. During the recent extended drought, the irrigation delivery season lasted two months in 2014 and as little as two weeks in 2015. The District currently collects the majority of its revenue from assessments that are levied on a per acre basis.

The District is a conjunctive use district, and water users in the District use both surface water from the District and private groundwater to supplement the surface water supply. The District is usually only able to supply a portion of the annual crop water needs of the typical grower in most years, and most growers must pump groundwater from privately owned wells to supply the remaining crop water demand when surface water is not available. The District delivery system is comprised of pipelines and canals, and many of the canals are unlined to allow seepage from the canals to help recharge the underground water supply. During above normal water years the District also delivers water to basins and other recharge areas to promote groundwater recharge. During dry years the water that was previously stored as groundwater is available to be pumped by growers for irrigation. The District also has some wells near District groundwater banking facilities that can be pumped to help supplement the District water supply or be marketed to others. The District is one of nine public agencies (along with one private water company) in and surrounding the Fresno-Clovis metropolitan area that participated in preparation of the Fresno Area Regional Groundwater Management Plan and continues as a participant in preparation of annual monitoring reports.

The District delivery system is used to deliver water to the growers as well as recharge the groundwater. During wet years the District also delivers water to dedicated recharge areas to promote groundwater recharge. During dry years the water that was previously stored as groundwater is available to be pumped by growers for irrigation. The District has constructed and operates four groundwater banking facilities and is currently in the process of developing an additional facility. These facilities have allowed the District to greatly expand its conjunctive use capability. During wet years with increased surface water supplies, the District is able to recharge additional water to replenish the groundwater at these facilities. During dry years with reduced surface water supplies, the District can operate the wells at the groundwater banking facilities to supplement the District's reduced surface water supplies. The District also operates many other recharge basins, where water is allowed to percolate into the underground where private wells in the area can pump the water for irrigation purposes. Seepage from the unlined canals within the District distribution system also contribute to groundwater recharge, which is beneficial for a conjunctive use district like FID.

2 – WATER SHORTAGE ALLOCATION PRACTICES & POLICIES

Existing FID Practices and Policies

Being a conjunctive use district, the majority of farmers within FID have the opportunity to receive FID surface water supplies and then supplement the surface water with groundwater supplies utilizing private groundwater wells. In most years, there is usually more demand for surface water than there is supply, so proper water management is critical. The amount of surface water available to farmers from FID varies each year and is dependent on hydrologic conditions in the Kings River watershed (FID's primary source of surface water) and the San Joaquin River watershed for Friant Class 2 water (FID's supplemental source of surface water). Groundwater use and supplies within FID are not regulated and farmers are able to pump the amount of groundwater needed to supplement FID surface water supplies. In general, groundwater pumping increases in dry years and decreases in wet years.

As the District's primary water supply is dependent upon precipitation received in the Kings River watershed, the annual available water supply is difficult to predict, especially early in the year. The majority of the water is stored within the snowpack in the Sierra Nevada Mountains, with spring and summer snow melt flowing into Pine flat Reservoir. The District is allocated a percentage of the water collected and stored at Pine Flat Reservoir based upon a water schedule administered by the Kings River Water Association (KRWA). If global climate change predictions indicating less precipitation as snow and more as rainfall are correct, then increased reservoir storage will be essential in the future to capture water for beneficial use.

As a CVP contractor in the Friant Division, the District's annual water supply allocation is determined by the USBR, and the District has virtually no ability to change the available water supply for a given year other than to carryover some water from the previous year. The USBR typically makes an initial water supply allocation in late January, and will adjust the allocation as the water year progresses if warranted by the snow pack and projected water supply. The final water supply allocation available to the District is often not known until July. Although the Friant Class 2 water is supplementary to the Kings River supply, each time the water supply allocation is changed by the USBR, the District will notify all water users so they can plan accordingly.

The water delivery season is established by the District's Board of Directors based on the surface water supply available that year. During the water delivery season, the District delivers water according to minimum entitlement requirements under Rule 5 of the District Rules and Regulations (attached). Based on the water supply declared or allocated by the USBR and the Kings River Watermaster (Kings River Water Association, discussed later), the water delivery season is established to equitably distribute the available water supply. Wet years provide for longer water delivery seasons than in dry years. Since the District is a conjunctive use district, individual growers can and do use groundwater to meet their water needs that are not met by surface water supplies. Canals can be used to transport groundwater, when capacity allows for it.

In general, FID delivers surface water to customers using a water scheduling system during the District's water delivery season (which typically varies in duration, start date, and end date each year). Each parcel that receives FID surface water has a designated day (or days) per month when it is able to receive FID water. FID's system is generally operated on a 15-day, 21-day, or 30-day rotation basis, with each acre receiving a monthly minimum allotment of 0.39 AF per acre per month (Rule 5). Approximately 60% of the acreage in FID is on a modified, 15-day rotation schedule receiving half the basic allotment twice each month. FID has also adopted rules allowing for flexible schedules by growers. By switching the days they take water, growers can alter schedules within their canal systems as long as they do not impact canal operations and other growers. A portion of FID (Area 112, approximately 10% of FID) operates under an arranged demand schedule, which allows further grower flexibility

In addition, the District has established several rules that address wasteful use of water and enforcement methods. Rules 29 and 30 of the District Rules and Regulations provides for the District to refuse further water service to water users who waste water delivered by the District until such conditions are remedied.

Recent FID Surface Water Shortages

The 2014 and 2015 water delivery seasons are examples of how the District allocates reduced water supplies during extremely dry years. The 2014-15 water year on the Kings River was the driest on record at only 21.5% of the average annual runoff, and cumulatively the past two water years have also been the driest on record. Additionally, the past four water years, 2011-12 to 2014-15, cumulatively are the driest 4-year period on record at only 36% of the average annual runoff. As such, the District has been practicing drought management for several years in a row.

In spring of 2014, the District determined that it had enough surface water supplies to deliver water to its customers for approximately two peak irrigation months in the summer. The District's Board of Directors approved a two month irrigation delivery season that started on June 1 and went through the end of July. While water users typically have irrigation water demands prior to June and after July each year, the Board recognized the need to minimize negative impacts to the groundwater conditions due to widespread private groundwater pumping, and thus decided to deliver water to users during the period of greatest irrigation water demand. Due to declining groundwater levels within the District, FID made the decision to stop operating its groundwater banking facility recovery wells after operating them for a short period of time. These wells were being used to pump banked water to supplement reduced surface water supplies, but the District did not want to contribute to declining groundwater levels in the vicinity of its groundwater banking facilities.

In 2015, the District experienced even further reduced surface water supplies compared to that of 2014. In spring of 2015, the District forecasted that there would not be enough surface water available to make equitable deliveries to users for even one irrigation. In such an event, the District was preparing to only convey water to groundwater recharge facilities (including earthen canals) to lessen the impact that private groundwater pumping would have on groundwater conditions. However, significant thunderstorms in the Kings River watershed within the Sierra Nevada Mountains during the spring months increased FID supplies enough to have a two-week water delivery season and provide lands that receive FID surface water with at least one irrigation. In such a situation, equity was maintained by having water users receive water from FID using the standard FID water schedule (day(s) of month) at their normal flow rate but for half the duration (e.g., 12 hours instead of 24 hours). During 2015, FID did not operate its groundwater banking wells in an effort to protect groundwater conditions.

Prior to the start of the 2015 irrigation season, the District mailed letters to customers explaining the water conditions and the anticipated water delivery season scheduling and duration. For the first time, locks and explanatory tags were added to all turnout control valves to discourage water theft.

3 – DROUGHT MANAGEMENT PLAN

Hydrology and Monitoring

FID has surface water supplies originating from the Kings River watershed and from the San Joaquin River watershed (via its CVP Class 2 contract). Each year, the USBR makes the final allocation determination as to how much CVP Class 2 supplies will be available to FID, if any. Due in large part to the recent drought, the San Joaquin River Restoration Program, and reduced CVP water supplies available to the San Joaquin River Exchange Contractors, FID has not received any CVP Class 2 supplies during the current drought. Thus, FID's primary surface water supply during droughts has typically been solely the Kings River.

FID is one of 28 member agencies of the Kings River Water Association (KRWA), which oversees Kings River water entitlements and deliveries to its members, including member storage within Pine Flat Reservoir on the Kings River. KRWA monitors and measures Pine Flat Reservoir inflow, outflow, and storage, flows at numerous locations along the Kings River, as well as member diversions off the Kings River. KRWA, in cooperation with the DWR, performs snowpack surveys throughout the Kings River watershed several times each year to estimate the amount of runoff and member entitlements. KRWA has also constructed several remote snow measurement stations within the watershed. Combined with watershed runoff forecast models from the DWR, FID uses this information to develop irrigation water delivery season scenario forecasts in winter and early spring to prepare and plan for expected irrigation delivery season duration and timing based on the estimated water supply.

As part of the Kings River Fisheries Management Program, voluntarily and cooperatively formed by the Kings River Conservation District, KRWA, and California Department of Fish and Game, several requirements are placed on Pine Flat Reservoir and Kings River operations. These operational requirements include maintaining a minimum 100,000 acre-foot Pine Flat Reservoir temperature control pool (10% of the reservoir's capacity) and minimum fish flow water releases below Pine Flat Dam. Through an existing agreement, FID alternates with a neighboring irrigation district each year in taking the responsibility for providing this fish flow below the dam out of its own water supply. During dry years, the KRWA member agencies struggle to maintain the temperature control pool and minimum fish flows, and must often collaborate together to meet these fishery requirements.

FID also performs groundwater level monitoring throughout the District. The District measures groundwater levels at approximately 60 well locations on a semi-annual basis. This information is used to develop FID's own annual groundwater reports as well as annual Fresno Area Regional Groundwater Management Group reports. The Fresno Area Regional Groundwater Management Group consists of nine public agencies and one private water company in the Fresno-Clovis Metropolitan Area (including FID) that adopted an SB 1938-compliant groundwater management plan in 2006. These annual reports are used to evaluate groundwater supply conditions in the region and assist FID and other agencies with optimizing surface water use to protect groundwater supplies since groundwater use is not regulated within FID.

Water Shortage Allocations

As previously discussed in Chapter 2, FID does not have a formal water shortage allocation policy, but with FID's current practice of establishing water delivery season timing and duration based on available surface water supplies to maximize benefits to its users and protection of groundwater resources, the purpose of such a policy is achieved.

The water delivery season is established by the District's Board of Directors based on the surface water supply available that year. During the water delivery season, the District delivers water according to minimum entitlement requirements under Rule 5 of the District Rules and Regulations (attached). Based on the water supply declared or allocated by the USBR and the Kings River Watermaster (Kings River Water Association, previously discussed), the water delivery season is established to equitably distribute the available water supply. Since the District is a conjunctive use district and groundwater use is not regulated within FID, individual growers can and do use groundwater to meet their water needs that are not met by surface water supplies.

Before the irrigation delivery season in winter and early spring, FID performs water supply scenario modeling to estimate irrigation delivery season duration and timing. This modeling continues throughout the irrigation delivery season as FID's stored water supply is diverted and runoff into Pine Flat Reservoir decreases as the snowpack decreases.

Operational Adjustments

During prolong droughts, such as the one experienced from 2011 through 2015, FID will make adjustments to its operations and water management. Since water users within FID will continue to pump groundwater to supplement a lack of surface water available from FID, the District makes all reasonable attempts to provide as much surface water as possible to its customers. This would include conveying as much surface water as possible directly to customers and avoid sending water to groundwater recharge facilities. This not only reduces the effective cost of water the growers experience through reduced groundwater pumping, but also helps protect groundwater supplies in the region.

Drought conditions also add challenges to operating the Kings River Fisheries Management Program. KRWA must coordinate and collaborate with each of its members to ensure that enough water remains in Pine Flat Reservoir to maintain the required temperate control pool (minimum reservoir water level). Further, FID alternates each year with Consolidated Irrigation District (CID) in being responsible for providing the required fishery flows downstream of Pine Flat Dam any given year, and must plan to hold back enough water in the reservoir to be able to provide such fishery flows. Both the temperature control pool and fishery flow requirements necessitate intense collaboration amongst KRWA members to ensure sustainability of the fishery program during drought conditions.

Demand Management

FID encourages growers within the District to improve irrigation efficiency and on-farm water management, especially during droughts. This includes utilizing available surface water instead of pumping groundwater. However, when FID has reduced water supplies available to growers, growers will increase groundwater use to supplement the reduced surface water supplies. Groundwater is not regulated within the boundaries of the District. The FID service area suffers from an average annual overdraft of the groundwater basin so use of available surface water is encouraged within the service area.

While FID cannot directly manage irrigation demands within the District, it does provide assistance to growers to improve irrigation efficiency. A growing number of water users within the District are transitioning from surface irrigation to drip/micro irrigation systems, which are more efficient in delivering and controlling water but also impact groundwater recharge which is needed in a conjunctive use district like FID. These systems generally require a continuous low flow water delivery to the irrigation systems, instead of FID’s standard rotation schedule. To accommodate these water users, the District allows users to obtain a low flow delivery license from the District as long as impacts to other water users on the District facility can be avoided. Some drip/micro irrigation water users within the District are able to remain on the standard rotation schedule by constructing on-farm reservoirs to store water between District deliveries.

In addition, FID helps connect growers with organizations that perform on-farm irrigation efficiency evaluations, including the Kings River Conservation District (KRCD) and the Irrigation Training & Research Center (ITRC) at California State Polytechnic University San Luis Obispo. FID typically provides names to the ITRC of potential farmers who might be interested in on-farm irrigation evaluations. The list is developed through recommendations from District water operators who have frequent interaction with farmers, and consists primarily of those on micro-irrigation. The District also includes notices regarding these evaluation services in its newsletters.

Further, FID’s current assessment rate structure provides a level of incentive pricing to encourage higher levels of irrigation efficiency. Most growers within FID pay an annual acreage-based assessment to receive FID surface water. In general, FID customers receive more FID surface water during wet years than in dry years. Thus, under FID's current rate structure, the effective volumetric cost for FID water is lower in wet years (encouraging surface water use) and higher in dry years (encouraging water conservation). Generally, during most years, groundwater within FID is more expensive to use than FID's surface water, which is by design to keep growers from switching from surface water to groundwater.

Incentive pricing, or tiered water pricing, in its traditional sense is meant to encourage reducing the amount of applied surface water, but this is counterproductive in a conjunctive use district like FID where you want to encourage the use of as much surface water as possible. With the District relying on its conjunctive use methods to maintain groundwater levels, incentive pricing to use less surface water may come at the expense of increased electrical use and/or depleted groundwater tables. Growers must supplement surface water supplies with their own groundwater pumps, but the District's new banking facility wells can also supply growers with recovered water during dry years. In lieu of groundwater pumping, growers can purchase extra water, such as Section 215 water (CVP flood water), when it becomes available. Another option available to each grower is that he can use only pumped groundwater, if it is cheaper, but he must still pay for his allocation or transfer it to another grower. In most cases, pumping groundwater is more expensive than using surface water, therefore, incentive pricing exists to avoid the higher priced water supply. Additionally, since the surface water supply is not enough to fully meet crop evapotranspiration requirements, incentive pricing exists to conserve water to minimize use of the more expensive groundwater. To the extent this is accomplished, the purpose of having an incentive price program is achieved.

Dry Year Alternative Water Supplies

As previously discussed, FID's primary water supply has historically been the Kings River. FID is also a CVP Class II contractor, but little to no CVP Class II water is available to contractors during droughts. However, FID does have access to treated or recycled urban wastewater each year which can be delivered to growers or groundwater recharge facilities. The volume of recycled urban wastewater available to FID is for the most part independent of type of hydrologic year.

Urban wastewater from the Fresno-Clovis Wastewater Treatment Plant within the District's service area is treated, recycled, and put in percolation basins to recharge the groundwater basin, as permitted by the Regional Water Quality Control Board. This water is then pumped by private water users for agricultural production. Some of this recharged water, by prior agreement, is pumped as groundwater into the District's conveyance system for use by agricultural water users. Further, tertiary treated urban wastewater is received by FID from the Clovis Treatment Plant by prior arrangement as permitted by the Regional Water Quality Control Board. This water is placed in the District's conveyance system for use by agricultural water users. Combined, FID typically receives around 30,000 AF/year of recycled urban waste water that is delivered to FID growers for irrigation use.

FID's groundwater banking facilities also provide dry year water supplies. During the past 10 years, FID has constructed and operated four groundwater banking facilities that combined can provide an estimated average annual water supply of approximately 14,000 acre-feet. FID is currently in the process of developing a fifth groundwater bank to further increase the supplemental water supply when needed. Stormwater, floodwater, and surplus wet year water supplies are conveyed to these banking facilities for groundwater banking, and recovery wells are used during dry years to recover this banked water back into FID's conveyance system for delivery to customers. However, as previously discussed, FID made the decision to curtail recovery well operations in 2014 and to not operate its recovery wells in 2015 in an effort to not further harm the already declining groundwater levels seen throughout the region.

As a CVP Class II contractor, FID does have the potential to purchase or exchange water from other CVP contractors if such water is available. During the recent drought, however, very little if any Class I water was available to contractors leading to a very limited CVP water market along the Friant-Kern Canal for FID.

Stages of Actions

Due to the readily available groundwater supply that most growers have access to in order to supplement reduced surface water supplies, the District is limited in its ability to impose drought-related actions or regulations on its customers. As previously discussed, groundwater use is not regulated within FID and growers will pump groundwater to supplement reduced surface water supplies. Implementing restrictions on surface water use, whether through required use reductions or higher water costs, will put more demand and stress on groundwater supplies, and would not achieve the water use reduction ultimately desired. The best course of action for FID during a drought is to equitably distribute the available surface water supply during the peak summer demand period.

Coordination and Collaboration

As previously discussed, careful coordination and collaboration between Kings River users through KRWA must occur during droughts in order to manage Pine Flat Reservoir storage, entitlements, and the Kings River Fisheries Management Program. During the winter and spring months, KRWA conducts snow surveys and runoff modeling to estimate the amount of runoff that will enter Pine Flat Reservoir and when this runoff is anticipated to occur. This helps the member agencies estimate how much water they will be entitled to and start planning that year's irrigation deliveries. During drought years, districts such as FID and CID may enter into cooperative agreements to ensure fishery and other environmental constraints are met if individual districts have extremely limited surface water supplies available for fishery program purposes.

FID also collaborates with the cities of Fresno and Clovis during drought years to maximize surface water use and minimize groundwater extraction. While the two cities have constructed surface water treatment facilities to utilize their FID water allocations, the cities are still greatly dependent on groundwater resources for urban water supply. With limited surface water supplies available from FID during droughts, FID highly encourages the cities to receive all of their FID surface water supplies at their surface water treatment facilities and curtail sending this water to their groundwater recharge ponds. This concept minimizes the use of, and impacts to, the region's groundwater supply.

Revenue and Expenditures

FID utilizes a per-acre assessment charge for its billing rate structure in most cases. This provides for a stable District revenue regardless of the amount of water delivered to its customers. The District's four developed groundwater banking facilities were constructed for dry year water supply, and can provide FID increased water exchange and marketing opportunities during droughts. Revenue from water banking exchanges and marketing is used to fund the banks' operations and to develop additional banking facilities and improvements that can provide further new dry year water supplies to the region. FID will be implementing a revised rate structure in the future to include collecting a portion of revenue through a volumetric delivery charge as required by SBx7-7.

FRESNO IRRIGATION DISTRICT

DROUGHT MANAGEMENT PLAN

ATTACHMENT 1

FRESNO IRRIGATION DISTRICT RULES AND REGULATIONS